Review Report: Biological Opinion on the Effects of Ocean Harvest of Salmon on Sacramento River Winter Chinook Evolutionary Significant Unit (ESU) [1]

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Executive Summary

This independent CIE review evaluated the 2010 draft Biological Opinion (BO) for Sacramento River Winter Run (SRWR) Chinook, a population classified as *endangered* under the ESA. The review concludes that the cohort reconstruction in Lindley et al. (2010) and the BO was undertaken to a high standard; the reports provide clear articulation of the analytical procedures and present well-reasoned arguments. Lacking from the analysis is consideration of the statistical variance. Such calculations would assist to interpret the trends in the data; however, they are unlikely to fundamentally alter the conclusions of the BO. In addition to very low recent escapements of SRWR Chinook, the cohort reconstruction indicated very low cohort replacement rates, dramatically lower than previous values. These occurred in spite of a total fishing closure in 2008 and 2009 (primarily targeting depressed Sacramento River fall Chinook and other stocks), implicating reduced early life survival as the main causative factor for the recent decline of SRWR Chinook.

The BO proposes to continue management measures that were initiated by the 2004 BO; no new measures are contemplated. There is an assumption that the management action (maintain recent fishing regulations) will not jeopardize the viability of the listed SRWR Chinook. Cohort reconstructions and fishing impact analysis indicate fairly consistent Age 3 contact rates (15-20%). This could be construed as a modest impact of fishing, but they still may be too high to permit recovery under low early life survival regimes.

The BO concludes that the SRWR Chinook population has a moderate-to-high risk of extinction, making a precautionary approach the prudent one. This approach is also justified in view of uncertainties associated with climate change and declines in ocean productivity. Uncertainties are also generated by the question as to whether the population is responding to a systematic decline in productivity or merely to temporary adjustments associated with natural variations in the ecosystem.
The key conservation question is how to catalyze the recovery of SRWR Chinook and ensure the viability of the population. Recovery actions listed in the BO include phased reintroductions, restoration of ecological flows, Delta Ecosystem Restoration, restoration

[1] While the terms of reference for this assignment specify Central Valley Chinook Salmon, the Biological Opinion provided for review is directed at Sacramento River Winter Chinook. The latter is the focus of the present CIE review.

of habitat function and reduction in predation, incentives for water conservation, and management of salmon harvest. In view of the moderate-to-high extinction risk, it is essential to find ways of improving SRWR Chinook survival. Within a short-term time frame, management of salmon harvest provides the most practical means to assist the population to recover when early life survival conditions improve; reduction in fishing mortality could effectively increase spawner returns by as much as 10-25%. The extent of additional fishing mortality reductions need to reflect the risk tolerance of the responsible management agencies. The review concludes that high quality scientific information has been compiled to inform the BO.

Background

The 2004 BO covering SRWR Chinook will expire in April 2010 and NMFS-SFD-SWR has prepared a new draft BO that will come into effect in May 2010. The SRWR Chinook population has been negatively affected by hydro development, habitat loss and fragmentation, global warming, reduced marine survival, fishing, hatchery introgression and loss of fitness. The population exists at a low level of abundance compared to historic levels and SRWR Chinook have been listed as endangered under the Endangered Species Act. Recent escapements have declined severely and were below 3,000 Chinook during 2007, 2008 and 2009, only slightly above the Recovery Criteria of 2500. Cohort replacement rates were 0.32, 0.18 and 0.16 in these 3 years indicating a rapidly declining population. During the 2000's, there was also a coincidental severe decline in Sacramento River fall Chinook (Lindley et al. 2009) which is outside the scope of the present review.

The main action in the BO involves area and timing closures between Point Arena and the U.S.-Mexico border extending over the fall-spring period. There are also size limits set out for the recreational and commercial salmon fisheries. This action continues management measures that have been in place since the previous BO was issued in 2004; no new management measures are proposed.

This report is the result of desk analysis undertaken over the period of Jan. 12 – Feb. 9. 2010. The report was prepared to address the questions listed in Annex 2. I addressed the questions by evaluating the assumptions underlying the analysis, the statistical rigor of the results, the justification for the quantitative results and more broadly the interpretations presented in the BO. The latter comments recognize the endangered status of SRWR Chinook and the need to develop a sound management strategy that protects the population from extinction and promotes population recovery.

Description of Review Activities

The review involved critical analysis of the reports listed in Appendix 1. Several additional references cited in the reports were also examined and a Pacific Salmon Commission Technical Report on Coded Wire Tagging (CWT) of Salmon (Expert Panel on the Future of the Coded Wire Tag Program for Pacific Salmon 2005) was also consulted.

Summary of Findings

1. Evaluate the strengths and weakness of the cohort reconstruction analysis used to estimate the impact of fishing harvest on the ESUs considered in this Opinion.

Cohort analysis involves the backwards reconstruction of a population, beginning with estimated spawning escapements of the oldest aged fish, estimated fishery recoveries, and assumptions regarding natural mortality rates (Expert Panel on the Future of the Coded Wire Tag Program for Pacific Salmon 2005). Overall, the cohort reconstruction analysis presents a well-reasoned and defensible estimate of the impact of fishing on SRWR Chinook. The various parameters estimated include harvest rates by age and fishery, age-specific maturation rates, contact rates and impact rates by fishing area and month. The data permit the identification of trends in marine survival over time. All of these parameters provide the foundation for the conclusions presented in the BO.

O'Farrell et al. (2010) developed the results for the cohort reconstruction – these analyses reflect an appropriate treatment of the data which will be understandable by most fisheries scientists. The data appendices are complete and well organized making it easy to understand the analytical steps that were followed.

2. Evaluate the interpretation of the coded wire tag recoveries and cohort reconstruction analysis, and any conclusions drawn about how these results are produced in light of how the fishery is managed.

CWT is widely employed for evaluation of hatchery production, identification of migration and exploitation patterns, estimating and forecasting abundance, and in-season regulation of fisheries. The cohort analysis results are used to guide management policy making it important to understand the statistical properties of the data. Probably the biggest weakness in the cohort analysis reflects the absence of uncertainty analyses for the parameter estimates, whether generated from variance or bias. Variance measures the variation among estimated catches of, and impacts on, CWT groups of salmon based on releases of individual CWT fish as it may depend on exploitation rates, size of CWT release groups, and sampling rates in fisheries and spawning escapements (Expert Panel on the Future of the Coded Wire Tag Program for Pacific Salmon 2005). Statistical uncertainty is affected by run size insofar as fewer CWTs are recovered under low stock size, thereby increasing variance. Bias reflects the discrepancy between the expected value of estimates and the true (but unknown) values.

A basic assumption of the SRWR Chinook cohort reconstruction is that hatchery and wild stocks experience similar exploitation rates. This assumption would be challenging to test owing to the difficulty of CWT tagging the naturally produced Chinook. In one study (Unwin 1997) there were survival differences between hatchery Chinook and wild fish; these have implications for recovery actions. In view of the difficulty to collect this information for SRWR Chinook, it would be informative to review the literature for both Chinook and coho salmon.

3. How could the cohort reconstruction data or analysis be improved?

The cohort reconstruction could be improved by testing critical assumptions related to the use of CWTs for quantitative estimation. For example: 1) what is the percentage of the ocean catch that is sampled at the landing sites? 2) what is the relative exploitation rate of hatchery and wild Chinook? 3) what is the statistical uncertainty? 4) what is the mortality rate for under-sized fish?

4. Are there additional quantitative or qualitative ways other than coded wire tag based methods to assess harvest impacts not considered in this Opinion?

Historically, ocean tagging of adult Chinook or fin-clipping of juveniles was utilized to generate harvest information. Neither of these approaches provides the degree of resolution of CWT programs. Alternate approaches that have been applied for Chinook marking include otolith thermal marking (for hatchery populations) and genetic stock identification methods. The latter is most frequently undertaken via analysis of satellite DNA, and is widely applicable to Chinook salmon. However, these technologies, even when used together, do not usually provide the resolution that is achievable by CWT. DNA stock identification requires a coast-wide genetic baseline encompassing Californian Chinook stocks and the reviewer is unaware of the existence of such a database.

Other approaches include the use of PIT (Passive Induced Transponder) tags and RFID (Radio Frequency Identification) tags which have been used effectively on Chinook smolts. These remote sensing methods rely upon "listening" devices located in close proximity to Chinook migration routes, and have been used in freshwater. Neither of these approaches permits mass-marking and they are therefore much less applicable than CWTs for estimating fishery and population parameters.

The approach taken in the BO to monitor the winter-run fishery involves post-season analysis to determine the status of the fishery in relation to the estimated stock sizes. An alternative quantitative or qualitative approach would involve pre-season forecasting based on either smolt counts, sibling populations (i.e. age-3 in year x to predict age-4 in year x+1) or parental abundance. The information so-derived could be used to fine-tune fisheries regulations based on the forecasts.

5. Overall, does the biological opinion represent the best scientific information available?

5.A. <u>Assumptions</u>

The BO makes a number of assumptions that require further evaluation.

1) The salmon by-catch in the groundfish fishery (whiting and bottom trawl) showed no incidental take of SRWR Chinook based on only one year of data. This information should be replicated to verify the composition of the by-catch in the event there are distributional shifts of SRWR Chinook relative to the location of the fishing fleet.

2) The argument developed under 2.a. on ocean productivity was developed for Sacramento River Fall Chinook (SRFC). The argument needs to be evaluated for winter-run Chinook. In particular "the timing of the onset of upwelling is critical for juvenile salmon that migrate to sea in the spring". This is a well-known feature of marine fish biology: the "match-mismatch" hypothesis. It would be important to investigate whether juvenile SRFC and SRWR Chinook have similar timing and distribution patterns and the respective strategies that they have evolved to appropriately time their migrations in the marine environment. This could be addressed using satellite DNA markers; genetic differentiation occurs in populations of Chinook salmon, including differentiation of winter-run from fall-run populations in the Upper Sacramento River (Garza et al. undated).

3) The BO summarizes information from Wells et al. (2008) to show that index parameters were generally favorable for salmon survival off California in 2007 and 2008. These index results are inconsistent with low SRWR Chinook returns and cohort replacement values for the broods that were resident in the ocean during 2007 and 2008.

4) The BO makes the assumption that the management action (maintain recent fishing regulations) will not jeopardize the viability of the listed SRWR Chinook. The management regime is identical to the 2004 BO which encompassed a period of both increasing (2004-2006) and decreasing (2007-2009) escapements.

5. B. Interpretation

5) In the section on Salmon ocean fishery, it states that: "It does appear from the scale of effort in this graph that the recreational fishery does represent significantly more effort than the commercial fishery, which might explain the greater number of tag recoveries". To justify this statement it would be important to compare catch-per-unit-effort as well as effort alone to account for differences in numbers of tag recoveries.

6) In section 2. Salmon ocean fishery there is an extensive discussion on SRFC and Klamath River Fall Chinook (KRFC). The implications for SRWR Chinook need to be provided and if the SRFC/KRFC data are used as a surrogate for SRWR Chinook this should be clearly stated.

7) In section 3. Cohort reconstructions and fishing impact analysis indicate fairly consistent Age 3 contact rates (15-20%). This could be construed as a modest impact of fishing, but they still may be too high to permit recovery under low marine survival regimes.

5.C. Fisheries Management and Recovery Planning

8) The fact that SRWR Chinook had very low cohort replacement rates coincidental with closure of the fishery in 2008 and 2009 (to protect SRFC and other Chinook populations) indicates that fishing mortality is not presently suppressing the population.

9) The BO indicates that SRWR Chinook can sustain present levels of fishing during periods of favourable early life survival conditions:

> "It is clear that this winter-run population (and consequently the entire ESU) is capable of positive growth (cohort replacement rates greater than 1.0) while sustaining the 10-25% reduction in the cohort spawning returns, at least up to returns of about 15,000 individuals during times of favourable or improving conditions that occurred for the most part over the last 15 years."

This raises a critical concern: what is sustainable during periods of high productivity may be detrimental to the population during periods of low productivity.

10) The BO discusses periodic reductions of marine productivity and Chinook survival. There should be built-in flexibility in the fisheries management system to reduce exploitation rates during periods of reduced marine survival.

11) Recovery criteria provide good targets including:
    - Maintenance of at least 3 populations
    - Census population > 2500
    - Stable run
    - No catastrophic events
    - Low hatchery influence

These are ambitious but necessary criteria for restoration of SRWR Chinook. An implementation strategy for the recovery plan should be developed so that management actions, budgets and timelines can be clearly specified.

12) There are a set of management actions identified for regulation of the fishery by means of area-specific measures including open and closed seasons, catch quotas, landing limits, bag limits, size limits and gear restrictions. A model is needed to

examine the effectiveness and trade-offs between the management measures and to evaluate the socio-economic repercussions.

13) The present SRWR Chinook population declined dramatically over the past 3 years and the BO proposes no change in current fisheries regulations. Additional reductions in exploitation rate (such as those in 2008 and 2009) should be considered until the population shows evidence of recovery.

14) Explicit open and closed seasons are defined in the BO. The timing of openings should be revisited to determine whether adjustments could assist in SRWR Chinook recovery.

5.D. Precautionary Principle

The Precautionary Principle is an approach to uncertainty, and provides for action to avoid serious or irreversible environmental harm in advance of scientific certainty of such harm (Cooney 2004). The precautionary principle supports action to anticipate and avert environmental harm without requiring a clear demonstration that such action is necessary. It is applicable when science cannot provide definitive evidence of all forms of harm in advance. During the late 1990's, Gilchrest-Farr "Fisheries Recovery Act" was introduced and makes use of the precautionary approach as one of its centerpieces (Thomas and Grader 2000). The legislation defines "Precautionary Approach" as "exercising additional caution in favor of conservation in any case in which information is absent, uncertain, unreliable, or inadequate as to the effects of any existing or proposed action on fish, essential fish habitat, other marine species, and the marine ecosystem in which a fishery occurs;" and "selecting and implementing any action that will be significantly more likely than not to satisfy the conservation objectives....."

The BO classifies SRWR Chinook as having a moderate-to-high risk of extinction, making a precautionary approach the prudent one. The approach is also justified in view of uncertainties associated with declines in ocean productivity and climate change. Uncertainties are also generated by the question as to whether the population is responding to a systematic decline in productivity or merely to temporary adjustments according to natural variation in the ecosystem.

5.E. Evaluation of Scientific Information

The question asks whether the BO represents the "best" scientific information available. Any scientific investigation can be improved and a more relevant question might be: Does the BO represent adequate scientific information to support informed decision making regarding the management and conservation of SRWR Chinook? The answer is yes: the scientific information in the BO and the supporting documents is high quality and credible. Effective application of the science so that it supports the recovery of the SRWR Chinook population in a timely fashion is the immediate challenge.

Conclusions and Recommendations

The cohort reconstruction is based on the work of O'Farrell et al. (2010) and clearly lays out the analytical methodology based on the CWT recoveries. It is complemented by extensive Appendices and a transparent presentation of the data. The results are highly credible. Missing from the analysis are variance measures and statistical descriptors, e.g. 95% confidence intervals and analysis of variance calculations. It is unlikely that these additional statistical analyses would fundamentally change the conclusions, however they would be informative to complement the data in the BO.

In addition to CWT analysis, DNA analysis of Chinook salmon from the commercial and recreational fishing grounds would serve as a useful approach to determine SRWR Chinook vulnerability to fishing mortality relative to other Chinook ESUs. This would broaden the geographical coverage and could have important fisheries management implications. I am unaware of the scope of DNA analysis in Californian Chinook and whether the other ESUs are well represented. If such is the case, then a more broadly based DNA analysis would provide perspective on the role of SRWR Chinook in the marine fisheries.

I agree with the BO in regards to the classification of extinction risk of SRWR Chinook. NMFS concluded that winter-run are at a moderate-to-high risk of extinction based on the small population size and greater risks associated with only one population. As well, NMFS concluded that winter-run are at a high risk of extinction based on spatial structure. The BO makes the statement that NMFS believes that the winter-run ESU is currently not viable and is at high risk of extinction as a single population representing the entire ESU. The VSP (Viable Salmonid Population) parameters and their associated extinction risks presented in the BO are summarized below:

VSP parameters	Extinction Risk
Population size	Moderate-to-high
Population growth rate	Moderate
Spatial structure	High
Diversity	High

In relation to the Recovery Criteria of 2500 spawners, recent escapements and cohort replacement rates are:

Year	Escapement	Cohort Replacement Rate
2006	17,304	2.11
2007	2,542	0.32
2008	2,850	0.18
2009	2,750	0.16

Over the last 3 years, there has been a dramatic reduction in returns and cohort replacement rates. In view of the declining escapements (which occurred in spite of the closure of the fishery during 2008 and 2009), the SRWR Chinook population appears to be on a precipitous downward trajectory. The key conservation question is how to catalyze the recovery of SRWR Chinook and ensure the viability of the population. The

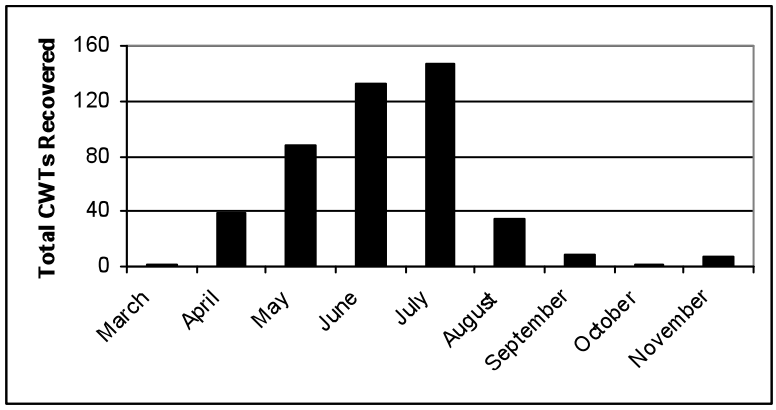
population is only slightly above the Recovery Criteria, and is vulnerable to extinction. Recovery actions listed in the BO include phased reintroductions, restoration of ecological flows, Delta Ecosystem Restoration, restoration of habitat function and reduction in predation, incentives for water conservation, and management of salmon harvest to support recovery of ESA-listed ESUs. These recovery actions are well-founded.

The BO concludes that the time and area closure measures present since 2004, when coupled with size limits, will avoid jeopardizing the continued existence of SRWR Chinook. The draft Biological Assessment (p.40) states:

> **"**We therefore conclude that the proposed action is likely to adversely affect the SRWR Chinook ESU due to the incidental take. However, we further conclude that the protective fishery management measures proposed in this BA will serve to avoid jeopardizing the continued existence of the SRWR Chinook salmon ESU."

In view of the relatively high extinction risks described in the BO, it would be essential to find other ways of improving SRWR Chinook survival in the short-term. This should include consideration of additional fishery regulations to maintain low fishing mortality so as to protect SRWR Chinook. The BO concludes that the SRWR Chinook ESU decline is not directly a result of fishing but is more likely due to poor early life survival conditions. The decline spans 2008 and 2009, when there was no harvest, indicating that early life survival was poor in freshwater and/or marine environments. Maintenance of low fishing mortality during periods of low early life survival, can partially mitigate the decline of salmon populations. Within a short-term time frame, management of salmon harvest provides the most practical means to assist the population to recover, and could effectively increase spawner returns by as much as 10-25%.

There are various ways to improve SRWR Chinook survival by means of fisheries regulation. These could involve closing the fishery until several years of suitable spawning escapements are observed. Benchmarks would be needed to define target population sizes (above the recovery criteria of 2500) to reduce the extinction risk and to determine when the population is sufficiently robust to support a fishery. There are a number of ways to reduce fishing mortality. The temporal distribution of CWT recoveries in the Draft Final BA (recovery years 2000-2007) is shown in the histogram below.



The data indicate that it would be necessary to close for a portion of the May – July fishing period that encompasses most of the catch. An early closure (May and/or June) would be less preferable than a July closure since fish protected in May and/or June could end up being harvested in July or August. Reductions in harvest rate could also be achieved via more stringent size regulations, area closures to the south of Point Arena, non-retention of SRWR Chinook, reduced individual daily bag limits, catch quotas and gear restrictions.

Management actions are a reflection of risk tolerance. SRWR Chinook are depressed and their future hinges upon a reversal of poor early life survival rates. Under the precautionary principle a risk averse approach is relevant for an endangered ESU and this implies vigorously implementing the identified recovery actions to support population recovery.

Conclusions

- The BO presents a highly defensible cohort reconstruction which is clearly presented and well supported by the data.
- It is unlikely that alternative approaches and/or technologies could generate the quality of scientific information presented in the BO.
- Based on the most recent 3 years of escapement and cohort replacement data, a precautionary, risk-averse approach to fisheries regulation is required to protect SRWR Chinook.
- Recovery planning activities in the BO are well conceived and need to be implemented as soon as possible.
- Management of exploitation rate and salmon harvest provides the most effective approach to stabilize and promote recovery of SRWR Chinook in the short-term.

Recommendations

- Determine and report the variability of the estimated parameters used for the cohort reconstruction.
- Test critical assumptions regarding the application of CWTs and the interpretation of CWT results e.g. hatchery and wild fish have the same exploitation patterns.

- Undertake a literature review to compare the production dynamics of wild vs. hatchery Chinook.
- Carry out DNA analysis to evaluate Chinook stock composition in marine fishery areas.

References

Cooney, R. 2004. The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An issues paper for policy-makers, researchers and practitioners. IUCN, Gland. http://www.bitsandbytes.ca/resources/PrecautionaryPrincipleissuespaper.pdf

Expert Panel on the Future of the Coded Wire Tag Program for Pacific Salmon. 2005. Report. Pacific Salmon Comm. Tech. Rep. No. 18: 230 p

Garza, J.C., S.M. Blankenship, C. Lemaire and G. Charrier. Undated. Genetic population structure of Chinook salmon (*Oncorhynchus tshawytscha*) in California's Central Valley. Draft Final Report for CalFed Project "Comprehensive Evaluation of Population Structure and Diversity for Central Valley Chinook Salmon". http://www.yubaaccordrmt.com/Studies%20%20Reports/CVChinDraftFinalReport-Garza.pdf

Lindley, Steven T. et al. 2009. What caused the Sacramento River fall Chinook stock collapse? Pre-publication report to the Pacific Fishery Management Council. March 18, 2009.

O'Farrell, M.R., M.S. Mohr and A.M. Grover. 2010 (draft). Sacramento River winter Chinook cohort reconstruction: analysis of ocean fishery impacts. NOAA Technical Memorandum. 108p.

Thomas M. and Z. Grader. 2000. The precautionary principle: making it work for fish and fishermen. Fishermen's News. June, 2000. http://www.pcffa.org/fn-jun00.htm

Unwin, M.J. 1997. Fry-to-adult survival of natural and hatchery-produced Chinook salmon (*Oncorhynchus tshawytscha*) from a common origin. Can. J. Fish. Aquat. Sci. 54: 1246-1254.

Appendix 1: Bibliography of Materials Provided for Review

Anonymous. 2010A (draft). Biological Opinion on the effects of Ocean Harvest of Salmon on Sacramento River Winter Chinook Evolutionary Significant Unit (ESU).

Anonymous. 2010B (revised final). An assessment of effects on Sacramento River Winter-Run Chinook Salmon from Authorization of Ocean Salmon Fisheries Pursuant to the Pacific Coast Salmon Fishery Management Plan and Additional Proposed Protective Measures.

Lindley, Steven T. et al. 2009. What caused the Sacramento River fall Chinook stock collapse? Pre-publication report to the Pacific Fishery Management Council. March 18, 2009.

Lindley, Steven T. et al. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary & Watershed Science 5: Article 4.

National Marine Fisheries Service. 2009. Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter‐run Chinook Salmon and Central Valley Spring‐run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead. Sacramento Protected Resources Division. October 2009.

O'Farrell, M.R., M.S. Mohr and A.M. Grover. 2010 (draft). Sacramento River winter Chinook cohort reconstruction: analysis of ocean fishery impacts. NOAA Technical Memorandum. 108p.

Appendix 2: CIE Statement of Work

Statement of Work for Dr. David Levy (Levy Research Services Ltd)

External Independent Peer Review by the Center for Independent Experts

Biological Opinion on the effects of Ocean Harvest of Salmon on Central Valley Chinook Salmon Evolutionarily Significant Units (ESUs).

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.com.

Project Description: This biological opinion will evaluate the impacts of Ocean Harvest of Salmon on ESA-listed Chinook salmon ESUs in California's Central Valley. The biological opinion will analyze issues such as level of take of listed ESUs vs. non-listed ESUs managed under the Salmon Fishery Management Plan of the Pacific Fishery Management Council, and the impact of this level of take on the survival and recovery of ESA-listed . 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 have working knowledge and recent experience in the application of (1) salmon cohort reconstructions through the use of coded wire tag in assessment of salmon population abundance and distribution, and 2) salmon population ecology. 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.

This list of pre-review documents may be updated up to two weeks before the peer review. **Any delays in submission of pre-review documents or reports for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables.** Furthermore, the 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.

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 can 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 9 February 2010, 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 to Dr. David Die, CIE Regional Coordinator, via email 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.

5 January 2010	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
12 January 2010	NMFS Project Contact sends the CIE Reviewers the report and background documents
12 January – 9 February 2010	Each reviewer conducts an independent peer review as a desk review
9 February 2010	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
23 February 2010	CIE submits the CIE independent peer review reports to the COTR
2 March 2010	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.

Key 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: Terms of Reference for the Peer Review

Biological Opinion on the effects of Ocean Harvest of Salmon on Central Valley Chinook Salmon Evolutionarily Significant Units (ESUs).

1. Evaluate the strengths and weakness of the cohort reconstruction analysis used to estimate the impact of fishing harvest on the ESUs considered in this Opinion.
2. Evaluate the interpretation of the coded wire tag recoveries and cohort reconstruction analysis, and any conclusions drawn about how these results are produced in light of how the fishery is managed.
3. How could the cohort reconstruction data or analysis be improved?
4. Are there additional quantitative or qualitative ways other than coded wire tag based methods to assess harvest impacts not considered in this Opinion?
5. Overall, does the biological opinion represent the best scientific information available?