Report on the 2004 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)

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Executive summary of comments and recommendations

In both the Biological Opinion and the Biological Assessment, the various statistical relationships used in the modelling are not or poorly documented, i.e. graphs of the observations with the relationship plotted are either not available, or if they are they are buried in appendices and not where they would be most informative, i.e. at the time the relationship is used. This makes it cumbersome to evaluate the adequacy of the statistical relationships used in the modelling.

Both the Biological Opinion and the Biological Assessment are tedious to read. A large amount of information is presented, in what appears to be a slightly different format in different parts of the report which makes it difficult to separate what is important from what is accessory.

The technical tools used in the NMFS OCAP biological opinion (e.g., modelling, calculations, analytical and assessment techniques) relate more to the management of the water than to its effect on the fish resources. With respect to fishes, modelling has been limited owing to the scarcity of basic data on abundance trends and gaps in knowledge of some basic relationships / parameters (e.g. sublethal effects of temperature outside the preferred range, mechanisms that are triggering migrations, survival between life stages etc.). The information available is probably insufficient to determine impacts to the individuals and to the populations with any confidence, particularly when the possibility of climate change is taken into account.

The modelling seems to be a collection of ad hoc procedures that have been developed independently and are used in various combinations at various times to provide results, as each independent model evolves. A comprehensive ecosystem modelling exercise should be undertaken such that all species can be looked at simultaneously with up-to-date information and techniques, including predator-prey relationships.

Several basic assumptions, such as those used in the modelling, habitat availability and suitability, as well as those related to diversion and entrainment, are clearly stated. However, one of the main assumptions, that past weather observations are indicative of the future, is neither clearly stated nor reasonable. There is ample evidence that the earth's climate is changing and this is likely to have an influence in the system under review within the time span of the project under evaluation.

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. This is both a consequence of the paucity of information used and because of the way the information is presented. There is no hierarchical organisation of the information; all the factors are listed whether they are major or minor. It would be preferable to present the information in a hierarchical sequence with the most important items given prominence and the less important ones less importance. In this respect, opening up historically

accessible habitat and restricting the commercial fisheries could have more positive impacts than the measures discussed here.

The analytical techniques are not capable of determining the significance of project impacts for ESA purposes, mostly because the data are insufficient to convincingly demonstrate the effects analytically. Some form of adaptive management (Failing et. al. 2004), where information is acquired and methodology developed as part of the management process, would probably be a more fruitful avenue to follow than the current one.

Adaptive management may be the most efficient way of rebuilding ESA listed resources and minimising the impact on other users of the water. Through adaptive management the knowledge base would also increase.

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 2004 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). The SOW asks reviewers to focus on the technical aspects of the NMFS biological opinion and the information provided in the OCAP biological assessment (BA), not to determine if NMFS' conclusions regarding the projects potential to jeopardize the continued existence of listed Central Valley salmonids are correct.

The charge to the CIE reviewers is to evaluate and comment on the technical information, models, analyses, results and assumptions that formed the basis for the assessment in the BO of the proposed long-term water operations for the projects described. The reviewers are expected to consider additional pertinent background information, such as previous NMFS biological opinions that pertain to Central Valley Project water operations (i.e., 1993 Winter-run Chinook salmon opinion and the 2000 Trinity River Restoration opinion) and the CALFED's adaptive management process (i.e., the Salmon Decision Process). The reviewers were asked to review both the data provided in the OCAP BA and the NMFS Biological Opinion, e.g. 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.

The 2004 NMFS Biological Opinion on the long-term Central Valley Project and State Water Project Operations, Criteria and Plan (OCAP) has been controversial:

- the Office of the Inspector General of the Department of Commerce reviewed the process for the preparation of the opinion and its audit of the review process,

published in July 2005, found that the process deviated from the Region's normal practice;
- a court case has been initiated in August 2005 by environmental non-governmental and fishermen's organisations;
- the California Bay – Delta Authority organised an OCAP Biological Opinion Review Workshop on October 12-13, 2005 and the report of the independent experts who took part in the October review was expected to be available in early 2006.

The readers of this review should be aware that I am not a salmon expert, nor an expert in water management. However, I have reviewed science on Atlantic salmon. In particular I have reviewed the definition of conservation for Canadian Atlantic salmon, I was a chair of the Canadian Atlantic Fisheries Scientific Advisory Committee (1989-1993), and as a member (1989-1996) and chair (1996-1999) of the Advisory Committee on Fisheries Management of the International Council for the Exploration of the Sea, I have reviewed and explained scientific advice on Atlantic salmon. With nearly 30 years experience in providing scientific advice for fishery management, I have approached this assignment as a generalist with the view of providing an educated scientific opinion on the documentation presented and the process followed.

Description of the review activities

Agreement on the terms of the review was reached on December 9, 2005, which made it impossible to provide the report within the original deadline of December 19, 2005, but e-mail correspondence confirmed that providing the report by early January 2006 was acceptable.

The OCAP Biological Opinion, Biological Assessment, and associated documents were provided on CD. Both were read. In addition, background information on the press coverage of the OCAP Biological Opinion, lawsuit, and audit were reviewed; parts of CALFED Annual Reports and a February 2002 CALFED report titled "Evaluating and Comparing Proposed Water Management Actions" were consulted as well. A complete list of the documents reviewed and/or consulted is provided in Appendix 1.

Summary of analyses and comments

My main comments relate to the quantity and quality of data used, how the data and results are presented, and on the process followed for the formulation of the Biological Opinion.

Quantity and quality of the data used

While reading the Biological Opinion and the Biological Assessment, one gets the impression that data on species abundance are relatively scarce (e.g. page 79 of the Biological Opinion, last paragraph. "but a comprehensive steelhead monitoring program has not been funded or implemented in the Central Valley or Trinity River basin"). In addition, it is not clear that many of the relationships used to estimate survival or reproductive success with respect to water temperature or flow are derived locally. Some (e.g. CALFED Bay-Delta Program, 2004) give the impression that monitoring has been increased over the last few decades, but that is not evident from the Biological Opinion or Biological Assessment. This suggests that there is considerable room for improvement in monitoring abundance and in evaluating the parameters of survival / reproductive success with respect to water temperature and flow or that not all available data has been used.

In both the Biological Opinion and the Biological Assessment, the various statistical relationships used in the modelling are not or poorly documented, i.e. graphs of the observations with the relationship plotted are either not available, or if they are available, they are buried in appendices and not where they would be most informative, i.e. at the time the relationship is used. This makes it cumbersome to evaluate the adequacy of the statistical relationships used in the modelling. When data are shown, e.g. figure 4.1 and 4.2 of the Biological Assessment, they are not always convincing, or suggest that modelling should more explicitly take into account the uncertainties and variability in the relationships. In any case, it would be desirable for the Biological Opinion to be an independent document and not require the reader to go to the Biological Assessment for verification of the basic information. Anderson 2005 (page 5) discusses the relationship between pump operations and migration survival. He notes that the "models have low statistical power, do not account for uncertainty in the survival estimates, and the correlations were highly influenced by a few outliers". He also states that cause and effect relationships should not be assumed. Simple correlations are useful to identify avenues for future research, but "they are not evidence for the significance of a variable's impact without more extensive analysis that includes other possible factors" (Anderson 2005, page 7). This is good advice.

Presentation of the data and results

Both the Biological Opinion and the Biological Assessment are tedious to read. A large amount of information is presented in what appears to be a slightly different format in different parts of the report. This may have evolved over time, possibly from legislated requirements for documentation, but the end result is that it is difficult to separate what is important from what is accessory. For both the Biological Opinion and the Biological Assessment, I have no doubt that it would be possible to produce a considerably shorter document that would be considerably clearer and more informative, particularly in bringing forward the supporting information. In today's web based information age it should be possible to have a succinct document with live links to the important background documents. If these documents have not gone through the Government

Paperwork Elimination Act (GPEA), putting them through that process could be an opportunity to improve the report formats and contents.

Unless the current format is dictated by law, it would be useful to review the format of the Biological Opinion to make it more informative and less bureaucratic. The current format does not help the reader to form an opinion based on facts and figures. Although there is a lot of text and statements, it is actually difficult to find where the meat of the report(s) is and, in particular, statements in the Biological Opinion are not directly supported by data – it is necessary to refer to the Biological Assessment to look, and sometimes find, the supporting data. When statements are made supporting information and mitigating assumptions should also be provided.

It is also difficult to find the relative importance of different threats. For example, Anderson 2005 page 3 notes that "Assessing the significance of the pump curtailments is problematic. Although the ROD identified allowable takes on the order of 1% of the JPE or its surrogate, the significance of these levels on population extinction cannot be estimated because the impacts are small compared to the major factors that determine population survival. Harvest of winter Chinook, which exceeded 60% prior to 1995, is now on the order of 20% (Kimmerer and Brown 2004) so harvest takes 20 to 60 times more than the pumps. […] In a single season over-harvesting could deplete the cumulative benefits of years of water management". If such clear statements of this nature are in either the Biological Opinion or the Biological Assessment I did not find them.

It would also be useful to develop an integrated performance measure that would directly indicate how changes in water supply and water quality affect fish and wildlife.

Process for formulating the Biological Opinion

The NMFS document is called a Biological Opinion, and in fact it is also a "consensus biological opinion". Pages 1 and 2 of the Biological Opinion give the impression that the NMFS, as an agency, was also involved in the preparation of the Biological Assessment. From a process perspective, this is not desirable – it is difficult to see how the Biological Opinion could differ from the Biological Assessment if they are based / use the same basic information and are developed jointly by the same people. Depending on the system in place, it could be preferable if the Biological Assessment was developed independently and if the Biological Opinion was a self-supporting document that evaluated the Biological Assessment. The National Academy of Science report on the Klamath river basin (NRC 2004) suggests that the Biological Opinion should be "in response to" Biological Assessments. If this were the case here the tone of the Biological Opinion would be different.

Response to specific questions

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

The technical tools used in the NMFS OCAP biological opinion (*e.g.*, modelling, calculations, analytical and assessment techniques) are presented in section V.A.1. *Information Available for the Assessment*, starting on page 91. They relate more to the management of the water than to its effect on the fish resources. With respect to fishes, modelling has been limited owing to the scarcity of basic data on abundance trends and gaps in knowledge of some basic relationships / parameters (e.g. sublethal effects of temperature outside the preferred range, mechanisms that are triggering migrations, survival between life stages etc.). Monitoring efforts seem to have increased since the mid to late 1990s, but they correspond to periods of low abundance and well established long-running monitoring efforts seem to be few. In addition, thresholds for water temperature, depths, and flows are not all derived for the species in the tributaries considered. Many of the values are either borrowed from other systems, or generally assumed values for large geographical areas which may or may not be applicable to the systems under review. The information available is probably insufficient to determine impacts to the individuals and to the populations with any confidence, particularly when the possibility of climate change is taken into account. The Biological Opinion recognises (page 92, last paragraph) that the CALSIM II model has high uncertainties, and that these are compounded in the second order models to predict temperature, mortality, or those used in gaming and economic analyses. The Biological Opinion hopes that "best professional judgement" will allow the identification of likely effects. This may be wishful thinking.

CALSIM II works on monthly temperature data and these cannot be expected to reflect daily and hourly values which are those that may be of more significance to salmonid survival (e.g. NRC 2004, page 8 states "nocturnal minimums can be as important as daily maximums in determining the survival of juvenile coho salmon"). It is not possible from the graphs presented in the reports to ascertain the daily or hourly variability of water temperatures and flow. The mean monthly temperature may in fact be of little predictive value for mortality estimation without knowing (using) the variability and duration of variability. Exposures of 24-48h or less could in fact be lethal and not be detected with the current approach. The model is probably able to provide the direction of changes, but it is unlikely to give the magnitude of the effect. The CALSIM II presents a pragmatic approach to the problem given the data available, but it is unlikely to correspond to the future reality.

A basic assumption is that the past, at least in terms of monthly variability, is indicative of future monthly variability and that there is no long term changes that are likely to present a significant number of years that would be considered anomalous when compared with past observations. This is stated reasonably clearly as an assumption, but the accompanying comment that climate is changing is not as clearly made. In all likelihood, it can be said that the past is not a reasonable indication of the future. In that sense the modelling may be indicative of the direction of the effects, but not of the magnitude.

The Juvenile Production Estimate (JPE) seems to be calculated from spawner escapement using fixed values (e.g. for gender composition, pre-spawning mortality, survival rates of egg to smolt, survival of smolts to the delta, etc.). It seems highly unlikely that all the parameter values will remain constant for all years, and the JPE can probably be expected to exhibit considerable uncertainty.

The water temperature model is believed to underestimate real temperature, but real-time operations apparently use a more conservative approach not fully represented in the model (page 94, last paragraph). It would seem that the said "more conservative approach" should be modelled and that the temperature that is currently modelled may be of little use.

The salmon mortality model only evaluates the effects of temperature on mortality for early life stages, and it does not evaluate potential impact on emergent fry, smolts, juvenile emigrants, or adults, nor does it consider other sources of mortality (in-stream flows, predation, etc.), which at times may be more important than temperature related mortality. As such, it is of limited usefulness.

Anderson (2005) succinctly describes the scientific validity of relationships between survival and flow (page 8): "For the most part, the analyses of various flow measures on salmon survival have been based on single variable linear models. These models are inappropriate from both scientific and management perspectives. Scientifically, single variable linear regressions simply do not represent the multivariate nonlinear interactions that determine fish migration and survival. In terms of management, overly simple models can be misleading: they run the risk of misdirecting or providing erroneous justification of a management action. For example, if migration survival depends on gate operations and if the operations are inadvertently correlated with pump operations, then evaluating the data with models that only consider pump operations would establish an erroneous correlation with survival". I concur with this statement.

Without having gone into the details of the modelling, one gets the impression that it is a collection of ad hoc procedures that have been developed independently, and are used in various combinations at various times, as each independent model evolves, to provide results. It looks as if comprehensive ecosystem modelling should be undertaken such that all species can be looked at simultaneously with up-to-date information and techniques, including predator-prey relationships.

CALFED Bay-Delta Program, 2004 page 12 states: "for example, models to assess the impact of pumping on salmon migration survival are overly simplistic and lack a biological basis." Further on, page 14: "The panel is convinced that whatever modelling is done must formally take account of the inherent stochastic variability of the forcing variables and responses of the system, explicit probability distribution functions of water needs based on Monte Carlo – generate sequences of hydrologic conditions with specified statistics". I concur with the Panel.

NOAA Fisheries is fully aware of the limitations mentioned in the paragraphs above, but it went ahead with using the models because they were the best (only ones) available, and also because it hoped that it could use the results for comparing the expected direction of the effects of various actions. This could work in a stationary environment where future climate, ecosystems, species composition, water quality, habitat availability and suitability, etc. could reasonably be expected to be similar to those observed in the past; this is unlikely to be the case here.

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

The discussion on modelling of section V.A.1., *Information Available for the Assessment*, describes adequately the assumptions used in modelling while section V.A.2, *Assumptions Underlying this Assessment*, of the Biological Opinion discusses those that are not associated with modelling.

Several basic assumptions, such as those used in the modelling, those related to habitat availability and suitability, as well as those related to diversion and entrainment are clearly stated. However, one of the main assumptions, that past weather observations are indicative of the future, is neither clearly stated nor reasonable. There is ample evidence that the earth's climate is changing, whether due to natural fluctuations or to human actions is beside the point, and this is likely to have an influence in the system under review within the time span of the project under evaluation. There seems to be a consensus that global climate change will be unfavourable for the area and species under review. For example, Wood et al. (page 1) states that "snow accumulation and melt patterns are sensitive to small shifts in temperature, and many previous studies indicate that the global warming effects on the seasonality of runoff in such regions will likely transfer a portion of summer melt runoff to earlier in the year. The consequences of this shift for managed water resources may be severe in places because in many western basins, snowpack represents significant water storage that helps to augment low streamflows in summer, when a relatively small proportion of annual precipitation falls."

On page 92, paragraph 2: NOAA Fisheries assumes that pumping rates are positively correlated with fish salvage rates. The Biological Opinion recognises that these

assumptions may be true for some species such as steelhead and fall-run winter Chinook salmon, but not for others where the opposite can be expected to be true, i.e. higher pumping rates cause higher mortality rather than higher survival. The modelling does not seem to take this into account.

Although most assumptions can be said to have been clearly stated, their expected effect is not re-stated at the time of analysing results and drawing conclusions. This, in fact, may give more weight to the results than they deserve, and consequently to the conclusions. Conclusions should therefore be presented in the context of the assumptions used to derive them. It is not sufficient to state the assumptions early in the development of the argument and then forget them at the end. In this context, section V.A.2 *Assumptions Underlying this Assessment* does not mention that habitat unavailability is one of the main reasons why the salmonids under consideration are in danger in the first place. It could have been useful to mention here as well as in Section III. The requirement to state the assumptions can be said to have been met, but if the intent of the requirement was to put the results in proper perspective that has not been achieved because the assumptions and caveats are not re-stated at the time of drawing the conclusions.

On page 104, paragraph 2 the Biological Opinion states "…NOAA fisheries expects the juvenile steelhead in Clear Creek can tolerate otherwise marginal water temperatures during the summer and proceed with their migration." This is a case where data, information, or other substantiation of the statement would have been useful. Similar statement on page 108, last paragraph "Since the winter-run Chinook salmon population has been steadily increasing, despite an average 8 percent mortality under today's conditions, an incremental increase of 1-2 percent loss of eggs and fry on average is not expect to be significant to the population." Here again, an explanation / substantiation for the statement would be helpful e.g. because mortality at those stages is already quite high. If high mortality at the early life-history stages is there reason, it brings up the "salami" problem: each individual salami slice is not expected to greatly decrease the salami, but in the end, there is no salami left.

The underlying assumption of the particle tracking model is that listed juvenile salmonids migrating through the Delta will behave like passive particles. This assumption is highly unlikely to hold most of the time, and therefore the model is of limited use.

• 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 data, analyses, results, and conclusions presented do not lead to a thorough understanding of the risks to individuals and populations from the proposed project. This is both a consequence of the paucity of information used and because of the way the information is presented in a protracted and bureaucratic way. Given the amount of material presented, it is difficult to locate the elements, or points, that are most important and relevant. It would not be a small undertaking to prepare the Biological Opinion under an alternate format, or with an informative executive summary, but I am sure it can be done and it could be a considerable improvement.

There is no hierarchical organisation of the information; all the factors are listed whether they are major or minor. It would be preferable to present the information in a hierarchical sequence with the most important given prominence and the less important ones less importance. In this respect, opening up historically accessible habitat and restricting the commercial fisheries could have more positive impacts than the measures discussed here.

• 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 are not capable of determining the significant of project impacts for ESA purposes, mostly because the data are insufficient to convincingly demonstrate the effects analytically. Some form of adaptive management (Failing et. al. 2004), where information is acquired and methodology developed as part of the management process would probably be a more fruitful avenue to follow than the current one.

• Were uncertainties considered in the opinion? 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 and related words are not common in the biological opinion. Predicted values from relationships were used, where a probabilistic framework should have been used. Past observations, even though they may not be representative of future ones, because of global climate change, show considerably more variations and cyclicity than predicted values from the models used. As indicated above, one of the main limitations of the biological opinion is related to NOT taking into account the high likelihood of future climate changes that are likely to have a negative impact on the species considered.

Interactions between the ESA-listed species and hatchery production of the same species have been mentioned and appropriately described. However, the interactions of hatchery production with ESA-listed species and different species have not been adequately covered. Uncertainties about the genetic impacts of the release of hatchery fishes may be relatively large and pernicious.

It is not clearly stated that the way that the models have been used probably compounds the uncertainties in the way that they build on one another. As indicated above, the effects of climate change are not clearly stated, yet it is likely that they will have considerable influence, e.g. Van Rheenen et al. 2004 state (page 257) "is evident that demand modification and system infrastructure improvements will be required to account for the volumetric and temporal shifts in flows predicted to occur with future climates in the Sacramento-San Joaquin River basins."

• 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?

I was not able to form a firm opinion on this question.

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

As indicated in the background section, I am not a salmon expert and therefore I am not thoroughly familiar with the literature. However, I have no doubt that some published or unpublished studies on ESA-listed fish species, similar species, ecological theory, and computer simulations/modelling were missed, but I have not noted any glaring omission.

• 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 find much convincing evidence on how fecundity, growth and migration would change in response to the proposed actions for individuals or for the species as a whole.

Conclusion and Recommendations

The 2003-2004 review of the Environmental Water Account (CALFED Bay-Delta Program 2004) states (page 5) that the operation of the Interagency Ecological Program for the last 30 years has made the area under examination one of the most data-rich estuarine systems in the USA. From my perspective, the Biological Opinion and Biological Assessment do not reflect a data-rich situation particularly with respect to information on abundance and on factors affecting abundance of at-risk species. This suggests that there are data that have not been used, for reasons unknown to me, (possibly because models have not been developed to use them).

Whether considerable additional data is available or not, there appears to be a need to completely overhaul the modelling basis, particularly with respect to the biological components of the system, but also with respect to the time resolution of the hydrological model into an integrated model that would simultaneously cover all the species of concern, including predator prey relationships. There is no doubt sufficient expertise in the area, and it would be particularly important to involve non-agency stakeholders in the development and peer review of the modelling.

Recent legislation and programs (August 28, 2000 CALFED Record of Decision, the Environmental Water Account, the Southern Delta Improvement Program, the 1992 Central Valley Project Improvement Act, Ecosystem Restoration Program) were aimed at decreasing the threats faced by endangered or threatened species. Despite the good intentions of the existing legislation and programs, the proposed actions are predicted to have an overall negative effect. This may be another example of loosing sight of the original objectives at the implementation stage.

Recent initiatives may hold promises to improve implementation. The *Salmon Decision Process* used water from the *Environmental Water Account* to protect juvenile spring-run Chinook salmon in the Delta and adult steelhead spawning in the American river (Biological Opinion, page 29, paragraph 2) and later adapted to protect juvenile steelhead and young-of-the-year spring run Chinook salmon. Such adaptive management may be the most efficient way of rebuilding of ESA listed resources. However, it is important that this process include appropriate monitoring and research in an integrated plan that is submitted to periodic reviews and adjustments. The 2004 Technical Review of the EWA suggests that coordinated multi-agency decision making process can greatly improve the efficiency of the actions from the two perspectives of increasing the protection to fishes and minimising the impact on other users of the water. With time, it can also be expected that the "culture" of each agency may be changed and that implementation of the program would lead to greater cooperation between agencies and stakeholders.

Failing et al. 2004 describe "a structured decision-making framework utilizing the probabilistic judgments of experts, a decision tree, and a Monte Carlo simulation" to gather insight into an experimental flow release program. The approach treats adaptive management as a policy alternative within a broader decision problem, and it demonstrates the utility of combining expert judgment processes and stakeholder values with adaptive management to improve the likelihood that proposed experimental approaches will deliver net value to society" (page 1). Such a process to arrive at a decision may avoid the "false belief that there is only one answer" (Thabault 2005, page 57) and could usefully be implemented here.

Appendix 1 – Bibliography of material reviewed

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Appendix 2 – Statement of work

Statement of Work

Consulting agreement between the University of Miami and Dr. Jean-Jacques Maguire

December 9, 2005

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 2004 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). The review will focus on the technical aspects of the NMFS biological opinion and the information provided in the OCAP biological assessment (BA). The review is not to determine if NMFS' conclusions regarding the projects potential to jeopardize the continued existence of listed Central Valley salmonids are correct.

The charge to the CIE reviewers is to evaluate and comment on the technical information, models, analyses, results and assumptions that formed the basis for the assessment in the BO of the proposed long-term water operations for the projects described. The reviewers should additional consider pertinent background information, such as previous NMFS biological opinions that pertain to Central Valley Project water operations (*i.e.*, 1993 Winter-run Chinook salmon opinion and the 2000 Trinity River Restoration opinion) 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.

Fundamental questions for the CIE reviewers

- Are the technical tools used in the NMFS OCAP biological opinion (*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 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 opinion? 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' demographies?

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 biological opinion (*i.e.* did the biological opinion apply the available information in a scientifically sound manner?), but not whether or not project operations need to be reinitiated under the ESA.

Notice of an Additional OCAP Technical Review and Relation of CIE Review to It

The OCAP has also been requested to provide an independent review of the BA and BO. They have taken on that request and held a public workshop Oct 12-13 in Davis, California to provide background and testimony about relevant scientific aspects of the OCAP. The terms of reference for their reviewers are similar to those given above.

Although based upon the same information, the CIE reviews will be independent of the OCAP review. The CIE reviewers will provide comments to NMFS through the CIE.

General Requirements

The CIE shall provide three independent scientists for this review. Expertise is required in hydrology and watershed ecology, salmonid biology and ecology, and fish stock assessment. No consensus opinion among the CIE reviewers is sought.

The activities required under this Statement of Work shall be conducted electronically, so no travel is needed.

CIE reviewers shall access the following two documents containing information related to the questions listed above. These are:

1. Long-term Central Valley Project and State Water Project Operations Criteria and Plan – Biological Assessment, including appendices. US Bureau of Reclamation. June 30, 2004.

2. Biological Opinion on the long-term Central Valley Project and State Water Project Operations Criteria and Plan. National Marine Fisheries Service. October 2004.

These documents and other background material (or links to them) have been posted on the CALFED website (http://science.calwater.ca.gov/workshop/workshop_ocap.shtml).

Background information on the ESA and NMFS's 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.

Specific Requirements

Each 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. Each reviewer may conduct their analyses and writing duties from their primary location. Each written report is to be based on the individual reviewer's findings, and no consensus report shall be accepted.

The itemized tasks of each reviewer consist of the following.

1. Read the two documents listed above, which provide the primary material to be considered in the review.

2. Consider additional scientific information as may be necessary.

3. No later than December 19, 2005[1], submit a written report[2] that addresses the fundamental questions listed above. See Annex I for additional details on the report outline. Each report shall be sent to Dr. David Die, via email at ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani, via email at mshivlani@rsmas.miami.edu.

[1] In a December 9, 2005 e-mail, CIE did not "*anticipate it being a problem submitting [the] report on or around January 6th*".
[2] Each written report will undergo an internal CIE review before it is considered final.

ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report shall be prefaced with an executive summary of comments and/or recommendations.

2. The main body of the report shall consist of a background, description of review activities, summary of analyses and comments, and conclusions/recommendations.

3. The report shall also include as separate appendices the bibliography of materials reviewed and a copy of the statement of work.