Center for Independent Experts (CIE) Review of the Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and steelhead trout.

Mike Bradford
Vancouver BC
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Executive Summary

The draft Recovery Plan for Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley steelhead was reviewed. In general, the plan was well organized and straightforward to understand. The reviews of the biology of the three species were well-conceived.

My major suggestions for the revision of the plan are as follows:

1. To the extent possible, provide quantitative analyses of trends in population size, diversity, productivity, harvest, survival rates etc. to support the descriptions of endangerment and threats.
2. Greater emphasis needs to be placed on the role of trends and cycles in the ocean environment in contributing to past trends in the populations, as well as their effects on future abundances (and persistence).
3. The use of a quantitative model is suggested to explicitly link stage-specific survival rates and their effects on overall abundance to habitat restoration activities.
4. A distinction needs to be drawn those threats (and consequent recovery actions) for which there is evidence or data, and those that are potential risks but for which evidence for the species in question is lacking. An example relates to the genetic threats from hatchery intervention—are there data for these threats in the Central Valley?
5. The results of the prioritization of threats and recovery actions in the Appendices can be better captured in the Plan. Detailed description of individual threats and actions should be replaced with a broader-based threat category and actions, preferably the result of the quantitative analysis described earlier.
6. Consideration needs to be given to focusing monitoring and adaptive management activities to demonstration watersheds or regions, rather than the whole basin.
7. A probabilistic or risk-based approach is suggested for the development of recovery goals, and for consideration of the effects of recovery actions on these populations. Nothing is certain in our attempts to manage populations, especially for a highly migratory species that depends on many habitats that are changing in the face of human activities and global warming.

The Review

The primary documents used in this review are the Recovery Plan (Review Draft, dated October 2008) for the 3 species and Appendices A-C and their attachments. Additional materials that were used are cited below. The review was a desk-based project and lasted 7 days.

General Comments

The Recovery Plan and Appendices for Central Valley winter and spring-run chinook salmon and steelhead provide a general overview of each species and identify causes for declines and measures to recover these species. The authors are faced with the difficult task of providing adequate detail so that the directions taken as the result of implementation of the Plan are sufficiently supported by data and analysis, while developing a document that is not overwhelming in its volume. For the most part, the plan is well written. Most of the comments that I have are aimed at strengthening the arguments for the threats analysis and recovery

Caughley (1994) described two paradigms for conservation biology that are both represented in the current Plan. The first, called the “small population paradigm”, focuses on the viability of small populations, considering genetic and demographic effects, risk of catastrophic events. etc. The concept of minimum viable population (MVP) size and some aspects of the Viable Salmon Population (VSP) approach reflect this paradigm, as does the development of numerical recovery targets, usually in terms of the number of reproducing adults. Caughley’s second paradigm was termed the “declining population paradigm”, and the focus of this approach was the analysis of the causes of decline, which is often habitat alteration. Recovery activities are organized on the basis of habitat restoration, rather than the focus on adult abundances.

The California Salmon Plan is a blend of both approaches, as is often the case in modern recovery plans. At this stage the actual numerical recovery targets are not identified, but it is unlikely that this will have much influence on recovery actions, at least in the short term. However, harvest rates are often tied to abundances, which may require the definition of numerical recovery goals if harvest restrictions are being imposed as a recovery action.

The two paradigms also enter in the approach taken to recovery. The plan focuses on an ecosystem-based approach to freshwater habitat restoration, which is a broad-based way to deal with the freshwater threats (and is consistent with the declining population paradigm). However, such an approach will be expensive and can be disruptive to other activities. The alternative approach is based more on the small-population paradigm and is more focused on activities that are focused on salmon survival so that populations can reach their recovery goals. Throughout this review I have suggested that there should be more emphasis on relating recovery actions directly to stage-specific survival rates to allow for a more quantitative approach to recovery planning. Consequently, many of my comments on the Plan revolve around the use of more quantitative analysis, both for the analysis of declines and the assessment and prioritization of recovery actions. At the moment a long list of threats is supplied, as is a long list of recovery activities, but it is difficult to determine from the Plan what actions are most likely to lead to recovery.

Finally, I think it is important to more explicitly recognize the role of uncertainty in recovery. Uncertainty can result from an incomplete understanding of the biology of the species and the effects of recovery actions on the populations. Uncertainty about recovery is also the result of the effects of unpredictable future events on the target populations. Climate change, weather patterns, oceanography, changes in human activities, chance events, and catastrophes will all affect population trajectories. The genetic effects of inbreeding or hatcheries are also difficult to predict. The authors should consider altering the language in the report to reflect the significant role of uncertainty in affecting the outcome of recovery actions. For example, recovery actions can "increase the likelihood of recovery" or "reduce the risk of extinction", thus emphasizing our ability to predict what will happen is really quite limited.

Responses for Questions in the SOW

Does the plan meet the minimum standards described in section 4(f)(1)(b) of the ESA by providing site-specific management actions, objective measurable criteria and estimates of time and cost?

The plan does not provide adequate measurable criteria for the recovery of populations at this stage, and this deficiency in noted on page 73. Some fairly generic standards and commonly used metrics are given in table 6 and 7, but I would not consider these to be sufficient. A recovery objective should be phrased as 'the probability (or as % of years) that population metric x will exceed criteria y in the next z years will be greater than p'. In a metapopulation, an additional dimension will be the specification of the fraction of the populations that will satisfy the previous inequality during the time frame. Adding the uncertainty recognizes that populations are usually highly variable and can fall below fixed recovery criteria even when they are not at risk.

Appendix B provides site-specific habitat restoration activities, and Appendix C provides typical costs on a project-by-project basis. Though management of fisheries and non-target harvest can be an important management action whose effects can dwarf individual habitat restoration projects, it only receives a line in the Appendix and little detail. The incremental costs of such actions are not considered in Appendix C. Similarly, the costs of alternative scenarios for hatchery production are also not considered.

Measurable, objective, criteria for the habitat restoration activities listed in Appendix B are generally lacking, although in many cases these are difficult to define. Standards for some habitat variables are available and could be used as criteria for success of some of the restoration activities.

The recovery plan does not attempt to integrate the goals, actions and costs into an overall "price tag" for recovery. Integration is slated to be included in a subsequent draft of the Plan (p. 97).

Does the plan delineate these aspects of the biology that are pertinent to its endangerment and recovery?

Winter-run chinook salmon

The biology of the species is explained well in the Plan and the Appendix. The comments below are based on a review of Appendix A.

In general, endangerment of salmon stocks is usually the result of a combination of 3 or 4 factors: alterations in freshwater habitats that reduce the productivity in this life stage (as smolts/spawner, for example), downward trends in ocean survival, and harvest rates that are excessive in light of the first two factors. The fourth factor that is not well-quantified consists of the genetic effects of either hatchery manipulations or inbreeding.

Recovery will then be most effective when the significance of each of these factors on the overall status of the population. A simple formulation that identifies the problem is to think of recovery (to larger population levels, ignoring diversity for the moment) is feasible when the inequality α MS (1-h) > 1 is satisfied, where α is the freshwater production rate (i.e., smolts/spawner), MS is the ocean survival rate, and h is the harvest rate, assuming that ocean mortality and harvest are independent of each other.

While all the necessary data for quantifying the significance of each life stage on population status are not likely available, I would like to have seen a greater attempt at a quantitative analysis of the data that are available, including some modeling of scenarios to help inform the threats analysis. Figure 2-2 provides an indication of a recent increase in productivity- this figure could be extended back in time (if the spawner data quality is sufficient). A more detailed analysis or discussion of the trends in Figure 2-2 would be useful, including a timeline of the changes in regulations or habitat conditions to help separate cause and coincidence.

A simple life-stage model based on Figure 2-4 and available information for this population as well as other populations would also be useful for analyzing threats and recovery actions.

2.2.2 Spawning

Are there estimates of the area of good spawning habitat such that it would allow the reader to have a sense of whether the habitat that is currently accessible is limiting or affecting survival? Is the decline from previous, much higher level of abundance (Figure 2-3) due to crowding on spawning beds? What is the state of the spawning beds, and are flows from the dam sufficient to remove fines, without the degradation of the channel that is often observed below dams? The comments on page 2-13 are not detailed enough to understand the impacts of the dam on the spawning areas.

2.3.1.2 Harvest

A time series of harvest rates or catches would be useful. It is not clear whether the CVI harvest index is the actual harvest rate. The statement that overutilization was not a significant factor in declines needs to be supported in analysis. Overharvest under conditions of poor marine survival has been shown to be a major contributor to population declines (Bradford and Irvine 2000). An example of the analysis of the role of harvest on population recovery is found in Pestes et al. 2008.

2.3.1.3 Disease

It is unclear if disease monitoring is ongoing for this population. Certainly the situation in the Klamath, Fraser and Yukon Rivers suggests the potential for increased disease outbreaks in warm water conditions is a threat for the future.

2.3.2 Hatcheries

The table of releases should be supplemented with information on catch, escapement and survival, if possible. The trend in hatchery survival from CWT data can be used as a surrogate for trends in wild survival, although hatchery survival is usually lower. CWT returns also provide useful information on coastal ocean distribution and exploitation patterns.

As described, the current hatchery program seems to represent best practice for a conservation hatchery. Though this section has a focus on threats, it is worth noting that the main benefit of the hatchery program is to provide insurance against a catastrophic loss of a brood due to something like a flood. These benefits have to be weighed against the potential genetic impacts described in the report. I assume that the Lindley (2007) suggestion of no more that a 5% hatchery contribution is a somewhat arbitrary value, and that the risks of exceeding this value are unknown. Are the risks based on the influence of hatchery activities inferred from other regions, or are they based on data from the CV?

2.3.4.1

Figure 2-5 could be cleaned up to remove some of the “logger out of water” occurrences that seem to be in the data.

2.3.5.2

Predation—simple life table calculations (i.e., Bradford 1995) suggest an 80% or higher mortality in the year-long fry-to–smolt stage is expected in wild chinook populations. While fish are an obvious predator, birds and mammals may also be significant.

Page 2-39

The impacts of hatchery releases seem speculative. It is not clear whether rearing habitat would be limited in an endangered population, or if the hatchery-wild interactions would occur for chinook in a large (and I assume turbid) river environment.

2.3.7.4 (Page 2-51)

Are there stomach content data that confirms predation by steelhead on wild salmon? This should be straightforward to obtain. The report is not clear whether this is speculation or observation.

Similarly, is the so-called “pied-piper” effect documented with evidence in the Sacramento, or in other systems? If not, it should be noted as speculation.

2.3.8.1 Harvest (in the ocean)

The relation between CVI and “fishery impact rate” and actual harvest or exploitation rates is unclear. Can this be explained? Was the hooking mortality of 14% estimated by PFMC, or was it an assumed value? Converting this to a total mortality rate requires encounter rate information.

In general, the harvest section is unclear. There should be a description of the fisheries that catch salmon, the gear types used, including incidental catches from groundfish or other fisheries. Based on effort and encounter rates, the previously mentioned hooking mortalities can be scaled up to estimate total mortality. Then the various indices and data sources need to be synthesized to provide a time series (if possible) or a narrative of the mortality of adults that is attributed to direct or indirect impacts of fishing. The logic that a 54% fishery mortality was deemed acceptable for a stock that was near its nadir seems surprising.

Figure 2-6 seems to be modified version of 2 earlier plots of spawner abundance. It does not appear to be cited in the text.

2.3.8.2 Ocean Conditions

Is there any evidence that the productivity of winter-run chinook co-varies with any of the ocean indices mentioned in the text? Based on the time series of spawners, some harvest information and age data, it should be possible to create a longer time series of replacement rates that would be at least partially representative of ocean conditions (like figure 2-2). Experience elsewhere has shown that different populations of chinook salmon can react quite differently to ocean conditions that presumably are due to differences in time and size at ocean entry and estuary and coastal habitat use. If the linkage between winter-run ocean survival and specific ocean conditions is unknown, that should be stated.

2.4.1.3 Life stage ranking.

The weighting scheme is a little unusual, as normally something like elasticities based on an age-structured model would be used to ask how much population productivity would be affected by an x% change in survival of a given life stage. The challenge is then to determine the relation between a stressor and the stage-specific survival rate. The caveats described on page 2-58 are appropriate.

Central Valley Spring Run Chinook Salmon

3.1.4

As in the case of the winter run population, the data in Figure 3-1, 3-2 could be converted to productivity estimates if the age structure is known and there is confidence in the consistency of the data. Productivity estimates can be augmented with return rates from CWT releases from the hatchery, if possible.

3.3.1.2

For the reader not familiar with the CVI, it would be useful to explicitly relate this to harvest or exploitation rate. As harvest can have a significant effect on abundance, especially when ocean productivity is low, time series of catches, harvest rates and more details of the fisheries that catch these populations is needed.

3.3.1.3 Disease and predation

My comments for winter-run equally apply here.

3.3.2.2 Small population sizes and three populations

While the present situation of having the stock largely restricted to three streams (and with relatively low numbers) is obviously less than ideal, the report repeatedly makes reference to the potential for a regional catastrophe. These considerations apply to any population that is restricted to a watershed or single region; this is especially the case for salmon in a large river where the whole population must migrate through a single mainstem twice during its life cycle. An example is the 1913 landslide in the Fraser River that resulted from railway construction and greatly reduced all of the sockeye salmon runs to headwater areas. This type of risk is almost independent of population size or distribution within the headwaters. It should also be noted that the impact of a catastrophic event would have to extend over 3-5 years, and it is assumed that the population would be unable to adapt to the change in conditions that had occurred.

3.3.11.2 Ocean conditions

While interesting, it is also known that response of chinook salmon populations to environmental conditions is highly variable as populations vary with respect to size and time of ocean entry as well as ocean migration routes. As was the case with winter-run, it would be useful to establish whether variation in spring-run chinook productivity is related to the ocean indices mentioned in this section.

Steelhead

In general, the steelhead section of Appendix A could use some editing to tighten the text. Although it is noted that data on these populations are few, there is nonetheless a need for more specific information in many sections. There needs to be a clear distinction between inferences made from data, and ones that are more speculative.

4.1.3.1

The description of life history is relatively superficial and seems to rely on Moyle (2002). I would prefer to see some specific data for the CV populations (age structure, size, timing), as well as an indication of any information on population dynamics-smolts/female, ocean survival rates, etc. Also, the section goes around the life cycle more than once as it starts with migrating adults and ends with fry. T he latter 2 paragraphs should be incorporated into the first few.

The relation between rainbow trout and steelhead should be mentioned here, at least in terms of demographic and genetic interactions.

Fisheries and hatcheries are not mentioned. The evidence for links between ocean indices and steelhead survival needs to be provided.

4.1.4.1

A few words on how these data were assembled would be useful.

4.1.4.2

This section should describe the "current" status of the DU <u>throughout</u> the basin. Material from 4.1.3.2 needs to be brought down, and a map would be helpful. As well as range, any indication of the numbers of spawners in specific streams would be helpful, if available.

4.1.4.3

"BRT" and the voting is not explained. What do the numbers in parentheses mean?

4.2.1.2

Are these “suitable” or “optimal” water temperatures?

4.2.3.1 and 4.2.3.2

Both sections contain the same material. There is a wealth of information on the relationship between fine sediments and egg and embryo survival that could be exploited to expand the last sentence in 4.2.3.2.

4.2.4.1

If the intent of these sections is “geographic and temporal distribution” then this section should describe the extent and type of habitats juveniles occupy after emergence from spawning areas—natal areas, downstream habitats, off-channel areas, mainstems, lakes, etc. The temporal aspects describe when transitions among habitat types occur.

4.2.4.2 (Missing section number)

Are there any CV-specific studies of habitat use? Is the winter habitat needed in Idaho appropriate for the CV?

4.2.5.2

Same paragraph is repeated from previous section.

4.2.6.1

An analysis of commercial catch records should provide information on habitat use at some life stages in the ocean, at least in the coastal area. It should be clarified if there are any studies of diet or habitat use for CV steelhead in the ocean as the references cited appear more generic.

4.3.1.1

While the habitat that is upstream is likely lost, a key question is whether the remaining habitat is of sufficient quality and quantity to support viable populations.

4.3.1.2

I assume there is bycatch in salmon and groundfish fisheries in the ocean and hooking mortality and unauthorized possession in freshwater- have these been quantified? If not, the rate should be stated as unknown.

4.3.1.3

Is there evidence that hatchery fish (in the wild) are less susceptible than wild fish? A citation is needed. There are already cases of increased incidence of disease as a result of warmer temperatures in other locations—this is a risk that should be identified.

The second sentence of this paragraph needs to be bolstered. Where is the evidence that "predation rates are an insignificant contributor to large declines…."? Most fish die of predation- the question is whether the rates have been increased because of human modifications of habitat or fauna.

4.3.4.2

The introduction suggests that the lower river is mainly used for migration yet it is unclear whether the subsequent paragraphs account for that—is the water quality impaired to the point that smolts will be affected--- are there data on specific contaminants? Do LWD and floodplain considerations impact migrating smolts? Are the hatchery-released smolts large enough to prey on wild smolts in the mainstem?

4.3.7.3

Many of the impacts listed here appear without supporting evidence- a greater distinction is needed those impacts that have been observed and documented and those that might occur or are conjectured to occur.

4.3.7.4

Previous sections have stated that the mainstem Sacramento River is not used as rearing habitat- while spawning below the dam will undoubtedly lead to a downstream distribution of juveniles, some evidence of how extensively the mainstem is used would be useful for this section.

I did not review the remainder of Appendix A for steelhead, but encourage the Agencies to carefully review these sections both from an editorial and content perspective.

Does the plan have a logical strategy to achieve recovery?

The structure, as outlined in Figure 1 of the SOW is certainly logical. It might be useful, for each of the three species, to have in the Plan a hierarchical table of the DPS, DGs and populations along with their current status and potential for recovery.

Breaking the life cycle in stages is useful to organize thinking about threats although having each stage repeated under each population or stream does lead to repetition in the documentation.

Is the recovery plan grounded in a clearly articulated and biologically meaningful conceptual framework?

For these species recovery to historical conditions is not possible because so much of the freshwater habitat has been occluded by water development projects. Consequently, the plan uses the VSP principles to establish recovery goals and objectives within the remaining useable habitat. These are reasonably and well articulated, at least in a qualitative manner.

The analysis of declines or the corresponding analysis of the efficacy of recovery actions does not rely on a quantitative model or analytical approach. Although many of the data to fully populate such are model are likely missing, it can serve as a device to encourage further thinking about the recovery actions most likely to lead to demonstrable change in the species status. Even simple life table calculations (fecundity, stage specific survival rates, leading to estimated numbers at each stage) are useful to project the numbers of fish that potentially need different habitat types as well as the role that changes in survival at each life stage will have on overall production. Bio-standards, such as redd areas, juvenile densities, smolts produced by km of stream, etc., are useful for rough estimates for estimating habitat requirements. This type of analysis can also form the basis for prioritizing recovery actions to ensure the most efficient use of resources, if increasing the number of salmon is the primary goal. I summarized data on the survival of chinook salmon some years ago (Bradford 1995), but there have been many datasets developed since then, especially in the Columbia Basin. Some data summaries from the Columbia are available in Gallinat and Ross (2007).

Questions Regarding Use and Application of the Technical Recovery Team Reports

The content from the Lindley reports are accurately reproduced in the Plan. As noted above, a table with historic and present day abundances, and the current status determination, by population or DPS would be useful as a summary.

The plan is not explicit about the difference between viability criteria and recovery criteria. Viability (p. 53) appears to be based on the VSP parameters of abundance, productivity, diversity and structure. Recovery criteria (p. 74; designed to result in delisting) utilize much the same ideas, with the important inclusion of threat reduction.

Noticeably absent from the recovery criteria were the “rules” for counting hatchery fish, especially those that spawn in the wild and their offspring, in any numerical targets that might be developed. Clarity about what fish are to be included is essential to avoid misunderstandings later on. Recovery plans sometimes also state the recovery is not achieved until the populations are viable without hatchery support; these criteria are important when conservation hatcheries are used to jumpstart diminished populations.

Questions Regarding the Recovery Strategy

Is there an explicit analysis of threats in terms of the five listing factors?

No. The five listing factors are analysed in Appendix A, but are not itemized in the Plan itself. The Plan contains a less-structured narrative of the factors thought to have contributed to the species current status.

Does the plan provide continuity between new threats and changes in threats identified in the listing rule?

No, since the plan does not list the threats from the listing rule. However, the plan does identify recent threats as well detail attempts to ameliorate threats so the narrative of threats appears to be up to date. A succinct table of the 5 listing factors and any recent changes to their status, by species, would be useful.

Does the plan contain a fair assessment and prioritization of stresses?

Appendix A contains a detailed listing of threats and impacts on freshwater habitats on a watershed-specific basis. Specifics are generally lacking, in terms of data or studies and some of them seem to be based on speculation as much as anything.

For species that are well below the capacity of their habitats, recovery is a function of the relationship between the threats and fish survival, and not the absolute amount of habitat. Those effects might be direct (i.e. predation or entrainment), or less direct (i.e., the effects of habitat on foraging conditions and its impact on the risk of predation during foraging; the effects of growth and condition on survival in subsequent stages; the role of migration rate on survival). The impact of a threat, or an action to abate it, will then depend on two factors: the relation between a change in habitat condition and a change in the survival of individuals, and the proportion of the population that is positively affected by a threat abatement activity. The changes in stage-specific survival also need to be considered in the context of the number of adults that are likely to result from the recovery action.

Whether or not a formal analysis such as the Shiraz model (Shuerell et al. 2006), a simpler age-stage model, or just the calculation of the intrinsic rate of growth, I feel there is a benefit to thinking about stresses in terms of adult returns, as well as the effect on habitats. Although all of the changes in freshwater habitats are described in the Plan, there may be merit in creating a timeline for the major changes in freshwater, and comparing that to the time series in productivity or Recruits/Spawner ratios. This can be useful for identifying large-scale linkages between land use, water development and salmon productivity. The reviews by Yoshiyama et al. provide examples.

Although Appendix A contains the results of the stressor prioritization analysis, the key points from this analysis are not well represented in the text of the Plan itself. For example, in the Executive Summary "three of the more important stressors" are listed as harvest, striped bass, and water supply in the Delta. I would expect these to be elaborated as listed in the Plan text, but there is no ranking of threats (e.g., p. 37). Similarly the threats in the Recovery Goals chapter and the remedial actions in the "Recovery Actions" are presented as long lists without particular priority. I believe the Plan could be strengthened if quantitative analyses would allow actions that are most likely to have the most immediate and largest benefits were identified.

If the species met the recovery criteria does it seem feasible that this species would likely persist for the foreseeable future?

"Recovery criteria" are not clearly outlined in the Plan. On page 72 "Population objectives" are outlined. Most of the objectives are broad and qualitative (although reasonable). A single quantitative benchmark is noted – that a population with non-negative growth and a size equivalent to historical abundance would have the highest rating ("historical" needs to be defined here, given that in many cases a great deal of the historical habitat is not longer available for use).

The "Recovery Criteria" section (p. 73) notes that measurable criteria cannot be provided at this time. It does outline criteria that are used to categorize populations with respect to risk (i.e., Table 6; methods in Table 7). However, the criteria used to determine whether a population should be delisted are likely different than those in Table 6. Some of the differences include the metapopulation issues (establishment of new, viable populations) and the reduction or elimination of threats to recovery or sustainability. Unfortunately, the threats abatement criteria section is too vague to answer the question posed above. This is understandable because it is very difficult to link habitat-based recovery actions that often occur at local scales to population-level responses in terms of abundance or survival rates. As noted above, a more quantitative approach or framework that addresses the link between life-stage survival and habitat conditions would be useful for addressing threats.

Many salmon populations south of Alaska are experiencing large fluctuations in abundance as a result of changing ocean conditions, both cyclical and long-term, and other impacts that are likely associated with climate change including disease, competitive interactions with invasive species, and energetic stress associated with changing discharge and thermal regimes in freshwater. In this type of environment, it might be more appropriate to ask 'if the recovery criteria are met do these populations have a greater likelihood of persisting into the future given the potential for unforeseen or unpredictable future events?' There are many salmon populations that have relatively productive freshwater habitats in the Pacific Northwest that are currently unable to sustain themselves because ocean conditions (survival and fishing) and adverse conditions during adult migration prevent the populations from replacing themselves. Longevity in these populations occurs because they are relatively abundant and can withstand multiple generations of poor productivity. The availability of productive freshwater habitats (good smolt/spawner rations) enables these populations to quickly recover if and when the factors causing decline are relaxed.

Thus the persistence of salmon populations depends not only on abundance, but also productivity. Long-term variation in productivity is difficult to predict, however, and factors such as the average, variation, and autocorrelation in productivity are important. Resilience is also enhanced by variation in age structure and spatial population structure.

Do the recovery strategy and criteria adequately consider large-scale environmental perturbations such as climate change and ocean variability?

No. The potential role of these factors in dominating population trajectories and swamping recovery efforts aimed at improving freshwater habitats is not well articulated. Some of this can be addressed through cross-correlative studies on productivity patterns among populations both within the Central Valley, and between the CV and other regions. See recent work by Peterman and others on integrating oceanographic effects over large numbers of salmon populations. Data on catch rates in commercial troll fisheries might be useful for indexing ocean abundance and brood survival, as will analyses of CWT data.

Bradford (1995) provides estimates of the distribution of total egg-adult mortality between freshwater and estuary/ocean habitats and shows that about half of the total mortality can be attributed to the marine stage. For a number of species, the number of seaward smolts/spawner is relatively well defined so that the ocean survival rates that will lead to increasing or decreasing total population size can be estimated. Ultimately, it is the ocean survival rates that dictate persistence in salmon populations.

In general, interannual variation in marine survival will be inversely related to the size of the seaward migrants. Ocean-type chinook salmon, with the smallest migrants often experience very significant fluctuations in abundance, which is evidenced in the time series for the winter-run. Such variability highlights the need to put recovery targets and efforts in a more probabilistic or risk-based format.

Are the links between human activities, effects on habitat and effects on fish clearly described?

The occlusion of habitat through dam construction and other large-scale activities is clearly described and the impacts are readily apparent. For the other habitat impacts, the effects can be very subtle and incremental. Part of the challenge for some of these species is determining the relative significance of each habitat (natal tributary stream, mainstem river, non-natal tributary, estuary, flood bypass etc.) on brood productivity.

In the case of spawning habitat, the threats and responses are more easily quantified. The amount of spawning habitat can be estimated based on recovery goals, and temperature, flow, and gravel quality can be assessed and readily optimized if required. Data on deficiencies in existing spawning habitat were not presented so it is difficult to determine if the recovery actions proposed for this habitat type will affect recovery.

The impacts of degraded habitats for juveniles on productivity are difficult to determine at the population level if the relative contribution of those habitats cannot be identified. This is a challenging task and could involve monitoring of downstream movements, genetic and chemical analyses of juveniles to determine stock of origin, and recent and past habitat use. Ultimately the analysis of adult returns (PIT tags, genetic markers, geochemical markers) is needed to determining the relative importance of different habitats. It also may be useful to think of the amount of habitat that was and is available for the historically much larger populations. Often, in the case of reduced populations, the focus is on habitat quality (i.e., the potential for growth and survival in those habitats) rather than habitat quantity (the amount of space available for some number of juveniles). Unfortunately this is often challenging for chinook salmon because of their plastic life history that is often conditional on the distribution and quality of rearing environments.

Determining habitat requirements may be more straightforward for steelhead. Although data are fewer, it should be possible to develop estimates of the amount of properly functioning habitat to produce the smolts needed for viable populations. The key question is whether there is enough habitat remaining below dams to generate the necessary number of smolts in sufficient streams.

Does the recovery plan have a logical framework for prioritizing recovery efforts at multiple spatial scales?

The Plan uses a qualitative approach (with a scoring scheme) to rank threats, and by inverse, rank recovery actions. This is used to identify the most significant factors thought to have contributed to the current status of the populations and the recovery actions that can address these threats.

Unfortunately the Plan itself only contains a list of “general recovery actions” (p. 85) that does not reflect the results of a framework operating at multiple spatial scales. A more detailed inventory of recovery actions is contained in Appendix B, but this is less of a framework than a detailed listing.

I would prefer to see a more evidence-based approach to the identification of threats and the likelihood that specific recovery actions will lead to measurable response of these populations. A population-based approach would use the species life cycle as a starting point, and would naturally start at broad spatial scales (spawning, rearing, migration, juvenile ocean habitat, etc.). Recovery actions (broadly identified) can then be identified for each species/habitat combination. A critical component of this stage is a quantification (to the extent possible) of the change in stage-specific survival that will arise as a result of implementation of the broadly identified recovery action. Individual projects (i.e., Appendix B) can follow under the broad categories. For each broad class of threat and recovery action, the actual evidence supporting the significance of the threat should be given, whether it be a direct study, information inferred from studies in similar ecosystems elsewhere, or resulting from ecological principles or speculation. While these broad stressor categories are itemized in Appendix A (i.e., p. 2-59), there is not a similar treatment of recovery actions in the Plan.

Do the proposed recovery actions link logically to the threats identified in the threats assessment?

The "recovery actions" listed on pages 85-88 of the Plan are not linked to the threats. Appendix B has 169 pages of actions, but they are not organized in a way that can be readily distilled. As noted earlier, the actions would be easier to assess if they were structured hierarchically such that the projects (individual actions) are grouped into major categories and an assessment made of the likelihood that the action will have a significant impact on stage-specific survival or productivity (i.e., to lead to population recovery).

Does the plan have a well-defined methodology for adaptive management?

None of the citations in this section of the Plan are contained in the "Literature Cited".

The plan clearly indicates the shortcomings in the monitoring of adult abundance. There is little mention of ocean catch statistics, or the use of genetic stock identification for ocean and river catches. Genetic techniques are also valuable for understanding population-specific migration and habitat use of juveniles without the use of large-scale marking programs.

The material on the desirable elements of a monitoring program is useful, but perhaps too detailed for the Plan. It is important to note that monitoring habitat alterations in terms of fish response is extremely challenging and often requires alternative analytical approaches to the simple hypothesis test proposed in this section. Much has been written on monitoring habitat restoration in recent years.

It has been my experience that Agencies usually underestimate the degree of program support (coordination, contract management, data management, data analysis, synthesis) required to run a long-term Adaptive Management experiment. The plan could benefit from a proposed structure for managing the AM plan, including reporting timelines, performance measures and feedback mechanisms.

There may also be merit in concentrating the "research quality" monitoring into a single watershed to achieve some efficiencies and to maximize the likelihood of having some early successes, given the widespread and extensive nature of the full CV program.

Given the large geographic area, and the many stakeholders and agencies involved, it is likely too much to attempt to implement a true adaptive monitoring program in the whole basin

Does the monitoring plan allow for progress towards recovery goals, and on ongoing evaluation of the recovery strategy?

Currently, quantitative recovery goals are not specified in the report, but they will likely entail reaching or exceeding some number of spawners. The recovery plan identifies the need for a robust monitoring program for adults which will allow evaluation of abundance goals.

To evaluate progress towards recovery goals and to evaluate a recovery program based largely on freshwater habitat restoration, some careful thought will be needed in developing evaluation protocols and the mechanisms that will be needed to make corrections to recovery action plans. Unfortunately, adult returns are a very inefficient way to monitor freshwater recovery actions as there is a long delay and significant variation in survival that occurs subsequent to the freshwater period (see Bradford et al. 2005 and references therein). Other measures, including indices of habitat function, juvenile abundance, habitat use and fish health and behaviour can be used. Work in the Columbia Basin provides useful examples and analysis (see http://www.cbfwa.org/csmep/web/documents/Documents.cfm?IssueID=38&doctype=Workgroup).

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Attachment A: Statement of Work for Dr. Michael Bradford

External Independent Peer Review by the Center for Independent Experts

Assessment of the Draft Central Valley Domain Recovery Plan for the Sacramento River Winter-Run and Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Units and Central Valley Steelhead Distinct Population Segment

Introduction

The purpose of this independent review is to evaluate and comment on the Draft Recovery Plan for the Sacramento River Winter-Run and Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Units (ESUs) and Central Valley Steelhead Distinct Population Segment (DPS). The scope of work should focus on the principal elements required in a recovery plan. These principal elements have been defined in section 4(f)(1) of the federal Endangered Species Act (ESA) and sections 1.1 and 1.2 of the National Marine Fisheries Service Interim Recovery Planning Guidance (NMFS 2006)

Section 4(f)(1)(b) of ESA states that "each plan must include, to the maximum extent practicable,

- a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
- objective, measurable criteria which, when met, would result in a determination…that the species be removed from the list; and,
- estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal."

From section 1.1, a recovery plan should:

- "Delineate those aspects of the species' biology, life history, and threats that are pertinent to its endangerment and recovery;
- Outline and justify a strategy to achieve recovery;
- Identify the actions necessary to achieve recovery of the species; and
- Identify goals and criteria by which to measure the species' achievement of recovery."

Background

There are 10 Evolutionarily Significant Units/Distinct Population Segments (ESUs/DPSs) of salmon and steelhead in California listed as Federally endangered or threatened under the ESA. They are organized into four geographic recovery domains. Each recovery domain contains one or more salmon and steelhead ESU/DPS, and (1) a Science Center led Technical Recovery Team responsible for developing historical population structure and population viability goals for the recovery plan, and identifying research and monitoring needs; and (2) a recovery coordinator responsible for facilitating the development of a recovery plan for the domain.

The Sacramento River winter-run and Central Valley spring-run Chinook salmon ESUs and the Central Valley steelhead DPS are located within California's Central Valley Recovery Domain. One multi-species plan for this domain is being developed for these three salmonid species. The final plan will be a multi-species recovery plan that will be a compendium of data and information that can be utilized on a watershed basis where species ranges overlap. The rationale for developing a multi-species recovery plan is that, although some research suggests that multi-species plans may lack the species specific information needed for delisting, in California's Central Valley, water management operations and habitat restoration efforts must be responsive to multiple species' requirements that over-lap in time and space. Individual species specific information is being developed for compilation into the multi-species plan to ensure species specific needs are adequately addressed in terms of the viability criteria and habitat needs, but also to identify potential conflicts between salmonid species as well as areas of over-lap or cross-species benefits.

The California Central Valley Domain Recovery Plan builds from the NMFS Southwest Fisheries Science Center Technical Recovery Team (TRT) ESU/DPS reports and a threats assessment (included as an appendix in the draft recovery plan). The TRT reports outline the historical population structure and draft viability criteria to be considered in recovery planning.

These reports can be found at the following website:
http://swfsc.noaa.gov/textblock.aspx?Division=FED&id=2260

CIE Peer Review Process:

The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the Center for Independent Experts (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 the NMFS management decisions.

The NMFS Office of Science and Technology serves as the liaison between the NMFS Project Contact and CIE 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 in accordance with the ToR producing a CIE independent peer review report as a deliverable. 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 NMFS Office of Science and Technology distributes the CIE reports to the NMFS Project Contact.

Requirements for CIE Reviewers:

The CIE shall provide three CIE reviewers with the required expertise in anadromous salmonid biology and ecology, preferably with experience in California's watersheds, data limitations and salmonid populations to complete an independent peer review and produce the deliverables in accordance with the SoW and ToR herein. 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. Three CIE reviewers are required to conduct a desk peer review of the Assessment of the Draft California Central Valley Domain Recovery Plan, and each reviewer's duties shall occupy a maximum of 7 days to review material, conduct the peer review and produce a CIE independent peer review report.

Statement of Tasks for CIE Reviewers:

CIE reviewers shall conduct an independent peer review of the draft of the California Central Valley Domain Recovery Plan. Reviews and comments are to focus upon: (1) the use of the best available scientific and commercial information; (2) interpretation and application of the National Marine Fisheries Service Southwest Fisheries Science Center Technical Recovery Team (TRT) recovery planning supporting documents and (3) determination on whether methods employed provide adequate linkages between TRT criteria, habitat-based threats and recovery actions and strategies. Reviewers are not expected to evaluate or comment upon the TRT documents or the Threats Assessment template.

<u>Prior to the Peer Review</u>: 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.

<u>Pre-review Documents</u>: 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.

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.

CIE reviewers shall be familiar with the following which are supporting information to the Draft California Central Valley Domain Recovery Plan:

- Technical Recovery Team Reports: Historical Structure and Draft Population Viability (http://swfsc.noaa.gov/textblock.aspx?Division=FED&id=2260)
- 2006 Interim Recovery Planning Guidance (http://www.nmfs.noaa.gov/pr/recovery/)
- Endangered Species Act (http://www.nmfs.noaa.gov/pr/pdfs/laws/esa.pdf)

Each reviewer's duties shall not exceed a maximum total of 7 days for literature review, peer review, and producing a written report in accordance with the ToR. Each reviewer may conduct their analyses and writing duties from their primary work location. Each report is to be based on the individual reviewer's findings, and no consensus report shall be required.

The itemized tasks of each reviewer consist of the following.

1. Read and review the draft California Central Valley Domain Recovery Plan.

2. Review and consider background documents and additional scientific information as necessary.

3. Each CIE reviewer shall submit their independent peer-review report in accordance to the Term of reference and Schedule of Milestones and Deliverables herein to the CIE lead coordinator Mr. Manoj Shivlani at mshivlani@ntvifederal.com and CIE regional coordinator Dr. David Die at ddie@rsmas.miami.edu. Each report is to be based on the individual reviewer's findings, and no consensus report shall be required.

Terms of Reference:

The CIE reviewer's peer review shall address each of the following questions;

Fundamental Questions for the CIE reviewers

Does the plan meet the minimum standards described in section 4(f)(1)(b) of ESA by including site-specific management actions, objective measurable criteria and estimates of time and cost?
Site-specific recovery actions addressing important threats to each of the listed species are included in Appendix B. As part of the recovery planning process, the Central Valley

Domain Technical Recovery Team developed objective measurable delisting criteria, which are included and described in the Draft Recovery Plan starting on page 70. Information related to the time and cost of species recovery is included in the Draft Recovery Plan starting on page 96. Additionally, an implementation schedule with specific details regarding the cost and time frames associated with recovery actions is in development and will be included in the a subsequent draft of the Recovery Plan.

Does the recovery plan delineate those aspects of the species biology, life history, and threats that are pertinent to its endangerment and recovery?
The biology and life history of all three listed species are described in both the *Background* section of the Draft Recovery Plan and in the *Life History and Biological Requirements* section of Appendix A. The threats to each listed species are described in detail in Appendix A, and prioritized lists of life stage-specific threats to the winter-run Chinook salmon ESU, the spring-run Chinook salmon ESU, and the steelhead DPS are presented in Attachments A, B, and C, respectively.

Does the plan have a logical strategy to achieve recovery that is relevant to habitats, life stages, populations, diversity groups and the overall ESU?
The recovery strategy has a foundation based on the hierarchical organization presented in Figure 1. Threats (see Appendix A and Attachments A,B, and C) to specific life stages and associated habitats were identified and prioritized at the population and diversity group (population groupings based on climatological, hydrological, and geological characteristics) scales. Recovery actions which link to specific threats were developed and are presented in Appendix B. The recovery strategy also includes biological recovery criteria for the population, diversity group, and ESU/DPS scale. …

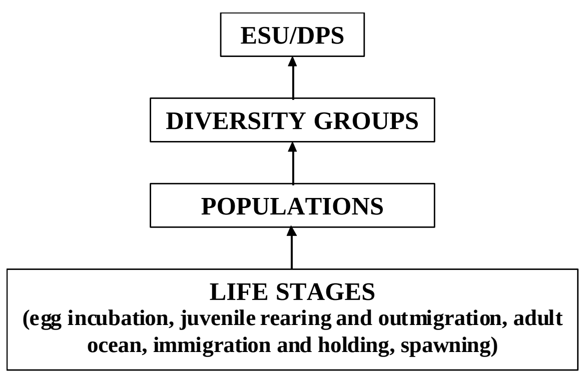

Figure 1. Conceptual model of the hierarchical structure of organizational levels used in the recovery plan.

Is the recovery plan grounded in a clearly articulated and biologically meaningful conceptual framework? Does the plan use best available scientific information? If better data or analyses are available, please identify. The recovery plan framework utilizes the viable salmonid populations concept (McElhany *et al*. 2000) to help guide the recovery process, including the development of recovery actions and recovery criteria.

Question Regarding Use and Application of the Technical Recovery Team Reports

Are the outputs from the historical population structure and population viability criteria described, and applied, appropriately? Information for the Technical Recovery Team reports regarding historical population structure (Lindley *et al*. 2004; 2006) and population viability criteria (Lindley *et al*. 2007) was included in the Draft Recovery Plan.

Is the plan clear about the differences been viability criteria and recovery criteria?

Question Regarding the Threats Assessment Process

Is there an explicit analysis of threats discussed in terms of the five listing factors (e.g., threats)? Does the plan provide continuity between new threats and changes to threats identified in the listing rule since publication? Species specific descriptions of threats related to the five listing factors are provided in the *Background* section of the Draft Recovery Plan.

Does the plan contain a fair assessment, and prioritization, of conditions, stresses and sources of stresses? The threats assessment methodology and results are presented in Appendix A.

Are other factors considered for each threat and its' source such as scope, severity, frequency, magnitude, etc. as suggested in the Recovery Guidance?

Is the threats assessment objective and are all realistic threats identified (even if it may not be feasible to address it in the recovery plan)?

Does the plan explicitly identify threats and track, through objective measurable criteria, how each threat will be reduced or ameliorated, through site-specific management actions? Are these final threats linked to the five listing factors for this ESU? Threats abatement criteria were developed and are described in the *Recovery Goals, Objectives and Criteria* section of the Draft Recovery Plan. The relationship between recovery actions and threat abatement goals and criteria is described in Appendix B.

Is the Threats Assessment protocol/methodology employed for assessing salmonid threats effective?

- Do the scoring and rankings in the matrices link logically to your understanding of the species and the systems they live in?
- Are the habitat types as defined in the matrices sufficient?
- Are the linkages between habitat types and life stages correct and complete?
- Does the protocol for threats assessment have a high likelihood of correctly identifying the dominant stressors for each population?

Does the recovery plan adequately address potential uncertainties related to the threats assessment?

Question Regarding the Conservation Assessment Process

Does the plan adequately assess the effectiveness of conservation actions to date including, if the action was in place before listing and the reasons why the efforts were considered insufficient?

Is it clear what threats are being addressed through conservation efforts and what threats remain unaddressed?

Question Regarding the Recovery Strategy

If the species (ESU/DPS) met all the recovery criteria, does it seem feasible that this species would likely persist for the foreseeable future?

Do the recovery strategy and recovery criteria adequately consider large-scale environmental perturbations such as climate change and ocean variability?

Are the links between human activities, effects on habitat, effects on individual fish, and expected responses of populations clearly described?

Does the recovery plan contain a logical framework for prioritizing recovery efforts at multiple spatial scales?

- For each of these populations, have the primary stressors been identified? Given the prioritized stressors, do the recovery actions have a high likelihood of achieving measurable results? Is there a logical link between stressors, populations and prioritized recovery actions such that they will have the highest likelihood for success?

Do the proposed recovery actions link logically to threats identified in the threats assessment?

- Do proposed recovery actions target the primary stresses/stressors for each population?
- Are recovery actions prioritized in a manner consistent with identified threats?

Question Regarding Monitoring and Adaptive Management

Does the plan have a well-defined methodology for adaptive management to evaluate whether recovery measures are producing the intended effects and, if not, for informing mid-course corrections in the recovery plan and its implementation? Information on the need for monitoring and adaptive management is presented in the Recovery Strategy section of the Draft Recovery Plan.

Does the plan include monitoring that will allow for (a) assessment of progress toward recovery goals, and (b) ongoing evaluation of the recovery strategy in the adaptive management framework?

Schedule of Milestones and Deliverables:

September 23, 2008	CIE shall provide the COTR with the CIE reviewers contact information, which will then be sent to the Project Contact
October 6, 2008	The Project Contact shall send the CIE Reviewers the pre-review documents
October 7-10	Each CIE reviewer shall conduct the independent peer review
October 20	Each CIE reviewer shall submit an independent peer review report to the CIE
October 31	CIE Steering Committee shall review and accept reports, and the reports shall be sent to the COTRs
November 7	COTRs will review reports for compliance, and CIE shall submit final CIE independent peer review reports to the COTRs
November 14	The COTRs shall distribute the final CIE reports to the Project Contact

Submission and Acceptance of CIE Reports:

Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, CIE shall send via e-mail the CIE reports to the COTRs (William Michaels William.Michaels@noaa.gov and Stephen K. Brown Stephen.K.Brown@noaa.gov) at the NMFS Office of Science and Technology by the date in the Schedule of 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.

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 approved changes. The Terms of Reference (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.

Key Personnel:

Contracting Officer's Technical Representative (COTR):

William Michaels
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Stephen K. Brown
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
Stephen.K.Brown@noaa.gov Phone: 301-713-2363 ext 133

Contractor Contacts:

Manoj Shivlani, CIE Lead Coordinator
10600 SW 131st Court, Miami, FL 33186
mshivlani@ntvifederal.com Phone: 305-383-4229

Project Contact:

Maria Rea, Central Valley Recovery Supervisor
NMFS, Sacramento Area Office
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814
maria.rea@noaa.gov Phone: 916-930-3623

Brian Ellrott, Central Valley Recovery Coordinator
NMFS, Sacramento Area Office
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814
brian.ellrott@noaa.gov Phone: 916-930-3612

Howard Brown, Central Valley Recovery Team Supervisor
NMFS, Sacramento Area Office
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814
howard.brown@noaa.gov Phone: 916-930-3608

ANNEX I:

REPORT GENERATION AND PROCEDURAL ITEMS

1. Each reviewer's report shall be prefaced with an executive summary of findings, 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 in accordance with the ToR, and conclusions/recommendations.

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

Please refer to the following website for additional information on report generation: http://www.rsmas.miami.edu/groups/cimas/report_Standard_Format.html