Joint U.S. – Canada Technical Review Panel for the Pacific Hake / Whiting Stock Assessment

Hotel Deca
4507 Brooklyn Avenue NE
Seattle, Washington

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Report prepared for:

Center for Independent Experts

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Executive Summary

- A STAR Panel met at the Hotel Deca, in Seattle, Washington, from February 7 – 11, 2011 to review the joint U.S. – Canada stock assessment for Pacific hake / whiting.

- The objective of the Panel was to conduct a detailed peer review of the results of the stock assessment, including data inputs and analytical models, and to summarize this evaluation clearly in a STAR Panel report to provide the best available scientific information to the Pacific Fisheries Management Council.

- The Joint STAT had reconstructed and re-evaluated nearly all of the data sources available for Pacific hake prior to this assessment.

- Primary fishery dependent and independent data sources used in the assessment included: total catch from all U.S. and Canadian fisheries, age compositions from the U.S. and Canadian fishery, and biomass indices and age compositions from the Joint U.S. and Canadian integrated acoustic and trawl survey.

- Acoustic survey data prior to 1995 were excluded and kriging has been applied to data since then to provide a more robust estimate of biomass and an estimate of annual sampling variability.

- Results from two models (SS and TINSS) were presented and included in forecast decision tables.

- Both models integrate over substantial uncertainty that is likely to be a gross underestimate of the true uncertainty in current stock status and future projections.

- The primary source of uncertainty relevant to management of the 2011 fishery is the strength of the 2008 year class, the estimate of which is highly uncertain.

- The STAR Panel concluded that the final base models (SS and TINSS) constitute the best available scientific information on the status of Pacific hake in U.S. and Canadian waters. The Panel tempered its conclusion on the uncertainty of the 2008 year class and the impact of this uncertainty on projections in 2011 and beyond. It also indicated that alternative model structures, including time-varying selectivity would likely give less optimistic characterizations of current stock status.

- A STAR Panel report was completed before the end of the meeting.

- The meeting was highlighted by the level of cooperation between the U.S. and Canadian assessment teams in presenting a clear and transparent collaborative stock assessment.

Background

A STAR Panel met at the Hotel Deca, in Seattle, Washington, from February 7 – 11, 2011 to review the joint U.S. – Canada stock assessment for Pacific hake / whiting (*Merluccius productus)*.

The Panel consisted of four members, one from the Scientific and Statistical Committee (SSC), and three external (CIE) reviewers, including myself. Tom Jagielo (SSC) chaired the Panel; Jan Yjiao and Max Cardinale were the other CIE reviewers. In addition, there were four advisory representatives to the Panel: Greg Workman (DFO), Dan Waldeck (PWCC GAP), Rob Jones (NWIFC GMT), and John DeVore (PFMC). There was also numerous scientific staff from the NWFSC and members of the general public representing different groups within the fishery.

The terms of reference for the joint U.S. – Canada technical review for the Pacific hake / whiting stock assessment, the proposed meeting agenda, the assessment document, and all background documents were posted and available for review on a PFMC FTP site by January 25, 2011.

The objective of the Panel was to conduct a detailed peer review of the results of the stock assessment, including data inputs and analytical models, and to summarize this evaluation clearly in a STAR Panel report to provide the best available scientific information to the PFMC.

Prior to 1997, separate Canadian and U.S. assessments for Pacific hake were submitted to each nation's assessment review process. Since 1997, the Stock Assessment and Review (STAR) process for the Pacific Fishery Management Council (PFMC) has evaluated assessment models and the PFMC council process, has generated management advice that has been largely utilized by both nations. A joint U.S. - Canada treaty on Pacific hake was formally ratified in 2006 but has not yet been fully implemented.

Whereas the 2010 assessment and review process included competing stock assessments from U.S. and Canadian analysts, as well as disagreement among analysts and reviewers on the use of certain data sources, the 2011 assessment represented the work of a joint U.S. and Canadian stock assessment team. In addition, the current stock assessment included a nearly complete re-analysis of all available data for the Pacific hake.

This set the background for the current STAR Panel. Dezhang Chu and Rebecca Thomas, from the NWFSC, presented analyses of the acoustic survey time series. Ian Stewart (NWFSC) and Robyn Forrest (DFO) presented the assessment methodology and results on behalf of the Joint Stock Assessment Team (STAT).

The STAR Panel provided a thorough review of the acoustic survey data and the stock assessment. The chair, Tom Jagielo, ensured that the Panel completed its objectives in a professional and proficient manner within the allotted time. Tom is to be commended for his timely compilation of the STAR Panel report during the meeting, to the point of having the report completed before the end of the meeting. The advisors to the Panel provided an important role. John DeVore kept the Panel focused on the objectives of the PFMC and

provided a corporate memory of the Pacific hake assessment history. Greg Workman provided a Canadian perspective, voicing the concerns of DFO. Rob Jones and Dan Waldeck ensured that their comments were included in the STAR Panel report. The Acoustic Survey team, and the Joint STAT, are to be commended for their thorough and clear presentations and for their willingness to answer requests by the Panel; no requests went unanswered.

Description of Reviewer's Role in Review Activities

The terms of reference for the joint U.S. – Canada technical review for the Pacific hake / whiting stock assessment, the proposed meeting agenda, the assessment document, and all background documents were posted by Stacey Miller (NFSC) on an FTP site approximately two weeks prior to the STAR Panel review. I read and reviewed all of these documents prior to the meeting.

During the STAR Panel review, detailed presentations were given by both the Acoustics Survey team, and the Joint STAT. These presentations were followed by extensive question, discussion, and review periods. On multiple occasions, the presenters were asked to provide further analyses that were subsequently reviewed during the meeting.

Although not explicitly stated, of the three CIE reviewers, I was considered to have the most experience and knowledge of acoustic survey methodology. Therefore, during the meeting, I led the questioning and discussion of acoustic survey results.

Before the meeting concluded, the Panel completed the STAR Panel report. This was compiled by the Chair, with contributions from each of the CIE reviewers. The final draft was reviewed by the Panel, Panel advisors, the joint STAT, and the Acoustics Survey team before the meeting ended.

To fulfill the requirements of the CIE, this report was completed subsequent to the review meeting.

Summary of Findings

The PFMC identified the following six terms of reference for the STAR Panel. The CIE confirmed these as the terms of reference for its reviewers.

1. Become familiar with the draft Pacific hake/Whiting stock assessment(s) and background materials.
2. Comment on the quality of data used in the assessment(s) including data collection and processing.
3. Evaluate and comment on analytic methodologies.
4. Evaluate model assumptions, estimates, and major sources of uncertainty and provide constructive suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.
5. Determine whether the science reviewed is considered to be the best scientific information available.
6. Provide specific suggestions for future improvement in any relevant aspects of data collection and treatment, modeling approaches and technical issues.

The CIE also requested a brief description on Panel review proceedings, highlighting pertinent discussions, issues, effectiveness, and recommendations.

ToR #1: Become familiar with the draft Pacific hake/Whiting stock assessment(s) and background materials.

The Panel spent the available time reviewing the stock assessment and revisions to the acoustic survey time series. The 2010 assessment, STAR Panel report, and other background information were available prior to the meeting and it was assumed that Panel members had reviewed them and were familiar with their content.

It was apparent during the meeting that members of the STAR Panel had reviewed the draft assessment document prior to the meeting and were familiar with the assessment models being used.

ToR #2: Comment on the quality of data used in the assessment(s) including data collection and processing.

The Acoustic Survey team and the Joint STAT are to be highly commended for their thorough re-analysis of nearly all available data prior to this assessment. Issues and concerns were raised during the 2010 Star Panel meeting, both by analysts and Panelists regarding data quality from the acoustic survey and the commercial fishery time series. This year, for the first time, the analysts made a concerted effort to standardize data input (as much as possible) for the two models used in the assessment.

The Acoustic Survey team concluded rightly, in my opinion, that survey data prior to 1995 should be excluded from the time series. These surveys focused on U.S. waters only, covered a reduced depth range, and provided unreasonably large variance estimates.

Surveys from 1995 to 2009 were re-analyzed from raw data to ensure inter-survey analytic consistency. This was facilitated by the development of EchoPro software that provided for the automated processing of raw acoustic data. The re-analysis is a positive step given that there are joint surveys using different acoustic vessels in U.S. and Canadian waters. Although the survey data were re-analyzed, the visual assignment of echogram regions remained unchanged. It was stated during the meeting that the assignment of Pacific hake regions from U.S. surveys was somewhat standardized as they were reviewed by multiple analysts. It was unclear if this was the case for the Canadian surveys. It was also unclear if there was any standardization between countries. As the assignment of echogram regions to fish species is a relatively subjective process, the Acoustic Survey team should consider reviewing the time series back to 1995 and also consider standardization protocols for future surveys (if they haven't already done so).

The Acoustic Survey team has used a consistent target strength / fish length relationship (Traynor 1996) to scale acoustic backscatter for the entire time series. More recent target strength research (Henderson and Horne 2007) has indicated a regression intercept 4 – 6 dB lower than that of Traynor (1996). This would indicate that biomass estimates from each survey would be substantially larger. The Acoustic Survey team decided to use the Traynor (1996) relationship as it is more consistent with other available information. This decision was made even though the Henderson and Horne (2007) results were based upon in situ and ex situ experiments using live fish. It was indicated that the Henderson and Horne (2007) relationship was not used as it was derived from in situ measurements at night, whereas the acoustic survey is conducted during daylight hours only. However, Traynor's (1996) relationship was also derived from in situ measurements at night. The differences between these relationships underscore the impact and uncertainty of target strength data and the importance of further research. It was stated during the meeting that a change in target strength could be accommodated in the assessment models by an associated change in survey catchability (q). Intuitively, this is difficult to accept as the acoustic survey time series is the only abundance index used in the assessment models and modeled abundance estimates are directly related the scale of abundance from the acoustic time series. Uncertainty regarding target strength is not currently included in the assessment models. The results from Traynor (1996) and Henderson and Horne (2007), and perhaps future research, could be used to bootstrap the bounds of this uncertainty in future assessments.

Annual acoustic survey data were kriged for the first time in this assessment. I consider this to be very positive as kriging allows for interpolation and extrapolation from transect density estimates. It also allows for the calculation of annual variance estimates due to distribution patchiness and irregular transects. The Panel expressed concern regarding the use of a single set of semi-variograms for each survey as this assumes the same spatial and age structure over the entire survey area. This assumption is violated, as age structure is known to vary by latitude. The Panel suggested that a regression model may help to characterize spatial structure and recommended that this be tested further in a sensitivity analysis.

The 2010 STAR Panel expressed concerns regarding the use of samples from trawl tows during acoustic surveys to represent population age structure. The 2010 Panel was especially concerned with the 2009 survey where Humboldt squid were very abundant and mixed with Pacific hake. The Acoustic Survey team presented thorough analyses in this assessment to address these concerns. I concur with their conclusion that the abundance estimate from the 2009 survey be included in the time series.

During acoustic surveys, trawl tows are made on an opportunistic basis to ground-truth the acoustic signal on echograms. The main concern of the 2010 STAR Panel was that samples from these tows do not adequately represent population age structure. As it is rare to trawl more than once on an aggregation during an acoustic survey, an experiment was conducted in 2010 to trawl multiple times on different parts of an aggregation. Although multiple tows were made on only seven aggregations during the experiment, results indicated variability but no systematic bias. The Panel agreed with findings of the Acoustic Survey team and encouraged further research to validate trawl representativeness. I was somewhat concerned that all but one experimental set was made by mid-water trawl, as it does not allow for adequate comparison of the size of fish in the demersal and pelagic zones. The Acoustic Survey team indicated that the one bottom trawl set caught “somewhat” larger fish. This issue should be addressed in future experiments by comparing samples from mid-water and bottom trawl sets within the same aggregation. It can be further evaluated by examination of the NWFSC shelf trawl survey data to see if there are annual changes in distribution of Pacific hake on or near the bottom.

Large numbers of Humboldt squid were detected acoustically and in trawl samples during the 2009 survey. Stratification by depth was observed with Pacific hake being much closer to the bottom than in previous surveys. The Acoustic Survey team presented results from three sensitivity analyses that indicated the 2009 biomass estimate was relatively insensitive to the choice of depth threshold, the species composition in trawl sets, and expert opinion in identifying squid. I expressed concern that the 2009 survey estimate may be biased if more hake were close to the bottom within the acoustic exclusion zone. The Acoustic Survey team dismissed this concern although acknowledging that the exclusion zone limit (0.5 m from bottom) was somewhat flexible. My concern was also echoed by Canadian fishers who indicated they were now fishing closer to the bottom and catching Pacific hake in areas where the fish did not show up on echograms. This requires further evaluation; although it may be difficult to quantify the amount of hake within the bottom exclusion zone, their presence or absence could be determined by directed bottom trawl sets in areas where Pacific hake are present but not observed near bottom on echograms.

Upon questioning from me, the Acoustic Survey team indicated that the mid-water trawl on the U.S. survey vessel was changed sometime after 2001, part way through the acoustic survey time series. Although no comparative tows were made at that time between the new and old trawl, it was assumed that the selectivity of the two gears was similar. This cannot be validated and is a source of uncertainty. It was also not clear to me if comparative tows have been made between the current trawls on the U.S. and Canadian survey vessels. If not, this should be done to ensure that both trawls have similar selectivity.

The quality of data from the commercial fishery appears to be fine. The STAT had re-constructed all data for this assessment; this was a monumental task. Annual catch data are available since 1966, with age frequencies since 1975. U.S. and Canadian fishery age data have been combined for the first time in this assessment. Length composition data prior to 1975 may exist but were not available for this assessment. The Joint STAT should follow up on these data.

Aging imprecision has been identified by the Joint STAT, where age of dominant cohorts tend to be assigned more frequently. In 2010, a blind double-read study was conducted using otoliths collected across the years 2003-2009. Resulting data were analysed to estimate both ageing error and the cohort effect. A proportion of 0.55 was added to the four strongest year classes (1980, 1984, 1999, and 2008). It was unclear to me why this was applied in the SS model but not in the TINSS model.

Current maturity schedules are based upon visual examination of gonads from samples collected from 1990 – 1992. Given the dramatic changes in growth observed during the early 1990s, maturity should definitely be re-examined. The Panel recommended that the maturity-at-age relationship be updated by collecting new samples and using histological analysis techniques.

Given its large population biomass, the role of Pacific hake in the eastern Pacific ecosystem is poorly understood. Annual changes in migration lead to differing local ecosystem effects. Pacific hake is likely to be an important predator of groundfish species and prey to such species as lingcod and Humboldt squid. Although lingcod populations have increased in recent years and Humboldt squid were abundant within the range of Pacific hake in 2009, the dynamics of predator and prey relationships are neither well understood nor quantified. Consequently, the resulting impact on modelling of the stock is unknown. Predator / prey relationships should be explored and quantified to inform future stock assessments.

ToR #3: Evaluate and comment on analytic methodologies.

I have interpreted this ToR to refer to the assessment models (SS and TINSS) used in this assessment. I have included all my comments regarding acoustic survey data and analysis under ToR #2.

As in the 2010 assessment, two models were presented for review to the STAR Panel in this assessment. The major difference from 2010 was the level of collaboration in 2011 by the Joint STAT. A single set of input data was used for the first time in both assessment models and the two models were presented in a collaborative assessment document.

The use of two models appears to be an artifact of the bi-national nature of the assessment and differing scientific approaches. Canadian analysts prefer the TINSS model while their American counterparts prefer the SS model. In 2010, these were referred to as “competing models”. The Joint STAT defended the use of parallel models in 2011 “to better understand the reasons for previous differences among models and to better present the uncertainty in current stock status in the spirit of the Pacific hake treaty”. Results from the

two models highlight not only the uncertainty in current stock status but also uncertainty in historical stock size. I am of the opinion that the presentation of results from two models in forecast decision tables confounds the job of fishery managers. The Joint STAT should explore the fundamental differences in the structure of the two models and, if possible, present a single model that best describes the dynamics of the Pacific hake stock.

The Joint STAT is to be highly commended for its diligence in compiling a single set of input data for both models including: annual commercial catch (with U.S. and Canadian catches modeled in one fleet), weight at age, acoustic survey index, and acoustic and fishery age-frequencies. By doing so, many of the concerns of the 2010 STAR Panel were addressed and it made the job of this Panel much easier.

The two models represent different philosophies of the two groups comprising the Joint STAT. The SS model follows a more traditional approach to estimate productivity, scale, and current status, and then estimates reference points. The TINSS is less traditional and more management oriented where leading estimated parameters are *MSY* and F_{MSY}. Structurally, the models are very similar and are based upon catch at age. The main differences are the treatment of selectivity, the negative log-likelihood function for catch-at-age residuals, partitioning of observation and process error, and priors on the leading estimated parameters *MSY* and F_{MSY}.

The STAR Panel and Joint STAT spent considerable time discussing similarities and differences between the two models. The final base models showed similar trends in spawning biomass throughout the time series with relatively good convergence in the current period. However, although trends were similar, the scale of spawning biomass differed between the models at the beginning of the time series (B_0). This caused some concern as reference points are based upon spawning biomass throughout the time series. The Panel concluded that differences in estimates of B_0 were driven primarily by the selection of parameter priors and structural differences in the models. As it was not within its terms of reference, the Panel did not choose one model over the other.

ToR #4: Evaluate model assumptions, estimates, and major sources of uncertainty and provide constructive suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.

The STAR Panel identified three main areas of concern, all of which increase uncertainty in assessment results. These include (in my order of priority): 1) uncertainty in the size of the 2008 year class, 2) the assumption of time-invariant asymptotic selectivity, and 3) divergence in the estimates of B_0.

Data from the 2010 fishery, including age compositions and fisher observations, indicate that the 2008 year class may be large. Unfortunately, the size of the 2008 year class cannot be estimated from the 2009 acoustic survey as the survey is currently designed to estimate the biomass of age 2+ fish. This is further confounded as acoustic surveys are conducted on an alternate year basis and there was no survey in 2010. A reliable estimate of the size of the 2008 year class is critical in projections in 2011 and beyond. Given that the current estimate of this year class is derived from 2010 commercial fishery data only,

confidence limits on it are so large as to make the estimate relatively meaningless. The Joint STAT has already identified this to be a major concern and has recommended the following as its highest priorities: 1) conduct an annual acoustic survey, and 2) develop alternative indices for juvenile or young (0 and/or 1 year old) Pacific hake, perhaps based on existing acoustic survey observations or new sampling efforts. The Panel concurred with and reiterated these recommendations. I would also suggest that the annual acoustic survey be conducted jointly with industry. Based upon my past experience, industry-based vessels are more efficient at catching and sampling fish than are government-based vessels. If a commercial fishing vessel(s) was deployed during the acoustic survey to ground truth acoustic targets and to collect biological samples, it could allow for increased acoustic sampling (i.e. more and/or closer transects) and provide more time for acoustic research (i.e. in situ target strength estimation). It would also allow for multiple trawl tows on some of the observed aggregations of Pacific hake. Survey design should also be re-evaluated to determine if age 1 fish can be estimated; survey area and gear may need to be changed to achieve this. Given the flexibility provided by kriging, the concept of traditional transects can also be re-visited and revised.

In this year's assessment, the Joint STAT assumed time-invariant selectivity in both the SS and TINSS models. In 2010, time-varying selectivity was used. In this assessment, annual empirical weight at age was used as a proxy to account for time varying growth. This helps to account for the dramatic changes in growth observed during the early 1990s but doesn't allow for estimation of uncertainty. The Joint STAT indicated that the use of time-varying selectivity is complex and would require some arbitrary and subjective choices. The STAR Panel suggested that the assumption of time-invariant selectivity is probably not valid as it assumes no selectivity at length or weight, and also that spatial and temporal patterns of data are representative of the population. The Panel recommended further exploration of alternate model structures. In its acceptance of the final base models, the Panel highlighted that the characterization of current stock status would probably be less optimistic if time-varying selectivity was assumed.

The scaling differences and divergence in the estimates of B_0 between the two models was deemed to be due to prior selection and structural differences in the models. This divergence creates great uncertainty in the calculation of reference points that are based upon historical stock biomass. It is important that the Joint STAT explore the fundamental differences in the two models to better understand the cause of historical differences in spawning biomass. Logically, the issue with regard to reference points could be addressed by the use of fishery-based points. However, as was explained during the meeting by the PFMC advisor, this is unlikely under U.S. law.

ToR #5: Determine whether the science reviewed is considered to be the best scientific information available.

The STAR Panel concluded that the final base models (SS and TINSS) constitute the best available scientific information on the status of Pacific hake in U.S. and Canadian waters. The Panel tempered its conclusion on the uncertainty of the 2008 year class and the impact of this uncertainty on projections in 2011 and beyond. It also indicated that alternative model structures, including time-varying selectivity would likely give less optimistic characterizations of current stock status. I concur with these conclusions.

ToR #6: Provide specific suggestions for future improvement in any relevant aspects of data collection and treatment, modeling approaches and technical issues.

This ToR is somewhat redundant as it is included as part of ToR #4. I have covered this ToR in my comments for ToRs 2 through 4. My recommendations (not prioritized) are summarized as follows. In some cases, the recommendations match those of the STAR Panel; in others, they reflect my own opinion only:

- As the assignment of echogram regions to fish species is a relatively subjective process, the Acoustic Survey team should consider reviewing the time series back to 1995 and also consider standardization protocols for future surveys (if they haven't already done so).
- As uncertainty regarding target strength is not currently included in the assessment models, the results from Traynor (1996) and Henderson and Horne (2007), and perhaps future research, could be used to bootstrap the bounds of this uncertainty in future assessments.
- The use of a single set of semi-variograms in kriging for each survey assumes the same spatial and age structure over the entire survey area. As age structure is known to vary by latitude, a regression model may help to characterize spatial structure.
- The STAR Panel encouraged further research to validate trawl representativeness. However, as all but one experimental set was made by mid-water trawl, it does not allow for adequate comparison of the size of fish in the demersal and pelagic zones. This should be addressed in future experiments by comparing samples from mid-water and bottom trawl sets within the same aggregation.
- There is some concern that the 2009 acoustic survey estimate may be biased if more hake were close to the bottom within the acoustic exclusion zone. This requires further evaluation; although it may be difficult to quantify the amount of hake within the bottom exclusion zone, their presence or absence could be determined by directed bottom trawl sets in areas where Pacific hake are present but not observed near bottom on echograms.
- It was not clear if comparative tows have been made between the current trawls on the U.S. and Canadian acoustic survey vessels. If not, this should be done to ensure that both trawls have similar selectivity.
- Length composition data prior to 1975 may exist but were not available for this assessment. The Joint STAT should follow up on these data.
- The maturity-at-age relationship should be updated by collecting new samples and using histological analysis techniques.
- Predator / prey relationships should be explored and quantified to inform future stock assessments.
- The presentation of results from two models in forecast decision tables confounds the job of fishery managers. The Joint STAT should explore the fundamental differences in the structure of the two models and, if possible, present a single model that best describes the dynamics of the Pacific hake stock.
- Conduct an annual acoustic survey, and develop alternative indices for juvenile or young (0 and/or 1 year old) Pacific hake, perhaps based on existing acoustic survey observations or new sampling efforts. The annual acoustic survey should be conducted

jointly with industry, as industry-based vessels are more efficient at catching and sampling fish than are government-based vessels. This could increase acoustic sampling (i.e. more and/or closer transects) and provide more time for acoustic research (i.e. in situ target strength estimation). It would also allow for multiple trawl tows on some of the observed aggregations of Pacific hake.

- Acoustic survey design should be re-evaluated to determine if age 1 fish can be estimated; survey area and gear may need to be changed to achieve this. Given the flexibility provided by kriging, the concept of traditional transects can also be re-visited and revised.
- The assumption of time-invariant selectivity is probably not valid and alternate model structures should be explored.

Conclusions and Recommendations

This assessment represents a tremendous improvement over that presented in 2010. The Joint STAT has provided a clear and transparent collaborative stock assessment document. It has not only described how it addressed the recommendations of the 2010 STAR Panel, but also those of the 2009 STAR Panel, and the 2009 industry contracted review. The Joint STAT responded to eleven requests during the meeting; special kudos go to Robyn Forrest and Chris Grandin, as the majority of requests related to changes in the TINSS model.

Through a strong collaborative effort, the Joint STAT and Acoustic Survey teams have reconstructed and thoroughly re-evaluated nearly all of the available data sources for the Pacific hake stock. A single set of input data was used for the first time in the SS and TINSS models, allowing for a much better understanding of the models and underlying uncertainties. Efforts were also made to make the SS model to be as consistent with TINSS as possible. It was therefore reassuring that results from the two models were much more comparable this year than in 2010.

The Joint STAT presented results from the two assessment models and indicated their preference that results from both models be included in management decision tables in order to “capture additional sources of uncertainty”. The STAR Panel concluded that the final base models (SS and TINSS) constituted the best available scientific information on the status of Pacific hake in U.S. and Canadian waters. As it was not within its terms of reference, the STAR Panel did not select one model over the other. Personally, I believe that it is preferable, if possible, to present management options from one model only.

The Joint STAT characterized many sources of uncertainty in model results, although it acknowledged that numerous other sources (e.g. target strength, timing of acoustic survey, depth distribution of hake during acoustic surveys, variation in the size and age composition of acoustic survey trawls, inter-annual differences in acoustic survey catchability, structural modeling choices, data weighting, and selection of prior probability distributions) could not be quantified. Even so, the results from both models exhibited very high levels of uncertainty throughout the time series, more especially so in the current period. The greatest current source of uncertainty is the size of the 2008 year class, estimated from 2010 commercial fishery data only. The current perceived increase in spawning stock biomass is driven almost entirely by the 2008 year class, thus making stock projections highly variable. The Joint STAT has attempted to temper this by providing projections assuming three “states of nature” in relation to the strength of the 2008 year class. However, it was not entirely clear how these states of nature related to the concept of risk (i.e. risk neutral vs. risk adverse). Fishery managers should be cognizant that stock trajectory is entirely dependent upon the 2008 year class and that these states of nature may be overly optimistic, as the characterization of current stock status would likely be revised downward if time-varying selectivity had been assumed.

As noted above, the uncertainty is not restricted to the size of the 2008 year class. Both models are highly sensitive to changes in survey selectivity; the TINSS model has also been shown to be sensitive to broad changes in natural mortality and binning of age composition data. Before corrections were made (during the meeting) to the TINSS model, binning was required to achieve convergence. This was no longer required when corrections were made. The TINSS model also requires a prior to be placed on acoustic survey catchability in order to achieve convergence whereas this parameter is freely estimated in SS. This illustrates the "tweaking" required by analysts in running these models. This becomes apparent in viewing retrospective analyses; the assessment history of Pacific hake has been fraught with problems in scaling estimates of spawning biomass.

I have included most of my recommendations in ToR #6 of the "Summary of Findings". However, I have two further recommendations, the first regarding logistics and the second regarding the terms of reference.

It was readily apparent during the meeting that the Joint STAT and Acoustic Survey teams did not have sufficient time to prepare this assessment. This was highlighted as errors were detected in the TINSS model (error in Baronov catch equation and error in likelihood weighting) that had to be corrected during the meeting. There is no way of knowing if other errors exist in either model that were not found and corrected. This would be alleviated if the analysts had sufficient time to review their analyses prior to submission to the STAR Panel. Consideration should be given to changing the assessment until later in the year to increase the quality of the assessment. This could be achieved by changing the management schedule from its current calendar year basis.

The terms of reference for the STAR Panel were relatively broad and somewhat redundant. During the meeting, the PFMC looked for advice on the determination of acceptable biological catch (ABC), i.e. from which model should it be derived. As this is of importance to fisheries managers, consideration should be given to tightening future terms of reference to recommend, if possible, the use of a single model.

Appendix 1. Bibliography of Materials Provided for Review

A. Draft Stock Assessment:

Joint US and Canadian Hake Technical Working Group. 2001. Status of the Pacific hake (Whiting) stock in U.S. and Canadian waters in 2011. *Pre-STAR version.*

B. Background Materials:

Chu, D. 2011. Estimating Pacific Hake *(Merluccius productus*) Biomass Using Geostatistics. National Marine Fisheries Service U.S. Department of Commerce. Northwest Fisheries Science Center, Acoustic Survey Team.

Chu, D. and R. Thomas. 2011. Integrated Acoustic and Trawl Survey: Design, Method, and Analysis. National Marine Fisheries Service U.S. Department of Commerce. Northwest Fisheries Science Center, Acoustic Survey Team.

Martell, S.J.D, W. E. Pine, and C. J. Walters. 2008. Parameterizing age-structured models from a fisheries management perspective. Canadian Journal of Fisheries and Aquatic Science. 65: 1586-1600.

Martell, S.J. 2010. Assessment and Management advice for Pacific hake in U.S. and Canadian waters in 2010.

Pacific Fishery Management Council. 2010. SSC Supplemental Report.

Pacific Fishery Management Council. 2010. SSC Report.

Pacific Fishery Management Council. 2010. Pacific Whiting the Joint U.S.-Canada STAR Panel Report

Stewart, I.J. and Owen S. Hamel. 2010. Stock Assessment of Pacific Hake, *Merluccius productus*, (a.k.a. Whiting) in U.S. and Canadian Waters in 2010.

C. Stock Synthesis Model Materials including:

- SS Model Changes for PFMC assessments in 2011
- Models_SS_Change Log (excel document).
- Zip file of SS Models_Simple
- Zip file of SS Models_SSv3.20a
- SS User Manual

D. Other Documents Referenced in this Report

Henderson, M.J., and J.K. Horne. 2007. Comparison of in situ, ex situ, and backscatter model estimates of Pacific hake (Merluccius productus) target strength. Can. J. Fish. Aquat. Sci. 64: 1781-1794.

Traynor, J.J. 1996. Target-strength measurements of walleye pollock (*Theragra chalcogramma*) and Pacific whiting (*Merluccius productus*). ICES Journal of Marine Science 53:253-258.

Appendix 2. Copy of the CIE Statement of Work

Attachment A: Statement of Work for John Wheeler

External Independent Peer Review by the Center for Independent Experts

Joint US-Canada Technical Review Panel for the Pacific Whiting Stock Assessment

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 Pacific hake (or whiting, *Merluccius productus*) stock assessment will provide the basis for the management of the largest groundfish fisheries off the West Coast of the U.S. and British Columbia. In 2009, Pacific whiting fishery accounted for 79% of the landed catch in the U.S. groundfish fishery. In addition, the treaty between the U.S. and Canada which establishes an annual assessment and management process is expected to be ratified sometime soon. The technical review will take place during a formal, public, multiple-day meeting of fishery stock assessment experts. Participation of external, independent reviewer is an essential part of the review process. The Terms of Reference (ToRs) of the peer review are attached in Annex 2. The tentative agenda of the panel review meeting is attached in Annex 3.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Two CIE reviewers shall have expertise in fish population dynamics, with experience in the integrated analysis modeling approach, using age-and size-structured models, use of MCMC to develop confidence intervals, and use of Generalized Linear Models in stock assessment models. One CIE reviewer shall have expertise in acoustic surveys for fish as they apply to and are used in fishery stock assessments. Each CIE reviewer's duties shall not exceed a maximum of 14 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 during the panel review meeting scheduled in tentatively in Seattle, Washington during the tentative dates of 7-11 February 2011.

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, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

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.

Panel Review Meeting: 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. Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring

that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility 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.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

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) Participate during the panel review meeting in the Seattle, Washington during the dates of 7-11 February 2011.
3) Tentatively during 7-11 February 2011 in Seattle, Washington as specified herein, and conduct an independent peer review in accordance with the ToRs (Annex 2).
4) No later than 25 February 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 to Dr. David Die, CIE Regional Coordinator, via email to 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.

4 January 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
24 January 2011	NMFS Project Contact sends the CIE Reviewers the pre-review documents
7-11 February 2011	Each reviewer participates and conducts an independent peer review during the panel review meeting
25 February 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator

11 March 2011	CIE submits CIE independent peer review reports to the COTR
18 March 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 Ann. 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:

William Michaels, Program Manager, COTR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
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Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
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Roger W. Peretti, Executive Vice President

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Key Personnel:

NMFS Project Contact:

Stacey Miller
National Marine Fisheries Service, 2032 SE OSU Drive, Newport OR 97365
Stacey.Miller@noaa.gov Phone: 206-437-5670

Jim Hastie
National Marine Fisheries Service, 2725 Montlake Blvd. E, Seattle WA 98112
Jim.Hastie@noaa.gov Phone: 206-860-3412

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.

a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

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
Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Joint US-Canada Technical Review Panel for the Pacific Whiting Stock Assessment

7. Become familiar with the draft Pacific hake/Whiting stock assessment(s) and background materials.
8. Comment on the quality of data used in the assessment(s) including data collection and processing.
9. Evaluate and comment on analytic methodologies.
10. Evaluate model assumptions, estimates, and major sources of uncertainty and provide constructive suggestions for improvements if technical deficiencies or additional major sources of uncertainty are identified.
11. Determine whether the science reviewed is considered to be the best scientific information available.
12. Provide specific suggestions for future improvement in any relevant aspects of data collection and treatment, modeling approaches and technical issues.
13. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

Tentative Agenda

Joint US-Canada Technical Review Panel for the
Pacific Hake / Whiting Stock Assessment
February 7-11, 2011
Hotel Decca
4507 Brooklyn Avenue NE
Seattle, WA 98105

Monday, February 7, 2011

9:00 a.m. Welcome and Introductions (Stacey Miller or Jim Hastie, NMFS). Review the Status of the Pacific hake / Whiting Treaty

9:15 a.m. Review the Meeting Agenda (Panel Chair, SSC rep.).
Review Terms of Reference for Assessments and Review Meeting
Assignment of reporting duties

9:45 a.m. Data Presentations
- Overview of the 2010 Hake/Whiting Fisheries
  - Canadian Waters (Chris Grandin, DFO)
  - U.S. Waters (Ian Stewart, NMFS)

10:15 a.m. Coffee Break

10: 45 a.m. Acoustic Survey: Design and Analysis (NMFS)

12:00 p.m. Lunch (on your own)
1:00 p.m. Acoustic Survey: (NMFS)
3:00 p.m. Coffee Break
3:30 p.m. Overview of the Data Sources for the 2011 Assessment (Ian Stewart,NMFS)
5:30 p.m. Adjourn for the day.

Tuesday, February 8, 2011
9:00 a.m. STAT Model Presentations
12:00 p.m. Lunch On Your Own
1:00 p.m. STAT Model Presentations Continued
Q&A session with the STATs
Panel develops list of model runs / analyses for the STAT(s).
5:30 p.m. Adjourn for day.

Wednesday, February 9, 2011
9:00 a.m. STAT presentation(s) of requested model runs/analyses.
11:00 a.m. Panel Discussion
12:00 p.m. Lunch On Your Own.
1:00 p.m. Panel develops second list of model runs / analyses for the STAT team(s).
5:30 p.m. Adjourn for day.

Thursday, February 10, 2011
9:00 a.m. STAT presentation(s) of second set of requested model runs/analyses.
12:00 p.m. Lunch (On Your Own).
1:00 p.m. Panel discussion.
- Identification of base model and elements for the decision table.
- Panel develops third list of model runs for decision table and begins drafting STAR report.

5:30 p.m. Adjourn for day.

Friday, February 11, 2011
9:00 a.m. STAT presentation(s) of third set of requested model runs/analyses.
10:00 a.m. Panel discussion.
- Discuss MCMC runs for base case model and decision table
- Panel agree to process for completing final STAR report by Council Briefing Book deadline
- Panel finishes report

12:00 p.m. Lunch on your own
5:00 p.m. Review Panel Adjourn.

Appendix 3. Panel Membership and other pertinent information from meeting

Panel Members:
Tom Jagielo, Chair, SSC
Yan Jiao, CIE
John Wheeler, CIE
Max Cardinale, CIE

Advisors:
Greg Workman, DFO
Dan Waldeck, PWCC, GAP
Rob Jones, NWIFC, GMT
John DeVore, PFMC

STAT:
Ian Stewart, NWFSC
Robyn Forrest, DFO
Chris Grandin, DFO
Owen Hamel, NWFSC
Allan Hicks, NWFSC
Steve Martell, UBC
Ian Taylor, NWFSC

Acoustic Survey Team:
Rebecca Thomas, NWFSC acoustic survey team
Dezhang Chu, NWFSC acoustic survey team

Others in Attedance:
Jim Hastie, NWFSC
Stacey Miller, NWFSC
Melissa Haltuch, NWFSC
Vlada Gertseva, NWFSC
Jason Cope, NWFSC
Chantel Wentzel, UW
Rod Moore, WCSPA, PFMC
Mark Maunder, QRA
Steve DeBlois, NWFSC acoustic survey team
David Jincks, MWT coop.
Jan Jacobs, American Seafoods
Steve Joner, Makah Tribe
Jennifer Hagen, Quileute Tribe

Brent Paine, UCB
Shuowei Li
John Pohl, NWFSC acoustic survey team
Julia Clemens, NWFSC acoustic survey team
Lisa Bonacci, NWFSC acoustic survey team
Larry Hufnagle, NWFSC acoustic survey team
Vanessa Tuttle, NWFSC
Richard Carroll, Ocean Gold Seafoods
Rick Dunn, Hake Conservation of BC
Brad Pettinger, Oregon Trawl Commission
Joe Bersch
Barry Ackerman, DFO

Note: this list includes “Others in Attendance” on day 1 but may not be inclusive of those in attendance on latter days.