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An Independent Peer Review of Two Models Estimating Potential Chinook Salmon Production After Dam Removal and Habitat Restoration on the Klamath River

Independent Peer Review for the Center for Independent Experts
Prepared for NTVI

By

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Executive Summary

This is an independent expert review of two separate and different approaches for estimating the Chinook salmon production potential of the Klamath River Basin before and after proposed removal of four mainstem dams and implementation of the Klamath Basin Restoration Agreement (KRBA). The information provided in the two modeling endeavors, as well as this and other peer reviews, will be used in a determination to be made by the Secretary of the Interior, in consultation with the Secretary of Commerce, regarding removal of four hydroelectric dams on the Klamath.

The two reports were reviewed with respect to the stated Terms of Reference. Comments were made on both specific detailed concerns, as well as broader, overarching issues that might influence the appropriateness of respective approaches.

Taken together, the reports by Hendrix (2011) and Lindley and Davis (2011) represent significant work contributing to the estimation of the numbers of fish that could potentially be produced after Klamath River dam removal and implementation of the KRBA. Both approaches described used a variety of innovative and state-of-the-art modeling techniques for their estimates. However, as noted in the detailed review below, there are several major concerns that have the potential to bias the results of both approaches, most likely in a downward direction. The reliance on existing and recent production data per habitat in other watersheds (both Hendrix, and Lindley and Davis) and within the Klamath (Hendrix) has the potential of underestimating the actual habitat capacity. Prior to further investigations on these issues, however, and assuming other review comments are addressed, I believe the methods presented in the two reports provide sufficiently robust results to serve as preliminary, albeit likely conservative, estimates of the Chinook production benefits to be gained by dam removal and the KRBA program.

Background

I have been contracted via the Center for Independent Experts (CIE), which contracts with the National Marine Fisheries Service's (NMFS) Office of Science and Technology to provide external expertise and independent peer review on the Klamath Basin fish production model(s). The United States, the States of California and Oregon, the Klamath, Karuk, and Yurok Tribes, Klamath Project Water Users, and other Klamath River Basin stakeholders negotiated the Klamath Basin Restoration Agreement (KBRA) and the Klamath Hydroelectric Settlement Agreement (KHSA), thereby proposing the largest dam removal restoration action in US history. In 2012, a determination will be made by the Secretary of the Interior, in consultation with the Secretary of Commerce, regarding removal of four hydroelectric dams on the Klamath. An analysis was needed to compare two alternatives: (1) dam removal and implementation of the KBRA; and (2) current conditions projected into the future. According to the contract, a written technical report was to be completed and available for CIE review on 16 May 2011 including: the assumptions incorporated into the fish production model, mathematical equations used to define reproduction, growth, and mortality for all phases of the fish production model, and definition of model coefficients described based on how they were derived. However, to inform the analysis and other environmental compliance documents, two Klamath River Chinook fish production models have been developed and were the subject of my review.

Description of the Individual Reviewer's Role in the Review Activities

I was asked to conduct an impartial and independent peer review in accordance with the Statement of Work (SoW) and Terms of Reference (ToRs) described in the contract. CIE reviewers shall possess a combination of expertise with working knowledge and recent experience in the application of fish production modeling, Bayesian methodologies, hydrology, climatology, river restoration, and Pacific salmon life history. I have extensive experience with Pacific salmon life history, population and habitat restoration ecology, and fish production modeling.

I performed this review based on my broad expertise and with heavy reliance on the published literature. As requested, the review was completely independent. I did not discuss this review with any other parties.

Two research reports were the focus of my review: Hendrix (2011) and Lindley and Davis (2011). For each of the ToRs, I addressed Hendrix first, then Lindley and Davis, as outlined below. For several of the ToRs I also wrote comments that applied to both of the reports.

Summary of Findings for each ToR

Evaluation and recommendations of data quality

Hendrix 2011

Of course, data quality can affect the results of modeling to varying degrees depending on the nature of the potential inaccuracies (measurement error, bias, etc.). Hendrix's model is based on "data from 1979 to 2000 in the Lower Klamath Basin". The data is presented in Table 1 which cites Table A1 in STT (2005). There was no way for this reviewer to assess the actual data quality because STT (2005) simply says "Values of $\{N_{t3,Sep1}\}$, $\{v_{at}\}$, …. and $\{r_a\}$ were provided by the Klamath River Technical Advisory Team" (STT 2005, p. 23). I am reassured by the fact that there has been scientific review of the data as described in STT (2005, p. 1): "The spawner and recruitment data used in this report are derived from cohort reconstructions provided by the Klamath River Technical Advisory Team. These data and methods have been recently revised (KRTAT 2002). Changes in data and methodology used in the cohort reconstructions were reviewed and accepted by the STT and SSC during their review of the new KOHM in 2001—2002." However, it is preferable that there be a peer review by experts outside the routine technical committee process. Therefore, future evaluations of Hendrix' work might include rigorous reviews of the source data and how the quality possibly influences the modeling outcomes.

Similar statements could be made about the data in Table 2.

Using a longer data record may have provided a different, and presumably stronger, fit of the basic spawner–recruit model. What about spawning and recruitment data through BY 2004, which should have been available? Records at the Pacific States Marine Fisheries Commission StreamNet site (http://www.streamnet.org/index.html), indicate data may be available through 2004. Further, KRTT 2011 may include relevant data through 2010 and, although their 2011 report was not available for Hendrix's analysis, this indicates data was available beyond 2002.

Lindley and Davis 2011

The authors present a paper that is extremely succinct. While it appears to be very efficient and is generally very clearly written, the data exposition is too sparse. As a point of reference, I doubt this paper would be publishable in a peer-reviewed journal without further data substantiation or at least citations of other reports that contain the data. Summary tables showing the average values of escapement and habitat data for the 77 chinook stocks and a similar section on physical and environmental measures for the upper Klamath would help reviewers to visualize how the modeling led to the results.

As described further below, there is a potentially huge bias in predictive modeling derived from estimates of production or capacity based on any populations thought to be at reduced production relative to habitat capacity. Data could be improved by emphasizing reference populations that are either thought to be fully functioning or from a restricted set of years of "healthy" production, and eliminating from consideration any populations thought to be "under producing".

The use of smolt production data may have been a worthwhile alternative to adult escapement data primarily because smolt data better reflects the ability of the freshwater habitat to produce salmon. This is because adult escapement data is influenced by marine survival and harvest effects as well as freshwater habitat and environmental effects. Obviously, however, smolt data is less available than escapement information, so any model based on smolt data would be based on limited observations. Several starting points for acquiring Chinook smolt data are PSIT and WDFW (2010), Pinnix et al. (2011), and many other similar technical reports, and the StreamNet website (http://www.streamnet.org/index.html).

Evaluation of strengths and weaknesses of, and recommendations to improve analytic methodologies

Hendrix 2011

Strengths:

- The design and approach is creative and generally well-supported in the report.
- Adding the CVI to the spawner-recruit model, especially the Bayesian technique for parsing the survival effects of each hatchery and each river flow in the survival estimates.
- Breaking the model into two portions of the life-cycle.
- Showing the pseudocode in Appendix A is very helpful for reviewing the layout and sequential steps of the model.
- For lack of better information, the creative representation of the gradually improving habitat via sampling from the truncated distributions, as described on the bottom of page 12 and top of page 13.
- The work incorporates extensive techniques to adequately account for uncertainty (see McElhany et al. 2010).

Several weaknesses are noted here and in the next two sections. Many of "weaknesses" mentioned in this review will be posed in the form of questions or suggestions for improvement.

Regarding the selection of priors described in Section 2.1.4, is there any merit to evaluating the relative performance of [the?] alternative prior [to the?] distributions to determine their effect on parameter estimation?

The statement on p. 7 that "There is no analytical solution [for S_{msy}] to the equation (Quinn and Deriso 1999), thus it was solved iteratively….." may not be fully accurate. Hilborn (1985) made the case for a method to solve the equation. Solving iteratively may lead to the same result, but perhaps Hilborn's method could be helpful.

There was no way to review, fully understand, or critique the Klamath Harvest Rate Model (KHRM), which was an integral component of Hendrix's modeling, because the citation was "In prep" and the methods of that model were not fully explained by Hendrix.

The first paragraph of the Discussion (p. 17) forthrightly points out a major weakness of the modeling undertaken here. The two major drawbacks pointed out in that paragraph could ideally be addressed with additional modeling: testing the effects of 1) a modified F-control rule, and 2) the alternative predicted escapement floor under the DRA. The modeling should be continued with these two additions.

<u>Lindley and Davis 2011</u>

General compliments to the authors for a very creative approach to modeling the production of a large number of other Chinook populations, as described in Section 2.3.2, including the gross geographic, habitat, environmental, and anthropogenic variables that influence production. The method is succinct and appears to be mathematically and statistically correct (although to be fully confident of this, one would need to examine the computer models and outputs carefully). My remaining comments on the approach address alternative possibilities and data issues.

The authors initially justify their broad-scale, basin-wide approach by citing Fausch et al. (1988), Frissell et al. (1986), Lanka et al. (1987); and Feist et al. (2010) who, taken together, support using models based on measures made at the basin scale from analysis of maps as sufficiently appropriate for basin-scale planning and fishery management (i.e., estimating how many fish should be produced from the watersheds). However, much detailed work has been underway over the past several decades to improve methods for estimating the number of fish that should be produced from a given amount of salmonid habitat. While it is true that alternative approaches often require finer data that must be collected in the field or by remote sensing, approaches using finer scaled habitat information may arguably produce more accurate predictions of capacity for the upper Klamath Basin. Some of the methods I would strongly recommend, among several others, are:

- The Ecosystem Diagnostic Treatment (EDT) method was originally described by Lichatowich et al. (1995) and Mobrand et al. (1997). It has been gradually updated and improved (e.g., Blair et al. 2009) and has been widely applied in ESA salmon recovery settings to estimate historical abundance and establish recovery targets (e.g., LCFRB 2010, Carmichael and Taylor 2010).
- The Shiraz model has been successfully applied and validated at the meso-scale for Chinook salmon in the Snohomish River (WA) Basin (Scheuerell et al. 2006) and applied to predicting spring Chinook success in Columbia River tributaries (Honea et al. 2009).
- The Unit Characteristic Method -- Chinook and steelhead stream rearing capacity is determined using channel units and other attributes and maximum rearing densities. Recently used to estimate survival in adult equivilants per habitat unit/life-state time step (Cramer and Ackerman 2009).
- RIPPLE (Dietrich and Ligon 2008) is a digital terrain-based model for linking salmon population dynamics to channel networks. This meso-scale approach is based on remote sensing of salmonid habitat.

Evaluation of and recommendations to improve model assumptions, estimates, and characterization of uncertainty

Hendrix 2011

It seems unclear in the description of Methods at the top of page 11, how the expected relative proportions of ocean and stream type in the future are calculated. How were these proportions estimated for the Klamath? Based on similar watersheds analyzed by Liermann et al (2010)? Based on some proportional expectations presented in Hamilton et al. (2005)? Unless I missed it, this should be clarified.

The assumption described on page 11 that "stocking to capacity was modeled by assuming that the numbers of adult returns were at or above the unfished equilibrium population size $E_{new,i,t}$ from 2019 to 2032 for model iteration *i* and year *t*." leads to some questions regarding the likelihood of the reintroduction program to increase the number of fish in the Upper Klamath to its full potential immediately. More likely, numbers will build gradually and the relative contributions of natural and hatchery production will vary in the new habitat (e.g. Anderson 2011). In general, reintroductions of salmon populations via hatchery programs, especially in larger watersheds, have had mixed success. Regardless of the mode of rebuilding (hatchery introductions and/or natural spawning), it will take a number of generations for populations to colonize and adapt to the newly opened habitat and develop their full array of biological diversity and productivity (e.g. Schindler et al. 2010). This may also depend on the degrees to which the hatchery donor stocks have been genetically altered by their years in the hatchery (e.g. Reisenbichler 1997, Burger et al. 2000, Knudsen et al. 2006). Lastly, supplementation, as proposed here via fry planting to capacity (p. 11), has often had mixed results as well as biological risks (e.g. Mobrand et al. 2005 and citations therein, Araki et al. 2007) so cannot be counted on to bring the system up to full production immediately. I suggest using a term here that gradually builds the reintroduced populations, perhaps similar to the approach used for the gradual positive influence of habitat restoration.

There are a number of assumptions made that perhaps should be evaluated.

- Assumption of relative proportions of spring and fall runs and/or ocean and stream types
- Assumption of additional habitat available and its condition to support salmon
- Assumption that previous estimated productivity will be reflective of future productivity (p. 4) (Concerns on this one developed further in the section below).
- Assumption that the population was fully productive in its habitat during the period of the spawner-recruit data (addressed further below)

The modeling could be used to evaluate the sensitivity of these assumptions.

In item 10.a. on page 56, I note a concern about terminology that, if correct, could influence the outcome of the model. Natural escapement estimation is split between the Lower Basin and UKL. Do either of these terms, by definition or practically, include the reach Between Iron Gate and Keno and the associated tributaries? One [of the terms?] should, but the naming terminology raises concerns about that reach not being included in the computations. Further, I cannot see anywhere in the pseudocode described on pages 55 and 56 where this middle reach production is accounted for in the modeling under the DRA.

Likewise, I cannot see the allowance for the effects of the KRBA habitat improvements, as described on bottom of page 12 and top of page 13, in the pseudocode. The approach described on pages 12 and 13 is a reasonable initial replacement for lack of better information, but is it incorporated into the model? If so, it may need better representation in the pseudocode.

At what point in the model (as represented by the pseudocode) are the upper and lower basins predicted production estimates combined? It's clear in the description of the model predictions on page 15 (Sections 3.2 and 3.3), that the estimates are separate but then combined (Figure 13). However, I could not see this step in the pseudocode on pages 55-57. This needs to be spelled out more clearly.

There was no mention in the Methods about how commercial, tribal, and recreational harvest was calculated in the model. The first mention of those metrics occurs in the Results on pages 15 and 16. Those metrics were, however, indicated in the pseudocode.

Why do the estimated proportions of greater escapements and harvests decrease after 2032 (top of page 17)? What is the biological basis for the decrease?

Lindley and Davis 2011

The assumption about grouping spring, spring/summer and summer runs as "spring run", and grouping fall and late-fall runs as "fall" run (p. 5) is questionable. Although I am unclear about how these groupings may have influenced the outcome of the modeling, in some cases grouping summer Chinook into a spring grouping would not be supported by life history biology. The basic differentiation of spring Chinook is that they migrate upstream in late spring before lower rivers warm significantly and then seek cool-water pool habitat in which to hold without feeding throughout the summer until spawning begins in the fall (Quinn 2005). For example, in the relatively nearby Rogue River, spring Chinook are defined as those mature Chinook salmon that enter freshwater during the period of February through 15 July, and reach the upper watershed by August 16 (ODFW 2007). In another example, Skagit summer run Chinook are grouped with fall run for management purposes because the summer run fish are more similar to fall fish in that they spawn relatively soon after entering freshwater, rather than holding for a long time prior to spawning (PSIT and WDFW 2009).

Both Reports

The assumption that current production levels in basins other than the Klamath are representative of potential Klamath production is fundamental to both Hendrix and Lindley and Davis's work. In each case, the models used refer to production in other locations as a basis for estimating expected production in the Upper Klamath (Hendrix refers to Liermann et al. (2010) and Lindley and Davis depend on existing escapement counts and watershed variables). The problem is that, in many cases, these reference populations are suffering their own chronic under-production, or the production potential of those watersheds is also unknown. For example, Lindley and Davis (2011) state that they assembled baseline reference data from NWFSC and CDF&G databases and "…..computed average abundances over the period of record for each watershed." (p. 5). The problem is that many of the runs are chronically depressed, some to the point where they are listed as threatened or endangered under the Endangered Species Act. Therefore, recent records of escapement data are from periods that do not represent full habitat production potential.

The basic problem is one of "shifting baselines" as characterized by Pauly (1995) and Pauly et al. (2002). Although Pauly was primarily referring to the chronic effects of overfishing on marine stocks, the same effects are manifested in Pacific salmon, not only from continued long-term heavy fishing, but also the chronic and gradual deterioration of salmon habitat by human activities. The shifted baselines have become an issue of perception – people perceive the potential for salmon production by viewing data from the recent past, or during their own period of experience, during which populations may often be depressed relative to full potential, even after allowing for varying degrees of degraded habitat capacity (Knudsen 2002).

In applying these issues to the current attempt to estimate Klamath potential salmon production capacity, is the goal to elevate the Upper Klamath to the same degraded potential of many of the other stocks, or should the target be the actual true capacity of the basins to produce salmon? As in other locations, expectations for production similar to historical production are likely unrealistic because some of the habitat has been permanently altered. But there still may be a higher potential production than accounted for in the Lindley and Davis' (2011) model because their approach is based on other currently depressed stocks, many of which are likely underperforming relative to their true capacity.

The remedy to this issue has been at least partially addressed in other watersheds where listed populations have required ESA recovery plans. In several notable cases, the recovery planners have utilized various habitat-based production estimation techniques to estimate current or baseline production capacity, historical capacity (as a reference point), and targets for "full" recovery (see ODFW 2007; SSDC 2007 [see individual watershed chapters]; PSIT and WDFW 2009; LCFRB 2010; Carmichael and Taylor 2010; ODFW 2010 and other similar plans for details). These new targets are based on expectations for the restored habitats and are often substantially greater than the current or baseline production. Importantly, some of these watersheds are the same as those used as the basis for Lindley and Davis's (2011) model. Thus, even in their reference watersheds, local managers recognize that salmon production can be elevated from present conditions. Therefore, for the Klamath model, it may be preferable to use expected production data from these recent recovery plans rather than recent escapement data. The model may then be better at predicting "full" production potential in the Upper Klamath.

Determine whether the science reviewed is considered to be the best scientific information available

Hendrix 2011

There are significant drawbacks to relying on a spawner-recruit analysis based on recent escapement data as was done by Hendrix. Although his modeling techniques are apparently accurate, carefully posed, rigorous, and include full consideration of uncertainty, there may be a fundamental flaw in reliance on the Ricker model, especially for estimating fishery reference points. The major, and risky, assumption with a retrospective analysis, such as the basic Ricker spawner-recruit model, is that the past represents the future (Hilborn and Walters 1992). This assumption should always be investigated because the data used in the S-R model may not accurately represent the full production potential of the habitat being evaluated. As illustrated by Knudsen (2002), the Spawner-recruit model can be plotted, a curve fit, and fishery reference points calculated, but that does not necessarily guarantee that the fishery reference points are correct. In fact, very depressed data, relative to actual capacity, will produce results with depressed references points that will, in turn, perpetuate the depression. Hamazaki (2009) used a heuristic life history population model that showed how the Ricker model can produce erroneous (low) estimates of S_{msy} when the population is under higher exploitation rates. In the case of the Klamath, are the existing habitats producing the maximum number of individuals possible? Or is the population low relative to its potential? Every effort should be made to understand whether the existing Klamath habitat, upon which all of Hendrix's modeling depends, is producing as many smolts as possible on average. If not, then the model should be adjusted to account for the low production.

Lindley and Davis 2011

There appears to be some confusion or uncertainty about the relative roles of stream- and ocean-type Chinook in the Klamath system. The discussion in the full paragraph at the bottom of page 10 and on page 11 is inconclusive about what proportions of each ecological type were, or could be, represented in the upper Klamath. I note that, at the bottom of page 11, there is a reference to assuming, in the comparison to Liermann's et al. (2010) results, that the Upper Klamath would have stream-type production. Yet Hamilton et al. (2005) and Hendrix (2011) both clearly assert a role for ocean-type production in the Upper Klamath as well.

The reference on p. 12 to fish counts averaging 10,456 per year over 1925-1961 at a rack below Iron Gate (from Fortune et al. 1966) seems to imply that those numbers might reflect previous Upper Klamath production. But the discussion of those numbers is inconclusive.

Recommendations for further improvements

Hendrix 2011

Several minor points noted for improvement:

- There are a handful of wording and spell-check errors that can be cleaned up.
- Apparent variation in terminology for the same expression in second paragraph 11 and the several following equations: $E_{new\ stream}$ versus $E_{new\ stream}$.
- Table 5 caption should include mention that these results are for the NAA (if that's true).

- The word “lower” may need to be removed form the Table 7 caption – my interpretation is that table 7 represents the results of the modeling without the dams, i.e., including the upper watershed.

<u>Lindley and Davis 2011</u>
It would be preferable if a table or appendix was provided showing the specific escapement data for the 77 Chinook runs that were used in the model and/or the status of the runs (endangered, threatened, healthy, etc.). As it stands, the only indication of exactly which populations were used as the basis of the predictive models is Figure 1, which is too coarse to differentiate specific stocks and does not differentiate between “healthy” runs and depressed runs.

Several minor points were noted for improvement.

- In the second full paragraph on page 10 there is a statement that the median bootstrap predictions (for the combined spring-fall models) were slightly larger (3,633) than that of the models based only on spring-run Chinook salmon data. Yet, on page 9 it was stated that the model-predicted median was 3,921 which is larger, not smaller.
- Table 6 caption should indicate that it is based on all the Chinook models combined (spring and fall-run).

Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

I did not confer with others, as this review was intended to be an independent peer review. My recommendations are listed below.

Conclusions

Taken together, the reports by Hendrix (2011) and Lindley and Davis (2011) represent significant work contributing to estimation of the numbers of fish that could potentially be produced after Klamath River dam removal and implementation of the KRBA. Both approaches as described used a variety of innovative and state-of-the-art modeling techniques for their estimates. However, as noted in the detailed reviews above, there are several major concerns that have the potential to bias the results of both approaches, most likely in a downward direction. The reliance on existing and recent production data per habitat in other watersheds (both Hendrix, and Lindley and Davis) and within the Klamath (Hendrix) has the potential of underestimating the actual habitat capacity. Prior to further investigations on these issues, however, and assuming other comments are addressed, I believe the methods presented in the two reports provide sufficiently robust results to serve as preliminary, albeit likely conservative, estimates of the Chinook production benefits to be gained by dam removal and the KRBA program.

Recommendations in Accordance with the ToRs

The following recommendations for improvement are summarized from above.

Evaluation and recommendations of data quality

Hendrix 2011

- Future evaluations of Hendrix' work might include rigorous reviews of the source data and how the quality possibly influences the modeling outcomes.
- Using a longer data record could improve model fit.

Lindley and Davis 2011

- Additional exposition of the data used in the analysis would be helpful to visualize how the modeling led to the results.
- Do not use Chinook production or capacity data from any populations thought to be at reduced production relative to habitat capacity.
- Data could be improved by emphasizing reference populations that are either thought to be fully functioning or from a restricted set of years of "healthy" production.
- Use maximum average fish per habitat (spawning, rearing, etc.) metrics to relate directly to habitat measures in the watersheds to be reopened or restored.

Evaluation of strengths and weaknesses of, and recommendations to improve analytic methodologies

Hendrix 2011

- Consider evaluating the relative performance of the alternative prior to distributions to determine their effect on parameter estimation.
- Explicitly release the Klamath Harvest Rate Model (KHRM), as it relates to ERRDA, for peer review.
- Test the effects of 1) a modified F-control rule, and 2) the alternative predicted escapement floor(s) in the KHRM under the DRA.

Lindley and Davis 2011

Consider the benefits of approaches that require and utilize finer scaled habitat information, because they may arguably produce more accurate predictions of capacity for the upper Klamath Basin. Such methods include the Ecosystem Diagnostic Treatment (EDT), the Shiraz model, the Unit Characteristic Method, and RIPPLE, among others.

Evaluation of and recommendations to improve model assumptions, estimates, and characterization of uncertainty

Hendrix 2011

- Clarify how the expected relative proportions of ocean and stream type in the future are calculated.

- Consider adding a term that gradually builds the reintroduced populations, perhaps similar to the approach used for the gradual positive influence of habitat restoration.
- Use the modeling to evaluate the sensitivity of some of the key assumptions.
- Ensure that the reach Between Iron Gate and Keno and the associated tributaries are included in the DRA production estimates.
- Include a better representation of the gradually improving habitat (due restoration) in the pseudocode.
- Clarify the point in the model (as represented by the pseudocode) where the upper and lower basin predicted production estimates are combined
- Describe in the Methods how commercial, tribal, and recreational harvest was calculated in the model.
- Explain (perhaps in the Discussion) why the estimated proportions of greater escapements and harvests decrease after 2032 (top of page 17).

Lindley and Davis 2011
Consider the implications of possible erroneous grouping summer runs as part of the "spring run".

Both Reports
Use the best data and modeling techniques to avoid misrepresenting the Klamath production potential due to reliance on information from chronically under-producing systems. It may be preferable to use expected production data such as those used in recent recovery plans, rather than recent escapement data to better predict "full" production potential in the Upper Klamath.

Determine whether the science reviewed is considered to be the best scientific information available

Hendrix 2011
Every effort should be made to understand whether the existing Klamath habitat, upon which all of Hendrix's modeling depends, is producing as many smolts as possible on average. If not, then the model should be adjusted to account for the low production.

Lindley and Davis 2011
Clarify the relative roles or proportions of stream- and ocean-type production in the Upper Klamath.

Clarify the purpose of describing the fish counts over 1925-1961 at a rack below Iron Gate (from Fortune et al. 1966).

Recommendations for further improvements

Hendrix 2011
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<u>Lindley and Davis 2011</u>

Provide a table or appendix showing the specific escapement data for the 77 Chinook runs that were used in the model and/or the status of the runs (endangered, threatened, healthy, etc.).

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Appendix 1: Bibliography of materials provided for review

Supporting Reference and Background Materials Included in the Packet

Reference Materials

Liermann, M. C., R. Sharma, and C. K. Parken. 2010. Using accessible watershed size to predict management parameters for Chinook salmon, Oncorhynchus tshawytscha, populations with little or no spawner-recruit data: a Bayesian hierarchical modelling approach. Fish Manag Ecol 17:40–51.

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Klamath Settlement Agreements

Summary of the Klamath Basin Settlement Agreements. 2010

Klamath Basin Restoration Agreement for the Sustainability of Public and Trust Resources and affected Communities (KBRA). February 18, 2010.

Klamath Hydroelectric Settlement Agreement (KHSA). February 18, 2010

Appendix 2:

Statement of Work for Dr. Eric Knudsen

External Independent Peer Review by the Center for Independent Experts

Klamath River Fall Chinook salmon production model and final report

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The United States, the States of California and Oregon, the Klamath, Karuk, and Yurok Tribes, Klamath Project Water Users, and other Klamath River Basin stakeholders negotiated the Klamath Basin Restoration Agreement (KBRA) and the Klamath Hydroelectric Settlement Agreement (KHSA), thereby proposing the largest dam removal restoration action in US history. In 2012 it is anticipated that a determination will be made by the Secretary of the Interior, in consultation with the Secretary of Commerce regarding removal of four hydroelectric dams on the Klamath. A benefit-cost (BC) analysis is needed to inform this determination. The BC analysis will compare two alternatives: (1) dam removal and implementation of the KBRA; and (2) current conditions projected into the future. To inform the BC analysis and environmental compliance documents, two Klamath River Chinook fish production models (Option A and B) has been developed. Option A is capable of providing annual forecasts of stage specific abundances under the two alternatives over a 50 year time period. A written technical report will be completed and available for the CIE review on 16 May 2011 including: the assumptions incorporated into the fish production model, mathematical equations used to define reproduction, growth, and mortality for all phases of the fish production model, and definition of model coefficients described based on how they were derived. This model and report will inform a landmark federal action with a recent litigious history. The results of this model have large potential implications on the economy of California and Oregon, commercial, tribal and recreational fisheries in California and Oregon, and tribal and public trust resources. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall possess a combination of expertise with working knowledge and recent experience in the application of fish production modeling, Bayesian methodologies, hydrology, climatology, river restoration, and Pacific salmon life history. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs must not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
3) No later than 2 June 2011, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

9 May 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
16 May 2011	NMFS Project Contact sends the CIE Reviewers the report and background documents
16-30 May 2011	Each reviewer conducts an independent peer review as a desk review
2 June 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
16 June 2011	CIE submits the CIE independent peer review reports to the COTR
20 June 2011	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2: Tentative Terms of Reference for the Peer Review

Klamath River Fall Chinook salmon production model and final report

1. *Evaluation and recommendations of data quality*
2. *Evaluation of strengths and weaknesses of, and recommendations to improve analytic methodologies*
3. *Evaluation of and recommendations to improve model assumptions, estimates, and characterization of uncertainty*
4. *Determine whether the science reviewed is considered to be the best scientific information available.*
5. *Recommendations for further improvements*
6. *Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations*