CHAPTER 10. INTEGRATION OF INDEPENDENT SCIENCE IN BDCP DEVELOPMENT

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[***Note to Reviewers****: The text of Chapter 10 is draft and subject to change as the BDCP planning process, including the independent science process, continues. This chapter, however, has been drafted and formatted to appear as it may in a draft BDCP HCP/NCCP document. Although the chapter includes declarative statements (e.g., "suggestions were used to refine…"), it is nonetheless a working draft that will undergo further modification based on input from the BDCP Steering Committee, state and federal agencies, and the public.*]

CHAPTER 10. INTEGRATION OF INDEPENDENT SCIENCE IN BDCP DEVELOPMENT

10.1 BACKGROUND AND REGULATORY REQUIREMENTS

The BDCP is built upon and reflects the extensive body of scientific investigation, study, and analysis of the Delta compiled over several decades,[1] including the results and findings of numerous studies initiated under the CALFED Bay-Delta Science Program and Ecosystem Restoration Program, the long-term monitoring programs conducted by the Interagency Ecological Program (IEP), research and monitoring conducted by state and federal resource agencies, and research contributions of academic investigators.

In addition, the BDCP Steering Committee considered several other recent reports on the Delta, including reports of the Governor's Delta Vision Blue Ribbon Task Force (January and October 2008), recent reports from the Public Policy Institute of California (Public Policy Institute of California 2007, 2008), and Delta flow criteria recommended by the State Water Resources Control Board and California Environmental Protection Agency (SWRCB and CalEPA 2010) Many elements of the BDCP conservation strategy parallel the recommendations of these other reports.

In the Five-Point Policy for HCPs, USFWS and NMFS encourage the use of independent science to help inform the development of HCPs.[2] The NCCPA requires the planning process to include opportunity for independent scientific input to assist with the development of the plan. This independent scientific input would:

A. Recommend scientifically-sound conservation strategies for species and natural communities proposed to be covered by the plan.

B. Recommend a set of reserve design principles that addresses the needs of species, landscapes, ecosystems, and ecological processes in the planning area proposed to be addressed by the plan.

C. Recommend management principles and conservation goals that can be used in

[1] See *The State of Bay-Delta Science* (2008).

[2] 65 Fed. Reg. 35242 (June 1, 2000).

developing a framework for the monitoring and adaptive management component of the plan.

D. Identify data gaps and uncertainties so that risk factors can be evaluated.[3]

10.2 Independent Science Advisory Process

To ensure that the BDCP would be based on the best scientific and commercial data available, the Steering Committee also sought input and advice from independent scientists on key elements of the Plan. Early in the planning process, the Steering Committee retained the services of an independent Science Facilitation team, consisting of staff from the Conservation Biology Institute and The Essex Partnership, to facilitate independent science panels consistent with the Five Point Policy and the Guidance for the NCCP Independent Science Advisory Process established in 2002 by the California Department of Fish and Game (DFG).[4] The BDCP Steering Committee also established a "Science Liaisons" group consisting of members of the Steering Committee to work with the Science Facilitators to ensure an appropriate level of independent scientific input into the development of the BDCP. The Science Liaisons and the Science Facilitators worked together to identify potential areas of scientific expertise needed to support plan development and to identify issues and questions for the science advisors to address. Basic planning guidelines to select and engage independent scientists were developed (see Appendix G-?? *Science Advisory Process - Bay Delta Conservation Plan, June 2007*). These planning guidelines were further refined in 2008 when the Science Liaisons and the Science Facilitators developed a process designed to accommodate different levels or tiers of review based on the scope of the input sought. This tiered approach is outlined in Appendix G-??, *Proposed Tiered Science Process, June 2008.*

Consistent with the requirements of the NCCPA and the policy directives of the Five-Point Policy,[5] the BDCP Steering Committee directed the 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 approaches to conservation planning for aquatic and terrestrial species in the Delta and developing adaptive management and monitoring programs.[6] Five different groups of independent science advisors were convened during the development of the BDCP.

Each of the independent science efforts are summarized in Section 10.3, *Independent Science Review Teams*, including a brief summary of major findings and information regarding how recommendations were incorporated into the overall planning process. Reports prepared by independent science advisors to the BDCP are provided in Appendix G, *Independent Science Advisors Reports.*

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[3] Fish & Game Code § 2810(b)(5).

[4] DFG. 2002. *Guidance for the NCCP Independent Science Advisory Process* at http://www.dfg.ca.gov/habcon/nccp/publications.html

[5] 65 Fed. Reg. 35242.

The Steering Committee also engaged a group of over 50 scientists in 2009 to review each of the draft conservation measures in development at that time using a scientific evaluation process developed for the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). The process for this DRERIP Evaluation is described in Section 10.4 *DRERIP Evaluation Process* and the results of the evaluation are provided in Appendix F, *DRERIP Evaluation Results*.

10.3 INDEPENDENT SCIENCE REVIEWS

10.3.1 Initial BDCP Independent Science Advisors

The first group of Independent Science Advisors gathered in September 2007 to provide guidance on the approach to planning for the conservation of aquatic species and ecosystem processes in the Delta. Specifically, the group advised the Steering Committee on the following elements of the BDCP:

- The application of conservation planning principles within the Plan Area;
- Geographic and temporal scope of the BDCP;
- Addressing facets of Delta ecosystem dynamics;
- Analytical methods used in BDCP formulation, methods of analysis; and
- Adaptive management and monitoring considerations.

Relative to conservation planning, the Advisors offered the following principles:

A. Changes in the estuarine ecosystem may be irreversible.

B. Future states of the Delta ecosystem depend on both foreseeable changes (e.g., climate change and associated sea-level rise) and unforeseen or rare events (e.g., the consequences of new species invasions).

C. The Delta is part of a larger river-estuarine system that is affected by both rivers and tides. The Delta is also influenced by long-distance connections, extending from the headwaters of the Sacramento and San Joaquin rivers into the Pacific Ocean.

D. The Delta is characterized by substantial spatial and temporal variability, including disturbances and extreme events that are fundamental characteristics of ecosystem dynamics. The Delta cannot be managed as a homogeneous system.

E. Species that use the Delta have evolved life history strategies in response to variable environmental processes. Species have limited ability to adapt to rapid changes caused by human activities.

F. Achieving desired ecosystem outcomes will require more than manipulation of Delta flow patterns alone.

G. Habitat should be defined from the perspective of a given species and is not synonymous with vegetation type, land (water) cover type, or land (water) use type.

H. Changes in water quality have important direct and indirect effects throughout the estuarine ecosystem.

I. Land use is a key determinant of the spatial distribution and temporal dynamics of flow and contaminants which, in turn, can affect habitat quality.

J. Changes in one part of the Delta may have far-reaching effects in space and time.

K. Prevention of undesirable ecological responses is more effective than attempting to reverse undesirable responses after they have occurred.

L. Adaptive management is essential to successful conservation.

M. Conservation measures to benefit one species may have negative effects on other species.

N. Data sources, analyses, and models should be documented and transparent so they can be understood and repeated.

O. Ecosystem responses, especially to changes in system configuration, can be predicted using a combination of statistical and process models. Statistical models document status, trends, and relationships between responses and environmental variables, whereas process-based models are useful in understanding system responses and for forecasting responses to new conditions.

P. There are many sources of uncertainty in understanding a complex system and predicting its responses to interventions and change.

A number of the above principles were used to develop and refine the overall BDCP Conservation Strategy as well as individual conservation measures and the evaluation of those measures. For example, Principles D, F, and J, lead to efforts to focus on regional strategies that acknowledge particular characteristics and tidal regimes as well as a focus on developing conservation measures that promote broader geographical range diversity for key species. Similarly, Principles N and O lead to the development of specific modeling tools designed to predict the outcomes of given actions and combinations of actions as evaluated in the Effects Analysis (Chapter 5, *Effects Analysis*).

10.3.2 Independent Science Advisors for Non-Aquatic Resources

A second group of Science Advisors convened in September 2008 to consider approaches to planning for the conservation of non-aquatic resources in the BDCP Planning Area. The group provided recommendations to the Steering Committee on various issues, including:

- Non-aquatic species to be considered for regulatory coverage under the BDCP;

- Terrestrial natural communities that should be addressed under the BDCP;
- Landscape-level approaches to conservation planning for non-aquatic resources;
- Additional sources of information to be developed to support the non-aquatic resource elements of the BDCP; and
- Conservation strategies that may be considered to address terrestrial and non-tidal wetland communities and dependent wildlife and plant species.

The Advisors offered specific advice on the species selection process, including consideration of listing status, occurrence within the planning area, potential to be affected by Plan actions, and sufficiency of information. The advisors also offered suggestions regarding potential covered species additions and deletions, as well as suggestions regarding potential planning species. The Advisors also offered specific suggestions regarding proposed conservation measures and design considerations regarding the refinement of the conservation strategy for non-aquatic resources. General principles suggested in considering the selection, design, and implementation of conservation measures included:

- Plan conservation measures hierarchically, working from ecosystem to community to species-level considerations. Do not plan conservation measures for specific covered species or communities in isolation, without considering their relationships with other species and communities in the broader ecosystem.
- Design reserve or management areas to achieve mosaics of community types within areas large enough to support the most area-dependent covered (or planning) species and desired ecological services, and to accommodate future shifts due to climate change (e.g., sea-level rise, changing runoff patterns, shifting climate "envelopes").
- Strive for representation of all community types in habitat mosaics well distributed across the Delta, but considering site-specific conditions. Where possible, maintain or create "soft edges" or natural transitions along environmental gradients, as opposed to abrupt transitions or "hard edges" between community types.
- Bigger is better for habitat conservation and restoration sites, but do not ignore small areas that support rare communities or species. For example, small areas of seasonal wetlands, inland dunes, or alkali flats support disproportionate numbers of imperiled species.
- Seek to preserve and enhance natural heterogeneity in elevation, water depth, flooding frequency, nutrient conditions, vegetation types, and adjacency of different habitat types within and among the conserved, restored, or maintained habitat mosaics.
- Enhance and preserve habitat connectivity where possible to maximize potential for natural range shifts, population expansions, escape from disturbance events (fires, floods), and maintenance of ecological processes, and to avoid isolating small populations of those species having limited dispersal abilities.

- Strive to create self-sustaining systems, but recognize that some communities and species may need active or perpetual management. For example, some invasive, nonnative species may require prolonged control efforts to sustain covered species or communities that they adversely affect.

Suggestions regarding covered species and design principles were used to refine the covered species list for the Plan and in refining the proposed conservation measures.

10.3.3 Independent Science Advisors on Adaptive Management

[***Note to Reviewers****: This section describes the scientific advisory process used in development of the BDCP adaptive management plan. As indicated in the note to reviewers at the beginning of the chapter, it is written as though this process is complete. Certain components of the adaptive management plan have been drafted, but the adaptive management plan is still in development.*]

The third group of Science Advisors met in December 2008 and provided input on approaches to the development of an adaptive management plan and decision making process for the BDCP, informed by data and information generated by monitoring and research efforts. This group built upon guidance on adaptive management that was provided in the first of the independent science workshops, offering more specific advice based on progress that had since been made in the development of the BDCP.

The Advisors offered eight principles for adaptive management as follows:

1. The scope and degree of reversibility of each proposed action (i.e., conservation measure) determines the form of adaptive management that can be applied (e.g.,“active” or experimental adaptive management versus “passive” adaptive management).

2. The knowledge base about the ecosystem is key to decisions about what to do and what to monitor, and includes all relevant information, not just that derived from monitoring and analysis within the context of BDCP.

3. Program goals should relate directly to the problems being addressed and provide the intent behind the conservation measures; objectives should correspond to measurable, predicted outcomes.

4. Models should be used to formalize the knowledge base, develop expectations of future conditions and conservation outcomes that can be tested by monitoring and analysis, assess the likelihood of various outcomes, and identify tradeoffs among conservation measures.

5. Monitoring should be targeted at specific mechanisms thought to underlie the conservation measures, and must be integrated with an explicitly funded program for assessing the resulting data.

6. Prioritization and sequencing of conservation measures should be assessed at multiple steps in the adaptive management cycle.

7. Specifically targeted institutional arrangements are required to establish effective feedback mechanisms to inform decisions about whether to retain, modify, or replace conservation measures.

8. A dedicated, highly skilled agent (person, team, office) is essential to assimilate knowledge from monitoring and technical studies and make recommendations to senior decision makers regarding programmatic changes.

A number of the principles above have been incorporated into the proposed BDCP Adaptive Management Program, including plans for an explicitly funded monitoring and assessment program, a research program, and clear institutional arrangements to establish feedback mechanisms to support decision making.

10.3.4 Logic Chain Review Panels

[***Note to Reviewers**: The logic chain development and review is currently in process. The results of this process will be used to inform various components of the BDCP as appropriate, including identification and development of biological goals and objectives for covered species and metrics for use in the monitoring and adaptive management programs.*]

The Delta Science Program provided assistance in assembling a fourth group of independent science advisors in February-March 2010 and a fifth group in July-August 2010 to evaluate and provide recommendations on the "Logic Chain" planning structure. The Logic Chain has been proposed as a framework to link recovery goals for covered fish species with BDCP goals, objectives, conservation measures, monitoring, and adaptive management. Two science reports on the Logic Chain were prepared.

In the first report, dated March 19, 2010 (Appendix G-?), the group of science advisors assessed the value of the Logic Chain as a tool, its internal consistency, and next steps for input of information into the Logic Chain. The group stated that the Logic Chain was a useful tool for clearly articulating and linking goals, objectives, actions, and outcomes, but recommended an alternate approach to:

- Clarify the links in the chain and reduce areas of ambiguity;

- Distinguish between order-of-magnitude approximations of goals and objectives that are acceptable in early planning and the more detailed descriptions developed later;
- Frame projected outcomes as testable hypotheses linked to specific conservation measures;
- Use metrics to evaluate the success of outcomes that clearly link to biological functions and consider the judicious use of surrogate metrics;
- Consider constraints to implementation of conservation measures;
- Consider the potential impacts of system dynamics, variation, and change over time; and
- Provide more detail to the adaptive management framework.

As next steps, the group recommended developing logic chains for a few species initially; leaving recovery goal development to responsible regulatory agencies; focusing on development of the BDCP biological goals and objectives; and convening a workshop to develop monitoring metrics.

In the second report, dated August 23, 2010 (Appendix G-?), the group assessed two populated logic chains to evaluate internal logic, measurability, and linkages, and consistency in approach. The group also recommended alternative strategies and metrics for goals and objectives and alternative ways to frame goals and objectives to be more practicable and provided advice on constructing an integrated monitoring program linked to the logic chains. Recommendations of this science group included:

- Simplify the logic chain structure to reduce the number of objective statements and to focus on BDCP objectives;
- Identify stressors that are outside of BDCP management;
- Focus BDCP objectives on measures of individual and population-level performance, such as habitat-specific estimates of growth and survivorship, quantitative estimates of abundance, and quantitative measures of movement and/or distribution;
- Take care in populating the compliance and performance monitoring actions and consider three monitoring levels separately, the global goal, the "covered activity" level, and compliance; and
- Link implementation of conservation measures, through monitoring and evaluation, to the adaptive management program.

10.4 DRERIP Evaluation Process

The BDCP Steering Committee undertook a rigorous process to incorporate new and updated information and to evaluate a wide variety of issues and approaches as it formulated a cohesive, comprehensive BDCP conservation strategy. This effort included an evaluation conducted early in 2009 by multiple teams of experts of draft BDCP conservation measures in development at that time, using the CALFED Bay-Delta Ecosystem Restoration Program's (ERP) Delta Region Ecosystem Restoration Implementation Plan (DRERIP) Scientific Evaluation Process.

In October 2008, the Steering Committee developed early drafts of BDCP conservation measures related to water operations, habitat restoration, and other stressors. The DRERIP evaluation process was used to evaluate these draft conservation measures. The DRERIP process was specifically developed to aid in planning and decision making regarding potential ecosystem restoration projects in the Delta. The process entails engaging teams of experts to work through a structured, step-by-step examination of the scientific efficacy of proposed restoration actions by analyzing both potential positive and negative outcomes which might result from a given action.

To conduct the DRERIP evaluations, the Steering Committee engaged 52 technical experts assembled into five teams to address related groupings of conservation measures. The DRERIP Technical Team meetings were limited to specific technical experts trained in the DRERIP evaluation process. The teams conducted DRERIP evaluations, from January-April 2009, on 32 draft conservation measures that could be evaluated using the process. The evaluations were conducted using a series of peer-reviewed DRERIP ecosystem and species conceptual models developed specifically for the Delta and additional relevant sources of information (e.g., published literature, recently collected data). The conceptual models describe the current scientific understanding regarding how the Delta ecosystem works and were designed to serve as a foundation for the evaluation process.

A description of the BDCP DRERIP evaluations and evaluation results is presented in Appendix F, *DRERIP Evaluation Results*. Results include an assessment of the likely magnitude of the ecological outcomes and the certainty of those outcomes that could be associated with implementing each evaluated conservation measure. However, because the DRERIP process was designed to evaluate restoration actions independently, it does not provide for a direct assessment of the combined magnitude and certainty of positive and negative ecological outcomes that would be associated with the contemporaneous implementation of multiple conservation measures under BDCP. To address this need, the Steering Committee established the Synthesis Team comprised of Steering Committee member representatives and technical experts that participated in the DRERIP evaluations to conduct an assessment of the likely synergistic ecological effects of concurrent implementation of multiple conservation measures based on the evaluation results for individual conservation measures. The Synthesis Team conducted their evaluation during March-April 2009 and provided recommendations to the Steering Committee for refining conservation measures, sequencing implementation of conservation measures, and adjusting DRERIP results for individual conservation measures based on their synergistic effects with implementation of other conservation measures.

DRERIP evaluation results were also used to inform development of the effectiveness monitoring for conservation measures (see Section 3.6, *Monitoring and Research Program*).

DRERIP evaluation results include assessments and sources of uncertainty surrounding the magnitude of ecological outcomes that could be expected with the implementation of each conservation measure. Based on these assessments, effectiveness monitoring was developed to collect the information necessary to address these sources of uncertainty and to inform the need for future adjustments to conservation measures to improve their performance over time through the BDCP adaptive management decision making process (Section 3.7, *Adaptive Management Program*).