Appendix 3G

Background on the Process of Developing the BDCP Conservation Measures

APPENDIX 3G
BACKGROUND ON THE PROCESS OF DEVELOPING THE BDCP CONSERVATION MEASURES

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Tables and Figures

Acronyms and Abbreviations

8RI	8-River Index
BDCP or the Plan	Bay Delta Conservation Plan
BiOps	biological opinions
CALFED	California Bay-Delta Authority
CalLite	Central Valley Water Management screening model
CALSIM II	California Water Resources Simulation model version II
CFR	Code of Federal Regulations
cfs	cubic feet per second
CSA	conservation strategy alternatives
CVP	Central Valley Project
Delta	Sacramento-San Joaquin River Delta
DFG	California Department of Fish and Game
DHCCP	Delta Habitat Conservation & Conveyance Program
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
DSM2	Delta Simulation Model version 2
DWR	California Department of Water Resources
EIR	environmental impact report
EIS	environmental impact statement
ESA	Endangered Species Act
fish and wildlife agencies	U.S. Fish and Wildlife Service, national Marine Fisheries Service, California Department of Fish and Game
FR	*Federal Register*
HCP	habitat conservation plan
NCCPA	Natural Community Conservation Planning Act
NMFS	National Marine Fisheries Service
ROA	Restoration Opportunity Areas
SWP	State Water Project
USFWS	U.S. Fish and Wildlife Service

Appendix 3G
Background on the Process of Developing the BDCP Conservation Measures

3G.1 Introduction

This document describes the process used and options considered in the development of various elements of the Bay Delta Conservation Plan (BDCP or the Plan) conservation strategy. It provides a history of the BDCP development process starting with the Planning Agreement in October 2006 through the issuance of this public draft BDCP in 2012. Additionally, it describes the basis, background, and context for the alternatives to take that are identified and discussed in Chapter 9, *Alternatives to Take*. The federal Endangered Species Act (ESA) requires that Section 10(a)(1)(B) permit applicants specify in a habitat conservation plan (HCP) what alternative actions to the taking of federally listed species were considered and the reasons why those alternatives are not proposed to be used [50 Code of Federal Regulations [CFR] Section 17.22(b)(1)(iii)(C)]. Chapter 9 describes the decision-making process by which conservation measures were selected to avoid and minimize take, and appropriately mitigate any unavoidable take that would likely occur as a result of the activities proposed for coverage under the BDCP. The chapter further details limits and constraints, including issues concerning practicability that guided the development of the conservation strategy.

3G.1.1 Summary Chronology

Figure 3.G-1 summarizes the chronology of the process detailed in this document. From 2006 to 2010, the BDCP planning process was guided by the BDCP Steering Committee. The proceedings of the Steering Committee, including convening of meetings, meeting agendas, and its deliberations, were facilitated by the California Natural Resources Agency. Steering Committee responsibilities included providing policy guidance and direction for the preparation of all elements of the BDCP. The Steering Committee formed various standing and *ad hoc* groups as needed to address specific technical issues related to BDCP development. The relevant technical groups and their scope of responsibility are described in this appendix. Working Groups were co-chaired by two Steering Committee members and technical committees were co-chaired by designated representatives of two Steering Committee members. Meetings of the Steering Committee and Steering Committee groups were noticed on the BDCP website and open to the public.

Following release of a preliminary administrative draft BDCP document in November 2010, a number of Working Groups were designated to continue the technical work that had been going on under the Steering Committee. These included working groups addressing Governance, the Yolo Bypass, Delta Water Quality, Cache Slough, South Delta Habitat, Conveyance, Financing, Compatibility with Delta Agriculture, Biological Goals and Objectives (for fish), and the Adaptive Range Of Water Operations Criteria. The products of these working groups helped to refine the conservation strategy.

During this period the draft conservation strategy presented in the November 2010 preliminary administrative draft BDCP was extensively revised. Revisions focused on the following major topics:

- Refining biological goals and objectives, and adding principles to guide their refinement.

- Refining and adding detail to the previously-defined conservation measures.
- Developing several new conservation measures (*CM19 Urban Stormwater Treatment, CM20 Recreational Users Invasive Species Management, and CM21 Nonproject Diversions*).
- Redesigning the approach to adaptive management and monitoring.

The Natural Resources Agency and DWR consulted extensively with the state and federal fish and wildlife agencies (U.S. Fish and Wildlife Service [USFWS], National Marine Fisheries Service [NMFS], and DFG) and stakeholders during this period to refine the strategy and respond to their comments on the November 2010 preliminary administrative draft. This process of refinement was assisted by several independent and scientific reviews of the BDCP, including two reports by the National Research Council (2010, 2011), and guidance on developing the biological goals and objectives for covered fishes (Anderson et al. 2011).

These revisions led to the release of an administrative draft BDCP at the end of February 2012. This was the first draft of the BDCP including both a conservation strategy and effects analysis to be provided for review by all permitting agencies and stakeholders, and was also the subject of review by the Delta Independent Science Board (2012), which produced detailed review comments. Following the release of the February 2012 administrative draft, continuing work focused on responding to agency and stakeholder comments on both science and policy issues. Biological goals and objectives were further revised. The proposed water facilities continued to go through design revisions, with a change from five proposed new north Delta intakes with a combined diversion capacity of 15,000 cubic feet per second (cfs), to three proposed new intakes with a combined diversion capacity of 9,000 cfs. The operating criteria for all new and existing water facilities were extensively reviewed and revised in collaboration with the permitting agencies. Procedures for governance of the Plan, adaptive management under the Plan, and day-to-day conduct of operations under the Plan were developed to a much greater level of detail than before. All conservation measures were critically reviewed and revised to provide a substantially higher level of detail and specificity.

3G.1.2 Purpose and Content of this Review

As described in Chapter 1, *Introduction*, the BDCP is intended to provide for the ecological needs of a number of at-risk species adversely affected by a range of human activities while also ensuring adequate and reliable water supplies from the Sacramento-San Joaquin River Delta (Delta) and its stream tributaries, for people, communities, agriculture, and industry. The BDCP sets out conservation measures for the Delta that conserve covered species in the Plan Area, help prevent species from becoming threatened or endangered, and improve ecosystem health, while at the same time avoiding, minimizing, or mitigating impacts to covered species and natural communities. The development of the conservation strategy was informed by findings and conceptual models developed over time through prior scientific efforts and supplemented by data and analysis developed through the BDCP process.

As further discussed in Chapter 1, the strategy was built upon the following scientific tenets and reflects the current state of available science.

- Increase the quality, availability, spatial diversity, and complexity of aquatic habitat in the Delta.
- Create new opportunities to restore the ecological health of the Delta by modifying the water conveyance infrastructure.

- Directly address key ecosystem drivers in addition to freshwater flow patterns rather than manipulation of Delta flow patterns alone.
- Improve connectivity among aquatic habitats, facilitate migration and movement of covered fish among habitats, and provide transport flows for the dispersal of planktonic material (organic carbon), phytoplankton, zooplankton, macroinvertebrates, and fish eggs and larvae.
- Improve synchrony between environmental cues and conditions and the life history of covered fish and their food resources in the upstream rivers, Delta, and Suisun Bay, including seasonal water temperature gradients, salinity gradients, turbidity, and other environmental cues.
- Reduce sources of mortality, and other stressors, on the covered fish and the aquatic ecosystem in the Delta.
- Improve habitat conditions for covered fish in the Delta and downstream in the low salinity zone of the estuary in Suisun Bay through the integration of water operations with physical habitat enhancement and restoration.
- Avoid, minimize, and mitigate adverse effects on terrestrial wildlife and plants resulting from implementation of measures to benefit aquatic species.
- Expand the extent and enhance the functions of existing natural communities, and the habitat of covered wildlife and plants that is permanently protected.
- Restore habitat to expand the populations and distributions of covered wildlife and plant species.
- Emphasize natural physical habitat and biological processes to support and maintain species covered by the Plan (i.e., covered species) and their habitat.

This document describes the conservation actions evaluated and the evaluation process conducted to develop a conservation strategy based on the scientific tenets above. Various sources of information helped inform the development of a conservation strategy. Among them was a report issued by the Public Policy Institute of California, *Envisioning Futures for the Sacramento-San Joaquin Delta* (Lund et al. 2007). The review also considered the California Bay-Delta Authority (CALFED) Program documents to further guide the consideration of potential conservation strategies. The BDCP Conservation Strategy Workgroup (established by the Steering Committee in February 2007) evaluated various approaches to conservation from these sources and others and developed a list of 10 conservation strategy alternatives (CSAs). The subsequent *Conservation Strategy Short-Listing Analysis Report* (Science Applications International Corporation 2007) identified "bundles" of potential conservation elements that were evaluated to determine the relative capacity of each bundle to achieve BDCP goals and objectives. A short list of four conveyance options was then developed by the Steering Committee based on the results of the short-listing analysis. The *BDCP Options Evaluation Report* (California Department of Natural Resources 2007) assessed the four conveyance options and its results helped provide the basis for the BDCP *Points of Agreement for Continuing into the Planning Process* (BDCP Steering Committee 2007), which concluded that a dual conveyance was the most promising approach to evaluate in the planning process. The Steering Committee and its working groups and technical teams developed and evaluated various conservation approaches and actions under dual conveyance, including variations related to water operations conservation measures, physical habitat restoration measures, other stressors conservation measures, and terrestrial habitat conservation measures. In January 2009, the Steering Committee identified the core elements to be carried forward in the conservation strategy

(California Department of Natural Resources 2009) and in July 2009, a working draft of BDCP Chapter 3, *Conservation Strategy* was prepared and posted on the BDCP website. From January to March 2010, the Steering Committee identified the specific conservation measures that would be included in the working draft conservation strategy to be evaluated in the effects analysis conducted during spring and summer 2010, and the draft conservation strategy and effects analysis were subsequently presented in November 2010 (preliminary administrative draft BDCP without the effects analysis) and February 2011 (the effects analysis).

Following agency review and comment and public input on the November 2010 preliminary administrative draft, all chapters and appendices of the BDCP were extensively revised and a new BDCP effects analysis prepared. These materials were released in late February 2012 as a revised administrative draft BDCP. Another round of extensive review and comment ensued, which largely validated the approach taken for the effects analysis but also lead to a thorough review of the conservation strategy. Particular emphasis was placed on the proposed north Delta diversion facilities and their operational flow constraints, but a detailed collaborative review also modified nearly all aspects of the conservation strategy, including the biological goals and objectives for covered species and natural communities, nearly all of the conservation measures, and the adaptive management and monitoring program. The revised document comprises the current BDCP draft.

This document provides a detailed description of the process used to develop a conservation strategy for the BDCP.

3G.2 Evaluation of Conservation Strategy Options and Scenarios

3G.2.1 Conservation Strategy Options

In February 2007 the Steering Committee established the Conservation Strategy Workgroup to begin developing and evaluating options for the conservation strategy. This workgroup conducted 15 meetings in the ensuing 5 months and developed and evaluated four conservation strategy options. The options were focused on the conservation of aquatic habitats that support delta smelt, longfin smelt, winter-run Chinook salmon, spring-run Chinook salmon, fall-run Chinook salmon, California Central Valley steelhead, green sturgeon, white sturgeon, and Sacramento splittail. Other fish species, wildlife, and plants had not yet been evaluated and included in the covered species list.

The Conservation Strategy Workgroup began by reviewing existing studies of proposed habitat conservation and water conveyance approaches for the Delta. A variety of sources were considered, including the aforementioned report describing various alternative approaches to restoring the Delta ecosystem while continuing to export water (Lund et al. 2007). By way of example of the sources considered, a summary of the nine alternatives, evaluations, conclusions, and associated rationale set forth in the report are provided in Table 3G-1 (at the end of this document). The Conservation Strategy Workgroup considered the alternatives recommended by the report (identified as *consider* in Table 3G-1) in the development of draft CSAs for the BDCP. The CALFED Bay-Delta Program had also evaluated a number of conveyance and conservation alternatives and subalternatives, including existing conveyance, modified through-Delta conveyance, and dual conveyance with an isolated facility. The Conservation Strategy Workgroup used this CALFED information in the development of alternatives.

Based on the five approaches suggested by Lund et al. (2007), other approaches evaluated by the CALFED Program, and an additional alternative recommended by local interests, the Conservation Strategy Workgroup identified 10 CSAs (BDCP Conservation Strategy Workgroup 2007) for consideration in developing the conservation strategy (Table 3G-2, at the end of this document).

3G.2.2 Conservation Strategy Short List

The 10 CSAs identified by the Conservation Strategy Workgroup included over 50 distinct conservation elements. A *conservation element* was defined as an action or set of interrelated actions with a specific purpose, typically addressing the effects of one or a few ecological stressors on covered fish species. Sets of different conservation elements addressing the full range of key stressors on fish were defined as a *conservation strategy*, which was a full program of conservation elements that in total would serve to address all of the goals and objectives of the BDCP.

The conservation elements were "bundled" into groups of elements, with each bundle containing elements related in their physical implementation and overall conservation purpose, which would be logically implemented together. Twenty-two bundles were created and analyzed in the *Draft Conservation Strategy Short-Listing Analysis Report* (Science Applications International Corporation 2007). The report provided an overview of the anticipated benefits and drawbacks of conservation elements and provided information for the Conservation Strategy Workgroup to use in eliminating and reaggregating the bundles into a short list of conservation strategy options (CSOs) for the BDCP.

The 22 bundles were grouped into four categories based on the type of actions they included:

- **Water Operations and Conveyance Bundles** contained water conveyance and export management elements, including some large-scale Delta infrastructure construction options (e.g., peripheral aqueduct construction).
- **Entrainment and Predation Mortality Reduction Bundles** included physical modification of pumps and intakes to avoid impacts on covered species, and physical habitat improvements that would help fish avoid predation.
- **Flow-Related Habitat Improvement Bundles** included reoperation, modification, or expansion of existing infrastructure in and upstream of the Delta to improve hydrologic and habitat conditions for covered species of fish and also physical modification of habitat to improve water flow conditions for covered species of fish.
- **Physical Habitat Restoration Bundles** included physical improvements to enhance and restore habitat in historical habitat areas in the Delta and in downstream and upstream areas.

The bundles were then evaluated in the report based on four types of criteria developed by the Conservation Strategy Workgroup. The four types were biological criteria, planning criteria, flexibility/durability/sustainability criteria, and other resource impacts criteria[1]. These short-listing criteria were developed based on the following elements:

- The BDCP Planning Agreement (October 2006) (i.e., the Planning Agreement Planning Goals [section 3] and Preliminary Conservation Objectives [section 6]).

[1] This group included considerations of the relative degree to which the bundle avoids impacts on the distribution and abundance of other native species within the BDCP Planning Area, the relative degree to which the bundle avoids impacts on the human environment, and the relative degree of risk of the bundle causing impacts on sensitive species and habitats in areas outside of the BDCP Planning Area.

- The draft BDCP Conservation Objectives approved by the Conservation Strategy Workgroup and BDCP Steering Committee.
- Previously developed criteria for evaluating approaches to conserving the Delta (Mount et al. 2006).

The criteria evaluation was conducted for all covered fish species in the BDCP Planning Agreement. The bundles were compared to each other as to their relative effectiveness and to existing conditions in the Delta under existing operations. Many, but not all, bundles were compatible with each other; a compatibility analysis of the bundles was prepared to assist the Conservation Strategy Workgroup in combining the elements into cohesive, logical CSOs. Based on the analysis of bundled conservation elements, the Conservation Strategy Workgroup combined sets of conservation elements to create a short list of four CSOs that were recommended to the Steering Committee for further analysis. Each CSO was focused on two key issues: water conveyance and aquatic habitat restoration. Each CSO was subjected to in-depth analysis of its relative capacities to achieve the planning goals and conservation objectives of the BDCP.

- **Option 1** used existing conveyance and export facilities and focused restoration actions in Suisun Marsh and the north and west Delta.
- **Option 2** improved through-Delta water conveyance and focused habitat restoration in Suisun Marsh and the north, west, and south-central Delta.
- **Option 3** involved dual-conveyance consisting of improved through-Delta conveyance and a new diversion on the Sacramento River that would convey water around the Delta to the existing south Delta CVP and SWP pumping facilities. Habitat restoration would be focused in Suisun Marsh and the north, west, and south-central Delta.
- **Option 4** established new Sacramento River diversions that would convey water around the Delta to the existing south Delta State Water Project (SWP) and Central Valley Project (CVP) pumping facilities. Habitat restoration would occur in Suisun Marsh and throughout the Delta.

These four CSOs were analyzed in the *BDCP Options Evaluation Report* (California Department of Natural Resources 2007). This report provided a largely qualitative assessment of the opportunities and constraints of each option relative to the planning goals and conservation objectives. The report followed the bundles evaluation, evaluating each criterion relative to a base condition (which approximated current biological and hydrodynamic conditions) and to each of the other options. The evaluation was based primarily on the results of hydrodynamic modeling (using the California Water Resources Simulation model version II (CALSIM II) and the Delta Simulation Model version 2 (DSM2) and on the opportunities for habitat restoration afforded by each. The modeling used two scenarios of water operational values. Results for each scenario provided information relating to the relative flexibility of each option to meet habitat conservation and water supply objectives.

The options evaluation concluded that both Options 3 and 4 appear to provide significant improvements over Options 1 and 2 across the biological, planning, and flexibility criteria, though Options 3 and 4 scored less well on the “other resource impacts” criteria.

Option 3 appeared to perform better than all other options in its ability to meet water supply planning goals and objectives, and in its resiliency in response to catastrophic events. Its performance biologically was consistently superior to Options 1 and 2, but was less robust than Option 4. Its dual conveyance feature had the potential to provide significant operational flexibility over and above the other options.

Option 4 appeared to provide the greatest opportunity to meet the greatest number of criteria. It allowed for the most opportunities over a much larger proportion of the Delta to combine the restoration of natural hydrology beneficial to covered fish species with the restoration of physical habitat for those species. It separated, geographically and hydrologically, the conflicting requirements of water conveyance and aquatic species conservation, and thereby allowed greater flexibility in accomplishing habitat conservation. A key constraint of Option 4 was to limit export capabilities to a single north Delta intake—a limitation that affects both water supply reliability and Delta inflows for conservation.

Tables 3G-3 and 3G-4 provide a summary of the comparison of options from the *BDCP Options Evaluation Report* (California Department of Natural Resources 2007).

Table 3G-3. Comparison of Options by Covered Fish Species

Species	Performance Rank[1]			
	Option 1	Option 2	Option 3	Option 4
1. Delta smelt	●	●●	●●●	●●●●
2. Longfin smelt	●	●●	●●●	●●●●
3. Sacramento River salmonids	●●●	●●●	●●●	●●●●
4. San Joaquin River salmonids	●	●●	●●●	●●●●
5. White sturgeon	●	●●●	●●●	●●●●
6. Green sturgeon	●●●	●●●	●●●	●●●●
7. Sacramento splittail	●●	●●	●●●	●●●●

[1] Based on information presented in Tables H-1 to H-9 of the *BDCP Conservation Strategy Options Evaluation Report* (California Department of Natural Resources 2007) addressing Biological Criteria #1–7.

Species performance ranks are as follows:

●●●● = Best performing

●●● = Second best performing

●● = Third best performing

● = Lowest performing

Where ranks are equal, the two options receive same rank.

Table 3G-4. Overall Comparison of Options by Criteria Category (Rank)[1]

Evaluation Criteria Category	Conservation Strategy Option			
	Option 1	Option 2	Option 3	Option 4
Biological	●	●●	●●●	●●●●
Planning	●	●	●●●●	●●●●
Flexibility/ Sustainability/Durability	●	●●	●●●	●●●●
Impacts on Other Resources	●●●●	●●●	●	●●

[1] Derived from information presented in Tables 7-1 and 7-2 of the *BDCP Conservation Strategy Options Evaluation Report* (California Department of Natural Resources 2007).
Criteria performance ranks are as follows:
●●●● = Best performing
●●● = Second best performing
●● = Third best performing
● = Lowest performing
Where ranks are equal, the two options receive same rank.

3G.3 Points of Agreement for Continuing the Planning Process

In November 2007, the Steering Committee prepared the *Bay Delta Conservation Plan Points of Agreement for Continuing into the Planning Process* that identified key points of agreement. The Steering Committee agreed that the BDCP would include the following elements, which would be further developed, analyzed and improved upon:

- Habitat restoration and enhancement
- Other conservation actions
- Conveyance facilities
- Water operations and management

From December 2007 to March 2008, the Steering Committee formed working groups to develop these four elements of the BDCP. These working groups were the Biological Goals and Objectives Working Group, the Habitat Restoration Program Technical Team, the Other Stressors Working Group, and the Conveyance Working Group. From these working groups, three subgroups were formed (Terrestrial Resources Subgroup, Fish Facilities Technical Team, and Habitat and Operations Technical Team) to further address these four elements of the BDCP.

In late 2008, a working group was formed to examine the conservation measures developed by these working groups and propose refinements to the conservation measures as needed (Integration Team). In late 2009, a working group was formed to develop monitoring metrics for measuring the effectiveness of proposed conservation measures and for measuring progress towards achieving the biological objectives during BDCP implementation (Metrics Group).

Additional working groups formed in 2007 to 2008 addressed the independent scientific review of the BDCP (Science Liaisons, Science Facilitators, and Independent Science Advisors Team), tools

proposed to analyze the potential impacts of the conservation strategy (Analytical Tools Technical Team), and the development of the BDCP governance structure (Implementation Structure/Governance Working Group).

3G.3.1 Habitat Restoration and Enhancement Actions Development

Two working groups led development of habitat restoration and enhancement elements of the BDCP: the Biological Goals and Objectives Working Group, and the Habitat Restoration Program Technical Team. The Biological Goals and Objectives Working Group was formed in December 2007 and was charged with developing draft ecosystem-, natural community-, and species-level biological goals and objectives for the conservation strategy. This working group conducted 19 meetings from January 3, 2008, to April 8, 2009. The Biological Goals and Objectives Working Group focused primarily on development of biological goals and objectives for the aquatic ecosystem, aquatic natural communities, and the covered fish species. Draft biological goals and objectives for terrestrial and nontidal wetland communities and the covered wildlife and plant species were developed by the Terrestrial Resources Subgroup of the Habitat Restoration Program Technical Team at the direction of the Biological Goals and Objectives Working Group.

The Habitat Restoration Program Technical Team was formed in January 2008 and held 31 meetings from January 9, 2008, to March 4, 2009. The team was charged with the following tasks:

- Developing and describing physical habitat protection, enhancement, and restoration concepts to address important covered species stressors and associated uncertainties.
- Identifying locations in the Plan Area where habitat-related conservation measures could be implemented.
- Developing draft habitat conservation measures designed to achieve BDCP biological objectives.

To develop conservation strategies for terrestrial biological resources, the Habitat Restoration Program Technical Team established the Terrestrial Resources Subgroup. The Terrestrial Resources Subgroup was charged with developing draft biological goals and objectives, conservation measures, and avoidance and minimization measures for terrestrial and nontidal wetland natural communities and covered wildlife and plant species. The Terrestrial Resources Subgroup initially conducted 13 meetings from April 1 to December 9, 2009. After a hiatus, the Terrestrial Resources Subgroup held 9 additional meetings from May 26 to August 25, 2010.

The BDCP will include a habitat restoration and enhancement program designed to increase the quality and quantity of habitat and otherwise help achieve the conservation objectives for BDCP covered species, enabled in part by improvements to conveyance over the near and long term. Initial habitat restoration and enhancement efforts will be directed toward areas that offer the greatest conservation opportunities, such as Suisun Marsh and the north and west Delta. Completion of a new Sacramento River intake and isolated conveyance facilities was expected to change the hydrodynamic conditions in the Delta in a manner that would likely afford new opportunities for habitat restoration and enhancement in various other parts of the Delta.

The types of habitat restoration and enhancement actions initially evaluated for inclusion in the conservation strategy included the following:

- Restoring intertidal habitat to establish vegetated marshes and associated sloughs to increase habitat diversity and complexity, food production, and in-Delta productivity, and rearing habitat for covered species.
- Increasing hydraulic residence time and tidal exchange in the Delta sloughs and channels by changing circulation patterns to increase primary productivity and foodweb support and improve turbidity conditions for delta smelt and longfin smelt.
- Increasing the amount of functional floodplain habitat to increase the quantity and quality of rearing habitat for salmonids and sturgeon and spawning habitat for Sacramento splittail, and generate food resources for pelagic species.
- Providing adequate water quality and quantity within the Delta at appropriate times to help conserve resident native fishes and improve rearing and migration habitats for salmon moving through the Delta.

3G.3.2 Other Conservation Actions Development

The Steering Committee agreed to evaluate and, as appropriate, include in the BDCP other conservation actions designed to help address a number of stressors on covered species other than water conveyance facilities and operations. The Other Stressors Working Group was formed in March 2008 and was charged with identifying nonhabitat and water operations-related stressors on covered fish species and developing draft conservation measures to reduce their effects. These stressors included exposure to contaminants, nonnative species, competition and predation, entrainment at non-SWP/CVP intake facilities, harvest, reduced genetic diversity and integrity, and effects of climate change. This working group developed draft conservation measures that would either be implemented by the BDCP management entity or by funding supporting entities to implement the measures. The Other Stressors Working Group conducted 22 meetings from March 25, 2008, to June 16, 2009.

3G.3.3 Conveyance Facilities Actions Development

The Steering Committee agreed that the most promising approach for achieving the BDCP conservation and water supply goals would involve a conveyance system with new points of diversion, the ultimate acceptability of which would turn on design, operational and institutional arrangements that the Steering Committee would develop and evaluate through the planning process.

The Conveyance Working Group was formed in January 2008 and conducted 42 meetings from January 18, 2008, to June 25, 2009. The group was charged with the following tasks:

- Developing and recommending conveyance system alternatives for approval by the Steering Committee and subsequent analysis by the working group.
- Reviewing draft conveyance system alternatives developed by DWR or others for new points of diversion to move water from north of the Delta to south of the Delta as set forth in the points of agreement (BDCP Steering Committee 2007).
- Developing criteria for near- and long-term water project operations.

The main new physical feature of this conveyance system included the construction and operation of a new point (or points) of diversion in the north Delta on the Sacramento River and an isolated

conveyance facility around the Delta. Further evaluations would also be conducted regarding potential modifications to existing south Delta facilities to reduce entrainment and otherwise improve SWP/CVP ability to convey water through the Delta while contributing to near- and long-term conservation and water supply goals. This approach could provide enhanced operational flexibility and greater opportunities for habitat improvements and fishery protection. During the BDCP process, the Steering Committee evaluated the ability of a full range of design and operational scenarios to achieve BDCP conservation and planning objectives over the near and long term, from full reliance on the new facilities to use of the new facilities in conjunction with existing facilities.

The Conveyance Working Group established the Fish Facilities Technical Team and the Habitat and Operations Technical Team to address specific technical aspects. The Fish Facilities Technical Team was charged with reviewing and evaluating approaches to locating and screening new diversion facilities. This technical team developed, analyzed, and provided recommendations to the Conveyance Working Group on fish screen criteria for the new north Delta diversion intake facilities, including design approach velocities, fish screen type, size, number, and locations. The Fish Facilities Technical Team conducted 12 meetings from May 2 to October 14, 2008.

3G.3.4 Water Operations and Management Actions Development

The Habitat and Operations Technical Team was charged with evaluating the hydrodynamic conditions related to the physical habitat restoration proposed by the Habitat Restoration Program Technical Team. The team modeled numerous water operations scenarios and evaluations of potential water operations on physical habitat and aquatic habitat conditions. Results of these evaluations were provided to the Conveyance Working Group for use in the development of near- and long-term water operations criteria. The Habitat and Operations Technical Team conducted 17 meetings from April 16 to August 13, 2008. The Steering Committee would develop and evaluate operating criteria for water conveyance facilities to achieve applicable near and long-term conservation and water supply goals.

3G.3.5 Integration and Metrics of Conservation Strategy Actions

The Integration Team was formed in October 2008 and was charged with conducting evaluations necessary to refine the draft conservation measures proposed by the Conveyance Working Group, Habitat Restoration Program Technical Team, and Other Stressors Working Group to ensure they were complementary and comprised a comprehensive strategy for conserving the covered fish species. The Integration Team conducted 15 meetings from October 28, 2008, to May 1, 2009.

The Metrics Group was formed in October 2009 and was charged with developing monitoring metrics for measuring the effectiveness of conservation measures and for measuring progress toward achieving the biological objectives during BDCP implementation. Aspects of the group's charge included identifying the framework within which monitoring would be used to test the hypotheses underpinning the conservation measures review and to address uncertainties related to the ecological outcomes and subsequent response of covered species following implementation of the conservation measures

3G.3.6 Additional Working Groups

The Steering Committee established a group of Science Liaisons that began meeting in March 2007 to provide recommendations and guidance to the Steering Committee regarding the inclusion of independent science in the BDCP planning process and to work with a science facilitator hired to coordinate the input of independent science advice to the planning process.

Reflecting the requirements of the Natural Community Conservation Planning Act (NCCPA) and the guidance in the USFWS Five-Point Policy (65 *Federal Register* [FR] 106), the BDCP Steering Committee tasked the science facilitators to convene independent scientists at several key stages of the BDCP planning process, enlisting well-recognized experts in ecological and biological sciences to produce recommendations on a range of relevant topics, including conservation planning for both aquatic and terrestrial species and developing adaptive management and monitoring programs. Reports prepared by independent science advisors to the BDCP including the following:

- *Independent Science Advisors Report* (Reed et al. 2007).
- Independent Science Advisors Report Concerning Non-Aquatic Resources (Spencer et al. 2008).
- Independent Science Advisors' Report on Adaptive Management (Dahm et al. 2009).
- Delta Science Program Panel Review of the "Logic Chain" Approach (Dahm et al. 2010).
- Delta Science Program Panel Second Review of the "Logic Chain" Approach (Reed et al. 2010).
- Bay-Delta Conservation Plan Science Advisors Draft Report on BDCP Goals and Objectives for Covered Fish Species (Anderson et al. 2011).

The Analytical Tools Technical Team was formed in December 2007 and was charged with identifying the analytical tools that were available or anticipated to be available for use in developing and evaluating the conservation strategy and for use in informing BDCP implementation. The Analytical Tools Technical Team conducted 7 meetings from December 18, 2007, to March 27, 2008.

The Implementation Structure/Governance Working Group was formed in January 2008 and was charged with developing and recommending for adoption by the Steering Committee the institutional mechanisms and assignment of responsibilities for implementing the BDCP within the context of other ongoing Delta regulatory or planning processes. In this context, this working group was also responsible for recommending a process for adaptive management decision-making by the BDCP implementing entity. The Implementation Structure/Governance Working Group conducted 32 meetings from January 18, 2008, to August 19, 2009.

3G.4 Identification of Core Elements of the Conservation Strategy

In January 2009, the Steering Committee identified the core elements to be carried forward in the conservation strategy for the BDCP. These core elements are set out in *An Overview of the Draft Conservation Strategy for the Bay Delta Conservation Plan* (California Department of Natural Resources 2009). The document provided an overview and synopsis of a draft conservation strategy, including its key components. The Steering Committee directed that progress continue on

the development of the BDCP and that certain issues be identified for further analyses. The overview document built on concepts set out in the BDCP Planning Agreement and the points of agreement (BDCP Steering Committee 2007). The Steering Committee confirmed a number of the core elements of the draft conservation strategy at that point in BDCP development and identified the remaining work necessary to complete a proposed conservation strategy. The core elements were selected for the following attributes:

- Elements that shape the overall architecture of the new hydrodynamic system intended to be developed as a result of the BDCP.
- Elements that appear likely to be included in any scenario to rehabilitate the Delta ecosystem and water supply system.
- Elements that can and should be planned or constructed in the next 5 to 10 years.

The core elements formed the nucleus of the conservation strategy, but other conservation measures would also be necessary to achieve the BDCP planning goals and biological goals and objectives. The following are the core elements identified in the overview document:

- Modify the Fremont Weir and Yolo Bypass to provide higher frequency and duration of inundation.
- Move primary diversion point to north Delta diversion facilities with fish screens to reduce entrainment and expand opportunities to achieve planning goals and conservation objectives.
- Hood bypass flow criteria.
- Manage south Delta exports/hydrodynamics to reduce entrainment of fish and food resources.
- Delta Cross Channel operations.
- Large-scale tidal marsh restoration in the Cache Slough area.
- Strategic tidal marsh restoration in the west Delta.
- Large-scale tidal marsh restoration in the Suisun Marsh area.
- Interim tidal gates.
- Delta outflow targets.
- Continuing identification, development, and refinement of measures to address other stressors on covered fish species and natural communities.

3G.5 DRERIP Evaluation and Working Draft Conservation Strategy

From January to May 2009, the core elements of the conservation strategy were evaluated through a detailed analysis using operations and hydrodynamic models (e.g., CALSIM II and DSM2) and a scientific evaluation process very similar to that created under the CALFED Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) ecological conceptual modeling tool. The modified DRERIP evaluation results, coupled with a follow-up synthesis evaluation, were used to refine the conservation measures. In July 2009, a working draft of BDCP Chapter 3, *Conservation Strategy* was published on the BDCP website. This document presented a full suite of conservation

measures addressing the aquatic ecosystem, natural communities, and species. The process to develop conservation measures to address covered wildlife and plant species supported by terrestrial and wetland natural communities was initiated in summer 2009.

3G.6 Development of Biological Goals and Objectives

Initial biological goals and objectives were established in 2007 by the BDCP Conservation Strategy Workgroup. These biological goals and objectives were developed into three hierarchical tiers representing the landscape scale, which addressed ecosystem processes that affect multiple natural communities; the natural community scale, which addressed ecosystem processes that affect multiple covered species; and the covered species scale, which addressed specific biological requirements supporting conservation of individual covered species.

Following release of the November 2010 preliminary administrative draft BDCP, the biological goals and objectives were revisited via a process of review and revision involving independent scientific review and collaborative discussion between the permit applicants and the resource agencies, assisted at times by representatives of the water contractors and various nongovernmental organizations. Separate review and revision tracks were adopted for the covered fishes, and for the landscape, natural community, and terrestrial species.

3G.6.1 Covered Fishes

The review and revision process for covered fishes began with an independent scientific review of the November 2010 preliminary administrative draft biological goals and objectives for several of the principal covered fishes (Anderson et al. 2011). This review established guidance and principles for developing effective biological goals and objectives and recommended specific goals and objectives for three species (winter-run Chinook salmon, Sacramento splittail, and delta smelt). These were taken as initial working goals and objectives for these species. Subsequent meetings with Anderson and his coauthors led to minor revision of these goals and objectives, and the principles set forth by Anderson et al. (2011) were used to also develop draft biological goals and objectives for the other covered fishes. The process of setting these draft goals and objectives also considered recovery goals identified in recovery plans prepared by USFWS, NMFS, and DFG for some fishes, and comparable documents for those species that did not yet have approved recovery plans. This process did not assume that the BDCP would be solely responsible for recovery of these species, and so the designated biological goals and objectives did not necessarily match the recovery goals, but instead represented the BDCP's potential to contribute to recovery within the Plan Area. For species that have a substantial portion of their range outside the Plan Area, the BDCP's potential contribution to recovery is necessarily limited.

The biological goals and objectives were again published in the February 2012 administrative draft BDCP. Subsequently there began meetings between fish biologists representing DWR and their consultants, USFWS and NMFS, and stakeholder biologists, with collaborative review and revision of the biological goals and objectives for all covered fishes. Meetings and draft revisions proceeded continuously through spring and summer of 2012. The process was accompanied also by a number of revisions to conservation measures, particularly *CM1 Water Facilities and Operation* and the operating criteria for water facilities, in order to assure that the conservation measures would be

sufficiently protective to achieve the biological goals and objectives. The biological goals and objectives for fish presented here thus represent collaborative agreement between DWR and the fish and wildlife agencies as relevant and measurable targets by which to measure BDCP's contribution to the recovery of the covered fishes.

3G.6.2 Landscape Scale, Natural Communities, Wildlife, and Plants

The review and revision process for landscape, natural community, wildlife, and plant biological goals and objectives (conveniently referred to as the "nonfish" goals and objectives) was conducted from July 2011 to August 2012 in a series of weekly meetings of the newly formed Terrestrial Technical Team. This group consisted of a wide range of wildlife biologists and botanists from the fish and wildlife agencies, DWR, their consultants, and stakeholder representatives. Species experts were also brought in as needed to provide technical advice. At these meetings, all nonfish biological goals and objectives were reviewed, discussed, and revised, until consensus was achieved between DWR and the permitting agencies. For most nonfish biological goals and objectives, consensus was secured and results were finalized in the February 2012 administrative draft BDCP. Further analysis and discussion continued after that on some goals and objectives and those results are first published in this public draft of the BDCP.

During the process, the participants reviewed each natural community and its associated covered species as a package. For each review cycle, the proposed biological goals and objectives, the conservation strategy, and the effects analysis were considered together to ensure feasibility and consistency. The team also considered the effects of the revisions to the terrestrial conservation strategy on existing and in-process regional conservation plans that overlap with BDCP. Although the impacts of BDCP on these plans are discussed in the environmental impact report (EIR)/environmental impact statement (EIS) for the BDCP (Chapter 12, *Terrestrial Biological Resources*), the Terrestrial Technical Team strove to avoid any conflicts with these plans through the refinement of the conservation strategy.

As with the goals and objectives for covered fishes, the process of setting these draft goals and objectives considered recovery goals identified in recovery plans prepared by USFWS, NMFS, and DFG for some species, and comparable documents for those species that did not yet have approved recovery plans. This process also did not assume that BDCP would be solely responsible for recovery of all covered species, and so the designated biological goals and objectives did not necessarily match the recovery goals, but instead represented the BDCP's potential to contribute to recovery within the Plan Area. For species that have a substantial portion of their range outside the Plan Area, BDCP's potential contribution to recovery is necessarily limited.

During the process of revising the nonfish goals and objectives, the technical team also had to resolve complicated issues about natural communities, such as the role of cultivated lands in supporting recovery of covered species, or the complex outcomes of converting managed wetlands to tidal natural communities, or the effects of levee removal on tidal exchange. Indeed, many issues in the effects analysis were first vetted during the development of biological goals and objectives, and in many cases the conservation measures were revised repeatedly in order to ensure high confidence that they would be effective in achieving the goals and objectives.

3G.7 Development of Conservation Measures

This section further describes the process and evaluations used to develop the conservation measures included in the conservation strategy.

3G.7.1 Water Operations Conservation Measures

3G.7.1.1 Conveyance Facilities Configuration

In 2007, the Steering Committee evaluated the practicability of three isolated conveyance facility configurations that would provide for dual-conveyance operations:

- A west Delta conveyance configuration consisting of a combination of surface canal and pipeline/tunnel conveyance facilities.
- An east Delta conveyance configuration consisting of a surface canal conveyance facility.
- A pipeline/tunnel conveyance facility.

Based on results of the evaluation, the Steering Committee selected the pipeline/tunnel configuration for a proposed project in the BDCP. Although the preliminary estimated costs for the pipeline/tunnel configuration were greater than for the west Delta and east Delta conveyance configuration, the Steering Committee selected this configuration because it minimized impacts on natural communities supporting habitat for the covered species and minimized impacts on the human environment.

3G.7.2 North Delta Diversion Facilities Location and Screening

3G.7.2.1 Location

Evaluations were conducted on a broad variety of north Delta diversion intake location configurations. Possible intake locations were analyzed in terms of the availability of water for the diversion, the ability to divert at each intake location, potential impacts on other diverters and dischargers, fish exposure to intakes, fish migration corridors, potential water quality, and costs involved in construction and operation. This high-level, preliminary analysis provided information sufficient to focus in on potential intake locations.

A detailed analysis of four intake configurations was conducted in 2010. Configuration 1 had five intake locations placed on the Sacramento River between Freeport and Courtland. Configurations 2 through 4 would have three intakes in the same location as in Configuration 1 (from Freeport to Hood), but the location of the fourth and fifth intakes would vary. In Configuration 2, the fourth and fifth intakes would be located upstream of the American River point of confluence with the Sacramento River, north of the first three intakes. In Configuration 3, the fourth and fifth intakes would be located downstream of the American River point of confluence with the Sacramento River and upstream of the Freeport Regional Water Authority intake and Sacramento Regional County Sanitation District outfall, also north of the first three intakes. In Configuration 4, the fourth and fifth intakes would be located south of the first three intakes, downstream of Steamboat Slough and upstream of the Delta Cross Channel.

Diversion capability appeared to be insensitive to the intake configurations considered in the detailed analysis. Operations and operational preference were shown to be more important than intake location for effects on tidal dynamics. The analysis also showed that intake locations primarily influence exposure risk, and to a lesser extent, migration pathways.

After extensive analysis and consultation with the fish and wildlife agencies and stakeholders, on July 25, 2012, the Governor of California, Secretary of the Interior, and Administrator of NMFS announced a revised proposed project for the BDCP that would construct and use three intakes (intakes 2, 3, and 5) instead of five at a maximum pumping capacity of 9,000 cfs (instead of 15,000 cfs proposed earlier). This configuration and capacity was chosen because the water facilities would meet projected water supply needs and would not require phased construction. The use of three intakes was found to be sufficient to meet diversion volume needs during the BDCP term, and would have lower environmental impacts compared to construction of five intakes.

3G.7.2.2 Screening

In August 2008, the Fish Facilities Technical Team developed a preliminary draft report (*Fish Facilities Technical Team Conceptual Screening Proposal*) with the purpose of reviewing and evaluating various approaches to the screening of diversion facilities along the Sacramento River between the City of Sacramento and Walnut Grove. The screen design principles used in this analysis incorporated guidance and criteria offered by NMFS, DFG, and USFWS. These principles included using designs that would do the following tasks:

- Focus on being the most biologically protective.
- Provide a positive, physical barrier between fish and water intakes.
- Avoid the need to collect, concentrate, and handle fish passing the intake.
- Avoid bypasses that concentrate fish in areas and increase the risk of predation.
- Steer clear of off-channel systems in order to avoid handling fish.
- Select locations that have desirable hydraulic characteristics (e.g., uniform sweeping velocities, reduced turbulence).
- Use the best available existing technology in use in the Sacramento Valley.
- Use smaller multiple intakes (as opposed to a single large intake) to enhance fish protection with operational flexibility under varying flow conditions.
- Minimize the length of intake(s) to reduce the duration of exposure to the screen surface for fish.
- Select locations on the Sacramento River as far north as practicable to reduce the exposure of delta smelt, longfin smelt, and other estuarine species.
- Avoid areas where predators may congregate or where potential prey would have increased vulnerability to predation.
- Avoid areas of existing riparian habitat.

The Fish Facilities Technical Team developed, analyzed, and provided recommendations on fish screen criteria, including design approach velocities, fish screen type, size and number (multiple versus a single intake), and locations(s) that would support both through and around the Delta

conveyance facilities. Three primary fish screening technologies were examined in the report: on-bank screens, in-river screens, and cylindrical screens.

On-bank screens would be similar to the many flat-plate, wedge-wire screens operating on the Sacramento River. The length would be designed to match any accompanying in-river screens at specific locations. In-river screens would be a long intake tower with dual screen surfaces similar to the City of Sacramento's water intakes on the Sacramento River and the American River. The major difference is that the pumps would not be situated on the tower but on the landside of the levee. Cylindrical screens would be similar to the many cylindrical screens operating on the Sacramento River. Several units would be combined in a cluster to provide the diversion capacity needed for each location. Four conceptual proposals came out of the screening proposal (BDCP Fish Facilities Technical Team 2008).

- *Conceptual Proposal A* consisted of a combination of in-river and on-bank screens situated at three locations on the Sacramento River between Freeport and Courtland. Each location would provide a diversion capacity of 5,000 cfs for a combined maximum diversion of 15,000 cfs.
- *Conceptual Proposal B* consisted of using cylindrical screens at ten locations along the Sacramento River between the City of Sacramento and Walnut Grove. Each location would have a diversion capacity of 1,500 cfs using a cluster of 15 cylindrical screens. Ten locations with a 1,500 cfs diversion capacity would be necessary to achieve a combined maximum diversion of 15,000 cfs.
- *Conceptual Proposal C* consisted of on-bank and in-river screens situated at ten locations on the Sacramento River between the City of Sacramento and Walnut Grove. Each location would provide 1,500 cfs of diversion capability for a combined maximum of 15,000 cfs.
- *Conceptual Proposal D* consisted of a combination of on-bank cylindrical screens and in-river dual face screens situated at ten locations on the Sacramento River between the City of Sacramento and Walnut Grove. Each location would provide 1,500 cfs diversion capacity for a maximum combined diversion of 15,000 cfs.

An additional study, the *Value Planning Study on Fish Screening Facilities Options*, was conducted by the DWR Delta Habitat Conservation & Conveyance Program (DHCCP) (California Department of Water Resources 2007). Contributing materials included the screening proposal (BDCP Fish Facilities Technical Team 2008), potential northernmost alignments for both a western and eastern scenario of an isolated canal, and a 5-day value methodology workshop with a multidisciplinary team in Sacramento, California, held in October 2008. The value planning study identified and scored 31 different concepts for intakes on the Sacramento River that would have the capability to divert up to 15,000 cfs. The three types of intakes were on-bank, in-river, and cylindrical. The capacity of intakes ranged from 500 to 5,000 cfs.

Each of these concepts was rated based on performance criteria, one of which was fish protection/fish benefits. However, as identified in the report, for the ratings to be relevant, the analysis needed to be extended to associate a level of importance to the performance factors.

In late 2010, NMFS suggested that if five intakes were to be constructed, a phased approach should be considered, first constructing three intakes, then analyzing their operational effects before constructing the remaining two. Subsequent analyses considered the cost and benefit of a three-intake design, as well as the marginal costs and benefits of subsequently constructing two more intakes.

Based on all of the analyses described above, the configuration ultimately selected included three intakes of 3,000 cfs each located between Freeport and Hood using on-bank screens. Operational criteria supporting this design included minimum performance standards for sweeping and approach velocities of flows near the screens, sufficient to minimize the risk of covered fishes becoming entrained or impinged on the screens.

3G.7.2.3 Operational Criteria

This section provides an overview of the development of the BDCP operational criteria, including the involvement of various workgroups and teams in this process.

The development of BDCP proposed water operations was performed through an iterative and multistep process involving substantial input from scientists and stakeholders. As described above, the conservation strategy options evaluation of four distinct conveyance scenarios (existing through-Delta conveyance, improved through-Delta conveyance, dual conveyance and peripheral Aqueduct) was finalized in September 2007 and resulted in a focus on dual conveyance. Water operations and integration of operations with habitat and biological criteria were explored throughout 2008 and 2009, resulting in Steering Committee approval of draft long-term operations criteria on January 29, 2010.

In response to the February 2012 effects analysis which evaluated both the January 2010 operations and Scenario 6 as described above, the fish and wildlife agencies issued “red flag” comments on the proposed criteria that led to extensive negotiations between DWR and the fish and wildlife agencies regarding revised criteria that would meet the ESA goal of minimizing and avoiding incidental take to the maximum extent practical, and the NCCPA goal of contributing to the recovery of each of the covered species and natural communities. The operating criteria presented in this plan have been approved by the fish and wildlife agencies as meeting the standards required for permit issuance.

The exploration and evaluation process for water operations is summarized below in chronological order.

3G.7.2.3.1 Conveyance Workgroup and Habitat and Operations Technical Team

In October 2007, the Conveyance Workgroup and the Habitat and Operations Technical Team were formed to evaluate a range of Delta water operations and integration of those operations with various habitat restoration elements. Screening-level evaluations were prepared based on geographically focused packages including north, west, and south Delta. Working groups and technical teams met periodically to develop technical information or recommendations about aspects of the conservation plan elements for consideration by the Steering Committee. The Conveyance Workgroup and the Habitat and Operations Technical Team conducted many meetings with input from technical experts.

The following geographically-focused packages and critical issues were evaluated:

- North Delta bypasses and diversion criteria
- West Delta and outflow operations
- South Delta operations

Many of the broad options considered under the geographically focused packages were integrated in delta-wide assessments. Preliminary analyses used the Central Valley Water Management screening model (CalLite) to better understand the integrated relationship between north Delta, south Delta, and Delta outflow criteria. Assumptions were made for north Delta floodplain habitat and tidal marsh, Sacramento River diversion and downstream bypasses, Delta salinity standards, west Delta habitat, tidal marsh, and Delta outflow. Implementation of various bypasses, north Delta diversion criteria, south Delta criteria, and outflow criteria were included in the CalLite modeling and the strong interrelationship between elements was reviewed. Focused hydrologic and hydrodynamic modeling was used as a tool to assist in the evaluation of some of the complex items listed above. Limitations in the modeling tools related to tidal marsh effects and time step were noted and plans were developed for enhancement of the tools.

3G.7.2.3.2 Integration Team and Conveyance Workgroup

From October 2008 through January 2009, the work products and findings of several workgroups were incorporated in evaluations by the Integration Team.

By the end of 2008, two interactive screening evaluations were conducted using the CalLite screening model: one in October and one in December. Various scenarios were analyzed to help explore concepts of interest by the stakeholders and were developed to assist in the formation of proposed conservation measurements. The scenarios developed and preliminary lessons learned are described below.

- *Fluctuating Delta Salinity.* Relaxations in the net Delta outflow requirements were investigated during summer and fall (4000 cfs in a wet year, 3000 cfs in an above-normal year, 2000 cfs in a below-normal year, 1000 cfs in a dry year, and 0 cfs in a critical dry year) to explore a range of salinity effects pertaining to the criteria of two parts per thousand that must be maintained in the Suisun Bay during the February through June spring runoff period (X2). Rio Vista flow, salinity, and export/inflow ratio standards were also relaxed during this period. The goal was to evaluate the range of variable salinity (increasing salinity in summer and fall of dry years) that could provide a competitive advantage to native species. These analyses provided many insights into the flow-salinity relationships in the Delta, and how they can be modified by water export practices.
- *Flooded Western Island.* Based on the Delta Risk Management Strategy (California Department of Water Resources 2012) analyses, scenarios of salinity shifts related to Sherman Island flooding were conducted. This work suggested that such a flooding event could result in an eastward shift in X2 of approximately 6 kilometers. The CalLite model was reconfigured to account for this effect. The simulation goal was to evaluate if flooding of large tracts of western islands may create large areas of low salinity habitat and allow X2 to be managed in a more easterly direction than under current regime. These studies showed that levee removal and export changes can both substantially alter the location of the low salinity zone, but also identified the need for additional modeling to reduce substantial uncertainties.
- *Preferential Hood Diversion without D-1641.* All standards related to the California State Water Resources Control Board Decision D-1641 (1999) were removed from a basic dual-conveyance simulation. This scenario was an educational study to evaluate system operations effects and evaluate incremental tradeoffs of regulatory actions.

- *Increased Spring River Flows.* Reservoir releases targeted peak flows in March and April to achieve Yolo Bypass inundation of approximately 5,000 cfs. The goal of the scenario was to evaluate Delta operations with increased inflows designed to substantially restore spring hydrographs on rivers and to increase frequency and duration of inundation of bypasses.
- *Increased Spring Delta Outflow.* The 8-River Index (8RI)[2] approach to February through June average X2 targeting was implemented along with minor off-ramps for extreme critical years (8RI less than 5 million acre-feet). The objective was to evaluate the potential for achieving substantially higher Delta outflows without creating adverse coldwater pool management concerns in key reservoirs. The analysis identified the magnitude of necessary tradeoffs between outflow and exports, and the sensitivity of the system to wetter versus drier water year types.
- *Increased Fall Delta Outflow***.** Fall X2 targets (September through November) were explored based on a water year 8RI index approach originally proposed by nongovernmental organizations. Storage criteria were included to limit the potential for upstream impacts (Shasta greater than 2.8 million acre-feet and Oroville greater than 1.0 million acre-feet). The goal was to evaluate potential for achieving higher fall Delta outflow targets without creating adverse coldwater pool management conditions in key reservoirs. Initial assessments indicated that the fall X2 targets, as constructed as a sliding scale based on the prior water year 8RI, appeared achievable with relatively low water costs.
- **Preferred South Delta Diversion.** South Delta pumping would continue at a reduced amount with limited entrainment effects while reducing the need for higher diversion at Hood. The analysis showed several limitations to a high reliance on south Delta exports.
- **Fully Isolated Hood Diversion.** The potential of a fully isolated north Delta diversion (no south Delta pumping) subject to more restrictive Hood bypass flow operations was evaluated. These no-south-Delta-pumping scenarios would open much of the central and southern Delta for restoration. The analysis showed many limitations to the fully isolated scenario.

In addition to the screening analyses discussed above, technical studies were outlined to assist in the development of an overall water operations package. These studies addressed the following effects:

- North Delta diversion effects
- North Delta migration corridors
- South Delta diversion effects
- Tidal Marsh restoration effects

Preliminary work was performed for the technical studies, but these studies were continued throughout subsequent phases of long-term water operations development.

[2] The 8-River Index is the combined Sacramento River and San Joaquin River basin runoff. Sacramento River runoff is calculated as the sum (in million acre-feet) of Sacramento River at Bend Bridge, Feather River inflow to Lake Oroville, Yuba River at Smartville, and American River inflow to Folsom Lake. San Joaquin River runoff is calculated as the sum (in million acre-feet) of Stanislaus River inflow to New Melones Lake, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to Lake McClure, and San Joaquin River inflow to Millerton Lake.

3G.7.2.3.3 Core Elements Preliminary Evaluation

By the end of 2008, the BDCP Steering Committee approved a draft set of core elements of a conservation strategy for preliminary evaluation (BDCP Integration Team 2008). The preliminary evaluation was principally designed to provide information for the DRERIP conceptual ecosystem and species evaluation process. The goal of this evaluation was to refine existing and develop new Delta-specific restoration actions as well as to provide Delta-specific implementation guidance, program tracking, performance evaluation and adaptive management feedback. Preliminary CALSIM II and DSM2 modeling was performed based on a range of parameters to better understand the changes to Delta flows and patterns of exports, Delta hydrodynamic responses due to modified diversions and tidal marsh restoration, travel time in the north Delta downstream of the diversion, and general changes to Delta water quality.

3G.7.2.3.4 Integration Team and Leaders and Caucus Team Proposed Project Development

Based on the results of the analysis of the core elements, key areas of uncertainty were identified as well as needed improvements to modeling. From February 2009 through December 2009, additional analyses and refinements were made to the water operations. These studies and modifications included the following work items.

- *Climate Change "Early-Look."* In order to include changes in runoff and increased sea level rise due to climate change in the current modeling, regional climate change scenarios were developed based on the climate scenarios used by DWR. A preliminary set of CALSIM II and DSM2 model simulations were performed to understand the effect of climate change on the existing system configuration and dual conveyance operations. Climate change was shown to have a significant effect on the timing of watershed runoff, earlier runoff due to more rain/less snow and earlier snowmelt, and significant reductions in late spring and summer streamflows. Upstream reservoir and coldwater pool management were found to be severely challenged under climate futures, while the Delta/export facilities were found to become more decoupled from the SWP/CVP storage operations. It was shown that salinity and X2 intruded further, but higher outflows could manage the extent of the intrusion. The BDCP proposed project was found to include several elements that provide some climate change adaptation. These include tidal marsh, floodplain inundation, and movement of the primary conveyance out of the major tidal zone in the delta.
- *North Delta Bypass Flows and Operations.* Various preliminary simulations were conducted to evaluate the location of intakes for north Delta diversion facilities. Also, operational rules for north Delta diversion facilities were developed to refine tidal operations under low flows.
- *Tidal Marsh Implementation in DSM2.* Corroborative simulations with the 2-D Resource Management Associates (2010) model were conducted to better calibrate this component of DSM2. Suisun Marsh restoration components were subsequently incorporated. In addition, CALSIM II's Artificial Neural Network was retrained to emulate the effects of tidal marsh restoration.
- *DSM2 ReCalibration.* Limitations associated with the DSM2 model were identified the model was recalibrated to include a more accurate representation of the Cache Slough region and Liberty Island flooding.

- *Daily Operations.* Other modeling improvements to better represent the Delta operations scenarios included the CALSIM II incorporation of daily operations in the Fremont weir operations and north Delta diversion for deriving a more accurate input to DSM2.
- *Delta Island Consumptive.* The Delta island consumptive use and drainage used in both DSM2 and CALSIM II models were reviewed to better represent the local behavior.

3G.7.2.3.5 Mini-Effects Analysis

In late 2009 and early 2010, a "mini-effects analysis" of the scenarios of preliminary proposed project under near-term and early long-term (proposed operations and two adaptive ranges, A and B) was performed. The objective of this analysis was to prepare conservation measures for the physical modeling of the proposed project. The preliminary modeling results were presented in comparison to the pre-BiOps and reasonable prudent alternative scenarios. In addition to these simulations, CALSIM sensitivity analyses were performed to identify relative effects of the following actions.

- Reasonable prudent alternative sensitivity. Action comparisons versus the reasonable prudent alternative "most likely" simulation.
    - Removal of NMFS BiOps San Joaquin export/inflow ratio (Action IV.2.1)
    - USFWS Old and Middle River Action 2 and 3 "low" bookend
    - USFWS Old and Middle River Action 2 and 3 "high" bookend
    - Removal of USFWS fall X2 Action 4
- Alternative D-1641 X2 approach. Comparison of standards versus the proposed project near-term simulation. Near-term operations with existing D-1641 X2 implementation.
- Proposed project action sensitivity. Action comparison versus the early long-term proposed operations simulation.
    - Hood Bypass flows per Range B
    - San Joaquin export/inflow ratio from October to June per Range B
    - Spring X2 based on 8RI per Range B, Fall X2 per USFWS reasonable prudent alternative.

3G.7.2.3.6 Preliminary Proposal for Long-Term Water Operations

The results of the mini-effects analysis combined with various biological and policy-level discussions in December 2009 and January 2010 led to a draft set of long-term water operations criteria for evaluation in the effects analysis. These criteria were termed the "preliminary proposal." On January 29, 2010, the Steering Committee approved for purposes of analysis the preliminary proposal for long-term water operations and the first full effects analysis of the conservation strategy was initiated on that set of operational criteria. These water criteria were presented in the November 2010 preliminary administrative draft BDCP, and were analyzed in the effects analysis that appeared in the February 2012 administrative draft BDCP. Aspects of that analysis focused on entrainment, Delta flow, salinity, and upstream rearing and spawning habitat. The February 2012 effects analysis also included analysis of an operational proposal advanced by the fish agencies, known as "Scenario 6." The Scenario 6 criteria contained additional provisions intended to benefit the covered fishes, including more restrictive south Delta operations and a fall X2 requirement. Following further discussions between the permit applicants and the permitting agencies, a

preliminary effects analysis of Scenario 6 was included in the February 2012 administrative draft BDCP (Appendix 5.J, *Effects on Natural Communities, Wildlife, and Plants*).

3G.7.2.3.7 Selection of Current Proposed Water Operations Criteria

In reviewing the February 2012 effects analysis, including the evaluation of the preliminary proposal, the fish and wildlife agencies identified a number of concerns with the preliminary proposal. As a result of these concerns, a new set of operational criteria was developed and is presented in Section 3.4.1.4.3, *Flow Constraints*. These criteria were established to evaluate their potential to meet the ESA requirement to minimize and avoid incidental take to the maximum extent practicable, and the NCCPA requirement to conserve each of the covered species in the Plan Area.

These criteria are similar to those previously modeled for Alternative 4 for the draft EIR. Alternative 4 differs from the preliminary proposal in that it includes the Scenario 6 south Delta operations, which further restrict south Delta exports. Alternative 4 also would construct an operable gate at the head of Old River, increasing protection for all salmonids compared to the preliminary proposal and existing baseline conditions. Alternative 4 also provides a north Delta diversion capacity of 9,000 cfs instead of the 15,000 cfs included in the preliminary proposal, reducing pumping capacity as well as physical footprint effects. Alternative 4, as presented in the February 2012 draft of the BDCP, also included the Fall X2 requirement from the delta smelt BiOp (U.S. Fish and Wildlife Service 2008).However, Alternative 4 does not provide for the level of increased spring outflows that the fish and wildlife agencies believe may be needed to meet biological objectives.

To support the selection of a revised operational scenario, the fish and wildlife agencies conducted modeling to examine the recovery needs of the covered fish throughout their range in the absence of habitat restoration. This analysis was refined over multiple runs to explore the operational flexibility of the BDCP to help meet the rangewide recovery needs without adversely affecting upstream reservoir operations. The fish and wildlife agencies worked collaboratively with DWR to develop an operational scenario that contributed to the recovery of the covered fish and fit within the constraints of the BDCP. As a result, it has been agreed that the uncertainties about level of needed spring and fall outflow are to be addressed by adopting decision trees prescribing selection of criteria at the time the north Delta diversions become operational. The decision trees set criteria for spring outflow and fall outflow. Under the decision tree structure, one of four possible operational criteria will be implemented initially based on the results of targeted research and studies. Targeted research and studies will proceed until the north Delta intakes become operational, with the results of those studies forming the basis for determining the outcome of each decision tree. Operating criteria may also be modified after that time, based on concurrence by the permittees and the fish and wildlife agencies, via the adaptive management process specified in the Plan.

3G.7.3 Natural Community Conservation Measures

The conservation strategy includes natural community conservation measures to benefit the aquatic resources (covered fish species, tidally influenced perennial aquatic natural communities, and aquatic ecosystem processes) and terrestrial resources (the covered wildlife and plant species and the non-tidal natural communities) addressed by the Plan. Development of the natural community conservation measures initially focused on addressing conservation needs for aquatic resources. The draft conservation measures for aquatic resources were then refined to incorporate elements

that would achieve the biological objectives for covered wildlife and plant species that used tidal habitats. Additional measures were developed to address those covered wildlife and plant species that use nontidal habitats for all or a portion of their life histories.

3G.7.3.1 Aquatic Resources

In January 2008, the Steering Committee established the Habitat Restoration Program Technical Team to develop physical habitat-related conservation measures (as opposed to flow-related habitat conditions). The team comprised technical experts representing the permit applicants, nongovernmental organizations, and fish and wildlife agencies. Development of conservation measures was supplemented with outside technical expertise on technical issues as needed. The process used by the team to develop initial habitat restoration and enhancement measures is described below.

3G.7.3.1.1 Species Stressors

At the start of the process, the Habitat Restoration Program Technical Team reviewed the available scientific literature, including information developed by the fish and wildlife agencies, to identify important stressors on the covered fish species that are manifested in the Delta. These stressors were evaluated using existing scientific information and previous evaluations (e.g., the CALFED Ecosystem Restoration Program) to determine if their adverse effects on the covered fish species could be alleviated through natural community restoration or enhancement actions.

3G.7.3.1.2 Natural Community Conservation Actions

Based on the assessment of covered fish species stressors manifested in the Delta, the Habitat Restoration Program Technical Team reviewed relevant literature (e.g., DRERIP models, CALFED Ecosystem Restoration Program conservation actions, recovery plans) to identify physical habitat conservation actions that could affect the influence of stressors on each of the covered fish species. The team identified the four types of natural community conservation actions, described below.

- *Tidal Natural Communities Restoration.* One hypothesized stressor on several of the covered fish species is food abundance and availability. Based on current hypotheses regarding the ecosystem functions of tidal marsh, the team identified restoration of tidal marsh as a mechanism to increase primary and secondary production in adjacent subtidal aquatic areas that would improve aquatic foodweb processes and thus increase the abundance of food for the covered fish species. A secondary outcome of tidal marsh restoration would also be restoration of shallow subtidal aquatic areas that would serve as rearing habitat for salmonids and Sacramento splittail and, in some locations, potential spawning habitat for delta smelt.
- *Seasonally Inundated Floodplain.* The team identified restoration of seasonally inundated floodplain as an opportunity to address stressors related to splittail spawning and rearing habitat, salmonid rearing habitat and risk of nonnative fish predation, and food availability. Restoration via setting back levees would increase the extent of floodplain area in the Delta that would be inundated during periods of high flow, thus increasing the extent of splittail spawning and rearing habitat, salmonid rearing habitat, and production and subsequent transport of phytoplankton, zooplankton, and invertebrates into Delta channels that would increase food for covered fish species rearing on restored floodplains and in-Delta channels.

- *Channel Margins.* The team identified enhancement of low-value leveed channel margins as an opportunity to address stressors related to the lack of juvenile salmonid rearing habitat, Sacramento splittail spawning habitat, exposure to nonnative fish predation, and food production and availability. Increasing the complexity of existing channel margins was hypothesized to increase the survival of out-migrating juvenile salmonids by increasing rearing habitat and growth and, depending on design, increasing the extent of splittail spawning habitat.
- *Riparian Natural Community.* The team identified restoration of tidal riparian natural community as an opportunity to improve the overall ecological functions of the Delta. Restoration of riparian natural community would increase complexity of channel margins and increase inputs of food and organic carbon (i.e., insect and leaf drop into channels) in support of aquatic foodweb processes.

3G.7.3.1.3 Natural Community Restoration and Enhancement Opportunities

Following identification of natural community restoration and enhancement actions that could alleviate the effects of covered fish species stressors, the Habitat Restoration Program Technical Team divided the Delta and Suisun Marsh into 11 hydrologic zones for purposes of spatially evaluating opportunities for restoring or enhancing each of the four habitat types. The team then compiled available information characterizing the physical and biological conditions in each of the zones to provide the basis from which to make subsequent evaluations of habitat restoration and enhancement opportunities. These zone attributes included, but were not limited to the following:

- Land surface elevation relative to mean sea level elevation.
- Existing land uses, for agricultural lands, crop type (annual versus perennial crops).
- Infrastructure.
- Areas of high habitat value for biological resources.
- Location relative to the distribution of covered fish species.

Concurrently, the team also conducted reviews of existing habitat restoration plans for the Delta and Suisun Marsh (e.g., CALFED Ecosystem Restoration Program) to identify restoration opportunities relevant to achieving BDCP goals and biological objectives.

Tidal Natural Communities Restoration

The Habitat Restoration Program Technical Team evaluated each of the hydrologic zones to identify locations suitable for restoring tidal marshes. To guide this evaluation, the team established a goal of distributing tidal marsh restoration around the Plan Area such that all the covered fish species associated with each of the Delta watersheds would benefit. Major criteria used to identify these locations included the following:

- Land surface elevations relative to mean sea level.
- Land uses.
- Infrastructure.
- Potential tidal connectivity.

Based on application of these criteria, the team delineated five Restoration Opportunity Areas (ROAs) with site characteristics within which tidal marsh restoration could be practicably implemented.

Seasonally Inundated Floodplain Restoration

The Habitat Restoration Program Technical Team evaluated each of the hydrologic zones to identify locations suitable for restoring seasonally inundated floodplain. Major criteria used to identify these locations included the following:

- Land surface elevations relative to mean sea level.
- Opportunities to coincidentally improve capacity of the flood control system.
- Existing ecological values of potentially affected habitats.
- Land uses.
- Opportunities to recreate historical connectivity of floodplains with tidal marshes.

Based on application of these criteria, the team identified the primary opportunities for increasing floodplain habitats as breaching or setting back levees along Old, Middle, and San Joaquin Rivers.

Channel Margin Enhancement and Riparian Restoration

The Habitat Restoration Program Technical Team coordinated with NMFS to identify opportunities for enhancing channel margin habitats to benefit rearing and out-migrating juvenile salmonids. The team generally identified leveed channels along major juvenile salmonid migration pathways through the Delta as the best opportunities for doing so. Because of the landscape position of where riparian habitats occur, opportunities for restoration of riparian habitats were identified as being coincidental with the restoration of tidal marsh (within transitional elevational zones from marsh plain to uplands), enhancement of channel margin habitats (e.g., as a component of constructed low benches along levees), and restoration of seasonally inundated floodplains.

3G.7.3.1.4 Establishing Natural Community Enhancement and Restoration Priorities

Following identification of natural community enhancement and restoration opportunities, the team developed and applied the following criteria. Results of this prioritization process were used by the Steering Committee to help identify draft BDCP natural community enhancement and restoration targets.

- Implementation/Cost Criteria
    - Requires construction of new or relocation of existing major infrastructure (roads, power lines, levees, railroads, pipelines).
    - Likely extent of significant local concern.
    - Level of likely difficulty to secure third party agreements (if necessary) to implement the restoration (e.g., require change in agencies policies/regulations; require legislative or congressional action; require funding contributions by a third party to make cost-effective).
    - Effects on local reclamation district infrastructure and functions, including drainage, conveyance, and flood protection and effects on adjacent land uses.

- Impacts on the ability to divert water.
- Compatibility/integration with east around-Delta conveyance footprint.
- Number and size of parcels/landowners.
- High maintenance costs relative to other opportunities.
- Susceptibility of restored and existing important terrestrial habitat loss to levee failures.
- Extent of adjacent lands suitable for sea level rise accommodation.
- Existing land uses of high economic value.
- Existing conditions/land uses of high ecological value.
- Proximity to significant wastewater discharge and diversion points.
- Possibility for exacerbating effects of other stressors on covered species.

- Opportunities Criteria
  - Proximity to important occupied species habitats (e.g., spawning areas, major out-migration corridors).
  - Landscape position relative to existing patches of habitat and other habitat restoration sites.
  - Likely importance in future with sea level rise.
  - Estimated importance in alleviating species stressors relative to opportunities.
  - Estimated likelihood for complementary benefits upstream/downstream relative to other opportunities (e.g., good pathways for distributing organic carbon from restored marsh to large portions of the Delta).
  - Degree of support by local interests.
  - Synergies with other planning efforts.
  - Enhanced ability to export and enhanced water quality.
  - Proportion of public land that reasonably could be made available for restoration.
  - Proximity and availability of suitable fill material where needed for marsh restoration.
- Likely Relative Magnitude of Covered Species Benefits
  - Sturgeon.
  - Splittail.
  - Sacramento River salmonids.
  - San Joaquin River salmonids.
  - Delta smelt.
  - Longfin smelt.

Application of these criteria resulted in the identification of the most practicable opportunities for restoring and enhancing natural communities in a manner expected to achieve the biological goals and objectives.

3G.7.3.1.5 Establishing Natural Community Enhancement and Restoration Targets

The rationale for the extent of natural communities to be enhanced and restored under the BDCP is described below.

Tidal Natural Communities Restoration Target

In addition to the information developed by the Habitat Restoration Program Technical Team regarding tidal natural community restoration opportunities, the Steering Committee reviewed tidal natural community restoration targets proposed by the CALFED Ecosystem Restoration Program (2000) and the Delta Vision Strategic Plan (Governor's Delta Vision Blue Ribbon Task Force 2008) to help formulate the BDCP tidal habitat restoration target. The CALFED Ecosystem Restoration Program (2000) recommended a target of approximately 55,000 acres of tidal habitat restoration in the Sacramento–San Joaquin River Delta and Suisun Marsh Ecological Management Zones. The Delta Vision Strategic Plan proposed a strategy to "restore large areas of interconnected habitats, on the order of 100,000 acres, within the Delta and its watershed by 2100," with interim targets of 27,500 and 55,000 acres by years 2020 and 2040 respectively (Governor's Delta Vision Blue Ribbon Task Force 2008).

In late 2008 and early 2009, the Steering Committee had several analyses performed to evaluate tidal restoration opportunity and feasibility in the Plan Area. The first evaluation identified the total acreage of land with elevations suitable for restoring tidal natural communities in the BDCP ROAs. This analysis identified approximately 125,000 acres of lands with suitable elevations to restore tidal marsh and shallow subtidal natural communities as well as to accommodate 3 feet of sea-level rise (Table 3G-5). The second analysis then weighted[3] these acres based on 17 different restoration opportunity criteria such as location, number and size of parcels, proximity to critical infrastructure, etc. The output from this analysis identified a total number of acres that had very high to very low potential opportunity to support tidal restoration (Table 3G-5).

From these two analyses, the BDCP Steering Committee proposed the preliminary restoration target of 55,000 acres in early 2009. In mid-2009, after discussions with wildlife agency staff, the final tidal natural community restoration target of 65,000 acres was agreed upon as biologically appropriate, practicable, and achievable within the permit term. The target includes restored subtidal and intertidal natural communities as well as transitional upland habitats to accommodate the effects of sea-level rise (i.e., upland areas that may be inundated by rising tides).

Following release of the November 2010 preliminary administrative draft BDCP, all of the aquatic and wetland natural community conservation measures were revisited via a collaborative process featuring extensive discussions and review of draft products in collaboration with the fish and wildlife agencies. During this process all biological goals and objectives for covered fishes and for tidal and wetland natural communities and their associated covered wildlife and plant species were revisited and redefined with greater precision. This required consequent modification of the aquatic and wetland natural community conservation measures to ensure that the associated biological goals and objectives would be met. This process was partially complete at the time of release of the February 2012 administrative draft BDCP. Substantial further analysis and negotiation was then

[3] BDCP ROAs subregions were weighted by applying a value of 1 to 5 to 17 different restoration opportunity criteria. A weighting value of 1 indicated a serious constraint on restoration while a weighted value of 5 meant a low constraint on restoration.

required in order to ascertain potential effects, appropriate biological goals and objectives, and necessary modifications to the conservation strategy affecting many covered species, particularly the fishes and certain animals with specialized aquatic habitat requirements (e.g. salt marsh harvest mouse and tricolored blackbird). This process was completed in late summer 2012 and the outcomes are reflected in the current draft BDCP.

Seasonally Inundated Floodplain Restoration Target

The Habitat Restoration Program Technical Team identified the primary opportunities for restoring floodplains to include breaching or setting back levees along Old, Middle, and San Joaquin Rivers. Restoration of 10,000 acres of seasonally inundated floodplain could be accommodated in this area by setting back levees by up to approximately 1,500 feet on each side of these river channels. The extent of restoration could be reduced or increased by either increasing or decreasing the length of levees that are set back. Increasing the restored floodplain acreage target, however, was not deemed practicable because sufficient flood flows to inundate a larger area would likely only occur at very low frequencies, resulting in a minimal increase in benefits for covered fish species.

Channel Margin Habitat Enhancement Target

The BDCP target to enhance 20 linear miles of channel margins was established to enhance rearing and migration habitat for juvenile salmonids and to mitigate effects of the construction of intakes along the Sacramento River. The habitat will be restored along important channels supporting out-migrating juvenile salmonids. There is uncertainty, however, about the effectiveness of channel margin restoration to increase the survival of juvenile salmonids passing through the Delta. Enhancement of 20 linear miles of channel margin was deemed to be sufficient to determine the effectiveness of enhancing channel margin habitats to increase survival.

Riparian Habitat Restoration Target

The BDCP target to restore 5,000 acres of riparian habitat will be implemented in conjunction with the restoration and enhancement of tidal natural communities, seasonally inundated floodplains, and channel margin habitat, where riparian vegetation will be established on restored habitat surfaces in locations supporting suitable soils and hydrology. The 5,000-acre target was established to achieve habitat objectives for the riparian-associated covered wildlife species. As described for these species in Chapter 3, *Conservation Strategy*, and Chapter 5, *Effects Analysis*, restoration of 5,000 acres of riparian habitat is expected to be sufficient to mitigate effects of the covered activities and contribute to the recovery of these species.

Table 3G-5. Summary of Potential Opportunities for Tidal Marsh Restoration by ROA Based on Practicability of Implementation, Suitability, and Cost

Restoration Opportunity Area and Land Units	Potential Opportunities for Tidal Marsh Restoration (acres)					
	Very High	High	Moderate	Low	Very Low	Total Potential
Yolo Bypass/Cache Slough Complex ROA	10,710	3,760	9,430	1,440	0	25,340
Cosumnes/Mokelumne ROA	0	1,400	2,400	3,510	180	7,490
East Delta ROA	0	0	0	4,740	800	5,540
South Delta ROA	0	0	0	15,300	13,600	28,900
West Delta ROA	1,230	490	880	970	210	3,780
Suisun Marsh ROA	0	37,200	16,400	50	0	53,650
Total	11,940	42,850	29,110	26,010	14,790	124,700

3G.7.3.2 Terrestrial Resources

The Steering Committee established the Terrestrial Resources Subgroup under the Habitat Restoration Program Technical Team to develop habitat protection, enhancement, and restoration conservation measures to address conservation of the nontidal natural communities and the covered wildlife and plant species habitats supported by those communities. Restoration of covered wildlife and plant species habitats associated with tidal and riparian natural communities, and with floodplain and channel margin areas, were addressed through the development of the conservation measures *CM5 Seasonally Inundated Floodplain Restoration*, *CM6 Channel Margin Enhancement*, and *CM7 Riparian Natural Community Restoration*. These conservation measures were refined to incorporate elements that would ensure that these actions would restore habitat for covered wildlife and plant species that use tidal marsh, tidal mudflat, floodplain, and riparian habitats.

The primary conservation emphasis for covered wildlife and plant species associated with terrestrial natural communities was on the protection and enhancement of existing natural communities and ensuring that they will not be converted to other cover types in the future. In addition to the natural community protection and enhancement measures, the subgroup identified an objective of restoring 2,600 acres of grassland, vernal pool complex, and nontidal marsh natural communities. These restoration actions were developed to contribute to the conservation of covered species and to mitigate effects of BDCP implementation.

The process used to develop the terrestrial natural community conservation measures is described below.

- The subgroup divided the Plan Area into 11 conservation zones, each of which represented a discrete geographic area, as a planning tool to provide a basis for spatially distributing the extent of each natural community and covered species habitat to be protected, enhanced, and restored throughout the Plan Area.
- The subgroup then established habitat conservation targets (i.e., the extent and location of natural communities and habitat types to be protected, enhanced, and restored under the BDCP) that provided the basis for developing the terrestrial natural community conservation measures. The following information was used to establish the targets:
    - Distribution and extent of each natural community in the Plan Area.

- Estimated effects of covered activities on covered wildlife and plant species and their habitats.
- Distribution and extent of each covered species' modeled habitat in the Plan Area.
- The estimated effects of covered activities on natural communities and covered wildlife and plant species and their habitats.
- Primary threats and stressors for each of the covered species.
- Location of habitat areas known to be occupied by each of the covered species.
- The distribution and extent of existing protected patches of each natural community and covered species habitat.
- Potential for increasing connectivity with conserved habitat areas adjacent to the Plan Area.

- To ensure that the conservation targets would achieve the biological goals and objectives for the covered wildlife and plant species, this information was evaluated for each of the following variables:
  - The patch size and connectivity of each natural community with other protected and unprotected natural community patches and communities.
  - The extent of modeled habitat for covered species that is supported by each natural community in each of the conservation zones.
  - The habitat value and endurance of patches of natural communities for associated covered species.
  - The patch size and connectivity of each covered species' modeled habitat to other patches of modeled protected and unprotected species habitat in and adjacent to the Plan Area.
  - Location of important known covered wildlife species population centers and covered plant species occurrences.
  - Proximity of modeled covered species habitats to known occupied habitats.
  - The extent of habitat needed to be conserved to mitigate impacts of the covered activities.
- The subgroup then developed conservation land assembly principles that were used to spatially distribute habitat protection and restoration targets to ensure that objectives related to the establishment of ecological corridors, patch size, and other functional attributes of habitat were provided for.

Based on this information, conservation measures were prepared describing the conservation actions that would be implemented to achieve the habitat conservation targets.

Following release of the November 2010 preliminary administrative draft BDCP, all of the terrestrial natural community conservation measures were revisited via a collaborative process featuring extensive discussions and review of draft products in collaboration with the fish and wildlife agencies through the Terrestrial Technical Team described above. During this process all biological goals and objectives for terrestrial natural communities and their associated covered species were revisited and redefined with greater precision. This required consequent modification of the terrestrial natural community conservation measures to ensure that the associated biological goals and objectives would be met. This process was largely complete at the time of release of the February 2012 administrative draft BDCP. However, further analysis and negotiation was then

required in order to ascertain potential effects, appropriate biological goals and objectives, and necessary modifications to the conservation strategy affecting several terrestrial species, particularly those that rely on cultivated lands for part of their habitat requirements (e.g., Swainson's hawk, sandhill crane, and giant garter snake).

3G.7.4 Other Stressors Conservation Measures

This section describes the development of the other stressors conservation measures. *Other stressors* are defined under the BDCP as those environmental stressors to the covered fish species that are not caused by water operations or habitat limitation. Conservation measures were developed to address the following stressors.

- Methylmercury contamination of sediments and the water column.
- Invasive aquatic vegetation.
- Low dissolved oxygen in the Stockton Deep Water Ship Channel.
- Predatory fishes.
- Nonphysical barriers to divert covered fishes from hazardous areas.
- Illegal harvest of covered fishes.
- Conservation hatcheries for delta smelt and longfin smelt.
- Pollutant loading from stormwater runoff.
- Invasive aquatic species.
- Entrainment and other effects associated with non-SWP/CVP water diversions.
- Minimization and avoidance of incidental take associated with construction of water facilities or restoration sites.

The Other Stressors Working Group began developing conservation measures in March 2008. The first task was to identify the full set of other stressors for the covered fish species. The working group used multiple sources to develop this list, including primary literature, agency reports such as biological assessments and opinions, pelagic organism decline progress reports, DRERIP conceptual models, previous BDCP technical documents, conference proceedings, and personal communication with Delta fish experts. After the full set of other stressors was identified, a list of potential experts was assembled for each stressor. These experts included federal, state, and local government agency staff; university professors; professional researchers; nongovernmental organization staff; permit applicants; and private consultants.

BDCP consultants then began researching these other stressors. Consultants conducted literature reviews and interviewed experts on each stressor. Multiple informational presentations were given at meetings during which a set of solution opportunities was identified for each stressor. Subject experts were also asked to present research and additional information on specific stressors.

On July 22, 2008, the Other Stressors Working Group identified 43 draft conservation measures, many of which were evaluated during the DRERIP coarse-level evaluations during summer 2008.

Based in part on DRERIP coarse-level evaluations, the Other Stressors Working Group modified the list of conservation measures addressing other stressors. Some draft measures were combined and

others were removed. A set of 35 draft other stressors conservation measures was delivered to the BDCP Steering Committee in September 2008.

The Other Stressors Working Group then developed a process for prioritizing the 35 draft conservation measures based on four factors:

- The conservation measure avoids, minimizes, and/or mitigates take (i.e., take related to BDCP actions) or contributes to recovery of covered species.
- The conservation measure enhances or restores habitat (including critical habitat) for covered species.
- The conservation measure could be reliably, efficiently, and accountably implemented over 50 years.
- The conservation measure and its underlying action are not already required by law or is under the jurisdiction of another agency.

This process resulted in the removal of 13 conservation measures. The remaining 22 conservation measures were then subject to three important questions regarding conservation credit:

- Will the conservation measure happen because BDCP took an action?
- Will the conservation measure provide a meaningful benefit to covered fish species?
- Will BDCP receive "credit" from fish and wildlife agencies for implementing the conservation measure? ("credit" could be either formal regulatory credit or other less formal credit from fish and wildlife agencies for providing benefits to species).

From this exercise, 16 conservation measures were submitted for analysis during the DRERIP full evaluation in winter 2009 (Essex Partnership 2009).

The other stressors conservation measures were evaluated during the mini-effects analysis and the full effects analysis during 2010 to determine their expected beneficial or adverse effects on covered fish species. Important related actions, which are actions that influence the anticipated effectiveness of BDCP conservation measures but are not under the direct control of BDCP, were separately evaluated during the same period. These conservation measures and their expected effects were reported in the November 2010 preliminary administrative draft BDCP.

Following agency review and comment of the November 2010 preliminary administrative draft, all other stressors conservation measures were reviewed and revised in preparation for the February 2012 administrative draft, with further review and revision completed in collaboration with the fish and wildlife agencies. That work is here summarized for each of the other stressor conservation measures.

- *CM12 Methylmercury Management* was completely rewritten following the November 2010 preliminary administrative draft. The current version of this measure was prepared with extensive review and input from the U.S. Environmental Protection Agency, DWR, California State Water Resources Control Board, and other staff involved in methylmercury hazard management in the Delta. The measure is consistent with existing practice and regulation but also proposes potential remediation techniques that could substantially reduce methylmercury contamination risks.
- *CM13 Invasive Aquatic Vegetation Control* was completely rewritten following the November 2010 preliminary administrative draft. The current version of this measure is focused on

ongoing and emergent risks posed by invasive aquatic vegetation throughout the Plan Area and builds heavily on the existing state program, managed by the California Department of Boating and Waterways, to continue aquatic vegetation control using chemical methods. The revised conservation measure also addresses restoration site design to minimize risks of site colonization by invasive aquatic vegetation, and identifies research actions that will support development of biological control techniques.

- *CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels* was substantially revised following the November 2010 preliminary administrative draft, with input from agency staff familiar with the studies and operations of the facility to date. The revised measure contains greater detail on results of initial operation of the aeration facility and identifies monitoring and adaptive management measures to optimize effectiveness of the conservation measure.
- *CM15 Localized Reduction of Predatory Fishes* was completely rewritten following the November 2010 preliminary administrative draft. The current version of this measure was developed with extensive input from fish agency staff and is highly focused on research and adaptive management to better understand the role of fish predation as a driver of covered fish species distribution, behavior, survival/abundance, and population status in the Plan Area. The measure proposes a limited suite of initial implementation actions with substantial investments in research prior to developing a full field implementation of the measure.
- *CM16 Nonphysical Fish Barriers* was not extensively revised; it remains focused on the goal of increasing the survival of juvenile covered fishes (primarily salmonids) by discouraging them from entering channels known to result in higher mortality than other viable migration routes. Results from initial implementation of these barriers are discussed, as are monitoring and adaptive management measures to optimize program effectiveness.
- *CM17 Illegal Harvest Reduction* was not extensively revised, but is presented in considerably greater detail than in previous drafts. It remains focused on increasing the enforcement of fishing regulations in the Delta and bays with the goal of reducing illegal harvest of covered salmonids and sturgeon.
- *CM18 Conservation Hatcheries* was completely rewritten following the November 2010 preliminary administrative draft. The current version of this measure was developed with extensive input from USFWS staff familiar with the existing and proposed delta and longfin smelt conservation hatchery programs. It is focused on providing fish suitable for use in research actions, many of which are identified in other conservation measures as necessary to address key uncertainties in understanding of the biology of these fishes.
- *CM19 Urban Stormwater Treatment* was mentioned only as a potential conservation measure in the November 2010 draft. In fall 2011, DWR directed that this be developed as a conservation measure. In its initial form it was based on the 2009 DRERIP evaluation of the potential conservation measure, but was extensively revised in response to agency comments on interim draft versions of the measure. The current version of this measure is intended to contribute to the biological objective that calls for water quality conditions in the Delta that help restore native fish habitat. It would achieve this by providing BDCP funding for grants to project proposals that provide enhanced water quality treatment for stormwater discharges to surface waters in the Plan Area.
- *CM20 Recreational Users Invasive Species Program* was mentioned only as a potential conservation measure in the November 2010 preliminary administrative draft. In fall 2011,

DWR directed that this be developed as a conservation measure. In its initial form it was based on the 2009 DRERIP evaluation of the potential conservation measure (Essex Partnership 2009), but was extensively revised in collaboration with DFG staff involved in the existing Aquatic Invasive Species Program (the measure would be implemented primarily by DFG in collaboration with the Implementation Office). The current version of this measure is intended to contribute toward achieving the biological goals that address maintenance of native biological diversity and control of invasive species. It will do this primarily by educating recreational users about the importance of avoiding further introductions of aquatic invasive species and by instituting recreational watercraft inspections that directly reduce the risk of invasive species introduction and proliferation.

- *CM21 Nonproject Diversions* was mentioned only as a potential conservation measure in the November 2010 preliminary administrative draft. In fall 2011, DWR directed that this be developed as a conservation measure. In its initial form it was based on the 2009 DRERIP evaluation of the potential conservation measure (Essex Partnership 2009), but was revised in collaboration with staff involved in the Bureau of Reclamation's existing Anadromous Fish Screen Program and DFG's existing Fish Screen and Passage Program (the measure would be implemented primarily by these entities in collaboration with the Implementation Office). The primary purpose of this conservation measure is to reduce incidental take of covered fishes by entrainment or impingement at nonproject diversions located in the Plan Area.

3G.8 References

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1 **Table 3G-1. Summary of Alternatives Developed and Evaluated (Lund et al. 2007)**

Alternative	Details	Summary Evaluation	Rationale
Freshwater Delta Alternatives aim to maintain the Delta as homogenous freshwater body. Delta salinity could be controlled through levees, outflows, and barrier structures.			
Alternative 1. Levees as usual – current or increased effort	The current levee-intensive system would be maintained at recent levels of effort or modestly upgraded to meet federal standards for agricultural levees. Water exports would continue to be pumped through the Delta. Levee failures would occur with increasing frequency.	Eliminate	Current and foreseeable investments at best continue a risky situation; other soft landing approaches are more promising; not sustainable in any sense.
Alternative 2. Fortress Delta (Dutch standards)	"Whatever it takes" investments would be made to support or fix levees deemed strategically important for urban areas, infrastructure, and water supply exports. To contain costs, the total length of the levees in the system would be shortened, reconfiguring some islands. Lower-reliability levees (mainly in the interior of the Delta) would be allowed to fail.	Eliminate	Great expense; unable to resolve important ecosystem issues.
Alternative 3. Seaward saltwater barrier	A permanent or movable barrier would be erected at the western edge of the Delta. This is one of the oldest and most extreme proposals for keeping salt water at bay, but it has recently reemerged because Dutch engineers have suggested the construction of a large movable barrier, similar to the Maeslant storm surge barrier that protects Rotterdam in The Netherlands.	Eliminate	Great expense; profoundly undesirable ecosystem performance; water quality risks.
Fluctuating Delta Alternatives aim for fluctuating environmental conditions in the western Delta (especially salinity) to improve habitat conditions for native fish species. Urbanization would be possible along the Delta's periphery behind strong levees.			
Alternative 4. Peripheral canal plus	An aqueduct would be constructed from the vicinity of Hood, on the Sacramento River, south along the Delta's eastern edge, sending water exports to Clifton Court Forebay. This would allow water exports to circumvent the Delta and yet continue to meet the Central Valley Project and State Water Project intakes. This proposal augments the traditional peripheral canal proposals with special operations, investments, and activities for environmental and other in-Delta land and water uses (hence the "plus").	Consider	Environmental performance uncertain, but promising; good water export reliability; large capital investment.

Alternative	Details	Summary Evaluation	Rationale
Alternative 5. South Delta restoration aqueduct	This aqueduct would be similar to the peripheral canal mentioned above, but its major outlet would enter the lower San Joaquin River. These supplemental freshwater flows would resolve various water quality and flow problems of the lower San Joaquin River and the south Delta while improving the quality of water exports and reducing entrainment of native fish at the pumps. Some flows could be channeled into a wetland and flood bypass channel through the south Delta, contributing to improved habitat and agricultural water quality. In-Delta investments would be made for environmental and other in-Delta uses.	Consider	Environmental performance uncertain, but more adaptable than Alternative 4, Peripheral canal plus; water delivery promising for exports and in-Delta uses; large capital investment.
Alternative 6. Armored-island aqueduct	A major, semi-isolated freshwater conveyance corridor for water exports would be created by armoring select islands and cutting off or tide-gating various channels within the central-east Delta.	Consider	Environmental performance likely poor unless carefully designed; water delivery promising; large capital investment.
Reduced-Exports Delta Alternatives do not rely on new Delta export facilities or levees. However, they do imply an ability to greatly modify the pattern and quantity of Delta exports.			
Alternative 7. Opportunistic Delta	Only opportunistic seasonal exports would be allowed, during times of high discharge of fresh water from the Delta (generally winter and spring). Export pumping capacities would be expanded to accommodate these high pumping periods, and some surface storage within and near the Delta may be built. Salinity levels would fluctuate in the west Delta, and many islands would eventually become flooded. Urbanization would be possible along the Delta's periphery, behind strong levees.	Consider	Expenses and risks shift to importing areas; relatively low capital investment; environmental effectiveness unclear.
Alternative 8. Eco-Delta	The Delta would be managed as a single, unified entity to favor key Delta aquatic and terrestrial species. Water extraction, transportation corridors, and other functions would be maintained as long as they do not interfere with rehabilitation goals. Some water exports would occur but less than in Alternative 7, Opportunistic Delta.	Consider	Initial costs likely to be very high; long-term benefits potentially high if Delta becomes park/open space/endangered species refuge.
Alternative 9. Abandoned Delta	A planned, multi-decade retreat from the Delta would occur, phasing out much of the Delta's farm economy. Water exporting agencies would transition to alternative water sources and would increase water use efficiency.	Eliminate	Poor overall economic performance; southern Delta water quality problems; like Alternative 1, without benefits.

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Table 3G-2. Conservation Strategy Alternatives Developed by the BDCP Conservation Strategy Workgroup

Conservation Strategy Alternative	Title	Theme
CSA-1	Operations Modifications with Existing Conveyance Configuration	Use existing Delta conveyance configuration, and improve State Water Project and Central Valley Project operations and facilities management and diversion-related infrastructure to reduce mortality of and improve flow-related habitat conditions for covered fish species sufficiently to increase their production, abundance, and distribution.
CSA-2	In-Delta Habitat Restoration under Existing Operations	Use existing Delta conveyance configuration and operations, and physically restore extensive tracts of physical aquatic and floodplain habitats in the Delta to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species.
CSA-3	Opportunistic Exports with In-Delta (within BDCP Planning Area) Habitat Restoration	Increase export capacity and limit exports to occur only during periods of high flow and when covered fish species are least vulnerable to entrainment, improve flow-related habitat conditions, and restore extensive tracts of physical aquatic and floodplain habitats in the Delta to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species.
CSA-4	South Delta Aqueduct with In-Delta Habitat Restoration	Create a new Delta conveyance configuration that would provide for improved fluctuating salinities and variable hydrology in the west and north Delta and improve ecosystem water quality in the south Delta; and restore extensive tracts of physical aquatic and floodplain habitats in the Delta to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species.
CSA-5	Isolated Facility with In-Delta Habitat Restoration	Create a new Delta conveyance configuration that would provide fluctuating salinities and variable hydrology throughout the Delta and avoid entrainment at the pumps; and restore extensive tracts of physical aquatic and floodplain habitats within the Delta to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species.
CSA-6	Suisun Marsh Habitat Restoration in Combination with In-Delta Habitat Restoration	Use the existing Delta conveyance configuration and operations; and restore physical aquatic and floodplain habitats in the Delta and Suisun Marsh to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species. This alternative would restore less in-Delta habitat (e.g., 40 to 60%) than would be restored under CSA-2.
CSA-7	Upstream Habitat Restoration in Combination with In-Delta (within Planning Area) Habitat Restoration	Use the existing Delta conveyance configuration and operations and restore physical aquatic and floodplain habitats in the Delta and outside the BDCP Planning Area along the Sacramento and San Joaquin Rivers and their tributaries to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species. This alternative would restore less in-Delta habitat (e.g., 40 to 60%) than would be restored under CSA-2.

Conservation Strategy Alternative	Title	Theme
CSA-8	Bifurcated South Delta Aqueduct with In-Delta Habitat Restoration	Alter the existing Delta conveyance configuration to provide for fluctuating salinities and variable hydrology in the west and north Delta and improve ecosystem water quality in the south Delta; and restore extensive tracts of physical aquatic and floodplain habitats in the Delta to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species.
CSA-9	Dual Conveyance with In-Delta (within Plan Area) Habitat Restoration	Alter the existing Delta conveyance configuration to provide flexibility in Delta operations to reduce effects of operations-related entrainment, improve fluctuating hydrologic conditions for covered fish species while maintaining in-Delta channel stage and water quality, and restore extensive tracts of physical aquatic and floodplain habitats in the Delta to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species.
CSA-10	Split Delta with San Joaquin River Corridor Restoration	Operate and reconfigure in-Delta conveyance of San Joaquin River to isolate covered fish species from the south Delta pumps and restore estuarine habitat in the south and west Delta to provide sufficient habitat area and quality to increase the production, abundance, and distribution of covered species.

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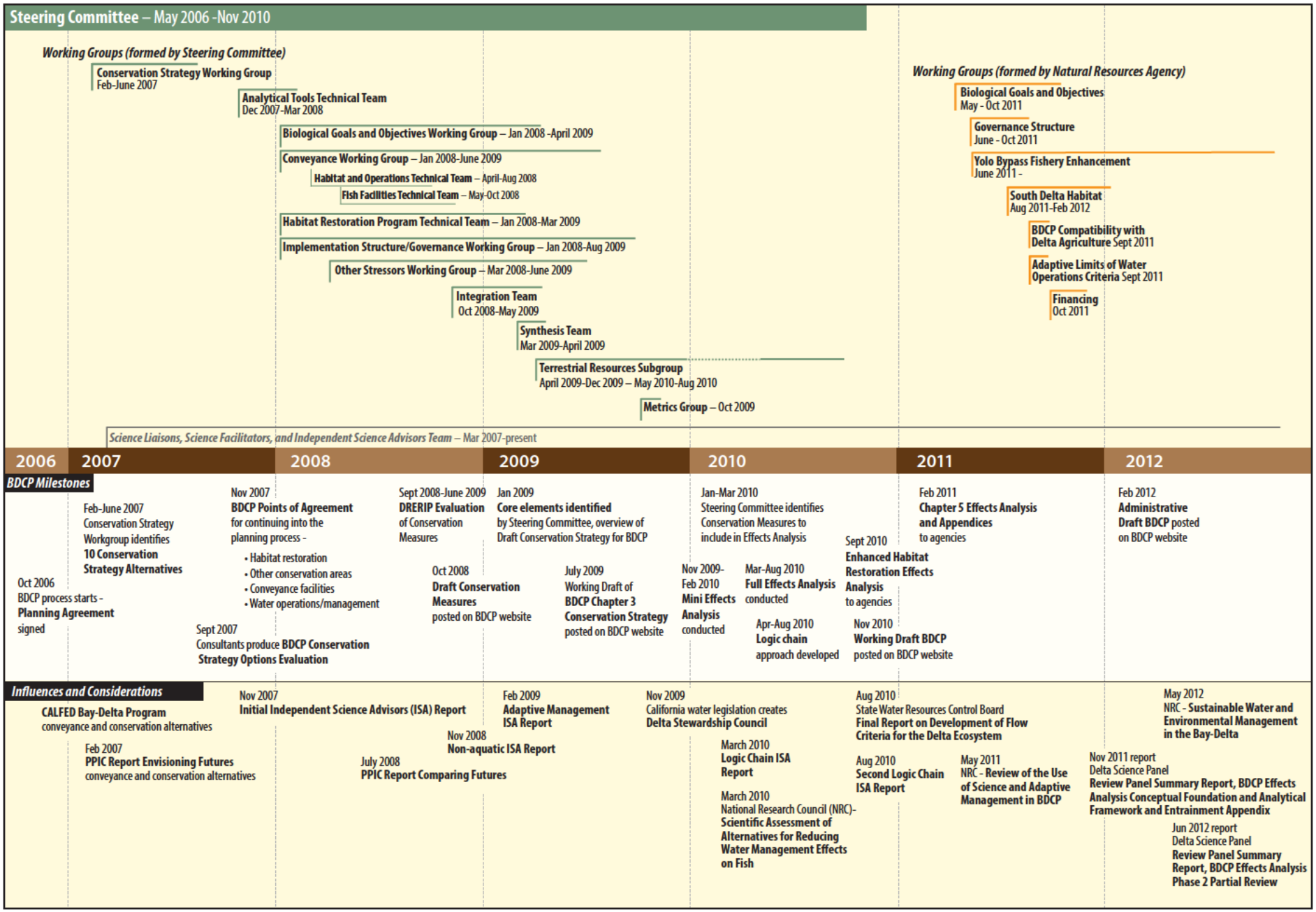

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Figure 3.G-1
General Timeline and Overview of BDCP Development