Appendix 11F
Substantive BDCP Revisions

Appendix 11F
Substantive BDCP Revisions

11F.1 Introduction and Background

This appendix presents substantive revisions to the BDCP that were made subsequent to publication of the public draft (November 2013). These revisions, which were made to address key comments and ongoing coordination with agencies and stakeholders, are reflected in the analysis of Alternative 4 in the RDEIR/SDEIS, and where applicable in Alternatives 4A, 2D, and 5A.

This appendix also presents revisions to the BDCP that were made to ensure consistency with the draft Implementation Agreement released in May 2014.

Revisions are presented in redline/strikeout format. Section numbering and titles from the public draft have been retained. Where large blocks are unchanged, the text has been omitted and replaced with the following text [unchanged text omitted], except in the case of biological goals and objectives for greater sandhill crane, and revised avoidance and minimization measures. For biological goals and objectives for sandhill crane, and substantively revised avoidance and minimize measures, the entire text of the goal, objective, or measure has been provided to aid readers. Explanatory text specific to this appendix (i.e., not excerpted from the BDCP) is shown in underline.

As mentioned above, most of the revisions presented below would also be applicable to Alternatives 4A, 2D, and 5A. Other than differences in acreages, the Environmental Commitments will be implemented in the same manner as outlined in the Conservation Measures presented below and in the Draft BDCP (see Section 4.1.2.3 of this RDEIR/SDEIS). Though the language below is written specifically for the BDCP and often refers to specific timing and processes under the Plan, the general substance of these measures and analyses are still applicable to Alternatives 4A, 2D, and 5A despite differences in terminology. Where the term Conservation Measure is used below it is equivalent to the corresponding Environmental Commitment (e.g., Conservation Measure 4 is the equivalent of Environmental Commitment 4).

11F.1.1 Use of CM3–CM11 to Offset Effects Associated with CM1

In various parts of the EIR/EIS analysis, activities proposed under CM3–CM11 are referenced as beneficial elements that serve to offset adverse effects associated with CM1, thereby functioning as *de facto* CEQA and NEPA mitigation measures with respect to those effects. Additional details about early implementation projects are provided below to provide examples in support of the types of habitat restoration, enhancement, and protection actions that could occur under CM3-CM11 as referenced throughout the RDEIR/SDEIS.

The projects below, which are also listed in Table 6-4, *Interim Implementation Actions: Restoration Projects with Potential to Contribute to Meeting BDCP Requirements,* of the Draft BDCP, are consistent with the goals and activities described for CM3–CM11. They have already undergone CEQA/NEPA review independent of this process and received approval, and accordingly provide meaningful examples of the activities that would be credited towards implementation of CM3–CM11.

11F.1.1.1 Lower Yolo Ranch Tidal Restoration Project

The Lower Yolo Ranch Tidal Restoration Project has two primary goals. First, it will create about 1,226 acres of tidal marsh and enhance 34 acres of nontidal marsh, and it will enhance about 174 acres of existing seasonal wetlands, 10 acres of tidal wetlands, and 59 acres of riparian areas.

Second, it is intended to partially fulfill DWR's and Reclamation's federal permit obligations, which require those agencies to create or restore at least 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh, as set forth in the U.S. Fish and Wildlife Service (USFWS) Delta Smelt BiOp (U.S. Fish and Wildlife Service 2008) and as referenced in the National Marine Fisheries Service (NMFS) Salmonid BiOp (National Marine Fisheries Service 2009) for coordinated operations of the SWP and CVP. This project would contribute 1,305 acres of wetland creation, 700 acres of wetland enhancement and 50 acres of riparian enhancement towards meeting BDCP requirements. These goals are consistent with CM4 and CM7.

The overall intent of CM4 *Tidal Natural Communities Restoration* is to develop a broadly distributed mosaic of restored tidal natural communities that address the foraging needs of covered fish species by increasing habitat suitability. Large-scale restoration of tidal natural communities is expected to generate emergent benefits (i.e., benefits that are more than the sum of their individual parts) as the area of restored tidal natural communities increases through implementation of individual restoration projects. Additionally, tidal wetland restoration will provide a broad range of habitat features, such as tidal channels within wetlands. The Lower Yolo Ranch Tidal Restoration Project could contribute up to 1,226 acres of tidal marsh and 10 acres of tidal wetlands towards CM4's goal of restoring 65,000 acres of freshwater and brackish tidal habitat, of which at least 55,000 acres is to be tidal perennial aquatic, tidal mudflat, tidal freshwater emergent wetland, and tidal brackish emergent wetland natural communities.

CM7 *Riparian Natural Community Restoration* will restore valley/foothill riparian natural community by implementing site-specific restoration projects for Swainson's hawk, white-tailed kite, valley elderberry longhorn beetle, riparian woodrat, and riparian brush rabbit. The 59 acres of enhanced riparian areas from the Lower Yolo Ranch Tidal Restoration Project would contribute to this goal of restoring 5,000 acres of riparian forest and scrub.

11F.1.1.2 Dutch Slough Tidal Marsh Restoration Project

The Dutch Slough Tidal Marsh Restoration Project has been finalized and certified by DWR. This project aims to benefit native species by reestablishing natural ecological processes and habitats, contributing to scientific understanding of Delta habitat restoration, providing shoreline access, and creating educational and recreational opportunities. It will restore approximately 560 acres of tidal marsh, 26 acres of riparian forest, 76 acres of managed nontidal marsh, 97 acres of subtidal open water, and 4 acres of native grassland. In addition, approximately 26 acres of managed nontidal marsh and 173 acres of irrigated pasture would be enhanced by modifying their management to benefit wildlife species. The goals of the Dutch Slough Tidal Marsh Restoration Project are consistent with those of CM4, CM7, and CM10.

As described above, CM4 would restore tidal natural communities and protect transitional uplands. The Dutch Slough project could contribute up to 560 acres of tidal marsh towards this conservation measure.

CM7 *Riparian Natural Community Restoration* would restore valley/foothill riparian natural community by implementing site-specific restoration projects for Swainson's hawk, white-tailed kite, valley elderberry longhorn beetle, riparian woodrat, and riparian brush rabbit. Swainson's hawk and white-tailed kite are present in the Dutch Slough Tidal Marsh Restoration Project area. The Dutch Slough project could contribute 26 acres of riparian forest to CM7.

CM10 *Nontidal Marsh Restoration* would restore nontidal freshwater emergent wetland and nontidal perennial aquatic natural communities to create additional foraging and breeding habitat for giant garter snake, greater sandhill crane, western pond turtle, and other native wildlife and plant species characteristic of these natural communities. The Dutch Slough project could contribute 76 acres of nontidal marsh to CM10. In keeping with the objectives of CM10, western pond turtle is present in the Dutch Slough project area. Additionally, the Dutch Slough project would involve enhanced habitat for giant garter snake.

11F.1.1.3 McCormack-Williamson Tract Project

The McCormack-Williamson Tract project, run by the Bureau of Land Management and The Nature Conservancy (with permission granted from Reclamation District #2110), will improve the McCormack-Williamson Tract levee system by resloping 9,500 linear feet of the landside levee slope and increasing onsite riparian habitat by planting the resloped levee area with native vegetation. The project would increase the amount of riparian habitat to 23 acres. In addition to achieving necessary levee rehabilitation, the project would also facilitate long-term plans to restore tidal wetland habitat. By breaching the levee to allow tidal inundation of a portion of the tract and allowing tidal action to return, the tract would be restored to tidal freshwater wetlands and seasonally inundated floodplain surrounded by riparian vegetation.

The McCormack-Williamson Tract Project goals parallel many of the goals in CM4. As described in the Draft BDCP, the overall intent of CM4 is to develop a broadly distributed mosaic of restored tidal natural communities that address the foraging needs of covered fish species by increasing habitat suitability. Large-scale restoration of tidal natural communities is expected to generate emergent benefits (i.e., benefits that are more than the sum of their individual parts) as the area of restored tidal natural communities increases through implementation of individual restoration projects. Additionally, tidal wetland restoration will provide a broad range of habitat features, such as tidal channels within wetlands.

11F.1.1.4 Southport Project

The Southport Project implements flood risk–reduction measures along the Sacramento River South Levee that protects the Southport community and will provide 280 acres of floodplain restoration. Partial funding for the project was secured through the DWR Early Implementation Project; however, funding for floodplain design and restoration has not been determined. A partner agency is needed to help fund the riparian floodplain restoration for the portion of the property that will not be used as mitigation for the flood control project. Depending on the funding source, this project may contribute up to 280 acres of floodplain restoration, which would be consistent with the goals of CM5 *Seasonally Inundated Floodplain Restoration*.

Under CM5, flood conveyance levees and infrastructure would be modified to restore 10,000 acres of seasonally inundated floodplain along river channels throughout the Plan Area. CM5 would restore floodplains that historically existed elsewhere in the Plan Area but that have been lost as a result of flood management and channelization activities. These restored floodplains would intentionally be allowed to flood to support valley/foothill riparian, nontidal freshwater perennial emergent, and nontidal perennial aquatic natural communities.

11F.2 Chapter 1, Introduction

The following change was made to Section 1.3.7.7, *Migratory Bird Treaty Act*, to ensure consistency with the Draft Implementation Agreement.

> The Migratory Bird Treaty Act of 1918 implements four international treaties for the conservation and management of bird species that may migrate through more than one country (16 USC 703 *et seq*.). The act makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird listed in 50 CFR 10, including feathers or other parts, nests, eggs, or products, except as allowed by implementing regulations (50 CFR 21). 50 CFR Section 21.27 authorizes the USFWS to issue permits, valid for up to three years, authorizing the incidental take of migratory birds that are protected as threatened or endangered under the ESA. Such a permit and its renewal are among the permits and authorizations being requested under the BDCP.

11F.3 Chapter 3, Conservation Strategy

11F.3.1 Section 3.3, Biological Goals and Objectives

The following substantive changes were made to this section.

- Added a definition of *stressor reduction targets*, a term used in several of the biological objectives for covered fish species.
- Added Goal DTSM3 and Objective DTSM3.1 for delta smelt. This goal and objective are supported by CM18.
- Added Goal LFSM2 and Objective LFSM2.1 for longfin smelt. This goal and objective are supported by CM18.
- Revised rationale for Objective WRCS1.1 for winter-run Chinook salmon.
- Revised rationale for Objective WRCS1.3 for winter-run Chinook salmon.
- Revised rationale for Objective FRCS1.1 for fall-run Chinook salmon.
- Revised rationale for Objective FRCS1.3 for fall-run Chinook salmon.
- Modified the performance targets in Objectives GSHC1.2 and GSHC1.4 for greater sandhill crane.

The revised text showing each of these changes is presented below.

11F.3.1.1 Section 3.3.1.2, Process for Developing Fish Species Biological Goals and Objectives

The following definition for *stressor reduction targets* was added.

> Stressor reduction targets were also developed for covered fish species as a way to better link the conservation measures to the biological goals and objectives. These stressor reduction targets address important mechanisms that affect species biological performance and that can be altered by

the conservation measures. The stressor reduction targets are guidelines that are subject to revision and change as biological understanding improves. Thus, they do not represent fixed performance standards for the BDCP; performance standards are established in the biological objectives. Current understanding of stressors affecting covered fish species suggests that achieving the stressor reduction targets would contribute substantially to achieving the biological objectives.

11F.3.1.2 Section 3.3.6.1, Delta Smelt (Section 3.3.6.1.3, Species Specific Goals)

The following goal and objective were added.

Goal DTSM3: Lowered risk of extinction and increased capacity for conservation research.
• Objective DTSM3.1: Provide facilities for *ex situ* conservation of delta smelt to: a) Achieve and maintain captive delta smelt populations that are large enough and managed and monitored in such a way that genetic diversity remains sufficient to ensure the genetic survivability of the estuary's delta smelt population. b) Maintain a sufficiently large excess production of captive delta smelt to support research needs into their biology and genetic management. c) Develop the production capacity of delta smelt to make possible the supplementation of the natural population, should USFWS and/or CDFW decide supplementation is appropriate.

Objective DTSM3.1 Rationale: Achieving this objective will greatly lower the probability of delta smelt extinction and provide for the possibility that the species could be repatriated if it was naturally extirpated from the San Francisco Estuary if the USFWS and CDFW determined at a future time that such an action was appropriate. The USFWS operates a number of conservation hatcheries throughout the U.S. that serve a similar purpose for other imperiled fish species and populations.

Delta smelt is a Delta endemic species, comprising a single genetic population, i.e., it is found nowhere else in the world. Further, it is a habitat specialist with a more restricted in-estuary distribution than other more common small, planktivorous fishes like northern anchovy, longfin smelt, and Mississippi silverside. The relative abundance of Delta smelt declined in the early 1980s and again in the early 2000s (Thomson et al. 2010). These declines have resulted in a long-term average negative population growth rate, ESA and CESA listing, and intensified regulatory efforts to protect the species. Due to its very limited local and global distribution and declining abundance, the commitment to large, captive Delta smelt populations under careful genetic management is a prudent element of a conservation strategy for this species. Establishing viable refugial populations of delta smelt would provide insurance against the potential extinction. A conservation hatchery also provides a stock of fish that could be used to test the effects of various stressors on these species in a controlled environment (e.g., Baskerville-Bridges et al. 2004; Bennett 2005), while minimizing the need to collect fish from the wild. Experiments performed on delta smelt at the conservation hatcheries are anticipated to be important parts of targeted research associated with the BDCP adaptive management and monitoring program.

11F.3.1.3 Section 3.3.6.2, Longfin Smelt (Section 3.3.6.2.3, Species Specific Goals)

The following goal and objective were added.

Goal LFSM2: Lowered risk of extinction and increased capacity for conservation research.
• **Objective LFSM2.1:** Provide facilities for *ex situ* conservation of longfin smelt in order to: a) Achieve and maintain captive Longfin Smelt populations that are large enough and managed and monitored in such a way that genetic diversity remains sufficient to ensure the genetic survivability of the estuary's Longfin Smelt population. b) Maintain a sufficiently large excess production of captive Longfin Smelt to support research needs into their biology and genetic management. c) Develop the production capacity of longfin smelt to make possible the supplementation of the natural population, should USFWS and/or CDFW decide supplementation is appropriate.

Objective LFSM2.1 Rationale: Achieving this objective will greatly lower the probability of longfin smelt extirpation from the San Francisco estuary and provide for the possibility that this DPS could be repatriated if it was naturally extirpated, if the USFWS and CDFW determined at a future time that such an action was appropriate. The USFWS operates a number of conservation hatcheries throughout the U.S. that serve a similar purpose for other imperiled fish species and populations.

USFWS recently determined that the population of longfin smelt in the Delta was a distinct population segment (DPS) that warranted listing under ESA. However, that listing decision was precluded by the need to complete higher priority actions. The Delta population of longfin smelt is one of several that occur in estuaries along the northern California coast that are collectively listed as threatened under CESA. The relative abundance of longfin smelt has been generally declining since monitoring began in 1967 (Thomson et al. 2010). The most significant decline in longfin smelt followed the invasion of the estuary by overbite clam in the latter 1980s. These declines have resulted in a long-term average negative population growth rate, CESA listing, and intensified regulatory efforts to protect the species. Due to the DPS' relatively limited local distribution and declining abundance, the commitment to large, captive longfin smelt populations under careful genetic management is a prudent element of a conservation strategy for this locally-adapted population. Establishing viable refugial populations of longfin smelt would provide insurance against its potential extirpation. A conservation hatchery also provides a stock of fish that could be used to test the effects of various stressors on these species in a controlled environment (e.g., Baskerville-Bridges et al. 2004; Bennett 2005), while minimizing the need to collect individuals from the wild. Experiments performed on longfin smelt at the conservation hatcheries are anticipated to be important parts of targeted research associated with the BDCP adaptive management and monitoring program.

11F.3.1.4 Section 3.3.6.3, Chinook Salmon, Sacramento River Winter-Run Evolutionarily Significant Unit

Objectives WRCS1.1 and WRCS1.3 were modified as shown below.

Objective WRCS1.1 Rationale: Appendix 3.G, *Proposed Interim Delta Salmonid Survival Objectives,* presents a 2012 technical memorandum prepared by NMFS outlining the framework for determining appropriate metrics for through-Delta survival based on limited data of current through-Delta survival rates. The technical memorandum outlines how NMFS estimated current through-Delta survival rates and the rationale for specific interim metrics defined within Objectives WRCS1.1, SRCS1.1, FRCS1.1, and STHD1.1. NMFS used a simple deterministic, stage-based life-cycle model and cohort replacement rates of 1.2, 1.3, and 1.4 (1.3, 1.4, and 1.5 for winter-run Chinook salmon) to define survival objectives in three time-steps: 19 years after permit issuance (19-year), 28 years after permit issuance (28-year), and 40 years after permit issuance (40-year). For each of the covered salmonids, the interim through-Delta survival objective represent 50% of the estimated increase in Delta survival required to achieve the modeled cohort replacement rates, based on improvements in through-Delta survival alone. That is, NMFS held pre- and post-Delta survival constant and calculated the improvement in Delta survival needed to achieve the target cohort replacement rates, assigning half of that improvement to the BDCP. The balance of the improvements required to achieve the modeled cohort replacement rates is expected to be derived from other recovery actions distributed throughout the entire range of covered salmonids, which could occur upstream, in the Delta, and/or in the ocean.

There have been no studies of through-Delta survival of winter-run Chinook salmon. Recent acoustic-tag survival studies of hatchery-reared late fall–run Chinook salmon estimate through-Delta survival at approximately 40%. This survival rate was used as a starting point for estimating Sacramento River winter-run Chinook salmon through-Delta survival. There are substantial differences in fish size and seasonal timing of migration between juvenile winter-run and late fall–run Chinook salmon that may affect their survival rates. Therefore, the level of uncertainty in using results of studies of juvenile late fall–run Chinook salmon survival to establish both existing conditions and objectives for winter-run Chinook salmon is relatively high. This issue will be the subject of additional experimental survival studies and analyses during the interim period.

NMFS acknowledges the limitations of this approach, but in balancing the risks to ESA-listed species, NMFS considered it better to proceed with interim targets and recognizes the need to periodically review these baseline estimates and document progress toward the 19-year, 28-year, and 40-year objectives. As new empirical survival estimates for Central Valley species become available, NMFS is prepared to review and revise these Interim Delta Survival Objectives as appropriate.

Increasing the through-Delta survival of juvenile salmonids will be accomplished by maximizing survival rates at the new north Delta intakes, increasing survival rates at the south Delta export facilities, reducing mortality at predation hotspots, increasing habitat complexity through restoration actions along key migration corridors, guiding fish originating in the Sacramento River away from entry into the interior Delta, and ensuring pumping operations do not increase the occurrence of reverse flows in the Sacramento River at the Georgiana Slough junction. The BDCP's contribution toward addressing these factors is anticipated to improve conditions for juvenile salmonids and thus increase survival throughout the Plan Area, thereby contributing to increased abundance of emigrating juvenile and immigrating adult salmonids. The increase in survival and resulting increase in abundance are intended to provide for the conservation and management of covered salmonids in the Plan Area.

Survival studies conducted in the Central Valley have generally focused on fall-run or late fall–run juvenile Chinook salmon of hatchery origin, many of which are of a larger size than juvenile winter-run or spring-run Chinook salmon (although spring-run Chinook salmon may migrate as YOY, juveniles, or yearlings, the majority appear to migrate as fry or YOY). Also, the various runs have different migration timing, so extrapolation of the measured survivals from surrogate hatchery-origin fall- or late fall–run juvenile Chinook salmon to wild-origin winter-run, spring-run, and even fall- and late fall–run Chinook salmon has some inherent uncertainty. Additionally, there is considerable uncertainty regarding current through-Delta survival rates for emigrating juvenile Chinook salmon.

This survival metric represents the survival necessary for the BDCP to contribute to Goal WRCS1. Achieving this Delta survival objective would provide approximately 50% of the improvement in survival deemed necessary to recover the species throughout its range. The BDCP would be responsible for this improvement. The remaining 50% of the improvement in juvenile survival are expected to be achieved through other recovery actions upstream of the Delta, within the Delta (i.e., outside of the BDCP), and downstream of the Delta. This objective is not intended to compensate for poor survival, which may occur at other life stages outside the Plan Area or as a result of factors not controlled by the BDCP.

While the BDCP would be responsible for the half of the improvements to achieve the Cohort Replacement Rate, it may not be feasible to separate out the BDCP's contribution from that of other current, ongoing, and future recovery and conservation efforts throughout the range of the species. However, the BDCP will be responsible for tracking survival through monitoring and adaptive management. The BDCP also may be able to parse out the factors affecting through-Delta survival and qualitatively frame its contribution to addressing these factors.

Ongoing work and BDCP monitoring conducted during early implementation are expected to provide important new data and modeling tools to improve the through-Delta survival targets for covered salmonids, particularly for winter-run Chinook salmon. As more data are collected and a greater understanding of through-Delta survival is gained, this information will be used to revise survival metrics to reflect actual conditions related to current through-Delta survival and the BDCP's potential contribution to increased survival. For example, NMFS, in collaboration with other investigators, has initiated a survival study intended to produce reach-specific survival estimates for juvenile winter-run and spring-run Chinook salmon and to test for differences in survival rates for wild- and hatchery-origin salmon.

The 5-year geometric mean survival objective is intended to exceed typical drought cycle of 2 years, and amortize across multiple generations (3- to 4-year lifespan). The timeframe for achieving the migration flow stressor reduction target is anticipated to be 15 years, to allow time to permit and construct Fremont Weir improvements and north Delta facilities and to complete further evaluation of nonphysical barriers. This timeframe balances the need to allow time to realize some of the BDCP benefits while providing an incentive to implement measures quickly.

Objective WRCS1.3 Rationale: The BDCP will address illegal harvest in the Plan Area to contribute to an increase in adult survival. Through *CM17 Illegal Harvest Reduction*, the BDCP intends to increase abundance of covered adult salmonids by decreasing the number of potential spawners taken illegally by recreational anglers and organized poaching rings. The scale of the illegal harvest issue within the Plan Area is unknown, but illegal harvest has been documented by the Delta-Bay Enhanced Enforcement Program (Department of Fish and Game 2012). Reducing this threat is anticipated to increase escapement of spawning adults.

While the specific number of contacts, warnings, citations, and arrests are documented, the number of violations that go undetected is unknown. An increase in enforcement is expected to result in a decrease in illegal harvest within the Plan Area over time; however, it will be difficult to definitively document or quantify the decrease in illegal harvest or conclude that an increase or decrease in the number of citations issued in a given year translates into a reduction in the extent of illegal harvest occurring within the Plan Area. Thus, the principal tool for monitoring will be tracking trends in the number and distribution of citations and arrests relative to level of effort.

Achievement of biological goal WRCS1 will be further supported by addressing the following stressors.

- **Predation.** Reducing predation rates in the Plan Area at certain hotspots where predators are known or expected to congregate or have disproportionately large effects on covered fish is intended to contribute to an increase in the survival of emigrating juvenile salmonids. Striped bass may be the most significant predator of Chinook salmon due to its ubiquitous distribution in the estuary and tributary rivers and the tendency for individuals to aggregate around water diversion structures (Brown et al. 1996 in Nobriga and Feyrer 2007). A variety of other nonnative predatory fish also occur in the Delta. *CM15 Localized Reduction of Predatory Fishes* is intended to reduce the abundance of piscivorous fish at specific locations and eliminate or modify predator hotspots throughout the Delta, particularly along major migratory routes used by salmonids. *CM16 Nonphysical Fish Barriers* will be employed to discourage juvenile salmonids from entering channels/migration routes that are known to have high predator abundance and/or predation rates, further reducing predation rates within the Plan Area and contributing to an increase in survival.

Foodweb dynamics are often complex, with indirect interactions that can mask or amplify top-down effects. For example, with competition between two prey species that share a common predator, predation rates on one prey species can increase in response to the presence of the alternative prey. In the Delta, it may be that nonnative prey (e.g., silverside, threadfin shad) maintain nonnative predator populations (e.g., striped bass, largemouth bass) at high levels, causing artificially high rates of predation on native fish, including covered salmonids. For these reasons, *CM15 Localized Reduction of Predatory Fishes* and *CM16 Nonphysical Fish Barriers* will be implemented through an experimental process guided by a strong adaptive management and monitoring program to ensure that the benefits of these measures are maximized and unintended adverse consequences are avoided.

- **Lack of rearing habitat.** Increasing habitat complexity along key migration corridors is expected to contribute to increased survival for juvenile salmonids. Juvenile winter-run Chinook salmon migrate downstream into the lower Sacramento River and Delta typically beginning in late December followed by an extended juvenile rearing period of 4 to 7 months prior to migrating into coastal marine waters (National Marine Fisheries Service 2009). Habitat conditions during juvenile rearing, including access to low-velocity, shallow-water habitat with few predators and abundant food supplies, are important for juvenile growth and survival. Providing enhanced access to seasonally inundated floodplain habitat in the Yolo Bypass (CM2) and other seasonally inundated floodplain habitat (CM5), a greater extent of tidal wetlands (CM4), and enhanced channel margin habitat (CM6) under the BDCP will improve juvenile rearing conditions and contribute to increased juvenile survival.

  Access to the Yolo Bypass, in addition to providing rearing habitat, serves as an alternative migration pathway for juvenile salmonids around those regions of the mainstem Sacramento River where the north Delta intakes will be located. This alternative migration route will avoid exposure of salmonids to the Delta Cross Channel and Georgiana Slough, which lead to the interior Delta where survival has been shown to be lower than in the mainstem Sacramento River and Sutter and Steamboat Sloughs (Perry et al. 2010). The alternative route also will reduce the risk of exposure to striped bass and other predatory fish inhabiting the Sacramento River between the Fremont Weir and Rio Vista. Other studies indicate that the relative survival of Chinook fall-run fry migrating through Yolo Bypass to Chipps Island was on average 50% higher than fish passing over the comparable section of the Sacramento River (Sommer, Harrell, et al. 2001). Survival of Sacramento River fish passing through the interior Delta was lower than fish passing through the Sacramento River (0.35 mean ratio of survival probabilities) (Newman and Brandes 2010). Thus, while improved access to Yolo Bypass will provide increased rearing habitat, it will also be expected to contribute toward reduced predation and increased survival.

- **Maximizing survival rates at the north Delta Intakes.** The operational criteria for the north Delta intakes are intended to maximize survival through dual conveyance and screening of intakes to minimize entrainment and modification of the Fremont Weir to create a viable alternate migratory pathway for juvenile salmonids. Flows will be managed in real time to minimize adverse effects of water diversions at the north Delta intakes on downstream-migrating salmonids. Screening of the new north Delta intakes will incorporate screens with 1.75-millimeter mesh, which is intended to exclude fish with a body size below 15 millimeters. Final specifications have not been completed for the north Delta intake screens, but approach velocity will be less than 0.33 feet per second (criterion for salmonid fry) and may be limited to 0.2 feet per second (existing criterion for juvenile delta smelt). Additionally, modifications to the Fremont Weir will allow increased flow into the Yolo Bypass between mid-November and mid-May to coincide with juvenile salmonid outmigration. The modifications to the Fremont Weir are intended to increase the duration and extent of inundation of the Yolo Bypass as well as enhance the habitat conditions within the bypass. The proportion of the population that may use the Yolo Bypass as an alternate migration corridor, as opposed to the mainstem Sacramento River, may be relatively small, but those fish that do migrate through the Yolo Bypass will not be exposed to the north Delta intakes.

The north Delta intakes will be operated so as to not increase the incidence of reverse flows in the Sacramento River at the Georgiana Slough junction, thereby limiting the potential for covered salmonids to inadvertently migrate into the interior Delta. Juvenile salmonids can be drawn into alternative channels, such as Georgiana Slough and the Delta Cross Channel, and into the interior Delta region where survival has generally been shown to be lower than in the Sacramento River mainstem or Sutter and Steamboat Sloughs (Perry et al. 2010; Brandes and McLain 2001). The importance of alternative channels that lead to the interior Delta region and the need to discourage their use by juvenile salmonids was recognized by NMFS (2009b) in the BiOp, which requires that engineered solutions be investigated to lessen the problem. Engineered solutions considered include physical and/or nonphysical barriers.

- **Increasing survival rates at the south Delta export facilities.** Appreciable losses of juvenile salmonids have occurred historically at the south Delta export facilities. Estimates of wild winter-run Chinook salmon loss at these facilities as a percentage of the wild-origin population entering the Delta have ranged from less than 0.1% in 2007 to over 5% in 2001 (Llaban 2011), under baseline conditions. Overall, entrainment/salvage loss of juvenile salmonids under the BDCP will be appreciably lower in the south Delta than under existing conditions, because operation of the north Delta intakes will reduce reliance on south Delta export facilities. See also benefits described under Objective L4.3.
- **Migration flows.** The north Delta intakes will be operated so as to not increase the incidence of reverse flows in the Sacramento River at the Georgiana Slough junction, thereby limiting the potential for covered salmonids to inadvertently migrate into the interior Delta. Juvenile salmonids can be drawn into alternative channels, such as Georgiana Slough and the Delta Cross Channel, and into the interior Delta region where survival has generally been shown to be lower than in the Sacramento River mainstem or Sutter and Steamboat Sloughs (Perry et al. 2010; Brandes and McLain 2001). The importance of alternative channels that lead to the interior Delta region and the need to discourage their use by juvenile salmonids was recognized by NMFS (2009b) in the BiOp, which requires that engineered solutions be investigated to lessen the problem. Engineered solutions considered include physical and/or nonphysical barriers.

11F.3.1.5 Section 3.3.6.5, Chinook Salmon, Central Valley Fall- and Late Fall–Run Evolutionarily Significant Unit

<u>Objectives FRCS1.1 and FRCS1.3 were modified as shown below.</u>

Objective FRCS1.1 Rationale: See Objective WRCS1.1 rationale above for a general discussion of the framework for developing the metrics presented within this objective and the rationale for the objective.

Juvenile fall-run Chinook salmon migrate downstream into the lower Sacramento River in the vicinity of the Yolo Bypass typically beginning in January and continuing through June, with the peak outmigration occurring from February through May. Juvenile late fall–run Chinook salmon migrate downstream into the lower Sacramento River in the vicinity of the Yolo Bypass, typically emigrating as smolts from November through February; however, juvenile late fall–run Chinook salmon may occur in the Sacramento River in the vicinity of Yolo Bypass most of the year, at various sizes. This difference in timing and sizes of the juvenile life stages of these two races of the ESU makes defining objectives and associated metrics for the ESU difficult.

Recent coded-wire-tag and -tag survival studies of hatchery-origin fall-run and late fall–run Chinook salmon were used as a starting point for estimating through-Delta survival for wild-origin Sacramento River fall-run Chinook salmon. As a result of differences in fish size and the seasonal timing of juvenile migration, there are substantial differences between wild- and hatchery-origin juvenile fall-run and late fall–run Chinook salmon that may affect their survival rates. Therefore, the level of uncertainty in using results of currently available acoustic-tag studies to establish both existing conditions and metrics within the objectives for wild-origin fall-run and late fall–run Chinook salmon is relatively high and will be the subject of additional experimental survival studies, monitoring, and analyses during the interim period. The through-Delta survival metrics presented here are considered interim, because they are based upon current data, which are limited, but are considered the best available science at this time.

Objective FRCS1.3 Rationale: See rationale for Objective WRCS1.3 for general rationale for this objective.

In general, achievement of biological goal FRCS1 will be further supported by addressing several stressors affecting survival within the Plan Area, including predation, and illegal harvest.

Through-Delta survival for fall-run Chinook salmon originating in the San Joaquin River tributaries has declined in recent years based on results of VAMP testing, with current through-Delta survival at approximately 5%, based on the most recent years (2008 to 2010) of VAMP studies. It has been hypothesized that predation on juvenile salmon in the lower San Joaquin River and Delta by species such as largemouth bass and striped bass has increased in recent years. The hypothesis is supported by observations of increased catch-per-unit effort of warm water, nonnative, predatory fish in electrofishing surveys conducted since the early 1980s by CDFW and University of California, Davis. The hypothesis is also supported by results of acoustic-tag studies in recent years showing high rates of juvenile fall-run Chinook salmon mortality and predation at a variety of locations, including the scour hole located immediately downstream of the confluence of the lower San Joaquin River and Head of Old River.

Although *CM15 Localized Reductions of Predatory Fishes* is intended to reduce predation on juvenile salmon at specific locations (e.g., Clifton Court Forebay), large-scale regional changes in the risk of predation in the lower San Joaquin River and Delta may significantly affect juvenile survival and the ability of the BDCP to achieve the overall Biological Goal of increased abundance. Changes in fishing regulations have been proposed, but not approved, as a complementary action that would result in regional changes in recreational angler harvest and assist the BDCP in achieving increased abundance. If regional increases in predation mortality are documented through acoustic-tag and other studies in the future, the relative allocation of responsibility assigned to the BDCP in achieving increased abundance, and specifically FRCS1.1 through-Delta survival metrics may need to be adjusted through adaptive management.

The BDCP's contribution toward addressing illegal harvest is anticipated to improve survival through the Plan Area. Reducing illegal harvest is expected to contribute to increased abundance of covered adult salmonids that may successfully spawn. The scale of the illegal harvest issue within the Plan Area is unknown, but illegal harvest is known to occur, and contributing to a decrease in this problem under the BDCP is anticipated to increase escapement of spawning adults.

11F.3.1.6 Section 3.3.6.18, Greater Sandhill Crane

Performance targets in and rationale for Objectives GSHC1.2 and GSHC1.4 were modified as shown below.

3.3.6.18.1, Applicable Landscape-Scale Goals and Objectives

While the landscape goals and objectives will provide broad-based benefits to the ecosystems upon which greater sandhill cranes depend, none are integral to the conservation strategy for this species.

3.3.6.18.1, Applicable Natural Community Goals and Objectives

Natural community biological goals and objectives integral to the conservation strategy for the greater sandhill crane are stated below.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.
• **Objective CLNC1.1:** Protect 47,125 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species. • **Objective CLNC1.2**: Target cultivated land conservation to provide connectivity between other conservation lands. • **Objective CLNC1.3**: Maintain and protect the small patches of important wildlife habitats associated with cultivated lands that occur in cultivated lands within the reserve system, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objective CLNC1.1 Benefits: The key to sustaining greater sandhill crane populations in the Plan Area is the sustainability of an economically viable and compatible cultivated landscape. This objective will protect sufficient suitable habitat in the Plan Area for covered species associated with cultivated lands, including the greater sandhill crane. Achieving this objective will offset the loss of cultivated land values from construction actions and the conversion of cultivated lands to tidal restoration. Combined with other conservation lands in the Plan Area and assuming that cultivated land uses will otherwise continue to provide habitat value to covered species in the Plan Area, achieving this objective will address the effects of covered activities on cultivated land values and conserve the wintering population of greater sandhill crane in the Plan Area and other covered species associated with cultivated lands.

Objective CLNC1.2 Benefits: Achieving this objective will promote connectivity of suitable cultivated lands to provide for larger parcels of suitable greater sandhill crane wintering habitat. Greater sandhill cranes use the same roost sites year after year (i.e., have high site fidelity) within the Greater Sandhill Crane Winter Use Area and suitable cultivated land foraging habitat must be in close proximity to these sites to sustain long-term use patterns. Therefore, protecting lands that are adjacent or near traditional crane roosts or foraging habitats will help to sustain and expand these existing use patterns. For example, with the increase in crane use of lands on and surrounding the Stone Lakes National Wildlife Refuge (Appendix 2.A, *Covered Species Accounts*), protecting and managing adjacent lands may help to increase use of this area and expand and protect the cranes' winter distribution within Conservation Zone 4.

Objective CLNC1.3 Benefits: Achieving this objective will retain existing noncultivated habitat elements on protected cultivated lands through the retention of seasonal wetlands and upland edges that sometimes occur in association with cultivated lands.

3.3.6.18.3, Species-Specific Goals and Objectives

The landscape-scale and natural community biological goals and objectives, and associated conservation measures, discussed above, are expected to protect, restore, and enhance suitable habitat for greater sandhill crane within the reserve system. The goals and objectives below address additional species-specific needs that will otherwise not be met at the landscape or natural community scale.

Goal GSHC1: Protection and expansion of greater sandhill crane winter range.
• **Objective GSHC1.1**: Within the 48,625 acres of cultivated lands protected under Objective CLNC1.1, protect 7,300 acres of high- to very high-value habitat for greater sandhill crane, with at least 80% maintained in very high-value types in any given year, as defined in *CM3 Natural Communities Protection and Restoration*. This protected habitat will be within 2 miles of known roosting sites in Conservation Zones 3, 4, 5, and/or 6 and will consider sea level rise and local seasonal flood events, greater sandhill crane population levels, and the location of foraging habitat loss. Patch size of protected cultivated lands will be at least 160 acres. • **Objective GSHC1.2:** To create additional high-value greater sandhill crane winter foraging habitat, up to 10% of the habitat protected under Objective GSHC1.1, but at least 160 acres, will involve acquiring low-value habitat or nonhabitat areas and converting it to high- or very high-value habitat[1]. Created habitat will be within 2 miles of known roosting sites in Conservation Zones 3, 4, 5, and/or 6, have a minimum patch size of 80 acres, and will consider sea level rise and local seasonal flood events, greater sandhill crane population level, and the location of habitat loss. The location of created habitat will be prioritized for areas within and surrounding the Stone Lakes National Wildlife Refuge Project Boundary. • **Objective GSHC1.3:** Create 320 acres of managed wetlands consisting of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within the Greater Sandhill Crane Winter Use Area[2] in Conservation Zones 3, 4, 5, or 6, with consideration of sea level rise and local seasonal flood events. The wetlands will be located within 2 miles of existing permanent roost sites and protected in association with other protected natural community types (excluding nonhabitat cultivated lands) at a ratio of 2:1 upland to wetland to provide buffers around the wetlands. • **Objective GSHC1.4:** In addition to the 320 acres of created managed wetland greater sandhill crane roosting habitat (Objective GSHC1.3), create two wetland complexes within the Stone Lakes National Wildlife Refuge project boundary[3]. The complexes will be no more than 2 miles apart and will help provide connectivity between the Stone Lakes and Cosumnes River Preserve greater sandhill crane populations. Each complex will consist of at least three wetlands totaling 90 acres of greater sandhill crane roosting habitat, and will be protected in association with other protected natural community types (excluding nonhabitat cultivated lands) at a ratio of at least 2:1 uplands to wetlands (i.e., two sites with 90 acres of wetlands each). One of the 90-acre wetland complexes may be replaced by 180 acres of cultivated lands (e.g., cornfields) that are flooded following harvest to support roosting cranes and provide highest-value foraging habitat, provided such substitution is consistent with the long-term conservation goals of Stone Lakes National Wildlife Refuge for greater sandhill crane. • **Objective GSHC1.5:** Create an additional 95 acres of roosting habitat within 2 miles of existing permanent roost sites. The habitat will consist of croplands that are flooded following harvest to support roosting cranes and that provide highest-value foraging habitat. Individual fields will be at least 40 acres and can shift locations throughout the Greater Sandhill Crane Winter Use Area, but will be sited with consideration of the location of roosting habitat loss and will be in place a minimum of one season prior to roosting habitat loss.

Objective GSHC1.1 Rationale: While Objective CLNC1.1 protects cultivated lands throughout the Plan Area to support covered species associated with these lands, Objective GSHC1.1 establishes the proportion of this overall protection that will be applied to the conservation of the species within the

---

[1] Low-value lands will be targeted for conversion to very high-quality greater sandhill crane habitat when the site meets all siting and design criteria and when equally suitable, existing lands are not available. That is, if conservation value between potential sites is relatively equal, the protection of existing sites should be prioritized over the conversion of incompatible land use types.

[2] Important geographically defined greater sandhill crane wintering areas in the Central Valley (Pogson and Lindstedt 1988; Littlefield and Ivey 2000; Ivey pers. comm.) (Figure 2A.19-2).

[3] The project boundary delineates the area surrounding the existing refuge for which the refuge has authority to acquire land or easements.

Greater Sandhill Crane Winter Use Area. Because the most important stressor on this species is the conversion of suitable crops in the Winter Use Area to unsuitable crops, the key to long-term conservation of the winter population is sustaining sufficient amounts and types of suitable cultivated lands.

The cultivated land base in the Winter Use Area has remained relatively stable; however, because crop patterns are subject to agricultural economic influences, the extent of the landscape that provides suitable habitat for the crane is less stable and uncertain over time has been declining. Additionally, many of the cultivated lands in the Winter Use Area have been converted conversion from crop types that provide habitat for the species to unsuitable vineyards and orchards. Therefore, the strategy for the greater sandhill crane is focused on conserving cultivated lands that provide high-value habitat for the crane, to increase the stability and certainty of compatible crops in the Winter Use Area.

The strategy involves targeting lands in Conservation Zones 3, 4, 5, and/or 6 (areas in the Plan Area that are within the Winter Use Area and excluding lands most vulnerable to sea level rise), where they are needed most because of rapid conversion to nonhabitat land cover types, and managing those lands as high-value foraging habitat for cranes. Objective GSHC1.1 requires that conservation lands providing foraging habitat be within 2 miles of known roost sites: This is because the highest levels of use are typically within approximately 2 miles of known roosts, and use (measured as a function of observed crane density) decreases beyond approximately 2 miles of a roost (Sacramento County 2008, Ivey pers. comm.). Objective GSHC1.1 also specifies that 80% of this foraging habitat will be managed at the highest habitat value in any given year (Table 3.3 4). Waste corn is the key food item for greater sandhill cranes in the Delta; therefore corn is considered the highest-value crop type. Rice is also a very high-value type, but only a relatively small proportion of the Winter Use Area is capable of supporting rice agriculture. Because crane reserves will represent a relatively small proportion of the available habitat within the Winter Use Area, managing the majority of this area to maximize food value for cranes could be important in sustaining the winter population. Therefore, 80% of the crane reserve acreage will be maintained in the highest-value crop types. The remaining 20% will be managed as at least high-value habitat (Table 3.3 4), which allows for crop rotations and other factors that could influence agricultural productivity (see Conservation Measure 11, Cultivated Lands Enhancement and Management Guidelines and Techniques). Sea level rise and local seasonal flood events will be considered when siting conservation lands, because crane foraging habitat is likely to become unsuitable at lower elevations with sea level rise as these areas are at risk of becoming flooded. Additionally, crane habitat may become unsuitable as a result of during large flood events within river floodplains. The minimum patch size is relatively large (160 acres) to minimize the potential effects of human-associated visual and noise disturbances.

Table D.3-1. Assigned Greater Sandhill Crane Foraging Habitat Value Classes for Agricultural Crop Types

Foraging Habitat Value Class	Agricultural Crop Type
Very high	Corn, rice
High	Wheat
Medium	Alfalfa and alfalfa mixtures, irrigated pasture, other grain and hay crops (barley, oats, sorghum), nonirrigated grain and hay, sudan
Low	Other irrigated field and truck crops and idle cropland, new lands being prepped for crop production, nonirrigated mixed pasture, nonirrigated native pasture
None	Orchards, vineyards, nurseries, turf farms

This objective will conserve cultivated lands sufficient to address the loss of cultivated land habitat value, and additional enhancement provided through GSHC1.2, as described below, will provide for the conservation and management of greater sandhill crane in the Plan Area.

Objective GSHC1.2 Rationale: Achieving this objective will enhance or create foraging habitat by requiring that up to 10% of the lands protected under GSHC1.1 be converted from an initial low- or no-value crop type to a high- or very high-value crop type (Table 3.3-4). Requiring that 10% (730 acres) of the crane reserves be created or enhanced by converting unsuitable crops to high-value crops will help to redress the past conversion from high-value to low-value crop types. The strategy involves targeting lands in Conservation Zones 3, 4, 5, and/or 6, which are zones in the Plan Area that are included in the Winter Use Area and do not include the lands most vulnerable to sea level rise (e.g., greater than 10 feet below sea level). Sea level rise and local seasonal flood events will be considered when siting conservation lands because crane foraging habitat is likely to become unsuitable at lower elevations with sea level rise as these areas become flooded due to sea level rise. Additionally, crane habitat may periodically become unsuitable as a result of large flood events within river floodplains.

Objective GSHC1.3 Rationale: Managed wetlands provide suitable foraging habitat and potential roosting habitat for greater sandhill cranes. Achieving this objective may increase the number and distribution of crane roost sites in the Greater Sandhill Crane Winter Use Area by creating 320 acres of greater sandhill crane roosting habitat within managed seasonal wetlands. Currently, the Plan Area contains 7,340 acres of greater sandhill crane permanent roosting habitat, 86% of which is within existing conservation lands. Creation of at least 320 acres of managed wetlands will increase the extent of protected permanent roosting habitat to 91%. The new crane roosts, each at least 40 acres in size, will supplement the existing network of roosts in the Winter Use Area. The rationale for conserving on lands in Conservation Zones 3, 4, 5, or 6, with consideration of sea level rise and local flood events, within 2 miles of existing permanent roost sites, is provided in Objective GSHC1.2, above. The managed wetlands will be conserved in association with other natural community types at a ratio of 2:1 upland to wetland to provide buffers around the wetlands that will protect cranes from the types of disturbances that would otherwise result from adjacent roads and developed areas (e.g., roads, noise, visual disturbance, lighting, pets). This is the average upland to wetland ratio for crane roosting habitat on Stone Lakes National Wildlife Refuge (McDermott pers. comm.).

Objective GSHC1.4 Rationale: Objective GSHC1.4 ensures that 180–270 acres of crane roosting habitat (depending on the type of roosting habitat) will be constructed within the Stone Lakes National Wildlife Refuge project boundary[4] (Figure 3.3-7). Achieving this objective will promote continued use and expanded use by cranes onto the Stone Lakes National Wildlife Refuge and surrounding lands and will provide additional connectivity between these lands and the Cosumnes River Preserve. Creating roosting habitat near the Greater Sandhill Crane Winter Use Area within the Stone Lakes National Wildlife Refuge project boundary will improve access to underused cultivated land foraging habitat in that area with the goal of expanding the distribution of the wintering population. The strategy includes using newly created roosting sites as a management tool to attract cranes to higher elevation zones less prone to periodic flooding due to sea level rise, large flood events and/or levee failure.

The area outside the Stone Lakes National Wildlife Refuge but within the refuge project boundary has largely been converted to vineyards, which do not provide habitat for cranes. Additional areas within the project boundary and surrounding lands are threatened by future conversions to vineyards as well. Past conversions have created an approximately 4-mile gap between wintering crane roosting and foraging sites in the Stone Lakes and Cosumnes areas. Creating two wetland complexes no more than 2 miles apart in this area will expand roosting and foraging opportunities for cranes, thus improving habitat connectivity between the Stone Lakes Basin and Cosumnes River Preserve crane populations. It will also ensure that conservation occurs in the vicinity of conveyance facility impacts, to offset disturbances and habitat loss that might otherwise cause some cranes to abandon the area, and in an area where the crane population is already constrained by land conversions (both urbanization and conversion to orchards and vineyards) to the east and sea level rise to the west. Conserved lands within the Stone Lakes National Wildlife Refuge project boundary

[4] The project boundary delineates the area surrounding the existing refuge for which the refuge has authority to acquire land or easements.

will be prioritized for transfer to the refuge to ensure management consistent with the rest of the refuge lands, therefore contributing to a regional management strategy for the crane.

Creating a complex of at least 3 to 6 wetlands in association with each other provides the ability to apply different management regimes to the wetlands, with different depths, timing, and duration of flooding. A diversity of conditions maximizes opportunities for establishing and retaining roosting cranes (McDermott pers. comm.). The wetland blocks provided in this objective are larger than the minimum block size stipulated in Objective GSHC1.3 because of the added need for conservation in this critical area where conversion to vineyards, urbanization to the east, and sea level rise to the west threaten the wintering crane population.

Objective GSHC1.5 Rationale: This objective addresses the loss from covered activities of winter-flooded corn fields that serve as both roosting habitat and highest-value foraging habitat within the Greater Sandhill Crane Winter Use Area. This type of crane roosting habitat is usually temporary as a result of seasonal changes in farm practices, crop rotational changes, or other management. This habitat type supplements the more static managed wetlands that serve as the primary roosting areas for cranes. These temporary roosting/foraging habitats allow cranes to vary their seasonal movement patterns and spread out into otherwise underused areas of the Delta; it also reduces excessively dense roosting concentrations which can contribute to disease losses from avian cholera. Objective GSHC1.5 is designed to provide similar function by allowing fields to rotate through the crane use area within protected cultivated lands. This will serve as a secondary source of high-value crane roosting/foraging habitat and provide a dynamic element to the crane conservation program. This objective is intended to offset loss of crane roosting habitat, and the compensatory roosting habitat will be in place prior to loss of roosting habitat as a result of water conveyance facility construction.

11F.3.2 Section 3.4, Conservation Measures

The following substantive changes were made to the conservation measures (CMs).

- The following definition was added as the first sentence in Section 3.4:

  > Conservation measures are actions or performance standards intended to minimize and mitigate impacts to the maximum extent practicable, and to provide for the conservation and management of Covered Species.

- For all conservation measures, the subsection titled *Adaptive Management and Monitoring* simply summarizes information presented in Section 3.6 as it pertains to that conservation measure. See references to each conservation measure in Section 3.6, revised portions of which are reproduced in Section D.3.4.

- Section 3.4.1, *CM1 Water Facilities and Operation*, was revised in multiple subsections.

- Section 3.4.2, *CM2 Yolo Bypass Fisheries Management*, was revised in multiple subsections.

- Section 3.4.4, *CM4 Tidal Wetland Restoration*, was revised to address concerns about the effects of tidal wetland restoration in the South Delta Restoration Opportunity Area.

- Section 3.4.10, *CM10 Nontidal Marsh Restoration*, was revised to include additional commitments for restoration lands.

- Section 3.4.11, *CM11 Natural Communities Enhancement and Management*, was revised to more effectively address invasive plant control, mosquito control, pesticide use, and the management of cultivated lands and managed wetlands for the benefit of covered species.

- Section 3.4.12, CM12 *Methylmercury Management*, was revised to address substantive comments by public reviewers.

- Section 3.4.15, *CM15 Localized Predator Control*, was revised on the basis of discussions with fish and wildlife agency staff.
- Section 3.4.16, CM16 *Nonphysical Barriers*, was revised to incorporate new information on types of barriers and their effectiveness, and to more clearly specify the siting of proposed barriers.
- Section 3.4.18, *CM18 Conservation Hatcheries*, was revised on the basis of consultation with the USFWS.
- Section 3.4.22, CM22 *Avoidance and Minimization Measures*, was reframed as a new component of the conservation strategy (i.e., not a conservation measure); see section D.3.3 for information on how the content of the individual avoidance and minimization measures was revised.
- Section 3.4.23, *Resources to Support Adaptive Management*, was revised on the basis of ongoing discussions with the fish and wildlife agencies.

The revised text showing each of these changes is presented below.

11F.3.2.1 Section 3.4.1, CM1 Water Facilities and Operation

Under Section 3.4.1.3.5, *Flow Modification Effects in the Sacramento River*, the section titled *Maintain Transport Flows Necessary for Downstream Movement of Delta and Longfin Smelt* was deleted in its entirety.

Section 3.4.1.4.1, *Proposed Water Facilities*, was revised as follows.

North Delta Intakes

Three new north Delta intakes will be located along the Sacramento River (Figure 4-2, Schematic Diagram of the Proposed North Delta Intake and Conveyance Facilities, Figure 4-3, Locations of the Proposed North Delta Intake and Conveyance Facilities, and Figure 4-4, Conceptual Intake Structure, in Chapter 4). Each intake will have a capacity of up to 3,000 cfs and will be fitted with fish screens designed to minimize entrainment or impingement risk for all covered fish species. Diverted waters will be conveyed to a new regulating forebay, and then south to SWP/CVP canals, via a pipeline and tunnel system. Construction of the north Delta intakes will allow great flexibility in operation of both south and north Delta diversions, as well as operation of the Delta Cross Channel. Diversions at the north Delta intake would be greatest in wetter years and lowest in drier years, when south Delta diversions would provide the majority of the CVP and SWP south of Delta exports. This is a result of north Delta bypass flow requirements, which are described in more detail below. Actual Delta channel flows and diversions may be modified to respond to real-time operational needs such as those related to Old and Middle Rivers, Delta Cross Channel, or north Delta bypass flows. The north Delta intakes and conveyance system are described in detail in Chapter 4, Section 4.2.1.1, *North Delta Diversions Construction and Operations*.

Constraints incorporated in the design and operation of the north Delta intakes include the following.

- The new north Delta diversion facilities will consist of three separate intake units with a total, combined intake capacity not exceeding 9,000 cfs (maximum of 3,000 cfs per unit; details in Chapter 4, Section 4.2.1.1, *North Delta Diversions Construction and Operations*).
- Project conveyance is provided by a tunnel capacity sized to provide for gravity flow from an intermediate forebay to the south Delta pumping facilities (Chapter 4, Section 4.2.1.2, *State Water Project Facilities Operations and Maintenance*).
- The facility will, during operational testing and as needed thereafter, demonstrate compliance with the then-current NOAA and CDFW fish screening design and operating criteria, which govern such things as approach and passing velocities and rates of impingement. In addition, the

screens will be operated to achieve the following performance standard and will be deemed to be out of compliance with permit terms if the standard is exceeded: Maintain survival rates through the reach containing new north Delta intakes (0.25 mile upstream of the upstream-most intake to 0.25 mile downstream of the downstream-most intake) to 95% or more of the existing survival rate in this reach. The reduction in survival of up to 5% below the existing survival rate will be cumulative across all screens and will be measured on an average monthly basis.

- The facility will precede full operations with a phased test period during which DWR, in close collaboration with NMFS and CDFW, will develop detailed plans for appropriate tests and use those tests to evaluate facility performance across a range of pumping rates and flow conditions. DWR will also implement operational constraints that minimize adverse impacts on covered fish species within that operational range, and demonstrate that biological performance standards are being achieved (Section 3.4.1.5, *Adaptive Management and Monitoring*). This phased testing period will include biological studies and monitoring efforts to enable the measurement of survival rates (both within the screening reach and downstream to Chipps Island), and other relevant biological parameters which may be affected by the operation of the new intakes.
- Operations will be managed at all times to avoid increasing the magnitude, frequency, or duration of flow reversals in Georgiana Slough above pre-NDD operations levels.
- The fish and wildlife agencies (USFWS, NMFS, and CDFW) retain final authority over the operational criteria and constraints (i.e., which pumping stations are operated and at what pumping rate) during testing. The fish and wildlife agencies are also responsible for evaluating and determining whether the diversion structures are achieving performance standards for covered fishes over the course of operations. Consistent with the experimental design, the fish and wildlife agencies will also determine when the testing period should end and full operations consistent with developed operating criteria can commence. In making this determination, fish and wildlife agencies expect and will consider that, depending on hydrologies, it may be difficult to test for a full range of conditions prior to commencing full operations. Therefore, tests of the facility to ensure biological performance standards are met are expected to continue intermittently after full operations begin, to enable testing to be completed for different pumping levels during infrequently occurring hydrologic conditions.
- Upon approval of the BDCP a work group will be formed by the AMT to design and implement a research program to address the key uncertainties identified in Table 3.4.1-5.
- Based on the results of the studies described above initial operating criteria will be established, including conditions under which pumping levels will be adjusted within the bypass flow criteria to minimize effects on migrating covered fish and to achieve water supply goals. This will include the use of real-time monitoring information on fish movements upstream of and in the Delta in response to hydrologic conditions and other behavioral cues.
- Once full operation begins, the real-time operations program will be used to ensure that adjustments in pumping are made when needed for fish protection or as appropriate for water supply.
- Initial post-pulse operations during juvenile migration (Dec–Jun):
    - While fish are migrating only Level 1 pumping is allowed.
    - When fish are not migrating Level 2 or 3 is allowed according to the criteria in Table 3.4.1-2.
    - If during Level 2 or 3 pumping fish are detected migrating towards the north Delta diversion, pumping will ramp down to Level 1.
    - The BDCP work group formed by the AMT will determine how to develop the triggers that will determine real-time operations related to covered fish migration past the north Delta diversions. This group will also determine the criteria for how pumping changes between levels (i.e., between Level 1, 2, and 3) in changes in covered fish migrations (i.e., presence or absence of a certain density or number of fish).

- Bypass flow criteria can follow Table 3.4.1-2 alone if other measures developed through research can minimize effects on migrating covered fish past the north Delta diversions (e.g., floating surface structures diverting fish to the opposite side of the Sacramento River from the diversions).

- Over time, the Adaptive Management Program will review the efficacy of the North Delta bypass criteria, in conjunction with its performance review on all the conservation measures, to determine what adjustments, if any, are needed to make sufficient progress towards the biological goals and objectives for salmon survival.
- DWR will contract with the Delta Science Program to host an independent review of the engineering design and approach to meeting biological criteria, including lessons learned from other large screening programs.

In Section 3.4.1.4.1, *Proposed Water Facilities*, the following subsection was added to the end of the section.

North Bay Aqueduct Alternate Intake

A new intake would be constructed on the west side of the Sacramento River across from the Sacramento Pocket area (precise siting still not determined). A new underground pipeline, made of 72 to 84-inch diameter steel and/or concrete pipe, approximately 28 miles long, would be constructed to deliver water from the Alternate Intake, connecting with the existing North Bay Aqueduct near the existing North Bay Regional Wastewater Treatment Plant. The Alternate Intake would be operated in conjunction with the existing intake at the Barker Slough Pumping Plant, with a combined withdrawal rate not to exceed 240 cfs. Intakes would be operated and maintained to minimize risk of covered fish species entrainment or impingement, as described in Section 4.2.1.4.10 *Barker Slough Pumping Plant* and Section 4.2.1.4.11, *North Bay Aqueduct Alternate Intake*.

In the event that the North Bay Aqueduct Alternate Intake is not constructed, the actions described in Section 4.2.1.4.11 *North Bay Aqueduct Alternate Intake* would not take place, and the Barker Slough Pumping Plant would be operated as described in Section 4.2.1.4.10, *Barker Slough Pumping Plant*, with a withdrawal rate not to exceed 130 cfs.

The following changes were made to Table 3.4.1-1.

Table 3.4.1-1. Water Operations Flow Criteria and Relationship to Assumptions in CALSIM Modeling

<table>
<tr><th>Parameter</th><th>Criteria</th><th>Summary of CALSIM Modeling[a]</th></tr>
<tr><td>Old and Middle River/ San Joaquin inflow-export ratio</td><td>• [no changes]</td><td>• [no changes]</td></tr>
<tr><td>Head of Old River gate operations</td><td>• [no changes]</td><td>• [no changes]</td></tr>
<tr><td>Spring outflow</td><td>• March, April, May: As described in Section 3.4.1.4.4, Decision Trees, initial operations will be determined through the use of a decision tree. If at the initiation of dual conveyance, the Permit Oversight Group determines that the best available science resulting from structured hypothesis testing developed through a collaborative science program indicates that spring outflow is needed to achieve the longfin smelt abundance objective the following water operations would be implemented within the decision tree. The high outflow scenario would be to provide a March–May average outflow scaled to the 90% forecast of eight-river index for the water year, with scaling as summarized in the table below.
March–May Average Outflow Criteria for “High Outflow” Outcome of Spring Outflow Decision Tree
<table>
<tr><th>Exceedance</th><th>Outflow criterion (cfs)</th></tr>
<tr><td>10%</td><td>>44,500</td></tr>
<tr><td>20%</td><td>>44,500</td></tr>
<tr><td>30%</td><td>>35,000</td></tr>
<tr><td>40%</td><td>>32,000</td></tr>
<tr><td>50%</td><td>>23,000</td></tr>
<tr><td>60%</td><td>17,200</td></tr>
<tr><td>70%</td><td>13,300</td></tr>
<tr><td>80%</td><td>11,400</td></tr>
<tr><td>90%</td><td>9,200</td></tr>
</table>
• March–May outflow targets are achieved using flow supplementation provided through an approved water transfer, by limiting CVP and SWP Delta exports to a total of 1,500 cfs, and finally, if these two water sources have been utilized, through releases from Oroville, with subsequent appropriate accounting adjustments between the SWP and the CVP. In order to protect upstream storage for other Sacramento Valley uses, changes in Delta exports would be considered the primary mechanism for achieving the spring outflow targets. Should additional releases from storage (or bypasses of storage) be needed to meet the outflow targets, Oroville releases would be considered as long as storage was considered sufficient for other tributary and carryover purposes. If the projected end-of-May Oroville storage, using the 90% forecast of the Feather River unimpaired flow, is</td><td>• The high spring Delta outflow goals were simulated as part of the BDCP high outflow scenario based on “forecasted” March–May eight-river index. Since long-term historical (1922–2003 hydrologic period used in CALSIM II) forecast of the March–May eight-river index values were not available, an approximate method was developed to project the March–May eight-river index based on assumed known information (e.g., measured January–February eight-river index). This method introduces a realistic level of uncertainty in the model implementation, but is not directly a forecast-based approach as would be implemented in real-time operations. In the CALSIM II modeling, the spring outflow targets were determined based on this “estimated” March–May eight-river index value. The estimated values can be considered something akin to a median or mean projection since it is not methodically-biased towards any side of the distribution. Should a more conservative method be implemented, the high outflow targets would need to be adjusted to achieve the same frequency of achievement.
• Forecasts of end-of-May Oroville storage, on the other hand, are based on a reconstructed 90% forecast of Feather River unimpaired inflow. The procedure to forecast Oroville storage is similar to that which is used for seasonal operations planning.</td></tr>
</table>

Parameter	Criteria	Summary of CALSIM Modeling[a]
	greater or equal to the 2 MAF target, then additional reservoir releases would be made. However, under no circumstances would Oroville releases for spring outflow targets exceed 17,000 cfs (powerhouse capacity). Assigning the spring outflow targets based on a forecasted March–May eight-river index ensures that the outflow targets are likely to be met at the frequency. • Alternatively, if best available science resulting from structured hypothesis testing developed through a collaborative science program shows that Delta foodweb has improved, and evidence from the collaborative science program shows that longfin smelt abundance is not strictly tied to spring outflow, the alternative operation under the decision tree for spring outflow would be to follow flow constraints established under D-1641. A spring outflow operation could also be selected in between the flow constraints established under D-1641 and the spring high outflow outcome of the decision tree. • February, June: Flow constraints established under D-1641 will be followed. • All other months: No constraints.	
Fall outflow	• September, October, November: As described in Section 3.4.1.4.4, *Decision Trees*, initial operations will be determined through the use of a decision tree. Within that tree, the evaluated starting operations would be to implement the USFWS (2008) BiOp requirements, and the alternative operation would be to operate to D-1641 requirements. The alternative operation or a point in between the alternative operation and the USFWS (2008) BiOp requirements would be allowed, if the research and monitoring conducted through the collaborative science program show that the position of the low-salinity zone does not need to be located in Suisun Bay and the lower Delta, as required in the BiOp, to achieve the BDCP objectives for Delta smelt habitat and abundance. • All other months: No constraints.	• Same as CM1 criteria.
Winter and summer outflow	• [no changes]	• [no changes]
North Delta bypass flows	• [no changes]	• [no changes]
Export to inflow ratio	• [no changes]	• [no changes]

[a] See Table C.A-1, *CALSIM II Modeling Assumptions for Existing Conditions (EBC1), No Action Alternative (EBC2) and BDCP Operational Scenarios*, in Appendix 5.C, Attachment 5.C.A.

[b] It has not yet been determined whether the combined export rate will include the diversion rate of the new north Delta diversions.

OMR = Old and Middle Rivers

Section 3.4.1.4.5, *Real-Time Operational Decision-Making Process*, was edited as shown below.

The CM1 real-time operational decision-making process (real-time operations [RTOs]) allows for short-term adjustments to be made to water operations, within the range of CM1 criteria described above in Section 3.4.1.4.3, *Flow Criteria*, in order to maximize conservation benefits to covered fish species and to maximize water supply[5]. RTOs would be implemented on a timescale practicable for each affected facility and are part of the water operating criteria for CM1, which will be periodically evaluated and possibly modified through the adaptive management program (Section 3.6). The RTOs will satisfy Water Code, section 85321:

The BDCP shall include a transparent, real-time operational decision-making process in which fishery agencies ensure that applicable biological performance measures are achieved in a timely manner with respect to water system operations.

As part of the BDCP, a Real Time Operations Team (RTO Team), comprising one representative each from USFWS, NMFS, CDFW, Reclamation, and DWR, will be assembled. The RTO Team will also include one representative of the SWP contractors and one representative of the CVP contractors, who will serve as nonvoting members. The voting members may, by consensus, expand the membership of the RTO Team. The RTO Team[6] will be responsible for evaluating real-time hydrology, operations, and fish data, and will use that information to make adjustments in operations. The RTO representatives will utilize technical teams (e.g., Smelt Working Group, Delta Operations for Salmonids and Sturgeon) and/or a subset of technical teams comprising PWA members and other interested parties (e.g., Delta Conditions Team) to provide and help evaluate the necessary information to assist them in their decision making. When developing adjustments to CM1 operations, in real-time, the RTO Team will consider the following.

- Covered fish species risks.
- Necessary actions to avoid adverse effects on covered fish species.
- Allocations in the year of action or in future years.
- End of water year storage.
- San Luis Reservoir low point.
- Delivery schedules for any SWP or CVP contractor.
- Actions that could be implemented throughout the year to recover any water supplies reduced by actions taken by the RTO team.

Consistent with Chapter 6, Section 6.3.2, *Annual Delta Water Operations Plan*, the RTO team will work with DWR and Reclamation to inform development of the Annual Delta Water Operations Plan. Prospectively, and consistent with the criteria establish in CM1 and the considerations enumerated above, the RTO Team will identify for the coming water year estimates of the potential adjustments to planned operations. These estimates will include the likely relative priority of different responses that the RTO Team might bring into play during RTOs and key tools that may be used to choose among them, the intended benefits for covered fish species, any expected effects on water supply, and the monitoring and analysis protocols in place to track potential adjustments. During the course of the year, the RTO Team will track and document real time operational adjustments as they are implemented in relation to what was identified in the Annual Delta Water Operations Plan, assess the effect of such adjustments on covered species and quantify effects on water supply resulting from the adjustment to planned operations. Accounting for the effects of an adjustment must consider other relevant factors that are potentially affecting planned operations, such as changing hydrology, operational failures, or obligations to meet the State Water Resource Control Board's water quality standards. Retrospectively, the RTO Team will report the tracking and accounting information to describe for each operational adjustment the environmental conditions that triggered the adjustment, the specific adjustment(s) that were made to planned operations, and the effects of the adjustments on water supply and covered fish species. The RTO Team will also document use of the Adaptive Management Fund as part of the real time operations. Documentation of any adjustment

[5] Real-time operations also apply to the Fremont Weir operable gate, as described in CM2.

[6] The RTO Team will develop its operating procedures and any other details of its governance structure.

that was made to operations, and the effect, if any, of the adjustment on water supply, will include information regarding the circumstances that warranted an adjustment and the expected benefits to covered species and to water supply.

The RTO Team will provide a publicly available website or other electronic medium to post information considered by the RTO Team, which may include real-time hydrology, operations, and fish data, and the operational changes made in response to these conditions. Posted information will be provided to the Implementation Office for inclusion in the Annual Water Operations Report. This information will be used by the RTO Team to review the efficacy of adjustments made to improve future decisions and inform development of subsequent Annual Delta Water Operations Plans.

The RTO Team will operate by consensus when making recommendations related to real time adjustments to water operations. In the event that consensus cannot be reached among the RTO Team, the matter will be elevated to the director of CDFW, the Regional Director of the relevant fish and wildlife agency, the director of DWR, and the regional director of Reclamation. Absent the concurrence of the relevant agency directors, the disputed real time operational adjustment will not be made.

The operational adjustments effectuated through the real time process apply only to the facilities and activities identified in CM1 and CM2. RTOs are expected to be needed during at least some part of the year at the Delta Cross Channel gates, Head of Old River gate, north and south Delta diversions, and the Fremont Weir Operable Gates. The RTO Team in making operational decisions will take into account upstream operational constraints, such as coldwater pool management, instream flow, and temperature requirements. The extent to which real time adjustments that may be made to each parameter related to these facilities shall be limited by the criteria and/or ranges set out in CM1 and CM2. That is, operational adjustments shall be consistent with the criteria, and within any ranges, established in the Conservation Measures. Any modifications to the parameters subject to real time operational adjustments or to the criteria and/or ranges set out in CM1 or CM2 shall occur only through the adaptive management program or by Plan amendment. Similarly, any changes to the facilities or activities subject to real time operational adjustments shall occur only through the adaptive management program or by Plan amendment.

Delta Cross Channel gates. The gates will be managed under RTOs from October 1 to November 30. The gates will be closed for a prescribed duration (i.e., a variable number of days during October through November) when juvenile salmonids are emigrating past the gates.

Head of Old River gate. The gate will be managed under RTOs from January 1 through June 15, and October 1 through November 30, based on real-time monitoring for the presence/absence of covered fishes, hydrologic conditions, and species risk. In determining the opening and closure of the Head of Old River gate, the fish and wildlife agencies' goal is to have the gate closed as much as possible in February through June 15; however, the gate may be open subject to RTO for purposes of water quality, stage, and flood control considerations. The final BDCP document will provide operational guidance for use by project operators in implementing these provisions.

North Delta diversions. Bypass flow operations will be managed under RTOs from December through June based on the presence of covered fish species and basin hydrology in order to improve survival past the diversions. The exact triggers and responses for RTO at the north Delta diversions are still under development. The various levels of pumping under CM1 are designed to protect salmonids during the expected presence of runs based on hydrology and expected migration timing. During operations, adjustments may be made to improve water supply and/or migratory conditions for fish by making real-time adjustments to the pumping levels at the north Delta diversions. Generally, RTOs will do the following.

- Manage north Delta diversion bypass flows within a preset range when juvenile salmonids are emigrating downstream past the intakes.
- Manage north Delta diversion bypass flows within a preset range when adult sturgeon are migrating upstream.

- Manage north Delta diversion bypass flows within a preset range to avoid an increase in frequency and magnitude of reverse flows (and entrainment) at Georgiana Slough compared to baseline. (Real-time adjustments to avoid reverse flows are primarily the responsibility of DWR operators with occasional input from RTO team as appropriate.)
- Manage the distribution of pumping activities among the three north Delta and two south Delta intake facilities to maximize survival of covered fish species in the Delta and water supply.

South Delta diversions. The south Delta diversions will be managed under RTO to achieve OMR criteria described in CM1 throughout the year based on fish protection triggers (e.g., salvage density, calendar, species distribution, entrainment risk, turbidity, and flow based triggers [Table 3.4.1-3]). Increased restrictions as well as relaxations of the OMR criteria may occur as a result of observed physical and biological information. Additionally, as described above for the north Delta diversions, RTO would also be managed to distribute pumping activities amongst the three north Delta and two south Delta intake facilities to maximize both survival of covered fish species in the Delta and water supply.

Table 3.4.1-3. Salvage Density Triggers for Old and Middle River Flow Adjustments January 1 to June 15

[no changes to table text]

Fremont Weir operable gate(s). The Fremont Weir operable gate(s) may be subject to RTOs from November 10 through May 15, when Sacramento River flow is high enough to support the diversion of water into the Yolo Bypass. Up to 500 cfs may be diverted into the bypass during May 16 to November 9 only for purposes of providing fish passage. Additional detail is provided in *CM2 Yolo Bypass Fisheries Enhancement* (Section 3.4.2.3, *Implementation*).

Section 3.4.1.5, *Adaptive Management and Monitoring*, has been largely superseded by text presented in Section 3.6. However, Table 3.4.1-5. *Key Uncertainties and Potential Research Actions Relevant to CM1* has been retained, with the following changes.

Table 3.4.1-5. Key Uncertainties and Potential Research Actions Relevant to CM1

Key Uncertainty	Proposed Research Actions	Timeframe
Are the initial spring outflow criteria (listed in Table 3.4.1-1) necessary, in conjunction with other conservation measures in the Plan, to achieve the biological objectives for covered smelt species?	[Studies necessary to evaluate this uncertainty, which is the root of the spring outflow decision tree, have not yet been determined.]	Completion prior to initial operation of north Delta diversions
Is the USFWS Reasonable and Prudent Alternative (RPA) action for Fall X2 (listed in Table 3.4.1-1) necessary, in conjunction with other conservation measures in the Plan, to achieve the delta smelt biological objectives?	[Studies necessary to evaluate this uncertainty, which is the root of the fall outflow decision tree, have not yet been determined.]	Completion prior to initial operation of north Delta diversions
Improve understanding of the relationship between flow regimes and year class recruitment for green and white sturgeon	Reanalysis of existing year-class strength data (e.g., from Fish [2010], with updates for additional years), with model selection of various potential explanatory flow variables (e.g., flows upstream of the Plan Area, flows within the Plan Area) in order to test clearly defined hypotheses (e.g., winter flows are important to migrating adults to stimulate upstream migration and gonadal maturation; Fish 2010). Possible field studies involving acoustically tagged sturgeon in the Plan Area to assess the importance of Delta outflow on adult and juvenile migration success.	Completion prior to initial operations of north Delta diversions, if possible, with additional study following implementation of CM1
Relationship between proposed intake design features and expected intake performance relative to minimization of entrainment and impingement risks.	Develop physical hydraulic model(s) to optimize hydraulics and sediment transport at the selected diversion sites (same as preconstruction study 1, *Site Locations Lab Study* [Fish Facilities Working Team 2013]).	10 months to perform study; needed prior to final design
Evaluation of tidal effects and withdrawals on flow conditions at screening locations	Develop site-specific numerical studies (mathematical models) to characterize the tidal and river hydraulics and the interaction with the intakes under all proposed design operating conditions (same as preconstruction study 2, *Site Locations Numerical Study* [Fish Facility Working Team 2013]).	8 months; needed prior to final design

Key Uncertainty	Proposed Research Actions	Timeframe
Design of refugia areas (macro, micro, and base refugia)	Test and optimize the final recommendations for refugia that will be required for installation at the north Delta diversion facilities (same as preconstruction study 3, *Refugia Lab Study* [Fish Facility Working Team 2013]).	9 months; needed prior to final design
Examination of refugia at future fish screens.	Evaluate the effectiveness of using refugia as part of diversion structure design for the purpose of providing areas for juvenile fish passing the screen to hold and recover from swimming fatigue and to avoid exposure to predatory fish. In addition, gain insights (through observation) into the biological benefits of incorporating refugia into diversion structures (same as preconstruction study 4, *Refugia Field Study* [Fish Facility Working Team 2013]).	2 years; needed prior to final design
Characterize the water velocity distribution at river transects within the proposed intake reaches for differing river flow conditions.	Characterize the water velocity distribution at river transects within the proposed diversion reaches for differing flow conditions. Water velocity distributions in intake reaches will identify how hydraulics change with flow rate and tidal cycle (same as preconstruction study 7, *Flow Profiling Field Study* [Fish Facility Working Team 2013]).	1 year; needed prior to final design
What are the effects of deep-water screens on hydraulic performance	Use a computational fluid dynamics model to identify the hydraulic characteristics of deep fish screen panels (same as preconstruction study 8, *Deep Water Screens Study* [Fish Facility Working Team 2013]).	9 months; needed prior to final design
How will the new north Delta intakes affect survival of juvenile salmonids in the affected reach of the Sacramento River?	Determine baseline rates of survival for juvenile Chinook salmon and steelhead within the Sacramento River in the vicinity of proposed north Delta diversion sites for comparison to post-project survival in the same area, with sufficient statistical power to detect a 5 percent difference in survival. Following initiation of project operations, continue studies using same methodology and same locations. Identify the change in survival rates due to construction/operation of the intakes (same as preconstruction study 10, *Reach-Specific Baseline Juvenile Salmonid Survival Rates*, and postconstruction study 10, *Post-Construction Juvenile Salmon Survival Rates* [Fish Facilities Technical Team 2011; Fish Facility Working Team 2013]).	Preconstruction study at least 3 years; must be completed before construction begins. Postconstruction study to cover at least 3 years, sampling during varied river flows and diversion rates.
How will the new north Delta intakes affect Delta and longfin smelt density and distribution in the affected reach of the Sacramento River?	Determine baseline densities and seasonal and geographic distribution of all life stages of covered fish species inhabiting reaches of the lower Sacramento River where proposed north Delta diversion structures will be sited. Following initiation of diversion operations, continue sampling using same methods and at same locations. Compare to baseline catch data. Identify potential changes due to construction of intakes (same as preconstruction study 11, *Baseline Fish Surveys*, and postconstruction study 11, *Post-Construction Fish Surveys* [Fish Facilities Technical Team 2011; Fish Facility Working Team 2013]).	Preconstruction study, at least 3 years. Post-construction studies to be performed for duration of project operations, with timing and frequency to be determined.
What is the relationship between Delta Cross Channel gates operations, covered fish movement and survival, and tidal flows?	Document effects of Delta Cross Channel gates operations on hydrodynamics and fish migration.	To be determined

Key Uncertainty	Proposed Research Actions	Timeframe
To what extent does CM1 change the abundance and distribution of *Microcystis*?	Assess abundance and distribution of *Microcystis* using field studies such as those of Lehman et al. (2005, 2010).	Summer months following implementation of CM1 (i.e., after north Delta intakes are completed and diversions at the south Delta export facilities decrease). Multiple year study to capture hydrological and operational variability.
How do north Delta intake bypass flows, Delta Cross Channel gate operations, and tidal habitat restoration under CM4 influence covered fish (primarily juvenile salmonid) movement and survival, in particular in relation to entry into the interior Delta through Georgiana Slough and the Delta Cross Channel?	Conduct modeling including CM1 operations and proposed CM4 site designs to assess hydrodynamics in Plan Area channels. Using acoustic tag studies, assess fish survival and movement in the Plan Area, particularly at the Sacramento River-Georgiana Slough junction (would be studied as part of CM16 assessment). Use flow data from existing gauges to derive Sacramento River inflow relationships with the flow split at the Sacramento River-Georgiana Slough divergence before and after implementation of CM1 and CM4.	3–5 years of study prior to CM1 implementation; 3–5 years of study following CM1 and CM4 implementation; number of years dependent on hydrology encountered and schedule of restoration.
What is the importance of flow for survival of juvenile Chinook salmon (fry/foragers) spending longer periods of time in the Plan Area, and how is survival affected by CM1 operations?	Use a combination of modeling and field studies: modeling would consist of assessing changes in survival based on foraging/fry survival from the in preparation NMFS life cycle model for Chinook salmon (Hendrix et al. 2014). Field studies would consist of tagging and detection of fry-sized Chinook salmon in order to estimate survival and its relationship to flow (as determined from appropriate gauges), using the latest technology in order to document effects on smaller individuals than have been examined to date.	For modeling, 2 years of study commencing immediately upon plan implementation, or as soon as possible after the life cycle model becomes available. For field study, 3–5 years of study prior to CM1 implementation in order to capture years with different varying hydrology; 3–5 years of study after CM1 implementation.
Do lower attraction flows below the north Delta intakes result in greater straying of upstream migrating adult anadromous fishes from the Sacramento River region?	Capture and acoustically tag adult salmonids and sturgeons in San Francisco Bay or Suisun Bay, then track movement using existing hydroacoustic array. Assess proportion entering non-natal river region, then relate this to flow experienced during migration period. As an alternative or in addition, a study of existing coded-wire tag data from recovered carcasses could be done, in a similar manner to that of Marston et al. (2012), in order to assess the rate of straying in relation to flows during upstream migration.	For field study, 3–5 years of study prior to CM1 implementation in order to capture years with different varying hydrology; 3–5 years of study after CM1 implementation.

Key Uncertainty	Proposed Research Actions	Timeframe
To what extent does the BDCP reduce straying of adult San Joaquin River region fall-run Chinook salmon?	Following the suggestions of Marston et al. (2012: 19), assess the influence on straying rate (as measured by coded wire tag returns) of 1) relative roles of south Delta exports and San Joaquin River flow, 2) the timing of pulse flows and export reductions, and 3) the role of pulse flows versus base flows. Changes in these factors and stray rate following implementation CM1 would be examined, in addition to changes in total escapement.	Depending on data availability, comparisons could be made between pre- and post-implementation of CM1, using data collected over several years representing a range of water-year types.
How do less south exports and the head of Old River operable gate, together with other conservation measures, influence through-Delta survival of San Joaquin River region juvenile salmonids?	Assess survival using acoustically tagged juvenile salmonids, employing methods similar to those of Buchanan et al. (2013). Overall through-Delta survival, together with reach-specific (e.g., head of Old River to middle River) and pathway-specific (e.g., Chipps Island via Old River) survival, would be used to assess the importance of CM1 operations as well as the effectiveness of other measures such as CM5 and CM15. Predation near the proposed head of Old River barrier (at and near the operable gate) would be studied with a multi-receiver hydroacoustic array.	Conduct 3–5 years of study prior to CM1 implementation in order to capture years with varying hydrology; and another 3–5 years of study after CM1 implementation.

11F.3.2.2 Section 3.4.2, *CM2 Yolo Bypass Fisheries Management*

CM2 Yolo Bypass Fisheries Management received extensive edits, as shown below.

Section 3.4.12 CM2 Yolo Bypass Fisheries Management

Under *CM2 Yolo Bypass Fisheries Enhancement*, the Implementation Office will modify the Yolo Bypass to increase the frequency, duration, and magnitude of floodplain inundation, and will conduct a diverse suite of further actions in the area intended to achieve beneficial outcomes for covered fish species. The conservation measure will improve passage and habitat conditions for Sacramento splittail, Chinook salmon, green and white sturgeon, Pacific and river lamprey, and possibly steelhead. The increased floodplain inundation and water surface will increase the regional supply of invertebrates that fish prey upon, which is expected to contribute to an increase in growth rates that is expected to in turn contribute to an increase in survival and subsequently the numbers of fish and other aquatic species (Sommer et al. 2004). This increased productivity will also potentially benefit other areas as it is transported off the floodplain and downstream within the Cache Slough Complex and the Sacramento River.

CM2 will be implemented in four phases (Section 3.4.2.3.3, *Timing and Phasing*), starting upon issuance of final permit and continuing to approximately 2063. Refer to Chapter 6, *Plan Implementation*, for additional details on the timing and phasing of CM2. Refer to Appendix 3.C, *Avoidance and Minimization Measures*, for a description of measures that will be implemented during construction activities to ensure that effects of CM2-related actions on covered species will be avoided or minimized.

While the primary function of the Yolo Bypass is a flood protection facility, the Yolo Bypass also provides many other functions and uses, such as; agriculture, waterfowl habitat, recreation and education. All of these functions and uses must be considered, and current, ongoing planning actions must be mindful of these other functions and uses. Coordination with the various stakeholders that represent these other functions and uses is very important, as is coordination between BDCP and other local, state and federal planning actions.

Besides BDCP and CM2, other local, state and federal planning actions are also proposed within the Yolo Bypass, including those proposed in the *2012 Central Valley Flood Protection Plan* and the *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan*. The *Central Valley Flood Protection Plan* (California Department of Water Resources 2012a) is a comprehensive new framework for system-wide flood management and flood risk reduction in the Sacramento and San Joaquin Basins. The actions covered in CM2 overlap with elements of this plan; therefore, DWR incorporated ecosystem enhancement activities into the plan.

The actions covered by the *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan* (Bureau of Reclamation and California Department of Water Resources 2012) are intended to address two of the Reasonable and Prudent Alternative (RPA) actions outlined in the NMFS (2009) BiOp: RPA Action I.6.1 and RPA Action I.7. RPA Action I.6.1 (Restoration of Floodplain Rearing Habitat) requires increased seasonal inundation in the lower Sacramento River Basin, and RPA Action I.7 (Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass) requires multispecies fish passage improvements within Yolo Bypass and assessment of their performance. While there are differences in the requirements of the NMFS (2009) BiOp and CM2, both RPA actions are intended to be covered under Conservation Measure CM2, as are two other Reasonable and Prudent Alternatives presented in the NMFS (2009) BiOp; RPA I.6.3 (Lower Putah Creek Enhancements) and I.6.4 (Improvements to Lisbon Weir). It is worth noting too, that the NMFS (2009) BiOp does not cover fall-run/late fall–run Chinook salmon, as they are not protected under the federal Endangered Species Act (ESA). Likewise, Sacramento splittail are not covered under the USFWS (2008) BiOp, as they are not protected under the federal ESA either. Both fall-run/late fall–run Chinook salmon and Sacramento splittail are covered fish species in BDCP.

The necessary integration of these separate but overlapping processes will occur formally once the BDCP has been approved, particularly the integration of the *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan* and BDCP, as well as any planning/implementation of RPAs I.6.2., I.6.3., and I.6.4., since if approved BDCP will become the vehicle for affecting change in Yolo Bypass and the NMFS (2009) BiOp and actions in response to the BiOp will be superseded by the BDCP and any related Section 7 consultation documents. Until that time however, coordination will continue to occur through the Yolo Bypass Fishery Enhancement Planning Team and other meetings appropriate for the sharing of information, planning and relevant discussion and coordination, as appropriate. The Yolo Bypass Fishery Enhancement Planning Team provides a forum to discuss and coordinate the integration of these and other ongoing planning efforts in the Yolo Bypass.

Other local, state and federal planning actions occurring in the Yolo Bypass include, but are not limited to: The Delta Plan (*Delta Stewardship Council*); Yolo County Natural Heritage Program (*Yolo County*); Mosquito Reduction BMPs (*Sacramento-Yolo Mosquito and Vector Control District*); Yolo Bypass Wildlife Area LMP (*CDWF, Yolo Basin Foundation*); Local Landowner Concepts (*e.g., Cal Marsh and Farm Ventures, LLC, California Trout, Knaggs Ranch LLC*); FloodProtect (*e.g., West Sacramento Area Flood Control Agency, Yolo County, Sacramento Area Flood Control Agency*); Yolo County Drainage and Water Improvement Study (*Yolo County*); Westside Sacramento Integrated Regional Water Management Plan (*e.g., Water Resources Association of Yolo County*); Ecosystem Restoration Program (*CDFW, USFWS, NMFS*), and; County General Plans (*Sacramento, Solano, Yolo, Sutter*).

These various programs and planning efforts all have different, and in some cases overlapping, goals and requirements. The various programs and planning efforts are at various stages of completion and have different timelines for implementation. Coordination between the various, ongoing programs and planning efforts, as well as potential future programs and planning efforts is very important and will continue to occur moving forward. As mentioned above, for CM2 the primary forum for presenting information and coordinating with stakeholders and other interested parties is the Yolo Bypass Fishery Enhancement Planning Team meetings, which occur semi-regularly (information on past meetings and upcoming meetings can be found on the BDCP web site at the following link - http://baydeltaconservationplan.com/PlanningProcess/BDCP/WorkingGroups/WorkingGroup-YoloBypass.aspx). It is anticipated that these meetings and other efforts related to stakeholder coordination will continue throughout the development of the Yolo Bypass Fisheries Enhancement Plan and EIR/EIS (Section 3.4.2.3.2, *Yolo Bypass Fisheries Enhancement Plan and EIR/EIS*). As the Yolo Bypass Fishery Enhancement Plan and EIR/EIS are developed, the continued coordination with stakeholders will provide important insights and considerations for each of the Component Projects that have been conceptually developed as part of CM2, and will be fully vetted within the Yolo Bypass Fishery Enhancement Plan and EIR/EIS (See Section 3.4.1.3.2, below for further information).The adverse and beneficial effects of CM2 are evaluated in Appendix 5.C, *Flow, Passage, Salinity, and Turbidity*; Appendix 5.D, *Contaminants*; Appendix 5.E, *Habitat Restoration*; Appendix 5.F, *Biological Stressors on Covered Fish*; and Appendix 5.H, *Aquatic Construction and Maintenance Effects*. This information supports Chapter 5, *Effects Analysis*.

3.4.2.1 Purpose

The primary purpose of CM2 is to meet or contribute to achieving the biological goals and objectives related to the survival, migration, distribution, and reproduction of covered fish species and to enhance natural ecological processes. CM2 will enhance the floodplain function of Yolo Bypass and improve connectivity to the Sacramento River for covered fish species by increasing the frequency, magnitude, and duration of floodplain inundation. CM2 will also improve fish passage at the Fremont Weir for covered fish species through structural and topographic modifications.

Increased frequency of inundation will enhance existing connectivity between the Sacramento River and Yolo Bypass floodplain habitat. Also, it can increase production of zooplankton and dipteran larvae (prey resources for covered fish species), mobilization of organic material, and primary production, with conditions suitable for spawning, egg incubation, and larval stages for covered fish species such as Sacramento splittail (if inundation is greater than 30 days), as splittail require 30 days for successful spawning, egg incubation and larval development. Inundation of 30 days or more will also benefit juvenile Chinook salmon that use the inundated floodplain for rearing by providing sufficient time for food resources to develop, such as macroinvertebrates. Seasonal flooding in the bypass will occur when it will be most effective at supporting native fish species (i.e., when it is in synchrony with the natural timing of seasonally occurring hydrologic events in the watershed).

Increased magnitude of inundation has the potential to increase primary and secondary aquatic productivity. Flooding increases the volume of water (areal extent and depth) in the photic zone, allowing for conditions that can result in increases in phytoplankton biomass. Increased biomass may lead to an increase in the abundance of zooplankton and planktivorous fish. This increase in primary and secondary productivity in the foodweb is expected within the immediate Yolo Bypass area, but may also be exported downstream with the phytoplankton and zooplankton (Sommer et al. 2001b).

Increased duration of inundation is expected to increase production of zooplankton and dipteran larvae (prey resources for covered fish species), mobilization of organic material, and primary production. Inundation lasting more than approximately 30 days between March 1 and May 15 is expected to benefit Sacramento splittail spawning and juvenile production. Adult splittail typically migrate upstream in January and February and spawn on seasonally inundation floodplains in March and April. In May the juveniles migrate back downstream (Moyle et al. 2004). Short-duration inundation (less than 30 days) events are expected to result in a lesser benefit to juvenile salmon growth when compared to inundation that extends longer than 30 days (BDCP Integration Team 2009).

Improved fish passage is anticipated through modifications to topography and weirs, which are expected to improve fish passage and reduce the risk of migration delays and stranding of adult fish. Stranding of fish and subsequent predation by birds and piscivorous fish have been identified as sources of mortality for juvenile salmon rearing within the floodplain habitat (Sommer et al. 2001b, 2005; BDCP Integration Team 2009). Illegal harvest of covered fish species may also be a source of mortality that could be exacerbated by existing migration delays, low flows, and stranding caused by shorter inundation periods.

Specifically, this conservation measure will advance the following benefits.

- Provide access to additional spawning habitat for Sacramento splittail (Sommer et al. 2001a, 2002, 2007a, 2008; Moyle 2002; Moyle et al. 2004; Feyrer et al. 2006). Because splittail are primarily floodplain spawners, successful spawning is predicted to increase with increased floodplain inundation.

- Provide additional juvenile rearing habitat for Chinook salmon, Sacramento splittail, and possibly steelhead (Sommer et al. 2001a, 2001b, 2002, 2007a, 2008; Moyle 2002; Moyle et al. 2004; Feyrer et al. 2006). Growth and survival of larval and juvenile fish can be higher within the inundated floodplain compared to those rearing in the mainstem Sacramento River (Sommer et al. 2001b).

- Improve downstream juvenile passage conditions for Chinook salmon, Sacramento splittail, river lamprey, and steelhead and Pacific lamprey. An inundated Yolo Bypass is used as an alternative to the mainstem Sacramento River for downstream migration of juvenile salmonids, Sacramento splittail, river lamprey, and sturgeon; rearing conditions and protection from predators are believed to be better in this area. Sommer et al. (2003, 2004) found that, other than steelhead and Pacific lamprey, juveniles from all of these species inhabit the Yolo Bypass during periods of inundation. The expected increased habitat and productivity resulting from increased inundation of Yolo Bypass are likely to also provide some benefits to covered species, including steelhead and lamprey.

- Improve adult upstream passage conditions of migrating fish using the bypass such as Chinook salmon, steelhead, sturgeon, and lamprey. An inundated Yolo Bypass is used as an alternative route by upstream migrating adults of these species when Fremont Weir is spilling. Increasing the frequency and duration of fish passage during inundation events will provide improved conditions for more covered species over longer portions of their migrations. However, the increased use of the bypass could put more fish at risk, if stranding conditions occur when flows are reduced. The overall benefits of providing additional flow in the bypass will be assessed through adaptive management (Section 3.6, *Adaptive Management and Monitoring Program*). Monitoring for fish stranding will also be implemented, and fish salvage and rescue operations will be carried out, as necessary, to avoid stranding and migration delays for covered fish species.
- Increase food for rearing salmonids, Sacramento splittail, and other covered species on the floodplain (Sommer et al. 2001a, 2001b, 2002, 2004, 2007a, 2008; Moyle 2002; Moyle et al. 2004; Feyrer et al. 2006). During periods when the bypass is flooded, a relatively high production of zooplankton and macroinvertebrates serves, in part, as the forage base for many of the covered fish species (Benigno and Sommer 2008; Moyle et al. 2004).
- Increase the availability and production of food in the Delta, Suisun Marsh, and bays downstream of the bypass, including restored habitat in Cache Slough, for delta smelt, longfin smelt, and other covered species, by exporting organic material and phytoplankton, zooplankton, and other organisms produced from the inundated floodplain into the Delta (Schemel et al. 1996; Jassby and Cloern 2000; Mitsch and Gosselink 2000; Lehman et al. 2008).
- Increase the duration of floodplain inundation and the amount of associated rearing habitat and increase migration pathways during periods that the Yolo Bypass is receiving water from both the Fremont Weir and the westside tributaries (e.g., Cache and Putah Creeks).
- Reduce losses of adult Chinook salmon, sturgeon, and other fish species to stranding and illegal harvest by improving upstream passage at the Fremont Weir (*CM17 Illegal Harvest Reduction*) and monitoring for fish stranding below Fremont Weir as flow into Yolo Bypass from the Sacramento River recedes. As necessary, implement fish salvage and rescue operations to avoid stranding and migration delays for covered fish species.
- Reduce the exposure and risk of juvenile fish migrating from the Sacramento River into the interior Delta through the Delta Cross Channel and Georgiana Slough, by passing juvenile fish into and through the Yolo Bypass upstream of the interior Delta (Brandes and McLain 2001). Studies of south Delta predation have found that the number of fish is approximately proportional to flow, e.g., if 25% of flow goes into the Bypass, it will probably convey about 25% of the migrating juvenile salmonids, unless a nonphysical barrier is used.
- Reduce the exposure of outmigrating juvenile fish to entrainment or other adverse effects associated with the proposed north Delta intakes and the proposed Barker Slough Pumping Plant facilities by passing juvenile fish into and through the Yolo Bypass upstream of the proposed intakes.
- Improve fish passage, and possibly increase and improve seasonal floodplain habitat availability, by retrofitting Los Rios Check Dam with a fish ladder, or creating another fish-passable route by which water from Putah Creek can reach the Toe Drain.

Increasing the frequency, magnitude, and duration of inundation in the Yolo Bypass is the largest opportunity for enhancing seasonally inundated floodplain that serves as habitat for covered species in the Central Valley. The Yolo Bypass is the only floodplain in the Plan Area that can be managed for habitat and species benefits without the restoration of historic floodplains that have been disconnected and/or developed for year-round land uses.

3.4.2.2 Problem Statement

[unchanged text omitted]

3.4.2.2.1 Flow Management in the Yolo Bypass

The Yolo Bypass is the largest contiguous floodplain on the lower Sacramento River. The bypass is a central feature of the Sacramento River Flood Control Project, which conveys floodwaters from the Sacramento and Feather Rivers and their tributary watersheds. Unlike conventional flood control systems that frequently isolate rivers and ecologically essential floodplain habitat, the Yolo Bypass has been engineered to allow Sacramento Valley floodwaters to inundate a broad floodplain.

The primary input to the Yolo Bypass is through the Fremont Weir[7]. Flow pulses in the Sacramento River are first diverted into Sutter Bypass, an 18,000-acre agricultural floodplain with many similarities to the Yolo Bypass; the Sacramento River immediately upstream of Fremont Weir has a relatively low channel capacity (28,250 cubic feet per second [cfs]), so Sutter Bypass flooding is often initiated in modest flow pulses (Sommer et al. 2001b). When the combined flow of Sutter Bypass and the Sacramento and Feather Rivers raises water levels at Fremont Weir to an elevation of 32.8 feet National Geodetic Vertical Datum of 1929, which typically occurs when combined total flow from these sources surpasses 55,000 cfs (Sommer et al. 2001b), flows begin to enter Yolo Bypass. Water entering the Yolo Bypass due to an overtopping of the Fremont Weir occurs in approximately 70% of water years (California Department of Water Resources 2012b)[8]. Complete inundation of the Yolo Bypass floodplain (which is 59,000 acres, or 92 square miles) typically occurs during significant flooding events, not from a typical overtopping event. Typical overtopping events do not result in complete inundation of the Yolo Bypass. When the Yolo Bypass is completely inundated during a significant flooding event, the area of inundation approximately doubles the wetted area of the Delta. Based on recent hydrologic modeling, preliminary results indicate that in general the wetted area from November 1 through May 30 in 67% of years currently ranges from approximately 25,000 acres wetted for 2 days to approximately 6,250 acres wetted for 30 days.

Floodwaters entering over Fremont Weir initially flow through scour channels to the Tule Pond, then into the Tule Canal, a perennial channel north of the Sacramento Weir, and the Tule Canal/Toe Drain, a perennial channel south of the Sacramento Weir on the eastern edge of the bypass. Floodwaters then spill onto the floodplain when discharge in the Toe Drain exceeds the channel capacity, at approximately 2,000 to 3,000 cfs, depending upon location along the Toe Drain. In major storm events, additional water enters from the east via Sacramento Weir, adding flow from the American and Sacramento Rivers (Sommer et al. 2001b). Flow also enters the Yolo Bypass from several small westside tributaries: Knights Landing Ridge Cut, Cache Creek, Willow Slough Bypass, and Putah Creek. These tributaries can augment the Sacramento River Basin floodwaters or cause localized floodplain inundation before Fremont Weir spills occur (Sommer et al. 2001b).

Management of the Fremont Weir is considered passive because the U.S. Army Corps of Engineers designed the weir to overtop at a specific stage and allow inundation of the Yolo Bypass floodplain. The Fremont Weir has no facilities to adjust the flow entering the Yolo Bypass. The Sacramento Weir, on the other hand is a needle dam, the top portion of which is manually operated to selectively change the flow split between the Sacramento River mainstem and the Yolo Bypass.

3.4.2.2.2 Floodplain Habitat

The Yolo Bypass is important in terms of agricultural production, wildlife and aquatic habitat, recreation (e.g., waterfowl hunting and bird or wildlife viewing), and educational opportunities. Seasonal inundation of the Yolo Bypass limits the types of crops that can be grown. Orchards and

[7] The Fremont Weir, located between river miles 81.7 and 83.4, is a fixed concrete weir constructed by USACE. It is 9,120 feet long, with an earthfill section dividing it into two parts. The crest of the concrete weir section is at elevation 33.5 feet (no vertical datum given), and the crown of the earthfill section is at an elevation of 47.0 feet (no vertical datum given) (U.S. Army Corps of Engineers 1955).

[8] This frequency is based on gage data from 1935 to 2012. Digital data are only available online for the period 1985–2012. Using only this data, the frequency of overtopping of the Fremont Weir is approximately 60%; using only data from the years after the completion of the Shasta Dam (1945–2012), the frequency of overtopping at the Fremont Weir is 69%.

winter crops are not viable. Agricultural crops grown in the bypass include rice (both wild and conventional), tomatoes, corn, millet, wheat, milo, and safflower. Cattle grazing occurs on approximately 8,000 acres of the bypass (California Department of Fish and Game 2008a).

The Yolo Bypass Wildlife Area makes up a considerable portion of the Yolo Bypass and is known to provide habitat for over two-hundred-and-eighty terrestrial vertebrate species, over 200 of which are birds, including 38 special-status species. Over 95% of all terrestrial vertebrate species found in the Yolo Bypass breed in the area. The Yolo Bypass Wildlife Area also provides habitat for hundreds of invertebrates and 24 special-status plants (Yolo Bypass Wildlife Area Land Management Plan 2007). In the winter and spring, flooded managed wetlands and agricultural fields provide important foraging habitat, especially for waterbirds. During the summer months, flooded rice fields provide important foraging and rearing habitat for the endangered giant garter snake and for breeding shorebirds. Other crops such as safflower, millet, milo, and sunflower provide insect prey for species such as the tri-colored blackbird, small mammal prey for predators such as the Swainson's hawk, and waste grain forage for waterfowl. Species such as burrowing owls, Swainson's hawks, and giant garter snake rely on the upland edge surrounding Yolo Bypass for foraging, breeding, and, in the case of the snake, refuge from winter flood events.

Yolo Bypass provides aquatic habitat for 42 fish species, 15 of which are native (Sommer et al. 2001a). The bypass seasonally supports several covered fish species, including delta smelt (typically found in the lower bypass, in the Cache Slough area), Sacramento splittail, steelhead, and spring-run, winter-run and fall-/late fall–run Chinook salmon. Typical winter and spring spawning and rearing periods for native Delta fish coincide with the timing of the flood pulse (Sommer et al. 2001b). The majority of the floodplain habitat is seasonally dewatered and is less likely to be dominated by nonnative fish species except in perennial waters.

Sommer et al. (2003) noted that floodplain inundation during high-flow years may favor several aquatic species in the estuary. The Yolo Bypass is an important nursery for young fish, and may help to support the foodweb of the San Francisco Estuary (Sommer et al. 2001b). Adult fish use the Yolo Bypass as a migration corridor (i.e., Chinook salmon and sturgeon) and for spawning (i.e., Sacramento splittail) (Harrell and Sommer 2003).

Physical structures in the bypass such as the Fremont Weir have been identified as impediments and potential barriers to successful upstream passage. Two primary passage issues exist.

- Passage impediments caused by existing structures within Yolo Bypass, which impede fish when Sacramento River water is flowing over the Fremont Weir.
- Flow attraction caused by westside tributary flows and the Cache Slough Complex tidal exchange when no water is flowing over the Fremont Weir and upstream passage is not possible under existing conditions.

3.4.2.2.3 Sacramento Splittail

Sacramento splittail show gradual upstream migration during the winter and spring to forage and spawn in flooded areas (Moyle 2002). Splittail spawn in seasonally inundated floodplain margin habitat associated with flooded vegetation (Sommer et al. 2001a; Moyle 2002; Moyle et al. 2004). Splittail typically spawn in late winter to spring, depositing adhesive eggs on submerged vegetation and other substrates. After hatching, the larvae and early juveniles forage and rear along the inundated floodplain prior to moving downstream into the estuary as waters recede.

[unchanged text omitted]

3.4.2.2.4 Chinook Salmon

[unchanged text omitted]

3.4.2.2.5 Sturgeon

Adult white sturgeon have been observed using the Yolo Bypass as an upstream migration corridor (BDCP Integration Team 2009; Harrell and Sommer 2003), and green sturgeon have been rescued from the Yolo Bypass at the Fremont Weir. In 2006, CDFW rescued 23 sturgeon (no species identification given) over the course of rescue operations at the Fremont Weir (Roberts pers. comm.). In 2011, 14 green sturgeon (and 19 white sturgeon) were rescued at the Fremont Weir (Healey and Vincik 2011). Thus, it appears that both species use the Yolo Bypass as a migration route (California Department of Fish and Game 2011). A recent set of studies provides design and operational criteria for sturgeon passage at Fremont Weir (California Department of Water Resources 2007; Webber et al. 2007). These criteria will provide guidance for developing anticipated modifications to the Fremont Weir to facilitate the Yolo Bypass Fisheries Enhancement Plan (YBFEP) and improve passage for adult sturgeon to reduce passage delays and stranding and related negative impacts. Refer to Section 3.4.2.3.2, *Yolo Bypass Fishery Enhancement Plan and EIR/EIS* below, for more information on the YBFEP and the YBFEP EIR/EIS.

[unchanged text omitted]

3.4.2.2.6 Other Covered Fish Species

[unchanged text omitted]

3.4.2.2.7 Covered Wildlife Species

Giant garter snakes in the Yolo Bypass are part of the Yolo Basin/Willow Slough subpopulation addressed in the recovery plan for this species (U.S. Fish and Wildlife Service 1999). This population centers on the western Yolo Bypass levee with the majority of reported occurrences west of the bypass, and along the western side of the interior of the bypass. Possible reasons for fewer giant garter snakes on the eastern side of the bypass include more frequent and longer-duration inundation events due to lower elevations on the east side, and the potential for predation along the Toe Drain.

Giant garter snakes forage and find cover in rice fields, wetlands, and adjacent uplands during their active season (early spring through mid-fall) and remain in underground burrows during their hibernation period (mid-fall through early spring). Giant garter snakes that have been observed in the Yolo Bypass during their active season could lie dormant in burrows in the bypass during the inactive season; however, the existing flood regime probably either precludes use of the bypass during their inactive period or displaces snakes during flood events.

Large colonies of nesting tricolored blackbirds have been documented in the Yolo Bypass (Meese 2007, 2009, 2010). Nesting sites are found near open water, with preferred nesting vegetation including tule or cattail marshes, willows, blackberries, thistles or nettles. Changes in the magnitude of floodplain inundation are not expected to change habitat conditions for the tricolored blackbird substantially, although changes in the timing and duration of habitat suitability may be altered.

Western burrowing owls nest in annual grasslands, levee slopes, steep cut banks, and other ruderal areas containing ground squirrel burrows. Western burrowing owl habitat occurs in the Yolo Bypass area, but there are no recorded occurrences. Modifications to the Fremont Weir that change the magnitude of floodplain inundation are not expected to cause substantial changes in overall habitat conditions, although decreases in potential foraging habitat may occur.

Swainson's hawks and white-tailed kites nest in riparian forests, oak woodlands, and other large trees associated with compatible foraging habitat such as pasture, row crops, or annual grassland. Active white-tailed kite nests have been documented in Yolo Bypass in recent years (Estep 2007, 2008), and Swainson's hawks are known to occur along the edges of Yolo Bypass. Modifications to the magnitude of floodplain inundation may affect the extent of available foraging habitat and when that habitat is available.

Yellow-breasted chat, least Bell's vireo, and western yellow-billed cuckoo all nest in riparian areas, with specific canopy and vegetation structure requirements; all have modeled habitat in the northern-most portion of the Bypass. Changes in the magnitude of floodplain inundation in the northern-most portion of the Bypass may result in changes to the extent of woody riparian vegetation, and may affect the extent of available nesting habitat.

Western pond turtles are known to occur in suitable habitats throughout Yolo Bypass, including wetlands, rice fields, irrigation channels, riparian areas, and adjacent uplands. Changes in the magnitude of floodplain inundation could increase the extent of suitable habitat in the Bypass.

Yolo Bypass' position on the Pacific Flyway makes it an important habitat resource for resident and migratory waterfowl and shorebirds. Rice fields and managed wetlands are important foraging, loafing, and breeding habitat for dabbling ducks, geese and shorebirds. Changes in the magnitude of floodplain inundation could increase the extent of suitable foraging habitat for ducks, geese and shorebirds. However, late-season flooding that precludes planting of rice, could reduce the extent of suitable foraging habitat for breeding, brooding and rearing birds.

3.4.2.3 Implementation

3.4.2.3.1 Enhancement Actions

[unchanged text omitted]

3.4.2.3.2 Yolo Bypass Fisheries Enhancement Plan and EIR/EIS

The YBFEP will propose a sustainable balance among important uses of the Yolo Bypass. Important uses of the Yolo Bypass include enhanced floodplain function to achieve the biological goals and objectives described above in Section 3.4.2.5, as well as flood protection, agriculture, threatened and endangered terrestrial species habitat (including implementation of the Yolo Natural Heritage Program), and managed wetlands habitat, as described in existing state and federal land management plans associated with the Yolo Bypass Wildlife Area and existing conservation easements on private land.

The term "sustainable balance" means integrating CM2 and selected component projects with existing Yolo Bypass land uses—including agriculture, recreation, managed wetland habitat, and educational programs—in a manner that is consistent with and contributes towards achievement of the biological goals and objectives associated with CM2, as described in Section 3.4.2.5, and the CM2 Sustainability Principles, outlined below. The following are the CM2 Sustainability Principles:

- The timing, frequency, and duration of seasonal floodplain inundation will be limited to that necessary to realize CM2's contribution to achieving the BDCP biological goals and objectives, while avoiding and minimizing impacts to existing Yolo Bypass land uses. .
- The implementation of CM2 and the associated component projects must be designed, implemented, and maintained to allow the passage of flood flows at the required flood system design flow and to comply with other flood management standards and permitting processes.
- The Final CM2 implementation plan, including seasonal floodplain habitat, will not compromise the economic and long-term sustainability of agriculture in the Yolo Bypass.
- The implementation of CM2 will not significantly affect overall managed wetlands habitat in the Yolo Bypass;
- The implementation of CM2 will support successful implementation of the Yolo Natural Heritage Program.
- The implementation of CM2 will protect and maintain public recreational access and related infrastructure within the YBWA.

- To the extent direct, indirect, or induced economic effects may be incidental to implementation of CM2, an economic mitigation program will be implemented to address impacts on landowners, growers, and the broader economy. Adverse economic impacts on the YBWA operating budget will be fully addressed by the establishment of a financial mechanism, such as an endowment, that assures a reliable funding stream over time.

With stakeholder and scientist input, the YBFEP will further refine CM2 and the component projects that will be evaluated. The YBFEP and associated YBFEP EIR/EIS will be completed by year 4. During their development, the component projects will be evaluated, individually or grouped as alternatives, to ensure that they will ensure that they are consistent with achieving a sustainable balance, as described above, with primary emphasis on achieving the biological goals and objectives. Project design and environmental compliance documentation will be completed, including the YBFEP EIR/EIS. Consistent with the requirements of CEQA, all significant impacts will be mitigated to the extent feasible.

As a result of the YBFEP process and completion of the environmental review process a final YBFEP will be adopted for implementation by the Executive Council. The final YBFEP will include the component projects which contribute toward achievement of the biological goals and objectives and the Sustainability Principles. Reasons that component projects will not be included in the final YBFEP include, but are not limited to the following:

- The action will not be effective.
- The action is not needed because of the effectiveness of other actions.
- The action will have unacceptable negative effects on flood control.
- The action will have significant negative effects on existing land use or species, which cannot be mitigated to less than significant.
- The action will not achieve a sustainable balance, as defined above.
- Landowner agreement to implement the action cannot be obtained.

Selected component projects that do not trigger EIR/EIS-level evaluation (Category 2 actions) will not be implemented until after completion of the YBFEP. Selected component projects that do trigger EIR/EIS-level evaluation under CEQA/NEPA (Category 3 actions) will be brought to a preliminary level of design for the YBFEP EIR/EIS. Permitting and the remainder of engineering design will begin after the YBFEP EIR/EIS is complete and a final YBFEP is adopted. Component projects requiring USACE Section 408 permissions may require that any real estate transactions have been completed, and Section 408 permissions may delay finalization of the ROD/NOD until USACE accepts final design.

The CM2 Executive Council will coordinate with its member agencies and other stakeholders (i.e., Yolo County, USACE, DWR, CVFPB, Bureau of Reclamation, USFWS, NMFS, CDFW, state and federal water contractors and landowners) through the Yolo Bypass Fisheries Enhancement Planning Team during the preparation of the YBFEP EIR/EIS to help identify the reasonable range of alternatives to be considered and evaluated within the YBFEP EIR/EIS, which will meet the purpose and need of CM2 and the YBFEP while achieving a sustainable balance. The alternatives that will be considered within the YBFEP EIR/EIS are expected to include various inundation footprints and durations, which would achieve the sustainable balance as defined above.

Completion of the YBFEP and associated EIR/EIS is anticipated to take 3 to 4 years. Full engineering design and permitting of multiple component projects are anticipated to take up to 3 additional years, depending on the scope and scale of component projects. Preparing and awarding construction contracts, and constructing the component projects within appropriate work windows are anticipated to span approximately 2 years.

Specifically, the YBFEP will address the following elements.

- Evaluate alternative actions to improve fish passage and reduce stranding, and provide enhanced access to floodplain rearing habitat for fish. Actions include, but are not limited to, physical modifications to the Fremont Weir and Yolo Bypass to manage the timing, frequency, and duration of inundation of the Yolo Bypass (Figure 3.4-1) with gravity flow from the Sacramento River; and fish passage improvements at Fremont and Lisbon Weirs.
- Evaluate alternative actions to increase the duration and frequency of floodplain inundation and increase the complexity of the inundated floodplain habitat [i.e., provide a range of water depths, cover types (that do not increase hydraulic roughness), dendritic channels, reduced stranding] while achieving a sustainable balance, as defined above.
- Identify actions that will be implemented and the sequence in which they will be implemented, based on the alternatives evaluation.
- Identify applicable BDCP biological objectives, performance goals, and monitoring metrics.
- Ensure plan compatibility with the flood control functions of the Yolo Bypass as well as achieving a sustainable balance, as defined above.
- Identify specific funding sources from the BDCP funding commitments.
- Identify and describe a process to address regulatory and legal constraints.
- Provide an implementation schedule with milestones for key actions.

The Implementation Office will consult with the USACE, CDFW, NMFS, and USFWS to develop the YBFEP, and will also coordinate with Yolo and Solano Counties, affected reclamation districts, landowners, the Natural Resources Conservation Service (NRCS), other flood control entities, and other entities that are planning and/or implementing actions within the Yolo Bypass, such as the Bureau of Reclamation and their Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan (Bureau of Reclamation 2012). Much of the coordination will occur through the Yolo Bypass Fisheries Enhancement Planning Team.

The Implementation Office will develop a public outreach strategy before the YBFEP process starts, which will establish a timeline and identify opportunities for stakeholder involvement, including a process by which stakeholder comments will be addressed in—or rejected from—the YBFEP. During development of the YBFEP, there will be some flexibility in decisions regarding the extent, duration and timing of floodplain inundation within the Yolo Bypass as part of CM2 and how best to achieve a sustainable balance on the Yolo Bypass. Stakeholders will have an opportunity to work with the Implementation Office to quantify the sustainable balance, defined at the beginning of this section, during the early stages of preparing the YBFEP EIR/S. Stakeholders will be able to provide input related to the alternatives to be considered and evaluated within the YBFEP EIR/S. These alternatives will likely include various inundation footprints, durations and timing scenarios consistent with achieving a sustainable balance, with the primary emphasis on achieving the biological goals and objectives. Stakeholders will also have an opportunity to work with the Implementation Office during implementation of the component projects, when the adaptive management process has been implemented and progress toward achieving the relevant biological goals and objectives (see Table 3.4.2-4) has been quantified. If CM2 is exceeding expectations in terms of achieving the relevant biological goals and objectives, component projects may be refined to better align with the sustainable balance. During implementation of CM2, the Implementation Office will coordinate with USACE, Reclamation, the California Department of Water Resources (DWR), reclamation districts, and other flood control entities, as appropriate, to ensure that fish passage improvements, bypass improvements, and Fremont Weir improvements and operations are constructed in accordance with the YBFEP and are compatible with the flood control functions of the Yolo Bypass.

3.4.2.3.3 Timing and Phasing

CM2 actions are proposed for implementation in four phases:

- Phase 1: year 1 to year 5
- Phase 2: year 6 to year 10
- Phase 3: year 11 to year 25
- Phase 4: year 26 to year 50

The discussion below identifies and describes the component project concepts that will be evaluated by the Implementation Office in the YBFEP and associated EIR/EIS as part of CM2. The discussion below identifies which projects are currently considered to be Category 1, 2, or 3 actions, as defined above under Section 3.4.1.3.1, *Enhancement Actions*. As part of the implementation process, reducing uncertainty related to the biological benefit and the ability of component projects to achieve the biological goals and objectives, collectively, will be a priority. The expected biological benefit and the contribution toward achieving the biological goals and objectives will be quantified to the extent feasible based on the existing data and models and other tools that are available. Additionally, anticipated impacts to existing land uses will also be quantified, to the extent feasible, to determine whether a sustainable balance is being achieved.

Phases 1 and 2: Year 1 to Year 10

The timeline below is preliminary; however, the Implementation Office is committed to taking the component projects that are selected to construction as soon as possible. Site numbers in parentheses correspond with locations on Figure 3.4-1.

[unchanged text omitted]

Component Project 19: Yolo Bypass Modifications to Direct or Restrain Flow. Through modeling and further concept development, this component project will determine which of the following actions are necessary to improve the distribution (i.e., wetted area) and hydrodynamic characteristics (i.e., residence times, flow ramping, and recession) of water moving through the Yolo Bypass: grading; removal of existing berms, levees, and water control structures (including inflatable dams); construction of berms or levees; reworking of agricultural delivery channels; and earthwork or construction of structures to reduce Tule Canal and Toe Drain channel capacities. The project will include modifications that will allow water to inundate certain areas of the bypass to provide biological benefits to covered species, reduce stranding of covered fish species in isolated ponds, and achieve a sustainable balance, as defined above. Necessary lands will be acquired in fee-title or through conservation or flood easement (Phase 2, Category 3 action).

Component Project 20: Yolo Bypass Wildlife Area Modifications. Modifications to the Yolo Bypass Wildlife Area required as a result of implementation of the YBFEP to maintain public access and hunter opportunity. This component project will construct and acquire as necessary new managed wetlands and facilities (e.g., check stations, parking lots, access facilities such as roads and bridges) throughout the Yolo Bypass necessary to provide safe access for hunting, wildlife viewing, wetland management and maintenance, and monitoring.

Phase 3: Year 11 to Year 25

Final permissions/permits from the permitting agencies for construction of the component projects directly affecting flood control structures (Fremont Weir, Sacramento Weir, and Colusa Basin Drain Outfall Gates, if affected, as well as project levees) not obtained in Phase 1 or 2 will be received by Phase 3 at the latest. Those component projects that are not able to obtain permits and be constructed during Phases 1 or 2 will do so in Phase 3. Full buildout is estimated to be completed in years 10, 11, or 12, at which time operations of these component projects will begin.

Phase 3 will encompass project operation, monitoring, and continued adaptive management (Section 3.6, *Adaptive Management and Monitoring Program*). A matrix of criteria will be developed and tested prior to Phase 3, and operations will be adjusted accordingly. For example, if results of monitoring and studies indicate that shorter or earlier gate operations within the adaptive management range may result in a more sustainable balance (i.e., yield equivalent or better biological benefits for covered fish and reduce impacts to existing land use), operation of the gated channel at Fremont Weir will be modified accordingly. If scientific results indicate that the wetter, later end of the adaptive management range may result in a more sustainable balance, operations will shift accordingly within existing or additional easements.

The following project will be designed, permitted, and, if feasible, constructed in Phase 3.

- **Component Project 21: Sacramento Weir Improvements.** At a minimum, modifications will be made to reduce leakage at the Sacramento Weir and thereby reduce attraction of fish from the Yolo Bypass to the weir where they cannot access the Sacramento River and could become stranded. The YBFEP will review the benefits and necessity of constructing fish passage facilities at the Sacramento Weir to improve upstream adult fish passage and positive drainage to reduce juvenile fish stranding. This action may require excavation of a channel to convey water from the Sacramento River to the Sacramento Weir and from the Sacramento Weir to the Toe Drain; construction of new gates at all or a portion of the weir; and modifications to the stilling basin (site 20 on Figure 3.4-1) (Phase 3, Category 3 action).

Phase 4: Year 26 to Year 50

[unchanged text omitted]

3.4.2.3.4 Operation Scenarios for Fremont Weir

Proposed modifications to the Fremont Weir will increase the biological benefit of the Yolo Bypass across a range of water-year types, while achieving a sustainable balance. Table 3.4.2-1 summarizes the opportunities and constraints associated with possible operations patterns of the proposed Fremont Weir gated channel (the “notch”) to manage the timing, frequency, and duration of inundation of the Yolo Bypass with inflow from the Sacramento River. The table also identifies additional operational considerations related to fisheries, agriculture, and wetland management. These operations were developed for discussion and illustration at the BDCP Yolo Bypass Fisheries Enhancement stakeholder group. They are expected to be typical of, but not necessarily identical to, actual operational guidelines that will be developed in the course of subsequent project-specific design, planning, and environmental documentation. The intent is to inundate the floodplain during periods of importance to the covered fish species, primarily from mid-November through April, with limited operations outside of this period sufficient to ramp down inundation in such a way as to avoid and minimize potential stranding of native fish, but control populations of nonnative fish.

In other words, the operational parameters in Table 3.4.2-1 for the extent, duration, timing and frequency of flooding events are representative of expected operations, but not binding at the programmatic level of this Conservation Measure.

Maintenance of Fremont Weir and Yolo Bypass Improvements

[unchanged text omitted]

Actions to Reduce Effects on Giant Garter Snake and Other Terrestrial Covered Species

Based on the current proposed operations, the increased periodic inundation in the Yolo Bypass could affect giant garter snakes overwintering in areas ranging from an estimated 520 acres of upland habitat (during 1,000-cfs flows through the gated channel) to an estimated 1,255 acres of upland habitat (during 4,000-cfs flows through the gated channel (Chapter 5, Section 5.6.18.1.2, *Periodic Inundation*). These estimates are subject to change as operations are better defined within the YBFEP. Project-associated inundation of areas that would not otherwise have been inundated is expected to occur in no more than 30% of all years, since Fremont Weir is expected to overtop the remaining estimated 70% of all years, and during those years operations of the gated channel will not typically affect the maximum extent of inundation. However, duration of inundation could be increased in all years, and this could adversely affect covered terrestrial species. In more than half of all years under existing conditions, an area greater than the project-related inundation area already inundates during the snake's inactive season. Additionally, the reduction in rice lands as a result of spring flooding could diminish the amount of available habitat for giant garter snake during the active season (Appendix 5.J, Attachment 5J.E, *Estimation of BDCP Impact on Giant Garter Snake Summer Foraging Habitat (Acreage of Rice) in the Yolo Bypass*). As described under *CM3 Natural Communities Protection and Restoration* (Table 3.4.3-1), a giant garter snake reserve with a mosaic of upland and aquatic habitats will be established adjacent to the Yolo Basin/Willow Slough subpopulation to reduce effects on giant garter snake that would result from habitat loss and increased periodic inundation in the Yolo Bypass. The reduction in rice production will be offset through restoration or protection of rice land or equivalent-value habitat at a 1:1 ratio. Other covered species expected to <u>benefit from</u> the restoration and protection of upland, aquatic and rice-field habitat in the Yolo Bypass include waterfowl, shorebirds, burrowing owl, white-tailed kite, Swainson's hawk, and tri-colored blackbird.

Table 3.4.2-1. Potential Operations Pattern for Fremont Weir Gated Channel and Other Considerations

[unchanged table omitted]

3.4.2.4 Adaptive Management and Monitoring

[See Section D.4.2 for changes to the Adaptive Management and Monitoring Program.]

3.4.2.5 Consistency with the Biological Goals and Objectives

[unchanged text omitted]

11F.3.2.3 Section 3.4.4, CM4 Tidal Wetland Restoration

<u>Under Section 3.4.4.3.4, *Siting and Design Considerations*, the section titled *South Delta Restoration Opportunity Area* was edited to address the issue of tidal restoration in the south Delta, as shown below.</u>

Tidal wetland restoration in the South Delta ROA would not begin until substantial progress had occurred toward tidal wetland restoration targets in other portions of the Delta. Moreover, these projects would have to have developed a large fraction of their target ecological function, as demonstrated by at least several years of monitoring data. Due to the time lags involved in planning, constructing, and monitoring tidal restoration projects, it is unlikely that the requisite monitoring data would have been acquired prior to implementation year 15, and would more likely be available by implementation year 20. At such time as members of the Adaptive Management Team agree that sufficient data and analysis have been performed to warrant an in-depth review of the feasibility and desirability of South Delta tidal wetland restoration, such a review would occur, as part of the regular 5-year review of BDCP effectiveness (see Section 6.3.5, *Five-Year Reviews*). Prior to this review, the 5-year tidal restoration targets (see Table 6-2) would be met through restoration efforts in ROAs other than South Delta.

The reason that south Delta tidal restoration would not need to occur until this milestone is two-fold. First, it provides sufficient time for tidal natural community restoration to occur in large blocks in high-priority sites (e.g., Suisun Marsh, Cache Slough, West Delta) where benefits to covered species are more certain. Second, this delay will allow for a formal scientific assessment of the performance of tidal natural community restoration in the Delta prior to initiating restoration in the south Delta.

The South Delta tidal wetland restoration feasibility assessment will be conducted by a task force to be appointed by the Adaptive Management Team, and reviewed by an appointed independent science panel. The task force will include key technical staff familiar with the construction and operation of major tidal wetland restoration projects implemented by BDCP, and key technical staff familiar with the conduct and analysis of monitoring and research studies performed to assess the effectiveness of those implemented restoration projects and their effects on covered fish species performance (see Section 3.6.4.7, *Effectiveness Monitoring* and Section 3.6.4.8, *Research* for a description and listing of the monitoring and research actions relevant to tidal wetland restoration and covered fish species performance). The task force will also include staff representing the permittees, the fish and wildlife agencies, and such other entities as the AMT deems appropriate. The task force will use the best scientific information available at the time to develop a written report addressing the following:

- an evaluation of the success of tidal wetland restoration projects completed to date with regard to resolution of relevant key uncertainties (listed in Table 3.6-17 *Key Uncertainties and Potential Research Actions Relevant to Tidal Wetland Restoration*);
- an evaluation of the success of tidal wetland restoration projects completed to date with regard to achievement of relevant biological goals and objectives;
- an evaluation of the success of tidal wetland restoration projects completed to date with regard to supporting improved covered fish performance; with particular regard to key uncertainties and research results regarding production of food, loss of food to invasive consumer species, and export of food from restoration sites;
- an evaluation of the population and distribution status of Delta smelt and other covered and native species with potential to benefit from South Delta restoration;
- modeling of south Delta restoration scenarios to understand the potential effects on flow, tidal range, salinity, temperature, etc.;
- an assessment of how south Delta tidal wetland restoration would be integrated with restored seasonally inundated floodplain to maximize ecosystem services and species habitat;
- an analysis of the adverse and beneficial effects of tidal natural community restoration on terrestrial covered and other species;
- consideration of dual operations on south Delta physical conditions and how that may be influenced by tidal natural community restoration in the south Delta;
- an evaluation of tidal natural community restoration on selenium, mercury, and other contaminants and their potential for bioaccumulation in covered and native species; and
- an assessment of the effects of south Delta tidal natural community restoration on implementation of the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (San Joaquin County HCP; San Joaquin Council of Governments 2000)[9].

The task force report will be used by the Adaptive Management Team (see Sect. 3.6.2.2 for a description of this group and their function in the adaptive management process) and an independent science panel comprised of representatives of major Delta-focused scientific organizations including the DSP, IEP, and others to be determined by agreement of the Authorized Entities and the Program Oversight Group to recommend whether tidal natural community restoration in the south Delta should proceed; and if so, at what scale and at which general locations. After review of the reports by the task force, the AMT, and the independent science panel, the Authorized Entities and the Program Oversight Group will then direct the Implementation Office to either refrain from tidal wetland restoration in the south Delta ROA, or to proceed with such restoration, to be performed in a manner substantially in agreement with the process recommended by the reports.

In the event that tidal wetland restoration does not occur in the South Delta ROA, or occurs at lower levels than identified in the biological objectives, funding allocated to CM4 may be repurposed to

---

[9] Waiting until year 20 or 10 years after dual operations begin to restore tidal wetlands in the south Delta will also delay the impacts of this restoration on agricultural landscapes there. This will help to minimize conflicts with the implementation of the San Joaquin County HCP. The formal assessment will consider its effect on the ability of the San Joaquin County HCP to meet its remaining targets for conservation easements on cultivated land that provides habitat for Swainson's hawk and other species covered by both plans.

implement alternative aquatic restoration measures, even if restoration acreages are reduced, e.g., by restoring more challenging sites or different habitats (i.e., channel margin).Proceeding with substantially less restoration in the south Delta than described in this conservation measure may require a Plan amendment (see Sect. 7.4.1 for the Plan amendment process).

Tidal natural communities restoration in the South Delta ROA will not be completed until the north Delta diversion facilities become operational. Planning and implementation may commence sooner, but access to these sites by fish will not be provided until the diversion facilities are operational. Phasing implementation in this way is intended to maximize benefits associated with restoration of tidal natural communities and minimize risk of entrainment or other adverse effects on covered fish.

Potential sites for restoring freshwater tidal natural communities include Fabian Tract, Union Island, Middle Roberts Island, and Lower Roberts Island. Sites selected for restoration would be dependent on the location and design of the selected conveyance pathway and operations for the through-Delta component of dual conveyance facility. Selected sites would be those that would provide substantial species and ecosystem benefits with the selected through-Delta conveyance configuration and most effectively avoid potential adverse effects of south Delta SWP/CVP operations. In conjunction with dual conveyance operations, tidal natural communities restoration in South Delta ROA will be designed to support the expansion of the current distribution of delta smelt into formerly occupied habitat areas.

11F.3.2.4 Section 3.4.10, CM10 Nontidal Marsh Restoration

Under Section 3.4.10.2.1, *Restoration Actions*, the section titled *Managed Wetlands* was edited as shown below.

At least 500 acres of managed wetlands will be created for greater sandhill crane to meet requirements under Objectives GSHC1.3 and GSHC1.4. The restored wetlands will be protected in association with other protected natural community types (excluding nonhabitat cultivated lands) at a 2:1 upland-to-wetland ratio to provide buffers around the wetlands. These uplands do not need to consist of crane habitat, but will consist of lands that are protected from land uses that could adversely affects cranes roosting in the created wetlands. The uplands will not be orchards or vineyards because those crop types are pruned by workers and sometimes sprayed during winter, and such disturbance could disrupt crane roost use. If protected through BDCP, the protected uplands will count toward protection requirements for other natural communities. The protected uplands may also consist of lands that have been protected through programs other than BDCP, provided such lands are protected in perpetuity with conservation easements and managed in a manner that protects cranes in the managed wetlands from adverse indirect effects of surrounding land uses. The managed wetland sites and associated uplands will be situated in a manner that maximizes the buffer area between the wetlands and surrounding land uses, to the extent feasible given land use constraints. Ideally, the managed wetlands will be situated at the center of the associated uplands.

Sites for restoration will be selected that are not expected to be inundated due to sea level rise. Sites will also be selected to avoid areas that experience local seasonal flood events that may be incompatible with the habitat management needs for greater sandhill crane. Sites will be selected well away from existing transmission lines, and from transmission lines to be constructed by BDCP, to minimize the risk of crane bird strikes. Wetland inundation extent, frequency, and duration will be monitored to ensure specified inundation goals have been achieved.

At least 320 of the 500 acres of managed wetlands will be created to meet Objective GSHC1.3. These will consist of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within the Greater Sandhill Crane Winter Use Area (Figure 2.A.19-3, *Greater Sandhill Crane Foraging Habitat and Associated Value Rankings*, in Appendix 2.A) in Conservation Zones 3, 4, 5, or 6.

At least 180 of the 500 acres of managed wetlands will be created to meet Objective GSHC1.4. This will consist of two 90-acre wetland complexes within the Stone Lakes National Wildlife Refuge project boundary[10] (Figure 3.3-6). The complexes will be no more than 2 miles apart and will help provide connectivity between the Stone Lakes and Cosumnes greater sandhill crane populations. Each complex will consist of at least three wetlands totaling at least 90 acres of greater sandhill crane roosting habitat, and each wetland will be at least 20 acres in size. One of the 90-acre wetland complexes may be replaced by 180 acres of cultivated lands (e.g., cornfields) that are flooded following harvest to support roosting cranes and provide highest-value foraging habitat, provided such substitution is consistent with the long-term conservation goals of Stone Lakes National Wildlife Refuge for greater sandhill crane.

11F.3.2.5 Section 3.4.11, CM11 Natural Communities Enhancement and Management

Several subsections of *CM11 Natural Communities Enhancement and Management* were revised to more effectively address the issues of invasive plant control, mosquito control, pesticide use, and management of cultivated lands and managed wetlands for the benefit of covered species. These revisions are shown below.

The following changes were made in Section 3.4.11.2.3, *General Enhancement and Management Actions*

The first paragraph in section *Invasive Plant Control* was edited as follows.

Some invasive plants pose a serious threat to ecosystem function, native biological diversity, and many covered plant species. However, many invasive plants cannot be effectively controlled because of their great abundance, high reproduction rate, and proficient dispersal ability; the high cost of control measures; or unacceptable environmental impacts of control measures. Therefore, invasive plant control efforts in the reserve system will use integrated pest management strategies[11] to focus on the eradication of new infestations and the control of the most ecologically damaging invasive plants for which effective suppression techniques are available. Avoidance and minimization measures described in Appendix 3.C will be implemented in association with invasive plant control activities to ensure that take of covered species is minimized. Control of invasive aquatic plants is addressed in detail in *CM13 Invasive Aquatic Vegetation Control*; therefore, this conservation measure focuses on the control of terrestrial invasive plants.

One bullet item was edited as shown below in section *Invasive Plant Control Guidelines and Techniques.*

- **Chemical control.** Herbicide application can be an effective means by which invasive plant infestations are controlled or eradicated. Herbicide application can be combined with other methods as part of an integrated pest management strategy or used singularly, depending on what is most effective for the specific infestation and situation. Herbicides will be applied by certified personnel consistent with California Department of Pesticide Regulation. See also *Pesticides*, below.

Section *Mosquito Abatement* was edited as shown below.

[10] The project boundary delineates the area surrounding the existing refuge for which the refuge has authority to acquire land or easements.

[11] Integrated pest management is defined by the University of California Integrated Pest Management Program as an ecosystem-based strategy that focuses on longterm prevention of pests or their damage through the combination of techniques such as biological control, habitat manipulation, modification of cultural practices and use of resistant varieties. The complete definition can be found at this website: http://www.ipm.ucdavis.edu/GENERAL/whatisipm.html.

Enhancement of aquatic and wetland habitats must be balanced with the need to minimize mosquito production to protect human health. On tidal restoration sites, minimization of suitable habitat will occur primarily through site design. Tidal restoration sites are expected to be designed to maximize tidal exchange and limit long residence times, two features that would be expected to limit mosquito productivity. These sites will also be managed within the BDCP reserve where populations of mosquito predators such as native frogs, swallows, and bats will be encouraged, an approach to mosquito control that is compatible with management for covered species.

Enhancement and management of managed wetlands and cultivated lands within the BDCP reserve may include a number of actions that are known to increase mosquito production: Slow, feather-edge flooding to increase waterbird foraging opportunities; late-spring (through April) or summer (July or August) flooding to provide waterbird habitat during typically dry parts of the year; shallow-water flooding to increase foraging habitat for shorebirds that have lower foraging depths than most dabbling waterfowl; and irrigation to increase seed production and biomass (waterfowl forage). To minimize mosquito populations, the below-listed practices (excerpted from Kwasny et al. 2004) will be employed on BDCP reserve lands when and where they do not conflict with management to benefit covered species or other regulatory constraints (e.g., intake restrictions to minimize impacts to endangered species or salinity in Suisun Marsh).

- Maintain stable water levels to reduce water surface level fluctuation associated with evaporation or seepage.
- Circulate water to provide a constant flow of water, avoiding stagnant conditions.
- Deep initial flooding that minimizes shallow water habitats when and where slower, feather-edge flooding isn't planned.
- Monitor soil salinities to ensure irrigation is necessary, if necessary, reduce or limit number of irrigations and irrigate in spring (late April or early May) when temperatures are cooler.
- Draw-down wetlands in late March or early April when temperatures are coolers on those wetlands not targeted for providing late spring or summer habitat for waterbirds.
- Irrigate to keep soil from getting completely dry and cracking.
- Conduct vegetation reduction management such as mowing, burning, discing, or grazing before flooding.
- Maintain flood and drain infrastructure to allow for the careful management of water levels.
- Enhance wetland topography to allow complete draining of the wetland unit.
- Installation of smaller, internal cross-levees to facilitate rapid irrigation and flood-up.
- Construct or improve ditches to prevent unwanted vegetation growth.
- Excavate deep channels or basins to maintain permanent water that can provide year-round habitat for mosquito predators and then inoculate water added during seasonal flood-up events.

Any mosquito control activities to be performed on reserve system land will be addressed in the reserve unit management plan in consultation with the local vector control district. The reserve unit management plan will detail the nature of mosquito control activities and explain specific measures implemented to avoid and minimize effects on covered species consistent with the BDCP. In addition, the BDCP Implementation Office will coordinate directly with the local vector control agency to monitor and manage mosquito production on managed wetlands and cultivated lands within the BDCP reserve. The Natomas Basin HCP is an example of a local conservation plan that has created and managed extensive wetlands in a successful partnership with a local vector control agency.

<u>Section *Pesticides* was edited as shown below.</u>

Pesticides will be used as part of an integrated pest management strategy to achieve biological goals and objectives (e.g., invasive plant or invasive animal control). Pesticide use will be done in accordance with label instructions, and in compliance with state and local laws. Additional restrictions may be placed by USFWS, NMFS and CDFW during their review of reserve unit management plans. Any pesticide use must comply with the October 2006 stipulated injunction disallowing use of certain pesticides within habitats and buffer zones established around certain habitats for California red-legged frog and the May 2010 stipulated injunction disallowing use of certain pesticides within habitat and buffer zones established for California tiger salamander and San Joaquin kit fox.

Section 3.4.11.2.7, *Cultivated Lands*, was renamed and edited as shown below.

Activities to Benefit Greater Sandhill Cranes, Waterfowl, and Shorebirds on Flooded Croplands

Habitat management in areas conserved as foraging habitat for greater sandhill crane will include deferring the tilling of corn and grain fields until later in the winter (ideally after December 21) to increase the amount and availability of forage for this species. Also, where feasible, a portion of corn or grain fields will be left unharvested to increase the quantity of forage available to greater sandhill cranes (forage gradually becomes available as senescent plant stalks fall over as a result of weathering).

To increase the foraging and roosting value of cultivated lands for greater sandhill cranes, some corn, grain, and irrigated pastures will be shallowly flooded during fall and winter. This will also improve foraging conditions for waterfowl and shorebirds. Cultivated land roosting habitat to meet Objective GSHC1.4 will consist of two wetland complexes, each complex will be comprised of at least three wetlands totaling 90 acres. One of the 90-acre wetland complexes may be replaced by 180 acres of cultivated lands (e.g., corn) that are flooded following harvest to support roosting cranes and provide highest value foraging habitat provided such substitution is consistent with the long-term conservation goals of the Stone Lakes National Wildlife Refuge for the greater sandhill crane. This is intended to minimize disturbance and provide not only the roost water, but also new foraging opportunities throughout the season in close proximity to the roosting habitat. For example, if the field block is divided into two 90-acre parcels (180 acres total), half of one field may be flooded early in the fall and half of the other field may be flooded and maintained from mid-winter until the end of the season, while the first is drained or left to evaporate. Birds will benefit from having new foraging area close to the roost while it is being converted. Cultivated lands selected for greater sandhill crane roosting sites may be corn or other compatible cropland types that allow for winter flooding (e.g., tomatoes, potatoes, carrot, wheat, etc.) as corn managed as roosting habitat decreases the foraging value for greater sandhill crane. If corn fields are chosen for roost sites, those fields grown for silage corn should be prioritized over those grown for grain as silage corn fields have lower foraging value.

Below are additional guidelines and techniques to be considered on cultivated lands within the BDCP reserve to benefit greater sandhill crane, waterfowl, and shorebirds.

- Employ harvest techniques that maximize the amount of waste grain (e.g., harvesting techniques associated with corn crops used for grain rather than those harvesting techniques associated with corn crops used for silage).
- Consider “knocking down” or mulching corn stalks to make grain more available. This management action might be used to attract greater sandhill cranes to a newly created foraging site or when monitoring indicates there is a need to increase carrying capacity on foraging lands within the reserve.
- Consider “bumping” corn at an appropriate height that would attract greater sandhill cranes but not geese.
- Incentivize practices that make grain more available to birds without flooding such as use of corn seed varieties which produce lower ear height and poorer stalk standability, reduced planting densities, and planting fields in alternating strips of standing corn and low growing vegetation or fallow land.

- Maintain a mosaic of dry and flooded crop types, and varying water depths (up to 20 cm deep), to promote a diverse community of waterbirds, including shorebirds, during fall migration and winter (Shuford et al. 2015).
- To provide wintering habitat for multiple waterbird guilds, including shorebirds, use a combination of flooding practices that include one-time, deep-water flooding (e.g., fall flooding in Suisun Marsh and Yolo Bypass to achieve deeper "hunt or shoot" water surface elevations) with smaller, maintenance flooding events to maintain wetted acres into the spring and summer, while also providing unflooded habitat (Strum et al. *in review*).
- Stagger the drawdown of flooded rice and other winter-flooded agricultural fields to prolong the availability of flooded habitat (Iglecia et al. 2012). Be aware of soil type because this practice may not be as effective on soils that drain quickly.
- Corn fields should be chopped and rolled as opposed to left in the harvest only condition (see: Ivey et al. 2003).
- Timing of flood up of roost sites should be staggered through the fall and early winter (for rice as well as corn) to prolong waste grain access and to spread out the high value foraging opportunities on insects and fossorial species (such as rodents and snakes) that the floodup period provides.
- In large fields, consider use of "cross checks" (small, internal levees) to optimize preferred roosting depth of four to six inches.
- Consider late-winter sub-irrigation (January/February) on fields where waste grain has been depleted to increase foraging opportunity on invertebrates.
- A mix of flooded and non-flooded corn fields should be provided to provide both dry- and wet-field foraging opportunities as well as greater sandhill crane roosting sites.
- Tilling of fields should be delayed as long as possible so waste grains remain available as a food source.
- Some early harvest crops, such as triticale or wheat, should be planted to allow early season post-harvest flooding to benefit early migrating shorebirds and provide early season (September) greater sandhill crane roosts.
- Remove as much stubble as possible in rice and other agricultural fields after harvest to provide the best shorebird habitat (Iglecia et al. 2012; Strum et al. *in review*).
- Shallowly flood available agricultural fields (e.g., fallow fields) during July, August, and September to provide early fall migration habitat for shorebirds. Fields should be free of vegetation prior to flooding, have minimal micro-topography (e.g., no large clods), and should remain flooded for up to three week periods (after three weeks, vegetation encroachment reduces habitat value for shorebirds; Point Blue and Audubon CA, unpublished data). For example, the post-harvest flooding of winter wheat and potato fields in early fall (July–September) can provide substantial benefits to shorebirds at a time of very limited shallow-water habitat on the landscape (Shuford et al. 2015). Such fields may need additional treatment for weed growth after drawdown.
- Manage levee habitats to have minimal vegetation but do not spray herbicide directly on, or drive on, levees during the nesting season (April–July) (Iglecia et al. 2012).
- Vegetation reduction on internal field levees is recommended to provide shorebird nesting habit however only by means that do not include direct spraying during the nesting season (Iglecia et al. 2012).
- Maintain a minimum top-width of 30 inches for internal levees, based on increased avocet use of wider levees (Iglecia et al. 2012).

- When possible, flood fields with nesting habitat (modified levees and islands) in late April to provide nesting habitat for American avocets (Iglecia et al. 2012).
- Finer grained substrate (clods smaller than a fist) in rice and other agricultural fields may be more appealing for nesting shorebirds (Iglecia et al. 2012).
- Maintain gently sloping levee and island sides (10–12:1) (Iglecia et al. 2012).
- Islands should be disked along with the rest of the field after harvest to help inhibit vegetation growth (Iglecia et al. 2012).
- Islands should be low in profile; less than 8" above the water surface to prevent use by burrowing predators such as mink. They should be surrounded by moats of water and at least 40' from shore. Most of each islands' surface should be sparsely vegetated. If annual discing doesn't achieve this condition, islands can be blanketed with vegetation-proof matting material, and covered with a thin layer of sand and gravel to prevent vegetation growth and maintain barren conditions preferred by shorebirds (Ivey pers. comm.).

Section 3.4.11.3, *Managed Wetlands*, was edited as follows.

The first of two subsections titled *Waterfowl and Shorebirds* was edited as shown below.

The at least 6,600 acres of managed wetland protected and managed to benefit waterfowl and shorebirds will be managed as a mosaic of wetland and upland types. At least 5,000 acres of protected, seasonal managed wetlands will be managed to maximize food biomass and energetic value for overwintering waterfowl and to increase foraging opportunities for shorebirds. The at least 1,600 acres of semi-permanent or permanent managed wetlands will be managed to provide summer nesting and brood-rearing habitat for waterfowl and shorebirds as well as late-summer foraging habitat for early waterfowl and shorebird migrants.

Food studies conducted in the late 1960s and early 1970s in Suisun Marsh found the bulk of wintering waterfowl feed on seeds from alkali bulrush (*Scirpus maritimus*), fat hen (*Atriplex triangularis*), and brass buttons (*Cotula coronopifolia*) (George 1965). A more recent Suisun study suggests waterfowl seed selection is likely even more diverse than this (Suisun Resources Conservation 1998). Wetland maintenance and habitat improvement in Suisun relies on the following principle: Hydrologic change influences plant community composition and structure thereby affecting the availability of waterfowl food (Fredrickson and Laubhan 1994 cited in Suisun 1998). The quality, abundance, and availability of wetland resources (e.g., water control infrastructure, availability of low-salinity water, levee integrity, etc.), as well as the spatial arrangement of different wetland types that provide such components, are critical factors that determine the abundance and biodiversity of wetland wildlife (Fredrickson and Laubhan 1994 cited in Suisun 1998).

BDCP reserve managers will manage the flood timing, water depth, soil submergence duration, and soil salinities on the 5,000 acres of seasonal wetlands to optimize plant diversity for foraging waterfowl and maximize the extent of habitat at appropriate foraging depths for shorebirds (between 10 and 20 cm). Effective water management requires maintenance and upkeep of water circulation and water drainage infrastructure such as levees, ditches, pumps, and tidal gates. In addition to water management, invasive species management will be very important to maintaining plant diversity and wetland and wildlife habitat value. Known invasive plant species that will require aggressive management include pepperweed, arrundo, and phragmites as well as others. Invasive wildlife species that have potential to require control due to their posed threat to wetland flora and fauna include wild pigs, red fox, house cats, or seed-predating insects. Managed wetlands within the BDCP reserve will be managed consistent with the Suisun Marsh Protection Act of 1977, the local Protection Policies and regulations, and agency permit restrictions and in coordination with the Suisun Resource Conservation District (SRCD) and the California Department of Fish and Wildlife.

The SRCD, through duties appointed by the Suisun Marsh Preservation Act of 1977, provides Suisun Marsh landowners technical assistance in permitting, water control, and habitat management to ensure the wetland and wildlife values of the Suisun Marsh are sustained and enhanced. More recently, in response to increased regulatory constraint, the SRCD authored the *Individual Ownership Adaptive Management Plan* (Suisun Resource Conservation District 1998). This plan outlines 11 updated water management schedules to assist wetland property owners and managers make management decisions pertaining to flood and drain timing, water level height, and soil submergence duration as well as vegetation management. BDCP reserve land managers will use this plan (or updated versions thereof) as a guide to write unit-specific management and monitoring plans to inform adaptive management. BDCP land managers will also work cooperatively with the SRCD to optimize benefits to waterfowl and shorebirds on BDCP reserve lands individually and as part of the regional wetland mosaic under SRCD's purview.

The 1,600 acres of permanent wetlands will be managed to provide stable water, forage (e.g., sago pond weed (*Potamogeton pectinatus*) and wigeon grass (*Ruppia martima*)), and cover for breeding, nesting, and brooding waterfowl and shorebirds. Permanent wetlands will also be managed to provide foraging habitat for early migrants that can arrive as early as July (Catherine Hickey pers. comm). Uplands will also benefit salt marsh harvest mouse and Suisun shrew by providing refugia during flood events.

The 6,600 acres of managed wetlands for waterfowl and shorebirds will also be managed, when and where such management does not conflict with the needs of waterfowl and shorebirds, to optimize habitat for covered species, specifically the salt marsh harvest mouse. These acres will be managed in a manner that avoids take of salt marsh harvest mouse and minimizes any adverse effects on this species (see *Enhancement and Management Guidelines and Techniques*, below).

Two key uncertainties related to managed wetland management, identified in *Effects Analysis of BDCP Covered Activities on Waterfowl and Shorebirds in the Yolo, Delta, and Suisun Basins* (Ducks Unlimited 2013), will be addressed through the adaptive management and monitoring program.

Potential research actions for investigating these uncertainties are provided in Table 3.4.11-2. The results of the research actions will inform the composition of seasonal, semi-permanent, and permanent managed wetlands within the at least 6,600-acre managed wetland reserve as well as the need for additional management and enhancement actions necessary to maximize native biodiversity on the at least 6,600-acre reserve.

The second of two subsections titled *Waterfowl and Shorebirds* was edited as shown below.

The primary goal of enhancement and management activities on the at least 5,000-acres of seasonal wetlands protected within the BDCP reserve will be to maximize food biomass and value for overwintering waterfowl and to increase the spatial and temporal extent of shorebird foraging habitat. Controlling soil salinities is an important management goal for maximizing food biomass, value and diversity. Soil salinities are controlled primarily through flood/drain cycles performed in late winter through spring to leach salts from the soil. The control of the cover and extent of invasive plant species is also an important management technique for increasing plant heterogeneity. Enhancement and management activities on managed wetlands will include, but will not be limited to, the below-listed activities consistent with Section 3.4.11.2.3, *General Enhancement and Management Actions*.

- **Water control—**Flooding and draining of wetland units to control water depth, water surface elevation, and soil saturation duration.
- The manual, chemical, or mechanized removal of invasive vegetation.
- The maintenance, enhancement, and replacement of water pumping infrastructure: tide gates, culverts, pumps, fish screens, etc.
- The maintenance and enhancement of natural or artificial topographic features (e.g., ditches, berms, etc.) to facilitate efficient drain times.
- The maintenance and enhancement of exterior and interior levees important to preserving the ongoing use and sustainability of Suisun managed wetlands with the BDCP reserve.

Guidelines and techniques for water control and wetland and upland manipulations are described below. Also described below are guidelines and techniques for avoiding effects on the salt marsh harvest mouse present in wetlands managed for waterfowl and shorebirds. Additional detail can be found in *Individual Ownership Adaptive Management Plan* (Suisun Marsh Resource Conservation District 1998). Enhancement and management of Suisun Marsh wetlands is expected to change over time in response to new regulatory restrictions or advancements in our understanding of ecosystem function and wildlife response. Suisun Marsh will be managed adaptively in coordination with the Suisun Resource Conservation District and the California Department of Fish and Wildlife to incorporate these changes and maintain high-value waterfowl and shorebird habitat.

- **Water control.** Water control techniques for the 6,600 acres of managed wetland in Suisun Marsh will be guided by wildlife management goals (e.g., maximizing overwintering forage or enhancing nesting and breeding habitat), physical constraints (e.g., pumps, ditches, location within the wetland complex, etc.), yearly environmental considerations (e.g., weed management, water year type, etc.), and regulatory restrictions (e.g., pumping restrictions associated with the potential presence of rare or endangered fish species). While flood and drain management will vary by site, common practices include: flooding wetlands in September or October to attract migratory birds and support recreation and one or more rapid leach cycles from February to July to manage soil salinities. The 5,000 acres of seasonal or semipermanent wetlands will be drawn down by July to allow vegetative growth and to perform routine maintenance. The 1,600 acres of permanent wetlands will maintain some number of wetted acres throughout the year to support waterfowl and shorebird breeding and brooding. The timing of flooding and draw down within the reserve will be staggered to maximize spatial and temporal variability of shorebird foraging habitat. Managed wetland depth within the reserve system will be managed, when and where possible, to maximize the extent of wetlands with suitable foraging depths for shorebirds (average depth of 15 cm, Hickey et al. 2003), especially in early fall when few wetlands are available for shorebird foraging and again in late spring and early summer (April through July) to support waterfowl and shorebird breeding, brooding, and rearing.
- **Soil salinity control.** The 6,600 acres of protected managed wetlands in Suisun Marsh will be managed to minimize soil salinities. Wetland units are flooded in the fall when migrating waterfowl and shorebirds begin to arrive. In the fall, water drawn for wetland flooding from adjacent sloughs and bays is typically somewhat saline. As water evaporates through the winter and spring, the salts remain in the wetland soils. Increased soil salinity decreases the diversity of plant species, including many important waterfowl forage species. To reduce soil salinities and increase plant diversity, spring-time flood and drain cycles are used to bring fresh water onto the unit, leach salt from the soil, and then remove the salt by draining the wetland unit. Water in the adjacent sloughs and bays is fresher in the spring after winter rains. To adequately control soil salinities, at least two or three leach cycles are usually necessary. As with all wetland management in Suisun Marsh, spring-time flood and drain cycles are influenced by site-specific factors including wildlife habitat objectives, physical management constraints, annual environmental constraints, and regulatory constraints. When and where possible, spring-time flood and drain cycles will be managed to maximize the temporal and spatial distribution of wetland acres at suitable foraging depths for shorebirds.
- **Enhancing shorebird breeding habitat.** Shorebirds in Suisun Marsh will use minimally vegetated islands, wetland edges, and low-grade levee slopes for breeding when in proximity to semipermanent or permanent wetlands with appropriate foraging depths. The slope of breeding islands, wetland edges, and levees within wetland units managed to support breeding shorebirds should be gradual (10 to 12 horizontal inches per vertical inch; Hickey and Shuford pers. comm.), either naturally or through enhancement. Levee maintenance during the breeding season, April through July, should be limited to emergency repairs with the exception of mowing the center or top of a levee; mowing down the center of a levee during the breeding season is allowed (Hickey and Shuford pers. comm.). Adding substrate (e.g., decomposed granite) to islands, wetland edges, or levees to improve nesting habitat conditions will be considered when and where feasible.

- **Managing waterfowl and shorebird breeding and brooding upland habitat.** Uplands adjacent to wetlands will be managed to support waterfowl and shorebird breeding and brooding. Upland management will primarily consist of plant and wildlife invasive species management. The siting of semipermanent and permanent wetlands in the reserve system is described in *CM3 Natural Communities Protection and Restoration.*

11F.3.2.6 Section 3.4.12, CM12 Methylmercury Mitigation

Revisions to *CM12 Methylmercury Management* are shown below.

Section 3.4.12 CM12 Methylmercury Mitigation

As described in Section D.5.3, Effects of Contaminants on Terrestrial Species below, and Appendix 5.D, *Contaminants*, BDCP actions have potential to result in increased availability of mercury, and specifically the bioavailable form methylmercury, to the foodweb in the Delta system. Due to the complex and very site-specific factors that will determine if mercury becomes mobilized into the foodweb, *CM12 Methylmercury Management,* is included to provide for site-specific evaluation for each restoration project. CM12 will be implemented in coordination with other similar efforts to address mercury in the Delta, and specifically with the DWR Mercury Monitoring and Analysis Section, as further described below.

This conservation measure will promote the following actions.

- Assessment of pre-restoration conditions to determine the risk that the project could result in increased mercury methylation and bioavailability
- Definition of design elements that minimize conditions conducive to generation of methylmercury in restored areas
- Definition of adaptive management strategies that can be implemented to monitor and minimize actual postrestoration creation and mobilization of methylmercury into environmental media and biota

The restoration design will always focus on the ecosystem restoration objectives and design elements to mitigate mercury methylation that will not interfere with restoration objectives. Design elements that help to mitigate mercury methylation will be integrated into site-specific restoration designs based on site conditions, community type (tidal marsh, nontidal marsh, floodplain), and potential concentrations of mercury in pre-restoration sediments. The adaptive management strategies can be applied where site conditions indicate a high probability of methylmercury generation and effects on covered species.

Refer to Chapter 6, *Plan Implementation*, for details on the timing and phasing of CM12. Refer to Appendix 3.C, *Avoidance and Minimization Measures*, for a description of measures that will be implemented to ensure that effects of CM12 on covered species will be avoided or minimized.

3.4.12.1 Problem Statement

For descriptions of the current condition of methylmercury in the Plan Area, see Appendix 5.D, *Contaminants.* Mercury is present in sediments and soils throughout the Delta, having been deposited by tributaries and rivers that drain areas of former mining operations in the adjacent mountains. The highest concentrations have been reported in Cache Creek and Yolo Bypass and, to a lesser extent, the Mokelumne-Cosumnes River system (Wood et al. 2010). However, because of its widespread dispersion in the system, mercury is potentially present at a wide range of concentrations in sediments of all ROAs throughout the Delta

Mercury in an inorganic or elemental form tends to adhere to soils and has limited bioavailability. Mercury may be converted by bacteria to a different form, called methylmercury, which is much more bioavailable and toxic than inorganic forms, and has a strong tendency to bioaccumulate in organisms. The toxicity and tissue concentrations of methylmercury are amplified as it biomagnifies through the foodchain. As a consequence, the filet mercury concentrations of most sportfish in the Delta exceed fish advisory guidelines.

Mercury methylation is accomplished by sulfate-reducing bacteria that occur in anaerobic (oxygen-depleted) conditions, such as are often found in wetland soils. Current research has shown that the conversion rate is highest in sediments subjected to periodic wetting and drying periods, including marshes and floodplains. The multiple environmental parameters that influence mercury methylation are complex (Windham-Meyers et al. 2010). In general, the highest methylation rates are associated with high tidal marshes with intermittent wetting and drying periods and anoxic conditions that support methylation (Alpers et al. 2008). Therefore, potential effects from mercury in the Plan Area are highly dependent on many factors that must be considered on a site-specific basis, including the following.

- In-place sediment (or flooded soil) concentrations of mercury, methylmercury, sulfate/sulfide, and organic compounds.
- The potential methylation rates of the surface sediments in restored environments.
- Other environmental conditions including pH, salinity, water residence time, and oxidation state.

Restoration actions that would increase the acreage of intermittently wetted areas by converting cultivated lands and other upland areas to tidal, open water, and floodplain habitats, could also potentially increase methylmercury production in these areas. Conversely, restoration actions that convert managed wetlands, which have the highest methylation rates, to non-managed systems would decrease mercury methylation; this is specifically important in Suisun Marsh.

3.4.12.2 Implementation

CM12 will be developed and implemented in coordination with the *Sacramento-San Joaquin Delta Methylmercury Total Maximum Daily Load* (Methylmercury TMDL) (Central Valley Regional Water Quality Control Board 2011a) and *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento-San Joaquin Delta Estuary* (Mercury Basin Plan Amendments)(Central Valley Regional Water Quality Control Board 2010 and 2011b). The DWR Mercury Monitoring and Evaluation Section will work with the Implementation Office to attain compliance for BDCP activities. CM12 will also be implemented to meet requirements of the U.S. Environmental Protection Agency (EPA) or the California Department of Toxic Substances Control actions.

The DWR Mercury Monitoring and Evaluation Section is currently working on DWR's compliance with the Methylmercury TMDL and Mercury Basin Plan Amendments. The Methylmercury TMDL programs are responsible for developing measures to control methylmercury generation and loading into the Delta in accordance with Methylmercury TMDL goals. Phase I emphasizes studies and pilot projects to develop and evaluate management practices to control methylmercury. Phase I (effective October 2011) will be underway for the next 7 years, with an additional 2 years to evaluate Phase I results and plan for Phase II. Phase II involves implementation of mercury control measures.

The DWR Mercury Monitoring and Evaluation Section is required as part of Phase I to submit final reports that present the results and descriptions of methylmercury control options, their preferred methylmercury controls, and proposed methylmercury management plan(s) (including implementation schedules) for achieving methylmercury allocations. Results will be integrated into Project-Specific Mercury Management Plans, as described in the following section.

3.4.12.2.1 Timing and Phasing

The timing and phasing of implementing CM12 will be contingent upon the timing and phasing of individual restoration projects developed under the BDCP.

3.4.12.2.2 Minimization and Mitigation Measures

The minimization and mitigation of restoration-related mercury methylation will be accomplished primarily through implementation of Project-Specific Mercury Management Plans for each restoration project. Through this program, site-specific factors that determine methylation potential can be more accurately assessed, efforts can be coordinated with ongoing research and TMDL compliance efforts of the DWR Mercury Monitoring and Evaluation Section, and the best approaches to restoration design and adaptive management can be implemented.

The section below describes the Project-Specific Mercury Management Plans. Also provided is an overview of some of the mitigation measures that are currently being researched.

Project-Specific Mercury Management Plans

For each restoration project under *CM4 Tidal Natural Communities Restoration*, a project-specific methylmercury management plan will be developed and will include the components listed below.

- A brief review of available information on levels of mercury expected in site sediments/soils based on proximity to sources and existing analytical data.
- A determination if sampling for characterization of mercury concentrations
- A plan for conducting the sampling, if characterization sampling is recommended.
- A determination of the potential for the BDCP restoration action to result in increased mercury methylation

If a potential for increased mercury methylation under the restoration action is identified, the following will also be included:

- Identification of any restoration design elements, mitigation measures, adaptive management measures that could be used to mitigate mercury methylation, and the probability of success of those measures, including uncertainties
- Conclusion on the resultant risk of increased mercury methylation, and if appropriate, consideration of alternative restoration areas

Because methylmercury is an area of active research in the Delta, each new project-specific methylmercury management plan will be updated based on the latest information about the role of mercury in Delta ecosystems or methods for its characterization or management. Results from monitoring of methylmercury in previous restoration projects will also be incorporated into subsequent project-specific methylmercury management plans.

In each of the project-specific methylmercury management plans developed under CM12, relevant findings and mercury control measures identified as part of TMDL Phase I control studies will be considered and integrated into restoration design and management plans. The Implementation Office, in conjunction with the Methylmercury TMDL program, will provide for a programmatic quality assurance/quality control (QA/QC) program that will specify sampling procedures, analytical methods, data review requirements, a QA/QC manager, and data management and reporting procedures. Each project-specific plan will be required to comply with these procedures to ensure consistency and a high level of data quality.

Overview of Mercury Methylation Mitigation Measures Research

Mitigation and minimization of mercury methylation is currently the topic of significant research by academics, government agencies, and private industry. However, at this time, a proven method to mitigate methylation and mobilization of mercury that could be applied across all the restoration projects that will be part of the BDCP. These decisions will have to be made with consideration of the new research information available at that time, on critical site-specific factors, and on the site conditions and intended restoration objectives of the project.

The mitigation measures described below are derived from a review of current research that has indicated potential to mitigate mercury methylation, some of which has been successful on small scales. These measures will be updated as additional information is produced by the Phase I Methylmercury TMDL control studies and other related research. The3.4.1.1.1 control studies conducted as part of the Methylmercury TMDL will include a description of mercury management practices identified in Phase I, an evaluation of the effectiveness, costs, potential environmental effects, and overall feasibility of the control actions.

Each project-specific methylmercury management plan will describe, at a minimum, the application or infeasibility of each of the mitigation measures described in detail in the following paragraphs. Thus, when considering implementing any mercury mitigation measure, the potential for nonbeneficial effects and interference with the overall objectives of the restoration project must be fully considered for each of the mitigation measures for each site individually. Wetland systems represent complex interactions among a multitude of physical and biological conditions that are in constant flux. CM12 is intended to evolve as it is informed by new research results over time that will inform selection and implementation of mitigation measures.

Characterize Soil Mercury

Mercury concentrations and distribution in soil will be characterized to inform restoration design, post-restoration monitoring, and adaptive management strategies. Site characterization will consider that specific biogeochemical conditions must be in place for methylation, regardless of the initial amount of mercury present in soils. Both mercury concentrations and critical biogeochemical indicators will be evaluated to determine methylation potential at any given site Sampling programs will also consider the fate and transport characteristics of the analyte. Factors determining the distribution of mercury in an area include distance from source areas (tributaries carrying mercury from upland mining areas such as Cache Creek), sediment grain size (mercury preferentially adheres to fine-grained sediments in depositional areas), and distribution of channel versus overbank alluvial deposits. Sampling designs will account for these variables to assess mercury distribution throughout a restoration site. Outcomes of the characterization could include pre-restoration site preparation, selection and design of appropriate mitigation measures, and design of post-restoration monitoring requirements.

Further mitigation measures and postconstruction monitoring will be mandatory if monitoring data show levels of methylmercury exceeding 0.06 nanogram per liter (unfiltered water sample), as developed by the Methylmercury TMDL.

Sequester Methylmercury Using Low-Intensity Chemical Dosing

Low-intensity chemical dosing (LICD) was developed as part of the U.S. Geological Survey (USGS) Subsidence Reversal and Carbon Capture Farming Program at a pilot restoration project on Twitchell Island. LICD has potential to provide the following benefits.

- Increased accretion in restored areas to counteract historical land subsidence in the Delta islands.
- Sequestration of carbon dioxide in wetland vegetation, mainly cattails (*Typha* spp.) and tules (*Scirpus californicus*).
- Sequestration of dissolved organic carbon in LICD floc.
- Sequestration of mercury in LICD floc.

The description of LICD presented here is primarily based on information provided by the EPA (U. S. Environmental Protection Agency and U.S. Geological Survey 2012).

Approach

The LICD process is based on the tendency of methylmercury to be chemically associated with dissolved organic carbon. The LICD process involves treating water with metal-based coagulants, such as iron sulfate or polyaluminum chloride, which bind with dissolved organic carbon and associated methylmercury, to form a floc that precipitates out of solution and is deposited. These coagulants are routinely used to remove dissolved organic carbon from drinking water. The LICD pilot program involves treating drainage waters from subsided peat islands with coagulants, then passing the coagulated water through wetland cells where the floc can settle out prior to the export of water to adjacent Delta channels.

The floc and the natural wetland vegetative matter rapidly accrete to raise the surface of the wetland, while also sequestering methylmercury and carbon. Laboratory studies indicate that up to 90% of the inorganic mercury and 70% of the methylmercury can be removed from the water column using LICD process (Henneberry et al. 2011). Preliminary studies indicate that the floc formed by this process is stable under reducing conditions, and may even have capacity to sorb additional mercury in the system (Henneberry et al. 2012). This initial research suggests that the methylmercury would not be remobilized after treatment.

In deeply subsided areas of the Delta, restoration to a more natural hydrology, and particularly a tidal regime, would require substantially increasing the ground surface elevation. Otherwise, the low-elevation, subsided areas would be subject to deep (up to 20 feet), permanent standing water when flooded. Field studies at Twitchell Island showed that cattails and tules accreted enough vegetative matter to increase land surface elevations by 2 to 4.5 centimeters per year, which is approximately 40 times the natural, historical accretion rate (Miller et al. 2011).

Uncertainties

[unchanged text omitted]

Minimize Microbial Methylation

[unchanged text omitted]

Design to Enhance Photodegradation

Photodegradation has been identified as an important factor that removes methylmercury from the Delta ecosystem by converting methylmercury to the inorganic (nonmethylated) form of mercury that does not bioaccumulate. Photodegradation of methylmercury occurs in the photic zone of the water column (the depth of water within which natural light penetrates). At the 1% light level, the mean depth for the photic zone in the Delta was calculated to be 2.6 meters, with measured depths ranging from 1.9 meters to 3.6 meters (Gill 2008; Byington 2007). Gill and Byington also conclude that photodegradation may be most active within the top half-meter of the water column in the Delta. Gill (2008) identified photodegradation of methylmercury as potentially the most effective mercury detoxification mechanism in the Delta. In the methylmercury budgets developed by Wood et al. (2010), Foe et al. (2008), Byington (2007), and Stephenson et al. (2007), photodegradation rates of methylmercury exceed methylmercury production rates from sediment.

Once photodegraded, mercury will either be volatilized to the air (Amyot et al. 1994), hydrologically transported, or stored in sediments where it could become available for methylation once again. Once methylated, mercury would again be biologically available.

To maximize photodegradation rates, restoration sites could be designed to optimize depths that do not exceed the photic zone.

Add Amendments to Mitigate Methylation

Mercury is methylated by sulfate-reducing bacteria that live in anoxic conditions found in tidal marsh restoration areas. Like sulfate, ferric (oxidized) iron is a source of energy to bacteria but provides more energy than sulfate and under more oxidized conditions. Adding ferric iron can promote the activity of iron-reducing bacteria, thereby depressing the activity of sulfate-reducing bacteria or moving it to deeper (less oxidized) sediment intervals where any methylmercury produced will not be less accessible for uptake. Other redox-active amendments that can inhibit sulfate reduction and have shown promise in suppressing Hg methylation include nitrate in a freshwater lake (Matthews et al. 2013) and manganese(IV) oxide in tidal marsh sediments (Vlassopoulos et al. 2014). Nitrate in particular may have unanticipated mitigating effects on methylmercury production in wetlands receiving agricultural runoff and merits further study. Alternately, adding ferrous (reduced) iron to sulfate-reducing sediments can promote the precipitation of iron sulfides. Dissolved mercury has a strong affinity for sulfide and can be removed by adsorption on or co-precipitation with iron sulfides, thereby making it less available to methylating bacteria (Liu et al 2009, 2012). Laboratory research has demonstrated that the addition of ferrous iron to pure cultures of sulfate-reducing bacteria in an anoxic system decreased net mercury methylation by approximately 75%, while field trials showed reduction in methylmercury export from unvegetated but not vegetated plots (Ulrich 2011). Iron addition to reduce methylation would have to be evaluated on a site-by-site basis. The evaluation should consider species-specific and community effects, fate and transport of the chemicals prior to implementation, and the cost/benefit of the addition.

Cap Mercury-Laden Sediments

[unchanged text omitted]

3.4.12.3 Adaptive Management and Monitoring

[See Section D.4.2 for changes to the Adaptive Management and Monitoring Program affecting CM12.]

Consistency with the Biological Goals and Objectives

[unchanged text omitted]

11F.3.2.7 Section 3.4.15, CM15 Localized Reduction of Predatory Fishes

<u>CM15 was extensively revised on the basis of discussions with fish and wildlife agency staff, as shown below.</u>

3.4.15 CM15 Localized Reduction of Predatory Fishes

The primary purpose of CM15 is to contribute to improved survival (to contribute to increased abundance) of covered salmonids emigrating through the Delta (Section 3.4.15.4, *Consistency with the Biological Goals and Objectives*) by locally reducing predation by nonnative predatory fishes (Lindley and Mohr 2003; Perry et al. 2010; Cavallo et al. 2012; Singer et al. 2012). Under CM15, the Implementation Office will reduce abundance of nonnative predatory fishes (predators) at specific locations and eliminate or modify holding habitat for predators at selected locations of high predation risk (i.e., predation “hotspots”). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of outmigrating juveniles that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, CM15 is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure will also not remove piscivorous birds, which appear to prey opportunistically on hatchery salmon (Evans et al. 2011). Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 will involve discrete study projects and research actions coupled with an adaptive management and monitoring program (Section 3.6, *Adaptive Management and Monitoring Program*) to evaluate effectiveness.

Removal of holding habitat for predatory fishes may also occur as a consequence of CM6 Channel Margin Enhancement, CM7 Riparian Natural Community Restoration, and CM13 Invasive Aquatic Vegetation Control.

Refer to Chapter 6, *Plan Implementation*, for details on the timing and phasing of CM15. See Chapter 8, *Implementation Costs and Funding Sources*, for a discussion of costs associated with implementation of CM15. Refer to Appendix 3.C, *Avoidance and Minimization Measures*, for a description of measures that will be implemented to ensure that adverse effects of CM15 on covered species will be avoided or minimized. Expected biological effects of implementing this conservation measure are summarized in Section 3.4.15.4, *Consistency with the Biological Goals and Objectives*, with further discussion in Appendix 5.F, *Biological Stressors on Covered Fish.*

3.4.15.1 Problem Statement

The purpose of a predatory fish reduction program is to reduce the abundance of predators, thereby reducing the mortality rates of protected or target species (in this case, covered salmonids) and increasing their abundance. To achieve this goal, predator control programs aim to limit the overall opportunity for fish predators to consume covered salmonids, typically by decreasing predator numbers, modifying habitat features that provide an advantage to predators over prey, reducing encounter frequency between predators and prey, or reducing capture success of predators. Beamesderfer (2000) proposed the following decision-making process to determine where intervention measures may prove effective and appropriate.

- Are one or more species significantly reducing the abundance of covered fish species, either directly by predation or indirectly by competition for a limited resource?
- Is it feasible to affect potential predators or competitors enough to provide benefits to the covered species?
- Do biological benefits outweigh costs and social/political considerations?

For covered salmonids, a high degree of uncertainty exists, which limits the ability to predict whether reducing predator numbers will help the BDCP meet its biological goals and objectives. Furthermore, some actions may not be acceptable for social, legal, or policy reasons. A recent review of the effects of fish predation on salmonids in the Delta concluded:

Although it is assumed that much of the short-term (<30 d) mortality experienced by these fish is likely due to predation, there are few data establishing this relationship. Juvenile salmon are clearly consumed by fish predators and several studies indicate that the population of predators is large enough to effectively consume all juvenile salmon production. However, given extensive flow modification, altered habitat conditions, native and non-native fish and avian predators, temperature and dissolved oxygen limitations, and overall reduction in historical salmon population size, it is not clear what proportion of juvenile mortality can be directly attributed to fish predation. (Grossman et al. 2013).

Given these uncertainties and constraints, CM15 will initially be implemented as an experimental feasibility assessment study and a series of connected research actions. Actions will be designed both to reduce uncertainties about the efficacy of this conservation measure and to increase its likelihood of desirable outcomes. The most plausible and feasible initial actions would be localized reduction of selected predatory fish species in known predation hotspots, and modification of habitat features that tend to increase predation risk. The goal would be to reduce loss of covered salmonids, principally juvenile salmonids migrating through the Delta.

The following sections review underlying ecological theory of the role of biological interactions in aquatic ecosystems, the role of habitat change on species assemblages, predation in the Delta, and predation hotspots.

3.4.15.1.1 Predation in Aquatic Ecosystems

[unchanged text omitted]

3.4.15.1.2 Predation in the Delta

Predators

Fish are generally opportunistic foragers, although prey choice can be affected by differences in prey characteristics such as morphology, energy content and behavior (reviewed by Grossman et al. 2013). Most predators are gape limited, meaning that smaller fish are vulnerable to more predators than larger fish. Thus, fish eggs can be eaten by essentially any fish species (and many invertebrates) in the Delta; fish larvae can be eaten by a large majority of the same taxa—even the covered fish species are known to prey opportunistically on fish larvae (Lott 1998); and small juvenile fish may still have a large number of potentially predatory fish taxa they need to avoid. However, predation rates typically decline as fish grow larger, reflecting the narrower range of species and life stages that can effectively capture and handle them. For fairly large juvenile fishes like salmonid smolts, only a handful of species inhabiting the Delta can routinely prey on them, primarily striped bass, largemouth bass and close relatives, Sacramento pikeminnow, and possibly adults of quasi-piscivorous species like white or green sturgeon, steelhead, and channel catfish. Different life stages can have different diets, which affects both available energy for growth and potential effects on prey species (Loboschefsky et al. 2012). For example, adult striped bass in the Delta feed primarily upon fish, while younger striped bass rely more on lower-energy invertebrate prey (Stevens 1966; Feyrer et al. 2003; Nobriga and Feyrer 2007); diets vary widely based on prey availability (Nobriga and Feyrer 2008). Though high turbidity environments can be an exception (Turesson and Bronmkark 2007), the prey choices of predators are typically density-dependent. Thus, predators tend to eat what is relatively abundant in the areas in which they are foraging.

[unchanged text omitted]

Predation on Covered Fish Species

In the Delta, predation occurs on covered species as eggs (delta smelt, longfin smelt) larvae (delta smelt, longfin smelt, splittail), juveniles (delta smelt, longfin smelt, salmon, steelhead, splittail, sturgeon) and adults (delta smelt, longfin smelt, splittail. Each of these species groups is described below.

Salmon are likely to encounter striped bass and Sacramento pikeminnow throughout juvenile emigration down the Central Valley rivers and in the Delta. Salmonid juveniles may be vulnerable to largemouth bass while forging in nearshore habitats around areas of SAV. Striped bass and largemouth bass were observed to consume salmonids, but in a recent evaluation less than 1% of those predators were observed with salmon in their stomachs (Nobriga and Feyrer 2007; Nobriga and Feyrer 2008). Sacramento pikeminnow predation on salmonids has been documented upstream (Vogel et al. 1998) but not in the Delta (Nobriga et al. 2006), even though large pikeminnow have been captured in the lower Sacramento River (Nobriga et al. 2006). Predators in the Delta may exhibit positive selectivity for juvenile salmonids because they are energy rich, easy to handle, and potentially naïve to invasive predators (reviewed by Grossman et al. 2013).

[unchanged text omitted]

Encounter, Capture and Consumption

The predation process consists of several components: search and encounter rates, pursuit and attack, capture and handling, and consumption (Grossman et al. 2013). Encounter frequencies between predators and covered fish are related to their overlap in habitat use spatially and temporally, the vulnerability of prey, which is typically linked to environmental conditions like river flows and turbidity (Cavallo et al. 2012), and their abundance relative to alternative prey (Link 2004).

Consumption rates of predators (by age-class or population level) can be estimated using bioenergetics models, which use an energy budget approach for growth of individual fish (Loboschefsky et al. 2012). Total consumption rates relate to predator number, predator size, water temperature, prey density, and sometimes prey vulnerability (i.e., microhabitat use of predator and prey and whether the prey has a refuge at low density).

Predation Hotspots

[unchanged text omitted]

3.4.15.2 Implementation

CM15 will include the following two elements.

- Hotspot feasibility assessment study. Implement experimental treatment at priority hotspots, monitor effectiveness, assess outcomes, and revise operations with guidance from the Adaptive Management Team.
- Research actions. Via the adaptive management program, support focused studies to quantify the population-level efficacy of the feasibility assessment study and any program expansion(s) intended to increase salmonid smolt survival through the Delta.

If demonstrably effective, the hotspot feasibility assessment study will be developed in three successive stages. During the first stage, a few treatment sites will be experimentally evaluated to test the general viability of various predator reduction methods. Secondary reduction actions, such as removal of abandoned vessels, may be implemented to determine if they will be effective on a large scale. After the initial scoping stage is complete, and if shown to be effective, the second stage will consist of implementation of a feasibility assessment study with a larger range of treatment sites and refined techniques, incorporating what is learned from the first stage. The main focus at this stage is to study the efficacy of predator reduction on a larger scale to determine whether it is making a demonstrable difference and/or has any unintended ecological consequences (i.e., unexpected changes to foodweb dynamics that may have negative effects on covered fish species). The feasibility assessment study may include such activities as direct predator reduction at hotspots (e.g., Clifton Court Forebay, head of Old River scour hole, the Georgiana Slough sites, and SWP/CVP salvage release sites) and removal of old human-made structures (e.g., pier pilings, abandoned boats).

The feasibility assessment study would begin with a preliminary assessment phase to compare two approaches for reducing local predator abundances: removal of predator hotspot structures (e.g., abandoned boats, derelict pier pilings) and general predator reduction in reaches with known high predation loss. To minimize uncertainty about the appropriate management regime necessary to maintain and enhance survival of covered salmonids, effectiveness monitoring will be implemented with the feasibility assessment study. Several metrics of actions and outcomes will be used. These are linked to the biological goals and objectives, most notably through-Delta survival objectives for covered salmonids. Effectiveness metrics include:

- Reduced abundance of predators – number of predatory fish removed or relocated from a reach (catch per unit effort), and abundance of predatory fishes in a locality after treatment compared to before-treatment conditions and reference sites (CPUE, hydroacoustic visualization of predator distribution). Document magnitude and duration of any potential effect.
- Increased survival of migrating salmonids – document survivorship of juveniles migrating through treated areas compared to pre-treatment conditions, and through the Delta compared to BDCP objectives (tagged fish study).
- Reduced habitat features that favor predation – modify, remove or reduce physical conditions and habitat features that increase risk for detection and capture by predators. Document the number of hotspots removed or modified, assess underwater conditions and fish distribution

using hydroacoustic technology, and/or conduct a tagged fish study for survival across the Clifton Court Forebay into the salvage facility.

If the feasibility assessment study shows that the main issues are resolvable, the third stage would consist of a defined predator reduction program (i.e., defined in terms of predator reduction techniques and the sites and/or areas of the Plan Area where techniques will be employed). Research and monitoring would continue throughout the duration of the program to address remaining uncertainties and ensure the measures are effective (i.e., that they reduce local abundance of predators and increase survival of covered salmonids). If the feasibility assessment study shows no benefits, or shows adverse effects on covered species, the Adaptive Management Team, in collaboration with the fish and wildlife agencies, will refine operations and decide whether and in what form predator reduction and further adaptive management will continue. The following sections provide an overview of lessons from other reduction programs, management principles and key uncertainties, and details of the hotspot feasibility assessment study.

3.4.15.2.1 Lessons from Predator Control Programs

Case studies from other aquatic systems illustrate the challenges and mixed outcomes from altering or manipulating predator-prey dynamics.

The benefits of predator reduction are challenging to achieve, demonstrate and sustain in open systems such as rivers. In the upper Colorado River Basin, the USFWS has implemented predator removal programs to support recovery of four endangered fishes (three minnows, one sucker). Six of seven reduction programs implemented during 1994-2001 failed to improve native fish populations, and a third of the reviewed programs failed to reduce predatory fish abundances (Mueller 2005). Problems included insufficient levels of predator removal, and rapid recolonization of treatment zones by new predators (Mueller 2005). Mueller (2005) suggested that reductions greater than 80% would be required to facilitate a measurable response in target native fish recruitment. A four-year study (2003-2006) for the Glen Canyon Dam Adaptive Management Program found that intensive mechanical removal (boat electrofishing with repeated passes, six times a year) was effective at reducing abundance of nonnative rainbow trout (Coggins et al. 2011). Relative abundance of native fishes increased in the treatment reach, compared to an upstream control reach. However, this success was aided by a system-wide decline in rainbow trout, resulting in reduced immigration to the treated river reach. Recommendations for future management include improved documentation of habitats preferred by predatory fish, using hydroacoustic surveys of predator abundance or fine scale habitat-based delineation of removal sites, to better target removal efforts (Coggins et al. 2011).

In the Lower Columbia River, a sustained predator reduction program has been implemented since 1990 to reduce the abundance of northern pikeminnow (Porter 2010; Independent Scientific Review Panel 2011). Salmonids comprise 64% of prey fish in pikeminnow downstream of Bonneville Dam (Porter 2011). Modeling simulations indicated that if predator-size northern pikeminnow were exploited at a 10 to 20% rate, the resulting restructuring of their population could reduce their predation on juvenile salmonids by 50%. The program uses a reward bounty for anglers. Other methods (gillnetting, longline, purse seine, trapnet) were tested and deemed inefficient at the system-wide scale. From 1991 to 2011, anglers have harvested over 3.7 million pikeminnow. In 2011, approximately 15% of pikeminnow were removed at a program cost of $1million (Porter 2011). After 20 years of modifications and fine-tuning, the program has achieved 10% to 20% exploitation rates on large northern pikeminnow, which are the most predaceous, and an estimated 40% reduction in modeled predation on outmigrating smolts compared to preprogram levels (Independent Scientific Review Panel 2011). However, no attempt has been made to relate predator reduction to adult return rates (Independent Scientific Review Panel 2011). The efficacy of the pikeminnow management program depends on the lack of compensatory response by other piscivores such as smallmouth bass and birds. Previous evaluations have not detected responses by the predatory community to sustained pikeminnow reduction, although responses to fisheries management programs may not be detected for several years.

In the Delta, Cavallo et al. (2012) conducted a pilot study on the North Fork Mokelumne River to evaluate effectiveness of localized predator reduction to improve reach-specific survival of salmon smolts (Cavallo et al. 2012). This study used a before-after/control-impact (BACI) study design. Predatory fish were removed by boat electrofishing on two occasions, 5 days apart. Acoustically tagged salmon survival increased significantly after the first predator reduction in the impact reach; however, survival estimates returned to preimpact levels after the second predator reduction. Reduction benefits were "undone" within 1 week. If site-specific predator reductions are to benefit juvenile salmon survival, sustained effort over time (with daily rather than weekly reduction efforts) may be necessary (Cavallo et al. 2012). However, such sustained efforts may be cost-prohibitive on more than a very localized scale.

In general, predatory fish control programs are difficult, costly, and have not produced strong positive, population-level responses in prey species (Grosshoz et al. 2013). Despite these logistic difficulties and expense, the fish predation panel nevertheless recommended additional BACI-design predator removal experiments to answer questions regarding the effects of predation (Grossman et al. 2013).

3.4.15.2.2 Management Principles and Uncertainties

Because of the high degree of uncertainty regarding predation/competition dynamics for covered fish species and the feasibility and effectiveness of safely removing large fractions of existing predator populations, the proposed predator reduction program is envisioned as an experimental feasibility assessment study within an adaptive management framework.

The feasibility assessment study will focus on increasing survival of migrating juvenile salmonids. The timing, pathways, and behavior of migrating salmonid smolts suggest that focused predator removal at discrete hotspots may increase their survival (e.g., Bowen et al. 2009; Perry et al. 2010; Cavallo et al. 2012). Effective methods exist for capturing and removing large predators and for measuring outcomes, including local predator density and salmon survival (e.g., smolt survival tagging studies, BACI reach-specific salmon survival).

These predator reduction efforts may also benefit juveniles of Pacific lamprey, river lamprey, green sturgeon, and white sturgeon that are migrating at the same time as the treatment.

For delta smelt and longfin smelt, however, reduction of large predators is less likely to provide benefits. Smelt spawn in the Plan Area, where they have previously been shown to be vulnerable to predation (Stevens 1963; Thomas 1967). During their egg and larval stages the smelts are also vulnerable to predation from a wide array of predators including small fishes such as silversides (Bennett 2005). Thus, larger fish such as adult striped bass are not the most significant predator, because they eat larger prey (Nobriga and Feyrer 2008). Moreover, reductions in large predator populations are likely to increase small predator populations, if predators have a strong influence on prey fish population dynamics (Essington and Hansson 2004). This has likely already been observed in the San Francisco Estuary's striped bass population. Kimmerer et al. (2000, 2001) suggested the adult striped bass population had resilience to persistent low recruitment of ago-0 fish stemming from compensatory density dependence in the juvenile stage. This is consistent with Loboschefsky et al. (2012), who reported increased abundance and prey consumption of age-2 striped bass during a period of declining adult consumption and ago-0 abundance in the 1990s and early 2000s. Furthermore, wide-scale reduction in an apex predator could trigger unintended trophic cascades. High uncertainty exists regarding whether the dynamic biotic interaction is top-down control, apparent competition, indirect effects, or other complex interactions (Vander Zanden et al. 2006). For example, wide-scale reductions in striped bass could result in competitive release and a compensatory response by silverside or other intraguild competitors.

In summary, predator reduction for delta smelt and longfin smelt faces two risks. First, it has to occur at a scale much larger than the hotspot approach proposed for salmonid smolts; the cost may be high and the probability of benefit may be low, if the program fails to identify the most significant predator species/life stage(s) and/or fails to remove enough predators. Second, unintended negative consequences could result, if too many of the wrong predator or competitor species are reduced—or even if the right predator population is reduced. Therefore, the BDCP feasibility assessment study will not undertake reduction efforts focused on benefiting delta smelt or longfin smelt.

Key uncertainties for developing and evaluating a predator reduction program include the following.

- Under what circumstances and to what degree does predation limit the productivity of covered fish species?
- Which predator species and life stages have the greatest potential impact on covered fish species?
- What habitat factors facilitate predation in the Delta, and how can those impacts be mitigated?
- How should hotspots for localized predator reduction and/or habitat treatment be prioritized?
- What are the best predator reduction techniques? Which methods are feasible, cost effective, and best minimize potential impacts on covered species?
- What are the effects of localized predator reduction measures on predator fish and covered fish species (e.g., increased survival)?
- How can predation rates on covered fish species be quantified?

These uncertainties are considered and addressed in the design of the feasibility assessment study and the research priorities, as detailed in the following sections.

3.4.15.2.3 Hotspot Feasibility Assessment Study

The hotspot feasibility assessment study will consist of discrete study projects and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. To minimize uncertainty about the efficacy of management regimes necessary to maintain and enhance survival of covered fishes, study experiments will be conducted to test the effects of predator reduction and structural habitat modifications or removal. The experiments will be designed to test a range of reasonable management alternatives at appropriate local spatial scales (Perry et al. 2010) and river flows (Kjelson and Brandes 1989; Cavallo et al. 2012). All experiments and research work under the feasibility assessment study will be subject to review and approval by the Adaptive Management Team.

Guidelines and Techniques

A plan will be developed for each study project. Treatment methods will be dictated by site-specific conditions and intended strategy. Elements of each study project plan will include the following.

[unchanged text omitted]

The feasibility assessment study will use the following approaches to reduce encounter frequency between predators and native fishes.

- Reduce the local abundance of predators.
- Remove or modify human-made predator hiding places.

Localized Reductions of Predatory Fish

The first strategy involves direct reduction of predators from areas with high predator densities (predator hotspots). Study projects to reduce predatory fish at hotspots will incorporate study design principles similar to those used by Cavallo et al. (2012) and proposed by Hayes et al. (2014). A test program will incorporate a BACI study approach, analyzing the abundance of predators and the survival of juvenile salmonids before and after predator reduction treatments. This approach would be implemented in river reaches with known predator hotspots, including Georgiana Slough, Old and Middle Rivers, and the lower Sacramento River near Paintersville Bridge. The study design would compare treated and untreated (control) reaches, or above and below treated areas (e.g., scour hole at the head of Old River). For the Clifton Court Forebay, which has no comparable control site, the assessment would be based on before and after conditions, or compared with previously documented levels of predation loss (Gingras 1997, Clark et al. 2009).

Once a location is selected, one of the reaches would receive predator reduction while the other one would represent the control reach. Experimental reaches would be relatively short (1 to 2 kilometers or less) to maximize the ability to effectively reduce the number of predators in the test reach. Predators would be relocated to other channels in the Delta that are not major migration corridors for emigrating juvenile salmonids. Multiple treatments of a given predator reduction strategy would be applied to the treated river reach to help develop an estimate of predator reduction effectiveness and an amount of time the treatment is effective (Cavallo et al. 2012, Hayes et al. 2014). Predators such as striped bass are highly mobile and may return to the treated area. Sustained reduction efforts would likely be necessary to maintain local reductions in predators (Cavallo et al. 2012, Coggins et al. 2011).

Various techniques to reduce local fish abundance are reviewed in Table 3.4.15-1; however, only physical reduction techniques will be considered for testing and implementation in the Delta. These include hook-and-line fishing, passive capture by net or trap (e.g., gillnetting, hoop net, fyke trap), and active capture by net (e.g., trawl seine, beach seine, tangle nets or purse seine) (Hayes et al. 2014). Protocols will follow sampling efforts used and currently being tested in the Sacramento and Columbia River basins (Michel et al. 2011 and Rub et al. 2011 [cited by Hayes et al. 2014]).

Advantages of physical reduction include public acceptance of these known techniques, lack of impacts on water quality, low level of hazard to nontarget organisms, higher level of feasibility compared to dewatering or chemical treatment in the open Delta waterways, and lower level of risk of unintended ecological consequences. Limitations include high exploitation rates required to achieve meaningful and measurable benefits, potentially high expense and intense labor, and short-lived benefits (Finlayson et al. 2010). The predator control techniques implemented would be analyzed to identify capture efficiency of predatory fish, as well as rates of injurious by-catch of covered fish. Addressing the uncertainty associated with the implementation of reduction techniques will be evaluated and refined through the adaptive management process, as described in Section 3.6.3.

Table 3.4.15-1. Potential Methods of Localized Reduction of Predatory Fish Populations

<table>
<tr><th>Technique</th><th>Advantage</th><th>Limitation</th><th>Potential Application</th></tr>
<tr><td colspan="4">Methods Potentially Applicable for the Delta</td></tr>
<tr><td></td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Hook-and-line</td><td colspan="3" rowspan="2">[unchanged text omitted]</td></tr>
<tr><td>Passive trapping (e.g., fyke nets, hoop net traps, baited traps)</td></tr>
<tr><td>Gillnetting</td><td>• Shown to be effective against striped bass and other mobile fish species
• Works well in turbid waters</td><td>• High by-catch of splittail and for some mesh sizes, adult salmonids
• Potentially lethal</td><td>• Use in areas of the Delta with turbid waters and lack of submerged vegetation or structures (e.g., the hole at Head of Old River)</td></tr>
<tr><td>Active capture (e.g., trawling or beach seines)</td><td colspan="3" rowspan="2">[unchanged text omitted]</td></tr>
<tr><td>Predator lottery fishing tournaments</td></tr>
</table>

Technique	Advantage	Limitation	Potential Application
Methods Unsuitable or Infeasible for the Delta			
Dewatering or water level fluctuation	[unchanged text omitted]		
Chemical treatment of targeted waters (e.g., rotenone)			
Pulsed pressure wave			
Bait prey fish (hatchery salmon) with oral piscicide			
Sources: Nielsen and Johnson 1983; Feyrer and Healey 2003; Finlayson et al. 2010; U.S. Army Corps of Engineers 2012; Cavallo pers. comm.			

Predator lottery fishing tournaments, a variant of the hook-and-line fishing technique, could be useful for reducing local abundance of predators at hotspots such as Clifton Court Forebay or along mainstem San Joaquin River (Cavallo pers. comm.). These tournaments would be designed to encourage intensive angling pressure at a particular location during a particular period of time (i.e., when covered prey species are present), and targeting specific predatory fish species (i.e., striped bass, largemouth bass). Such tournaments would be cost-effective, and potential by-catch would be minimized by requiring fisherman to use only particular hook-and-line methods that are known to be effective for the target predator(s). Following a tournament, tagged fish would be released and recaptured at these localized hotspots, using methods similar to those used to evaluate prescreen loss at Clifton Court Forebay (Gingras 1997; Clark et al. 2009) or at other locations within the Delta (Cavallo et al. 2012). The results would be compared to survival studies of covered fish within localized hotspots prior to predator reduction efforts.

Other potential methods of predator control considered but not addressed further in this analysis include biological techniques (e.g., predators, intraspecific manipulation, pathological reactions), dewatering or water fluctuation techniques (e.g., reservoir drawdown), streamflow manipulation, predator fish barriers, chemical treatment (i.e., using broadcast applications of piscicide or oral delivery of treated bait), and the use of high-intensity sound waves (e.g., explosives and pulsed pressure waves [U.S. Army Corps of Engineers 2012]). These methods are not considered further due to limited feasibility, potential permitting issues, public health and safety concerns, and/or poor public perception.

Effectiveness would be measured in terms of reduced relative abundance of predators and increased relative survival of juvenile salmon through the site. Hydroacoustic tracking and DIDSON cameras can provide a general estimate of predator densities within the river reaches (e.g., the number of predators along the shore, within the main part of the channel, or around prominent in-channel vegetation or structures). For example, boat-mounted DIDSON cameras have been used to document high densities of predators along the shoreline and near water diversion structures (Freeport Regional Water intake and Sacramento Water Treatment Plant) (C. Michel NMFS, unpublished data).

To evaluate relative survival, tagged salmon smolts would be released in the designated treatment and control reaches before and after treatment, and survival tracked through the Delta. Another potential approach would be to release floats, fitted with GPS trackers and live hatchery salmon smolts (approved by CDFW) connected by hook timers, to drift through reaches. (Hayes et al., 2014). The number of missing smolts, or tethers recovered with hooked predators could be used as an index of relative reach mortality. Tethered salmon may also be used to determine where elevated predation occurs (e.g., nearshore, in the channel, near structures) in order to refine and target reduction techniques (Hayes et al. 2014).

To evaluate predation-related loss at the new north Delta intakes on the Sacramento River, it will be necessary to monitor the reach where the intakes will be located and estimate potential predation risk within this reach. Studies are currently being designed to provide key baseline survival rates for emigrating covered salmonids and presence/absence data for other covered and predatory fish species within the reach containing the new intakes. These studies will be implemented to collect baseline data and then after installation of the north Delta intake facilities to document whether survival through this reach of the river changes.

In some locations, longer-term monitoring of expected reach-specific survival can help solidify predictions of baseline survival (e.g., Newman 2008; Perry et al. 2010; Singer et al. 2012). The comparison would take into account flow rates through the area (Kjelson and Brandes 1989; Perry et al. 2010; 2012; Cavallo et al. 2012) and water temperature (Kjelson and Brandes 1989; Baker et al. 1995; Marine and Cech 2004), since these factors play a significant role in affecting predation losses as indexed by smolt survival (Cavallo et al. 2012).

Habitat Modification to Reduce Predator Holding Areas

The feasibility assessment study also will evaluate the modification or elimination of habitat features that provide holding habitat for predatory fish and/or increase capture efficiency by predators. Examples of such habitat features include submerged human-made structures (e.g., abandoned boats, derelict structures, bridge piers), water diversion facilities (e.g., intakes, forebays [Vogel 2008]), channel features (e.g., scour hole at head of Old River [Bowen et al. 2009]), beds of invasive aquatic vegetation (Nobriga et al. 2005; to be treated under *CM13 Invasive Aquatic Vegetation Control*), and salvage release sites (California Department of Water Resources 2010b). It is hypothesized that removal of structures could reduce local aggregations of predators and could contribute to increased survival of juvenile salmonids migrating past these areas.

Species-specific habitat suitability data can be used to focus removal or modification efforts on those locations with the highest densities of predators (Coggins et al. 2011). Hydroacoustic surveys (e.g., C. Michel, NMFS unpublished data) can also target high-density areas for treatment.

Another approach is to modify salvage release methods and vary or increase release locations to avoid unintentionally creating predator feeding stations at the release pipe. A study experiment will increase the number of release sites from four to eight, alternate the timing of releases between the eight sites to discourage predators from holding at release sites, and remove debris near salvage release sites monthly from October through June to reduce the predation loss of salvaged splittails and other fish. Increasing the number of release sites, alternating the timing of releases between the sites, and removing debris that may provide predator cover are expected to contribute to a reduction in predation of covered fish species.

Effectiveness will be evaluated using a before-and-after comparison study design to assess predator abundance and smolt survival near the modified hotspot. The abundance of predators will be measured near the physical structure or habitat feature before and after treatment, and compared with abundance in a nearby unaltered reach. Reach-specific survival rates of tagged salmon smolts will be assessed (Cavallo et al. 2012, Hayes et al. 2014). Survival assessments will take into account the role of flow rates (Kjelson and Brandes 1989; Perry et al. 2010; 2012; Cavallo et al. 2012) and water temperature (Kjelson and Brandes 1989; Baker et al. 1995; Marine and Cech 2004) in comparing the before-and-after-removal survival results.

3.4.15.2.4 Program Timeline

During year 1 and 2, the Implementation Office will evaluate the strategies for logistical issues, relative effectiveness, incidental impacts on covered fish, and cost-effectiveness. The initial two years of assessment will be used to improve understanding of the intricacies of implementing each strategy of predator reduction specifically in the Delta ecosystem. Initially, the implementation of the feasibility assessment study may be managed by Implementation Office staff, but eventually responsibility would transfer to CDFW and NMFS field staff, including the authority to make decisions in conjunction with the Implementation Office.

After year 2 of feasibility assessment study implementation, the Implementation Office will refine the scope and methodology of the study—based on review by and coordination with the fish and wildlife agencies—and continue with implementation for an additional 4 to 6 years. Review and coordination with the fish and wildlife agencies will occur every other year thereafter for the duration of the implementation period. At the end of this implementation period, study assessment will involve independent science review and publication of findings. After the reviews are considered, the Adaptive Management Team, in collaboration with the fish and wildlife agencies, will refine operations and decide whether and in what form predator reduction and further adaptive management will continue.

3.4.15.3 Adaptive Management and Monitoring

[See Section D.4.2 for a description of changes to the Adaptive Management and Monitoring Program]

3.4.15.4 Consistency with the Biological Goals and Objectives

[unchanged text omitted]

11F.3.2.8 Section 3.4.16, CM16 Nonphysical Barriers

CM16 Nonphysical Barriers was revised to incorporate new information on types of barriers and their effectiveness, and to more clearly specify the siting of proposed barriers.

Section 3.4.16.1, *Problem Statement*, was edited as shown below.

For descriptions of the ecological values and current condition of fish barriers in the Plan Area, see Chapter 2, Section 2.3.3.3.3, *Water Supply Facilities and Facility Operations,* and Section 3.3.7.3, *Chinook Salmon, Sacramento River Winter-Run ESU*. Section 3.3.7.3 (and subsequent salmonid sections) also describes the need for nonphysical fish barriers as a component of the conservation strategies for covered salmonids, based on the existing conditions and ecological values of these resources.

The discussion below describes conditions that may be improved through implementation of CM16.

Juvenile salmonids experience low survival rates while migrating through the Delta toward the ocean. Survival rates vary among routes taken through the Delta (Brandes and McLain 2001; Perry and Skalski 2008, 2009; Holbrook et al. 2009; Perry et al. 2010), potentially as a result of differential exposure to predation, entrainment mortality at state and federal water export facilities and small agricultural diversions, and other factors associated with particular routes taken through the Delta (San Joaquin River Group Authority 2006; Burau pers. comm.; Perry et al. 2010).

Perry et al. (2010, 2013) found that based on observed patterns for hatchery-origin late fall–run Chinook salmon, eliminating entry into the interior Delta through Georgiana Slough and the Delta Cross Channel would increase overall through-Delta survival by up to about one-third. Survival for routes through the interior Delta was at most 35% that of survival for fish remaining in the Sacramento River (Perry et al. 2009). Such low probability of survival when migrating through the interior Delta indicates that significant population-level impacts could result if a sizable portion of the salmon population passed through this area. Some 20 to 41% of tagged salmon use Sutter and Steamboat Sloughs during migration, while 9% to nearly 35% of the population enters the interior area (Perry 2010; Perry et al. 2010, 2012). Low survival probabilities and high proportions of the population migrating through the interior Delta combine to significantly reduce salmon survival through the Delta during migration.

The need to reduce juvenile salmonid entry into the interior Delta was recognized in the NMFS SWP/CVP BiOp (2009a, 2011), which requires that engineering solutions be investigated to achieve a reduction. These solutions may include physical or nonphysical barriers. Physical barriers have been used in the Delta, such as the Delta Cross Channel gates and the rock barrier at the Head of Old River, to prohibit the entry of fish into channels where survival rates are low. Physical barriers that block all or nearly all of the flow into a channel are effective at prohibiting entry of salmonids into the channel, but they also alter flow dynamics in these channels, which may affect tidal flows, sediment loads, bathymetry, water supply reliability, potential for noxious algal blooms, toxic concentrations, and other water quality parameters. Operation of nonphysical barriers, including floating structures covering only a small portion of the water column, is predicted to cause smaller changes in the physical configuration of the channel, thus reducing flow-related effects, while improving survival of salmonids by deterring or discouraging them from entering channels with a higher risk of mortality.

Installation and seasonal operation of nonphysical barriers are hypothesized to improve survival of juvenile salmonids migrating downstream by guiding fish into channels in which they experience lower mortality rates (Welton et al. 2002; Bowen et al. 2012; Bowen and Bark 2012; Perry et al. 2014; California Department of Water Resources 2012b). A true nonphysical barrier functions by inducing behavioral aversion to a noxious stimulus, e.g., visual or auditory deterrents (Noatch and Suski 2012). One type of nonphysical barrier that has been tested with the Plan Area is the BioAcoustic Fish Fence (BAFF), which employs a three-component system comprising an acoustic deterrent within a bubble curtain that is illuminated by flashing strobe lights. As discussed further below, this type of nonphysical barrier has shown promising results in field studies within the Plan Area, as well as at other locations such as a field experiment on Atlantic salmon (*Salmo salar*) smolts in the River Frome, UK (Welton et al. 2002). Field trials of nonphysical barriers that use only one component, such as sound or light, have demonstrated less success in deterring fish. For example, out of 25 separate single-component sound and light systems placed in 21 different locations in Europe and the United States to affect the behavior of salmonids near water intakes and canals, fewer than 50% were effective in altering fish behavior (Bureau of Reclamation 2008).

DWR has undertaken a pilot study using a BAFF at the Georgiana Slough–Sacramento River divergence to determine the effectiveness of the BAFF in preventing outmigrating juvenile Chinook salmon from entering Georgiana Slough (California Department of Water Resources 2012b; Perry et al. 2014). Approximately 1,500 acoustically tagged juvenile late fall–run Chinook salmon produced at the Coleman National Fish Hatchery were released into the Sacramento River upstream of Georgiana Slough and their downstream migrations past the BAFF and divergence with Georgiana Slough were monitored (California Department of Water Resources 2012b; Perry et al. 2014). During the 2011 study period, the nonphysical barrier reduced the percentage of salmon smolts passing into Georgiana Slough from 22.1% (barrier off) to 7.4% (barrier on), a reduction of approximately two-thirds of the fish that would have been entrained into Georgiana Slough (California Department of Water Resources 2012b; Perry et al. 2014). This improvement produced an overall efficiency rate of 90.8%; that is, 90.8% of fish that entered the area when the barrier was on exited by continuing down the Sacramento River. There was some indication that the behavior and movement patterns of juvenile salmon were influenced by the high river flows that occurred in spring 2011. However, at high (> 0.25 meter per second) and low (< 0.25 meter per second) across-barrier velocities, BAFF operations resulted in statistically significant increases in overall efficiency for juvenile salmon. A second evaluation of the BAFF system at this location in 2012 showed somewhat lower fish exclusion rates into Georgiana Slough, indicating a reduction in the percentage of fish that otherwise would be entrained into Georgiana Slough by about one-half (California Department of Water Resources 2013). This lower rate may be because of the lower river flow conditions in 2012, compared to 2011 (California Department of Water Resources 2014).

The uncertainties regarding the effectiveness of nonphysical barriers on all covered species, and at different flow rates, are continuing to be evaluated. While the response by juvenile hatchery-origin late fall–run Chinook salmon to the nonphysical barrier at Georgiana Slough appears positive, it does not necessarily reflect the response of other salmonids, particularly the smaller wild-origin winter-run Chinook salmon and the larger steelhead migrants (California Department of Water Resources

2012b). Studies of a BAFF at the divergence of Old River from the San Joaquin River (head of Old River) found that although there was evidence of the BAFF deterring Chinook salmon smolts from entering Old River, the ability of the BAFF to protect fish at this location appeared to be limited because of high predation and hydrodynamics (Bowen et al. 2012; Bowen and Bark 2012.

Perry et al. (2014) observed that fish more distant (across the channel) from the BAFF were less likely to be entrained into Georgiana Slough than those closer to the BAFF as they passed the slough, suggesting that guiding fish further away from the Georgiana Slough entrance would reduce entrainment into the slough. In essence, fish on the Georgiana Slough side of the critical streakline (the streamwise division of flow vectors entering each channel, or the location in the channel cross section where the parcels of water entering Georgiana Slough or remaining in the Sacramento River separate) have a higher probability of entering Georgiana Slough; the BAFF increases the likelihood that fish remain on the Sacramento River side of the critical streakline. In addition to the BAFF system evaluations of what may be considered true nonphysical barriers, studies are also underway to determine the effectiveness of a floating fish guidance structure at Georgiana Slough (California Department of Water Resources 2013). This structure uses steel panels suspended from floats to change water currents so that fish are guided towards the center of the river (away from the entrance to Georgiana Slough), but does not substantially change the amount of water entering the slough. Studies of this technology in other locations have found it to be successful for guiding fish toward more desirable routes, e.g., at the Lower Granite Dam on the Snake River, Washington (Adams et al. 2001, as cited by Schilt 2007). For this reason, although not a true nonphysical barrier in that a small portion of flow is redirected, this technology is presented as a potential means for achieving the purpose of CM16 because the large majority of flow does not change its destination; as with the BAFF, the objective essentially is to keep fish on the Sacramento River side of the critical streakline.

Section 3.4.16.2.1, *Required Actions*, was edited as shown below.

The Implementation Office may install nonphysical barriers at the sites described below. These barriers will consist of technology appropriate for each site, which may be a combination of sound, light, and bubbles, similar to the BAFFs tested at the head of Old River and at Georgiana Slough (Bowen et al. 2012; Bowen and Bark 2012; California Department of Water Resources 2012b; Perry et al. 2014); or floating fish guidance structures similar to that tested at Georgiana Slough in 2014 (California Department of Water Resources 2013). Design and permitting for the initial barrier installations will take approximately 2 years, with installation and operation beginning in year 3. The cost estimate for this conservation measure (Chapter 8, *Implementation Costs and Funding Sources*) assumes that seven barriers would be constructed and operated during the permit term; however, fewer than seven barriers may be constructed if they are found to be less effective biologically and more expensive per barrier than the cost estimates. Similarly, more than seven barriers may be constructed if they are found be biologically effective and less costly per barrier than estimated. Current evaluations of a floating fish guidance structure may provide a more cost effective alternative to the three-component barrier, or may also provide greater benefits when used in combination with the three-component system (California Department of Water Resources 2013).

Section 3.4.16.2.2, *Siting and Design Considerations*, was edited as shown below.

Siting and design considerations may include survival rates of juvenile salmonids along specific migration routes within the Plan Area; site-specific conditions such as flow, turbidity, substrate, and channel bathymetry; and predator interaction with nonphysical barriers. Currently, potential sites for nonphysical barrier placement include Georgiana Slough, Head of Old River (Figure 3.4-34), Delta Cross Channel, Turner Cut, and Columbia Cut (note that Turner and Columbia Cut each have two channels, and thus would require two barriers).Barriers at these locations have a high potential to deter juvenile salmonids from using specific channels/migration routes that may contribute to decreased survival resulting from increased predation and/or entrainment. The Implementation Office may consider other locations in the future, if, for example, future research demonstrates differential rates of survival in Sutter and Steamboat Sloughs or in Yolo Bypass relative to the mainstem Sacramento River that justify redirecting fish into these migration pathways. The

Implementation Office will be responsible for installation, operation, maintenance, and removal of the nonphysical barriers. Nonphysical barrier placement may be accompanied by actions to reduce local predator abundance, if monitoring finds that such barriers attract predators or direct covered fish species away from potential entrainment hazards but toward predator hotspots. Nonphysical barriers of the BAFF type will be removed and stored offsite while not in operation (Holderman pers. comm.), whereas floating fish guidance structures do not require removal and would be left in place.

Site-specific conditions will drive the design of nonphysical barrier in terms of techniques to anchor and secure the structure, measures to indicate the location of the structure for the safety of waterway users (i.e., recreational boaters) and preferences for fish migration routes. BAFF structures may be appropriate at the Georgiana Slough, Head of Old River, and Delta Cross Channel sites, while floating structures may be suitable at the Turner Cut and Columbia Cut sites. Accordingly, this scenario was used to develop the cost estimates described in Chapter 8, *Implementation Costs and Funding Sources*. As described there, the capital and operational costs of nonphysical barriers increase dramatically in deep and wide sections of channels. Therefore, the expected and measured benefits of barriers at particular locations must be evaluated against their biological benefits.

The Implementation Office will evaluate the potential for nonphysical barriers to attract predators. Studies carried out at the Head of Old River indicated that the beneficial effects of nonphysical barriers could be undermined by predatory fishes such as striped bass that occurred near the barriers; however, it is not clear if predator densities are higher near nonphysical barriers, if certain types of nonphysical barriers may be more attractive to predators (e.g., sound, air and/or light barriers), or how effectively certain types/combinations of barriers function to direct covered salmonids away from areas with a high risk of entrainment and/or predation based on site-specific conditions. Evaluations of the non-physical barrier at Georgiana Slough in 2011 suggest that predation rates were low, although the relatively high flow velocities were suspected for reducing the residence time of fish near the barrier, thereby reducing the predation potential (California Department of Water Resources 2012b). Further investigations are necessary to determine whether, and under what conditions, nonphysical barriers may be appropriate.

11F.3.2.9 Section 3.4.18, CM18 Conservation Hatcheries

CM18 Conservation Hatcheries was revised in collaboration with USFWS staff, as shown below.

3.4.18 CM18 Conservation Hatcheries

Under *CM18 Conservation Hatcheries*, the Implementation Office will support establishment of new and expand existing conservation propagation programs for delta and longfin smelt. The Implementation Office will support two programs.

- The development of a delta and longfin smelt conservation hatchery by USFWS to house delta and longfin smelt refugial populations and provide a continued source of delta and longfin smelt for experimentation.
- The expansion of the refugial population of delta smelt and establishment of a refugial population of longfin smelt at the University of California (UC) Davis Fish Conservation and Culture Laboratory (FCCL) in Byron.

The principal purpose of CM18 is to ensure the existence of refugial captive populations of both delta and longfin smelt to provide insurance against the extinction of these species. The use of two refugial facilities will decrease the likelihood of loss of captive fish to catastrophe, such as loss of facility power or water supply, or to disease. The second purpose of the refugial populations is to provide a source of animals for experimentation, as needed, to address key uncertainties about delta and longfin smelt biology, the long-term genetic management of the refugial populations, and marking techniques that may facilitate future capture-mark-recapture research on wild fish. This approach minimizes the need to harvest wild stock for research purposes. This conservation measure will also support achievement of the biological goals and objectives, as detailed below in Section 3.4.18.4, *Consistency with the Biological Goals and Objectives.*

The refugial populations established and maintained by USFWS with funding from the BDCP could also function as a source of animals for reintroduction or supplementation of wild populations, should USFWS make a policy decision in the future that such reintroduction or supplementation is appropriate. Reintroduction or supplementation is not proposed by the BDCP.

Refer to Chapter 6, *Plan Implementation*, for details on the timing and phasing of CM18. Refer to Table 5.4-1 and Table 5.6-1 in Chapter 5, *Effects Analysis*, for a discussion of the effects of CM18 construction activities on terrestrial covered species and natural communities. Refer to Appendix 3.C, *Avoidance and Minimization Measures*, for a description of measures that will be implemented to ensure that effects of CM18 on covered species will be avoided or minimized.

3.4.18.1 Problem Statement

For descriptions of the ecological values and current condition of delta and longfin smelt in the Plan Area, see Chapter 2, *Existing Ecological Conditions,* and Appendix 2.A, *Covered Species Accounts*. The decline of delta smelt prompted listings under both the ESA and the California Endangered Species Act (CESA). USFWS currently lists delta smelt as threatened under the ESA, and the California Fish and Game Commission classifies delta smelt as endangered under the CESA. Similar declines in the longfin smelt population in the Delta prompted the California Fish and Game Commission in 2010 to list the species as threatened under CESA. The longfin smelt is currently a candidate species for listing under the ESA. Delta populations of both delta smelt and longfin smelt have experienced dramatic declines over the past five decades of monitoring, including further declines over the past decade or so due to a combination of factors (Sommer et al. 2007b; Baxter et al. 2008, 2010) (Figure 2.A.1-2, *Annual Abundance Indices of Delta Smelt Delta Smelt from 1959 to 2009*, and Figure 2.A.2-3, *Annual Abundance Indices of Longfin Smelt from 1967 to 2009*, in Appendix 2.A).

Genetic analyses indicate that delta smelt constitutes a single, well-mixed population (Stanley et al. 1995; Trenham 1998; Fisch et al. 2009; Fisch 2011). Genetic variation within Delta longfin smelt has received less detailed study, but work to date (Stanley et al. 1995; Israel and May 2010) has not identified multiple populations in the region. Accordingly, it is likely that the proposed refugial populations could be used to preserve and maintain a significant fraction of genetic diversity at the species (for delta smelt) or distinct population segment (for longfin smelt) level.

Establishing viable refugial populations of delta smelt and longfin smelt would provide insurance against the potential extinction of these species. If the native smelt populations continue the trajectory of decline seen over the past several decades, the point could come when a conservation hatchery is the only option to preserve them. A conservation hatchery also provides a stock of fish that could be used to test the effects of various stressors on these species in a controlled environment (e.g., Baskerville-Bridges et al. 2004; Bennett 2005), while minimizing the need to harvest wild stocks and put them at further risk. Experiments performed on delta smelt and longfin smelt at the conservation hatcheries are anticipated to be important parts of targeted research associated with the BDCP adaptive management and monitoring program.

Implementation of CM18 is thus expected to reduce the risk of extinction for both species via *ex situ* conservation of refugial populations. Artificial propagation and maintenance of refugial populations of delta and longfin smelt would provide the following benefits.

- Provide a safeguard against the possible extinction of delta and/or longfin smelt by maintaining captive populations that have genetic variability reflecting that of naturally spawned populations (Lande 1988; Hedrick et al. 1995; Sveinsson and Hara 1995; Carolsfeld et al. 1997; Sorensen 1998; Hedgecock et al. 2000; Kowalski et al. 2006; Turner et al. 2007; Turner and Osborne 2008; Essex Partnership 2009).

- Improve the knowledge base regarding threats to and management of delta and longfin smelt by providing an opportunity to study the effects of various stressors on these species in a controlled environment using hatchery-reared specimens instead of wild caught individuals.
- Develop production capacity sufficient to supplement delta and longfin smelt populations naturally propagated in the wild, should a future Service and/or CDFW policy decision warrant it (Lande 1988; Deblois and Leggett 1993; Sveinsson and Hara 1995; Carolsfeld et al. 1997; Sorensen 1998; Flagg et al. 2000; Richards et al. 2004; Kowalski et al. 2006; Purchase et al. 2007;). Such a supplementation, combined with effective habitat restoration and other measures to improve conditions in their natural environment, could contribute to achieving self-sustaining population levels in the wild. However, neither DFW nor USFWS has determined that such supplementation is necessary or appropriate, and reintroduction of artificially propagated delta and longfin smelt is not proposed by the BDCP.

3.4.18.2 Implementation

The new facility proposed by USFWS will house genetically managed refugial populations of delta and longfin smelt (Clarke 2008). The starting population for this new facility will likely consist of a combination of both wild-caught fish and hatchery broodstock supplied from the UC Davis FCCL facility (Hoover pers. comm.). The existing USFWS delta smelt captive population in the Livingston Stone Fish Hatchery has low mortality rates of adults[12]. Transport mortality is less than 0.5% monthly, and fish are screened for pathogen risks prior to transport. Mortality during rearing ranges from 0.5 to 1% in the nonspawning months, and 3 to 5% during the spawning season due to necessary handling (Hoover pers. comm.) Mortality rates at the new facility are expected to be similar. State-of-the-art genetic management practices will be implemented to maintain close genetic variability and similarity between hatchery-produced and natural-origin fish.

The facility will be designed to provide captive propagation of other species, if necessary, in the future. The facility will discontinue housing refugial populations of delta and longfin smelt only when these species achieve recovery, as defined by USFWS. The specifications and operations of this facility have not been developed, nor has the facility location been determined, though it is expected to be located within the Plan Area. Additional permitting and environmental documentation will be needed to implement this conservation measure once facility designs and funding are available. Because of these challenges, it is expected that design, permitting, and construction of the facility will take approximately 6 years, with the facility becoming operational by year 7.

The FCCL currently houses about 250 pairs of spawning delta smelt, which produce around 200,000 eggs each year. The FCCL is currently permitted to supplement its refugial population with 50 wild delta smelt per year, which are typically captured on the lower Sacramento River near Decker Island. At the FCCL, typical survival rates are about 10 to 20% from egg to adult, with most fish lost during the larval phase; adult mortality rates are typically low. The facility is attempting to establish a longfin smelt refugial population, although dedicated funding at present is very limited. The facility is permitted to capture 50 wild longfin smelt a year, but ability to capture live, healthy, wild longfin smelt is limited (Lindberg pers. comm.).

To expand both refugial populations and maintain them over the long term, this conservation measure assumes a maximum capture rate for delta smelt and longfin smelt of double the current maximum, to 100 each annually. This maximum capture rate is not expected to be needed every year.

The FCCL and the Genomic Variation Laboratory at UC Davis are and will be the primary entities developing and implementing genetic management of the delta smelt refugial population from 2009 until the larger facility is operational; thereafter they may play a secondary role by keeping a back-up population(s). Design, permitting, and construction of upgrades to the existing FCCL facility are expected to take 3 years, with the upgrades becoming operational in year 4.

[12] The existing Livingston facility would likely be discontinued and its population relocated at the new facility described in the "Implementation" section of this conservation measure.

Genetic management practices will be implemented to maintain genetic diversity comparable to that of natural-origin fish, minimize genetic adaptation to captivity, minimize mean kinship, and equalize family contributions. The current genetic management plan for the refugial population of delta smelt at the FCCL has been shown to be successful in retaining genetic diversity of the founding wild broodstock through the F3 generation, preventing substantial genetic divergence from the wild population by supplementing the captive population with wild fish, and maintaining an effective population size of more than 500 individuals (Fisch et al. 2013).

The Implementation Office will, as appropriate, enter into binding memoranda of agreement or similar instruments with USFWS and UC Davis. If and when populations of these species are considered recovered by USFWS, the Implementation Office will terminate funding for the propagation of the species and either fund propagation of other covered fish species, if necessary and feasible, or discontinue funds to this conservation measure and reallocate them to augment funding other conservation measures identified in coordination with the fish and wildlife agencies through the adaptive management process (Section 3.6.3).

3.4.18.3 Adaptive Management and Monitoring

[See Section D.2.4 for the revised treatment of adaptive management and monitoring for CM18.]

3.4.18.4 Consistency with the Biological Goals and Objectives

Table 3.4.18-1. Biological Goals and Objectives Addressed by CM18

Biological Goal or Objective	How CM18 Advances Biological Objective
Goal DTSM3 Lowered risk of extinction and increased capacity for conservation research.	
Objective DTSM3.1: (1) Achieve and maintain captive Delta Smelt populations that are large enough and managed and monitored in such a way that genetic diversity remains sufficient to ensure the genetic survivability of the estuary's Delta Smelt population. (2) Maintain a sufficiently large excess production of captive Delta Smelt to support research needs into their biology and genetic management. (3) Develop the production capacity of delta smelt to make possible the supplementation of the natural population, should USFWS and/or CDFW decide supplementation is appropriate.	The creation and expansion of refugial hatchery populations of delta smelt will ensure *ex situ* conservation of this species.
Goal LFSM2: Lowered risk of extinction and increased capacity for conservation research.	
Objective LFSM2.1: (1) Achieve and maintain captive Longfin Smelt populations that are large enough and managed and monitored in such a way that genetic diversity remains sufficient to ensure the genetic survivability of the estuary's Longfin Smelt population. (2) Maintain a sufficiently large excess production of captive Longfin Smelt to support research needs into their biology and genetic management. (3) Develop the production capacity of longfin smelt to make possible the supplementation of the natural population, should USFWS and/or CDFW decide supplementation is appropriate.	The creation and expansion of refugial hatchery populations of longfin smelt will ensure *ex situ* conservation of this DPS.

11F.3.2.10 Section 3.4.23, Resources to Support Adaptive Management

Section 3.4.23, *Resources to Support Adaptive Management*, was renumbered as Section 3.4.22 and extensively revised as shown below.

3.4.22 Resources to Support Adaptive Management

The conservation strategy sets out a comprehensive set of conservation measures that are expected to achieve a range of identified measurable biological goals and objectives. As described in this chapter, the conservation measures include certain actions to improve flow conditions, increase food production, restore habitat, and reduce the adverse effects of other stressors. The conservation strategy also recognizes the considerable uncertainty that exists regarding the understanding of the Delta ecosystem and the likely outcomes of implementing the conservation measures, both in terms of the nature and the magnitude of the response of covered species and of ecosystem processes that support the species. To effectively address such uncertainty, the conservation strategy includes an adaptive management program that provides for flexibility in the implementation of the conservation measures.

Under the adaptive management program, the conservation measures may be modified or adjusted, through the process described in Section 3.6, *Adaptive Management and Monitoring Program*, to further advance the biological objectives. Any such changes to conservation measures must be consistent with the commitments and cost estimates set out in Chapter 8, *Implementation Costs and Funding Sources*, including those reflected in the Adaptive Management Fund (Section 3.4.23.5). Similarly, biological objectives may also be adjusted through the adaptive management process (Section 3.6.3.5.3, *Changing a Conservation Measure or Biological Objective*). Strategies for making adaptive management changes to the conservation strategy will include the following.

- Changing approaches to the implementation of the conservation measures.
- Shifting resources from less effective to more effective conservation measures.
- Adding new conservation measures.
- Revising biological objectives.
- Utilizing the Adaptive Management Fund to expand conservation measures (Section 3.4.22.5).

These strategies will be evaluated by the parties involved in the adaptive management process, as described in Section 3.6.3.5.3, as they consider changes to the conservation measures and biological objectives. Such strategies may be applied to any of the conservation measures, including those that involve water operations, habitat restoration, or other stressors, to benefit the aquatic or terrestrial species covered by the Plan. Any potential adaptive management change to a conservation measure, either individually or cumulatively, may not require the commitment of resources in excess of those provided for under these strategies, including the Adaptive Management Fund, or under the commitments of the Plan participants, including the Authorized Entities, set out in Table 8-41, *BDCP Funding Provided by Participating State and Federal Water Contractors* (Chapter 8).

As part of the adaptive management process, adjustments to water operations criteria established under *CM1 Water Facilities and Operation* may be necessary. Every 5 years, water facility operating criteria will be comprehensively reevaluated as part of the program-level assessment conducted by Implementation Office, as described in Chapter 6, Section 6.3.5, *Five-Year Comprehensive Review*. In addition, water facility operating criteria will be evaluated comprehensively after 25 years (i.e., 15 years after new facility operations begin) in light of environmental conditions and climate change predictions at the time, as describe in Chapter 6, Section 6.3.5.2, *25-Year Climate Change Review*. In the event that changes to CM1 are adopted through the adaptive management process or through these periodic reviews, the resources needed to implement such changes will be drawn from the following sources and in the order of priority set out below.[13]

1. Interannual adjustments in operations.
2. Sharing of water supply improvements.
3. Funding shifts to the most effective conservation measures.
4. Adaptive Management Fund, including the Environmental Flow Program.

The following describes each of the potential resources available to support an adaptive management change to CM1 operations and the extent to which these resources may be available for such purposes.

3.4.22.1 Interannual Adjustments in Operations

[unchanged text omitted]

3.4.22.2 Sharing of Water Supply Improvements

[unchanged text omitted]

3.4.22.3 Redirected Funding to the Most Effective Conservation Measures

[unchanged text omitted]

3.4.22.4 Environmental Flow Program

The 2014 California Water Action Plan (Water Action Plan; California Natural Resources Agency et al. 2014) includes an action to protect and restore important aquatic ecosystems (Water Action Plan Action 4). This action is to be achieved, in part, through enhanced water flows in stream systems statewide and through integrated regulatory and voluntary efforts. As the Water Action Plan notes, “[i]ntegration across and between all voluntary and regulatory efforts may be necessary to truly achieve basic ecological outcomes.”

Specifically, the Water Action Plan commits that: “the administration, with the involvement of stakeholders, will build on the work in tributaries to the Sacramento and San Joaquin rivers, analyze the many voluntary and regulatory proceedings underway related to flow criteria, and make recommendations on how to achieve the salmon and steelhead and ecological flow needs for the state’s natural resources through an integrated, multi-pronged approach.”

To help implement this important action, the State of California will create an Environmental Flow Program (EFP) that will operate statewide, including the Delta. The broad purpose of the EFP is to help achieve the goals described above in the Water Action Plan. The state and federal governments agree to cooperate on a strategy for improved flows as described in the Water Action Plan. The EFP will include but will not be limited to the following approaches to obtaining and utilizing environmental flows:

- Voluntary transactions within the regulatory system for the purpose of helping meet ecological goals and flow needs in the watersheds that are the subject of such transactions as well as downstream.
- Acquisition of long-term access to water for the purpose of providing environmental flows, so long as the benefits exceed existing environmental mitigation obligations.

[13] That is, if the resources necessary to implement the change can be obtained through a higher-priority source, lower-priority sources will not be used.

- Other projects in addition to water acquisition that provide environmental flows for public benefit such as water conservation, water efficiency programs, consumptive use reduction, new above and below ground water storage, conjunctive use, or other tools.

The administration of the EFP has not yet been determined. However, it will be administered consistent with the BDCP, BDCP permits, and the IA.

3.4.22.4.1 Relationship between the Environmental Flow Program and BDCP

The BDCP is a vital element of the Water Action Plan. Specifically, the BDCP is critical to the success of Water Action Plan Action 3: "Achieve the co-equal goals for the Delta". Successful implementation of BDCP will be necessary to achieve both the water supply and ecological goals of the Water Action Plan. Therefore, the EFP will be designed to provide for BDCP purposes as well as broader statewide ecological objectives. Enhanced flows provided through the EFP for environmental benefit in Central Valley upstream tributaries will be available to help provide for BDCP purposes. Specifically, BDCP purposes of the EFP will include:

- Scientific experimentation to better determine flow needs for BDCP covered species while minimizing impacts to water supply, including those flows described in the BDCP Decision Trees (see Section 3.4.1.4.4, *Decision Trees*).
- Providing Delta outflows that are found to be necessary at the beginning of CM1 operations through the Decision Tree process to contribute to the recovery of the covered fish and, in concert with all BDCP conservation measures, to achieve BDCP biological goals and objectives.
- Provide for additional ecological needs during the BDCP permit term as determined by the BDCP Adaptive Management Program.

As it relates to the BDCP, the EFP will be funded through specific commitments from the United States, the State of California, and the BDCP Permittees, with funding allocations described in Chapter 8, Section 8.3.4.1.3, *Adaptive Management Fund*. The BDCP Authorized Entities commit to providing minimum environmental flows through the EFP to support the BDCP adaptive management and monitoring program as described below.

BDCP Years 1–10

In the first 10 years of Plan implementation, before CM1 initial operations commence, environmental flows are needed to help resolve which branch of the Decision Trees (or an intermediate point within each branch) is selected for initial CM1 operations to support delta smelt and longfin smelt. This important monitoring and research focus area is described in more detail in Table 3.4.1-5 and in the Adaptive Management and Monitoring Program, Section 3.6.4.7.3, *Decision Trees Focus Area*. Monitoring and research on flows is also needed during the first 10 years of Plan implementation to confirm initial water facility operations to support covered salmonid and sturgeon needs in order to achieve the biological goals and objectives for these species as described in Section 3.1.1, *Biological Goals and Objectives* (e.g., salmonid survival objectives). To meet these experimentation needs, a minimum of 500,000 acre-feet/year of environmental flows will be provided during the first 10 years of Plan implementation (Table 3.4.22-1). To allow time for adequate funding to be assembled and for environmental flow acquisition to occur, these minimum flows will be available by at least Year 7. This deadline will allow for at least two years of full experimentation prior to initial operations under BDCP.

BDCP Years 11–26

The second time period for environmental flows is defined as Years 11–25. This time period is concurrent with the first 15 years of new water operations under BDCP. During this period, flow experimentation will continue to be needed to support effectiveness monitoring (see Table 3.4.1-4 for specific flow experimentation needs) and research to answer key uncertainties related to water operations (see Table 3.4.1-5). To meet these continued needs, a minimum of 900,000 acre-feet/year of environmental flows will be provided through the EFP for BDCP by Year 11 to be available during years 11–25 of Plan implementation (i.e., an additional 400,000 acre-feet/year, Table 3.4.22-1). The use of these minimum environmental flows will be determined by the outcome of the Decision Tree at the start of new operations:

- Depending on the extent to which these environmental flows would be required for Delta outflows for delta and/or longfin smelt, all or a portion of the environmental flows could be available to meet any additional needs of salmonids or sturgeon or other necessary actions not already met by the Decision Tree outcome as determined by the BDCP adaptive management program. Environmental flows under BDCP that are not required for environmental purposes as determined through the BDCP adaptive management program will be available for improving water supply for BDCP Authorized Entities or sale to third parties.

- If the Decision Tree process results in initial operations that correspond to the high outflow scenario (i.e., high outflow for fall and spring), all available environmental flows up to 900,000 acre-feet will be used to contribute to the high outflows. Environmental flows beyond what are needed to contribute to the high outflow scenario will be available to meet other adaptive management needs. If environmental flows are insufficient to meet high outflow flows, then the SWP and CVP will operate as necessary to provide the high outflows required by the Decision Trees.

BDCP Years 26–50

The final time period for environmental flows is defined as years 26–50. This time period corresponds to when the effects of climate change are expected to be most evident in the Plan Area and other areas that affect the survival of the covered species, and therefore have the greatest influence on uncertainties surrounding Plan effectiveness (see Appendix 5.A for more details). By year 26, a minimum of 1,300,000 acre-feet/year of environmental flows will be acquired (i.e., an additional 400,000 acres-feet/year over the last time period), regardless of the outcome of the Decision Trees or other adaptive management decisions (Table 3.4.22-1). A minimum of 400,000 acre-feet/year of these environmental flows will be available for additional adaptive management actions that may be needed to augment flow beyond that associated with the high outflow scenario, as determined by the BDCP adaptive management program. Other unallocated environmental flows could also be used for additional adaptive management actions as determined by the adaptive management program.

Table 3.4.22-1. Minimum Environmental Flows to be Available for BDCP Adaptive Management through the Environmental Flow Program

Time Period	Min. Environmental Flows (TAF/year)[1]	Total Cumulative Min. Environmental Flows (TAF/year)[1]	Deadline for Min. Environmental Flows	Priority BDCP Uses
Years 1–10 (prior to CM1 initial operations)	500	500	Year 7	• Decision Trees experimentation • Experimentation for covered salmonid and sturgeon outflow needs
Years 11–25 (early CM1 operations)	400	900	Year 11	• Decision Tree high outflow scenario • Other flow needs as determined by adaptive management program
Years 26–50 (later CM1 operation when climate change effects are greatest)	0 or 400	900 or 1,300	Year 26	• Responses to climate change effects and other uncertainties • Additional adaptive management actions as necessary (minimum of 400 TAF/yr)
Total	900 or 1,300			

[1] TAF = thousand acre-feet. Water amounts are defined by upstream acquisition amounts, not downstream outflow. Additional environmental flows may need to be acquired to ensure outflow needs given water loss between source and outflow location.

Contingencies

Acquisition of the minimum environmental flow requirements described above is feasible based on the recent history at DWR and the participating state and federal water contractors of water transfers using the methods outlined above. The amount and timing of minimum environmental flow requirements were established to ensure their feasibility as well as to meet potential adaptive management needs of the covered fish. However, if the environmental flows are not obtained as required as a result of limited willing sellers or costs higher than budgeted, the Authorized Entity Group and Permit Oversight Group must meet and confer to determine an appropriate course of action to meet the environmental flow requirement or make adequate progress towards the relevant biological goals and objectives in a different manner. The process for resolution is described in Chapter 7. If a dispute arises, the matter will be resolved through the process described in Section 15.8 of the Implementing Agreement, *Review of Disputes Regarding Implementation Matters*. Contingencies related to shortfalls in funding are addressed separately in Section 8.4.2, *Actions Required in the Event of a Shortfall in State or Federal Funding.*

3.4.22.5 Adaptive Management Fund

BDCP will establish an Adaptive Management Fund to, in part, support the Environmental Flow Program. The Adaptive Management Fund will also support changes to conservation measures CM2-21 as determined by the BDCP adaptive management program. This Adaptive Management Fund will be used to support adaptive management changes to CM1 operations, as well as to other conservation measures, determined to be necessary during Plan implementation. Funding for the Adaptive Management Fund will be jointly provided by the Authorized Entities, the State of California, and the United States as described in Chapter 8 (see Section 8.3.4.1.3, *Supplemental Adaptive Management Fund*).

The components of the fund and the process by which it would be made available to support changes to conservation measures through the adaptive management process are as follows. Any decision to access the fund to change resources allocated to a conservation measure would be considered in the context of a proposed change to CM1 operations, or any other conservation measure, as part of the adaptive management process, which is expected to occur in association with the 5-year review process. The fund, however, would be available at any time to support the Environmental Flow Program described above.

Before the fund could be accessed to change a conservation measure, the following actions will have been taken or determinations made.

- A periodic review has determined that one or more of biological objectives are unlikely to be achieved through implementation of the existing conservation measures (Section Chapter 6, 6.3, *Planning, Compliance, and Progress Reporting*).
- The biological objectives have been assessed in light of their achievability under the Plan and, if circumstances and the new scientific information warranted, adjustments to such objectives were made.
- A lack of progress toward achieving one or more biological objectives is related to or caused by the covered activities or conservation measures.
- Adjustments to one or more conservation measures (e.g., more flow, changes in habitat restoration targets or locations) are likely to address the problem.
- To the extent appropriate, existing assets have been reallocated to support adequate changes to conservation measures (Section 3.4.22.3, *Redirected Funding to the Most Effective Conservation Measures*).
- Measures that do not adversely affect water supply, if any, have been implemented.

If the consideration of the foregoing factors confirms the need to use the fund, the Implementation Office, pursuant to the direction provided through the adaptive management process, would initiate actions to deploy the money available through the Adaptive Management Fund to provide the additional resources necessary to implement the adaptive management change. These funds could be used, for instance, to implement additional natural community restoration, expand other stressors conservation actions, or a combination of approaches.

3.4.23 References Cited

3.4.23.1 Literature Cited

[Only new, changed, and deleted citations are shown.]

Adams, N. S., Johnson, G. E., Rondorf, D. W., Anglea, S. M., Wik, T., 2001. Biological evaluation of the behavioral guidance structure at Lower Granite Dam on the Snake River, Washington in 1998. In: Coutant, C. C. (Ed.), Behavioral Technologies for Fish Guidance American Fisheries Society Symposium, vol. 26. American Fisheries Society, Bethesda, MD, pp. 145–160.

Baker, P. F., T. P. Speed, L. K. Franklin. 1995. Estimating the Influence of Temperature on the Survival of Chinook Salmon Smolts (*Oncorhynchus tshawytscha)* Migrating Through the Sacramento – San Joaquin River Delta of California. 52:855-863.

Baskerville-Bridges, B., J. C. Lindberg, J. Van Eenennaam, S. I. Doroshov. 2004. *Delta Smelt Research and Culture Program 5-Year Summary, 1998–2003*. Project No. 2000-B03; Proposal No. 99-B145. Prepared by University of California, Davis, Department of Animal Science. Prepared for the CALFED Bay-Delta Program.

BDCP Integration Team. 2009. *Evaluation of North Delta Migration Corridors: Yolo Bypass. Draft Technical Memorandum*. April. Prepared for the Bay Delta Conservation Plan Integration Team.

Beier, P., and R. Noss. 1998. Do Habitat Corridors Provide Connectivity? *Conservation Biology* 12(6):1241–1252.

Bennett, W. A. 2005. Critical Assessment of the Delta Smelt Population in the San Francisco Estuary, California. *San Francisco Estuary and Watershed Science* 3(2). Available: <http://repositories.cdlib.org/jmie/sfews/vol3/iss2/art1/>. Accessed: March 27, 2012.

Black Hoffman, S., M. Shepard, M. Vaughan, C. LaBar, and N. Hodges. 2009. *Yolo Natural Heritage Program (HCP/NCCP) Pollinator Conservation Strategy*. November. The Xerces Society for Invertebrate Conservation, Sacramento, CA.

Bowen, M. D., S. Hiebert, C. Hueth, and V. Maisonneuve. 2012. 2009 Effectiveness of a Non-Physical Fish Barrier at the Divergence of the Old and San Joaquin Rivers (CA). Technical Memorandum 86-68290-09-05. US Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, CO.

Bowen, M. D., and R. Bark. 2012. 2010 Effectiveness of a Non-Physical Fish Barrier at the Divergence of the Old and San Joaquin Rivers (CA). Technical Memorandum 86-68290-10-07. US Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, CO.

Brown, R., S. Greene, P. Coulston, and S. Barrow. 1996. An Evaluation of the Effectiveness of Fish Salvage Operations at the Intake to the California Aqueduct, 1979–1993. In: J. T. Hollibaugh (ed.). *San Francisco Bay: The Ecosystem*. San Francisco, CA: Pacific Division of the American Association for the Advancement of Science. Pages 497–518.

Buchanan, R. A., J. R. Skalski, P. L. Brandes, and A. Fuller. 2013. Route Use and Survival of Juvenile Chinook Salmon through the San Joaquin River Delta. *North American Journal of Fisheries Management* 33(1):216-229.)

California Department of Boating and Waterways. 2009b. *Water Hyacinth Control Program Operations Management Plan 2009 Updated Manual Appendix C*. Available: <http://www.agriculturedefensecoalition.org/sites/default/files/file/contra_costa_wh_73/73X_2009_CA_Boating_Waterways_Department_WHCP_Operations_Management_Plan_Manual_2009_04_Appx_C_WHCP_OMP.pdf>.

California Department of Fish and Game. 2012a. Issue Statement Regarding Delta/Bay Enforcement Proposal. Sacramento, CA. Email 4/4/2012

California Department of Fish and Game. 1987. Testimony on the Suisun Marsh for the State Water Resource Control Board's Bay-Delta Hearing. July.

California Department of Water Resources. 2012b. 2011 *Georgiana Slough Non-Physical Barrier Performance Evaluation Project Report*. Sacramento, CA.

California Department of Water Resources. 2013. 2014 Georgiana Slough Floating Fish Guidance Structure Study. Project kick-off meeting presentation, July 29, 2013. Sacramento, CA.

California Department of Water Resources. 2014. 2014 Georgiana Slough Floating Barrier Project Fact Sheet. Sacramento, CA.

California Natural Resources Agency, California Department of Food and Agriculture, California Environmental Protection Agency. 2014. California Water Action Plan.

Castillo, G., J. Morinaka, J. Lindberg, R. Fujimura, B. Baskerville-Bridges, J. Hobbs, G. Tigan, and L. Ellison. 2012. Pre-Screen Loss and Fish Facility Efficiency for Delta Smelt at the South Delta's State Water Project, California. *San Francisco Estuary and Watershed Science 10(4).*

California Natural Resources Agency, California Department of Food and Agriculture, California Environmental Protection Agency. 2014. California Water Action Plan.

Cavallo, B., J. Merz, and J. Setka. 2012. Effects of Predator and Flow Manipulation on Chinook Salmon (*Oncorhynchus tshawytscha*) Survival in an Imperiled Estuary. *Environmental Biology of Fishes.* Published online April 4.

Chotkowski, M. 1999. List of Fishes Found in San Francisco Bay-Delta Shallow Water Habitats. *Interagency Ecological Program Newsletter* 12(3):12–18.

Clark, K. W., M. D. Bowen, R. B. Mayfield, K. P. Zehfuss, J. D. Taplin, and C. H. Hanson. 2009. *Quantification of Pre-Screen Loss of Juvenile Steelhead in Clifton Court Forebay*. Fishery Improvements Section, Bay-Delta Office, California Department of Water Resources, Sacramento, CA, in collaboration with National Marine Fisheries Service Central Valley Fish Facilities Review Team, Interagency Ecological Program Management Team.

Coggins, L. G., M. D. Yard, W.E. Pine III. 2011. Nonnative Fish Control in the Colorado River in Grand Canyon, Arizona: An Effective Program or Serendipitous Timing? *Transactions of the American Fisheries Society.* 1548-8659.

Cohen, S. E., and S. M. Bollens. 2008. Diet and Growth of Non-Native Mississippi Silversides and Yellowfin Gobies in Restored and Natural Wetlands in the San Francisco Estuary. *Marine Ecology Progress Series* 368:241–254.

Ducks Unlimited. 2013. BDCP Waterfowl Effects Analysis. July. Prepared for Laura King Moon, Program Manager, BDCP. Rancho Cordova, CA.

Enright, Chris. 2008. *Suisun Marsh Salinity Control Gate: Purpose, Operation, and Hydrodynamics/Salinity Transport Effect*. February 28.

Essington, T. E., and S. Hansson. 2004. Predator-Dependent Functional Responses and Interaction Strengths in a Natural Food Web. *Canadian Journal of Fisheries and Aquatic Sciences* 61:2215–2226.

Estep Environmental Consulting. 2007. The Distribution, Abundance and Habitat Associations of Swainson's Hawk (*Buteo swainsoni)* in South Sacramento County. Prepared for the City of Elk Grove. April.

Estep Environmental Consulting. 2008. The Distribution, Abundance and Habitat Associations of Swainson's Hawk (*Buteo swainsoni)* in Yolo County. March. Prepared for Technology Associates International Corporation and Yolo Natural Heritage Program.

Evans, F. E., N. J. Hostetter, D. D. Roby, K. Collis, D. E. Lyons, B. P. Sandford, R. D. Ledgerwood, S. Sebring. 2012. Systemwide Evaluation of Avian Predation on Juvenile Salmonids from the Columbia River based on Recoveries of Passive Integrated Transponder Tags. *Transactions of the American Fisheries Society* 141:975–989.

Fisch, K. M., J. A. Ivy, R. S. Burton, B. May. 2013. Evaluating the Performance of Captive Breeding Techniques for Conservation Hatcheries: A Case Study of the Delta Smelt Captive Breeding Program. *Journal of Heredity.* November. 104(1):92-104.

Fish, M. A. 2010. A White Sturgeon Year-Class Index for the San Francisco Estuary and Its Relation to Delta Outflow. *Interagency Ecological Program Newsletter* 23(2):80-84.

Fish Facilities Technical Team. 2011. *BDCP Fish Facilities Technical Team Technical Memorandum*. July. Available: <file:///C:/Users/19132/Desktop/loc383/Fish%20Facilities%20Team%20Technical%20Memo%20Final%207.15.2011.pdf>. Accessed May 12, 2014.

Fish Facility Working Team. 2013. *Work Plan—Intake Design Criteria and Performance Monitoring Development*. June 28. California Department of Water Resources, California Department of Fish and Wildlife, U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service, and the National Marine Fisheries Service.

Gilmer, D. S., M. L. Miller, R. B. Bauer, and J. R. LeDonne. 1982. California's Central Valley Wintering Waterfowl: Concerns and Challenges. *Transactions of the North American Wildlife and Natural Research Conference* 47: 441–452.

Gingras, M. 1997. *Mark/Recapture Experiments at Clifton Court Forebay to Estimate Pre-Screen Loss of Juvenile Fishes: 1976–1993*. Interagency Ecological Program Technical Report No. 55. November.

Grossinger, R. M., R. A. Askevold, J. Beagle, E. E. Beller, E. Brewster, S. Gardner, S. Pearce, J. Ruygt, M. Salomon, C. J. Striplen, B. Stanford and A. W. Whipple. 2012. *Napa Valley Historical Atlas: Exploring a Hidden Landscape of Transformation and Resilience*. San Francisco Estuary Institute.

Grossman G. D., T. Essington, Brett Johnson, J. Miller, N. E. Monsen, and T. N. Pearsons. 2013. *Effects of Fish Predation on Salmonids in the Sacramento River – San Joaquin Delta and Associated Ecosystems. Final report of a workshop on the State of the Science on Fish Predation on Salmonids in the Bay-Delta*. California Department of Fish and Wildlife, Delta Science Program, and NOAA's National Marine Fisheries Service. Available: http://www.dfg.ca.gov/erp/predation.asp

Hayes, S., C. Michel, M. Sabal, D. D. S. Lindley, J. Smith, T. Quinn. 2014. Testing the Effects of Manipulated Predator Densities and Prey Transit Time on Juvenile Salmonid Survival at the San Joaquin and Old River Confluence.

Hendrix, N., A. Criss, E. Danner, C. M. Greene, H. Imaki, A. Pike, and S. T. Lindley. 2014. Life cycle modeling framework for Sacramento River winter-run Chinook salmon. Technical Memorandum NOAA-TM-NMFS-SWFSC-530. July. National Marine Fisheries Service, Southwest Fisheries Science Center, Long Beach, CA.

Henneberry, Y. K., T. E. C. Kraus, P. S. Nico, W. R. Horwath. 2012. Structural Stability of Coprecipitated Natural Organic Matter and Ferric Iron under Reducing Conditions. *Organic Geochemistry* 48:81–89.

Hestir, E. L. 2004. Trends in Estuarine Water Quality and Submerged Aquatic Vegetation Invasion. Ph.D dissertation, University of California, Davis.

Hickey, C., G. W. Page, W. D. Shuford, S. Warnock, S. Abbott, M. Pitkin, N. Warnock. 2003. A Strategy for Supporting California's Central Valley and Coastal Shorebird Populations. *Southern Pacific Shorebird Conservation Plan.* Version 1.1. December.

Iglecia, M. N., K. Strum, K. Sesser, D. Skalos, C. Hickey, M. E. Reiter, R. Kelsey. 2012. Developing Regional Shorebird Conservation Through Practices on Private Lands. *Society for Conservation Biology.* July.

Ivey, G. L., B. E. Dugger, C. P. Herziger, M. L. Casazza, and J. P. Fleskes. 2014. *Characteristics of Sandhill Crane Roosts in the Sacramento-San Joaquin Delta of California*. Presentation at the 12th American Crane Workshop. Proceedings of the North American Crane Workshop 12:12–19.

Ivey, G. L, C. P. Herziger, and M. Gause. 2003. *Farming for Wildlife: An Overview of Agricultural Operations at Staten Island, San Joaquin County, California*. August. Prepared for The Nature Conservancy.

Keeley, J. E. 1993. Native Grassland Restoration: The Initial Stage—Assessing Suitable Sites. Pages 277–281 in J. E. Keeley (ed.), *Interface Between Ecology and Land Development in California*. Los Angeles, CA: Southern California Academy of Sciences.

Kjelson, M. A., and P. L. Brandes. 1989. The Use of Smolt Survival Estimates to Quantify the Effects of Habitat Changes on Salmonid Stocks in the Sacramento- San Joaquin Rivers, California. U. S. Fish and Wildlife Service.

Lehman, P. W., G. Boyer, C. Hall, S. Waller, and K. Gehrts. 2005. Distribution and toxicity of a new colonial Microcystis aeruginosa bloom in the San Francisco Bay Estuary, California. *Hydrobiologia* 541: 87–90.

Lehman, P. W., S. J. Teh, G. L. Boyer, M. Nobriga, E. Bass, and C. Hogle. 2010. Initial impacts of *Microcystis* on the aquatic food web in the San Francisco Estuary. *Hydrobiologia* 637: 229–248.

Liu, S., B. Suits. 2012. Chapter 5: Estimating Delta-Wide Broide Using DSM2- Simulated EC Fingerprints. *Methodology for Flow and Salinity Estimates in the Sacramento- San Joaquin Delta and Suisun Marsh.* June.

Liu, L., J. Wood, N. Nur, D. Stralberg, M. Herzog. 2009. California Clapper Rail (*Rallus longirostris obsoletus)* Population Monitoring: 2005-2008. *PRBO Conservation Science.* Petaluma, CA. Prepared for California Department of Fish and Game.

Manly, B. F. J. 2007. *Review of An Evaluation of Four Sacramento-San Joaquin River Delta Juvenile Salmon Survival Studies by K. B. Newman.* April 10. Western EcoSystems Technology Inc.

Marine, K. R., J. J. Cech. 2004. Effects of High Water Temperature on Growth, Smoltification, and Predator Avoidance in Juvenile Sacramento River Chinook Salmon. *North American Journal of Fisheries Management* 24:198-210.

Marston, D., C. Mesick, A. Hubbard, D. Stanton, S. Fortmann-Roe, S. Tsao, and T. Heyne. 2012. Delta Flow Factors Influencing Stray Rate of Escaping Adult San Joaquin River Fall-Run Chinook Salmon (*Oncorhynchus tshawytscha*). *San Francisco Estuary and Watershed Science* 10(4).

Mathews, D. A., D. B. Babcock, J. G. Nolan, A. R. Prestigiacomo, S. W. Effler, C. T. Driscoll, S. G. Todorova, K. M. Kuhr. 2013. Whole-lake Nitrate Addition for Control of Methylmercury in Mercury-Contaminated Onondaga Lake, NY. *Environmental Research.* 125:52-60.

Meese, R. J. 2007. *Settlement, Breeding, Productivity, and Color-banding of Tricolored Blackbirds in 2007 in the Central Valley of California*. Final Report. Davis, CA. Prepared for U.S Fish and Wildlife Service, Pacific Region and Audubon California.

Meese, R. J. 2009. *Detection, Monitoring, and fates of Tricolored Blackbird colonies in 2009 in the Central Valley of California.* Final Report. Prepared for California Department of Fish and Game and U.S. Fish and Wildlife Service.

Meese, R. J. 2010. *Detection, Monitoring, and fates of Tricolored Blackbird colonies in 2010 in the Central Valley of California.* Final Report. Prepared for California Department of Fish and Game and U.S. Fish and Wildlife Service.

Moyle, P. B. 2002. *Inland Fishes of California*. Revised and expanded. Berkeley, CA: University of California Press.

Moyle, P. B., R. D. Baxter, T. Sommer, T. C. Foin, and S. A. Matern. 2004. Biology and Population Dynamics of Sacramento Splittail (*Pogonichthys macrolepidotus*) in the San Francisco Estuary: A Review. *San Francisco Estuary & Watershed Science* 2(2). Article 3. Available: <http://repositories.cdlib.org/jmie/sfews/vol2/iss2/art3>. Accessed: May 22, 2012.

Mueller, G. 2005. Predatory Fish Removal and Native Fish Recovery in the Colorado River Mainstem: What Have We Learned? *Fisheries* 30(9):10–19. Available: <http://www.fort.usgs.gov/Products/Publications/21228/21228.pdf>. Accessed: December 15, 2011.

National Marine Fisheries Service Southwest Region. 2009. Biological Opinion and Conference on the Long-Term Operations of the Central Valley Project and State Water Project. June.

Noatch, M. R., and C. D. Suski. 2012. Non-physical barriers to deter fish movements. Environmental Reviews 20(1):71-82.

Perry, R. W. 2010. Survival and Migration Dynamics of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin River Delta. Ph.D. Dissertation. University of Washington, Seattle, WA.

Perry, R. W., J. G. Romine, S. J. Brewer, P. E. LaCivita, W. N. Brostoff, and E. D. Chapman. 2012. Survival and migration route probabilities of juvenile Chinook salmon in the Sacramento-San Joaquin River Delta during the winter of 2009–10: U.S. Geological Survey Open-File Report 2012–1200. U.S. Geological Survey, Reston, VA.

Perry, R. W., P. L. Brandes, J. R. Burau, A. P. Klimley, B. MacFarlane, C. Michel, and J. R. Skalski. 2013. Sensitivity of survival to migration routes used by juvenile Chinook salmon to negotiate the Sacramento-San Joaquin River Delta. *Environmental Biology of Fishes* 96(2-3):381-392.

Perry, R. W., J. G. Romine, N. S. Adams, A. R. Blake, J. R. Burau, S. V. Johnston, and T. L. Liedtke. 2014. Using a non-physical behavioural barrier to alter migration routing of juvenile Chinook salmon in the Sacramento–San Joaquin River Delta. *River Research and Applications* 30(2):192-203.

Riley, F., and S. Finlayson. 2004a. *Chronic Toxicities of Herbicides Used to Control Water Hyacinth and Brazilian Elodea on Neonate Cladoceran and Larval Fathead Minnow.* Administrative Report 04-004. December 31. Aquatic Toxicology Laboratory, California Department of Fish and

Game, Elk Grove, CA. Prepared for Office of Spill Prevention and Response, California Department of Fish and Game.

Schilt, C. R. 2007. Developing fish passage and protection at hydropower dams. Applied Animal Behaviour Science, 104(3), 295-325.

Seabloom, E. W., E. T. Borer, V. L. Boucher, R. S. Burton, K. L. Cottingham, L. Goldwasser, W. K. Gram, B. E. Kendall, and F. Micheli. 2003. Competition, Seed Limitation, Disturbance, and Reestablishment of California Native Annual Forbs. *Ecological Applications* 13:575–592.

Sharp, B. L., and B. E. Kus. 2006. Factors Influencing the Incidence of Cowbird Parasitism of Least Bell's Vireo. *Journal of Wildlife Management* 70(3):682–690.

Shuford, D. 2015. Waterbirds Benefit from Crops and Field Management Practices in California's Sacramento- San Joaquin River Delta. *Point Blue Publication Brief.*

Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, W. J. Kimmerer. 2001. Floodplain Rearing of Juvenile Chinook Salmon: Evidence of Enhanced Growth and Survival. 58:325-333.

Suisun Resources Conservation District. 1998. Adaptive Habitat Management Plan Template.

Thomson, J. R, W. J. Kimmerer, L. Brown, K. B. Newman, R. Mac Nally, W. A. Bennett, F. Feyrer, and E. Fleishman. 2010. Bayesian Change-Point Analysis of Abundance Trends for Pelagic Fishes in the Upper San Francisco Estuary. *Ecological Applications: A Publication of the Ecological Society* 20:1431–1448.

Trenham, P. C. 2001. Terrestrial Habitat Use by Adult California Tiger Salamanders. *Journal of Herpetology* 35:343–346.

U.S. Environmental Protection Agency and U. S. Geological Survey. 2012. Scope of Work: Regional Applied Research Effort (RARE) Proposal. Evaluating a water treatment method to prevent the formation and export of MeHg in restored wetlands and ricelands of the Sacramento-San Joaquin Delta (Delta).

Vlassopoulos, D., J. Goin, E. A. Henry, D. Glaser. 2014. Suppression of Methylmercury in Sediments by Manganese(IV) Oxide.

Walsh, G. Cabrero, Y. M. Dalto, F. Mattioli, R. Carruthers, and L. Anderson. 2012. Biology and Ecology of Brazilian Elodea (*Egeria Densa*) and Its Specific Herbivore Hydrellia sp. in Argentina. *Biocontrol.* Accepted July 25, 2012.

Wiese, F. K., J. K. Parrish, C. W. Thompson, and C. Maranto. 2008. Ecosystem-Based Management of Predator-Prey Relationships: Piscivorous Birds and Salmonids. *Ecological Applications* 18(3):681–700.

Yolo Bypass Wildlife Area. 2008. Land Management Plan. Prepared for California Department of Fish and Game. June.

Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. *California Department of Fish and Game Fish Bulletin* 179:71–176.

3.4.23.2 Personal Communications

Swenson, Ramona. Cardno ENTRIX, Sacramento, CA. June 7, 2012—telephone conversation with Chris Earle, ICF International, regarding foodweb interactions in Delta fish community, potential for predator effects, and recommendations for revising CM15.

11F.3.3 Appendix 3.C, Avoidance and Minimization Measures

The avoidance and minimization measures were modified as follows.

- Avoidance and minimization measures were formerly treated as CM22. However, their purpose is not to conserve the covered species, but to minimize incidental take of the species. Avoidance and minimization are therefore better treated as another element (Section 3.7) of the overall conservation strategy. The text of Section 3.7 is unchanged from that of CM22. All changes to the avoidance and minimization measure text appear in Appendix 3.C, *Avoidance and Minimization Measures*.
- *AMM2 Construction Best Management Practices and Monitoring* was revised to include additional measures to reduce the potential for trash entering the Stone Lakes National Wildlife Refuge.
- *AMM6 Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material* was revised for clarification and to better describe the potential environmental effects of implementing this AMM.
- *AMM11 Covered Plant Species* was revised to specify potential impacts to five covered plant species.
- *AMM18 Swainson's Hawk and White-Tailed Kite* was split into separate AMMs for Swainson's hawk (AMM18) and white-tailed kite (AMM39), and incorporated changes recommended by agency staff.
- *AMM19 California Clapper Rail and California Black Rail* was split into separate AMMs for California Clapper Rail (AMM19) and California Black Rail (AMM38), and incorporated changes recommended by agency staff.
- *AMM20 Greater Sandhill Crane* was extensively revised to modify the scope and provisions of the AMM.
- *AMM21 Tricolored Blackbird* was revised to expand the minimum avoidance buffer from 250 feet to 300 feet.
- *AMM26 Salt Marsh Harvest Mouse and Suisun Shrew* was revised to reflect the outcomes of discussions with the fish and wildlife agencies.
- The previous version of *AMM27 Selenium Management* was deleted and a new AMM for selenium was developed in collaboration with fish and wildlife and water quality agency staff.
- *AMM37 Recreation* was revised to include a measure for adding signage for boaters to slow down when passing preserves with marsh habitat.

11F.3.3.1 AMM2 Construction Best Management Practices and Monitoring

AMM2 Construction Best Management Practices and Monitoring was revised to include additional measures to reduce the potential for trash entering the Stone Lakes National Wildlife Refuge.

The Implementation Office will ensure that all construction and operation and maintenance activities in and adjacent to sensitive resources areas (e.g., covered fish, wildlife, and plant species habitats, and natural communities), as identified in the BDCP or subsequent project-level documents, implement BMPs and have construction monitored by a qualified technical specialist(s). Depending on the resource of concern and construction timing, construction activities and areas will be monitored for compliance with water quality regulations (SWPPP monitoring) and with AMMs developed for sensitive biological resources (biological monitoring).

Before implementing an approved project, the Implementation Office will prepare a construction monitoring plan for the protection of covered fish, wildlife, and plant species. The plan will include, but not be limited to the following elements.

- Reference to or inclusion of the SWPPP prepared under the Construction General Permit, where one is needed (AMM3).
- Summaries or copies of planning and preconstruction surveys (if applicable) for natural communities and covered species.
- Description of AMMs to be implemented, including a description of project-specific BMPs or additional measures not otherwise included in the BDCP.
- Descriptions of monitoring parameters (e.g., turbidity), including the specific activities to be monitored (e.g., dredging, grading activities) and monitoring frequency and duration (e.g., once per hour during all in-water construction activities), as well as parameters and reporting criteria (e.g., Turbidity is not to exceed 10 NTU above background. Exceedances will be reported to the fish and wildlife agencies and the construction superintendent must identify and correct the cause.).
- Description of the onsite authority of the monitors to modify construction activity and protocols for notifying the CDFW, NMFS, and USFWS, if needed.
- A daily monitoring log prepared by the construction monitor, which documents the day's construction activities, notes any problems identified and solutions implemented to rectify those problems, and notifications to the construction superintendent and/or the fish and wildlife agencies regarding any exceedances of specific parameters (i.e., turbidity) or observations of covered species. The monitoring log will also document construction start/end times, weather and general site conditions, and any other relevant information.

The following measures will be implemented prior to and during construction activities or other covered activities for the protection of covered fish, wildlife and plant species, their designated critical habitat, and natural communities. Additional measures may be developed for site-specific conditions or specific covered species during the review and preconstruction planning of individual projects.

- All in-water construction activities will be conducted during the allowable in-water work windows established by USFWS, NMFS, and CDFW for the protection of covered fish species.
- Qualified biologists will monitor construction activities in areas identified during the planning stages and species/habitat surveys as having covered fish, wildlife, and plant species, their designated critical habitat, and other sensitive natural communities. The intent of the biological monitoring is to ensure that specific AMMs that have been integrated into the project design and permit requirements are being implemented correctly during construction and are working appropriately and as intended for the protection of covered species, natural communities, and the environment in general.

- Biological monitors will be professional biologists selected for their knowledge of the covered species and natural communities that may be affected by construction activities. The qualifications of the biologist(s) will be presented to the fish and wildlife agencies for review and written approval prior to initiating construction. The biological monitors will have the authority to temporarily stop work in any area where a covered species has been observed until that individual has passively or physically been moved outside of the work area, or if any AMMs or BMPs are not functioning appropriately for the protection of covered fish, wildlife, or plant species.

- During construction, the nondisturbance buffers described under the covered species' AMMs, below, will be established and maintained as necessary. A qualified biologist will monitor the site consistent with the requirements described for covered species to ensure that buffers are enforced and covered resources are not disturbed.

- Exclusionary fencing will be placed at the edge of active construction activities and staging areas (after having been cleared by biological surveys) to restrict wildlife access from the adjacent habitats. The need for exclusionary fencing will be determined during the preconstruction surveys and construction planning phase and may vary depending on the species and habitats present. The fencing will consist of taut silt fabric, 24 inches high (36 inches high for California red-legged frogs), staked at 10-foot intervals, with the bottom buried 6 inches below grade. Fence stakes will face toward the work area (on the opposite side of adjacent habitat) to prevent wildlife from using stakes to climb over the exclusion fencing. Exclusion fencing will be maintained such that it is intact during rain events. Fencing will be checked by the biological monitor or construction foreman periodically throughout each work day. If fencing becomes damaged, it will be immediately repaired upon detection and the monitoring biologist will stop work in the vicinity of the fencing as needed to ensure that no sensitive wildlife species have entered. Active construction and staging areas will be delineated with high-visibility temporary fencing at least 4 feet in height, flagging, or other barrier to prevent encroachment of construction personnel and equipment outside the defined project footprint. Such fencing will be inspected and maintained daily by the construction foreman until completion of the project. The fencing will be removed from areas only after all construction activities are completed and equipment is removed. No project-related construction activities will occur outside the delineated project construction areas.

- Project-related vehicles will observe a speed limit of 20 miles per hour in construction areas, except on county roads and state and federal highways. A vehicle speed limit of 20 miles per hour will be posted and enforced on all nonpublic access roads, particularly on rainy nights when California tiger salamanders and California red-legged frogs are most likely to be moving between breeding and upland habitats. Extra caution will be used on cool days when giant garter snakes may be basking on roads.

- All ingress/egress at the project site will be restricted to those routes identified in the project plans and description. Cross-country access routes will be clearly marked in the field with appropriate flagging and signs.

- All vehicle parking will be restricted to established areas, existing roads, or other suitable areas.

- To avoid attracting predators, all food-related trash items such as wrappers, cans, bottles, and food scraps will be disposed of in enclosed containers and trash will be removed and disposed of at an appropriate facility at least once a week from the construction or project site. All contracts with contractors will include language reminding them of the obligations to abide by all laws related to litter. These obligations will be applicable both within work areas and while traveling along public roads within the Plan Area. Vehicles carrying trash will be required to have loads covered and secured to prevent trash and debris from falling onto roads and adjacent properties.

- To avoid injury or death to wildlife, no firearms will be allowed on the project site except for those carried by authorized security personnel or local, state, or federal law enforcement officials.

- To prevent harassment, injury, or mortality of sensitive wildlife by dogs or cats, no canine or feline pets will be permitted in the active construction area.
- To prevent inadvertent entrapment of wildlife during construction, all excavated, steep-walled holes or trenches more than 1 foot deep will be covered at the close of each working day with plywood or similar material, and/or provided with one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they will be thoroughly inspected for trapped animals. If a covered species is encountered during construction work, to the extent feasible, construction activities should be diverted away from the animal until it can be moved by a USFWS- or CDFW-approved biologist.
- Capture and relocation of trapped or injured wildlife can only be performed by personnel with appropriate USFWS and CDFW handling permits. Any sightings and any incidental take will be reported to CDFW and USFWS via email within 1 working day of the discovery. A follow-up report will be sent to these agencies, including dates, locations, habitat description, and any corrective measures taken to protect covered species encountered. For each covered species encountered, the biologist will submit a completed CNDDB field survey form (or equivalent) to CDFW no more than 90 days after completing the last field visit to the project site.
- Plastic monofilament netting or similar material will not be used for erosion control, because smaller wildlife may become entangled or trapped in it. Acceptable substitutes include coconut coir matting or tackified hydroseeding compounds. This limitation will be communicated to the contractor through specifications or special provisions included in the construction bid solicitation package.
- Covered wildlife can be attracted to den-like structures such as pipes and may enter stored pipes and become trapped or injured. All construction pipes, culverts, or similar structures; construction equipment; or construction debris left overnight in areas that may be occupied by wildlife will be inspected by the biological monitor prior to being used for construction. Such inspections will occur at the beginning of each day's activities, for those materials to be used or moved that day If necessary, and under the direct supervision of the biologist, the structure may be moved up to one time to isolate it from construction activities, until the covered species has moved from the structure of their own volition, been captured and relocated, or otherwise been removed from the structure.
- Rodenticides and herbicides will be used in accordance with the manufacturer recommended uses and applications and in such a manner as to prevent primary or secondary poisoning of covered fish, wildlife, and plant species and depletion of prey populations upon which they depend. All uses of such compounds will observe label and other restrictions mandated by the U.S. Environmental Protection Agency (EPA), the California Department of Pesticide Regulation, and other appropriate state and federal regulations, as well as additional project-related restrictions imposed by USFWS, NMFS and/or CDFW. If rodent control must be conducted in San Joaquin kit fox habitat, zinc phosphide should be used because of its proven lower risk to kit fox. In addition, the method of rodent control will comply with those discussed in the 4(d) rule published in the final listing rule for tiger salamander (69 *Federal Register* [FR] 47211–47248). The rodent control restrictions described above will be implemented *in perpetuity*.
- Nets or bare hands may be used to capture and handle covered fish or wildlife species. A professional biologist will be responsible for and direct any efforts to capture and handle covered species. Any person who captures and handles covered species will not use soaps, oils, creams, lotions, insect repellents, solvents or other potentially harmful chemicals of any sort on their hands within 2 hours before handling covered fish or wildlife. Latex gloves will not be used either. To avoid transferring diseases or pathogens between aquatic habitats during the course of surveys or the capture and handling of covered fish or wildlife species, all species captured and handled will be released in a safe, aquatic environment as close to the point of capture as possible, and not transported and released to a different water body. When capturing and handing covered amphibians, the biologists will follow the Declining Amphibian Task Force's *Code of Practice* (U.S. Fish and Wildlife Service no date [a]). While in captivity, individual

amphibians will be kept in a cool, moist, aerated environment such as a dark (i.e., green or brown) bucket containing a damp sponge. Containers used for holding or transporting these species will be sanitized and will not contain any standing water.

- CDFW, NMFS and/or USFWS will be notified within 1 working day of the discovery of, injury to, or mortality of a covered species that results from project-related construction activities or is observed at the project site. Notification will include the date, time, and location of the incident or of the discovery of an individual covered species that is dead or injured. For a covered species that is injured, general information on the type or extent of injury will be included. The location of the incident will be clearly indicated on a U.S. Geological Survey 7.5-minute quadrangle and/or similar map at a scale that will allow others to find the location in the field, or as requested by CDFW, NMFS and/or USFWS. The biologist is encouraged to include any other pertinent information in the notification.
- Habitat subject to permanent and temporary construction disturbances and other types of ongoing project-related disturbance activities will be minimized by adhering to the following activities. Project designs will limit or cluster permanent project features to the smallest area possible while still permitting achievement of project goals. To minimize temporary disturbances, all project-related vehicle traffic material storage will be restricted to established and/or designated ingress/egress points, construction areas, and other designated staging/storage areas. These areas will also be included in preconstruction surveys and, to the extent possible, will be established in locations disturbed by previous activities to prevent further effects.
- Spoils, RTM, and dredged material will be disposed of at an approved site or facility in accordance with all applicable federal, state, and local regulations.
- Upon completion of the project, all areas subject to temporary ground disturbances, including storage and staging areas, temporary roads, pipeline corridors, will be recontoured to preproject elevations, as appropriate and necessary, and revegetated with native vegetation to promote restoration of the area to pre-project conditions. An area subject to "temporary" disturbance is any area that is disturbed to allow for construction of the project, but is not required for operation or maintenance of any project-related infrastructure, will not be subject to further disturbance after project completion, and has the potential to be revegetated. Appropriate methods and native plant species used to revegetate such areas will be determined on a site-specific basis in consultation with USFWS, NMFS, and/or CDFW, and biologists (AMM10).

11F.3.3.2 AMM6 Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material

<u>*AMM6 Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material* was revised for clarification and to better describe the potential environmental effects of implementing this AMM.</u>

In the course of constructing or operating project facilities, substantial quantities of material are likely to be removed from their existing locations based upon their properties or the need for excavation of particular features. Spoils refer to excavated native soils and are associated with construction of pumping plant facilities and other water conveyance features. RTM refers to the mixture of saturated soils and biodegradable soil conditioners or additives that will be generated by tunneling operations and are appropriate for reuse based upon chemical characterization and physical properties. Dredged material refers to sediment removed from the bottom of a body of water for the purposes of in-water construction or water conveyance operations (e.g., sediment collected at intake sites), or water storage requirements. The quantities of these materials generated by construction or operation of BDCP facilities will vary based on various factors, such as location, topography and structure being constructed. These materials will require handling, storage, and disposal, as well as chemical characterization, prior to any reuse. Temporary storage areas will be designated for these materials. However, to reduce the long-term effects on land use and potentially support implementation of other elements of the BDCP, the Implementation Office will develop site-specific plans for the beneficial reuse of these materials, to the extent practicable.

3.C.2.6.1 Temporary Storage Area Determination

Spoils, RTM, and dredged material will be temporarily or permanently stored in designated storage areas. Sediment collected at intake sites would be stored at solids lagoons adjacent to sedimentation basins. Selection of designated storage areas will be based upon, but not limited to, the following criteria.

- Material may be placed in project designated borrow areas.
- Areas for temporary storage will be located within 10 miles of the construction feature.
- Areas for temporary storage will not be located within 100 feet of existing residential or commercial buildings.
- Areas for temporary storage will not be located within 100 feet of a military facility.
- Areas for temporary storage will not be located within 100 feet of existing roads, rail lines, or infrastructure.
- To the extent practicable, material will not be temporarily stored in sensitive natural communities and habitat areas, including the following habitat types: wetlands and surface waters, vernal pool complex, alkali seasonal wetland complex or grasslands, and riparian areas. If it is necessary to temporarily store materials in any of the habitat types listed above, the appropriate covered species AMMs will be followed for that habitat type.
- Placement of material potentially affecting western burrowing owl burrows will be avoided to the extent practicable (see AMM23 for description of burrow avoidance).
- Placement of material in greater sandhill crane foraging habitat will be minimized as described in AMM20.
- Placement of material in greater sandhill crane roost sites will be avoided as described in AMM20.
- Storage sites on Staten Island will be sized and located in coordination with USFWS, CDFW, and greater sandhill crane experts to minimize direct and indirect effects on greater sandhill crane.
- Placement of material in vernal pool complex or alkali seasonal wetland complex will be avoided to the extent practicable. If avoidance of these complexes is not practicable, the wetted vernal pool or alkali seasonal wetland acres will be avoided by at least 250 feet).
- Landowner concerns and preferences will be considered in designating sites for temporary storage. DWR will consult directly with landowners to refine the storage area footprint to further minimize impacts to surrounding land uses, including agricultural operations.
- Where practicable, dredged material will be disposed of on higher elevation land that is set back from surface water bodies a minimum of 150 feet. Upland disposal will help ensure that the material will not be in contact with surface water prior to its draining, characterization, and potential treatment.

Additional considerations have been made for the storage of RTM. For example, the proposed RTM storage area locations have been designed to be close to where the material will be brought to the surface, as well as close to where reuse is expected to occur. In some cases, storage areas are located adjacent to barge landings to facilitate movement to other reuse locations in the Delta.

- The area required for material storage is flexible and will depend on several factors.
- The speed with which material is brought to the surface, stored, dried, tested, and moved to reuse locations will be important in determining the final size of storage areas. If material can be dried faster and moved offsite more quickly, less area will be needed at each location.

- The depth to which the material is stacked. Material that is stored in deeper piles will require less area but may dry more slowly, extending the time that is needed. It was assumed that RTM would be placed in piles with a depth of six feet.
- The proportion of material at one storage area or another. There will be flexibility during construction to prioritize material storage in some areas as opposed to other areas, based on feasibility of reuse or minimization of impacts.

3.C.2.6.2 Temporary Storage Site Preparation

A portion of the temporary storage sites selected for storage of spoils, RTM, and dredged material will be set aside for topsoil storage. The topsoil will be saved for reapplication to disturbed areas postconstruction. Vegetative material from work site clearing will be chipped, stockpiled, and spread over the topsoil after earthwork is completed, when practicable and appropriate to do so and where such material does not contain seeds of undesirable nonnative species (i.e., nonnative species that are highly invasive and threaten the ecological function of the natural community to be restored in that location). Cleared areas will be grubbed as necessary to prepare them for grading or other construction activities. Rocks and other inorganic grubbed materials will be used to backfill borrow areas. The contractor will remove from the work site all debris, rubbish, and other materials not directed to be salvaged, and will dispose of them in an approved disposal site after obtaining all permits required.

3.C.2.6.3 Draining, Chemical Characterization, and Treatment

RTM and associated decant liquid will undergo chemical characterization by the contractor(s) prior to reuse or discharge, respectively, to determine whether it will meet NPDES and the Central Valley Regional Water Quality Control Board requirements. Should RTM decant liquid constituents exceed discharge limits, these tunneling byproducts will be treated to comply with NPDES permit requirements. Discharges from RTM draining operations will be conducted in such a way as to not cause erosion at the discharge point. If RTM liquid requires chemical treatment, chemical treatment will ensure that RTM liquid will be nontoxic to aquatic organisms.

While additives used to facilitate tunneling will be nontoxic and biodegradable, it is possible that some quantity of RTM will be deemed unsuitable for reuse. In such instances, which are anticipated to occur in less than 1% each of excavated spoils, RTM, and dredged material, the material will be disposed of at a site for which disposal of such material is approved.

Hazardous materials excavated during construction will be segregated from other construction spoils and properly handled in accordance with applicable federal, state, and local regulations. Riverine or in-Delta sediment dredging and dredge material disposal activities may involve potential contaminant discharges not addressed through typical NPDES or SWRCB CGP processes. Construction of dredge material disposal sites will likely be subject to the SWRCB General Permit (Order No. 2009-0009-DWQ). The following list of BMPs will be implemented during handling and disposal of any potentially hazardous dredged material.

- The Implementation Office will ensure the preparation and implementation of a pre-dredge sampling and analysis plan (SAP). The SAP will be developed and submitted by the contractors as part of the water plan required per standard California Department of Water Resources (DWR) contract specifications (Section 01570). Prior to initiating any dredging activity, the SAP will evaluate the presence of contaminants that may affect water quality from the following discharge routes.
    - Instream discharges during dredging.
    - Direct exposure to contaminants in the material through ingestion, inhalation, or dermal exposure.
    - Effluent (return flow) discharge from an upland disposal site.

- Leachate from upland dredge material disposal that may affect groundwater or surface water.

- Conduct dredging within the allowable in-water work windows established by USFWS, NMFS, and CDFW.
- Conduct dredging activities in a manner that will not cause turbidity in the receiving water, as measured in surface waters 300 feet down-current from the construction site, to exceed the Basin Plan objectives beyond an approved averaging period by the Central Valley Regional Water Quality Control Board and CDFW. Existing threshold limits in the Basin Plan for turbidity generation are as follows.
    - Where natural turbidity is between 0 and 5 NTUs, increases will not exceed 1 NTU.
    - Where natural turbidity is between 5 and 50 NTUs, increases will not exceed 20%.
    - Where natural turbidity is between 50 and 100 NTUs, increases will not exceed 10 NTUs.
    - Where natural turbidity is greater than 100 NTUs, increases will not exceed 10%.
- If turbidity generated during dredging exceeds implementation requirements for compliance with the Basin Plan objectives, silt curtains will be used to control turbidity. Exceptions to turbidity limits set forth in the Basin Plan may be allowed for dredging operations; in this case, an allowable zone of dilution within which turbidity exceeds the limits will be defined and prescribed in a discharge permit.
- The dredge material disposal sites will be designed to contain all of the dredged material and all systems and equipment associated with necessary return flows from the dredge material disposal site to the receiving water will be operated to maximize treatment of return water and optimize the quality of the discharge.
- The dredged material disposal sites will be designed by a registered professional engineer.
- The dredged material disposal sites will be designed, constructed, operated, and maintained to prevent inundation or washout due to floods with a 100-year return frequency.
- Two feet of freeboard above the 100-year flood event elevation will be maintained in all dredge material disposal site settling ponds at all times when they may be subject to washout from a 100-year flood event.
- Dredging equipment will be kept out of riparian areas and dredged material will be disposed of outside of riparian corridors.

Temporary storage sites will be constructed using appropriate BMPs such as erosion and sediment control measures (*AMM4 Erosion and Sediment Control Plan* and *AMM3 Stormwater Pollution Prevention Plan*) to prevent discharges of contaminated stormwater to surface waters or groundwater.

Once the excavation spoils, RTM, or dredged material have been suitably dewatered, and as the constituents of the material will allow, it will be placed in either a lined or unlined storage area, suitable for long-term storage. These long-term storage areas may be the same areas in which the material was previously dewatered or it may be a new area adjacent to the dewatering site. The storage areas will be created by excavating and stockpiling the native topsoil for future reuse. Once the area has been suitably excavated, and if a lined storage area is required, an impervious liner will be placed on the invert of the material storage area and along the interior slopes of the berms surrounding the pond. Due to the expected high groundwater tables, it is anticipated that there will be minimal excavation for construction of the long-term material storage areas. Additional features of the long-term material storage areas will include berms and erosion protection measures to contain storm runoff as necessary and provisions to allow for truck traffic during construction.

3.C.2.6.4 Material Reuse Plans

Prior to construction, draining, and chemical characterization of excavation spoils, RTM, and dredged material, the Implementation Office will identify sites for reusing such materials to the extent practicable, in connection with BDCP construction activities and habitat restoration and protection activities, as well as potential beneficial uses associated with flood protection and management of groundwater levels within the Plan Area. The Implementation Office will undertake a thorough investigation to identify sites for the appropriate reuse of material, and, based upon the properties of the material and in consultation with other interested parties, the Implementation Office will identify the specific site for that material. Potential methods of reuse may include, but not be limited to, the following.

- Fill material for construction of embankments or building pads.
- Fill material for levee maintenance.
- Fill material for habitat restoration projects.
- Fill material for roadway projects.
- Fill material for localized subsidence reversal.
- Material for flood response.
- Material to fill BDCP-related borrow areas.
- Other beneficial means of reuse.

Material applied to reduce the localized effects of subsidence will be placed on lower elevation lands and lands adjacent to levees to minimize effects on agricultural practices and improve levee stability. The material may be left in place and used as stockpile to assist in flood response; however, to the extent feasible, the material will be relocated and the storage site restored to its former condition in areas where such restoration is desirable for the conservation of covered species, such as locations supporting greater sandhill crane foraging habitat. The feasibility of these approaches to reuse will depend on the suitability of the material for each purpose based on testing of relevant properties. Site-specific factors such as local demand for materials and the ability to transport the materials will also be important considerations in assessing options for reuse. To the extent that the reuse of the materials for these purposes may lead to adverse environmental effects, such effects will be addressed through site-specific environmental documents prepared under the National Environmental Policy Act and California Environmental Quality Act. These could include environmental documents for proposed habitat restoration projects for which the materials can be used.

The Implementation Office will consult relevant parties, such as landowners, reclamation districts, flood protection agencies, federal and state agencies with jurisdiction in the Delta, and counties, in developing such site-specific spoil, RTM, and dredged material reuse plans. Where the Implementation Office determines that it is appropriate that materials be used to prepare land at elevations suitable for BDCP-related restoration or protection projects, it will coordinate in developing site-specific plans for transporting and applying the materials to work sites.

Following removal of excavation spoils, RTM, and dredged material from temporary disposal sites, stockpiled topsoil at these areas will be reapplied, and disturbed areas will be returned, to the extent practicable, to preconstruction conditions, as specified in AMM10. The areas will be carefully graded to reestablish preconstruction surface conditions and elevations and features will be reconstructed (e.g., irrigation and drainage facilities). Restoration of the RTM draining sites will be designed to prevent surface erosion and subsequent siltation of adjacent water bodies. Following these activities, the land will be suitable for returning to agricultural production, under the discretion of the landowner. Such areas may also be appropriate for the implementation of habitat restoration or protection in consideration of the biological goals and objectives.

In some instances, it may not be practicable to transport and reuse spoil, RTM, or dredged materials due to factors such as the distances and costs involved and/or any environmental effects associated with transport (e.g., unacceptable traffic concerns or levels of diesel emissions). In such instances, sites will be evaluated for the potential to reapply topsoil over the spoils, RTM, or dredged material and to continue or recommence agricultural activities. If, in consultation with landowners and any other interested parties, the Implementation Office determines that continued use of the land for agricultural or habitat purposes will not be practicable, the potential for other productive uses of the land will be examined, including stockpile and staging areas for flood response or hosting solar or wind power generation facilities. Such instances may require the acquisition of interest in the land and/or coordination with utilities or other entities; specific arrangements will be made on a case-by-case basis.

3.C.2.6.5 Potential Environmental Effects

It is anticipated that one or more of these disposal and reuse methods could be implemented on any individual spoil, RTM, or dredged material site. Depending on which combination of these approaches is selected, implementation of material reuse plans could create environmental impacts requiring site-specific analysis under CEQA and/or NEPA. Many of these activities would require trucks or barges to gather and haul materials from one section of the Plan Area to another. For instance, reuse of material in the implementation of tidal habitat could require material to be transported to locations in the West Delta ROA (including Sherman and Twitchell Islands) or the Cosumnes/Mokelumne ROA (including Glannvale Tract and McCormack-Williamson Tract), among other areas. Locations for reuse in support of levee stability could include areas protected by non-project levees or where levee problems have been reported in the past, including Staten Island, Bouldin Island, Empire Tract, Webb Tract, Bacon Island, or other places in the Delta. While reuse locations near to the spoil or RTM areas would be preferred, such activity would require use of local roadways, which could lead to short-term effects on traffic, noise levels, and air quality. Similarly, earthwork and grading activities to restore sites to preconstruction conditions and to apply the materials consistent with their reuse could create noise and effects on air quality during the implementation of reuse plans.

If materials are applied for the purposes of flood protection, flood response, habitat restoration or subsidence reversal, it is possible that existing topsoil could be overcovered and that Important Farmland or farmland with habitat value for one or more covered species could be disturbed temporarily or converted from active agricultural uses. Additionally, materials placed near levees could affect drainage and/or irrigation infrastructure. If material is used for habitat restoration that would have otherwise been implemented as part of the BDCP, reuse of materials could offset the need for fill materials from other sources. Such effects would be described in further detail by individual site-specific environmental review for habitat restoration activities under BDCP.

Depending on the selected reuse strategies, however, implementation of spoil, RTM, and dredged material reuse plans could also result in beneficial effects associated with flood protection and response, habitat creation, and depth to groundwater in areas where the ground level is raised.

11F.3.3.3 AMM11 *Covered Plant Species*

AMM11 Covered Plant Species was revised to specify potential impacts to five covered plant species.

A complete botanical survey of project sites will be completed using Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Plants (U.S. Fish and Wildlife Service 1996) and Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities (California Department of Fish and Game 2009). The surveys will be floristic in nature and conducted in a manner that maximizes the likelihood of locating special-status plant species or special-status natural communities that may be present (i.e., during the appropriate season and at an appropriate level of ground coverage).

Special-status plant surveys required for project-specific permit compliance will be conducted during the planning phase to allow design of the individual restoration projects to avoid adverse modification of habitat for specified covered plants. The purpose of these surveys will be to verify that the locations of special-status plants identified in previous record searches or surveys are extant, identify any new special-status plant occurrences, and cover any portions of the project area not previously identified. The extent of mitigation of direct loss of or indirect effects on special-status plants will be based on these survey results. Locations of special-status plants in proposed construction areas will be recorded using a GPS unit and flagged.

The following measures will be implemented.

- Design restoration projects to avoid the direct, temporary loss of occupied habitat from construction activities for delta button celery, slough thistle, and Suisun thistle. If delta button celery or slough thistle occurs in a floodplain restoration area, restoration projects may be designed to include occupied habitat in the restored floodplain provided ground disturbance is avoided in the occupied habitat and the restoration is designed such that the anticipated level of flooding and scouring is compatible with the life-history needs of the covered plant species. In tidal restoration areas, Suisun thistle occurrences may experience the indirect effect of tidal damping. This effect will be monitored and adaptively managed to ensure the occurrence is protected from loss.
- Avoid modeled habitat for vernal pool plants to the maximum extent practicable. Where practicable, no ground-disturbing activities or alterations to hydrology will occur within 250 feet of vernal pools. As identified in AMM12, the Implementation Office will ensure that there will be no adverse modification of critical habitat for vernal pool plants. No more than 10 wetted acres of vernal pools will be removed as a result of covered activities throughout the permit term.
- Avoid the loss of extant occurrences of all covered plant species with the exception of the loss of one occurrence of Heckard's peppergrass and the potential temporal loss of the four intertidal plant species: Mason's lileaopsis, Suisun marsh aster, Delta tule pea, and delta mudwort.
- If an occurrence has more than 10 individuals, no more than 5% of the total number of individuals in the occurrence will be removed. If an occurrence has 10 or fewer individuals, all individuals may be removed. Loss of individuals for all occurrences will be offset through replacement of occupied habitat at a ratio of at least 1:1, to achieve no net loss of occupied habitat. These requirements do not pertain to Suisun thistle, slough thistle, and delta button celery, for which no individuals may be removed (see above). These requirements also do not apply to the historical occurrence of Heckard's peppergrass in Hass Slough (CNDDB Element Occurrence number 7); take of this occurrence by tidal restoration (CM4), while not expected, is allowed (Chapter 5, *Effects Analysis*, Table 5.6-19).
- To minimize the spread of nonnative, invasive plant species from restoration sites, the Implementation Office will retain a qualified botanist or weed scientist prior to clearing operations to determine if affected areas contain invasive plants. If areas to be cleared contain invasive plants, then chipped vegetation material from those areas will not be used for erosion control; in these cases the material will be disposed of to minimize the spread of invasive plant propagules (e.g., burning, composting).
- To minimize the introduction of invasive plant species, construction vehicles and construction machinery will be cleaned prior to entering construction sites that are in or adjacent to natural communities other than cultivated lands, and prior to entering any BDCP restoration sites or conservation lands other than cultivated lands. Vehicles working in or travelling off paved roads through areas with infestations of invasive plant species will be cleaned before travelling to other parts of the Plan Area. Cleaning stations will be established at the perimeter of covered activities along construction routes as well as at the entrance to reserve system lands. Biological monitoring will include locating and mapping locations of invasive plant species within the construction areas during the construction phase and the restoration phase. Infestations of

invasive plant species will be targeted for control or eradication as part of the restoration and revegetation of temporarily disturbed construction areas.

This avoidance and minimization measure does not apply to the routine management, maintenance, and educational activities of the Implementation Office and its partners in the reserve system. The Implementation Office will determine during implementation the most effective and cost-efficient means to minimize the unintentional spread of invasive plants through vehicle travel.

During the planning phase, the Implementation Office will ensure that covered activities in designated critical habitat areas for Suisun thistle or soft bird's-beak (Figure 3.C-6 and Figure 3.C-7), if any, will not result in the adverse modification of any of the primary constituent elements for Suisun thistle or soft bird's-beak critical habitat. The CDFW Suisun Marsh Unit tracks both of these species (GIS-mapped) in Suisun. No covered activities will take place within designated Suisun thistle or soft bird's-beak critical habitat areas without prior written concurrence from USFWS that such activities will not adversely modify any primary constituent elements of Suisun thistle or soft bird's-beak critical habitat.

Primary constituent elements for Suisun thistle are defined as follows.

- Persistent emergent, intertidal, estuarine wetland at or above the mean high water mark as extended directly across any intersecting channels).
- Open channels that periodically contain moving water with ocean-derived salts in excess of 0.5%.
- Gaps in surrounding vegetation to allow for seed germination and growth.

Primary constituent elements for soft bird's-beak are defined as follows.

- Persistent emergent, intertidal, estuarine wetland at or above the mean high water mark (as extended directly across any intersecting channels).
- Rarity or absence of plants that naturally die in late spring (winter annuals).
- Partially open spring canopy cover (i.e., photosynthetic photo flux density of approximately 790 nMol/m2/s) at ground level, with many small openings to facilitate seedling germination.

Also see AMM37 for measures to avoid and minimize recreation-related effects on the following species: brittlescale, Carquinez goldenbush, delta button celery, heartscale, San Joaquin spearscale, and all vernal pool plant species.

11F.3.3.4 AMM18 Swainson's Hawk

AMM18 Swainson's Hawk and White-Tailed Kite was split into separate AMMs for Swainson's hawk (AMM18) and white-tailed kite (AMM39), and incorporated changes recommended by agency staff.

3.C.2.18.1 Preconstruction Surveys

Preconstruction surveys will be conducted to identify the presence of active nest sites of tree-nesting raptors within 0.25 mile of project sites, staging and storage areas, transportation routes, work areas, and soil stockpile areas, by a qualified biologist with experience identifying Swainson's hawk. Surveys will be conducted to ensure nesting activity is documented prior to the onset of construction activity. Swainson's hawks nest in the Plan Area between approximately March 15 and September 15. While many nest sites are traditionally used for multiple years, new nest sites can be established in any year. Therefore, construction activity that is planned after March 15 of any year will require surveys during the year of the construction. If construction is planned before March 15 of any year, surveys will be conducted the year immediately prior to the year of construction. If construction is planned before March 15 of any year and subject to prior-year surveys, but is later postponed to after March 15, surveys will also be conducted during the year of construction.

The survey protocol established in Table D-2 is modified from the recommended timing and methodology for Swainson's hawk nesting surveys in the Central Valley (Swainson's Hawk Technical Advisory Committee 2000). The protocol will be used to detect active nests for Swainson's hawk. For construction activities initiated before March 15, both Phase 1 and Phase 2 surveys are required. The surveys are conducted in two phases depending on the timing of planned construction. Phase 1 surveys are required for all construction activity not initiated prior to March 15. Phase 1 surveys include three separate equally spaced surveys conducted from April 1 to April 20. If active nests are found or nesting activity is identified, construction is postponed near the active nest or nest activity area. If no activity is found following completion of the three surveys, then construction can proceed. Phase 2 surveys are conducted if construction activity is to occur during the breeding season. Phase 2 surveys include three separate surveys conducted at least 3 days apart anytime from June 1 to July 15. If active nests are found, appropriate avoidance and minimization measures will be implemented as described herein. If no activity is found, then construction can proceed with no restrictions until the following breeding season.

A 650-foot-radius non-disturbance buffer will be established around each active Swainson's hawk nest site. No entry of any kind related to the BDCP construction activity will be allowed in the buffer while a nest site is occupied by Swainson's hawk during the breeding season unless otherwise approved by CDFW. Active nests will be monitored to track progress of nesting activities. The buffer will be clearly delineated with fencing or other conspicuous marking. Entry into the buffer will be granted when a qualified biologist determines that the young have fledged and are capable of independent survival or the nest has failed and the nest site is no longer active.

Removal of nest trees will be avoided to the maximum extent possible. In the event that a nest tree (defined as a tree that has been used for nesting at least once in the last 3 years) needs to be removed during project related activities, CDFW will be notified in writing of the location of the nest tree and timing of removal period. No trees with active nests will be removed during the breeding season. The tree replacement protocol described below will be followed. This protocol may be modified with CDFW authorization.

Where construction cannot be sufficiently limited to avoid disturbing Swainson's hawks during nesting, or where the buffer size has been modified with CDFW approval, at a minimum the following measures will be implemented as part of a nesting bird monitoring and management plan that will be approved by CDFW. The final plan may include additional measures that are specific to site conditions.

- Five days and three days prior to the initiation of construction at any site where a nest is within 1/4 mile of construction, a CDFW-approved biologist (designated biologist) will observe the subject nest(s) for at least 1 hour and until normal nesting behavior can be determined. Nest status will be determined and normal nesting behaviors documented, which may be used to compare to the hawks' activities once construction begins. The results of preconstruction monitoring will be reported to CDFW within 24 hours of completing each survey.
- Where a Swainson's hawk nest occurs within 150 feet of construction, the project must be initiated prior to nest building or after young have hatched. The designated biologist will monitor the nesting pair during all construction hours, and construction hours will be limited to 0800 to 1700.
- Where a Swainson's hawk nest occurs between 100 to 325 feet from construction, the designated biologist will observe the nest for at least 4 hours per construction day to ensure the hawks are involved with normal nesting behavior. Construction hours will be limited to 0800 to 1700.
- Where a Swainson's hawk nest occurs between 325 to 650 feet from construction, the designated biologist will observe the nest for at least 2 hours per construction day to ensure the hawks are involved with normal nesting behavior.
- Where a Swainson's hawk nest occurs between 650 to 1,300 feet from construction, the designated biologist will observe the nest for at least 3 days per construction week to ensure the hawks are involved with normal nesting behavior and to check the status of the nest.

Physical contact with an active nest tree will be prohibited from the time of egg laying to fledging, unless CDFW consents to the contact. Construction personnel outside of vehicles will be restricted to greater than 650 feet, or the length of the buffer approved by CDFW, from the nest tree unless construction activities require them to be closer. If personnel must approach closer than 100 feet of an active nest tree for more than 15 minutes while adults are brooding, the nesting adults will be monitored for stressed behavior. If stressed behavior is identified, personnel will leave the area until behavior normalizes. If personnel must approach closer than 150 feet for more than 1 hour, the same applies. Any other necessary distance of approach within the designated buffer shall be monitored as determined by the designated biologist. All personnel will be out of the line of sight of the nest during breaks.

If during construction the designated biologist determines that a nesting Swainson's hawk within 1/4 mile of the project is disturbed by project activities, to the point where there is a potential for take of the nest, the designated biologist will have the authority to stop all covered activities. The designated biologist may stop covered activities if Swainson's hawk exhibits distress and/or abnormal nesting behavior (e.g., swooping/stooping, excessive vocalization [distress calls], agitation, failure to remain on nest, failure to deliver prey items for an extended time period, failure to maintain nest) as a result of project activities that may cause reproductive failure (nest abandonment and loss of eggs and/or young). Contractors will not resume project activities with a ¼ mile of the nest until CDFW has been consulted by the designated biologist, and both the designated biologist and CDFW confirm that the Swainson's hawk behavior has normalized. The designated biologist will notify CDFW if nests or nestlings are abandoned and if the nestlings are still alive to determine appropriate actions for salvaging the eggs or returning nestlings to the wild.

Table D-2. Timing and Methodology for Swainson's Hawk Nesting Surveys

	Survey Dates	Survey Time	Number of Surveys	Methodology
Phase 1 surveys (required for all construction activities initiated after March 15)	First week of April	Sunrise to 12:00 p.m.; 4:00 p.m. to sunset	1	Position the surveyor at 50 to 200 feet from suitable nesting habitat with a clear view of trees and surrounding area. Scan all trees for a minimum of 2 hours within 0.25 mile of the project boundary. Observe perching, nest building, mating, courtship, and other prenesting behaviors to identify a nest or nesting activity area.
	Second week of April	Sunrise to 12:00 p.m.; 4:00 p.m. to sunset	1	Repeat the above survey in areas not determined to be occupied during the first survey. Attempt to confirm nest locations within nesting activity areas.
	Third week of April	Sunrise to 12:00 p.m.; 4:00 p.m. to sunset	1	Repeat the above survey in areas not determined to be occupied during the first and second survey. In cases where a nest site was not identified within a nesting activity area during the first two surveys, approach the nesting activity area carefully to locate nests. If a nest is not found where there is reasonable certainty of nesting activity, rely on observations of courtship, mating, nest building, and other behaviors to define a nesting area and establish a buffer.
Phase 2 surveys (also required for all construction activities initiated after May 30)	June 10 through July 15	Sunrise to 12:00 p.m.; 4:00 p.m. to sunset	3 surveys spaced at least 3 days apart	Inspect all previously identified nests for activity status. Walk and scan all other suitable nest trees within 0.25 mile of the project boundary for nests not found during the initial survey.

3.C.2.18.2 Nesting Habitat Replacement

The following measures will be implemented to minimize near-term effects on the Swainson's hawk populations that could otherwise result from loss of nesting habitat during the first 10 years of the permit term, before most of the restored riparian natural community has matured. Nesting habitat is limited throughout much of the Plan Area, consisting mainly of intermittent riparian, isolated trees, small groves, tree rows along field borders, roadside trees, and ornamental trees near rural residences. Removal of nest trees and nesting habitat could further reduce this limited resource and reduce or restrict the number of active Swainson's hawks within the Plan Area until restored riparian habitat is sufficiently developed. To account for this potential near-term loss of nesting habitat, the following additional measures will be implemented.

3.C.2.18.2.1 Tree Replacement with Saplings

Planting trees as potential nesting habitat for Swainson's hawk is addressed in *CM7 Riparian Natural Community Restoration* and *CM11 Natural Communities Enhancement and Management*. While those measures address the overall long-term restoration of nesting habitat and the enhancement of BDCP reserves for this species, the following measures specifically address the removal of nest trees or nesting habitat during construction and provide a mechanism to compensate for this loss in order to minimize the near-term effects on Swainson's hawk populations.

a) At least five trees (5-gallon-container size) will be planted in the reserve system for every tree suitable for Swainson's hawk (20 feet or taller) anticipated to be removed by construction during the near-term period. Of the replacement trees planted, a variety of native tree species will be planted to provide trees with differing growth rates, maturation, and life span.

b) Replacement trees will be planted in the reserve system in areas that support high-value Swainson's hawk foraging habitat. They will be planted in clumps of at least three trees each at appropriate sites within or adjacent to conserved cultivated lands, or may be incorporated into the riparian plantings as a component of the requirement for 5,000 acres of riparian restoration where they are in close proximity to suitable foraging habitat. Replacement trees that are incorporated into the riparian restoration will not be clustered in a single region of the Plan Area, but will be distributed throughout the lands protected as foraging habitat for Swainson's hawk.

c) At least 10% of replacement trees will be planted on lands in the reserve system that are specifically protected as Swainson's hawk foraging habitat acquired as part of the conservation strategy for cultivated lands or the grassland natural community. These plantings will count toward the nesting habitat requirement in Objective SH2.1 (Chapter 3, Section 3.3, *Biological Goals and Objectives*).

d) The survival success of the planted trees described in (a), (b), and (c) above will be monitored for a period of 5 years to assure survival and appropriate growth and development. Plantings will subsequently be monitored every 5 years to verify their continued survival and growth. For every tree lost during the first 5-year time period, a replacement tree will be planted immediately upon the detection of failure. All necessary planting requirements and maintenance (i.e., fertilizing, irrigation) to ensure success will be provided. Trees will be irrigated for a minimum of the first 5 years after planting, and then gradually weaned off the irrigation during a period of approximately 2 years. If larger stock is planted, the number of years of irrigation will be increased accordingly. In addition, 10 years after planting, a survey of the trees will be completed to assure at least 80% establishment success.

3.C.2.18.2.2 Tree Replacement with Mature Trees

To further and more directly minimize the effects of near-term loss of nesting habitat, a program to plant mature trees will be implemented. Planting larger, mature trees, including transplanting trees scheduled for removal, and supplemented with additional saplings, is expected to accelerate the development of potential replacement nesting habitat.

a) In addition to the planting of sapling nest trees as described in item (a) above (Section 3.C.2.18.2.2, *Tree Replacement with Saplings*), five mature native trees (at least 20 feet in height) will be planted for every 125 acres of construction footprint in which more than 50% of suitable nest trees (20 feet or taller) within the 125-acre block are removed. Mature trees can be replaced with either nursery trees or trees scheduled to be removed by construction. To determine the number of replacement trees required, a grid of 125-acre blocks will be placed over each component of project footprint in which trees are to be removed, and the grid will be fixed in a manner that places the most complete squares of the grid in the project footprint (i.e., the grid will be adjusted so that, to the extent possible, entire squares rather than portions of squares will overlap with the project footprint).

b) The mature trees will be planted at a location that otherwise supports suitable habitat conditions for Swainson's hawk. This could be around project facilities (while taking into consideration potential effects of noise and visual disturbance from facility operation), on reserve lands, other existing conservation lands (non-BDCP), or excess DWR land, as long as the Implementation Office controls the property. These trees will be planted as close as biologically feasible to the suitable nest tree affected (e.g., near the newly constructed intake facilities), unless such location would have low long-term conservation value due to factors such as threat of seasonal flooding or sea level rise, in which case the trees may be planted elsewhere in the reserve system.

c) As with the sapling trees, the mature replacement trees will be monitored and maintained for 5 years to ensure survival and appropriate growth and development. Success will be measured using an 80% survival rate at 5 years after planting. In addition, 15 (5-gallon-container size) trees will be planted at each mature tree replacement site to provide longevity to the nest site. These 15 trees may be part of the trees committed to the project by item (a) included above as long they meet the survival criteria described in item (d) above (Section 3.C.2.18.2.2, *Tree Replacement with Saplings*).

d) To enhance Swainson's hawk reproductive output until the replacement nest trees become suitable for nesting, 100 acres of high-value foraging habitat (alfalfa rotation) will be protected in the near-term[14] for each potential nest site removed (a nest site is defined as a 125-acre block in which more than 50% of nest trees are 20 feet or greater in height) as a result of construction activity during the near-term. This high-value foraging habitat requirement will be in addition to the proposed 1-to-1 acre replacement of Swainson's hawk foraging habitat in the near-term as identified in the BDCP implementation schedule in Chapter 6 (Table 6-2). This requirement could be counted toward Objectives CLNC1.1 and SH1.1 (Chapter 3, Section 3.3, *Biological Goals and Objectives*). The foraging habitat to be protected will be within 6 kilometers of the removed tree within an otherwise suitable foraging landscape and on land not subject to threat of seasonal flooding, construction disturbances, or other conditions that would reduce the foraging value of the land.

e) To reduce temporal impacts resulting from the loss of mature nest trees, the plantings described above will occur prior to or concurrent with the loss of trees.

11F.3.3.5 AMM19 California Clapper Rail

AMM19 California Clapper Rail and California Black Rail was split into separate AMMs for California Clapper Rail (AMM19) and California Black Rail (AMM38), and incorporated changes recommended by agency staff.

If construction or restoration activities are necessary during the breeding season, preconstruction surveys for California clapper rail will be conducted where suitable habitat for the species occurs within or adjacent to work areas. Surveys will be initiated sometime between January 15 and

[14] Protection will occur in the near term, but the lands will be protected in perpetuity.

February 1. A minimum of four surveys will be conducted (two passive surveys followed by two active surveys). The survey dates will be spaced at least 2 weeks apart and will cover the time period from the date of the first survey through the end of March and mid-April. This will allow the surveys to encompass the time period when the highest frequency of calls is likely to occur. These surveys will involve the following protocol (based on U.S. Fish and Wildlife Service 2015), or other USFWS- and CDFW-approved survey methodologies that may be developed based on new information and evolving science, and will be conducted by biologists with the qualifications stipulated in the USFWS- or CDFW-approved methodologies.

- Survey stations will be established such that the entire marsh is covered by 75- to 100-meter radius circular plots. Listening stations (passive) and call playback (active) survey stations will be established no more than 200-meters apart along roads, trails, and levees that will be affected by covered activities.
- For passive surveys, an observer will be assigned to a listening station for the duration (2 hours) of each survey.
- For active surveys, an observer will be assigned to each survey station for 45 minutes. A total of 3 calls will be conducted at each playback/listening station spaced at 15 minutes apart.
- Surveys will proceed until clapper rail(s) are detected. Once a rail is detected, the project site is considered occupied and at that time, all surveys within the project site will be terminated.
- Sunrise surveys will begin 60 minutes before sunrise and conclude 75 minutes after sunrise (or until presence is detected).
- Sunset surveys will begin 75 minutes before sunset and conclude 60 minutes after sunset (or until presence is detected).
- Surveys will not be conducted when tides are greater than 4.5 National Geodetic Vertical Datum or when sloughs and marshes are more than bankfull.
- California clapper rail vocalizations will be recorded on a data sheet. A GPS receiver and compass will be used to identify survey stations, angles to call locations, and call locations and distances. The call type, location, distance, and time will be recorded on a data sheet.

If California clapper rail is present in the immediate construction area, the following measures will apply during construction activities.

- To avoid the loss of individual California clapper rails, activities within or adjacent to the species' habitat will not occur within 2 hours before or after extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge), when the marsh plain is inundated. During high tide, protective cover for California clapper rail is sometimes limited, and activities could prevent them from reaching available cover.
- To avoid the loss of individual California clapper rails, activities within or adjacent to tidal marsh areas will be avoided during the rail breeding season (February 1 – August 31), unless surveys are conducted to determine rail locations and territories can be avoided.
- If breeding California clapper rails are determined to be present, activities will not occur within 500 feet of an identified calling center (or a smaller distance if approved by USFWS and CDFW). If the intervening distance is across a major slough channel or across a substantial barrier between the rail calling center and any activity area is greater than 200 feet, it may proceed at that location within the breeding season.
- **Exception:** Inspection, maintenance, research, or nonconstruction monitoring activities may be performed during the California clapper rail breeding season in areas within or adjacent to breeding habitat (within 500 or 200 feet, as specified above) with USFWS and CDFW approval and under the supervision of a qualified, permitted biologist.

11F.3.3.6 AMM20 Greater Sandhill Crane

AMM20 Greater Sandhill Crane was extensively revised to modify the scope and provisions of the AMM.

If covered activities are to occur during greater sandhill crane wintering season (September 15 through March 15) in the Greater Sandhill Crane Winter Use Area (Appendix 2.A, Figure 2.A-19-2), the following avoidance and minimization measures will be implemented.

11F.3.3.6.1 3.C.2.20.1.1 Timing

- Construction will be minimized during the sandhill crane wintering season to the extent practicable in light of project schedule and cost and logistical considerations. For example, construction of some project facilities such as vent shafts may be accelerated so that they occur outside of the crane wintering season. The loudest construction activities, such as pile driving, that need to occur for only limited time periods should be scheduled for periods outside the crane wintering season to the extent practicable.
- To the extent practicable, construction that cannot be completed prior to commencement of the wintering season will be started before September 15 or after March 15, such that no new sources of noise or other major disturbance that could affect cranes will be introduced after the cranes arrive at their wintering grounds.

11F.3.3.6.2 3.C.2.20.1.2 Bird Strike Hazard

Performance Standard: No take of greater sandhill crane associated with new facilities

The BDCP will be implemented in a manner that will not result in take of greater sandhill cranes as defined by Section 86 of the California Fish and Game Code (i.e., no mortality) associated with the new facilities. This performance standard will be accomplished by one of, or any combination of, the following:

- Design the transmission line alignment to minimize risk. When locating powerlines, choose specific site locations that are in low risk zones or outside of the Greater Sandhill Crane Winter Use Area.
- Remove, relocate or underground existing lines. Reduce the number of existing lines in risk zones to offset placement of new lines in risk zones. Prioritize elimination or reduction of existing lines and avoidance of new lines in the highest risk zones.
- Underground new lines in high-risk zones of the greater sandhill crane winter use area.
- Use natural gas generators in lieu of transmission lines in high-risk zones of the greater sandhill crane winter use area to provide power for the construction of the water conveyance facilities.
- Install bird strike diverters on existing lines in high-risk zones . Bird diverters will be required on all new lines. Bird strike diverters will be placed on existing lines within the crane use area at a rate of one foot of existing transmission line (complex) for every one foot of project transmission line (complex) constructed, in an area with the same or higher greater sandhill crane strike risk to provide a net benefit to the species. Bird strike diverters will be installed on project and existing transmission lines in a configuration that research indicates will reduce bird strike risk by at least 60% or more. Bird strike diverters placed on new and existing lines will be periodically inspected and replaced as needed until or unless the project or existing line is removed, or are otherwise no longer a strike risk for greater sandhill cranes. The most effective and appropriate diverter for minimizing strikes with greater sandhill crane on the market according to best available science will be selected.
- Manage habitat to shift cultivated land roost site locations away from risk zones created by new transmission lines. This can be accomplished by not flooding past or current roosting sites

located in the vicinity of the new transmission line, thereby eliminating the sites' attractiveness as roosting habitat; and establishing new roost site equal or greater in size at new location in a lower risk zone but within 1 mile of the affected site. The relocated cultivated land roost site will be established prior to commencement of the wintering season that occurs prior to construction of new transmission lines. The existing cultivated land roost site will be flooded during the wintering season prior to construction; it will not be flooded during the wintering season that occurs during the year construction begins. A wildlife agency–approved, qualified biologist familiar with crane biology will design the new roost site and direct implementation of the roost site establishment.

- Final transmission line design will be determined in coordination with the wildlife agencies and wildlife agency–approved, qualified biologist familiar with crane biology (as described above), to achieve the performance standard and ensure the measures described herein are incorporated.

Powerline Plan and Analysis

Prior to powerline construction, the wildlife agency-approved, qualified crane biologist familiar with crane biology will coordinate with the Implementation Office to develop a plan for achieving the performance standard (no take of greater sandhill crane associated with the new facilities) using one or a combination of the measures described above. The plan will include an analysis, using the method described in Attachment 5.J.C, *Analysis of Potential Bird Collisions at Proposed BDCP Powerlines*, of the Draft BDCP to demonstrate that this standard has been met for the final transmission line alignment. The best available science will be used to estimate bird strike reduction associated with powerline diverters installed on existing lines in highest risk zones for the species and to design and implement roost site surveys as described in Section 3.C.2.20.1.6, *Surveys to Inform Avoidance and Minimization*. To ensure greater sandhill crane habitat loss is avoided and minimized to the maximum extent practicable, wildlife agency staff will be involved in discussions with the powerline provider regarding technical constraints on powerline placement and undergrounding. The final powerline plan and analysis will be subject to review and approval by the wildlife agencies prior to its implementation to ensure that birdstrike risk is minimized and take, as defined by Section 86 of the California Fish & Game Code, is avoided. Powerline construction will be implemented consistent with this plan.

Required Measures

Consistent with the performance standard of no take of greater sandhill crane associated with new facilities, the following measures will also be implemented to minimize bird strike hazard. While any combination of the measures described under *Performance Standard*, above, may be implemented to meet the performance standard, all of the following measures are required.

- During the final powerline design process, undergrounding of all new permanent powerlines will be comprehensively evaluated with respect to cost, operational risks, bird strike risks, and other relevant factors.
- Upon approval by the power providers, bird diverters will be installed on all new temporary and permanent powerlines, following Avian Power Line Interaction Committee protocols. These diverters will be maintained for the entire period that the lines are in place. This may contribute toward meeting the performance standard of no take of greater sandhill crane associated with the new facilities (described above).
- All new above-ground powerlines will be at least 100 meters from all crane roost sites[1] . This can be accomplished through alignment design or through crane roost site relocation. For relocation of cultivated land roost sites, both the existing[15] and new roost site will be flooded a year prior to construction; and the existing[3] roost site will not be flooded during the wintering

[15] "Existing" roost habitat is that which is designated by the crane roost model at the time of CM1 plan finalization. The crane roost model will be based on recent survey data as described in Section 3.C.2.20.1.7, *Monitoring to Inform Avoidance and Minimization*.

season that occurs during the year construction begins. For relocation of wetland roost sites, the relocated site will be flooded one year prior to construction; and during construction, both roosting sites will be flooded. A wildlife agency–approved, qualified biologist familiar with crane biology will design new roost sites and direct implementation of roost site establishment. Potential sites will be identified and monitored prior to establishment. Relocated roost sites will be maintained until construction is complete in the affected region.

- New[16] permanent powerlines will be placed outside of areas with a bird strike risk index of 1.0 or greater as shown on Figure 2, Appendix 5.J, Attachment 5J.C, *Analysis of Potential Bird Collisions at Proposed BDCP Powerlines*, of the Draft BDCP.
- Use of construction equipment greater than 50 feet in height will be minimized to the extent practicable in light of project schedule and cost and logistical considerations.

See also AMM30 Transmission Line Design and Alignment Guidelines.

3.C.2.20.1.3 Effects on Greater Sandhill Crane Foraging and Roosting Habitat Resulting from CM1 Water Facilities and Operation

The following measures will be implemented to avoid and minimize effects on greater sandhill crane resulting from implementation of the final design of the water conveyance features (*CM1 Water Facilities and Operation*).

Foraging Habitat

- Minimize direct loss of foraging habitat. CM1 final design will minimize pile driving and general construction-related loss of greater sandhill crane foraging habitat to the extent practicable.
- Minimize pile driving and general construction-related combined noise effects on foraging habitat. The Implementation Office will minimize the area of crane foraging habitat to be affected during the day (from 1 hour after sunrise to 1 hour before sunset) by construction noise exceeding 50 dBA L_{eq} (1 hour)[17]. Combined pile driving and general construction-related noise levels will be estimated prior to commencement of construction using the methods described in Attachment 5J.D, *Indirect Effects of Construction of the BDCP Conveyance Facility on Greater Sandhill Crane*, as revised in this Appendix D of the RDEIR/SEIS, incorporating site-specific information related to equipment to be used and existing noise barriers such as levees. Artificial noise barriers may be installed to decrease noise levels at foraging habitat below 50 dBA L_{eq} (1 hour). However, the visual effects of noise barriers on sandhill cranes are unknown; therefore, all other options to reduce noise will be implemented before installing noise barriers in close proximity to crane habitat.
- Enhance foraging habitat to avoid loss of foraging values that could otherwise result from unavoidable noise-related effects. The Implementation Office will enhance 0.1 acre of foraging habitat for each acre of foraging habitat to be indirectly affected within the 50 dBA L_{eq} (1 hour) construction noise contour. The enhanced foraging habitat will be established one crane wintering season (September 1 to March 15) prior to construction and will be maintained until the activities causing the indirect noise effect is completed. The enhanced habitat will consist of corn fields that will not be harvested, and will be managed to maximize food availability to greater sandhill cranes (e.g., corn stalks will be knocked down or mulched to make grain available to foraging cranes). A management plan for the enhanced habitat will be completed prior to establishing the habitat, in coordination with a biologist with at least 5 years of experience managing greater sandhill crane habitat on cultivated lands, or experience directing

[16] New powerlines are those that did not previously exist, that is, if a powerline is replaced along the same alignment as one that previously existed, then that is not considered a "new" powerline, but a "replacement" powerline.

[17] 50 decibels averaged over a 1-hour period.

such management. The enhanced habitat will be located outside the construction-related 50 dBA L_{eq} (1 hour) noise contour and within 1 mile of the affected habitat.

Roosting Habitat

Preconstruction surveys will be conducted for greater sandhill crane temporary and permanent roost sites within 0.75 mile of the construction area boundary. Surveys will be conducted during the winter prior to project implementation, over multiple days within the survey area by a qualified biologist with experience observing the species. Alternatively, roost sites within 0.75 mile of the construction area boundary can be identified by a qualified greater sandhill crane biologist familiar with roost sites in the Plan Area. If a greater sandhill crane roost site is located within 0.75 mile of the construction area boundary, then to the extent practicable, nighttime (1 hour before sunset to 1 hour after sunrise) project activities will be relocated to maintain a 0.75-mile nondisturbance buffer. If this is not practicable, the following measures will be implemented to avoid and minimize effects on roosting greater sandhill cranes.

- Avoid direct construction-related loss of roost sites. Activities will be designed to avoid direct loss of crane roost sites. This can be accomplished by siting activities outside identified crane roost sites or by relocating the roost site if it consists of cultivated lands (roost sites that consist of wetlands rather than cultivated lands will not be subject to relocation). A cultivated land roost site can be relocated by not flooding the site where the impact will occur during years when construction will occur and by establishing a new roost site equal or greater in size at a new location away from the disturbance (outside the 50 dBA L_{eq} [1 hour] pile driving and general construction noise contour) but within 1 mile of the affected site. The relocated roost site will be established one year prior to construction activities affecting the original roost site. A qualified biologist familiar with crane biology will design the new roost site and direct implementation of the roost site establishment. Potential sites will be identified and monitored prior to establishment. Relocated roost sites will be maintained until construction is complete in the affected region. Combined pile driving and general construction-related noise levels will be estimated prior to commencement of construction using the methods described in Attachment 5J.D, *Indirect Effects of Construction of the BDCP Conveyance Facility on Greater Sandhill Crane*, as revised in this Appendix D of the RDEIR/SEIS, incorporating site-specific information related to equipment to be used and existing noise barriers such as levees.

- Avoid and minimize pile driving and general construction-related noise effects on roost sites. Activities within 0.75 mile of crane roosting habitat will reduce pile driving and general construction noise during nighttime hours (from 1 hour before sunset to 1 hour after sunrise) such that pile-driving and general construction noise levels do not exceed a combined 50 dBA L_{eq} (1 hour) at the nearest temporary or permanent roosts during periods when the roost sites are available (flooded). This can be accomplished by limiting construction activities that could result in pile-driving and general construction noise levels above 50 dBA L_{eq} (1 hour) at the roost site to day time only (from 1 hour after sunrise to 1 hour before sunset); siting nighttime project activities at a sufficient distance from crane roost sites to ensure that pile-driving and general construction noise levels do not exceed a combined 50 dBA L_{eq} (1 hour) at the roost site; relocating cultivated land or wetland roost sites as described above; and/or installing noise barriers between roost sites within the 50 dBA L_{eq} (1 hour) contour and the pile-driving and general construction noise source areas, such that construction noise levels at the roost site do not exceed 50 dBA L_{eq} (1 hour). The installation of noise barriers will be used only if the first three options cannot be implemented to the extent that noise levels do not exceed 50 dBA L_{eq} (1 hour) at the roost site.

  If the roost site to be indirectly affected within the 50 dBA L_{eq} (1 hour) pile-driving and general construction combined noise contour is a wetland site rather than cultivated land, then the existing wetland site will not be removed. A new, cultivated land roost site will be temporarily established at a new location away from the disturbance (outside the 50 dBA L_{eq} (1 hour) noise contour) but within 1 mile of the affected site, at a ratio of 1 acre created for each acre of temporary or permanent roost site within the pile-driving and general construction 50 dBA L_{eq}

(1 hour) noise contour. The new roost site will be established prior to commencement of the wintering season that occurs prior to construction of new powerlines affecting the original roost site, and will be maintained until the activities creating the indirect disturbance are completed. A qualified biologist familiar with crane biology will design the new roost site and direct implementation of the roost site establishment.

3.C.2.20.1.4 Measures to Avoid and Minimize Potential Effects from Lighting and Visual Disturbance

The Implementation Office will implement the following measures to avoid and minimize potential lighting and visual effects that could result from construction or operation and maintenance.

- Route truck traffic to reduce headlight impacts in roosting habitat.
- Install light barriers to block the line-of-sight between the nearest roosting areas and the primary nighttime construction light source areas.
- Operate portable lights at the lowest allowable wattage and height, while in accordance with the National Cooperative Highway Research Program's *Report 498: Illumination Guidelines for Nighttime Highway Work.*
- Screen all lights and direct them down toward work activities and away from the night sky and nearby roost sites. A biological construction monitor will ensure that lights are properly directed at all times.
- Limit the number of nighttime lights used to the greatest extent practicable in light of worker safety requirements.
- Install a vegetation screen or other noise and visual barrier along the south side of Hood Franklin Road along the length of Stone Lake National Wildlife Refuge's property to reduce disturbance to sandhill cranes. The noise and visual barrier will be a minimum of 5 feet high (above the adjacent elevated road, if applicable) and will provide a continuous surface impenetrable by light. This height may be obtained by installing a temporary structure, such as fencing (e.g., chain link with privacy slats) or a semipermanent structure, such as a concrete barrier (e.g., a roadway median barrier or architectural concrete wall system) retrofitted with an approved visual screen, if necessary, to meet the required height. This barrier will not be installed immediately adjacent to crane foraging habitat, and placement will be coordinated with a qualified crane biologist approved by the wildlife agencies.

3.C.2.20.1.5 Staten Island Performance Standard

Because of the density of greater sandhill cranes wintering on Staten Island and the importance of Staten Island to the existing population of the greater sandhill crane in the Plan Area, the final placement of conveyance facilities and RTM at this site will be minimized to the extent practicable, except where the use of RTM on the island affirmatively contributes to the sustainability of the population. BDCP-related construction will not result in a net decrease in crane use on Staten Island as determined by deriving greater sandhill crane use days for the entire winter period[18]. This standard will be achieved through some combination of the following (and including the above required avoidance and minimization measures for CM1).

[18] Expected loss of crane use will be estimated by using data on crane use days/acre by habitat type on Staten Island from past studies and future monitoring before construction begins (using averages among available years). These will be used to predict the number of lost crane use days within the footprint of the habitat loss and within the 50 dBA L_{eq} (1 hour) pile-driving and general construction noise contour. Preproject crane surveys will provide additional data on crane use day densities per habitat type to improve the prediction. Use day densities will be used to guide decisions regarding crop habitat needed to be maintained on Staten Island to maintain this performance standard during construction.

- Minimize and/or shift the footprint of activities on Staten Island. The RTM footprint identified on Staten Island is a worst-case scenario. It is expected that the RTM footprint on Staten Island will need to be reduced substantially from shown on the current conveyance facility footprint in order to meet the Staten Island performance standard. Some combination of the following measures will be implemented to achieve this reduction.
  - Stockpile RTM higher than 6 feet to reduce the amount of land affected by RTM stockpiles.
  - Remove RTM from Staten Island periodically during construction to minimize the RTM footprint.
  - Stage the storage and reuse of RTM such that the size of the storage area is minimized at any given time.
  - Reduce RTM storage areas and associated activities during the crane wintering season.
  - Prioritize placement of facilities and RTM in areas of low or no crane use. For example, the very northern end of Staten Island is an area of low crane use that would be a high priority for placement of facilities and RTM.
- Minimize noise, lighting, and visual disturbances during construction (See measures described above for CM1).
- Minimize construction activity and RTM storage during the crane wintering season to the extent practicable.
- Supplemental feeding/foraging habitat enhancement. The enhanced habitat will consist of corn fields that will not be harvested, and will be managed to maximize food availability to greater sandhill cranes. A management plan for the enhanced habitat will be completed prior to establishing the habitat, in coordination with a qualified crane biologist (with at least 5 years of experience managing greater sandhill crane habitat on cultivated lands, or experience directing such management). The enhanced habitat will be located outside the construction-related 50 dBA L_{eq} (1 hour) noise contour and within 1 mile of the affected habitat.
- Maintain flooding and irrigation capacity. Stage CM1 activities on Staten Island such that they do not disrupt flooding and irrigation to the extent that greater sandhill crane habitat will be reduced during the crane wintering season.
- In determining any long-term uses of RTM on Staten Island, priority will be given to uses that are consistent with the sustainability of greater sandhill crane habitat on the island. RTM will be moved off the island after short-term use or storage unless a determination is made that long-term use of the RTM on Staten Island will not be detrimental to the crane population on the island.

Prior to construction on Staten Island, the qualified, wildlife agency–approved crane biologist will coordinate with the Implementation Office to develop a strategy for achieving the Staten Island performance standard using a combination of the measures described above, and prepare a plan based on the final construction design on Staten Island that includes all avoidance and minimization measures necessary for achieving the performance standard. This plan will be subject to review and approval by the wildlife agencies prior to its implementation. All avoidance and minimization measures will be in place, consistent with the plan, prior to project construction on Staten Island.

3.C.2.20.1.6 Surveys to Inform Avoidance and Minimization

The modeling method used to inform the placement of diverters on existing lines in high-risk zones of the greater sandhill crane winter use area and to evaluate the acres of foraging and roosting habitat affected by the 50 dB noise contour requires spatially explicit roosting and foraging habitat and population density models. The GIS-based methods used to determine the total effected and compensatory habitat will be performed once, at the time of CM1 plan finalization. The greater sandhill crane roosting and survey data used to evaluate habitat loss, and to identify lands in fulfillment of minimization requirements, at the time of CM1 plan finalization will be no more than two wintering seasons old at the time of the evaluation. This allows for avoidance and minimization requirements to be quantified using up-to-date information. If the Implementing Entity chooses to phase avoidance and minimization quantification along with construction phasing, the roosting and foraging habitat and population data must be updated so that it is never more than five years old. The greater sandhill crane roosting and foraging habitat and population models will be updated using on-the-ground surveys performed by a wildlife agency–approved, qualified biologist familiar with crane biology and experienced with crane population-level survey techniques. The greater sandhill crane foraging habitat model can be updated using agricultural land-use data or a combination of land-use and survey data.

11F.3.3.7 AMM21 Tricolored Blackbird

AMM21 Tricolored Blackbird was revised to expand the minimum avoidance buffer from 250 feet to 300 feet.

Prior to implementation of covered activities, a qualified biologist with experience surveying for and observing tricolored blackbird will conduct a preconstruction survey to establish use of marsh habitat by tricolored blackbird colonies. Surveys will be conducted in suitable habitat within 1,300 feet of proposed construction areas. Three surveys will be conducted within 15 days of construction with one of the surveys within 5 days of the start of construction. The CDFW Suisun Marsh Unit tracks tricolored blackbird colonies yearly in Suisun Marsh as part of the UCD/USFWS tricolored blackbird portal project; these records will also be searched. If active tricolored blackbird nesting colonies are identified, minimization requirements and construction monitoring will be required.

Covered activities must avoid active tricolored blackbird nesting colonies and associated habitat during the breeding season (generally March 15–July 31). Avoidance measures will include relocating covered activities away from the nesting colonies and associated habitat to the maximum extent practicable. AMMs will be incorporated into the project design and other portions of the application package prior to submission for coverage under the BDCP.

Projects should be designed to avoid construction activity to the maximum extent practicable up to 1,300 feet, but not less than a minimum of 300 feet, from an active tricolored blackbird nesting colony. This minimum buffer may be reduced in areas with dense forest, buildings, or other habitat features between the construction activities and the active nest colony, or where there is sufficient topographic relief to protect the colony from excessive noise or visual disturbance as determined by a biologist experienced with tricolored blackbird.

Covered activities potentially affecting a nesting colony will be monitored by a qualified biologist to verify that the activity is not disrupting the colony. If it is, the activity will be modified, as practicable, by either delaying construction until the colony abandons the site or until the end of the breeding season, whichever occurs first, temporarily relocating staging areas, or temporarily rerouting access to the construction site. Implementation Office technical staff will coordinate with the fish and wildlife agencies and evaluate exceptions to the minimum nondisturbance buffer distance on a case-by-case basis.

11F.3.3.8 AMM26 Salt Marsh Harvest Mouse and Suisun Shrew

AMM26 Salt Marsh Harvest Mouse and Suisun Shrew was revised to reflect the outcomes of discussions with the fish and wildlife agencies.

Where suitable salt marsh harvest mouse or Suisun shrew habitat has been identified within a tidal restoration work area or within 100 feet of a tidal restoration work area where ground-disturbing activities will occur (e.g., at a levee breach or grading location) a CDFW- and USFWS-approved biologist will conduct pre-construction surveys for the mouse prior to ground disturbance. If a mouse is discovered, tidal restoration activities near the mouse will cease until wildlife staff can be contacted and a relocation plan can be developed). Prior to tidal restoration ground-disturbing activities, vegetation will first be removed with nonmechanized hand tools (e.g., goat or sheep grazing, or in limited cases where the biological monitor can confirm that there is no risk of harming salt marsh harvest mouse or Suisun shrew, hoes, rakes, and shovels may be used) to allow salt marsh harvest mouse and Suisun shrew to passively move out of the location. Vegetation must be cleared to bare ground and removed from the work area including roads, work area, etc. The upper six inches of soil excavated within salt marsh harvest mouse habitat will be stockpiled and replaced on top of backfilled material. Vegetation will be removed under supervision of a CDFW- and USFWS-approved biological monitor familiar with salt marsh harvest mouse and Suisun shrew. Vegetation removal will start at the edge farthest from the salt marsh and work its way towards the salt marsh. This method of removal provides cover for salt marsh harvest mouse and Suisun shrew and allows them to move towards the salt marsh as vegetation is being removed.

Temporary exclusion fencing will be placed around a defined tidal restoration work area before construction activities start and immediately after vegetation removal. The fence should be made of material that does allow a salt marsh harvest mouse to pass through and should be buried to a depth of 2 inches so that mice cannot crawl under the fence. Supports for the fence must be placed on the inside of the exclusion area. Prior to the start of daily activities during initial ground disturbance, the CDFW- and USFWS-approved biologist will inspect the salt marsh harvest mouse-proof boundary for holes or rips. The work area will also be inspected to ensure no mice are trapped inside. Any mice found along or outside the fence will be closely monitored until they move away from the construction site. Tidal restoration work will be scheduled to avoid extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge) to allow for salt marsh harvest mouse and Suisun shrew to more easily move to higher grounds.

The CDFW- and USFWS-approved biologist with previous salt marsh harvest mouse experience will be on site during construction activities related to tidal restoration in suitable mouse habitat. The biologist will document compliance with the project permit conditions and avoidance and conservation measures. The approved biologist has the authority to stop tidal restoration activities if any of the requirements associated with these measures is not being fulfilled. If the CDFW- and USFWS-approved biologist requests work stoppage because of take of any listed species, CDFW and USFWS staff will be notified within one day by e-mail or telephone.

11F.3.3.9 AMM27 Selenium Management

The previous version of *AMM27 Selenium Management* was deleted and the following new AMM for selenium was developed in collaboration with fish and wildlife and water quality agency staff.

Under *AMM27 Selenium Management* the Implementation Office will minimize conditions resulting from BDCP actions that could potentially promote mobilization of selenium into the food chain. Specifically, this measure will promote the following actions:

- Evaluation of the potential for BDCP actions to increase selenium bioavailability for identified higher risk geographic areas of the Plan Area
- Implementation of site selection, design and adaptive management strategies to minimize increases in selenium in the aquatic food chain
- Implementation of post-restoration programs to monitor for possible increases in selenium due to BDCP actions

For descriptions of the current condition of selenium in the Plan Area, see Appendix 5D, *Contaminants*; Chapter 2, *Existing Ecological Conditions*; and Section 3.3, *Biological Goals and Objectives*.

3.C.2.27.1 Problem Statement

Selenium is a naturally occurring element in Delta sediments, soil, and adjacent mountains. However, in some areas it has been concentrated and mobilized, mainly by recirculation of irrigation water through selenium-containing soils during agricultural operations, especially in the San Joaquin Valley. Historically the San Joaquin River has been the primary contributor of selenium to the Delta.

This AMM addresses mechanisms related to BDCP actions that could result in increased exposure of covered species to selenium, as described below.

- *Water Operations* could result in an increase in the ratio of the contributions to the Delta from San Joaquin River relative to the Sacramento River, leading to overall increased selenium loading to the Delta, and specifically the South Delta
- *Restoration actions* could result in mobilization of selenium, depending on the amount of selenium in the newly inundated sediments, the length of inundation (residence time), and whether sufficient time allows the selenium to cycle through the aquatic system into the food chain.

Selenium is more bioavailable in an aquatic system compared to upland locations, and inundation of ROAs could mobilize selenium sequestered in soils, and increase exposure of covered species. In aquatic systems, selenium is most mobile in chemically reducing conditions. Such conditions are maximized in areas of slow moving water, longer water residence times and low flushing rates (Presser and Luoma 2006; Lemly 1999). The longer residence times also allow the selenium to move up the food chain. Bioaccumulation is much higher for benthic-based food chains than for pelagic-based. Sessile filter feeders can bioaccumulate and pass up to higher trophic levels hundreds of times the waterborne concentration of selenium. However, plankton excrete most of the selenium they consume and it is not bioaccumulated and passed through the food chain (Stewart et al. 2004)

3.C.2.27.2 Implementation

CM1 Water Operations

The Implementation Office will maintain a selenium monitoring program in conjunction with ongoing state and federal led monitoring programs. Before implementation of *Water Operations,* the Implementation Office will prepare a comprehensive Selenium Monitoring Program. This program will include reporting on a yearly basis, at a minimum to state and federal regulators, as well as dissemination for public use on the BDCP Implementation Office website. The monitoring program will also cover identified data needs to monitoring restoration actions.

Restoration

For each restoration project under CM4 *Tidal Natural Communities Restoration*, a project-specific selenium management evaluation (or plan, as needed) will be developed to evaluate the likelihood that BDCP actions would result in increased selenium entering the foodweb. The plan would specify measures to minimize the conditions known to support mobilization of selenium, and monitoring programs, if required. Each project-specific evaluation will include the following components:

1. A brief review of available information to determine the likelihood that elevated levels of selenium and supportive biogeochemical conditions are present; projects within the South Delta and Suisun Marsh would likely be candidates
2. A brief review of predicted changes in water residence time and increasing reducing conditions at the project site that could promote mobilization of selenium into fish and invertebrates
3. Based on results of Steps 1 and 2 above, a determination if pre-construction sampling for characterization of selenium concentrations is warranted to determine if selenium is elevated under pre-restoration conditions
4. Development and implementation of a project-specific plan for conducting sampling for pre-restoration characterization, if warranted

5. Re-evaluation of the likelihood that the project could result in selenium mobilization, and recommendations for restoration design elements and post-construction monitoring to address those risks

Design Elements to Minimize Selenium Mobilization

Under this AMM, the Implementation Office will evaluate site-specific restoration conditions and design elements that could minimize conditions conducive to increases of bioavailable selenium in restored areas. The design elements will be integrated into site-specific restoration designs based on site conditions, community type (tidal marsh, nontidal marsh, floodplain), and potential organic forms of selenium in water. The overall ecosystem restoration objectives will be considered throughout the process so that any mitigation does not interfere with these objectives.

Currently, there are no proven methods for mitigating selenium mobilization at restoration sites, and current research results will be consulted when implementing this program. Given our current understanding of selenium biogeochemistry, the design minimization measures will be focused on providing oxidizing conditions, minimizing residence times and maximizing flows.

One approach may be to limit the concentration of organics in the top layers of sediment and also within the water column. However, removal of organics may often be counter to the intent of the restoration project and would need to be considered within the larger context of objectives. Increased flows may also be an attractive option to limit selenium mobilization.

Adaptive Management

Adaptive management will be implemented when post-restoration monitoring results indicate that BDCP actions have resulted in increased bioavailability of selenium. The action levels for adaptive management will be identified in the Selenium Monitoring Plan.

3.C.2.27.3 Schedule

AMM27 provides specific tidal natural communities restoration design elements to reduce the potential for bioaccumulation of selenium and its bioavailability in tidal habitats. Consequently, this mitigation would be implemented as part of the tidal natural communities restoration design schedule.

3.C.2.27.4 Oversight and Coordination

The Implementation Office will identify a qualified specialist in selenium cycling and biological effects who will oversee all aspects of implementing AMM27. The appointed selenium specialist will review and approve all conclusions and recommendations generated from this program, and will develop a Quality Assurance/Quality Control program to cover all sampling, analysis and reporting under the program. The specialist will also be responsible for integrating new, relevant information generated by research over the course of this program.

3.C.2.27.5 Timing and Phasing

The selenium monitoring program to track potential changes to selenium concentrations will be developed prior to implementation of water operations under CM1.

11F.3.3.10 AMM37 Recreation

AMM37 Recreation was revised to include a measure for adding signage for boaters to slow down when passing preserves with marsh habitat.

The following avoidance and minimization measures will be implemented for recreational use within the reserve system. For additional conditions related to recreational use, see *CM11 Natural*

Communities Enhancement and Management (Chapter 3, Section 3.4, *Conservation Measures*). Rare exceptions to the measures listed below will be considered and approved by the Implementation Office and the fish and wildlife agencies on a case-by-case basis. Exceptions will be approved only if they are consistent with the biological goals and objectives. Any exceptions will be clearly identified in the recreation plan described in CM11.

3.C.2.37.1 General Recreation-Related Avoidance and Minimization

The following measures are related to construction of trails and other recreational facilities.

- Trails will be sited and designed with the smallest footprint necessary to cross through the instream area. Trails will be designed to avoid any potential for future erosion. New trails that follow stream courses will be sited outside the riparian corridor. Trails that follow stream courses will have designated stream access points for fishing if allowed.
- Construction of trails and other recreation amenities in riparian areas will be limited to outside the breeding season for nesting birds.
- The recreational facility will be designed to avoid the removal of riparian vegetation or wetlands.
- The number and length of trails that parallel the edge of the riparian forest and tidal marsh will be limited unless located sufficiently away from those communities to minimize disturbance and allow use of open habitats by edge-dependent species. When adjacent to riparian or tidal marsh communities, trails will be on the top of a levee or behind the top of bank except where topographic, resource management, or other constraints or management objectives make this not feasible or undesirable.
- New trails in vernal pool or alkali seasonal wetland complexes and grasslands with stock ponds will be sited at least 250 feet from wetland features, or may be sited closer based on the site's microtopography to ensure the trail does not adversely affect the local watershed surrounding a wetland feature. Existing trails may be used in the vicinity of vernal pools and alkali seasonal wetland features provided they are maintained to prevent erosion and do not encroach into the wetland features.
- Existing access routes and levee roads will be used, if available, to minimize impacts of construction in special-status species habitats and riparian zones.
- Trails in areas of moderate or difficult terrain and adjacent to a riparian zone will be composed of natural materials or will be designed (e.g., a bridge or boardwalk) to minimize disturbance and need for drainage structures, and to protect water quality.

The following measures are related to siting recreation facilities in relation to biological resources.

- Recreational uses in the reserve system will be designed to minimize impacts on biological resources.
- Recreation will only be allowed where it is compatible with the biological goals and objectives.
- Recreational use and impacts will be monitored by the Implementation Office to ensure that uses do not substantially and adversely affect covered species. If any use is found to have substantial adverse effects on covered species, that use will be discontinued until adjustments in the use can be made to reduce or eliminate impacts.

- Allowable recreational uses will be controlled and restricted by area and time to minimize impacts on natural communities and covered species and to ensure that the biological goals and objectives. For example, trails will be closed during and immediately following heavy rains and annually winterized to minimize erosion and sedimentation.
- Activities will be allowed in keeping with the ecological needs of the given habitat. Any off-trail activities and other active recreation not listed as allowed in CM11 (e.g., outdoor sports, geocaching), unless otherwise authorized by the Implementation Office, are prohibited. Recreational uses will be allowed only during daylight hours and designated times of the year (i.e., limited seasonal closures to protect sensitive covered species; see below for specific examples) unless authorized through a use permit (i.e., backpacking). Exceptions may be made for educational groups and events that are guided by an Implementation Office staff person or docent approved by the Implementation Office.
- New staging areas will be developed to the extent feasible in areas within reserves that are already disturbed and not suitable for habitat restoration, and that do not contribute to the biological goals and objectives. Sites at the edges of reserves will be chosen over sites on the interior of reserves.
- No motorized vehicles will be allowed in reserves, except on designated recreational access roads and for use by the reserve manager staff or with the prior approval of the reserve manager (e.g., contractors implementing BDCP actions such as habitat restoration and monitoring, grazing tenants, fire-suppression personnel, and maintenance contractors). For reserves under conservation easements, vehicle use will be allowed as part of the regular use of the land (e.g., agricultural operations, permanent residents, utilities, police and fire departments, other easement holders), as specified in the easement.
- When compatible with the biological goals and objectives, dogs may be allowed during daylight hours in designated reserves or in designated areas of reserves, but only on leash. Leash law restrictions will be strictly enforced by reserve managers and staff because of the potential impact of dogs on covered species such as San Joaquin kit fox, western burrowing owl, California red-legged frog, and California tiger salamander. Leash enforcement may include citations and fines. Dogs used for herding purposes by grazing lessees or for hunting must be under verbal control and have proof of vaccination.
- Picnic areas will be operated during daylight hours only. No irrigated turf or landscaping will be allowed in picnic areas. To the extent feasible, picnic areas will be located on the perimeter of reserves and will be sited in already disturbed areas. No private vehicles will be allowed in picnic areas, unless the picnic area is at a staging area and except for limited special events approved by the Implementation Office. Maintenance and emergency vehicles will be permitted access to picnic areas.
- Backpack camps will be limited to use by no more than 25 people at each site. In coordination with the reserve manager, the Implementation Office will monitor use and maintenance of backpack camps and may implement a reservation and permitting process for use of backpack camps.
- Public collecting of native species will be prohibited within reserves.
- Introduction of domestic or feral animals, including cats, ducks, fish, reptiles, and any exotic nonnaturalized species, is prohibited within the reserves to prevent interference with and

mortality of native species, except by the reserve manager for management purposes (e.g., livestock for grazing or dogs for livestock control or protection).

- Recreational uses will be controlled using a variety of techniques including fences, gates, clearly signed trails, educational kiosks, trail maps and brochures, interpretive programs, and patrol by land management staff.
- Construction of recreational facilities within reserves will be limited to those structures necessary to directly support the authorized recreational use of the reserve. Existing facilities will be used where possible. Facilities that support recreation and that may be compatible with the reserve include parking lots (e.g., small gravel or paved lots), trails (unpaved or paved as required by law), educational and informational kiosks, up to one visitor center located in a disturbed or nonsensitive area, and restroom facilities located and designed to have minimal impacts on habitat. Playgrounds, irrigated turf, off-highway vehicle trails, and other facilities that are incompatible with the biological goals and objectives will not be constructed.
- Signs and informational kiosks will be installed to inform recreational users of the sensitivity of the resources in the reserve, the need to stay on designated trails, and the danger to biological resources of introducing wildlife or plants into the reserve.
- When compatible with the biological goals and objectives, recreation plans for reserves adjacent to existing conservation lands (non-BDCP) will try to ensure consistency in recreational uses across open-space boundaries to minimize confusion for the public. Reserves adjacent to existing conservation lands (non-BDCP) with different recreational uses will provide clear signage to explain these differences to users that cross boundary lines. The Implementation Office will be responsible for securing and signing reserve boundaries.

3.C.2.37.2 Measures Specific to Natural Communities and Covered Species

3.C.2.37.2.1 Grassland, Alkali Seasonal Wetland Complex, and Vernal Pool Complex Natural Communities

The following measures will be implemented to avoid and minimize effects on covered species in the grassland, alkali seasonal wetland complex, and vernal pool complex natural communities.

- **San Joaquin kit fox.** New trails will be prohibited within 250 feet of active kit fox dens. Trails will be closed within 250 feet of active natal/pupping dens until young have vacated, and within 50 feet of other active dens. No dogs will be allowed on properties with active kit fox populations. Rodent control will be prohibited even on grazed or equestrian-access areas with kit fox populations.
- **Western burrowing owl.** New trails will be prohibited within 250 feet of active western burrowing owl nests. If an owl pair nests within 250 feet of an active trail, Implementation Office staff will consult with the fish and wildlife agencies to determine the appropriate action to take. Actions may include prohibiting trail use until young have fledged and are no longer dependent on the nest. Leash laws will be enforced. Rodent control will be prohibited even on grazed or equestrian-access areas with burrowing owl populations, except where necessary to protect important infrastructure.
- **California red-legged frog, California tiger salamander.** New trails will be prohibited within 100 feet of wetlands and streams that provide suitable habitat for covered amphibians, unless

topography or other landscape characteristics shield these trails from the covered species habitat or a lack of effect of the trail on the species can be otherwise demonstrated.

- **Plants (brittlescale, Carquinez goldenbush, delta button celery, heartscale, San Joaquin spearscale).** New trails will avoid populations of these species. Trails will be closed if they would potentially affect populations.
- **Vernal pool and alkali seasonal wetland crustaceans and plants.** No new trail construction will be allowed in vernal pool or alkali seasonal wetland features.

3.C.2.37.2.2 Riparian Natural Community

The following measures will be implemented to avoid and minimize effects on covered species in the riparian natural community, in addition to the general measures related to riparian areas described in Section 3.C.2.1.37.1.

- **Least Bell's vireo, yellow-breasted chat, western yellow-billed cuckoo**. Construction in and near riparian areas will be limited to outside of the breeding season.
- **Swainson's hawk, white-tailed kite.** Construction in and near riparian areas will be limited to outside of the breeding season. During breeding season, trails will be closed within 600 feet of active nests.
- Plants (delta mudwort, delta button celery, Delta tule pea, Mason's lilaeopsis, side-flowering skullcap, slough thistle, Suisun marsh aster). New trails will avoid populations of these species. Trails will be closed if they would potentially affect populations. Fishing areas will be designated to focus public use along waterways.

3.C.2.37.2.3 Cultivated Lands

The following measures will be implemented to avoid and minimize effects on covered species on cultivated lands.

- **Swainson's hawk.** Construction within 600 feet of potential nest trees will be limited to outside of the breeding season. During the breeding season, trails will be closed within 600 feet of active nests.
- **Greater sandhill crane roost sites.** Construction will be limited to spring and summer (outside of the crane wintering season). No hunting will be allowed at sites with temporary or permanent crane roosts. Where feasible, no fall or winter hunting will be allowed on adjacent fields. Recreation on sites with crane roosts will be limited to public roadways and overlook areas. No pets will be allowed onsite.

3.C.2.37.2.4 Managed Wetlands

The following measures will be implemented to avoid and minimize effects on covered species in the managed wetland natural community, in addition to the general measures related to wetlands described in Section 3.C.2.1.37.1.

- **Greater sandhill crane (on sites within Greater Sandhill Crane Winter Use Area where wetlands are managed specifically for crane)**. Construction will be limited to spring and summer (outside of the wintering season). No hunting will be allowed at sites with temporary or permanent crane roosts. Where feasible, no fall or winter hunting will be allowed on adjacent fields. Recreation on sites with crane roosts will be limited to public roadways and overlook areas. No pets will be allowed onsite.

- **California black rail, California clapper rail.** Construction in and near suitable habitat will be limited to outside of the breeding season. Trails will be limited to levees. No pets will be allowed onsite during the breeding season and leash laws will be enforced outside of the breeding season (excluding hunting activities).
- **Salt marsh harvest mouse.** Trails will be limited to levees. Leash laws will be enforced (excluding hunting activities).

3.C.2.37.2.5 Tidal Brackish Emergent Wetlands and Tidal Freshwater Emergent Wetland Natural Communities

The following measures will be implemented to avoid and minimize effects on covered species in the tidal brackish emergent wetland and tidal freshwater emergent wetland natural communities, in addition to the general measures related to wetlands described in Section 3.C.2.1.37.1.

- **California black rail, California clapper rail.** Construction in and near suitable habitat will be limited to outside of the breeding season. Trails will be limited to levees and upland areas. No pets will be allowed onsite during the breeding season, and leash laws will be enforced outside of the breeding season (excluding hunting activities).
- **Suisun song sparrow.** Trails will be limited to levees or upland areas. No pets will be allowed onsite during the breeding season, and leash laws will enforced outside of the breeding season (excluding hunting activities).
- **Salt marsh harvest mouse.** Trails will be limited to levees or upland areas. No pets will be allowed onsite during the breeding season, and leash laws will be enforced outside of the breeding season (excluding hunting activities).
- **Plants (delta mudwort, Delta tule pea, Mason's lilaeopsis, soft bird's-beak, Suisun marsh aster, Suisun thistle).** New trails will avoid populations of these species. Trails will be closed if they would potentially affect populations. Fishing areas along sloughs will be designated to focus public use along waterways.
- **All tidal species**. Signs will be added adjacent to tidal preserves asking boaters to slow down when passing to minimize the effects of noise and wakes on species that utilize the marsh edge.

3.C.2.37.2.6 Nontidal Perennial Aquatic and Nontidal Freshwater Emergent Wetland Natural Communities Natural Communities

The following measures will be implemented to avoid and minimize effects on covered species in the nontidal perennial aquatic and nontidal freshwater emergent wetland natural communities, in addition to the general measures related to wetlands described in Section 3.C.2.1.37.1.

- **Tricolored blackbird.** New trails will be prohibited within 100 feet of wetlands that provide suitable habitat for breeding tricolored blackbirds, unless topography or other landscape characteristics shield these trails from the habitat or a lack of effect of the trail on the species can be otherwise demonstrated. Leash laws will be enforced. Trails will be closed within 250 feet of active nesting colonies until it can be demonstrated that the nesting cycle has completed.

- **Giant garter snake.** New trails will be prohibited within 100 feet of nontidal wetlands that are restored for giant garter snake, unless topography or other landscape characteristics shield these trails from the habitat or a lack of effect of the trail on the species can be otherwise demonstrated. Leash laws will be enforced. Rodent control will be prohibited on adjacent grassland uplands, except where necessary to protect important infrastructure.

11F.3.3.11 AMM 38 California Black Rail

AMM19 California Clapper Rail and California Black Rail was split into separate AMMs for California Clapper Rail (AMM19) and California Black Rail (AMM38), and incorporated changes recommended by agency staff.

Preconstruction surveys for California black rail will be conducted where potentially suitable habitat for this species occurs within 500 feet of work areas. Potentially suitable habitat includes tidal and non-tidal seasonal or perennial wetlands at least 2 acres in size with any kind of vegetation types consistent with black rail use in the Delta over 10 inches high, whether or not the patch in question was mapped as modeled habitat. Surveys will be initiated sometime between January 15 and February 1. A minimum of four surveys will be conducted. The survey dates will be spaced at least 2 to 3 weeks apart and will be scheduled so that the last survey is conducted no more than two weeks before April 15. This will allow the surveys to encompass the time period when the highest frequency of calls is likely to occur. These surveys will involve the following protocols (based on Evens et al. 1991), or other CDFW-approved survey methodologies that may be developed using new information and best-available science, and will be conducted by biologists with the qualifications stipulated in the CDFW-approved methodologies.

- Listening stations will be established at 100-meter intervals throughout potential black rail habitat that will be affected by covered activities. Listening stations will be placed along roads, trails, and levees to avoid trampling.
- California black rail vocalization recordings will be played at each station, and playing will cease immediately once a response is detected.
- Each listening station will be occupied for 6 minutes, including 1 minute of passive listening, 1 minute of "grr" calls followed by 30 seconds of "ki-ki-krrr" calls, then followed by another 3.5 minutes of passive listening.
- Each survey will include a survey at sunrise and a survey at sunset.
- Sunrise surveys will begin 60 minutes before sunrise and conclude 75 minutes after sunrise (or until presence is detected).
- Sunset surveys will begin 2 hours before sunset and conclude 60 minutes after sunset (or until presence is detected).
- Surveys will not be conducted when tides are greater than 4.5 National Geodetic Vertical Datum or when sloughs and marshes are more than bankfull.
- California black rail vocalizations will be recorded on a data sheet. A GPS receiver and compass will be used to identify surveys stations, angles to call locations, and call locations and distances. The call type, location, distance from listening station, and time will be recorded on a data sheet.

If California black rail is present in the immediate construction area, the following measures will apply during construction activities.

- To avoid the loss of individual California black rails, activities within 500 feet of potential habitat will not occur within 2 hours before or after extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge). During high tide, protective cover for California black rail is sometimes limited, and activities could prevent them from reaching available cover.

- To avoid the loss of individual California black rails, activities within 500 feet of tidal marsh areas and managed wetlands will be avoided during the rail breeding season (February 1 – August 31), unless surveys are conducted to determine that no rails, are present within the 500 ft buffer.
- If breeding California black rail is determined to be present, activities will not occur within 500 feet of an identified calling center (or a smaller distance if approved by CDFW). If the intervening distance between the rail calling center and any activity area is greater than 200 feet and across a major slough channel or substantial barrier (e.g., constructed noise barrier) it may proceed at that location within the breeding season.
- If California black rail are determined to be present in habitat that must be disturbed, vegetation will be removed during the non-breeding season (September 1 – January 31) to encourage them to leave the area. Vegetation removal will be completed carefully using hand tools or vegetation removal equipment that is approved by a CDFW-approved biologist. The biologist will search vegetation immediately in front of the removal equipment, and will stop removal if rails are detected. Vegetation removal will resume when the rail leaves the area.
- If construction activities require removal of potential California black rail habitat, whether or not rails have been detected there, vegetation will be removed during the non-breeding season (September 1 – January 31). Vegetation removal will be completed carefully using hand tools or vegetation removal equipment that is approved by a CDFW-approved biologist. The biologist will search vegetation immediately in front of the removal equipment, and will stop removal if rails are detected. Vegetation removal will resume when the rail leaves the area.
- **Exception**: Inspection, maintenance, research, or non-construction monitoring activities may be performed during the California black rail breeding season (February 1 – August 31) in areas within or adjacent to breeding habitat (within 500 feet) with CDFW approval and under the supervision of permitted CDFW- approved biologist.
- If the construction footprint is within 500 feet of a known calling center, noise reduction structures such as temporary noise reducing walls, will be installed at the edge of construction footprint, as determined by an on-site CDFW-approved biologist. Noise-causing construction will begin during the non-breeding season (September 1 – January 31) so that rails can acclimate to noise and activity prior to initiating nests.

11F.3.3.12 AMM39 White-Tailed Kite

AMM18 Swainson's Hawk and White-Tailed Kite was split into separate AMMs for Swainson's hawk (AMM18) and white-tailed kite (AMM39), and incorporated changes recommended by agency staff.

Preconstruction Surveys

Preconstruction surveys will be conducted to identify the presence of active nest sites of tree nesting raptors within 0.25 mile of project sites, by a CDFW-approved biologist with experience identifying white-tailed kite nests. Surveys of the construction sites and all staging and storage areas, transportation routes, work areas, and soil stockpile areas will be conducted within 30 days prior to construction to ensure nesting activity is documented prior to the onset of construction activity during the nesting season. White-tailed kites nest in the Plan Area between approximately March 15 and September 15. While many nest sites are traditionally used for multiple years, new nest sites can be established in any year. Therefore, construction activity that is planned after March 15 of any year will require surveys during the year of the construction. If construction is planned before March 15 of any year, surveys will be conducted the year immediately prior to the year of construction. If construction is planned before March 15 of any year and subject to prior-year surveys, but is later postponed to after March 15, surveys will also be conducted during the year of construction.

Construction will be restricted to the greatest extent possible during the nesting season where nest sites occur within 0.25 miles of construction activities and suitable buffering between the work site and the nest site does not exist, as determined by a CDFW-approved biologist. Surveys for white-tailed kite nests and nesting activity will follow a protocol approved by CDFW. If active nests are found or nesting activity is identified within 0.25 miles of construction activities appropriate avoidance and minimization measures will be implemented as described below and in consultation with CDFW. Results of the surveys will be documented and submitted to CDFW no more than 5 days prior to beginning project activities.

The CDFW-approved biologist will conduct a second survey of potential nesting trees and active nests, and monitor white-tailed kite nests no more than 72 hours prior to construction. If no nesting activity is found, then construction can proceed with no restrictions.

Where construction activities within 0.25 miles of an active nest cannot feasibly be avoided, construction will be initiated prior to egg-laying to the extent possible. If eggs and or young are present in the nest, work will be restricted until a CDFW-approved biologist determines that white-tailed kites have acclimated to disturbance and exhibit normal nesting behavior.

A 650-foot-radius non-disturbance buffer will be established around each active white-tailed kite nest site. No entry of any kind related to the construction activity will be allowed in the buffer while a nest site is occupied by white-tailed kite during the breeding season. The buffer size may be modified based on the field examination and determination by the CDFW-approved biologist of conditions that may minimize disturbance effects, including line-of-sight, topography, land use, type of disturbance, existing ambient noise and disturbance levels, and other relevant factors, as authorized by CDFW. The buffer will be clearly delineated with fencing or other conspicuous marking. Active nests will be monitored to track progress of nesting activities. Entry into the buffer will be granted when the CDFW-approved biologist determines that the young have fledged and are capable of independent survival or the nest has failed and the nest site is no longer active.

Nest trees will not be removed during the breeding season unless avoiding removal is infeasible and the nest is not active. If nest tree removal is necessary, tree removal will occur only during the nonbreeding season (September 15 – February 28). CDFW authorization must be obtained with the tree removal period specified. The tree replacement protocol described below will be followed.

All personnel will remain out of the line of sight of the nest during breaks.

Where it is infeasible to avoid construction within 0.25 mile of an active white-tailed kite nest identified in preconstruction surveys, at a minimum the following measures will be implemented as part of a nesting bird monitoring and management plan that will be approved by CDFW. The final plan may include additional measures that are specific to site conditions.

- Five days and three days prior to the initiation of construction at any site where a nest is within 650 feet of construction, the designated Biological Monitor will observe the subject nest(s) for at least 1 hour and until normal nesting behavior can be determined. Nest status will be determined and normal nesting behaviors observed, which may be used to compare to the nesting activities once construction begins. The results of preconstruction monitoring will be reported to CDFW within 24 hours of each survey.

- Where pre-project surveys have identified an active white-tailed kite nest within 150 feet of construction, construction must be initiated prior to the initiation of nesting activity or after young have hatched. The designated Biological Monitor will monitor the nesting pair during all construction hours, and construction hours will be limited to between 0800 and 1700.

- Where pre-project surveys have identified an active white-tailed kite nest between 150 to 330 feet from construction, the Biological Monitor will observe the nest for at least 4 hours per construction day to ensure the white-tailed kites demonstrate normal nesting behavior. Construction hours will be limited to between 0800 and 1700.

- Where pre-project surveys have identified an active white-tailed kite nest between 330 to 650 feet from construction, the Biological Monitor will observe the nest for at least 2 hours per construction day to ensure the white-tailed kites demonstrate normal nesting behavior.
- Where pre-project surveys have identified an active white-tailed kite nest between 650 to 1,300 feet from construction, the Biological Monitor will observe the nest for at least 3 days per construction week to ensure the white-tailed kites demonstrate normal nesting behavior and to check the status of the nest.

If during construction monitoring, the Biological Monitor determines that a nesting white-tailed kite within 650 feet of construction is disturbed by construction activities, to the point where reproductive failure could occur, the biologist will have the authority to immediately stop project activity and work will cease. The biological monitor will have the authority to order the cessation of all project activities if white-tailed kite exhibits distress and/or abnormal nesting behavior (e.g., swooping/stooping, excessive vocalization [distress calls], agitation, failure to remain on nest, failure to deliver prey items for an extended time period, failure to maintain nest) that may cause reproductive failure (nest abandonment and loss of eggs and/or young) as a result of project activities. Project activities will not start again until the biologist has consulted with CDFW, and both the biologist and CDFW confirm that the white-tailed kite behavior has normalized.

During construction or ongoing operation and maintenance activities, physical contact with an active nest tree is prohibited from the time of egg laying to fledging, unless approved by CDFW. Construction personnel outside of vehicles must remain at least 650 feet, or the length of a buffer approved by CDFW, from the nest tree.

Nesting Habitat Replacement

The following measures will be implemented to minimize near-term effects on the white-tailed kite populations that could otherwise result from loss of nesting habitat during the first 10 years of the permit term, before most of the restored riparian natural community has matured. Nesting habitat is limited throughout much of the Plan Area, consisting mainly of intermittent riparian, isolated trees, small groves, tree rows along field borders, roadside trees, and ornamental trees near rural residences. Removal of nest trees and nesting habitat could further reduce this limited resource and reduce or restrict the number of active white-tailed kites within the Plan Area until restored riparian habitat is sufficiently developed. To account for this potential near-term loss of nesting habitat, the following additional measures will be implemented.

Tree Replacement with Saplings

Planting trees as potential nesting habitat for white-tailed kite is addressed in *CM7 Riparian Natural Community Restoration* and *CM11 Natural Communities Enhancement and Management*. While those measures address the overall long-term restoration of nesting habitat and the enhancement of BDCP reserves for these species, the following measures specifically address the removal of nest trees or nesting habitat during construction and provide a mechanism to compensate for this loss in order to minimize the near-term effects on white-tailed kite populations.

- At least five trees (5-gallon-container size) will be planted in the reserve system for every tree suitable for white-tailed kite nesting (20 feet or taller) anticipated to be removed by construction during the near-term period. Of the replacement trees planted, a variety of native tree species will be planted to provide trees with differing growth rates, maturation, and life span.
- Replacement trees will be planted in the reserve system in areas that support high-value white-tailed kite foraging habitat. They will be planted in clumps of at least three trees each at appropriate sites within or adjacent to conserved cultivated lands, or may be incorporated into the riparian plantings as a component of the requirement for 5,000 acres of riparian restoration where they are in close proximity to suitable foraging habitat. Replacement trees that are incorporated into the riparian restoration will not be clustered in a single region of the Plan

Area, but will be distributed throughout the lands protected as foraging habitat for white-tailed kite.

- At least 10% of replacement trees will be planted on lands in the reserve system that are specifically protected as white-tailed kite foraging habitat acquired as part of the conservation strategy for cultivated lands or the grassland natural community. These plantings will count toward the nesting habitat requirement in Objective SH2.1 (Chapter 3, Section 3.3, *Biological Goals and Objectives*) of the Draft BDCP.
- The survival success of the planted trees described in (a), (b), and (c) above will be monitored for a period of 5 years to assure survival and appropriate growth and development. Plantings will subsequently be monitored every 5 years to verify their continued survival and growth. For every tree lost during the first 5-year time period, a replacement tree will be planted immediately upon the detection of failure. All necessary planting requirements and maintenance (i.e., fertilizing, irrigation) to ensure success will be provided. Trees will be irrigated for a minimum of the first 5 years after planting, and then gradually weaned off the irrigation during a period of approximately 2 years. If larger stock is planted, the number of years of irrigation will be increased accordingly. In addition, 10 years after planting, a survey of the trees will be completed to assure at least 80% establishment success.

Tree Replacement with Mature Trees

To further and more directly minimize the effects of near-term loss of nesting habitat for white-tailed kite, a program to plant mature trees will be implemented. Planting larger, mature trees, including transplanting trees scheduled for removal, and supplemented with additional saplings, is expected to accelerate the development of potential replacement nesting habitat.

- In addition to the planting of sapling nest trees as described in item (a) above (Section 3.C.2.18.2.2, *Tree Replacement with Saplings*), five mature native trees (at least 20 feet in height) will be planted for every 125 acres of construction footprint in which more than 50% of suitable nest trees (20 feet or taller) within the 125-acre block are removed. Replacement mature trees can be either nursery trees or trees scheduled to be removed by construction. To determine the number of replacement trees required, a grid of 125-acre blocks will be placed over each component of project footprint in which trees are to be removed, and the grid will be fixed in a manner that places the most complete squares of the grid in the project footprint (i.e., the grid will be adjusted so that, to the extent possible, entire squares rather than portions of squares will overlap with the project footprint).
- The mature trees will be planted at a location that otherwise supports suitable habitat conditions for white-tailed kite. This could be around project facilities (while taking into consideration potential effects of noise and visual disturbance from facility operation), on reserve lands, other existing conservation lands (non-BDCP), or excess DWR land, as long as the Implementation Office controls the property. These trees will be planted close to the suitable nest tree affected, unless such location would have low long-term conservation value due to factors such as threat of seasonal flooding or sea level rise, in which case the trees may be planted elsewhere in the reserve system.
- As with the sapling trees, the mature replacement trees will be monitored and maintained for 5 years to ensure survival and appropriate growth and development. Success will be measured using an 80% survival rate at 5 years after planting. In addition, 15 (5-gallon-container size) trees will be planted at each mature tree replacement site to provide longevity to the nest site. These 15 trees may be part of the trees committed to the project by item (a) included above as long they meet the survival criteria described in item (d) above (Section 3.C.2.18.2.2, *Tree Replacement with Saplings*).
- To enhance white-tailed kite reproductive output until the replacement nest trees become suitable for nesting, 100 acres of high-value foraging habitat (alfalfa rotation) will be protected in the near-term for each potential nest site removed (a nest site is defined as a 125-acre block in

which more than 50% of nest trees are 20 feet or greater in height) as a result of construction activity during the near-term. This high-value foraging habitat requirement will be in addition to the proposed 1-to-1 acre replacement of white-tailed kite foraging habitat in the near-term as identified in the BDCP implementation schedule in Chapter 6 (Table 6-2). This requirement could be counted toward Objectives CLNC1.1 and SH1.1 (Chapter 3, Section 3.3, *Biological Goals and Objectives*) of the Draft BDCP. The foraging habitat to be protected will be within 6 kilometers of the removed tree within an otherwise suitable foraging landscape and on land not subject to threat of seasonal flooding, construction disturbances, or other conditions that would reduce the foraging value of the land.

- To reduce temporal impacts resulting from the loss of mature nest trees, the plantings described above will occur prior to or concurrent with the loss of trees.

11F.3.4 Section 3.6, Adaptive Management and Monitoring Program

The adaptive management and monitoring program, Draft BDCP Section 3.6, was extensively revised. Principal changes included:

- Various edits detailing the adaptive management process, modified for consistency with the Draft Implementation Agreement released in May 2014.
- An extensive new section describing nine different “focus areas” representing different areas of concentrated activity in monitoring and adaptive management. Each focus area represents a principal theme of monitoring and research under BDCP, viz. the decision trees; covered fish performance; the Yolo Bypass; tidal wetland restoration; riparian, channel margin, and floodplain restoration; managed wetlands; upland and nontidal wetlands; cultivated lands; and terrestrial species status and trend monitoring.
- Extensive modifications and additions to the section discussing potential partners with DWR in performance of monitoring and research actions.
- Detailed tables explicitly connecting the conservation measures, biological goals and objectives, monitoring actions, and research actions. These tables specify how each biological objective would be tracked and studied using monitoring and research, show which monitoring and research actions would be performed in conjunction with each conservation measure, and show how these monitoring and research actions would be used to support and inform the overall process of implementing the BDCP conservation strategy.

3.6 Adaptive Management and Monitoring Program

[unchanged text omitted]

Table 3.6-1. Role of Adaptive Management in Relation to Other Parts of the Plan

[unchanged table text omitted]

The Adaptive Management and Monitoring Program is detailed in the following sections:

- Section 3.6.1 describes the regulatory context for adaptive management and monitoring in HCPs and NCCPs.
- Section 3.6.2 describes the structure of the Adaptive Management and Monitoring Program, highlighting the organizational structure of the program, including independent scientific review.

- Section 3.6.3 describes how adaptive management would be implemented under BDCP. Subsections describe adaptive management principles and the adaptive management process, including decision making.
- Section 3.6.4 describes the BDCP monitoring and research program. Subsections describe how the program will be overseen, the role of partnerships, the types of monitoring addressed, and the structure and activities of the research program.
- Section 3.6.5 describes how BDCP will manage the monitoring, research, and adaptive management data and reports that will be produced under the Adaptive Management and Monitoring Program.

3.6.1 Regulatory Context

[unchanged text omitted]

3.6.2 Structure of the Adaptive Management and Monitoring Program

[unchanged text omitted]

3.6.2.1 Science Manager

The Science Manager's responsibilities are described in Chapter 7, Section 7.1.1.2, *Science Manager: Selection and Function*. The Science Manager will report to the Program Manager and will, among other things, serve as Chair of the Adaptive Management Team and assist the team in the development and administration of the adaptive management and monitoring program, in coordination with the Interagency Ecological Program (IEP) and other science programs. In addition to chairing the Adaptive Management Team, the Science Manager will serve as the BDCP representative on the Science Steering Committee and the Policy-Science Forum established through implementation of the Delta Science Plan. The Science Manager will work, with the guidance of the Adaptive Management Team, with the Delta Science Program, and with others to integrate, to the extent appropriate, the BDCP adaptive management and monitoring program with the Delta Science Plan.

The Science Manager will also direct the monitoring and research elements of the Adaptive Management and Monitoring Program. The Science Manager will supervise staff charged with data storage and management (Section 3.6.5, *Data Management*), publication and reporting of the products of the Adaptive Management and Monitoring Program (Section 3.6.4.1, *Communications*), management of program funds, issuance of requests for proposals and contracts to perform monitoring and research tasks (Section 3.6.4.2, *Contracting*), and performance of monitoring and research activities under each of the monitoring program focus areas (Section 3.6.4.4, *Focus Areas*). The Science Manager will also be responsible for developing formal agreements, as appropriate, with partners in the monitoring and research programs.

3.6.2.2 Adaptive Management Team

The Adaptive Management Team will be chaired by the Science Manager, and will consist of representatives of DWR, Reclamation, two participating state and federal water contractors (one each representing the SWP and CVP), CDFW, USFWS, and NMFS as voting members. Advisory, nonvoting members will be the IEP Lead Scientist, the Delta Science Program Lead Scientist or designee, and the Director of the NOAA Southwest Fisheries Science Center. The directors of DWR and CDFW and the regional directors of Reclamation, USFWS, and NMFS will each designate a management-level representative to the Adaptive Management Team who can represent both policy and scientific perspectives on behalf of their agency, including on matters related to adaptive management proposals and research priorities.

The Adaptive Management Team will have primary responsibility for administration of the adaptive management and monitoring program, and will decide when and on what terms to seek independent science review to evaluate technical issues for the purpose of supporting adaptive management decision making. These decisions to seek independent science review will be made considering budget and schedule limitations and other factors. The Adaptive Management Team, with support of the Implementation Office, will have primary responsibility for the overall development, management, and oversight of the biological monitoring and research program. Specifically, the Adaptive Management Team will have primary responsibility for the development of performance measures, effectiveness monitoring and research plans; analysis, synthesis and evaluation of monitoring and research results; soliciting independent scientific review; and developing proposals to adapt (e.g., modify a conservation measure) as resource conditions change and understanding evolves. The Adaptive Management Team will provide recommendations to the Program Manager, to be incorporated into the Annual Work Plans and Budgets, including amendment of the current-year budget, to help ensure that the conservation measures achieve the biological objectives and that the biological objectives remain appropriate. These recommendations will be informed by the monitoring and research program (Section 3.6.4) and will help ensure that the BDCP continues to be implemented consistent with ESA and NCCPA permit issuance criteria. These responsibilities will be carried out in a manner that satisfies State and Federal regulatory and other legal requirements.

[unchanged text omitted]

3.6.2.3 Independent Scientific Review

[unchanged text omitted]

3.6.2.4 Integration with the Delta Science Plan

[unchanged text omitted]

3.6.3 Adaptive Management Process

3.6.3.1 Principles of Adaptive Management

[unchanged text omitted]

3.6.3.2 Building on Lessons Learned from Other Adaptive Management Programs

[unchanged text omitted]

3.6.3.3 Addressing Uncertainty

[unchanged text omitted]

3.6.3.4 Nine-Step Plan

[unchanged text omitted]

3.6.3.5 Adaptive Management Decision Process

[unchanged text omitted]

3.6.3.5.1 Role of the Adaptive Management Team

[unchanged text omitted]

3.6.3.5.2 Operation of the Adaptive Management Team

[unchanged text omitted]

3.6.3.5.3 Changing a Conservation Measure or Biological Objective

Changing a conservation measure or biological objective is a major decision that will be made in accordance with the procedure set forth here. This section implements the decision process set forth in Chapter 7, Section 7.1, *Roles and Responsibilities of Entities Involved in BDCP Implementation*. These decisions will be made jointly by the Authorized Entity Group and Permit Oversight Group if agreement can be reached, or, with advice from the dispute resolution panel, by the fish and wildlife agencies as final authorities in these matters, if attempts by the Authorized Entity Group and Permit Oversight Group to reach agreement are unavailing. With respect to potential changes to conservation measures or biological objectives, the role of the Adaptive Management Team is to develop recommendations for changes that will be forwarded to the Authorized Entity Group and Permit Oversight Group for consideration. These changes would be made consistent with the commitments in the Plan, the governance process described in Chapter 7, *Implementation Structure*, and the regulatory assurances described in Chapter 6, *Plan Implementation*.

In the event that the Adaptive Management Team determines that a change in a Conservation Measure or a biological objective may be warranted, it may develop a proposal for a change. The Authorized Entities, the Fish and Wildlife Agencies, and the Stakeholder Council may submit to the Adaptive Management Team, through the Science Manager, proposals for a change to a Conservation Measure or biological objective, and such proposals shall be considered by the Adaptive Management Team. The Adaptive Management Team may also receive proposals for adaptive changes from other interested parties and, at its discretion, review any such proposals to determine whether such proposals will receive further consideration.

If the Adaptive Management Team reaches consensus that a proposed change to a conservation measure or biological objective is advisable, then the Adaptive Management Team will provide a consensus recommendation package to the Program Manager for forwarding to the Authorized Entity Group and Permit Oversight Group consistent with Section 3.6.3.5.2, *Operation of the Adaptive Management Team*. If the Adaptive Management Team cannot reach consensus, it will forward a recommendation package to the Program Manager consisting of proposals, each prepared by a member or group of members within the team, that represent the differing views of how the matter should be resolved. Recommendations submitted to the Authorized Entity Group and Permit Oversight Group regarding potential changes to conservation measures or biological objectives will include the following.

- A description of the proposed change, including, as applicable, the extent, magnitude, and timing of the proposed modifications.
- The scientific rationale for the proposed change, and why it is reasonably expected to better achieve the biological objectives (if the change is to a conservation measure) or goals (if the change is to an objective) of the Plan.
- Identification of any alternatives that were considered and the reasons for their rejection.
- A description of any uncertainties associated with the change and potential approaches to reducing any such uncertainties. If the proposal is to temporarily change a conservation measure as part of the adaptive management learning process, a description of the underlying conceptual model and experimental design will be included.
- A report describing any information derived from independent science review and an explanation of how that information was addressed in the recommendation.

- An analysis of the potential cost in water, money, or other resources of the change being proposed.
- An analysis of the means by which the adaptive resources available to support adaptive management actions will be used to fund the proposed change, if applicable.
- A cover letter and any information the Program Manager believes may be helpful in assisting the Authorized Entity Group and the Permit Oversight Group in making their decision.

The Authorized Entity Group and the Permit Oversight Group will jointly meet to consider and act on the proposals of the Adaptive Management Team. As part of these deliberations, the parties will consider the policy, legal, and regulatory principles set forth below, as well as budgetary and scheduling considerations, and the parameters established for the adaptive resources available to support the change under consideration. It will be the responsibility of members with concerns to brief the Groups on those concerns. If the Authorized Entity Group and the Permit Oversight Group agree that the proposed changes are warranted, the relevant conservation measures or biological objectives will be modified and such changes implemented as directed. The Authorized Entity Group and Permit Oversight Group will attempt to make a decision based on the information they have received from the Adaptive Management Team and the Program Manager, or may consult with either for further information, or may commission independent expert review.

Any member of the Authorized Entity Group or Permit Oversight Group may introduce information not contained in the recommendation package to inform a decision, and may enlist independent expert review of that new information if it has not already been obtained. In the event a member of the Authorized Entity Group or Permit Oversight Group wishes to bring in such new information to inform a decision, that information will, if any member of either Group requests it, first be provided to the Adaptive Management Team for comment. If any member of either Group requests it, the Adaptive Management Team will consider the new information and respond either with a consensus report or, if there is no consensus, with individual comments, in writing, to the Authorized Entity Group and Permit Oversight Group with an assessment of the value and applicability of the information to the decision at hand. The Program Manager will be responsible for documenting any changes made to the conservation measures or the biological objectives. Such information will be included in the Annual Progress Report, as described in Chapter 6, Section 6.3.3.

As part of their deliberations on changes to conservation measures, the Authorized Entity Group and the Permit Oversight Group will take into account the following legal, policy, and regulatory principles.

- The scope and nature of a proposed adaptive response will be considered within the totality of the circumstances, including the degree to which the change is reasonably expected to offset the impacts of covered activities or associated federal actions and Plan implementation or to better achieve plan biological objectives.
- The proposed adaptive management action must be consistent with the legal authority of the entity responsible for effectuating the action.
- The Adaptive Management process will be used to help ensure that conservation measures are in conformity with ESA and NCCPA permit issuance criteria throughout the course of Plan implementation. Changes will be limited to those actions reasonably likely to ensure that (1) the impacts (or levels of impacts) of a covered activity or associated federal action on covered species that were not previously considered or known are adequately addressed or (2) a conservation measure or suite of conservation measures that are less than effective, particularly with respect to effectiveness at advancing the biological goals and objectives, are modified, replaced, or supplemented to produce the expected biological benefit.[19]

[19] The occurrence of a "changed circumstance" may also lead to an adaptive response subject to this paragraph, as provided in Chapter 6.4.2, *Changed Circumstances*.

- The strength of the scientific evidence linking the proposed change to a conservation measure to the ability of the BDCP to achieve the relevant biological objective or objectives.
- An assessment will be made of a potential adaptive change so that the desired outcome(s) will be achieved with the least resource costs. As long as equal or greater biological benefits can be achieved, adaptive responses will favor changes that minimize impacts on water supply or reliability.
- Prior to any decision to change a conservation measure in a manner that would potentially result in the modification of water supplies consistent with Section 3.4.23, *Resources to Support Adaptive Management*, nonoperational alternatives will be considered and, if such alternatives are rejected, the Adaptive Management Team will provide an explanation to the Authorized Entity Group and the Permit Oversight Group as to why they were not sufficient to address the effects of the covered activity or achieve the biological objective(s) of the plan.

If the Authorized Entity Group and the Permit Oversight Group jointly agree that the proposed change to a conservation measure or biological objective is warranted, the change will be adopted and incorporated into the Plan.

In the event that the Authorized Entity Group and the Permit Oversight Group are unable to reach agreement on a proposed change to a conservation measure or biological objective, the dispute review process described in Chapter 7, Section 7.1.7, *Elevation and Review of Implementation Decisions,* will be used. If invoked, the appropriate Fish and Wildlife Agency official with authority over the matter, after considering the available information and taking into account the advice of the review panel, shall decide whether the proposed change, or an alternative to the proposed change, will be adopted.

The Program Manager shall be responsible for documenting any changes made to the Conservation Measures or the biological objectives. Such information will be included in the Annual Progress Report, as described in Chapter 6, Section 6.3.3.

3.6.3.5.4 Relationship of Adaptive Management to Real-Time Operations

[unchanged text omitted]

3.6.3.5.5 Periodic Review of the BDCP Conservation Strategy and Implementation

In addition to the annual adaptive management review process contemplated above, the Implementation Office will commission a comprehensive review of the BDCP every 5 years. Part of that review, to be conducted under the direction of the Adaptive Management Team, will assess the effectiveness to date of conservation measures in achieving the biological objectives; it will also include a review of the results of status and trends monitoring of covered species and natural community conditions. The Implementation Office will oversee preparation of other parts of the comprehensive review, including compliance actions taken, as described in Chapter 6, Section 6.3.5, *Five-Year Comprehensive Review*.

3.6.3.6 Adaptive Management Processes in BDCP

Although adaptive management as described earlier in this section will be an ongoing process in BDCP, used on a year-to-year basis to assess conservation strategy effectiveness and for other purposes as described in Table 3.6-1, there are several aspects of the BDCP conservation strategy for which specific adaptive management responses have been developed. These include tidal restoration, and climate change. The following discussion explains the use of adaptive management in each of these processes.

A suite of key uncertainties associated with tidal wetland restoration, including a key uncertainty associated with the effectiveness of tidal wetland restoration in the south Delta, are described in Section 3.6.4.8.4, *Tidal Wetland Restoration Focus Area*. The issue is whether tidal wetland restoration in the south Delta it will yield more benefit than harm for covered species. The answer to this question will depend both upon the success of tidal wetland restoration under BDCP in general, and also upon issues specific to the south Delta such as the rate of predation in tidal wetlands, the role of invasive species in local foodwebs, and water quality limitations in the area. Accordingly, BDCP will defer construction of any tidal wetland restoration sites in the south Delta until studies of such sites in the north and west Delta, combined with results from ongoing monitoring and research in the south Delta, can demonstrate a high confidence that south Delta tidal wetland restoration will in fact yield benefits to BDCP covered species. The adaptive management process for reaching this decision, described in Section 3.6.4.7.4, *Tidal Wetland Restoration Focus Area,* involves an in-depth formal review including BDCP stakeholders and independent scientific review, to be performed after approximately 20 years of Plan implementation, at which time a decision will be made regarding the appropriate scope and geographic focus of tidal wetland restoration in the south Delta.

Section 6.3.5.2 describes a *Twenty-Five Year Climate Change Review* to be performed after 25 years of Plan implementation. At that time an assessment will be developed to determine whether the timing and magnitude of observed environmental and ecosystem changes attributable to climate change have been consistent with Plan expectations. Review results will be used to formulate appropriate adaptive management responses.

3.6.4 Monitoring and Research

Monitoring and research are critical elements of adaptive management, providing the data and analysis structure needed for informed decision making. Monitoring and research actions will be conducted primarily to meet the following objectives.

- To resolve or reduce known uncertainty in the conceptual models underlying the biological objectives and the conservation measures (primarily by research).
- To assess the effectiveness of the methods being used to implement the conservation measures and to monitor their progress (by both monitoring and research).
- To measure and track performance relative to the BDCP biological objectives (primarily by monitoring).
- To track status and trend of covered species occurring within units of the reserve system (primarily by monitoring).
- To demonstrate compliance with the terms of the incidental take permits authorizing BDCP (primarily by monitoring).
- To demonstrate compliance with the terms of other permits and authorizations needed to implement BDCP (by monitoring as described in the *Mitigation and Monitoring Reporting Plan* [California Department of Water Resources 2015]).

The Adaptive Management Team, with support of the Implementation Office, will have primary responsibility for the overall development, management, and oversight of the biological monitoring and research program. The monitoring and research program will be coordinated with the comprehensive monitoring framework and other elements of the Delta Science Plan to the extent appropriate, while still ensuring that BDCP regulatory requirements are met. While this section provides a framework to guide initial implementation of the monitoring and research program, the Adaptive Management Team will reexamine elements of the program over the course of Plan implementation and revise approaches, as appropriate, to ensure the program is conducted to effectively and efficiently support adaptive decision making. The Science Manager, guided by the Adaptive Management Team, will coordinate such efforts with the Authorized Entity Group, Permit Oversight Group, Stakeholder Council, IEP coordinators, the Management Analysis and Synthesis Team, and Delta Science Program and, as necessary, the Delta Independent Science Board, with additional coordination as needed to ensure consistency of reporting and to minimize duplication of effort with other regional monitoring programs.

The following subsections describe the structure of the monitoring and research program within the implementation office. See also section 3.6.5 *Data Management*.

3.6.4.1 Communications

The Implementation Office will make monitoring data and reports available to partners and to the general public via several types of communications as described below. These data and documents will be maintained in the BDCP library. The library will include documents and data prepared for BDCP including the monitoring protocols, monitoring framework plans, and Reserve Unit Management Plans described in this chapter. The library will also include documents and data from other sources used in BDCP implementation. The library will have a physical location, but will primarily consist of electronic media accessible to authorized users via an online interface.

3.6.4.2 Annual Effectiveness Monitoring and Research Plan

[unchanged text omitted]

3.6.4.3 Focus Areas

The monitoring and research programs will include nine focus areas. These focus areas have been defined to partition distinct monitoring actions either geographically or by unique topic area. The focus areas are briefly described below; see Section 3.6.4.4, Partnerships for further detail on the partners mentioned in the descriptions. Section 3.6.4.7, *Effectiveness Monitoring* describes for each focus area the biological goals and objectives addressed by the focus area and the monitoring actions proposed for implementation within that focus area. The focus areas somewhat overlap; many monitoring and research actions will provide data and analysis useful to one or more focus areas. The resulting sharing of information between the focus areas is summarized in Figure 3.6-2.

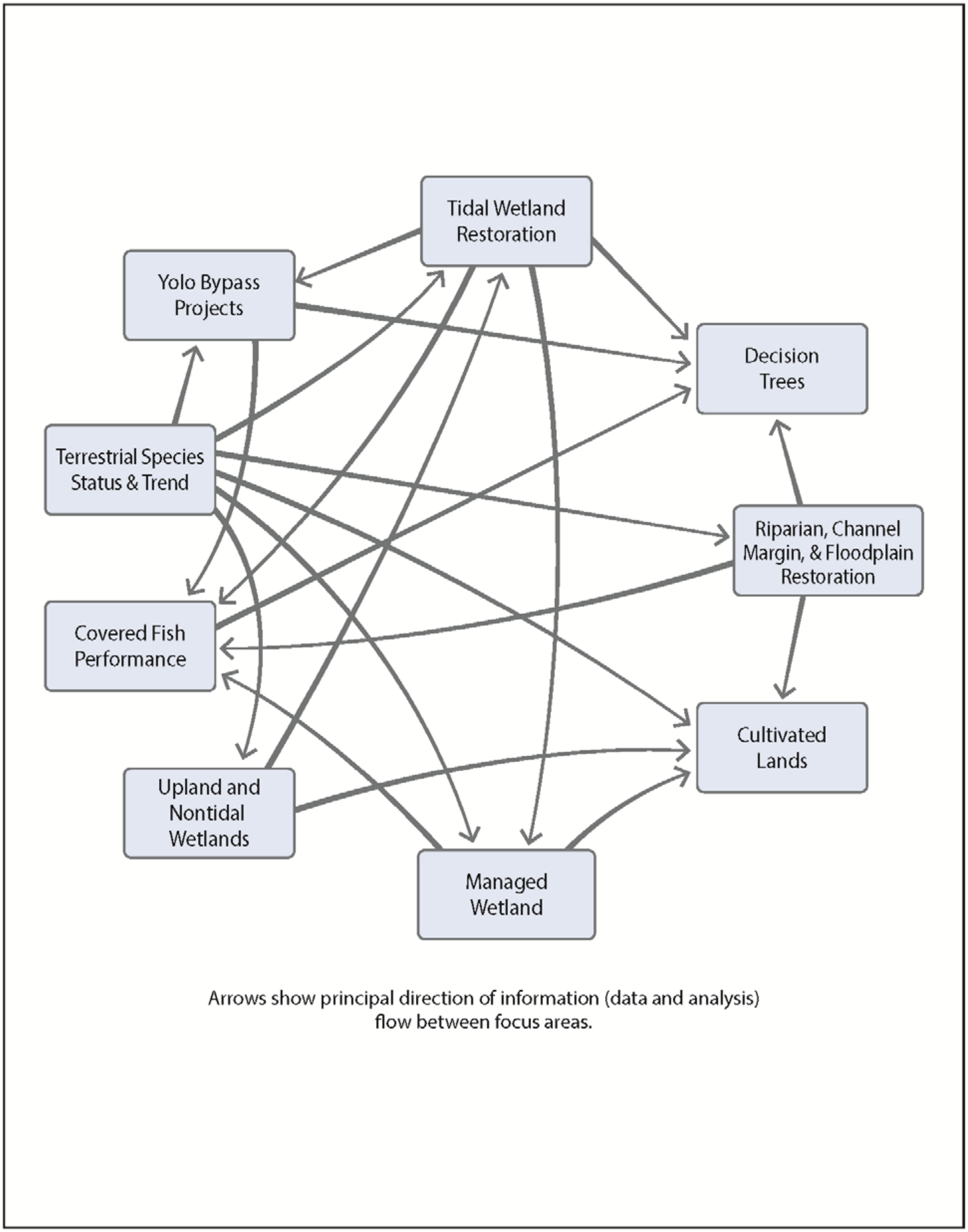

Figure 3.6-2
Relationships Between the Focus Areas

- *Decision Trees:* This focus area includes all monitoring and research needed to resolve which branch of the Decision Trees is chosen for initial operations (see Section 3.4.1.4.4, *Decision Trees* for a description of the Decision Trees). Potential partners for monitoring and research in this focus area include the IEP, Delta Science Program, Ecosystem Restoration Program, Central Valley Water Board, Sacramento Stormwater Quality Partnership, State Water Contractors, USGS, San Francisco Estuary Institute, Central Valley Joint Venture, CDFW Bay-Delta Office, Ecological Species Recovery Program, and UC Davis Research Programs. Unlike the other focus areas, the Decision Trees focus area has a deadline, terminating when the new north Delta diversions become operational.

- *Covered Fish Performance:* This focus area includes effectiveness monitoring and research studies examining Plan progress toward fulfilling the biological goals and objectives for covered fish species. Potential partners for monitoring and research in this focus area include the IEP, Delta Science Program, Ecosystem Restoration Program, Central Valley Water Board, State Water Contractors, USGS, San Francisco Estuary Institute, CDFW Bay-Delta Office, and UC Davis Research Programs. This focus area has broad application in the conservation strategy, addressing implementation of conservation measures CM1, CM2, CM4, CM5, CM6, CM8, and CM13 through CM21.

- *Yolo Bypass:* This focus area includes monitoring and research for all BDCP actions associated with the Yolo Bypass. Many of these monitoring actions and research studies will be performed in collaboration with partners having a focal interest in the Yolo Bypass, including the IEP, Delta Science Program, Ecosystem Restoration Program, Central Valley Water Board, Sacramento Stormwater Quality Partnership, State Water Contractors, USGS, Central Valley Joint Venture, CDFW Bay-Delta Office, and UC Davis Research Programs. This focus area primarily addresses implementation of conservation measures CM2 and CM11.

- *Tidal Wetland Restoration:* This focus area includes effectiveness monitoring and research actions examining the consequences of tidal wetland restoration. Many of these monitoring actions and research studies will be performed at the scale of an individual restoration site, but others will have a regional focus. Potential partners for monitoring and research in this focus area include the IEP, Delta Science Program, Ecosystem Restoration Program, Central Valley Water Board, Sacramento Stormwater Quality Partnership, State Water Contractors, USGS, San Francisco Estuary Institute, Central Valley Joint Venture, CDFW Bay-Delta Office, Ecological Species Recovery Program, and UC Davis Research Programs. This focus area primarily addresses implementation of CM4 and CM12.

- *Riparian, Channel Margin & Floodplain Restoration:* This focus area includes effectiveness monitoring and research studies examining floodplain, channel margin, and riparian restoration projects intended to benefit both terrestrial and fish covered species. Potential partners for monitoring and research in this focus area include the IEP, Delta Science Program, Ecosystem Restoration Program, USGS, Central Valley Joint Venture, CDFW Bay-Delta Office, Ecological Species Recovery Program, California Native Plant Society, and Audubon Tri-colored Blackbird Working Group. This focus area addresses implementation of conservation measures CM5, CM6, CM7, and CM11.

- *Managed Wetlands:* This focus area includes effectiveness monitoring and research studies examining managed wetlands management and restoration for terrestrial covered species, waterfowl and shorebirds. Potential partners for monitoring and research in this focus area include the IEP, Delta Science Program, Ecosystem Restoration Program, Central Valley Water Board, Sacramento Stormwater Quality Partnership, State Water Contractors, USGS, San Francisco Estuary Institute, Central Valley Joint Venture, CDFW Bay-Delta Office, Ecological Species Recovery Program, and UC Davis Research Programs. This focus area addresses implementation of CM10.

- *Upland and Nontidal Wetlands:* This focus area includes effectiveness monitoring and research studies examining restoration and management of grassland, vernal pool, alkali seasonal wetland, and related natural community management for terrestrial covered species. Potential partners for monitoring and research in this focus area include the USGS, San Francisco Estuary Institute, Central Valley Joint Venture, CDFW Bay-Delta Office, Ecological Species Recovery Program, California Native Plant Society, and Audubon Tri-colored Blackbird Working Group. This focus area addresses implementation of conservation measures CM8, CM9, and CM11.

- *Cultivated Lands:* This focus area includes effectiveness monitoring and research studies examining cultivated lands management for terrestrial covered species. Potential partners for monitoring and research in this focus area include the Central Valley Water Board, State Water Contractors, USGS, San Francisco Estuary Institute, Central Valley Joint Venture, CDFW Bay-Delta Office, Ecological Species Recovery Program, California Native Plant Society, and Audubon Tri-colored Blackbird Working Group. A principal stakeholder will be landowners that have sold conservation easements to be incorporated into the reserve system. This focus area addresses implementation of CM3 and CM11.
- *Terrestrial Species Status & Trend:* This focus area includes monitoring to track populations of terrestrial species within the conservation reserve system (CM3), and their use of those reserves. Potential partners for monitoring and research in this focus area include the USGS, Central Valley Joint Venture, CDFW Bay-Delta Office, Ecological Species Recovery Program, California Native Plant Society, and Audubon Tri-colored Blackbird Working Group. Species status and trend monitoring is not prescribed by any Plan biological goals and objectives; rather, it tracks the extent and manner in which covered terrestrial species use reserve system lands. It also addresses the effectiveness of the restoration conservation measures, CM4 through CM11, for the applicable covered species.

Each monitoring and research focus area will be guided by a focus area framework plan. Section 3.6.4.7, *Effectiveness Monitoring* summarizes the framework for each focus area; complete framework plans will be developed during Plan implementation and subject to periodic updates and revisions through the adaptive management procedures described earlier (Section 3.6.3). The following prescribes the content requirements for focus area plans.

- Identify monitoring and research needs to be addressed by the focus area.
- Identify relationships with other focus areas (an example appears in Figure 3.6-2).
- Ensure that the framework plan addresses all biological goals and objectives and related monitoring requirements in this chapter that are pertinent to the focus area. “Related monitoring requirements” may include actions prescribed under existing biological opinions, terrestrial species status and trend monitoring needs, compliance monitoring needs, or monitoring commitments pursuant to agreements with monitoring partners. Provide a table showing which conservation measures, biological goals and objectives, other regulatory requirements, and monitoring techniques are addressed by the framework plan. Table 3.6-4 (Section 3.6.4.7.2; focus areas and BGOS) provides the basis for fulfilling this requirement.
- Discuss how the proposed suite of monitoring actions will enable evaluating the needs of the framework plan (primarily, tracking progress toward the biological goals and objectives) with the least practicable level of effort.
- Identify relevant modeling needs. These could include conceptual response models, existing numerical models, or models that may have to be developed to achieve the intended purposes of the framework plan.
- Identify approaches to site- and regional-scale monitoring and research appropriate to the focus area, and describe the roles of any partners to these actions.
- Provide guidance on monitoring techniques, protocols, etc., including specification of the technique, when it must be applied, what to use as a standard for comparison (e.g., reference sites, before-and-after comparisons, etc.), monitoring frequency, and other information needed to develop level of effort and procedural guidance. Recognizing that monitoring techniques change over time in response to improved technology and understanding, this guidance will focus on the *function* of the monitoring and the *uses* of the data, not on the details of how data

will be acquired. Detailed monitoring protocols will appear in plans developed for individual monitoring or research actions.

- Prioritize and sequence the proposed monitoring and research actions. Describe rationale for prioritization and sequencing.
- Identify relevant monitoring partners and show how their data collection, storage or processing will be integrated with the BDCP adaptive management and monitoring program. Representatives of each potential partner should be contacted to execute any agreements needed to formalize these relationships.

3.6.4.4 Partnerships

As discussed in other parts of the Plan, extensive research and monitoring has occurred in the Delta for years and is ongoing. To build on that work, adaptive management and monitoring under the BDCP will be a collaborative process. Collaborative partnerships with existing agencies and scientific organizations that already conduct research and monitoring in the Delta relevant to BDCP will serve several purposes.

- Ensuring that BDCP protocols, quality assurance procedures, and data structures for the collection and storage of monitoring information are compatible with those used by other agencies and scientific organizations in the Delta region.
- Facilitating storage, sharing, and analysis of information collected by agencies and scientific organizations.
- Development of complementary monitoring and research programs that will avoid redundancy.
- Facilitating peer review of BDCP research proposals, monitoring protocols, reports, and other scientific documents relevant to monitoring and adaptive management procedures.
- Where appropriate, facilitating the joint collection and analysis of monitoring and research data by BDCP and its partners to create efficiencies and cost savings.

A variety of partnerships are expected to be formed by BDCP to address specific monitoring and research tasks (Table 3.6-2). Chief among these are partnerships with those involved in preparation and implementation of the Delta Science Plan. Partnerships could be formed with any scientific group engaged in monitoring or studying biological resources in the Plan Area, including natural resource agencies, non-governmental organizations such as land trusts, mitigation banks, academic or research institutions, and others.

The Adaptive Management Team will need to rely on a variety of information sources derived from existing monitoring and research efforts in the Delta. The Adaptive Management Team will coordinate its activities with implementation of the Delta Science Plan, the Delta Science Program, the IEP, and other partners as appropriate. The Adaptive Management Team will use data collected through these programs, as appropriate, to support evaluation of the effectiveness of the conservation strategy in achieving the Plan's biological goals and objectives. Furthermore, the Implementation Office may fund partners to conduct monitoring tasks on its behalf, or may engage in cost-sharing agreements with partners.

Several organizations and agencies monitor species and ecosystem conditions that are relevant to the BDCP implementation. A selection of these organizations are described below.

1 **Table 3.6-2. Potential Partners for the Monitoring and Adaptive Management Program**

	Focus Area[2]									Partnering Category[1]							
Group & Members	Decision Trees	Fish Performance	Yolo Bypass	Tidal Restoration	Riparian/Floodplain	Managed wetland	Upland/Nontidal	Cultivated lands	Status & Trend	Ecosystem Monitoring	Species Monitoring	Research	Data sharing	Method review	Tech. assistance	Collaborator	**Types of Information**
Interagency Ecological Program (IEP) DWR, CDFW, BOR, USGS, USFWS, DWR, ACOE, SWRCB, NMFS	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓			✓	Stakeholder Feedback, continuous water quality monitoring, biological baseline, interagency review, compliance monitoring
Delta Science Program Delta Stewardship Council board of independent scientific review	✓	✓	✓	✓	✓	✓				✓					✓	✓	Independent scientific review (e.g., of monitoring plans, reports)
Ecosystem Restoration Program CDFW, NMFS, USFS	✓	✓	✓	✓	✓	✓				✓						✓	Grant program targeted to fish passage, species assessment, ecological processes, water quality, and habitat restoration
Central Valley Water Board	✓	✓	✓	✓		✓		✓		✓			✓			✓	Water quality
Sacramento Stormwater Quality Partnership Cities and County of greater Sacramento region	✓		✓	✓		✓							✓			✓	Community involvement, landowner access
State Water Contractors	✓	✓	✓	✓		✓		✓					✓			✓	Water quality, research on restoration, aquatic resources and fish
U.S. Geological Survey (USGS; multiple programs)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Giant garter snake monitoring, water quality
San Francisco Estuary Institute	✓	✓		✓		✓	✓	✓		✓		✓	✓	✓	✓	✓	Birds, Bay-wide modeling, aquatic resource inventory, contaminants, wetland & riparian, wetlands. Networking portal for monitoring
Central Valley Joint Venture	✓		✓	✓	✓	✓	✓	✓	✓	✓			✓			✓	Ongoing monitoring tracks other monitoring technical conservation committees
California Department of Fish and Wildlife (CDFW) Bay-Delta Office	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			Ongoing monitoring, technical expertise, sensitive species, invasives
Ecological Species Recovery Program California State University Stanislaus				✓	✓	✓	✓	✓	✓	✓		✓	✓				Listed terrestrial species
UC Davis Research Programs	✓	✓	✓	✓		✓				✓	✓	✓	✓	✓	✓	✓	Fish community and abundance
California Native Plant Society					✓	✓	✓	✓	✓		✓		✓		✓		Plants, invasives, technical advisory group, methods advice & review
Audubon Tri-colored Blackbird Working Group Collaborates with Farmers, Agricultural Associations, Resource Agencies					✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		Bird monitoring

Notes

[1] Partnering category: BDCP would work with the partner primarily on these types of collaborative activity.

[2] Focus area: See section 3.6.4.4 for a description of each of the monitoring and research program focus areas.

3.6.4.4.1 Interagency Ecological Program

The IEP brings state and federal natural resource and regulatory agencies together to monitor and study ecological changes and processes in the Delta. The IEP consists of ten member entities: three state agencies (DWR, CDFW, and the State Water Resources Control Board), six federal agencies (USFWS, Reclamation, USGS, USACE, NMFS, and EPA), and one *ex officio* member (currently, the San Francisco Estuary Institute). These program partners work together to develop a better understanding of the estuary's ecology and the effects of the SWP/CVP operations on the physical, chemical, and biological conditions of the estuary.

The IEP has coordinated Delta monitoring and research activities conducted by state and federal agencies and other science partners for over 40 years (Table 3.6-3). IEP monitoring activities are generally carried out in compliance with water rights decisions and ESA/CESA permit and/or BiOp conditions. Most of the monitoring under the IEP focuses on open-water areas and the major Delta waterways conveying water to the SWP/CVP facilities in the south Delta and downstream, including the entire Bay-Delta area. The IEP produces publicly accessible data that include fish status and trends, water quality, estuarine hydrodynamics, and foodweb monitoring. Until recently, the IEP maintained and hosted the Bay Delta and Tributaries System or the HEC-DSS Time-Series Data System. These systems have been archived. Currently, DWR and IEP are working toward the migration to a standardized and modernized data system. This will make the data more easily accessible. Because of the history, size, and scope of this program's monitoring and research efforts in the Delta, it is expected to be a key partner in the implementation of BDCP's adaptive management and monitoring program.

3.6.4.4.2 Delta Science Program

Research actions are also supported through the Delta Science Program, whose mission is to provide the best possible unbiased scientific information to inform water and environmental decision making in the Delta region. The Delta Science Program's objectives are listed below.

- Initiate, evaluate and fund research that will fill critical gaps in the understanding of the current and changing Delta system.
- Facilitate analysis and synthesis of scientific information across disciplines.
- Promote and provide independent, scientific peer review of processes, plans, programs, and products.
- Coordinate with agencies to promote science-based adaptive management.
- Interpret and communicate scientific information to policy- and decision-makers, scientists, and the public.
- Foster activities that build the community of Delta science.

The Delta Science Program has particular expertise and experience organizing and facilitating independent scientific reviews. It also has primary responsibility for developing and implementing the Delta Science Plan (see Section 3.6.2.4, *Integration with the Delta Science Plan*, for details). The Delta Science Program is expected to support BDCP in the review of monitoring and research methods and results, and to provide technical support to the adaptive management process.

Table 3.6-3. Delta Fish Monitoring Programs Coordinated through the Interagency Ecological Program that are Relevant to the BDCP

[unchanged table text omitted]

3.6.4.4.3 Ecosystem Restoration Program

The Ecosystem Restoration Program (ERP) is a multi-agency effort aimed at improving and increasing aquatic and terrestrial habitats and ecological function in the Delta and its tributaries.

Principal participants overseeing the ERP are CDFW, USFWS, and NMFS. The ERP has supported and continues to support research actions, restoration projects, and other relevant activities in the Delta, and could partner with BDCP in research and monitoring relevant to many BDCP conservation measures.

3.6.4.4.4 Central Valley Water Board

The Central Valley Water Board administers a regional monitoring program intended to coordinate Delta water quality monitoring in compliance with Clean Water Act permit conditions (Central Valley Regional Water Quality Control Board 2012).

3.6.4.4.5 Central Valley Joint Venture

The Central Valley Joint Venture sets regional population targets for waterfowl and shorebirds and conducts research and monitoring in wetlands and cultivated lands, tracks other regional monitoring, and supports technical conservation committees. The Joint Ventures includes 21 State and Federal agencies, private conservation organizations and one corporation. They may act as a partner in BDCP monitoring of managed wetlands.

3.6.4.4.6 California Department of Fish and Wildlife Bay-Delta Office

The CDFW Bay-Delta Office engages in a variety of research and sampling programs that are primarily focused on Delta fishes, and are performed in association with the Interagency Ecological Program.

3.6.4.4.7 Endangered Species Recovery Program at CSU Stanislaus

CSU Stanislaus conducts a monitoring program focused on mammals, including riparian brush rabbit, riparian woodrat, and San Joaquin kit fox, all of which are BDCP covered species. CSU Stanislaus could serve as a partner in the monitoring design and implementation for these species.

3.6.4.4.8 U.S. Geological Survey

Several USGS programs represent potential partnerships. The USGS Giant Garter Snake Project monitors habitat and populations of giant garter snake, a BDCP covered species, and is a potential partner in monitoring actions addressing this species, The National Water-Quality Assessment (NAWQA) Program monitors streams, rivers, ground water, and aquatic systems in relation to water quality. The Delta Flows Network provides long-term flow data for 21 stations throughout the Delta and the network conducts three-dimensional (3D) modeling to predict system response to proposed physical and operational changes. The Delta Flows Network currently collaborates with other organizations including: DWR, SWRCB, CDFW, Reclamation, and USFWS. Both the NAWQA Program and the Delta Flows Network collect data and perform analyses relevant to studies performed under the Decision Trees (CM1), tidal natural community restoration (CM4), and possibly other conservation measures.

3.6.4.4.9 California Native Plant Society

The California Native Plant Society provides recommendations for standardized survey and conservation methods (e.g., seed collecting, banking, etc.). The Rare Plant Program develops current, accurate information on the distribution, ecology, and conservation status of California's rare and endangered plants. The California Native Plant Society also designs and implements monitoring programs for natural communities around the state. All BDCP covered plant species are listed by CNPS. Therefore, they are a potential partner to monitoring and research efforts affecting these species.

3.6.4.4.10 Audubon's Tricolored Blackbird Working Group

The Tricolored Blackbird Working Group, coordinated by the Sacramento chapter of the National Audubon Society, works with stakeholders to implement habitat conservation projects, monitoring, and research programs; affecting tricolored blackbird, a BDCP covered species. They are a stakeholder and potential partner in monitoring restoration actions to benefit the tricolored blackbird, as well as species status and trends in BDCP reserves and the Plan Area as a whole.

3.6.4.4.11 Yolo Basin Foundation

The Yolo Basin Foundation in partnership with CDFW, focuses on stewardship of Yolo Basin wetlands and wildlife at the Yolo Bypass Wildlife Area. Their programs involve education and collaboration with farmers, private wetland managers, conservation organizations and wildlife and water quality agencies. They are a stakeholder and potential partner in various aspects of CM2, including monitoring and research in the Yolo Bypass.

3.6.4.4.12 Sacramento Stormwater Quality Partnership

The Sacramento Stormwater Quality Partnership is a multi-jurisdictional program made of Sacramento County and the incorporated cities of Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova to ensure water quality and quantity for cities. The Partnership may be a stakeholder and monitoring or research partner in CM19 implementation.

3.6.4.4.13 San Francisco Estuary Institute

SFEI has long standing regional research and monitoring programs and data portals to other monitoring programs. They conduct bird monitoring, Bay-wide modeling, aquatic resource inventory mapping, wetland and riparian technical advising, wetlands monitoring and data portal, network portal for others monitoring, and contamination. SFEI is a potential monitoring and research partner for BDCP related restoration in Suisun Marsh in particular.

3.6.4.4.14 UC Davis Research Programs

Multiple Departments at UC Davis, as well as the Center for Watershed Sciences, conduct ongoing research within the Delta, such as fish community and abundance monitoring. UC Davis is a potential partner for a variety of monitoring and research actions concerned with BDCP effects on the aquatic environment.

3.6.4.4.15 State and Federal Contractors Water Agency

The State and Federal Contractors Water Agency funds projects that fundamentally advance the understanding of the complex environments/systems within the Sacramento-San Joaquin Delta. The agency has 3 main program areas for addressing Delta issues: Science Research and Review, Delta Governance and Ecosystem Restoration. The State and Federal Contractors Water Agency is actively involved in tidal natural community restoration in the Delta, including in Suisun Marsh (Tule Red), Cache Slough (Lower Yolo Ranch), and the Cosumnes-Mokelumne area (McCormick-Williams Tract) (see Chapter 6 for details). As a result, they are a potential collaborator in the implementation, monitoring, and research associated with CM4 and possibly other conservation measures.

3.6.4.5 Approach for Monitoring and Research

[unchanged text omitted]

3.6.4.5.1 Indicators

[unchanged text omitted]

- They are technically feasible, easily understood, and cost-effective to measure by all personnel involved in the monitoring.

Indicators are defined for each of the monitoring actions described in Section 3.6.4.7, *Effectiveness Monitoring*. For most monitoring actions, the choice of indicators is prescribed by the terms of the biological objectives addressed by the monitoring action. For other monitoring actions, further work will be needed to define the appropriate indicators.

3.6.4.5.2 Statistical and Sampling Design

Statistical and sampling design will vary with the goals and purposes of sampling or monitoring. Sampling design seeks to minimize extraneous variance in the measured values of indicators or variables. Selection of variables will be guided by a thorough knowledge of the ecological relationships that drive natural communities. Sampling intensity and probability of detection will be considered to ensure that all covered species are adequately inventoried and monitored. Methods of data analysis will be established prior to sampling design, and a statistician or biologist with sufficient statistical expertise will be consulted. Sampling designs, including methods of data analysis, will be subject to independent scientific review to ensure that statistical and sampling design of research and monitoring actions are appropriate and reliable. Some of the issues to consider in sampling design are listed below (Scheiner and Gurevitch 1993).

[unchanged text omitted]

3.6.4.5.3 Reference Standards

Both monitoring and research actions under BDCP will conform to the scientific principle that any investigation presents both null and alternative hypotheses, where the null hypothesis states that an action has no effect and the alternative hypotheses state expected effects of the action. In order to discriminate between these outcomes, a monitoring or research action requires a reference standard to which an outcome can be compared in order to determine whether an effect has occurred. If an effect occurs, that effect should be described in quantitative terms associated with measures of statistical significance. In general, reference standards are of four types: reference sites, BACI (before/after and control/impact designs), or models. Many conservation measures will use more than one reference standard. Each of the reference standards is discussed below.

Reference Sites

Reference sites are commonly used when restoration is the goal. In this case a site or group of sites are selected that represent the desired endpoint of a restoration effort. Thus, reference sites would often be used to help monitor the development and condition of habitat creation and enhancement sites in the BDCP reserve system. Monitoring would be used to compare conditions at the restoration site to conditions at the reference sites, and over time, conditions at the restoration site are expected to approach those at the reference sites.

Reference sites are commonly used in restoration, but the technique has limitations. It is usually only applicable to site-based actions and thus does not provide information about ecosystem changes at larger spatial scales. Conditions at the reference sites may change over time, making the reference site into a “moving target.” This can complicate determining whether the restoration sites are developing as expected. Perhaps most importantly, if the restoration site does not develop like the reference site, it can be difficult to determine why this is the case, or to show that the different development trajectories are or are not desirable in the context of overall restoration goals. Finally, the Delta reflects a highly altered ecosystem with a limited number of reference sites that provide long-term information on historical conditions. For some restoration sites, a suitable reference site may not exist; for instance, this will be a common condition in tidal wetland restoration. For other sites, such as degraded vernal pool complex, very suitable reference sites may be available. At some sites, such as channel margin enhancement sites, the goal of restoration is to create an engineered system that provides certain specific ecosystem functions; for such sites, reference sites may be neither available nor appropriate for measuring progress toward the desired functions.

Before/After and Control/Impact Studies

In both before/after and control/impact studies (also called BACI studies), treatments are used in an experimental design. Conditions are held constant, as far as practicable, for two (or more) experimental treatments; one treatment represents a baseline condition and the others represent controlled departure from the baseline, for instance by using a different grading design on a restoration site. Replications are used to develop a population of cases that can be used for statistical inference. BACI design approaches are commonly used to assess ecosystem change (Green 1979; Underwood 1992, 1994). This approach is typically presented as a means for testing if an effect on the system has occurred as a result of an action that has been taken. The study design may also be used to evaluate conservation and restoration projects (Michener 1997; Lincoln-Smith et al. 2006) and test whether conditions are changing. This type of monitoring approach is commonly used in restoration ecology, particularly where numerous natural and anthropogenic disturbances represent unplanned, uncontrollable events that cannot be replicated or studied using traditional experimental approaches and statistical analyses.

Control/impact studies have the advantage that they can be designed to follow a rigorous experimental design allowing clear and quantitative distinctions between alternatives. For this reason they are very commonly used in laboratory studies or field studies at spatial scales that allow creation of multiple replicates. Both types of studies are identified in the BDCP research programs (Section 3.6.4.8, *Research*), but constitute a minority of the research actions proposed. This is because control/impact studies tend to become impractical with increasing spatial or temporal scale. For instance, it may not be feasible to create replicates for a 100 acre tidal restoration site, or it may not be feasible to wait for results of a test that requires many years to complete. Also, it may be impractical to perform restoration on a control site when it is reasonable to expect that the treatment site would yield better results for a comparable cost. In such cases the use of alternative reference standards (reference sites, before/after studies, or modeling) may yield acceptable results more quickly, enabling rapid application of knowledge on other sites.

Before/after studies will likely be used to evaluate progress at many restoration sites as well as for most of the "other stressors" conservation measures (CM13 to CM21). For instance, before/after studies are appropriate for measuring changes in the extent of invasive aquatic vegetation controlled under CM13 or for measuring changes in the number of poaching enforcement actions taken under CM17.

Input/output comparisons constitute a specialized type of before/after study that is suitable for linear flow features such as the Yolo Bypass. In this technique, aquatic parameters are measured at the upper and lower ends of the restoration reach, to infer restoration effects on the aquatic system.

Baseline Conditions in Before-and-After Experimental Design

Baseline and monitoring survey results will be used as the basis for BACI designs intended to evaluate program effectiveness. In some cases, baseline monitoring may involve monitoring at reference (control) sites inside or outside the Plan Area. Surveys to establish baseline conditions are used to compare biological and physical conditions before and after implementation of actions and to evaluate the effectiveness of those actions. The Adaptive Management Team will ensure that a sufficiently robust baseline monitoring program is established to measure the condition of the ecosystem at the time prior to the implementation of an action against which change can be compared. This will entail both assessing existing databases and determining what new measurements will be useful prior to the implementation of a conservation measure. A number of these surveys were needed in order to develop the Plan and have already been completed, but more local-scale surveys, and surveys conducted closer in time to the action, are likely to be needed in association with individual actions (e.g., restoration projects or predatory fish control plans).

Baseline surveys will be performed prior to implementation of actions with sufficient lead time to allow future detection of changes in trajectories for the expected outcomes after implementation.

As described in Section 3.6.4.3, *Partnerships*, a substantial number of monitoring programs currently exist in the Delta and surrounding area, and some current and historical data can be used to aid in establishing baseline conditions. Depending on the conservation measure being implemented, documenting baseline conditions may include the following types of tasks.

- Inventory and document resources and improve mapping.
- Conduct sampling to verify or better understand spatial/temporal variation in physical variables such as water quality and flow parameters, and in habitat use by terrestrial or aquatic organisms.
- Research and document historical data and trends, as appropriate.
- Use aerial photos and ground surveys, as needed, to assess quality and location of local and regional landscape linkages between unprotected natural areas and adjacent, existing conservation lands.

Model-Based Studies

Models of many kinds have been used to develop the BDCP conservation strategy and to evaluate its likely effects on covered species and natural communities; see Section 5.2. Methods for a detailed discussion of these models and their application. For some elements of the conservation strategy, most notably the flow management aspects of CM1, there is no practical alternative to using models to evaluate alternative outcomes. This process has been implemented extensively in developing BDCP, using CALSIM and related models (described in Section 5.2) to develop the flow constraints identified in CM1 and to determine their likely effects on covered species. As in CM1, BDCP will use model-based studies when alternative approaches are not feasible, but will also use monitoring data to test model outcomes and refine the models accordingly. Models may also be used in an exploratory mode, to select alternatives that are best suited to rigorous testing using BACI studies or to generate predictions that are testable using data collection methods.

3.6.4.5.4 Protocols

When available and appropriate, existing and accepted monitoring protocols will be adopted to help facilitate data integration with other studies. In cases where standardized protocols are not yet available, protocols will be developed with reference to relevant guidance, such as the National Park Service's Inventory and Monitoring Program guidelines for monitoring protocols (Oakley et al. 2003) or the Bureau of Land Management's monitoring guidelines for plants (Elzinga et al. 1998). Proposed protocols will be subject to review and approval by the fish and wildlife agencies, and will be identified in relevant monitoring focus area framework plans. Designated monitoring protocols will be appropriate to the task, implemented precisely, and as cost-effective as possible. The BDCP will cooperate with relevant partners in efforts to standardize monitoring protocols for consistency with protocols used in neighboring and regional HCPs, NCCPs, and other conservation and environmental monitoring programs. Ongoing training by the Implementation Office or its contractors will ensure consistent protocol implementation.

3.6.4.6 Compliance Monitoring

Monitoring that tracks compliance with BDCP biological objectives is classed as effectiveness monitoring (Section 3.6.4.7) because it assesses the effectiveness of the BDCP conservation strategy. Consequently, compliance monitoring consists only of actions that do not assess progress toward the biological objectives, but which are required pursuant to the terms and conditions of the BDCP and its associated permits. .

Compliance monitoring will also be required in association with other permits and authorizations associated with BDCP covered activities (e.g., permits issued by the State Water Board or by the

USACE). This type of compliance monitoring is described in the Mitigation and Monitoring Reporting Plan [DWR 2015]), and is not further discussed in this document.

As noted in Chapter 7, Section 7.1.1.3, *Implementation Office: Function, Establishment, and Organization*, fulfillment of compliance monitoring and reporting requirements, including the preparation of the Annual Progress Report, is solely the responsibility of the Implementation Office, and thus is not a responsibility of the Adaptive Management Team. Compliance monitoring activities will be conducted in accordance with guidance provided by the Adaptive Management Team. Compliance monitoring will be conducted for all conservation measures, whether implemented directly by the Implementation Office or by other supporting entities through contracts, memoranda of agreement, or other agreements with the Implementation Office.

The Implementation Office will track and ensure compliance monitoring is conducted in accordance with provisions of the BDCP and its associated regulatory authorizations, and will provide results to the fish and wildlife agencies as part of the Annual Progress Report. Compliance monitoring will comprise two main categories.

- **Construction monitoring**. Construction monitoring will be used to ensure that constructed features and structures, as well as the avoidance and minimization measures associated with construction activities, are implemented in a manner consistent with the BDCP.
- **Terms and Conditions compliance monitoring**. The Implementation Office will gather the necessary information and prepare annual reports that are sufficient to demonstrate compliance with the BDCP and its associated authorizations and to help facilitate interagency coordination. Annual progress reports will include a description and accounting of compliance with all terms and conditions stated in the BDCP incidental take permits. The compliance monitoring program will also allow for transparent, real-time operational decisions to ensure that biological performance measures are being met, consistent with the requirements of the Delta Reform Act (Water Code Section 85321). These activities are further described in Section 3.6.5, *Data Management and Reporting*, and in Chapter 6, Section 6.3, *Planning, Compliance, and Progress Reporting*.

3.6.4.6.1 Construction Monitoring

[unchanged text omitted]

3.6.4.6.2 Terms and Conditions Compliance Monitoring

Monitoring to demonstrate compliance with terms and conditions of the incidental take permits for BDCP will be conducted during the implementation phase and throughout the permit term. Annual Progress Reports will include a description and accounting of compliance monitoring results. The Implementation Office will be responsible for implementing compliance monitoring.

3.6.4.7 Effectiveness Monitoring

3.6.4.7.1 Principles of Effectiveness Monitoring

Effectiveness monitoring is undertaken to determine whether an action is effective. For BDCP, the effectiveness monitoring program is intended to assess the effectiveness of the conservation strategy, both overall by assessing progress towards achievement of the biological goals, and in detail by assessing effectiveness of each conservation measure and each biological objective.

Effectiveness monitoring may be used to directly measure whether a conservation measure achieves the expected biological objectives. If an objective is not being achieved, then additional study of relevant processes captured in the conceptual model underlying the conservation measure likely is needed. If an objective is being achieved, additional study may reveal more efficient approaches to achieving the same result.

Effectiveness monitoring can be used as part of a scientific investigation to evaluate processes described in conceptual models, because the conceptual model predicts that a given action will cause certain changes in the modeled system. If effectiveness monitoring verifies that this occurs, the outcome is consistent with a hypothesis that the conceptual model is accurate. If effectiveness monitoring does not verify the expected outcome, then either the conceptual model is flawed or the monitoring approach is flawed. Additional study may be needed to distinguish between various alternative explanations; the approach may entail a research action, as described below in Section 3.6.4.5, *Research*.

Assuming that effectiveness monitoring does not identify inconsistencies in conceptual models, it can be used to assess progress towards meeting biological goals and objectives. Each conservation measure is based on a conceptual ecological model of how the measure will affect some aspect of the Delta ecosystem. If the model is accurate, implementation of the measure will result in meeting the biological objectives that the measure has been designed to achieve. Effectiveness monitoring can be used to measure that progress and to assess whether the objectives are being achieved or progress is adequate. For this reason, effectiveness monitoring results are expected to weigh heavily in decisions about which conservation measures are sufficient as implemented and which should be modified via adaptive management to perform more effectively.

Thus, effectiveness monitoring can be used to evaluate the effectiveness of conservation measure implementation and to identify situations where a different implementation approach may yield preferable outcomes. Examples include using effectiveness monitoring results to answer questions such as "How can we modify nonphysical barriers to be easier to install and maintain?" or "How can the invasive species inspection program be modified to maximize the number of watercraft inspected?" or "Which channel margin enhancement projects have been most effective, and why?"

3.6.4.7.2 Implementing Effectiveness Monitoring

Effectiveness monitoring will be performed in perpetuity per the terms of the Plan under the guidance of the Adaptive Management Team, in coordination or collaboration with the Delta Science Program and other monitoring partners, as appropriate. Initial effectiveness monitoring actions are identified in the respective conservation measures (Section 3.4) and listed by conservation measure in Table 3.D-2 of Appendix 3.D, *Monitoring and Research Actions*. Metrics and protocols for effectiveness monitoring will be developed early in Plan implementation and periodically revised in response to factors such as improvements in scientific understanding, improved technology, and the needs of integrated regional monitoring programs. It is anticipated that the extent of effectiveness monitoring will be reduced over time as causal relationships between the conservation measures and the responses of covered species and natural communities are better understood. However, continued effectiveness monitoring will be required to continue to verify progress toward achieving biological goals and objectives that cannot be tracked with simple compliance monitoring, and the need for effectiveness monitoring will be periodically renewed as conceptual ecological models are improved and new techniques for implementation are tried via the adaptive management process.

Table 3.6-4 lists (by name; see Table 3.3-1 for the full text stating each biological objective) all of the biological objectives and shows which are addressed within each focus area. For biological objectives addressed by more than one focus area, appropriate monitoring actions will be developed and performed according to the relationships between focus areas shown in Figure 3.6-2.

Table 3.6-4. Biological Objectives Addressed by each of the Monitoring and Research Focus Areas.

	Focus Area								
Biological Objective Name[1]	Decision Trees	Covered Fish Performance	Yolo Bypass	Tidal Wetland Restoration	Riparian, Channel Margin & Floodplain Restoration	Managed Wetlands	Upland/Nontidal Restoration	Cultivated Lands	Status & Trend
Landscape-scale objectives:									
• L1.1			X	X	X	X	X	X	
• L1.2			X	X	X	X	X	X	
• L1.3				X		X		X	
• L1.4		X	X	X	X	X	X	X	
• L1.5				X	X			X	
• L1.6			X	X	X	X	X	X	
• L1.7, L1.8				X					
• L2.1, L2.2				X	X			X	
• L2.3					X				
• L2.4		X		X	X				
• L2.5		X	X	X	X				
• L2.6		X	X	X	X	X	X		
• L2.7				X					
• L2.8		X	X	X	X				
• L2.9		X	X	X	X				
• L2.10				X	X			X	
• L2.11				X	X			X	
• L2.12					X				
• L3.1			X	X	X	X	X	X	X
• L3.2		X	X	X	X				
• L3.3		X	X	X	X				
• L3.4		X	X	X	X				
• L4.1		X			X				
• L4.2		X	X		X				
• L4.3		X							
Tidal Perennial Aquatic natural community objectives:									
• TPANC1.1				X					
• TPANC2.1		X	X	X	X	X			
Tidal Brackish Emergent Wetland natural community objectives:									
• TBEWNC1.1			X	X					
• TBEWNC1.2				X					
• TBEWNC1.3			X	X					
• TBEWNC1.4				X					
• TBEWNC2.1				X					

Biological Objective Name[1]	Focus Area: Decision Trees	Covered Fish Performance	Yolo Bypass	Tidal Wetland Restoration	Riparian, Channel Margin & Floodplain Restoration	Managed Wetlands	Upland/Nontidal Restoration	Cultivated Lands	Status & Trend
Tidal Freshwater Emergent Wetland natural community objectives:									
• TFEWNC1.1			X	X					
• TFEWNC1.2			X	X					
• TFEWNC2.1			X	X					
• TFEWNC2.2				X					
Valley-Foothill Riparian natural community objectives:									
• VFRNC1.1					X				
• VFRNC1.2					X				
• VFRNC2.1					X				
• VFRNC2.2				X	X				
• VFRNC2.3				X	X				
• VFRNC2.4					X		X	X	
• VFRNC3.1					X				
Nontidal Freshwater Perennial Emergent Wetland and Nontidal Perennial Aquatic natural community objectives:									
• NFEW/NPANC1.1						X	X		
Alkali Seasonal Wetland Complex natural community objectives:									
• ASWNC1.1, ASWNC1.2, ASWNC2.1, ASWNC2.2, ASWNC2.3, ASWNC2.4							X		
Vernal Pool Complex natural community objectives:									
• VPNC1.1, VPNC1.2, VPNC1.3, VPNC1.4, VPNC2.1, VPNC2.2, VPNC2.3, VPNC2.4, VPNC2.5							X		
Managed Wetland natural community objectives:									
• MWNC1.1						X			
Grassland natural community objectives:									
• GNC1.1, GNC1.2, GNC1.3, GNC1.4, GNC2.1, GNC2.2, GNC2.3, GNC2.4, and GNC2.5							X		
Cultivated Lands natural community objectives:									
• CLNC1.1, CLNC1.2, and CLNC1.3								X	
Delta Smelt objectives:									
• DTSM1.1		X	X	X	X				
• DTSM1.2		X							
• DTSM1.3		X	X	X	X				
• DTSM2.1a, DTSM2.1b, and DTSM2.1c		X	X	X	X				
• DTSM3.1		X							
Longfin smelt objectives:									
• LFSM1.1		X	X	X	X				
• LFSM1.2		X		X					
• LFSM2.1		X	X						

	Focus Area								
Biological Objective Name[1]	Decision Trees	Covered Fish Performance	Yolo Bypass	Tidal Wetland Restoration	Riparian, Channel Margin & Floodplain Restoration	Managed Wetlands	Upland/Nontidal Restoration	Cultivated Lands	Status & Trend
Salmonid fishes objectives:									
• WRCS1.1, SRCS1.1, FRCS1.1, and STHD1.1		X	X	X	X				
• WRCS1.2, SRCS1.2, FRCS1.2, and STHD1.2		X	X	X					
• WRCS2.1, SRCS2.1, FRCS2.1, AND STHD2.1		X	X						
• WRCS1.3, WRCS3.1, SRCS1.3, SRCS3.1, FRCS1.3, FRCS3.1, STHD1.3, and STHD3.1		X							
• WRCS3.2, SRCS3.2, FRCS3.2, and STHD3.2		X							
Sacramento splittail, sturgeon, and lamprey objectives:									
• SAST1.1, GRST3.1, and WTST3.1		X	X	X	X				
• GRST1.1		X	X	X	X				
• GRST2.1, WTST2.1, PRL1.1, PRL1.2		X	X						
• WTST1.1		X	X	X	X				
Riparian brush rabbit objectives:									
• RBR1.1, RBR1.2, RBR1.3, RBR1.4, and RBR1.5					X		X		
• RBR1.6					X		X		
Riparian woodrat objectives:									
• RW1.1 and RW1.2					X		X		
Salt marsh harvest mouse objectives:									
• SMHM1.1				X		X			X
• SMHM1.2				X		X			X
California black rail objectives:									
• CBR1.1				X					
Greater sandhill crane objectives;									
• GSHC1.1, GSHC1.2, and GSHC1.5								X	
• GSHC1.3						X	X	X	
• GSHC1.4						X	X	X	
Swainson's hawk objectives:									
• SH1.1 and SH2.1					X		X	X	
• SH1.2, SH1.3, and SH2.2					X		X	X	
• SH1.4							X	X	
Tricolored blackbird objectives:									
• TRBL1.1						X	X	X	
• TRBL1.2 and TRBL1.3						X	X	X	
Western burrowing owl objectives:									
• WBO1.1							X	X	

Biological Objective Name[1]	Focus Area								
	Decision Trees	Covered Fish Performance	Yolo Bypass	Tidal Wetland Restoration	Riparian, Channel Margin & Floodplain Restoration	Managed Wetlands	Upland/Nontidal Restoration	Cultivated Lands	Status & Trend
Giant garter snake objectives:									
• GGS1.1			X	X		X	X	X	
• GGS1.2			X	X		X	X	X	
• GGS1.3			X	X		X	X	X	
• GGS1.4			X	X		X	X	X	
• GGS2.1, GGS2.2, and GGS2.4			X	X		X	X	X	
• GGS2.3			X	X		X	X	X	
• GGS3.1			X	X		X	X	X	
Valley elderberry longhorn beetle objectives:									
• VELB1.1 and VELB1.2					X				X
Vernal pool crustacean objectives:									
• VPC1.1							X		
Brittlescale, heartscale, and San Joaquin spearscale objectives:									
• BRIT/HART/SJSC1.1 and BRIT/HART/SJSC1.2							X		
Carquinez goldenbush objectives:									
• CGB1.1							X		
• CGB1.2							X		
Delta button celery objectives:									
• DBC1.1					X		X		X
Delta mudwort and Mason's lilaeopsis objectives:									
• DMW/ML1.1				X	X				
Delta tule pea and Suisun marsh aster objectives:									
• DTP/SMA1.1				X					
Slough thistle objectives:									
• ST1.1					X		X		X
Soft bird's-beak and Suisun thistle objectives:									
• SBB/SuT1.1, SBB/SuT1.2, SBB/SuT1.3, and SBB/SuT1.4				X					
Vernal pool plants objectives:									
• VPP1.1							X		
• VPP1.2							X		

Notes
[1] See Table 3.3-1 for full text statements of each biological objective.

3.6.4.7.3 Decision Trees Focus Area

Nearly all of the studies that will be used to resolve the Decision Trees constitute research performed to resolve key uncertainties in CM1. Accordingly, that work is detailed in the description of the BDCP Research Program, in Section 3.6.4.8.1, *Decision Trees Focus Area*.

3.6.4.7.4 Covered Fish Performance Focus Area

There are 41 biological objectives related to evaluation of covered fish species performance (Table 3.6-4). Table 3.6-5 identifies monitoring actions needed to measure progress towards these biological objectives. The required monitoring can be broadly ascribed to one of four types. The first type of monitoring consists of collection and interpretation of information that is already being collected by some entity other than BDCP. This includes existing fish surveys, physical environmental and flow data, and various habitat assessments. The second type of monitoring consists of major monitoring efforts (which may include elements of research, discussed below in Section 3.6.4.8.2) that require development of rigorous, detailed plans in collaboration with a group of partners that includes the fish and wildlife agencies and in many cases, a number of other partners. Examples include monitoring of the production of food for covered fish species, and monitoring to improve current methods of estimating covered fish species mortality, abundance, and habitat quality. The third type of monitoring includes monitoring actions, specific to BDCP, that are performed at individual reserve units in accordance with site-specific monitoring requirements of a reserve unit management plan. This includes monitoring to verify compliance with plan requirements, and monitoring to identify effectiveness, such as by identifying the timing and extent of covered fish species use of an area. The fourth type of monitoring consists of verifying BDCP effectiveness with regard to performance of a conservation measure not targeted to function at the reserve unit scale, i.e., CM1, CM2, or CMs 13 to 21. Examples include effectiveness monitoring relevant to the proposed north Delta intakes (CM1), the dissolved oxygen injection facility (CM14), and the nonphysical barriers (CM16). Additionally, reviews and synthesis prepared within the covered fish performance focus area will review and consider monitoring and research results from the decision trees focus area, as well as habitat-oriented results from the Yolo Bypass, tidal wetland restoration, and riparian, channel margin, and floodplain restoration focus areas.

1 **Table 3.6-5. Monitoring Actions for Covered Fish Performance Focus Area**

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CFP-M01	NDD fish screen biological effectiveness	WRCS1.1, WRCS3.2, SRCS1.1, SRCS3.2, FRCS1.1, FRCS3.2, STHD1.1, STHD1.1, STHD3.2	CM1	Observe fish activity at screen face (using Didson cameras or other technology to be determined prior to facility operations) and use mark/recapture study of salmonid and smelt proxy fishes to evaluate impingement injury rate. Performance metrics to be determined prior to study initiation (same as post-construction study 7, Evaluation of Screen Impingement [Fish Facilities Technical Team 2011]).	Juvenile salmonid survival through the reach containing the NDDs, tracking life history stage.	Compliance with design criteria.	Study to be performed at varied river stages and diversion rates, during first 2 years of facility operation.
CFP-M02	NDD fish screen calibration	L4.3, DTSM1.2, LFSM1.2, WRCS1.1, WRCS3.2, SRCS1.1, SRCS3.2, FRCS1.1, FRCS3.2, STHD1.1, STHD3.2, GRST1.1, WTST1.1	CM1	Perform hydraulic field evaluations to measure velocities over a designated grid in front of each screen panel. Repeat as necessary to set initial baffle positions and confirm compliance with design criteria. This monitoring will be conducted at diversion rates close to maximum diversion rate.	Water velocity field across surface of each screen.	Compliance with design criteria.	Initial studies require approximately 3 months beginning with initial facility operations.
CFP-M03	NDD fish screen cleaning	L4.3, DTSM1.2, LFSM1.2, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1, GRST1.1, WTST1.1	CM1	Perform visual inspections (diver and/or camera) to evaluate effectiveness of cleaning mechanism and screen integrity. Determine whether cleaning mechanism is effective at protecting the structural integrity of the screen and maintaining uniform flow distribution through the screen. Adjust cleaning intervals as needed to meet requirements. (same as post-construction study 3, Periodic Visual Inspections [Fish Facilities Technical Team 2011]).	Cleaning mechanism effectiveness, frequency of cleaning.	Compliance with design criteria.	Initial study to occur during first year of facility operation with periodic re-evaluation over life of project.
CFP-M04	NDD fish screen construction	L4.3, DTSM1.2, LFSM1.2, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1, GRST1.1, WTST1.1	CM1	Document North Delta Diversion design and construction compliance with fish screen design criteria.	Performance of action.	Performance of action.	Prior to construction and as-built.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CFP-M05	NDD fish screen entrainment	WRCS1.1, WRCS3.2, SRCS1.1, SRCS3.2, FRCS1.1, FRCS3.2, STHD1.1, STHD1.1, STHD3.2	CM1	Measure entrainment rates at screens using fyke nets located behind screens. Identify species and size of entrained organisms. Use trawl surveys in channel to calibrate density of entrained organisms. Performance metrics to be determined prior to study initiation (same as postconstruction study 8, Screen Entrainment [Fish Facilities Technical Team 2011], but with addition of trawl surveys).	Entrainment rates; species and size of entrained organisms; density of those organisms in the channel.	Performance of action.	Study to be performed at varied river stages and diversion rates, during first 2 years of facility operation.
CFP-M06	NDD fish screen hydraulic effectiveness	L4.3, WRCS1.1, WRCS3.2, SRCS1.1, SRCS3.2, FRCS1.1, FRCS3.2, STHD1.1, STHD3.2, GRST1.1, WTST1.1	CM1	Confirm screen operation produces approach and sweeping velocities consistent with design criteria. Measure flow velocities within refugia (same as postconstruction study 2, Long-term Hydraulic Screen Evaluations, combined with postconstruction study 4, Velocity Measurement Evaluations [Fish Facilities Technical Team 2011]).	Approach and sweeping velocities under a range of flow conditions; velocities in flow refugia.	Compliance with design criteria.	Approximately 6 months beginning with initial facility operations.
CFP-M07	NDD operations independent measurement	L3.3, L3.4, WRCS3.1, WRCS3.2, SRCS3.1, SRCS3.2, FRCS3.1, FRCS3.2, STHD3.1, STHD3.2	CM1	Document North Delta Diversion compliance with operational criteria, with reference to existing environmental monitoring programs including (1) IEP Environmental Monitoring Program: Continuous Multi-parameter Monitoring, Discrete Physical/ Chemical Water Quality Sampling; (2) DWR and Reclamation: Continuous Recorder Sites; (3) Central Valley RWQCB: NPDES Self Monitoring Program; and (4) USGS Delta Flows Network and National Water Quality Assessment Program.	As specified in the cited monitoring programs.	Compliance with operational criteria.	Start prior to construction of water diversion facilities and continue for the duration of the permit term.
CFP-M08	NDD operations measurement and modeling	L3.3, L3.4, WRCS3.1, WRCS3.2, SRCS3.1, SRCS3.2, FRCS3.1, FRCS3.2, STHD3.1, STHD3.2	CM1	Document North Delta Diversion compliance with the operational criteria using flow monitoring and models implemented by the Implementation Office.	Metrics to be developed; must be consistent with data structures supporting real-time operations.	Compliance with operational criteria.	Start prior to completion of water diversion facilities and continue for the duration of the permit term.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CFP-M09	NDD refugia effectiveness	L4.3, DTSM1.2, LFSM1.2, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1, GRST1.1, WTST1.1	CM1	Monitor refugia to evaluate effectiveness relative to design expectations. Evaluate refugia operation at a range of river stages and with regard to target species or agreed proxies (same as postconstruction study 5, Refugia Effectiveness [Fish Facilities Technical Team 2011]).	To be developed once refugia design has been completed, and prior to facility operation.	Compliance with design criteria.	Approximately 6 months beginning with initial facility operations.
CFP-M10	NDD salmonid survivorship	WRCS1.1, WRCS3.2, SRCS1.1, SRCS3.2, FRCS1.1, FRCS3.2, STHD1.1, STHD1.1, STHD3.2	CM1	Determine overall impact on survival of juvenile salmonids throughout the diversion reach related to the operation of the new facilities. Use mark/recapture and acoustic telemetry studies (or other technology, such as Disdon cameras, to be determined prior to facility operations) to evaluate any impacts of facility operations on juvenile salmonids, under various pumping rates and flow conditions, to insure that the survival objectives for juvenile salmonids traversing the diversion reach are being met.	Monitoring protocols and performance metrics are to be developed prior to NDD operations.	Compliance with design criteria and performance expectations.	Study to be performed at varied river flows and diversion rates, during first 2 to 5 years of facility operation.
CFP-M11	Plan area: Conservation hatcheries	DTSM3.1, LFSM2.1	CM18	Verify success of the ex situ conservation program.	Genetic diversity (precise functional definition to be determined).	Achieve genetic diversity comparable to that of populations in habitat.	For Plan duration, at intervals to be determined but not more than 5 years.
CFP-M12	Plan area: Illegal Harvest Tracking	WRCS1.3, SRCS1.3, FRCS1.3, STHD1.3	CM17	Assess effectiveness of CM17 by collating and analyzing standard information collected by wardens during their enforcement duties.	Trends in number, types and distribution of citations and arrests associated with illegal harvest made by wardens within the Plan Area.	An increase in the abundance of covered salmonids and green and white sturgeon over time.	Year-round enforcement and annual reporting, for the duration of the BDCP permit term.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CFP-M13	Plan Area: Passage delays	WRCS2.1, SRCS2.1, FRCS2.1, STHD2.1, GRST2.1, GRST3.1, WTST2.1, WTST3.1	CM2, CM14	Assess passage delays and the effectiveness of efforts to reduce them in Yolo Bypass and other anthropogenic barriers and impediments (i.e., Sacramento and Stockton Deep Water Ship Channel, Delta Cross Channel). Report results in annual progress report.	Passage time through principal potential barriers; changes and trends over seasonal and interannual timescales.	To be determined in consultation with fish agencies.	Begin monitoring upon final BDCP permit authorization and continue on an annual basis through year 15, to cover the range of hydrologic conditions (i.e., wet years and dry years).
CFP-M14	Plan area: Predaceous fishes	L2.8, L4.1, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1	CM15	Monitor predator distribution and abundance at known predator hotspots to determine effectiveness of implementation actions to reduce potential predation loss.	Catch per unit effort; additional metrics regarding juvenile salmonid survival to be identified during study design.	Measurable and persistent predator reduction effect.	Annually in years 3 through 13; once every 3 years thereafter.
CFP-M15	Plan area: salmonid survival	WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1, WRCS3.2, SRCS3.2, FRCS3.2, STHD3.2	CM1, CM2, CM15, CM16, CM21	Group of related studies to be designed in collaboration with CDFW and NMFS. Component studies address survivorship estimation, nonphysical barrier monitoring (see CM16), entrainment studies (see CM1), predator control effectiveness studies (see CM15), and hydraulic/inundation studies (see CM1). AMT approval is required. Studies are to be integrated with M10 as practicable.	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be stated in each of the study plans.	Begin monitoring upon final BDCP permit authorization and continue through year 15.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CFP-M16	Plan area: SDWSC dissolved oxygen	L2.4, SRCS1.1, SRCS2.1, FRCS1.1, FRCS2.1, STHD1.1, STHD2.1, GRST1.1, GRST3.1, WTST1.1, WTST3.1.	CM14	Review/evaluate dissolved oxygen levels at various distances from the diffuser(s).	Dissolved oxygen concentrations.	Achievement of DO concentrations consistent with the DWSC DO TMDL of 6 mg/L from September 1 through November 30 and 5 mg/L at all other times on a year-round basis, particularly from May through October when DO levels have historically fallen below the target levels.	Year-round monitoring of DO, for the BDCP permit term.
CFP-M17	Reserve unit: Habitat: Nonphysical barrier effectiveness	L4.2, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1	CM16	Monitor the effectiveness of nonphysical fish barriers in deterring juvenile salmonids from migrating into interior Delta and other waterways known to result in reduced survival.	Fraction of juvenile salmonids diverted, relative to no-barrier baseline conditions.	No fixed criterion. Results will be used to determine whether barrier type or location should be changed, or if alternative conservation actions would yield greater benefit for the required level of effort.	Annually for 5 years beginning at permit authorization, reevaluating monitoring needs after year 5.
CFP-M18	Plan area: Delta smelt: Cache Slough habitat	DTSM2.1C	CM4	Study to be designed in collaboration with fish agencies. A detailed study plan and AMT approval are required.]	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be stated in study plan.	To be stated in study plan.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CFP-M19	Plan area: Delta smelt: fecundity	DTSM1.1	CM4	Long-term studies to be designed in collaboration with CDFW and USFWS. A detailed study plan and AMT approval are required.	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be stated in study plan.	To be stated in study plan.
CFP-M20	Plan area: Delta smelt: habitat quality	DTSM2.1A	CM4	Long-term study to be designed in collaboration with CDFW and USFWS. General metrics and success criteria stated in objective, but a detailed study plan and AMT approval are required.	See action description. Briefly, the metrics are spatially explicit representations of salinity, Secchi disk depth, calanoid copepod density, proximity to tidal marsh, and water temperature.	To be stated in study plan.	To be stated in study plan.
CFP-M21	Plan area: Delta smelt: Recovery Index	DTSM1.3	CM4	Long-term studies to be designed in collaboration with CDFW and USFWS. A detailed study plan and AMT approval are required.	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be stated in study plan.	To be stated in study plan.
CFP-M22	Plan area: longfin smelt: status	LFSM1.1, LFSM1.2	CM1, CM4, CM21	Group of related studies to be designed in collaboration with CDFW and USFWS. Component studies address recruitment relative to winter-spring flows, fish surveys, and food surveys (integration with action CFP-M23). AMT approval is required.	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be stated in each of the study plans.	To be stated in each of the study plans.
CFP-M23	Plan area: covered fish food supply	L2.9, DTSM2.1B, LFSM1.1	CM2, CM4, CM5	Long-term study to be prepared and performed in collaboration with fish agencies. A detailed study plan and AMT approval are required.	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be stated in study plan.	To be stated in study plan.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CFP-M24	Plan area: Sacramento splittail abundance	SAST1.1, L3.2, L2.5, L2.8, L2.9	CM2, CM4, CM5	Assess the abundance of Sacramento splittail as part of the Fall Midwater Trawl and evaluate the response of the population to habitat restoration actions. AMT approval is required.	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be determined in collaboration with fish agencies.	At year 15, assess whether the objective has been met and present the agencies with the plan for continued monitoring (annual, every-other-year, every 5 years).
CFP-M25	Plan area: sturgeon: juvenile survival	GRST1.1, WTST1.1, L2.8, WTST3.1, GRST3.1, L2.5, L2.9	CM1, CM2, CM4, CM5, CM6, CM13, CM17, CM19, CM21	Group of related studies to be designed in collaboration with CDFW and NMFS. Component studies address refugia and foraging habitat, food availability, and fish surveys near restored sites; uses information from M3, M8, and partner programs. AMT approval required.	Metrics to be determined in collaboration with fish agencies and in context of study methods.	To be determined in collaboration with fish agencies.	To be determined in collaboration with fish agencies.

Notes

1. The Covered Fish Performance Focus Area would also use monitoring results from the following monitoring actions: TWR-M13 (Table 3.6-7); and YB-MO4, YB-M05, YB-M06 (Table 3.6-6).

3.6.4.7.5 Yolo Bypass Focus Area

There are 54 biological objectives related to evaluation of fish, wildlife, and natural communities in the Yolo Bypass (Table 3.6-4). A large fraction of these are species-specific objectives for covered fish species (26 objectives) or the giant garter snake (9 objectives); the remainder are landscape and natural community objectives tracking larger-scale changes on the Yolo Bypass that will occur as component projects are implemented under CM2 *Yolo Bypass Fisheries Enhancement*. Table 3.6-6 identifies monitoring actions needed to measure progress towards these biological objectives. These monitoring actions are all related to habitat restoration or enhancement projects proposed under CM2.

The required monitoring covers a broad range of topics, with diverse spatial and temporal scales. Some monitoring actions simply verify performance of actions specified in CM2; others assess changes in conditions at individual restoration sites; and still others are complex long-term collaborative study efforts intended to measure progress toward achieving objectives for covered fish species and to determine overall CM2 effectiveness.

1 **Table 3.6-6. Monitoring Actions for the Yolo Bypass Focus Area**

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
YB-M01	Yolo: Fremont Weir flows	L2.5, LFSM1.1, WRCS1.2, SRCS1.2, FRCS1.2, STHD1.2, GRST2.1, WTST2.1, PRL1.2	CM2	Document that flow over Fremont Weir meets flow requirements (details in Chapter 6, *Plan Implementation*).	Flow.	Flow conditions over Fremont Weir meet CM2 prescriptions for floodplain inundation (extent, duration and frequency).	During overflow at Fremont Weir and periods when Fremont Weir is designed to flood, for the duration of the BDCP.
YB-M02	Yolo: Tule Canal/Toe Drain construction	WRCS1.2, WRCS2.1, SRCS1.2, SRCS2.1, FRCS1.2, FRCS2.1, STHD1.2, STHD2.1, GRST2.1, WTST2.1, PRL1.1	CM2	Document compliance with Tule Canal/Toe Drain improvements plan in both project design and as-built reports.	Design criteria are documented.	Tule Canal/Toe Drain improvements meet design criteria post construction.	Prior to construction and as-built.
YB-M03	Yolo: Tule Canal/Toe Drain operations	L2.5, LFSM1.1, WRCS1.2, SRCS1.2, FRCS1.2, STHD1.2, GRST2.1, WTST2.1, PRL1.2	CM2	Document that flow in Tule Canal/Toe Drain meets operational requirements (details in Chapter 6, *Plan Implementation*).	Flow.	Flow within the Tule Canal/Toe Drain meets operational requirements.	Prior to completion of the modifications to the facilities for duration of the BDCP.
YB-M04	Plan area: fish passage	L1.4, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1, SRCS2.1, FRCS2.1, WRCS2.1, PRL1.1, PRL1.2, STHD2.1, L2.5, L2.8, L2.9	CM2	Upstream and downstream fish passage at Fremont Weir. Methods likely to include Pit tag and other suitable techniques/ studies of covered juvenile fish (primarily salmonids as well as lamprey) downstream migration past Fremont Weir, as well as upstream passage of covered adult fish past Fremont Weir (primarily salmonids, sturgeon and lamprey). A detailed study plan and AMT approval are required.	To be determined following selection of methodology.	Achievement of passage criteria as specified in the stated biological objectives.	Monitoring to occur for a period of 5 years, once Fremont Weir modifications are completed. Monitoring will track adult juvenile migration through Yolo Bypass, between Fremont Weir and Cache Slough.
YB-M05	Yolo: Fish food production	L2.5, L2.9, DTSM2.1b, LFSM1.1, WRCS1.2, SRCS1.2, FRCS1.2, STHD1.2, SAST1.1, GRST3.1, WTST3.1	CM2	Plankton and invertebrate sampling.	Diversity of species sampled, number of organisms. More specific metrics may be developed for compatibility with models of food production.	Increases in plankton and invertebrate abundance, and transport of plankton and invertebrates off of Yolo Bypass to areas occupied by delta smelt.	Every 5 years after modifications to Fremont Weir are completed.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
YB-M06	Yolo: Use by covered fishes	L2.5, L2.8, L2.9, L4.2, DTSM1.3, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1, SAST1.1, GRST1.1, WTST1.1	CM2	Assess use of Yolo Bypass by covered fish species. Methods to be determined in collaboration with fish agencies.	Extent of Yolo Bypass use by covered fish species and the CM2 proportional contribution to overall achievement of BDCP biological goals for covered fishes.	Detection of use by adult and juvenile covered fish species within the flooded portions of Yolo Bypass. Estimation of proportional contribution, verifiable by AMT and independent scientific review.	Surveys will occur between November 10 and May 15 through year 15; continuation after year 15 may occur, subject to determination by AMT. Other monitoring or research to resolve the metric is to be designed and executed in cooperation with the fish agencies.
YB-M07	Reserve unit: habitat: fish refugia	L2.8	CM2, CM4, CM5, CM6, CM15	Verify creation of fish refugia at reserve units and assess their functionality. For the purposes of this monitoring, CM15 activity locations are treated as reserve units.	To be determined in consultation with fish agencies.	To be determined in consultation with fish agencies.	During reserve unit design, at reserve unit completion, and at 5-year intervals thereafter.
YB-M08	Plan area: reserve system size and connectivity	L1.1, L1.2, L1.4, L1.6, L3.1, L3.2, TBEWNC1.1, TBEWNC1.3, TFEWNC1.1, TFEWNC1.2, GGS1.1, GGS1.2, GGS1.3, GGS1.4, GGS2.1, GGS2.2, GGS2.3, GGS2.4, GGS3.1, GSHC1.3, DTSM1.1, DTSM1.3, DTSM2.1b., LFSM1.1, WRCS1.1, SRCS1.1, FRCS1.1, STHD1.1, SAST1.1, GRST1.1, WTST1.1.	CM2	Assess connectivity between reserve system units in context of the requirements of the cited biological objectives.	Acres in reserve system and connectivity between reserves.	Attainment of acreage targets and progressive improvement in connectivity between BDCP reserves, or between existing conservation lands and BDCP reserves.	Annually, for Plan duration.

Notes

1. The Yolo Bypass Focus Area would also use monitoring results from the following monitoring actions:
   CFP-M23, CFP-M24, and CFP-M25 (Table 3.6-5);
   RCF-M05 (Table 3.6-8);
   TWR-M08, TWR-M12, and TWR-M13 (Table 3.6-7); and
   UNR-M17 (Table 3.6-10).

3.6.4.7.6 Tidal Wetland Restoration Focus Area

There are 46 biological objectives related to tidal wetland restoration (Table 3.6-4). Table 3.6-7 identifies monitoring actions needed to measure progress towards these biological objectives. These actions are associated with conservation measures CM4 Tidal Natural Communities Restoration, CM11 Natural Communities Enhancement and Management, and CM12 Methylmercury Management.

The required monitoring can be broadly ascribed to one of three types. The first type consists of information collected at the scale of an individual reserve unit, in accordance with the monitoring provisions of the reserve unit management plan (see Section 3.4.11.2.2 for a description of reserve unit management plans). Most monitoring within the reserve unit is compliance monitoring performed to confirm that a reserve unit has a feature or function prescribed in its design and meets a design-specified performance measure. The second type of monitoring consists of collection and interpretation of information that is already being collected by some entity other than BDCP. This includes existing data collection on regional water quality, general NPDES permit compliance, fish surveys, and some other data. The third type of monitoring consists of major monitoring or research efforts that require development of rigorous, detailed plans in collaboration with a group of partners that includes the fish and wildlife agencies and in many cases, a number of other partners. Examples include studies to assess the production and export from restored tidal wetlands of food for covered fish species; and studies to improve current methods of estimating covered fish species mortality, abundance and habitat quality. In this connection, see section 3.6.4.8.4 *Tidal Wetland Restoration Focus Area* for a discussion of important key uncertainties in tidal restoration, and an adaptive management process to resolve uncertainty in the future location of tidal restoration within the Plan Area.

1 **Table 3.6-7. Monitoring Actions for Tidal Wetland Restoration Focus Area**

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
TWR-M01	Plan area: Stormwater treatment	L2.4, SRCS1.1, FRCS1.1, STHD1.1, GRST1.1, GRST3.1, WTST1.1, WTST3.1	CM19	Review SWB-required reporting by grant recipients to assess/evaluate performance relative to stated objectives of CM19 and L2.4.	Compliance of funded projects with NPDES MS4 and Phase II NPDES MS4 permit conditions.	Demonstrated reductions in pollutant loads in urban stormwater effluent generated by local jurisdictions.	Annually reported for 10 years following completion of each stormwater treatment project.
TWR-M02	Reserve unit: Geomorphology: Tidal wetlands	L1.4, L1.7, L2.7, L2.10, TBEWNC1.4, TBEWNC1.2, TFEWNC2.2	CM4	Ensure that tidal reserve unit design incorporates the geomorphic structures named in the biological objectives, and track continued presence of these structures through Plan implementation.	Tidal natural community geomorphology, as specified in the biological objectives.	Presence of sinuous, high-density, dendritic networks of tidal channels through tidal areas. Gradual transition in elevation and hydrology, from subtidal areas, to marsh plain, to ecotonal areas and adjacent uplands.	Annually for first 5 years after restoration; then every 5 years following restoration until end of permit term
TWR-M03	Reserve unit: Habitat: Brackish marsh vegetation	L2.6, SMHM1.1	CM4	Vegetation sampling in middle and high brackish marsh.	Plant species composition and relative cover.	Consistent with “Viable Habitat Areas” for salt marsh harvest mouse defined in the final Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California.	Within 6 months of successful restoration of tidal brackish emergent wetland or of acquisition of managed wetland for salt marsh harvest mouse, and at least once every 5 years thereafter.
TWR-M04	Reserve unit: Habitat: Pepperweed	TBEWNC2.1	CM4	Verify perennial pepperweed remains a minor component of restored brackish emergent natural communities.	Percent cover of perennial pepperweed	Cover value of 10% or less.	Annually for the first 5 years after restoration, and at least once every 5 years thereafter.
TWR-M05	Reserve unit: Habitat: Water temperature	L2.4	CM4	Track water temperature in restored tidal wetland reserve units.	Temperature; sites and timing to be determined in consultation with fish and wildlife agencies.	Maintenance of temperatures comparable to seasonal norms for the region.	Annually for first 5 years after restoration.
TWR-M06	Reserve unit: Occurrence: Delta tule pea and Suisun marsh aster	CBR1.1, DTP/SMA1.1, SBB/SUT1.1	CM4	Surveys for Delta tule pea and Suisun Marsh aster to determine pre- and post-restoration effects.	Delta tule pea and Suisun marsh aster population (or local stand) size and extent.	Criteria for Delta tule pea and Suisun marsh aster as stated in Objectives DMW/ML1.1 and DTP/SMA1.1: No net loss of occurrences.	At least one year pre-restoration and every year post-restoration until the success criteria are met; and then every three years thereafter for 10 years.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
TWR-M07	Reserve unit: Habitat: Giant garter snake	GGS1.1, GGS1.4, GGS2.3, GGS3.1	CM3, CM4, CM10	Track progress toward compliance with acreage targets and other specifications contained in these species objectives for giant garter snake.	Parameters described in Section 3.4.4.3.4, Siting and Design Considerations, Covered Species, Giant Garter Snake.	Criteria provided under Section 3.4.4.3.4, Siting and Design Considerations, Covered Species, Giant Garter Snake.	As specified in the reserve unit management plans.
TWR-M08	Reserve unit: Habitat: General vegetation	L1.4, L2.5, L2.6, L2.8, L2.9, TFEWNC2.1, VFRNC2.2, VFRNC2.3, GGS1.1, GGS1.4, GGS2.3, GGS3.1, GGS2.1, TPANC1.1.	CM4, CM11	Characterize vegetation of terrestrial and wetland communities in each reserve unit, with regard to species and structure.	Vegetation species composition, successional state, and structure.	Reflective of historic conditions, based upon criteria listed in the biological objectives. Comparable to natural, undisturbed reference sites or based on historical ecology studies such as Beagle et al. 2012. Low detection rates for invasive, non-native species.	As specified in the reserve unit restoration plan, or if not specified, then within 6 months of successful restoration of the site, and at least once every 5 years thereafter.
TWR-M09	Reserve unit: Habitat: Salt marsh harvest mouse	SMHM1.2, SMHM1.2	CM10, CM11, CM4	Track creation and function of salt marsh harvest mouse viable habitat areas.	Location and extent of salt marsh harvest mouse viable habitat areas.	Consistent with "Viable Habitat Areas" for salt marsh harvest mouse defined in the final Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (U.S. Fish and Wildlife Service in prep.) and/or as specified in site-specific restoration plan.	Pre-restoration, within 6 months of restoration of tidal brackish emergent wetland or acquisition of managed wetland, and every 5 years thereafter, or as specified in the reserve unit management plan
TWR-M10	Plan area: Methylmercury allocation compliance	L2.4	CM12	Track reserve unit compliance with methylmercury load allocation standards.	Methylmercury allocations per applicable regulatory standards.	Adhere to the numeric targets selected for the load allocation of methylmercury. Current targets are defined per Resolution No. R5-2010-0043 of the Delta Mercury Control Program, under which allocations of methylmercury for restored wetlands vary depending on Delta subarea.	To be determined in collaboration with regulatory agencies.
TWR-M11	Reserve unit: Occurrence: Mason's lilaeopsis and Delta mudwort	DMW/ML1.1	CM4, CM6, CM7	Surveys for Mason's lilaeopsis and delta mudwort in suitable habitat.	Mason's lileeopsis and delta mudwort population (or local stand) size and extent.	No net loss of occurrences.	At least one year pre-restoration and every year post-restoration until the success criteria are met; and then every three years thereafter for 10 years.
TWR-M12	Reserve unit: Occurrence: Covered fishes	L2.5, WRCS1.2, SRCS1.2, FRCS1.2, STHD1.2	CM2, CM4, CM5, CM6	Foraging, refuge and holding habitat quality.	Use of restoration sites by covered fish species, esp. spawning, holding and foraging by splittail,	Detection of site use by Chinook salmon, splittail, and the following covered fish species: longfin smelt and Delta smelt in the Suisun Marsh, West Delta and Cache Slough ROAs;	Monthly surveys during one water year between the second and fifth year following restoration site construction. Existing studies/ monitoring

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
					and holding and foraging by covered salmonid species.	steelhead in the West Delta, Cache Slough and Consumes/ Mokelumne ROAs. Occurrences of spawning splittail, particularly during dry years when seasonally inundated floodplain habitat may be functioning at capacity. Occurrences of juvenile salmonids and splittail during periods of rearing and outmigration in the Plan Area.	efforts (i.e., FMWT, zooplankton study) will be used to track larger, emergent trends in abundance of covered fish and important foodweb species, such as zooplankton.
TWR-M13	Plan area: Invasive species preemptive control	L2.6, TPANC2.1	CM20	Effectiveness monitoring will consist of identifying the type, distribution, and abundance of aquatic invasive species detected during program implementation and reporting those species in the annual report.	See action description	Performance of action.	Annually throughout permit term.
TWR-M14	Plan area: Suisun thistle and soft bird's-beak seed banking	SBB/SuT1.2	CM4	Establish a seed bank as specified in CM4.	See description in CM4.	Successfully establish the seed bank.	At least 1 year prior to start of construction on any tidal restoration project in Suisun Marsh.
TWR-M15	Plan area: *Ex situ* conservation of Suisun thistle	SBB/SuT1.3	CM4	Establish an ex situ population as specified in CM4.	See action description.	Successfully establish the ex situ population.	Initiate ex situ population by year 5.
TWR-M16	Plan area: *In situ* conservation of Suisun thistle	SBB/SuT1.4	CM4	Establish two occurrences of Suisun thistle.	Criteria as provided in the final tidal marsh recovery plan (USFWS 2013).	Compliance with criteria provided in the final tidal marsh recovery plan (USFWS 2013).	During reserve unit site selection; annually until 5 years after criteria are met; then every 5 years.

Notes
1. The Tidal Wetland Restoration Focus Area would also use monitoring results from the following monitoring actions:
CFP-M18, CFP-M19, CFP-M20, CFP-M21, CFP-M22, CFP-M23, CFP-M24, and CFP-M25 (Table 3.6-5);
MW-M03 (Table 3.6-9);
RCF-M03 and RCF-M05 (Table 3.6-8);
S&T-M03, S&T-M04 and S&T-M05 (Table 3.6-12);
UNR-M17 (Table 3.6-10); and
YB-M07 and YB-M08 (Table 3.6-6).

3.6.4.7.7 Riparian, Channel Margin, & Floodplain Restoration Focus Area

There are 23 biological objectives related to riparian, channel margin, and floodplain restoration (Table 3.6-4). Table 3.6-8 identifies monitoring actions needed to measure progress towards these biological objectives. These actions are associated with conservation measures CM5 Seasonally Inundated Floodplain Restoration, CM6 Channel Margin Enhancement, CM7 Riparian Natural Community Restoration, and CM11 Natural Communities Enhancement and Management.

Most of the required monitoring actions consist of information collected at the scale of an individual reserve unit, in accordance with the monitoring provisions of the reserve unit management plan (see Section 3.4.11.2.2 for a description of reserve unit management plans). Most monitoring within the reserve unit is compliance monitoring performed to confirm that a reserve unit has a feature or function prescribed in its design and meets a design-specified performance measure; status and trend monitoring is also performed at the reserve unit scale. Monitoring in this focus area will also utilize results of monitoring performed for other focus areas (the covered fish performance and tidal wetland restoration focus areas) in evaluating some biological objectives relevant to the riparian, channel margin, and floodplain restoration conservation measures.

Table 3.6-8. Monitoring Actions for the Riparian, Channel Margin & Floodplain Restoration Focus Area

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
RCF-M01	Reserve unit: Habitat: Cowbird parasitism	L2.6, MWNC1.1	CM7	Monitor least Bell's vireo nests for cowbird parasitism.	Percent of least Bell's vireo nests with cowbird eggs.	As stated in the reserve unit management plan for the monitored area.	Perform annual surveys for least Bell's vireo. If nests found, check nests weekly throughout vireo breeding season.
RCF-M02	Reserve unit: Habitat: Non-native fishes	L4.1, L4.2	CM2, CM6, CM16, CM15	Evaluate the distribution and abundance of piscine predators at enhancement sites. Include an assessment of whether piscivorous predators use woody debris associated with enhanced channel margins as ambush cover.	To be determined, in accordance with cited objectives.	Decreased distribution and abundance of predators at enhancement sites; and negligible use of woody debris in channel margins by known predators such as striped and largemouth bass.	Performed across a range of water year types and a range of field sites; precise scope of study to be determined by AMT.
RCF-M03	Reserve unit: Geomorphology: Floodplains	L2.1, L2.2, L2.3, L1.4, L1.5, L2.10, L2.11	CM4, CM5	Track performance of reserve units in supporting the types of floodplain function identified in the biological objectives.	The biological objectives identify elevations and flooding frequency; channel migration potential, succession of floodplains, transitional habitats from tidal, freshwater emergent wetland, to upland communities.	Gradual transition in elevation and hydrology, from frequently flooded areas to flood refugia. Channel can migrate within restored site. On average, 50 acres of floodplain will be inundated a minimum of every other year, 500 acres will be inundated a minimum of every 5 years, and all 1,000 acres will be inundated a minimum of once every 10 years, by year 15.	Annually for first 5 years after restoration; then every 5 years following restoration until end of permit term.
RCF-M04	Reserve unit: Habitat: Riparian vegetation	L2.3, L2.6, VFRNC2.1, VFRNC2.4, VFRNC3.1, SH1.1, SH1.2, SH1.3, SH2.1, SH2.2	CM7, CM11	Riparian natural community vegetation sampling.	Sampling needs to measure species composition and abundance, as well as measures of structural heterogeneity, successional stage, patch size, presence of rare and uncommon vegetation alliances.	For structural heterogeneity: 1,000 acres early- to mid-successional; 500 acres of mature riparian intermixed with early- to mid-successional, in minimum 50-acre blocks; and/or as specified in site-specific restoration plans and/or species-specific biological objectives.	For protected areas, within 6 months of site acquisition and every 5 years thereafter. For restored areas, every 5 years after successful restoration, or as specified in species-specific biological objectives.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
RCF-M05	Reserve unit: Connectivity	L3.1, L3.2, L3.3, L3.4	CM1, CM4, CM5	Assess habitat connectivity and its capacity to support landscape-scale movements by covered species.	Habitat and hydraulic connectivity benefiting covered species, quality and quantity of transitional/migratory habitats, density and diversity of habitat elements.	Increased connectivity between primary channels and seasonal floodplains, as well as use by covered species while avoiding stranding of covered fish species.	Every 5 years following floodplain restoration until end of permit term.
RCF-M06	Reserve unit: Habitat: Feral predators	RBR1.5	CM7, CM11	Assess compliance with feral predator minimization requirements stated in biological objective RBR1.5.	Presence of feral predators (cats and dogs).	Feral predators absent from occupied riparian brush rabbit habitat.	Annually in occupied riparian brush rabbit habitat.
RCF-M07	Reserve unit: Habitat: Riparian brush rabbit	RBR1.1, RBR1.2, RBR1.3, RBR1.4	CM7, CM11	Survey for suitable habitat features for riparian brush rabbit, including flood refugia, as specified in the biological objectives.	Presence of suitable habitat features.	300 acres meets habitat criteria as defined in CM7 and Appendix 3.E; suitable refugia not further apart than 20 meters in riparian brush rabbit habitat	Within 6 months of site acquisition of protected habitat or after restoration is determined to be successful for restored habitat, and every 5 years thereafter.
RCF-M08	Reserve unit: Habitat: Riparian woodrat	RW1.1, RW1.2, L3.1	CM7, CM8	Survey for suitable habitat features for riparian woodrat, as specified in the biological objectives.	Presence of suitable habitat features.	300 acres that meet habitat criteria as defined in CM7 and Appendix 3.E; suitable refugia not further apart than 20 meters in riparian woodrat habitat.	Within 6 months of site acquisition of protected habitat or after restoration is determined to be successful for restored habitat, and every 5 years thereafter.
RCF-M09	Reserve unit: Habitat: Valley elderberry longhorn beetle	VELB1.1, VELB1.2	CM7, CM11	Ensure correct siting and design of reserve units intended to provide mitigation for impacts to Valley elderberry longhorn beetle or its habitat.	As stated in the biological objectives.	Compliance with siting and design requirements.	During reserve unit design and at completion of reserve unit restoration.

Notes

1. The Riparian, Channel Margin & Floodplain Restoration Focus Area would also use monitoring results from the following monitoring actions:
   CFP-M23, CFP-M24, and CFP-M25 (Table 3.6-5);
   S&T-M02 (Table 3.6-12);
   TWR-M08, TWR-M10, TWR-M11, and TWR-M13 (Table 3.6-7); and
   YB-M07 and YB-M08 (Table 3.6-6).

3.6.4.7.8 Managed Wetlands Focus Area

There are 26 biological objectives relevant to the managed wetlands focus area (Table 3.6-4). Table 3.6-9 identifies monitoring actions needed to measure progress towards these biological objectives. Managed wetlands are widely distributed across various natural communities in the Plan Area and are subject to a variety of management activities, so these biological objectives are associated with varied conservation measures, including CM4, CM5, CM7, CM8, CM10, and CM11.

Most of the required monitoring actions consist of information collected at the scale of an individual reserve unit, in accordance with the monitoring provisions of the reserve unit management plan (see Section 3.4.11.2.2 for a description of reserve unit management plans). Most monitoring within the reserve unit is compliance monitoring performed to confirm that a reserve unit has a feature or function prescribed in its design and meets a design-specified performance measure; status and trend monitoring is also performed at the reserve unit scale. Monitoring in the managed wetlands focus area will also use results of monitoring performed for other focus areas in evaluating some biological objectives; for example, evaluation of Plan effects on the giant garter snake must consider its use of many different natural community types, in addition to managed wetlands.

Table 3.6-9. Monitoring Actions for the Managed Wetlands Focus Area

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
MW-M01	Reserve unit: Habitat: Vegetation in nontidal marsh	L2.6, NFEW/NPANC1.1	CM10	Vegetation sampling.	Total and relative cover of native, nontidal marsh vegetation within a mosaic of open water.	As specified in site-specific restoration plan.	As specified in site-specific restoration plan.
MW-M02	Reserve unit: Connectivity: Giant garter snake and greater sandhill crane habitat	GGS1.1, GGS1.4, GGS2.3, GGS3.1, GSHC1.3	CM11	Measure giant garter snake and greater sandhill crane habitat connectivity per requirements in biological objectives; track progress toward achieving objectives.	See specifications in biological objectives.	Achieve specifications in biological objectives.	Every 5 years following restoration until end of permit term.
MW-M03	Reserve unit: Hydrology: Managed wetlands	GGS1.1, GGS2.3, GGS3.1, GGS1.4, L3.2, L1.3	CM4, CM5, CM10	Track inundation extent, frequency and duration in managed wetlands.	Inundation frequency and duration, amount of future tidal habitat and buffer habitat above future inundation.	Criteria will vary with reserve unit; to be agreed with management partners.	Annually for plan duration.
MW-M04	Reserve unit: Occurrence: Greater Sandhill crane	GSHC1.4, GSHC1.3	CM10	Monitor greater sandhill crane roost sites to verify effectiveness of AMMs intended to prevent abandonment of roost sites situated near CM1 facilities construction sites.	Presence of roosting cranes.	Cranes have not abandoned roost sites.	During construction activities in vicinity of roost sites, annually for 3 years after construction is completed, and, during the season of expected occupancy, every 5 years thereafter.
MW-M05	Reserve unit: Habitat: Tricolored blackbird	MWNC1.1, TRBL1.1, TRBL1.2, TRBL1.3, L3.1	CM11	Site-level assessment in tricolored blackbird nesting habitat.	Age of vegetation.	Young, lush stands of emergent vegetation, as specified within the biological objectives.	Within 6 months of site acquisition and every 5 years thereafter.

Notes

1. The Managed Wetlands Focus Area would also use monitoring results from the following monitoring actions:
   RCF-M01 (Table 3.6-8);
   S&T-M04 and S&T-M05 (Table 3.6-12);
   TWR-M08, TWR-M09, and TWR-M13 (Table 3.6-7);
   UNR-M16 and UNR-M18 (Table 3.6-10); and
   YB-M08 (Table 3.6-6).

3.6.4.7.9 Upland and Nontidal Wetland Restoration Focus Area

There are 68 biological objectives relevant to the upland and nontidal wetland restoration focus area (Table 3.6-4). Table 3.6-10 identifies monitoring actions needed to measure progress toward these biological objectives. A large fraction of all the covered terrestrial species occupy uplands or nontidal wetlands (which include, for instance, alkali seasonal wetlands and vernal pools), so an especially large number of natural community and species-specific biological objectives fall into this focus area. The focus area primarily addresses conservation actions implemented under CM8, CM9, CM10, and CM11.

Most of the required monitoring actions consist of information collected at the scale of an individual reserve unit, in accordance with the monitoring provisions of the reserve unit management plan (see Section 3.4.11.2.2 for a description of reserve unit management plans). Most monitoring within the reserve unit is compliance monitoring performed to confirm that a reserve unit has a feature or function prescribed in its design and meets a design-specified performance measure; status and trend monitoring is also performed at the reserve unit scale. Monitoring in this focus area will also use results of monitoring performed for the terrestrial species status & trend focus area in evaluating some biological objectives.

1 **Table 3.6-10. Monitoring Actions for the Upland/Nontidal Wetland Restoration Focus Area**

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
UNR-M01	Plan area: Connectivity: Grasslands mosaic	GNC1.2, GNC1.4, GNC2.1, L3.1, CLNC1.2, CLNC1.3, SH1.2, SH1.3, SH2.2	CM3, CM8	Measure reserve unit connectivity per requirements in biological objectives.	Location relative to fragmented grassland patches or adjacency to riparian or emergent wetland natural communities; and/or as specified within species associated biological objective.	Connectivity with grassland patches and provision of upland adjacent to riparian or emergent wetland natural communities, and/or as specified within species associated biological objective.	Update at least once every 5 years.
UNR-M02	Plan area: Habitat: Grassland restoration	GNC1.2	CM8	GIS mapping and tracking of acreages successfully restored.	1,000 acres restored by year 10 and 2,000 acres (cumulative) restored by year 25.	Proportional progress toward goals stated in biological objective.	Update maps and acres successfully restored at least once every 5 years.
UNR-M03	Plan area: Habitat: Upland native vegetation alliances	L2.6, GNC2.1, GNC2.2	CM8	Plan area: Upland native vegetation alliances.	Extent, distribution, and number of upland native vegetation alliances across the reserve system.	A mosaic of alliances with consideration of historical sites.	Every 5 years throughout permit term.
UNR-M04	Reserve unit: Habitat: Carquinez goldenbush	CGB1.2, L3.1	CM8, CM11	Assess erosion and habitat degradation in occupied Carquinez goldenbush habitat.	Extent and condition of impaired habitat.	Demonstrate reversal of any erosion or degradation trends.	Within 6 months of site acquisition and every 5 years thereafter.
UNR-M05	Reserve unit: Habitat: Ponds in grassland	GNC1.3	CM8	Assess condition of ponds in protected grasslands.	Inundation depth and duration, vegetation cover.	Suitable conditions for covered reptiles and amphibians.	Every 5 years.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
UNR-M06	Reserve unit: Habitat: Vegetation composition	L2.6, GNC2.1, GNC2.2	CM8	Vegetation sampling in reserve units.	Percent cover of vegetation by species.	Achieve minimum percent cover dominated by species that compose California annual grassland series or native grassland series as defined by Sawyer et al. (2009, or latest edition), as defined in reserve unit management plan. Do not exceed percent cover of noxious weeds or bare ground defined in plan. Native species richness and diversity to be improved or maintained over time.	Prior to restoration, and annually for first 5 years or until success criteria are met, whichever is longer
UNR-M07	Reserve unit: Habitat: Vegetation in alkali seasonal wetlands	L2.6, ASWNC2.1, ASWNC2.4	CM9	Track emergent wetland vegetation composition and structural complexity in alkali seasonal wetlands.	Freshwater emergent wetland vegetation sampling: composition, diversity, and structural complexity.	Achieve conditions reflective of historical conditions.	Every 5 years after restoration is determined to be successful.
UNR-M08	Reserve unit: Habitat: Vegetation in vernal pools	ASWNC1.2, VPNC1.2, VPNC1.3, VPP1.2	CM9	Track vegetation composition in vernal pool natural community.	Plant species dominance, and percentage of relative cover attributable to native vernal pool species. Number of individual species.	Dominant species will be “vernal pool indicators,” “vernal pool associates,” or “vernal pool generalists,” as defined in California Department of Fish and Game (1998). Number of individuals meets or exceeds number necessary for viable population based on best available scientific information.	Annually after restoration until success criteria are met, then once every 5 years for 10 years.
UNR-M09	Reserve unit: Habitat: Vernal pool complex pollinators	GNC2.4, VPNC2.2, VPNC2.5	CM11	Insect sampling in vernal pool complexes.	Abundance of native solitary bees and other pollinators.	Equal to or greater than baseline.	Within 6 months of site acquisition and every 5 years thereafter.
UNR-M10	Reserve unit: Hydrology: Alkali seasonal wetlands	MWNC1.1, ASWNC2.1, ASWNC2.4, GNC2.2, L3.1, VPNC2.1, GNC2.5, VPNC2.3	CM9, CM11	Track alkali seasonal wetland hydrology to ensure continuation of characteristic saturation or ponding regimes.	Duration of wetland saturation or ponding.	Hydrology characteristic of alkali seasonal wetlands supporting a diversity of endemic alkali seasonal wetland species, based on reference wetlands.	Within 6 months of site acquisition and every 5 years thereafter.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
UNR-M11	Reserve unit: Hydrology: Vernal pools	MWNC1.1, ASWNC2.1, VPNC1.2, VPNC1.3, VPNC2.1, GNC2.5	CM11	Track vernal pool hydrology to ensure continuation of characteristic depth/duration of inundation.	Vernal pool depth and duration.	Hydrology characteristic of vernal pools, supporting a diversity of endemic vernal pool based on reference pools, or as specified in site-specific restoration plan.	Within 6 months of site acquisition, then annually until success criteria are met, and every 5 years for 10 years.
UNR-M12	Reserve unit: Habitat: Burrows	ASWNC2.3, ASWNC2.4, GNC2.3, GNC2.4, SH1.1, WBO1.1	CM8, CM11	Assess burrow availability for burrow-dependent species in grassland natural communities.	Burrow availability metric to be determined in consultation with CDFW and USFWS.	Increase above baseline, or as defined in biological objectives or species-specific conservation plans.	Within 6 months of site acquisition and every 5 years thereafter.
UNR-M13	Reserve unit: Habitat: Grassland prey abundance	ASWNC2.3, GNC2.4, WBO1.1	CM8	Track availability of prey for grassland-dependent species.	Prey abundance and accessibility.	Increase above baseline, or as defined in biological objectives or species-specific conservation plans.	Within 6 months of site acquisition and every 5 years thereafter.
UNR-M14	Reserve unit: Habitat: Vegetation in alkali seasonal wetlands and vernal pools	ASWNC2.4, VPNC2.1, VPNC2.2, VPNC2.5	CM9	Track availability of suitable foraging plants in alkali seasonal wetlands and vernal pools.	Survey foraging plant density and type. Food biomass density and energetic value.	Equal to that which was lost.	For 2 years prior to enhancement to determine baseline, for 3 years after enhancement to determine post restoration condition; and once every 10 years thereafter.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
UNR-M15	Reserve unit: Habitat: Vegetation in grasslands	L2.6, TRBL1.1, TRBL1.2, TRBL1.3, GNC1.2, GNC1.4, GNC2.1, GNC2.2, GNC2.5, SH1.1, VPNC2.4, VPNC2.5, ASWNC2.2, ASWNC2.4, GGS1.2, GGS1.1, GGS1.4, GGS2.3, GGS3.1, GGS2.2, RBR1.6, VPNC2.3, WBO1.1.	CM3, CM8, CM9, CM10, CM11	Track grassland vegetation attributes.	Extent, distribution, density, richness, and diversity of native annual, perennial grasses, and geophytes, and alliances; dominance of species that compose California annual grassland series or native grassland series, as defined by Sawyer and Keeler-Wolf (2009, or latest edition), intermingled with other native species.	Increase above baseline, or as defined in the reserve unit management plan.	Prior to restoration, and annually for first 5 years or until success criteria are met, whichever is longer. Then 5 years through permit term.
UNR-M16	Reserve unit: Occurrence: Covered plants	ASWNC2.1, BRIT/HART/SJSC1.1, BRIT/HART/SJSC1.2, CGB1.1, GGS2.2, GNC1.1, GNC1.2, GNC1.4, GSHC1.3, RBR1.6, VPNC1.1, VPNC1.2, VPP1.1, VPP1.2, CLNC1.1, CLNC1.3.	CM8, CM9, CM10, CM11	Track location and numbers of covered plant species and rare plant alliances in upland and nontidal wetland natural community types.	Record, quantify and delineate occurrences of covered plant species and rare alliances. Location and numbers of plants, location and area of rare alliances.	Presence of covered plant species and rare plant alliances.	At and every 5 years following reserve unit establishment
UNR-M17	Reserve unit: Habitat: Invasive vegetation	L2.6, GNC2.1, GNC2.2, VPNC2.3, GGS1.2	CM8, CM11	Perform vegetation sampling (methods to be specified in reserve unit management plan).	Percent cover of non-native, invasive plants (terrestrial and aquatic) and bare ground/open water. Maps of invasive species infestations. Habitat risk assessment.	Control or elimination of infestations that threaten ecosystem and covered species habitat functions. Quantitative standards as specified in reserve unit management plan.	Within 6 months of site acquisition and every 5 years thereafter; or prior to restoration and annually for first 5 years or until success criteria are met, whichever is longer.

ID # (1)	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
UNR-M18	Reserve unit: Connectivity: Wildlife obstacles	CLNC1.3	CM8, CM11	Verify continuing presence of features that support habitat connectivity across cultivated lands.	Obstacles to wildlife movement, as specified in the biological objective.	No significant obstacles to wildlife movement in reserve system.	Within 6 months of site acquisition and every 5 years thereafter.
UNR-M19	Plan area: Conservancy fairy shrimp protection	VPC1.1	CM3, CM9, CM11	Protect a previously unprotected occurrence of conservancy fairy shrimp.	As stated in the biological objective.	Successful achievement of the biological objective.	At any time during reserve system assembly.

Notes

1. The Upland/Nontidal Wetland Restoration Focus Area would also use monitoring results from the following monitoring actions:
   MW-M04 and MW-M05 (Table 3.6-9);
   RCF-M04, RCF-M06, RCF-M07, and RCF-M08 (Table 3.6-8);
   S&T-M02 (Table 3.6-12);
   TWR-M08 (Table 3.6-7); and
   YB-M08 (Table 3.6-6).

3.6.4.7.10 Cultivated Lands Focus Area

There are 37 biological objectives relevant to the cultivated lands focus area (Table 3.6-4). Table 3.6-10 identifies monitoring actions needed to measure progress towards these biological objectives. Most biological objectives dealing with cultivated lands are species-specific objectives related to terrestrial species that depend upon cultivated lands for essential habitat elements; thus there are five objectives dealing with greater sandhill crane, six dealing with Swainson's hawk, three dealing with tricolored blackbird, and nine dealing with giant garter snake, among others. The focus area primarily addresses conservation actions implemented under CM11, but cultivated lands may be associated with reserve system lands protected under conservation measures for floodplains (CM5), channel margins (CM6), riparian areas (CM7), and grasslands ("cultivation" includes rangeland; CM8).

Most of the required monitoring actions consist of information collected at the scale of an individual reserve unit, in accordance with the monitoring provisions of the reserve unit management plan (see Section 3.4.11.2.2 for a description of reserve unit management plans). Most monitoring within the reserve unit is compliance monitoring performed to confirm that a reserve unit has a feature or function prescribed in its design and meets a design-specified performance measure; status and trend monitoring is also performed at the reserve unit scale. Monitoring in this focus area will also use results of monitoring performed for other focus areas (terrestrial species status & trend, upland and nontidal wetland restoration, managed wetland, and riparian, channel margin and floodplain restoration) in evaluating some biological objectives.

1 **Table 3.6-11. Monitoring Actions for the Cultivated Lands Focus Area**

ID # [1]	Monitoring Action(s)	Biological Objective(s) Addressed	Relevant CMs	Action Description	Metric	Success Criteria	Timing and Duration
CL-M01	Reserve unit: habitat: GSHC	GSHC1.1, GSHC1.2, GSHC1.5	CM3, CM11	Monitor availability of high value habitat features for greater sandhill crane, as defined in CM3 Natural Communities Protection and Restoration, and specific to GSHC objectives.	Metrics stated in the biological objectives.	Success criteria stated in the biological objectives.	As stated in the biological objectives.

Notes

1. The Cultivated Lands Focus Area would also use monitoring results from the following monitoring actions:
MW-M02, MW-M03, and MW-M05 (Table 3.6-9);
RCF-M03 and RCF-M04 (Table 3.6-8);
S&T-M (Table 3.6-12);
TWR-M07 and TWR-M08 (Table 3.6-7);
UNR-M12, UNR-M13, UNR-M15, UNR-M16, UNR-M17, and UNR-M18 (Table 3.6-10); and
YB-M08 (Table 3.6-6).

3.6.4.7.11 Terrestrial Species Status & Trend Focus Area

The purpose of status and trends monitoring is to determine the overall status of the biological resources addressed by the Plan, including covered species (FGC 2805(g)(1)). Status and trends monitoring serves two purposes: It provides effectiveness monitoring for the conservation strategy as a whole; and it contributes data and analyses that support efforts to determine the status of the population at larger spatial scales than the Plan Area.

Status and tends monitoring can contribute to evaluating the overall effectiveness of the conservation strategy by establishing a trend baseline that can be used to assess population stability, and by providing information that shows whether species are occupying and reproducing in restored or protected habitat. These types of information are useful in developing adaptive management responses. For example, if a population shows a decrease in counts or density, the monitoring data can be used to assess whether that decrease exceeds expected variation; if so, this could trigger an adaptive management response that might include models or data collection to assess potential drivers that may be causing the decline, as well as adoption of a strategy to reverse the decline. Conversely, if population monitoring shows stable or increasing populations, this would tend to validate the effectiveness of the conservation strategy in conserving the species within the Plan Area.

Monitoring data would also feed into efforts to conserve species at a scale larger than that of the Plan Area, such as are called for in species recovery plans. These data could be used to support and refine models and analysis of rangewide status and conservation strategy effectiveness, as well as to assess the proportional BDCP contribution to the overall species recovery effort.

Status and trends monitoring incorporates models that identify and predict the environmental variables affecting species performance (performance metrics being defined within the model). Such models are necessary in order to formulate the monitoring approach and to interpret the data collected. These models vary widely in character. The simplest are verbal conceptual models, such as a statement that improved habitat suitability will yield increased populations. More complex conceptual models are usually graphically based and incorporate the effects of a wide range of environmental variables; Figure 3.6-3 provides an example of one such model. Still more complex models may be computational and dynamic, providing quantitative tracking of environmental variables and their effects on populations. It is common for models to become more complex and detailed over time, as more and better data become available and enable the testing of more complex hypotheses. This is anticipated to be the case with BDCP; Appendix 2.A includes the conceptual models for all covered species, and in most cases, these models are verbal conceptual models, with graphic conceptual models having been developed for a few of the best-studied species.

The example conceptual model (Figure 3.6-3) shows how status and trends monitoring can test predictions of driver effects on species populations and evaluate the BDCP conservation strategy.

Status and trends monitoring will establish a baseline, and estimate abundance and/or density relative to baseline within the Plan Area (primarily on Reserve and public lands or through partnerships before Reserve lands are established). The metric for status and trends monitoring is increased abundance and density relative to baseline, or specific recovery targets from recovery plans. Another metric for status and trends monitoring is increased distribution throughout the species' range of modeled, suitable habitat within the Plan Area, decreasing the clustering of populations and associated threats, and providing evaluation of the habitat models.

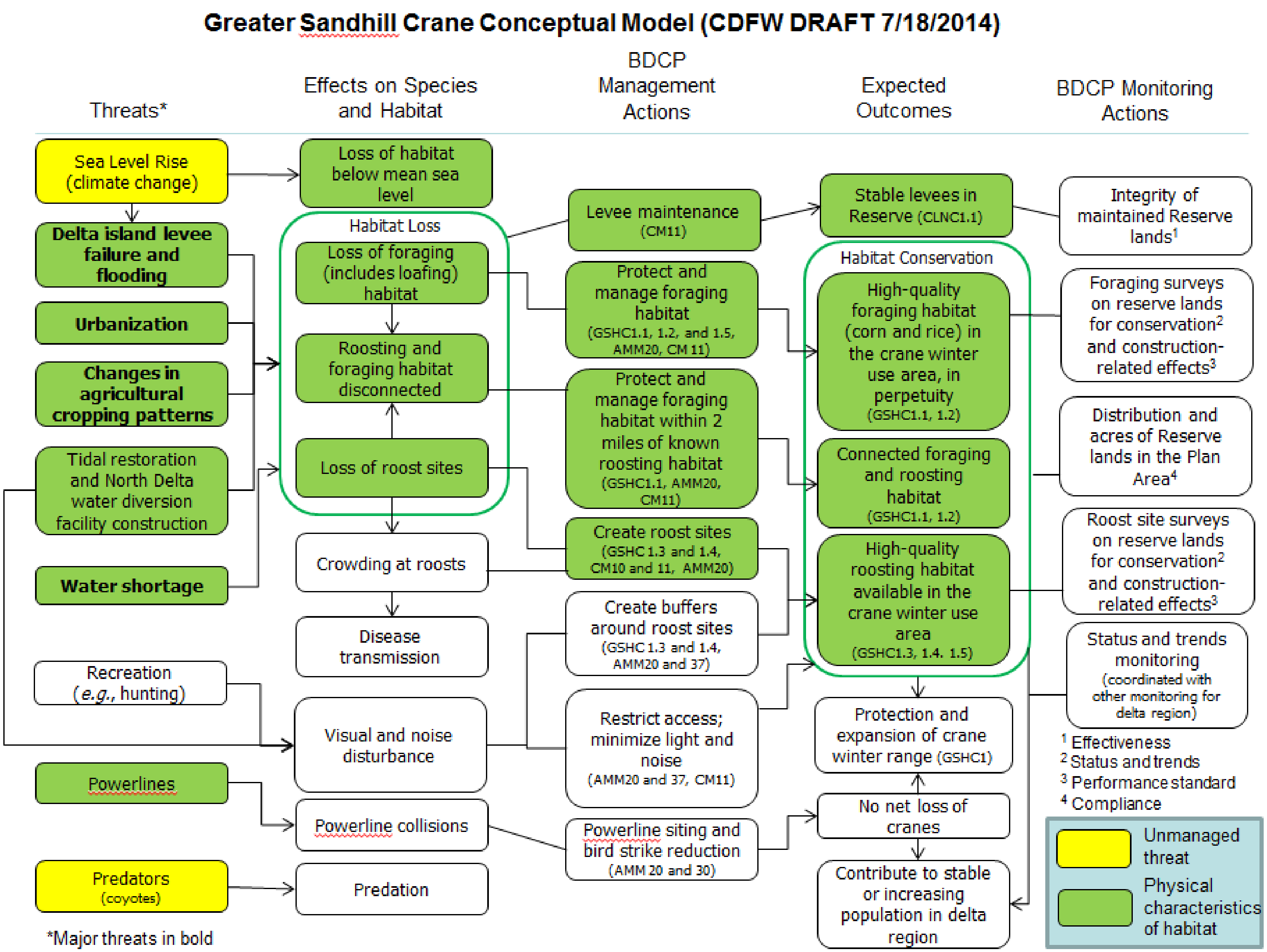

Figure 3.6-3. Example of a graphic conceptual model, for the greater sandhill crane.

Table 3.6-12 lists BDCP monitoring actions for species that are prioritized for immediate baseline studies and status and trends monitoring. If recommendations are not available from the literature, monitoring of these species should be conducted at least every five years after baseline to monitor trends. For monitoring Suisun Marsh species, follow the Walking in the Marsh protocol to increase safety and reduce impacts to wildlife/plants (Customer 2009).

Table 3.6-12. Monitoring Actions for the Terrestrial Species Status & Trend Focus Area

ID # (1)	Species	Biological Objective(s) Addressed	Metric	Protocol (1)	Timing and Duration (2)
S&T-M01	Riparian woodrat	RW1	Growth and expansion of population	USFWS (n.d.) and Williams (1993); coordinate with CSU Stanislaus Endangered Species Recovery Program (ESRP) and the U.S. Fish and Wildlife Service (USFWS). Substitute camera traps for live traps to get trends in detection rates and changes in distribution (Applebee pers. comm.).	Williams (1993) recommended annual 7-10-day live trapping. Where a decline is detected, a quarterly monitoring program should include an evaluation of habitat conditions and live trapping so that the population size could be estimated. If a sharp decline from baseline is detected, monthly live trapping, habitat evaluation, and appropriate research to determine the cause of decline (consult with ESRP and USFWS). Annual trapping should continue until the recovery metric is met; however, due to dramatic annual fluctuations, camera trapping over the long term should determine trends in detection rates and distribution. Monitoring should occur at least every five years, consistent with Endangered species status review periods.
S&T-M02	Carquinez goldenbush	CGB1	Occurrences in sustained suitable habitat	Cypher (2002); Guidelines for conducting and reporting botanical inventories (USFWS 1996); Protocols for surveying and evaluating impacts to special status native plant populations and natural communities (CDFW 2009). Conduct an inventory throughout all suitable and modeled habitat as feasible. Coordinate with CDFW Region 3.	To establish a baseline estimate conduct annual inventories at the appropriate times of year when the species is present and identifiable (usually during flowering or fruiting) for at least five years; multiple site visits during a field season may be necessary to make observations during the appropriate phenological stage. Baseline survey duration should include enough years to cover the range between low and high rainfall. Continue monitoring every 5 years thereafter to determine persistence.
S&T-M03	California Ridgway's Rail (formerly California Clapper Rail)	TBEWNC1.1, TBEWNC1.2	Habitat supports recovery plan targets	Recommended for Suisun Marsh: Invasive Spartina Program (ISP) Protocol C, modified transect survey (Spautz and Albertson 2006). Monitoring sites should be coordinated with CDFW Region 3, CDWR, and USGS audio detection surveys. Coordinate with USGS, CDFW, and CDWR prior to developing the monitoring plan.	Annual monitoring during breeding season throughout Suisun Marsh and the west Delta as far east as (but not including) Sherman Island, over at least 10 years or until recovery targets are met for Suisun Marsh (USFWS 2013). Intensive monitoring every 5 years will be necessary to document any range expansion over the long term.

ID # (1)	Species	Biological Objective(s) Addressed	Metric	Protocol (1)	Timing and Duration (2)
S&T-M04	Suisun thistle	SBB/SuT1	Protected and expanded populations and delisting criteria	Guidelines for conducting and reporting botanical inventories (USFWS 1996); protocols for surveying and evaluating impacts to special status native plant populations and natural communities (CDFW 2009). Coordinate with CDFW Region 3.	For baseline, annual population monitoring of rosettes and reproductive plants of all conserved occurrences for five consecutive years (USFWS 2013), or a higher number of years that covers the range between low and high rainfall. Continue annual monitoring until delisting criteria are met (USFWS 2013 section 3.1.2) and any populations established under the Plan are determined to be self-sustaining. Delisting criteria are 4 separate populations and an annual mean of at least 4,000 individuals across the 4 populations (minimum mean of 500 individuals in a single population); or 7,000 individuals for a widespread indivisible population (USFWS 2013). Continue monitoring every 2 years to determine if there are less than 1,000 individuals over a consecutive 2-year period (USFWS 2013).
S&T-M05	Western yellow-billed cuckoo	VFRNC1, VFRNC2	Large patches of habitat with increased structural diversity that contributes to recovery	Halterman et al. (2011) or the latest version currently in preparation. Consider modifying the survey protocol to increase the chance of detections (more surveys in July) (Dettling and Seavey 2012), with CDFW and USFWS approval.	Sampling schedule per Halterman et al. (2011). Visit each survey site a minimum of four times within the breeding season (late May to mid September), with a minimum of 12 days between surveying at a particular site, and a maximum of 20 days between surveys. Surveys should be conducted annually for at least 4 years to establish baseline (to account for fluctuations) (Dettling and Seavey 2012), and continued until it is determined whether or not the Plan Area contributes to the goal of 150 pairs along the Sacramento River (Dettling and Seavey 2012) and 10 pairs within the Plan Area.
S&T-M06	Delta button-celery	DBC1	Expand distribution and increase abundance	Cypher (2002); guidelines for conducting and reporting botanical inventories (USFWS 1996); protocols for surveying and evaluating impacts to special status native plant populations and natural communities (CDFW 2009). Conduct an inventory throughout all suitable and modeled habitat as feasible.	Conduct inventories at the appropriate times of year when the species is present and identifiable (usually during flowering or fruiting); multiple site visits during a field season may be necessary to make observations during the appropriate phenological stage. For baseline, survey duration should include enough years to cover the range between low and high rainfall. Continue monitoring every 5 years to determine persistence.

ID # (1)	Species	Biological Objective(s) Addressed	Metric	Protocol (1)	Timing and Duration (2)
S&T-M07	Least Bell's Vireo	VFRNC2.2	Stable or increasing population (recovery target)	USFWS (1998). Surveys should consist of either standard point count or area search methods (Ralph et al. 1993). Focus surveying in modeled habitat. If nesting pairs detected, include nest monitoring to detect and remove cowbird eggs or young, and color-band nestlings and adults (USFWS 1998).	Survey during the nesting season (April 15–July 31) for 5 consecutive years for baseline. The highest potential to detect breeding is middle to late May. Continue monitoring at least every 5 years to detect change in distribution (ICF 2012), and to determine if the Plan Area contributes to the recovery target of a stable population of several hundred or more breeding pairs established and protected in the Sacramento and San Joaquin Valleys is reached (USFWS 1998).
S&T-M08	Longhorn fairy shrimp	VPNC1	Recovery goal of self-sustaining populations	USFWS (1996a) and (County of South Sacramento et al. 2010 Appendix L). Coordinate monitoring with the Solano Land Trust's Jepson Prairie Preserve management plan (2006). Survey a sufficient number of pools to test for a statistically significant difference among pool types, with a randomly stratified sub sample and a reference pool sub sample. Rotate sub samples after every two surveys to account for site variability and habitat change and to cover all pools.	Survey after the first substantial storm event (rainfall greater than 0.15 inches) during the rainy season (October 16–April 14) to determine when pools have been inundated (greater than 3 cm [1.2 inches] of standing water 24 hours after a rain event). Sample 3 times during the wet season per monitoring cycle, whereby the first sampling event should occur early in the aquatic phase (a month after inundation), the middle event when hydrophytes start floating, and the last event late in the aquatic phase (early stages of drying). Visit sites annually for 6 years for baseline, then monitor every 3 years. Monitor cyst bank status during the dry season, if necessary.
S&T-M09	Riparian brush rabbit	RBR1	Growth and expansion of populations	USFWS (n.d.) and Williams (1993); coordinate with ESRP and the USFWS. Substitute camera traps for live traps to get trends in detection rates and changes in distribution (Applebee pers. comm.).	Williams (1993) recommended annual 7-10-day live trapping. Where a decline is detected, a quarterly monitoring program should include an evaluation of habitat conditions and live trapping so that the population size could be estimated. If a sharp decline from baseline is detected, conduct monthly live trapping, habitat evaluation, and appropriate research to determine the cause of decline (consult with ESRP and USFWS). Annual trapping should continue until the recovery metric is met; however, due to dramatic annual fluctuations, camera trapping over the long term will determine trends in detection rates and distribution. Monitoring should occur at least every five years, consistent with Endangered species status review periods.

ID # (1)	Species	Biological Objective(s) Addressed	Metric	Protocol (1)	Timing and Duration (2)
S&T-M10	San Joaquin kit fox	GNC1	Grassland protection to reach recovery targets	USFWS (1999) with the following modifications (must be approved by USFWS and CDFW Region 3). Spotlighting should not be used (Fiehler pers. comm.). Protocol should consist of camera stations baited with a cat food can staked to the ground, on which SJKF will readily deposit scat. Scat should be collected individually in a paper bag, genetically analyzed by the Conservation Genetics Laboratory at the Smithsonian Institution or UC Davis, and identified to the species level. Camera station details should be consistent with the methods used by Constable et al. (2009), including tracking of competitors and prey.	Annual surveys over at least 5 years to establish a baseline of whether or not the Plan Area supports persistent populations (Fiehler pers. comm.). At least 5 years of baseline surveys should be repeated after habitat has been restored or conserved. Additionally, whenever a sighting is reported, baited cameras should be placed in the area to confirm the detection. If a population is discovered, a long-term monitoring plan should be developed to help determine whether or not a viable metapopulation can be established north of Merced County (per Williams et al. [1998] level b actions in the recovery strategy). Surveys must be conducted between May 1 and November 1 (USFWS 1999).
S&T-M11	Slough Thistle	ST1	Expand distribution and increase abundance	Cypher (2002); guidelines for conducting and reporting botanical inventories (USFWS 1996); protocols for surveying and evaluating impacts to special status native plant populations and natural communities (CDFW 2009). Conduct an inventory throughout all suitable and modeled habitat as feasible.	Conduct inventories at the appropriate times of year when the species is present and identifiable (usually during flowering or fruiting); multiple site visits during a field season may be necessary to make observations during the appropriate phenological stage. For baseline, survey duration should include enough years to cover the range between low and high rainfall. Continue monitoring every 5 years to determine persistence.
S&T-M12	Soft bird's beak	SBB/SuT1	Protected and expanded populations that meet recovery targets for Suisun Bay	Guidelines for conducting and reporting botanical inventories (USFWS 1996); protocols for surveying and evaluating impacts to special status native plant populations and natural communities (CDFW 2009). Coordinate with CDFW Region 3. Attempting to count individuals is not recommended, as this may damage the fragile root connections to the host plant. Instead, surveys should be done using best estimate of logarithmic abundance class (*i.e.*, 10s, 100s, 1,000s, etc.) (USFWS 2013).	Monitor distribution and abundance annually for five consecutive years for baseline, or a higher number of years that represents the range of low to high rainfall. Continue annual monitoring until delisting criteria are met for the Suisun Bay recovery unit (USFWS 2013) and any populations established under the Plan are determined to be self-sustaining. Delisting criteria are 10 separate populations and a mean of at least 3,000 individuals per population; or 30,000 individuals for a widespread indivisible population (USFWS 2013). Continue monitoring every 2 years to determine if there are less than 1,000 individuals over a consecutive 2-year period (USFWS 2013).

ID # (1)	Species	Biological Objective(s) Addressed	Metric	Protocol (1)	Timing and Duration (2)
STM13	Boggs Lake hedge-hyssop	VPP1	Protected vernal pool plant populations contribute to recovery	Identify the species by walking parallel transects spaced 5–10 meters apart within and around the margins of vernal lakes or pools (Cypher 2002). Create a sampling design following BLM guidelines (Elzinga et al. 1998). Monitor modeled habitat within the Jepson Prairie and Altamont Core Areas, Stone Lakes National Wildlife Refuge (NWR), and Tule Ranch in the Yolo Bypass Wildlife Area (WA). Coordinate monitoring in Jepson Prairie with the Solano Land Trust's Jepson Prairie Preserve management plan (2006) and with USFWS and CDFW monitoring plans or programs.	Measure plant occurrences in pools starting one month before the typical flowering phase (April–August), or when flowering is observed in reference pools nearby. Monitor at least 3 times: early-season sampling at the pool margins, mid-season sampling at margins and throughout the pool when water levels start to recede, and late-season sampling at margins and throughout the pool when water levels have receded to a maximum level of 5 cm (USFWS 2005, Sacramento County et al. 2010). Monitor each year for at least 5 years (ICF 2012) for baseline. Survey duration for baseline should include enough years to cover the range between low and high rainfall. Continue monitoring every 5 years after protection of 95% of habitat, to determine if habitat protection supports viable populations.
STM14	Suisun shrew	TBEWNC1, TBEWNC2, GNC1.4	Protected or created habitat contributes to recovery	Consult with CDFW Region 3 and Wildlife Branch before developing a protocol. Follow USFWS' protocol for the Buena Vista Lake Shrew (USFWS 2012) as modified by CDFW for the Suisun shrew and region.	For baseline, survey large tidal marshes annually over at least 3 years to account for the annual and geographic variation of population fluctuations, including or in addition to at least two years following extreme climate events (USFWS 2013). Monitor another two years for biological/ ecological studies described in USFWS (2013). Continue monitoring every 5 years to determine whether or not increased habitat contributes to recovery.
STM15	Salt-marsh harvest mouse	SMHM1	Sustained healthy population	Shellhammer (2002) or the most recent agency-approved protocol developed by the SMHM working group. Coordinate with CDFW Region 3.	Monitor over a minimum of a 4-month period between April and July, with one sampling event each month (Shellhammer 2002). Monitor every 5 years until capture efficiency targets have been met at least twice, and again after 20 years if there had been no obvious changes to habitat (USFWS 2013). Capture efficiency targets are occupancy of 40% of viable habitat areas (VHAs) within a marsh complex at a capture efficiency level of 5.0 or better, plus an additional 50% of VHAs with capture efficiency level of 3.0 or better (USFWS 2013).

Notes

The protocol listed or described is the most current protocol in use by experts or approved by the agencies (USFWS and/or CDFW). Specific monitoring plans should verify if there is a more recent protocol approved by the agencies that is standard and most commonly used. Monitoring plans should also consider protocols that are consistent with other region-wide monitoring efforts, for effective data compilation, synthesis, and analysis, as approved by the appropriate agency or agencies.

May be modified in a more detailed monitoring plan based on monitoring results, feasibility or other considerations, or as recommended by species experts.

3.6.4.8 Research

[unchanged text omitted]

Contents of a research action report will focus on responding to the questions framed during action design (Section 3.6.3.4.4, *Step 4: Plan and Design Implementation Actions*) but will in all cases include a detailed, explicit statement of how the action has addressed relevant key uncertainties and how those findings have modified relevant conceptual ecological models. The report will also present a fully detailed explanation of the background, methods, results, and implications of the research, and will identify new or residual sources of uncertainty. Reports will receive independent peer review by reviewers chosen by the Adaptive Management Team.

The following subsections identify principal research concerns for each of the focus areas.

3.6.4.8.1 Decision Trees Focus Area

The decision trees, described in Section 3.4.1.4.4, *Decision Trees*, are a structured adaptive management process that will assist in determining initial flow criteria for CM1. This adaptive management process will commence upon BDCP approval and will continue until final operating criteria are determined at the initiation of CM1 operations; thereafter, any revisions to the operating criteria would be enacted according to the adaptive management process described above (Section 3.6.3.5, *Adaptive Management Decision Process*). There are two decision trees; one addresses fall outflow requirements and their importance to delta smelt, and the other addresses spring outflow requirements and their importance to longfin smelt. See Section 5.5.1.1.2, *Fall X2 Decision-Tree Process*, for an explanation of the importance of the fall outflow decision tree to delta smelt, the potential outcomes associated with each branch of the decision tree, and the prevailing sources of uncertainty in those outcomes. Section 5.5.2.1.1, *Spring Outflow Decision-Tree Process,* provides the corresponding discussion for longfin smelt.

The decision trees adaptive management process is specified in Section 3.4.1.4.4, *Decision Trees,* while this section identifies the research actions that must occur to support that process.

Note to reader: Additional text for this subsection has not yet been developed and may not be developed prior to final BDCP permitting. Most of the research needed to resolve the Decision Trees is already underway under the aegis of existing programs such as the Interagency Ecological Program (IEP) and Collaborative Science and Adaptive Management Program (CSAMP). Any further research needs are subject to determination through collaborative discussions between the permittees, Reclamation, and the fish and wildlife agencies.

3.6.4.8.2 Covered Fish Performance Focus Area

A wide array of ongoing and proposed research activities are focused on population status of covered fish species. This work is being performed currently by many of the BDCP partners (Table 3.6-2), as well as by a variety of state and federal agencies, both individually and collaboratively through existing programs such as the Interagency Ecological Program (IEP) and Collaborative Science and Adaptive Management Program (CSAMP). Table 3.6-15 lists research activities needed to resolve an array of 33 key uncertainties regarding the effects of BDCP conservation measures on covered fishes.

1 **Table 3.6-15. Key Uncertainties and Potential Research Actions Relevant to Covered Fish Performance**

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
CFP-R01	Relationship between proposed intake design features and expected intake performance relative to minimization of entrainment and impingement risks.	Develop physical hydraulic model(s) to optimize hydraulics and sediment transport at the selected diversion sites (same as preconstruction study 1, Site Locations Lab Study [Fish Facilities Working Team 2013]). 10 months to perform study; needed prior to final design	CM1
CFP-R02	Evaluation of tidal effects and withdrawals on flow conditions at screening locations	Develop site-specific numerical studies (mathematical models) to characterize the tidal and river hydraulics and the interaction with the intakes under all proposed design operating conditions (same as preconstruction study 2, Site Locations Numerical Study [Fish Facility Working Team 2013]). 8 months to perform study; needed prior to final design	CM1
CFP-R03	Design of refugia areas (macro, micro, and base refugia)	Test and optimize the final recommendations for refugia that will be required for installation at the north Delta diversion facilities (same as preconstruction study 3, Refugia Lab Study [Fish Facility Working Team 2013]). 9 months to perform study; needed prior to final design	CM1
CFP-R04	Examination of refugia at future fish screens.	Evaluate the effectiveness of using refugia as part of diversion structure design for the purpose of providing areas for juvenile fish passing the screen to hold and recover from swimming fatigue and to avoid exposure to predatory fish. In addition, gain insights (through observation) into the biological benefits of incorporating refugia into diversion structures (same as preconstruction study 4, Refugia Field Study [Fish Facility Working Team 2013]). 2 years to perform study; needed prior to final design	CM1
CFP-R05	Characterize the water velocity distribution at river transects within the proposed intake reaches for differing river flow conditions.	Characterize the water velocity distribution at river transects within the proposed diversion reaches for differing flow conditions. Water velocity distributions in intake reaches will identify how hydraulics change with flow rate and tidal cycle (same as preconstruction study 7, Flow Profiling Field Study [Fish Facility Working Team 2013]). 1 year to perform study; needed prior to final design	CM1
CFP-R06	What are the effects of deep-water screens on hydraulic performance	Use a computational fluid dynamics model to identify the hydraulic characteristics of deep fish screen panels (same as preconstruction study 8, Deep Water Screens Study [Fish Facility Working Team 2013]). 9 months to perform study; needed prior to final design	CM1
CFP-R07	How will the new north Delta intakes affect Delta and longfin smelt density and distribution in the affected reach of the Sacramento River?	Determine baseline densities and seasonal and geographic distribution of all life stages of covered fish species inhabiting reaches of the lower Sacramento River where proposed north Delta diversion structures will be sited Following initiation of diversion operations, continue sampling using same methods and at same locations. Compare to baseline catch data. Identify potential changes due to construction of intakes (same as preconstruction study 11, Baseline Fish Surveys, and postconstruction study 11, Post-Construction Fish Surveys [Fish Facilities Technical Team 2011; Fish Facility Working Team 2013]). Preconstruction study will require at least 3 years. Post-construction studies to be performed for duration of project operations, with timing and frequency to be determined.	CM1

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
CFP-R08	How will the new north Delta intakes affect survival of juvenile salmonids in the affected reach of the Sacramento River?	Determine baseline rates of survival for juvenile Chinook salmon and steelhead within the Sacramento River in the vicinity of proposed north Delta diversion sites for comparison to post-project survival in the same area, with sufficient statistical power to detect a 5 percent difference in survival. Following initiation of project operations, continue studies using same methodology and same locations. Identify the change in survival rates due to construction/operation of the intakes (same as preconstruction study 10, Reach-Specific Baseline Juvenile Salmonid Survival Rates, and postconstruction study 10, Post-Construction Juvenile Salmon Survival Rates [Fish Facilities Technical Team 2011; Fish Facility Working Team 2013]). The preconstruction study will require at least 3 years; must be completed before construction begins. Postconstruction study to cover at least 3 years, sampling during varied river flows and diversion rates.	CM1
CFP-R09	Where is predation likely to occur in the vicinity of the new North Delta intakes?	Perform field evaluation of similar facilities (e.g., Freeport, RD108, Sutter Mutual, Patterson Irrigation District, and Glenn Colusa Irrigation District) and identify predator habitat areas at those facilities (same as FFTT preconstruction study 5, Predator Habitat Locations). This 1 or 2 year study is needed prior to intake facility final design.	CM1, CM15
CFP-R10	What are predator density and distribution in the intake reach of the Sacramento river?	Use a Didson camera or other technology and/or acoustic telemetry at two to three proposed screen locations; perform velocity evaluation of eddy zones if needed. Collect baseline predator density and location data prior to facility operations; compare to density and location of predators near operational facility. Identify ways to reduce predation at the facilities (same as FFTT study 9. Predator Density and Distribution, both pre- and postconstruction). These studies should be started as soon as possible to collect multiple annual datasets before construction begins. The studies should continue with 3-year postconstruction study (provided varied river flows and sufficient predator populations)	CM1, CM15
CFP-R11	What are the best predator reduction techniques? Which are feasible, most effective, and best minimize potential impacts on covered species?	Perform literature search and potentially field evaluations at similar facilities (e.g., Freeport, RD108, Sutter Mutual, Patterson Irrigation District, and Glenn Colusa Irrigation District). Test and evaluate various predator reduction techniques at operational south Delta facilities with regards to efficacy, logistics, feasibility, cost and benefits, and public acceptance. Determine if these techniques also take covered fishes and assess ways to reduce such by-catch, if necessary (extended version of FFTT Pre-construction study 6, Predator Reduction Methods). This 2 years must be completed prior to final design of north Delta intakes.	CM15
CFP-R12	How do less south exports and the head of Old River operable gate, together with other conservation measures, influence through-Delta survival of San Joaquin River region juvenile salmonids?	Assess survival using acoustically tagged juvenile salmonids, employing methods similar to those of Buchanan et al. (2013). Overall through-Delta survival, together with reach-specific (e.g., head of Old River to middle River) and pathway-specific (e.g., Chipps Island via Old River) survival, would be used to assess the importance of CM1 operations as well as the effectiveness of other measures such as CM5 and CM15. Predation near the proposed head of Old River barrier (at and near the operable gate) would be studied with a multi-receiver hydroacoustic array. Conduct 3–5 years of study prior to CM1 implementation in order to capture years with varying hydrology; and another 3–5 years of study after CM1 implementation.	CM1

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
CFP-R13	What are the effects of localized predator reduction measures on predator fish and covered fish species?	Use before and after studies to evaluate the distribution and abundance of predators and covered fish species at treatment location and nearby sites. Metrics include abundance, age classes, and distribution of predators such as striped bass, largemouth bass, and other smaller piscivorous fish. Measure rates of site recolonization by predators following reduction treatments. This 2- to 3-year study should be performed by year 5	CM15
CFP-R14	Under what circumstances and to what degree does predation limit the productivity of covered fish species?	Evaluate predation effect on productivity of covered fish species using life-cycle simulation models and site-specific bioenergetics modeling (Loboschefsky et al. 2012). This would be a 1-year study, best performed after other studies providing detailing the incidence of predation.	CM15
CFP-R15	How should hotspots for localized predator reduction and/or habitat treatment be prioritized?	Document the extent and locations of predator hotspots within the Delta, and evaluate relative intensity of predation and feasibility of treatment. Use a habitat suitability approach at known hotspots to identify specific physical features and hydrodynamic conditions that facilitate elevated predation loss. Perform tagging studies to identify areas that facilitate intense predation (e.g., Bowen et al. 2009; Vogel 2011). This 1-year study, should be performed by year 5	CM15
CFP-R16	Which predator species and life stages have the greatest potential impact on covered fish species?	Determine whether large predators that are comparatively easy to target for reduction are the key predators of some or many covered fishes. Conduct site-specific monitoring of predator abundance (by species and life stage) during periods when covered fish species (particularly juvenile salmonids) are present. Determine site-specific diet composition of predators (e.g., using DNA analysis of predator stomach contents). This 1- to 3-year study should be performed by year 5	CM15
CFP-R17	Is modification of sportfishing regulations a viable and effective means of achieving localized predator reduction?	Perform literature review and interviews with qualified agency and independent scientists to summarize potential benefits, hazards, costs, and implementation issues associated with using modification of sportfishing regulations to manage predatory fish in the Delta. This up-to-1-year study should be performed by year 5.	CM15
CFP-R18	How have other BDCP conservation measures affected the distribution and intensity of predation in the Plan Area?	Restoration actions are expected to create additional habitat for some species of predators along with covered species (e.g., CM2 Yolo Bypass Fisheries Enhancement, CM4 Tidal Natural Communities Restoration, CM5 Seasonally Inundated Floodplain Restoration, CM6 Channel Margin Enhancement, and CM7 Riparian Natural Community Restoration). Monitoring and potential active adaptive management studies will be developed, if increased predation is suspected or demonstrated in conjunction with habitat restoration or enhancement projects. Study timing and duration to be determined by Adaptive Management Team; studies best performed periodically during BDCP implementation as progress proceeds on these other CMs.	CM15
CFP-R19	How effective are nonphysical barriers over the long term?	Multiple studies can inform this question, including (1) evaluate change in distribution, abundance and survivorship of covered species in barrier vicinity; (2) evaluate covered species behavioral response to barriers; (3) evaluate effectiveness of barriers in high-flow areas and reversing-flow areas; and (4) evaluate the barrier performance with studies using tagged juvenile salmonids.	CM16
CFP-R20	How do nonphysical barriers affect predators?	Determine the abundance of predators, by species, within the area of the nonphysical barriers, both before and after installation, and evaluate the effect of the barriers on the survival of outmigrating juvenile salmonids. Determine whether predators are attracted to the nonphysical barriers, and if so, the locations relative to the barrier where they aggregate, and how they respond to changes in barrier operation.	CM16

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
CFP-R21	Do nonphysical barriers delay upstream-migrating adult salmonids and sturgeons?	Evaluate the behavior of upstream-migrating adult salmonids and sturgeons at nonphysical barriers, for evidence of delay caused by the barriers. Viable methods may include conducting DIDSON monitoring, or by acoustic tagging.	CM16
CFP-R22	Improve understanding of the relationship between flow regimes and year class recruitment for green and white sturgeon	Reanalysis of existing year-class strength data (e.g., from Fish [2010], with updates for additional years), with model selection of various potential explanatory flow variables (e.g., flows upstream of the Plan Area, flows within the Plan Area) in order to test clearly defined hypotheses (e.g., winter flows are important to migrating adults to stimulate upstream migration and gonadal maturation; Fish 2010). Possible field studies involving acoustically tagged sturgeon in the Plan Area to assess the importance of Delta outflow on adult and juvenile migration success. Completion prior to initial operations of north Delta diversions, if possible, with additional study following implementation of CM1	CM1
CFP-R23	To what extent does the BDCP reduce straying of adult San Joaquin River region fall-run Chinook salmon?	Following the suggestions of Marston et al. (2012: 19), assess the influence on straying rate (as measured by coded wire tag returns) of 1) relative roles of south Delta exports and San Joaquin River flow, 2) the timing of pulse flows and export reductions, and 3) the role of pulse flows versus base flows. Changes in these factors and stray rate following implementation CM1 would be examined, in addition to changes in total escapement. For field study, 3–5 years of study prior to CM1 implementation in order to capture years with different varying hydrology; 3–5 years of study after CM1 implementation.	CM1
CFP-R24	Do lower attraction flows below the north Delta intakes result in greater straying of upstream migrating adult anadromous fishes from the Sacramento River region?	Capture and acoustically tag adult salmonids and sturgeons in San Francisco Bay or Suisun Bay, then track movement using existing hydroacoustic array. Assess proportion entering non-natal river region, then relate this to flow experienced during migration period. As an alternative or in addition, a study of existing coded-wire tag data from recovered carcasses could be done, in a similar manner to that of Marston et al. (2012), in order to assess the rate of straying in relation to flows during upstream migration. 3–5 years of study required prior to CM1 implementation; another 3–5 years of study following CM1 and CM4 implementation; the actual number of years will be dependent on hydrology encountered and schedule of restoration.	CM1
CFP-R25	What is the relationship between Delta Cross Channel gates operations, covered fish movement and survival, and tidal flows?	Document effects of Delta Cross Channel gates operation, in conjunction with other aspects of CM1 implementation, on hydrodynamics and fish migration. Study timing/duration to be determined.	CM1
CFP-R26	How do north Delta intake bypass flows, Delta Cross Channel gate operations, and tidal habitat restoration under CM4 influence covered fish (primarily juvenile salmonid) movement and survival in the interior Delta due to entry through Georgiana Slough and the Delta Cross Channel?	Conduct modeling including CM1 operations and proposed CM4 site designs to assess hydrodynamics in Plan Area channels. Using acoustic tag studies, assess fish survival and movement in the Plan Area, particularly at the Sacramento River-Georgiana Slough junction (would be studied as part of CM16 assessment). Use flow data from existing gauges to derive Sacramento River inflow relationships with the flow split at the Sacramento River-Georgiana Slough divergence before and after implementation of CM1 and CM4. 3–5 years of study prior to CM1 implementation; 3–5 years of study following CM1 and CM4 implementation; number of years dependent on hydrology encountered and schedule of restoration.	CM1

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
CFP-R27	Does increased enforcement reduce the incidence of illegal harvest, and if so, does this result in a beneficial outcome at the population level for the relevant species (adult salmonids and sturgeons)?	Use monitoring data to assess magnitude of harvest effects on covered species populations; use literature and other BDCP-related monitoring to assess the magnitude of that effect relative to other conservation actions.	CM17
CFP-R28	How long can refugial populations of both Delta and longfin smelt be maintained with little or no supplementation from wild stocks?	Monitor genetic diversity and captive population size, tracking performance over time relative to genetic composition of naturally produced populations.	CM18
CFP-R29	What techniques will reduce the cost and improve the effectiveness of preproject monitoring?	The BDCP will support research to develop means of more quickly and effectively estimating preproject entrainment risk and project effectiveness in reducing entrainment risk. Scoping of this research and assessment of its results will be performed by the Adaptive Management Team.	CM21
CFP-R30	To what extent does CM1 change the abundance and distribution of Microcystis?	Assess abundance and distribution of Microcystis using field studies such as those of Lehman et al. (2005, 2010). Study to be performed during summer months following implementation of CM1 (i.e., after north Delta intakes are completed and diversions at the south Delta export facilities decrease). Multiple year study to capture hydrological and operational variability.	CM1
CFP-R31	How do BDCP covered activities alter suspended sediment concentrations and water clarity in Plan Area waters used by Delta and longfin smelts, and Sacramento splittail?	Develop a suspended sediment model that includes representation of potential areas of tidal restoration (CM4) and areas of flow alteration due to water operations (CM1). Apply this model to develop and adapt sediment management actions, e.g., by modeling alternative locations for release of reusable tunnel material and sediment removed by the north Delta intakes, in order to maximize the potential for beneficial effects on suspended sediment in the Plan Area.	CM1, CM4
TWR-R14	What new invasive species will enter the Plan Area in the future, and what existing invasive species will proliferate relative to current conditions?	Through the adaptive management process, the Adaptive Management Team will recommend appropriate responses to the appearance of new invasive species threats or the proliferation of existing invasive species by identifying research priorities or modifying conservation measure implementation to maintain focus on those invasive species that pose the greatest threat to Delta ecosystems and that can be dealt with by controlling the risk of accidental introduction.	CM20
TWR-R15	Do juvenile sturgeon use restored tidal wetlands?	Capture and acoustically tag juvenile sturgeons in Plan Area, then track movement using existing hydroacoustic array. Assess fraction of time in or adjacent to restored tidal wetlands. Begin the 3-5 year-long study when 20% of tidal wetland restoration acreage is achieved.	CM4

Ten key uncertainties in Table 3.6-15 concern aspects of the design, operation, and performance of the proposed north Delta intakes. They include hydraulic and hydrodynamic studies, considerations related to entrainment and impingement, design and siting of refugia, effects on salmonid and smelt performance, and predation studies. Predation in general is a dominant theme among the key uncertainties, represented in 10 different potential studies. Five studies address other factors (besides predation) influencing covered species survivorship; these include the effects of altered south Delta diversion operations on San Joaquin River salmonid survivorship and straying, whether nonphysical barriers effectively improve survivorship, how flow regimes affect sturgeon recruitment, the effectiveness of increased enforcement to interdict illegal harvest, and integrative studies of how multiple BDCP actions (north and south Delta diversions, tidal restoration, altered operation of physical and nonphysical barriers) result in net changes to survivorship. Another group of studies address BDCP effects at the ecosystem and landscape scales; these include studies of altered hydrodynamics, changes in water quality and turbidity attributes critical to covered fishes, changes in *Microcystis* abundance and distribution, and changes in the types and abundances of aquatic invasive species. Completion of this research will greatly improve understanding of the Delta processes critical to survival and recovery of covered fish species.

3.6.4.8.3 Yolo Bypass Focus Area

The ten key uncertainties in the Yolo Bypass focus area (Table 3.6-16) primarily address the question of how effective CM2 is in achieving its intended outcomes. Five of these uncertainties call for studies focused on fish passage. Four studies would seek to determine whether the component projects at Fremont Weir, Sacramento Weir, lower Putah Creek, and the remaining portions of the bypass are having their intended effect. A fifth would measure the proportion of upstream migrant salmonids and sturgeons entering the bypass, and would determine whether they encounter migration delays as a result. Two other studies are focused on the anticipated increase in forage production as a consequence of floodplain inundation in the bypass; one of these studies would measure the actual changes in production of food available for use by rearing salmonids, and the other would determine whether this is resulting in improved growth rates. One study would investigate changes in Sacramento splittail reproduction and survivorship as a result of the altered inundation regime in the bypass. Another would investigate whether increases in inundation in the bypass are resulting in increased predation on covered fishes. Finally, one study would seek to determine whether the altered inundation regime is affecting elderberry shrubs and other valley/foothill riparian vegetation in the bypass.

Table 3.6-16. Key Uncertainties and Potential Research Actions Relevant to the Yolo Bypass

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
YB-R01	How effective are the fish passage modifications at Fremont Weir?	Evaluate the effectiveness of the fish passage gates at Fremont Weir, and evaluate the effectiveness of the sturgeon ramps.	CM2
YB-R02	How effective are the fish passage modifications at Sacramento Weir?	Determine whether Sacramento Weir improvements have benefited fish passage and minimized stranding risk.	CM2
YB-R03	How effective are the fish passage modifications within the Yolo Bypass?	Determine whether stilling basin modification has reduced stranding risk for covered fishes. Determine effectiveness of Tule Canal/Toe Drain and Lisbon Weir improvements in reducing the delay, stranding, and loss of migrating salmon, steelhead, and sturgeon.	CM2
YB-R04	Is the modified inundation regime improving reproduction and survivorship of Sacramento splittail in the Bypass?	Document Sacramento splittail spawning and spawning success in the Yolo Bypass during Fremont Weir operation.	CM2
YB-R05	Have the Lower Putah Creek enhancements had the expected effects on fish passage?	Evaluate whether the Lower Putah Creek realignment has improved upstream and downstream passage by covered fish.	CM2
YB-R06	Is the modified inundation regime affecting predation on covered fishes in the Bypass?	Determine severity of predation effects on covered fish using the Yolo Bypass.	CM2
YB-R07	Is the modified inundation regime improving production of forage for covered fishes?	Determine plankton and invertebrate production rates during periods the Fremont Weir is operated.	CM2
YB-R08	Is the change in foraging resources producing improved growth rates among rearing salmonids?	Determine growth rates of juvenile salmonids that have entered the Yolo Bypass during Fremont Weir operation.	CM2

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
YB-R09	Do increased frequency and duration of flooding in Yolo Bypass affect the health and vigor of elderberry shrubs and other valley/foothill riparian vegetation in the Yolo Bypass?	Monitor key indices of plant health and vigor for elderberry shrubs and other riparian species at selected sites prior to implementation of CM2, and at regular intervals (to be determined) following Fremont Weir improvements.	CM2
YB-R10	What proportion of upstream migrating adult salmonids and sturgeons enter the Yolo Bypass and may be subject to delay at passage barriers?	Capture and acoustically tag adult salmonids and sturgeons in San Francisco Bay or Suisun Bay, then track movement using existing hydroacoustic array, augmented as necessary with new hydrophones in the Yolo Bypass area. Assess use of different routes through the Plan Area to upstream spawning areas. Study should include collection of 3–5 years of data prior to implementation of CM2 passage improvement projects in order to capture years with varying hydrology (including overtopping and no overtopping of Fremont Weir), and an additional 3–5 years of data collection after CM2 passage improvement projects have been implemented. (Note that this action is similar to CFP-R24 and the same tagged fish could be used to answer both questions.)	CM2

3.6.4.8.4 Tidal Wetland Restoration Focus Area

Tidal wetland restoration has not been widely practiced in the Delta, and as a result, there remain large uncertainties about how best to create sustainable tidal wetlands with desired functional attributes. Table 3.6.4.8.3-1 lists key uncertainties and potential research actions relevant to tidal wetland restoration.

Table 3.6-17. Key Uncertainties and Potential Research Actions Relevant to Tidal Wetland Restoration

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
TWR-R01	How does tidal marsh restoration affect production of food suitable for covered fish species both within and outside of the restored sites?	Quantify the primary and secondary production, including food suitable for covered species, both within restored tidal marsh natural communities and transported from restored areas to adjacent open-water habitat and its fate.	CM4
TWR-R02	How have hydrodynamic changes associated with tidal restoration affected organic carbon transport and fate?	Quantify the flux of organic carbon produced in restored tidal marsh plain into existing channels in the Plan Area.	CM4
TWR-R03	How has tidal marsh restoration affected benthic invertebrate communities? In particular, how are invasive mollusks affecting zooplankton production in restored tidelands?	Document and evaluate water quality conditions in restored subtidal aquatic habitats. Assess density and foraging effectiveness of Asian clams or other invasive species that colonize restoration sites. Periodically repeat surveys to determine if delayed colonization occurs.	CM4
TWR-R04	Improve understanding of the life cycles and ecological relationships of invasive mollusks.	Identify constraints limiting larval transport, settlement and establishment of invasive mollusks; the role of nutrients in facilitating invasion; and potential control mechanisms for invasive mollusks.	CM4

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
TWR-R05	How is temporal habitat loss resulting from tidal natural communities restoration affecting salt marsh harvest mouse and Suisun shrew?	On restored tidal brackish marsh, perform a capture and release tagging study to determine colonization rate, abundance, and distribution of salt marsh harvest mouse. On lands adjacent to planned tidal restoration sites, perform capture and release tagging study to determine whether a sufficient population of salt marsh harvest mouse exists to serve as a source population for recolonizing newly restored areas. Conduct similar studies for Suisun shrew.	CM4
TWR-R06	How do nonnative species use restored tidal natural communities?	In addition to the Asian clam studies (TWR-R3), evaluate potential colonization of restored tidal natural communities by other invasive flora and fauna. Assess effects of nonnative species in restoration sites on covered species and natural communities. Identify ways to avoid and minimize those impacts.	CM4
TWR-R07	To what extent does CM4 result in changes in contaminants that could affect covered fishes?	Compare contaminant concentrations in/near restored areas before and after restoration has occurred, at representative sites. Must occur prior to restoration, and following restoration, with sufficient sampling intensity over a variety of hydrological conditions to allow inferences to be made about a range of water-year types.	CM4
TWR-R08	What shorebird species are using restored tidal wetlands and in what relative abundance? Does habitat use shift over time as tidal wetlands evolve?	Perform regular surveys to determine seasonal abundance of shorebirds on restored tidal wetlands. Survey methods and timing will be coordinated with shorebird surveys on managed wetlands, cultivated lands, and nontidal wetlands so that relative abundance and habitat use can be tracked within the BDCP Reserve over time.	CM4
TWR-R09	How effectively does CM12 minimize production and mobilization of methylmercury from lands in the reserve system and the foodweb?	A connected group of studies will be needed, likely to be implemented at a representative selection of restoration sites. Studies will evaluate wetland management strategies intended to minimize methylation; evaluate the ecological fate of wetland-generated methylmercury; evaluate the biological thresholds for mercury exposure for covered species to guide methylmercury objectives and Delta wetland management priorities; and evaluate the Plan Area–wide effectiveness of CM12 site screening.	CM12
TWR-R10	Do measures implemented under CM12 to minimize microbial methylation of mercury interfere with the potential of a restoration project to meet its intended purpose?	Comparatively evaluate conservation sites in different types of wetland natural communities.	CM12
TWR-R11	What are the most effective designs of tidal restoration sites to achieve tidal flow velocities that preclude rooting by IAV?	Resolution requires a linked series of studies: (1) Conduct empirical and lab studies to determine flow constraints on rooting of IAV species of concern. (2) Conduct model studies to assess velocity field for alternative restoration site design. (3) Conduct field tests in restoration site projects.	CM13
TWR-R12	How are restored natural communities being affected by IAV and have there been changes in existing areas?	Evaluate the effect of tidal natural communities restoration on the establishment of IAV in subtidal aquatic habitats. Evaluate whether there have been changes in IAV that could be related to Plan operations (e.g., changes in Delta hydrodynamics).	CM13
TWR-R13	Is it feasible to create conditions that favor the growth of native pondweeds (*Stuckenia* spp.)	Various approaches exist to address this topic, potential ones include (1) Evaluate environmental conditions that support native pondweed stands,	CM13

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
	rather than IAV?	focusing on abiotic factors, particularly salinity, that determine growth and distribution of native pondweeds. (2) Evaluate how future salinity changes affect growth and distribution of pondweeds and Egeria. (3) Determine what differences in environmental conditions and abiotic factors favor Stuckenia over Egeria. (4) Evaluate to what extent restoration sites can be designed to encourage colonization and growth of native pondweeds while discouraging Egeria. (5) Determine the potential for native pondweed stands to contribute to restoration of native communities and ecosystem functions in the Delta. (6) Determine if the epifaunal invertebrate assemblages supported by native pondweed stands provide substantial foraging and cover benefits in comparison with Egeria.	
TWR-R14	What new invasive species will enter the Plan Area in the future, and what existing invasive species will proliferate relative to current conditions?	Through the adaptive management process, the Adaptive Management Team will recommend appropriate responses to the appearance of new invasive species threats or the proliferation of existing invasive species by identifying research priorities or modifying conservation measure implementation to maintain focus on those invasive species that pose the greatest threat to Delta ecosystems and that can be dealt with by controlling the risk of accidental introduction.	CM20
TWR-R15	Do juvenile sturgeon use restored tidal wetlands?	Capture and acoustically tag juvenile sturgeons in Plan Area, then track movement using existing hydroacoustic array. Assess fraction of time in or adjacent to restored tidal wetlands. Begin the 3–5 year-long study when 20% of tidal wetland restoration acreage is achieved.	CM4

Adaptive Management Process for Tidal Restoration in the South Delta

One of the principal uncertainties identified during BDCP development concerned the timing, extent, and outcomes of tidal wetland restoration in the South Delta ROA. In order to accommodate this uncertainty, tidal wetland restoration in the South Delta ROA would not begin until substantial progress had occurred toward tidal wetland restoration targets in other portions of the Delta. Moreover, these projects would have to have developed a large fraction of their target ecological function, as demonstrated by at least several years of monitoring data. Due to the time lags involved in planning, constructing, and monitoring tidal restoration projects, it is unlikely that the requisite monitoring data would have been acquired prior to implementation year 15, and would more likely be available by implementation year 20. At such time as members of the Adaptive Management Team (AMT; see Sect. 3.6.2.2 for a description of this group and their function in the adaptive management process) agree that sufficient data and analysis have been performed to warrant an in-depth review of the feasibility and desirability of South Delta tidal wetland restoration, such a review would occur, as part of the regular five-year review of BDCP effectiveness (see Section 6.3.5, *Five-Year Reviews*). Prior to this review, the five-year tidal restoration targets (see Table 6-2) would be met through restoration efforts in ROAs other than South Delta.

The reason that south Delta tidal restoration would not need to occur until this milestone is two-fold. First, it provides sufficient time for tidal natural community restoration to occur in large blocks in high-priority sites (e.g., Suisun Marsh, Cache Slough, West Delta) where benefits to covered species are more certain. Second, this delay will allow for a formal scientific assessment of the performance of tidal natural community restoration in the Delta prior to initiating restoration in the south Delta.

The South Delta tidal wetland restoration feasibility assessment will be conducted by a task force appointed by the AMT, and reviewed by an appointed independent science panel. The task force will include key technical staff familiar with the construction and operation of major tidal wetland restoration projects implemented by BDCP, and key technical staff familiar with the conduct and analysis of monitoring and research studies performed to assess the effectiveness of those implemented restoration projects and their effects on covered fish species performance (see Section 3.6.4.7, *Effectiveness Monitoring* and Section 3.6.4.8, *Research* for a description and listing of the monitoring and research actions relevant to tidal wetland restoration and covered fish species performance). The task force will also include staff representing the permittees, the fish and wildlife agencies, and such other entities as the AMT deems appropriate. The task force will use the best scientific information available at the time to develop a written report addressing the following:

- an evaluation of the success of tidal wetland restoration projects completed to date with regard to resolution of relevant key uncertainties (listed in Table 3.6-17 *Key Uncertainties and Potential Research Actions Relevant to Tidal Wetland Restoration*);
- an evaluation of the success of tidal wetland restoration projects completed to date with regard to achievement of relevant biological goals and objectives;
- an evaluation of the success of tidal wetland restoration projects completed to date with regard to supporting improved covered fish performance; with particular regard to key uncertainties and research results regarding production of food, loss of food to invasive consumer species, and export of food from restoration sites;
- an evaluation of the population and distribution status of Delta smelt and other covered and native species with potential to benefit from South Delta restoration;
- modeling of south Delta restoration scenarios to understand the potential effects on flow, tidal range, salinity, temperature, etc.;
- an assessment of how south Delta tidal wetland restoration would be integrated with restored seasonally inundated floodplain to maximize ecosystem services and species habitat;
- an analysis of the adverse and beneficial effects of tidal natural community restoration on terrestrial covered and other species;
- consideration of dual operations on south Delta physical conditions and how that may be influenced by tidal natural community restoration in the south Delta;
- an evaluation of tidal natural community restoration on selenium, mercury, and other contaminants and their potential for bioaccumulation in covered and native species; and
- an assessment of the effects of south Delta tidal natural community restoration on implementation of the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (San Joaquin County HCP; San Joaquin Council of Governments 2000).

The task force report will be used by the AMT and an independent science panel comprised of representatives of major Delta-focused scientific organizations including the DSP, IEP, and others to determined by agreement of the Authorized Entities and the Program Oversight Group to recommend whether tidal natural community restoration in the south Delta should proceed; and if so, at what scale and at which general locations. After review of the reports by the task force, the AMT, and the independent science panel, the Authorized Entities and the Program Oversight Group will then direct the Implementation Office to either refrain from tidal wetland restoration in the south Delta ROA, or to proceed with such restoration, to be performed in a manner substantially in agreement with the process recommended by the reports.

In the event that tidal wetland restoration does not occur in the South Delta ROA, or occurs at lower levels than identified in the biological objectives, funding allocated to CM4 may be repurposed to implement alternative aquatic restoration measures, even if restoration acreages are reduced, e.g., by restoring more challenging sites or different habitats (i.e., channel margin). Proceeding with substantially less restoration in the south Delta than described in this conservation measure may require a Plan amendment (see Sect. 7.4.1 for the Plan amendment process).

3.6.4.8.5 Riparian, Channel Margin, and Floodplain Restoration Focus Area

Table 3.6-18 lists key uncertainties and potential research actions relevant to riparian, channel margin, and floodplain restoration. Riparian, channel margin, and floodplain restoration has been widely practiced in the Central Valley for many years, and the general approach to such restoration is well understood. The key uncertainties therefore address uncertainties in how to optimize the restored or created habitat to yield the greatest benefit to covered species and natural communities.

Table 3.6-18. Key Uncertainties and Potential Research Actions Relevant to Riparian, Channel Margin, and Floodplain Restoration

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
RCF-R01	How is predation affecting covered fishes in restored natural communities?	Quantify abundance of nonnative fishes in restored floodplains. Assess effects of nonnative fish predation on covered species and natural communities in restored sites. Identify ways to avoid and minimize those impacts.	CM5
RCF-R02	Does channel margin enhancement contribute to an increase in survival of fry-sized Chinook salmon in restored river reaches?	At representative channel margin enhancement sites, mark and recapture fry-sized Chinook salmon. This work should include collection of 3–5 years of data before CM6 implementation at the site in order to establish a baseline condition capturing years with varying hydrology, and an additional 3–5 years of data collection after the channel margin enhancement has been constructed.	CM6
RCF-R03	How frequently are channel margins enhanced under the BDCP inundated; and how frequently are existing riparian and wetland benches inundated, and how does this change because of the BDCP?	Develop, in collaboration with fish agencies, a study to more precisely define this uncertainty and to resolve it using a combination of modeling and field data collection.	CM6
RCF-R05	What enhancement techniques are most effective for improving riparian brush rabbit and riparian woodrat habitat?	Establish experimental vegetation plots and control plots, apply varying enhancement techniques, and compare results with best available information regarding suitable habitat characteristics for the species. Also assess in terms of species occupation.	CM7
RCF-R06	What techniques are effective for controlling exotic plants but safe for use on or near native plant and wildlife species?	Conduct a variety of exotic plant control techniques in experimental study plots and compare effectiveness.	CM11
RCF-R07	What enhancement techniques are most effective for improving least Bell's vireo, yellow-breasted chat, and western yellow-billed cuckoo habitat?	Establish experimental vegetation plots and control plots, apply varying enhancement techniques and compare results with best available information regarding suitable habitat characteristics for the species. Also assess in terms of species occupation.	CM7, CM5
RCF-R08	Can self-sustaining occurrences of Heckard's peppergrass, Suisun thistle, slough thistle and delta button celery be created?	Assess microhabitat requirements, planting methods (i.e., seed broadcast or outplanting), restoration protocols, and enhancement and management techniques through experimental trials.	CM4, CM5, CM9

Three key uncertainties address aquatic species, looking at how restoration alters predation risk, Chinook salmon survivorship (Chinook salmon are anticipated to be the principal covered species benefitting from channel margin enhancement), and changes in inundation along both existing riparian and wetland benches in the Plan Area, and along channel margins enhanced under BDCP. Such changes in inundation are likely because of BDCP-related changes in flow timing and volume, and also because of the effects of BDCP restoration actions on the dynamics of the tidal prism in the Delta. Five other key uncertainties address terrestrial species, seeking ways to improve habitat for a variety of riparian and channel-margin dependent species while controlling the invasion and spread of undesirable, non-native plants.

3.6.4.8.6 Managed Wetlands Focus Area

Table 3.6-19 lists the five key uncertainties and potential research studies relevant to the management of managed wetlands. Two studies address management optimization for the benefit of the salt marsh harvest mouse. Two studies address shorebirds and waterfowl and their performance on managed wetlands vis-à-vis other natural community types protected under BDCP. The fifth study, which applies to all natural community types represented in the BDCP reserve system, examines the risk of new or the proliferation of existing populations of invasive, non-native species.

Table 3.6-19. Key Uncertainties and Potential Research Actions Relevant to Managed Wetlands

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
MW-R01	What are the effects of various managed wetland management regimes on salt marsh harvest mouse habitat and populations?	Establish experimental plots, apply varying managed wetland management techniques and compare results with best available information regarding suitable habitat characteristics for salt marsh harvest mouse. Also (in a separate study) determine colonization rates and distribution at restored sites, and determine sufficient population size exist on restored site.	CM11
MW-R02	What is the waterfowl food value and density on existing seasonal, semipermanent, and permanent managed wetlands in Suisun Marsh, and how do these values change with the loss of managed wetlands due to tidal restoration and the increased intensity of management and enhancement on remaining managed wetlands?	Perform surveys to determine waterfowl diversity and abundance and waterfowl food quality and biomass density on a subset of managed wetlands within Suisun Marsh that represents the spectrum of management and salinity conditions.	CM11
MW-R03	What habitat value, if any, do seasonal and semipermanent wetlands provide for the salt marsh harvest mouse?	Perform a capture and release tagging study to determine the abundance of salt marsh harvest mice within managed wetland managed to maximize waterfowl and shorebird productivity.	CM11
MW-R04	Perform baseline surveys and regular follow-up surveys to determine relative seasonal abundance of shorebirds on managed wetlands, cultivated lands, and nontidal wetlands (vernal pool, alkali seasonal wetlands, nontidal emergent wetlands) and to evaluate shorebird response to enhancement and management actions.	Perform baseline surveys and regular follow-up surveys to determine relative seasonal abundance of shorebirds on managed wetlands, cultivated lands, and nontidal wetlands (vernal pool, alkali seasonal wetlands, nontidal emergent wetlands) and to evaluate shorebird response to enhancement and management actions. Survey methods and timing will be coordinated with shorebird surveys on restored tidal wetlands so that relative abundance and habitat use can be tracked within the BDCP reserve system over time.	CM11
TWR-R14	What new invasive species will enter the Plan Area in the future, and what existing invasive species will proliferate relative to current conditions?	Through the adaptive management process, the Adaptive Management Team will recommend appropriate responses to the appearance of new invasive species threats or the proliferation of existing invasive species by identifying research priorities or modifying conservation measure implementation to maintain focus on those invasive species that pose the greatest threat to Delta ecosystems and that can be dealt with by controlling the risk of accidental introduction.	CM20

3.6.4.8.7 Upland and Nontidal Wetlands Focus Area

Table 3.6-20 lists four key uncertainties and potential research actions relevant to creation, restoration, and management of uplands and nontidal wetlands in the BDCP reserve system. These natural community types have been widely managed for conservation in the Central Valley for many years, and the general approach to their management is well understood. All four key uncertainties are shared with the riparian or managed wetland focus areas, and consider ways to improve the control of invasive, non-native plants on the reserve system; shorebird use of nontidal wetlands; the risks of future invasive species colonization or proliferation within the reserve system; and the feasibility of establishing self-sustaining occurrences of Heckard's peppergrass, Suisun thistle, slough thistle, and delta button celery.

Table 3.6-20. Key Uncertainties and Potential Research Actions Relevant to Upland and Nontidal Wetlands

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
MW-R04	Perform baseline surveys and regular follow-up surveys to determine relative seasonal abundance of shorebirds on managed wetlands, cultivated lands, and nontidal wetlands (vernal pool, alkali seasonal wetlands, nontidal emergent wetlands) and to evaluate shorebird response to enhancement and management actions.	Perform baseline surveys and regular follow-up surveys to determine relative seasonal abundance of shorebirds on managed wetlands, cultivated lands, and nontidal wetlands (vernal pool, alkali seasonal wetlands, nontidal emergent wetlands) and to evaluate shorebird response to enhancement and management actions. Survey methods and timing will be coordinated with shorebird surveys on restored tidal wetlands so that relative abundance and habitat use can be tracked within the BDCP Reserve over time.	CM11
RCF-R06	What techniques are effective for controlling exotic plants but safe for use on or near native plant and wildlife species?	Conduct a variety of exotic plant control techniques in experimental study plots and compare effectiveness.	CM11
RCF-R08	Can self-sustaining occurrences of Heckard's peppergrass, Suisun thistle, slough thistle and delta button celery be created?	Assess microhabitat requirements, planting methods (i.e., seed broadcast or outplanting), restoration protocols, and enhancement and management techniques through experimental trials.	CM4, CM5, CM9
TWR-R14	What new invasive species will enter the Plan Area in the future, and what existing invasive species will proliferate relative to current conditions?	Through the adaptive management process, the Adaptive Management Team will recommend appropriate responses to the appearance of new invasive species threats or the proliferation of existing invasive species by identifying research priorities or modifying conservation measure implementation to maintain focus on those invasive species that pose the greatest threat to Delta ecosystems and that can be dealt with by controlling the risk of accidental introduction.	CM20

3.6.4.8.8 Cultivated Lands Focus Area

Table 3.6-21 lists two key uncertainties and potential research actions relevant to cultivated lands management in the BDCP reserve system. Both key uncertainties are shared with other focus areas addressing reserve system management. One considers ways to improve the control of invasive, non-native plants on the reserve system; the other seeks to better understand shorebird use of BDCP-protected natural community types.

Table 3.6-21. Key Uncertainties and Potential Research Actions Relevant to Cultivated Lands

ID#	Key Uncertainty	Potential Research Actions	Relevant CM
MW-R04	Perform baseline surveys and regular follow-up surveys to determine relative seasonal abundance of shorebirds on managed wetlands, cultivated lands, and nontidal wetlands (vernal pool, alkali seasonal wetlands, nontidal emergent wetlands) and to evaluate shorebird response to enhancement and management actions.	Perform baseline surveys and regular follow-up surveys to determine relative seasonal abundance of shorebirds on managed wetlands, cultivated lands, and nontidal wetlands (vernal pool, alkali seasonal wetlands, nontidal emergent wetlands) and to evaluate shorebird response to enhancement and management actions. Survey methods and timing will be coordinated with shorebird surveys on restored tidal wetlands so that relative abundance and habitat use can be tracked within the BDCP Reserve over time.	CM11
TWR-R14	What new invasive species will enter the Plan Area in the future, and what existing invasive species will proliferate relative to current conditions?	Through the adaptive management process, the Adaptive Management Team will recommend appropriate responses to the appearance of new invasive species threats or the proliferation of existing invasive species by identifying research priorities or modifying conservation measure implementation to maintain focus on those invasive species that pose the greatest threat to Delta ecosystems and that can be dealt with by controlling the risk of accidental introduction.	CM20

3.6.4.8.9. Terrestrial Species Status & Trend Focus Area

Note to reader: Text for this section is being developed by wildlife agency technical staff, and has not yet been provided for review.

3.6.5 Data Management

[unchanged text omitted]

3.6.6 References Cited

[Only new, changed, and deleted citations are shown.]

California Department of Fish and Game. 2009. Protocols for surveying and evaluating impacts to special status native plant populations and natural communities. Available: https://www.dfg.ca.gov/biogeodata/cnddb/pdfs/Protocols_for_Surveying_and_Evaluating_Impacts.pdf

Carignan, V., and M-A. Villard. 2004. Biological Indicators in Environmental Monitoring Programs: Can We Increase Their Effectiveness? Pages 567–582 in G. B. Wiersma (ed.), *Environmental Monitoring*. Boca Raton, FL: CRC Press.

Central Valley Regional Water Quality Control Board. 2012. Central Valley Basin Plan, Chapter 6, Surveillance and Monitoring. Available: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/bp_ch6.shtml. Accessed June 13, 2016.

Conway, C. J. 2009. Standardized North American marsh bird monitoring protocols, version 2009-2. Wildlife Research Report #2009-02. U.S. Geological Survey, Arizona Cooperative Fish and

Wildlife Research Unit, Tucson, AZ. Available: http://www.cals.arizona.edu/research/azfwru/NationalMarshBird/index.htm

County of Sacramento, City of Elk Grove, City of Galt, City of Rancho Cordova, Sacramento Regional County Sanitation District, Sacramento Area Sewer District, Sacramento County Water Agency, Southeastern Connector. 2010. South Sacramento Habitat Conservation Plan working draft. Available: http://www.per.saccounty.net/PlansandProjectsIn-Progress/Pages/SSHCPTablesofContent.aspx

Customer, Preferred. 2009. Walking in the Marsh: Methods to Increase Safety and Reduce Impacts to Wildlife/Plants. http://www.sfbayjv.org/sfbjv_events_pdfs/Walking%20In%20the%20Marsh.pdf, accessed 2015.02.10.

Cypher, E. A. General rare plant survey guidelines. California State University, Stanislaus, Endangered Species Recovery Program, Bakersfield, CA. 26 pp. Available: http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/rare_plant_protocol.pdf

Dettling, M. D., and N. E. Seavey. 2012. Yellow-billed cuckoo survey effort along the Sacramento and Feather Rivers. Progress report to the California Department of Fish and Game, Grant #1182002. PRBO Conservation Science, Petaluma, CA. 20 pp. plus appendices.

Elzinga, C. L., D. W. Salzer, J. W. Willoughby. 1998. Measuring and Monitoring Plant Populations. Bureau of Land Management.

Green, R. H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, Inc.

ICF International. 2012 Final Santa Clara Valley Habitat Plan. Available: http://scv-habitatagency.org/DocumentCenter/Home/View/143

Lemly, A. D. 1999. Selenium Transport and Bioaccumulation in Aquatic Ecosystems: A Proposal for Water Quality Criteria Based on Hydrological Units. *Ecotoxicology and Environmental Safety* 42:150–156.

Liu, L., P. Abbaspour, M. Herzog, N. Nur, and N. Warnock. San Francisco Bay tidal marsh project annual report 2006; distribution, abundance, and reproductive success of tidal marsh birds. PRBO Conservation Science, Petaluma, CA. 49 pp. Available: http://data.prbo.org/apps/sfbslr/uploads/docs/PRBOTidalMarsh2006AnnualReport.pdf

Lincoln-Smith, M. P., K. A. Pitt, J. D. Bell, B. D. Mapstone. 2006. Using Impact Assessment Methods to Determine the Effects of a Marine Reserve on Abundances and Sizes of Valuable Tropical Invertebrates. 63:1251-1266

Loboschefsky, E., G. Benigno, T. Sommer, K. Rose, T. Ginn, A. Massoudieh, and F. Loge. 2012. Individual-Level and Population-Level Historical Prey Demand of San Francisco Estuary Striped Bass Using a Bioenergetics Model. *San Francisco Estuary and Watershed Science* 10(1).

Michener, W. K. 1997. Quantitatively Evaluating Restoration Experiments: Research Design, Statistical Analysis, and Data Management Considerations. *Society for Ecological Restoration 5(4): 324-337.*

Nur, N. and H. Spautz. 2002. Data collection protocol, tidal marsh passerines in Wetlands Regional Monitoring Program Plan 2002, Part 2: Data Collection Protocols. Available: http://www.wrmp.org/docs/protocols/Wetland%20Birds.doc

Point Blue Conservation Science. 2005. Clapper rail protocol for the San Francisco Estuary large-scale population surveys. 2 pp. Available: http://www.prbo.org/cadc/rail/docs/CLRAProtocol2005.pdf

Presser, T. S., and S. N. Luoma. 2006. *Forecasting Selenium Discharges to the San Francisco Bay-Delta Estuary: Ecological Effects of a Proposed San Luis Drain Extension*. Available: <http://pubs.usgs.gov/pp/p1646/>. Accessed: October 5, 2011.

Ralph, C. John; Geupel, Geoffrey R.; Pyle, Peter; Martin, Thomas E.; DeSante, David F. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41 p. Available: http://www.fs.fed.us/psw/publications/documents/psw_gtr144/psw_gtr144.pdf. Accessed June 13, 2016.

Shellhammer, H. 2002. Data collection protocols surveying for the salt marsh harvest mouse (*Reithrodontomys raviventris*), California vole (*Microtis californicus*) and other small mammals in Wetlands Regional Monitoring Program Plan 2002, Part 2: Data Collection Protocols. Available: http://www.wrmp.org/docs/protocols/Salt%20Marsh%20Harvest%20Mouse.pdf

Spautz, H. and Albertson, J. 2006. San Francisco Estuary Invasive Spartina Project California Clapper Rail Survey Protocol C. Appendix 1. Clapper rail survey protocols in 2010 clapper rail surveys for the San Francisco Estuary Invasive Spartina Project. Olofson Environmental Inc., Berkeley, CA. Available: http://www.spartina.org/project_documents/clapper_rails/2010_CLRA_Rpt_G-Compiled_Appendices.pdf

Stewart, A. R., S. N. Luoma, C. E. Schlekat, M. A. Doblin, and K. A. Hieb. 2004. Food Web Pathway Determines How Selenium Affects Aquatic Ecosystems: A San Francisco Bay Case Study. *Environmental Science and Technology* 38:4519–4526.

Underwood, A. J. 1992. Beyond BACI: The Detection of Environmental Impacts on Populations in the Real, but Variable, World. *Journal of Experimental Marine Biology and Ecology.* 161:145-178.

Underwood, A. J. 1994. On Beyond BACI: Sampling Designs that Might Reliably Detect Environmental Disturbances. *Ecological Society of America.* 4(1):3-15.

U.S. Fish and Wildlife Service. (n.d.). Draft habitat assessment guidelines & survey protocol for the riparian brush rabbit and the riparian woodrat. 11 pp. Available: http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/RBR_RWR_draft_habitat_assessment_&_protocol.pdf

U.S. Fish and Wildlife Service. 1996. Guidelines for conducting and reporting botanical inventories. Available: http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/Listed_plant_survey_guidelines.pdf

U.S. Fish and Wildlife Service. 1996a. Interim survey guidelines to permittees for recovery permits under Section 10(a)(1)(A) of the Endangered Species Act for the listed vernal pool branchiopods. 11 pp. Available: http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/Interim_VP_Survey_Guidelines_to_Permittees_4-96.pdf

U.S. Fish and Wildlife Service. 1998. Draft recovery plan for the least Bell's vireo. Region 1, Portland, OR. 139 pp.

U.S. Fish and Wildlife Service. 1999. San Joaquin kit fox survey protocol for the northern range. Sacramento Fish and Wildlife Office. 12 pp. Available: http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/kitfox_no_protocol.pdf

U.S. Fish and Wildlife Service. 2005. Recovery plan for vernal pool ecosystems of California and southern Oregon. Region 1, Portland, OR. Available: http://www.fws.gov/carlsbad/SpeciesStatusList/RP/20051215_RP_VPFS.pdf

U.S. Fish and Wildlife Service. 2012. Survey protocol for determining presence of the Buena Vista Lake ornate shrew. Survey protocols and other guidelines, available: http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/es_survey.htm

U.S. Fish and Wildlife Service. 2013. Recovery plan for tidal marsh ecosystems of northern and central California. Region 8, Sacramento, CA. Available: http://www.fws.gov/sacramento/es/recovery-planning/tidal-marsh/Documents/TMRP_Volume1_RP.pdf

Vogel, D. 2011. *Insights into the Problems, Progress, and Potential Solutions for Sacramento River Basin Native Anadromous Fish Restoration.* Prepared for Northern California Water Association and Sacramento Valley Water Users.

Williams, D. F. 1993. Population censuses of riparian brush rabbits and riparian woodrats at Caswell Memorial State Park during January 1993. Final report to the California Department of Parks and Recreation Inland Region, Lodi, CA.

Williams et al. 1998. Recovery plan for upland species of the San Joaquin Valley, California. U.S. Fish and Wildlife Service, Region 1, Portland, CA. 289 pp + appendices

Personal Communications:

Applebee, Daniel. Senior Environmental Scientist, California Department of Fish and Wildlife, Wildlife Branch

Fiehler, Craig. Environmental Scientist, California Department of Fish and Wildlife, Central Region

3.7 Avoidance and Minimization Measures

This section generally describes measures to avoid and minimize effects on covered species and natural communities that could result from covered activities. The avoidance and minimization measures (AMMs) that will be implemented through this framework are detailed in Appendix 3.C, *Avoidance and Minimization Measures*. These measures help to satisfy regulatory requirements of the ESA and the Natural Community Conservation Planning Act. These measures will also minimize adverse effects on natural communities, critical habitat, and jurisdictional wetlands and waters throughout the Plan Area. These measures will be implemented throughout the BDCP permit term.

3.7.1 Phases of Avoidance and Minimization Actions

Specific AMMs have been developed that will be implemented for each BDCP project. Identification and implementation of the appropriate AMMs for each project will occur in four phases.

- **Planning-level surveys and project planning.** Site-specific surveys will be conducted during the project planning phase to identify natural communities, covered species habitat, and covered species to which AMMs apply. Projects will be designed to avoid and minimize impacts based on information developed during the planning-level surveys.
- **Preconstruction surveys.** Biological surveys may be necessary during the months or weeks prior to project construction, depending on the results of the planning surveys. Results of the planning surveys will be used to determine which AMMs will be applied prior to or during construction (e.g., establishing buffers around kit fox dens or covered bird species nests). Preconstruction surveys may also involve site preparation actions such as collapsing unoccupied burrows.
- **Project construction.** Many AMMs will be implemented during project construction. For some activities, a biological monitor will be present to ensure that the measures are effectively implemented. For some species (e.g., California red-legged frog), the biological monitor will relocate individuals from the construction area to specified nearby safe locations.
- **Project operation and maintenance.** Some of the AMMs apply to long-term operation and maintenance activities, such as operation and maintenance of the water conveyance facilities and ongoing covered species' habitat enhancement and management These AMMs will be implemented throughout the life of the project. AMMs applicable to long-term enhancement and management will be incorporated into site-specific management plans.

3.7.2 Summary of Avoidance and Minimization Measures

The AMMS are summarized below and in Table 3.7.2-1. Each AMM is detailed in Appendix 3.C, *Avoidance and Minimization Measures*.

3.7.2.1 Measures Benefitting All Covered Species and Natural Communities

AMM1 Worker Awareness Training and *AMM2 Construction Best Management Practices and Monitoring* are applicable to all projects that entail in-water work and/or ground disturbance or other demolition or construction activity (e.g., removal of derelict vessels as prescribed under *CM15 Localized Reduction of Predatory Fish*). AMM1 provides worker awareness training to ensure awareness of the AMM requirements by all jobsite personnel, and AMM2 provides for specification of numerous project-specific construction BMPs.

3.7.2.2 Measures Primarily Benefiting Covered Fishes

AMM3 through AMM9 will be implemented when construction activities or other covered activities occur in the vicinity of aquatic resources potentially occupied by covered fishes, as well as when performing construction activities that entail ground disturbance and associated potential impacts such as erosion, sedimentation, or materials spills. These AMMs will also benefit other native aquatic species, including covered species other than fish, such as giant garter snake and western pond turtle.

- *AMM3 Stormwater Pollution Prevention Plan* and *AMM4 Erosion and Sediment Control Plan* will be implemented for all projects entailing substantial ground disturbance. These measures minimize the risk of project-related sedimentation or turbidity causing adverse effects on water quality, which otherwise could harm covered species.
- *AMM5 Spill Prevention, Containment, and Countermeasure Plan* will be implemented for all projects where materials spills could result in contamination of surface waters. This measure minimizes the risk of project-related toxicant effects on covered species.
- *AMM6 Spoils, Tunnel Muck, and Dredged Material Disposal Plan* will be implemented for all projects that entail dredging, tunneling, or other substantial excavation such that excavated material must be disposed. This measure minimizes the risk of water quality or habitat degradation caused by dewatering from excavated materials or improper disposal of excavated materials.
- *AMM7 Barge Operations Plan* addresses potential adverse effects (such as grounding) arising from the use of barges to transport construction project equipment and materials. This measure serves to minimize the risk of harm to covered species or impairment of their habitat that might otherwise result from barge operations.
- *AMM8 Fish Rescue and Salvage Plan* describes protocols and approaches to perform fish rescue and salvage in cases where a potentially fish-bearing water body must be dewatered. It would primarily be implemented during cofferdam installation but would also have broader applications during construction of some restoration projects. It serves to minimize the risk of incidental take of covered fishes in association with dewatering of their habitat.
- *AMM9 Underwater Sound Control and Abatement Plan* would apply primarily to activities that entail pile driving in or near water bodies supporting covered fishes. It requires measures to minimize the risk of producing underwater sound of intensities and durations sufficient to harm covered fishes.

3.7.2.3 Measures Primarily Benefiting Plants, Animals, or Natural Communities

AMM10 Restoration of Temporarily Affected Natural Communities requires restoration for construction-related activities temporarily affecting natural communities, and prescribes the content of such a plan. It minimizes the risk of permanent impairment of natural communities or of habitat for the covered species they support.

AMM11 through AMM26 address needs unique to individual covered species or (for plants and vernal pool crustaceans) a group of covered species. These measures generally require preconstruction surveys and/or habitat assessments, but may also allow assumptions of presence. Depending on the species, they may also require the following precautions.

- During the design phase, evaluate site-specific conditions and design projects to avoid particularly sensitive areas (e.g., sandhill crane roost sites) to the extent practicable and incorporate other design measures as appropriate to avoid and minimize incidental take.
- Implement seasonal or timing restrictions for activities in sensitive areas (e.g., to avoid critical times for nesting or dispersal).

- Passively or actively relocate individuals out of construction areas. An example of passive relocation is the installation of one-way doors on burrowing owl burrows and collapsing burrows after verifying that no owls are present.

3.7.2.4 Measures Primarily Benefiting the Protection of All Natural Communities and Covered Species

AMM27 through AMM36 focus primarily on the protection of all natural communities and covered species. When implemented the measures will minimize the risk of BDCP activities on human health and the natural environment.

- *AMM27 Selenium Management* describes a process to identify and evaluate potentially feasible actions for the purpose of minimizing conditions that promote bioaccumulation of selenium in restored areas. It is currently unknown if the effects of increased residence time, and thus potential increases in selenium bioavailability, associated with restoration-related conservation measures will lead to adverse effects on fish and wildlife, which potentially include covered species.
- *AMM28 Geotechnical Studies* describes subsurface investigations that will be performed at the locations of the water conveyance alignment and facility locations and at material borrow areas. The main geotechnical issues in the Delta include stability of canal embankments and levees, liquefaction of Delta soils (particularly loose, saturated sands), seepage through coarse-grained soils, settlement of embankments and structures, subsidence, and soil-bearing capacity.
- *AMM29 Design Standards and Building Codes* ensures that standards, guidelines, and codes establishing minimum design criteria and construction requirements for project facilities will be followed by the BDCP engineers.
- *AMM30 Transmission Line Design and Alignment Guidelines* describes transmission line alignment measures to avoid impacts on biological resources and the routine magnetic field reduction measures that all regulated California electric utilities will consider for new and upgraded transmission line and transmission substation construction.
- *AMM31 Noise Abatement* describes components that will be included in a noise abatement plan to avoid or reduce potential in-air noise impacts related to construction, maintenance, and operation.
- *AMM32 Hazardous Material Management* ensures that each BDCP contractor responsible for construction of a BDCP facility or project will develop and implement a hazardous materials management plan (HMMP) before beginning construction. The HMMPs will provide detailed information on the types of hazardous materials used or stored at all sites associated with the water conveyance facilities (e.g., intake pumping plants, maintenance facilities) and will include appropriate practices to reduce the likelihood of a spill of toxic chemicals and other hazardous materials during construction and facilities operation and maintenance.
- *AMM33 Mosquito Management* ensures that consultation on implementing mosquito control techniques with appropriate mosquito and vector control districts, including the San Joaquin County and Sacramento-Yolo Mosquito and Vector Control Districts, will occur.
- *AMM34 Construction Site Security* ensures that all security personnel will receive environmental training similar to that of onsite construction workers so that they understand the environmental conditions and issues associated with the various areas for which they are responsible at a given time.
- *AMM35 Fugitive Dust Control* describes basic and enhanced control measures that will be implemented at all construction and staging areas to reduce construction-related fugitive dust.
- *AMM36 Notification of Activities in Waterways* ensures appropriate agency representatives will be notified when BDCP activities could affect water quality or aquatic species.

3.7.2.5 Measures to Minimize Impacts Associated with Recreation

AMM37 Recreation describes measures that will be implemented for construction of trails and other recreational facilities and recreational use in the reserve system. These measures, once implemented, will minimize impacts on biological resources and specific natural communities and wildlife species.

Table 3.7-1. Summary of the Avoidance and Minimization Measures

Number	Title	Summary
Benefit All Natural Communities and Covered Species		
AMM1	Worker Awareness Training	Includes procedures and training requirements to educate construction personnel on the types of sensitive resources in the project area, the applicable environmental rules and regulations, and the measures required to avoid and minimize effects on these resources.
AMM2	Construction Best Management Practices and Monitoring	Standard practices and measures that will be implemented prior, during, and after construction to avoid or minimize effects of construction activities on sensitive resources (e.g., species, habitat), and monitoring protocols for verifying the protection provided by the implemented measures.
Primarily Benefit Covered Fishes		
AMM3	Stormwater Pollution Prevention Plan	Includes measures that will be implemented to minimize pollutants in stormwater discharges during and after construction related to covered activities, and that will be incorporated into a stormwater pollution prevention plan to prevent water quality degradation related to pollutant delivery from project area runoff to receiving waters.
AMM4	Erosion and Sediment Control Plan	Includes measures that will be implemented for ground-disturbing activities to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas affected by construction activities, and that will be incorporated into plans developed and implemented as part of the National Pollutant Discharge Elimination System permitting process for covered activities.
AMM5	Spill Prevention, Containment, and Countermeasure Plan	Includes measures to prevent and respond to spills of hazardous material that could affect navigable waters, including actions used to prevent spills, as well as specifying actions that will be taken should any spills occur, and emergency notification procedures.
AMM6	Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material	Includes measures for handling, storage, beneficial reuse, and disposal of excavation or dredge spoils and reusable tunnel material, including procedures for the chemical characterization of this material or the decant water to comply with permit requirements, and reducing potential effects on aquatic habitat, as well as specific measures to avoid and minimize effects on species in the areas where reusable tunnel material would be used or disposed.
AMM7	Barge Operations Plan	Includes measures to avoid or minimize effects on aquatic species and habitat related to barge operations, by establishing specific protocols for the operation of all project-related vessels at the construction and/or barge landing sites. Also includes monitoring protocols to verify compliance with the plan and procedures for contingency plans.
AMM8	Fish Rescue and Salvage Plan	Includes measures that detail procedures for fish rescue and salvage to avoid and minimize the number of Chinook salmon, steelhead, green sturgeon, and other covered fish stranded during construction activities, especially during the placement and removal of cofferdams at the intake construction sites.
AMM9	Underwater Sound Control and Abatement Plan	Includes measures to minimize the effects of underwater construction noise on fish, particularly from impact pile–driving activities. Potential effects of pile driving will be minimized by restricting work to the least sensitive period of the year and by controlling or abating underwater noise generated during pile driving.

Number	Title	Summary
Primarily Benefit Covered Plants, Wildlife, or Natural Communities		
AMM10	Restoration of Temporarily Affected Natural Communities	Restore and monitor natural communities in the Plan Area that are temporarily affected by covered activities. Measures will be incorporated into restoration and monitoring plans and will include methods for stockpiling and storing topsoil, restoring soil conditions, and revegetating disturbed areas; schedules for monitoring and maintenance; strategies for adaptive management; reporting requirements; and success criteria.
AMM11	Covered Plant Species	Conduct botanical surveys during the project planning phase and implement protective measures, as necessary. Redesign to avoid indirect effects on modeled habitat and effects on core recovery areas.
AMM12	Vernal Pool Crustaceans	Includes provisions to require project design to minimize indirect effects on modeled habitat, avoid effects on core recovery areas, minimize ground-disturbing activities or alterations to hydrology, conduct protocol-level surveys, and redesign projects to ensure that no suitable habitat within these areas.
AMM13	California Tiger Salamander	During the project planning phase, identify suitable habitat within 1.3 miles of the project footprint, ash survey aquatic habitats in potential work areas for California tiger salamander. If California tiger salamander larvae or eggs are found, implement prescribed mitigation.
AMM14	California Red-Legged Frog	During the project planning phase, identify suitable habitat within 1 mile of the project footprint, conduct a preconstruction survey, implement protective measures for areas where species presence is known or assumed, and establish appropriate buffer distances. If aquatic habitat cannot be avoided, implement prescribed surveys and mitigation.
AMM15	Valley Elderberry Longhorn Beetle	During the project planning phase, conduct surveys for elderberry shrubs within 100 feet of covered activities involving ground disturbance, and design project to avoid effects within 100 feet of shrubs, if feasible. Implement additional protective measures, as stipulated in AMM2. Elderberry shrubs identified within project footprints that cannot be avoided will be transplanted to previously approved conservation areas in the Plan Area.
AMM16	Giant Garter Snake	During the project planning phase, identify suitable aquatic habitat (wetlands, ditches, canals) in the project footprint. Conduct preconstruction surveys and implement protective measures.
AMM17	Western Pond Turtle	Identify suitable aquatic habitat and upland nesting and overwintering habitat in the project footprint. Conduct preconstruction surveys in suitable habitat twice including 1 week before and within 48 hours of construction. Implement protective measures as described.
AMM18	Swainson's Hawk and White-Tailed Kite	Conduct preconstruction surveys of potentially occupied breeding habitat in and within 0.25 mile of the project footprint to locate active nest sites.
AMM19	California Clapper Rail and California Black Rail	Identify suitable habitat in and within 500 feet of the project footprint. Perform surveys and implement prescribed protective measures in areas where species is present or assumed to be present.
AMM20	Greater Sandhill Crane	Conduct preconstruction surveys to determine winter roost occupancy within 0.5 mile of the project footprint and determine related areas of foraging habitat. Implement protective measures in occupied areas. Minimize indirect effects of conveyance facility construction through temporary (during construction) establishment of 700 acres of roosting/foraging habitat.
AMM21	Tricolored Blackbird	Conduct preconstruction surveys in breeding habitat within 1,300 feet of the project footprint, if the project is to occur during the breeding season. Avoid any construction activity within 250 feet of an active tricolored blackbird nesting colony, and minimize such activity within 1,300 feet.
AMM22	Suisun Song Sparrow, Yellow-Breasted Chat, Least Bell's Vireo, Western Yellow-Billed Cuckoo	Conduct preconstruction surveys of potential breeding habitat in and within 500 feet of project activities. It may be necessary to conduct the breeding bird surveys during the preceding year depending on when construction is scheduled to start. Implement protective measures in occupied areas.

Number	Title	Summary
AMM23	Western Burrowing Owl	Perform surveys where burrowing owl habitat (or sign) is encountered within 150 meters of a proposed construction area. If burrowing owls or suitable burrowing owl burrows are identified during the habitat survey, and if the project does not fully avoid direct and indirect impacts on the suitable habitat, perform preconstruction surveys and implement certain minimization measures.
AMM24	San Joaquin Kit Fox	Conduct habitat assessment in and within 250 feet of project footprint. If suitable habitat is present, conduct a preconstruction survey and implement U.S. Fish and Wildlife Service guidelines. Implement protective measures in occupied areas.
AMM25	Riparian Woodrat and Riparian Brush Rabbit	Conduct surveys for projects occurring within suitable habitat as identified from habitat modeling and by additional assessments conducted during the planning phase of construction or restoration projects following U.S. Fish and Wildlife Service *Draft Habitat Assessment Guidelines and Survey Protocol for the Riparian Brush Rabbit and the Riparian Woodrat*. Implement protective measures in suitable habitat.
AMM26	Salt Marsh Harvest Mouse and Suisun Shrew	Identify suitable habitat in and within 100 feet of the project footprint for projects in the species range. Ground disturbance will be limited to the period between May 1 and November 30, to avoid destroying nests with young. Prior to ground-disturbing activities, vegetation will first be removed with nonmechanized hand tools (e.g., goat or sheep grazing, or in limited cases where the biological monitor can confirm that there is no risk of harming salt marsh harvest mouse or Suisun shrew, hoes, rakes, and shovels may be used). Implement protective measures in suitable habitat.
AMM27	Selenium Management	Develop a plan to evaluate site-specific restoration conditions and include design elements that minimize any conditions that could be conducive to increases of bioavailable selenium in restored areas. Before ground-breaking activities associated with site-specific restoration occurs, identify and evaluate potentially feasible actions for the purpose of minimizing conditions that promote bioaccumulation of selenium in restored areas.
AMM28	Geotechnical Studies	Conduct geotechnical investigations to identify the types of soil avoidance or soil stabilization measures that should be implemented to ensure that the facilities are constructed to withstand subsidence and settlement and to conform to applicable state and federal standards.
AMM29	Design Standards and Building Codes	Ensure that the standards, guidelines, and codes, which establish minimum design criteria and construction requirements for project facilities, will be followed. Follow any other standards, guidelines, and code requirements that are promulgated during the detailed design and construction phases and during operation of the conveyance facilities.
AMM30	Transmission Line Design and Alignment Guidelines	Design the alignment of proposed transmission lines to minimize impacts on sensitive terrestrial and aquatic habitats when siting poles and towers. Restore disturbed areas to preconstruction conditions. In agricultural areas, implement additional BMPs. Site transmission lines to avoid greater sandhill crane roost sites or, for temporary roost sites, by relocating roost sites prior to construction if needed. Site transmission lines to minimize bird strike risk.
AMM31	Noise Abatement	Develop and implement a plan to avoid or reduce the potential in-air noise impacts related to construction, maintenance, and operations.
AMM32	Hazardous Material Management	Develop and implement site-specific plans that will provide detailed information on the types of hazardous materials used or stored at all sites associated with the water conveyance facilities and required emergency-response procedures in case of a spill. Before construction activities begin, establish a specific protocol for the proper handling and disposal of hazardous materials.
AMM33	Mosquito Management	Consult with appropriate mosquito and vector control districts before the sedimentation basins, solids lagoons, and the intermediate forebay inundation area become operational. Once these components are operational, consult again with the control districts to determine if mosquitoes are present in these facilities, and implement mosquito control techniques as applicable. Consult with the control districts when designing and planning restoration sites.

Number	Title	Summary
AMM34	Construction Site Security	Provide all security personnel with environmental training similar to that of onsite construction workers, so that they understand the environmental conditions and issues associated with the various areas for which they are responsible at a given time.
AMM35	Fugitive Dust Control	Implement basic and enhanced control measures at all construction and staging areas to reduce construction-related fugitive dust and ensure the project commitments are appropriately implemented before and during construction, and that proper documentation procedures are followed.
AMM36	Notification of Activities in Waterways	Before in-water construction or maintenance activities begin, notify appropriate agency representatives when these activities could affect water quality or aquatic species.
AMM37	Recreation	Implement avoidance and minimization measures for recreational use within the reserve system. Measures to be implemented address the siting, designing, and construction of trails and other recreational facilities. Allowable recreational uses will be controlled using a variety of techniques including fences, gates, clearly signed trails, educational kiosks, trail maps and brochures, interpretive programs, patrol by land management staff, and restrictions by area and time.

11F.4 Chapter 4, Covered Activities and Associated Federal Actions

The following changes were made to Chapter 4.

4.1 Introduction

[unchanged text omitted]

4.2 Covered Activities

[unchanged text omitted]

Table 4-1. Summary of Conservation Measures

[unchanged table text omitted]

Implementation of the conservation measures and the monitoring activities are covered activities under the BDCP and its associated authorizations. Implementation of conservation measures or monitoring activities will be carried out by DWR and the participating state and federal water contractors. To support BDCP, Reclamation may also implement or fund all or a portion of any conservation measure except construction of CM1, which will be performed by DWR. Reclamation may also or conduct or fund monitoring. BDCP-related actions or funding by Reclamation will be consistent with federal authorizations and appropriations at the time the action is conducted.

[unchanged text omitted]

4.2.1 CM1 Water Facilities and Operation

[Entire section is supplanted by detailed project description presented in the Recirculated Draft EIR/EIS]

4.2.2 CM2 Yolo Bypass Fisheries Enhancement

[unchanged text omitted]

4.2.3 CM3 to CM11: Habitat Restoration, Enhancement, and Management Activities

[unchanged text omitted]

4.2.4 CM12 to CM21: Other Stressors

[unchanged text omitted]

4.2.5 Avoidance and Minimization Measures

[See Section 3.7 for current exposition of the AMMs]

4.2.6 Monitoring Activities

[See Section 3.6 for current exposition of the monitoring activities]

4.2.7 Transfers and other Voluntary Water Market Transactions

[unchanged text omitted]

4.3 Federal Actions Associated with the BDCP

The activities described in this section have been designated as federal actions associated with the BDCP. These actions consist of CVP-related activities in the Delta that are primarily carried out by Reclamation. Reclamation has authority to act consistent with current authorizations, regulatory commitments, or future new authorizations. To support BDCP, Reclamation may also implement or fund all or a portion of any conservation measures except construction of CM1, which will be performed by DWR. Reclamation may also conduct or fund monitoring. BDCP-related actions or funding by Reclamation will be consistent with federal authorizations and appropriations at the time the action is conducted. At this time no new activities have been authorized for performance of BDCP actions, so participation in BDCP actions would be limited to the scope of Reclamation's current authorizations. However, future authorizations and appropriations could allow Reclamation to fund and implement more elements of BDCP than are currently authorized.

[unchanged text omitted]

4.4 References Cited

[Only new, changed, and deleted citations are shown.]

4.4.1 Literature Cited

California Department of Boating and Waterways 2009. *Water Hyacinth Control Program Operations Management Plan 2009 Updated Manual Appendix C*. Available: <http://www.agriculturedefensecoalition.org/sites/default/files/file/contra_costa_wh_73/73X_2009_CA_Boating_Waterways_Department_WHCP_Operations_Management_Plan_Manual_2009_04_Appx_C_WHCP_OMP.pdf>.

Black Hoffman, S., M. Shepard, M. Vaughan, C. LaBar, and N. Hodges. 2009. *Yolo Natural Heritage Program (HCP/NCCP) Pollinator Conservation Strategy*. November. Sacramento, CA: The Xerces Society for Invertebrate Conservation.

Keeley, J. E. 1993. Native Grassland Restoration: The Initial Stage—Assessing Suitable Sites. Pages 277–281 in J. E. Keeley (ed.), *Interface Between Ecology and Land Development in California*. Los Angeles, CA: Southern California Academy of Sciences.

Lund, J., E. Hanak, W. Fleenor, R. Howitt, J. Mount, P. Moyle. 2007. *Envisioning Futures for the Sacramento-San Joaquin Delta*. San Francisco, CA: Public Policy Institute of California.

4.4.2 Personal Communications

11F.5 Chapter 5, Effects Analysis

11F.5.1 Appendix 5J, Effects on Natural Communities, Wildlife, and Plants, Attachment 5J-D, Indirect Effects of the Construction of the BDCP Conveyance Facility on Sandhill Crane

Revisions to Appendix 5J, Attachment 5J-D primarily concern changes attributable to the altered “footprint” of temporary and permanent construction impacts. These changes affect several text sections and two figures, as shown below.

Figures

Acronym and Abbreviations

[unchanged text omitted]

Attachment 5J.D

Indirect Effects of the Construction of the BDCP Conveyance Facility on Sandhill Crane

5J.D.1 Introduction

[unchanged text omitted]

5J.D.1.1 Sandhill Crane Habitat Use in the Plan Area

[unchanged text omitted]

5J.D.1.2 Noise Impacts on Sandhill Cranes

[unchanged text omitted]

5J.D.2 Existing Noise Environment Conditions

[unchanged text omitted]

5J.D.3 Methods and Assumptions for Noise Impact Analysis

5J.D.3.1 Sensitivity to Noise and Thresholds for Mitigation

[unchanged text omitted]

5J.D.3.2 Construction Equipment Noise Estimates

A wide variety of construction equipment will be used at each facility construction site and will vary throughout the construction period. Multiple source construction noise, including intermittent impact noise from pile driving, was characterized by calculating the noise levels that would be produced when the loudest six pieces of construction equipment were operating simultaneously, and noise from heavy trucks was calculated assuming three heavy trucks operating in the same general area simultaneously. Certain portions of the conveyance facility project area will have more limited construction activity and construction noise sources, including borrow areas, spoils/muck areas, and tunnel muck conveyor belt corridors. Table 5J.D-2 lists the typical noise levels from construction equipment, and Table 5J.D-3 indicates which construction activity areas are likely to have each general noise source type.

Table 5J.D-2. Commonly Used Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level (dBA) 50 Feet from Source
Pile-driver (Impact)	101
Grader	85
Bulldozers	85
Heavy Truck	85
Loader	80
Air Compressor	80
Backhoe	80
Pneumatic Tool	85
Excavator	85
Auger Drill Rig (for drilled piles)	85
Crane, Derrick	88
Concrete Mixer Truck	79
Compactor (Ground)	83
Concrete mixer	85
Conveyor Belt Return/Load/Booster Drive	85
Conveyor Belt Mid-segment	75
Roller	74
Generator	84

Federal Highway Administration 2006, and conveyor belt equipment specifications.
dBA = A-weighted decibel

Table 5J.D-3. Matrix of Construction Noise Sources at Each Construction Activity Area Type (at 50 feet)

Construction Activity Areas	Noise Sources for Analysis					
	Pile Driver	Multiple Source Construction	Conveyor Belt	Heavy Trucks	Geotechnical Activities *	Access Road Construction
Noise level at 50 feet from Source	*101 dBA*	*96 dBA*	*85/75 dBA*	*85 dBA*	*89 dBA*	*90 dBA*
Intake	*See detail*	X			X	
Coffer dam	X	X			X	
Waterside intake feature	X	X			X	
Sediment basins	X	X			X	
Intake forebay	X	X			X	
Electrical substation	X	X			X	
Forebay	See detail	X			X	
Outlet structure	X	X			X	
Inlet structure	X	X			X	
Electrical substation	X	X			X	
Siphons	X	X			X	
Barge Unloading Facility	X	X			X	
Shaft Location	X	X	X		X	
Permanent Surface Impact	X	X			X	
Temporary Surface Impact		X			X	
Operable Barrier		X			X	
Concrete Batch Plant		X			X	
Tunnel Muck Area			X	X	X	
Intake Work Area				X	X	
Pipeline Work Area				X	X	
Tunnel Work Area				X	X	
Control Structure Work Area				X	X	
Safe Haven Work Area				X	X	
Potential Borrow Area				X	X	
Potential Spoil Area				X	X	
Fuel Station				X	X	X
Road Work Area				X	X	X
Temporary Access Road Work Area				X	X	X

*Assumes up to 2 borehole drilling sites within 50 feet of a receiver, plus a generator.

5J.D.3.3 Construction Traffic Noise Estimates

[unchanged text omitted]

5J.D.3.4 Impact Assessment Methods

[unchanged text omitted]

Table 5J.D-4. Calculated Distance to Noise Contours for Each Type of General Construction Noise Source

Construction Site Noise Source Type[1]	*Noise level at 50 ft*	Noise Contours (feet from source)			
		Distance to 80 dBA	*Distance to 70 dBA*	*Distance to 60 dBA*	*Distance to 50 dBA*
Impact Pile Driver	101	350	850	2,100	5,250
General Construction[2]	96	225	550	1,350	3,350
Heavy trucks[3]	90	125	300	750	1,900
Conveyor Belt Return/Load (ends of conveyor) and Boosting Drives (inline at 1.5 mile intervals)	85	80	200	500	1,200
Conveyor Belt Mid-segment (along the length of belt between ends and boosting drives)	75		80	200	500

1 Federal Highway Administration 2006, conveyor belt equipment specifications, and calculated as below.
2 Calculated assuming the six loudest pieces of construction equipment operating simultaneously.
3 Calculated assuming three heavy trucks operating simultaneously in same area of site.

The construction noise contours for general construction noise and pile driving were combined with the construction traffic noise contours. Overlay of the noise contours on the modeled foraging and known roost/forage areas depicts the expected worst-case noise levels to occur in these areas during project construction based on the assumptions above (see Figures 5J.D-3 and 5J.D-4).

Evaluation of the combined general project construction noise and pile driving contours in relationship to the known roosting/foraging sites shows that there are nine areas where noise levels on roosting and foraging sites are expected to exceed 50 dBA (locations 1 through 15 on Figures 5J.D-3 and 5J.D-4). Modeled foraging habitat occurs adjacent to or in the near vicinity of much of the BDCP conveyance facility construction area. Table 5J.D-5 shows the highest expected noise level for each construction activity type at the nearest roost/forage site, and nearest modeled habitat, absent implementation of minimization measures.

The traffic noise contours shown on Figures 5J.D-3 and 5J.D-4 are based on a combination of construction and non-construction traffic. The noise contours are calculated for peak traffic loads, therefore, they represent the loudest noise levels expected, which would typically be during daytime and peak commuting hours. Based on the current project design and absent measures to minimize noise in crane habitat, 50 dBA traffic noise contour will affect the following roost sites:

- temporary roost site north of Lambert Road between Franklin Boulevard and Bruceville Road;
- permanent roost site on Hood Franklin Road just below North Stone Lake;
- several permanent roosts along Interstate 5;
- edge of the temporary and permanent roost sites along Tyler Island Road;
- permanent roost sites south of State Route 12 on Bouldin Island; and
- permanent and temporary roost sites north and south of West 8 Mile Road.

Table 5J.D-5. Construction Equipment Noise Emission Levels and Estimated Noise Levels in Foraging and Roosting Habitat

Possible Construction Equipment	Typical Noise Level[1] (dBA) at 50 ft from Source	Calculated Noise Level (dBA)	
		at Nearest Modeled Foraging Habitat (distance)	at Nearest Roost/Forage Site (distance)
Pile-driver (Impact)	101	101 (50 ft)	51 (5,000 ft)
Combined noise generation[3]	96	96 (50 ft)	48 (4,000 ft)
Heavy Trucks[4]	90	90 (50 ft)	55 (1,300 ft)
Muck Conveyor Belt Return/Load and Boosting Drives	85	85 (50 ft)	55 (750 ft)
Conveyor Belt Mid-segment	75	75 (50 ft)	< 50 (750 ft)

[1] Federal Highway Administration 2006.
[2] Calculated based on assumed attenuation of 7.5 dB with each doubling of distance over soft ground.
[3] Calculated assuming the six loudest pieces of construction equipment operating simultaneously.
[4] Calculated assuming three heavy trucks operating simultaneously in same area of site.
dBA = A-weighted decibel

To quantify the total effect of the increase in construction and pile driving noise on sandhill crane habitat, we calculated the acreage of each sandhill crane habitat type occurring within each 10 decibel range interval. Table 5J.D-6 summarizes those results showing that as much as 8,682 acres of habitat (7,676 acres modeled foraging, 196 acres permanent roosting, 810 acres temporary roosting) could be affected by noise levels above 60 dBA , which would be noticeably above existing baseline noise levels (40–50 dBA) in most areas.

Table 5J.D-6. Acres of Sandhill Crane Habitat Affected by Increased Noise Levels from Project Construction

Noise Level Range	Habitat Types	General Construction and Pile Driving (acres)
>80 dBA	Modeled Foraging	832
	Roosting-Permanent	12
	Roosting-Temporary	54
	Subtotal Habitat	899
80-70 dBA	Modeled Foraging	1,799
	Roosting-Permanent	27
	Roosting-Temporary	112
	Subtotal Habitat	1,938
70-60 dBA	Modeled Foraging	5,045
	Roosting-Permanent	157
	Roosting-Temporary	644
	Subtotal Habitat	5,845
60-50 dBA	Modeled Foraging	17,327
	Roosting-Permanent	1,008
	Roosting-Temporary	1,909
	Subtotal Habitat	20,243

5J.D.4 Noise Impact Conclusions

Based on the assumptions and calculations in this analysis, in the absence of avoidance and minimization measures as much as 14,112 acres of crane habitat could experience noise levels above baseline levels as a result of combined general construction and pile driving activities.

Note that this analysis was conducted based on the assumption that there was direct line-of-sight from sandhill crane habitat areas to the construction site, and therefore is a worst-case estimate of effects. In many areas existing levees will partially or completely block the line-of-sight and will function as effective noise barriers substantially reducing noise transmission. Additionally, as described above, in the absence of data indicating the effect that noise levels above baseline would have on greater sandhill crane, a conservative approach was used by assessing noise levels above 50 dBA even though the standard significance threshold for DWR is 60 dBA.

Sandhill cranes have been observed to habituate to increased levels of roadway noise (Gary Ivey, pers. comm.; Rod Drewien pers. comm.; David Brandt pers. comm.; Dwyer and Tanner 1992); however, little is known about their response to intermittent noise (Gary Ivey, pers. comm.; Rod Drewien pers. comm.; David Brandt pers. comm.). As stated in the Platte River Recovery Implementation Program Final Environmental Impact Statement, “At present, there is no consensus on the influence of human disturbances to potential crane habitat, or even how the concept of disturbance should be evaluated.” (U.S. Fish and Wildlife Service 2006). Therefore, it is not possible at this stage to draw definitive conclusions regarding the sandhill crane response to the increased noise environment expected to be caused by this project. We can conclude that the noise environment will be affected and noise levels will increase in sandhill crane habitat by moderate levels over larger areas (e.g., up to 20 decibel increase on approximately 26,000 acres), and by high levels over a more limited area (e.g., 20-30 decibel increase over approximately 12,800 acres).

Avoidance and minimization measures may be implemented to reduce noise related effects on cranes. Measures to reduce effects may include designing the project to avoid noise producing activities near high crane use areas, reducing noise producing activities during the winter when cranes are present, reducing night time activities in the vicinity of crane roost sites, and installing noise barriers between construction and traffic activities and crane roost sites.

[For the remainder of Attachment 5J-D, unchanged text omitted. Revised figures are shown below.]

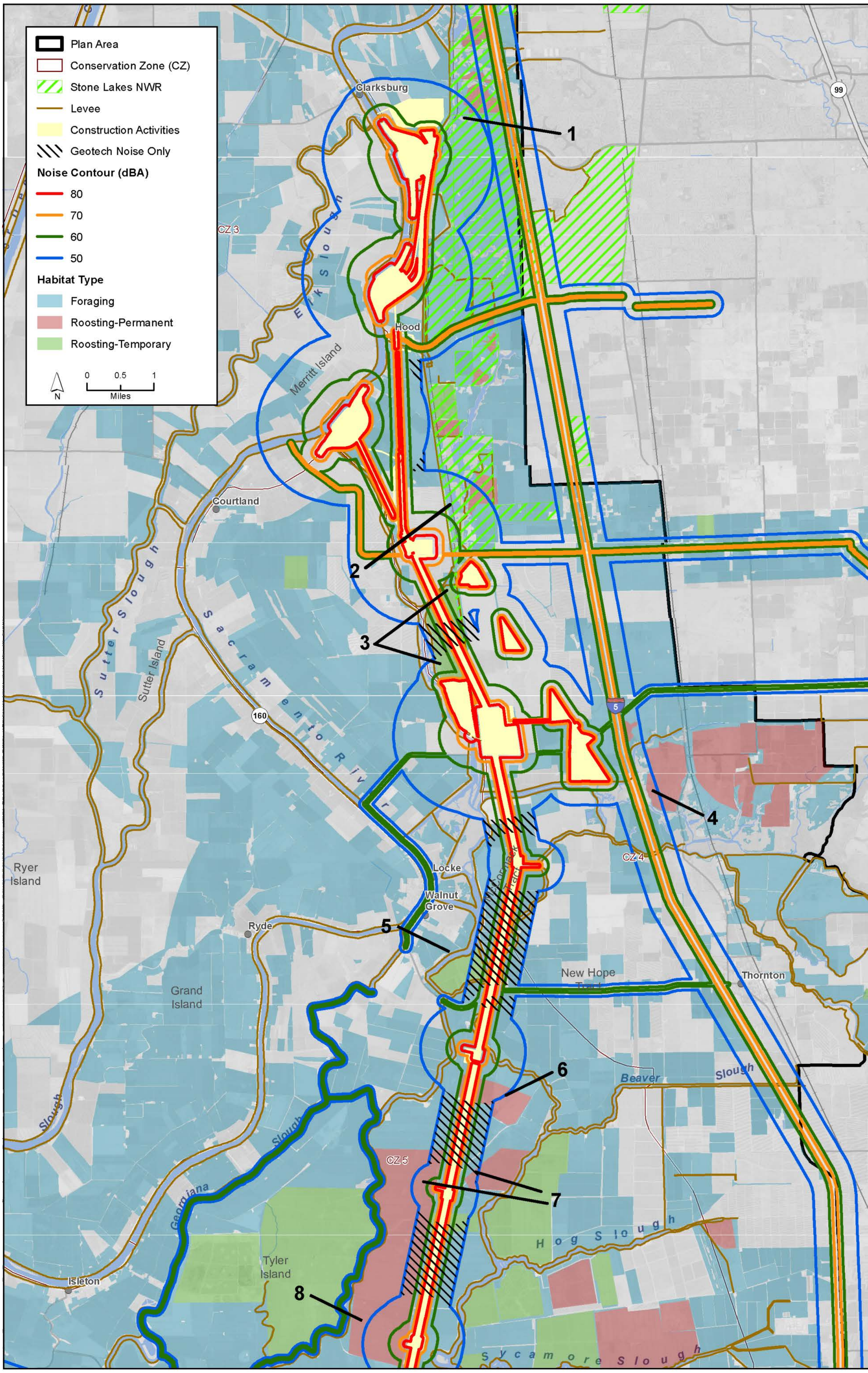

Figure 5J.D-3. Greater Sandhill Crane Indirect Effects General Construction, Truck Traffic, and Pile Driving (North)

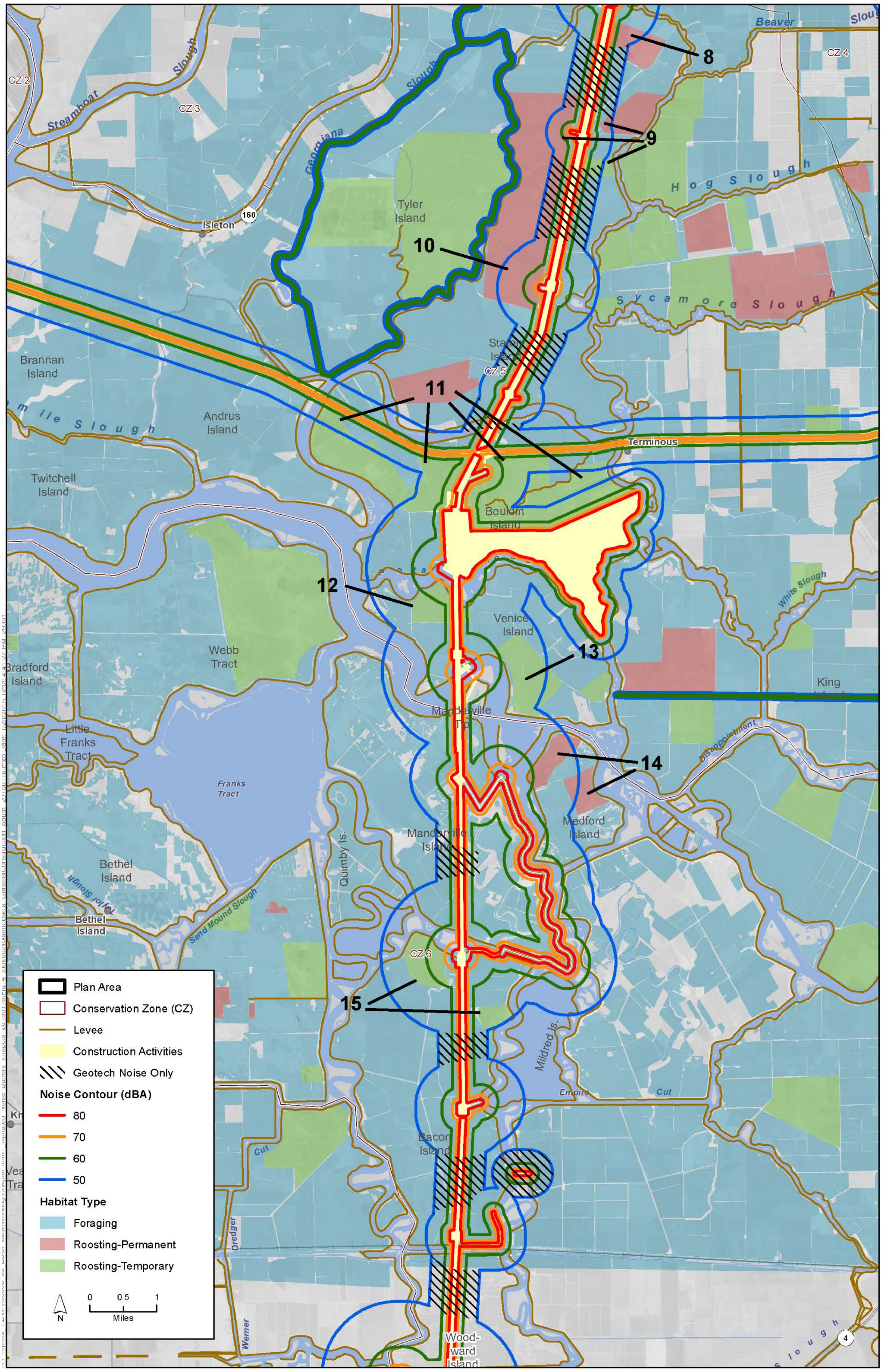

Figure 5J.D-4 Greater Sandhilll Crane Indirect Effects General Construction, Truck Traffic, and Pile Driving (South)

11F.5.2 Effects of Contaminants on Terrestrial Species

A detailed technical evaluation of the potential for BDCP actions to mobilize contaminants into the food chain is provided in *Appendix 5D Contaminants*, in the Draft BDCP, which includes analysis of:

- Contaminant occurrence and distribution in the Delta;
- Fate and transport; biogeochemistry;
- Bioavailability; and
- Mechanisms by which BDCP could change exposures and bioavailability of contaminants to the food web.

The conclusions developed based on these analyses for each contaminant are summarized in Table D.5-1 below; mercury and selenium were the only contaminants identified that BDCP actions could potentially result in increased foodweb exposure and impacts to covered species. Refer to *Appendix 5D Contaminants* for a more detailed analysis of each of the contaminants listed in Table D.5-1.

Table D.5-1. Impact Conclusions for Aquatic Resources

Contaminant	Conclusion
Methylmercury	• BDCP Water Operations -quantitative modeling showed small changes that were within the range of analytical uncertainty, in total mercury and methylmercury levels in water and fish tissues due to the BDCP. *No Adverse Impacts* • BDCP Restoration Actions - methylmercury could be generated by inundation of BDCP restoration areas, resulting in increased bioavailability to covered species • Provisions in *CM 12* for pre-assessment, planning, and adaptive management of BDCP restoration actions will minimize mercury methylation resulting in *No Adverse Impact*
Selenium	• BDCP Water Operations- quantitative modeling for the identified high-risk species, sturgeon, does not indicate an increased risk compared to toxicity thresholds. Based on that conservative analysis, the conclusion is *No Adverse Impact* • Selenium is concentrated as irrigation water is recycled and naturally occurring selenium is leached from the irrigated soils. In the long term, selenium inputs to the Delta should decrease as the proportion of cultivated lands are turned to wetlands and floodplains under the BDCP. • BDCP Restoration Actions could mobilize selenium into the food chain under a narrow set of conditions as restoration areas are inundated. *AMM27 Selenium Management* will be implemented to minimize this potential. Together with the overall decrease in selenium inputs resulting from transforming agricultural use to restoration, *No Adverse Impact*.
Copper	• BDCP Water Operations will result in decreased flow in the Sacramento River under certain conditions. Since copper concentrations in the Sacramento River watershed have been tied to flow rates, and overall copper concentrations are low, *No Adverse Impact* • Restoration Actions will take some land out of agricultural use, and end the application of pesticides (some of which contain copper) to those areas, thus reducing overall loading of copper to the Delta and resulting in beneficial effects on covered fish species. *No Adverse Impact*

Contaminant	Conclusion
Ammonia[a]	• Water Operations - Quantitative analysis indicates that the Sacramento River will have sufficient assimilation capacity under the BDCP to dilute ammonia in Sacramento wastewater treatment plant effluent to avoid adverse effects from these contaminants on the covered fish. *No Adverse Impact* • Restoration Actions - Few to no effects are expected from restoration actions on ammonia. *No Adverse Impact*
Pesticides—Pyrethroid	• Water Operations - Quantitative analysis indicates that the Sacramento River will have sufficient assimilation capacity under the BDCP to dilute pyrethroids in Sacramento wastewater treatment plant effluent. *No Adverse Impact* • Restoration Actions - Flooding of formerly agricultural land may result in mobilization of pyrethroids in agricultural soils into the aquatic system, increasing bioavailability to aquatic organisms; however, current information does not allow estimation of resultant mobilization of pyrethroids due to ESO restoration. Restoration actions will take some land out of agricultural use, and end the application of pesticides (including pyrethroids) to those areas, thus reducing overall loading of these chemicals to the Delta and resulting in a beneficial effect. Overall levels of and bioavailability of pyrethroids is not expected to be substantially affected by BDCP actions. *No Adverse Impact*
Endocrine Disruptors	• Water Operations and Restoration Actions - Since endocrine disruptors are a diverse group of chemicals, it is not possible to evaluate fully the potential effects on the distribution and bioavailability of these chemicals resulting from restoration actions. However, CM 19, which will mitigate contaminant inputs from stormwater would be expected to decrease loading of endocrine disruptors to the Delta system, resulting in overall reductions, and *No Adverse Impact*
Pesticides—Organochlorine	• Water Operations – no mechanism for BDCP water operations to affect organochlorine pesticides was identified. *No Adverse Impact* • Restoration Actions - Flooding of formerly agricultural land may mobilize pesticides in agricultural soils into the aquatic system, potentially increasing bioavailability to aquatic organisms, and specifically benthic organisms. However, since the bioavailability and toxicity of these chemicals is not higher in an aqueous system compared to terrestrial, no appreciable mobilization into the food web from restoration actions is anticipated. *No Adverse Impact*.
Pesticides—Organophosphates	• Water Operations – no mechanism for BDCP water operations to affect organochlorine pesticides was identified. *No Adverse Impact* • Restoration Actions - flooding of formerly agricultural land may mobilize pesticides in agricultural soils into the aquatic system, potentially increasing bioavailability to aquatic organisms. However, the solubility, tendency to adhere to soils and particulates, and degradation rates for these compounds vary; however, organophosphate pesticides are metabolized by fish and do not tend to bioaccumulate. • Restoration actions will take some land out of agricultural use, and end the application of pesticides (including organophosphates) to those areas, thus reducing overall loading of these chemicals to the delta and resulting in a beneficial effect. *No Adverse Impact*

[a] Ammonia in water generally forms some amount of ammonium. Therefore, the use of the term ammonia implies that both ammonia and ammonium may be present.

Note: Varying levels of uncertainty are associated with all conclusions based on qualitative and quantitative analytical results, which are estimates based on current information and best available scientific analysis.

The impact analysis below is based on the conclusions presented in the technical appendix, and includes some limited background on technical bases for those conclusions. However, the main focus of this section is to discuss potential effects on aquatic species. Please refer back to *Appendix 5D Contaminants* for further technical details.

The following provides an overview of the BDCP-related mechanisms that could result in increased mercury in the food web, and how exposure to individual species may occur based on feeding habits and where their habitat overlaps with the areas where mercury bioavailability could increase.

11F.5.2.1 Mercury

11F.5.2.1.1 Overview of Mercury in the Delta System

In general, levels of mercury in the delta system are elevated in water, sediment, and biota, with higher levels in certain areas. The Delta and Suisun Marsh (as part of the San Francisco Bay) are both listed on the Clean Water Act Section 303(d) list as impaired water bodies for mercury (See Section 5D.4.1.1). The available sample data discussed below is expressed in varying ways including total mercury and methylmercury; loading; and concentrations for sediment, water, and biota.

The major sources of mercury to the delta are former mining areas located in the mountains that drain into the Sacramento River watershed, especially through Yolo Bypass, and to a lesser extent, through the Cosumnes-Mokelumne River. In general, sediment total mercury concentrations are highest in the northern tributaries near the source areas, and follow a decreasing concentration gradient to the central and southern delta (Heim et al 2008). The same trend is seen in water concentrations and loading.

Cache Creek, which discharges in the upper part of Yolo Bypass, has the highest loadings and concentrations of mercury in the delta system. However, mercury concentrations in both sediment and water in Yolo Bypass decrease substantially at the lower portion of Yolo Bypass before discharging back into the Sacramento River. Methylmercury concentrations in water decrease significantly (by 30% to 60%) downstream of Rio Vista, where concentrations were at or below 0.05 nanograms per liter (ng/L) (Foe 2003; Wood et al. 2010). Sediment concentrations of mercury are highest where Cache Creek and Putah Creek discharge into Yolo Bypass, and then generally decrease downstream within Yolo Bypass (Heim et al 2010).

The San Joaquin River is a relatively minor contributor of mercury loads to the Delta system, compared to the Sacramento River watershed. However, due to lower flows in the San Joaquin River, mercury concentrations in water are often higher than in the Sacramento River. The Cosumnes-Mokelumne River, with an average waterborne mercury concentration of 0.31 ng/L, is the largest contributor of mercury in the San Joaquin watershed, but it only accounts for 2.1% of the total methylmercury in the Delta (Wood et al. 2010). Less data for this area is available.

In Suisun Marsh, mercury appears to be highest in sloughs where up to 36.62 ng/L was reported by Heim et al (2010). Methylmercury is highest in managed wetlands, because the wetting and drying cycles promote methylation.

11F.5.2.1.2 Mechanism for Potential Mercury Effects from BDCP Actions

BDCP actions will not increase the overall amount of mercury in the delta system. However, two mechanisms were identified that could affect the bioavailability of mercury in the delta system:

(1) Changes in waterborne concentrations of mercury resulting from different flow and mixing regimes under CM1 Water Operations; and

(2) Methylation of mercury into a more bioavailable form from inundation of restoration areas under CM2, CM4, and CM5.

CM1 Water Facilities and Operation

The operational impacts of new flows under *CM1 Water Facilities and Operation* on mercury and methylmercury concentrations were evaluated both qualitatively in the context of a conceptual model for mercury in the delta, and quantitatively using a numerical model; details on these analyses are described in Appendix 5D. These two lines of analyses must be considered together, since a very high level of uncertainty is associated with both approaches, as further described below.

Based on the conceptual model, since the Sacramento River is a much larger contributor of mercury to the Delta system relative to the San Joaquin River, a reduction of the proportion of flows from the Sacramento River and an increase in the proportion of flows from the San Joaquin River would be expected to result in an overall decrease in mercury loading to the delta under CM1 water operations. However, since the concentrations of mercury in San Joaquin River are sometimes higher than the Sacramento River, there could be slight localized increases in mercury concentrations.

The quantitative analysis uses a DSM2-based model coupled with an equation to translate water concentrations to fish tissue concentrations. Although a high level of uncertainty is associated with the model, it was deemed useful as a line of evidence to estimate BDCP effects. The level of uncertainty is unavoidable given currently available data, and is associated with uncertainties in these areas:

- The starting estimation of source water mercury concentrations;
- Using a conservative model that does not fully account for chemical transformations of mercury;
- Using a regression model to estimate fish tissue concentrations from water concentrations; and
- Applying the results of a bioaccumulation model based on largemouth bass to other aquatic species and terrestrial species.

Largemouth bass was selected because a data set of coincident water concentrations and fish tissue concentrations is available, and is not for other species. Because of their position in the pelagic food chain, largemouth bass are a Delta species with high potential to bioaccumulate methylmercury and thus serve as a conservative bioindicator of methylmercury exposure potential for most species.

The methodology and full quantitative model results are included in Appendix 8I. The results in terms of water quality effects are fully presented in BDCP EIR/EIS Chapter 8, *Water Quality,* and specifically Impact WQ-13. Based on the results, substantial mercury effects due to CM1 Water Operations were found for Alternatives 5 through 9, but not for Alternatives 1 through 4. A direct application of these results would be extremely conservative for any of the terrestrial species evaluated here due to differences in trophic levels, and therefore mercury bioaccumulation rates, and also because aquatic species will have more direct exposure to mercury changes in water. These factors compound the uncertainties of the analysis of mercury effects on terrestrial species from CM1 Water Operations. However, given the trends shown by the quantitative modeling, substantial effects on terrestrial species are indicated for Alternatives 5 through 9, but not for Alternatives 1 through 4.

The effects of mercury and methylmercury in fish due to proposed water operations (CM1) in comparison No Action Alternative (ELT) and Existing Conditions are not considered to be adverse to all fish species evaluated for Alternatives 1 through 5 (See AQUA-219 for further details). Effects under Alternatives 6 through 9 could result in adverse effects on fish species that could potentially indicate a risk of exposure to the Black Rail.

CM2, CM4, and CM5 Restoration Actions

Restoration will involve inundation of soils that may contain mercury. Because insoluble mercury found in dry soils can be converted into the more toxic form of methylmercury in an aquatic system, restoration actions could result in mobilizing mercury into the food web. Many environmental and chemical factors work together to determine the rate of mercury methylation, including how often the soils are inundated, if the soils completely dry out between inundation, the amount of mercury contained in the inundated soils, and geochemical regime (oxidizing vs. reducing). Other influencing factors include vegetation, grain size, availability of binding constituents (iron, sulfur, organic matter), and factors influencing success of the microbes responsible for the methylation process (nutrients and dissolved oxygen) (Alpers et al. 2008; Wood et al. 2010; Miles and Ricca 2010).

Research is ongoing to better understand the fate and transport of mercury in the environment, and specifically the amount mobilized by restoration actions. Substantial research is currently being undertaken to better understand the mechanisms for mercury methylation associated with wetland restoration by the DWR Mercury Monitoring and Evaluation Section and the Delta Mercury Control Program. Early results are expected starting in 2015, as outlined in Technical Memorandum for the Methylmercury Control Study Workplan (December 20, 2013) (The Open Water Workgroup et al 2013).

Mercury is transformed by reducing bacteria in flooded fine sediments subjected to periodic drying-out periods under anaerobic (oxygen-depleted), reducing environments (Alpers et al. 2008; Ackerman and Eagles-Smith 2010). The drying period between inundations appears to be an important factor. Methylmercury production is higher in high marshes that are subjected to inundation periods during only the highest monthly tidal cycles; production appears to be lower in low marshes not subjected to dry periods (Alpers et al. 2008). Floodplains, which are inundated relatively infrequently, likely support high rates of methylation, but in very short spikes restricted to flood events, which are typically very sporadic.

The presence of an electron donor is required for the reducing bacteria to accomplish methylation. Research indicates that iron and sulfur are effective donors. The ability of manganese to interfere with the methylation process is being investigated. Thus, levels of iron, sulfate and manganese can determine if mercury is methylated, regardless of the initial mercury concentrations in inundated sediments.

These factors are all very site specific, resulting in widely varying methylation rates, regardless of the amount of inorganic mercury contained in the inundated soils. Further, once methylated, partitioning of methylmercury into the water column, sediment and biota is not a constant ratio. Thus, mercury methylation rates must be determined on a site-specific basis.

Given the factors controlling methylation, managed wetlands provide for the highest rates of methylation (Windham-Myers et al. 2010). Thus restoration actions in Suisun Marsh that convert managed to unmanaged tidal wetlands are expected to decrease mercury methylation on a local scale, and total bioavailable methylmercury on a broader scale in the Suisun Marsh system. Overall, BDCP restoration actions should result in a net benefit to Suisun Marsh in terms of mercury.

In summary, the factors that determine mercury methylation rates are complex, resulting in a high level of uncertainty about the effects of restoration on net methylmercury production in the Study Area. A generalized conceptual model indicates that:

- Although methylation is controlled by many factors, mercury must be present in sediment for methylation.
- Mercury methylation would occur in high marsh and likely floodplains, where the sediment is allowed to dry out between inundations
- Methylation rates spike immediately following inundation, and then typically decrease; thus elevated methylation rates associated with restoration inundation are expected to be short term.

Based on available information, the restoration opportunity areas of primary concern include:

- Cache Slough ROA in Yolo Bypass – Yolo Bypass contains the highest levels of mercury in the Delta, specifically where Cache Creek and Putah Creek discharge. However, the Cache Slough ROA is located south of the most of the high-mercury area and data has demonstrated lower water and sediment concentrations in most of the lower Yolo Bypass where the ROA is located. The highest rate of methylation would be expected immediately following inundation, with rates slowing down over time.
- Suisun Marsh ROA – mercury is elevated in certain parts of the Suisun Marsh system. However, transformation of managed agricultural wetlands to tidal wetlands would be expected to result in an overall decrease in methylmercury, and an overall benefit.
- Cosumnes-Mokelumne ROA –The Cosumnes-Mokelumne River is identified as a source of mercury from the mountains upstream of discharging to the Delta, although the amount of mercury (loading) is low compared with the Yolo Bypass and Sacramento River basin. This area is less studied than the higher mercury areas.

11F.5.2.1.3 Overview of Mercury Effects on Biota Associated with Restoration

In general, mercury is of concern in an aqueous system in terms of bioaccumulation within the foodweb, and potential for effects on terrestrial species and humans. The primary concern for methylmercury is its bioaccumulation into piscivorous wildlife (Melwani et al. 2009; Ackerman et al. 2012) and humans (Davis et al. 2012). Little evidence of direct effects of mercury on aqueous biota is documented.

Organisms feeding within pelagic-based (algal) food webs have been found to have higher concentrations of methylmercury than those in benthic or epibenthic food webs; this has been attributed to food chain length and dietary segregation (Grimaldo et al. 2009). That is, the pelagic food chain tends to be longer than the benthic food chain, which allows for greater biomagnification of methylmercury in top predators. Also, there is less prey diversity at the top of the pelagic food chain than in the benthic food chain; pelagic top predators eat smaller fish and little else, while benthic top predators consume a variety of organisms, many of which are lower in the food chain than fishes and thus have less potential for methylmercury biomagnification. Also, bioaccumulation of methylmercury likely varies by species as there are taxonomic differences in hepatic (liver) detoxification rates (rate at which methylmercury is converted to a more inert form of mercury by the liver) (Eagles-Smith et al. 2009).

Forage fishes similar to delta smelt show high spatial variability in the bioaccumulation of methylmercury (Gehrke et al. 2011; Greenfield et al. 2013) as do juvenile Chinook salmon (Henery et al. 2010). It has not been demonstrated that these accumulations impair these small fishes so similar exposures in restored habitats may not affect these species' viability, though they may be of concern for passing mercury up the food web to predator fish, birds and humans.

Limited data is currently available for mercury effects associated with marsh restoration projects in the delta. Ackerman et al. (2013) found increased methylmercury concentrations in Forester's tern and American avocet eggs within three months post restoration in the South Bay Salt Pond restoration areas. However, the authors cautioned that this increase could represent a short term maximum effect given that methylmercury production and bioaccumulation often shows a short term spike immediately following perturbation.

11F.5.2.2 Selenium

11F.5.2.2.1 Overview of Selenium in the Delta

Occurrences of selenium in the Delta, along with fate and transport and biogeochemical factors that determine the mobility and bioavailability of selenium are fully discussed in Section 8, Water Quality, of the EIS/EIR, and Appendix 5D, Contaminants of the BDCP.

Selenium is soluble in an oxidized state, however, the majority typically becomes reduced and partitions into the sediment/particulate phases in an aqueous system. These reduced sediment/particulate phases are the most bioavailable (Presser and Luoma 2010), and are taken up by plant roots and microbes, entering the food chain through uptake by lower organisms. A portion of the selenium also is recycled into sediments as biological detritus. Lemly and Smith (1987) indicate that up to 90% of the total selenium in an aquatic system may be in the upper few centimeters of sediment and overlying detritus (Lemly 1999).

Water flow rates and residence times also determine the amount of selenium accumulated in the food web. Reducing conditions that support uptake into the food chain are more prevalent in slow moving waters with high residence times. Also, the longer residence time allows for transformation of the selenium in sediments into a bioavailable state, initial uptake by biota, and then transfer to higher trophic levels.

The ratios between selenium in particulates (which is more bioavailable), the water column, and in biota is a complex relationship that can vary across different hydrologic regimes, seasons, and foodchains (Presser and Luoma 2010). Since specific species (filter feeders) remove selenium from the water column very efficiently, water column selenium concentrations are sometimes not reliable indicators of risk to biota (Presser and Luoma 2010).

The type of food chain is also an important determinant of selenium risk and bioaccumulation. Plankton excrete most of the selenium they consume, and do not tend to bioaccumulate through the food chain (Stewart et al. 2004). This is an important factor that mitigates bioaccumulation in benthic-feeding fish species. Sessile filter feeders, such as the bivalve overbite clam (*Potamocorbula amurensis*), can bioaccumulate hundreds of times the waterborne concentration of selenium, and transfer it up a benthic-based food chain. In Suisun Bay, the bivalve overbite clam (*Potamocorbula amurensis*) is reported to be a highly efficient accumulator of selenium, and is present in great abundances, resulting in a high risk of exposures in the benthic-based food chain. The particulate concentrations of selenium (the most bioavailable) in the Suisun Bay region are considered low, typically between 0.5 and 1.5 micrograms per gram (μg/g), the bivalve overbite clam (*Potamocorbula amurensis*) contains elevated levels of selenium that range from 5 to 20 μg/g (Stewart et al. 2004). Given the fact that *Potamocorbula* may occur in abundances of up to 50,000 per square meter, 95% of the biota in some areas are made up of this clam.

11F.5.2.2.2 Mechanism for Potential Selenium Effects from BDCP Actions

BDCP actions will not increase the overall amount of selenium in the delta system. However, two mechanisms were identified that could affect the bioavailability of mercury in the Delta system:

- Water operations under CM1 could result in an increase in the ratio of San Joaquin River to Sacramento River water contributions to the Delta, leading to overall increased selenium loading to the Delta, and specifically the South Delta
- Restoration actions could result in mobilization of selenium, depending on the amount of selenium in the newly inundated sediments, the length of inundation (residence time), and biogeochemical factors.

Water Facilities and Operation

Effects on selenium water concentrations and bioavailability under water operations (CM1) was evaluated using a quantitative model, as described in Appendix 8M.

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 4A would result in small changes (approximately 1% or less) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) throughout the Delta, with little difference among locations (Appendix 8M). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0, indicating low probability of adverse effects. These results are consistent for all alternatives (see Appendix 8M, Tables M21 through M29).

Restoration

Selenium is more bioavailable in an aquatic system compared to upland locations, and inundation of ROAs could mobilize selenium sequestered in soils, increasing exposure of covered species. In aquatic systems, selenium is most mobile in chemically reducing conditions. Such conditions are maximized in areas of slow moving water, longer water residence times and low flushing rates (Presser and Luoma 2006; Lemly 1999). The longer residence times also allow the selenium to move up the food chain. Bioaccumulation depends on whether the food chain is benthic or pelagic-based. Sessile filter feeders can bioaccumulate and pass up to higher trophic levels hundreds of times the waterborne concentration of selenium. However, plankton excrete most of the selenium they consume and it is not bioaccumulated and passed through the food chain (Stewart et al. 2004)

Given the factors described above, the following are considered the areas where bioaccumulation of selenium in the food web is of most concern:

- South Delta restoration areas that receive selenium from the San Joaquin River

- Suisun Marsh restoration areas where sessile clams bioacuumulate selenium; of most concern are benthic feeders, and their predators

11F.5.2.2.3 Overview of Selenium Effects on Biota

Selenium is an essential nutrient for avian species and has a beneficial effect in low doses. However, higher concentrations can be toxic (Ackerman and Eagles-Smith 2009 Ohlendorf and Heinz 2009) and can lead to deformities in developing embryos, chicks, and adults, and can also result in embryo mortality (Ackerman and Eagles-Smith 2009, Ohlendorf and Heinz 2009). The effect of selenium toxicity differs widely between species and also between age and sex classes within a species.

The primary source of selenium bioaccumulation in birds is through their diet (Ackerman and Eagles-Smith 2009, Ohlendorf and Heinz 2009) and selenium concentration in species differs by the trophic level at which they feed (Ackerman and Eagles-Smith 2009, Stewart et al. 2004). At Kesterson Reservoir in the San Joaquin Valley, selenium concentrations in invertebrates have been found to be two to six times the levels in rooted plants. Furthermore, bivalves sampled in the San Francisco Bay contained much higher selenium levels than crustaceans such as copepods (Stewart et al. 2004). Studies conducted at the Grasslands in Merced County recorded higher selenium levels in black-necked stilts which feed on aquatic invertebrates than in mallards and pintails, which are primarily herbivores (Paveglio and Kilbride 2007). Diving ducks in the San Francisco Bay (which forage on bivalves) have much higher levels of selenium levels than shorebirds that prey on aquatic invertebrates (Ackerman and Eagles-Smith 2009). Therefore, birds that consume prey with high levels of selenium have a higher risk of selenium toxicity.

11F.6 Chapter 6, Plan Implementation

Chapter 6 addresses various issues related to implementation of the BDCP. The following substantive changes were made to this chapter.

- New subsection of Section 6.1.1, *Performing Implementation Actions*, addressing the use of conservation easements.
- Modifications to Section 6.3, *Planning, Compliance, and Progress Reporting*, needed to ensure consistency with the Draft Implementation Agreement issued in May, 2014.
- Further modifications to Section 6.3, *Planning, Compliance, and Progress Reporting*, describing a *Twenty-five-Year Climate Change Comprehensive Review.*
- Changes to Section 6.5, *Changes to the Plan or Permits*, needed to ensure consistency with the Draft Implementation Agreement issued in May, 2014.

The revised text showing each of these changes is presented below.

[unchanged text omitted]

6.1 Implementation Schedule

[unchanged text omitted]

6.1.1 Performing Implementation Actions

[unchanged text omitted]

6.1.1.1 Property Acquisition and Conservation Easements

In many cases, conservation measures will be implemented on existing public land and will not require the acquisition of property. Where this is not practicable, land will be acquired in fee or by conservation easement. For example, property acquisition will be necessary to preserve natural communities (Table 6-2). The criteria used to select properties for acquisition varies by conservation measure (e.g., see *CM3 Natural Communities Protection and Restoration* for a description of acquisition criteria for this conservation measure).

Thorough field assessments will be needed to assess the suitability of a particular property for implementation of a conservation measure. The Implementation Office will also need to ensure that property encumbrances (e.g., existing easements, leases, rights-of-way, title restrictions, resource extraction rights, hazardous materials) do not conflict with the ability to achieve Plan goals and objectives. For properties acquired using easements, easement terms should be negotiated before purchase. Property acquisitions for actions that involve modifications to levees (e.g., setting back levees to restore seasonally inundated floodplain habitat) include obtaining concurrence of the responsible agencies to initiate planning studies.

Conservation easements will be used as an important tool in Plan implementation in three ways:

- Conservation easement placed on land acquired in fee title through the Implementation Office or one of its land acquisition partners to secure credit under the Plan.
- Conservation easement purchased from a private party and placed on the land or water still owned by the landowner (i.e., as an alternative to fee title acquisition).
- Conservation easement placed on land in public ownership, where there is no identified impediment to using a conservation easement, to ensure permanent protection consistent with the Plan.

If the land is owned by a Permittee, a conservation easement must be placed on the site to ensure permanent protection, unless there is an identified impediment to creating a conservation easement, in which case protection will be assured through the use of another site protection instrument approved by the Wildlife Agencies. For lands acquired for the reserve system through other public entities, permanent protection will be ensured by a conservation easement, or where there is an identified impediment to creating a conservation easement, through the use of another site protection instrument approved by the Wildlife Agencies.

6.1.1.1.1 Easements on Private Land

This Plan assumes that the Authorized Entities will purchase some of the land for the reserve system in conservation easements rather than in fee title. For example, conservation easements are appropriate where landowners wish to remain on the property and the Plan's conservation goals can still be met with an easement. Conservation easements have been used throughout California to preserve farms, ranches, and the working landscapes that they support. The conservation easements purchased by the Implementation Office are intended to conserve natural communities and covered species consistent with the biological goals and objectives of the Plan. Only portions of properties that meet one or more of the goals of the Plan will count towards the Plan's conservation strategy. In some cases, an easement may be placed over more of a property than initially counted with the hope that other portions of the property may be restored or enhanced to meet Plan goals in the future.

Some ranchers and farmers may prefer selling a conservation easement to selling their land in fee title so they can remain on their land and continue to conduct livestock or agricultural operations. Livestock grazing will be an important management tool in the grassland portions of the reserve system (see Chapter 3), so grazing is likely to be compatible with the conservation goals of the Plan and therefore suitable for conservation easements. Similarly, covered species such as Swainson's hawk and greater sandhill crane rely on agricultural practices on cultivated lands (see Section 3.4.11), therefore cultivated lands are suitable for conservation easements if managed in a manner that is compatible to the habitat needs of covered species.

6.1.1.1.2 Easements on Existing Public Lands

As described in Chapter 3, one component of the conservation strategy is to enhance the management and monitoring of existing public lands. The Plan will provide additional funds or staff to public landowners to perform specific management and monitoring tasks that will substantially benefit the covered species and natural communities. To ensure that these sites will be managed in perpetuity to benefit the covered species, permanent conservation easements will be placed on these lands to ensure that uses are compatible with the conservation strategy of the Plan as described in Chapter 3. These sites will be enhanced to support the Plan and will be incorporated into the reserve system.

The Plan will count existing public lands towards the requirements of the conservation strategy once these lands are placed under a conservation easement that is consistent with the easement requirements described in this section.

6.1.1.1.3 Process for Developing Conservation Easements

This section describes the process for developing acceptable conservation easements. These guidelines and rules will be used by the Implementation Office or by its partners acquiring conservation easements on behalf of the Implementation Office with Plan funding.

All conservation easements acquired to meet the goals of the Plan will be in perpetuity and in accordance with California Civil Code Sections 815 et seq.[20] as well as the current policies of the Wildlife Agencies. The conservation easements will be dedicated to the Permittee or to a conservation organization (e.g., Delta Conservancy, The Nature Conservancy) if that organization is approved by the Implementation Office, the Wildlife Agencies, and the landowner. In addition, a binding agreement must exist between the Permittees and the easement holder to ensure compliance with the permits and Plan. An objective of the easements is to have consistency in enforcement, monitoring, and maintenance. Conservation easements on land owned by the one of the Permittees must be held by another conservation organization.

USFWS and CDFW will be named as third party beneficiaries on all conservation easements. To ensure compliance with the Plan, all conservation easements will follow a template easement as close as is reasonably possible. Reasonable variations from the template may be needed to address site-specific constraints or conditions. CDFW and USFWS, along with the Implementation Office, must review and approve the template easement.

It is the responsibility of participating landowners to abide by the terms of these conservation easements. The terms and prices of conservation easements will be negotiated on a case-by-case basis between the landowner and the Implementation Office (or a partner organization acting on their behalf). The specific terms of the conservation easement will be developed on a case-by-case basis depending on site conditions, landowner preferences and operations, and species and habitat needs. Some landowners may wish to reserve a portion of their property for uses that are incompatible with the Plan such as a home site, agricultural use unsuitable for covered species, or a recreational facility with high intensity use. In these cases, the conservation easement may either exclude the incompatible site or apply to the entire property but define the portion of the site in

[20] This section of California law allows placement of restrictions on the use of land for conservation purposes that is binding on all successive owners of that land.

which the incompatible uses are allowed[21]. The Plan will only receive count the portion of the property that is compatible with Plan biological goals and objectives.

Each conservation easement for the property or portion of the property that will be incorporated into the reserve system will be drafted to:

- ensure that the property will be kept in its natural or existing condition (all or portions of the site may also be enhanced or restored),
- protect the existing, enhanced and/or restored conservation values of the property forever,
- ensure that the easement cannot be extinguished without the prior written consent of the Permittees and the identified third party beneficiary Wildlife Agencies,
- confine the allowable uses of the property to those activities that do not interfere with the preservation or enhancement of those conservation values consistent with the Plan, and
- prevent any use of the property that would impair or interfere with the conservation values of the property.

The conservation values will be specifically described in terms of covered species and their habitat, as well as other natural community types on the property. Conservation values will be described, at a minimum, using the land cover types and covered species habitat described in Appendix 2A. A legal description and map must be included in the easement.

Each conservation easement will prohibit certain activities as described in the template easement, except as necessary to meet the biological goals and objectives of the Plan (including infrastructure required to support monitoring, management, and maintenance) or to provide recreational services consistent with the Plan (See Chapter 3, Section 3.4.11.2.3, *General Enhancement and Management Actions, Recreation*). These allowances will be described in the reserve unit management plan that will be developed by the Implementation Office.

Prohibited uses on conservation easements for natural (non-cultivated) lands will include the following:

- Unseasonal watering;
- Recreational uses not specified in an approved recreation plan (Section 3.4.11.2.3, *General Enhancement and Management Actions, Recreation*);
- Use of fertilizers, pesticides, biocides, herbicides or other chemicals;
- Use of off-road vehicles and use of any other motorized vehicles except on existing roadways, excepting off-road vehicle use required to conduct any allowed management practice set forth in the reserve unit management plan;
- Any construction, reconstruction, relocation or placement of any road, building, billboard, fencing, or sign, or any other structure or improvement of any kind, or altering the surface or general topography of the easement area without written approval by the easement holder and Wildlife Agencies unless otherwise allowed in the reserve unit management plan;
- Agricultural uses, including, without limitation, vineyards, nurseries, or intensive livestock use (e.g., dairy, feedlot) except as may be provided for in the reserve unit management plan (e.g., prescribed grazing);
- Any legal or de facto division, subdivision or partitioning of the Easement Area/Property or any fee transfer of less than the entire Easement Area/Property;
- Depositing or accumulation of soil, trash, ashes, refuse, waste, bio-solids or any other materials;

[21] There may be advantages to having the conservation easement apply to the entire site, for example, to avoid costly boundary surveys needed to define the conservation easement more narrowly than the property boundary.

- Planting, introduction, or dispersal of nonnative plant or animal species;
- Filling, dumping, excavating, draining, dredging, mining, drilling, removing, or exploring for or extraction of minerals, loam, soil, sands, gravel, rocks, or other material on or below the surface of the Easement Area/Property, and granting or authorizing any surface entry for any of these purposes;
- Removing, destroying, or cutting of trees, shrubs, or other vegetation, except as provided for in the reserve unit management plan;
- Manipulating, impounding, or altering any water course, body of water, or water circulation on the easement area and activities or uses detrimental to water quality, including but not limited to degradation or pollution of any surface or subsurface waters; and
- Without the prior written consent of the easement holder, separating the mineral, air or water rights for the easement area owned by landowner.
  - Conservation easements may have additional prohibited uses, or refinements of the above prohibited uses, to address site specific conditions such as species habitat needs.
  - Conservation easements on cultivated lands will have prohibited uses similar to those described above for natural lands, except that normal agricultural practices will be allowed to the extent that they are compatible with the conservation needs of covered species associated with cultivated lands.
  - In addition, all recorded conservation easements must include or incorporate by reference the items listed below.
- The initial pre-acquisition assessment of covered species habitat and natural communities present.
- A detailed list of the allowable uses and use restrictions within the easement boundary, consistent with the minimum requirements stated above.
- Any mandatory terms and conditions to maintain or enhance natural communities pursuant to Section 3.4.11 *Natural Communities Enhancement and Management of this Plan*.
- Provisions for access by the Wildlife Agencies and the Implementation Office or its designee to monitor compliance with the terms of the conservation easement and to carry out all applicable management and monitoring requirements described in Chapter 3.
- The allowances or restrictions on public access and recreation on the site, compatible with the conservation goals of the Plan, Sections 3.4.11.2.2, *Reserve Unit Management Plans* and 3.4.11.2.3, *General Enhancement and Management Actions, Recreation* in Chapter 3, and landowner wishes. Easements acquired from private parties who retain fee title to the land are expected to prohibit or greatly limit public access or recreation in order to preserve the private uses on the site (e.g., cultivated agriculture or livestock grazing). Easements acquired from private parties who retain fee title to the land are expected to prohibit or greatly limit public access or recreation in order to preserve the private uses on the site (e.g., cultivated agriculture or livestock grazing).
- Conservation easements on grazing lands will describe the general nature of the grazing to be allowed. The easement will specify the desired vegetation and other species habitat conditions and, if necessary, impose limits on the timing, stocking density, and duration of permitted grazing to meet those conditions. These desired conditions and grazing limitations will be allowed to fluctuate according to the adaptive management process. A baseline condition will be described to provide a benchmark to measure habitat enhancement on the site. The conservation easement may accomplish this requirement by reference to a separate reserve unit management plan prepared for the lands covered by the easement.
- If cultivated agricultural land is acquired, the conservation easement will ensure that the land meets one or more biological goals and objectives of the Plan. The easement will specify the desired species habitat conditions and, if necessary, impose limits on the timing, crop types, and

flooding regime to meet those conditions. These desired conditions and limitations will be allowed to fluctuate according to the adaptive management process. A baseline condition will be described to provide a benchmark to measure habitat maintenance or enhancement on the site. The conservation easement may accomplish this requirement by reference to a separate reserve unit management plan prepared for the lands covered by the easement. If the site contains aquatic or riparian habitat or other features that support or could support covered species, the conservation easement will also generally describe measures to maintain or enhance those species' habitats. The conservation easement may accomplish this requirement by attaching or referencing a separate reserve unit management plan prepared for the lands covered by the easement. Alternatively, if the reserve unit management plan is prepared later, it may contain additional detail on site enhancement.

- Conservation easements will take into account issues of water use efficiency and runoff into adjacent or nearby streams and their potential effects on covered species, if applicable.
- Provisions for enforcement and available remedies for the Implementation Office or appropriate other party in the event that title holder or third party violates the terms of the conservation easement.
- If the easement boundaries are different from the parcel boundaries, a legal description and map will accompany the easement.
- When a reserve unit management plan is prepared for private property according to Section 3.4.11.2.2, *Reserve Unit Management Plans*, the Implementation Office will record a Memorandum of Unrecorded Reserve Unit Management Plan, indicating where that reserve unit management plan may be found and that the terms of such reserve unit management plan will be followed. Such a title record ensures that the reserve unit management plan will be tied to the conservation easement in the event property ownership changes. The title record also ensures management of the site in perpetuity.

To approve and accept a conservation easement, the Implementation Office must have the following documentation.

- A pre-acquisition assessment of the property summarizing the baseline biological conditions including the presence and condition of natural communities and the presence and condition of covered species, if known (a complete biological inventory of the site would be conducted after the easement is recorded).
- A preliminary title report and legal description of the property.
- Assurance that any superior liens or interests will not substantially conflict with the property's conservation values.
- Evidence of all other easements, covenants, restrictions, reserved rights, and other property interests (including water rights).
- A Phase I environmental analysis for hazardous materials with results deemed by the Implementation Office to be compatible with the conservation values of the site.
- A map and description of the parcel and its physical condition (e.g., roads, buildings, fences, wells, other structures) and its relation to other components of the reserve system and other properties subject to other permanent protections for conservation purposes.
- A Property Analysis Report (PAR) or comparable assessment of the initial capital costs and ongoing management funds required to manage and monitor the lands (e.g., applicable components of Habitat Plan cost estimate).

6.1.1.2 Planning and Design

[Remainder of Section 6.1, unchanged text omitted]

6.2 Interim Implementation Actions

[unchanged text omitted]

6.3 Planning, Compliance, and Progress Reporting

[unchanged text omitted]

6.3.1 Annual Work Plan and Budget

On an annual basis[22], the Implementation Office will prepare the Annual Work Plan and Budget for the upcoming implementation year. The work plan will describe the activities, including those related to the implementation of conservation measures and the adaptive management and monitoring program, which are expected to be implemented. The budget will set out projected expenditures and identify the sources of funding for those expenditures. A final Annual Work Plan and Budget will be completed no later than 1 month prior to the beginning of the implementation year

The Program Manager will solicit input on the draft Annual Work Plan and Budget from the Permit Oversight Group and the Stakeholder Council, and submit the Annual Work Plan and Budget to the Authorized Entity Group for review and approval. As part of this process, the Permit Oversight Group will review the draft plan and provide written concurrence, within thirty (30) days, or as soon as practicable thereafter, that the draft plan accurately sets forth and makes adequate provision for the implementation of the applicable joint decisions of the Authorized Entity Group and the Permit Oversight Group or decisions of an agency with authority over the matter. If the Permit Oversight Group concludes that the draft plan does not do so, it will provide written notification to the Program Manager and the Authorized Entity Group, within the 30 day timeframe, or as soon as practicable thereafter, of the specific reasons for its conclusion. In such event, the Authorized Entity Group may direct the Program Manager to modify the draft plan to the satisfaction of the Permit Oversight Group. If the Authorized Entity Group does not, the Program Manager, Authorized Entity Group and the Permit Oversight Group will, in a timely manner, meet and confer in an effort to resolve the matter in dispute. If the Parties are unable to reach resolution, the review process described in Chapter 7.1.7 may be invoked by any member of the Authorized Entity Group or the Permit Oversight Group.

A draft of the Annual Work Plan and Budget will be submitted for review and comments to the Authorized Entity Group no later than 3 months, and the Permit Oversight Group and the Stakeholder Council no later than 2 months, prior to the release of the final Annual Work Plan and Budget. A final Annual Work Plan and Budget will be completed no later than 1 month prior to the beginning of the implementation year.

[unchanged text omitted]

6.3.2 Annual Delta Water Operations Plan

On an annual basis, DWR and Reclamation will jointly develop an Annual Delta Water Operations Plan. The first of such plans will be prepared in the year prior to the initiation of operations of the north Delta diversion and conveyance facilities (assumed to be year 9). Subsequent plans will be prepared and finalized no later than 3 months prior to each implementation year. The Annual Delta Water Operations Plan will include the following elements.

[22] The Implementation Office will decide how the planning year will be bounded (e.g., calendar year, federal fiscal year, state fiscal year, or water year).

- Operational priorities for both fisheries and water supply for the upcoming year for the purpose of maximizing conservation benefits to covered fish species and maximizing water supplies.
- Expected operations, including consideration of real time operational adjustments, consistent with the criteria established in CM1 and CM2.
- Monitoring, data collection, research efforts, and potential adaptive management actions associated with water operations for the upcoming year.
- The potential need for the Supplemental Resources Fund to assist in achieving the overall goals of the BDCP for the coming year due to anticipated operating conditions.

DWR and Reclamation will use prior years' Annual Water Operations Reports to inform development of the Annual Delta Water Operations Plan. DWR and Reclamation will seek input from other members of the Authorized Entity Group, the Implementation Office, Permit Oversight Group, Adaptive Management Team, and the Stakeholder Council regarding the draft Annual Delta Water Operations Plan. DWR and Reclamation will retain final approval authority over the plan; however, the Permit Oversight Group will, within 30 days of receipt of the draft plan, or as soon as practicable thereafter, review the draft plan and provide written concurrence that the plan is consistent with the provisions of the BDCP, the Implementing Agreement,[23] and the associated regulatory authorizations.

If the Permit Oversight Group concludes that the draft plan is not consistent, it will notify DWR and Reclamation in writing, within the 30 day timeframe, or as soon as practicable thereafter, of the specific reasons for its conclusion. In such event, DWR and Reclamation may modify the plan to the satisfaction of the Permit Oversight Group. If they do not, DWR, Reclamation and the Permit Oversight Group will, in a timely manner, meet and confer in an effort to resolve the matter in dispute. If these parties are unable to reach resolution, the review process described in Chapter 7, Section 7.1.7, *Elevation and Review of Implementation Decisions,* may be invoked by any of these parties. In the event that the Permit Oversight Group invokes the elevation process, DWR and Reclamation may nonetheless begin to implement the plan, provided that their operations do not substantially preclude a potential resolution of the issue in dispute. The Implementation Office will incorporate the final Annual Delta Water Operations Plan into the Annual Work Plan and Budget (Section 6.3, *Planning and Compliance and Progress Reporting*).

6.3.3 Annual Progress Report

At the end of each implementation year, the Implementation Office will begin the preparation of an Annual Progress Report. The reports will be based upon existing information, data, and analysis. These reports will provide an overview of the Plan activities carried out during the previous implementation year and provide information sufficient to demonstrate that the BDCP is being implemented consistent with the provisions of the Plan, the Implementing Agreement, and the associated regulatory authorizations.

The Program Manager shall solicit input on the draft of the Annual Progress Report from the Permit Oversight Group and the Stakeholder Council, and submit the report to the Authorized Entity Group for review and approval. The Implementation Office shall finalize and submit the Annual Progress Report to the Fish and Wildlife Agencies for their acceptance within six months of the close of the reporting year.

The annual progress report will include, among other things, the following types of information.

- The Annual Delta Water Operations Report (Section 6.3.4, *Annual Water Operations Report*).

[unchanged text omitted]

[23] The Implementing Agreement, Appendix 7.A, is a separate legal document, the purpose of which is to establish the obligations of the parties with respect to the implementation of the Plan.

6.3.4 Annual Delta Water Operations Report

Beginning in the first year that the north Delta diversions and conveyance facilities become operational, and for each year thereafter, the Implementation Office will prepare an Annual Delta Water Operations Report. The report will document the operations of the SWP and the CVP within the Plan Area over the course of the prior implementation year and provide sufficient information to demonstrate that such operations were implemented in a manner consistent with the provisions of the Plan, this Agreement, and the associated regulatory authorizations.

The Implementation Office will seek input from the Authorized Entities, Fish and Wildlife Agencies, and the Stakeholder Council on the draft Annual Delta Water Operations Report. Within six months of the close of the reporting year, the Implementation Office shall complete the report and incorporate it into the Annual Progress Report

[unchanged text omitted]

6.3.5 Five-Year Comprehensive Review

6.3.5.1 Five-Year Review Process

At 5-year increments (in year 5, year 10, etc.), the Implementation Office will prepare a Five-Year Comprehensive Review. The purpose of these reviews is to assess, on aperiodic, program-level basis, the overall effectiveness of the BDCP, including progress made toward achieving the biological goals and objectives and water supply reliability targets. As such, these reviews will focus on identifying and evaluating broad ecological trends in the Delta and changes in the status of covered species.

The objectives of the Five-Year Comprehensive Review are as follows.

- To provide an overview of the status of BDCP implementation, including implementation of conservation measures and the progress made toward meeting biological goals and objectives.
- To assess covered species trends and natural community conditions associated with BDCP implementation relative to overall trends and conditions for covered species and natural communities based on all relevant information.
- To evaluate the relevance of the various monitoring actions and research projects to the effective implementation of the BDCP.
- To evaluate the BDCP monitoring program, including the program's capacity to adequately measure the BDCP's progress toward achieving biological goals and objectives.
- To evaluate whether observed or predicted ecosystem-scale changes in the Delta attributable to climate change effects are consistent with changes as anticipated in this Plan

The Five-Year Comprehensive Review will be carried out by the Implementation Office in coordination with the Interagency Ecological Program, Delta Science Program, and Independent Science Board. The Implementation Office will work with the Interagency Ecological Program lead scientist and the Delta Science Program Science Manager to consolidate data and information from a range of sources.

The Program Manager will solicit input on the draft findings of the Five-Year Comprehensive Review from the Permit Oversight Group and the Stakeholder Council, and submit the review report to the Authorized Entity Group for review and approval. The Implementation Office will complete and submit the Five-Year Comprehensive Review report to the fish and wildlife agencies for their acceptance within 6 months of the close of the 5-year period subject to the review.

6.3.5.2 Twenty-five-Year Climate Change Comprehensive Review

This Plan anticipates certain environmental changes attributable to climate change; these changes are described in Appendix 5.A and their effects have been incorporated into the conservation strategy (Chapter 3) as well as the effects analysis (Chapter 5).

The fifth five-year review (i.e., the 25-year review) will include a comprehensive assessment of whether the timing and magnitude of observed environmental and ecosystem changes attributable to climate change have been consistent with Plan expectations. This comprehensive review will:

- Utilize hydrological and biological modeling using the best available climate change forecasts to assess prospective changes for the remaining duration of the permits.
- Explicitly evaluate progress to date toward meeting the biological objectives of the BDCP, relative to observed trends in climate change, including both its direct effects (e.g., sea level rise) and indirect effects (e.g., changes in foodwebs or the timing of life history stages of covered species).
- Assess the extent to which ongoing climate change affects attainment of Plan's overall goals of ecosystem health and water supply reliability.

Review results will be used to formulate appropriate adaptive management responses consistent with the BDCP adaptive management program, as well as the potential to initiate the changed circumstance responses to climate change discussed in Section 6.4.2.2.8, *Climate Change*.

6.3.6 Five-Year Implementation Plan

Based on the Five-Year Comprehensive Review, the Implementation Office will prepare a Five-Year Implementation Plan that identifies and assesses prospective issues likely to arise over the upcoming five year period. The Five-Year Implementation Plan will contain, among other things, the following information.

- Description of potential changes to program administration.
- Description of potential adaptive management changes to conservation measures, biological objectives, or the monitoring, and research programs.
- Summary of the planned actions and schedule, including potential revisions to those actions and schedules, related to the implementation of the conservation strategy.
- Description of expected long-term and system-wide monitoring actions and anticipated research studies.
- Budget projections reflecting the costs of implementing the planned actions.

The Program Manager shall solicit input on the draft Five-Year Implementation Plan from the Permit Oversight Group and the Stakeholder Council, and submit the draft plan to the Authorized Entity Group for review and approval. As part of this process, the Permit Oversight Group will review the draft plan and provide written concurrence, within thirty (30) days, or as soon as practicable thereafter, that the draft plan accurately sets forth and makes adequate provision for the implementation of the applicable joint decisions of the Authorized Entity Group and the Permit Oversight Group or decisions of an agency with authority over the matter.

In years when Five-Year Implementation Plans are prepared, the Annual Workplan and Budget may be included with or prepared separately from the Five-Year Implementation Plan.

6.4 Regulatory Assurances, Changed Circumstances, and Unforeseen Circumstances

[unchanged text omitted]

6.5 Changes to the Plan or Permits

[unchanged text omitted]

6.5.1 Administrative Changes

The administration and implementation of the BDCP will require frequent and ongoing interpretation of the provisions of the Plan. Actions taken on the basis of these interpretations that do not substantively change the purpose, intent, or terms of the Plan or the Implementing Agreement will not require modification or amendment of the BDCP, the Implementing Agreement, or its associated authorizations. Such actions related to the ordinary administration and implementation of the BDCP may include, but are not limited to, the following.

- Clerical corrections to typographical, grammatical, and similar editing errors that do not change the intended meaning; or to maps or other exhibits to address insignificant errors.
- Variations in the day-to-day management of reserve system lands.
- Adjustments to monitoring protocols to incorporate new protocols approved by the fish and wildlife agencies.
- Administration of the Implementation Office.
- Changes in the representatives of member entities in the Stakeholder Council.
- Minor corrections to land ownership descriptions.
- Changes to survey, monitoring, reporting and/or management protocols that do not adversely affect covered species or habitat functions and values.
- Updates or corrections to the land cover or other resource maps or species occurrence data.

6.5.2 Minor Modifications or Revisions

As part of the process of Plan implementation, the Implementation Office may need to make minor modifications or revisions to the BDCP and/or its Implementing Agreement from time to time to respond appropriately to new information, scientific understanding, technological advances, and other such circumstances. Minor modifications or revisions are likely to be technical in nature and will not involve changes that will adversely affect covered species, the level of take, or the obligations of Authorized Entities.

Minor modifications or revisions may include, but are not limited to, the following circumstances.

- Transfers of targeted acreages between ROAs consistent with criteria set out in Chapter 3, *Conservation Strategy*.
- Transfers of targeted natural community acreages among conservation zones, provided such change does not preclude meeting preserve assembly requirements, significantly increase the cost of BDCP management, or preclude achieving covered species and natural community goals and objectives.
- Adjustments of Conservation Measures or biological objectives developed through and consistent with the adaptive management program, as described in Chapter 3.6.

- Extensions of earth-moving or ground disturbance outside the right-of-way limits analyzed in the BDCP effects analysis for covered activities and associated federal actions involving infrastructure development or natural community restoration.
- Other proposed changes to the Plan that the fish and wildlife agencies have determined to be insubstantial and appropriate for implementation as a minor modification.

6.5.2.1 Procedures for Minor Modifications or Revisions

The Implementation Office, the Authorized Entities, or the fish and wildlife agencies may propose minor modifications or revisions by providing written notice to the other parties. Such notice will include a description of the proposed minor modifications or revisions, an explanation of the reason for the proposed minor modifications or revisions, an analysis of their environmental effects including any impacts on covered species, and an explanation of why the effects of the proposed minor modifications or revisions will have the following characteristics.

- They will not significantly differ from, and will be biologically equivalent or superior to, the effects described in the Plan.
- They will not conflict with the terms and conditions of the Plan.
- They will not significantly impair implementation of the conservation strategy.

The fish and wildlife agencies and/or the Authorized Entities may submit comments on the proposed minor modification or revision in writing within 60 days of receipt of notice. The Authorized Entities must agree to any proposed minor modification.

If the fish and wildlife agencies do not concur that the proposed minor modification or revision meets the requirements for a minor modification or revision, the proposal must be processed as a formal amendment as described in Section 6.5.3, *Formal Amendment.* Any Authorized Entity or fish and wildlife agency may invoke the review process set forth in the Implementing Agreement, Section 15.8, to resolve disagreements concerning a proposed minor modification or revision.

If the Fish and Wildlife Agencies concur that the requirements for a minor modification or revision have been met and the modification or revision should be incorporated into the Plan, the BDCP shall be modified accordingly. If any Fish and Wildlife Agency fails to respond to the written notice within the 60-day period, the agency will be deemed to have approved the proposed minor modification or revision.

Notwithstanding the foregoing, agreement of the Authorized Entities shall not be required for minor modifications that involve changes to Conservation Measures or biological objectives adopted through the adaptive management process, as described in Section 3.6, *Adaptive Management and Monitoring Program* .

6.5.3 Formal Amendment

Under some circumstances, it may be necessary to substantially amend the BDCP and the Implementing Agreement. Any proposed changes to the BDCP that do not qualify for treatment as described in Sections 6.5.1, *Administrative Changes*, or 6.5.2, *Minor Modifications or Revisions*, will require a formal amendment. Formal amendment to the BDCP and the Implementing Agreement also will require corresponding amendment to the authorizations/permits, in accordance with applicable laws and regulations regarding permit amendments. The Implementation Office will be responsible for submitting any proposed amendments to the Permit Oversight Group.

Amendments to the BDCP likely will occur infrequently and will follow the process set forth in Section 6.5.3.1, *Process for Formal Amendment*. Formal amendments include, but are not limited to, these following changes.

- Substantive changes to the boundary of the Plan Area, other than those associated with the acquisition of terrestrial natural community in the surrounding Delta counties, as described in Chapter 1, Section 1.4.1, *Geographic Scope of the BDCP.*
- Additions of species to the covered species list.
- Increase in the take of covered species beyond that authorized.
- Adding new covered activities and associated federal actions to the Plan.
- Substantial changes in implementation schedules that are likely to have significant adverse effects on the covered species.
- Changes in conservation measures that would require additional obligations of the Authorized Entities beyond those provided for within the adaptive resources established under the Plan and the Implementing Agreement.
- Changes to Biological Goals

6.5.3.1 Process for Formal Amendment

Formal amendments will involve the same process that was required for the original approval of the BDCP. In most cases, an amendment will require public review and comment, CEQA and NEPA compliance, and intra-Service Section 7 consultation. Amendments will be prepared by the Implementation Office, subject to review and approval of the Authorized Entity Group prior to submission to the Permit Oversight Group. Each fish and wildlife agency, for which the proposed amendment is applicable, will use reasonable efforts to process proposed amendments within 180 days.

6.5.3.2 Additions to Covered Species List

In the event the authorized entities desire to add species to the list of covered species, the authorized entities will propose an amendment to the BDCP and request an amendment to the permits and the integrated biological opinion. Any such request will be supported by sufficient evidence to meet the requirements of the ESA and the NCCPA. The fish and wildlife agencies shall give due consideration to, and full credit for, conservation measures previously implemented as part of the Plan that benefit such species.

6.5.4 Extension of Permit Duration

[unchanged text omitted]

6.5.5 Suspension of the Federal Permits

USFWS or NMFS may suspend the Federal Permits, in whole or in part, for cause in accordance with 50 CFR § 13.27 and 222.306(e) and other applicable laws and regulations in force at the time of such suspension. Unless emergency suspension is necessary to avoid jeopardy to a covered species, USFWS or NMFS shall not issue a notice of proposed suspension in accordance with 50 C.F.R. § 13.27(b) without first (1) attempting to resolve, in accordance with Section 15.8, any disagreements regarding the implementation or interpretation of the BDCP, the Implementing Agreement or the permits; and (2) identifying the facts or conduct which may warrant the suspension and requesting the Implementation Office to take appropriate remedial actions. Unless emergency suspension is necessary, USFWS and NMFS shall not suspend a federal permit, in whole or in part, to avoid the likelihood of jeopardy to a covered species, without first following the dispute resolution process in Section 22.5 of the Implementing Agreement. Any proposed decision to suspend the USFWS permit must be reviewed and approved in writing by the Assistant Secretary for Water and Science and the Assistant Secretary for Fish Wildlife and Parks, before it is effective. Any proposed decision to suspend the NMFS permit must be reviewed and approved in writing by the appropriate Under Secretary at the Department of Commerce. This responsibility shall not be delegated.

6.5.5.1 Reinstatement of Suspended Federal Permit

In the event USFWS and/or NMFS suspends a federal permit, in whole or in part, as soon as possible but no later than 10 days after the suspension, USFWS or NMFS, as applicable, will meet and confer with the Implementation Office concerning how the suspension can be ended. At the conclusion of any such conference, USFWS or NMFS will identify reasonable, specific actions, if any, necessary to effectively redress the suspension. In making this determination, USFWS or NMFS will consider the requirements of the ESA and its regulations, the conservation needs of the COVERED SPECIES, the terms of the federal permit and of the Implementing Agreement, and any comments or recommendations received from the Implementation Office. As soon as possible, but not later than thirty (30) days after the conference, USFWS/NMFS will send the Implementation Office written notice of any available, reasonable actions necessary to effectively redress the deficiencies giving rise to the suspension. Upon performance or completion, as appropriate, of such actions, USFWS/NMFS will immediately reinstate the federal permit. In the event of any total or partial suspension of a federal permit, all parties will act expeditiously and cooperatively to reinstate the federal permit.

6.5.6 Revocation of the Federal Permits

USFWS and NMFS each agree that it will not revoke or terminate a federal permit, in whole or in part, pursuant to 50 C.F.R. §§ 13.28–13.29 and 50 C.F.R. §§ 17.22(b)(8) and 17.32(b)(8) unless the Permittees fail to fulfill their obligations under the BDCP, the Implementing Agreement, or the federal permits, and only after identifying the facts or conduct which may warrant the revocation and requesting the Implementation Office to take appropriate remedial actions, and following the review process in Implementing Agreement Section 15.8 if invoked by a Permittee, unless immediate revocation is necessary to avoid the likelihood of jeopardy to a covered species. USFWS and NMFS each agree that it will not revoke or terminate a federal permit, in whole or in part, to avoid the likelihood of jeopardy to a covered species, without first following the dispute resolution process in Section 22.5 of the Implementing Agreement.

Any proposed decision to revoke the USFWS permit must be reviewed and approved in writing by the Assistant Secretary for Water and Science and the Assistant Secretary for Fish Wildlife and Parks, before it is effective. Any proposed decision to revoke the NMFS permit must be reviewed and approved in writing by the appropriate Under Secretary at the Department of Commerce. This responsibility shall not be delegated.

6.5.7 Suspension or Revocation of the State Permit

CDFW may suspend or revoke, in whole or in part, the state permit in the event that it determines that the Permittees have failed to fulfill their obligations under the BDCP, the Implementing Agreement, or the state permit. Unless an immediate suspension is necessary to avoid jeopardy, CDFW shall not suspend or revoke the state permit without first notifying in writing the Implementation Office and Permittees of the basis for its determination and the proposed action to revoke or suspend and meeting and conferring with the Program Manager and the Permittees regarding the matter. The Parties shall meet and confer within 15 days of issuance of such notice to assess the action or inaction that warranted CDFW's determination and to identify any appropriate responsive measures that may be taken. Within 45 days of receiving notice from CDFW, Permittees shall either satisfy CDFW that they are in compliance with the state permit or reach an agreement with CDFW to expeditiously obtain compliance.

Following this 45 day period, CDFW may suspend, but shall not revoke the state permit until such time as the review process set forth in Section 15.8 of the Implementing Agreement has been completed, provided the process has been invoked by a Permittee. Any decision to suspend or revoke the state permit must be in writing and must be signed by the Director of CDFW. This responsibility shall not be delegated.

6.5.7.1 Failure to Maintain Rough Proportionality

[unchanged text omitted]

6.6 References Cited

Ackerman, J. T., C. A. Eagles-Smith. 2009. Selenium Bioaccumulation and Body Condition In Shorebirds and Terns Breeding in San Francisco Bay, California, USA. *Environmental Toxicology and Chemistry.* 28:2134-2141

Ackerman, J., and C. Eagles-Smith. 2010. Agricultural Wetlands as Potential Hotspots for Mercury Bioaccumulation: Experimental Evidence Using Caged Fish. *Environmental Science and Technology* 44:1451–1457.

Ackerman, J. T., H. P. Herzog, H. Hartman, 2012. *The South Bay Mercury Project: Using Biosentinels to Monitor Effects of Wetland Restoration for the South Bay Salt Pond Restoration Project (Waterbird Mercury Component).* U.S. Geological Survey, 79p.

Brandes, P. L., J. S. McLain. 2001. Juvenile Chinook Salmon Abundance, Distribution, and Survival in the Sacramento- San Joaquin Estuary. *Biology of Central Valley Salmonids Fish Bulletin.*

Davis, J.A., R. E. Looker, D. Yee, M. Marvin-Di Pasquale, J.L. Grenier, C.M. Austin L. J. McKee, B. K. Greenfield, R. Brodberg, J. D. Blum. 2012. Reducing Methylmercury Accumulation in Food Webs of San Francisco Bay and its Local Watersheds. *Environmental Research.* 119: 3-26

Eagles-Smith, C. A., J. T. Ackerman, J. Yee, T. L. Adelsbach. 2009. Mercury Demethylation in Waterbird Livers: Dose-Response Thresholds and Differences Amoung Species. U.S. Geological Study. Davis, CA.

Foe, C. 2003. Mercury Mass Balance for the Freshwater Sacramento-San Joaquin Bay-Delta Estuary.

Gehrke, G. E., J. D. Blum, D. G. Slotton, B. K. Greenfield. 2011. Mercury Isotopes Link Mercury in San Franscio Bay Forage Fish to Surface Sediments. *Environmental Science and Technology.* Oakland, CA. Pages 1264-1270.

Greenfield, B. K., D. G. Slotton, K. H. Harrold. 2013. Predictors of Mercury Spatial Patterns in the San Francisco Bay Forage Fish. *Environmental Toxicology and Chemistry.* Pages 2728-2737.

Grimaldo, L., T. Sommer, N. Van Ark, G. Jones, E. Holland, P. B. Moyle, B. Herbold, and P. Smith. 2009. Factors Affecting Fish Entrainment into Massive Water Diversions in a Tidal Freshwater Estuary: Can Fish Losses be Managed? *North American Journal of Fisheries Management* 29:1253–1270.

Henery, R. E., T. R. Sommer, C. R. Goldman. 2010. Growth and Methylmercury Accumulation in Juvenile Chinook Salmon in the Sacramento River and Its Floodplain, the Yolo Bypass. *Transactions of the American Fisheries Society.* 139:550-563.

Llaban, A. 2011. Salmonid and Green Sturgeon Incidental Take and Monitoring Report. California Department of Water Resources. September.

Melwani, A. R., S. N. Bezalel, J. A. Hunt, J. L. Grenier, G. Ichikawa, W. Heim, A. Bonnema, C. Foe, D. G. Slotton, J. A. Davis. 2009. Spatial Trends and Impairment Assessment of Mercury in Sport Fish in the Sacramento- San Joaquin Delta Watershed. *Environmental Pollution. 1-13.*

Miles, A. K. M. A. Ricca. 2010. Temporal and Spatial Distributions of Sediment Mercury at Salt Pond Wetland Restoration Sites, San Francisco Bay, CA, USA. *Science of the Total Environment.* 408:1154-1165.

Ohlendorf, H. M., G. H. Heinz. 2009. Selenium in Birds. *Environmental Contaminants Biota: Interpreting Tissue Concentrations, Second Edition.*

Paveglio, F. L., K. M. Kilbride. 2007. Selenium in Aquatic Birds from Central California. *Journal of Wildlife Management.* 71(8): 2550-2555.

Presser, T. S., S. N. Luoma. 2010. Ecosystem-Scale Selenium Modeling in Support of Fish and Wildlife Criteria Development for the San Francisco Bay-Delta Estuary, California. *U.S. Geological Survey.* December.

Windham-Myers, L., M. Marvin-DiPasquale, J. Fleck, C. N. Alpers, J, Ackerman, C. Eagles-Smith, C. Stricker, M. Stephenson, D. Feliz, G. Gill, P. Bach and, A. Brice, R. Kulakow. 2010. Methylmercury Cycling, Bioaccumulation, and Export From Agricultural and Non-Agricultural Wetlands in the Yolo Bypass. Pages 1-6.

[unchanged text omitted]

11F.7 Chapter 7, Implementation Structure

Substantive changes made to this chapter are shown below.

[unchanged text omitted]

7.1 Roles and Responsibilities of Entities Involved in BDCP Implementation

[unchanged text omitted]

7.1.1 Program Manager

[unchanged text omitted]

7.1.1.1 Program Manager: Selection and Designation of Staff

[unchanged text omitted]

7.1.1.2 Science Manager: Selection and Function

[unchanged text omitted]

The Science Manager will report to the Program Manager and will, among other things, assume the following responsibilities.

[unchanged text omitted]

- Assist the Adaptive Management Team in synthesizing and presenting the results of studies and research, compiling the findings of monitoring efforts, and summarizing the current scientific knowledge on relevant Delta resources to the Program Manager, the Authorized Entity Group, Permit Oversight Group, Stakeholder Council, and others.

  Matters relating to the conduct of scientific reviews and the solicitation of independent scientific advice to assist in the implementation of the BDCP, including independent science review of adaptive management decisions affecting water operations, will be managed by the Adaptive Management Team, in a manner that ensures their independence and scientific integrity. The Adaptive Management Team, through the Science Manager, will coordinate such efforts with the Delta Science Program, the IEP, Stakeholder Council, the Authorized Entity Group, and the Permit Oversight Group.

7.1.1.3 Implementation Office: Function, Establishment, and Organization

[unchanged text omitted]

Specifically, under the direction of the Program Manager, the Implementation Office will assume responsibility for the implementation of the following broad range of actions.

- Oversight and coordination of administration of program funding and resources.
- Preparation of annual budgets and work plans.
- Establishment of procedures and approaches to implement plan actions.
- Planning, oversight, and implementation of actions set out in the conservation measures.
- Technical and logistical support to the Adaptive Management Team with respect to the administration of the Adaptive Management and Monitoring Program,
- Coordination with Delta-wide governance entities, including the Delta Stewardship Council, the Delta Science Program, the Delta Protection Commission, and the Delta Conservancy.
- Implementation of public outreach programs.
- Fulfillment of compliance monitoring and reporting requirements, including the preparation of annual reports.
- Reporting, at least on an annual basis, to the Delta Stewardship Council on the status of Plan implementation, including on matters related to the adaptive management and monitoring activities.

The Implementation Office shall not be responsible for certain implementation actions. Specifically, the Implementation Office will have limited, if any, involvement in the following matters:

- The Implementation Office will not be responsible for the construction or operation of SWP and/or CVP facilities other than to monitor infrastructure development and water operations for the purpose of assembling the information necessary to evaluate and report on compliance with the terms and conditions of the Plan, the Implementing Agreement, and the associated regulatory authorizations, as described in Chapter 6.4. The BDCP sets out the parameters within which DWR and Reclamation will conduct SWP and CVP operations and infrastructure development. DWR and Reclamation may choose to operate the SWP and CVP and develop new project infrastructure using their current organizational capacity or by contract with other entities.
- The Implementation Office shall not administer the Adaptive Management and Monitoring Program. Rather, the program will generally be administered by the Adaptive Management Team, which will be chaired by the Science Manager (See Chapter 3.6.2.1). The Implementation Office will provide logistical and technical support to the Adaptive Management Team.

The Program Manager will fulfill the staffing needs of the Implementation Office by drawing from existing personnel at DWR, Reclamation, State and Federal Contractors Water Agency (SFCWA), and from other sources, including from sources outside of agencies, if appropriate and if such personnel possess the expertise and experience necessary to carry out the tasks associated with BDCP implementation. The specific staffing needs of the Implementation Office will be determined by the Program Manager, with input from the Authorized Entity Group and the Permit Oversight Group. Staff assigned to the Implementation Office will act under the direction of the Program Manager. The engagement of personnel from DWR, Reclamation, and other entities, however, will not affect or modify the existing authorities of federal, state, and local agencies or nongovernmental organizations that pertain to personnel matters. Personnel may be retained under the Intergovernmental Personnel Act (5 USC 3371–3375); through personal services contracts, or other appropriate mechanisms. The Authorized Entities and the fish and wildlife agencies will each designate a lead representative from their respective agencies to serve as liaisons to the Implementation Office.

[unchanged text omitted]

7.1.1.4 Assignment of Responsibilities

[unchanged text omitted]

7.1.1.5 No Delegation of Authority

[unchanged text omitted]

7.1.2 Entities to Receive Regulatory Authorizations

[unchanged text omitted]

7.1.3 Authorized Entity Group

The Authorized Entity Group will be established to provide program oversight and general guidance to the Program Manager regarding the implementation of the Plan. The Authorized Entity Group will consist of the Director of DWR, the Regional Director for Reclamation, a representative of the SWP contractors and a representative of CVP contractors. The Authorized Entity Group will be responsible for ensuring that the management and implementation of the BDCP are carried out consistent with its provisions, the Implementing Agreement, and the associated regulatory authorizations.

7.1.3.1 Function

The Authorized Entity Group will provide oversight and direction to the Program Manager on matters concerning the implementation of the BDCP, provide input and guidance on general policy and program-related matters, monitor and assess the effectiveness of the Implementation Office in implementing the Plan, and foster and maintain collaborative and constructive relationships with the Fish and Wildlife Agencies, other public agencies, stakeholders and other interested parties, and local government throughout the implementation of the BDCP.

The Authorized Entity Group will engage in a number of specific matters including, but not limited to, the following:

- Provide oversight of the administration and funding of implementation activities.
- Provide oversight regarding the implementation of non-water related Conservation Measures by the Implementation Office.
- Approve, jointly with the Permit Oversight Group, changes to Conservation Measures or biological objectives proposed by the Adaptive Management Team.

- Decide, jointly with the Permit Oversight Group, all other adaptive management and monitoring program matters for which concurrence has not been reached by the Adaptive Management Team.
- Approve, jointly with the Permit Oversight Group, the Annual Monitoring and Research Plan.
- Select the Program Manager and provide input into the selection of the Science Manager.
- Review and approve the Annual Work Plan and Budget.
- Review and approve Annual Progress Reports, including Annual Delta Water Operations Reports, and other compliance-related documents.
- Review and approve submission of Plan amendments to the Permit Oversight Group.

The Program Manager will organize, convene, and provide support to the Authorized Entity Group and its proceedings,[24] including its meetings with the Permit Oversight Group. The Program Manager will further ensure that the Authorized Entity Group receives and reviews all proposed work plans, reports, budgets, and other relevant information generated by the Implementation Office, the state and federal fish and wildlife agencies, the Adaptive Management Team, and other sources. The Program Manager will further ensure that the Authorized Entity Group has sufficient opportunity to provide input regarding these documents.

The participation of the Authorized Entities on the Authorized Entity Group will not trigger or otherwise cause a delegation of authority or responsibility for any of the implementation actions described in the BDCP from one Authorized Entity to another or to the Implementation Office. Rather, the specific roles and level of involvement in implementation actions are defined either by existing statutory and regulatory authorities or by provisions set out in this Plan and its associated Implementing Agreement. For many of the implementation actions and commitments, a specific Authorized Entity will have the sole responsibility for implementation; for other actions and commitments established by the Plan, the Authorized Entities may be jointly and severally responsible for their implementation. For instance, the operation of the SWP will remain under the control and responsibility solely of DWR; likewise, the operation of the CVP will continue to be under the control and responsibility of Reclamation. As such, while it is expected that the Authorized Entity Group will express a single position of the group regarding a matter under its consideration; the entity(ies) with vested statutory or regulatory authority over the matter will make the final determination.

The Program Manager will solicit input on the draft Annual Work Plan and Budget from the Permit Oversight Group, the Adaptive Management Team, and the Stakeholder Council, and submit the plan and budget to the Authorized Entity Group for review and approval. As part of this process, the Permit Oversight Group will review the draft plan and provide written concurrence prior to the Authorized Entity Group's approval that the draft accurately sets forth and makes adequate provision for the implementation of the applicable joint decisions of the Authorized Entity Group and the Permit Oversight Group or decisions of an agency within the Permit Oversight Group with authority over the matter. The content of the Annual Work Plan and Budget and the timing of preparation and submission of the document to the Authorized Entity Group are described in Chapter 6, *Plan Implementation,* Section 6.3, *Planning*, *Compliance, and Progress Reporting*.

The Authorized Entity Group will meet on a schedule of its own choosing, but at a minimum, on a quarterly basis. The Authorized Entity Group may also be convened by the Program Manager, as needed, to review issues that arise during the implementation of the Plan, including proposed amendments to the Annual Work Plan and Budget. The Program Manager may further request that the group reconvene to consider proposed amendments to the Annual Work Plan and Budget. The Authorized Entity Group will also meet with the Permit Oversight Group (Section 7.1.5, *Permit Oversight Group*), at least on a quarterly basis to review Plan implementation issues, including those

[24] In the event that the Program Manager position is vacant, then DWR and Reclamation will designate agency staff to serve this role until such time as the position has been filled.

related to the adaptive management and monitoring program and the restoration and preservation of habitat.

The Authorized Entity Group shall have the responsibility to inform the public of its deliberations and decisions. As such, the Program Manager will ensure that the public receives notice of upcoming meetings of the Authorized Entity Group, that meeting agendas are posted prior to such meetings, and that any decisions of the Authorized Entity Group are made available through the BDCP website. On a periodic basis, the Authorized Entity Group will hold meetings that are open to the public. The Authorized Entity Group will institute procedures with respect to public notice of and access to these meetings and to any public meetings it holds with the Permit Oversight Group. The date, time, and location of the meetings will be posted on the BDCP website at least ten (10) days prior to such meetings. The meetings will be held at locations within the City of Sacramento or the legal Delta.

7.1.4 DWR and Reclamation: Operation of the SWP and CVP and Preparation of the Annual Delta Water Operations Plan

[unchanged text omitted]

7.1.5 Permit Oversight Group

The Permit Oversight Group will consist of the Fish and Wildlife Agencies, specifically, the Regional Director of USFWS, the Regional Administrator of NMFS, and the Director of CDFW. Consistent with their authorities under the ESA and the NCCPA, the fish and wildlife agencies will retain responsibility for monitoring compliance with the BDCP, approving certain actions, and enforcing the provisions of their respective regulatory authorizations. In addition to fulfilling those regulatory responsibilities, the Fish and Wildlife Agencies will also provide technical input on a range of implementation actions that will be carried out by the Implementation Office.

7.1.5.1 Function

To ensure that the BDCP is being properly implemented, the Permit Oversight Group will coordinate agency review of the actions being implemented under the Plan and assessments of compliance with the provisions of the Plan, its Implementing Agreement, and associated regulatory authorizations. The Permit Oversight Group will be involved in certain decisions relating to the implementation of water operations and other conservation measures, actions proposed through the adaptive management program or in response to changed circumstances, and approaches to monitoring and scientific research. The Implementation Office will work with the Permit Oversight Group and the Authorized Entity Group to institute mutually agreeable processes to enhance opportunities for such collaboration and engagement.

The Permit Oversight Group will have the following roles, among others, in implementation matters:

- Approve, jointly with the Authorized Entity Group, changes to conservation measures or biological objectives proposed by the Adaptive Management Team (Section 7.1.5, *Permit Oversight Group*).
- Decide, jointly with the Authorized Entity Group, all other adaptive management and monitoring program matters for which concurrence has not been reached by the Adaptive Management Team (Section 7.1.5, *Permit Oversight Group*).
- Approve, jointly with the Authorized Entity Group, the Annual Monitoring and Research Plan.

- Participate in decision-making regarding real-time operations, consistent with the criteria of *CM1 Water Facilities and Operation* and other limitations set out in the BDCP and annual Delta water operations plans.
- Provide input into the selection of the Program Manager and the Science Manager.
- Provide input and concurrence with respect to the consistency of specified sections of the Annual Work Plan and Budget with the BDCP and with certain agency decisions.
- Provide input and concur with the consistency of the Annual Delta Water Operations Plan with the BDCP.
- Provide input and accept Annual Reports, including Annual Delta Water Operations Reports.
- Provide input and approve plan amendments.

The participation of the Fish and Wildlife Agencies on the Permit Oversight Group will not trigger or otherwise cause a delegation of authority or responsibility for any of their regulatory actions described in the BDCP from one such agency to the Permit Oversight Group or to another Permit Oversight Group agency. Rather, the specific roles and level of involvement in implementation actions are defined by existing statutory and regulatory mandates and by provisions set out in this Plan and its associated Implementing Agreement.

[unchanged text omitted]

7.1.5.2 Participants

[unchanged text omitted]

7.1.6 Adaptive Management Team

[unchanged text omitted]

The Adaptive Management Team will be chaired by the Science Manager, and will consist of representatives of DWR, Reclamation, two participating State and federal water contractors (one each representing the SWP and CVP),CDFW, USFWS, and NMFS. Each of the foregoing parties shall be voting members. The Lead Scientist for the Interagency Ecological Program, the Lead Scientist for the Delta Science Program and the Director of the NOAA Southwest Fisheries Science Center shall also be members of the Adaptive Management Team, but shall serve in an advisory capacity only and shall not be eligible to vote on matters. The directors of DWR and CDFW and the regional directors of Reclamation, USFWS, and NMFS will each designate a management-level representative to serve on the Adaptive Management Team each of whom shall be qualified to represent both policy and scientific perspectives on behalf of their respective agencies.

The Adaptive Management Team will operate by consensus.[25] In the event that consensus is not achieved, the matter will be elevated to the Authorized Entity Group and the Permit Oversight Group for resolution. Any proposed changes to conservation measures or biological objectives will be elevated to the Authorized Entity Group and the Permit Oversight Group for their concurrence or for their own determination regarding the matter. If concurrence is not achieved, the entity or entities with decision-making authority will make a decision, subject to the review process set forth Section 7.1.7, *Review of Disputes Regarding Implementation Decisions*. The Adaptive Management Team may invite individuals or convene subteams consisting of individuals who are not members of the team to provide input into specific issues under consideration. These individuals or groups of individuals may be from the technical staffs of the entities represented on the Adaptive Management Team, the Technical Facilitation Subgroup of the Stakeholder Council, or other entities or institutions, as deemed appropriate by the team. As part of its deliberations, the Adaptive Management Team may

[25] For the purpose of this section, *consensus* will be considered to be reached if either all members of the Adaptive Management Team agree to the proposal at hand or no member of the team dissents from the proposal.

seek input from independent scientists or from other appropriate sources, including the Technical Facilitation Subgroup of the Stakeholder Council. Operation of the Adaptive Management Team, with respect to making decisions and development recommendations, is described in Section 3.6.3.5.2, *Operation of the Adaptive Management Team*.

The Program Manager may request that the Adaptive Management Team provide internal scientific review (internal to the Implementation Office) on specific technical issues of importance to the success of the adaptive management program and the conservation strategy implementation. The Adaptive Management Team will also assess on a regular basis the overall efficacy of the adaptive management program, including the results of effectiveness monitoring, selection of research and adaptive management experiments, and relevance of new scientific information developed by others (e.g., universities, Delta Science Program) to determine whether changes in the implementation of the conservation measures and the monitoring program would improve the effectiveness of the BDCP in achieving its biological goals and objectives.

The Adaptive Management Team shall determine its meeting schedule and administrative matters. The Implementation Office shall ensure that a record of Adaptive Management Team meetings and its actions is posted to a website or other appropriate electronic medium to ensure public access. The record should include a list of meeting attendees, meeting agenda, decisions and/or recommendations made, assignments to conduct additional work on a matter, audiovisual presentations or other materials distributed, and other documents relevant to the deliberations of the Adaptive Management Team. On a periodic basis, the Adaptive Management Team shall open its meetings to the public. The Adaptive Management Team will institute procedures with respect to public notice of and access to these meetings. The date, time, and location of the meetings will be posted on the BDCP website at least ten (10) days prior to such meetings. The meetings will be held at locations within the City of Sacramento or the legal Delta.

7.1.7 Review of Disputes Regarding Implementation Decisions

The permittees and the Fish and Wildlife Agencies will be responsible for making decisions with regard to the implementation of the BDCP. With respect to those proposed implementation decisions for which the Authorized Entity Group and the Permit Oversight Group have joint decision-making authority and are unable to reach agreement, the review process described in this section make be invoked to help resolve matters in dispute.

In the event of a dispute between the Authorized Entity Group and the Permit Oversight Group, the parties, will describe the basis for the dispute and identify options that may be available to help resolve the matter. The Parties will meet and confer to consider these options and to determine whether agreement can be reached on the matter. If after the meeting the matter remains unresolved, the entity with decision-making authority, as set out in Table 7-1 of the Plan, will make a final decision.

Prior to that final decision by the entity with decision-making authority, any member of the Authorized Entity Group or the Permit Oversight Group may initiate a nonbinding review process concerning the matter in dispute. The decisions that are eligible for this nonbinding review process are listed in Table 7-1. A member of either group may trigger this process by providing the Authorized Entity Group and the Permit Oversight Group with a written notice of dispute that describes the nature of the dispute and a proposed approach to resolution. Such notice must be provided to the parties within 14 days of the announcement of a tentative decision by the entity with decision-making authority. The entity with decision-making authority over the matter shall refrain from taking any actions to implement its decision until the review process has been completed.

Within 14 days of the issuance of the written notice of dispute, the parties, with the assistance of the Implementation Office, will form a three member panel of experts. One member of the panel will be selected by the Authorized Entity Group, one member will be selected by the Permit Oversight Group, and a third member will be selected by mutual agreement of the first two panel members. Sixty (60) days after written notice of dispute, both Parties will submit letter briefs and documentary evidence. No discovery will be allowed. At its discretion, the panel may require rebuttals or responses from the Parties. If so required, the Parties will submit rebuttals or responses within thirty (30) days of the request. Also, at its discretion, the panel may meet and confer with any of the parties regarding the matter and gather whatever available information it deems necessary and appropriate. Within 60 days of the submittal of the written positions of the parties, or rebuttals if so required, a non-binding recommendation will be issued by a majority of the panel, in writing, which will include a statement explaining the basis for the recommendation. If the recommendation is not issued by that date, the entity with decision-making authority may make its final decision. The timely completion of the review process is important to the effective implementation of the BDCP. The schedule described above shall be adjusted as necessary to inform the decisions in a timely manner.

Within 30 days of issuance of the panel's nonbinding recommendation, the entity with final decision-making authority over the matter will consider those recommendations, as well as any other relevant information concerning the issue at hand, and convey its final decision regarding the matter to the Authorized Entity Group and the Permit Oversight Group.

The availability of this review process will have no effect on the ability of a party to pursue legal remedies that may otherwise be available regarding a disputed matter. The recommendations of the panel are not intended to be given special deference by a reviewing court relative to the expert judgment of the agency making the final decision.

7.1.8 Other Regulatory Agencies

[unchanged text omitted]

7.1.9 Supporting Entities

The Implementation Office, through the Program Manager, may request that other entities, referred to as Supporting Entities, perform certain implementation tasks, where such entities have the authority, resources, expertise, and willingness to successfully undertake and complete the task. Where specific tasks are so assigned, the Program Manager will ensure that tasks and associated responsibilities are carried out properly and in coordination with other implementation actions. The Authorized Entities and the Fish and Wildlife Agencies may also be Supporting Entities. Other Supporting Entities may include the following entities.

- The Delta Conservancy, which has been designated by statute as a primary state agency to implement ecosystem restoration in the Delta.
- Sponsors of regional conservation planning programs, including those engaged in natural community conservation plan (NCCP) and/or habitat conservation plan (HCP) development or implementation, or of other similar conservation programs, that overlap or are adjacent to the Plan Area.
- State and federal agencies.
- Other public agencies and private entities that have authority, capacity, or expertise to implement actions described in the conservation strategy in a cost-effective, reliable, and timely manner.

The Program Manager will oversee each Supporting Entity's performance of its responsibility for carrying out a specific task. Decisions by the Program Manager to engage another entity in the implementation of specific plan elements or actions will be accomplished by written contract (through the existing authorities of an Authorized Entity) and will be based on the entity's jurisdictional authority, level of expertise, and its capacity to carry out the element or action in a timely and successful manner. The Program Manager, with the concurrence of the Authorized Entity

Group, may terminate a Supporting Entity's role in Plan implementation in the event that the Supporting Entity does not perform a task adequately. The Supporting Entity will be responsible, subject to oversight by the Program Manager, for entering into the necessary contracts and acquiring interests in real and personal property, in some cases obtaining permits or other authorizations, and taking all other steps needed to complete the implementation task.

The take authorizations that will be issued pursuant to the BDCP will provide regulatory coverage under the ESA and the NCCPA for all activities covered by the Plan. As such, no additional take authorizations will be required to implement these activities, regardless of whether the action is carried out by the Implementation Office or a supporting entity. The Permittees shall remain ultimately responsible for compliance with the Plan, this Agreement, and the associated regulatory authorizations.

7.1.10 Stakeholder Council

[unchanged text omitted]

7.1.10.1 Membership

[unchanged text omitted]

7.1.10.2 Function

[unchanged text omitted]

For the benefit of the Stakeholder Council members and the general public, the Program Manager will provide information and conduct briefings regarding Plan implementation. Briefings will include presentations of drafts of the Annual Report, Annual Work Plan and Budget, Annual Delta Water Operation Plan, the Annual Water Operations Report, the Five Year Comprehensive Review, and the Five Year Implementation Plan, as described in Chapter 6, *Plan Implementation*. In addition, to further facilitate access to information and promote transparency in decision-making, the Implementation Office will maintain a public, on-line data base of key documents and information, such as annual implementation reports, work plans, and budgets (Chapter 6, *Plan Implementation*, Section 6.3, *Planning, Compliance, and Progress Reporting*).

The Stakeholder Council will develop its own process to consider and provide input regarding the various aspects of BDCP implementation, including matters related to work plans and budgets, the Annual Delta Water Operations Plan,, implementation of conservation measures, adaptive management changes, monitoring and reporting activities, scientific research and review processes, and annual reports. A Technical Facilitation Subgroup will be established to provide input to the Implementation Office and the Adaptive Management Team on technical and scientific matters. The Stakeholder Council process will complement, but not substitute for, ongoing collaboration and communication between stakeholders and the Implementation Office; the Authorized Entity Group, the Permit Oversight Group, and the Fish and Wildlife Agencies. The Implementation Office will organize, help convene, and provide support to the Stakeholder Council and its proceedings.

7.1.10.3 Dispute Resolution

[Remainder of chapter: unchanged text omitted]

Appendix 11F, Attachment 1

Delta Science Program Independent Review Panel Phase 3 Report, Review of the BDCP Effects Analysis

In March 2014, the Delta Science Program Independent Review Panel issued its Phase 3 report on their review of the Bay Delta Conservation Plan (BDCP) Effects Analysis. The following sections include each of the Report's recommendations, along with a response from ICF/DWR on how each of those recommendations has been or will be addressed for the Final Effects Analysis, which will be provided as part of the Final BDCP.

General Charge Questions

1. How well does the Effects Analysis meet its expected goals?

Summary

Compared to the initial development of the BDCP Effects Analysis, the Panel consensus is that the Phase 3 version is a much improved and impressive compilation of background material and scientific and technical knowledge about the Bay-Delta that provided a plausible basis for the conservation measures. The Panel concluded that all of the available data and arguments for the rationale behind the Effects Analysis assumptions and conclusions are contained within the BDCP documents, although we suggest that the Effects Analysis (Chapter 5) itself is still poorly substantiated and leaves too much to appendices and other BDCP chapters without explicit cross references. The lack of accessibility to information conveys a "trust us" message.

Evaluation of BDCP effects was typically systematic in that it attempted to identify key attributes affecting Covered Species and described, to the extent possible, the importance of that attribute, the potential effect of the BDCP on the attribute, and uncertainty regarding the evaluation. Findings from multiple approaches taken to assess potential effects were described and strengths and shortcomings were identified when possible. However, this level of detail, which sometimes included conflicting information, inhibits rather than elucidates comprehension of the findings.

The tenuous conclusion drawn from the Effects Analysis is that <u>many of the critical justifications behind the supposed benefits of the conservation measures are highly uncertain</u>. Other than the impression that the foundation of the BDCP is weak in many respects, the default burden to ensure Covered Species benefit, if not recovery, rests on adaptive management. The adequacy of the BDCP therefore rests not in the intent and development of the conservation measures, but in the rigor and application of adaptive management to ensure that the critical uncertainties are addressed and strategically incorporated into a progressively refined Plan.

There is great potential in the area of decreasing invasive aquatic vegetation (IAV) abundance. Control of extremely invasive IAV, such as *Egeria densa* (Brazilian waterweed) and *Eichhornia crassipes* (water hyacinth), could be substantial and effective if the Plan follows through on its actions. The prospects of success with predator control appear marginal and then only if hotspot actions are followed through year after year. The effects of water withdrawals by the Plan may lead to expanded populations of the non-indigenous, invasive clams *Potamocorbula amurensis* and *Corbicula fluminea* without further direct actions to control their population growth. The fate of *Microcystis aeruginosa* is also not promising. Between trends in climate warming and planned water withdrawals, the prospects for *Microcystis* blooms appear to remain unchanged or slightly worse under the Plan, although the direction of these potential outcomes is highly uncertain.

The Effects Analysis develops a robust conceptual model of aquatic food webs and the diverse linkages that may impact the net production of food for covered fish species. Yet, the Effects Analysis contains a number of assumptions, some of which are inappropriate (such as the magnitude and location of invasive clam depression of phytoplankton production), and others highly uncertain. Uncertainties are mentioned, but no effort was made to include conservation efforts reaching only a portion of the biological objectives and goals. Thus the analysis of effects further assumes only the most beneficial potential results, but doesn't incorporate other possibilities. Other aspects of food webs in aquatic habitats are described but remain unanalyzed, some of which may enhance, while others may inhibit achievement of biological objectives. While the overall conceptual model is adequate, integration and synthesis is lacking. Consequently the conclusions and net effects are not appropriate given the gaps in analyses and the uncertainties.

For terrestrial communities and covered species, the Effects Analysis provides a simple accounting of the number of acres of natural communities and suitable habitat that will be removed and restored but very little information is provided about the management actions that will be implemented to maintain them over the duration of the conservation plan.

Recommendations

- Provide detailed cross-referencing and indexing between Chapter 5 and the associated technical appendices as well as other chapters of the BDCP, especially the Adaptive Management Plan.

  Response: ICF will review Chapter 5 and ascertain to what extent existing cross-referencing needs to be strengthened, particularly with respect to Chapter 3.

- Improve reporting of uncertainty levels within Chapter 5 Effects Analysis, including within the Executive Summary.

  Response: ICF made substantial efforts to incorporate acknowledgment of uncertainty into the effects analysis, with summary diagrams explicitly showing levels of uncertainty of the effects of the BDCP that were derived from the uncertainty associated with the importance of attributes and the change in the attributes that BDCP may give. As noted below in the response to the recommendation to 'Guide the scientific community by highlighted research priorities to address critical information gaps.', the effects analysis has been updated to include more explicit consideration of uncertainty and how it is linked to monitoring and adaptive management. ICF will review further the current reporting of uncertainty and coordinate with DWR and the permitting fish agencies to establish to what extent reporting of uncertainty can/should be enhanced.

- Identify the most relevant monitoring indicators necessary to evaluate the trajectory of outcomes with respect to the biological objectives.

  Response: Monitoring actions are described in Appendix 3.D of the Public Draft BDCP. Revisions to the draft Plan include summary statements of the monitoring and research actions in Section 3.7 of the Plan. These summary statements show which biological objectives are addressed by each monitoring action and provide guidance for preparation of a detailed monitoring plan to implement the action. Many of those actions, including most of those dealing with population changes in covered fish species, will require development and implementation of very detailed plans involving multiple stakeholders. Research actions are also discussed because of their importance in resolving uncertainties about the conceptual models underpinning the biological objectives and/or about the probable effectiveness of conservation measures.

- Complete work on biological objectives.

  Response: The only biological objective that was incomplete at the time of release of the public draft BDCP was that for longfin smelt biological performance. This objective will be complete in the final Plan.

- Provide triggers for adaptive management

  Response: The adaptive management and monitoring program does not define “triggers” for several reasons. First, the composition of the AMT is such that any aspect of the Conservation Strategy can be brought up for review at any time, so triggers would at best serve as guidance1. Second, evolution of conceptual models and other advances in science often show that a trigger is either of secondary importance or has a different quantitative significance than originally conceived; we did not want to create guidance that would later distract attention from real concerns. Third, the adaptive management process is implemented and executed by scientists and managers who are sensitive to the complexity of the ecosystems being managed. Accordingly, we chose a strategy in which the AMT includes representatives of several agencies whose mission and interests are served by identifying areas where BDCP is not performing as envisioned, and by

[1] The composition of the AMT is defined in BDCP Section 7 as follows: “will be chaired by the Science Manager, and will consist of representatives of DWR, Reclamation, a CVP contractor-Permittee, a SWP contractor-Permittee, CDFW, USFWS, and NMFS, who will serve as voting members; and the IEP Lead Scientist, the Delta Science Program lead scientist or a designee, and the Director of the NOAA Southwest Fisheries Science Center, who will serve as nonvoting members. The directors of DWR and CDFW and the regional directors of Reclamation, USFWS, and NMFS will each designate a management-level representative to the Adaptive Management Team who can represent both policy and scientific perspectives on behalf of their agency, including on matters related to adaptive management proposals and research priorities.”

investigating and remediating such areas. Thus adaptive management will be triggered by the regulatory drivers and the organizational missions of the agencies charged with protection of the Delta's biological resources.

- Guide the scientific community by highlighted research priorities to address critical information gaps.

  Response: ICF has divided each section of the beneficial and adverse effects to covered fishes into two subsections: one consists of the previous text and is titled Analysis and the other, following the Analysis section, is titled Main Uncertainties, Potential Research Actions, and Link to Adaptive Management and Monitoring. The latter subsection refers back to Chapter 3 and summarizes potential research, monitoring, and the main uncertainties associated with the conservation measures discussed in the preceding Analysis section.

- Improve on the systematic approach for integrating net effects for Covered Species.

  Response: ICF will coordinate with DWR and the permitting fish agencies to review the current approach and evaluate whether reasonable improvements can be made to address the substance of the panel's comment. The panel's apparent suggestion to combine the qualitative rankings for each attribute/stressor will be considered, although to this point ICF has considered that the overlap between different attributes makes such an approach challenging.

- Develop life cycle models for each of the Covered Species in order to evaluate BDCP effects

  Response: While it is of course desirable to have life cycle models for all covered fish species, it is not feasible within the scope of the BDCP preparation to develop such life cycle models; experience gleaned from existing life cycle models suggests that each model takes several years to develop. It is anticipated that several life cycle models currently in preparation and those that would be developed over the 50-year permit term would be used to assess the BDCP during implementation and to guide adaptive management. In lieu of a life cycle model for each species, the Effects Analysis draws on species and ecosystem conceptual models that are informed by several quantitative models and qualitative analyses. As noted above, areas of uncertainties regarding the conceptual models or analysis tools used, have been better identified and as more information is developed, can be used to improve existing and future life cycle models.

Comments

The length and detail of the text and accompanying tables indicate considerable effort to document information used to determine the net effects. However, this level of detail, which sometimes included conflicting information, inhibits rather than elucidates comprehension of the Effects Analysis findings.

Overall, the BDCP and the 22 conservation measures have the goal to enhance fish and wildlife species in the Plan Area. Twenty-one of the conservation measures involve actions intended to restore habitat and benefit Covered Species. Conservation Measure 1 (Water Facilities and Operation) also has the goal to benefit covered species but this specific action involves activities that may adversely impact species (e.g., water removal and construction activities) while also benefiting some species (e.g., reduced entrainment at the south Delta pumps). Therefore, a key goal of the BDCP Effects Analysis is to determine whether the overall positive effects of the conservation measures outweigh the adverse effects of water removal and project construction, and if so, to what degree.

The Effects Analysis attempted to evaluate the effects of the BDCP on each covered fish species in an open, unbiased manner. Sixteen life-cycle models for Covered Species were examined for applicability to the BDCP, but only two were deemed to be relevant. It was not clear why life cycle models were not developed for the specific purpose of evaluating BDCP effects on each of the Covered Species. Quantitative effects could not be described, rather effects of each attribute were ranked as zero, low, moderate, or high effect. A systematic approach to synopsize the overall net effect on each species was not used even though a ranking approach that could have been used in a systematic roll-up was described. Instead, professional judgment was used to assess the overall net effect.

If there is one area of general scientific consensus among the Panel about the implementation of the Bay Delta Conservation Plan is that its <u>outcomes remain highly uncertain</u>. As such, one would expect that the Effects Analysis would reflect this general conclusion by stressing a high level of uncertainty around all of its conclusions. There is also general consensus among stakeholders that the high level of uncertainty should not be an impediment to any action in the restoration of the Bay Delta ecosystem. The only way to address the highly uncertain outcomes of BDCP implementation is through rigorous monitoring and adaptive management. The BDCP Effects Analysis should better integrate where uncertainty exists, identify the most relevant monitoring indicators necessary to evaluate the trajectory of the outcome, provide triggers for adaptive management and guide the scientific community by highlighted research priorities to address critical information gaps. On these points the Effects Analysis as a stand-alone document falls short.

Table 5.2-8 identifies the biological objectives for each of the covered fish species and whether or not the Effects Analysis was able to assess the likelihood of the BDCP achieving the objectives. Some of the biological objectives were quantitative, thereby providing a specific metric that could be evaluated both prior to BDCP implementation and after implementation. For example, for winter-run Chinook originating in the Sacramento River, the objective is to achieve a 5-yr geometric mean survival through the Delta of 52% by year 19 (from an estimated 40% at present), to 54% by year 28, and to 57% by year 40. Although the table notes that this objective is interim and subject to possible change as new data are collected, the Review Panel complements the BDCP team for developing <u>quantitative biological objectives to be achieved within</u>

specific time periods. Ideally, the Effects Analysis should evaluate likelihood of the BDCP achieving each biological objective.

The inability to fully evaluate the likelihood of achieving each biological objective at this time highlights the need for a rigorous monitoring and Adaptive Management Plan. Chapter 5 seems to recognize this need in light of the incomplete evaluation of biological objectives. The Panel was not tasked with reviewing monitoring and adaptive management plans. Nevertheless, monitoring efforts should be designed to quantify whether or not the biological objectives are being achieved. The adaptive management plan needs to be linked to monitoring with identified trigger points and actions to steer the effort towards achievement of the biological objectives.

For terrestrial communities and covered species, the Effects Analysis, for the most part, provides a simple accounting of the number of acres of natural communities and suitable habitat that will be removed and restored but very little information about the management actions that will be implemented to maintain them over the duration of the conservation plan. The estimates of habitat restoration assume that restoration targets for the different habitats will be achieved with certainty, an assumption that unlikely to be met. In addition, the contribution of natural community restoration to species habitat restoration is estimated by multiplying the percentage of modeled habitat comprising the natural community by the total acres of natural community restoration in the plan area. This approach, however, confounds the spatially explicit nature of many of the species distributions within the Plan Area. For instance, only the riparian woodland south of Highway 4 within the Plan Area is considered potential riparian woodrat habitat which makes sense given their current distribution. The riparian woodland in this region currently comprises approximately 12.1% of the riparian woodland in the entire Plan Area. It is inappropriate to apply this percentage the estimate the amount of restored habitat in the Plan Area that will be available to riparian woodrats. If none of the restored habitat occurs south of Highway 4 then none of it will be potentially available to riparian woodrats. It makes much more sense to identify only riparian woodland restored south of Highway 4 as potential riparian woodrat habitat. Because the distribution of many of the species in the Plan Area is limited by their current distribution and dispersal abilities, the potential for colonization of restored areas should be identified using spatially explicit information. In the case of the riparian brush rabbit and riparian woodrat, a specified number of acres of riparian woodland should be restored within their potential range in the Plan Area.

The issue of the management of terrestrial communities and covered species is addressed in very broad terms in Chapter 5. In some cases there is mention of maintaining communities in a successional state that will make it suitable for a particular species (e.g., early successional riparian forest for riparian brush rabbits and western yellow-billed cuckoo), but many of the uncertainties surrounding long-term management of species and habitats are subsumed into adaptive management. Adaptive management is unlikely to succeed unless clear targets and thresholds for alternative management approaches are identified.

2. How complete is the Effects Analysis; how clearly are the methods described?

Summary

The Effects Analysis is a monumental effort incorporating over 745 pages of text and another 4,500 page of supporting appendices. The assessment covers potential changes in the physical environment, natural communities (12), fish (11 species), wildlife (25) and plant (12) species associated with BDCP. For fish species, 12 different categories of stressors and 32 attributes were examined over four different life stages. As many as 14 different operating scenarios were examined from the status quo to the long-term effects of BDCP implementation with climate change. For terrestrial species, areas of habitat loss and gained through management actions were examined.

Chapter 5 provides an overview of the spatial and temporal scope of the analysis, definitions of project baselines that differ depending on regulatory authority, recognition of climate change information, identification of a variety of models used to evaluate effects, treatment of viable salmon population criteria, and the approach to determining net effects on fish and wildlife. Biological goals and objectives were identified; this is important because the Effects Analysis should address each biological objective.

As might be expected, with the size of the Effects Analysis task, the quality of the assessments ranged in scientific rigor based on the amount of available data and best available science. Some aspects of the assessment, e.g., such as water quality and flow, were quantitatively assessed using sophisticated mathematical models. Aspects of the Chinook salmon assessment were also based on empirical data and process-based models. However, for many of the other fish species and their potential stressors, conceptual models supported by the scientific literature were the only recourse. In the case of Effects Analysis on fish, a workshop of professional biologists was used to incorporate feedback and to better express levels of uncertainty associated with assessment conclusions. The distinction between conclusions drawn from quantitative models and conceptual models was made clear.

The vastness of the Effects Analysis report and appendices is both its strength and weakness. In order to draw conclusions regarding effects of individual stressors or net effects on a species, it was often necessary in the report to draw on information from a number of appendices or other sections of the report. In many cases, these sections were not referenced or the specific findings of those sections not restated. This leaves the reader to hunt for the pertinent facts. It also appears at times that conclusions are based on a select subset of the facts that influence both the strength and certainty of the conclusions.

Because the variety of topics that the BDCP covers, how clearly the methods are described varies between topics. Several panelists gave input into Question 2 based on their areas of expertise.

Covered Fish

Approximately 72% of the objectives for covered fish could not be fully evaluated at this time due to insufficient information. The overall net effects conclusion for each species seemed to be based on the judgment of the authors, rather than a systematic ranking of attribute importance, change in response to the BDCP, and uncertainty in the rankings. Sixteen life cycle models for Covered Species were examined for applicability to the BDCP, but only two were deemed to be relevant, although the Panel is concerned about the exclusion of some life-cycle models. A systematic approach for synthesizing the net effect on each Covered Species was not used even though a ranking system was described that could have been used as a semi-quantitative scoring approach. Instead, professional judgment was used to assess the overall net effect.

In section 5.5, the text describes a numeric ranking for evaluating the importance of the attribute to the species, and the effect of the BDCP action on the attribute. The summary table (e.g., Fig. 5.5.1-5) was extremely difficult to read, used text to describe the effect (zero to high) and color to describe certainty. A small, essentially illegible "-" sign identified negative rankings. This summary table needs to be redesigned to improve readability.

No major omissions for the scientific literature or failure to use best available data were found in the Effects Analysis. However, the Effects Analysis did not develop new methods when gaps in assessment capabilities were encountered. For example, no attempt was made to modify any of the existing delta smelt models for the express purpose of this assessment.

An inevitable risk in using any mathematical model is extrapolation outside the range of the model. This extrapolation is likely whenever projecting to environmental conditions that have not yet occurred such as the changes that could be brought about by the BDCP. It is imperative that model-based assessments clearly state when such extrapolation is occurring and the potential direction of bias that might likely arise.

Hydrodynamics

The coupling of the multi-D, DSM2, and CALSIM II models is not a standard method that would naturally be understood by the reader. The documentation for this coupling is part of the EIS documentation, not part of the BDCP documentation. A short summary of the method should be included in Chapter 5.

Terrestrial Species

The methods for the terrestrial species are adequately described in the various appendices (but see specific comments on the description of the methods for the habitat restoration in Appendix 5.J.B).

Recommendations

Over-arching Recommendations

- Include a table of cross-references for each section or appendix referenced in the Net Effects.

  Response: Within the scope of recommendation 1a, ICF will review the extent to which existing cross-referencing needs to be strengthened.

- Add formal comparisons of model results in the Effects Analysis and appendices.

Response: ICF will add comparisons of model results that deal with similar biological outcomes (e.g., through-Delta survival), in the relevant appendices.

- Include within the Net Effect sections, discussions of contradictions or non-supportive facts in order to better capture some of the uncertainty in the conclusions.

  Response: ICF will review the existing text and provide additional discussion to address the Panel's recommendation.

- Emphasize the following Effects Analysis statement: "These expectations represent a working hypothesis of the relationship between actions, stressors, and biological performance."

  Response: ICF has added the statement (or similarly worded statement) in various locations throughout the text, in particular in the Net Effects sections. In addition, a following sentence has been added to make the link back to the sections described under the response to the recommendation*: Guide the scientific community by highlighted research priorities to address critical information gaps* above. An example of typical text is as follows: "As noted for other covered fishes, the expectations for the outcomes of the BDCP for spring-run Chinook salmon represent a working hypothesis of the relationship between actions (conservation measures and other covered activities), environmental attributes (stressors, both positive and negative), and biological performance. As described in the subsections discussing Main Uncertainties, Potential Research Actions, and Link to Adaptive Management and Monitoring in sections 5.5.4.1 and 5.5.4.2, extensive monitoring and potential research actions are included in the BDCP in order to assess the effectiveness of the conservation strategy and to allow refinement through adaptive management."

Covered Fish

- Model-based assessments should clearly state when extrapolation is occurring and the potential direction of bias that might likely arise.

  Response: ICF has added extensive summaries of the proportion of modeled data that occur beyond the range of the empirical data used to develop the relationships in the model-based assessments; the new subsections are entitled Extrapolation Beyond Empirical Data and occur with the methods sections for various biological models in Appendices 5.B, 5.C, and 5.G. In most cases, the potential direction of bias that could arise is unknown, but is stated when known.

- Redo the format of the effects on attributes summary tables (e.g., Fig. 5.5.1-5) to improve readability.

  Response: ICF has redone the format of the effects summary figures by providing red text for negative effects and adding '+' symbols for positive effects. These redone formats will be included in the final BDCP, once any changes to attribute effects are finalized.

Hydrodynamics

- A short summary of the method to inter-link multi-D hydrodynamic models, 1-D (DSM2) models, and CALSIM II should be included in Chapter 5.

  Response: BDCP Modeling description included in here is a very brief summary. The detailed description is included in Public Draft BDCP EIR/EIS Appendix 5A.

  Several main components of BDCP such as the proposed north Delta intakes, modifications to the Fremont Weir, large scale tidal marsh restoration in the Delta and changes in the operations criteria of the existing south Delta export facilities can significantly influence the hydrologic response in the Sacramento – San Joaquin Delta and across the CVP-SWP system.

  BDCP is seeking a 50 year permit. Therefore, the analysis was performed at two points of time: Early Long-Term (ELT) when the proposed north Delta intakes are operational, and Late Long-Term (LLT) at the end of the permit period. ELT was assumed to occur around the year 2025, and LLT around 2060. BDCP modeling at ELT assumed 25,000 acres of new open water areas in the Delta, and 65,000 acres at LLT. The modeling at ELT and LLT also considered climate change and sea level rise as inherent. A projected sea level rise of 15cm at Golden Gate Bridge was assumed at ELT and 45cm at LLT.

  BDCP modeling approach considered these complex, inter-dependent, large-scale changes to the system, and allowed performance of a comprehensive evaluation of the BDCP and its effects on various covered species. The approach was partitioned into two stages. In the first stage, the key analytical tools were prepared to consider the proposed changes under BDCP, and expected changes over time such as climate change and sea level rise. Once the tools were prepared, in the second stage, they were integrated and applied to evaluate the physical effects of BDCP on the CVP-SWP system and the Delta.

  Figure 1 shows the analytical framework and the integrated models used in the evaluation of BDCP. All the key physical models included in the analytical framework were refined to take into consideration the proposed large scale changes under BDCP, and climate change and sea level rise.

  The physical modeling approach applied for the BDCP integrates a suite of analytical tools in a unique manner to characterize changes to the system from “atmosphere to ocean”. Figure 2 illustrates the general flow of information for incorporating climate and sea level change in the physical modeling analyses. Climate and sea level can be considered the most upstream and most downstream boundary forcings on the system analyzed in the physical modeling for the BDCP. However, these forcings are outside of the influence of the BDCP and are considered external forcings. The effects of these forcings are incorporated into the key models used in the analytical framework. For selected future climate scenarios, regional hydrologic modeling was performed with the Variable Infiltration Capacity (VIC) hydrology model using temperature and precipitation projections of future climate. VIC model generates natural streamflows under each assumed climate condition.

The climate impacted inflows based on VIC simulations were incorporated into CALSIM II simulations. CALSIM II planning model was used to simulate the operation of the CVP and SWP with and without BDCP over a range of hydrologic conditions. The CALSIM II model utilizes a monthly time-step to route flows throughout the river-reservoir system of the Central Valley. For providing a reasonable estimate of the spills and the potential diversion at the north Delta intakes, a monthly to daily flow disaggregation technique was included in the CALSIM II model for the Fremont Weir, Sacramento Weir, and north Delta intakes. The river flows and Delta exports from the CALSIM II model are used as input to the Delta hydrodynamics and water quality models, and upstream reservoir storage and releases are used as input to the River and Reservoir Temperature models.

Delta Simulation Model (DSM2), a one-dimensional hydrodynamics and water quality model was selected as the key model that is capable of simulating hydrodynamics, water quality and particle tracking in the Delta, on a tidal scale, accurately and quickly over a wide range of hydrologic conditions, which is necessary for a long-term planning study such as BDCP. Prior to its use in BDCP, DSM2 was recalibrated in 2009 to better reflect existing geometry in the Delta.

DSM2 has simplified representation of largely two-dimensional features such as open water areas or tidal marshes and three-dimensional processes such as gravitational circulation which is known to increase with sea level rise in the estuaries. Therefore, DSM2 was recalibrated or “corroborated” based on a dataset that accurately represents the conditions in the Delta under the proposed restoration and sea level rise. This dataset was simulated using higher dimensional models capable of resolving the two- and three-dimensional processes well. Once corroborated or recalibrated DSM2 under the proposed conditions using the datasets from the higher-dimensional model DSM2 can simulate the hydrodynamics and salinity transport with similar consistency as the higher-dimensional models, which allows evaluation of BDCP over a wide range of hydrologic conditions.

Figure 3 shows a schematic of how the hydrodynamics and water quality modeling was formulated for BDCP. UnTRIM Bay-Delta Model (MacWilliams et al., 2009), a three-dimensional hydrodynamics and water quality model was used to simulate the sea level rise effects on hydrodynamics and salinity transport under the historical operations in the Delta. RMA Bay-Delta Model (RMA, 2005), a two-dimensional hydrodynamics and water quality model was used to simulate tidal marsh restoration effects with and without sea level rise on hydrodynamics and salinity transport under the historic operations. The results from the UnTRIM model were used to corroborate RMA and DSM2 models so that they simulate the effect of sea level rise accurately. The results from the RMA model were used to corroborate DSM2 so that it can simulate the effect of tidal marsh restoration with and without sea level rise accurately. The corroborated DSM2 was used to simulate hydrodynamics and water quality in the Delta by integrating the tidal marsh restoration and sea level rise effects over a 16-year period (WY 1976 – 1991), using the hydrological inputs and exports determined by CALSIM II under the projected operations. It was also used to retrain Artificial Neural Networks that can emulate modified flow-salinity relationship in the Delta.

CALSIM II relies on an Artificial Neural Network (ANN) that attempts to mimic the flow-salinity relationships as simulated in DSM2, but provide a rapid transformation of this information into a form usable by the CALSIM II operations model. The ANN is implemented in CALSIM II to constrain the operations of the upstream reservoirs and the Delta export pumps in order to satisfy particular salinity requirements. For evaluating BDCP using CALSIM II, the ANN was retrained using the “corroborated” DSM2 model that represents the effect of large scale restoration and sea level rise on the Delta hydrodynamics and salinity transport.

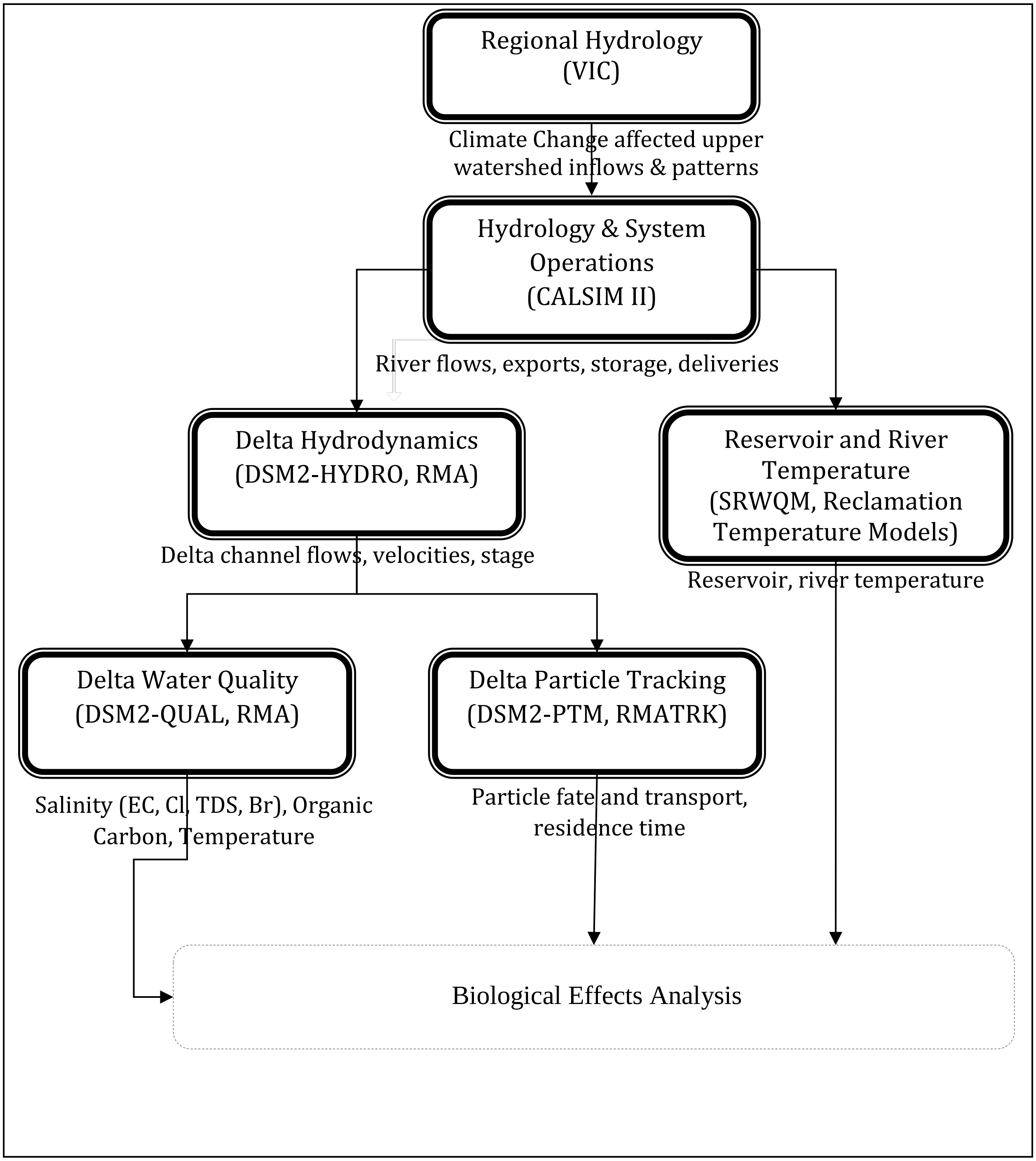

Figure 1: Analytical framework and the models used to evaluate the effects of the BDCP

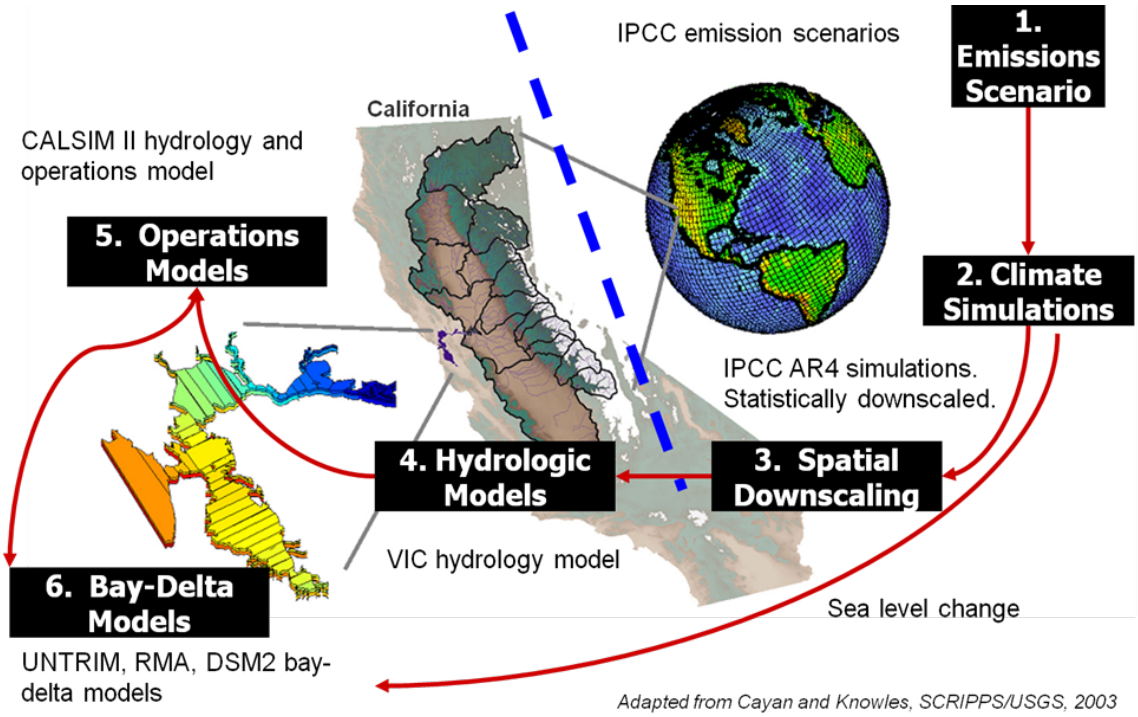

Figure 2: Characterizing climate change impacts from atmosphere to oceans

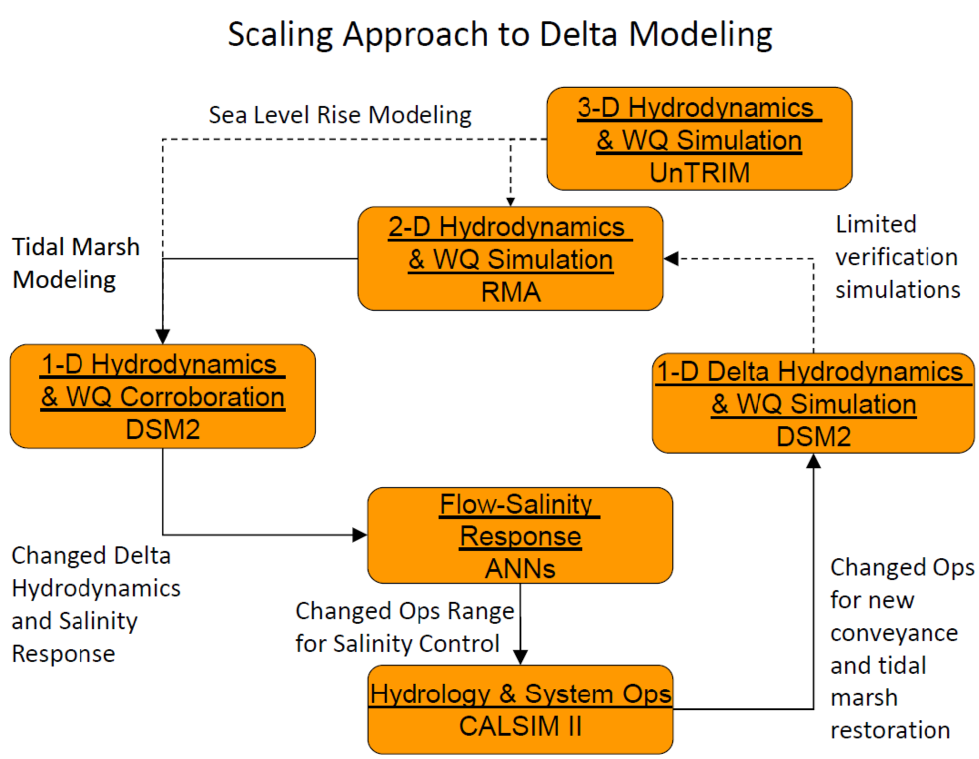

Figure 3: Hydrodynamics and Water Quality Modeling Approach used in the BDCP

Comments

Effects on Covered Fish

Chapter 5 addressed topics that it should address given information available at this time. Chapter 5 provides an overview of the:

- spatial and temporal scope of the analysis
- definitions of project baselines that differ depending on regulatory authority
- recognition of climate change effects on future conditions
- identification of BDCP actions
- identification of a variety of models and their limitations for evaluating BDCP effects
- an ESA take assessment including effects on viable salmon population criteria
- a qualitative approach for determining effects of each attribute on species habitat and performance
- an approach for classifying certainty of the effects analysis, and
- a description of the approach for evaluating overall net effects of the BDCP on each fish and wildlife species.

Additionally, biological goals and objectives were identified in Chapter 5. Identification of biological goals and objectives in Chapter 5 is important because the Effects Analysis should address the ability of the BDCP to achieve each biological objective. However, Chapter 5 states that approximately 72% of the objectives for covered fish could not be fully evaluated at this time due to insufficient information. It is noted in Chapter 5 that these information needs would be incorporated into monitoring and research actions, which are described in Section 3.6 (not reviewed by the Panel). Given the incomplete information, the Effects Analysis states, "*These expectations represent a working hypothesis of the relationship between actions, stressors, and biological performance.*" This is an important statement that should be highlighted in Chapter 5 rather than in the middle of a paragraph on page 5.2-36.

Implementation of methods for evaluating BDCP effects was not readily transparent. Section 5.5 describes a numeric ranking approach for evaluating 1) the importance of the attribute to the species, and 2) the effect of the BDCP action on the attribute. Rankings reportedly ranged from -4 to +4. These two values were reportedly multiplied to develop a ranking of effect for each attribute. Certainty was reportedly evaluated using the same numerical ranking approach for both the importance of the attribute on the species and the BDCP effect on the species attribute. This approach seems reasonable given the limitations of existing information, and the evaluation would be transparent. However, the numeric values of these rankings were not presented or discussed in the BDCP. Instead, figures were presented (e.g., Fig. 5.5.1-5) that used text to describe the effect (zero to high) and color to describe certainty. A small, essentially illegible "-" sign identified negative rankings. It was not clear whether this summary figure incorporated the importance of the attribute to the population, although importance of the attribute was often described in the text.

The numeric ranking approach described above was not used to evaluate net effects of the BDCP on each species, even though it seems that it could have been used and compared with the professional judgment evaluations. Instead, the overall net effects conclusion for each species seemed to be based on the judgment of the authors, rather than a systematic ranking of attribute importance, change in response to the BDCP, and uncertainty in the rankings. Chapter 5 notes that its conclusions were compared with professional judgments of agency personnel provided during a series of workshops in August 2013. This is worthwhile, but a table showing the variability in the judgments would have been useful as a means for indicating variability in the assessment rankings.

The Panel does not provide comments on methodologies presented in the technical appendices, except when discussed below. The level of detail in the descriptions of methodologies in the appendices varies considerably. In many cases, the original document must be consulted for a description of the methodology. Given the variety of information sources, referral to the original report for methodology was not unexpected.

Hydrodynamics

One of the issues that had to be worked through with the hydrodynamic models for the Effects Analysis was how to use hydrodynamic models that were designed for the current bathymetric configuration of the Delta and the watershed. The CALSIM II model is a watershed optimization model that has operational criteria based on salinity intrusion into the Delta. Changing main point of diversion in Conservation Measure 1, adding ROAs in Conservation Measure 3, and factoring in climate change (especially sea level rise), all change the circulation patterns in the Delta and the associated salinity intrusion. It is necessary to use the physically based multi-dimensional hydrodynamic models to first calculate hydrodynamic parameters (stage and flow) and salinity throughout the system. Because the multi-dimensional models are computationally intensive to run, the results of the multi-dimensional models are used to calibrate the DSM2 (1-D) model. The DSM2 (1-D) model is then used to create the relationship between salinity intrusion and river input flows. This river inflow-salinity intrusion relationship is what CALSIM II needs for optimization.

The coupling of the multi-D, DSM2, and CALSIM II models is not a standard method that would naturally be understood by the reader. The documentation for this coupling is part of the Environmental Impact Statement documentation, not part of the BDCP documentation. A short summary of the method should be included in Chapter 5.

Effects on Terrestrial Species

The methods for the terrestrial species are adequately described in the various appendices (but see specific comments on the description of the methods for the habitat restoration in Appendix 5.J.B).

3. Is the Effects Analysis reasonable and scientifically defensible? How clearly are the net effects results conveyed in the text, figures and tables?

Summary

The effects analysis covers a multitude of topics. Each panelist provided input into Question 3 based on their areas of expertise.

Overall Approach to Determine Net Effects

The Effects Analysis, particularly for covered fish, tries to incorporate information on potentially beneficial or detrimental effects covering 12 different stressors, 32 attributes, and multiple life stages using best available information and science. Only a perfect life cycle model with perfect information on all the effects and their interactions could possibly weight the results correctly and draw unambiguous conclusions. Any and all actual effects analyses are far from that measure of perfection, including the BDCP. The effect summary figures (e.g., Figure 5.5.2-5) attempt to illustrate the multidimensional aspects of the assessment process and, along with the Net Effect narratives, try to convey an overall assessment conclusion. A serious limiting factor of the current cumulative Net Effects is a near complete absence of any explicit weighting (in summary tables) of the biological importance of the many attributes under consideration (e.g., Figure 5.5.1-5). Size and direction of anticipated effects on the attributes is provided in the summary figures, along with color coding levels of certainty. Even though summary tables show values for each life stage, what cannot be discerned is whether any critical life stages or attributes are being adversely affected by the BDCP. Consequently, it is also unclear whether the Net Effects conclusions are correctly taking critical life stages into account when deriving overall Net Effects conclusions.

The approach to net effect conclusions needs to be reconsidered and revamped. The net effect summary figure (e.g., Figure 5.5.2-5) does not include the relative importance of the categories (e.g., food, entrainment, etc.). Without incorporating their relative importance in the summary figure, net effect conclusions are potentially meaningless and uncertainty cannot be characterized. The net effect conclusions for a fish species need to therefore take into account the relative importance of the various categories, make them explicit, and interpret Plan effects within that context on a species-by-species basis.

Covered Fish

The Effects Analysis does not adequately defend conclusions regarding the net effects of the BDCP, including habitat restoration. Habitat restoration certainly has the potential to increase the productivity of species such as salmonids, but the literature contains relatively few studies documenting the population response of salmonids to habitat restoration. The conclusion statements from Chapter 5 (and/or the Executive Summary) tend to overstate the beneficial effects of BDCP for many different fish populations (e.g., salmonids, delta smelt, green and white sturgeon). The net effects analysis tends to over-reach conclusions of positive benefits for covered fish species, given the inability to quantify the overall net effect and the realization of high uncertainty.

Key issues/questions that still need to be address for covered fish include:

1. The importance of interactions between BDCP flows and habitat restoration.

   Response: This issue appears related to the panel's subsequent examination of the specific analysis related to hydrodynamics at the Georgiana Slough junction with the Sacramento River (see question 7). As noted in the response to the recommendation in that section, ELT runs of BDCP CM1 operations without habitat restoration were already undertaken and were discussed in the synthesis of the results from the Sacramento River reverse flows analysis (section 5C.5.3.8.5; see in particular Figures 5C.5.3.146 and 5C.5.3-147). These runs illustrated the effects of restoration versus changes in river flow.

2. Will the migrant life history sufficiently benefit from conservation measures to offset moderate negative impacts related to reduced spring flows? Migrant salmonids may benefit less from conservation measures, and may experience a negative net effect.

   Response: The issue here essentially relates to the panel's observation (p.30 of the report) that the proportions of the different juvenile salmonid life history types (foragers vs. migrants) were not factored into the analysis. As noted in the response to the recommendation: *The Yolo Bypass evaluation should recognize that natural origin Chinook salmon have a higher fraction of foraging type juveniles compared with migrant Chinook produced in hatcheries. Natural origin juveniles would likely benefit more than hatchery fish* below, the means of assessing net effects has been revised to reflect the effects on juvenile salmonids as being the weighted effects on foragers and migrants, with weights provided by the assumed proportions of these life-history types. This allows the importance of different proportions from different races of Chinook salmon to be more explicitly considered.

3. To what extent is foraging habitat and exposure of foraging salmonids to predators affected by reduced spring flows?

   Response: As explained further by the panel on p.31 of the report, this issue relates to the uncertainty in flow-related effects on foragers and how it was represented in the effects analysis. ICF will review this representation and revise the text accordingly.

4. The text does not distinguish between hatchery versus wild salmonids in the analysis.

   Response: As noted in reponse to the recommendation: *"Wild" salmonids should be considered separately from hatchery fish whenever possible* below, the effects analysis implicitly focused on wild-origin fish. This has been clarified in the introduction to each salmonid species' effects analysis. In addition, acknowledgement that inference is often based on empirical data from hatchery-origin fish has been added.

Conceptual Models

In general, the conceptual models for dissolved oxygen and contaminants are well developed, although consideration of nutrient form and nutrient ratios (e.g., Glibert *et al.* 2011) would be a nice addition given the interest and recent publications on these topics. Also, algal toxins could be an attribute for monitoring to reduce uncertainty in contaminants and food web conceptual models.

Although there are good synthetic conceptual models developed for the Bay-Delta longfin smelt population encapsulated in the Effects Analysis (e.g., Baxter 2010; Rosenfield 2010), the conceptual model is still constrained by the lack of a life-history model that would elucidate the role of prey composition and abundance in population dynamics.

Food Webs

Restoration of tidal wetlands (and other communities) is highly uncertain and at least an extremely long process. The Effects Analysis does not adequately justify the critical assumption of the benefit of tidal wetland restoration as a food web subsidy for covered pelagic fish given the uncertainties of tidal wetland restoration itself. The conceptual model of the food web appears to include many of these processes. However, within the narrative current understanding as well as the implications of inherent uncertainties are not fully explored.

Organic Matter Subsidies to the Delta Food Web

There is an expectation that restoration activities will result in increases in abundance of lower trophic levels but the structure of the lower food web will be critical in whether this increased production can support covered species. Not only quantity, but also quality of the primary production that is supported by restoration activities is important. Water residence time within ROAs and other characteristic transport timescales for Delta channels are not the only factors to consider. The type of phytoplankton primary production that is stimulated is highly uncertain and likely dependent upon water temperature, nutrient concentrations, vertical mixing and grazing. In addition, an increased residence time may promote toxigenic cyanobacteria (*Microcystis aeruginosa*).

Hydrodynamics and Physical Changes at Export Facilities

For hydrodynamic modeling, only one set of ROAs were modeled. Because the locations of these assumed ROAs are not being presented to the public, there are details of the hydrodynamic modeling that cannot be factored into the Panel's evaluation of the Effects Analysis.

Conservation Measure 1 now includes significant modifications to Clifton Court Forebay. This region has been identified as a predation hot spot by multiple studies. Reduction in predation hot spots should be considered in the physical design.

Terrestrial Species

The Effects Analysis for terrestrial species focuses almost exclusively on a simple summation of the number of acres of suitable habitat that are removed or restored for each species by the conservation measures. The simple accounting approach does not consider landscape-level effects such as connectivity and patch size nor does it take into account differences in habitat quality.

Recommendations

Overall Approach to Determine Net Effects

- Clearly indicate on effect summary figures (e.g., Figure 5.5.2-5) both beneficial (+) and detrimental (–) effects.

  Response: Within the scope of the recommendation: *Redo the format of the effects on attributes summary tables (e.g., Fig. 5.5.1-5) to improve readability* above, ICF redid the format of the effects summary figures by providing red text for negative effects and adding '+' symbols for positive effects. These redone formats will be included in the final BDCP, once any changes to attribute effects are finalized.

- In order to incorporate biological importance into the Net Effects process, the rows (i.e., categories, attributes) of the effects figures (e.g., Figure 5.5.21-5) could be ranked or rearranged in clusters according to biological importance for the specific species (e.g., high, medium, low). In this way, it would be easier to assess whether any biologically important attributes are likely to be negatively impacted and at what level of impact. It will also allow readers to discern whether any biologically important attributes also have high levels of uncertainty assigned to them.

  Response: The effects summary figures already include the biological importance of the attributes on the different life stages of a given species. This is because each cell within the figure reflects the magnitude of effect as the importance of an attribute multiplied by the change to the attribute that could arise from the BDCP. Unimportant attributes therefore would receive only low or moderate effects magnitudes even if the BDCP resulted in very large changes.

- From the August 2013 Covered Fish workshops, it would be valuable to include in the Net Effects summary, what fraction of the attendees agreed with the Net Effects conclusions (i.e., direction, amplitude and level of certainty).

  Response: Presumably the panel is referring to the conclusions for each effect discussion that leads to the Net Effects discussion, as opposed to the Net Effects section itself, which does not have a formal characterization (direction, amplitude, and level of certainty) in the same way that the individual effects sections do. The August 2013 workshops included a number of agency personnel (varying from around 1-4 per agency), but that agency comments generally were consolidated by agency (i.e., there were a limited number of responses, which makes consideration of a formal fraction challenging). The summary provided by ICF aimed to capture the range of the responses and whether there was general concurrence. Although attendees were provided workbooks to assess their own rankings in preparation of the workshops, discussions during the workshops in some instances led to modified rankings, reflecting the ability of the group to reach consensus. ICF will coordinate with DWR and the permitting fish agencies to review conclusions.

Covered Fish

- Examine and re-write conclusion statements about population net effects in both Chapter 5 and the Executive Summary to objectively express the range in anticipated population effects.

  Response: ICF will review and amend existing text to address the panel's comment in coordination with the fish and wildlife agencies.

- Evaluate effects of conservation measure attributes on species while considering all other potentially interacting conservation measures.

  Response: Several analyses consider the interactions of various conservation measures on species. To the extent tools are available to integrate the potential changes to the environment caused by a suite of conservation measures, they have been employed.For example, the Delta Passage Model includes the effects of CM1 (water facilities and operation, in the context of plan area flows, entrainment potential, etc.), CM2 (entry into Yolo Bypass), and CM16 (nonphysical fish barriers). Consideration of all potentially interacting conservation measures would be challenging; the Effects Analysis considers the effects of the conservation measures and the Net Effects section discusses the concluded overall potential outcome.

- Consider relative abundance of salmon life histories when evaluating net effects on each species.

  Response: Relative abundance of different juvenile life history types will be explicitly included in a reworked effects analysis, wherein effects on juvenile salmonids will reflect the average of effects on foraging and migrating juveniles (weighted by their relative proportions).

- "Wild" salmonids should be considered separately from hatchery fish whenever possible.

  Response: The effects analysis implicitly focused on wild-origin fish. This has been clarified in the introduction to each salmonid species' effects analysis. In addition, acknowledgement that inference is often based on empirical data from hatchery-origin fish has been added.

Conceptual Models

- Consideration of nutrient form and nutrient ratios (e.g., Dugdale *et al.* 2007; Glibert *et al.* 2011) would be a nice addition to food web models given the interest and recent publications on these topics.

  Response: As discussed in 5.E.4.2.2.5 (BDCP), changes in nutrient composition have been correlated with changes in phytoplankton composition in the Delta (Glibert et al. 2011). However, the distribution of nutrient composition in the mosaic of Delta landscapes is complicated and varies spatially and temporally. The complexity of the relationship of nutrient form and ratios is beyond the scope of the food web model applied to evaluate the potential food subsidy provided by CM4 under the Plan. However, the food web analysis does incorporate phytoplankton growth based on observations within the Delta. The potential phytoplankton growth as a function of depth was calculated using a relationship developed by Lopez et al. (2006) from measured temperature, irradiance, and light attenuation in Mildred Island in 2001 and Franks Track during 2002. Lopez et al. (2006) present a relationship between depth and daily phytoplankton growth rate as a function of depth in meters. The relationship between nutrients and phytoplankton growth is not sufficiently well understood to incorporate into the sub-regional analysis of phytoplankton growth at this time. Additional analyses in 5.E.4.2.2.5 (BDCP) have incorporated competition from benthic grazers and quantified the potential change to other food subsidies under CM4. The future composition of algal communities in the Delta is noted as an uncertainty regarding the success of CM4 (5.E.4.4.3). Proposed changes to wastewater treatment plant discharges should benefit food production in the Delta by reducing ammonium in areas like Suisun Bay. This may increase diatom production above the level predicted by the Lopez et al. (2006) model (Parker et al. 2012). Tidal marsh restoration also may increase diatoms by increasing nitrate through nitrification (the conversion of ammonium to nitrate) (Ecosystem Restoration Program 2011). However, the relative importance of ammonium compared to clam grazing in primary production and trophic dynamics is a topic of continued debate (e.g., Glibert et al. 2011; Cloern et al. 2012; Lancelot et al. 2012; Kimmerer et al. 2012). It is likely that uncertainties can be resolved only by monitoring of the restored habitats and measuring actual food production. In the meantime, the basic relationship between depth and phytoplankton production developed by Lopez et al. (2006), which has a strong empirical foundation, provides a baseline estimate of phytoplankton production from which to estimate the relative importance of additional factors as more information becomes available.

- Algal toxins could be an attribute for monitoring to reduce uncertainty in contaminants and food web conceptual models.

  Response: As discussed in Section 5.5.1.2.3, current research of algal toxins, and Microcystis blooms in particular, indicates that blooms occur in the late summer and early fall. Lehman et al. (2008) found water flow to be a major controlling factor of Microcystis together with higher temperature. The 2008 study noted that nutrient concentration was not a driving force for Microcystis blooms. However a subsequent study by Lehman et al. (2014) indicated that ammonium concentrations, which are highest during the summer months when low flow conditions prevail, were strongly associated with Microcystis abundance. Further evaluation of the relationship of streamflow to Microcystis abundance indicated that blooms occurred in the lower San Joaquin River when the majority of flow was coming from the Sacramento River. Overall, this research suggests that Microcystis blooms are supported by the presence of ammonium in the summer to early fall when high temperature and low flow conditions prevail. Increased residence times allow Microcystis additional time to flourish once a bloom has begun.

Water operations under CM1 and restoration under CM4 would lead to longer water residence times in some portions of the Plan Area where Microcystis is most likely to occur. As noted in new text within Chapter 3's discussion of CM1, proposed research actions would assess the extent to which Microcystis abundance and distribution in summer/fall was changed by the BDCP.

Food Web

- A simple surface area versus water volume calculation would provide a first-order estimate of potential food subsidy to open water habitats of the low salinity zone.

  Response: The Prod-Acres index used for the foodweb analysis in 5.E.4.2.2.5 also incorporates area, depth and potential phytoplankton growth as a function of that depth. The potential of CM4 restoration to contribute to the Delta foodweb was evaluated with a simple index of food production, termed prod-acres, that is based on potential phytoplankton growth rate calculated from water depth. Phytoplankton production is generally greater in shallow areas and declines with depth because light penetration attenuates with depth (Section 5.E.4.3.5.3, *Drivers of Primary Production in the Delta*). The index accounts for the area within each depth-strata and the phytoplankton growth rate for the given depth defined by Lopez et al. (2006) summed for all depth-strata within a given subregion. Shallow water habitats are capable of higher phytoplankton growth rates and the volumetric method suggested would undercount the potential food subsidy provided by extensive marsh restoration.

- Evaluate and compare the magnitude and temporal and spatial variation in the multiple organic matter subsidies to the Delta food web.

  Response: The relative change in emergent productivity/detrital contributions has been quantified in 5.E.4.2.2.5 for each subregion. The additional analysis calculates the change in relative abundance of each food source and notes the potential pathways for consumption to covered fish species. It is noted in the Plan that these sources of food may be important to covered species at different life stages and times of year. Many fish species are often found with detritus in their guts including splittail, sturgeon and, to lesser degrees salmonids and smelts. Detrital diets have been shown to support growth and reproduction in smaller invertebrate prey populations such as amphipods (Kneib 1997). Feyrer et al. (2003) found that detritus was the most prevalent food item found in splittail guts, although they also consumed bivalves (including *Potamocorbula*) and mysids. Emergent vegetation contributes to the detrital food pathway as well as provides a habitat for aquatic insects. Wetland insects play a prominent role in the consumption and processing of primary production and associated detritus and serve as an important food source for higher trophic levels, including a delta smelt, juvenile salmonids, splittail, invertebrate, and avian species (Davies 1984; Stagliano et al. 1998). Studies at Liberty Island found that insect larvae (primarily Chironomid pupae) were an important component of the delta smelt diet (Whitley and Bollens 2013) where they are often associated with emergent vegetation (tules) that serves as substrate for larval insects. Chironomid midge pupae were found to be the primary food source of juvenile Chinook salmon and were found a dominant food source in many fishes by Grimaldo et al. (2009) in isotope studies.

- Incorporate into the Effects Analysis the idea that tidal wetland restoration may mitigate some of the nutrient loading into Delta by acting as a nutrient sink through emergent vegetation production, phytoplankton production as well as fluxes to the atmosphere via denitrifcation.

Response: Following the panel's suggestion, ICF has incorporated text into subsection 5.5.1.1.1 for delta smelt and other related sections that discusses the potential for tidal wetland restoration to affect nutrient flux within the Plan Area. This text summarizes information from the DRERIP tidal marsh conceptual model (Kneib et al. 2008) related to nutrient flux, as well as one more recent relevant local example from Liberty Island (Lehman et al. 2010). Overall, the conclusion that there would be no change in zooplankton composition because of changes in nutrient sources is retained, but the conclusion is made with low instead of high certainty, to acknowledge the potential change that CM4 may have. The new text specific to subsection 5.5.1.1.1 is as follows:

> "Changes in zooplankton community composition that have occurred within the Plan Area appear to have been a result of factors that would not change under the BDCP (e.g., invasive species introduction, changes in nutrient composition because of nutrient loading from wastewater treatment plants). For this reason, the public draft BDCP effects analysis concluded with high certainty that there would be no change in zooplankton community composition because of the BDCP, a conclusion that agency biologists at the August 2013 workshops concurred with. However, review of the public draft effects analysis by an independent scientific panel convened by the Delta Science Program noted that there is potential for restored habitat to alter nutrient composition by acting as a nutrient sink through emergent vegetation production, phytoplankton production, and flux to the atmosphere by denitrification (Parker et al.

2014). The DRERIP conceptual model for tidal marsh (Kneib et al. 2008) suggested that there is high importance, understanding, and predictability for the assimilation and accumulation in marsh structure and processes of nutrients and other materials entering the marsh through the aquatic (and terrestrial) interfaces (Wigand et al. 2003, Holland et al. 2004, Craft 2007, Deegan et al. 2007, Smalling et al. 2007; all as cited by Kneib et al. 2008). The tidal marsh conceptual model also notes that unvegetated mudflats, such as are more likely to occur in restored wetlands in the Delta as opposed to in mature marsh ecosystems, may be larger nutrient sinks than vegetated marsh (Jordan et al. 2003, as cited by Kneib et al. 2008). Tidal marsh may also export nutrients and other constituents to adjacent aquatic areas, whether as material generated within the marsh or imported material that was not assimilated or accumulated; the net flux is dependent on tidal regime, marsh flora/fauna composition, and freshwater contribution (Kneib et al. 2008). The DRERIP conceptual model noted that on an annual basis tidal emergent marsh tends to export nitrogen species (Valiela et al. 1978, as cited by Kneib et al. 2008), but may be a sink (e.g., for nitrate and nitrite) in some cases (Spurrier and Kjefvre 1988, as cited by Kneib et al. 2008). Overall the DRERIP conceptual model for tidal marsh concluded that the predictability of the overall effect of nutrient flux is low because of variability in nutrient inputs and the structure of marsh vegetation/substrate (Kneib et al. 2008). Lehman et al. (2010) found that Liberty Island, an accidental restoration site in the North Delta subregion (see discussion in subsection 5E.B.3.1.1 of Attachment 5E.B 1, *Review of Restoration in the Delta*, in Appendix 5.E, *Habitat Restoration*), mostly exhibited a net export of nutrients including nitrate and ammonium, although the flux of the former was considerably greater than the latter, and there were seasonal differences, with export tending to occur in winter and fall, and import in summer. Lehman et al. (2010) noted that the material flux in Liberty Island that they studied represents a small fraction of the potential variability that may occur, because river discharge is considerably more variable than the conditions they encountered. Overall, because the BDCP would not affect the main sources of nutrients that may affect phytoplankton and therefore zooplankton community composition (i.e., the Sacramento Regional Wastewater Treatment Plant; see subsection 5.5.1.4.2 *Application of Existing Conceptual Models in Net Effects Analysis*, above; see also subsection 5.D.4.4, *Ammonia/um*, in Appendix 5.D, *Contaminants*), the conclusion from the BDCP public draft that the BDCP would result in no change in zooplankton community composition for larval delta smelt because of changes in nutrient composition is retained; in contrast to the public draft BDCP, this conclusion is now made with moderate certainty because of the factors related to tidal marsh restoration that were discussed above. Monitoring and potential research actions related to CM4 would address this uncertainty, as part of the studies summarized below in the subsection entitled *Main Uncertainties, Potential Research Actions, and Link to Adaptive Management and Monitoring*."

- Estimate the potential food web subsidy attained based on the degree to which habitats are connected hydraulically to Suisun and Grizzly Bays. These areas could serve as "proof of concept" for other, unidentified Restoration Opportunity Areas.

  Response: As noted in 5.E.0.1.1, the export of marsh production helps transfer the higher production of shallow-water habitats to the deepwater habitats preferred by pelagic fish species such as delta smelt and longfin smelt (Lucas et al. 2002). Production from the lower Yolo Bypass, including Liberty Slough and Cache Slough marshes, stays relatively intact as it moves down the estuary (Monsen 2003). This production may contribute significantly to the greater foodweb, ultimately benefitting open-water species such as delta smelt and longfin smelt (Brown 2004). Based on existing data from Liberty Island and other restoration sites in the Delta, local transport to adjacent sloughs and parcels is expected on tidal timescales, but food resources may diminish with transport time. Lucas et al. (2002) found that the ability of clams to reduce phytoplankton is dependent on site-specific features. These features could be incorporated into the design of restoration to minimize the effect of clams and to maximize production of planktonic food in the Delta. Hydraulic connectivity of restoration sites to adjacent areas would need to be evaluated on a site specific basis.

Hydrodynamics and Physical Changes at Export Facilities

- When Conservation Measure 3 is implemented, the details of the connection between the Restoration Opportunity Areas and the adjacent channels and the order in which the Restoration Opportunity Areas are established need to be top design criteria.

  Response: Conservation measures (CMs) describe how the goals and objectives (and permit terms and conditions) will be achieved. For tidal restoration, siting and design considerations (CM4) reflect existing literature and expert opinion regarding the important parameters controlling restoration success (e.g., connectivity, tidal flow, sediment concentrations, turbidity, planktonic concentrations, etc.). The CM3 and CM4 siting and design sections also communicate where there may be constraints in implementing tidal restoration (e.g., effects on X2, invasive species colonization, mercury methylation, etc.). Tidal restoration siting and design criteria and considerations will be updated fr the Final Plan in coordination with agency and expert staff as we work to resolve concerns about the uncertainty associated with restoration success. It is important to note that what we understand about restoration siting and design will continue to evolve as monitoring and research results become available.This evolution of understanding will be incorporated into the Adaptive Management process.

- Since Conservation Measure 1 is proposing significant physical changes be made to Clifton Court Forebay, the identified predation hot spots within Clifton Court Forebay should be considered in the re-design.

  Response: This possibility is being investigated as part of BDCP. However, the size of the forebay is not changing substantially, and residence time in the forebay is not expected to change substantially. DWR, under existing BiOPs and other programs has been evaluating ways to reduce predation in the forebay, including installing a fishing facility within the forebay, for use by recreational anglers (see http://baydeltaoffice.water.ca.gov/announcement/CCF_Public_IS-MND_2013_0613.pdf for description); this direct removal of predatory gamefish is likely to reduce predation in the forebay, but the magnitude of effect is unknown. As noted in section 5.2.3 of Chapter 5 in the public draft BDCP, improvements to fish salvage (including reductions in fish loss within Clifton Court Forebay)required by the NMFS BiOp Action Suite IV.4 were assumed to be part of baseline conditions for the BDCP. Under the BDCP, actions taken at predation "hotspots", described in CM15 *Localized Reduction of Predatory Fish* would also examine predation in the forebay and could result in physical modifications to predator habitat.

Terrestrial Species

- Landscape-level effects should be considered.

  Response: Landscape-level effects are described in Section 5.3, however, these effects descriptions are largely focused on the aquatic environment (i.e., flow, water quality, aquatic habitat, and foodweb). This section will be expanded to include landscape-level effects on the terrestrial community.

Comments

Effects on Covered Fishes

A Comprehensive Summary Figure Would Be Useful. For specific actions affecting covered fishes, the Effects Analysis summarizes findings of multiples investigations when available and often qualifies the findings with opinion statements of how important the attribute might be and how certain the finding is. This assessment by the authors of the Effects Analysis is often compared with a summary of conclusions, including a statement of uncertainty, developed from a workshop with agency personnel in August 2013. This approach is reasonable given the information available, but as noted elsewhere, improvements could be made to systematically summarize 1) the relative importance of the attribute, 2) the level of change caused by BDCP implementation, and the certainty of this evaluation. The relative importance of an attribute was often provided within the narrative of Chapter 5, but a comprehensive table or figure summarizing this metric was not presented along with the effect of the BDCP on the attribute and the certainty associated with the rankings. A comprehensive summary figure is a key step leading to the overall net effect determination for each species. This figure would also enhance transparency in the final professional judgment of net effects.

Furthermore, some sections of the Effects Analysis did not seem to reach a conclusion or describe the certainty about the findings, e.g., text description of Feather River flow effects on spring Chinook (see Feather River discussion below).

Salmonid Life History Increases Uncertainty. Salmonids have a variety of juvenile life history types that result in differential use of Delta habitats over time. The Effects Analysis characterized these life history types as foragers and migrants. Foraging juvenile salmonids are younger, smaller and typically inhabit shallower habitats compared with larger, older yearling salmonids that pass through the Delta relatively quickly. Recognition and consideration of these two life history strategies in the BDCP Effects Analysis (e.g., Fig. 5.5.3-4) is important. However, as noted below, the complex life history of salmonids, including life history differences between wild and hatchery origin fish, leads to greater uncertainty in the overall net effect of the BDCP actions on salmonid populations.

Literature Shows Major Restoration Needed to Improve Fish Populations. The Effects Analysis does not adequately defend conclusions regarding the net effects of the BDCP, such as habitat restoration, on fish species. Habitat restoration certainly has the potential to increase the productivity of species such as salmonids, but the literature, including published papers and technical reports, contains relatively few studies documenting the population response of salmonids to habitat restoration (see reviews by Roni *et al.* 2008, 2011). Findings in the literature on the response of salmonid populations to habitat restoration was not adequately addressed in the Effects Analysis when describing the net effect of each species, although the methods section (5.2.7.10.3) did provide a reference by NMFS stating that quantitative linkages between specific habitat actions and viable salmonid population criteria is difficult. The difficulty in documenting population responses to habitat restoration should be recognized and addressed with large and strategic habitat restoration projects and detailed monitoring. For example, in a comprehensive evaluation of salmon responses to habitat restoration in Puget Sound, Roni *et al.* (2011) concluded:

> "Given the large variability in fish response (changes in density or abundance) to restoration, 100% of the habitat would need to be restored to be 95% certain of achieving a 25% increase in smolt production for either species. Our study demonstrates that considerable restoration is needed to produce measurable changes in fish abundance at a watershed scale."

Conclusions Often Overstate Beneficial Effects. The Panel believes that the net effects analysis tends to over-reach conclusions of positive benefits for covered fish species, given the uncertainty and inability to quantify the overall net effect. Given the findings of Roni *et al.* (2011), it may be inappropriate to extend an uncertain but potentially positive effect conclusion to statements about species conservation, especially under future climate scenarios. For example, the following grand conclusion statements from Chapter 5 (and/or the Executive Summary) tend to overstate the beneficial effects of BDCP:

> "The magnitude of benefits for winter-run Chinook salmon at the population level cannot be quantified with certainty. Nonetheless, the overall net effect is

expected to be a positive change that has the potential to increase the resiliency and abundance of winter-run Chinook salmon relative to existing conditions."

Statements about increased resiliency and abundance are inappropriate given the high uncertainty expressed in the initial sentence. The statements tend to focus on the upper end of beneficial effects rather than a balanced analysis that might capture the range in net effects. The Panel underlined the questionable text.

"The BDCP should help conserve the species in the Plan Area and help it cope with expected climate change…." The term "conserve" implies a large beneficial population effect for salmon that may help the population recover from ESA listing. Maybe the BDCP will lead to a positive effect, but the magnitude of the effect is uncertain, as stated above, so it seems inappropriate to imply the BDCP would eliminate attributes in the Delta that cause lower population viability. The life cycle models suggested climate change effects would overwhelm the evaluated BDCP actions on winter Chinook salmon.

The following conclusion for delta smelt overstates and over-emphasizes the potential for significant beneficial effects (by emphasizing great potential) while also noting the conflicting conclusion of high uncertainty in the net effect: "While there is great potential for large benefits for delta smelt, there is a high level of uncertainty regarding the resulting effects. However, combined with the Fall X2 decision tree, the BDCP will have at least a minor beneficial effect on the species, but a great potential for larger benefits depending on actual food production and location of delta smelt population in relation to restored areas." The high-end benefit is emphasized in the BDCP text. Perhaps there is higher certainty for a positive versus negative net effect but there is high uncertainty for the net effect of actions on the delta smelt population, ranging from little to high population effect. This evaluation would benefit by the removal of "great".

For green and white sturgeon, the BDCP concluded: "Therefore, the BDCP is expected to conserve both species in the Plan Area through improvements in abundance, productivity, life history diversity, and spatial diversity." The term "conserve" implies a large beneficial population effect that was not supported by the evaluation. The conclusion statement also implies and therefore overstates measureable positive changes to four population viability criteria. These benefits may reflect the goals of the BDCP, but the uncertain magnitude of benefits to sturgeon should not be described as improving abundance, productivity, life history diversity, and spatial diversity.

Interactions between conservation measures. Interactions between BDCP flows and habitat was not adequately addressed in the report. For example, Table 5.5.3-4 shows that habitat units typically increased for foraging salmonids in response to habitat restoration, but the habitat analysis did not appear to consider whether salmonids would have access to the habitat during reduced flows under the BDCP scenarios (see Table 5.E.4-1). For example, flows were expected to be ~15% to 20% lower during January to April when many foraging salmonids are rearing in the Delta area. In other words, how much rearing habitat is available and what is the habitat quality for foraging salmonids when flows have been reduced 10-20%? The Cache Slough region is one example where key habitat restoration sites might be affected by reduced river flows. Perhaps tidal fluctuations overwhelm river flows in some of the lower habitats, but this should be stated in the report. For foraging salmonids, do reduced flows of the BDCP negate the reported habitat gains from some restoration activities?

Recommendation: evaluate effects of conservation measure attributes on species while considering all other potentially interacting conservation measures. This approach was taken for some measures (e.g., Delta Passage Model evaluations) but not all.

> **Response:** As noted in the response to a previous recommendation, several analyses consider the interactions of various conservation measures on species and to the extent tools are available to integrate the potential changes to the environment caused by a suite of conservation measures, they have been employed. As the panel notes, the Delta Passage Model is an example of such a model, and it includes the effects of CM1 (water facilities and operation, in the context of plan area flows, entrainment potential, etc.), CM2 (entry into Yolo Bypass), and CM16 (nonphysical fish barriers). As noted in the response to the previous recommendation, consideration of all potentially interacting conservation measures would be challenging; the Effects Analysis considers the effects of the conservation measures and the Net Effects section discusses the concluded overall potential outcome.

<u>Migrant salmonids may benefit less from conservation measures and may experience a negative net effect.</u> The effect of each attribute on migrant versus forager salmonids was examined in Chapter 5, but summary Figure 5.5.3-2 did not capture differences in the assumed relative abundances of these life histories among the species. Plan area flows were typically ranked as a moderate negative effect on migrant salmonids in the Sacramento River and a low negative effect on foragers. However, this attribute was ranked the same for each salmonid species regardless of the proportion migrants versus foragers assumed in the population. The negative impact of reduced plan area flows should have been greater on Sacramento River species such as spring Chinook and steelhead that are dominated by migrant life histories.

Migrant life histories are less likely to benefit from habitat restoration activities, which are a key focus of the BDCP conservation measures. This implies that spring Chinook and steelhead may experience less benefit from BDCP actions than other salmonid species, or they may even experience a negative net effect in response to reduced spring flows. The key question, which deserves more attention in the BDCP, is whether the migrant life history will sufficiently benefit from conservation measures to offset moderate negative impacts related to reduced spring flows. This question is key for spring Chinook and steelhead that are composed mostly of migrant life histories.

<u>Characterize uncertainty in plan area flow effects on salmonid life history types.</u> The Delta Passage Model (DPM) is a key tool for this evaluation because it predicts survival of migrant salmonids while considering river flows, passage into interior areas, entrainment to pumps, and passage into the Yolo Bypass. The survival model is largely based on Chinook salmon exceeding 140 mm in fork length, therefore the DPM does not represent foragers or smaller migrants, which are the target of the habitat restoration activities.

The Effects Analysis states that it was assumed with moderate certainty that flow has high importance to foraging winter Chinook salmon, then notes that the moderate level of uncertainty reflects the relative lack of investigation on the influence of flows on smaller salmonids (Page 5.5.3-24, line 39-41). Moderate uncertainty is quite different from moderate certainty, which is also concluded in each salmonid summary figure (e.g., 5.5.3-4). If there is no information on how flows affect survival of smaller foraging salmonids in the Delta, it is difficult to accept a moderate level of certainty associated with the low negative impact of flows on foraging juveniles salmonids, especially when data suggest flow has a significant effect on larger salmonid (migrant) survival (Fig. 5C.5.3-4). To what extent is foraging habitat and exposure of foragers to predators affected by reduced spring flows? For winter Chinook and fall Chinook, the forager life history is the dominant type, indicating less certainty about the net effect of BDCP flows on these species compared with species dominated by migrant life histories that have been tagged and analyzed, e.g., Fig. 5C.5.3-4.

Hatchery versus "wild" origin salmonids. The presence of hatchery salmonids is typically noted in the introductory descriptions of each salmonid species in Chapter 5. The degree to which hatchery salmonids contribute to the two life history types was not described, though hatchery fish are released as migrants. For example, 80% of juvenile spring Chinook were assumed to be migrants. To what extent was this due to the release of migrants from hatcheries given that some of the natural population produces primarily foragers? The text does not otherwise distinguish between hatchery versus wild salmonids in the analysis. Although some hatchery stocks are protected by the ESA, it would seem that wild salmonids would have a higher priority than hatchery-produced salmonids, even though hatchery runs provide important role in the Central Valley and ocean fisheries. Perhaps resolution of effects and uncertainty inhibit analyses specific to wild salmonids. Nevertheless, wild salmonids should be considered independently from hatchery salmonids when possible.

Do habitat actions only affect salmonid capacity and not productivity? Fig. 5.5.3-2 shows BDCP effects on productivity of each salmonid species by attribute. No effect is shown for habitat attributes such as channel margin, floodplain, riparian, etc. In contrast, these attributes are scored in other Figures for each species, e.g., Fig. 5.5.3-4. Does this reflect an opinion that these habitat actions only increase the capacity of the habitat to support salmonids rather than habitat quality?

Obtain more information from life cycle models. Life cycle simulations were only performed for winter-run Chinook salmon using the OBAN and IOS models. Comparison of through-delta survival and adult returns by management scenario (Table 5.G-2) was very useful. One way to compare and evaluate the two models is to assess consistency in the management scenario rank (best to worst) for the various response variables. For instance, if the same management scenario always ranks first, then that would indicate high level of consistency and support for that conclusion. On the other hand, if management scenario rankings varied greatly between assessments then conclusions would have high degrees of uncertainty (See Table 1, below).

Some life cycle models inappropriately excluded. Appendix 5G excluded delta smelt life cycle models in the Effects Analysis without adequate justification. Based on the premise of using the "best available science," it is unclear how none of the delta smelt models could have reached that level of acceptance. One justification was that none of the models used zooplankton data; however, the BDCP Net Effects assessment indicated zooplankton was only of moderate importance to delta smelts (Figure 5.5.1-5). It would therefore seem that some assumptions about zooplankton could have been made, allowing life-cycle modeling to be performed. Robustness studies could have accompanied the modeling process. Furthermore, if the BDCP team felt none of the delta smelt models to be adequate, why was there no investment made in model development for such an important species of interest?

Net Effects

The Net Effects summary figures (e.g., Figures 5.5.1-5, 5.5.2-5, etc.) are very useful for synopses for each fish species, but they are incomplete. It would be visually helpful to explicitly include both positive (+) and negative (–) signs for each combination of life stage and category. There continue to be discrepancies between conclusions regarding certainty and level of effect between the text and summary tables. The quantitative scoring method described on page 5.5.1 seems to be largely ignored. Instead, a qualitative ocular assessment of the summary tables seems to be applied separately to the certainty and level of effect dimensions. For salmonid species, weighting is discussed for migrant vs. foraging forms, but this too is seemingly ignored (or at least not mentioned) in the Net Effect conclusions.

The approach to Net Effects conclusions needs to be reconsidered and revamped. The Net Effects summary figures (e.g., Figure 5.5.2-5) do not include the relative importance of the categories (e.g., food, entrainment, etc.). Without incorporating their relative importance, Net Effects conclusions are potentially meaningless and uncertainty cannot be characterized. Levels of uncertainty have different weight depending on the importance of the various categories. An assessment might have high uncertainty for all low importance categories and still have high overall certainty if all the important categories carry with them high certainty. Conversely, the overall assessment would have low certainty, if one or more of the high importance categories carry high uncertainty. The Net Effects conclusions for a fish species needs to therefore take into account the relative importance of the various categories, make them explicit, and interpret Plan effects within that context on a species-by-species basis. Uncertainty plus uncertainty is more uncertainty. Uncertainty never averages or cancels out uncertainty; any more than noise plus noise is less noise. One graphical approach to conveying importance of the various categories and attributes is to order or group the rows of the figures according to their importance for a particular fish species. It would then be possible to see if any detrimental effects of the BDCP are associated with any important biological processes or not.

Life-cycle simulations were only performed for winter-run Chinook salmon (i.e., models OBAN and IOS). Comparison of through-Delta survival and adult returns by management scenario (Table 5.G-2) was very useful. One way to characterize model consistency is to assess how consistent the management scenarios rank (best to worst) across the models and different response variables. For instance, if the same management scenario always ranks first, then that would indicate a high level of consistency and support for that conclusion. On the other hand, if management scenario rankings varied greatly between assessments, conclusions would have a high degree of uncertainty.

Restoration of tidal wetlands (and other communities) is highly uncertain or at least an extremely long process

Restoration of tidal wetlands is considered in detail in the section on aquatic food webs (Question 12). In general, tidal wetland restoration of biological function is quite difficult with respect to ecosystem processes beyond tidal flux and especially with respect to ecological equivalency to comparable natural wetlands. This has been reviewed in a number of studies and conclusions have remained consistent over the past two or three decades (e.g., Kentula 1996, Simenstad and Thom 1996, Zedler and Callaway 1999, BenDoer *et al.* 2009, Moilanen *et al.* 2009).

Lack of specificity in Restoration Opportunity Areas limits conclusions of many aspects of Effects Analysis

For the hydrodynamic modeling, only one set of Restoration Opportunity Areas were modeled. (See discussion of implementation of models in Question 2.) Because the locations of these Restoration Opportunity Areas are not being presented to the public, there are details of the modeling that cannot be factored into the Panels evaluation of the Effects Analysis. As examples: 1) in Panel Question 7, the placement of the Restoration Opportunity Areas influences reverse flows in Georgiana Slough, 2) the calibration of the 1-D model based on the 2-D model results is sensitive to Delta Cross Channel operations, which could be the result of Restoration Opportunity Areas representation in the system. (See question 5 Restoration Opportunity Areas modeling discussion.) When Conservation Measure 3 is implemented, the details of the connection between the Restoration Opportunity Areas and the adjacent channels and the order in which the Restoration Opportunity Areas are established need to be top design criteria.

Clifton Court Forebay physical changes need more evaluation before implementation because of its reputation as a predation hotspot

Conservation Measure 1 now includes significant modifications to Clifton Court Forebay. These modifications include building a wall in Clifton Court Forebay to create two separate regions, the north region would receive water from the North Delta pump facilities and the south region would receive water from the existing south Delta channels. In addition, the current size of the Clifton Court Forebay would also be enlarged by flooding an adjacent tract of land to the south. Based on the public panel discussion with ICF and the Fish agencies on January 29, 2014, the philosophy behind the modifications is that the water coming from the North Delta facilities will have already been pre-screened for critical fish species. Therefore, there would be significant savings in not filtering north Delta diversion (NDD) water through the south Delta fish screening facility.

ICF acknowledged that this is a newer element of the design for Conservation Measure 1. There was no documentation in Appendix 5.H (Aquatic Construction and Maintenance Effects) regarding this construction. The building of a dam in the center of Clifton Court Forebay and dredging another tract should be considered in Appendix 5.H.

Clifton Court Forebay has been identified as a predation hot spot by multiple studies. The Fish Predation science panel (Grossman *et al.* 2013) stated in their final report that: "Clifton court Forebay (CCFB) has been identified by multiple sources as an inhospitable location for salmonids. Within CCFB several areas are particularly hazardous including: 1) the deep scour hole just inside CCFB by the radial gates; 2) the trash gates in front of the Tracy Fish Collection Facility; and 3) section of Old River adjacent to the radial gates." Since Conservation Measure 1 is proposing significant physical changes be made to Clifton Court Forebay, these predation hot spots should be considered in the re-design.

Delta Food Web

5.3.38 Cache Slough and Suisun Marsh Restoration Opportunity Areas are suggested as areas of substantial increase in Prod-Acres. Given that these Restoration Opportunity Areas are defined, some work could be done to estimate the potential food web subsidy attained based on the degree to which habitats are connected hydraulically to Suisun and Grizzly Bays. These areas could serve as "proof of concept" for other, unidentified Restoration Opportunity Areas. An interesting outcome of such an exercise would be a determination of the potential for export and trophic transfer (a positive outcome) versus localized cultural eutrophication, increased biochemical oxygen demand and dissolved oxygen sags in tidal sloughs (negative outcome).

The discussion of water residence time throughout the Delta (Section 5.3.36) suggests an increase of 3 to 4 days as compared to the current configuration. But this analysis is also site-specific. The approach used to calculate residence time is also of concern. The residence time in each Restoration Opportunity Areas is a function of bathymetry, the exchange between the Restoration Opportunity Area and the adjacent channels. The 1-D DSM2 model does not have the capability to calculate this parameter. In addition, because the specific locations and configurations of the Restoration Opportunity Areas are not presented in the Effects Analysis, the panel has no basis to comment on the validity of the approach.

The phytoplankton productivity model that results in Prod-Acres is limited in terms of prediction or certainty in outcomes. Again, it comes down to a question not only of quantity but also quality of the primary production that is supported. The result of longer residence time is likely to increase phytoplankton primary production (i.e., "slower is greener") this may not hold when invasive clams are introduced to the system (Lucas and Thompson, 2012). Additionally, the type of phytoplankton primary production that is stimulated is highly uncertain and likely dependent upon water temperature, nutrient concentrations, vertical mixing and grazing. Lehman *et al.* (2013) suggested that increased residence and warmer water temperatures in excess of 19 - 20° C will promote toxigenic cyanobacteria including *Microcystis aeruginosa*. It should be recognized that *Microcystis* is only one potentially important toxigenic cyanobacteria in the Bay-Delta – *Aphanizomenon* was abundant in 2011 and 2012 in the Bay-Delta (Karobe *et al.* 2013).

Tidal wetland restoration may mitigate some of the nutrient loading into the Delta by acting as a nutrient sink through emergent vegetation production, phytoplankton production as well as fluxes to the atmosphere via denitrifcation. These ideas are not considered within the Effects Analysis. The decay of large amounts of invasive aquatic vegetation (a result of control measures) also has the potential to increase biochemical oxygen demand and inorganic and organic nutrient supply; this may shift phytoplankton community composition and promote local eutrophication. This issue is raised in a single bullet point on page 5.F-130, line 26

Terrestrial Species

Rather than using current estimates of habitat occupancy within the Plan Area to estimate occupancy of restored habitat, we recommend using spatially explicit occupancy models (see comments under question 4). In addition, the minimum width and maximum distance of riparian habitat corridors should be identified for terrestrial mammals that are restricted to riparian habitats (riparian woodrat and riparian brush rabbit). Persistence of these species in the Plan Area requires riparian habitat patches that are sufficiently large to support stable populations as well as riparian corridors that will allow movement between suitable habitat patches. Both the minimum patch size and minimum corridor parameters (width, distance, overstory cover) should be specified to ensure long-term occupancy of restored riparian habitat.

4. How well is uncertainty addressed? How could communication of uncertainty be improved?

Summary

A broad consensus exists among the Panel that Chapter 5 does not adequately address uncertainty. In its current form, at the level of detail conveyed, in the models used, and in the verbal assessments and conclusions, the level of uncertainty is downplayed. Within appendices sometimes more explicit discussion of uncertainties can be found, but a disconnect exists between the summary pages with the conclusions drawn in Chapter 5. In situations in which an array of outcomes may be possible, only the more beneficial outcomes are quantitatively assessed or used in conclusions about the BDCP. Communication of uncertainty would be improved by consideration of a range of potential outcome values in models.

The Panel cannot determine whether the conclusions about covered fish species or other species in the BDCP are accurate. Detailed monitoring is needed to evaluate the BDCP conclusions, in addition to the outcomes for the biological objectives that could not be fully evaluated at this time in the BDCP. The BDCP effects analyses are qualitative and conclusions regarding net effects on each species typically reflect professional opinion. Therefore, the Effects Analysis does not lend itself to evaluation of chained statistical uncertainties. The tremendous length of the documents did not reduce the uncertainty in the overall net effects.

Recommendations

- Unknowns and research needs should be incorporated into the BDCP as explicit conservation measures, in other words, as a required part of the BDCP.

  Response: Research needs are defined within the conservation measures (and within the adaptive management, monitoring and research program), but are not conservation measures *per se* because performance of studies does not contribute to the recovery of species and is therefore not recognized as a conservation action. Specific research needs are described in Appendix 3.D and in each conservation measure in the public draft BDCP; in the final BDCP, research needs are described in Section 3.7 and referenced for each effect conclusion in Chapter 5 as described above. The research needs are addressed as key uncertainties. The Adaptive Management Team will identify the procedure for addressing each key uncertainty. Most key uncertainties are already recognized by existing agencies or scientific institutions working in the Delta, so BDCP anticipates addressing the uncertainties by collaborative research engaging scientists who are already working on these issues.

- Monitoring needs, timing and intensity also need more explicit incorporation into the BDCP. While often well explicated in an appendix (e.g., within Appendix 5.F-Biological stressors on covered fish), they are frequently absent within the material discussed in Chapter 5 or treated as an uncertainty.

  Response: Please see response to the recommendation: *Guide the scientific community by highlighted research priorities to address critical information gaps* which notes the addition of subsections titled *Main Uncertainties, Potential Research Actions, and Link to Adaptive Management and Monitoring*. These subsections generally link back to more detailed information in Chapter 3 regarding monitoring; however, great detail on monitoring timing and intensity is not provided as part of this planning-level analysis; such detail is would be provided during plan implementation.

- Research needs are often mentioned as sections within appendices. These should be consolidated within Chapter 5. This would help guide future research priorities for the Delta.

  Response: Chapter 5 has been modified to refer to future research needs as described above. These references, however, are not intended to guide future research priorities for the Delta. Section 3.6 describes the research program, and Appendix 3.D identifies research needs to be addressed during BDCP implementation.

Comments

Effects on Covered Fishes

For covered fishes, when evaluating the importance of an attribute to a species and evaluating the effect of the BDCP on that attribute, the Effects Analysis was typically careful to describe the level of certainty associated with this evaluation. The evaluation of certainty was typically a judgment by the BDCP authors rather than a quantitative measure of certainty (e.g., standard deviation), therefore estimates of certainty have their own level of uncertainty. The Effects Analysis did not lend itself to evaluation of “chained statistical uncertainties” as identified in the charge questions addressed to the Panel because the effects analyses were not quantitative. Nevertheless, the judgments of certainty have value, though they could be improved upon (see below).

Judgments of certainty were also compared with judgments provided by California agency scientists at the August 2013 workshops. However, identification of agency certainty seemed to be the interpretation by the BDCP authors of the agency response rather than a systematic evaluation of certainty scores. At the January 2014 Effects Analysis Panel meeting, ICF noted that they did not think it was possible to consistently document variability in Effects Analysis evaluations by agency personnel at the August 2013 workshops. As a result, evaluation of certainty of BDCP effects on attributes of each species is limited to the interpretation of the BDCP authors.

Please see discussion above on the overall net Effects Analysis for each species. Although conclusion statements typically stated high uncertainty in the overall net effects, they also tend to ignore uncertainty when highlighting the potential benefits to conservation without also stating the lower end of the effects range.

Monitoring and Research

As an example of the high uncertainty in the BDCP to achieve biological goals and objectives, many of the sections of appendices have sections on monitoring and research needs. These often highlight impacts of conservation measures in which the outcomes may have a range of positive to negative impacts. The unknowns and research needs should be better incorporated into the analyses of biological impacts of the BDCP. At a minimum they should be required as an explicit conservation measure. In a number of instances, especially in Appendices, for example Appendix 5.F, needs are highlighted for a robust monitoring and evaluation program, coupled with a detailed, prescriptive adaptive management plan. BDCP success will depend on monitoring and evaluations and responding to issues as they emerge. Furthermore, high uncertainty in the outcomes for the covered species means that budgets for monitoring and adaptive management must be developed with uncertainty in mind.

Disconnect between Uncertainty and BDCP Conclusions

Frequently, explicit modeling is reduced to small portions of conceptual models. When a range of potential outcomes may result from uncertainties in multiple conditions, only the most beneficial outcome is considered when coming up with a conclusion or summary. Some of these are discussed in other sections of this report. One example can be found in Appendix 5.F. When considering the impacts of some of the conservation measures, for example, Conservation Measure 13, removal of *Egeria* is discussed with multiple potential effects (Appendix 5.F, p. 5.F-48 and following), some beneficial, such as removing habitat for predators of covered fish, while others may exacerbate populations problems for covered fish, such as cascading effects through the food chain of the loss of some invertebrates that feed on *Egeria*, shifts in aquatic web linkages, and the rapid replacement of *Egeria* by other invasive submerged aquatic vegetation. Nonetheless, these uncertainties are simply ignored when it comes to conclusions, where it is determined that only the beneficial results of control invasive aquatic vegetation will result from the BDCP (pp. 5.F-48-49). To be fair, occasionally the poorer results dominate conclusions; for example, *Microcystis* may increase due to management activities inside and outside the region but these conclusions fail to emerge in the discussion of the aquatic food webs within Chapter 5.

The discussion of the aquatic food webs is based on a good conceptual model, but the dynamics of the food web are ignored and only a single component, phytoplankton productivity, is modeled as a result of restoration efforts in the relatively near- and far-term. Detrital contributions could also enhance food webs, but are not considered in any detail. Phytoplankton productivity is unrealistically modeled, and assumed to essentially be consumed along linkages that connect directly to covered fish. Chapter 5 does mention invasive bivalves, but fails to incorporate their potential as direct competitors for plankton within the food web, even though that potential is discussed. In other words, the BDCP is inconsistent in how models and analyses handle uncertainty and model assumptions, making it difficult to complete assessment.

Restoration

Because this is discussed in other sections, we will only mention that there is great uncertainty associated with the restoration of the wide range of ecosystems slated for restoration. Many of these systems have a poor record of achieving restoration, especially in short-to-moderate time periods. This range of ecosystems also varies considerably in the degree of difficulty of restoring functions. Nonetheless, the outcomes for conservation measures and their interaction and effectiveness are glossed over and uncertainties are not apparent in conclusions and summary discussions. For example, wetland restoration will require considerable input of sediment in the short-term to meet the outcomes described in the BDCP. Yet Chapter 5 models tidal wetland restoration with a constant concentration of suspended sediment, even though the document discusses the fact that sediment has been declining over the past decades, and further that the operations of the north Delta pumps may remove 8-9% more. In other words, there is considerable inconsistency between a discussion of uncertainty and how uncertainty is incorporated into the conclusions.

Similarly, restoration of many of the terrestrial habitats for other covered species also involves considerable uncertainty, especially as to the rate at which function will return that will be recognized by covered species. Consequently uncertainty of the occupancy targets for terrestrial species are not addressed. In all cases, a single value of number of acres that will be occupied is provided. No estimates of the uncertainty of achieving stated restoration goals nor uncertainty of the proportion of the restored habitat that will be occupied are included.

North Delta Diversion

In addition, the validity of the primary assumption that there will be no entrainment of fish at the north Delta diversion (NDD) should be evaluated. In reality, there will be some fish lost at the transfer point; therefore, the empirical relationship would be altered including this additional transfer point.

Water Clarity and Suspended Sediments

Section 5.3-24 (lines 31-38) correctly identifies a low level of certainty around changes in water clarity but does not include the potential positive or negative implications for changes in water clarity.

Suspended sediment is one of two key components driving the development of tidal wetlands in the Delta, especially under sea level projections, yet Delta inflow has been experiencing a decline in suspended sediment and operations of the NDD may remove 8-9% more. BDCP indicates there may not be sufficient sediment for marsh restoration (Chap. 5, p. 109).

The NDD operations should factor in suspended sediment into the operational criteria. Adaptive management should consider the possibility operating the NDD such that the first flush, which contains a large sediment load, is not exported.

5. How well does the Effects Analysis describe how conflicting model results and analyses in the technical appendices are interpreted?

Summary

The Effects Analysis covers a multitude of topics. Each panelist gave input into Question 5 based on their areas of expertise.

Hydrodynamics

Hydrodynamic models are sensitive to how the open water regions are represented and how they are connected to the adjacent channels. Because the panel was not provided the bathymetric configuration of the Restoration Opportunity Areas or the order in which the Restoration Opportunity Areas were established, it is not feasible to evaluate the sensitivity of the models to the placement of the Restoration Opportunity Areas. DSM2 (1-D) and RMA/TRIM (mult-D) hydrodynamic models represent Restoration Opportunity Areas is differently. This could be a significant source of error, especially when Delta Cross Channel gates configuration is open.

Life Cycle Models: Winter Chinook Salmon

No formal comparison of output from the OBAN and IOS models was provided, either on an absolute scale or relative scale. It should be acknowledged that adult escapement differs between models by a factor of 5. Through-Delta survival projects were also fractionally different between models. In neither case was an explanation for the discrepancy provided. The relative ranking of the different BDCP scenarios (Table 5.G- between models should be provided in the report, and certainly should be assessed, in part, based on the degree of consistency in predictions of the BDCP scenario ranks between models.

Salmonids: Delta Passage Model

For salmonids, the Delta Passage Model Salvage Estimates and the Salvage Density methods produced reasonably consistent estimates. Variance calculations need to be corrected. There appear to be analytical errors in expressing uncertainty.

Salmonids: Temperature Model

The text is not clear how the models predict these changes associated with the BDCP during egg incubation, if the BDCP has no effect on upstream conditions, as reported in sections of Chapter 5. In spite of these conflicting results, Figure 5.5.4-1 shows that there would be zero effect on eggs in the Sacramento River with moderate to high certainty in this conclusion. This evaluation needs clarification and should be consistent with the Appendix.

Terrestrial Species

Suitable habitat for each species in the Plan Area was based on expert opinion and therefore there are no model results to interpret. The plan adequately addresses conflicting estimates of the number of sandhill cranes that may be killed by collisions with powerlines.

Recommendations

Covered Fish

- A direct comparison of the output from competing models should be presented.

  Response: ICF identified the analysis based on Newman (2003) and the DPM as ‘competing models’ (although there are some important differences, e.g., inclusion of Yolo Bypass in the DPM) and added a comparison of the results in a new section (5.C.5.3.4) in Appendix 5.4) in Appendix 5.C. This showed that the results from the models were reasonably correlated, with differences for spring-run Chinook salmon possibly occurring because of the inclusion of Yolo Bypass in the DPM. In addition, a comparison of IOS and OBAN results was added (see response to the recommendation: *Compare model output as described below. Escapement values for OBAN (Tables 5.G-8 and 5.G-12) and IOS (Table 5.G-24) models differ by roughly a factor of 5. No formal comparison of the model projections from the IOS and OBAN models was presented. A ranking of model output for median adult escapement of the two models shows reasonable agreement (see Table 1 below). The two models flip the number 1 and 2 ranks of scenarios EBC1 and EBC2. The largest discrepancy was in scenario HOS-LLT with alternative rankings of 5 and 8. Such a table should be included in the report, along with an analogous comparison of through-Delta survival. A comparison of scenarios ranks is in keeping with the sentiment that only the relative output of the models be considered*).

- Clarify confusing and conflicting text related to salmon models.

  Response: ICF will review and clarify any text that could be construed as confusing and conflicting.

- Explanation for the large discrepancies in predictions in adult returns (i.e., factor of 5) should be provided and possible consequences to Effects Analysis. Use of relative effects does not eliminate systematic biases of models.

  Response: ICF will examine the potential reasons for the discrepancies in adult return predictions, and add explanation as necessary.

Hydrodynamics

- Identify which Restoration Opportunity Areas are represented differently between the DSM2 and the RMA/TRIM models, especially in the Mokelumne system, which is sensitive to Delta Cross Channel operations.

  Response: The modeling of Restoration Opportunity Areas (ROAs) using the RMA model was described in EIR/EIS Appendix 5A Section D.6. EIR/EIS Appendix 5A, Section D.8, describes the DSM2 corroboration process in detail. It includes a description of how the ROAs were represented in DSM2 as compared to the RMA model. As described in the methodology, the corroboration process relied upon using consistent bathymetric representation of the ROAs and boundary conditions between the two models. As a first step in the corroboration process, the physical changes reflecting the ROAs were incorporated into DSM2.

  In DSM2, an open water area such as the proposed ROAs was represented by a reservoir or a wide channel with a weir at the entrance, such that the surface area matches with the wetted surface area simulated by the RMA model corresponding to the mean water surface elevation in the channel to which the ROA is connected. In addition, the inflow and outflow into reservoir/channel representing the ROA in DSM2 were refined to match RMA breach flows on a 15 minute time step. Generally, the corroboration process was focused on matching the breach flows between the two models, and matching the flow changes in the Delta channels at the connection to the ROA. This was to ensure the changes in Delta flows in DSM2 as a result of the ROAs was consistent with RMA. As shown in the Appendix 5A Section D.8, the corroboration process resulted in DSM2 generally emulating the hydrodynamics predicted by RMA with the ROAs and sea level rise, even though small differences between the models exist.

  In response to the specific comment regarding the DSM2 performance when Delta Cross Channel gates were open, both RMA and DSM2 show a consistent direction of change, even though the magnitude of change in net flow in Georgiana Slough is different by less than 200 cfs, which is relatively small compared to the net flow of about 3,000 to 4,000 cfs. However, the two models match well during December though June period, which is the period of primary concern due to the migrating fish presence. Further, BDCP CM1 criteria requires that Delta Cross Channel gates remain closed during this period and would only be allowed to be open July through September and partially during October.

  The small discrepancy in the net flow between the two models when the gates are open may affect the simulated salinity conditions in the central Delta in the summer months. However, as shown in the corroboration results, the salinity results from the two models match fairly well in this region of the Delta.

Therefore, the resulting trends based on DSM2 simulations are a good indicator of expected changes in the hydrodynamics and salinity transport with the assumed ROAs and sea level rise.

- Publications from that CASCaDE (http://cascade.wr.usgs.gov/index.shtm) would be resources to guide the evaluation of propagation errors in the BDCP Effects Analysis.

Response: The scope of the BDCP is quite large and the analysis is very complex. The integrated analysis performed includes multiple sources of uncertainty (both model related, and Plan related). Model uncertainty was identified and addressed as much as possible throughout the analysis of the BDCP. It was addressed in many ways including multi-model evaluations, parametric sensitivity analysis, and comparisons to the empirical data, when suitable. This information were used to qualify the overall conclusions drawn. Additionally, Section 5.2 identifies limitations of specific models used.

The models used in the BDCP analysis are not predictive models in how they are applied in this project, and therefore the model results are only used in a comparative analysis and only serve as an indicator of condition (e.g. compliance with a standard) and of trend (e.g. generalized impacts). Individual physical models used in this comparative analysis were verified when sufficient empirical data are available (e.g. DSM2 calibration and corroboration).

CALSIM II is the main model used to simulate the effects of the BDCP on the flows, storage, and diversions in the CVP-SWP system. CALSIM II, which is a rule based optimization model, simulates operations under a future physical (hydrology, facilities, Delta geomorphology) and regulatory conditions on a monthly time step. The physical information (ANN, and flow inputs) that CALSIM II relies on has been verified and any biases were identified and documented. However, the uncertainty in CALSIM II operational results based on the future regulatory criteria is hard to quantify, and it is hard to separate out uncertainty in CALSIM II results due to physical and regulatory changes for a given scenario. The only way to quantify the uncertainty in CALSIM II results would be by simulating several scenarios bracketing the anticipated range of regulatory criteria and physical conditions.

For this reason, the entire effects analysis was performed at two time intervals to bracket the potential effects from varying physical conditions, i.e. ELT and LLT. At LLT, the assumed climate change effects, sea level rise, and restoration were incrementally larger than ELT. There were several sensitivity analyses performed for BDCP to capture the numerous uncertainties for a range of climate change, sea level rise, and restoration cases and were compared to the results used in the effects analysis. These analyses were documented in the EIR/EIS Appendix 5A Section D.

> Following is the response received from the CASCaDE team when when information was requested on how the propagation of errors are addressed in the CASCaDE propgram.

> While there are multiple sources of uncertainty in this study, the complexity of the systems being studied and the detailed nature of our investigations make the evaluation of a large ensemble of scenarios using linked model runs with varying parameters that would be necessary for a full uncertainty assessment prohibitively difficult. Indeed, given the numerical requirements of a detailed and sophisticated hydrodynamic model like our hydrodynamic model, DFlow 3D FM (DFM), we will likely need to limit scenario evaluations for study components dependent on DFM output to representative years within the 100-year climate scenarios.

> Nonetheless, for modeling components where sufficient historical data are available, we will attempt to evaluate model error and analytically estimate the possible influence of such errors on downstream results. One way to do this is to assess model sensitivity to various inputs using general model runs or, if time permits, sensitivity runs specifically designed for this purpose. Uncertainty in "upstream" inputs may then be propagated downstream using the resulting measures of input sensitivity.

> Further, we will evaluate climate scenarios chosen to represent the range of projected futures, in terms of precipitation and air temperature trend magnitudes, present in the IPCC AR5 GCM ensemble. As in CASCaDE I, this approach will allow us to evaluate the influence of two of the largest sources of uncertainty in our scenario evaluations: 1) GCMs' differing sensitivities to GHG emissions (model uncertainty), and 2) a plausible range of projected GHG emissions trajectories (forcing uncertainty).

> As noted above, the approach used in the BDCP to evaluate the uncertainty associated with the models is similar to the approach used by the CASCaDE team. As such, the effects analysis performed is suitable to identify potential trends under the BDCP.

Comments

Life-Cycle Models

When discussing IOS and OBAN life cycle modeling results, the Effects Analysis stated:

> *"The results of both models suggest future climate change effects would dominate changes in adult winter-run Chinook salmon escapement in the future, which is of appreciable concern for the species. Factoring in climate change, relatively small differences in upstream conditions between the BDCP LLT scenarios and EBC2_LLT resulted in greater adult escapement under HOS_LLT or lower adult escapement under ESO_LLT and LOS_LLT. These results reflect what appears to be appreciable model sensitivity to relatively small changes in estimated upstream conditions because, as noted above, <u>the BDCP does not</u>*

> *change Shasta Reservoir and upper Sacramento River operating criteria, so that changes in upstream areas derived from modeling, be they positive or negative, may not be fully reflective of the nature of actual changes that could occur."* (pg. 5.5.3-45, lines 38-46)

The above statement about climate change impacts on Chinook abundance is clear and noteworthy, but the text below it is confusing and should be clarified (did the model receive inaccurate information for upstream conditions?).

Chinook Salmon

For egg incubation of spring Chinook, Chapter 5 describes conflicting results (pg. 5.5.4-14). The text states, "Several models show no change in upstream condition as a result of BDCP". In the same paragraph, it states that SacEFT predicts a 12% reduction in egg incubation "condition" based on water temperature effects on egg survival. In contrast, the Reclamation Egg Mortality model predicts no effect due to the BDCP except in below normal water years (12% reduction in survival). SALMOD predicts negligible impacts of the BDCP on eggs, fry and smolt. The text concludes that the adverse impacts are related to high sensitivity of some models to small changes in upstream conditions. The text is not clear when describing how the models might predict these changes during egg incubation, if the BDCP has no effect on upstream conditions as reported in portions of Chapter 5. In spite of these conflicting results, Figure 5.5.4-1 shows that there would be zero effect on eggs in the Sacramento River with moderate to high certainty in this conclusion. This evaluation needs clarification.

- Habitat and flow modeling efforts in the Delta were not linked. As noted above, habitat suitability modeling indicates somewhat large habitat increases for foraging salmonids in response to restoration activities. However, these estimates of habitat did not account for reduced flows that would occur when juvenile salmonids are present in the Delta area, especially in wet years. In other words, will reduced BDCP flows affect access by juvenile salmonids to the habitat identified in Table 5.5.3-4, or do tidal fluctuations overwhelm river flows in all of these habitats?

Lack of Consideration of Propagation of Errors or Sensitivity Analysis in Linked Models

A direct comparison of the output from competing models is rarely presented. Results from different models are rarely formally compared on either an absolute or a relative scale. When different models projections exist, the BDCP rarely attempts to explain why the discrepancies are occurring or describe the direction of the expected errors.

Uncertainty plus more uncertainty produces even more uncertainty. Uncertainty never averages or cancels uncertainty any more than noise plus additional noise produces less noise. The propagation of errors will not be a simple sum of uncertainties in most cases. One can use variance in stages formula

$$Var(\hat{\theta}) = E_2\left[Var_1(\hat{\theta}|2)\right] + Var_2\left[E_1(\hat{\theta}|2)\right]$$

to propagate errors over multiple processes or sequentially linked models and where 1 and 2 denote sources of error in estimating the parameter θ by $\hat{\theta}$. Levels of uncertainty have different credence depending on the importance of biological stressors or attributes. An assessment might have high uncertainty for all low-importance attributes and still have overall high certainty if all the important attributes carry with them high certainty. Conversely, the overall assessment would have low certainty if one or more high-importance attributes carry high uncertainty. Overall uncertainty will never be less than the highest level of uncertainty for the more important biological attribute being considered.

There are several different cases in the Effects Analysis where multiple models are linked together. Each model has inherent errors either due to assumptions made in the modeling or numerical method errors. One of the best examples of how to link models in the Delta system is the U.S. Geological Survey's CASCaDE project (http://cascade.wr.usgs.gov/index.shtm). Publications from that project would be resources to guide the evaluation of propagation errors in the BDCP Effects Analysis.

The assumptions made in Hydrodynamic Models TRIM/ RMA versus DSM2 or CALSIM2 Result in a Range of Outcomes; Their Analysis is Limited to Only One Set of ROA Configurations

During the hydrodynamics presentation on 1/28, the calibration of the DSM2 (1-D) model compared to the TRIM/RMA (multi-d) models showed that the models agreed better when the Delta Cross Channel was closed than when the Delta Cross Channel was open. When the Delta Cross Channel is open, transport is influenced more by the circulation in the Mokelumne channels on the east side of the Delta.

The fact that the two models do not match well when the Delta Cross Channel is open indicates that the representation of Restoration Opportunity Areas is different between the 1-D and 2-D models. Hydrodynamic models are sensitive to how the open water regions are represented and how they are connected to the adjacent channels.

Because the panel was not provided the bathymetric configuration of the Restoration Opportunity Areas or the order in which the Restoration Opportunity Areas were established, it is not feasible to evaluate the sensitivity of the models to the placement of the Restoration Opportunity Areas.

6. How well does the Effects Analysis link to the adaptive management plan and associated monitoring programs?

Summary

While the adaptive management plan is considerably more developed in the BDCP Phase 3, it remains characterized as a silver bullet but without clear articulation about exactly how key assumptions will be vetted or uncertainties resolved to the point that the BDCP goals and objectives are more assured. The concept of adaptive management is appropriately described and allocated a prominent role in the implementation structure. However, as is increasingly documented, the commonly acknowledged process of adaptive management continues to be misunderstood and misapplied (Allen *et al.* 2011; Fontaine 2011; Westgate *et al.* 2013), often resulting in a loss of rigor and commitment in application. The consequence hasn't improved much since Walter's (1986) description of the adaptive management process as beginning:

> *"…with the central tenet that management involves a continual learning process that cannot conveniently be separated into functions like research and ongoing regulatory activities, and probably never converges to a state of blissful equilibrium involving full knowledge and optimum productivity."*

In the case of the uncertainties surrounding the assumptions and predictions of the BDCP, the Panel emphasizes that BDCP needs to recognize the risks of **not** institutionalizing an exceedingly rigorous adaptive management process in order to avoid ecological surprises that will be difficult or impossible to reverse once they have established (Lindenmayer *et al.* 2010; Westgate *et al.* 2013). BDCP must make a commitment to the fundamental process, and specifically the required monitoring, not just the concept of adaptive management. As Murphy and Weiland (2014) counsel:

> *"…adaptive management that targets listed species represents a complex process that can be resource intensive, including in its demand for guidance from research, monitoring, and modeling, therefore requiring substantial technical and institutional capacity. That considered, adaptive management has a great potential to improve the effectiveness and efficacy of resource management actions provided it is properly implemented."*

In the final assessment of the Effects Analysis, the Panel found the cautionary conclusion of Olden *et al.* (2014) about large-scale flow experiments to be particularly germane:

> *"…managers and policy makers must embrace both the scientific uncertainty and surprise learning opportunities that inevitably arise from these experiments, and not purposely ignore uncertainty to avoid complicating their message to stakeholders, only to later invoke this issue when flow experiments fail to deliver expected ecological or social outcomes."*

Recommendations

- The Effects Analysis effectively communicates the important principles and implementation stages of adaptive management, but the specific process whereby adaptive management would be utilized to ensure BDCP meets its goals and objectives by rigorous adaptive management need to be described in much more detail. There needs to be a more obvious commitment to active adaptive management.

    Response: The adaptive management process is described in the Conservation Strategy (Chapter 3). See Section 3.6.3.5 of the Public Draft BDCP for a detailed description of the decision process whereby adaptive management would be implemented.

    We agree that further detail is needed, and as described above, have been developing and incorporating that detail into Chapter 5, associated with the specific conclusions drawn in the Effects Analysis. Additional detail included in Chapter 3 will show that the proposed suite of monitoring actions is sufficient to address all of the BDCP biological objectives. There will also be a detailed exposition of required research actions and we are developing a detailed description of adaptive management processes to address at least three major sources of uncertainty in the Plan (the Decision Trees, the utility of tidal restoration in the South Delta, and the potential of restored tidal marsh to export fish food to adjacent subtidal habitats). However, many of the required monitoring and research actions will require further planning and detail before implementation is possible.

- There is explicit linkage between key uncertainties underlying the assumptions of the Effects Analysis and the monitoring and research that need to address them through adaptive management. However, many of the critically uncertain ecosystem processes, population responses, etc. that are identified as adaptive management targets are delegated to research, rather than monitoring. Any metric upon which decisions about the expected or predicted performance of a management measure will be made should be a foundational monitoring metric, not a focus of research, which is often vulnerable to competing priorities.

    Response: BDCP Section 3.6, supported by Appendix 3.D and the "Monitoring and Adaptive Management" subsection of each of the conservation measures, identifies both monitoring actions and key uncertainties tied to each of the conservation measures. Section 3.6 has since been revised to show clearly how the monitoring actions, taken as a whole, are sufficient to assess progress on all of the biological objectives. Each monitoring action describes the metrics to be used, as far as is possible at this stage of planning (some monitoring actions will require complex experimental designs to be collaboratively designed with a variety of other stakeholders, named in the revised Section 3.6 text, and for these the metrics cannot yet be precisely stated). However, it is inevitable that some of those metrics are based on a conceptual model that is likely to require revision in the context of further study, i.e. research. For example, the biological objective for delta smelt habitat, DTSM2.1, refers to metrics that include salinity, vertical circulation, turbidity, and calanoid copepod densities; yet there is ongoing debate about the absolute and relative importance of each of these metrics as contributors to delta smelt habitat suitability. It is therefore appropriate to study the matter and perhaps to revise the metrics in response to that information.

- To facilitate an active adaptive management plan that has some chance of ensuring the beneficial result of BDCP conservation measures, each and every key uncertainty should be "fleshed out" into implementable adaptive management "experiments" where the following are specifically described: (1) a conceptual model, or components of an existing model, that characterizes the uncertainty and what it influences; (2) assessment of the relationship between the uncertainty and the BDCP goals and objectives; (3) sensitivity of the proposed implementation to the uncertainty; (4) success criteria, monitoring metrics, baseline levels, thresholds and trigger points that will identify whether or when the performance of the conservation measure is deviating significantly from the anticipated target or prediction; (5) alternative hypotheses and how they affect the original conceptual model; and, adaptation of the (6) implementation action or (7) adaptation of the goals and objectives.

Response: We agree in principle with the commenter. Nonetheless, we do not plan to fully "flesh out" each key uncertainty at this stage of Plan development, because the seven components named by the commenter are not known for individual key uncertainties and are subject to continuous change in light of new scientific knowledge. We agree, though, that a more complete definition of each key uncertainty is desirable, and will make text modifications to that end. Please note, not all key uncertainties will be studied and resolved instantaneously at the outset of Plan implementation. Rather, research on the key uncertainties will be pursued by the AMT over a period of time, based on perceived priorities and availability of suitable funding (note that BDCP is not yet funded; to do so at this point would be an irrevocable commitment of resources on a project that has not yet been authorized, which would violate requirements of CEQA and NEPA). It is currently expected that the Implementation Office will award funds for research and will require proposers to state what conceptual and other models will be used, testable hypotheses, experimental design, and other study elements typical of such proposals. The AMT will award funds to those studies that offer greatest promise to resolve key uncertainties in a timely and cost-effective manner.

- Linkages between scientific development of the Effects Analysis and adaptive management should continue, if not expand, with implementation of the BDCP. At the minimum, consider the necessity to guarantee independent science review at the interface between the Adaptive Management Team and the Implementation Office, to ensure close to real time tracking of adaptive management experiments and decisions.

Response: BDCP Section 3.6 and portions of Chapter 7 describe the relationship between the Implementation Office and the AMT during BDCP implementation. The AMT has discretion to use independent scientific review whenever appropriate, and the BDCP specifically identifies such review as being appropriate in development of monitoring and research plans (especially complex, collaborative plans that synthesize the concerns of multiple stakeholders). Current revisions to Section 3.6 are likely to expand the scope of such review to include specific adaptive management tasks, as well.

Comments

Perhaps the largest challenge to achieving the stated goals and objectives of the BDCP is how many of these critical uncertainties can be addressed by adaptive management given the baseline and the required monitoring? For example, some of the key uncertainties identified in the Effects Analysis (Appendix 3.D), often associated with conservation measures 4, 5, 7, and 11, include:

- The ability of the restored habitat to meet the objectives and expected outcomes, including the time it takes to meet the biological objectives. (Can this be addressed by both magnitude and siting of restoration action?)
- The risk that the restored habitat will be colonized by invasive species such as nonnative submerged vegetation, nonnative predatory fish, and/or clams. (Hardly uncertain, but controllable?)
- The change in magnitude of predation mortality on covered fish. (Doesn't this require an existing reliable estimated of predation mortality?)
- Food web responses to habitat restoration actions on both a local and a regional scale.
- The risk of adverse effects resulting from unsuitable changes in water quality and exposure to toxic contaminants. (How much can be modeled?)
- The proportion of the covered species population that actively inhabit restored habitats and the change in growth rate, survival, abundance, life-history strategies, and population dynamics. (A very difficult baseline to quantify!)

The Effects Analysis provided explicit associations of such key uncertainties with each conservation measure and linked these to "potential research actions" (BDCP, Table 3.D-3).

The context of a "phased approach to serve as a large-scale experimental program" in adaptive management context implies conceptual models, baselines and thresholds?

Linkages between scientific development of the Effects Analysis and adaptive management should continue, if not expand, with implementation of the BDCP. In particular, it will be important to ensure that there is direct science input to the adaptive management process, and preferably an independent science body that has no conflict of interest in interpreting and adapting conservation measures. In the proposed implementation structure, the Science Manager chairs the Adaptive Management Team and coordinates with the Delta Science Program, and the Delta Independent Science Board may also be consulted about *"…matters relating to these monitoring activities and research efforts*." (Chap. 7-25, pp. 7-25). However, the Delta Independent Science Board is not engaged to the extent that they could deal with extensive monitoring and research results and adaptive management decisions in real time. We would doubt that the adaptive management process would be efficient, timely and evaluated without an independent scientific advisory body that reports to the Adaptive Management Team, Science Manager, Program Manager and the Delta Science Program.

Review of Specific Analyses

7. Are the analyses related to the north Delta diversion facilities appropriate and does the Effects Analysis reasonably describe the results? In particular:

Q. Was existing empirical information such as Perry et al. 2010 and Newman 2003 incorporated appropriately into the modeling? Where model runs required extrapolation beyond existing data ranges, were assumptions and interpretations appropriate?

Summary

The empirical information in Perry (2010) and Newman (2003) must be guardedly and cautiously applied in the modeling in future cases when north Delta diversion is operational. These empirical relationships are based on the best available information regarding current physical and operational configuration of the Delta. We assessed the validity of four model assumptions. The panel concluded: 1) the assumption of a 3-day moving average to characterize flow on the Sacramento below Georgiana Slough is not valid in the new configuration, 2) exporting water at the north Delta diversion facilities will change circulation patterns at the important north Delta channel junctions (i.e. Steamboat, Sutter, Delta Cross Channel, Georgiana), 3) an additional transfer point out of the Sacramento at the north Delta diversion will alter the empirical relationship, and there are issues with original assumptions in Newman (2003). The concerns raised above, at best, add additional uncertainty to the conclusion drawn by BDCP. At worst, these concerns may result in systematic biases in the model projections. The direction of the net effect of these biases is unknown.

Recommendations

- Consult with Russell Perry and Ken Newman on their perspectives regarding the applicability of their models to the Effects Assessment.

  Response: ICF consulted with Drs Perry and Newman in order to obtain their perspectives on the use of the models for the Effects Analysis. They acknowledged that the models are based on relationships derived from empirical data collected under the existing configuration of the Delta and that this should be noted as a caveat in the analyses. To this end, ICF has added text such as the following in the new subsections titled *Extrapolation Beyond Empirical Data* that were mentioned in the response to the recommendation: *Model-based assessments should clearly state when extrapolation is occurring and the potential direction of bias that might likely arise* above: “In addition to the extrapolation beyond the empirical data, it is important to note that the relationships upon which the method is based were developed under the current configuration of the Delta and therefore could be subject to change under future configurations of the Delta as a result of habitat restoration and water operations proposed by the BDCP, as well as other factors such sea level rise. ..”

- Perform more hydrographic modeling below the anticipated north Delta diversion to determine whether the nature of the outflow will violate assumptions or parameterizations of the Perry (2010) model and alter model output.

  Response: It is not immediately clear to ICF what sort of additional hydrographic modeling is being suggested by the Panel, nor was it clear to Drs Perry and Newman. ICF has followed up with the DSP to seek clarification on this subject from the panel. Additional runs have already been undertaken without including the restoration and including the proposed north Delta intakes, and were discussed in the synthesis of the results from the Sacramento River reverse flows analysis (section 5C.5.3.8.5; see in particular Figures 5C.5.3.146 and 5C.5.3-147). These runs illustrate the effects of restoration versus changes in river flow.

- Additive simulations should be performed varying the parameterization and possible structure of the relationships with Perry (2010) and Newman (2003) to determine robustness of the model results to changes in Sacramento River outflow under the BDCP.

  Response: It is not immediately clear to ICF what sort of parameterization and structural change variation is being suggested by the Panel, nor was it clear to Drs Perry and Newman. ICF has followed up with the DSP to seek clarification on this subject from the panel.

Comments

The empirical relationships, derived in Perry (2010) and Newman (2003), are based on the best available information regarding current physical and operational configuration of the Delta. For these relationships to be useful, they also need to describe the Delta under BDCP. To assess the validity of these relationships, we must examine how the system will change with the addition of the north Delta diversion. There are four primary sets of questions to address: 1) Will the system continue to have a “quasi-steady state” condition or the will the timescale of flow variance change? Is a 3-day moving average to characterize flow on the Sacramento below Georgiana Slough a legitimate assumption?, 2) Will the circulation patterns change at the important channel junctions (i.e., Steamboat, Sutter, Delta Cross Channel, Georgiana) as a result of north Delta diversion operations?, 3) Will the north Delta diversion be another transfer point out of the Sacramento river migration corridor?, and 4) Are the assumptions used in the original analysis valid?

Will the system continue to have a “quasi-steady state” condition or will the timescale of flow variance change as the result of north Delta diversion operations?

In the current configuration of the system, the north Delta is in a quasi-steady state. In general, flows on the Sacramento at Freeport change slowly over time (i.e., on the order of days). The only operation that can dramatically alter circulation patterns is the opening or closing of the Delta Cross Channel gates. The position of this gate is not frequently changed. And, when changed, the system reaches a different quasi-steady state condition after about a day. A visual example of this step change is found in Perry (2010, Fig. 3). Therefore, the assumption of a three-day moving average to characterize flow on the Sacramento below Georgiana Slough seems reasonable for the current configuration (flow and operations) of the North Delta.

When the north Delta diversion facilities become operational, the North Delta will no longer be in a quasi-steady state condition. The flows will behave more like what is currently observed in the South Delta as the pumping will not be continuous throughout the day. And, pump volume will also change at least daily. The timescale of flow variance will change more rapidly over time (i.e., on the order of hours). Therefore, the three-day moving average flow assumption is not valid in the new configuration with the north Delta diversion.

Will the circulation patterns change at the important channel junctions (i.e., Steamboat, Sutter, Delta Cross Channel, and Georgiana) as a result of north Delta diversion operations?

We know that opening and closing the Delta Cross Channel changes the circulation patterns in the north Delta. Exporting water at the north Delta diversion facilities will also change circulation patterns at the important channel junctions (i.e., Steamboat, Sutter, Delta Cross Channel, Georgiana). The DSM2-Hydro simulations that were used for the analysis of this issue in section 5C.5.3.5 are capable of outputting data even on a 15 minute time step. This model resolution should be able to quantify these differences. If the circulation patterns change, the proportion of fish distributed to each downstream channel will be altered as well. Therefore, the empirical relationship created for the current configuration of the Delta is not valid for the future configuration.

Will the north Delta diversion be another transfer point out of the Sacramento migration corridor?

Throughout the analysis in 5C.5.3.5, there is an assumption of zero entrainment of as a result of 100% effective diversion screens. However, the north Delta diversion will be pumping water. Therefore, empirical relationship between the flow at Sacramento below Georgiana and the number of fish present will be different from the current empirical relationship using the current (no north Delta diversion) configuration.

In addition, the validity of the primary assumption that there will be no entrainment of fish at the north Delta diversion should be evaluated. In reality, there will be some fish lost at the transfer point, therefore, the empirical relationship would be altered including this additional transfer point.

Are the assumptions used in the original analysis valid?

Newman (2003), Table 2 presents a summary of the covariates used in his modeling. There are two columns, mean and sample standard deviation. In this table, he reports a mean value for Delta Cross Channel gates of 0.61 with a sample standard deviation of 0.49. The Delta Cross Channel gate signal is a binary signal. It should be either open (1) or closed (0). Under no circumstances should that variable be reported as something other than 0 or 1. This analysis should have been broken into two time periods: gate open and gate closed conditions. This table raises a significant concern that the author did not have a basic understanding of how the Delta Cross Channel gate changes flow patterns (and migration patterns) in the Delta.

The concerns raised above, at best, add additional uncertainty to the conclusion drawn by the Plan. At worst, these concerns may result in systematic biases in the model projections. The direction of the net effect of these biases is unknown.

Q. Does the analysis of the frequency of reverse flows at Georgiana Slough accurately characterize changes in hydrodynamics due to changes in river stage, sea level rise, and Delta habitat restoration?

Modified question based on 1/29/2014 meeting discussion: Will the operation of the north Delta diversion change the circulation patterns around the Sacramento junctions with the Delta Cross Channel and Georgiana Slough such that fish (particularly migrating fish) have a higher likelihood of being diverted into the interior of the Delta via Georgiana Slough or the Delta Cross Channel due to tidal flood/ebb flows in this region?

Summary

We know, based on long-term field observations and hydrodynamic modeling, that the transition point from uni-directional flow and bi-directional flow at the tidal timescale occurs somewhere between Sacramento River above the Delta Cross Channel (RSAC128) and Sacramento River below Georgiana (RSAC123) for the current configuration and operations of the Delta. The operation of the north Delta diversion facility will reduce the amount of freshwater flow in the region of the Delta Cross Channel and Georgiana junctions. Hydrodynamic modeling will likely show that transition point between uni-directional and bi-directional flow will move upstream as a result of north Delta diversion operations. This transition location is also a function of whether the Delta Cross Channel is open or closed. If bi-directional flow occurs more frequently near the Sacramento junctions with the Delta Cross Channel and Georgiana Slough, fish will have a higher likelihood of being diverted into the interior of the Delta via Georgiana Slough or the Delta Cross Channel.

Recommendations

The DSM2 simulations should be re-run for the ELT and LLT simulations with bathymetry that does not include the Restoration Opportunity Areas but driven with ELT or LLT river flow and tidal stage boundary conditions and operations. These simulations would clearly show how north Delta diversion operations change circulation patterns near Georgiana Slough and the Delta Cross Channel.

> **Response:** Additional runs have already been undertaken at ELT without including the Restoration Opportunity Areas and including the proposed north Delta intakes. The results from these additional run were discussed in the synthesis of the results from the Sacramento River reverse flows analysis (section 5C.5.3.8.5; see in particular Figures 5C.5.3.146 and 5C.5.3-147). These runs illustrate the effects of restoration versus changes in river flow at Georginana Slough.

Comments

During the Effects Analysis Panel presentation on 1/29/2014, one of the Panel members (N. Monsen) asked for clarification of Question 7b. Based on that discussion, we concluded that the main questions that the Fish Agencies would like to see the panel address were:

> *"Will the operation of the north Delta diversion change the circulation patterns around the Sacramento junctions with the Delta Cross Channel and Georgiana Slough such that fish (particularly migrating fish) have a higher likelihood of being diverted into the interior of the Delta via Georgiana Slough or the Delta Cross channel due to tidal flood/ebb flows in this region?*
>
> *Will this change in flow regime as a result of north Delta diversion operations result in fish encountering this junction multiple times rather than just once, thus increasing the probability of the fish being diverted into the interior Delta?"*

It should be noted that these rephrased questions are very different than what the analysis in Sections 5C.4.3.2.6 and Section 5C.5.3.8.1 of the Effects Analysis addressed. The following suggest an approach to answer the modified question and comment on the analysis in Sections 5C.4.3.2.6 and Section 5C.5.3.8.1.

Part A: Suggested approach to address the modified 7b question

For this discussion, please refer to the Draft Environmental Impact Report/Environmental Impact Statement Appendix 5A that has examples of observed tidal stage and flow time series data from three key locations along the Sacramento River (Appendix C of this document).

The Sacramento River throughout the Delta has a tidal signal for both stage and flow. The Sacramento observation station at Freeport (RSAC155), above the proposed north Delta diversion intakes, has a tidal flow signal (Appendix 5A-D1, p. 128). At Freeport, both the tidal and tidally-averaged flow is always uni-directional downstream. Therefore, a neutrally-buoyant particle going with the flow at this location will always be traveling downstream, although the velocity at which it moves is dependent on the phase of the tides.

In the current bathymetric configuration and operations of the Delta Cross Channel (no north Delta diversion facilities), the observation station on the Sacramento above the Delta Cross Channel (RSAC128, Appendix 5A-D1, p. 129) also has downstream uni-directional flow both for the tidal and the tidally-averaged timescale. However, the flow signal on the Sacramento below Georgiana Slough (RSAC123, Appendix 5A-D1, p. 130) has reversing tidal flows. Therefore, even though the tidally-averaged flow at RSAC123 is downstream. A particle moving with the velocity field in the region of RSAC123 will flow both upstream and downstream. Therefore, the tidal excursion or range that a neutrally-buoyant particle will move upstream and downstream, at RSAC123 is important to determine how many times the particle will encounter junctions (such as Georgiana and Delta Cross Channel).

The Sacramento River above the Delta Cross Channel (RSAC128) and the Sacramento River below Georgiana (RSAC123) are only 5 river km apart and yet the flow signals at these stations are very different. These flow signals are distinctly different because there are two junctions, the Delta Cross Channel and Georgiana Slough, between these measurement stations where a portion of the water is diverted towards the Central Delta. The flow signal at RSAC123 also changes depending on whether the Delta Cross Channel is open or closed.

Therefore, we know, based on long-term field observations and hydrodynamic modeling, that the transition point between uni-directional flow and bi-directional flow at the tidal timescale occurs somewhere between RSAC123 and RSAC128 for the current configuration and operations of the Delta.

To determine how the north Delta diversion operations will change circulation patterns around the Delta Cross Channel and Georgiana Slough, the DSM2 model can be used to determine the location along the Sacramento where the flow transitions from unidirectional and bi-directional tidal flows. This transition location will also be a function of whether the Delta Cross Channel is open or closed. It is also useful to determine the extent of tidal excursion to determine whether particles would encounter either the Delta Cross Channel junction or the Georgiana Slough junction multiple times.

The operation of the north Delta diversion facility will reduce the amount of freshwater flow in the region of the Delta Cross Channel and Georgiana junctions. Modeling will likely show that transition point between unidirectional and bi-directional flow will be moved upstream. This transition point may be even as far upstream as RSAC128 (Sacramento above DCC).

Part B: Comments related to the analysis in Sections 5C.4.3.2.6 and 5C.5.3.8.1

The approach taken for the analysis in Sections 5C.4.3.2.6 and 5C.5.3.8.1 focused only on the exchange between the Sacramento River with Georgiana Slough. The approach of analyzing flow direction every 15 minutes was a reasonable approach given the original 7b question. However, the analysis did not attempt to also look at the exchange through the Delta Cross Channel, which should be done for the modified 7b question.

The bigger issue with this particular analysis is the assumed Delta bathymetry used for the ELT and the LLT simulations. For both the ELT and LLT simulations, Restoration Opportunity Areas are included in the bathymetry. The tidal field is significantly changed by the inclusion of these Restoration Opportunity Areas. Note that these Restoration Opportunity Areas are only one possible configuration. As of this BDCP draft, the final locations of the Restoration Opportunity Areas, the order of construction the Restoration Opportunity Areas, and the bathymetric connections between the Restoration Opportunity Areas and the adjacent channels have not been established.

In the BDCP conclusion for this analysis states:

> *"Ongoing research is investigating link is between the distribution of energy dissipation and the distribution of tidal prism within the context of Plan Area restoration and other factors (DeGeorge pers. comm.). … it is unknown whether the presently limiting conveyance capacity of a number of Delta channels for tidal flows may become enlarged by scouring in response to Plan Area changes in geometry resulting from habitat restoration. These factors may have*

consequences for the hydrodynamics at the Sacramento River-Georgiana Slough divergence and other locations." (5C.53-331, lines 22-29)

This conclusion indicates that the present hydrodynamic modeling does not separate the effects of the north Delta diversion from the preliminary Restoration Opportunity Areas configuration in the ELT and LLT simulations.

One of the best reasons to use hydrodynamic modeling as an analysis tool is that models have the capability of isolating individual effects. The DSM2 simulations should be re-run for the ELT and LLT simulations with bathymetry that does not include the Restoration Opportunity Areas but does have the ELT or LLT river flow and tidal stage boundary conditions and operations. These simulations would clearly show how north Delta diversion operations change circulation patterns near Georgiana Slough and the Delta Cross Channel.

8. How should the effects of changes in Feather River flows on fish spawning and rearing be characterized? In particular, how should the trade-off between higher spring flows and lower summer flows be interpreted? Does the analysis adequately capture the expected benefits of CM 2, Yolo Bypass Fishery Enhancement?

Summary

Chapter 5 correctly recognized that flow/habitat relationships are necessary for evaluating changes in Feather River flow and temperature on salmonids. However, relationships between flow and habitat were not presented in Chapter 5, therefore it was not possible for the Panel to evaluate changes in spawning and rearing habitat. Most salmonids reportedly inhabit the low flow channel which will reportedly experience little change. BDCP effects relate primarily to the fraction of salmonid populations inhabiting the high flow channel plus fish exposure to the high flow reach during upstream and downstream migrations.

Chapter 5 provides a reasonable discussion of the approximate benefits of increasing flow into Yolo Bypass and allowing more juvenile salmon, especially foragers, to utilize this rearing habitat. Potential adverse effects on migrating adults should be monitored.

Recommendations

- Develop flow/habitat relationships for salmonids in the Feather River high flow channel, approximate the proportion of the population that uses this habitat, and correct inconsistencies in the text and summary figure.

  Response: ICF has reviewed the literature and previous effects analyses (principally related to FERC relicensing of the Oroville facilities) for existing flow/habitat relationships for spawning and rearing fall-/late fall- and spring-run Chinook salmon and steelhead in the Feather River HFC and reported the proportion of the population using the reach. For spawning, we: (1) estimated a weighted usable area index by applying CALSIM outputs, (2) developed exceedance curves of weighted usable area index and compared these among scenarios. These results more accurately portray actual changes in habitat in the

Feather River rather than assume that more flow is better. For rearing, previous studies indicate that flow is a poor predictor of habitat area. Therefore, this was not done. Instead, we report the use of the HFC by rearing salmonids and discuss potential effects.

ICF has also carefully reviewed the text and summary figure to correct any inconsistencies.

- The Yolo Bypass evaluation should recognize that natural origin Chinook salmon have a higher fraction of foraging type juveniles compared with migrant Chinook produced in hatcheries. Natural origin juveniles would likely benefit more than hatchery fish.

Response: As noted in the response to the recommendation: *"Wild" salmonids should be considered separately from hatchery fish whenever possible* above, it has now been made explicit that the analysis focused on wild-origin fish. As such, the proportions of foragers and migrants already reflected wild-origin fish, so this is already considered in the evaluation of CM2 *Yolo Bypass Fisheries Enhancements*. Note that the means of assessing net effects has been revised to reflect the effects on juvenile salmonids as being the weighted effects on foragers and migrants, with weights provided by the assumed proportions of these life-history types.

Comments

Feather River

Salmon and Steelhead. Chapter 5 provided a summary of beneficial and adverse effects of Feather River flows on juvenile and spawning spring Chinook salmon. The analysis was based on expected changes in monthly flows in the low and high flow channels and associated changes in water temperature. The text recognizes that salmon habitat area and quality are important (see introductory paragraph), but the evaluation did not attempt to convert predicted flow and temperature scenarios to habitat units for steelhead and Chinook salmon. Lack of habitat data for each species reduces the certainty of the anticipated effects, except when flows and temperature are expected to experience little change, as in the low flow channel. Key to this analysis is the reportedly high use by salmonids of the low flow channel relative to the high flow channel, given that the low flow channel is expected to experience relatively little change.

The text states that juvenile spring Chinook salmon may be present in the Feather River from November through June. Chapter 5 also concludes that juvenile migration would not be affected by BDCP flows, which are higher in spring and lower in summer in the high flow channel during BDCP operations. Why is juvenile migration not affected by higher spring flows and lower summer flows? To what extent is rearing habitat in the high flow channel affected by higher flows and to what extent are juveniles using this habitat? There is no mention of the actual temperature experienced by the fish in the Feather River.

It is not clear how the low positive effect with moderate certainty (Figure 5.5.4-1) was derived, given that there was no presentation on flow/habitat relationships, which were discussed as being key to the analysis. Chapter 5 states that real-time operations could be used to minimize adverse effects in the Feather River, but there is no mention of whether this will be done and what the criteria might be to protect salmon. The Chapter 5 description of Feather River effects on salmonids did not incorporate information related to exceedance of minimum flows that was discussed in Appendix 5C.5.2.

For steelhead, the analysis and text involving Feather River flows are somewhat more conclusive. A key statement is that the vast majority of steelhead reportedly spawn and rear in the low flow channel which would receive little effect from the BDCP (what percentage of steelhead rear in the high flow channel?). Adult and juvenile steelhead may experience somewhat higher flows during migration, but there is no judgment of whether this is beneficial or not. The text also states that summer flows in the high flow channel would be reduced by 50%, a period that includes year-round rearing of steelhead. The Panel notes that steelhead prefer higher velocities than other salmonids, but changes in the amount of habitat in relation to velocity was not presented. The text concludes with moderate certainty that there would be a low negative effect in the Feather River (the text should clearly identify that it is the rearing stage in the high flow channel that is affected). However, Figure 5.5.6-1 shows zero effect on rearing steelhead and low positive effect on migration. The results in this figure are not consistent with the text.

Yolo Bypass

Chapter 5 provides a reasonable discussion of the approximate benefits of increasing flow into Yolo Bypass and allowing more juvenile salmon, especially foragers, to utilize this rearing habitat. Reported data indicate only ~12% of the juvenile population would utilize the habitat. For spring Chinook salmon, the analysis assumed 80% of the juveniles were migrant rather than foraging Chinook. These values apparently included hatchery spring Chinook salmon which are mostly migrants and less likely to utilize rearing habitat and benefit from Yolo Bypass compared with wild Chinook salmon that are more likely to be foragers that benefit from the Yolo Bypass. Yolo Bypass is more likely to benefit wild Chinook (to the extent that they are "foragers") than hatchery Chinook salmon, and it would be worth discussing this in Chapter 5.

Potential adverse effects of Yolo Bypass on juveniles, such as stranding, were described. Potentially adverse temperature effects or predation affects (if predators are attracted to the Bypass) were not described, but BDCP authors stated at the January meeting that temperature and predator attraction are not likely to pose a problem within Yolo Bypass. Adult salmonids could be adversely affected in Yolo Bypass, as discussed in Chapter 5; these fish should be monitored to ensure safe migration.

9. Does the analysis adequately describe the predation and other screen-related effects of the proposed north Delta diversion structures? Is the application of the observed mortality rate at the fish screen of the Glenn-Colusa Irrigation District (GCID) an appropriate assumption for expected mortality at the proposed BDCP north Delta intakes? Are there other studies on salmonid survival at positive barrier fish screens that would be appropriate to apply?

Summary

Chapter 5 concluded that there is a low negative impact related to contact and impingement of salmonids with the north Delta diversion screens, but the technical appendix states that this effect could not be evaluated. Regarding predation, the Panel believes that there is uncertainty about the extent to which juvenile salmon and predators will aggregate near the intakes, and this is an issue that must be monitored. Positive barrier fish screens are widely used throughout the Pacific Northwest to protect juvenile salmonids from entrainment into water diversions, and this information should be readily available to the BDCP team.

Recommendations

- Correct inconsistency in conclusions in Chapter 5 and the Appendix regarding impingement.

  Response: ICF corrected the inconsistency by indicating that the potential effects described in Appendix 5.B could not be estimated with high certainty (the text previously only said 'with certainty'), which is consistent with the moderate certainty level concluded in section 5.5 of Chapter 5. As noted in the response to the recommendation: *Guide the scientific community by highlighted research priorities to address critical information gaps,* the addition of a new subsection titled *Main Uncertainties, Potential Research Actions, and Link to Adaptive Management and Monitoring* includes discussion of monitoring and potential research needed to address uncertainty, and links back to the discussion in Chapter 3 related to CM1.

- Monitor predator aggregation and predation rates at north Delta intakes.

  Response: It is envisaged that monitoring of predator aggregation and predation rates at the north Delta intakes would occur as part of monitoring/research into the effects of the north Delta intakes on juvenile salmonid survival (see discussion of monitoring and potential research actions associated with CM1 [section 3.4.1.5 in Chapter 3] and CM15 [section 3.4.15.3] in Chapter 3, and related potential research actions in Appendix 3.D *Monitoring and Research Actions*).

- Conduct literature search on positive barrier fish screens, which are widely used.

  Response: Information on positive barrier fish screens has been incorporated into the effects analysis, based on studies of the some of the covered fish species (e.g., UC Davis fish treadmill studies). As noted by the panel, "regarding predation at the north intake, salmon and predator behavior in response to flow and habitat conditions along the screen intakes will likely be the key determinants of salmon mortality at the intakes. This information must be gathered during project implementation". Such information would be gathered as part of monitoring and research(see the monitoring and research discussion for CM1 in section 3.4.1.5 of Chapter 3, as well as Appendix 3.D *Monitoring and Research Actions*).

Comments

Screen Contact and Impingement

The Effects Analysis stated in regard to fish contact and impingements at the north Delta intakes:

> *"It is concluded with moderate certainty that there will be a low negative change to the north Delta intakes attribute to foraging and migrating juvenile salmonids as a result of contact and impingement at the north Delta diversions".*

A reasonable summary of information leading to this conclusion was presented, although more information on relative abundances of foraging Chinook (smaller & more susceptible fish) versus migrant Chinook could have been presented. It was stated that monitoring would occur during operation as a means to ensure low adverse effects. This monitoring is important because debris build-up might alter contact and impingement rates. However, Appendix 5.B: Entrainment stated:

> *"Because of the lack of an established relationship between passage time, screen contact rate and injury or mortality, it is not possible to conclude with certainty what the effects of the north Delta intakes may be on juvenile Chinook salmon or indeed on juvenile steelhead…".*

Therefore, information presented in Chapter 5 on injuries related to the north delta intakes was inconsistent with information presented in the supporting Appendix. This inconsistency needs to be corrected.

Predation at north delta intakes. The Effects Analysis presents some findings that indicate mortality of salmonids associated with predation is uncertain at the north delta intakes and that monitoring and adaptive management would address this issue. The use of monitoring and adaptive management to address the predation issue is important, and implementation of these activities is key to minimizing predation risk. The Panel believes that there is uncertainty about the extent to which juvenile salmon and predators will aggregate near the intakes.

One of the predation analyses relied upon information collected in relation to salmon losses at the Glenn Colusa diversion and screen. Application of the Glenn Colusa analysis to the north delta intake suggested a cumulative loss of 12% of the juvenile winter-run Chinook salmon at the north Delta intake, a value that is high for a relatively short reach of river. Relatively few details about the Glenn Colusa predation study were presented in Chapter 5 or in the supporting appendix (5F: Biological stressors), therefore the Review Panel cannot directly address the question above on this issue. Nevertheless, the Glenn Colusa study seems to indicate that predators may aggregate near fish screens and consume many salmonids. The study at Glenn Colusa highlights the need to monitor fish predation at the north Delta intakes.

Positive barrier fish screens are widely used throughout the Pacific Northwest to protect juvenile salmonids from entrainment into water diversions, and fish screening criteria are widely applied. The BDCP team could access relevant documents on the web. However, regarding predation at the north intake, salmon and predator behavior in response to flow and habitat conditions along the screen intakes will likely be the key determinants of salmon mortality at the intakes. This information must be gathered during project implementation.

10. Does the Effects Analysis provide a complete and reasonable interpretation of the results of physical models as they relate to upstream spawning and rearing habitat conditions, particularly upstream water temperatures and flows resulting from proposed BDCP operations?

Summary

A valid approach was used to calculate daily flow and daily temperatures in the upstream locations. However, the presentation of the temperature results and the synthesis of the results should be improved to aid understanding. The Fish Agencies should also refine the types of analysis they need to best show the temperature impact on fish as the result of BDCP actions. Currently, the temperature analysis includes: 1) a comparison of *mean monthly* temperatures categorized by water year type, exceedances of water temperature thresholds for the different fish species calculated for each month and categorized by water year type, and 3) the number of years where the exceedance occurred categorized by the level of concern (Table 5C.4-4, pgs. 5C4- 19, example Table 5C.5.2-42, pgs. 5C5.2-79).

Recommendations

- Question 10 is one of the topics in the Effects Analysis where the data is presented in individual species and life stage sections. It is very hard to synthesize the results in this format.

  Response: The individual species and life stage results of physical models are synthesized in Chapter 5.

- To help the reader understand what locations, which species, what life stages are most likely to be impacted by temperature as a result of upstream reservoir operations in response to north Delta diversion requirements, a synthesis section in the main Effect Analysis Chapter 5 should be included. This synthesis should address the summary of the problem presented in Section 5C.4 (5C.4-16 lines 26-32).

  Response: ICF will summarize the temperature effects in each river.

- Most charts in this section are hard to visually synthesize the temperature data. Color coding the charts would help guide the reader. Table 5C.5.2-197 (pg. 5C.5.2-364) is a good example of how to improve chart readability.

  Response: ICF will assess the potential for revising the tables, and recommends color coding a subset of the most important tables.

- Table 5C.5.2-32 (p. 5.C.5.2-79) show compares the level of exceedance for the different scenarios. This table is not effective at communicating that the level of exceedance is shifting between different categories. For example, less "orange" classifications may mean that there are more "red" classifications. It would be helpful to re-visit how this information is presented.

  Response: ICF will work with agency staff to develop an additional presentation of results in these tables based on this comment to make them more helpful to the reader.

- Another potential key statistic that could be extracted from the model data is the number of *consecutive* days in which water temperature is greater than the threshold level.

  Response: ICF will work with agency staff to explore reporting consecutive days exceeding threshold temperatures.

Comments

Approach to Calculating Upstream Flows and Water Temperatures:

The CALSIM II watershed model was used to specify the monthly flows in each of the upstream rivers. These monthly results were then "downscaled" to daily values based on the historical records at three historical locations in the watershed. These flows are used as inputs into the Sacramento River Water Quality Model (SRWQM) or the Reclamation Temperature model, depending on the location. This downscaling approach seems to be reasonable approach to estimate flows. The temperature models used are specific to this region and have been used in other applications.

The temperature analysis included: 1) a comparison of *mean* monthly temperatures categorized by water year type; 2) exceedances of water temperature thresholds for the different fish species calculated for each month and categorized by water year type; and, 3) the number of years where the exceedance occurred categorized by the level of concern (Table 5C.4-4, pgs. 5C4-19, example Table 5C.5.2-42, pgs. 5C5.2-79).

Analysis and Synthesis of the Temperature Modeling:

Question 10 is one of the topics in the Effects Analysis where the way the data is presented makes it very hard to synthesize the results. The topic of temperature was evaluated in the Upstream Habitat Results Section 5C.5.2 (548 pages long) for each species and life stage. In many cases the description of the results were very repetitive and did not explain how the results differed from other species.

To help the reader understand what locations, which species, what life stages are most likely to be impacted by temperature as a result of upstream reservoir operations in response to north Delta diversion requirements, a synthesis section in the main Effect Analysis Chapter 5 should be included. The current summary of upstream temperature (Table 5.3-5, p. 5.3-21) is too general to be useful. It is not a sufficient synthesis of the information contained in Section 5C.5.2. This synthesis should address the summary of the problem presented in Section 5C.4 (5C.4-16 lines 26-32).

11. Does the Effects Analysis use a reasonable method for "normalizing" results from the salvage-density method to the population level for salmonid species?

Summary

The normalization approach seems to simply adjust entrainment values based on relative population size over the years of observation so that entrainment values relative to water export may be more comparable from year to year. The normalization should be used for qualitative purposes but not for modeling purposes, because it will mask some of the variation and uncertainty. This standardization has utility for the purpose of calculating entrainment per volume of exported water, but it provides only a partial view of the pumping effect on fish populations. The percent of the populations entrained is more important. This value has more relevance to Effects Analysis on the population. It also appears the variance calculations for salvage abundance and entrainment index are being calculated incorrectly.

Recommendations

- Calculation of salvage density and entrainment need to be revisited and the variance calculations corrected. Current variance calculations for salvage density are underestimating actual variance and uncertainty.

  Response: The original concern with this analysis (as posed in the question for the panel to address) was related to whether the normalization method that was applied was appropriate. Based on the panel comments, ICF concludes that the normalization method was appropriate, but that the method used to estimate variance was not. Given that differences in mean estimates of entrainment index are the main response used to judge differences between scenarios, ICF believes that changes in the variance will not affect the conclusions of the analysis. However, ICF will coordinate with DWR and the permitting fish agencies that posed the original question for the panel to address, in order to determine whether it is felt that revision of the analysis is necessary.

Comments

The salvage-density method was developed to provide an index to entrainment that reflects the volume of export, taking into account fish species abundance. The method assumes a linear relationship between entrainment and export flows. There is some evidence this assumption of linearity may not be correct over the total range of conditions (Kimmerer 2008).

An estimate of total salvage abundance (S) for year i is estimated by the product

$$\hat{S}_i = \widehat{D}_i \cdot V_i$$

where

$\widehat{D}_i$ = estimate of fish salvages per volume of water export,

V_i = volume of water export.

The estimate of salvage loss is then “normalized” for an average population size of the fish according to the formula

$$\tilde{S}_i = \left(\frac{S_i}{N_i}\right)\overline{N}$$

where

N_i = fish abundance for the ith year,

$\overline{N}$ = average fish abundance over the years of inference.

Ideally, the fish abundance values should be based on the same population as the fish being salvaged. For example, winter-run Chinook where normalization is based on juvenile production estimates. In the case of fall and late fall-run and spring-run Chinook salmon, the normalization is based on adult run size and in the case of longfin smelt, a trawl index. For each of these latter cases, there is the additional assumption that juvenile abundance is proportional to either adult abundance or the trawl index, i.e.,

$$N_i = cA_i V_i$$

or

$$N_i = cT_i V_i$$

where

A_i = adult abundance in year i,

T_i = trawl index in year i, and

V_i = water volume in year i.

The normalized values, $\tilde{S}_i$ can be used in indices of annual salvage numbers but should not be used in subsequent simulations or the calculations of interval estimates. The normalization process has dampened the variability among annual values such that any subsequent variance calculations will underestimate the actual magnitude of the uncertainty (i.e., confidence interval [CI] width).

The entrainment index (E_i)s calculated

$$E_i = \frac{\hat{S}_i}{V_i}$$

per Section 5.B.5.4.3. It is unclear whether the actual salvage abundance $(\hat{S}_i)$ estimate or the normalized value $(\tilde{S}_i)$ is used in these calculations.

The variance calculations for the entrainment index (Section 5.B.5.4.3, lines 8–17) appear to be wrong. Based on the description, the average index value is calculated by taking the entrainment density for all relevant water years $(D_i, i = 1, \cdots, n)$ multiplying these values by alternative water volumes from CALSIM $(V_j, j = 1, \cdots, m)$, then averaging over all nm. The variance is based on the empirical variance using the nm values, i.e.,

$$\widehat{\text{Var}}\left(\hat{\hat{S}}\right) = \frac{s_{S_{ij}}^2}{nm},$$

per the plan, and where the S_{ij} are all possible values over n and m, then

$$E\left(\frac{s_{S_{ij}}^2}{nm}\right) = \frac{\bar{V}^2\sigma_D^2}{nm} + \frac{\bar{D}^2\sigma_V^2}{nm} + \frac{\sigma_V^2\sigma_D^2}{nm}.$$

However, based on the stratified nature of the calculations, the correct variance has the form

$$\text{Var}\left(\hat{\hat{S}}\right) = \frac{\bar{V}^2\sigma_D^2}{n} + \frac{\bar{D}^2\sigma_V^2}{nm} + \frac{\sigma_V^2\sigma_D^2}{nm}$$

where

$\bar{V}$	=	average water volume,
σ_V^2	=	variance in water volume values,
$\bar{D}$	=	average density,
σ_D^2	=	variance in density values.

The report variance is too small. The variance of the total salvage estimate also appears to be wrong (pages 5.B-65 and 66). The calculation of total salvage (S) was based on the description to be:

$$S = \widehat{\text{density}} \cdot \text{Volume}$$

Volume where the estimator of density was based on a linear regression of log salvage density vs. day of inundations. The report then states that the confidence intervals were then computed using the 95% confidence levels of the estimates of the regression." This calculation, as described, is wrong. The calculations should be based on the variance estimate for the back-transformed estimate of density from the regression, i.e.,

$$\text{Var}(\hat{S}) = \text{Var}(\widehat{\text{density}} \cdot \text{Volume})$$

$$= \text{Volume}^2 \, \text{Var}(e^{\hat{y}})$$

$$\doteq \text{Volume}^2 \, \text{Var}(\hat{y})(e^{\hat{y}})^2$$

where $y = \ln(\text{density}) = \alpha + \beta x$.

See Appendix D for appropriate variance calculations for the salvage model.

12. Are the assumptions of the analysis of aquatic habitat restoration food web effects appropriate for covered fish species? Are the conclusions and net effects appropriate?

Summary

The BDCP develops a robust conceptual model of aquatic food webs and the diverse linkages that may impact the net production of food for Covered Fish. Yet the BDCP contains a number of assumptions, some of which are inappropriate, others of which contain considerable uncertainty. Uncertainties are mentioned, but no effort was made to include whether conservation efforts reach only a portion of the goals of biological objectives. Thus the analysis of effects further assumes only the most beneficial potential results in any calculations, but doesn't incorporate other possibilities. Other processes of food webs in aquatic habitats are described but remain unanalyzed, some of which may enhance, while others of which would inhibit their biological objectives.

While the overall conceptual model is adequate, integration and synthesis is lacking. Consequently the conclusions and net effects are not appropriate given the gaps in analyses and the uncertainties.

Recommendations

- Model the potential flow of energy through the pelagic food web – baseline information

  Response: Modeling energy flow would require a much more sophisticated approach (e.g EcoPath) than is feasible in this project. Our approach of using a simpler model outlined in 5.E.4.2.2.5 (BDCP) can provide insights on this issue however. The revised approach incorporates the potential augmentation of the food supply from multiple sources as well as competition for food resources. The inclusion of grazing by invasive clams highlights an alternative flow of energy through the pelagic food web that was not previously accounted for in the Effects Analysis.

- Assume a variety of primary production flows to covered species due to competitors or environmental issues – to what extent might their optimistic scenarios vary from equally potential realities

  Response: The foodweb analysis in in 5.E.4.2.2.5 (BDCP) has been augmented per the panel recommendations and comments. The prod-acres index of the potential food subsidy provided under CM4 has been amended to include the potential effects of competition from benthic grazers. The original analysis based on the depth-dependent phytoplankton growth rate from Lopez et al. (2006) defines the potential food subsidy. An additional analysis that examines the depth-dependent influence of clam grazing (Lucas et al. 1999) has been completed to bracket the range of possible outcomes. The rates of clam grazing used are based on the regional average grazing rate observed in the Delta (Thompson, pers.comm.). The relative change in emergent productivity/detrital contributions has also been quantified in 5.E.4.2.2.5 for each subregion. It is noted in the Plan that these sources of food may be important to covered species at different life stages and times of year. The combined approach demonstrates a range of potential outcomes of CM4 for covered fish species and highlights additional areas of research, adaptive management and restoration design to maximize that benefit.

- Assume shifts in composition of plankton from favorable to unfavorable species (with respect to covered species) – even with potentially higher productivity by plankton, what happens if energy flows into other pathways other than nearly immediately into the covered species

Response: It is unclear why the panel provides a recommendation to assume shifts in plankton composition from favorable to unfavorable; the comments following the recommendations do not clarify this issue. With respect to the potential for energy to flow into pathways other than those available to covered species, this potential has been acknowledged in the effects analysis by referencing consumption by invasive clams, for example. New text has been added to Chapter 5 to better link the uncertainty in the effects analysis to monitoring and adaptive management discussed in Chapter 3. Example excerpts from the delta smelt section: "The above analysis of the potential effects of the BDCP's proposed restored tidal habitat on delta smelt represents a working hypothesis of the relationship between CM4 actions, environmental attributes (stressors), and biological importance. As identified above, the main uncertainties in potential outcomes of the BDCP to delta smelt are related to the production and export of food web materials from restored tidal habitat, and the suitability of restored habitat for occupancy by delta smelt. A suite of monitoring actions are proposed for assessing the effectiveness of tidal habitat restoration…paramount among which are the assessment of use by delta smelt and other covered fish species…; a regional food supply study for delta smelt and other covered fish species…; a study of habitat quality for delta smelt…; and a study of habitat extent in the Cache Slough subregion... The potential for production and export of food web items from restored tidal habitats has a number of key uncertainties that suggest a number of possible research actions…, including: quantifying primary and secondary production (particularly food for covered fishes such as delta smelt) within restored areas (and export to adjacent areas); assessing how hydrodynamic changes associated with tidal restoration affect flux of organic carbon; and determining the extent and effects that nonnative species (e.g., clams) have on restoration effectiveness. Section 5.F.6.4 of Appendix 5.F, Biological Stressors on Covered Fish, notes that potential research to reduce uncertainty around invasive mollusk occurrence (including P. amurensis and Corbicula fluminea) would include investigation of constraints limiting larval transport, settlement and establishment; the role of nutrients in facilitating invasion; and potential control mechanisms for invasive mollusks. …CM13 Invasive Aquatic Vegetation Control aims to limit colonization of restored habitat and other portions of the Plan Area by IAV such as E. densa. This would be achieved with an early detection and rapid response program, including detection, mapping, and monitoring, as outlined further in section 3.4.13 of Chapter 3, Conservation Strategy. Potential research to address uncertainty associated with CM13 would include assessing tidal restoration designs to limit IAV and assessing the extent to which Plan operations have affected Delta hydrodynamics and therefore potential for IAV colonization…; additional uncertainties and research needs related to IAV are described in section 5.F.4.4 of Appendix 5.F, Biological Stressors. Knowledge gained from research and monitoring of the above issues related to restored tidal habitat will allow adaptive management to refine and prioritize restoration actions in order to achieve species-specific biological objectives... Should criteria for success of tidal habitat restoration (e.g., occupation by delta smelt, extent of suitable habitat acreage, production/export of suitable food) not be met, adaptive management will allow implementation of contingency measures such as topographic recontouring of restoration sites…."

- Incorporate a detrital energy flow – this might shift energy flow back toward covered species

    Response: The relative change in emergent productivity/detrital contributions has been quantified in 5.E.4.2.2.5 for each subregion. The additional analysis calculates the change in relative abundance of each food source and notes the potential pathways for consumption to covered fish species. It is noted in the Plan that these sources of food may be important to covered species at different life stages and times of year. Many fish species are often found with detritus in their guts including splittail, sturgeon and, to lesser degrees salmonids and smelts. Detrital diets have been shown to support growth and reproduction in smaller invertebrate prey populations such as amphipods (Kneib 1997). Feyrer et al. (2003) found that detritus was the most prevalent food item found in splittail guts, although they also consumed bivalves (including *Potamocorbula*) and mysids. Emergent vegetation contributes to the detrital food pathway as well as provides a habitat for aquatic insects. Wetland insects play a prominent role in the consumption and processing of primary production and associated detritus and serve as an important food source for higher trophic levels, including a delta smelt, juvenile salmonids, splittail, invertebrate, and avian species (Davies 1984; Stagliano et al. 1998). Studies at Liberty Island found that insect larvae (primarily Chironomid pupae) were an important component of the delta smelt diet (Whitley and Bollens 2013) where they are often associated with emergent vegetation (tules) that serves as substrate for larval insects. Chironomid midge pupae were found to be the primary food source of juvenile Chinook salmon and were found to be a dominant food source in many fishes by Grimaldo et al. (2009) in isotope studies.

- The direction of restoration in these systems that would support phytoplankton is not simple and linear, adaptive management would need to be an aggressive component of the BDCP with authority to take immediate actions, regardless of what those might be

Response: Additional guidance will be provided for restoration guidelines and adaptive management documentation based on the results of additional foodweb modeling.

Comments

The conceptual model of the food web appears to contain all the significant compartments required for an adequate assessment of the impact of the BDCP. The BDCP contains a number of conservation efforts that have the potential to provide considerable enhancement of the populations of covered fish. These include increasing habitat, providing a diversity of habitat conditions that may enhance different life history stages, as well as allowing for potential increases in food web services for covered species. However, other than estimates made for phytoplankton production, no other assessments are made. First we review some of the assumptions inherent in the BDCP consideration of food webs.

An overarching assumption is that Conservation Measures have rapid and positive impacts. With respect to food webs, wetland and aquatic systems restoration are assumed to be effectively restored and functional immediately or in a short time frame and meet the biological objectives of the BDCP. This result is based on a number of additional assumptions, all of which contain considerable uncertainty. Similarly, while potentially negative impacts on the success of restoration are considered in passing, e.g., invasive bivalves, none of their potential effects are incorporated into their analyses or conclusions. The simplest effects perspective of the BDCP is that it edits out all potential outcomes except for the most favorable one.

Restoration of natural ecosystems, however, is difficult and fraught with great uncertainties and some systems that are assumed to have a positive influence on covered species are particularly difficult. The contingency of ecological communities means they will not automatically assemble in some predictable manner (Parker 1997). Chapter 5 contains even less information this time concerning details about timing and sequencing required to evaluate potential impacts. Understanding the sequences is also critical because they have major influences (Drake 1990, 1991; Hobbs and Cramer 2008). For example, the BDCP implies a consistent increase in restoration acreage through time, but without strong management intervention prior to opening of new wetland or shallow aquatic habitat, submerged aquatic invasive species such as bivalves, *Egeria*, or other newly detected species may expand rapidly into the new tidal habitat. The result would be a much larger management problem without the food web benefits proposed by the BDCP.

The assumption of rapid positive food web benefits from restoration of aquatic habitat is a potential benefit, but the degree of benefit, its timing, and even whether benefits will accrue is uncertain. Restoration even may be on a pathway to achieving desired biological objectives, but the time frame may be considerable and beyond the 50-year period of the BDCP. Similarly, changing the order of different conservation measures may push ecological systems onto different trajectories. Usually these cannot be predicted, and requires an integrated monitoring and adaptive management with considerable authority and manpower. Restoration rarely achieves immediate conservation or biodiversity goals (Hobbs and Cramer 2008, Hobbs *et al.* 2011). While tidal water as a process can be achieved by opening dikes, restoration of biological function is actually quite difficult with respect to ecosystem processes beyond tidal flux and especially with respect to ecological equivalency to comparable natural wetlands (Kentula 1996; Simenstad and Thom 1996; Zedler and Callaway 1999; Lockwood and Pimm 1999). More recent studies substantiate these evaluations (Burgin 2008; BenDoer *et al.* 2009; Moilanen *et al.* 2009).

The BDCP further ignores critical data that should have been incorporated into trajectories concerning the restoration of wetland and associated aquatic habitat. This is a crucial piece because the restoration that is planned is critical key to increasing suitable habitat and food web productivity. The issue is sediment supply for these restorations. The BDCP assumes a constant sediment concentration for the time period of the plan (Appendix 5.E, pp. 43-44: turbidity held constant in models and interpretations), yet they indicate that sediment concentration has been declining over the past 50 years (p. 109) and that the BDCP conservation measures will further reduce the sediment supply by an additional 8-9%. While in their discussion of sediment supply, they also conclude that declining sediment concentration and the impact of CM1 will mean much lower sediment supply, these issues have no impact on the BDCP analysis and inference. Yet the loss of sediment supply creates great uncertainties in the rate and potential for restoration of these habitats, while only the most optimal circumstances are modeled or estimated.

Similarly, the BDCP uses a simple depth-productivity model to quantify how habitat restoration may impact primary production (Figure 5.E.4-85, Relationship between Phytoplankton Growth Rate and Depth, in Appendix 5.E, Habitat Restoration). This assumes the relationship between phytoplankton growth rate and depth developed by Lopez *et al.* (2006) is accurate. The analysis focused solely on the relationship between phytoplankton and depth, while recognizing that other factors may influence phytoplankton production in particular locations (p. 121).

Ironically, the literature they rely on, Lopez *et al.* (2006) and Lucas and Johnson (2012), indicate that biomass and production of phytoplankton in the Delta do not fit this simple model expectations. A major limitation of the depth-productivity model is the impact bivalve grazing on available net production. Net phytoplankton production (in excess of potential grazing) peaked at different depths and at much lower rates depending on overall habitat depth and water residence time. Assumptions of phytoplankton production and their conversion to zooplankton and invertebrates as food sources for covered species in aquatic systems consequently lack realism.

A third assumption involves the production of food for covered fish. Food produced in the restoration areas is assumed to directly benefit covered fish and indirectly by export. The restoration of these areas are predicted to create better habitat and food for juvenile Chinook salmon, splittail, sturgeon, delta smelt, and longfin smelt. Two issues arise from this assumption, one is their analysis of phytoplankton production and the second is that the analysis never includes potential competitors.

In contrast to their assumption, they cite literature that models the impact of introduced clams and their rate of filtering of phytoplankton and other aquatic organisms. These models suggest 1) that the depth-productivity model they used is completely inaccurate in the context of invasive clams and 2) remind us that while the potential impact of clams are mentioned as an uncertainty, only the most optimal scenario without clams is used for conclusions about the short and long-term benefits of the BDCP.

Beyond the analysis of assumptions, the other compartments of the food web are not incorporated into their analyses. For example, the potential for detritus as a major source of food web production was reviewed at some point and mentioned during the discussion of food webs. However, no incorporation or estimation of potential detritus production was made, nor was the detrital web discussed any further. Ironically, this could be a significant and positive impact on covered species.

Similarly, the role of SAV and emergent vegetation were not assessed although they were mentioned. The issue of competitors was not assessed. No incorporation was made of anthropogenic nitrogen influences on phytoplankton community composition (for example increasing the proportion of *Microcystis*). While the BDCP generally has a review of most of these compartments that they illustrate in the conceptual model, no quantitative models, nor estimates derived from the literature review were developed to allow a variety of scenarios that might indicate the potential robustness of the impacts of the conservation measures. Thus, some quantitative detail on one or a few compartments, complete with large tables showing all the numbers produced, lacks significant meaning when other compartments are merely discussed. The overall impression is that these compartments live in conceptual isolation, lacking the integration of multiple and linked processes/interactions together into a synthesis.

Consequently the BDCP analyses are ambiguous and conclusions and estimates of net effects overestimate the net positive impacts of conservation measures.

13. Is the analysis of food web benefits to longfin smelt from habitat restoration appropriate? How well do the analyses link intended food web improvements to improvement in the longfin smelt spring Delta outflow/recruitment relationship?

Summary

While the Effects Analysis develops an appropriate logic train suggesting that restoration actions (e.g., CM4) would result in the production and export of increased longfin smelt "food", this objective is constrained by considerable uncertainty (acknowledged as only "Partial" assessment) because the data is lacking to quantitatively estimate the relationship between longfin smelt production and what might be exported from tidal wetland restoration and converted to food web linkages to the smelt. Although there are good, synthetic conceptual models developed for the Bay-Delta longfin smelt population encapsulated in the Effects Analysis (e.g., Baxter *et al.* 2010; Rosenfield 2010), this uncertainty is further constrained by the lack of a life-history model that would elucidate the role of prey composition and abundance in population dynamics. Delta smelt are principally planktivorous, feeding on copepods, cladocerans and mysids in the Bay-Delta (Moyle 2002; Feyrer *et al.* 2003; Hobbs *et al.* 2006). A potentially significant change in the viability of food web support of longfin smelt by the shift from the native *Eurytemora affinis* to non-indigenous species such as

Pseudodiaptomus forbesi and *Sinocalanus doerri* is implicated in declining availability of natural prey for longfin smelt. However, these changes were also confounded by flow diversions and restriction of the mixing zone and potential increased entrainment into water diversions and the increased predation of the overbite clam *Potomocorbula amurensis* on mysids and other zooplankton prey after its introduction in 1986 (Alpine and Cloern 1992; Kimmerer 2002).

Recommendations

- Strengthen the documented data and other evidence supporting the presumption that export of detrital matter would specifically contribute to food web linkages supporting longfin smelt.

> **Response:** ICF notes that there is not a 'presumption' per se but instead, as the panel notes, a hypothesis of potential linkage with respect to tidal restoration and effects on longfin smelt; this hypothesis leads to a conclusion regarding magnitude of change to food attributes that has a level of uncertainty associated with it. ICF will review the extent to which additional documentation can be added and will add whatever is relevant to the discussion. Uncertainty aside, the existing literature suggests that most pelagic species rely on detrital, epiphytic, and pelagic organic carbon subsidies throughout their life time. The importance of prey subsidized by detrital versus other sources is less important if there are little differences between primary consumer and secondary consumer pathways.

Comments

While there is viable evidence that poor survival and growth are a major cause of longfin smelt decline (Bennett and Moyle 1996; Sommer *et al.* 2007), the mechanism and magnitude of increased production of desired longfin smelt prey contributed by restoring tidal natural communities and other proposed BDCP restoration actions is still highly uncertain (see response, above, to Question 12). As discussed elsewhere, the contribution of restoring shallow water tidal wetlands to net phytoplankton production and increased plankton abundance available to longfin smelt is basically hypothetical because of the uncertainties of primary consumption within the restoring ecosystems, especially by non-indigenous clams, and whether these systems would be sources or sinks for any increased production. The Effects Analysis does acknowledge that tidal wetland restoration is also likely to export detrital organic matter, as well as macroinvertebrates, but the potential contribution of these food web sources to longfin smelt production is equally uncertain without more explicit and quantitative linkages to the longfin smelt prey potentially involved, such as mysids.

From that standpoint of linking food web benefits to the longfin smelt spring Delta outflow/recruitment relationship, the Effect Analysis does provide a reasonable rationale for smelt post-larvae and juveniles to benefit from exported production from the Suisun Marsh ROA, albeit with the same uncertainty associated with the utility of that exported production. Current understanding of juvenile longfin smelt occupancy of the Suisun Bay and West Delta subregions during March through June, before moving further into San Francisco Bay proper, suggests that linking the outflow/recruitment relationship to the management of spring (March-May) Delta outflow (Chap. 2, Section 2.4.1.4.4 Decision Trees) could be a management strategy.

14. How well does the analysis address population-level effects of the BDCP on white sturgeon?

Summary

The analysis does an excellent job of summarizing what is currently known about the life history and ecology of white sturgeon (southern distinct population segment) using the most recent analyses and peer-reviewed publications. In addition, the conclusions regarding the level of certainty about the effects of the different conservation measures on white sturgeon, based the expert panel convened in August 2013, are thoroughly discussed in the text and well summarized in Figure 5.5.8-2.

Estimating the effects of the BDCP on white sturgeon population levels is very difficult because of: 1) the lack of a thorough understanding of the effects of flow regimes on downstream migration and year class recruitment; 2) considerable uncertainty about white sturgeon sensitivity to water quality and whether current water quality conditions constitute negative impacts; (3) a poor understanding of the role of intertidal and subtidal habitat on food availability for migrating juveniles; and 4) little information about factors influencing growth and survival of adults in San Francisco Bay and the ocean.

Given these limitations, the Effects Analysis does an adequate job of using existing information to predict the effect of the various conservation measures on white sturgeon.

Recommendations

- Implement measures to improve estimates (reduce uncertainty) of adult survival and population size of white sturgeon in the Delta.

  Response: Public draft BDCP section 3.3.7.9.3 describes species-specific biological objectives for white sturgeon. Population survivorship and size are addressed by using survivorship as a proxy for abundance. This proxy was selected because it is feasible to detect and quantify survivorship improvements attributable to management actions, e.g. reductions in poaching (via CM17) and reductions in stranding within the Yolo Bypass (via CM2). Revisions to BDCP Section 3.6 (currently in draft form) identify a relevant monitoring action, focused on juvenile sturgeon survivorship, as a “Group of related studies to be designed in collaboration with CDFW and NMFS. Component studies address refugia and foraging habitat, food availability, and fish surveys near restored sites; uses information from M3, M8 [M3 is a food supply monitoring action; M8 is a salmonid survivorship monitoring action], and partner programs. Metrics, success criteria, and timeframe to be determined. AMT approval required.” Absolute white sturgeon population size and survivorship are treated in the global management goals (also listed in section 3.3.7.9.3). The essential difference between the BDCP objectives and the global management goals is that the BDCP covered activities have limited potential to affect species rangewide status due to (a) the limited management authority of the BDCP permit holders and (b) the limited portion of the species' range within the BDCP Plan Area. Therefore an objective was selected that has high potential to quantify the magnitude of the BDCP contribution to the species' conservation.

- Undertake research studies to identify the reason(s) for the observed association between high flows and high recruitment.

  Response: For the purposes of BDCP, this topic is being addressed as stated above, as a key uncertainty. Specific studies are not defined because the topic may be substantially better understood by the time BDCP is authorized and begins to receive funding. Studies in the Delta would be very difficult. Juvenile sturgeon spend one to three years in the Delta and are thought to move widely during that time. Mark-recapture studies would have a low probability of success due to low catch rates, and acoustic tagging studies would have a low probability of success due to the long time periods and need for spatially extensive tracking networks. One possible line of study would be to look at success upstream, e.g. in the vicinity of Red Bluff Diversion Dam, where outmigration occurs along a single channel and associations between flows and movement could be more easily tested.

- Initiate studies to understand the links (or lack thereof) between water quality and intertidal and subtidal habitat on growth and survival of 1) migrating juveniles and 2) adults.

  Response: This topic also falls under the scope of the key uncertainties named above (item 14.a). This particular question could be addressed using a habitat modeling approach similar to that described by Niklitschek and Secor (2005) for Atlantic sturgeon in Chesapeake Bay. We also understand that there is currently a proposal for a post-doc at UCD to do a coupled lab/field study to derive indices of habitat suitability (e.g., from choice experiments, or bioenergetics, in relation to different field conditions) that could then be validated with a field study. If such research is not underway by the time BDCP is authorized/funded, it would be an appropriate subject for BDCP research support.

Comments

The life history of white sturgeon, high adult survival and fecundity in combination with episodic recruitment in high water years, suggests that the multiple approach to conservation measures should promote increased adult survival and ensuring high recruitment when conditions are favorable. We agree with the conclusions of the Effects Analysis that reduction of illegal harvest (CM 17) and reduction of entrainment at the Fremont weir (CM 2) are both highly likely to have a positive effect on adult survival.

Similarly, we agree that the restoration of tidal wetlands under CM4 are very likely to provide significantly increased rearing habitat and epibenthic and benthic food resources. Perhaps more than the pelagic covered species, white sturgeon could also derive significant benefits from enhanced and exported detrital organic matter from tidal wetland restoration because much, if not most, of their natural (and unnatural given the non-indigenous clams contributions to their diets) prey on mudflats and in adjacent channels are detritivores.

Quantitatively estimating the effects of these conservation measures on adult survival will require more rigorous, focused sampling efforts. The large confidence intervals associated with recent estimates of adult survival will make it nearly impossible to document effects of the conservation measures. The effects of water diversion and changes in flow regimes on white sturgeon recruitment are much more difficult to predict and will require a more thorough understanding of the mechanisms behind the correlation between recruitment and flow volume.

Adequacy of Technical Appendices

Appendix 5.B—Entrainment

Summary

Section 5.B.4.1 (p. 5.B-11 lines 18-23) has the most important statement of the entire appendix. This conclusion that should be the first conclusion in the executive summary:

> *"Under the ESO (Evaluated Starting Operations), in the wetter water years (wet and above-normal water years…), most of the combined total exports would come from the new north Delta facility and exports from the south Delta facility would be lower than existing biological conditions … The use of the north Delta pumps would be lower in the dryer years with most pumping going from the south Delta pumps in dry and critical water year… Less use of the north Delta pumps in drier water years reflects requirements to maintain adequate bypass flows at the north Delta diversions." (5.B-11, lines 18-23)*

This conclusion is the basis of most of the entrainment analysis in Appendix 5.B for the South Delta facilities. There may be different approaches to come up with the regression between export rate and salvage, but the simplistic conclusion is that when the pump operations are lower, so is the entrainment of fish. However, in the dry and critical years, entrainment at the South Delta facilities will be higher because the north Delta facilities' operations will be limited.

The next question to ask, therefore, is how often we will be under dry or critical year conditions. Will California have more frequent dry water years, resulting in fewer times when the north Delta diversion facilities can be operated?

Recommendations

- The conclusion stated above in the summary Section 5.B.4.1 (p. 5.B-11 lines 18-23) should be the first conclusion in the Appendix 5.B executive summary and should be included in Chapter 5.

  Response: ICF will add this sentence (or similar description) to the recommended locations as necessary, if the sentiment has not already been captured with existing text.

- The Climate Change (Appendix 5.A) portion of the Effects Analysis needs to address the question for frequency of dry/critical water years and relate it back Appendix 5B.

  Response: The public draft BDCP EIR/EIS Appendix 5A Section D.3.2, describes the simulated changes in the hydrology under the modified climate senarios used for BDCP evaluation. The overall reductions in runoff are less than 10% at ELT, but up to 20% by LLT.The analysis showed that at ELT, under the median climate change scenario, the changes are small in the northern watersheds, however the San Joaquin River basin shows a trend towards reduced flows. At LLT, however, the reductions were apparent even in some of the northern watersheds in addition to the San Joaquin River basin. The results from this analysis were used to adjust the inflow timeseries' and hydrologic indices in the CALSIM II model. The frequency of dry and critical years, using the Sacramento Valley 40-30-30 index per SWRCB D-1641, increased from 37% to 39% at ELT and to 41% at LLT. The BDCP document has been amended to include the proportions of water-year types under ELT and LLT scenarios, in addition to the existing summary of water-year types based on current climate. The document now also notes that the summary by water year type is based on the current climate water year type for all scenarios. (Specifically, these notations have been added to section 5.2.7.4 of Chapter 5, section 5.B.4 of Appendix 5.B, and section 5.C.5 of Appendix 5.C). Thus, the panel's concern that summaries by water-year type did not properly take into account changes in the proportions of the different water-year types is accounted for, because the individual years represented by a given water-year type for current climate were classified as the same water-year type for the ELT and LLT scenarios; without this convention, the results may have been skewed in the manner that the panel was concerned about (although the number of years within each water-year type did not change greatly from current climate to ELT and LLT).

- The documentation of the DSM2 and particle tracking model (PTM) model in this appendix should be greatly expanded to provide clarity in their approach.

  Response: The science panel's detailed comments related to this recommendation note 'the documentation of the DSM2 PTM model in this appendix should be greatly expanded to provide clarity in their approach. Some of this documentation may already be in Appendix 5.C, however, the present documentation is not sufficient to allow Appendix 5.B to act as a stand-alone document.' Appendix 5.B is not intended to be a standalone document, so that to address the panel's recommendation, ICF would improve cross-referencing to sections in other appendices wherein DSM2/PTM is described in more detail. Additionally, the documentation describing how DSM2 and PTM were applied in BDCP physical modeling would be included.

Comments

Section 5.B.4.1 (p. 5.B-11 lines 18-23) has the most important statement of the entire appendix. This conclusion that should be the first conclusion in the executive summary:

> *"Under the ESO (Evaluated Starting Operations), in the wetter water years (wet and above-normal water years…), most of the combined total exports would come from the new north Delta facility and exports from the south Delta facility would be lower than existing biological conditions … The use of the north Delta pumps would be lower in the dryer years with most pumping going from the south Delta pumps in dry and critical water year… Less use of the north Delta pumps in drier water years reflects requirements to maintain adequate bypass flows at the north Delta diversions." (p. 5.B- 11, lines 18-23)*

This conclusion is the basis of most of the entrainment analysis in Appendix 5.B for the South Delta facilities. There may be different approaches to come up with the regression between export rate and salvage, but the simplistic conclusion is that when the pump operations are lower, so is the entrainment of fish. However, in the dry and critical years, entrainment at the South Delta facilities will be higher because the north Delta facilities operation will be limited.

The next question to ask, therefore, is how often we will be under dry or critical year conditions. Are we going to have more frequent drier water years, resulting in fewer times when the north Delta diversion facilities can be operated? The Climate Change (Appendix 5.A) portion of the Effects Analysis needs to address this question and relate it back to this Appendix.

In this appendix, the first conclusion stated is: "The BDCP would substantially change the amount and pattern of water exports from the south Delta SWP/CVP facilities, which generally would be expected to lower the number of fish of all species entrained relative to existing biological conditions." (Appendix 5.B, p. 5.B-iii, lines 38-40)

We agree that the south Delta export patterns will change substantially, especially in wet and above normal years. However, it is also important to look at how the flow patterns will also change in the north Delta. This is an equally important piece of evaluation that should be included in the entrainment analysis. The use of the DSM2 PTM is a first attempt at this type of analysis. However, the documentation of the DSM2 PTM model in this appendix should be greatly expanded to provide clarity in their approach. Some of this documentation may already be in Appendix 5.C, however, the present documentation is not sufficient to allow Appendix 5.B to act as a stand-alone document.

Appendix 5.C—Flow, Passage, Salinity, and Turbidity

Summary

Appendix 5.C has been a catch-all appendix ever since Phase 1 of this Effects Analysis review. Unlike the Entrainment or Contaminants appendices, this appendix does not have an individual issue that it is trying to address. This appendix is 2,636 pages long and spans a laundry list of topics including flows in river, salmon migration through the Delta, Delta Cross Channel and Georgiana Slough circulation, non-physical barriers, temperature modeling, water clarity, turbidity, invasive species, nutrients, dissolved oxygen, and algae. This appendix should have been divided into multiple appendices in previous iterations of the BDCP document. At this point, the division of the appendix will likely never happen. As a result, this is a very difficult appendix to review. In general, the Panel read through portions of this appendix to answer specific questions for the main charge questions for Chapter 5.

Recommendations

- Most Appendix 5.C recommendations are included in the Chapter 5 questions.

  Response: Please see responses to Chapter 5 recommendations.

- Guiding operational rules in place for the current configuration of the Delta, such as E/I ratios, need to be reviewed to see if they still make sense for the combined system.

  Response: In the same way that the current BiOps (NMFS 2009; FWS 2008) were 'layered' onto D-1641, so too will the BDCP be in addition to D-1641 or whatever Water Quality Control Plan is in place. The BDCP assumes all of the D-1641 criteria would continue to be implemented with the exception of the Emmaton water quality compliance station which would be moved to Threemile Slough. However, it is acknowledged that those criteria may be adjusted by the SWRCB over time. Based on our analysis, none of the D-1641 criteria appear to lose utility under BDCP.

- The calculation of transport time scales should be done with relation to a particular question being addressed rather than calculated as a bulk parameter.

  Response: ICF will assess the feasibility of estimating residence time within each subregion in order to address this comment, and will coordinate with DWR and the permitting fish agencies regarding the feasibility of doing so within the time remaining for finalization of the BDCP.

- Improve the synthesis of results in Section 5C.5.3.1: Passage, Movement, and Migration Results, Flow Summary.

  Response: The results of Section 5C.5.3.1 have been synthesized in Chapter 5.

- Water clarity and suspended sediment should have been in an appendix all its own rather than being buried in Part 6 of Appendix 5.C.

  Response: ICF opted to include water clarity/suspended sediment in this appendix because the appendix generally dealt with abiotic parameters, of which water clarity is an important one.

Comments

Baseline Operations (Section 5C.2.2)

The Effects Analysis used two different baseline conditions, one that was consistent with the USGFWS BiOp RPA actions (EBC2) and one in which the USFWS RPA (Fall

X2 action) was not included (EBC1). The panel will not comment the details of the baseline operations that were used to represent current conditions because this level of detail is beyond the area of expertise of the panel. We defer this issue to public comments by interested stakeholders, state and federal agency personnel that have more understanding of these details.

Proposed Operations, Maximum Allowable Export Rules (Section 5C.2.2.2.1)

Before the north Delta diversion facility is operational, the operating criteria for both the North and South facilities need to be established. Guiding operational rules in place for the current configuration of the Delta, such as E/I ratios, need to be reviewed to see if they still make sense for the combined system. For instance:

> *"For the BDCP cases, the [Export/Import] E/I ratio was assumed to apply only to south Delta exports; the north Delta intake diversions were assumed to exempt form E/I rule because the north Delta diversions are controlled by the bypass flow rules. The south Delta pumping was limited by the E/I calculated with the inflow minus the north Delta diversions; this would allow slightly higher total exports during periods when Sacramento River flows are high and north Delta diversion are high." (p. 5C.2-3, lines 41-42; p. 5C.2-4 lines 1-3)*

Residence Time (Section 5C.4.4.7)

The residence times calculated using 38 particle release sites using the DSM2 PTM model is of limited use. The calculation of transport time scales should be done with relation to a particular question being addressed. For example, how long will water reside in a specific Restoration Opportunity Area and how does that transport timescale compare to other important timescales, such as phytoplankton growth rates, contaminant reaction time, etc.

The Delta is a very diverse mosaic of regions. Each sub-section of the Delta has unique characteristics. Transport timescales in each sub-region is a function of operations (such as the operation of the Delta Cross Channel and the placement of temporary barriers, flooding in the Yolo Bypass), bathymetry, and connectivity to adjacent regions. Transport timescales calculated in sub-regions rather than full Delta "average" residence time will give much more detailed information about changes in circulation patterns as a result of alterations to the system as a result changes in operations and additions of restoration opportunity areas.

Passage, Movement, and Migration Results, Flow Summary (Section 5C.5.3.1, Pages 5C.5.3-1 through 5C.5.3-64)

Please improve the synthesis of results in this section. These pages contain only charts with no dialogue or graphs to aid the reader. This section likely contains very important information about how the circulation changes in the Delta will change as a result of the Conservation Measures at key locations throughout the Delta.

Attachment 5C.D (Water Clarity-Suspended Sediment Concentration and Turbidity) (5C.D-1 through 5C.D-64)

Water clarity and suspended sediment should have been in an appendix all its own rather than being buried in Part 6 of Appendix 5.C. This is a topic is as important as Entrainment and Contaminants. This section is a good resource to read for background on issues related to sediment transport in the Delta.

Appendix 5.D—Contaminants

Summary

Currently, the contaminants section of Chapter 5 comprises 1 ½ pages of a 745 page document with most of the information related to contaminant effects contained in a single table. There are many caveats to consider with contaminants and this topic should get more attention within Chapter 5. Appendix 5D has a very well written introduction that lays out the key issues related to both mercury and selenium in the Delta. This introduction should be included in Chapter 5 where it will be read and considered. This list of potential contaminants seems reasonable and the conceptual model for contaminants (Fig 5D.3-1) is well developed. The growing list of contaminants of emerging concern is a clear sign that additional contaminants may need consideration in the future.

The Executive Summary of Appendix 5.D (p. 5.D-i, lines 24 -29) states that quantitative analyses were applied where available but were not sufficient to fully examine the potential for contaminant effects. This statement is important for characterizing the level for which potential contaminant effects can be assessed, however this is not part of the bulleted summary within the Executive Summary (p. 5.D.ii, lines 35-42).

The Contaminants Appendix is limited to direct contaminant effects on covered species even though it is recognized that both direct and indirect contaminant effects must be considered (p. 5.2.3, lines 5-7). The Effects Analysis authors indicate that indirect contaminant effects are handled within Appendix 5.F: Biological Stressors on Covered Fish. Given the degree to which indirect contaminant effects are presently covered in Appendix 5.F this is not satisfactory. A Phase II Panel recommendation was to incorporate grey literature where needed in the contaminants section, especially for indirect contaminant effects. These recommendations were not taken and stand from the original review.

The separation of direct and indirect contaminant effects lead to strange splits in organization, including for *Microcystis* which is included as a “contaminant” in the contaminant conceptual model but is not part of the discussion in Appendix 5.D: Contaminants. Rather, *Microcystis* is considered in Appendix 5.F.

Both Conservation Measure 15: Methylmercury Management (pp. 4-257) and AMM27 Selenium Management (p. 5.D-37, line 18) should be evaluated by contaminants experts to determine if these approaches will be acceptable for mitigation. The modeling of Methylmercury effects are highly uncertain due in large part to site-specific characteristics that cannot be modeled at present.

Recommendations

- Provide more information with Chapter 5: Effects Analysis rather than relying heavily on Appendix 5.D: Contaminants.

  Response: The results and key information from Appendix 5.D have been synthesized in Chapter 5. The majority of the information will remain in Appendix 5.D.

- Include both indirect and direct contaminant effects within Contaminants Appendix (Phase II recommendation).

  Response: Contaminant effects on covered species food sources were researched, but little information was identified. For the majority of contaminants, research has focused on bioaccumulation in higher trophic levels, which is covered in the analysis of direct effects on covered fish species. Where information was identified on food sources, it was added and the discussion was expanded. Specifically, information was available for ammonium and pyrethroids.

- Methylmercury Management and Selenium Management should be evaluated by contaminants experts.

  Response: Input from contaminants experts has been ongoing throughout development of CM12 Methylmercury Management. This development process has entailed extensive collaboration with agencies and institutional staff concerned with methylmercury management (see citations and personal communications in the CM12 text, i.e. in Public Draft BDCP Section 3.4.12). This collaboration is continuing and, as specified in CM12, will continue at the scale of individual restoration sites during Plan implementation. BDCP does not have a selenium management conservation measure; potential BDCP effects related to selenium are being assessed and mitigated through the EIR/EIS process. At this writing that mitigation strategy is an area of active discussion between BDCP permit applicants and relevant resource agencies.

- Incorporate grey literature where needed (especially herbicide application for control of Invasive Aquatic Species).

  Response: The analysis of herbicide application was expanded based on the recently published Effect Analysis and Risk Assessment for Exposure of Water Hyacinth Control Program Stressors to Listed Anadromous Fish Species and their Designated Critical Habitat in the Sacramento-San Joaquin Delta (NMFS Central Valley Office, January 2013).

- Provide clear statements within Chapter 5 and the Executive Summary of Appendix 5.D about the high level of uncertainty associated with contaminant effects as a result of site-specific details that cannot be modeled without explicit information about the location and connectivity of ROAs.

Response: ICF reviewed the existing text and added the following additional clear statement to Appendix 5.D of the type noted by the panel in order to address the comment:

Given the complex nature of contaminant biogeochemistry, hydrology; behavior and physiology of covered fish species; and the individual contaminant toxicity that together determine resultant effects, a considerable level of uncertainty is associated with this analysis. Although the analytical approach is designed to minimize uncertainties, they do remain. In geographic areas where there is a higher risk of contaminant effects, site specific analyses and adaptive management strategies may be beneficial to reduce uncertainties for individual BDCP projects. For methylmercury and selenium, such programs are included in the BDCP, as discussed above.

The following text was added to Chapter 5 to address the comment:

> "However, given the broad geographic range of this study, and the numerous physical and biological factors that determine fate and transport and bioavailability of contaminants, a relatively high level of uncertainty is associated with both qualitative and quantitative analyses. Results should be viewed as estimates to determine the potential for effects on covered species. In cases where potential for harmful effects were indicated, such as for methylmercury and selenium, site specific mitigation measures are included."

Comments

The Contaminants Appendix is limited to direct effects of contaminants on covered species despite the recognition (Chap. 5, pg. 5.2-3, lines 5-7) that that both direct and indirect contaminant effects must be considered. Appendix 5.D states that with the exception of herbicides used to control Aquatic Vegetation, the BDCP does not add any contaminants to the Plan Area. Nonetheless, as stated (Chapter 5, page 5.3-26, lines 29-30) BDCP activities will alter freshwater flow and alter water residence times at various locations in the Delta. These changes can result in major changes in how contaminants interact with the Delta ecosystem by changing the local concentration of a given contaminant or duration of exposure. For these reasons, restricting the analysis to direct effects on covered species is inadequate.

The inherent challenges in navigating a document of this size could be overcome by placing all of the contaminant effects under the Appendix entitled "Contaminants". This was a recommendation made during the Phase 2 review. Indirect effects are handled elsewhere in the Effects Analysis (Appendix 5.F: Biological Stressors on Covered Fish) however at present discussion of potential indirect contaminant effects are not sufficient in scope, detail, or characterization of uncertainty. Ammonia (NH3) / ammonium (NH4) effects, as written in Appendix 5.D, appear to consider indirect effects of ammonia/ium which is inconsistent with the authors' intent for Appendix 5.D.

Appendix 5.D has a very well written introduction that lays out the key issues related to both mercury and selenium in the Delta. The analysis was very careful to separate out the effects of Conservation Measure 1 (north Delta diversion facilities) from the effects of Conservation Measure 2 (Establishment of ROAs). In general, the environmental effects related to constructing ROAs are a bigger concern for contaminants than the north Delta diversion. However, in the case of selenium, changing the pumping operation location in conjunction with the establishment of ROAs in the South Delta has a potential significant effect. Changing to the north Delta diversions shifts the primary source of water in the South Delta to San Joaquin derived water rather than Sacramento source water under certain conditions.

It is recognized that Methylmercury concentrations would continue to exceed criteria under the BDCP and restoration actions are likely to increase production, mobilization and bioavailability of Methylmercury (5.D-24, lines 41-44). There is considerable uncertainty related to Methylmercury production resulting from BDCP activities. This is due in large part to site-specific information needed to construct reasonable models and trophic interactions from various sources are not easily modeled (5.D-22, lines 11-17)

DSM2 is a one-dimensional model that represents open water areas as well-mixed, continuously stirred tank reactors. In addition, the location of the ROAs and how these areas are connected to the adjacent channels is unknown.

Currently, dissolved Se in the San Joaquin is an order of magnitude higher than in the Sacramento River. (Monsen *et al.* 2007) Therefore, even if the proportion of San Joaquin discharge relative to the Sacramento River is low, the increase in Se concentration could still be significant. This conclusion should be reviewed. There is much uncertainty in the DSM2 results, especially for residence times in the newly established open water regions.

Section 5.D.43 (lines 8-10) on the impact of restoration on ammonium suggest that restoration will not have an impact on NH4 concentrations – This is overly simplistic as tidal wetlands are known to be important in nitrogen biogeochemistry, acting as a source via sediment re-mineralization (Cornwell *et al.* 2014) or clam excretion (Kleckner 2009) or as a sink via organic matter production or coupled nitrification – denitrifcation (Cornwell *et al.* 2014).

Conservation Measure 13: Invasive Aquatic Vegetation Control is discussed in Section 5.F-6. There is little consideration of the potential effects on lower trophic levels (algal primary producer) due to herbicide applications. This issue is raised in a single bullet on page 5.F-130 Line 24-25. While the literature is not well developed for the SFE there is at least some indication that herbicide applications are detrimental to photosynthetic organisms (phytoplankton). This should be addressed as a possible effect with implications for adaptive management.

Appendix 5.F—Biological Stressors on Covered Fish

Summary

Appendix 5.F examines the effects of 10 conservation measures on four key biological stressors: invasive aquatic vegetation (IAV), predation, invasive mollusks, and *Microcystis*. Effects of these actions on fishes was largely based on professional opinion while utilizing available information. While intentions of these actions is good, the outcome for fishes is uncertain, indicating the need to monitor and adapt. Key issues include expansion of invasive clams that consume phytoplankton, more favorable conditions for *Mycrocystis and harmful algal blooms,* and continuous effort needed to control invasive aquatic vegetation and predator abundances.

Recommendations

- Page 5.F-107, last paragraph, first sentence, and Executive Summary: The 1% to 12.8% range in predation effects due to the north Delta diversion is a mixture of population-level and localized effects and should not be treated as measuring the same quantity. That range estimate is deceptive and technically incorrect.

  Response: ICF reviewed the concerns raised by the panel in order to ascertain whether corrections were required. The range of values are actually population-level estimates (for the juvenile population entering the Plan Area). The panel's comments suggested that they misunderstood the method of calculation for the fixed 5% loss at each of three intakes—the method took into account the percentage of the population entering Yolo Bypass and the percentage lost before reaching the north Delta intakes; this is why the upper estimates are ≤ ~13%, compared to the 14% 'localized' value calculated by the panel.

- Monitor progress and maintain efforts to control invasive species than impact covered fishes.

  Response: The principal invasive species that affect covered fish species are non-native fishes that act as predators and competitors; non-native molluscs that consume phytoplankton and zooplankton and thereby degrade food webs which formerly supported native fishes; and non-native aquatic vegetation that degrades native fish species habitat. A review of invasive species in the Delta indicates that episodes of invasion have been a relatively continuous process for most of the past 150 years, and there is thus a substantial risk that additional invasive species will occupy the Delta during the BDCP plan term. BDCP conservation measures include actions to address each of these groups of invasive species, as well as to perform relevant monitoring and research.

  CM13 Invasive Aquatic Vegetation Control describes continuation and further development of an existing egeria and water hyacinth control program currently administered by the Department of Boating and Waterways. Monitoring and research actions relevant to CM13 include compliance monitoring to document the location, extent, and type of control measures implemented. Effectiveness will be conducted at two scales: Delta-wide and at individual restoration sites. Delta-wide monitoring will include annual risk assessment and subsequent prioritization of treatment areas throughout the Delta. Individual restoration sites will be monitored for consistency with the site-specific restoration plan to determine whether success criteria have been met. CM13 also includes research actions to address key uncertainties such as effective design of tidal restoration sites to achieve tidal flow velocities that preclude rooting by invasive plants, and whether it is possible to design restoration to favor growth by native pondweeds (Stuckenia spp.) rather than invasive vegetation.

CM15 Localized Reduction of Predatory Fishes describes an approach to reducing, at the site scale, predation of salmonids (and sturgeons) by non-native fishes. There are numerous uncertainties about how such a program should be implemented, so this conservation measure details a substantial monitoring, research, and adaptive management program to identify and develop a feasible strategy for implementation. See Sections 3.4.15.2 and 3.4.15.3 of the draft BDCP for a detailed explanation.

CM20 Recreational Users Invasive Species Program describes an approach to minimizing the risk of new invasive species in the Delta by inspecting recreational watercraft. Combined with other programs unrelated to BDCP, such as restrictions on the discharge of ballast water in inshore waters and controls on live fish and shellfish importation, the risk of new species introductions is being minimized more than was the case through most of the historic period. Effectiveness monitoring for CM20 will consist of identifying the type, distribution, and abundance of aquatic invasive species detected during program implementation. Because CM20 is essentially a preventative measure, the primary purpose of adaptive management will be to ensure that the measure remains focused on the principal invasive species of concern. Programs similar to CM20 are now well established in California, so there are no key uncertainties associated with CM20.

Finally, invasive mollucs remain a key uncertainty for tidal restoration under BDCP. This risk was not discussed in the CM4 text in the public draft BDCP. We are currently developing a research and adaptive management plan focused on this issue, which will be incorporated in the final BDCP.

Comments

Biological stressors can result from "competition, herbivory, predation, parasitism, toxins and disease." The objective of the conservation measures is to reduce the negative effects of key biological stressors on covered fish species. Appendix F examines the effects of 10 conservation measures on four key biological stressors: invasive aquatic vegetation (IAV), predation, invasive mollusks, and *Microcystis*. This review is designed around the four biological stressors and the prospects for change under the BDCP plan.

<u>Invasive Aquatic Vegetation (IAV).</u> The plan states controlling IAV is expected to reduce densities of largemouth bass but could enhance open water conditions favorable to striped bass. The control of IAV should increase turbidity which should be beneficial to foraging by juvenile fish and reduce predation. Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes)* are the two most abundant IAV in the Delta. The CM13 proposes to treat approximately 1,700–3,400 acres of *Egeria* per year in and near restored habitat. Currently, *Egeria* is increasing at a rate of approximately 15% per year. Efforts will need to be sustained and focused to be effective.

Assessments of the benefits of IAV control were based on "scientific literature," consultations with local experts, and conceptual models of key processes, habitat, and covered fish species. There is also practical experience to draw from. At Franks Tract, *Egeria* control was 47% effective (5.F-40), while Delta-wide *Egeria* continues to expand at about 15%/year. Annual treatment of 1500 acres/year would be expected to maintain the status quo.

Figure 5.F.5-3 projects it would take approximately 10 years to eradicate *Egeria* under a high treatment scenario and a 20% annual expansion rate. Some of this benefit may be offset by the fact that habitat restoration under the Plan would also create susceptible *Egeria* habitat. Water hyacinth control, on the other hand, appears to be already successful.

Predation. Predation control is to be locally focused on predator hotspots. Ten spots have been specified, along with the new north Delta water diversion facilities and nonphysical barriers. It is unclear how effective these localized remodels will be because the predators being controlled (i.e., largemouth bass and striped bass) are moderately to highly mobile.

For the north Delta diversion facilities, two approaches were used to estimate predation-related effects: bioenergetics modeling and fixed estimate of 5% predation loss at each of three intakes screens. The Executive Summary states predation losses at north Delta intakes should be from less than 1% to 12.8%. However, this range is contradicted by the simple fixed estimate model: Assuming three intakes each with a 5% independent rate of loss, then the overall rate is $1 – (1 – 0.05)^3 = 0.1426$ or 14.26%. The bioenergetics model was considered the Plan's best approach to assessing predation near the intakes. However, the fourth assumption of this model (p. 5.F-15) states predation was assumed to be proportional to the prey's relative abundance. This is in contrast with most energetics models that assume consumption has a lower threshold dependent on the predator's physiology and size. Predation is then proportional to predator abundance. The analysis also apparently ignores smaller size prey (assumption 6, p. 5.F-16). This analysis was also based on guesstimates of expected predator abundance at the future north Delta intake facilities. The model also assumes all prey are at equal risk, regardless of their location in the channel.

Using the bioenergetics models to express the effects of predation at the north Delta intakes as a percentage of total juvenile predation can be misleading (p. 5.F-75).

Localized predation rates are more useful and can be compared to the 5% design specifications. Alternatively, the effect of predation at the intakes could be expressed in terms of proportional change in through-delta survival. Under the fixed predation loss method, it is unclear how proportions of 11.7%, 12.1%, and 12.8% for various fish stocks are estimated (p. 5.F-77) when a simple model based on independent intake events estimates $(1 – (1 – 0.05)^3 \times 100\% = 14.26\%$.

The predator removal program at the north Delta intakes and elsewhere is projected to remove 8,840 striped bass annually. The net effect is a project reduction in 13,320 juvenile salmonids being consumed. The Plan does not estimate the fraction of striped bass removal in the delta (i.e., another measure of relative reduction in predation). The

Plan states it is uncertain how long such a removal effort could be sustained, and that predator removal treatments are likely short lived.

The effects of habitat restoration on predator control are uncertain. Effects on turbidity, flow, etc., may be much localized. In addition, it is unclear whether restoration actions will benefit prey, predators, or both.

Invasive Mollusks. The overbite clam (*Potamocorbula amurensis*) currently dominates the brackish transition zone of the delta estuary. Its presence has dramatically altered the zooplankton community. It can filter the entire water column once a day in delta channels. The decline in phytoplankton has been subsequently correlated with declines in copepods and mysid shrimp, a food source of the delta smelt and longfin smelt. The overbite clam has a salinity range of tolerance that could be affected by the Plan's water operations. There is expected to be "generally little difference (25%) in average suitable habitat for the clam between EBC2 scenarios and ESO scenarios …" However, there is risk of *Potamocorbula* expansion:

> *"For ESO without Fall X2 (modeled as ALT1_ELT and ALT1_LLT), the area of suitable abiotic habitat for Potamocorbula would increase 7 to 9% in wet water-year types compared with the EBC1 baseline, but would be little different for all other water-year types. Suitable abiotic habitat for clams would increase in wet and above normal water-year types by about 18 to 28% in early long-term compared with EBC2 baselines (EBC2, EBC2_ELT) and increase 11 to 30% in late long-term." (Appendix 5.f, page 5.F-117, lines 7-11)*

Restoration actions to produce more shallow water habitat may not have a net positive effect. While shallow water habitat produce phytoplankton, the presence of *Corbicula* may result in a phytoplankton sink (p. 5.F-121). One of the few management options is to manipulate salinity which is a function, in part, of river flow. The water withdrawals from the north Delta Diversion should not help the situation. Decision whether to implement the Fall X2 will affect the area of notable colonization by *Potamocorbula*.

Mycrocystis. *Microcystis* blooms can have an adverse effect on phytoplankton, zooplankton, and fish. Factors associated with blooms include high water temperature, high water transparency, low flows, high nutrient concentration, and high nitrogen/phosphorus (N/P) ratios. Runoff from land use contributes to these favorable conditions. *Microcystis* affects fish populations through declines in food sources, mortality, and reduced fecundity. Water operations that reduce flow and increase water residence time may promote *Microcystis*. Shallow water habitat reduction may also promote *Microcystis*. Actions that increase water velocity and turbidity are helpful in controlling *Microcystis* blooms. ESO_ELT and LOS_ELT scenarios are projected to increase average water residence time (Table 5.F.8-2), which would have a detrimental effect in trying to control *Myrcocystis*. Submerged aquatic vegetation (SAV) control may produce water conditions unfavorable to *Microcystis*. Climate warming may be a significant driver in *Microcystis* trends in the future.

Appendix 5.G—Fish Life Cycle Models

Summary

It is not clear to the Panel why life cycle models were not developed specifically for the evaluation of the BDCP. The Panel previously identified a number of expectations for the life cycle model appendix, which had yet to be released. The Panel also recognized that these expectations might not be achieved, and noted that the inability to achieve these expectations would indicate higher uncertainty in the ability of the BDCP to achieve the biological goals and objectives.

Recommendations

- Provide more detailed description of the 14 different scenarios modeled (Table 5.G-2) than shown on p. 5.G-17. For instance, specify what are the low- and high-flow operations specified in scenarios HOS and LOS.

  Response: ICF will strengthen the cross-referencing between this description and other locations within the BDCP wherein the necessary detail is provided (e.g., Appendix 5.C).

- Check survival estimates. The 94-98% or 96-98% survival values (inconsistent text, p. 5.6-42 and Table 5.G-3) between ocean entry and age 2 seem very high. Rechisky *et al.* (2009), for instance, found early ocean survival of yearling Chinook salmon smolts from the Columbia River to be as low as 0.28 within the first month. Rechisky *et al.* (2012) reported early ocean survival of yearling Chinook salmon smolts to range from 0.04–0.29.

  Response: ICF reviewed the issue noted by the panel and found that the values were incorrectly described within table 5.G-3 as 'survival'; they in fact represent mortality, and this has been corrected. The lower bound is 94%, which has been made consistent in the text and table, and the mortality range of 94-98% equates to 0.02-0.06 survival, which is at the lower end of the range noted by Rechisky et al. (2009, 2012) and highlighted by the panel.

- Clarify what information and how the information from Michel (2010) and Perry *et al* (2013) were incorporated in the IOS models (page 5.G-44).

  Response: The information regarding the use of Michel (2010) was presented earlier in the methods description (section 5.G.2.3.1.4, p. 5.5-40); the information regarding the use of Perry et al. (2010, not 2013 as incorrectly noted by the panel) was provided in the fuller description of the Delta Passage Model, as referenced earlier in the method description (section 5.G.2.3.1.5, p. 5.5-40)

- Perform a sensitivity analysis at to generate confidence intervals at the north delta intakes using mortality values at existing structures (Perry 2010) (p. 5.G-46). The 95% survival value used in simulations of the north Delta intake is an engineering specification.

Response: While the 95% survival value referenced by the panel is a stressor reduction target formulated as part of the BDCP biological goals and objectives (see Chapter 3), the panel's point is valid. ICF will address the comment by undertaking additional IOS runs in conjunction with further exploration of the patterns related to the recommendation: *Evaluate and compare sensitivity of populations to a broader range in mortality at the north delta intakes and passage through the Delta. A 5% mortality at the north Delta intake is projected to cause a 58 to 61% reduction in adult escapement (i.e., EBC2- ELT or EBC2-LLT vs. ESO-95-ELT or ESO-95-LLT). This is a huge effect that would have to be mitigated by other BCDP conservation actions. Presently, 5% entrainment is based on engineering specifications and is lower than at other intake facilities (Perry 2010). These results are also in sharp contrast when through-Delta mortality was increased by 5% and escapement changed by only 0 to 4.6% in the OBAN model. Additional analyses must be done over a wider range of mortality values, 1% to 10%, to assess how bad the intake problem could be and how well must the intake function. In addition, the discrepancy between the effects of the 5% north Delta intake mortality and the 5% through-Delta mortality needs to be reconciled. It is unclear why these sensitivity results noted in the Conclusion (5.G.4) were not reconciled. They appear to be an important finding of the life cycle analysis.*

- Consider describing extinction rates. OBAN – Adult Escapement (pp. 5.G-51 to 5.G-61). Examination of plots (Figure 5.G-15, p. 5.G-19) suggests extinction rates for winter-run Chinook salmon would be very high for all long-term (LLT) scenarios and not insignificant for short-term (ELT) scenarios.

Response: ICF has discussed the appropriateness of reporting extinction rates for this type of analysis. Upon further examination, the populations in all model scenarios never reaches 0. Therefore, extinction rate would be identical (=0) for all scenarios. We considered using a minimum population size as a quasi-extinction threshold, but due to assumptions in the model that require all model outputs be compared on a relative basis, we conclude that comparing to a threshold value was inappropriate. We describe this further in the text.

- Compare model output as described below. Escapement values for OBAN (Tables 5.G-8 and 5.G-12) and IOS (Table 5.G-24) models differ by roughly a factor of 5. No formal comparison of the model projections from the IOS and OBAN models was presented. A ranking of model output for median adult escapement of the two models shows reasonable agreement (see Table 1 below). The two models flip the number 1 and 2 ranks of scenarios EBC1 and EBC2. The largest discrepancy was in scenario HOS-LLT with alternative rankings of 5 and 8. Such a table should be included in the report, along with an analogous comparison of through-Delta survival. A comparison of scenarios ranks is in keeping with the sentiment that only the relative output of the models be considered.

Response: ICF believes the panel's suggestion to be sound and such comparisons will be included in the final BDCP. It should be noted that the IOS and OBAN models do not model the same time periods: IOS covers 1922-2003 (with escapement summaries based on 1926-2003), whereas OBAN covers 1972-2003.

Table 1. Relative ranking of alternative model scenarios for medial adult escapement based on the IOS and OBAN models (1 = highest, 10 = lowest).

	EBC 1	EBC 2	EBC2 -ELT	EBC2 -LLT	ESO-ELT	ESO-LLT	HOS-ELT	HOS -LLT	LOS-ELT	LOST -LLT
IOS	1	2	3	7	6	10	4	5	8	9
OBAN	2	1	3	7	4	9	5	8	6	10

- Define ES0 95 ELT. Sensitivity analysis (p. 5.G-79) refers to a model (i.e., ES0 95 ELT) not defined in Table 5.G-2 at the beginning of the Appendix.

  Response: ICF has added scenarios without previous definition to Table 5.G-2; the scenarios have been renamed to make it clearer that they are modifications of the ESO_ELT and ESO_LLT scenarios (e.g., ESO_ELT 5% Mortality instead of ESO_95_ELT).

- Evaluate and compare sensitivity of populations to a broader range in mortality at the north delta intakes and passage through the Delta. A 5% mortality at the north Delta intake is projected to cause a 58 to 61% reduction in adult escapement (i.e., EBC2-ELT or EBC2-LLT vs. ESO-95-ELT or ESO-95-LLT). This is a huge effect that would have to be mitigated by other BCDP conservation actions. Presently, 5% entrainment is based on engineering specifications and is lower than at other intake facilities (Perry 2010). These results are also in sharp contrast when through-Delta mortality was increased by 5% and escapement changed by only 0 to 4.6% in the OBAN model. Additional analyses ***must*** be done over a wider range of mortality values, 1% to 10%, to assess how bad the intake problem could be and how well must the intake function. In addition, the discrepancy between the effects of the 5% north Delta intake mortality and the 5% through-Delta mortality needs to be reconciled. It is unclear why these sensitivity results noted in the Conclusion (5.G.4) were not reconciled. They appear to be an important finding of the life cycle analysis.

  Response: ICF concurs with the panel that this is a very important issue and has coordinated with OBAN and IOS modelers to provide a consistent set of sensitivity analyses for the OBAN and IOS models, by adjusting the ESO_ELT and ESO_LLT scenarios to include 1%, 5%, and 10% north Delta intake mortality. These results are then compared side by side to illustrate differences between the OBAN and IOS models. Note that ICF is unclear to what the panel is referring with the statement "Presently, 5% entrainment is based on engineering specifications and is lower than at other intake facilities (Perry 2010)." The 5% loss reflects the biological objective's stressor reduction target and aims to capture the potential negative effects of the intakes, such as near-field predation and impingement (it is not anticipated that entrainment would occur, i.e., fish being pulled through the screens). To our knowledge, Perry's (2010) study only focused on entrainment into the interior Delta through Georgiana Slough and the

Delta Cross Channel, as opposed to entrainment in relation to fish screens; it is correct that the entrainment into these channels generally is considerably larger than 5%. The effects of entrainment into these channels is explicitly captured by IOS but not by OBAN.

Comments

A total of 17 candidate life cycle models were considered for use in the Effects Analysis (seven Chinook, eight smelt, one splittail, and one steelhead model). Appendix 5.G reviewed a number of life history models in the Central Valley, but concluded that only two of the Chinook models (i.e., Interactive object-oriented simulation [IOS] model and *Oncorhynchus* Bayesian analysis [OBAN]) were applicable to the BDCP. The OBAN model for winter Chinook involved factors such as water temperature in the Sacramento River (Bend Bridge), exports at the south Delta pumps, days of flow in Yolo Bypass, Delta Cross Channel operation, striped bass (predator) abundance, ocean harvest and ocean upwelling. None of the smelt models were selected, despite the fact that four models (state-space, multivariate autoregression, Bayesian change point, and smolt survival regression) met their five selection criteria. Given the relative importance of the delta smelt, it is unclear how none of the models met the criteria of best available science. It is also unclear, given the important of BDCP, why the plan did not invest in independent model developed tailored to its objectives or invest in modifying one or more of the existing models to better meet the objectives of the plan. The IOS and OBAN models were used to assess effects only on winter-run Chinook salmon.

Under the BDCP, the ISO and OBAN models were used to simulate the projected effects of:

a. Benefits of CM 2 Yolo Bypass Fisheries Enhancement
b. Benefits of SM 15 Nonphysical Barriers (assumed 67% diversion away from Georgiana Slough)
c. Detrimental effects of juvenile entrainment at north Delta intakes (assumed 5% mortality)

No other BDCP conservation measures were considered. How the benefits of Yolo Bypass Fisheries Enhancement were modeled is unclear.

The OBAN model "cannot account for north Delta exports" and "does not include any Delta flow-based covariates other than export (EXPT) and Yolo Bypass inundation (YOLO) and, therefore, cannot account for any potential changes in survival below the north Delta diversions, e.g., because of changes in water velocity" (p. 5.G-32).

Consequently, the effect of lower flows due to water withdrawal or slower water velocities and subsequent increased smolt predation were not incorporated in the OBAN modeling. Appendix 5.G goes on to state that because of these modeling limitations, all performance measures should be compared on a relative basis.

However, ratios of model output (i.e., relative differences) will not eliminate biases due to structural defects in the model under alternative scenarios.

The IOS model also assumed "survival and travel times during River Migration are independent of flow" (p. 5.G-44). However, the IOS model does model the effects of flow and route selection and water exports on smolt survival in the Delta (p. 5.G-33). Such assumptions are very important because water withdrawals will affect flows which, in turn, are known to affect the travel time and survival of salmon smolts.

Calibration of the models was limited by available data which, in turn, can limit the range in valid model response. Nevertheless, model descriptions are generally adequate as a whole. Primary model outputs considered median through-Delta survival and annual escapement. In population assessments of endangered or listed species, it is common to include 50-year or 100-year extinction rates. Increasing median escapement has limited value if a salmon population continues to have an unexceptionally high probability of extinction in the future. The simulations should also be summarized in terms of extinction rates under the 14 different operational/environmental scenarios (Table 5.G-2).

The appendix does not include a formal comparison of model output for OBAN and IOS, either on an absolute scale or relative scale. It should be acknowledged that adult escapement differs between models by a weighting factor of 5. More importantly, the relative ranking of the different BDCP scenarios (Table 5.G.-2) between models should be included in Appendix 5.G. Certainty should be assessed, in part, based on the degree of consistency in model predictions.

Appendix 5.J—Effects on Natural Communities, Wildlife, and Plants Summary

In general, the Panel felt that the information in Appendix 5.J was clearly presented in the tables and figures. Because so much of the information in the appendix depends on the accuracy of the GIS database, the authors should provide a reference or preferably a link to a description of the database and an analysis of its accuracy. As discussed in other sections of our review, providing a single value for the number of acres of habitat that will be occupied by each species is scientifically questionable.

Recommendations

- The description of the methods used to arrive at the number of acres of restored habitat that will be occupied needs to be revised.

    Response: The terrestrial wildlife conservation strategy is based on the restoration and protection of natural communities. Covered species are assumed to inhabit restored or protected habitat in the same or greater densities as existing habitat. However, the strategy does not commit to this because the BDCP Implementing Office cannot control every variable that might be limiting species distribution or abundance. The monitoring and adaptive management strategies are meant to assess the effectiveness of the conservation strategy in achieving the goals and objectives. We will add text to make this assumption more clear. For certain plant species, specific occurrence goals are set primarily to meet recovery plan goals within the Plan Area.

- Consider including a range of values (minimum and maximum) of potential occupied habitat rather than a single value.

Response: The endangered species permits issued by the two federal and one state agency must include a single estimate of "take" of modeled species habitat that is expected to be lost as a result of the covered activities. This estimate becomes the limit that cannot be exceeded in order to stay in compliance with the permits. Therefore, HCPs and NCCPs must estimate a reasonable worst case of the amount modeled species habitat lost in order to provide adequate take coverage during the entire length of permit. Therefore, providing ranges for the amount of potential modeled habitat unnecessarily complicates the analysis and the permit conditions. However, the description of each species' modeled habitat includes a discussion of the sources and levels of uncertainty in each model. Based on this information, readers can assess the general accuracy of each model.

Comments

Appendix 5.J is divided into five sections each of which addresses a different conservation issue related to natural communities. Our comments on some sections are rather brief and some questions are not relevant to a section so we have included our comments on each section under each question. If there are no comments on a section under a particular question, we felt there was no need to address it.

a. How well are the proposed analytical tools defined, discussed and integrated?

Construction-Related Nitrogen Deposition on BDCP Natural Communities

The analysis of construction-related nitrogen deposition is thorough and sufficient. It is clear that the amount of nitrogen produced by construction-related activities of the BDCP will be negligible relative to the amount that is currently being contributed by the surrounding urban and agricultural areas.

Natural Community Restoration and Protection Contributing to Covered Species Conservation

The estimates of the current distribution of natural vegetation types in the Plan Area depend on the accuracy of the GIS database that used for the analysis. Provide a citation for the database and a brief discussion of the error associated with the different community types. In addition, the description of the approach that was used to estimate the amount of habitat for each species (pp. 5J.B-1 and 5J.B-2) is poorly worded and needs revising. The description should state that the details of the approaches used to develop the species-specific habitat models are provided in the species accounts in Appendix 2A.

Analysis of Potential Bird Collisions at Proposed BDCP Powerlines

The authors did an excellent job of integrating spatially explicit information about roost and foraging sites in the Plan Area to estimate the number of potential encounters with power lines and combining this with information in the scientific literature on mortality estimates from each encounter.

Indirect Effects of the Construction of the BDCP Conveyance Facility on Sandhill Crane

The authors considered all of the important indirect effects of the construction on sandhill cranes in the Plan Area. The analytical tools they used were appropriate for the analyses. Most of the estimates of indirect effects came from studies in other regions but that is unavoidable because no detailed studies have been conducted in the Plan Area.

Estimation of BDCP Impact on Giant Garter Snake Summer Foraging Habitat (Acreage of Rice) in the Yolo Bypass

This section is a simple accounting of the number of acres that are planted to rice within the Yolo bypass that may be removed when the bypass is inundated. Rice fields are used as foraging habitat by giant garter snakes and therefore could result in a loss of this habitat for the snake in the Plan Area. By intersecting the maximum amount of rice that was planted in area with the inundation level that results in the maximum amount of rice removed, the analysis provides an estimate of the maximum amount of potential foraging habitat that will be removed. We feel this approach is adequate to address this very specific question.

b. How clear and reasonable is the scale of analysis?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

The scale of vegetation distribution information (1 acre, from Appendix 2A) is reasonable for most species. Although some wildlife species may use habitat patches that are < 1 acre, it is unlikely that those patches contribute significantly to the amount of suitable habitat in the Plan Area.

c. How well were the Panel's earlier comments addressed and applied in the technical appendices/analyses?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

Earlier comments were addressed to some degree. The previous version of this appendix did not have any text at the beginning describing the methods that were used to arrive at the numbers presented in the tables. The description, however, needs to be edited and should specify that the assumptions behind the approaches used when developing habitat models can be found in Appendix 2A.

The other sections of this appendix were not previously reviewed.

d. How well did the technical appendix evaluate the effects of potential BDCP conservation measures on the specified variable(s)?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

As discussed in our review of Chapter 5, the estimate of the amount of habitat that will be occupied by a species following restoration is questionable. The number of acres of suitable habitat that are temporarily or permanently removed and restored are clearly conveyed in the tables in Appendix 5.J. But, the approach used in Appendix 5.J assumes that the proportion of the appropriate habitat that is within the current range of the species in the Plan Area is an appropriate estimate of the proportion of suitable habitat that will be occupied when habitat restoration measures are completed.

However, if habitat restoration does not occur within the potential range of the species in the Plan Area, none of it will be occupied. The best way to address this is to set specific goals for habitat restoration within the potential range of the species in the Plan Area and to identify occupancy thresholds.

e. Were the conclusions drawn from the results accurate and did these conclusions appropriately consider uncertainty, including chained statistical uncertainties?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

As discussed in our review of Chapter 5, uncertainty was not considered when estimating the number of acres of restored habitat that a species would occupy following restoration.

f. Were appropriate models used in the technical appendices? If model results conflicted, was this clearly stated and was the conflict appropriately addressed?

Analysis of Potential Bird Collisions at Proposed BDCP Powerlines

The authors considered all 12 bird species that are covered by the BDCP when addressing collision risk. They concluded, and we concur, that the only species that may suffer significant mortality from BDCP-related power lines in the areas is the sandhill crane. The authors used the highest estimate of the probability of mortality due to power line collisions from the published literature when making their computations. In addition, their estimates of the number of potential encounters between cranes and power lines were based on spatially explicit data from the BDCP region. We feel their estimate of potential crane mortality from new power lines that will be constructed is appropriate based on the information available from the site and the literature. We also feel that the estimates of the reduction in crane mortality due to placing bird diverters on existing lines are appropriate. We emphasize, however, that crane mortality from power line collisions should be closely monitored in the Plan Area and additional bird diverters should be put in place if targets for overall reduction in crane collisions are not achieved.

g. How well are the models and analyses described, interpreted and summarized?

Analysis of Potential Bird Collisions at Proposed BDCP Powerlines. The results of their analyses are well described and are well summarized in Tables 2-7 of Appendix 5.J.C. Their estimates of the mitigation from marking power lines are also well described and summarized in section 5.0 of Appendix 5.J.C.

References Cited

Allen, C. R., J. J. Fontaine, K. I. Pope, and A. S. Garmestani. 2011. Adaptive management for a turbulent future. *J. Environ. Mgmt.* **92**:1339-1345.

Alpine, A. E., and J. E. Cloern. 1992. Trophic interactions and direct physical effects control phytoplankton biomass and production in an estuary. *Limnol. Oceanogr.* **37**:946–955.

Baxter, R. D., R. Breuer, L. R. Brown, L. Conrad, F. Freyer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, P. Hrodey, A. Mueller-Solger, T. Sommer, and K. Souza. 2010. *Interagency Ecological Program 2010 Pelagic Organism Decline Work Plan and Synthesis of Results: Interagency Ecological Program for the San Francisco Estuary*. Sacramento, CA.

BenDor, T., J. Sholtes, and M. W. Doyle. 2009. Landscape characteristics of a stream and wetland mitigation banking program. Ecol. Appl. 19:2078–2092.

Bennett, W. A., and P. B. Moyle. 1996. Where have all the fishes gone? Interactive factors producing fish declines in the Sacramento–San Joaquin Estuary. Pp. 519–542 in J.T. Hollibaugh (Ed.), **San Francisco Bay: The Ecosystem**. Pac. Div. Am. Assoc. Adv. Sci.

Burgin, S. 2008. BioBanking: An environmental scientist's view of the role of biodiversity banking offsets in conservation. *Biodiv. Conserv.* **17**:807–816.

Cornwell, J. C, P. M. Glibert, and M. S. Owens. 2014. Nutrient fluxes from sediments in the San Francisco Bay Delta. *Est. Coasts*. DOI 10.1007/s12237-013-9755-4.

Drake, J. A. 1991. Community-assembly mechanics and the structure of an experimental species ensemble. *Am. Nat.* **137**:1-26.

Drake, J. A. 1990. Communities as assembled structures: do rules govern pattern? *Trends Ecol. Evol.* **5**:159-164.

Dugdale, R. C., F. P. Wilkerson, V. E. Hogue and A. Marchi. 2007. The role of ammonium and nitrate in spring bloom development in San Francisco Bay. *Est. Coastal Shelf Sci.* **73**:17-29.

Feyer, F., B. Herbold, S. A. Matern and P. B. Moyle. 2003. Dietary shifts in a stressed fish assemblage: Consequences of a bivalve invasion in the San Francisco Estuary. *Environ. Biol. Fish.* **67**: 277-288.

Fontaine, J. J. 2011. Improving our legacy: Incorporation of adaptive management into state wildlife action plans. *J. Environ. Mgmt.* **92**:1403-1408.

Glibert, P. M., D., Fullerton, J. M., Burkholder, J. Cornwell, and T. M. Kana. 2011. Ecological stoichiometry, biogeochemical cycling, invasive species, and aquatic food webs: San Francisco Estuary and comparative systems. *Rev. Fish. Sci.* **19**: 358-417.

Grossman, G. D., T. Essington, B. Johnson, J. Miller, N. E. Monsen and T. N. Pearsons. 2013. Effects of fish predation on salmonids in the Sacramento-San Joaquin Delta and associated ecosystems. 25 September 2013, Submitted to the California Department of Fish and Wildlife, Delta Science Program, and NOAA's National Marine Fisheries Service, 71 pp. (www.dfg.ca.gov/er/predation.asp).

Hobbs, J. A., W. A. Bennett, and J. E. Burton. 2006. Assessing nursery habitat quality for native smelts (Osmeridae) in the low-salinity zone of the San Francisco estuary. *J. Fish Biol.* **69**:907–922.

Hobbs, R. J. and V. A. Cramer. 2008. Restoration ecology: interventionist approaches for restoring and maintaining ecosystem function in the face of rapid environmental change. *Ann. Rev. Environ. Res.* **33**:39-61.

Hobbs, R. J., L. M. Hallett, P. R. Ehrlich, and H. A. Mooney. 2011. Intervention ecology: applying ecological science in the twenty-first century. *BioScience* **61**:442-450.

Kentula, M. E. 1996. Wetland restoration and creation, pp. 87-92. In: J. D. Fretwell, J. S. Williams and P. J. Redman (eds.) **National Water Summary on Wetland Resources**. USGS Water Supply Paper 2425. Reston, Virginia, USA.

Kimmerer, W. J. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? *Mar. Ecol. Prog. Ser.* **243**:39–55.

Kimmerer, W. J. 2008. Losses of Sacramento River Chinook salmon and delta smelt to entrainment in water diversions in the Sacramento-San Joaquin Delta. *San Fran. Est. Watershed Sci.* 6(2).

Kleckner, A. 2009. The role of an invasive clam, *Corbula amurensis,* in the cycling of nitrogen in Suisun Bay, CA. M.S. Thesis, San Francisco State Univ.

Kurobe, T., D. Baxa, C.E. Mioni, R. M.Kudela, T.R. Smythe, S. Waller, A. Chapman, A, S. Teh. 2013. Identification of harmful cyanobacteria in the Sacramento-San Joaquin Delta and Clear Lake, California by DNA barcoding. *SpringerPlus* 2: 1-12. 10.1186/2193-1801-2-491.

Lehman, P. W., K. Marr, G. L. Boyer, S. Acuna, S. J. Teh. 2013. Long-term trends and causal factors associated with *Microcystis* abundance and toxicity in San Francisco Estuary and implications for climate change impacts. *Hydrobiologia* **718**:141-15.

Lindenmayer, D. B., G. E. Likens, C. J. Krebs, and R. J. Hobbs. 2010. Improved probability of detection of ecological ‘‘surprises’’. *Proc. Natl. Acad. Sci. USA* **107**: 21957–21962.

Lockwood, J. L. and S. L. Pimm. 1999. When does restoration succeed? Pp. 363-392. In: E. Weiher and P.A. Keddy (eds.) **Ecological Assembly Rules: Perspectives, Advances and Retreats**. Cambridge Univ. Press, Cambridge, UK.

Lopez, C. B., J. E. Cloern, T. S. Schraga, A. J. Little, L. V. Lucas, J. K. Thompson and J.R. Burau. 2006. Ecological Values of Shallow-Water Habitats: Implications for the Restoration of Disturbed Ecosystems. *Ecosystems* **9**:422-440.

Lucas, L. V. and J. K. Thompson. 2012. Changing restoration rules: Exotic bivalves interact with residence time and depth to control phytoplankton productivity. *Ecosphere* 3 (12). DOI.org/10.1890/ES12-00251.1

Michel, C. J. 2010. River and estuarine survival and migration of yearling Sacramento River Chinook salmon *(Oncorhynchus tshawytscha)* smolts and the influence of environment. Master’s thesis. University of California, Santa Cruz. Santa Cruz, CA.

Moilanen, A., A. J. A. van Teeffelen, Y. Ben-Haim, and S. Ferrier. 2009. How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. *Restor. Ecol.* **17**:470–478.

Monsen, N. E., J. E. Cloern, and J. R. Burau. 2007. Effects of flow diversion on water and habitat quality: Examples from California’s highly manipulated Sacramento-San Joaquin Delta. *San Francisco Est. Watershed Sci.* **5**: Article 2.

Moyle, P. B. 2002. **Inland fishes of California**. University of California Press, Berkeley.

Murphy, D. D., and P. S. Weiland. 2014. Science and structured decision making: fulfilling the promise of adaptive management for imperiled species. *J. Environ. Stud. Sci.* (on-line; DOI 10.1007/s13412-014-0165-0)

Newman, K. B. 2003. Modelling paired release-recovery data in the presence of survival and capture heterogeneity with application to marked juvenile salmon. *Stat. Modelling* **3**:157- 177.

Olden, J. D., C. P. Konrad, T. S. Melis, M. J. Kennard, M. C. Freeman, M. C. Mims, E. N. Bray, K. B. Gido, N. P. Hemphill, D. A. Lytle, L. E. McMullen, M. Pyron, C. T. Robinson, J. C. Schmidt, and J. G. Williams. 2014. Are large-scale flow experiments informing the science and management of freshwater ecosystems? *Front. Ecol. Environ.* doi:10.1890/130076.

Parker, V. T. 1997. The scale of successional models and restoration objectives. *Restor. Ecol.* **5**:301-306.

Perry, R. W. 2010. Survival and migration dynamics of juvenile chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin River delta. Ph.D. dissertation, University of Washington, Seattle, WA.

Perry, R., P. Brandes, J. Burau, A. Klimley, B. MacFarlane, C. Michel, and J. Skalski. 2013. Sensitivity of survival to migration routes used by juvenile Chinook salmon to negotiate the Sacramento-San Joaquin River Delta. *Environ. Biol. Fishes* **96**:381-392.

Rechisky, E. L., D. W. Welch, A. D. Porter, M. C. Jacobs, and A. Ladouceur. 2009. Experimental measurement of hydrosystem-induced delayed mortality in juvenile Snake River spring Chinook salmon (*Oncorhynchus tshawytscha*) using a large-scale acoustic array. *Can. J. Fish. Aquat. Sci.* **66**:1019-1024.

Rechisky, E. L., D. W. Welch, A. D. Porter, M. C. Jacobs-Smith, and P. M. Winchell. 2013. Influence of multiple dam passage on survival of juvenile Chinook salmon in the Columbia River estuary and coastal ocean. *Proc. Natl. Acad. Sci. United States* **110**:6883-6888.

Rechisky, E. L., D. W. Welch, A. D. Porter, M. C. Jacobs-Scott, P. M. Winchell, and J. L. McKern. 2012. Estuarine and early-marine survival of transported and in-river migrant Snake River spring Chinook salmon smolts. *Sci. Rep.* **2**, Article number: 48, doi:10.1038/srep00448.

Roni, P., K. Hanson and T. J. Beechie. 2008. Global review of the physical and biological effectiveness of stream habitat rehabiliataion techniques. *N. Am. J. Fish. Mgmt.* **28**:856-890.

Roni, P., G. R. Pess, T. J. Beechie and S. A. Morley. 2011. Estimating salmon and steelhead response to watershed restoration: How much restoration is enough? *N. Am. J. Fish. Mgmt.* **30**:1469-1484.

Rosenfield, J. A. 2010. Life History Conceptual Model and Sub-Models for Longfin Smelt, San Francisco Estuary Populations: Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). Sacramento, CA.

Simenstad, C. A. and R. M. Thom. 1996. Functional equivalency trajectories of the restored Gog-Le-Hi-Ti estuarine wetland. *Ecol. Appl.* **6**:38-56.

Sommer, T., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Müller-Solger, M. Nobriga, and K. Souza. 2007. The collapse of pelagic fishes in the Upper San Francisco Estuary. *Fisheries* **32**:270–277.

Walters, C. J. 1986. **Adaptive Management of Renewable Resources**. McMillan, New York, NY, USA.

Westgate, M. J., G. E. Likens, and D. B. Lindenmayer. 2013. Adaptive management of biological systems: A review. *Biol. Conserv.* **158**:128-139.

Zedler, J. B., and J. C. Callaway. 1999. Tracking wetland restoration: do mitigation sites follow desired trajectories? *Restor.* Ecol*.* **7**:69-73.

Appendix 11F, Attachment 2
FWS BDCP Progress Report
December 2012/February 2013 Administrative Draft

FWS BDCP Progress Report
December 2012/February 2013 Administrative Draft

This document includes responses to the Progress Reports developed by the U.S. Fish and Wildlife Service (FWS) in response to the February 2013 Administrative Draft of the Bay Delta Conservation Plan (BDCP). A previous review was conducted in April 2012 and comments were submitted as "red flag" comments on the previous draft of the Bay Delta Conservation Plan (BDCP). Section 1 of this document captures the updates to the "red flag" comments submitted by FWS in April 2013 after review of the December 2012/February 2013 Administrative Draft and ICF International's subsequent responses and changes. Section 2 of this document captures additional comments and issues resulting from review of the December 2012/February 2013 Administrative Draft. The responses to each comment are based on the Biological Assessment (BA) that was submitted for ESA consultation, based on the California WaterFix, which ultimately became the proposed action. The purpose of this document is to demonstrate how the California WaterFix has responded and addressed each of the red-flag and progress report comments. Where these comments were focused on elements specific to an HCP/NCCP approach, the response notes that an HCP is not being pursued as part of the California WaterFix, although the BDCP and other HCP/NCCP alternatives are considered feasible alternatives and are fully analyzed for the purposes of CEQA and NEPA in this Final EIR/EIS. Further consideration will be given to these comments and appropriate revisions to the Draft BDCP made if an HCP/NCCP alternative is ultimately approved at the conclusion of the CEQA/NEPA process.

Section 1: Update to "Red Flags" Document

Issue Area 1: Incomplete conceptual foundation for the Effects Analysis

FWS 1.1—The effects analysis deals with the critical concept of uncertainty inconsistently and does not effectively integrate, use, and report uncertainty in the Net Effects.

Original Comment: The BDCP Independent Science Advisors, the National Research Council review panel, the Delta Science Program panel, and we have all commented on the inherent uncertainty in the scientific understanding of certain aspects of the Bay-Delta ecosystem. This extends to difficulty predicting how the ecosystem might respond to BDCP implementation. Uncertainty needs to be used objectively and consistently, and the appendices and Net Effects need to develop and propagate uncertainty through the threads of the effects analysis. Highly important variation in the value and uncertainty of individual conservation measure features will occur over space and time as a function of implementation strategy and other factors. Many of the current conservation measures and issues are, or appear to be, overly simplified or otherwise superficially analyzed. The list includes OMR management, fish-habitat relationships, the habitat-for-flow trade-off, predator suppression, nuisance vegetation suppression, and others. Each of the foregoing issues raises uncertainties that propagate through the threads of analysis and must be reckoned within the "net" conclusions. To the extent we can form our own conclusions about the Net Effects without having access to all the revised documents, it appears that inconsistency in dealing with uncertainty has resulted in conclusions that overly optimistically predict Preliminary Project benefits for almost all of the target fish species almost everywhere. As such, we are reluctant to rely on the conclusions of the present effects analysis. We await receipt of the outstanding appendices, and look forward to working closely with our partners to provide technical assistance as these matters are resolved.

March 2013 Update: The revised documents have improved treatment of uncertainty in some areas, but this comment remains a critical issue. The assessment of restoration effects remains incomplete and optimistic, as we describe as a separate issue. Elsewhere, most of the treatment of uncertainty remains informal and qualitative, including descriptions of alternative hypotheses, sentences stating the degree of uncertainty where professional judgment is relied upon for the Net Effects, etc. The Service thinks the following additional specific changes should be incorporated to better address uncertainty in the EA:

1. We are satisfied with the structure and general approach of the HSI-related analysis, but deployment of the model is restricted in scope and represents only one possible choice of input values. In order to more fully explore the possible range of outcomes, additional input value choices should be (including minimum, median, and maximum values – in addition to those values included until now). In other words, the HSI procedure should be repeated with less (and more) optimistic estimates of restoration/creation performance (similar to the fall X2 analysis in Appendix 5C). Note: the GAM analyses that underlie some of the predicted delta smelt responses to habitat gradients were already "liberal" in that they used presence-absence instead of density (Kimmerer et al. 2009). Therefore, approximations to these curves for the HSI should not extend outside the GAM data because doing so generates a modeled species response that is inconsistent with the actual trawl data.

2. The HSI-based analysis does not appropriately allow for habitat restoration to have net negative effect on covered fish species, which is a possible outcome. The HSI-based approach rates outcomes on a scale from 0 to 1. In the context of the "net effects," this means that no project or CM will ever be detrimental; the worst case is no effect. Given uncertainties about the paths and outcomes of restoration and habitat creation, the analysis should acknowledge that some projects might be detrimental to the overall outcome (see comments, below, regarding unintentional deep-water habitat creation like Franks Tract and Mildred Island). Additionally, where variability could be introduced into the HSI analysis we sometimes find the estimates to be biased upward in favor of habitat restoration success in the future (for example, the HSI-estimated egg-larvae life stage suitability curve using the GAM-based method is up to 50% more optimistic than the sample-based data would suggest it should be – see Figure E.4-4).

3. Use of a more sophisticated splittail Habitat Suitability Index; the current one only uses depth as a determinant of splittail habitat suitability. We do not find the argument compelling. Splittail migrate to different habitats to complete different parts of their life cycle, so there must be additional factors that define habitat suitability for fish of different ages. There is information on splittail temperature limits, salinity distributions, seasonal timing of occupancy of particular regions, etc. in the literature.

4. The Net Effects summary graphs should include "uncertainty bars" that are larger when uncertainty is higher and smaller when uncertainty is lower so that both expected

magnitude and confidence in the conclusion are simultaneously conveyed. The Delta Science Program independent panel's 2012 report suggested some ways to approach this.

We have also provided extensive track change edits and bubble comments in both Chapters 3 and 5 that we think will improve the document further and provide a basis for discussions to resolve these issues. Adoption of these recommendations will help the EA better respond to Recommendation 13 of the June 2012 DSP Review Panel.

ICF Response to FWS 1.1: The proposed project is not an HCP and does not include largescale restoration. Additionally, only species listed as threatened or endangered were evaluated in the BA. As such, no HSI analysis was used and splittail are not evaluated in the BA. The effects analysis does attempt to describe uncertainties in the data, tools, and interpretation of that information throughout the analysis as appropriate. Additionally, edits were made in the July BA to incorporate feedback from Phase 1 of the Independent Science Panel Review for the California WaterFix, including those related to describing uncertainty.

FWS 1.2—A key missing piece from the Analytical Framework document is how the Effects Analysis will be framed in the context of fish population dynamics.

Original Comment: We expected this to occur in the draft Technical Appendix on the subject of fish populations, but that document did not fully analyze long-term and recent population trends in the target fishes. There is clear evidence that most of the covered fish species have been trending downward. The document should clearly and accurately lay out what is known of the foundations of each species' population dynamics (e.g., density-dependent under some circumstances?, trends in carrying capacity?, etc.) as mechanistically as possible and discuss how BDCP actions will influence these processes. Because the conceptual foundations presented to date do not frame the effects in the context of historical and present-day fish population dynamics and the most parsimonious explanations of their causes, it is unclear how the net effects should be interpreted. We await receipt of the life cycle modeling appendix to complete our review of this issue, and look forward to continuing to work with our partners to help ensure that the best available science is used in the effects analysis.

March 2013 Update: Chapter 5 has made some improvements in its depiction and use of fish population dynamics, but this remains a critical issue. One example is the use of the longfin smelt model provided to ICF by USFWS last fall. The track changes edit of the Fish Life Cycle Models Appendix 5G pdf provided by ICF seems to have entirely edited out the descriptions of the Maunder and Deriso (2011) and Miller et al. (2012) statistical life cycle models. We want to clarify that we did not ask for such a change to be made and do not think it is necessary or appropriate to strike descriptions of these analyses from the supporting materials for Chapter 5.

We will use this opportunity to clarify that the IEP monitoring program has decades of relative abundance data for covered fish species – some examples of which are summarized in Table 2A.1-1. These data sets are the bases for the Maunder and Deriso and Miller et al. analyses, as well as all other population assessments that have preceded them. The Service thinks the following additional specific changes should be incorporated, preferably into Appendix 5G, and then used to provide an objective foundation for the Net Effects:

1. 20 mm, Summer Townet Survey, Fall Midwater Trawl, Spring Kodiak Trawl, and Suisun Marsh abundance indices for delta smelt
2. Normalized salvage density time series for delta smelt
3. Scatterplots showing the relationships among these indices
4. Description of what is implied by these relationships and objective summaries of the factors that the following authors have explored to explain them (Stevens and Miller 1983; Jassby et al. 1995; Kimmerer 2002; Bennett 2005; Kimmerer et al. 2009; Mac Nally et al. 2010; Thomson et al. 2010; Maunder and Deriso 2011; Miller et al. 2012)
5. 20mm, Fall Midwater Trawl, Bay Study Midwater Trawl, Bay Study Otter Trawl, Spring Kodiak Trawl, and Suisun Marsh abundance indices for longfin smelt
6. Normalized salvage density time series for longfin smelt
7. Scatterplots showing the relationships among these indices
8. Description of what is implied by these relationships and objective summaries of the factors that the following authors have explored to explain them (Stevens and Miller 1983; Jassby et al. 1995; Kimmerer 2002; Rosenfield and Baxter 2007; Kimmerer et al. 2009; Mac Nally et al. 2010; Thomson et al. 2010)
9. Fall Midwater Trawl, Suisun Marsh, Chipps Island, and USFWS Beach Seine abundance indices for splittail
10. Salvage density time series for age-0 and age-1 and older splittail – *these should not be normalized as they are an abundance index of themselves*
11. Scatterplots showing the relationships among these indices
12. Description of what is implied by these relationships and objective summaries of the factors that the following authors have explored to explain them (Meng and Moyle 1995; Sommer et al. 1997; Kimmerer 2002; Moyle et al. 2004; Feyrer et al. 2006; Kimmerer et al. 2009).

These fixes will broadly help to address the 2012 independent panel review recommendations, including 1, 3, 5, 10, 13, and 15. These fixes would also provide the Service with the basic status and population dynamic trends for the covered species which we need to include in permit documents.

ICF Response to FWS 1.2: The July 2016 BA included methods and analyses agreed upon for use in this Section 7 consultation during a number of technical team meetings including DWR, Reclamation, the consulting team, and the permitting fish agencies (FWS and DFW). With respect to the first part of the comment, in July 2013 ICF explained to FWS the reasons for removing the more detailed Maunder and Deriso (2011) and Miller et al. (2012) statistical life cycle model descriptions, i.e., lack of information to develop key model inputs for factors such as delta smelt prey abundance. FWS concurred with this rationale. A basic description of these and other models was retained in the public draft BDCP. With respect to the second portion of the comment, these analyses were conducted with a view to inclusion in the Final BDCP. However, with the change to a Section 7 consultation framework, work on the final BDCP was stopped, and the need for inclusion of the analyses became moot for species not covered under Section 7 (longfin smelt and Sacramento splittail). In addition, for delta smelt, FWS directed that it was not necessary to include a species account for delta smelt, so the

information was not included in the Section 7 consultation's submitted BA in August 2016. Given the development of similar information by FWS staff in other venues (e.g., see Figure 2 of Nobriga, M. L., E. Loboschefsky, and F. Feyrer. 2013. Common Predator, Rare Prey: Exploring Juvenile Striped Bass Predation on Delta Smelt in California's San Francisco Estuary. Transactions of the American Fisheries Society: 1563-1575.), it is expected that FWS possess the necessary information for inclusion in their CWF Biological Opinion if they deem it to be appropriate.

Issue Area 2: Inadequate conceptual models and analysis of estuarine fish habitat, and consequent project issues

FWS 2.1—The objectives for restoring habitat addressed in the Chapter 5's Restoration Appendix are simply described, but it is not clear whether the plan will or can achieve them.

Original Comment: The draft Appendix E states that BDCP's habitat restoration has two objectives1[1]. The first is to "increase the amount of available habitat for covered fish species." This first objective is reasonable, but does not clearly articulate that new habitat needs to be good quality habitat. We know quite a bit about what determines habitat value to covered fish species. This knowledge is partly reflected in the habitat suitability indices that are currently under development, but is often discounted elsewhere in the Chapter 5 documents. The habitat for BDCP target fishes, and all estuarine fishes for that matter, is fundamentally created by the interaction of tidal and river channel flows with the broader estuary landscape. The Preliminary Project proposes to extract larger volumes of fresh water from the Delta than are currently exported against a backdrop of rising sea level and a re-design of the estuary landscape that will change tidal flows. Whether this can be accomplished while other parts of the plan simultaneously contribute to recovery of covered species is an unanswered question of central importance. Fully incorporating existing science on the interplay of freshwater flow and the Plan Area landscape and its constituent species would provide more accurate and defensible conceptual models for the Effects Analysis. We also suggest consulting the Department of Interior Adaptive Management Technical Guide and other adaptive management resources on the role of (potentially conflicting or alternative) conceptual models in the adaptive management process. We look forward to working with our partners and providing technical assistance toward the resolution of this issue.

The second objective is "to enhance the ecological function of the Delta." This formulation is not clear. The Delta provides multiple ecological services, and alterations to different parts of the Delta may potentially contribute to them in different ways. There have been several large-scale, unintentional or quasi-intentional "wetland restoration projects" in the Bay-Delta since 1920. These include Franks Tract in the 1930s, Mildred Island in the early 1980s, Liberty Island in the latter 1990s, and Napa River marsh in the past decade to name a few. There is also the seasonal fish habitat generated by large-scale floodplain restoration along the lower Cosumnes River that started in the mid-1990s. The draft appendix never mentions these events or synthesizes what is known about them. This is a critical aspect of the analysis, and needs to be done credibly. We believe these "unintended experiments" provide useful lessons in what we may expect from actions on similar spatial scales in similar circumstances in various restoration scenarios.

A close look at the estimated elevations of restored habitats shows that much of the acreage is not at intertidal elevation and thus will not readily produce the dendritic channel mosaics on a tidal marsh plain that are frequently espoused in the appendix for their fish production benefits. Particularly by the late long-term, there is a lot of the subtidal habitat types in the model outputs[22]. We do not know if unintentional habitat restorations that have occurred have increased the productivity of the Delta beyond what it would have been without them. In a pure carbon-productivity sense they might have – because productivity is just creation of biological carbon per unit of time. However, these and other "wetland restorations" have not noticeably increased the capacity of the Delta to produce larger populations of BDCP-covered native fishes. As achieving this is a key premise of the BDCP, understanding these examples and learning from what has happened in each case is a matter of great importance. We look forward to providing assistance to our partners as these comments are addressed.

<u>March 2013 Update:</u> The BDCP has benefited from the addition of a version of operations (the "high outflow scenario") that includes improved Delta outflow during the spring and fall months to benefit delta smelt, longfin smelt, green sturgeon, and other species. The Service worked with DWR on this version of operations and believe it would provide better conservation outcomes for covered fish species than the other three versions presented in the project description. With regard to off-channel habitat restoration, the revised Chapter 5.5 has improved regarding its acknowledgement about the uncertainty in landscape restoration; however, critical issues in the original critique that are central to the success of the BDCP remain inadequately addressed.

Scientific literature cited in the plan, new analyses provided by DWR, and conclusions of the independent scientific review panel have reinforced our concern that the BDCP restoration plan has not been carefully thought out and has uncertain prospects for benefiting native aquatic estuarine species, particularly delta smelt and longfin smelt.

Given the occurrence and apparently favorable growth rates of delta smelt occupying the Cache Slough complex, the Service expects benefits from the creation of new open intertidal and tidally flushed habitat in that region. However, we are concerned about the effects of marsh creation in other areas, and about the net effect of the restoration proposal as a whole, given its large spatial scale.

1. It is unclear how much food production will be available for export from new tidal marsh areas, because the percentage capture of that production into benthos by exotic bivalves that are likely to infest newly restored areas is hard to predict and might be high (Lucas and Thompson 2012). Since we expect that the benefit of these new marsh areas to the smelts would arise from export of plankton into river channels, benefits of new habitat might not scale up in proportion to the geographical area of new marshes if those marshes evolve in a way that is particularly adverse to plankton production and export processes.

2. New modeling presented to a BDCP audience on March 5th, 2013 by John De George of RMA, and informal comments by USGS staff to us, suggest that tidal energy will be strongly limiting in BDCP tidal marsh restoration, with the available tidal prism spread over a much larger area by the late long-term if the proposed acreages are fully implemented. The attenuation of tidal exchange in individual restoration areas might tend to reduce the export of plankton and reduce turbidity; both of these effects would increase with the total area of

newly created marsh, and might tend to reduce the value of early restoration areas as new ones are added elsewhere.

3. The effects analysis acknowledges that a portion of the Sacramento River sediment supply will be diverted at the North Delta intakes, and that that diversion might be detrimental to native fishes, estimating the average effect to be minus 8-9% of sediment. It is hard to draw definitive conclusions about the ultimate effect of this change, but an average loss of 8-9% of the sediment supply that would ordinarily pass into the Delta and Suisun Bay likely implies higher average water clarity throughout the year. Besides potentially negative effects on delta smelt and longfin smelt and their habitat, which benefit from turbid water, clearer water would encourage growth of exotic aquatic plants and related effects in many areas of the North and West Delta.

4. The independent science panel review recommended caution and thorough planning with respect to restoration activities (recommendation #6). It said, in part:

   Considerable uncertainty exists, however, about the likelihood of one of the co-equal goals, i.e., the conservation of the Bay-Delta system. Among the principal issues are the sequencing and scale of the implementation of the planned conservation measures. The Plan recommends a large number of conservation measures, but provides no explanation as to how and when they would be implemented, what the particular sequence would be and the intervals between implementation of conservation measures. The Plan also proposes to increase restored tidal and other habitats at a large scale. In terms of general approaches, large-scale efforts at protection and restoration are theoretically positive but on-the-ground implementation can be difficult and is fraught with uncertainty. (Panel report, pp. 18-19)

   The panel proposed specific fixes in several areas (page 19). The new draft effects analysis addresses some of these fixes, but in our view further follow-up is needed on these issues to clarify what the BDCP intends to do to fill the gaps identified by the panel. The plan's ultimate conclusions regarding the outcome of creating such large new areas of tidal marsh remain more positive and certain than the literature and scientific authorities suggest they should be.

5. We were disappointed not to see the in-depth evaluation of unintentional wetland "restoration experiments" that we requested last spring. We continue to advise our partners that this is a necessary analysis. Key references for Bay-Delta shallow water habitat issues and fish food include: Turner and Kelley 1966; Meng et al. 1994; Aasen 1999; Meng and Matern 2001; Matern et al. 2002; Lucas et al. 2002; Reed 2002; Sommer et al. 2002; Mueller-Solger et al. 2002; Brown 2003; Feyrer and Healey 2003; Feyrer et al. 2003; [Crain et al. 2004; Feyrer 2004; Grimaldo et al. 2004 *in* Feyrer et al. 2004]; Sommer et al. 2004; Dean et al. 2005; Feyrer et al. 2005; Nobriga et al. 2005; Wright and Schoellhamer 2005; Brown and May 2006; Grosholz and Gallo 2006; Hobbs et al. 2006; Lopez et al. 2006; Brown and Michniuk 2007; Feyrer et al. 2007 [2 splittail papers in TAFS]; Cloern 2007; Cohen and Bollens 2008; Hestir et al. 2008; Lehman et al. 2008; [RL] Miller et al. 2008; Moyle 2008; McLain and Castillo 2009; Lehman et al. 2010 [Liberty Island]; Moyle et al. 2010; Howe and Simenstad 2011; Santos et al. 2011; Gewant and Bollens 2012;

Grimaldo et al. 2012; Lucas and Thompson 2012; Greenfield et al. 2013. There is also a substantial relevant literature from other systems.

Many of these papers are cited in the draft BDCP documentation, but the analysis is not incisive. We certainly agree that there is considerable uncertainty regarding wetland restoration performance in the estuary (see above); however, as this extensive list of publications implies, there is already a lot that has been learned that can help distinguish potentially "good" restoration approaches from very likely "bad" ones, particularly in terms of the consequences to native fishes. The additional insight would help calibrate the BDCP net effects, or at least provide an additional, objective window into the realism of its conclusions. These authors also provide key analyses of wetland function and species occupancy that can inform relatively detailed conceptual models. We can provide ICF with copies of these papers if necessary.

The Service also recommends the following specific changes:

i. The documents accurately characterize delta smelt spawning habitat in descriptions of the species biology, but the Chapter 3 conservation measures and the Chapter 5 Habitat Suitability Indices and Net Effects make unsupportable or ambiguous linkages between habitat restoration and likely spawning habitat. Fix: Incorporate red line strikeout edits and either (1) show through modeling what subset of "tidal habitat restoration" will have sandy beaches with a turbid, active overlying water column, or (2) avoid the speculation that habitat restoration will create spawning habitat and the speculation that spawning habitat is limiting delta smelt recruitment.

ii. The documents accurately characterize longfin smelt spawning habitat in descriptions of the species biology, but the Chapter 3 conservation measures and the Chapter 5.5 Net Effects make unsupportable or ambiguous linkages between habitat restoration and likely spawning habitat. Fix: Incorporate red line strikeout edits and either (1) show through modeling what subset of "tidal habitat restoration" will have sandy beaches with a turbid, active overlying water column, or (2) avoid the speculation that habitat restoration will create spawning habitat and the speculation that spawning habitat is limiting recruitment. The stressor reduction target for longfin smelt spawning habitat proposes as a target, a condition that already occurs currently. "Increase overlap of suitable spawning substrate, flow, salinity, and water temperature in the lower Sacramento and lower San Joaquin Rivers such that spawning, as indicated by the presence of early larval longfin smelt in DFG larval smelt surveys, occurs in at least three of the following locations in all years: Lower Sacramento, Cache Slough ROA, Lower San Joaquin, Suisun Bay, and Suisun Marsh ROA. Increasing the extent of suitable spawning habitat for longfin smelt will contribute to an increase in spawning success, thereby contributing to an increase in juvenile and, over-time, adult longfin smelt abundance." Thus, as written this target is already achieved. Fix: first, acknowledge that spring Delta outflow is a well-established driver of longfin smelt abundance, and formulate a stressor reduction target that provides spring Delta outflow in accordance with the Service's standing recommendation. Second, provide a plausible prediction of marginal longfin smelt benefits that will be realized by enhancing extent of spawning habitat or delete the corresponding stressor reduction target.

iii. It is possible that increases in QWEST associated with CM1 and SAV removal associated with CM13 might (jointly) lead to higher spawning success of both smelt species in the mainstem of the San Joaquin River where some spawning is thought to occur presently; we have suggested revisions that can articulate this potential benefit and should be considered when the adaptive management plan for these actions is developed.

iv. The current state of science regarding splittail spawning habitats is misapplied; splittail are not known to spawn in tidal environments. Fix: Do not claim that any BDCP action other than CM2 will provide spawning habitat for splittail.

v. Chapter 3.3 issue: CM18 (Conservation hatchery) is linked to wild population goals and objectives for delta and longfin smelts. This is inappropriate and contrary to the Service's present policy for these species. Fix: CM18 will need new objectives designed specifically for it.

As we have tried to make clear in this update, the uncertainties associated with restoration are of such importance that the success of the BDCP as a Delta conservation effort may hinge on the realism of plan expectations and effectiveness of the BDCP adaptive management program. Moreover, these uncertainties must be viewed as uncertainties for water operations, which are also a driver of covered aquatic species abundances. The effects analysis should more clearly acknowledge these uncertainties to motivate the intensive further study that will be required. The State should not assume the habitat restoration components of the plan will succeed in full, because they may not. We endorse NMFS's recommendation that alternative plausible levels of success for habitat restoration be evaluated in the effects analysis. The BDCP will have to jointly adaptively manage both restoration and water operations to have the best chance of favorable conservation outcomes for covered species and their habitats.

The Service is providing numerous track change edits and bubble comments that we think will improve the document further. If any track-changes comment appears to conflict with the written comments above, the written comments take precedence.

Addressing the Service's concerns described above should also improve the BDCP's responsiveness to Recommendations 1, 2, 5, 6, 8, and 16 in the June 2012 DSP Review Panel report.

We look forward to working with DWR and our other partners to resolve these issues.

ICF Response to FWS 2.1: The proposed action is no longer an HCP and does not include largescale restoration. Some tidal restoration is proposed to compensate for effects as described in Section 3.4 of the BA. The restoration would require project-specific consultation and performance measures. As part of the restoration included in the BA, specific functions and habitat characteristics are described. For example, spawning habitat impacts and associated proposed mitigation is explicitly described. The proposed action also includes a spring outflow criteria such that there would be no changes in March through May outflow with the project in place. Effects on longfin smelt are evaluated in the 2081(b) incidental take application, and DFW will incorporate any further Independent Science Panel review

comments into the final permit. The proposed action does not include CM 18 or other hatchery actions and because splittail are not listed, they are not included in the BA. No final BDCP was prepared, and therefore there were no revisions to a stressor reduction target. However, the BA does address more recent Independent Science Panel review recommendations to better articulate the uncertainty.

FWS 2.2—The modeling shows a gain of shallow, intertidal habitats in the Plan Area by the early long-term, which is a goal of the BDCP. However, it also shows that there is a net loss of intertidal habitat and a large increase in deep water habitat by the late long-term.

Original Comment: The Bay-Delta is not currently limited in terms of deep water habitats, and some relevant historical experience suggests deeper off-channel habitats are likely to be more favorable habitat to exotic species than to natives, so an increase in the depth of restored habitats does not appear to be a desirable outcome. Thus the benefits attributed to creating the proposed habitat acreages may be quite optimistic. We look forward to providing technical assistance on this issue; a good start would be a more in-depth investigation of the expected depth distribution in potentially restored areas in the early and late long-term time periods.

March 2013 Update: This is a resolved issue.

FWS 2.3—The effects analysis underemphasizes Bay-Delta water flows as a system-wide driver of ecosystem services to the San Francisco Estuary.

Original Comment: While climate and associated hydrology affect the magnitude of watershed runoff, system hydrodynamics downstream of the big dams (e.g., exports, OMR flows, X2, gate operations, etc.) are largely driven by coordinated water operations. All of these influence the habitats and population dynamics of listed species. It is critical that the BDCP effects analysis identify changes in operations that will importantly alter hydrodynamics, and address in depth the dependency of the ecosystem and its constituent species on flows. Reduction of flows (in full consideration of timing, magnitude, variability) is the most fundamental cause of stress and driver of change to the fishes and food web that have adapted to the tidal and freshwater mixing environment that is the Bay-Delta ecosystem. In addition, some of the other stressors listed and assumed to be addressed through the conservation measures are either directly or indirectly influenced by Delta inflows, exports, and outflows. Until the roles of flows and flow alteration, for which there is substantial literature, are adequately represented in conceptual models and developed in the effects analysis, we are reluctant to rely on its conclusions. We look forward to providing technical assistance on this issue as it is resolved.

March 2013 Update: The EA has improved discussions of the effects of flow on covered fishes, their habitat and their survival. It also has a set of longfin smelt spring outflow population simulations and delta smelt fall outflow habitat simulations per our previous recommendations. However, issues resulting from disagreements about the importance of water flows for fish species remain in the draft, including the subjective quality of some of the net effects conclusions, the framing of the effects analysis itself, and some of the biological objectives and stressor reduction targets. As the Service will have to determine which version or versions of water project operations meet statutory criteria for permit issuance, satisfactory resolution of this critical issue for the permit application will require framing the effects analysis appropriately. It will need to clearly articulate that each of the four versions of operations in the current project description has associated with it a distinct effects analysis based on specific assumptions about the importance of water flows through the Delta to covered species that depend on flow. These analyses have substantially different implications for the likelihood that the four operations alternatives will achieve plan biological objectives. These analyses should be presented separately, including analysis-specific net effects presentations, to show how each set of assumptions about the importance of flow leads to different conclusions about the likelihood that each of the four operations alternatives can succeed in achieving the plan's biological objectives. Until the Service can distinguish the effects analysis underlying the "high outflow scenario," which is based on technical advice we provided DWR, this comment will remain a critical issue. The Services discussed this issue with DWR and their consultant, ICF, in early August 2012, and provided them a short white paper on about August 6th, 2012 describing how the the effects analysis should be framed.

The Service also recommends the following changes:

1. Do not confound Delta outflow's influence on delta smelt or longfin smelt recruitment with "transport flows," which is a speculative and unlikely mechanism given the very massive tidal flow connection between Suisun Bay and the western Delta. Delete the analysis of "transport flows" or change it to an analysis of low-salinity zone habitat suitability consistent with Bennett et al. (2002), Hobbs et al. (2006), Hobbs et al. (2010), and Kimmerer et al. (2009).

2. The critical habitat analysis in Appendix 5-I needs to acknowledge the potential negative effect on critical habitat of lower Delta outflow during the summer months per the DOI issue paper dated October 2010.

The Service has provided additional track change edits and bubble comments that we think will improve the document further. If any track-changes comment appears to conflict with the written comments above, the written comments take precedence.

ICF Response to FWS 2.3: The proposed project does not include a decision tree. Instead, it includes operational criteria, including real-time operations, to address each of the listed species' needs relative to the proposed project based on the best available information available. These criteria incorporate Fall X2 and a new spring criteria that ensures there would be no changes in March through May outflow with the project in place. Additionally, the adaptive management program can be used to make adjustments as appropriate as new information is developed.

Transport flow analyses were not included in the BA, and methods used for analysis of Delta Smelt were developed in coordination with FWS and DFW. The BA includes an evaluation of all PCEs for designated Delta Smelt critical habitat. No Final BDCP was prepared.

FWS 2.4—The Low Salinity Zone (LSZ) is a dynamic habitat defined by the tides and freshwater flow that requires a globally tailored conservation strategy.

Original Comment: It is widely recognized that estuarine habitat suitability is driven by the interaction of a flow regime with a brackish, tidally influenced landscape. Changing this interaction by reducing outflow can set a series of ecosystem changes in motion that degrade expected ecological services. In the Bay-Delta, both the flow regime and the landscape are highly altered, and the Preliminary Project proposes new changes. It is well established that variation in Delta outflow or X2 is correlated with many important ecosystem processes and the abundance or survival of estuarine biota. It is also well established that the most important mechanisms and seasons for species that use the LSZ vary. Chapter 5 does not directly grapple with the conservation implications of these and other relevant facts, arguing that the mechanisms causing flow effects on certain fish species are not "well-understood". But the phenomena of species-flow responses are well-developed in the scientific literature. Unless there are concerns about the adequacy of the underlying data, which there may be, flow relationships developed in the scientific literature should be used as the initial basis to predict the effects of changes in flow regime. The effects of flow regime on species and ecosystem processes in the LSZ have been an important subject of study for a long while, and, in addition to their role in the water operations consultations form part of the basis for regulatory processes underway or contemplated by the State Board and EPA. We look forward to working with our partners on resolving the framing of the LSZ habitat analysis.

<u>March 2013 Update:</u> Status linked to related preceding item: partly addressed, with some issues outstanding. Two follow-up issues under this heading have arisen because the current review includes the whole BDCP and not just water operations and the effects analysis.

1. The absence of the longfin smelt population growth objective that we have been discussing with our State partners for several months is a critical issue. The Service worked with the California Department of Fish and Wildlife on this objective in the fall of 2012 as a way to require measurable progress toward recovery while allowing the permittee(s) flexibility in how the objective is achieved. In the absence of the objective, it is not clear that the BDCP will need to show progress toward longfin smelt recovery on any timetable. Our understanding is that CDFW has been asked to review the objective now, and its absence from the plan is temporary. We look forward to working with CDFW and DWR on resolution of this issue.

2. The lack of a "stressor reduction target" for flow for longfin smelt is a critical issue. More than forty years of science has clearly established that Delta outflow is a primary driver of longfin smelt abundance (e.g. Thomson et al. 2010). The Service believes that both tidal marsh habitat improvements and adequate Delta outflow are needed for the plan to achieve a contribution to recovery for this species. The BDCP should include flow as a "stressor" to recognize that conservation of this species involves managing water operations to assure adequate Delta outflow.

ICF Response to FWS 2.4: As the ESA compliance approach is Section 7, there are no longer BGOs or stressor reduction targets. However, the adaptive management program can be used to make adjustments as appropriate as new information is developed.

FWS 2.5—The Low Salinity Zone (LSZ) is the primary habitat for delta smelt and primary rearing habitat for larval longfin smelt and juvenile to adult splittail.

Our update on this issue is divided into two parts, each associated with part of the original comment.

2.5.a. Original Comment: The Preliminary Proposal modeling indicates that Delta outflows during February- June will more frequently be near the minima required by the SWRCB under D- 1641. This will represent a substantial negative project effect on longfin smelt. The effects analysis and Net Effects only partly address this issue, reporting that Preliminary Project is expected to provide a large, positive impact to food resources that will offset the negative impact to "transport flows". But there are multiple mechanisms by which Delta outflow can affect longfin smelt recruitment; transport flow is only one of them. Transport flows might be managed via gates or other engineering solutions. The other mechanisms for which there is stronger scientific support are kinetic energy mechanisms (low-salinity zone habitat area and retention from gravitational circulation in the estuary). The problems that reduced outflow creates by changing these processes do not have reasonable engineering solutions, and at present appear to be manageable only via outflow. Thus, although some of the potential impact of outflow reductions is reported, the analysis is too narrowly focused.

Both projected sea level rise and the Preliminary Proposal are also anticipated to cause the average location of X2 to move upstream during the summer and fall. The modeling indicates that intra-annual variability would be lost for several months in the late summer and fall in all water year types; even wet years would functionally become dry years for a third of delta smelt's life cycle. The effects analysis acknowledges this result, but the Net Effects concludes that habitat restoration and food web enhancement will greatly offset this loss of habitat value. The conclusion is in part speculation and in part does not reflect current scientific understanding. This has several implications for delta smelt. First, under the preliminary project delta smelt habitat would less frequently lie in Suisun Bay and Marsh during summer and fall. The habitat suitability modeling shows that this would limit the capacity of tidal marsh restoration in the Suisun region to contribute to delta smelt production. Second, lower summer outflows would increase the length of time that seasonal delta smelt habitat constriction occurs and overlaps with physiologically stressful water temperatures. This means that more food production would be required to maintain current delta smelt growth and survival rates, even in areas where temperatures remain suitable. In areas where temperatures exceed physiologically suitable levels during the summer ($\sim 24^0$ C), no amount of food production will increase growth or survival rates. Third, the restricted distribution of delta smelt during most summers and essentially all falls would increase the chance that a localized catastrophic event could pose a serious threat to the survival of the delta smelt population.

March 2013 Update: The project description has been updated since the last review to include the "high outflow scenario" that was developed with the Service's advice. This version of operations addresses concerns we have expressed about the adequacy of Delta outflow to support delta smelt and longfin smelt. We continue to have important concerns about the restoration prospects for smelts and representation of the issue in the effects analysis in the eastern and southern regions of the Plan Area. Because delta and longfin smelts are generally pelagic fish, they are not expected to extensively rear in many restored tidal habitats except under very specific circumstances where there is somewhat deep (> 1, but < 4 meters), cool, and very turbid open water (examples: Liberty Island, Suisun Bay, Sherman Lake). These conditions cannot be created everywhere. Current scientific understanding suggests that some regions of the Plan Area are unlikely to be good places for delta and longfin smelt – especially if the only practical option is to flood subsided Delta islands; existing examples include the interiors of Franks Tract and Mildred Island.

Looking at the proposal as a whole, estimates of tidal marsh restoration acreages may be overstated simply because the physical characteristics of the Estuary cannot support the objective. As discussed in comment 2.1, upstream areas in the Estuary (east of the major constriction at Carquinez Strait and other locations) may not receive sufficient tidal energy to be tidal habitat; this outcome would greatly reduce the expectation of benefit to the smelts if our belief that benefits arise primarily where tidal fluxes mix fish prey items into open-water river channel areas is well-founded (see Lehman et al. 2010). We are concerned that actual acreages that are restored – indeed, that *can* be restored, if there is to be an expectation of marginal benefits to native aquatic species accruing at each step – will be only a small fraction of what the BDCP proposes. This is not necessarily a fatal problem: given the uncertainties of restoration, it may prove most beneficial to attempt restoration on a smaller (but still large) scale. The remedy for this issue in the present draft is to more accurately characterize these effects and the challenges they pose, to lay a foundation for the intensive study and adaptive management that will be required during implementation.

The Service also suggests the following additional specific changes should be incorporated to better address Recommendations 2, 3, 4, 6, 13, and 15 of the June 2012 DSP Review Panel report :

1. Sensitivity analysis of the Habitat Suitability Indices including the variance that arises using alternative input assumptions as described in our detailed comments above.
2. Use of a more sophisticated splittail Habitat Suitability Index; the current one only uses depth as a determinant of splittail habitat suitability. We do not find that to be a compelling argument. Splittail migrate to different habitats to complete different parts of their life cycle, so there must be additional factors that define habitat suitability for fish of different ages. There is information on splittail temperature limits, salinity distributions, seasonal timing of occupancy of particular regions, etc. in the literature.
3. The Net Effects summary graphs should include "uncertainty bars" that are larger when uncertainty is higher and smaller when uncertainty is lower so that both expected magnitude and confidence in the conclusion are simultaneously conveyed. The 2012 independent science panel report has some useful advice on this.

As a supplemental response on this item, the Service has provided additional track change edits and bubble comments that we think will improve the document further.

ICF Response to FWS 2.5.a: The proposed action is no longer an HCP and does not include largescale restoration. Some tidal restoration is proposed to compensate for effects as described in Section 3.4 of the BA. As described in that section, restoration sites will be selected and designed in coordination with NMFS, FWS, and DFW, and will include performance measures to ensure they achieve the expected outcomes. Separate environmental review, including ESA compliance will be needed for each restoration site. No HSI was used in the BA. Splittail are not listed, and as such, they are not included in the BA. The BA does address more recent Independent Science Panel review recommendations to better articulate the uncertainty.

<u>2.5.b. Original Comment:</u> Turbidity is another important component of delta smelt habitat suitability. Section C.4.1.4 ("Turbidity") states: "[f]irm conclusions regarding changes in turbidity in the BDCP Plan Area are difficult to make." But some large-scale changes in sediment fluxes might affect turbidity on scales important to smelt, and should be straightforward to analyze. The

Sacramento River is the most important contributor of sediment to the Bay-Delta. According to the Effects Analysis it contributes an estimated 80% of its load during high flow events. The North Delta diversions in the Preliminary Project have the ability to take up to 15,000 cfs during high flow events. For a 70,000 cfs event, this could be 20% of the Sacramento River water including its suspended sediment load. The effects analysis makes no attempt to analyze how much sediment loss per year that would represent and whether it would change the ratio of supply to loss of sediment from the estuary. The same calculations should be done for the south Delta to give the results full context. In summary, the current Effects Analysis does not appropriately deal with critical issues involving the role of the Low Salinity Zone as habitat for longfin smelt, delta smelt, and splittail. Until it addresses the right questions regarding flow, LSZ location, and turbidity, we are reluctant to rely on its conclusions. We look forward to working with our partners as these issues are resolved.

March 2013 Update: The proposed conveyance capacity has been reduced to 9,000 cfs and the revised EA has a greatly improved scientific discussion of turbidity, including the requested estimate of sediment that would be removed by diverting water directly from the Sacramento River. These changes are helpful responses to our prior concern, which was echoed in Recommendation 12 of the independent science panel's June 2012 report.

This remains an important issue, because we are concerned that an average loss of 8-9% of sediment will have greater negative effects on delta smelt and longfin smelt and their habitats downstream of the diversions than are acknowledged in the effects analysis and net effects, and will likely encourage the growth of exotic aquatic plants in the lower Sacramento River and in off-channel tidal marsh areas. This issue is also discussed in comment 2.1 above.

As a supplemental response, the Service has provided additional track change edits and bubble comments that we think will improve the document further, particularly in Chapter 5.5 where we think that based on the collective discussion and analysis in the EA, the likelihood of generally lower turbidity in the Sacramento River and North Delta in the future is stronger than the draft document suggests.

> **ICF Response to 2.5.b.: No final BDCP has been prepared. However, the effects of changes in water clarity as a result of operations have been described in the BA, and include revisions provided by USFWS staff during review of administrative drafts of the BA.**

FWS 2.6—There is no reason to expect that invasive vegetation will not proliferate in the East and South Delta ROAs, and no reason to expect a meaningful increase in south Delta turbidity if vegetation could be successfully controlled.

Original Comment: There should not be an a priori assumption that SAV can be controlled via ecologically sound methods in the east, central and south Delta. These are comparatively low turbidity, high vegetation areas already, under the existing hydrodynamic regime. There is nothing in the Preliminary Proposal that would dramatically change channel geometry, increase SJR flows, or increase sediment inputs that could be expected to change the turbidity of the entire southern half of the Delta.

March 2013 Update: Chapters 3 and 5 have greatly improved scientific discussions of invasive vegetation. These changes are helpful responses to our prior concern about the effects analysis, which was echoed in the independent science panel's recommendations 6, 8, and 16 from the June 2012 report.

We suggest avoiding claims that particular projects or ROAs will contribute (by themselves) to population level goals and objectives for delta and longfin smelt. There are likely thresholds in the extent of tidal marsh habitat that needs to adjoin areas of open-water in order for the marsh to subsidize the open-water instead of generating circumstances where the productivity is consumed within the marsh or quickly consumed by bivalves (clams) as it is dispersed from the marshes and other shallow areas. Such thresholds would depend on a number of factors and might be hard to predict. This possibility, and the potential path-dependence of the outcome of restoration, represent two key uncertainties that we hope the BDCP Adaptive Management Program can address.

As a supplemental response, we have provided track change edits and bubble comments that we think will improve the document further, particularly in Chapter 3 and 5.5.

> **ICF Response to FWS 2.6: The proposed action is no longer an HCP and does not include largescale restoration. Some tidal restoration is proposed to compensate for effects as described in Section 3.4 of the BA. As described in that section, restoration sites will be selected and designed in coordination with NMFS, FWS, and DFW, and will include performance measures to ensure they achieve the expected outcomes. Separate environmental review, including ESA compliance will be needed for each restoration site. No final BDCP has been prepared.**

FWS 2.7—Chapter 5 is deficient in its descriptions of channel margin, riparian, and floodplain habitat restoration outside of Yolo Bypass.

Original Comment: The Yolo Bypass tends to benefit native fishes because (1) it floods frequently with major inundation events; (2) it floods during times of year that BDCP target fishes can, and have evolved to, use it; and (3) upon drying it leaves very little permanent habitat for non-native fishes to colonize and reproduce in, because most non-native fishes are late spring/summer spawners. The original habitat analysis attributed seasonal floodplain benefits along the San Joaquin River that we do not believe are plausible; however, we understand there is now general agreement on this point and we will not comment on it further. However, the Sacramento River from Sacramento to about Rio Vista is also highly constrained, in this case by levees rather than regulated hydrology, and there are strict flood control capacity requirements that are enforced by USACOE. The effects analysis does not describe how this constrained reach of the river can support the proposed changes, where they will be, or assess their feasibility.

March 2013 Update: NMFS independently articulated these concerns last year, and we defer to their analysis of the response in the new draft BDCP (see NMFS memo comment 1.14).

> **ICF Response to FWS 2.7: The BA includes an analysis of effects of wetland benches, which was developed in coordinating with NMFS, and channel margin habitat restoration is proposed to offset project effects (See Section 3.4 of the BA).**

FWS 2.8—Increased residence times and reduced flushing of the Delta by Sacramento River water appear likely to result in interior – Delta channels that are further dominated by agricultural runoff, invasive aquatic vegetation, warmer temperatures, and increased algal productivity with its associated dissolved oxygen swings.

Original Comment: These environmental conditions favor non-native/invasive species (e.g. Egeria densa, largemouth bass, water hyacinth, Microcystis) and disfavor native fishes. The Delta is already more biologically similar to a lake than it once was, due to the historical accumulation of human modifications. We expect that by reducing Delta flows, the Preliminary Project would likely facilitate the spread of habitat conditions that are unfavorable to delta smelt, and and less favorable to other target fish species survival and recovery.

March 2013 Update: Chapters 3 and 5.5 have improved scientific discussions of residence time in the southern Delta and its likely connection to invasive vegetation and *Microcystis* blooms. These changes are helpful responses to our concern about the effects analysis, which was echoed in the DSP Science Panel Recommendations 6, 7, 8, and 13 in their June 2012 report.

ICF Response to FWS 2.8: The analysis developed in response to this comment was carried forth to the BA.

Issue Area 3: The Effects Analysis relies on selective use and interpretation of statistical and mathematical models.

FWS 3.1—The effects analysis did not use the available splittail life cycle model at all to support its Net Effects conclusion.

Original Comment: There is a published stage-based life cycle model for splittail where the effects of various environmental variables were examined for their effects on long-term trajectory of population abundance. This model helped frame the preferred time-interval for floodplain activation necessary to ensure splittail persistence in the Central Valley. This available approach to an Effects Analysis for a listed species of native fish was not discussed in the present Effects Analysis.

March 2013 Update: During our conversations with DWR and the consultant last fall, Service staff agreed that it was not necessary to use the splittail life cycle model in a predictive mode because that exercise had been completed to the extent it could be in the paper in which it was published. We appreciate the model description added to Appendix 5G.

ICF Response to FWS 3.1: The ESA approach is Section 7, and as such, does not include an analysis of splittail.

FWS 3.2—The effects analysis did not use the best available longfin smelt statistical models to support its net effects conclusion.

Original Comment: The newest published statistical analyses of longfin smelt are quasi-life cycle models that account for prior abundance and spring flow influences (among other factors) on this species. These models were discussed and discounted as not being ‘life cycle models’. Dismissing them because they are not ‘life cycle models’ is unhelpful: they are the best available scientific tools to evaluate project effects on longfin smelt. The older regression models that were used in the effects analysis are published, but can easily be shown not to perform as well as the newer models. The older models also average the flow influence on longfin smelt across half a calendar year, which likely affects conclusions about the reduction in springtime outflow seen in modeling outputs for the Preliminary Proposal. We look forward to working with our partners and providing technical assistance as this issue is resolved.

March 2013 Update: There has been a great deal of new data analysis on the topic of longfin smelt response to Delta outflow that has occurred since last spring in response to the "CS5" exercise, though we acknowledge this work remains to be published. The Service provided ICF with these new analytical tools last fall and one of them has been incorporated into the EA as an additional or alternative means of evaluating the expected long-term impact of BDCP influence on the spring Delta outflow "mechanism(s)" that is part of the well-established relationship between longfin smelt recruitment and Delta outflow.

We also provided ICF with a linear regression tool, but we did not see results based on it in the revised EA. This is an important issue because both its linear and nonlinear regressions should be used in the EA, as they are based on different plausible assumptions about how to represent current and potential longfin smelt population dynamic responses to flow variation and food web restoration. These are important approaches to present as part of the foundation for the adaptive management studies of outflow that are under development.

These adjustments will help address Recommendations 10 and 17 in the 2012 independent panel's review.

ICF Response to FWS 3.2: Subsequent to these comments in advance of the public draft BDCP, FWS directed ICF not to include either of the regressions on the basis of the peer review of a submitted paper including these methods. Therefore the public draft BDCP included analyses based on Kimmerer et al.'s 2009 X2-abundance regressions for longfin smelt. For the CWF 2081 ITP application, DFW suggested that an approach incorporating past abundance would be useful to assess potential cumulative effects over time of slightly less Delta outflow under the project. Such an approach is available from the recent publication of Nobriga and Rosenfield (2016), but this was not adopted in the 2081 application effects analysis because the predictive ability of the model is relatively poor compared to a simpler approach (e.g., a regression-based approach such as that of Kimmerer et al. 2009) and density dependence that suggests a Delta outflow effect is "tempered" later in the life cycle; this tempering was discussed qualitatively in the ITP as lessening the differences in abundance that could result from Delta outflow differences, so that such differences would not accumulate into differences in abundance over time. Based on feedback from DFW, the analysis included in the 2081 application was an update of the approach used by Mount et al. (2013) in their review of the public draft BDCP, i.e., abundance as a function of winter/spring (January-June) X2 including step functions for the *Potamocorbula amurensis* invasion and the Pelagic Organism Decline. An independent review panel convened in spring 2016 noted the uncertainties in knowledge of longfin smelt with respect to assessing effects of the project, based on review of the working draft 2081 application take analysis for longfin smelt (Simenstad et al. 2016); this same panel will be convened late in 2016 to review the appropriateness of the analysis in the submitted 2081 application.

FWS 3.3—The effects analysis continues to insist on an analytical approach to entrainment that does not reflect the best available science.

Original Comment: The current Draft Effects Analysis (as of September 13, 2011) downplays the potential effects of entrainment to the delta smelt population: (e.g., Section B.1.1.1), "[H]owever, analyses to date have not found correlation between entrainment and population level responses of delta smelt ..." The delta smelt population is now at historically low abundance and population losses due to entrainment may have significant population effects depending on their magnitude and frequency. While it is true that some regression-based analyses have failed to reveal an export affect to the delta smelt population, other approaches that more effectively investigate the role of fish distribution to entrainment have revealed an important relationship between water operations and the risk of population-level entrainment effects to delta smelt. Kimmerer (2011) demonstrated that entrainment losses averaging 10% per year can be "…simultaneously nearly undetectable in regression analysis, and devastating to the population." We look forward to working with our partners to ensure that the best model-based analyses of proportional entrainment for both South- and North-Delta diversion facilities are brought to bear to resolve this issue.

March 2013 Update: The original issue has been sufficiently addressed. We have provided additional track change edits and bubble comments that we think will improve the document further in Chapter 5.5. However, an important related issue remains. The stressor reductions targets for entrainment of the two smelt species propose to have proportional entrainment "at a level below the average" observed from 1995-2012. Achievement of these targets is already assured by the existing USFWS BiOp, and should be improved upon in a dual conveyance scenario. Furthermore, there is no rationale to explain why positive effects of achieving low rates of entrainment will not affect the fish populations until "year 40" [delta smelt] or "over time" [longfin smelt]. Since reducing cumulative entrainment of these species to no more than 5% of the population is already a BDCP biological objective, a more sensible stressor reduction target would be framed in terms of variables that affect entrainment risk.

ICF Response to FWS 3.3: As the proposed action is not an HCP, there are no stressor reduction targets. The entrainment analysis was conducted consistent with direction provided by DFW and FWS. It illustrates the potential for less entrainment with the CWF than would occur under baseline conditions, although the extent of this is challenging to quantify with certainty because of the major role of real-time operational decisions in affecting entrainment risk.

FWS 3.4—We think that the delta smelt state-space model is a useful framework to explore hypotheses about what drives delta smelt abundance.

Original Comment: However, the Maunder-Deriso model is a new application that needs additional collaborative work before it reaches maturity. We are concerned that the present model may have identifiability problems, as we discussed in our technical comments last fall. Until that concern is resolved, we are unsure whether the parameter estimates developed in that model represent what they are described to represent. We are also unsure why the model uses the official DFG Fall Midwater Trawl Abundance indices for delta smelt, but does not use the official DFG Summer Townet Survey or 20 mm Survey abundance indices. The rationale for this (which may be simple) is not explained. The model also assumes a specific form of density dependence between generations.

We have questioned the appropriateness of this choice, because on very thin ground it limits the universe of plausible explanations for delta smelt reproductive success that can be derived from the model.

The intent of this new model was to explain a specific historical dataset, and other than some broad assumptions it does not contain much of the mechanism presented in current delta smelt conceptual models (like DRERIP, or POD conceptual model, or the Fall Outflow Adaptive Management Plan conceptual model). The published version of the model used data through 2006. The model was updated for the Effects Analysis to include data through 2010. When this was done, the model fit deteriorated dramatically relative to what was reported in the paper. While this does not (at all) cause us to think it should be discarded, it does underscore questions about the maturity of the tool. The current model's success in fitting a specific set of historical data may not translate to good predictions of the the effects of flow and habitat change. The current model may perform still more poorly when CALSIM II water operations outside the envelope of historical experience are used as input.

It is important for the Effects Analysis to acknowledge that some data that may prove to be essential to modeling delta smelt or longfin smelt dynamics have been collected only recently. There are a number of studies now underway that address questions about fall outflow processes and delta smelt ecology as a whole. The novelty of the Maunder-Deriso model, and existence of other tools and analyses taking a process-oriented approach to to predicting the effects of flow and habitat changes, make the framing of the effects analysis very important. It is equally – possibly more – important that uncertainty at all levels be properly developed and acknowledged. Achieving these things, which are important to having an effects analysis we can rely on, will require work and a willingness to adapt on the part of ICF. We look forward to continuing to work with ICF and our other partners to ensure that the best science is identified and used defensibly in the effects analysis.

<u>March 2013 Update:</u> The track changes edit of the Fish Life Cycle Models Appendix 5G pdf provided by ICF seems to have edited out the descriptions of the Maunder and Deriso (2011) and Miller et al. (2012) statistical life cycle models. Here, we clarify that we did not ask for such a change to be made, and do not think it is either necessary or appropriate to strike descriptions of these analyses from the supporting materials for Chapter 5. It was mutually agreed that the Maunder and Deriso model was not a suitable *forecasting* tool in its current state, but the EA should retain a description of what it is and the findings of their exploration of the input data. The same is true for the statistical models of Miller et al. 2012, Thomson et al. 2010, and Mac Nally et al. 2010, because it is the findings that these different analytical approaches have in common, including the difficult bioenergetic situation that delta smelt face from late spring through early fall, that may emerge as robust and valuable conclusions of the modeling exercises carried out to date.

ICF Response to FWS 3.4: As previously noted, the July 2016 BA included methods and analyses agreed upon for use in this Section 7 consultation during a number of technical team meetings including DWR, Reclamation, the consulting team, and the permitting fish agencies (FWS and DFW). With respect to the first part of the comment, in July 2013 ICF explained to FWS the reasons for removing the more detailed Maunder and Deriso (2011) and Miller et al. (2012) statistical life cycle model descriptions, i.e., lack of information to develop key model inputs for factors such as delta smelt prey abundance. FWS concurred with this rationale. A basic description of these and other models was retained in the public draft BDCP.

Issue Area 4: The BDCP's net effects conclusions rest on an equivocal food web conceptual model

FWS 4.1—The FWS agrees that the pelagic food web that historically supported greater abundance of estuarine fishes including longfin smelt and delta smelt has been impaired and that contributing to its restoration is a key component of a conservation strategy for the Bay-Delta.

Original Comment: However, food limitation is a ubiquitous feature of ecology in the Bay-Delta. It affects non-native species as well as the BDCP target species. Thus, the issue is not really "food limitation" per se. Rather, the issue is food web pathways and the number of steps in a food chain between primary producers (phytoplankton and plants) and the BDCP covered fishes. For the smelts, the desired food pathway would be dominated by this short food chain: diatoms calanoid copepods and mysids low-salinity zone fishes. The short food chain outlined above dominated the historical low-salinity zone food web. Longfin and delta smelt are highly dependent on it (and minor variations of it). The other BDCP target fishes also use it, but have more generalized diets that often include benthic organisms and riparian and floodplain insects. The draft appendix has a very long section on food web changes when a simpler summary of the major points would be more effective.

The focus of food web restoration in the effects analysis is on floodplain and tidal marsh restoration. The production of diatoms may have been limited by disconnecting floodplains from their rivers and by reclaiming tidal marshes. These are the primary hypotheses behind the BDCP habitat restoration conservation measures. However, the two best-substantiated drivers of diatom suppression are overbite clam grazing and ammonium concentrations in the estuary. The suppression of diatoms is hypothesized to have provided a competitive advantage to lower quality primary producers and primary producers like Egeria densa and Microcystis that have virtually no food web value to the BDCP target fishes. This change in the base of the food web has reduced the amount of fish production that can be supported by the historical diatom-based food chain, and forced the fish to rely on other longer and more energy-limited food pathways. Longer food chains are less productive, and do not support as many fish. Because splittail and young Chinook salmon are the covered species that most extensively utilize floodplains and tidal marsh networks, they should be expected to gain the greatest food web benefits that restoration of these habitats can provide. However, this is not what the Net Effects concluded. Rather, it concluded that habitat restoration would provide greater benefit for the smelts despite their limited overlap and more restricted diets.

Shortcomings in the Net Effects resulting from mischaracterization of processes limiting transfer of production in new habitat areas to native fish biomass renders the present analysis inconsistent with best available science, and we are reluctant to rely on it to judge the design of the preliminary project. As with other modeling issues, we look forward to working collaboratively with our partners as these issues are resolved.

March 2013 Update: The revised Chapter 5.5 has improved regarding its acknowledgement about the drivers of the estuarine food web (clams and nutrients). The changes would have represented a larger improvement if they had included a more detailed analysis of unintentional restoration experiments (see update to comment 2.1 above). Such an analysis would have helped address Recommendation 8 of the 2012 independent review panel report, and helped avoid logic problems like those discussed below.

The Conservation Measure 4-based approach to solving food web issues for smelts is only weakly supported in the scientific literature. The document itself states (Appendix 5E):

To be used in the analysis, sufficient data had to be available to describe the condition at the scale of the geographic subregion, and it was necessary to be able to forecast conditions in the future with and without the BDCP either through modeling or conclusions. For example, planktonic food is an important factor in defining habitat for delta smelt (Bennett 2005) that likely relates to the presence of certain species of zooplankton (Criterion 1). *However, there is not sufficient data to characterize zooplankton abundance or community structure at the scale of the subregion (Criterion 2), nor is there an ability to project zooplankton response to future conditions [emphasis added].*

The proposed use of turbidity as a substitute for food is also not supported by best available science:

- To incorporate a measure relating to feeding, turbidity was used as an indicator of feeding potential in the subregions and in restored habitat (the potential of the restoration to add to the food supply in the Delta was treated as a separate analysis in Section 5E.4.3). Delta smelt abundance is strongly correlated with high turbidity, and it is believed to relate to the ability of fish to find and capture prey (Bennett 2005) (Criterion 1). There is sufficient information collected as part of the regional fish monitoring programs to characterize turbidity in the subregions (Criterion 2). At the present time there is no model available to project turbidity in the future, although there is reason to expect that turbidity in the Delta may decline in the future (Ruhl and Schoellhamer 2004). Recognizing the strong association with delta smelt presence, turbidity was used as a factor in the delta smelt model, but turbidity was assumed not to change over the BDCP period (Criterion 3).
- We remain skeptical of the use of turbidity as a substitute for smelt food supply, and more skeptical of the conclusion that this supply will remain unchanging into the future given the acknowledgment that turbidity values in the Estuary are expected to decline through time. The EA itself suggests sediment supply will be reduced by 8-9% by the North Delta diversions. For additional advice, see Recommendation 8 from the June 2012 DSP review panel (Accurately characterize food resources and food webs).
- The Habitat Suitability Analysis does not include an accurate estimate of food/prey availability and fate for either of the smelts for existing or proposed future conditions. The phytoplankton productivity estimate taken from Lopez et al. (2006) is an instantaneous productivity rate the authors themselves describe as not reflective of general habitat and hydrodynamic conditions in the Delta. A more accurate analysis of the productivity of Delta tidal environments would include analysis of the transport and fate of productivity in the Delta environment. Specifically, Lopez et al. (2006) underscore the evidence that much of the productivity in the Delta is being shifted to the benthos by exotic bivalves and away from the pelagic environment. The authors emphasize that analysis of instantaneous productivity estimates might, therefore, not yield meaningful answers if the role of the bivalves is neglected. The article includes the passage: “The unexplained patchy distribution

of Corbicula fluminea in the Sacramento-San Joaquin Delta implies high uncertainty in the outcomes of creating new aquatic habitats (Lucas and others 2002).” The Effects Analysis assumes an increase of 40% in productivity available to the pelagic food web as the result of the proposed restoration program. Given the findings of Lopez et al. and others (e.g. Nixon 1988, Cloern 2007, Lucas and Thompson 2012), we believe the actual improvement in system-wide productivity increase to the pelagic food web is very uncertain and might be substantially less than 40%. As with some other comments (e.g., update to comment 2.5.a above), the remedy to this issue is to more objectively assess the effects.

- As a supplemental response, the Service has provided numerous track change edits and bubble comments that we think will improve the document further.

ICF Response to FWS 4.1: The proposed action is no longer an HCP and does not include largescale restoration. Some tidal restoration is proposed to compensate for effects as described in Section 3.4 of the BA. As described in that section, restoration sites will be selected and designed in coordination with NMFS, FWS, and DFW, and will include performance measures to ensure they achieve the expected outcomes. Separate environmental review, including ESA compliance will be needed for each restoration site. No HSI analysis was prepared for the BA and no final BDCP has been prepared.

Issue Area 5: The analysis and interpretation of BDCP are hindered by indeterminate model baselines and related issues

FWS 5.1—A key point of continuing analytical confusion is the use of multiple baselines.

Original Comment: The current set-up for the BDCP employs two ‘base case’ model runs (EBC1 and EBC2). The EBC1 does not include the full suite of elements in the current FWS and NMFS OCAP RPAs. The EBC2 attempts to include the RPAs in their present-day form, but it does not accurately capture them all. There are numerous cases in Chapter 5 where it is not clear what Project model result is being compared to which baseline condition. This generates confusion. We look forward to continuing to work with our partners to be sure that baselines used in the effects analysis are appropriately constructed and are used clearly and correctly.

March 2013 Update: As a result of this comment, ICF is developing a scope to conduct a new “aggregate” analysis that meets the needs of FWS and NMFS. FWS intends to continue to work with them and the other agencies to complete this analysis and incorporate it into the effects analysis of the proposed project prior to submitting the section 10 application.

ICF Response to FWS 5.1: The analysis of the proposed action in the BA includes a single baseline, and was developed in coordination with NMFS and FWS. NMFS and FWS will conduct the jeopardy analysis using the information provided in the BA as well as the application of the analytical framework they have developed consistent with the Delta Independent Science Panel reviews in 2016.

FWS 5.2—CALSIM II demand representation in 2060 studies should have some justification.

Original Comment: Some explanation for, or error estimate of, assuming a 2020 level water demand for a 2060 climate change simulation should be made. Presumably portions of the State (Southern California, the American River Basin, etc.) are going to continue to grow through 2060. Some estimate in the change of cropping patterns over the 40 years (2020 – 2060) should also be made (or at least a write-up of why it cannot be made) should be included. Without clear resolution of this issue, it appears to us that the modeling may underestimate water demand in the late long-term. We are unable to provide technical assistance on this issue, but look forward to its resolution.

March 2013 Update: ICF responded to this comment by noting that water demand in the export area was expected to top out at a 2020 level. However, this important issue remains unresolved because we could not find where in the documentation that it is stated explicitly that it is an analytical assumption of the BDCP EA that demand growth upstream of Freeport will top out at a 2020 level. Fix: please clarify that it is a modeling assumption that a 2060 climate will interact with a 2020 level of water demand in the Late Long-Term.

ICF Response to FWS 5.2: The proposed action is modeled at the 2025/2030 period and therefore the issue described above does not apply. All of the modeling assumptions are described in Appendix 5.A in the BA.

FWS 5.3—The proposed restoration in each "Restoration Opportunity Area" (ROA) is only compared against the lands bounded within the ROAs, which themselves lie in larger regions.

Original Comment: These comparisons of present-day ROA habitat to future ROA habitat are inappropriate – especially in cases like the east and south Delta ROAs, which are currently dry land. Mathematically, if a terrestrial habitat is subsequently flooded, the improvement for target fishes increases by an infinite percentage even if the habitat performs poorly because a habitat suitability index that is even a tiny fraction of 1 is still infinitely higher than zero, which is the suitability of dry land to fishes. Habitat analyses need to be based on comparisons against currently available aquatic habitat acreages in the entire regions containing the ROAs. They also need to be synthesized and integrated into Plan Area-wide totals, with river flow and climate changes incorporated, in order for the analyses to be meaningful.

March 2013 Update: This specific representation issue appears to have been sufficiently addressed in the EA. Full resolution of issues related to evaluation of habitat restoration in the EA is contingent on implementation of fixes that are discussed above.

Resolution of the issue will help address Recommendations 5 and 6 of the June 2012 independent review panel report.

ICF Response to FWS 5.3: The proposed action is no longer an HCP and doesn't include largescale restoration. As such, there is no analysis of ROAs.

Section 2: New Issue Areas Arising From Review of December 21, 2012 and March 6, 2013 BDCP Drafts

Issue Area 6: Plan adaptability

FWS 6.1—Clarify the role of biological objectives as the basis for adaptive management of BDCP conservation measures.

Biological goals represent the ultimate conservation outcomes toward which the Plan strives. In some cases, achievement of ultimate goals lies within the power of the BDCP; in others the achievement of goals depends in part on factors that are outside the control of the water projects. Objectives are lower-level outcomes within each goal that are achievable by the BDCP and essential to achieving the overarching goal.

BDCP conservation measures are designed to achieve the biological objectives of the Plan. Because of this, BDCP adaptive management must be structured to provide for adjustment of the conservation measures to achieve the objectives as efficiently as possible.

The document is generally clear that the BGOs will be used to guide the implementation of conservation measures. However, the plan needs to clearly articulate that achieving biological objectives is the whole basis of the conservation plan. Achieving and continuing to achieve objectives will be necessary for progress toward the biological goals and recovery of covered species, and may be required for compliance with the HCP permit. There are several passages in Section 3.6 and elsewhere that need to be edited to clarify the role of the biological objectives.

> **ICF Response to FWS 6.1: As the ESA compliance approach is Section 7, there are no longer BGOs. However, the adaptive management program can be used to make adjustments as appropriate as new information is developed.**

FWS FWS 6.2—The BDCP must set forth governance and adaptive management plans that will facilitate adaptive management.

A core feature of the management problem the BDCP is designed to address is uncertainty. Three years ago, the Federal Agencies issued a white paper on application of the Services' 5-point policy for HCPs to the BDCP. It articulated the role of two permitting strategies developed in the 5-point policy: prescriptive plans and outcome-based plans.

> "The BDCP is a complex, landscape scale, long-term HCP with a high degree of uncertainty as to how close the initial conservation measures will come to achieving the plan's biological goals and objectives. It falls into the category of plans that will be a mixture of the two strategies, with initial prescriptions associated with adaptive management, and specific biological outcomes defining the ultimate success of the plan. This type of plan will allow management flexibility so the permittee may institute actions necessary to achieve the plan's goals while providing boundaries for future expectations and commitments. In addition, a results-based plan will address uncertainty in the ecosystem and provide the conservation assurances required by the Act. The Services will be challenged to make the findings required for permit issuance if the plan does not include clearly defined and scientifically supported biological goals and objectives, an adaptive management plan that tests alternative strategies for meeting those biological goals and objectives, and a framework for adjusting future conservation actions, if necessary, based on what is learned." (4/29/2010 memo, page 1)

In an outcome-based plan, biological objectives provide targets that conservation measures are expected to reach, thereby contributing to the conservation outcomes required by the permit. If the objectives have been appropriately crafted, their achievement assures that a project is doing what it can to contribute to the accomplishment of the ultimate biological goals of the plan. If the CMs fail to achieve the biological objectives around which they are designed, then the plan must provide the means (adaptive management) to change the conservation measures to achieve the outcomes.

We are concerned about the ability of the draft BDCP to successfully facilitate adaptive management. Our concerns span chapters 3, 6, and 7. A large number of issues our staff have identified in Section 3.6 remain unresolved. Also, discussion between the Service and DWR regarding the content of Chapter 6 is not yet complete. Because these sections are "works in progress," the following list of critical issues is not exhaustive.

1. Absence of a decision table in Chapter 7 (Governance). The most basic function of Governance is to define who makes decisions. In July 2012, the BDCP principals adopted a draft table describing how key BDCP implementation decisions are to be made, what the elevation path is if there is disagreement, and who has final authority to decide. Unfortunately, the decision table was removed from Chapter 7 shortly thereafter. In its absence, the Governance chapter does not clearly define or summarize how important classes of decisions would be made, including adaptive management changes, and leaves equally unclear who would have final authority to decide in each class of decision. Restoring the July 2012 governance decision table, or writing a new Section conveying the information in that table, is necessary to provide a clear path for decision making in the document and for plan implementation.

2. Ambiguity in roles and responsibilities in Chapter 7. There remain ambiguities or apparent conflicts in roles and responsibilities in the Chapter 7, including Section 7.3.4. Clarifying the roles of the adaptive management team, the science manager, and the program manager is a critical issue, given the potential difficulty of the decisions that lie ahead. Adaptive management is fundamental to the BDCP, and the plan should be unambiguous that scientific studies, development of proposals to adjust the conservation measures based on new information, and other adaptive management functions will be managed and administered jointly by the parties that form the Adaptive Management Team, and not by the Implementation Office or its employees and officers, except to the extent that one of them (the Science Manager) is a member of the Adaptive Management Team.

3. Ambiguous limits on adaptive management changes to conservation measures in Chapter 3. As an example, Section 3.6.3.3.2 limits circumstances in which adaptive changes to conservation measures can be implemented:

    - With respect to adaptive changes to conservation measures that would result in a greater commitment of water, land, or money by the permittees, the scope and magnitude of an adaptive response will be limited to those actions reasonably likely to ensure that (1) the impacts (or levels of impacts) of a covered activity that were not previously considered or known are adequately addressed or (2) a conservation measure or suite of conservation measures that is less than effective, particularly with respect to effectiveness at advancing the biological goals and objectives, is modified, replaced, or supplemented to produce the biological benefit. (pages 3.6-26 to 3.6-27 in March 2013 BDCP draft)

A permanent adaptive change to a BDCP conservation measure will most likely be needed because (a) the conservation measure is not achieving or not on track to achieve the biological objective(s) it is designed to achieve; or (b) a different version of the conservation measure that costs less water or money to implement has been found that is equally effective or more effective at achieving the relevant biological objectives. This formulation should not be controversial: it is the basis of adaptive management in many other systems, and articulates the way the conservation measures would be managed to achieve the co-equal goals of the BDCP.

We are concerned by the ambiguity of the limits described in the quoted passage above. In our view, they can be interpreted to allow the changes (a) or (b) we have listed, but they can also be interpreted to prohibit them if they cost water, depending on whether "advancing the biological goals and objectives" and "produce the biological benefit" both mean 'achieving the objective(s).' It is also not clear what other kinds of adaptive management changes the limits might prohibit, or are intended to prohibit, since the text was presumably inserted for a specific reason. This sort of ambiguity, which has other examples, is very problematic in a plan that depends on adaptive management and is meant to provide a clear, cooperative mechanism to implement it. Left as is, these ambiguities seem likely to add new conflict on top of already-difficult management problems.

1. Lack of clarity on how AMT implements adaptive management. The Service has identified a large number of issues of varying levels of importance in Section 3.6. They include confusing language about circumstances "triggering and adaptive response" that do not align with the 9-step adaptive management model adopted by the BDCP; ambiguities in how decisions are made, including at least one example in 3.6.3.3.2 (page 3.6-27) that appears to conflict with the July 2012 Governance decision table discussed in 6.2(1) above; and other issues. It will be very important to follow-up on these issues to ensure that the adaptive management process is clearly defined and workable.

   The plan also needs to clearly articulate that the science program developed to support adaptive management will be structured to facilitate participation by agency scientists, stakeholders, and a broad array of academic scientists. The current provisions for participation by stakeholder participation and science do not adequately lay out the stakeholder roles in the technical dialogue and do not clearly develop an appropriately expansive role for academic scientists. The current draft is also vague on the role of the Delta Science Program, which we believe may play a crucial role in assuring the quality and transparency of science in the BDCP.

   The Delta Science Plan, which is under preparation, is likely to propose a broad collaborative science structure that includes direct science/policy discussions involving agency executives and senior academic scientists. We view this as a very good idea. We also recommend that the draft Science Plan be included in the discussion going forward, since the Delta Science Plan will become part of the management environment in which a BDCP would be implemented. Separately, a recent draft memorandum prepared by the Delta Stewardship Council's Independent Science Board expressed skepticism that the current draft BDCP governance chapter does enough to facilitate cooperation in the adaptive management program. Given the stature of that panel, its critique should also be part of the dialogue going forward.

ICF Response to FWS 6.2: An Adaptive Management Plan would be implemented to support current and ongoing operations and the implementation of the proposed project. The plan is being developed in coordination with all five agencies and other stakeholders, including the Delta Stewardship Council, and is the subject of independent science review. The plan describes how decisions are made, how research is designed and funded, how each stakeholder will engage, and the process for integrating scientific information into decisions. It should be noted however, that because the proposed action is not an HCP, there are no proposed biological goals and objectives, although the plan does identify several key areas of research linked to critical species issues.

FWS FWS 6.3—The Decision Tree

The decision tree articulates the concept that four sets of operational criteria will be proposed in the project description. They include the "high outflow scenario," which was developed with the advice of the Service, and three alternatives that provide reduced Delta water flows. Given the fundamental disagreements that exist over the importance of flows for covered fish species, it is reasonable to investigate these other scenarios as initial management alternatives through the adaptive management program. However, the March 2013 language of Section 3.4 is ambiguous on the role of these alternatives in the BDCP permit.

CM1 includes two decision trees, one for fall outflow and one for spring outflow, that specify alternative outcomes for each criterion. Because each decision tree has two possible outcomes, the decision trees lay out four possible outcomes in outflow criteria when the spring and fall outflow components are combined, as described in Table 3.4.1-1. These four outcomes would be covered by the permit. These operating criteria will be subject to a determination by the permitting agencies, based on best available science developed through the decision-tree process, specifying what the spring and fall outflow criteria will be at the time CM1 operations begin. (March 2013 BDCP, page 3.4-19)

We have two concerns about this passage, as written. First, the meaning of "covered by the permit" in the third sentence is ambiguous, but it could be interpreted as an expectation that the permit would include findings that the whole project description, including all four versions of water operations, satisfies statutory issuance criteria. It is not clear how the Service could make such findings at present, since the project description as a whole does not fully implement the Service's 2008 Reasonable and Prudent Alternative for CVP/SWP water operations. We interpret the sentence to mean, instead, that all four versions of operations would be analyzed prior to potential permit issuance, findings would be made with respect to each alternative version of operations based on the best available science, and the result of those analyses would be expressed in the permit.

Second, the last sentence seems to imply ("[t]hese operating criteria will be subject to a determination…") that if the initial finding is revisited prior to the start of CM1 operations, the new finding would be limited to a choice among the four original operations alternatives. It may be that this is not the intended meaning. Bullet #3 near the bottom of the page says "[a]t the time dual conveyance operations begin, the permitting agencies identify spring and fall outflow criteria sufficient to meet the biological goals and objectives," which seems clearly to articulate that the decision at the time of CM1 operations would not be constrained to a choice among the original four alternatives. If, however, the intended meaning of these passages is that the choice of operations a decade or more in the future is to be limited to a selection among the four original alternatives, regardless of the results of new scientific studies everyone agrees are important, that would be highly problematic.

We are very concerned by the ambiguity of these statements, and other statements in Section 3.4 and its tables regarding the decision tree, which seem very likely to cause conflict in the future.

> **ICF Response to FWS 6.3: The proposed project does not include a decision tree. Instead, it includes operational criteria, including real-time operations, to address each of the listed species' needs relative to the proposed project based on the best available information available. These criteria along with the entirety of the proposed action, are the basis of the ESA consultation.**

FWS 6.4—Changed Circumstances.

There are numerous problems with the latter sections of Chapter 6 (6.4 and 6.5). The list of foreseeable changed circumstances described in 6.4 needs to be expanded and the range of adaptive responses available to address those changed circumstances is far too narrow and limiting. The subject of range of adaptive responses is directly related to the subject of adaptive limits, which also have not been defined. Changed circumstances should also include a time-frame for implementation of the remedial measures. The 5-Agencies will need to review this section and come to agreement on revising its contents prior to release of the public draft of the plan. More detailed comments on the issues with this section of Chapter 6, which are intended to start a dialogue on the chapter, are provided in our "track-changes" submittal.

> **ICF Response to FWS 6.4: Changed circumstances are not a component of Section 7 consultations and as such, none are included in the BA.**

FWS 6.5—Adaptive Limits.

"Adaptive limits" in the BDCP refers to the most extreme sets of practicable operational parameters that might be required of or authorized to the permittee through the working of adaptive management over the life of the permit. Some discussion of what such parameter-by-parameter limits might be has already occurred, but the neither the concept of adaptive limits nor a draft example of them is included in the current BDCP draft. Without adaptive limits, limits to the commitment of resources that might be required of the permittee(s) remain undefined.

As is clear in both the HCP Handbook and the Five Point Policy, the permittee(s) in an HCP is protected by the inclusion of adaptive limits that "clearly state the range of possible operating conservation program adjustments due to significant new information, risk or uncertainty. This range defines the limits of what recourse commitments may be required of the permittee(s). This process will enable the applicant to assess the potential economic impacts of adjustments before agreeing to the HCP." 65 Fed. Reg. 35253; see also HCP Planning Handbook at 3-24 – 3-25.

In the BDCP, adaptive limits would provide an important assurance that would protect the permittee(s) from an open-ended obligation to commit resources irrespective of circumstances. They would also provide an important level of transparency to the permittee(s) and the public regarding the commitments represented in the plan. It will be important to clarify the effect of changed circumstances (Section 6.4) on the adaptive limits.

We are also concerned that the four operational alternatives in the project description might be interpreted to represent the adaptive limits for the permit. This is not an appropriate interpretation, and it will be important to cross-check the relevant chapters to be sure it is clear that operations might be adjusted in ways that cause water yield to move up or down within the adaptive limits, depending on new scientific findings.

> **ICF Response to FWS: Adaptive limits are not a component of Section 7 consultations and as such, none are included in the BA.**

FWS 6.6—Real-time operations.

Real-time operations, described in CM1, are discussed in chapter 3 under 3.4.1.4.5 and are described as being separate and distinct from the adaptive management process. Yet the document is confusing because Chapter 3 states that the purpose of the adaptive management process is to allow for adjustments to be made to conservation measures, including operational criteria. It will be important going forward to clarify the governance and management of real-time operations.

> **ICF Response to FWS 6.6: Delta operations described in Chapter 3 of the BA may be adjusted through both real-time operations and adaptive management. The real-time operations process will occur on a monthly, weekly, and sometimes daily basis while the adaptive management process will be used to inform proposed changes to the conservation measures (3.4.6, *Collaborative Science and Adaptive Management Program)*.**

Appendix 11F, Attachment 3
NMFS BDCP Progress Report
December 2012/February 2013 Administrative Draft

NMFS BDCP Progress Report
December 2012/February 2013 Administrative Draft

This document includes responses to the Progress Reports developed by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) in response to the February 2013 Administrative Draft of the Bay Delta Conservation Plan (BDCP). A previous review was conducted in April 2012 and comments were submitted as "red flag" comments on the previous draft of the Bay Delta Conservation Plan (BDCP). Section 1 of this document captures the updates to the "red flag" comments submitted by NMFS in April 2013 after review of the December 2012/February 2013 Administrative Draft and ICF International's subsequent responses and changes. Section 2 of this document captures additional comments and issues resulting from review of the December 2012/February 2013 Administrative Draft. The responses to each comment are based on the Biological Assessment (BA) that was submitted for ESA consultation, based on the California WaterFix, which ultimately became the proposed action. The purpose of this document is to demonstrate how the California WaterFix has responded and addressed each of the red-flag and progress report comments. Where these comments were focused on elements specific to an HCP/NCCP approach, the response notes that an HCP is not being pursued as part of the California WaterFix, although the BDCP and other HCP/NCCP alternatives are considered feasible alternatives and are fully analyzed for the purposes of CEQA and NEPA in this Final EIR/EIS. Further consideration will be given to these comments and appropriate revisions to the Draft BDCP made if an HCP/NCCP alternative is ultimately approved at the conclusion of the CEQA/NEPA process.

Updated assessments of the April 2012 "red flag" comments are show under the heading "**Update**" and comments have been categorized:

- Critical = Significant disagreement between NMFS and consultant team and/or no significant progress made to resolve issue.
- Important = Significant progress has been made or is in process of being made on methods. We have not yet seen the results, or there is disagreement on results, or interpretation of results that NMFS believes could be resolved with more time and effort.
- Resolved = Red flag is resolved.

Section 1—Progress Assessment on Resolution of Previous Comments/Issues: NMFS List of Issues Unresolved in BDCP Administrative Draft

NMFS 1.1—Hood Diversion Bypass Flows (Critical)

<u>Previous Comment:</u> The Effects Analysis of the Preliminary Proposal (PP) raises concerns over reduced flows downstream of the North Delta diversions, especially in winter and spring months. These flows relate to:

A. Increased frequency of reversed Sacramento River flows at the Georgiana Slough junction. The January 2010 PP rules included a provision that north Delta pumping would not increase these reverse flows. CALSIM II results provided by CH2M-Hill indicate that the PP will increase the percent of time Sacramento River flows are reversed, causing increased entrainment of juvenile salmonids into the Central Delta. If the frequency of reverse flows increases due to the PP, then the diversion amounts allotted under the PP could not be implemented. The DSM2 analysis of reverse flows in the DPM suggests that tidal marsh restoration in the Delta will nearly offset both the effects of sea-level rise and large water diversions from the Sacramento River, a conclusion which needs much more explanation in the EA (see comment on tidal marsh effects).

B. Long-term viability of sturgeon populations. There are concerns that Sacramento River flow reductions will impact the reproductive success of white and green sturgeon, which have been documented to produce strong year classes mostly in years with high flows in April and May (AFRP study). We do not know if this has been addressed in revised Appendix C.

1) Further explanation and analysis of the reverse flow issue.

2) Work with the Services to find a diversion operating scheme that is still likely to be permitable after adequate modeling and analysis has been conducted.

Update: The modeling analysis in the Admin Draft indicates that the Evaluated Starting Operations (ESO) will generally result in a reduction in flows below the north Delta diversions, but that those reductions will not result in increased duration or magnitude of reverse flows at the Georgiana Slough junction. This conclusion is relatively counter-intuitive and the concepts and mechanisms that support this conclusion, and the level of uncertainty around it, need to be very clearly explained in thorough detail. We also recommend independent peer review of these methods and results. Regardless of the modeling results, the planning parties agreed that the north Delta diversions would be operated in a manner that would not result in increased frequency, duration or magnitude of reverse flows at the Georgiana Slough junction. Therefore, the description of Conservation Measure 1 (CM1) needs to very clearly explain that real-time operations will be managed to insure that diversions in the north Delta will not result in increased frequency, duration or magnitude of reverse flows at the Georgiana Slough junction. Such a description is currently missing from CM1.

With regard to the Delta flows needed for sturgeon reproductive success, the spring outflows provided under the High Outflow Scenario (HOS) appear to meet the 25,000 cfs outflow in 50% of years as recommended in NMFS' Combined Scenario 5 (CS5) criteria. The other decision tree scenarios do not provide these flow parameters and therefore would not be likely to provide the necessary benefits to contribute to the recovery of green sturgeon.

There are additional concerns with the modeled ESO bypass flows with regard to juvenile salmonid survival downstream of the new intakes. The effects analysis acknowledges that there are potential impacts from reduced flows downstream of the intakes, as seen in the results of the Newman (2003) analysis, which shows slightly reduced (though not statistically significant) survival rates through the Delta, and the Delta Passage Model, which shows a slight decrease in smolt survival prior to the addition of survival benefits from Yolo Bypass.

NMFS has conducted a simple analysis of survival using Newman's (2003) and Perry's (2010) flow-survival relationships showing average survival rates under different bypass criteria levels (provided under separate cover). This assessment indicates a significant reduction in salmonid survival under level 3 pumping criteria for the ESO as compared to Existing Biological Conditions (EBC2). This is a key finding and should be carried through into the net effects analysis.

In summary, our recommendations on this topic are to:

- Submit the reverse flow analysis and conclusions to independent peer review.
- Amend the HOS decision tree to include the green sturgeon criterion.
- Augment the effects analysis to include NMFS analysis and to highlight magnitude and certainty of effects associated with Level 3, as compared to Level 2 and Level 1 pumping/bypass criteria.
- Submit the NMFS and ICF analyses of survivals associated with varying pumping/bypass criteria to independent peer review.
- In light of steps above, seriously consider amending Level 3 pumping/bypass criteria prior to submitting the Section 10 application.

ICF Response to NMFS 1.1:

Since the Progress Report was issued in April 2013, ICF, NMFS, Reclamation, CDFW, and DWR have worked to together to address and understand this issue, both through changes in the proposed action as well as analytical methods used to evaluate its effects.

Relative to changes in the proposed project, DWR and Reclamation proposed in the BA that the operations would include April-May outflows consistent with the No Action Alternative; real-time transitional criteria for the NDD to respond to observed fish presence and hydrodynamic conditions; and a criteria to ensure that the magnitude and frequency of reverse flows downstream of Georgiana Slough are no greater than they would be under the NDD. Together, these avoid

First, a more-detailed description of the reverse flow issue and the hydrodynamic patterns at and near the North Delta intakes was included in the Public Draft BDCP and the BA. This analysis and explanation were topics for the Delta Stewardship Council Independent Science Panel review in January 2014. The results of this independent review were used to update the analysis included in the BA, which does not include habitat restoration in the modeling, which was of concern to the review panel. See section 5.4.1.3.1.2.1.2 of the BA.

The effects of the operation of the intakes also have been further explored. The effects analysis includes the suggested Newman 2003 and Perry 2010 analyses (See section 5.4.1.3.1.2.1.3 of the BA) , as well as a more thorough analysis of salmon survival under the various pumping levels as they are proposed to operate based on Perry 2010 (Appendix 5.D, 5.D.1.2.4).

Delta Passage Model results were corrected and were continually updated based on sensitivity analyses and input provided by NMFS and DFW, although the overall conclusions from this modeling tool did not change.

NMFS 1.2—Salmonid Net Effects (Critical)

<u>Previous Comment:</u> All salmonid species are grouped together, with no separate evaluations for the separate ESUs of Chinook salmon or for steelhead. It is important for the net effects analysis to describe individual ESUs/species, and provide full consideration of the life-history diversity and

timing exhibited by each ESU/species. We also need the Sacramento River populations and San Joaquin populations for Spring-run Chinook, Fall-run Chinook, and Central Valley steelhead summarized by river basin, prior to the roll-up by ESU/DPS. Steelhead life-history and ecology especially warrant a separate evaluation. "Net effects" is useful for comparing alternative operations, but will not provide the robust effects analysis needed for ESA purposes (see comment on ESA baseline).

> Separate all Chinook by ESU, by San Joaquin and Sacramento populations, and separate steelhead in all analyses and discussion.

Update: The initial issue has been addressed. Each species and Evolutionarily Significant Unit (ESU) has a separate analysis.

Now that the analysis has been separated out by species and ESU, we have been able to determine the following concerns with the net effects analysis:

- The net effects section does not provide a well-integrated assessment of the overall population-level effects of the plan. It is primarily a reporting of disparate segments and a summary of the different analyses, without an analytical method or over-arching conceptual model to tie them all together (i.e., feed one into another). It is still a discussion of the application of different methods to different life stages. Results are based on "environmental attributes" that are scored for magnitude of effect and uncertainty; the agencies did not have an opportunity to assess these scores and there are no tables of these attribute magnitude/certainty scores provided for salmon and sturgeon.
- During the effects analysis review workshops conducted in November/December 2012, ICF and the interagency technical team agreed that the environmental attributes analysis in the net effects section should be fundamentally re-worked to make flow a much more robust element of the stressor tables by including the "five attributes" of flow (magnitude, timing, frequency, duration, and rate of change), how the project would affect each of these attributes, and how these changes would affect fish. These agreements are not reflected in the framework of the current environmental attributes analysis and should be incorporated into the next draft.
- There needs to be a systematic method for selecting the number of attributes that are summed in the net effects. For example, for steelhead, there are four categories of food in the summary figure, which doesn't seem appropriate for salmonids, especially the migrants. At the same time, no benefit is assigned to channel margin habitat restoration in the figure. A table showing the summed scores for all attributes would be more helpful than the figure.
- The attributes themselves need to be better defined. E.g., how does "Sacramento River Flows" differ from "Sacramento River Habitat" differ from "channel margin" or "riparian"? A conceptual model would help with this. The assessment should be of the change in these factors attributable to the project.
- There needs to be a second level of analysis to weight the results by the proportion of each life history type exposed to the effect (e.g., the 95% migrants to 5% foragers split for juvenile steelhead seems appropriate, but each segment is given equal emphasis in the summary figure).

- Some QA/QC needs to be done to make sure the conclusions from the text match the summary figure (e.g., in steelhead, the figure shows a moderate benefit from Feather River flows, but there is no discussion of this in the text).
- The changes in flows mentioned for some locations need to be translated to their effects on water temperature in order to fully understand their impact. For example, a 28% reduction in flow for the American River shown under ESO and HOS in the summer and fall months could potentially cause significant temperature issues for juvenile steelhead, as these are the months that the river can get very warm in lower-flow years.
- There also needs to be a more systematic method for assigning level of benefit from a CM to a species. For example, in the steelhead net effects section, the sensitivity analysis for non-physical barriers showed a 0.00 (zero) survival increase in one year, and a 0.03 increase in a second year, yet the conclusion was a moderate positive change with moderate certainty. We recommend that a facilitated workgroup including biologists from all five agencies and ICF be charged with assigning specific magnitude and certainty scores and documenting the rationale and data sources for those determinations.

As part of the South Delta Research Collaborative, NOAA's Southwest Fisheries Science Center has developed a simple "top-down" conceptual model of south Delta operational effects on salmonids, which among other things links hydrodynamics to predation. We recommend that ICF coordinate with the agency staff involved in this collaborative process and exchange information on common issues being analyzed in both efforts.

In summary, our recommendations on this topic are to:

- Conduct a facilitated workshop with the agencies to identify conceptual models of operational effects on salmonids and sturgeon and to agree on a model to guide the quantitative net effects analysis.
- Conduct a facilitated workshop with agencies to discuss and define environmental attributes and scores, the methodology of combining and weighting scores, and incorporation of the five attributes of flow.
- Complete a thorough cross-check of conclusions in text against those in figures.
- Explore flow-temperature relationships in upstream areas to provide a better inference of effects of reduced flow on temperature stress.

ICF Response to NMFS 1.2: The shift to Section 7 for ESA compliance changed the way in which conclusions are presented. Chapter 7 of the BA includes the effects conclusions reached by DWR and Reclamation for each species addressed in the BA, including rationale and reference to specific sections of the effects analysis to support that rationale. Much of the effects analysis was developed in coordination with NMFS, FWS, and DFW, and as such, incorporates the technical concerns noted in this comment pertaining to weighting and interpretation of results. However, as part of the completion of the Biological Opinion, NMFS will make determinations relative to species and critical habitat effects.

NMFS 1.3—ESA Baseline, Future Conditions, and Climate Change (Important)

Previous Comment: In order to conduct the ESA jeopardy analysis on the PP, the baseline condition and projections of future baseline conditions, including effects of climate change, need to be re-written to be consistent with the 2009 Biological Opinion and current case law. ESA regulations define the environmental baseline as "the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process." Implicit in this definition is a need to anticipate the future baseline, which includes future changes due to natural processes and climate change. For the ESA jeopardy analysis we add the effects of the proposed action[1] to the environmental baseline to determine if there will be an appreciable reduction in the likelihood of survival and recovery of the species (by reducing its reproduction, numbers or distribution).

> Upstream effects associated with climate change need to be in the baseline and future conditions, with any effects of the project (in the Delta or associated with upstream operations) added to that future condition to determine jeopardy. A project proposed in this type of baseline conditions needs to more than offset its effects in order to alleviate a jeopardy finding.

Update: As a result of this comment, ICF is developing a scope to conduct a new "aggregate" analysis that meets the needs of USFWS and NMFS. NMFS intends to continue to work with them and the other agencies to complete this analysis and incorporate it into the effects analysis of the proposed project prior to submitting the Section 10 application.

> **ICF Response to NMFS 1.3: The analysis of the proposed action in the BA includes a baseline consistent with the comment, and was developed in coordination with NMFS and FWS. NMFS and FWS will conduct the jeopardy analysis using the information provided in the BA as well as the application of the analytical framework they have developed consistent with the Delta Independent Science Panel reviews in 2016.**

NMFS 1.4—Analysis of Water Temperature Impacts (Important)

Previous Comment: Lethal and sub-lethal water temperature thresholds need to be examined at a finer scale. Currently the effects analysis relies heavily on a Reclamation water temperature model which can only estimate monthly values, which have limited value for predicting project effects on fish. In addition, the effects analysis has only presented frequencies of temperature threshold exceedances, while the magnitude and duration of exceedance is also very important. We do not know if this has been addressed in revised Appendix C.

1. Provide tables and probability plots of magnitude and duration of temperature exceedances at certain upstream locations, by water year type and month.
2. Technical discussion with Reclamation and CH2MHill about how to post-process data.
3. Investigate the use of SWFSC's Sacramento River temperature model to predict project effects and make hindcasts of empirical temperatures.

[1] Effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline.

4. Investigate the use of the new American River temperature (and storage and flow?) model

Update: NMFS and ICF are working to develop temperature data presentation methods that provide a more useful representation of results. Daily data will be used when available to indicate the magnitude and duration of temperature exceedances at compliance locations. These new analytical methodologies have not yet been incorporated into the effects analysis.

ICF Response to NMFS 1.4: ICF and NMFS worked together to develop and implement a method for analyzing water temperature that provided NMFS the needed information. This analysis was incorporated into Appendix 5.C, and is interpreted in the effects analysis (Section 5.4.2 of the BA) throughout the 'Upstream' section for each species.

NMFS 1.5—Assumption of Habitat Restoration CM Success (Critical)

Previous Comment: In several places, the EA assumes that adverse impacts of the PP will be offset by unsubstantiated benefits of habitat restoration. The EA assumes that all restoration will be successful and work as predicted, with little or no evidence to support this prediction and no attempt to analyze the potential outcomes of less than perfect success.

1. It is imperative to avoid language such as "This conservation measure will...", because the anticipated CM outcomes are based on conceptual thinking, not execution. To be able to comprehensively think through the adaptive management and monitoring plan, implementers need to try to anticipate a range of responses that must be managed in order to be prepared for the uncertainty of the response.
2. Alternative outcome scenarios should be evaluated to bracket the range of possible outcomes from proposed habitat restoration.

Update: Language has been altered to reflect uncertainty to an extent, but alternative outcome scenarios have not been evaluated; all analyses and results assume that restoration activities will be successful. Alternative outcome scenarios showing varied effectiveness of habitat restoration efforts have not been provided, and therefore it is not possible to assess the effects of CM1 without the assumed benefits of completely successful habitat restoration. The total success of habitat restoration efforts remains highly uncertain, and an appropriate analysis should include an evaluation of the biological effects of at least a partial failure of efforts that are expected to "improve" conditions.

ICF has indicated that a comprehensive list of previously restored areas and "lessons learned" is included in the description of CM3, but we were not able to find the summary of "lessons learned". The list in Table 3.4.3-5 shows several estuarine aquatic habitat restoration projects but the "Results" column does not provide any direct links to improved biological metrics such as growth, survival, or abundance of native fishes.

ICF Response to NMFS 1.5: The proposed action is no longer an HCP and does not include largescale restoration. Some tidal restoration is proposed to compensate for effects as described in Section 3.4 of the BA. As described in that section, restoration sites will be selected and designed in coordination with NMFS, FWS, and DFW, and will include performance measures to ensure they achieve the expected outcomes. Separate environmental review, including ESA compliance will be needed for each restoration site.

Additionally, adaptive management will be utilized to minimize failures and adjust to observed restoration failures.

NMFS 1.6—Overreliance on Real-time Operations and Adaptive Management (Important)

Previous Comment: In several places, the EA assumes that adverse impacts of the PP will be fully resolved through the implementation of real-time operations and adaptive management. This may not always be possible. For example, long-term trends towards reduced carryover storage may not be able to be mitigated using real-time operations. How adaptive management might work in this situation has not been fully assessed. There are going to be limitations on what adaptive management and real time operations can accomplish.

1. Examine recent (five to ten years) real-time management of the cold water pool in Shasta Reservoir to determine both the effectiveness of real-time operations and a range of adaptive management options.

Update: The majority of upstream issues have been addressed through major changes in the proposed project (not withstanding some remaining issues with egg mortality and juvenile survival discussed below). However, there remains a need to more clearly describe how real-time operational adjustments will be implemented to achieve some of the stated objectives of the water operations. Specific examples include the need to thoroughly describe how the new intakes will be operated to: 1) avoid reverse flows at Georgiana Slough; 2) implement pulse protection when monitoring indicates that winter-run Chinook are "riding" a flow pulse; and 3) determine when a sufficient percentage of winter-run Chinook have passed the intakes to end the pulse protection and initiate standard level 1 pumping procedures. While it is understandable that these real-time criteria have not been developed to date (because they have not been necessary to complete CALSIM modeling and run monthly average models of effects), we will need greater specificity on real-time operations in order to meet Section 10 permit issuance criteria and complete the underlying Section 7 analysis. We recommend that an interagency technical team be formed immediately to work with ICF to start scoping these real-time criteria.

ICF Response to NMFS 1.6: ICF, NMFS, DWR, and CDFW have worked together to take a closer look at the hydrodynamics at and around the North Delta Diversions, including changes in the frequency and magnitude of reverse flows at Georgiana Slough. Please see response to NMFS 1.1, especially regarding revisions to the proposed action.

NMFS 1.7—North Delta Diversion Effects (Resolved)

Previous Comment: Mortality rates from predation and other screening effects are difficult to predict, as there is a high level of uncertainty associated with predation and other effects on juvenile salmonids. The estimate of <1% loss at all 5 screens is not sufficient without giving additional consideration to higher estimates of mortality (GCID empirical studies showed a 5% per screen loss rate, much higher than the <1% used in the DPM).

1. Bracket the analysis of screen related mortality around a 5% per screen loss assumption.

2. Investigate the use of DWR's hydrodynamic model to assess local flow alterations at the proposed diversion structures, including the creation of predator holding areas. Specific questions are whether the model can simulate on-bank structures and the additional hydrodynamic effects of active pumping.

Update: This comment has been addressed through the inclusion of a more comprehensive analysis of potential screen related mortality including an assessment of a 5% per screen loss rate. The recommendation to conduct a detailed hydrodynamic analysis of the screen face area is being advanced by the Fish Facilities Studies Group. This analysis should be incorporated into the effects analysis when it is available.

ICF Response to NMFS 1.7: The Fish Facilities Technical Team is continuing this evaluation. Results will be incorporated into the Biological Opinion if available.

NMFS 1.8—Predator Control Conservation Measure (Important)

Previous Comment: We agree that predation is a significant risk factor to the listed species, but the assumed positive results of this CM are questionable and unsupported (see F.5.4.1.4 in Appendix F). As an example, localized control of striped bass may not be feasible as this species exists throughout the Plan area and are highly mobile. Few specific details have been presented on how the CM will be implemented, and an aggressive predator removal program could result in significant incidental take of listed species. Due to the high level of uncertainty, we find it very unlikely that we could rely on this measure for any benefits during the permit process.

1. Remove this CM measure from the plan, and move it to an experimental research program and link to adaptive management. Reflect this appropriately in the EA.

Update: The authors have generally toned down the level and certainty of beneficial effects anticipated from CM15 (Predator Control). However, the measure still lacks an appropriate metric to measure the success (or lack thereof) of the predator control program and seems to assume phase 1 (the scoping stage) will show success and phase 2 will be implemented. There is no discussion of what happens if phase 1 shows no benefits from the program. The conservation measure needs to clearly explain how the success of this action will be measured (metrics and success criteria). The analysis of CM15 also needs to take the next step and describe the expected outcomes if the measure is less than fully successful. This is a very important element of any analysis of actions whose outcome is highly uncertain and should be considered a universal recommendation for all measures where the results of implementation have high uncertainty.

ICF Response to NMFS 1.8: Predator reduction measures are now proposed as part of the adaptive management plan described in Section 3.4 of the BA, and the analysis of project effects does not assume any benefits from this measure.

NMFS 1.9—Delta Passage Model (Important)

Previous Comment: The Delta Passage Model (DPM) is used as the sole predictor of smolt survival in baseline and PP scenarios. However, the assumptions, inputs, and results are still being validated and reviewed. The datasets used in this model are very limited and largely based on results from hatchery late-fall run Chinook, which are then being applied to other runs of Chinook.

1. Continue refinement and development of DPM. Weigh validity of results against those of other models and relationships. The use of Newman, 2003 may be another tool to use for assessing the survival of fall and spring run smolts through the Delta.

Update: DPM continues to be refined through discussions with Cramer Fish Sciences and NMFS. Survival analyses based on methods in Newman (2003) have been incorporated into the effects analysis, and results of both models showing similar trends for the modeled years are discussed in the net effects section. NMFS recommends that this model continue to be used as an informative tool but that the results be closely scrutinized to determine what is driving them and if they make sense based on the system as we know it. NMFS also recommends that additional peer review should be conducted – perhaps a reconvening of those who participated in the previous workshop in June 2011.

ICF Response to NMFS 1.9: Throughout the development of the BA effects analysis, ICF revised the DPM based upon NMFS and CDFW comments, including developing a number of sensitivity analyses and inclusion of updated information in the model.

NMFS 1.10—Deficient Analysis of Fry Passage/Survival (Important)

Previous Comment: Because the DPM model is only for smolt sized fish, the salmonid analysis is insufficient as it provides no information on fry-sized salmonid passage/survival.

1. Add qualitative analysis of fry survival based on best available data. Perhaps add time/added mortality to a modified version of an updated DPM model.

Update: In this new draft, fry growth is analyzed relative to the Yolo Bypass and a fry Particle Tracking Model (PTM) analysis was included (See Sections 5C.5.3.7; 5C.5.4.1.4). ICF has acknowledged these analyses need additional agency input for the public draft. The PTM analysis was discussed at recent species-specific meetings where it was determined that it may not be appropriate for this application. NMFS has requested (and ICF is working on) more detailed (3- and 7-day) PTM output to allow a closer look at travel time through key reaches, which may potentially be linked to fry survival rates through those reaches. It is generally agreed that neutral particle movement does not necessarily mimic the movement of living fish and the SWFSC/NMFS life cycle model will include a "smart PTM" component that attempts to add more "life-like" movement to the particles, which may provide a better way to analyze fry survival.

ICF Response to NMFS 1.10: NMFS has agreed that ICF should wait to see if the SMART PTM is ready for use in the final Plan analysis. If not, additional PTM analyses were to be developed in coordination with NMFS and CDFW and incorporated into the final Plan. Such analyses were not initiated and completed before work on the final Plan was terminated. For the CWF BiOp, SMART PTM will be available.

NMFS 1.11—PTM Runs Inadequately Capture Altered North Delta (Important)

Previous Comment: PTM model runs did not include conditions in which ND diversions would be at the upper limits of allowable pumping (high proportion of total river flow). The technical memo from NMFS and USFWS highlighted the issue and the resolution to the problem. We will need additional modeling runs to adequately assess ND diversion impacts on salmonid travel time and route entrainment.

1. Do additional PTM analysis following guidelines outlined in NMFS/USFWS memo.

Update: While it appears from Chapter 5, Appendix 5B.6 and Appendix 5C.4.3.2.4 that some of the suggested time periods were included, Attachment 5C.A.9 indicates that PTM was run for 24 representative months. These are the same months that were used in the previous (February 2012) effects analysis draft. The methods attachment needs to be updated to reflect the additional runs.

The time periods recommended by NMFS and USFWS were selected based on evaluation of impacts of a 15,000 cfs capacity project. It is possible that different time periods would be more appropriate to assess the effects of a 9,000 cfs capacity diversion. NMFS will continue to look into this and determine whether the modeled periods capture an appropriate range of effects from the updated project.

ICF Response to NMFS 1.11: The description of methods was updated to reflect all of the runs completed. At this time, no additional runs have been requested. For the CWF BiOp, SMART PTM will be available.

NMFS 1.12—D1641 Export/Inflow Ratio (Important)

Previous Comment: Combined north and south Delta exports under the PP exceed the current D-1641 Delta Export/Inflow standard. (The PP calculation method measures Sac River inflow below the North Delta diversions and does not include ND diversions as part of total exports).

1. Provide summary analysis of differences between PP and EBC by month and water year type using alternate E/I calculations.
2. Show resulting flow data for both calculation methods.

Update: The Export/Inflow (E/I) ratio has been applied two different ways in the three project scenarios (ESO, HOS, and LOS). The "Partial E/I", which measures Sacramento River inflow below the north Delta diversions and excludes north Delta diversions as part of total exports, has been applied to ESO and LOS. However, HOS has been modeled using the "Full E/I", which includes the full Sacramento River inflow upstream of the diversions as inflow and the north Delta diversion exports as exports. This is an inconsistency in approach that raises questions about the subsequent analyses. ICF has indicated that new analyses have been done but have not yet been fully incorporated into the effects analysis. There is placeholder language in CM1 showing both options but the actual operational criteria to be implemented upon project completion has yet to be decided. NMFS recommends that the "Full E/I" criteria be adopted and that this methodology be applied across all scenarios for consistency.

ICF Response to NMFS 1.12: In August 2013, ICF reviewed with NMFS, CDFW, USFWS, and DWR the modeling assumptions and differences between the 2 methods for calculating E/I ratios. Results indicate that there is a minor difference in June, but that other months were very similar. As a result of this information, it was agreed that the current D-1641 criteria would remain and that BDCP would not include a new E/I ratio. A clear description of why the different E/I ratios were used for the decision tree along with a demonstration of minimal differences were included in the public draft (Appendix 5.C.A). This same approach was carried forth in the proposed project.

NMFS 1.13—Yolo Bypass (Important)

Previous Comment: Yolo Bypass has great potential for fisheries benefits, but the current EA may be overstating the benefits without adequate studies or data to support these conclusions. Without project specific plans to help quantify the effects, concerns remain about issues such as sturgeon passage, juvenile salmonid survival under lower flow regimes, ability to get juveniles into the floodplain through notch and reduction of flows in the mainstem Sacramento River to accommodate additional flooding in Yolo Bypass. Also, some races/runs of salmon may not have access to Yolo Bypass.

1. Provide project specific plans and consider the risks of managing the floodplain under lower flows related to issues above.

Update: ICF has indicated that these project specific plans are not yet available, but risks related to stranding, passage, etc., are acknowledged. See Section 5C.5.4.1. This is another conservation measure where a lack of specific designs and operating criteria create significant uncertainty as to the efficacy of the measure and level of biological benefits that it will provide. However, the net effects analysis attributes broad success and significant benefits from the measure with no analysis of the consequences of less-than-complete success. We suggest that this is another area where an analysis of less than fully successful implementation should be conducted to determine the sensitivity of the overall plan to the success of this CM.

ICF Response to NMFS 1.13: The proposed project no longer includes Yolo Bypass restoration. This action is being planned and implemented separately from the California WaterFix and as such will include project-specific plans, information, designs, and analysis.

NMFS 1.14—Channel Margin Habitat (Important)

Previous Comment: Altered flows resulting from the North Delta diversions may result in reduced water levels affecting the percentage of time that current wetland and riparian benches are inundated.

1. Compare anticipated water levels under future scenarios with those in the design documents of restored wetlands and riparian benches to analyze potential dewatering of those features.

Update: NMFS and ICF are coordinating to develop and execute an effective analysis of the effects of proposed operations on inundation of existing wetland and riparian benches. We will need to assess the results of this analysis with respect to effects on covered fish once the analysis is completed. This analysis should also be submitted to independent peer review.

ICF Response to NMFS 1.14: The BA includes an analysis of effects of wetland benches and channel margin habitat restoration is proposed to offset project effects (See Section 3.4 of the BA).

NMFS 1.15—Construction and Maintenance Impacts (Important)

Previous Comment: The EA does not adequately address the potential for adverse impacts on sturgeon, fall-run Chinook adults, and steelhead adults, which are generally present in the project area during the proposed in-river work windows described for construction and maintenance of North Delta facilities.

1. Discuss ways of minimizing impacts and implementing mitigation for species not protected by work windows.

Update: NMFS has been working with ICF to incorporate more detail into the construction and maintenance impacts analysis. This has resulted in significant improvements in the analysis. However, several elements, particularly regarding the long-term maintenance of the facilities, lack the detail and specificity to allow NMFS to conduct a thorough assessment of the amount and extent of take that will need to be included in the permit and the Section 7 consultation analysis for the project. NMFS generally requires in-water construction projects to be at the 80% design stage for Section 7 consultations, and we will likely need that level of design completion to conduct a thorough assessment of the amount and extent of take for this large construction project. We request information from ICF on when this level of design will be ready in order to understand the implications for the schedule, if any.

ICF Response to NMFS 1.15: Since changing the ESA compliance approach to Section 7, substantial information has been developed and included in the project description, and the associated analysis has been substantially refined. As of September 2016, NMFS has determined the information included in the BA was sufficient for entering formal consultation. ICF will continue to coordinate with NMFS regarding specific construction-related detail and associated analyses to support development of the BiOp.

NMFS 1.16—Tidal Marsh Impacts on Riverine Flow (Important)

Previous Comment: The effect analysis assumes that restored tidal marsh will act to decrease flow reversals, which has not been well explained. It seems that tidal marsh restoration was modeled as a single configuration; there has been no description of that configuration to indicate how they were implemented in the hydrodynamic models. Therefore, there is a lot of uncertainty regarding model results.

1. Document changes to hydrodynamic models that were implemented to characterize tidal marsh restoration.

Update: ICF has communicated to NMFS that the data that can be provided is limited, and that ICF and DWR have provided as much specificity as they can. ICF met with NMFS and other agencies on March 5, 2013, to provide additional information regarding the relationship between restoration and tidal dampening as they relate to riverine hydrodynamics, and more specifically to reverse flows near Georgiana Slough (See Appendix 5.C). We suggest that the document include a more comprehensive narrative of the tidal hydrodynamics and the effects of tidal habitat restoration, including a discussion of the RMA modeling conducted on this topic. Because of the importance of this analysis to determining potential project effects on covered fish, we recommend that these methods be independently peer reviewed and appropriately characterized for their uncertainty.

ICF Response to NMFS 1.16: A more detailed description of the hydrodynamic implications of tidal wetland restoration, especially as it relates to Sacramento River flows and Georgiana Slough flows was included in the public draft (Chapter 5, Section 5.3.3.2.1, *Hydrodynamics*). However, the proposed project does not include substantial habitat restoration and as such, the modeling and analysis included in the BA do not require interpretation of the relationship between restoration and tidal dampening.

NMFS 1.17—Cumulative Effects Show Long-Term Viability Concerns for Salmon (Critical)

Previous Comment: The analysis indicates that the cumulative effects of climate change along with the impacts of the PP may result in the extirpation of mainstem Sacramento River populations of winter-run and spring-run Chinook salmon over the term of the permit.

1. Incorporate operational criteria into the PP that will protect and conserve suitable habitat conditions in the upper river for the species under the 50 year HCP (these operational criteria should be designed to meet the performance criteria in the NMFS BiOp RPA).

2. Convene a 5-agency team of experts specialized in Shasta operations and temperature management to develop the above described operational criteria.

Update: The current efforts to develop a fully “aggregated” effects analysis should address the analytical concerns related to this issue, but the fact that the cumulative effects of the project when combined with effects of climate change and other baseline conditions is showing the potential extirpation of mainstem Sacramento River populations of winter-run and spring-run Chinook salmon over the term of the permit remains as a serious concern.

The reported OBAN and IOS modeling results indicate a potential issue with either the modeling tools (OBAN and IOS), or the author’s assertion that the upstream flows associated with EBC2 and ESO are “essentially identical”. The conclusions in this section state that “The majority of the effects of both BDCP and climate change were driven by increases in upstream temperatures affecting egg survival, which, relative to the BDCP contribution, is a potential modeling artifact and not an actual predicted effect.” However, ICF has determined that these are the best modeling tools available. The results cannot necessarily be discounted because they do not show what was “expected”. Since these methods were deemed acceptable, the results need to be fully acknowledged.

The results of these models signal a need for further investigation to determine why they are not what are “expected”. It seems that upstream releases between ESO and EBC2 do not match as well as thought, as seen in Table 5C.5.2-2 titled “Difference and Percent Difference in Flows in the Sacramento River at Keswick, Year-Round”. Some summertime and fall months in drier years are very different, which may be what is causing the biological models to show a negative egg survival response. The table below shows the results of month-to-month comparisons of flows out of Keswick for LLT. It indicates that the ESO flows could be as much as 6,500 cfs less than EBC2 flows (November) when months are evaluated individually, and not grouped by month and water year type.

Table 5C.5.2-2. Difference and Percent Difference in Flows in the Sacramento River at Keswick, Year-Round

Month	Maximum Difference (ESO_LLT–EBC_LLT)
January	-7,683
February	-1,571
March	-4,825
April	-1,221
May	-830
June	-2,979
July	-5,916
August	-3,712
September	-2,691
October	-5,510
November	-6,504
December	-4,594

We recommend that ICF work with the Shasta operations experts at Reclamation, and possibly a broader workgroup of biological and operations experts to resolve these issues and determine if/how the entire project can be operated to insure that BDCP does not cause impacts to upstream spawning and rearing habitat in the Sacramento River.

ICF Response to NMFS 1.17: The proposed project was revised to avoid and minimize changes in Sacramento River flows caused by the project. Additionally, as described in the BA (Section 3.1.4.5), Reclamation initiated an RPA revision process specific to Sacramento River temperature management to address existing and future operational issues for CVP operations unrelated to the proposed project.

NMFS 1.18—Holistic Estuarine Evaluation (Critical)

Previous Comment: The effects analysis should examine synergistic and cumulative ecological impacts associated with reducing inflows to an estuary that is already severely degraded, and discuss the importance that water quantity, quality, and the natural hydrograph have to the ecosystem, as well as the direct impacts on native fish species. So far, the impacts to fish have mostly been examined in a piecemeal fashion (e.g., examining impacts of flow reduction on adult homing).

1. Incorporate a holistic evaluation of impacts on the estuarine ecosystem. Include discussion of the importance of water quantity, quality, and the natural hydrograph to the ecosystem, and the direct impact that changes to these conditions have on native fish species.

Update: The holistic evaluation described above in our previous recommendation does not appear in the 2013 Admin Draft of BDCP. We suggest that ICF use Carlise et al. (2010) as a starting point for this discussion. Carlisle et al. found that in an analysis of over 200 stream systems, "biological assessments showed that, relative to eight chemical and physical covariates, diminished flow magnitudes were the primary predictors of biological integrity for fish and macroinvertebrate communities". In other words, the change in flow was a better predictor of whether the biotic communities were impaired than variables such as temperature, pH, total nitrogen, or urban land cover. It is also well recognized that streamflow reductions can impair the ecological function of downstream estuaries (Drinkwater and Frank 1994; Jassby et al. 1995; Loneragen 1999; Flannery et al. 2002; Winder et al. 2011).

ICF Response to NMFS 1.18: The recommended paper was reviewed by ICF but was not deemed appropriate to include in the analysis, as the emphasis of the analysis was the comparison between the proposed Plan and baseline conditions, as opposed to the comparison to (unimpaired) reference conditions as was undertaken by Carlisle et al. (2011).

NMFS 1.19—Burden of Proof (Important)

Previous Comment: Deference should be given to known population drivers and documented relationships (e.g., sturgeon recruitment relationship with flows is well documented, though the exact mechanism is not completely understood). Since flow is a key component of habitat for aquatic species, do not assume that it can be substituted for by other actions.

Do not assume that incremental benefits in a conservation measure will compensate for known population drivers related to flow.

Update: There has been significant improvement in the language used to describe the level of certainty of potential benefits attributed to those CMs that are less certain in their implementability or effectiveness for protecting covered fish. However there remain some instances of overstating/understating of beneficial/detrimental effects. For instance, the net effects analysis concludes that CM2 will "increase floodplain availability and usage and improve conditions for juvenile and adult winter-run Chinook salmon". However, the analytical methods for juveniles suggest only a low or moderate positive change. There are some stated conclusions that are based on analyses that are not yet complete (e.g., bench inundation). Some conclusions suggest that decreases in flows due to the project are "rare" because they only occur in some months of drier water years. But since dry and below normal water years can occur 40% of the time, this should not be considered a "rare" occurrence. There are numerous additional examples of these types of analytical discrepancies provided in the "track-changes" comments on the Admin Draft provided by NMFS.

ICF Response to NMFS 1.19: ICF, DWR, Reclamation, NMFS, FWS, and DFW worked collaboratively to develop the methods and analysis included in the BA, including the appropriate way to characterize results.

NMFS 1.20—Incomplete Analyses and Documentation (Important)

Previous Comment: The full appendices were not released concurrently with Chapter 5 which makes review of the results problematic.

1. Provide all appendices/analysis simultaneously so Services can have all pertinent information used in Effects Analysis summaries without having to backtrack weeks later.

Update: While NMFS received the majority of the document on 12/21/12, this did not include Chapter 5.5 Effects on Covered Fish. Appendix 5.B Entrainment was provided on 1/2/13. Chapter 5.5 Effects on Covered Fish was provided on 2/7/13. This lag reduced the ability to simultaneously view results in appendices and assess how they were incorporated into Chapter 5.5.

The "complete" Admin Draft was delivered on March 4, 2013. This presumably includes all additional outstanding sections (Section 5.3, Ecosystem and Landscape Effects; Table 5.2-5, Biological Objectives for Covered Fish and Their Assessment in the Effects Analysis; Tables 5C.0-3 and 5C.0-4, Summary Tables; Appendix 5.I, Critical Habitat and Essential Fish Habitat Analyses). NMFS has not had an opportunity to conduct a thorough review of this recent submittal.

Specific documentation for all analytical methods are not included or are outdated or incorrect (e.g., SacEFT documentation is outdated according to its developers; OBAN, MIKE21, SALMOD, Reclamation Mortality Model documentation is not included at all). This makes it impossible to fully understand how these models were configured or to determine the exact drivers of the reported results. It appears at times that the chapters/appendices were written by staff unfamiliar with the model operations and intricacies of results.

NMFS suggest that future drafts include updated and correct documentation (manuscripts, user's manuals, etc.) for all analytical methods. Documentation should include listings of all relevant input parameters and relationships. ICF should also draw on the expertise of the developers of specific models to interpret model results, identify uncertainties and limitations, and verify the stated conclusions.

ICF Response to NMFS 1.20: The full and complete BA was provided to NMFS and FWS on July 29, 2016 and was also posted to the California WaterFix website.

NMFS 1.21—Insufficient Biological Goals and Objectives (Important)

Previous Comment: The conservation measures are sometimes defining the BDCP species objectives, which is insufficient. 30% juvenile through-Delta survival is not a suitable goal for a 50 year conservation plan.

1. The BDCP objectives should be biological, species-level outcomes.

Update: This issue has generally been resolved (for salmonid BGOs) through the incorporation of the recommendations provided in NMFS' technical memo on juvenile salmonid through-delta survival. However, the text that describes the BDCP's level of responsibility for achieving the through-delta survival objectives does not match what is described in the NMFS tech memo on salmonid BGOs. The tech memo calls for the BDCP to be responsible for 100% of the improvement in smolt survival through the Delta, not >50%. This is because it will be impossible to determine causation for any measured increase in through-delta survival rate. The specific objectives are interim and should be reevaluated over time. The actual tech memo should be included as an appendix to Chapter 3.

The biological objectives for sturgeon abundance and productivity (under GRST1) are vague and rely too much on "documenting the current distribution" and future studies. There needs to be greater emphasis on the objective to provide adequate adult attraction flows.

ICF Response to NMFS 1.21: As the ESA compliance approach is Section 7, there are no longer BGOs.

NMFS 1.22—OMR Flows Unimproved in Drier Water Years (Important)

Previous Comment: Improved OMR flows under the PP occur during wetter years when OMR is less of an issue for covered fish. PP OMR flows are often worse than, or similar to, EBC in drier years. Sacramento Basin fish are most vulnerable to entrainment into the central Delta in drier years when Sacramento River flows have the potential to reverse and OMR levels are below -2,500 cfs. San Joaquin basin fish are best protected by increased Vernalis flows and/or a HORB which the PP does not address.

1. Analyze the risk in different water year types and with different flow levels in the Sacramento River.
2. Implement Scenario-6 to help address the adverse impacts seen under the PP.

Update: This issue has generally been addressed by adopting "Scenario 6" into the proposed project and including the High Outflow Scenario into the decision tree. There were additional south Delta operational criteria included in the agency recommendations developed in the CS5 process. These included additional protections in the "shoulder" months of the juvenile salmonid migratory period (March and June), as well as summer OMR criteria intended to provide protections against sturgeon entrainment into the export facilities. The potential biological benefits of these CS5 criteria should be assessed in the effects analysis. ICF's participation in the South Delta Research Collaborative will provide an important linkage between BDCP and the conceptual models and hypotheses emerging from that effort. This remains a key issue because of the importance of improving survival of emigrating salmonids from the San Joaquin River system, which is generally less than 10%. We recommend continued iterations on these operations prior to Plan completion, and between Plan completion and full implementation (during ELT).

ICF Response to NMFS 1.22: Scenario 6 remains the proposed operational criteria for south Delta operations. The effects analysis shows substantial reductions in entrainment. Real-time operations are also included as part of the proposed action and includes triggers for adjustments consistent with the current RPAs.

NMFS 1.23—Non-Physical Barriers (Important)

Previous Comment: Assessment of non-physical barriers is inadequate, and the potential negative effects of predation associated with non-physical barriers haven't been assessed.

1. Include analysis of potential adverse effects of non-physical barriers.

Update: This is another instance where the certainty of beneficial effects from a CM is overstated in relation to the amount and quality of data on which those conclusions are based. The Georgiana Slough non-physical barrier (NPB) effectiveness is based on one year of data from high flow conditions. We have yet to see results from a lower-flow year when reverse flows at the Georgiana Slough junction may be more frequent. It should also be acknowledged that under the OCAP Reasonable and Prudent Alternatives (RPA) the development and implementation of NPBs would be required if they are found to be effective.

Also, the way in which the effects of NPBs are described is confusing and potentially misleading. According to Appendix 5C.5.4 Methods, there was a 67% reduction in the proportion of fish entering GS/DCC (from 22.1% to 7.4%). However, in the text it is often stated that the NPB provides a "67% deterrence", which implies that 67% of fish approaching the junction would be deterred, and therefore stay in the mainstem. That is not true. It would be better to describe this as a "67% decrease in proportional entry into GS."

ICF Response to NMFS 1.23: The analysis included in the BA is based upon the best available information relative to both beneficial and negative effects of the non-physical barrier proposed at Georgiana Slough. No other non-physical barriers are proposed. As described in the BA, future consultation would be necessary to implement this conservation measure.

NMFS 1.23.1—Carry-over of OCAP RPA's on Technological Improvements to the South Delta Facilities (Critical)

Previous Comment: By not carrying forward technological fixes in the South Delta called for in the OCAP RPAs into the Conservation Measures, we would expect the effects analysis to specifically flag this and analyze it as a degradation to future conditions (as compared to the baseline which should include the RPA improvements).

1. Add south Delta technological improvement RPA's to Conservation Measures

Update: ICF states that "Many RPAs are assumed to be completed prior to the implementation of BDCP and/or CM1 and are therefore assumed in the baseline (This is clarified in Tables 3.2-1 and 5.2-2.)". However, all the comparisons in the effects analysis are to current levels of pre-screen loss and salvage, not to what they might be with these RPA elements implemented. Therefore, the results overstate the benefits of the project as compared to an appropriate baseline condition which should include these RPA required improvements.

This same issue is repeated by the fact that the analytical baseline (EBC) does not include potential beneficial effects of Yolo Bypass floodplain habitat restoration, and implementation of non-physical barriers, both of which are included in the OCAP RPA. This is a significant flaw in the net effects analysis. The analysis needs a clearly stated caveat of interpretation of results to reflect this limitation. The aggregate analysis should be helpful in addressing these beneficial effects in a different framework.

ICF Response to NMFS 1.23.1: Table 3.1-1 of the BA details which RPAs are included in the baseline and which are assumed to be implemented as part of or during California WaterFix implementation. The baseline condition has been crosschecked and ensured consistent across all effects analyses to prevent overstatement of benefits. The Yolo Bypass restoration is assumed to be part of the baseline, as are ongoing improvements to south Delta facilities required by the BiOps.

NMFS 1.24—Feasibility of 65K acres of Habitat Restoration (Critical)

Previous Comment: Recent evaluation of land available for habitat restoration indicates potential roadblocks to acquiring all the land proposed in the PP. DWR's own analysis suggests that 65K acres is very unlikely.

1. Analyze the potential effects of partial implementation of habitat restoration and incorporate alternative actions or measures to compensate for this possibility.

Update: The previous comment from 2012 was referring specifically to tidal wetland habitat. Since that time DWR has revised their habitat restoration feasibility analysis and expanded the definition of the "tidal natural communities" category to include all tidally influenced habitats to be restored under BDCP. DWR believes that it will be possible to fully achieve the plan's habitat restoration goals. However, there is no specific analysis of the feasibility of acquiring 65,000 acres of land appropriate for tidally influenced habitat restoration provided in the document. All related analyses proceed as if restoration will be wholly successful; there are no bounding analyses to show the effects of CM1 operations if restoration either cannot be completed to the full extent or is not fully successful. Therefore, our previous recommendation stands: Analyze the potential effects of partial implementation of habitat restoration and incorporate alternative actions or measures to compensate for this possibility.

ICF Response to NMFS 1.24: The proposed action is no longer an HCP and does not include largescale restoration. Some tidal restoration is proposed to compensate for effects as described in Section 3.4 of the BA. The restoration would require project-specific consultation and performance measures.

Section 2—Additional Issues to be Resolved for Public Draft

Chapter 1

Introduction—Track changes comments submitted separately.

ICF Response: No final BDCP was prepared.

Chapter 2

Existing Ecological Conditions—Track changes comments submitted separately.

ICF Response: No final BDCP was prepared.

Chapter 3

NMFS 2.1—Decision tree process needs to include consideration of flow needs for salmonids and sturgeon (Section 3.4)

Modeling results of the HOS indicate that flow requirements intended to address the needs of smelt would also be likely to address some of the flow requirements for salmonids and sturgeon identified through the CS5 process. However, the description of the Decision Tree management process states that monitoring and research used to determine which "tree branch" would be implemented would only look at smelt issues and would not attempt to determine which flow scenario would be appropriate for salmonids and sturgeon. The monitoring and research should also investigate the flow needs of salmonids and sturgeon and the determination of which flow scenario will be implemented should be based on the needs of all covered species. There also needs to be a clear understanding that while the current Decision Tree would create four possible combinations of spring and fall outflow criteria that would be included in the range of potential options for initial study, prior to commencement of conveyance operations, there will be a new determination by the permitting agencies specifying what the spring and fall outflow criteria will be at the time the new facility begins to operate. This determination will be based on all best available science, including that developed during the decision tree process.

ICF Response to NMFS 2.1: The proposed project does not include a decision tree. Instead, it includes operational criteria, including real-time operations, to address each of the listed species' needs relative to the proposed project based on the best available information available. Additionally, the adaptive management program can be used to make adjustments to this criteria as appropriate as new information is developed, including regarding listed salmonids and sturgeon.

NMFS 2.2—Sensitivity analysis of likely effects of future increase in south-of-delta storage capabilities (Section 3.4)

There is a high likelihood that south-of-delta storage capabilities will be increased over the 50-year term of this permit. There is also the potential for such an increase in storage capacity to result in water operation parameters (pumping rates/timing, OMR flows, I/E ratios, etc.) that differ from those modeled in the current analysis. There needs to be a "sensitivity analysis" of the likely effects of future increase in south-of-delta storage capabilities on these operational parameters and the resulting biological effects on covered species.

ICF Response to NMFS 2.2: The proposed project does not include any proposed changes in south-of-Delta storage, nor is this included in the baseline. The effects of the operational criteria proposed are evaluated in the BA, and the BiOp will include take limits that must not be exceeded.

NMFS 2.3—No description of "operational phasing" of north Delta facilities (Section 3.4 and 3.6)

The document lacks any language describing the agreement to use "operational phasing" in lieu of construction phasing, as agreed to by the BDCP principals. The plan will need to include significant detail on the monitoring and metrics necessary to implement the operational phasing agreement and a detailed description of how all aspects of that agreement will be implemented. We have provided the document describing the details of the Principals' agreement last spring, and these need to be accurately reflected in the conservation measures and as a separate section of the adaptive management chapter.

ICF Response to NMFS 2.3: Operational phasing has been incorporated into the facility design constraints in Chapter 3 (Section 3.3.2.1).

NMFS 2.4—The Role of Adaptive Management (Section 3.6)

Almost three years ago, the Federal Agencies issued a white paper on application of the Five Point Policy to the BDCP (document attached to this memorandum). It articulated the role of adaptive management in the BDCP, saying, in part, that

> "The BDCP is a complex, landscape scale, long-term HCP with a high degree of uncertainty as to how close the initial conservation measures will come to achieving the plan's biological goals and objectives. It falls into the category of plans that will be a mixture of the two strategies, with initial prescriptions associated with adaptive management, and specific biological outcomes defining the ultimate success of the plan. This type of plan will allow management flexibility so the permittee may institute actions necessary to achieve the plan's goals while providing boundaries for future expectations and commitments. In addition, a results-based plan will address uncertainty in the ecosystem and provide the conservation assurances required by the Act. The Services will be challenged to make the findings required for permit issuance if the plan does not include clearly defined and scientifically supported biological goals and objectives, an adaptive management plan that tests alternative strategies for meeting those biological goals and objectives, and a framework for adjusting future conservation actions, if necessary, based on what is learned." (4/29/2010 memo, page 1)

The adaptive management program created by the BDCP serves the essential functions of (1) assuring that alternative conservation measure designs that might more efficiently achieve objectives are studied and, where appropriate, implemented; (2) providing a workable framework for deliberating difficult management issues and proposing solutions; and (3) providing transparency in the management of the BDCP to ensure public confidence that the conservation measures and strategies implemented under the plan are based on the best available science. We have concerns with the current draft on all three of these points.

ICF Response to NMFS 2.4: The adaptive management program for the proposed project, which is not an HCP, is an integral component and has attempted to capture the three essential functions above.

NMFS 2.5—Adaptive limits (Section 3.6)

"Adaptive limits" in the BDCP refers to the most extreme sets of operational parameters that might be required or authorized to the permittee through the working of adaptive management over the life of the permit. Some discussion of what such parameter-by-parameter limits might be has already occurred, but neither the concept of adaptive limits nor a draft example of them is included in the current BDCP draft. This leaves open the question of what commitment of resources might be required of the permittee.

As is clear in both the HCP Handbook and the Five Point Policy, the permittee in an HCP is protected by the inclusion of adaptive limits that "clearly state the range of possible operating conservation program adjustments due to significant new information, risk or uncertainty. This range defines the limits of what recourse commitments may be required of the permittee. This process will enable the applicant to assess the potential economic impacts of adjustments before agreeing to the HCP." 65 Fed. Reg. 35253; see also HCP Planning Handbook at 3-24–3-25.

In the BDCP, adaptive limits would provide an important assurance that would protect the permittee from an open-ended obligation to commit resources irrespective of circumstances. They would also provide an important level of transparency to the permittee and the public regarding the commitments represented in the plan. The range of adaptations to reflect evolving scientific understanding and improved information on the effectiveness of the various conservation measures are usually described as changed circumstances within an HCP that has high scientific uncertainty, such as this one, and therefore do not trigger a formal plan amendment. Thus, the adaptive limits serve as an important guide regarding the boundaries of the anticipated changed circumstances.

ICF Response to NMFS 2.5: Adaptive limits are not a component of Section 7 consultations and as such, none are proposed.

NMFS 2.6—Role of BGOs (Section 3.3)

Biological Goals and Objectives form the core of the BDCP. Biological goals represent the ultimate conservation outcomes toward which the plan is striving. In some cases, achievement of ultimate goals lies within the power of the BDCP; in others the achievement of goals depends in part on factors that are outside the control of the water projects. Objectives are lower-level outcomes within each goal that are essential to achieving the overarching goal. To be effective, objectives need to be SMART: specific, measurable, achievable, relevant to the goal, and time-bound. In addition to meeting the other SMART criteria, BDCP objectives are "achievable" because they are within the power of the water projects to achieve, and essential to BDCP success because they are "relevant to the goal[s]."

BDCP conservation measures are designed to achieve the biological objectives of the plan. Because of this, BDCP adaptive management will primarily focus on adjustment of the conservation measures to achieve the objectives as efficiently as possible.

The document generally makes it clear that the BGOs will be used to guide the implementation of conservation measures, but we have important concerns with the way objectives are used.

1. The plan needs to clearly acknowledge and articulate that achieving the outcomes described in the Objectives is the actual basis of the entire conservation strategy and its constituent conservation measures. Continuing to achieve objectives is necessary for progress toward recovery of covered species and in many cases will be required for compliance with the terms of the BDCP permit.

2. The plan needs to clearly articulate that the adaptive management program will focus on ensuring that plan objectives are being met. Indeed, looking at alternative management strategies to achieve program objectives is fundamentally what AM is designed to do. Failure of conservation measures to achieve objectives will, therefore, be a basis for the AMT to propose changes to conservation measures. There are several statements of the role of adaptive management in chapters 3, 6, and 7 that need to be edited to make this clear.

3. The plan needs to make clear that objectives are themselves subject to adaptive management. Objectives are ultimately based on models describing the relationship of

covered species to their environments, and changes to those models might occasion any of the following: changing an objective either up or down, adding an new objective to reflect improved understanding, removing an objective that is superseded or found not to be relevant to achieving its overarching goal. Deliberations on these issues is properly a subject for the AMT, with oversight by the AEG, POG, and ultimately the fish and wildlife agencies with final authority on adaptive management decisions. Though chapter 7 lays out a clear role for the AMT in these matters, Section 3.6 is currently ambiguous and contradictory on the role of the AMT and how it makes decisions. Furthermore, Section 3.6 does not adequately articulate how the AMT will exercise its responsibilities with respect to the nine enumerated steps of adaptive management, making it quite unclear whether the AMT is appropriately empowered to carry out its mission.

4. Implementation of the conservation measures as initially described in the plan does not constitute the extent of the responsibilities of the Authorized Entities. Achieving the outcomes described in the objectives is the primary responsibility of those implementing the plan.

ICF Response to NMFS 2.5: As the ESA compliance approach is Section 7, there are no longer BGOs.

NMFS 2.7—Effects of proposed operations on Coordinated Operations Agreement

There have been frequent discussions within various workgroups and meetings on the potential for some proposed operational scenarios to affect the Coordinated Operations Agreement (COA) agreement between Reclamation and DWR, but we were unable to find anything in the document describing this subject. If this is truly an issue, and certain operational scenarios intended to benefit covered species will require amendments to the COA agreement, this should be described somewhere in the document as part of the process necessary to implement the BDCP.

ICF Response to NMFS 2.7: Operations of the proposed project do not necessitate changes to the COA as described in Chapter 3 of the BA. Appendix 5.A of the BA includes modeling results to demonstrate this.

Chapter 4

Covered Activities and Federal Actions - Track changes comments submitted separately.

ICF Response: No final BDCP was prepared.

Chapter 5

NMFS 2.8—Potential project related impacts on upstream egg and juvenile survival continue to be predicted in model results (Section 5.5 and Appendix 5.C)

OBAN, IOS and SacEFT model results continue to indicate that slight differences in Keswick release strategies between the ESO and EBC will result in increased egg mortality upstream. Lower flows in key summer and fall months increase egg mortality for winter-run and spring-run Chinook salmon and potentially other runs. SacEFT habitat results show significant impacts on spawning and rearing habitat for winter-run that are above and beyond effects of climate change.

Critical year egg mortality is very high by the LLT suggesting that a few dry/critical years in a row could potentially cause significant impacts to Sacramento River-dependent ESUs over the 50 year permit timeframe. The analysis shows that ESO criteria could result in riskier operations relating to stranding risk for juveniles (over two times more low risk years under EBC). The document should provide full SacEFT results – not just a summary of "good" year conditions. We are also interested in "poor" year conditions between the scenarios.

The analysis should provide a better examination of "worst case scenarios" for indicators like juvenile production, egg survival, escapement, etc. ESO appears to have riskier operations that result in half as many juveniles in minimum estimates of SALMOD. It may be useful to develop threshold juvenile production estimates (JPEs) of concern that can be compared between scenarios.

> **ICF Response to NMFS 2.8: The proposed project was revised to avoid and minimize changes in Sacramento River flows caused by the project. Additionally, as described in the BA (Section 3.1.4.5), Reclamation initiated an RPA revision process specific to Sacramento River temperature management to address existing and future operational issues for CVP operations unrelated to the proposed project. In addition, a "worst case scenario" threshold was developed with agency input for the BDCP and evaluated using SALMOD outputs in the Nov 2013 Draft BDCP. The "worst case scenario" threshold analysis was later refined and evaluated in the Biological Assessment with agency input for the new proposed project.**

NMFS 2.9—Additional Analysis of Feather River and Oroville Reoperations (Section 5.5 and Appendix 5.C)

Increased summertime temperatures in the Feather River may have effects on the reproductive success of sturgeon, especially for the high outflow scenario. While the high spring-time Feather River flows modeled in HOS could attract sturgeon into the Feather River from the Sacramento River, summertime releases are decreased compared to EBC2 to provide for end-of-September storage requirements. The decreased summertime river flows increase water temperatures in the high-flow channel; the resulting temperatures reported in the effects analysis would be lethal to sturgeon eggs and embryos. This is not discussed in the net effects section because lethal egg temperatures are not considered in the net effects conclusions. NMFS is also concerned with the low frequency with which the ESO and HOS meet the recommended minimum spring flows in above normal and below normal water years.

The forecasting method for Oroville releases is not clearly defined in any section. The effects of relying on Oroville to meet HOS spring-time Delta outflow requirements are reviewed in Chapter 5 (Appendix C Attachment A), and there are references to reduction of exports to also meet the outflow target. Chapter 5 Appendix C.2 presents NMFS' recommended Feather River flow schedule, but there are unexplained modifications and no description of the driving constraints or storage forecasting methodology. While these operations need to be described, the effects analysis should also address any influence of the potential temperature compliance point included in the Dec 2012 Settlement Agreement for Licensing of the Oroville Facilities. This would require compliance to 64° F from May-September in the high flow channel, and the Robinson Riffle criteria for protection of spring-run Chinook in the low flow channel, which could be affected as a result of changes in end of May storage and resulting diminishment of the cold water pool. Because of the potential biological importance of re-operation of Oroville, we recommend that the entire set of decisions and effects analysis be submitted for independent peer review to further assist in predicting these effects.

> **ICF Response to NMFS 2.9: As described in Section 4.4 of the BA, NMFS is consulting with FERC regarding Feather River operations. The proposed project operations do not include the HOS, and as described in Section 4.4, the proposed project would not preclude operations of Feather River consistent with the draft BiOp and settlement agreement for the Feather River FERC relicensing, and there would be no differences in operations as modeled.**

NMFS 2.10—Turbidity Reduction Analysis (Chapter 5 and Appendix 5.F)

While Chapter 5 and Appendix 5.F contain discussion and evaluation of water clarity and the change in sediment delivery to the Delta due to the project, it does not specifically address the localized change in turbidity or sediment transport that may result due to reduced river velocity downstream of the north Delta diversion structures.

ICF could use DSM2 results to evaluate whether any reductions in flow velocity downstream of the intakes will reduce sediment transport capacity, causing deposition and reduced turbidity.

> **ICF Response to NMFS 2.10: For the BDCP effects analysis, the potential effect of less flow below the NDD resulting in less turbidity as a result of changes in velocity, for example, was examined with respect to the analysis based on Newman (2003), which used DSM2 inputs and estimated turbidity as a function of flow.**

NMFS 2.11—Poor linkage between net effects results and achievement of biological objectives (Section 5.5 and Section 3.3)

The net effects analysis needs to include a section(s) that specifically ties the results of the net effects to the achievement of the BGOs for each species. We need to be able to determine the likelihood of the various operational scenarios actually achieving the BGOs for each species. A rough examination of this issue in the current draft indicates that it may be difficult to meet the through-delta survival objectives for salmonids under the proposed operational criteria.

> **ICF Response to NMFS 2.11: As the proposed project is no longer an HCP, there are no BGOs. However, the effects analysis included in the BA reflects several years of multi-agency coordination to develop methods and analyses based on the best available information.**

Chapter 6

NMFS 2.12—Expansion of Changed Circumstances and adaptive responses to those Changed Circumstances (Section 6.4)

There are numerous problems with the latter sections of Chapter 6 (Sections 6.4 and 6.5). The list of foreseeable changed circumstances described in Section 6.4 needs to be significantly expanded and the range of adaptive responses available to address those changed circumstances is far too narrow and limiting. At a minimum, changed circumstances should consider all foreseeable changes in storage, conveyance and operations external to the BDCP conservation measures but that could substantially affect the CALSIM runs and therefore the effects analysis that supports the BDCP permit issuance criteria. These include: new North of Delta storage, new South of Delta storage, and new State Water Resources Control Board San Joaquin and Delta flow criteria. In general, we expect any one of these would trigger a new analysis of effects and the potential for changes to conservation measures. The Five Agencies will need to review this section and come to agreement on revising its contents prior to release of the public draft of the plan. More detailed comments on the issues with this section of Chapter 6 are provided in NMFS' "track-changes" submittal.

ICF Response to NMFS 2.12: As the proposed project is no longer an HCP, there is no discussion within the BA regarding changed circumstances. However, an integral component of the proposed project is the adaptive management program, which would be used to develop and integrate information as it is developed to constantly improve management of the Delta, even as other conditions change.

Chapter 7

NMFS 2.13—Governance

While many of the important issues regarding the governance of plan implementation have been resolved over the last few years, one of the remaining significant issues is the lack of a clear tables and graphics describing how entities relate to each other (e.g. organization charts or flow charts) and which entities will retain final decision making power over each of the major categories of decisions to be made. We recommend that the "decision table" that was developed in the Principals workshop process be included in the document, with any necessary edits, to explain the decision-making process that was agreed to in the text.

There are also some issues regarding the role of the implementing office and its employees that remain to be resolved in Chapters 3, 6, and 7. The plan needs to be clear that adjustment of the conservation measures and other actions that are necessarily and appropriately part of adaptive management are to be managed and administered by the Adaptive Management Team, and not by the Implementation Office or any of its employees, including the Program Manager and the Science Manager.

ICF Response to NMFS 2.13: As the proposed project is not an HCP, there is no governance structure. However, an integral component of the proposed project is the adaptive management program, which identifies the roles, responsibilities, and decision-makers for various aspects of the adaptive management.

Chapter 8

Implementation Cost and Funding Sources - Section is pending changes and was not reviewed at this time.

Chapter 9

Alternatives to Take - Track changes comments submitted separately. Intend additional review upon release of revised version.

Chapter 10

Integration of Independent Science - Track changes comments submitted separately. Intend additional review upon release of revised version.