Center for Independent Experts Review of the North Central California Coast (NCCC) Recovery Plan

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October 23, 2008

Executive Summary

The North Central California Coast (NCCC) recovery plan provides the rational for listing, an analysis of threats and habitat conditions, and an approach for designing recovery action plans mainly directed that the rehabilitation of freshwater habitats in a large number streams on the California Coast. The Plan summarizes a large body of work, but also contains a large amount of information-much of which is detailed analysis, on a watershed-by-watershed of recovery actions.

From the perspective of a stand-alone technical document, the recovery plan sometimes lacks the necessary detail to either support or allow the evaluation of the recovery plan. There are very little data (if any) in the report, and in some cases it is very difficult to determine how things were done because of the lack of details in the methods.

The Plan could also benefit from a more quantitative analysis of both the declines and the potential for recovery (through modeling). Although the data available for the NCCC fall well short of the information typically available for coho populations in the Pacific Northwest, there should be enough to initiate this type of analysis. Some options include:

- Long term catch (or ideally catch rate) data to show trends in ocean abundance.
- Comparisons of coho abundance from early studies (Scott/Waddell, etc.) to present day, and corresponding trends in land use patterns.
- Relating current coho distribution and abundance to the scores of the threats or habitat conditions tables, as well as other potential covariates.
- Population modeling using existing information on population dynamics, coupled with future scenarios about ocean survival rates and rates of change of stream productivity associated with habitat rehabilitation.

These analyses would provide technical support for the assertions being made in the recovery plan about the declines, the current status of the Evolutionary Significant Unit (ESU) and the likely efficacy of recovery activities.

The Plan would also benefit from more explicit analysis of risk and the use of risk-based language. There is no guarantee of recovery or extinction because of the uncertainty in future events. Recovery actions are designed to increase the probability of population increases or reduce the chance of further declines. Ideally, these risks would be accounted for in a quantitative framework.

Finally, a large amount of the report focuses on freshwater habitat conditions, but it does not, in my view, pay sufficient attention to the role of poor ocean conditions as a dominating factor that can drive the whole NCCC complex to low levels of abundance, irrespective of freshwater productivity. Once the potential impacts of ocean conditions are formally analysed, recovery actions should be modeled or evaluated under different future scenarios for ocean conditions. That would serve to address a key question of whether the NCCC are recoverable, or under what ocean survival scenarios the ESU would recover.

The Review

My review begins with two general issues, before responding to the questions in the statement of work (SOW).

Coho salmon population dynamics

Although the basic life cycle of the coho salmon is described in chapter 1 and is made use of in subsequent section, in my view the large body of knowledge on coho salmon population dynamics could be used to greater advantage in recovery planning. In 2000, I made use of existing data for coho salmon in the Pacific Northwest to develop a simple 2-staged model based on the "hockey-stick" model of smolt production (Bradford et al. 2000) which has proven useful for coho salmon recovery planning (Bradford and Irvine 2000; Bradford and Wood 2004). Other, more detailed mechanistic models have also been developed.

On the freshwater side, coho salmon usually exhibit strong density-dependent mortality caused by physical habitat limitations. As long as there are sufficient spawners to fully seed the available habitats, smolt production is largely independent of spawner density, creating a flat smolt-spawner relation. Smolt production is usually limited by the availability of pool habitats, either for summer or winter rearing (Sharma and Hilborn 2001, Nickelson et al. 1992). Because stream morphology varies widely, there is considerable stream-to-stream variation in the carrying capacity. An empirical review produced estimates ranging from 500 to 4,500 smolt/km, with most streams in the 1,000 to 2,000 smolts/km range (Bradford et al 1997). On top of the stream-specific variation, there is some year-to-year variation in smolt production within a stream; the CV is in the 25-30% range. While it is tempting to try to ascribe this variation to regional weather (floods, low flows etc.), a spatial analysis suggests that most of the variation in annual smolt yields is unique to each watershed, undoubtedly due to the interaction between regional weather and watershed-specific factors (Bradford 1999). To my knowledge there is not a single environment variable that has successfully predicted annual variation in smolt yields across a range of streams.

The lack of a relation between smolt yield and spawner abundance at higher spawner densities also does not support the hypothesis of a significant feedback role for marine derived nutrients (MDN) from coho spawner carcasses. If MDN were a significant factor in smolt production, smolt abundance should increase with spawner density. In the Pacific Northwest, MDN from vastly more abundant pink and chum salmon carcasses may play a greater role in coho smolt production (Bilby et al. 1992).

Bradford et al. (2000) fit rectilinear broken-stick or "hockey-stick" models to coho salmon smolt-spawner data. This model has two parameters, the slope of the rising limb (α, as smolts/spawner), which is the rate of smolt production in the range of spawner abundances where the stream is not fully saturated, and K, the carrying capacity as smolts/km. While likely an oversimplification, this model does facilitate thinking about how marine survival (MS) and freshwater production interact, especially at low population levels.

The key outcome of using this model is that the recovery of small coho salmon populations is contingent on the interaction between the ocean survival rate and α, the freshwater productivity at low abundance. Population growth will occur when the inequality $\alpha MS(1-h)>1$ is true (h is the harvest rate). Stream carrying capacity (K) is not a consideration for the sustainability of small populations. Assuming the streams in Bradford et al. (2000) are representative of coho streams that are not in a degraded state, the available estimates for α suggest that at marine survival rates of under 3% (which includes ocean fishing) will result in declines in half of the populations; at 2% marine and fishery survival most populations are predicted to decline.

The determinants of α have not been well studied, as most coho studies have focused on carrying capacity issues. Coho spawning success is usually good, with egg-fry survivals of 20% being measured; these are more than twice those recorded for pink, chum, and sockeye salmon (Bradford 1995). Because coho spawning is often scattered in headwater areas, it likely enables females to choose sites that are uncrowded and have good quality gravel. Most fry that are produced are swept immediately downstream after emergence; Bradford et al. (2000) found an average rate of migration of over 400 fry/female spawner leaving the natal stream in the spring months. This is significant as the total emergent fry per female is expected to be in the 3000 egg/female * 20% survival = 600 fry/female range.

A clue to the cause of variation in α (the smolt productivity parameter) is provided by a negative relation between spring fry migrations and α. That is, the most productive streams (high α) were those that had the lowest rates of outmigration of newly emergent fry. Bradford et al. (2000) hypothesized that those streams that were able to retain fry during the spring emergence/outmigration period were those that would produce the most smolts/spawner when abundances were low.

Under this framework, the key to population recovery is to address the factors that will lead to the retention of fry in the spring and will enhance the survival of those fry through to the smolt stage. These factors have not been identified in the field, but may include the severity of spring flows, channel complexity, and habitat configuration (the organization of spawning and rearing habitats along the channel).

Detailed research studies in streams with small numbers of coho spawners are needed to determine whether California streams with the current habitat conditions are producing smolts at rates observed in the Pacific Northwest. If these rates are much lower, then poor survival due to habitat conditions or predation may be a limiting factor for recovery. If estimates of α are not especially low, then estuary, ocean or fishing factors may have a greater role. Such research may also lead to a more focused habitat program directed at improving α, rather than broad-based activities that might lead to an increase in K, but will have little impact on recovery.

Empirical Evidence

As a stand-alone document, the recovery plan is almost devoid of data and quantitative analysis. Consequently, the reader is not provided with any evidence of the current status of the ESU relative to the past, nor with evidence supporting the causes of declines and threats. Although the long-term datasets of spawners, smolts, harvest survival rates may be more incomplete for this region compared to areas further to the north, some data nonetheless must exist. I reviewed some of this in the 2001 status review, and certainly some of these time series are continuing. Even a few recent estimates of spawner abundances can be provided to put the current status in the context of the recovery goals. Where possible juvenile density or smolt estimates should be plotted against parent spawner abundances to calculate juvenile/spawner ratios. Current spawner estimates can be used to predict likely juvenile and smolt production rates, which can then be used to determine current habitat requirements.

As an example, we attempted a quantitative analysis of the declines in the abundance of coho salmon in the interior regions of Fraser River, British Columbia (Bradford and Irvine 2000). Using spawner counts, estimates of marine exploitation rates, and ocean survival rates from tagging data, we showed that the primary cause of the region-wide decline was a combination of a sharp decline in ocean survival coupled with a failure to reduce harvest rates during the period of ocean change. However, within the basin, rates of decline of counts of fish in individual streams was related to variations in land-use in the basin, with more dramatic declines occurring in areas of extensive urban and agricultural activity. We also found that a independent qualitative ranking of habitat impacts was also related to rates of decline. In this rating system, the various major impacts were given 0-3 scores for each basin and the scores were added together.

It seems unlikely that this level of analysis would be possible for NCCC in the absence of the necessary time series of abundances and vital rates. Nonetheless, the recovery plan could make better use of what information is available in an attempt to support the threats analysis. For example, do the long-term declines in abundance in Scott and Waddell creeks better match changes in ocean conditions and climate or changes in land-use patterns since the 1930s? Are there examples of streams where the land-use has not changed significantly in the past 50 years that might be used to index oceans conditions? Can any catch data for the California salmon fishery be used to address the decadal changes in ocean abundance that could then be match to ocean or land-use patterns? Perhaps these types of analyses have been conducted in other documents, but I feel the recovery plan, as a stand-alone document, could benefit from more supporting information. Sharma et al. (2005) is an example of a modeling approach to addressing recovery actions. IFCRT (2006) considers the recovery potential for endangered coho populations under variable ocean survival conditions.

The following are responses to the questions in the SOW.

Fundamental Questions for the CIE Reviewers.

Does the plan meet the minimum standards described in section 4 of the ESA..?

The plan does extensively describe habitat restorations on a watershed-by-watershed basis that provides advice for site-specific management actions. The overall costs listed in Chapter 14 focus almost entirely on freshwater habitat restoration and do not include costs associated with the marine environment, fisheries management, or the management of competing salmonids or other gamefishes to enhance coho survival. I was unable to reconstruct the $3.2 billion figure from the material in Appendix K; more information on how that figure was arrived at is needed.

The Act apparently does not require an estimate of the uncertainty around the recovery costs. As noted below, it should be recognized that there are substantial uncertainties, not only about the costs, but also the probability that the expenditures will lead to recovery, given unpredictable future trends in ocean conditions, climate change or other factors that could dominate a recovery program based on freshwater habitat restoration. A recovery plan can increase the likelihood that a population can recover (or reduce the risk of extinction), but it can never leave the impression that recovery is certain.

Does the plan delineate those aspects of the species biology, life history and threats that are pertinent to its endangerment and recovery?

Though the Plan does provide a general overview of these factors, as noted earlier, a much more quantitative focus could be taken that leads to a more focused approach to recovery. A key issue that is not addressed is the role of long-term changes in ocean survival rates (as well as fishing) on the current status of the ESU. At the moment the focus is almost completely on freshwater habitat. There is plenty of reason to be concerned about freshwater habitats, but I could not find evidence to refute the ocean condition hypothesis. Based on the relatively well-defined production parameters for coho-producing streams, a key question is whether marine survival rates are low enough to prevent recovery regardless of short- or long-term freshwater habitat rehabilitation. If that is the case, then the only alternative may be to use carefully designed hatchery supplementation to increase the smolts/spawner ratios sufficiently to ensure an increase in spawner abundance over time.

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 division of the ESU into domains and populations of differing degrees of independence is well thought out, and the recovery goals are reasonable as long-term targets. As the current level of analysis is unable to pinpoint the cause of decline and the most likely paths to recovery, the plan has taken a comprehensive approach to remediate all habitats (as well as mitigate other impacts). One aspect that is noticeable absent is a explicit consideration of time in the recovery actions. Some of the proposed changes in land-use practices may take decades before stream habitats improve noticeably- is this too long given current trends in abundance? A more quantitative approach would be helpful here.

Is the plan grounded in a clearly articulated and biologically meaningful conceptual framework? Does the plan use the best available information?

Throughout this review I indicate ways in which data from other coho populations or studies might be brought to bear on the current case. Information from these studies may be useful to help link population parameters with the extensive freshwater habitat analysis contained in the Plan. Certainly the detailed information on habitat conditions for the watersheds would be considered using best available information.

Is the Plan suitable as an outreach tool?

Although I can imagine that there are many sophisticated environmental groups in the NCCC region that would digest the ~1,000 pages of material in the Plan, for most a much more distilled and digestible version is needed. As a member of the public in the NCCC region I would be very concerned about the content of the plan, as it suggests widespread recovery measures that could have significant impact on activities within each basin. The absence of an analysis of the "recoverability" of the ESU in the face of ocean conditions, or an analysis if whether the restrictions and rehabilitation measures within basins would significantly decrease the risk of extinction, would not give me confidence if I were a landowner.

Questions regarding the use and application of technical recovery team reports

This section is based on a review of Chapters 5, 7, and 9, and Spence et al. 2008.

The delineation of spawning aggregates and populations, and targets for each is a difficult task and requires some arbitrary decisions to be made to move forward in the absence of specific information. I believe the authors have done a good job of this, as they have recognized that there is normally exchange of adults and sometimes juveniles among nearby streams that will influence Ne, as well as potentially creating a "source-sink" metapopulation structure. In such a structure, spawner aggregations in smaller streams may be supported by larger, more productive basins. In British Columbia we have seen this to be the case in large watersheds, where the sub-populations in smaller streams tend to "wink-out" when ocean conditions drive the overall abundance downwards.

It would be useful to elaborate on how the recovery targets have been generated in the recovery plan itself. Essentially, Spence et al. are using the average spawner density that fully seeds coho streams based on analyses of a suite of streams from the Pacific

Northwest. In other words, this is the minimum spawner abundance that will nearly maximize smolt production in most streams. Once this point is reached, no additional production is expected from the stream. Not surprisingly, I think this is a reasonable approach since I developed it in Bradford et al. (2000). One area of considerable uncertainty is whether these targets are relevant for large river mainstems, which may not be productive coho habitat, as the meta-analysis is largely based on small streams. This problem may be relevant to the Russian River case.

While target spawner numbers serve to ensure freshwater production is maximized, they do not speak to the issue of long-term sustainability nor the potential for harvest (as seem to be indicated on p 80). This will be conditional on ocean conditions or large-scale climatic factors that produce trends in freshwater. These large-scale factors will influence replacement rates (i.e., Spawner(t+3)/Spawners(t)) for the whole Domain.

Since all of the populations are apparently well below any optimal level of spawners, the exact values of the targets are not critical at this stage. Hopefully smolt and spawner monitoring programs within the NCCC will allow the development of local targets that will optimize smolt production from Domain streams.

Differences between viability criteria and recovery criteria.

The viability criteria (p 42, Table 4) are criteria often used to assist in ranking populations with respect to extinction risk. Normally they are expressed with a numerical abundance or trend (ie, Table 4), a time frame or time window, and a probability. The PVA criterion has these characteristics, but the others do not. Each would benefit from a statement like “in the next 50 years, the population should remain above 2500 spawners 80% of the time” or similar. Many very viable salmon populations have fallen below such numerical criteria occasionally and recovered without difficulty.

The population-level recovery criteria (p 80-81) are presented as abundance and other targets that would result in the populations being considered “recovered”. Most of the criteria are based on the previously described viability criteria, but also include the viability target that takes into account the size of the watershed. The plan is clear about this. I was curious that there is no distinction about wild and hatchery fish in the targets. Are fish returning to hatcheries included, and are hatchery fish spawning in the wild considered equivalent to wild fish? This needs to be clarified as a successful hatchery program could have a significant impact on the status of a population if these fish were counted along with the natural spawners.

Questions regarding the Threats Assessment Process

The Recovery plan does not contain a "Threats Assessment Process" per se, so I have tried to find the relevant sections for each question under this heading.

Explicit analysis of threats in term of five listing factors-

The five listing factors are discussed in Chapter 2. They are presented in a very generic form and are similar to the factors implicated in salmon declines through the eastern Pacific basin.

Factor A: Freshwater habitat. There is no doubt that all of these factors can contribute to salmon declines, but not all of them result in extinction, nor do they limit recovery necessarily. For example, studies in the Pacific Northwest have shown that removal of riparian cover (logging) can increase autotrophic production and coho production, counter to expectation. I am not implying that the threats listed in this section are erroneous, but without evidentiary support it is unclear why a critical reader should support them all as listed. Such evidence might include an analysis of the temporal patterns of decline in relation to change in land use or other factors (ex. Were there healthy populations in the early 1900s even though agricultural and industrial impacts had begun? In areas the major impacts had already occurred by the late 1900s, what was the status in 1980? Are the declines coincident with harvest or changes in ocean conditions?). Spatial analysis, including a comparison of status and land use, is also useful for parsing the effects of ocean and freshwater conditions (ex. Have major declines in salmon populations occurred in basins that have been relatively unchanged in the past 50 years?).

Factor B: Harvest. Bradford et al. (2000) provide rough guidelines to appraise the impact of the combination of harvest and marine survival on coho replacement rates. In the Plan, there is no analysis of the actual harvest rates or survival rates. I think it is possible to evaluate the combined impacts of these factors, contrary to the statements on p 21.

Factor C (predation and disease) is written in an unfortunate manner, as the loss from egg-to-adult is normally expected to be greater than 99%- much of this loss is due to predation and disease in some form or another (mechanical loss of eggs in stream beds being another factor). I think the intent is to address the role of greater than normal rates of these factors. There is potential for negative interactions between warmer stream temperatures and disease organisms. The role of exotic species in some of these basins as an additional source of mortality needs to be highlighted further.

I cannot comment on Factor D.

Factor E: Throughout the Plan the dominating role of the ocean is not highlighted as much as it should be. Unlike some of the factors in freshwater that either fluctuate annually at a watershed scale (see Bradford 1999), or have very long-term trends due to land-use changes creating differences in productivity, changes in the ocean have the potential to effect fish from every stream in the region in a coherent manner, and can place populations from even the most productive streams below replacement levels, sometimes for many years in a row (see Bradford and Irvine 2000). Such changes can trump all other factors or threats affecting population trajectories.

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

The plan uses the terms *factors, stresses, and threats* in different sections. "Stresses" are referred to explicitly on p 56. Many of these stresses are combined into a "Threats Table" (Table 9, p 73). Nearly all, if not all of this table concerns freshwater habitat quality, as estuary and ocean conditions and ocean fishing are not mentioned.

The threats table is an example of a qualitative risk assessment that is currently a popular device for organizing information and breaking down complex problems. The utility of this table can be advanced if it is explicitly linked to an objectives tree that identifies an overall goal, and sub-objectives to which the threats relate. The approach described by Jones et al. (1996) might be worth considering. As an example, I interpret the main objective of the current Table 9 as restoring the NCCC streams to fully functioning coho salmon habitat that include all features (with all threats are given equal attention).

Alternative objectives are possible. For example, if the objective was to recover the population from currently, critically low levels of abundance, the dominant threats might be different. As noted in my first comments, recovery is only possible when freshwater productivity is sufficient to overcome marine survival losses, so the main threats are low marine survival (if indeed this is true) and the factors that lead to good (or poor) smolt/spawner ratios (α) at low abundance.

I would like to see a more explicit linkage of the threats analysis to coho life history and biology. For example, the analysis of Bradford et al. (2000) does not show any evidence of spawning ground limitation for coho salmon, so the creation or restoration of large amounts of spawning habitat might not lead to an increase in survival. Similarly, the widespread restoration of rearing habitat may not be essential for increasing survival of juveniles when they are relatively few. That is, there should be less priority on increasing the capacity of the watershed (K) compared to increasing survival of the few fish that are actually present.

Identifying the factors that will increase survival in small populations is a difficult challenge. Bradford et al. (2000) hypothesize that flows and habitat conditions that cause newly emerged fry to be retained in spawning areas may be important in increasing α. Spring flows also appears be a factor in other salmonids such as brook trout (Jensen and Johnsen 2002). Creating habitat and flow complexity immediately below spawning grounds may contribute to the retention of fry and the enhancement of smolt production. Other factors that may lead to higher values of α include ensuring optimal foraging conditions so that the risk of foraging is reduced, reducing predation from native and non-native species (including unnaturally sized hatchery fish releases), and providing overwinter habitat if flow and temperature considerations cause other habitats to be used during winter.

Does the plan explicitly track how each threat will be reduced?

The plan does provide measureable criteria for the freshwater habitat attributes. The technical origins of the targets are in the appendices, and most are supported with scientific literature. Without watershed-specific estimates for the present state of many of the attributes, it is difficult to determine how realistic the goals are. The suite of threats is comprehensive and can be aligned to the "Factors" listed in Chapter 3.

Is the Threats Assessment protocol effective?

Comments are based on the CAP workbook (p 68). The questions in this section refer to "matrices" which I assume to be Tables 8 and 9. The details of the CAP scoring system were found in Appendix C. In general I found the habitat components of the analyses to be well described, and the rating system to be quite logical and substantiated by a good review of the relevant literature.

Spawning gravels

P 16- top, the last sentence of the spawning gravels section may not be true as coho are usually able to find pockets of gravel (see Bradford et al. 2000 and earlier comments). The focus on pool tailouts may result in underestimates of the total spawning as coho are known to spawn in isolated gravel deposits, which are difficult to quantitatively estimate without extremely detailed surveys.

Adult population density

Though depensation is likely under some scenarios (skewed sex ratios), there is no available evidence to suggest that it occurs in coho. One caveat to this claim is that there is no data for situations where there are few spawners in very large systems—the data that are available are for small numbers of spawners are in small streams where mate finding is probably not an issue.

It might be useful to have another category in this analysis (split the "fair" category) as the span for "fair" is quite wide and covers some biologically significant part of the range (not fully seeded systems). Although reference is made to comparing adult spawner densities to attributes of the habitat matrix, I could not find this analysis. It would be a good step to provide support for the risk matrix. An example is in Bradford and Irvine (2000). Although the ideal situation would be to have 3-4 generations of counts, but I would think that the categories are broad enough that 1-2 years of spawner data would be enough to anchor the ratings.

Juvenile density:

This is another situation where abundance data might be useful to relate to some of the habitat metrics in the matrix. This will depend on the scale of the juvenile sampling (pools, or all habitat types), as it has been our experience that pool densities tend not to vary as much because these are the prime habitats for juveniles.

Smolts, Pool habitat shelter:

I am not familiar with literature on smolt habitat (pools, etc.), as our experience has been that smolt migration is directly from overwinter habitats. More supporting evidence would be useful here.

Smolt Abundance:

The smolt abundance ratings seem unrealistic. Using an adult density of 42 spawners/km the equation on p 31 yields a smolt production rate of 4,000 smolts/km. This is very unlikely (see Bradford et al. 1997), as the median for reasonably healthy streams is around 1,500 smolts/km. There is little evidence that coho populations can be sustainable at 1% marine survival rates (which is implied by the equation on p 31). An alternative approach would be to use a smolt production model (Bradford et al. 1997, or Sharma and Hilborn 2001) to predict “good” production under the assumption of sufficient seeding and reasonable habitat conditions.

In the absence of any smolt data (as is inferred on p 32) the value of this metric is quite tenuous, as it does leave the impression of more information than is actually contained in it.

The “Multiple Life Stage” entries:

These attributes mainly relate to land-use patterns in the riparian and upland areas. At first glance they seem to be well-thought out. It would be interesting to conduct some multivariate analysis to see if there is redundancy in them, or if they are correlated with instream values or fish data.

Final comments:

The relationship between Table 8 (current habitat conditions) and Table 9 (Threats Table) is not very clear. For example, there is a row labeled “agriculture” in both tables, but the ratings are quite different. Similar results are noted for some of the other entries that superficially, at least, seem to be the same entity in both tables.

Sometimes, a pathways-of-effects diagram (Jones et al. 1996) or similar is useful to link the threats to features of the habitat and life history of the fish. This might help to organize thinking about which of the threats is most likely preventing population recovery.

Questions regarding the Conservation Assessment Process

There is no reference to a "Conservation Assessment Process" in the Plan. I interpret this as a reference to Chapter 4, "Assessment of Protective Efforts".

This chapter describes various actions taken to increase the abundance of coho salmon and improve their habitats. Unfortunately, from a scientific perspective, there is nothing in this chapter that can be used to assess the effectiveness of the conservation actions to date. Without the presentation of any trends in abundance of any life stage, or measurements of habitat conditions (stream flow, LWD volume added etc.) that provide evidence of a change in conditions, the assessment is entirely anecdotal.

Questions regarding the Recovery Strategy

I assume the "Recovery Strategy" refers to the "Strategy for Recovery" (Ch 8).

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

This question cannot be answered until there are estimates of smolt-adult survival for the species for the California Coast. These can be directly calculated from smolt-adult return rates, or CWT programs, or inferred from Spawner/spawner ratios and some measure of freshwater productivity. I was unable to find these in the report, though there was reference to 1% survival in parts of the text. At 1%, the sustainable smolt production rate is >100 smolts/spawner (>200 smolts/female spawner), which is a rate not often seen in relatively unimpacted basins (Bradford et al. 2000). In the Pacific Northwest ocean survival rates below 3% generally lead to widespread decreases in spawner abundance. If California ocean survival rates are 1%, it will be difficult to recover populations if they have freshwater production parameters similar to other streams in the range. If the recovery criteria for habitat are met (resulting in reasonably productive habitats in the watersheds that result in good smolt/spawner ratios), and if the ocean mortality (fishing and natural) is adequate, from a demographic perspective populations should be able to persist. It is important to keep in mind that numerical targets for the streams are useful guidelines for seeding them, but sustainability is far more dependent on productivity (ie, assuring $\alpha*MS>1$) than on abundance.

Does the strategy adequately consider climate change and ocean variability?

A clear description of what climate change modeling predicts for the NCCC region was not evident in the plan. There appeared to be reference to more droughts and floods, but more detail would be useful. Habitat rehabilitation activities that create habitat diversity and water management will help to offset the impacts of climate change if they indeed to result in droughts and extreme rainfall events.

Survival in the ocean is always variable, but the key issue is that of long-term trends towards low survival rates that are unsustainable for coho salmon. The plan does not articulate this well, either in terms of past performance or future predictions.

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

Habitat conditions and how they have been affected by human activities are well described in the Appendix material. A more quantitative approach (if data are available) that made use of our knowledge of coho population biology might be useful when considering specific impacts on highly depleted populations. For example, those factors that lead to a diminishment of the capacity of the watershed to produce smolts are likely less important than factors that affect productivity (i.e., survival).

Does the recovery plan contain a logical framework for prioritizing recovery efforts?

The material on p 75-76 and p 101 was reviewed for this question. In a general sense, the framework is logical in that it first focuses on the areas where coho are currently present, and radiates out from there for later, lower priority actions. As noted, the focus should be on recovery actions that improve the survival of the existing population. It is difficult to comment on the scientific basis of the determination of the core and Phase 1 areas or process used to prioritize which actions were to be supported as no details were provided. Appendix G is not helpful for understanding this process. The phrase "were coho are currently present" needs to be better defined (e.x., does this refer to any spawners, most spawners, juveniles, smolts; is the finding of one fish enough to define the Core?).

Have the primary stressors been identified? Is there a link between the stressors and recovery actions?

This part of the recovery plan and the questions in the SOW are very unclear. The term "stressor" does not appear to be used in the recovery plan. On p 56 (col 1), it states that "The Threats Table is organized into Stresses and Source of Stresses which when combined, constitute a threat to the species" (capitalization as in the Plan). Unfortunately the "CAP Threats Table" (Table 9, p 73) does not contain the aforementioned Stresses and Sources of Stresses, but a list of human activities (Threats) that are presumed to impact fish or fish habitat.

Consequently, I assume that the "Threats" in Table 9 are equivalent to the "stressors" referred to in this question. The list of threats is what one would expect for degraded salmon streams. There are a few areas that perhaps could be considered in a more detail:

1. The role of exotic species (eg, largemouth and smallmouth bass) on survival of native species (and plans for their control, if needed).

2. The impact of steelhead and chinook enhancement on coho salmon. Large releases of steelhead fry could compete with coho in situations where pool habitats are limited. Larger steelhead will prey on coho fry. Is there a conflict between steelhead enhancement and coho recovery in these watersheds?

3. Long-term declines in ocean conditions and coho marine survival. Low ocean survival can trump all other recovery actions; increases in ocean survival can increase spawner abundance far faster than habitat rehabilitation.

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

In general, the proposed recovery actions appear to be guided by either the most impacted habitat attributes or the highest rated threats. The major weakness in this approach is the assumption that action on the highest rated threat will result in the largest response from the population. This may be true, but the lack of quantitative evidence on the productivity of these streams relative to known standards, and the role that the various habitat conditions have on decreasing productivity (if that has occurred) is needed.

There is also redundancy in many of the “threats” as well. Nearly all activities require roads, many involve water abstraction, etc. In the case of roads, which are often given a high rank, it is unclear whether the density of forestry roads carries a greater risk to the watershed (where tree-cutting also occurs) than agricultural or urban roads that might be better constructed or are associated with lower impact activities.

Questions regarding Monitoring and Adaptive Management

It is apparent that the lack of abundance monitoring in the NCCC is a critical shortcoming that will hamper the assessment of the status of the ESU as well as the efficiency of recovery efforts. The goal of an index watershed in each of the five domains is reasonable. While this may take time to implement, supporting any existing programs to begin development of an adult, juvenile, and smolt data series is imperative. Long-term monitoring requires a significant investment of resources and perhaps more importantly stable leadership to be successful. My experience has been that there is a tendency to underestimate the amount of effort required to sustain these programs – I am referring to the effort in the office to sustain continuity of funding, database assembly and analysis, not field crews. Consequently loading one “pilot” watershed with a battery of monitoring and rehabilitation efforts may have merit to promote learning and hopefully provide an opportunity to document successes.

I concur that efforts to monitor changes in freshwater habitats in areas receiving recovery actions is needed. I consider research on ocean conditions to be a lower priority, as long as there is a smolt or coded-wire-tag (CWT) program to allow estimation of catch and survival. Although the marine studies could have long-term benefit, a single or reliable predictor of salmon survival using environmental variables has not yet emerged in other regions. The short-term focus should be on tracking changes in the marine environment to determine if coho populations are even potentially recoverable.

Final Comments on this Review for CIE and the Agency

For this review, nearly 1,000 pages of documentation were provided. To make the review of the Plan efficient for the reviewers, in the future I would suggest that CIE and the Agency spend a little more time with the statement of work (SOW) to ensure the questions are unambiguous and not overlapping. I found that the questions used words or phrases that were not used in the Plan, such that for most of the questions I had to interpret to which section of the Plan the question was referring. Ideally, the questions should have either an explicit chapter reference, or at least should be easily matched to the corresponding chapter. These are some examples of this confusion drawn from the SOW questions:

"Threats Assessment Process"- does not exist in the Table of Contents (TOC)

"Conservation Assessment Process" – is this the same as Conservation Action Planning (chapter 6)?

"Recovery Strategy"—the document is a Recovery Plan, individual chapters refer to Recovery Criteria, Recovery Actions and Strategy for Recovery, but there is no explicit reference to a "Recovery Strategy"

"Factors, Stresses, Stressors and Threats" – these are referred to somewhat interchangeably. There is no reference to "Stressors" in the plan, though it does appear in some of the question.

The optimal SOW would be questions that were ordered and linked to each chapter, potentially followed by overview questions that are relevant to whole document. Those that pose the questions have to be aware that it is very difficult to get a complete grasp of the content of such a volume of material so the extent to which the questions can be directed to specific sections of the document should result in a more useable review.

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Attachment A: Statement of Work for Dr. Michael Bradford

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

Assessment of the Draft Recovery Plan for the Central California Coast Coho Salmon Evolutionarily Significant Unit

Introduction

The purpose of this independent review is to evaluate and comment on the Draft Recovery Plan for the North Central California Coast Recovery Domain (NCCC Domain) and the Central California Coast coho salmon Evolutionarily Significant Unit (CCC coho salmon ESU) module. 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 NCCC Domain recovery plan will be developed over several phases which will include one module for each ESU/DPS, with a final compilation and restructuring into a multi-species plan. The development of modules for each ESU/DPS will be in the following sequence: CCC coho Salmon ESU, Central California Coast steelhead DPS, California Coastal Chinook salmon ESU and Northern California steelhead DPS.

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 species specific modules was precipitated by research demonstrating that multi-species plans lacked the species-specific information needed for listing. Thus, individual species-specific information is being developed for compilation into the multi-species plan to ensure species needs are adequately addressed in terms of the viability criteria and habitat needs.

The NCCC Domain recovery plan builds from the NMFS Southwest Fisheries Science Center Technical Recovery Team (TRT) ESU/DPS reports and a conservation assessment and strategy methodology. 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 (as they are too large to transmit via email): http://swfsc.noaa.gov/textblock.aspx?Division=FED&id=2266. The conservation planning process, called the Conservation Action Planning (CAP) workbook, was developed by The Nature Conservancy and others and is endorsed in our National Recovery Planning Guidance.

Extensive information on the CAP process can be found at: http://conserveonline.org/workspaces/cbdgateway/cap.

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 Recovery Plan for the Central California Coast Coho Salmon Evolutionarily Significant Unit, 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 expertise necessary

Statement of Tasks for CIE Reviewers:

The CIE reviewers shall conduct an independent peer review of the Assessment of the Draft Recovery Plan for the Central California Coast Coho Salmon Evolutionarily Significant Unit to determine whether the best possible assessment is implemented. The CIE reviewers shall conduct preparations prior to the peer review, conduct the peer review, and complete the deliverables in accordance with the ToR and deliverable dates as specified. The CIE reviewers shall evaluate the Assessment of the Draft Recovery Plan for the Central California Coast Coho Salmon Evolutionarily Significant Unit. Their primary responsibility is to conduct an impartial peer review to ensure that results and conclusions are based on sound science, and the CIE reviewers shall not comment on management decisions. The CIE peer review shall explicitly address the following Terms of Reference.

<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.

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

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 NCCC Recovery Plan and CCC coho salmon module:

- Technical Recovery Team Reports: Historical Structure and Draft Population Viability (http://swfsc.noaa.gov/textblock.aspx?Division=FED&id=2266)
- 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)

The itemized tasks of each reviewer consist of the following.

1. Read and conduct peer review of the draft NCCC Domain Recovery Plan and CCC coho salmon ESU component in accordance with the Terms of Reference herein.

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

3. Each CIE reviewer shall submit an independent peer-review report addressing each Term of Reference in this Statement of Work in accordance with the Schedule of Milestones and Deliverables as specified herein to the CIE lead coordinator, Manoj Shivlani, at shivlanim@bellsouth.net, 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:

A review of the partial draft of the NCCC Recovery Plan and CCC coho salmon ESU component is being requested. 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. 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?

Does the recovery plan delineate those aspects of the species biology, life history, and threats that are pertinent to its endangerment and recovery?

Does the plan have a logical strategy to achieve recovery that is relevant to habitats, life stages, populations, diversity groups and the overall ESU?

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.

Is the plan suitable for serving as an outreach tool and does it invite public participation in the process?

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?

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?

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

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?

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 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) 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? i.e.,

- 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?

- 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:

August 25, 2008	CIE shall provide the COTR with the CIE reviewer contact information, which will then be sent to the Project Contact
September 5, 2008	The Project Contact shall send the CIE Reviewers the pre-review documents and report
September 8-19, 2008	Each CIE reviewer shall conduct the independent peer review
September 19, 2008	Each CIE reviewer shall submit an independent peer review report to the CIE
October 3, 2008	CIE Steering Committee shall review and accept reports, and the reports shall be sent to the COTRs
October 8, 2008	COTRs will review reports for compliance, and CIE shall submit final CIE independent peer review reports to the COTRs
October 15, 2008	The COTRs shall distribute the final CIE reports to the Project Contact

Submission and Acceptance of CIE Reports:

Each CIE reviewer shall complete and submit an independent CIE peer review report in accordance with the ToR, which shall be formatted as specified in Annex 1, and the report shall be sent via email to Manoj Shivlani, CIE lead coordinator, at shivlanim@bellsouth.net and Dr. David Die, CIE regional coordinator, at ddie@rsmas.miami.edu. 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):

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ANNEX I:

REPORT GENERATION AND PROCEDURAL ITEMS

1. Each reviewer's report shall be prefaced with an executive summary of findings, comments and 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.