APPENDIX A

Responses of the Delta Independent Science Board to charge questions provided by the Delta Stewardship Council

SUMMARY

This appendix addresses four groups of questions that were provided by Delta Stewardship Council staff to help us, the Delta Independent Science Board, frame our legislatively mandated review of the Draft EIR/EIS of the Draft Bay Delta Conservation Plan (BDCP). The summary on this page reproduces, in italics, the headings under which the Council staff grouped the charge questions. Our responses include comments on related sections of the Draft BDCP Plan.

Overall, we found extensive description and analysis of the proposed conveyance facilities and operations and of the associated habitat Conservation Measures. Our responses focus on causes for concern about the effectiveness of the proposed Conservation Measures.

Completeness, structure, and effectiveness of presentation—The analyses vary in the rigor of the science employed, defer detailed assessment of habitat restoration, mostly neglect Delta levees, exclude San Francisco Bay, and also ignore effects of fertilizers and pesticides in water-service areas of the Central Valley Project and State Water Project. The presentation contains few of the lists of assumptions and few of the analytical summaries that readers will need to make informed choices among the various alternatives. This need for synthesis applies more generally to findings that are presented repetitively or are scattered widely. Notably lacking are graphics that provide data-rich synthesis at a glance.

Approach, analysis, tools and modeling—Few of the many uncertainties in EIR/EIS are acknowledged in conclusions about impacts and mitigation actions. Assumptions are rarely listed fully and conspicuously.

Monitoring and adaptive management—The reviewed documents posit adaptive management of an uncertain future without examining plausible outcomes. The BDCP Plan presents adaptive management more as a notion than as a tested, problematic practice. We found no evaluation of adaptive management's prior use in the region or in analogous settings elsewhere, nor much consideration of the potentially confounding or constraining effects of biotic, abiotic, and societal factors or conflicting trends between species. The strategy presented hinges on trust in an Adaptive Management Team and in uncertain funding.

Statutory questions—In the Delta Reform Act of 2009, conditions for incorporating the BDCP into the Delta Plan include "comprehensive review and analysis" of effects related to freshwater flows, climate change, fish and aquatic resources, and water quality. Difficulties for the EIR/EIS in these areas include oversimplified modeling of water supply, neglect of ecosystem perspectives in impact assessments for fish and aquatic resources, reliance on hypothetical ecological benefits from restored tidal wetlands in assessment of those impacts, uncertain effects of climate change and sea-level rise on the proposed Conservation Measures, use of non-comparable data from different water-quality monitoring programs, and use of water-quality guidelines that may provide insufficient protection to ecosystems.

CONTENTS

REVIEW PROCESS AND SCOPE

California law directs the Delta Independent Science Board to review the Draft EIR/EIS of the Bay Delta Conservation Plan (BDCP). The directive states simply, "The Delta Independent Science Board shall review the draft environmental impact report and submit its comments to the council and the Department of Fish and Game" (Sacramento - San Joaquin Delta Reform Act of 2009, §85320(b)).

Staff of the Delta Stewardship Council helped us define the scope of this mandated review by providing specific charge questions[1]. The Council staff arranged the questions under four headings:

- Completeness, structure, and effectiveness of presentation
- Approach, analysis, tools and modeling
- Monitoring and adaptive management
- Statutory questions

Our responses are grouped under these same four headings and address each of the questions in turn. Each question can be found quoted in full, in italics, beneath each of the headings above.

Most of the charge questions refer chiefly to material in the EIR/EIS. Some of our responses refer the reader to details in individual EIR/EIS chapter reviews, which can be found in Appendix B.

For some charge questions we also had to draw also on material in the BDCP Plan itself. This is particularly the case for the questions on monitoring and adaptive management.[2].

The "Statutory questions" refer to section 85320(b) of the Delta Reform Act. This section states conditions for incorporating the BDCP into the Delta Plan. Those conditions include "comprehensive review and analysis" of several of the topics considered in our comments below.

Our review refers to the Draft BDCP and the BDCP Draft EIR/EIS[3]. For brevity we refer to these two documents as the BDCP Plan and the EIR/EIS, respectively.

[1] http://deltacouncil.ca.gov/sites/default/files/documents/files/Item_6_Attach_1_7.pdf

[2] The section below on monitoring and adaptive management, beginning on page 10, was written largely by Michael C. Healey, Professor Emeritus of Biological Oceanography at University of British Columbia, Lead Scientist of the Calfed Bay Delta Program in 2007-2008, and member of the Delta Independent Science Board in 2010-2012.

[3] Files dated December 9, 2013, and at http://baydeltaconservationplan.com/PublicReview.aspx

COMPLETENESS, STRUCTURE, AND EFFECTIVENESS OF PRESENTATION

Articulation of objectives and purpose

1. Are the project objectives and purpose clearly articulated, to enable the identification of a reasonable range of alternatives?

EIR/EIS Chapter 2 clearly articulates overall objectives and relates them to challenges to meeting the coequal goals. The statements of purpose address CEQA and NEPA requirements. Subsequent sections discuss ecosystems, water supply, and water quality. Supporting documents include primers on the Delta and water exported from it (Appendix 1A), potential risks from earthquakes and climate change (Appendix 3E), expected consequences of reducing exports to areas south of the Delta (Appendix 5B), and background on how the alternatives were developed (Plan, Appendix 3A).

Chapter 2 could frame water supplies more broadly to help show whether the range of alternative actions is "reasonable." For example, water exports from the Delta could be described as part of a portfolio of actions that include water conservation, reoperation, water markets, alternative conveyance, wastewater reuse, water storage, desalination, and regional self-sufficiency. Supporting references could include the Delta Plan (2013) and the California Water Action Plan (2013).

Definition of alternatives

2. Are the alternatives clearly defined?

EIR/EIS Chapter 3 contains detailed descriptions of action alternatives, and the meaning of "no action" is clarified by information in Appendix 3D, "Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions." The "Highlights of the EIR/EIS brochure"[4] offers a generalized guide to the action alternatives.

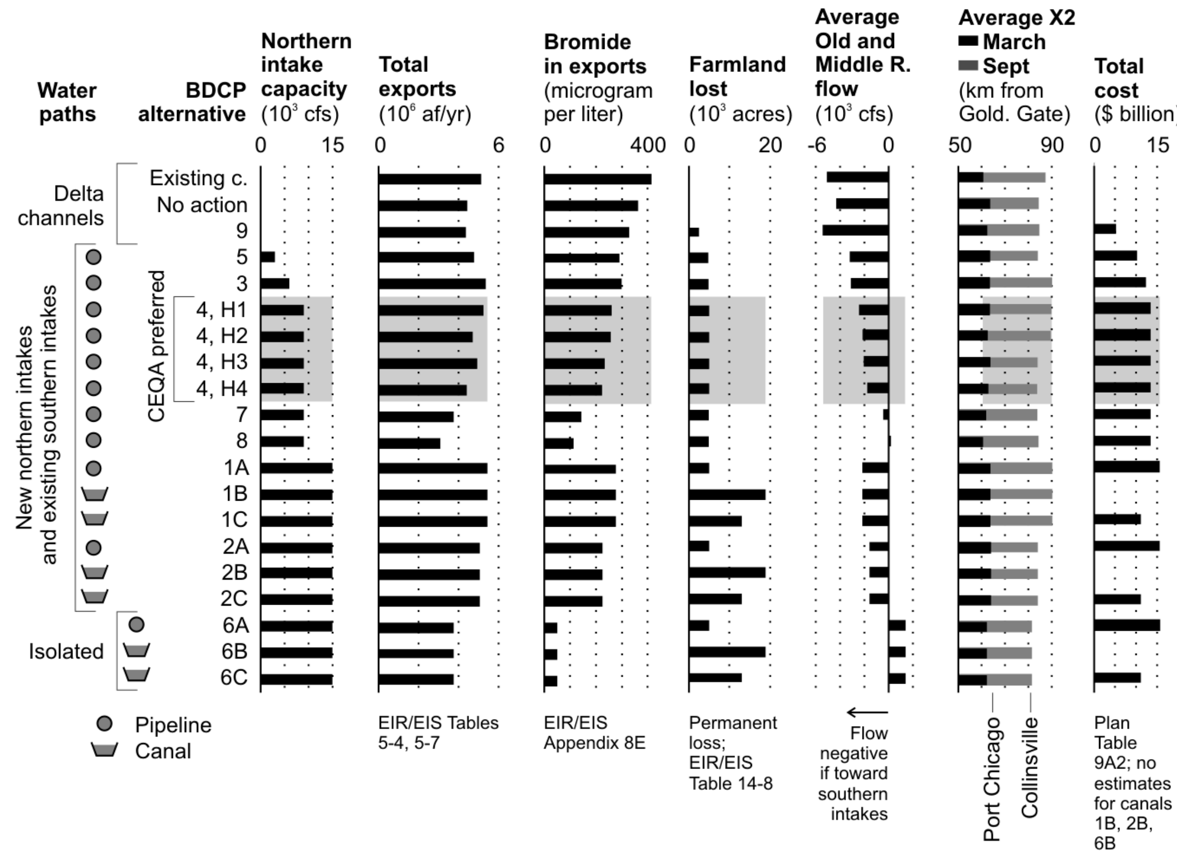
The EIR/EIS could identify the preferred CEQA alternative more clearly in several respects:

- How strongly preferred is Alternative 4 if the eventual project is not required to resemble it (Chapter 3, p. 3-4; Highlights Brochure sidebar, p. 7)?
- "As of this EIR/EIS, the federal Lead Agencies have not identified a Preferred Alternative for the purposes of NEPA" (p. 3-3). Please explain fully.
- The reasoning that led to the preference for Alternative 4 could be brought forward from Chapter 31. Section 31.3 is far more informative than are its more prominently placed alternatives: a brief explanation in Chapter 3 (p. 3-3), a summary of an announcement by state and federal officials (p. ES-22), and descriptions that emphasize the screening process developed and used (EIR/EIS Chapter 3 and Appendix 3A; Plan Appendix 3A and Chapter 9).
- The EIR/EIS blurs the most distinctive element of Alternative 4: the decision tree with four operational branches of Scenario H. The decisions are to be governed by research, but no plans for this research are presented (See ISB Appendix B). In its description of alternatives,

[4] Highlights+of+the+Draft+EIR-EIS+12-9-13.pdf, available at http://baydeltaconservationplan.com/PublicReview/PublicReviewDraftEIR-EIS.aspx

Chapter 3 defers first mention of any of the four operation plans by name until a footnote on page 3-67, and a table on page 3-208 defines them in obscure shorthand. The Highlights Brochure cites H1, H2, H3, and H4 (p. 20) but does so without defining them (p. 10).

The EIR/EIS needs focused summaries of the expected performance of alternatives. For readers keen on details, the report could provide comprehensive spreadsheets. All readers, especially decision-makers and the broader public, need graphics that provide informative summaries at a glance, and which are linked to detailed tabular comparisons, as in this diagram:



Range of alternatives

3. From a scientific perspective, does the EIR evaluate a reasonable range of potentially feasible alternatives that would reduce or eliminate significant impacts of the project and obtain most of the basic project objectives and purpose? If potentially feasible alternatives are not fully evaluated, is a clear rationale provided as to why not? Are there potentially feasible alternatives that would reduce or eliminate significant impacts of the project and obtain most of the basic project objectives that should have been considered (and either rejected or fully evaluated) but were not?

The broader alternatives not evaluated include reducing California's reliance on water from the Delta and its tributaries. By contrast, water conservation is at the top of the list of actions in the California Water Action Plan (2013), and the Delta Plan sets a policy of reducing reliance on this water "through improved regional water self reliance" (2013, policy WR P1, p. 102). The evaluation could use insights about "Scarcity: the challenges of water and environmental management in the Delta and beyond," in National Research Council (2012, p. 29-46).

in the Delta and Beyond

The EIR/EIS could be amended to explain why these conservation measures were excluded as components of alternatives. They already appear in Appendix 5B as responses to public policies, levee failures, or climate changes that would reduce supplies of water to areas south and west of the Delta. The alternatives included in the BDCP Plan may then be compared more readily with other plans for making California water supplies more reliable.

Detail of analyses

4. Are the alternatives studied in adequate detail to differentiate outcomes among the alternatives?

Overall, the EIR/EIS offers a level of detail that overwhelms more than it discerns. Much of this detail is unavoidable, given the large matrix of alternatives and impacts, the complexity of many of the scientific issues, and the associated uncertainties.

The question of detail raises two more fundamental concerns: the difference in the level of analysis between the water-conveyance facilities (CM 1 analyzed at the project level) and the habitat restoration efforts (analyzed more generally at the program level); and neglected impacts on San Francisco Bay, Delta levees, and south-of-Delta agriculture. We also struggled to locate important details that are scattered among the reviewed documents.

<u>Program vs. project</u>

The EIR/EIS makes clear that concurrent actions receive different levels of analysis (p. ES-4 to ES-5; 1-13 to 1-14; 4-2). The concurrent actions include construction of new north Delta diversion and conveyance facilities (CM1) and "near-term" acquisition and restoration of natural communities (CM3-CM10) (EIR/EIS, p. 3-21; BDCP Plan, p. 6-3). CM1 receives both program-level and project-level assessment, whereas the other actions only receive program-level and therefore, less rigorous, assessment.

The EIR/EIS offers several explanations for the different levels of analysis: the BDCP is to be managed adaptively; few sites of ecosystem restoration have been selected; restoration is still “at a conceptual level” of design; and project-level analysis of habitat restoration is to be carried out as the restoration efforts progress (EIR/EIS p. 4-2). Still, the difference in level of detail presented effectively treats the co-equal goals unequally. We are concerned that the merely programmatic analysis of habitat restoration provides too little basis for decision-making by the Delta Stewardship Council and other parties. Furthermore, the benefits of habitat restoration are assumed when a beneficial cumulative impact is concluded under NEPA or a less than significant cumulative impact is concluded under CEQA (e.g., 11-3023).

<u>Impacts neglected</u>

The impacts selected for analyses are described as "the direct and reasonably foreseeable indirect impacts associated with implementation of the BDCP alternatives" (p. 4-10). However, the actual selections disregard:

Effects of altered Delta outflows on San Pablo Bay and San Francisco Bay. Section 4.2.1.2 dismisses impacts to San Francisco Bay with hardly any justification. There are potential impacts, however, noted elsewhere (ISB Appendix B, Chapter 4 review).

Effects of and on levees. Although the EIR/EIS cites the threat of levee failures as a justification for new pipelines or canals, the reviewed documents offer no detailed analysis of how levee failures could affect the various alternatives, or of how the alternatives may affect the economics of levee maintenance (ISB Appendix B, Chapter 9 review). It has been argued that CEQA guidelines do not identify levees as resources, and that levee failure is too speculative for analysis. However, few Delta facilities are more important to its current functions than are its levees, and levee failure has happened too often (and the threat of future failures is invoked too much) to be excluded from thorough analysis in the EIR/EIS.

Effects on agriculture. We found no discussion of how increased reliability of water exports will affect crop selection, applications of fertilizer and pesticides, salt accumulation in the San Joaquin and Tulare basins, and water quality of agricultural runoff in the service areas of the Central Valley Project and the State Water Project. As with levee failure, the plausible impacts of these agricultural effects go beyond mere speculation; enough is known to bracket and assess a range of possible outcomes.

Assessed impacts and their comparisons

5. Overall are the analyses reasonable and scientifically defensible? How clearly are the roll-up comparisons among alternatives conveyed in the text, figures and tables?

<u>Reasonableness and scientific defensibility</u>

Please see the section below, headed "Best available science" (p. 9).

<u>Clarity</u>

Overall accessibility to the public and decision-makers. The immensity of the EIR/EIS impedes thoughtful comparison of its findings about the impacts of the no-action and action alternatives. Much of the draft contains excellent writing, understandable analysis, and cross-references among its various parts. Nevertheless, the draft suffers from a paucity of analytical summaries, synthesis graphics (e.g., p. 3 above), lists of assumptions, and navigational aids that would enable readers to make strategic, well-informed decisions about the alternatives presented. Federal law provides grounds for expecting such clarity in an impact assessment: "Environmental impact statements shall be written...so that decision-makers and the public can readily understand them" (Council on Environmental Quality §1502.8).

It might be argued that, given its length and complexity, there simply was not enough time for the draft to be made readily understandable. This sounds penny wise and pound foolish. Our calls for greater clarity began in June 2012[5] and continued in comments on the 2013 Administrative EIR/EIS[6].

The available summaries include a table of impacts in the Executive Summary (Table ES-9) and chapter synopses in the EIR/EIS Highlights document (footnoted, p. **Error! Bookmark not defined.**). These summaries, while welcome, fall short of making the draft understandable and lack qualifying statements. The rather cryptic table of impacts (Table ES-9)

[5] http://deltacouncil.ca.gov/sites/default/files/documents/files/DISB_Letter_to_JMeral_and_DHoffman-Floerke_061212.pdf

[6] http://deltacouncil.ca.gov/sites/default/files/documents/files/DSC_Letter_on_BDCP_Review.pdf, p. 10-11

notably lacks caveats about differing degrees of uncertainty. Most of the chapter synopses in the Highlights document offer more background than analysis.

Justification for the preferred alternative. The EIR/EIS summarizes its case for the preferred CEQA alternative but buries this summary in section 31.3. A readily understandable report would contain an up-front, well-illustrated summary that lays out the main arguments for (and against) the preferred alternative by comparing it against other options—the no-action alternative, the through-Delta channel corridors, the east and west canals, an isolated tunnel, and dual tunnels of various capacities.

The comparison needs to include visual aids that help the reader visualize the main expected consequences of the various alternatives and relate these consequences to the co-equal goals. The prototype on page 3 illustrates how graphics can compare alternatives more efficiently and quantitatively than do text and tables alone. This kind of diagram should also represent expected major effects on ecosystems and species, and should express uncertainties in the plotted estimates.

Chapter summaries. Useful chapter summaries in the EIR/EIS are limited largely to its longest chapters (11 and 12). The Executive Summary provides an overview comparison among alternatives (section ES-9) and a lengthy tabular summary of impacts, but the table is cryptic and graphics are lacking. The Executive Summary also provides (p. ES-61 to ES-132). The EIR/EIS Highlights Brochure summarizes chapters unevenly, in most cases with more emphasis on description than on analysis. The BDCP Plan's prodigious Effects Analysis lacks a summary that goes beyond describing the chapter's contents (BDCP Plan section 5.1).

The EIR/EIS thus offers few of the summaries needed by decision-makers or by the public at large. The summaries should approach, in level of detail, the sections that begin the climate appendices to the Effects Analysis (BDCP Plan part 5A). The summaries would also proceed not just impact by impact, as done well in the chapter on Terrestrial Biological Resources (p. 12-5 to 12-31), but by alternatives (for instance, no-action vs. actions, and certain kinds of actions vs. other kinds of actions).

The BDCP documents should incorporate the best available features of scientific communications. Nearly every scientific journal requires articles to begin with a well-written summary or abstract that lays out the main findings and their broader implications. For example, each abstract at the annual workshop of the Interagency Ecological Program includes a "Statement of Relevance" that puts the science in context.

Navigational aids. The EIR/EIS includes related parts of the BDCP Plan. This extension is footnoted on front matter of the EIR/EIS (p. ES-3, 1-2, and 3-3) and is clarified by cross-references to the BDCP Plan. However, the section "EIR/EIS Organization" (p. 1-31 to 1-35) describes the EIR/EIS as being self-contained, as does the EIR/EIS Highlights Document (on its p. 5 and 6), and the helpful 145-page index posted in December 2013 covers the EIR/EIS only.

The EIR/EIS scarcely mentions the public health and ecological problems associated with potential toxicity from the blue-green alga *Microcystis*. The reader must go to the BDCP Plan to find details about *Microcystis* toxicity and discussion of most of its potential environmental effects (Appendix B, review of Chapter 25).

APPROACH, ANALYSIS, TOOLS AND MODELING

Evaluation methods

1. Does the environmental impact analysis utilize appropriate evaluation methods? Were tools/analyses appropriate and described adequately?

As discussed in our response to the first set of charge questions, the EIR/EIS contains a great deal of information without condensing it into systematic comparisons of the impacts of alternatives that would help decision-makers, stakeholders, or the public reason their way through a complex series of options. Graphical remedies, illustrated by the diagram on page 3, would not be hard to include in the Final EIR/EIS. But beyond merely improving the Final EIR/EIS, detailed yet readily grasped comparisons of the alternatives are essential to facilitate the public process, manage expectations, and elicit meaningful public and policy discussions.

Above we noted impacts that the EIR/EIS mostly or entirely neglects (p. 4). Reasons to set aside these issues—of effects on San Francisco Bay, Delta levees, and irrigated agriculture—were not evident to us in the wealth of detail provided about the screening process.

In the Effects Analysis in the BDCP Plan's Chapter 5, the semi-quantitative results for each aquatic species are tabulated (e.g. Figure 5.5.1-5 for Delta smelt), but the final assessment of overall net effects is a qualitative interpretation of the tabulated effects. This analysis is highly uncertain because the combined importance of all effects was based on a subjective analysis of the attribute scores conducted by one set of experts. "Experts," however, can include a broad range of perspectives and experiences; another group of experts might well reach a different conclusion (Appendix B, Chapter 11 review).

The hydrodynamic modeling appears to presuppose that any and all failed island levees would be quickly repaired. A more realistic approach would take cues from recent levee failures that have not been repaired. Simulations that include newly flooded islands may require three-dimensional modeling, but the results could be usefully applied to analysis of how levee failures would affect the various alternatives. At a minimum, where hydrodynamic modeling is premised on an optimistic assumption about levee repairs, that assumption should be stated prominently, and attending uncertainty should be carried forward into impact assessments.

The surface water modeling neglects interactions with ground water. While the repertoire of models employed appears acceptable for most cases, the reasoning of their selection ought to be concisely mentioned, given the large number of such models available for analyses. The limitations and assumptions of the models also should be noted.

The air-quality modeling excludes photochemical effects or any type of air quality modeling although earlier discussions greatly focus on photochemical pollutants and their transport.

For aquatic resources, inadequate attention was given to species interactions and food webs, particularly for non-covered species such as invasive clams.

Uncertainty

2. How well is uncertainty addressed and communicated?

Uncertainty is difficult to address and communicate for such a complex and dynamic series of actions. However, without some specific and balanced discussion of the general order of magnitude of error or uncertainty in major results, it is difficult for readers to make informed judgments about the various alternative actions.

Uncertainty is addressed and communicated more in the BDCP Plan than in the EIR/EIS, where conclusions are often stated without adequately acknowledging uncertainties or discussing how the project might prepare for or respond to a variety of outcomes. In some instances, uncertainties are used as an excuse not to assess possible outcomes of an action or use certain models (e.g. fish life cycle and bioenergetics models); in many other instances, uncertainties have not been carried forward as caveats to conclusions about impacts. Uncertainties need to be addressed in a more forthright way so that scientific validity can be better assessed and stakeholder expectations can be better bounded. It may be possible, for instance, to assign a relative confidence level (such as A, B, or C) to many of the impacts listed in Table ES-9.

Sensitivity to assumptions, uncertainty, and conflicting data

3. Do the analyses describe sensitivity of conclusions to assumptions and uncertainty and how possible conflicting data and analyses are interpreted?

There is some discussion of the sensitivity of conclusions to assumptions and uncertainty in the BDCP Plan and associated appendices, but that is not carried over into the EIR/EIS. Given the complexity of actions being proposed, the abundance of data, and the multitude of analysis techniques available, quantification of uncertainties will be difficult, but some estimates would be helpful. A simple formal decision analysis would likely help organize the problem and provide a framework for separating more from less important uncertainties and their effects on the relative likely performance of alternatives.

Many of the analyses need to spell out underlying assumptions in an easily identified format. In addition, where the assumptions are weak, the implications of this weakness ought to be mentioned. Bulleted lists of key assumptions could clarify:

- Error propagation in the hydrodynamic models (e.g., errors of initial and boundary conditions used for DSM2 and CALSIM II, and errors from exclusion of ground-water interactions in the model)
- Major limitations of the models used and conclusions reached
- Sensitivity of model results to an assumed configuration of restoration projects
- Assumptions about reservoir operations in the hydrodynamic models
- Assumptions about continued existence of some of the most subsided and least reliable Delta islands
- Assumptions about how adaptive management is likely to play out.

Places where bulleted, annotated lists of key assumptions would be helpful include:

- Chapter 6: DSM2 used for salinity-flow analysis is a one-dimensional model having inherent limitations in simulating open water areas, flow in bends and small channel, inlet/outlets and three-dimensional turbulent mixing, particularly with sea level decimeters higher than today's.

- Chapter 11: The implicit assumption of no interactions among the covered species as well as other abundance species such as the invasive clams weakens species-specific conclusions.
- Chapter 22: The best practice is to evaluate air-quality models used with existing data to document the uncertainties, but such procedures are either not followed or left undocumented.
- Chapter 23: The models used for noise analysis do not include the nocturnal atmospheric boundary layer effects, which surely will skew the inferences made.

Best available science

4. Is best available science employed in the environmental analysis of project alternatives and their effects?

EIR/EIS Chapters 5 to 30 vary in scientific rigor, scientific understanding, inclusion of relevant research findings, and citation of relevant reports. The chapters on Air Quality (Chapter 22) and Mineral Resources (Chapter 26), for instance, appear more robust scientifically than those on Geology (Chapter 9) and Public Health (Chapter 25) (details, Appendix B).

Each chapter and appendix needs a date stamp that describes when and how thoroughly it was last updated. Some of the impact assessments presented are several years out of date, as judged from the references cited (e.g. EIR/EIS Chapters 9, 10, and 12; BDCP Plan Appendices 3B and 5E). For instance, projections of tidal-marsh response to sea-level rise appear several years out of date (Appendix B, Chapter 12 review, tidal-marsh sidebar).

Articulation and reasonableness of assumptions

5. Are assumptions used in modeling and for analytical purposes clearly articulated and reasonable considering the complexity and current scientific understanding?

Many of the analyses need to spell out underlying assumptions in an easily identified format, as noted above under the heading "Sensitivity to assumptions, uncertainty, and conflicting data" (p. 8).

MONITORING AND ADAPTIVE MANAGEMENT

Adaptive management is essential for achieving the goals of the BDCP, and state law requires the Delta Stewardship Council to use "a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions" (§85307(f)).

Adaptive management, monitoring, and research are mentioned many times throughout the EIR/EIS, but ISB comments are based primarily on section 3.6 of the BDCP Plan, with additional discussion specific to each BDCP action in section 3.4. Appendix 3G of the BDCP Plan also has a section on monitoring, evaluation, and adaptive management. Administration of adaptive management is described in Chapter 7 and some comments on implementation of adaptive management are made throughout Chapter 6. Appendix 3D, deals with monitoring and research and provides tables listing potential compliance and effectiveness monitoring actions.

Direction from the Delta Stewardship Council provided us with two basic questions to address in evaluating how the BDCP incorporated adaptive management, monitoring, and research. As noted above, we consider adaptive management and monitoring in some detail in this response because of their critical importance to successful implementation of the BDCP.

Description and achievability

1. How well is the adaptive management strategy described and are the stated goals achievable?

<u>Description of adaptive management</u>

Adaptive management is described in section 3.6 as a three-phase process containing 9 steps. The overall characterization of adaptive management is consistent with standard works on the subject and with the treatment of adaptive management in the Delta Plan. Section 3.6 also describes issues in designing a robust adaptive management experiment, as well as the pitfalls in implementing an adaptive management experiment. The section clearly describes adaptive management and some of the issues that arise in trying to implement it.

<u>Adaptive Management Team</u>

Although adequate as a description of adaptive management, the process described in section 3.6 is not a strategy for implementation. In the BDCP Plan, the details of design and implementation of adaptive management are left to a future Adaptive Management Team, to be chaired by a Science Manager. The Science Manager is a new position established as part of the Implementation Office responsible for achieving the goals of the BDCP. The Adaptive Management Team is to be comprised of managers because, the Plan argues, adaptive management is fundamentally a management activity. We agree that the Adaptive Management Team should be comprised of managers because buy-in by managers is important to the success of adaptive management experiments. However, adaptive management is not part of the toolbox or the experience of most resource managers. Adaptive management experiments are like clinical trials in medicine—they have requirements for scientific insight and objective validity, planning, execution, time lines, and information gathering that differ from ordinary resource management.

Given the complexity of the scientific questions and uncertainties associated with implementing BDCP and the importance of adaptive management to successful implementation, the Science Manager must be well versed in the design and application of adaptive management and have the ability to interpret this way of implementing and managing conservation actions to the Adaptive Management Team. It will also be important for the Science Manager to consult with the community of experts in adaptive management and to draw from the experience of practitioners involved in other large-scale adaptive management programs, nationally and globally. Most of all, the Science Manager must know when it is appropriate to use adaptive management and when it is not and realize expectations of what is and what is not achievable. Experience in design and implementation of adaptive management is not one of the qualifications of the Science Manager listed in Chapter 7—but it should be.

Adaptive-management experiments

No specific goals are stated for adaptive management beyond its basic purposes of assisting managers to manage uncertainty, and to learn about the systems they are managing through the management actions that they implement, and to adjust actions when appropriate. Because no specific adaptive management programs are described, it is not possible to determine whether the Plan will benefit from its use. The BDCP recognizes that adaptive management has failed in other situations for a variety of reasons, including failure to plan and model adaptive experiments properly, failure to implement adaptive management plans, failure to ensure adequate funding, failure to follow through with effective monitoring and scientific evaluation of adaptive experiments, and failure to coordinate planning and implementation among scientists, stakeholders, and managers (Walters 2007, Scarlett 2013). The BDCP Plan includes measures to prevent some of these failures. However, until a culture of adaptive management is developed in the participating agencies, implementation of the BDCP is likely to be thwarted by the kinds of obstacles that Walters (1997, 2007) and Allen and Gunderson (2011) describe.

Conducting adaptive management and designing robust management experiments will require a working set of models that link conservation actions to desired outcomes through species or ecosystem dynamics. The BDCP has employed a broad range of models in its effects analysis (described in BDCP Plan Chapter 5 and its appendices). However, it is not clear that these models are available or even suitable for designing adaptive-management experiments. For example, habitat suitability models are probably not sufficient on their own. It was not clear to us whether the BDCP Plan intends the Conservation Measures to be implemented *as experiments*, which is in actuality the heart of the adaptive management process. Instead, it appeared that uncertainties would be dealt with primarily through targeted research projects. It is important to frame adaptive management as experiments that provide opportunities to reduce uncertainty about subsequent restoration actions.

Assuming that the BDCP will, in at least some instances, implement Conservation Measures as experiments, it is important to have an objective way to decide when conducting such experiments makes sense. The Plan acknowledges that adaptive experimentation may not always be desirable but does not offer a clear approach to deciding whether to experiment or not. Because adaptive experimentation requires resources, one way to assess the benefits of a particular experiment is to compare the cost of conducting the experiment against the value of the information that will be gained from the experiment. If the value of the incremental reduction in uncertainty likely to result from an experiment is small relative to the cost of the experiment, it may make sense not to conduct the experiment but to frame adaptive management as an observational study supported by monitoring. Although it remains important to acknowledge the uncertainty, it is also important to recognize that the benefits of reducing uncertainty do not always justify the costs of experimentation.

In some instances (which may be commonplace in the Delta) adaptive experimentation may not be possible: conservation actions may be confounded with one another; control over drivers of change may be lacking; or physical, legal, financial, or social factors may constrain, individually or collectively, the range of options that can be explored. In such circumstances, other approaches to implementation may be better than adaptive management. Several such situations and possible alternative approaches are discussed by Williams et al. (2009) and Allen and Gunderson (2011).

Still other issues will likely affect the application of adaptive management in the Delta, many of them stemming from the complexity of the BDCP and the potential for confounding and conflict among objectives, actions, and outcomes. Suffice it to say that this complexity reinforces our view that the Science Manager must have a firm grasp of the potential and the pitfalls of adaptive management and an appreciation of continually emerging approaches to managing complex systems.

Adequacy of monitoring

2a. Is the proposed monitoring adequate to evaluate if the goals and objectives are being achieved?

BDCP identifies three kinds of monitoring: compliance monitoring, effectiveness monitoring, and status and trends monitoring. Although this is a logical way of classifying monitoring activities, it does not necessarily mesh well with adaptive management. Adaptive management is designed to generate information that will clarify uncertainties in understanding the dynamics and responses of species and ecosystems to management actions. In some cases the required monitoring might not fit into any one of the three categories.

Compliance monitoring includes monitoring for regulatory compliance and compliance with design standards for Conservation Measures. Potential compliance monitoring actions for each conservation measure are listed in Table 3D-1. Monitoring of design-standard compliance is fairly straightforward, being dictated by specifications in a Conservation Measure. Monitoring for regulatory compliance can be more complex as can, for example, monitoring to ensure compliance with flow or water-quality design criteria. As the design criteria and outcomes for most Conservation Measures are not yet developed, it is difficult to say whether the compliance monitoring actions listed in Table 3D-1 are both necessary and sufficient.

Effectiveness monitoring and status and trends monitoring are combined in Appendix 3D and potential monitoring actions for each Conservation Measure are listed in Table 3D-2 of the Appendix. In the preamble to Table 3D-2, it is stated that "Precise details of each of the effectiveness monitoring actions are not presented here and will be developed and then periodically updated through the adaptive management and monitoring program." Consequently, it is difficult to comment on the adequacy of the proposed monitoring actions at this time. However, Table 3D-2 does not provide any meaningful clues as to how the proposed monitoring will tie into any adaptive management experiments. Without explicit linkages between monitoring and the adaptive management practices it is intended to support, it is difficult to see how adaptive management can really be achieved.

Section 3.4 of the BDCP Plan discusses each of the 22 Conservation Measures in turn and repeats some of the potential compliance and effects monitoring actions identified in Tables 3D-1 and 3D-2. In addition, for some Conservation Measures, section 3.4 provides a table of "key uncertainties" and suggested research projects to address them. Because uncertainty is central to the impetus to adopt adaptive management, we examined section 3.4 for indications of how adaptive management would be used to address the key uncertainties. We found several peculiarities in the treatment of key uncertainties.

1. Key uncertainties are identified for only 8 of the 22 Conservation Measures. For the others, the Chapter specifically states that no key uncertainties (or needed research) were identified. Given the high uncertainty associated with *all* of the Conservation Measures, we find this statement insufficient.
2. Even where key uncertainties are identified, they seem to misrepresent the broad range of uncertainties inherent in a Conservation Measure. For example, only two key uncertainties are identified for CM-2, Yolo Bypass Fishery Enhancement: (a) the effectiveness of Yolo Bypass modifications, and (b) the effects of increased frequency and duration of flooding in the bypass on the health and vigor of riparian vegetation. Uncertainty (a) is vague and, in our view, does not in any sense capture the extent and variety of uncertainties inherent in a major change in hydrology, floodplain inundation, and habitat configuration, and in its effects within and beyond the Bypass. Uncertainty (b) depends on the determination of "health and vigor of riparian vegetation," which are largely subjective terms.
3. Key uncertainties that are identified are all to be addressed through targeted research projects rather than being incorporated into the adaptive management program. Although it may be more efficient to address some uncertainties through targeted research, many could be more effectively addressed in the context of a proper adaptive management design. This possibility does not seem to be considered in the BDCP Plan. A principal strength of adaptive management is that it allows managers to design their day-to-day management actions to provide critical information on key uncertainties. The BDCP does not appear to take advantage of this strength. Perhaps the responsibilities of the Adaptive Management Team are to include such design considerations. This would be appropriate but, if so, the text should reflect this responsibility. This concern applies not only to the design of adaptive management experiments but also to the clarification of key uncertainties.
4. Another benefit of incorporating uncertainties into a broader adaptive management plan is that individual uncertainties and outcomes can be linked to one another. The Delta is an interconnected system, and actions in one region are affected by actions in other regions. Although targeted research will often be the best option, it will be important to embed these efforts in a broad and holistic adaptive-management framework to address the inter-connectedness.

Although the BDCP Plan does not appear to make effective use of an adaptive management process, the monitoring and research activities described may still be sufficient to measure progress toward achieving the BDCP objectives. Given how the BDCP Plan is structured, however, it is difficult to determine if this is the case. In assessing the suitability of monitoring, there is a logical flow of relationships from conservation objectives, to actions to achieve those objectives, to expected outcomes from the actions, to monitoring to detect those outcomes, and then to evaluating criteria for success or failure and finally to making adjustments as needed. These components do not seem to be associated in this way anywhere in the BDCP Plan, even though its Chapter 3 describes the necessary variables. In Table 1 below we have combined some information from two different tables to illustrate the relationship between objectives, actions, outcomes, and monitoring for CM-4 (Tidal Natural Communities Restoration). A similar assessment could be done for other Conservation Measures.

Table 1. Examples of biological objectives, how a Conservation Measure advances those objectives, proposed monitoring actions, metrics to be measured during monitoring, and the proposed criteria for success. Compiled from Tables 3.4.4-1 and 3.4.4-3 for CM-4 (Tidal Natural Communities Restoration).

Objective	How action advances the objective	Monitoring action	Relevant metric	Success criteria
L2.5: Maintain or increase the diversity of spawning, rearing, and migration conditions for native fish species in support of life-history diversity.	Tidal restoration is expected to improve some rearing habitat elements for Chinook salmon, Sacramento splittail, longfin smelt, delta smelt, sturgeons, and possibly steelhead. Tidal natural communities restoration in West Delta ROA is also expected to improve future rearing habitat suitability for delta smelt within the anticipated eastward movement of the low-salinity zone with sea-level rise.	Site level assessment	Use of restoration sites by covered fish species with respect to time or space or both	Detection of site use by Chinook salmon, splittail, and the following covered fish species: longfin smelt and Delta smelt in the Suisun Marsh, West Delta and Cache Slough ROAs; steelhead in the West Delta, Cache Slough and Cosumnes/ Mokelumne ROAs
L2.7: Produce sinuous, high-density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.	Where feasible, tidal restoration projects will be designed to meet this objective. This habitat element will provide direct foraging opportunities for salmon and splittail and, with sufficient amounts of restoration, may provide prey for pelagic fishes.	Site level assessment	Properties of tidal-channel network	Areal and linear extents of sinuous, high-density, dendritic networks of tidal channels
L2.9: Increase the abundance and productivity of plankton and invertebrate species that provide food for covered fish species in the Delta waterways.	Restoration of tidal natural communities is expected to improve some rearing habitat elements for Chinook salmon, Sacramento splittail, longfin smelt, delta smelt, sturgeons, and possibly steelhead.	Plankton and invertebrate sampling in restored habitats	Plankton and invertebrate abundance in restored floodplain	Increase in usable food exported from restored tidal natural communities to adjacent open-water habitat occupied by covered fish species

This example table illustrates the logical connections among conservation objectives, restoration actions, anticipated outcomes, and proposed monitoring. Perhaps at this stage in the planning that is the best one can expect. At a more detailed level, however, a multitude of questions remains. Consider Objective L2.5, “Maintain or increase the diversity of spawning, rearing, and migration conditions for native fish species in support of life-history diversity." Without questioning whether this objective is meaningful as a way to strengthen the viability of covered fish species, knowing whether one has achieved the objective depends on knowing the current diversity of spawning, rearing, and migration conditions for native fishes (what are the metrics for these attributes of habitat?), knowing that this diversity of habitat supports life-history diversity (what are the metrics of life-history diversity?) and knowing that restoring tidal natural communities will increase habitat diversity for native species in ways that do, indeed, strengthen life-history diversity.

Similar comments could be made about the objectives to create networks of dendritic channels in restored tidal marshes and to enhance plankton production to provide food for covered fish species. Is measuring the presence of dendritic networks sufficient or should the amount (or minimum amount on an absolute or percentage basis) of sinuous networks be the goal? Similarly, will the presence of plankton and invertebrates provide enough information to assess success? It may be better to have benchmarks (e.g., 20% increase over some period of time). It will also be important to consider the composition of the plankton and invertebrate assemblages because organisms are not equal in their food value.

The proposed monitoring touches only superficially on these objectives. Our purpose in pointing out these complexities is not to nit-pick about Conservation Measures but to illustrate that the objectives are more nuanced and the potential outcomes more complex than suggested by the proposed monitoring. At this stage we cannot say whether the proposed monitoring is necessary and sufficient to evaluate whether the goals and objectives are being achieved. We assume that the Adaptive Management Team will further refine the goals and objectives. Such refinement, and the validation of monitoring actions, would be greatly strengthened if the models linking objectives to outcomes were more clearly presented.

Managing adaptive management

2b. Are the data management, analysis, reporting, and decision-making processes adequate to create a defensible and transparent implementation of adaptive management?

<u>Decision-making</u>

In the BDCP Plan, sections 3.6.4 and 7.3.4 address issues of data management, analysis, and reporting. The proposed administrative structure for BDCP is hierarchical. At the top, providing oversight and dispute resolution, is the "Authorized Entity Group" consisting of representatives of DWR, Reclamation, and Water Contractors. State and federal fish and wildlife agencies will participate in a "Permit Oversight Group," which will ensure regulatory compliance with BDCP Plan authorizations. Implementation of the BDCP Plan, including adaptive management, monitoring, and research, will be the responsibility of a newly created Implementation Office headed by a Program Manager who will report to the Authorized Entity Group. A key individual in the Implementation Office will be the Science Manager, who will report to the Program Manager and will have responsibility for guiding and facilitating adaptive management, monitoring, and research. In this capacity, the Science Manager will chair an Adaptive Management Team. The Adaptive Management Team will include representatives of DWR, Reclamation, CVP and SWP water contractors, CDFW, USFWS, and NMFS. The IEP Lead Scientist, the Delta Science Program Lead Scientist, and the Director of the NOAA Southwest Fisheries Science Center are to be nonvoting members of the Team.

The Adaptive Management Team will take the lead in developing a framework for monitoring and will enlist the assistance of the Interagency Ecological Program (IEP) in implementing the program. The Science Manager and the Adaptive Management Team will develop and implement a process for compiling, evaluating, and synthesizing the results of monitoring and will prepare a plan to maintain databases of monitoring and synthesis results. The Adaptive Management Team will also manage the BDCP research program in coordination with IEP and the Delta Science Program. The Team will identify research priorities and will administer a process to select and coordinate the researchers who will be involved in the program. In addition, the Adaptive Management Team will be responsible for the compilation and synthesis of the results of studies and analyses undertaken by other organizations that are assisting in the implementation of the BDCP Plan. The Science Manager will ensure that BDCP science activities, reporting, and reviews are coordinated with other science activities being conducted in the Delta. Based on these analyses, the Adaptive Management Team will recommend to the Program Manager any necessary changes in the BDCP Plan or the Conservation Measures.

Overall, this decision-making arrangement does not seem to bring enough authority and resources for adaptive management to be implemented decisively and in a timely way. With this structure, each cycle of adaptive management would probably occur very slowly, if at all.

Data management

This proposed administrative structure centralizes—in the Adaptive Management Team and the Science Manager—the key administrative decisions regarding adaptive management, monitoring and research, data management, analysis, and development of recommendations concerning science-based modification to the BDCP. If the individuals involved have the appropriate skills and the independence needed to critically evaluate project effectiveness, and if provisions are made to link data management and data bases with existing relevant data bases (both in-house and external to the main agencies involved in BDCP), then the centralized system should be effective. The BDCP envisions making use of the science synthesis approaches developed in the Delta Science Plan and working with the Delta Science Program to assemble, analyze, and synthesize the large volume of data that will be accumulated. We endorse this approach. We also support ensuring that the BDCP data are publically available so outsiders can make their own analyses.

Large volumes of data will be generated as BDCP is implemented, but BDCP is only one of many activities in the Delta that will be generating voluminous scientific data. A distinguished panel found that as of 2012, “science efforts related to the Delta are performed by multiple entities with multiple agendas and without an overarching plan for coordinating data management and information sharing” (National Research Council, 2012). Goals of the Delta Science Plan include coordinated data management and sharing among agencies involved in Delta science. The BDCP's scientific work should be tightly integrated with the Delta Science Program to ensure that science and data management for the BDCP follow the “One Delta, One Science” concept, which will provide benefits to all parties, particularly regarding the credibility and transparency of scientific work overall.

It may be difficult to ensure that the appropriate skill sets are present in the Implementation Office. We have already noted that the listed qualifications for the Science Manager do not include expertise in adaptive management. Because this is a new position, this shortcoming is easily corrected. However, personnel for the Implementation Office, which will provide the staff to manage the databases, analyses, modeling, etc., will be drawn from existing staff in DWR and other state agencies. The BDCP needs a staffing plan that dovetails with the need to strengthen the agencies' capabilities in field observations, data management, modeling, and synthesis.

Timing

In a key role not identified in the documents, the Science Manager and Adaptive Management Team should identify the goals and objectives for monitoring, the desired outcomes, and an adaptive framework for evaluating when outcomes have been met. In Table 3.E-2, Effectiveness Monitoring Actions are described, for example, and in some cases the timing and duration for monitoring are described. Without knowing the response rates of the system, or how different restoration actions and climate change will interact with the desired outcomes, it does not seem feasible to establish a specific timeframe. Rather, the described timeframes should be viewed as initial guides that will be revised depending upon outcomes, since it may take more (or less) time for outcomes to be realized.

Adaptive-management decisions often must be made quickly, yet implementing the full 9-step adaptive management process can be ponderously slow, especially when encased in a hierarchical organizational structure. There is the potential to exacerbate a science-policy conflict: scientists often want to obtain deeper knowledge about complex details, whereas managers and policy-makers are interested in reaching decisions about which actions to take and where best to allocate resources (the “more research” vs. “just do it” conflict). Consideration should be given to how to make adaptive management flexible and nimble, yet still scientifically rigorous.

Adaptive management will need to keep pace with change in the Delta. One strategy is to use model projections of future conditions to anticipate how practices might need to change to fit future conditions—“anticipative” adaptive management. Vlieg and Zandvoort (2013) have contrasted this approach, which is practiced in the Rhine-Meuse Delta in the Netherlands, with the “reactive” adaptive management proposed for the Delta, suggesting that a hybrid of the two approaches might be best. Because the details of adaptive management in BDCP have yet to be developed, there is an opportunity to consider these ideas.

Collaboration

Although the BDCP Plan acknowledges the need to coordinate adaptive management with the Delta Science Program, it largely ignores the framework for adaptive management developed in the Delta Plan and (especially) the Delta Science Plan. Instead, an operational structure is described that is almost entirely within the BDCP governance organization, as outlined in Chapter 7 of the Plan. This contrasts with a growing recognition of the need to engage a wide array of people and entities in a truly “collaborative adaptive management” (Susskind et al. 2012, Scarlett 2013). A Collaborative Science and Adaptive Management Program (CSAMP) and Collaborative Adaptive Science Team (CAMT) were formed in mid-2013 to develop a robust science and adaptive management program, primarily to inform the implementation of the current Biological Opinions applicable to the Delta[7]. Although these groups were formed too recently to be included in the Draft BDCP documents, their relations to the adaptive management structure proposed for BDCP should be included in the Final documents.

Funding

Funding for adaptive management can also become a contentious issue (Walters 2007). The Plan (Chapter 8) identifies a budget on the order of $500 million for monitoring (both compliance and effectiveness monitoring) and an additional ca. $400 million for research (Tables 8-30 and 8-31). No funding is specifically earmarked for adaptive management in the Plan. This is appropriate, as adaptive management should be an integral part of planning and implementation for all the Conservation Measures, not a separate activity. However, adaptive management planning and implementation cost more than traditional management, both in personnel and capital expenditure, as synthesis and changes in management must be actually and routinely implemented. It is not clear that these extra costs were included in the budget for the Implementation Office. Chapter 3 identifies a separate "supplemental adaptive management fund" of at least $450 million (section 3.4.23.5) that could be accessed if other resources are insufficient or cannot be accessed to support an adaptive change in Conservation Measures. Apparently, these funds are not available, however, for routine costs of management. The budgets presented in Tables 8-30 and 8-31 were based on estimated staff and resources required to undertake the monitoring and research actions listed in the Plan plus an additional $140 million to cover monitoring and research needs not identified in the Plan. How the supplemental adaptive management fund budget was determined is not clear.

Although the budget for monitoring and research is substantial, it is actually small compared with BDCP's total cost. Even a budget of this size could easily be exhausted by the multitude of possible monitoring and experimental actions for each Conservation Measure. The BDCP Plan has identified a broad range of possible monitoring and research actions related to the Conservation Measures. But the BDCP Plan also acknowledges that these will need to be reconsidered as the detailed implementation plans develop. The Adaptive Management Team will have the difficult task of determining how to allocate the inevitably limited resources for monitoring and research. Difficult trade-offs are inevitable, highlighting the need to develop an objective, rigorous, and transparent process for prioritizing monitoring and research activities.

A great deal of planning and evaluation will be required during the early years of implementation. We envision a need for further analyses to clarify conservation actions and how to fit these into an adaptive management program, pilot testing of some conservation actions, negotiations for land acquisition, and many other tasks necessary to finalize the conservation program. This suggests a front-loading of activity in the Implementation Office. However, on an annualized basis the budget for the Implementation Office does not differ much across the 50-year term of the project. We suggest evaluating whether additional funds should be allocated for up-front planning and evaluation, including development of suitable interagency data, modeling, and monitoring capabilities.

[7] http://deltacouncil.ca.gov/sites/default/files/documents/files/ Item_7_Attach_1_CAMT%20Progress%20Report%20Version%206_0%20140207.pdf

Contingency plans

Monitoring and adaptive management are proposed to evaluate whether conservation actions are achieving their intended objectives. What if things do not go as planned? The history of ecological restoration shows that restoration projects rarely have exactly the intended consequences in the expected time frame. Section 3.4.3.4.2 in the BDCP Plan states that contingency measures will be developed for site-specific conservation actions to be implemented in the event that success criteria are not met. However, the BDCP Plan also states that these contingency measures differ from adaptive management because they are site-specific and targeted at meeting success criteria. Similar contingency plans are mentioned for other Conservation Measures throughout section 3.4. There will inevitably be situations, however, in which the adjustments are not possible or incur too great a cost or where there is a large-scale failure of restored habitat to function as anticipated. What happens then?

Given the complexity and the high stakes of many of the actions to be undertaken in BDCP, it would seem prudent to have contingency plans and action thresholds at least generally outlined *before* discovering that things are not working as planned. There is no mention of contingency plans in section 3.6, which describes adaptive management. Contingency planning is not mentioned in BDCP Plan Chapters 6 and 7 (Plan Implementation and Implementation Structure) nor in the EIR/EIS. The BDCP Plan should build contingency plans into the adaptive management process.

Additional comments

Steps toward adaptive management in Appendix 3G

1. Page 3, lines 32-37: "An equally important purpose of this memorandum is to introduce a simple deterministic, stage-based life cycle approach to define BDCP objectives, periodically review and update them, and monitor progress toward achieving the intermediate and final Cohort Replacement Rate (CRR) milestones.....it is imperative to establish interim objectives in order to guide monitoring and the management decision making process in the near term."—Without using the term, this statement outlines the beginnings of an Adaptive Management Program. Page 6 goes on to list general assumptions and then introduces the models to be used. Uncertainty is discussed in the Introduction as well.
2. Page 8, lines 25-27: “Where species-specific data were available they were used directly. More often, this will not be the case and adjustments were made based on how different life history characteristics would be expected to influence survival.”—This is followed by assumptions, by data from other areas that lend support to the assumptions, and by statement of future challenges in model modification. This is probably the best that can be done under the circumstances. The approach seems to fit into the early steps of the adaptive management process.
3. Page 11, lines 9-13: "There are several other factors that might be considered in further defining or revising these Interim Survival Objectives, including scaled objectives based on wet and dry years. However, at this point we are reluctant to more finely define or scale survival objectives until additional species-specific survival estimates are collected over a range of hydrologic conditions. However, as new information becomes available, the potential to define wet and dry year expectations should be revisited."—Again, this statement both acknowledges and contributes to the adaptive management process. Likewise, climate

change is presented as an uncertainty issue in terms of future annual variability scenarios.

Broad questions

1. What strategies for funding and oversight of monitoring and adaptive management will best promote credibility and independence in the science supporting adaptive management?
2. What kinds of management actions will be subject to adaptive adjustment? Are both operations and habitat Conservation Measures subject to adaptive management?
3. What future conditions are likely to prompt adaptation? The draft mentions sea-level rise and changes in Delta outflow requirements. Other futures worth considering include the flooding of additional subsided islands, requirements for upstream reservoirs to release cold water, tightened water-quality standards for byproducts of disinfection, and salinity regulation for Delta and south-of-Delta agriculture.
4. Will requiring the Adaptive Management Team to reach consensus be unrealistic and lead to delays or inaction?

Other comments on BDCP Plan Chapter 3

1. The interaction between the Adaptive Management Team and the Implementation Team is critical for the success of the 9-step adaptive management process described in section 3.6.3.4. More details should be provided about how these two teams will interact in actually doing adaptive management.
2. In section 3.6.3.5.4 it is stated, “The adaptive management and decision-making processes described in this section do not apply to these real-time operations.” How will this limitation affect the adaptive management plan as a whole?
3. Appendix 3E-7, lines 6-8: "Precise details of each of the effectiveness monitoring actions are not presented here and will be developed and then periodically updated through the adaptive management and monitoring program (Section 3.6)."—In terms of effectiveness monitoring, this is not an unexpected response. Some specific monitoring actions are mentioned in Table 3E-2 but these are general and often repetitive.
4. Research questions in Table 3E-3 are broad, and in some cases somewhat repetitive in terms of data already being collected in the Delta (which would require reanalysis or a meta-analysis). The document acknowledges that these will be modified over time.

STATUTORY QUESTIONS

Scientific basis and clarity

1. *Comment on the scientific basis and clarity related to the EIR-EIS conclusions:*

Issues of clarity are considered above, under "Completeness, structure, and effectiveness of presentation" (p. 2-5), and in our overview. The responses below, on the scientific basis for the conclusions, draw on the resource-chapter reviews in Appendix B, to which we refer the reader for details.

Freshwater flows

a. the review and analysis of the range of flow criteria, rates of diversion, and any other operational criteria required to satisfy the criteria for approval of a natural community conservation plan as provided in subdivision (a) of Section 2820 of the Fish and Game Code, and other operational requirements and flows necessary for recovering the Delta ecosystem and restoring fisheries under a reasonable range of hydrologic conditions, which will identify the remaining water available for export and other beneficial uses.

EIR/EIS Chapter 5 examines the changes in surface water operations and deliveries that would likely accompany each of the project alternatives. For each alternative, results for Delta outflow, exports, project deliveries (north and south of the Delta), and major surface reservoir storage are presented. The modeling approach uses CALSIM II, with additional temperature and Delta flow and salinity modeling, for a particular climate change scenario (sea level rise and climate warming), averaging a wide range of potential climate warming scenarios for conditions around the year 2060.

The analysis of this complex problem for a wide range of alternatives is inherently difficult and potentially confusing. The analysis presented is more advanced than is typically seen for project evaluation in employing climate change scenarios. This implies some uncertainties, as system operating rules and environmental regulations are likely to change as well with climate. The modeling results are reasonably good, though unavoidably imperfect. However, the model results are overwhelming in quantity, not well summarized, and insufficiently linked to interpretation. An explicit comparison of the range of water deliveries for major user locations (project and non-project) over the range of wet and dry conditions would be valuable.

Chapter 5 provides little comparative summary of impacts on water supply. This shortcoming limits the ability of this analysis-filled chapter to contribute to thoughtful discussion and comparison of the alternatives. There seems to be little difference between 6,000 cfs and 9,000 cfs alternatives, presented, though deliveries for the 3,000 cfs tunnel capacity are much less. Much of the difference among alternatives seems likely to be driven as much or more by operating and regulatory policies than by infrastructure capacities. This should be a topic of meaningful discussion.

The major analytical problem is the gap between CALSIM-II modeling of the water-supply system and actual operations. The State Water Project and Central Valley Project account for only a part of the water management decisions and impacts in this vast system. DWR and USBR modeling has improved considerably in recent decades but remains centered on the SWP and CVP. This limited modeling therefore largely ignores or oversimplifies most water management decisions in California, which are those taken by local and regional governments and water users. The limited modeling thus seems inadequate for impact analysis of a system governed largely by local agencies.

Related to this problem is the continuing evolution of the CALSIM model and its variants. MBK modeling presented to us in the January 2014 meeting of the ISB highlighted differences in results that reflect both model evolution and modeler judgment. The MBK results (which still remain unpublished and proprietary) also highlighted the complicating effects of operational decisions and of the regulations that govern them. (Delays in making these results public are interfering in the ability to consider these results.) According to Mount et al. (2013), current regulations would limit flexibility for operations of dual facilities.

<u>Climate change</u>

b. the potential effects of climate change (including possible sea level rise up to 55 inches), and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the EIR.

The reviewed documents explicitly consider how climate change may affect water supply and ecosystems, and how the proposed Conservation Measures may act to lessen these effects. However, the likelihood and magnitude of these effects and of the associated uncertainties need to be stated or addressed more clearly in several respects: synergistic effects triggered by climate change; changes in frequency and impacts of extreme events and extreme conditions; and the range of plausible impacts on the effectiveness of the Conservation Measures (review of Chapter 29 and tidal-marsh sidebar in review of Chapter 12). There will be considerable uncertainty as to how water system operations, levee maintenance, environmental regulations, and water demands will react to climate change. In all areas, considerable changes should be expected, although the exact responses are now unavoidably uncertain.

<u>Fish and aquatic resources</u>

c. the potential effects on migratory fish and aquatic resources.

Please see our Appendix B for a detailed review of EIR/EIS Chapter 11. Concerns expressed there include:

1. The chapter needs to consider impacts from an ecosystem perspective. The existing analysis by Conservation Measures and individual species, although perhaps necessary, neglects the co-equal goal of *ecosystem* health. Success will depend on a fully functioning system, and therefore on analyses that incorporate integration and interaction across species, within a species, and across regions.
2. Positive and timely benefits of habitat restoration are highly uncertain. Failure to realize these benefits will invalidate the final conclusion of no net negative effect.
3. Full life cycles receive too little attention, as do effects of flow on entrainment.
4. The qualitative nature of the effects analysis aligns its results more with "hypotheses" than with "conclusions" or "predictions."
5. Uncertainty in the analyses needs to be carried forward, underlying assumptions need to be stated more explicitly, and hypotheses need to be distinguished more clearly from conclusions.

6. Adaptive management of migratory fish and aquatic resources will require a well-planned and comprehensive program of research and monitoring that will target causality and test hypotheses in the BDCP Plan. The decision-tree process is not adequately described.

Water quality

d. the potential effects of each Delta conveyance alternative on Delta water quality

The EIR/EIS analyzes all Delta conveyance alternatives for their potential impacts on water quality. The analyses generally conclude that the different alternatives would not alter water quality appreciably, for most constituents of concern. Our review of Chapter 8 describes concerns about these findings, including:

1. Some of the analyses hinge on comparison of data from different environmental monitoring programs that differ vastly in limits of detection. The EIR/EIS draws conclusions that are likely incorrect because they are based on non-detects of analytes.
2. The models used to estimate changes in water quality are likely to have uncertainty, particularly under future conditions with more complex hydrodynamics due to climate change and likely changes in Delta levees.
3. The chapter relies on existing water quality guidelines to determine ecological harm. Such guidelines are increasingly recognized as being inadequate to protect against loss of ecosystem function.
4. The chapter ignores water-quality impacts of providing a more reliable water supply for agriculture. While the EIR/EIS does consider economic benefits to agriculture, the consequences to water quality of increased use of fertilizers and pesticides have not been considered. . Surprisingly, there seems to be no quantification or comparison of the effects of project alternatives on salt exports to the West side of the San Joaquin Valley.

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