REVIEW OF NMFS BIOLOGICAL OPINION ON THE LONG-TERM CENTRAL VALLEY PROJECT (CVP) AND STATE WATER PROJECT (SWP) OPERATIONS, CRITERIA AND PLAN (OCAP)

by

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For

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EXECUTIVE SUMMARY

I was asked to evaluate and comment on the technical information, models, analyses, results and assumptions in the proposed State Water Project (SWP) Operations, Criteria and Plan (OCAP) that forms the basis for the assessment in the Biological Opinion (BO). The fundamental question is whether the operation plans devised by the Bureau of Reclamation will jeopardize the continued existence of the following species:

- Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*, hereafter
- referred to as winter-run)
- Central Valley spring-run Chinook salmon (*O. tshawytscha*, hereafter referred to as
- spring-run)
- Central Valley (CV) steelhead (*O. mykiss*)
- Central California Coast (CCC) steelhead (*O. mykiss*)
- Southern Distinct Population Segment (DPS) of North American green sturgeon
- (*Acipenser medirostris*, hereafter referred to as Southern DPS of green sturgeon)
- Southern Resident killer whales (*Orcinus orca*, hereafter referred to as Southern Residents)

I have considered the following documents that were provided by download from a CIE ftp site on 15 December 2008:

1. Draft Biological Opinion on the long-term Central Valley Project and State Water Project Operations Criteria and Plan. National Marine Fisheries Service December 2008.
2. Two previous reviews of the 2004 Biological Opinion prepared (by Maguire and McMahon) for CIE.

In addition, the following materials were provided:

1. Draft RPA Appendix A: Decision Criteria for Sacramento River Water Temperature Management
2. Draft RPA Appendix B: Conservation Actions Submitted by Tehama-Colusa Canal Authority
3. Draft RPA Appendix C: Yolo Bypass Actions
4. Draft RPA Appendix D: Summary of American River Flow Management Standard
5. Draft RPA Appendix E: Chinook Salmon Decision Tree
6. OCAP Draft RPAs for Review 12.11.2008
7. OCAP Biological Assessment, Chapter 2-Project Description for the Central Valley Project and State Water Project

My review focused on aspects of the reports related to hydrology and fluvial geomorphology, as these influence salmonids. My key findings are summarized below:

1. The technical tools used in the NMFS OCAP BO (*e.g.*, modeling, calculations, analytical and assessment techniques) are able to determine impacts to the individuals and to the populations for selected environmental variables only (e.g., temperature and flow). The

models that were used to model water supply, flow, velocity and particle movement are the best available but limited in their capacity to describe some of the complexities of the Central Valley river systems, specifically declining conveyance capacity of levee-controlled reaches, aggradation of levee controlled reaches, and dynamics of levee breaches should they occur.

2. The assumptions are clearly stated, but not until late in the BO (these should be summarized in the early chapters). The assumptions are reasonable for the environmental variables being considered and reasonable based on current scientific thinking. But many variables are mentioned only in passing and not built into the modeling.

3. The biological assessment and BO adequately assess the individual responses of fish to certain effects (*i.e.*, flows, water temperatures, salinity, diversions, *etc*.) and the best available information used by NMFS to evaluate how fish are likely to respond to those impacts. However, some significant variables are not built into the modeling, notably river aggradation and the potential failure of the levee system.

4. The data, analyses, results, and conclusions presented do not lead to a thorough understanding of the risks to individuals and populations from the proposed project impacts. Scientific information should have been considered in the category of land use (clearing the riparian forest, conversion of wetlands to agricultural/urban land, sedimentation from agricultural/urban land, instream mining/dredging), and river sedimentation. Cumulative effects are mentioned in the text, but I could not see how they were built explicitly into the modeling effort.

5. I am not convinced the models focusing on flow and temperature are capable of determining the significance of project impacts for Endangered Species Act (ESA) purposes. The project will certainly impact those variables, but whether those will be the key variables in light of other environmental changes can be debated. In my opinion, the BO should consider assessing 3-D channel change, riparian vegetation change, and physical habitat structure.

6. Uncertainties were addressed in the BO for water delivery and the effect on water temperatures in the upper river, which then allowed some consideration of how this would affect pumping rates in the Delta. For other environmental variables, uncertainties were not considered in the BO in the way normally done in science by expressing probabilities, prediction limits, etc. The net result is that the tables in Section 9 usually can only predict directions of change.

7. In the absence of available information to establish probable responses to impacts (*e.g.*, survival across the Delta, steelhead population estimates, steelhead losses at the Delta pumps, spring-run Chinook salmon populations above Red Bluff Diversion Dam), reasonable scenarios were developed to identify types of exposures. Comparisons were made to other species with similar impacts?

8. The BO does a reasonable job of covering the relevant published and unpublished studies on ESA-listed fish species, similar species, ecological theory, and computer simulation-modeling. The BO does a good job of describing the general cause-and-effect relations between individual environmental variables and fish abundance, but the site specific data and analyses are missing from the BO for each project component. The impact of so

many environmental variables on salmonid abundance could be handled in a space-time intelligence system (STIS). This would allow better integration and synthesis than is currently apparent.

9. I was unable to formulate a judgment on whether evidence was sufficient to support conclusions relative to species' responses to demographic changes (*e.g.*, changes in fecundity rates, changes in growth rates for individuals, and changes in numbers of individuals that immigrate or emigrate from populations).

INTRODUCTION

Background

According to the statement of work (SOW), the purpose of this independent review is to evaluate and comment on the use of the best available scientific and commercial information as it pertains to the development of the 2008 NMFS BO on OCAP. The review will focus on the technical aspects of the NMFS BO and the information provided in the OCAP biological assessment (BA). The review will not determine if NMFS' conclusions regarding the project's potential to jeopardize the continued existence of listed species (anadromous salmonids, green sturgeon, and killer whales) are correct.

In 2004, NMFS issued a BO (2004 BO) on OCAP proposed by the US Bureau of Reclamation (Reclamation). Following the issuance of the 2004 BO, three separate peer review processes, by the CALFED Science Program, CIE, and a summary review by the NMFS Southwest Fisheries Center, identified technical deficiencies in the 2004 BO. The 2004 BO also has been legally challenged, and Reclamation requested re-initiation of consultation in 2006. The OCAP includes water management operations that provide drinking water to over 23 million people and thousands of acres of agriculture in California. This consultation involves both Federal and state agencies, and affects local water districts and users. Given the complexity and sensitivity of the OCAP consultation, NMFS is seeking independent peer review of the BO to ensure that NMFS has used the best available information for its analysis.

Terms of Reference

1) Are the technical tools used in the NMFS OCAP BO (*e.g.*, modeling, calculations, analytical and assessment techniques) able to determine impacts to the individuals and to the populations?

2) Are assumptions clearly stated and reasonable based on current scientific thinking?

3) Do the biological assessment and BO adequately assess the individual responses of fish to certain effects (*i.e.*, flows, water temperatures, diversions, *etc*.) and was the best available information used by NMFS to evaluate how fish are likely to respond to those impacts.

4) Do the data, analyses, results, and conclusions presented lead to a thorough understanding of the risks to individuals and populations from the proposed project impacts? If not, what relevant scientific information should be considered?

5) Are the analytical techniques capable of determining the significance of project impacts for Endangered Species Act (ESA) purposes? If not, what additional or alternative analytical techniques are recommended? What *available* science should be used to best address the impacts of this large-scale water project as examined in the BO?

6) Were uncertainties considered in the BO? If so, were they described in a way that frames the data or puts it in the proper perspective (*e.g.*, the appropriate time scale, or the likelihood that

an event will happen)? What uncertainties and limitations were not addressed that might impact the BO substantively?

7) In the absence of available information to establish probable responses to impacts (*e.g.*, survival across the Delta, steelhead population estimates, steelhead losses at the Delta pumps, spring-run Chinook salmon populations above Red Bluff Diversion Dam), were reasonable scenarios developed to identify types of exposures? Were comparisons made to other species with similar impacts?

8) Were relevant published and unpublished studies on ESA-listed fish species, similar species, ecological theory, and computer simulation/modeling missed?

9) Was evidence provided to support conclusions relative to species responses to demographic changes (*e.g.*, changes in fecundity rates, changes in growth rates for individuals, and changes in numbers of individuals that immigrate or emigrate from populations)? Was evidence provided to support the conclusions about how the proposed actions affect the species' demographics?

Description of Review Activities

The charge to the CIE reviewers is to evaluate and comment on the technical information, models, analyses, results and assumptions in the proposed OCAP that form the basis for the assessment in the BO. I have considered the following documents, which were provided to me by download from a CIE ftp site on 15 December 2008:

1. Draft Biological Opinion on the long-term Central Valley Project and State Water Project Operations Criteria and Plan. National Marine Fisheries Service December 2008.
2. Previous reviews of the 2004 Biological Opinion
3. Other supporting documents.

A complete list of the literature I have consulted in this review is presented in Appendix A.

SUMMARY OF FINDINGS

My response to each of the assigned questions is presented below.

1) Are the technical tools used in the NMFS OCAP BO (*e.g.*, modeling, calculations, analytical and assessment techniques) able to determine impacts to the individuals and to the populations?

First and foremost, I am not a modeler, so I cannot completely judge the suitability of the models used for water supply, flow, velocity and particle movement (CALSIM-II and DSM2). The BO states that the basis for selecting these models is apparently given in chapter 9 of the OCAP BA, but I found that inadequate. The justification should be given in the BO. Similarly, it was not possible to evaluate how effectively they are integrated into

other models that eventually model salmon mortality; Figure 2-11 does not suffice for explanation, nor does the text in sections 2.4 and 2.5.

This genre of hydrologic models works well for channels that are stable, but the Sacramento River is experiencing significant aggradation between poorly constructed levees. Mention is made (on page 164) of the RIVER2D model that handles complex habitat types and alternative habitat suitability. This may be the best model available, but still is 2-dimenional, which is significant because it cannot explicitly address the sedimentation/aggradation problem in levee-controlled reaches of the Sacramento River. It is not mentioned again in the BO. Central Valley rivers are no longer connected with their floodplains in many reaches where restoration will be difficult. The aggradation only increases the likelihood of breaches in the levee system, which could cause disasters for fish restoration programs. The Central Valley is topographically lower than much of the rivers that drain it; the hydrological variability is high and likely to increase with climate change; the flood-control system has limited conveyance capacity, and extreme floods are inevitable. I know of no hydrologic models that incorporate these complexities.

2) Are assumptions clearly stated and reasonable based on current scientific thinking?

The assumptions are clearly stated, but not until late in the BO (they should be summarized in the early chapters). The assumptions are reasonable for the environmental variables being considered and reasonable based on current scientific thinking. But many variables are mentioned only in passing and not built into the modeling.

The Draft BO was cumbersome and very difficult to read and evaluate compared to other similar environmental assessments that I have reviewed. Inspection of the Table of Contents reveals how little attention was given to creating a coherent outline that presented topics in a logical sequence. A better organizational approach is needed. Most importantly, the treatment of related topics is not uniform. For instance, section 6 has major headings by project component, but the subheadings differ greatly between them. The impact of future alternative scenarios is difficult to decipher because scenarios bear little relations to project components. The background and consultation history (section 1) was tedious but comprehensive and therefore helpful for reviewers who have not followed the issues from the beginning. The analytical approach (section 2) was difficult to follow, with too many conceptual diagrams for which the linkages are unexplained. The boxed insert on page 19 and Figure 2-9 helped more than the bureaucratic, laborious text or figures that precede them. Assumptions, like those for the models mentioned on page 31, are either absent altogether or vague reference is made to other documents.

3) Do the biological assessment and BO adequately assess the individual responses of fish to certain effects (*i.e.*, flows, water temperatures, diversions, *etc*.) and was the best available information used by NMFS to evaluate how fish are likely to respond to those impacts.

The portions of the report that describe and explain population trends (section 4.2) and environmental baselines (section 5.0) provide explanations in the form of text without supporting statistical analyses. Maps, tables, and figures are provided for CV salmon and

Chinook salmon data, but not for the environmental data that affect fish. This is a classic case of "multiplicity" in science. The BO provides cause-and-effect links between salmon populations and habitat blockage water development (diversion dams, flood control), land use, water quality, hatchery operations, ocean commercial/sport harvesting, inland sport harvesting, disease and predation. The land use category includes brief discussions of the effects of clearing the riparian forest, conversion of wetlands to agricultural/urban land, sedimentation from ag/urban land, instream mining/dredging. The text contains some references, but no effort is made to separate the various effects of habitat blockage and water development. Natural environmental cycles are also discussed (El Niño, ocean productivity, global climate change, non-native invasive species). All links between cause-and-effect are plausible, but the full explanation is lacking because the individual effects have not been separated. One has to wait until page 129 and then page 199 to view flow diagrams that link some of the environmental variables with fish abundance.

Very little attention was given to the condition of the weir and bypass system that conveys most of the extreme floods in the lower valley. Sedimentation of flood bypasses threatens to impair flood conveyance. The most significant oversight in this section is the effect of sedimentation from headwater streams is causing the channel bed of the Sacramento River to aggrade as much as two meters over short periods of time.

4) Do the data, analyses, results, and conclusions presented lead to a thorough understanding of the risks to individuals and populations from the proposed project impacts? If not, what relevant scientific information should be considered?

The environmental effects on salmon are described in section 5. The cumulative effects are briefly discussed in section 8: water diversions, agricultural practices, increased urbanization, and global climate change. The cumulative effects of these are not quantified to any meaningful degree. Granted this is a challenging task, but not impossible. Two other long-term and irreversible effects are only discussed briefly: logging and hydraulic mining in the headwaters, as well as removal of riparian vegetation in the Valley. Logging in the Sierra Nevada has introduced large volumes of fine sands and silts into the river systems. A common effect is for fines to infiltrate into the gravel bars and riffles, reducing water circulation and sometimes causing embeddedness. The removal of the riparian forest corridor on the valley floor facilitates water temperature increases and loss of large woody debris (which increases habitat patchiness). A major issue is the hydraulic mining sediment that continues to move through the Sacramento River system, causing significant aggradation, risk to levees, and jeopardizing salmon populations. The research by Singer and Aalto (2008a, 2008b), Singer et al. (2008), Florsheim et al. (2008), James and Singer (2008), Burton and Cutter 92008), and Fridirici (2008) provide some historical insights on the problem.

The environmental effects of the proposed action are discussed in section 6. This section was almost unreadable because of the lack of organization (why didn't the presentation follow the model in Figure 2-11?), the uneven writing, and mixture of massive data without supporting quantitative analysis.

5) Are the analytical techniques capable of determining the significance of project impacts for Endangered Species Act (ESA) purposes? If not, what additional or alternative analytical techniques are recommended? What *available* science should be used to best address the impacts of this large-scale water project as examined in the BO?

The analytical techniques used to formulate future scenarios are not widely discussed in the BO. Fluvial geomorphologists with field experience in Central Valley rivers (e.g., Kondolf, Singer, Aalto, Florsheim and Mount) should be consulted to provide field-based measurements of channels over time and the increased risk of levee failure. This project could make good use of a space-time intelligence system (STIS), commercial software produced by BioMedware in Ann Arbor, Michigan (Jacquez et al. 2005). It provides insight to the temporal aspects of spatial data. This is accomplished through a distinctive spatial database with temporal measures embedded and integrated through the STIS. It uses these data to create linked maps and graphs that allow the user to explore change over time. Temporal change is common to many phenomena, and when combined with spatial location, it can provide a dynamic and informative view of trends and patterns. Examples are numerous in GIS analyses. STIS offers great possibility for modeling change in environmental variables that affect fish abundance. STIS generated maps move, which allows the user to visualize data changes through time. Spatial data (e.g., river location, fish distributions) can be displayed as maps, tables, or graphs. Moreover, it is possible to perform geostatistics over time and at any point in time.

6) Were uncertainties considered in the BO? If so, were they described in a way that frames the data or puts it in the proper perspective (*e.g.*, the appropriate time scale, or the likelihood that an event will happen)? What uncertainties and limitations were not addressed that might impact the BO substantively?

Uncertainties were addressed in the BO for water delivery and the effect on water temperatures in the upper river, which then allowed some consideration of how this would affect pumping rates in the Delta.

For other environmental variables, uncertainties were not considered in the BO in the way normally done in science by expressing probabilities, prediction limits, etc. The net result is that the tables in Section 9 usually can only predict directions of change. The way to handle uncertainties is through adaptive management, a system of salmonid management that will allow for flexibility as new data and new models become available. As noted by Kondolf (2000, pp. 53-54), adaptive management requires "…good monitoring data, ongoing evaluation of project performance, and deliberate experimental manipulations to test the system response."

The most significant uncertainty, in my opinion, is the future of the levee system. A catastrophic failure of the levees could undermine the significant investment, past and future in restoring salmon in the Central Valley river system.

I found the NAS/NRC (2004) assessment on salmon in the Columbia River and the NRC/NAS (2004, 2008) assessments on salmon in the Klamath River Basin to be more thorough and more open about discussing the uncertainties. Again, the cumulative effects of water development, sedimentation (from hydraulic mining and logging), levee building, urbanization, and agriculture have not been modeled in a spatially explicit manner. On the one hand, the BO recognizes these effects in the review of literature but they are not built into the modeling in a meaningful way. On the other hand, the system is so complex, the BO does make a reasonable attempt to link flow and temperature with salmon mortality.

7) In the absence of available information to establish probable responses to impacts (*e.g.*, survival across the Delta, steelhead population estimates, steelhead losses at the Delta pumps, spring-run Chinook salmon populations above Red Bluff Diversion Dam), were reasonable scenarios developed to identify types of exposures? Were comparisons made to other species with similar impacts?

Table 6-11 (page 191) summarizes the effects considered in the OCAP Biological Assessment and in the BO. The proposed scenarios seem reasonable, in the absence of complete understanding of the geomorphology and hydrology. The Draft RPA for review, dated 12.11.2008 gave a clear presentation of one preferred scenario. This makes it difficult for the reader to compare impacts on other species. This comparison was possible by the time one read through section 9. I would like to see the model inputs and outputs (CALSIM, DESM2, SALMOD, etc.) for each proposed action to provide some unified information.

The section (9) on integration and synthesis of the effects was more readable than the rest of the BO. This section was organized by species, with subheadings under each for geographic region affected. Finally, some organization that is internally consistent! I found Tables 9-2, 9-5, 9-6, 9-9 , 9-10, 9-11, 9-12 to be helpful, if only in a semi-quantitative way, for comparing impacts between species. I carefully read the scenarios for each project component, but I was challenged to see the relation between various project components.

8) Were relevant published and unpublished studies on ESA-listed fish species, similar species, ecological theory, and computer simulation/modeling missed?

The BO does a reasonable job of covering the relevant published and unpublished studies on ESA-listed fish species, similar species, ecological theory, and computer simulation-modeling. The impact of sedimentation on aggradation and habitat patchiness is more important in the Sacramento River, I believe, than presented in the report. The work of Aalto and collaborators (see my list of references in Appendix A), which shows dramatic rates of aggradation in levee-controlled reaches of the Sacramento River, should be incorporated into habitat models.

The impact of so many environmental variables on salmonid abundance could be handled in a space-time intelligence system (STIS). This would allow better integration and synthesis than is currently apparent.

Kondolf has noted (2000, p. 49): "Geomorphology must be considered at both the watershed and reach scales." The BO does this in a qualitative sense, but what is lacking is a space-time intelligence system (STIS) analysis of hydrologic, vegetation, and geomorphic effects on salmonid viability. To understand changes in range of salmonids over time, it is necessary to understand how the following variables have also changed over space and time: flow regime, sediment budgets, channel shifting (vertical, horizontal), large woody debris supply and transport, channel form, bed mobility, spawning gravel quality, bank and floodplain revegetation, flow-groundwater interactions. The BO discusses most of these variables, but their effect on salmonid abundance is not clear.

Some evidence was presented, but not in a consistent coherent way that makes for easy reading. The BO does a good job of describing the general cause-and-effect relations between individual environmental variables and fish abundance, but the site specific data and analyses are missing from the BO for each project component. Some critically important geomorphic variables are essentially absent, or appear in important tables without supporting data: channel form, bed material size, spawning gravel quality, sediment budgets.

9) Was evidence provided to support conclusions relative to species responses to demographic changes (*e.g.*, changes in fecundity rates, changes in growth rates for individuals, and changes in numbers of individuals that immigrate or emigrate from populations)? Was evidence provided to support the conclusions about how the proposed actions affect the species' demographics?

I was not able to formulate a judgment on this question, which lies outside my area of expertise.

CONCLUSIONS AND RECOMMENDATIONS

For a variety of reasons (organization, uneven writing), the Draft Biological Opinion on the long-term Central Valley Project and State Water Project Operations Criteria and Plan was difficult to read and evaluate. It contains a sizeable literature review, some monitoring data on fish, and very little quantitative spatial-temporal data on environmental variables that affect salmonid abundance. The BO makes mention early about the models to be used to link (at least some) environmental variables to salmonids, but the basis for choosing these models and the assumptions behind them are missing from the BO. The scientific community understands that uncertainties exist in any environmental analysis, especially when modeling and prediction are involved, but the BO does not address this major point in a meaningful way. The BO is very strong in relating fish abundance to individual variables, at least in terms of reviewing the relevant literature, but the separate effects or cumulative effects were not quantified for a great number of variables outside of flow, temperature, and salinity. Whereas flow, temperature and salinity certainly are critical variables, the effects of other variables may prove to be just as important, especially losing the shade and large woody debris from riparian vegetation, and the decline in physical habitat quality with sedimentation/aggradation. The effects of environmental variables could be treated in a more sophisticated way by utilizing space-time intelligence system (STIS) software, which basically automates changes in spatial distribution of variables over time. Nevertheless, NMFS has made a good faith effort to model the links between flow,

temperature and salinity, and salmon mortality. It is complex enough just to understand the possible scenarios with flow, temperature/salinity, and salmon mortality.

Appendix A. Bibliography of Materials Used Prior and During Peer Review

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Appendix B. Copy of the Statement of Work

External Independent Peer Review by the Center for Independent Experts (CIE)

Review of the 2008 National Marine Fisheries Service's (NMFS) Biological Opinion (BO) on the long-term Central Valley Project (CVP) and State Water Project (SWP) Operations, Criteria and Plan (OCAP)

Project Background:

The purpose of this independent review is to evaluate and comment on the use of the best available scientific and commercial information as it pertains to the development of the 2008 NMFS BO on OCAP. The review will focus on the technical aspects of the NMFS BO and the information provided in the OCAP biological assessment (BA). The review will not determine if NMFS' conclusions regarding the project's potential to jeopardize the continued existence of listed species (anadromous salmonids, green sturgeon, and killer whales) are correct.

In 2004, NMFS issued a BO (2004 BO) on OCAP proposed by the US Bureau of Reclamation (Reclamation). Following the issuance of the 2004 BO, three separate peer review processes, by the CALFED Science Program, CIE and a summary review by the NMFS Southwest Fisheries Center, identified technical deficiencies in the 2004 BO. The 2004 BO also has been legally challenged, and Reclamation requested re-initiation of consultation in 2006. The OCAP includes water management operations that provide drinking water to over 23 million people and thousands of acres of agriculture in California. This consultation involves both Federal and state agencies, and affects local water districts and users. Given the complexity and sensitivity of the OCAP consultation, NMFS is seeking independent peer review of the BO to ensure that NMFS has used the best available information for its analysis.

The charge to the CIE reviewers is to evaluate and comment on the technical information, models, analyses, results and assumptions in the proposed OCAP that form the basis for the assessment in the BO. The reviewers should additionally consider pertinent background information, such as previous NMFS BOs that pertain to CVP water operations (*i.e.*, 1993 Winter-run Chinook salmon BO and the 2000 Trinity River Restoration Program BO) and the CALFED's adaptive management process (*i.e.*, the Salmon Decision Process). The reviewers should review both the data provided in the OCAP BA and the NMFS BO. For example, they should review how NMFS assessed the individual responses of fish to certain effects (*i.e.*, flows, water temperatures, diversions, *etc.*) and whether the best available information was used by NMFS on how fish are likely to respond to those impacts.

Overview of CIE Peer Review Process:

The NMFS Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the CIE to conduct independent peer reviews of stock assessments and various scientific research projects. The primary objective of the CIE peer review is to provide an impartial review, evaluation, and recommendations in accordance to the Statement of Work

(SOW), including the Terms of Reference (TOR) herein, to ensure the best available science is utilized for NMFS management decisions.

The NMFS Office of Science and Technology serves as the liaison with the NMFS Project Contact to establish the SOW which includes the expertise requirements, TOR, statement of tasks for the CIE reviewers, and description of deliverable milestones with dates. The CIE, comprised of a Coordination Team and Steering Committee, reviews the SOW to ensure it meets the CIE standards and selects the most qualified CIE reviewers according to the expertise requirements in the SOW. The CIE selection process also requires that CIE reviewers can conduct an impartial and unbiased peer review without the influence from government managers, the fishing industry, or any other interest group resulting in conflict of interest concerns. Each CIE reviewer is required by the CIE selection process to complete a Lack of Conflict of Interest Statement ensuring no advocacy or funding concerns exist that may adversely affect the perception of impartiality of the CIE peer review. The CIE reviewers conduct the peer review, often participating as a member in a panel review or as a desk review, in accordance with the TOR producing a CIE independent peer review report as a deliverable. At times, the ToR may require a CIE reviewer to produce a CIE summary report. The Office of Science and Technology serves as the COTR for the CIE contract with the responsibilities to review and approve the deliverables for compliance with the SoW and ToR. When the deliverables are approved by the COTR, the Office of Science and Technology has the responsibility for the distribution of the CIE reports to the Project Contact. Further details on the CIE Peer Review Process are provided at http://www.rsmas.miami.edu/groups/cie/

Requirements for CIE Reviewers:

1) We request three CIE reviewers to conduct an independent peer review.
2) Each CIE reviewer's duties shall not exceed a maximum total of 7 days - several days for document review and several days to produce a written report of the findings.
3) Each CIE reviewer may conduct their analyses and writing duties from their primary location (desk review). Each written report shall be based on the individual reviewer's findings.
4) Each CIE reviewer shall produce an independent summary report addressing the elements identified in the ToR (Annex 1) and the format specified in Annex 2.
5) The expertise among the CIE reviewers shall include anadromous fishery management in managed water system, ability to interpret hydrodynamic and fishery dynamics models, hydrology, familiarity with Pacific anadromous fish and life history requirements, and fish stock assessment and biostatistics.

The CIE reviewers shall have the expertise necessary to complete an impartial peer review and produce the deliverables in accordance with the SoW and ToR as stated herein (refer to the ToR in Annex 1).

Statement of Tasks for CIE Reviewers:

The CIE reviewers shall conduct necessary preparations prior to the peer review, conduct the peer review, and complete the deliverables in accordance with the ToR and milestone dates as specified in the Schedule section.

Prior to the Peer Review: The CIE shall provide the CIE reviewers contact information (name, affiliation, address, email, and phone) to the Office of Science and Technology COTR no later than the date as specified in the SoW, and this information will be forwarded to the Project Contact.

Pre-review Documents: Approximately two weeks before the peer review, the Project Contact will send the CIE reviewers the necessary documents for the peer review, including supplementary documents for background information. The CIE reviewers shall read the pre-review documents in preparation for the peer review.

CIE reviewers shall access the following documents containing information related to the ToR:

1. Draft Biological Opinion on the long-term Central Valley Project and State Water Project Operations Criteria and Plan. National Marine Fisheries Service December 2008.
2. Long-term Central Valley Project and State Water Project Operations Criteria and Plan – Biological Assessment, including appendices. US Bureau of Reclamation. April 29, 2008.
3. Reviews of the 2004 Biological Opinion (4 documents ~ 75 pages)

These documents and other background material (or links to them) will be provided to the CIE reviewers by the Project Contact according to the schedule herein..

4. [possible other Background docs: previous NMFS BOs that pertain to CVP water operations (*i.e.*, the 2000 Trinity River Restoration Program BO and 2004 OCAP BO) and the CALFED's adaptive management process (*i.e.*, the Salmon Decision Process), VSP criteria.

5. Background information on the ESA and NMFS' responsibilities for implementing the ESA is available from the NMFS Office of Protected Resources web site at: http://www.nmfs.noaa.gov/pr/laws/esa.htm.

Documents 2. through 5. can be available for pre-review in September 2008. This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process. Furthermore, the CIE reviewers are responsible for only the pre-review documents that are delivered to them in accordance to the SoW scheduled deadlines specified herein.

Desk Peer Review:

The primary role of the CIE reviewer is to conduct an impartial peer review in accordance to the ToR herein, to ensure the best available science is utilized for NMFS management decisions (refer to the ToR in Annex 1).

Terms of Reference: The ToR for the CIE peer review is attached to the SoW as Annex 1. Up to two weeks before the peer review, the ToR may be updated with minor modifications as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

Independent CIE Peer Review Reports:

The primary deliverable of the SoW is each CIE reviewer shall complete and submit an independent CIE peer review report in accordance with the ToR, and this report shall be formatted as specified in the attached Annex 2.

Schedule of Milestones and Deliverables:

11/04/08	CIE shall provide the COTR with the CIE reviewer contact information, which will then be sent to the Project Contact
12/11/08	The Project Contact will send the CIE Reviewers the pre-review documents
12/26/08-01/09/09	Each reviewer shall conduct an independent peer review
01/16/09	CIE shall submit draft CIE independent peer review reports to the COTRs
01/30/09	CIE will submit final CIE independent peer review reports to the COTRs
02/07/09	The COTRs will distribute the final CIE reports to the Project Contact

Acceptance of Deliverables:

Each CIE reviewer shall complete and submit an independent CIE peer review report in accordance with the ToR, which shall be formatted as specified in Annex 2, to Manoj Shivlani, CIE Lead Coordinator, via shivlanim@bellsouth.net, and Dr. David Die, CIE Regional Coordinator, via ddie@rsmas.miami.edu. Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, the CIE shall send via e-mail the CIE reports to the COTR (William Michaels William.Michaels@noaa.gov at the NMFS Office of Science and Technology by the date in the Schedule of Milestones and Deliverables. The COTRs will review the CIE reports to ensure compliance with the SoW and ToR herein, and have the responsibility of approval and acceptance of the deliverables. Upon notification of acceptance, CIE shall send via e-mail the final CIE report in *.PDF format to the COTRs. The COTRs at the Office of

Science and Technology have the responsibility for the distribution of the final CIE reports to the Project Contacts.

Key Personnel:

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Request for Changes:

Requests for changes shall be submitted to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the ContracToR within 10 working days after receipt of all required information of the decision on substitutions. The contract will be modified to reflect any approved changes. The ToR and list of pre-review documents herein may be updated without contract modification as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

ANNEX 1

Terms of Reference

For the 2008 National Marine Fisheries Service's (NMFS) Biological Opinion (BO) on the long-term Central Valley Project and State Water Project Operations, Criteria and Plan (OCAP) Peer Review

- Are the technical tools used in the NMFS OCAP BO (*e.g.*, modeling, calculations, analytical and assessment techniques) able to determine impacts to the individuals and to the populations?

- Are assumptions clearly stated and reasonable based on current scientific thinking?

- Do the biological assessment and BO adequately assess the individual responses of fish to certain effects (*i.e.*, flows, water temperatures, diversions, *etc*.) and was the best available information used by NMFS to evaluate how fish are likely to respond to those impacts.

- Do the data, analyses, results, and conclusions presented lead to a thorough understanding of the risks to individuals and populations from the proposed project impacts? If not, what relevant scientific information should be considered?

- Are the analytical techniques capable of determining the significance of project impacts for Endangered Species Act (ESA) purposes? If not, what additional or alternative analytical techniques are recommended? What *available* science should be used to best address the impacts of this large-scale water project as examined in the BO?

- Were uncertainties considered in the BO? If so, were they described in a way that frames the data or puts it in the proper perspective (*e.g.*, the appropriate time scale, or the likelihood that an event will happen)? What uncertainties and limitations were not addressed that might impact the BO substantively?

- In the absence of available information to establish probable responses to impacts (*e.g.*, survival across the Delta, steelhead population estimates, steelhead losses at the Delta pumps, spring-run Chinook salmon populations above Red Bluff Diversion Dam), were reasonable scenarios developed to identify types of exposures? Were comparisons made to other species with similar impacts?

- Were relevant published and unpublished studies on ESA-listed fish species, similar species, ecological theory, and computer simulation/modeling missed?

- Was evidence provided to support conclusions relative to species responses to demographic changes (*e.g.*, changes in fecundity rates, changes in growth rates for individuals, and changes in numbers of individuals that immigrate or emigrate from populations)? Was evidence provided to support the conclusions about how the proposed actions affect the species' demographics?

Further Purposes of the Review

In addition to answering the fundamental questions posed above, another intended use of this review is to help ensure that best available information is used for future ESA consultations, such as early consultation components for OCAP, and the South Delta Improvement Program. Reviewers shall address possible inadequacies in the NMFS BO (*i.e.*, Did the BO apply the available information in a scientifically sound manner?).

ANNEX 2

Format and Contents of CIE Independent Reports

1. The report should be prefaced with an Executive Summary with concise summary of goals for the peer review, findings, conclusions, and recommendations.

2. The main body of the report should consist of an Introduction with
    a. Background
    b. Terms of Reference
    c. Description of Review Activities

3. Summary of Findings in accordance to the Term of Reference

4. Conclusions and Recommendations in accordance to the Term of Reference

5. Appendix for the Bibliography of Materials used prior and during the peer review.

6. Appendix for the Statement of Work

7. Appendix for other pertinent information for the CIE peer review.