Independent Peer Review Report on the STAR Panel Review of the Pacific hake (*Merluccius productus*) Joint US-Canada Technical Review Panel Stock Assessment

Prepared for the Center for Independent Experts

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February 2011

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Executive Summary

• This document is the individual CIE Reviewer report for the Pacific hake/whiting STAR (Stock Assessment Review) Panel meeting held in Seattle from 7 to 11 February 2011 and provided at the request of the Center for Independent Experts (CIE) (see Annex 1).

• This report solely represents the views of the independent reviewer (Dr. Massimiliano Cardinale).

• This reviewer completely agrees with all of the findings reported in the *Summary STAR Panel Report*. Findings that are reported in the *Summary STAR Panel Report* are not necessarily fully repeated in this individual report. This report focuses on clarifications of elements contained in the Summary Report and some additional views of the individual reviewer that may not have been entirely discussed at the meeting.

• The assessment team met all of the review terms of reference (TORs).

• This reviewer believes that the STAT panel has done an excellent job in carrying out the assessment, analysing all available source of data, modelling uncertainty and provide a full sensitivity analysis of both the data and the models (TINSS and SS3).

• Further recommendations aimed at improving the data source used in the hake stock assessment were made. These are based on additional future research and further re-analysis and modelling of the original data set.

Introduction

A joint Canada-US Pacific hake (*Merluccius products*) Stock Assessment Review (STAR) Panel met in Seattle during 7-11 February 2011 to review a draft stock assessment document that had been prepared by the joint Canada-US stock assessment team (STAT). The Panel started at 9:00 a.m. Monday, February 7, 2011 with the presentation of the terms of reference and the adoption of the agenda for the meeting.

Description of review activities

This review was undertaken by Dr. Massimiliano Cardinale in Seattle, between 7 and 11 February 2011 as part of the Pacific hake STAR Panel. Relevant documents (see bibliography, Attachment B) were made available two weeks prior to the STAR meeting via a link to an ftp server. The documentation was reviewed prior to the meeting. The background information and assessment of the Pacific hake was presented by the STAT team members. Background information relevant to this review are presented in a series of appendices, including a bibliography (Attachment A); CIE Statement of Work (Attachment B); report format (Annex 1); Terms of Reference (Annex 2); meeting agenda (Annex 3); meeting participants (Annex 4); additional documentations (Annex 5). Comments included here are provided following the terms of reference (TORs) (Annex 2) and are those of this independent reviewer only. The list of main documents provided as background material or presented during the meeting is included in Attachment A. Additional presentations and documentations

were made available during the meeting and were continuously updated under the ftp (ftp://ftp.pcouncil.org/pub/Hake_STAR_2011/) (Annex 5).

Summary of findings

Recommendations

1. Continue the exploration of fleet specific selectivity both in the basic data and in the model formulation
2. Continue to explore the development of a model with time varying selectivity
3. Providing an annual estimate of the maturity ogives using histological methods or at least an update of the currently used maturity ogives
4. Perform an age validation through tagging or other methods and explore the possibility of estimating age dependent natural mortality and its effect on the assessment.
5. Improve the estimation of the acoustic biomass and acoustic number at age through the use of regression models that explicitly account for spatial autocorrelation in the data
6. Perform an annual acoustic survey to reduce uncertainty of the last year biomass estimate especially in the presence of large year classes
7. The two basic models presented after the lining up process are considered the final models for assessment and management formulation and represent the best scientific information given the data available.
8. Currently implemented RPs are based on biomass. They are all heavily relying on the SR function and estimates of biomass at the beginning of the time series with the assumption that the stock was un-fished at that time. However, the SR function is un-informative in the case of Pacific hake. In this situation a much simple approach, based on YPR analysis, would be more robust to the uncertainty of the initial biomass at the equilibrium (i.e. at F = 0). Even if it is likely that F_{msy} proxies as, for example, F_{max} or F_{01} will underestimate the real F_{msy} of the stock. Thus, it will be conservative in terms of catching opportunities, hake is a long-living species (more than 20 years) with low M at older ages, thus reduced yearly catching opportunities on a yearly basis will not affect catches in the long term.
9. Future assessments should take into account the sub-population structure of the Pacific hake stock and take into account specific features as the possible existence of semi-resident coastal population through separate assessment and management.

TORs

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

All relevant documentation, basic data and models description was provided in an electronic format via an ftp server before the meeting and it was reviewed prior to the meeting. Additional electronic and some paper material (i.e. the errata of the original TINNS model run) were also made available during the meeting, as required or following request of the STAR panel. The quality of the written material was excellent.

Recommendations: none

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

Input data

Fisheries independent data

Data processing
The joint US-Canadian acoustic survey was used to derive the spatial distribution, an index of the total biomass and the age structure of the Pacific hake stock. Data prior to 1995 were not used as the survey design was fundamentally different compared to the most recent years (i.e. different spatial and bathymetric coverage). A large effort has been deployed by the STAT to estimate the sensitivity of the reconstructed biomass index, its associated uncertainty and the age structure of the stock of Pacific hake to the representativeness of the hauls. The recent experiments showed the effect on the estimated hake length structure of different trawl depth conducted within a fish aggregation is negligible. Also, there is no apparent net avoidance by hake during trawling operations, thus the estimated selectivity (i.e. logistic curve with a plateau at 5+) is considered appropriate. Also, the impact of Humboldt squid on the estimated biomass is limited and mostly affects the uncertainty of the hake biomass estimated.

Biomass estimated by kriging
The use of kriging to estimate the survey biomass index is a great improvement compared to previous assessments. This is especially important since the sampling scheme has changed over time in terms of the length, location of transects and the period of the survey. Geostatistical models overcome part of those problems by explicitly accounting for the correlation effect in the spatial distribution of the examined data including a spatial dependence term (i.e. covariogram). A single yearly variogram was fitted and used to derive the spatial distribution of the hake stock as well as the total hake biomass. An important improvement compared to previous assessments is given by the fact that an estimate of the uncertainty of the hake biomass is directly calculated using kriging. However, it is considered that a single co-variogram for such a large area is inappropriate and, both the processes that regulate the spatial structure of the hake stock and, thus, the spatial structure itself, are likely to change over the area. Such changes are linked to different environmental features, density-

dependent and age-dependent distribution and prey-predator interactions along the stock distribution area among others. The emphasis of geostatistical approaches on the correlation structure of the data may mask some underlying species–environment relationships that are responsible for causing the autocorrelation in the first place. In contrast to geostatistcal techniques, non-linear regression techniques, for example GAM, attempt to explain the spatial pattern of the data solely based on the effect of the examined co-located variables. In this context regression models that explicitly account for spatial correlation would be preferable. Such framework would also be able to model the different age classes separately, providing a survey spatial estimate for each class. Also, the inclusion of ecologically meaningful variables will help to elucidate the mechanisms that regulate the spatial distribution of hake in the area as it was requested by the 2009 STAR panel. Moreover, not only the spatial differences of the survey scheme, in terms of length and location of the transects, but also the temporal effect (i.e. different periods of sampling between years) can be properly accounted. Finally threshold responses are common in species distribution data (Turner, 2005) in relation to demographic variables (e.g. the average abundance of the studied species) and are known as density-dependent habitat selection (see Ciannelli et al., 2008 and references therein). For example, the hake stock has a more northerly distribution during warmer years. This can be accounted by allowing the regression model formulation to change over different temporal or environmental regimes using, for example, the TGAM (i.e. threshold GAM). Thus, priority should be given to combine geostatistical and regression techniques in a blend capable of accounting for both the underlying spatial structure of the samples and the nonlinear and non-additive nature of habitat–species interactions. Recent mixed-effect approaches (GAMM; Wood, 2004b) to fitting a GAM with spatially correlated errors might provide an appropriate framework for modelling the acoustic hake data in the future.

Fisheries dependent data

Canadian fisheries data

Two fleets, the Canadian domestic and the Canadian Joint Venture were analysed and catch at age were derived for the entire Canadian catches. Most Canadian landings occur in the 3th quarter. The seasonal pattern was rather similar to the previous years although the catches declined in the Canadian domestic fleet during the last years. A random sample is taken from the catches and successively aged. The age composition key is then applied directly to split the catches and derive the catch at age for the fleets.

US fisheries data

The US landings in 2010 have increased of about 46% compared to 2009. A fleet specific by-catch ceiling has been implemented this year to the US fleets, reducing the rush for fish during the start of the fisheries. Two fleets were considered, the US shore and US at the sea fleet. The entire TAC has not been taken in the latest years with the catches amounting to about 80-90% of the TAC in 2009-2010. The fleets have observed large aggregations of 2-year olds during 2010, and have tried to avoid them by changing the spatial location of the fisheries and even implementing a voluntary fishing ban of few weeks. In the last 5 years, the fishing pattern shows an increase of the catches during the second part of the year for the US at the sea fleet.

Issues with the basic fisheries dependent data

In the base run, the data were not weighted for spatial-temporal sampling but the catches were treated as belonging to a single fleet, and taken in a single fishing season. In theory, catch at age in number of individuals should be developed on a Metier basis (i.e. a homogenous subdivision of a fishery by vessel type e.g. by vessel size, with a distinguished temporal and spatial fishing pattern). This has also been highlighted during the most recent STAR panels. However, this year the STAT did run sensitivity analyses to test the effects of different degrees of resolution in the data processing (e.g. by month and by fleet). This procedure has the merit to allow accounting for both changes in the selectivity of the different fisheries during the year and the growth of hake during the fishing season. Another issue is linked to the large recruitment variability of Pacific hake. Given the fact that large year classes appears sporadically (i.e. pulse recruitment), a yearly acoustic survey is crucial to provide an important source of information for incoming year classes. This is particular important when considering that most of the uncertainty in stock forecast are linked with the appearance of such large recruitment.

Issues with the biological data

General comments
I was impressed by the level of mathematical and statistical sophistication of the models, as well as the effort made to test the sensitivity of the models to a series of different setting and data elaboration and representativeness. Nonetheless, I am not fully satisfied with the quality and quantity of biological data. In general, biological realism is lacking in the assessment, while the sensitivity modelling part is much more developed. Models are obviously data driven and it is advisable that in the next assessments a larger deal of attention should be devoted to achieve a larger biological realism in the input data.

Weight at age

An empirical weight at age matrix (WAA) was used in 2010. The WAA matrix was derived for all catches combined. As the hake growth varies according to both a year and a cohort effect, and that such variability is not satisfactorily captured by any growth model, the use of empirical WAA is appropriate. However, a much finer resolution of the WAA matrix estimation (by fleet and season) should have the merit to closely match the observed growth changes during the year. Although a single average WAA matrix was derived and used in the basic run, sensitivity analyses were also conducted using disaggregated WAA derived for each fleet and seasons. This is certainly a large improvement compared to previous assessments as it more robustly takes into account the observed large variability of hake growth during the year.

Also, weight at age before 1975 is not shown, so the reader remains with the doubt about the values of WWA before 1975 and how those were derived in absence of biological sampling during those years.

Maturity

The maturity data are scanty as they are based on a single year (i.e. 1990-1992) and few sampled individuals. With such large variation in growth observed during the last decades, maturity schedule has likely changed greatly and needs to be yearly estimated. Also, with such large variation in growth, maturity ogives have also likely affected the estimates of the hake SSB. In this case, not only maturity ogives should be yearly derived through histological analysis or histologically calibrated macroscopical maturity keys but SSB itself is considered a suboptimal proxy for reproductive potential (Morgan and Brattey, 2005). In these circumstances, potential egg production should be used instead. The report refers sometime to fecundity, but in reality it refers to the proportion of fish at a mature age and this should be consistently corrected along the text.

Natural mortality

Natural mortality is modelled to be constant by age. However, hake has generally rather different M at age that changes greatly between recruits (Age 1) and adults (Age 4+). Thus, a more realist vector of M at age should be developed. In absence of stomach contents analyses, this could be done using simple empirical methods (Abella et al., 1997) and the sensitivity of the assessment should be evaluated.

Ageing

A large deal of sensitivity has been performed by including uncertainty in ageing estimation in the model (e.g. age error matrix). However, there is no formal validation of the ageing through independent methods (e.g. tagging). In the East Atlantic and in the Mediterranean, hake has been found to grow much faster than estimated from otoliths once tagging data were confronted with classical ageing through otoliths reading. This has had large consequences on the estimate of the number at age matrix, M and assessment results. Thus, effort should be devoted to validate ageing and avoiding having a very precise but poorly accurate ageing matrix.

Recommendations

Fisheries dependent data

- Continue the exploration of fleet specific selectivity both in the basic data and in the model formulation
- Continue to explore the development of a model with time varying selectivity

Fisheries independent data
Improve the biological data such as:

- Providing an annual estimate of the maturity ogives using histological methods or, at least, an update of the currently used maturity ogives

- Perform an age validation through tagging or other methods and explore the possibility of estimating age dependent natural mortality and its effect on the assessment.

- Improve the estimation of the acoustic biomass and acoustic number at age through the use of regression models that explicitly account for spatial autocorrelation in the data

- Perform an annual acoustic survey to reduce uncertainty of the last year biomass estimate especially in the presence of large year classes

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.

TORs 3 and 4 are dealt with together below.

The STAT team did present a comprehensive table (Table 1) to sum up the major differences in model settings between the TINSS and SS3 models. See the table for details on the comparisons of the model structure and model assumptions. See the Summary STAR report for details on method differences and data handling approach.

TINSS

Management oriented model, with time invariant selectivity. Steepness and B_0 are estimated and then MSY and F_{msy} are derived. Some age classes (<1.5% annually) were bound together in the original base model presented by the STAT. Relative large uncertainty is observed in the estimation of the 2008 year class. Auto-correlation was evident in the MCMC chain results. The model results are sensitivity to survey selectivity, catchability, binding of ages and M. The smaller uncertainty during the last years estimate in the original base model presented by the STAT compared to the SS3 model is partially linked to the use of fixed selectivity and the binding of some of the age classes.

SS3

Process oriented model with multinomial age frequency data fitting, estimated steepness in recruitment (*h*) and ageing error. The selectivity is modelled but assumed to follow a logistic curve with a plateau at 5 years old, with catchability of older fish set at 1. Large uncertainty is observed in the estimation of the 2008 year class and this uncertainty is slightly larger than in the TINSS model. Sensitivity shows that the last year estimates are insensitive to changes in data processing resolution (i.e. growth model and fishing seasonality) but it affects the estimates of MSY. An exception is given by the use of time varying selectivity, which gives a smaller estimate for the 2008 year class.

Key issues

It is likely that selectivity of the fleets changes over time, thus a model that can account for such changes should be preferable (e.g. SS3) A similar argument applies for the time varying selectivity, allowing to change the shape of the selectivity curve in the assessment gives much more realism to the model, and also answer the comments of the 2010 STAR panel. Although sensitivity shows that the last year estimates are insensitive to changes in data processing resolution (i.e. growth model and fishing seasonality) SS3 model with varying selectivity achieved much larger realism in biological and fisheries patterns. The fact that in the last year the SSB estimates are similar (but lower as the 2008 year class is reduced) to the basic model is not a decisive argument for using a more parsimonious model (i.e. the base model with invariant selectivity). The choice of different data processing resolution affects the estimates of MSY.

It is evident that while the two final models (i.e. TINSS and SS3 after revision following STAR panel requests) gives rather similar estimates for the last years, they substantially differ in the estimation of the starting point of the times series, including B_0 and derived estimates of F_{msy} and MSY. Currently implemented reference points (RPs) are based on initial biomass. Thus, they all heavily rely on the SR function. However, the SR function is un-informative in the case of Pacific hake. In this situation a much simpler approach, based on YPR analysis, would be more robust to the uncertainty of initial biomass at the equilibrium (i.e. F= 0). Even if it is likely that F_{msy} proxies, for example F_{max} or F_{01}, will underestimate the real F_{msy} of the stock and thus will be conservative in terms of catching opportunities, and given that hake is a long-living species (more than 20 years) with low M at older ages, reduced catching opportunities on yearly basis will not affect catches in the long term. Also, doubts arise about the use of a Beverton and Holt model. The SR in the plot shows that a hockey-stick SR curve will be possibly more appropriate. As there are very few data close to the origin, steepness is thus poorly estimated, and assumed equal to the prior estimates from a meta-analysis study based on different stocks.

Also, SPR35 and B40 are insensitive to changes in growth, natural mortality, maturity schedule and they require knowledge of the stock-recruitment curve. In the case of Pacific hake, the SR plot is not informative, and thus, F_{msy} from a simpler method such as YPR should be favoured.

Model alternatives were requested by the STAR panel (see general report for details of alternative runs). Some of them were not fulfilled as it would require substantial recoding of the TINSS model (see STAR panel Summary report). The requested alternative runs were:

- Switching off the binning from the TINNS model and compare estimated selectivity between the models
- Including ageing error in the TINNS model
- Analysing the age distribution of the stock in 1966 from the two final models as differences in estimated selectivity between TINSS and SS3 affect the B_0 estimates.
- Standardize the weight at age assumption in the stock forecast
- Standardize the treatment of survey timing for both models.

The lining up process brought the estimation of stock size over time from the two models very close to each other. However, a large difference still exists for the starting point of the time series and the realisation of the reference point, especially B_0. Also, the largest uncertainty is still due to the size of the 2008 year class, which is based on a single observation (i.e. from the fisheries). The uncertainty of the size of the 2008 year is very similar between the two models. This indicates the necessity for an annual survey to get an extra observation for the incoming year classes. The base models use a time invariant selectivity. However, sensitivity analysis done with SS3 showed that imposing a time-varying selectivity in the model will change the perception of the 2008 year class, which is reduced. The key-issues are thus the estimation of the size of the 2008-year class and the values of the reference point at the start of the time series (i.e. B_0). Most of the difference in the estimation of B_0 is likely given by the fact that the input catch at age data are weighted in SS3 while they are uniformly treated in TINSS.

Recommendations

The STAR concluded the two basic models presented after the lining up process has considered the final models for assessment and management formulation. The STAT panel was requested to update the set of sensitivity runs for the final model and provide the new tables and figures.

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

The STAT panel should be commended for having performed, during 2010, a full revision of all data sources, lining up of the models in terms of the treatment of basic information and a detailed analysis of models differences, including fixing of small bugs in the models. I consider the assessment presented as the best scientific information available with the present data.

Recommendations

Currently implemented RPs are based on biomass. They are all heavily relaying on the SR function and estimates of biomass at the beginning of the time series with the assumption that the stock was un-fished at that time. However, the SR function is un-informative in the case of Pacific hake. In this situation a much simple approach, based on YPR analysis would be more robust to the uncertainty of the initial biomass at the equilibrium (i.e. at F = 0). Even if it is likely that F_{msy} proxies (i.e.: F_{max} or F_{01}) will underestimate the real F_{msy} of the stock, and thus, will be conservative in terms of catching opportunities, and since hake is a long-living species (more than 20 years) with low M at older ages, reduced catching opportunities on a yearly basis will not affect catches in the long term.

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

See comments under TOR 2.

7. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

The STAT panel was open, transparent and very well prepared in advance. Basic data and model framework were adequately presented during the panel or through documents prior of the meeting. A possible improvement for the presentation of the result in the report could be the creation of a *Glossary* and an *Acronym* list at the end of the document. Also, the quantities and basic management parameters in the table (e.g. SPR, depletion) of the executive summary could be explicitly spelled out and explained in more detail. This will greatly facilitate the reading of the report for the public.

The STAT team should be commended for their effort, timing and clarity in presenting the results. However, two to four more weeks prior to the assessment meeting will allow the STAT to more carefully scrutinise the data, models and results and avoid last minute correction of modelling bugs as those that occurred this year (e.g. TINSS errata). Thus moving the STAT meeting at least two weeks later in time from the current schedule will be highly beneficial for assuring and increasing the quality of the assessment.

Others

A conservation issue might arise with the presence of resident populations in the coastal areas, especially if they intermix in a specific location or time of the year with the much larger coastal stock. There is little information on the mixing of the different stocks and most of the fish are thought to belong to the major assessed stock for which a TAC is derived. Genetic studies (Iwamoto et al. 2011) showed a certain deal of genetic segregation along the coast. However, also in absence of genetic differentiation, the existence of separated behavioural unit spawning linked to a specific location but mixing with the main stock during the feeding season has important conservation implications. Such units might have largely different stock dynamic compared to the main stock and being largely resident. Future assessments should take into account the sub-population structure of the Pacific hake stock and other specific features, given the possible existence of semi-resident coastal population, through separate assessment and management.

Table 1. Major settings and differences between the TINSS and SS3 models.

STAR Panel request #1:

The panel discussed key differences between the TINSS and SS models.
The panel requested that the STAT provide a list of priors, key assumptions,
and critical differences in model structures between the TINSS and SS models.
This will guide the decision for formulating alternative model runs and sensitivity request for the STAT.

STAT Response

	TINSS	SS	STAT category
Data use			
Likelihood for age-composition data	Multivariate logistic	Multinomial (0.001 added to obs. an	1
Weighting of composition likelihood	Automatic	Iterative	0
Weighting heterogeneity among years for compositional data	Uniform	Reflects sample size	1
Additional variance component for acoustic survey index	Variance, multiplicative	log-SE, additive	0
Aggregation of small age-frequencies	<=1.5%	None	1
Fit to age 1 in fishery age compositions	No	Yes	0
Maturity	Logistic by age	Age from logistic by length x growth	0
Priors			
Steepness (*h*)	NA	Informative Beta	1
FMSY	Informative log-Normal	NA	1
MSY	Informative log-Normal	NA	1
Acoustic catchability (*q*)	Informative log-Normal	Analytical solution	1
Total precision (observation error and recruitment variability)	Informative Gamma	NA	1
Ratio of observation error to recruitment variability	Informative Beta	NA	1
Sigma R	Function of variance ratio ar	Iterated	1
Dynamics			
Leading parameters estimated	MSY, FMSY	Steepness, log-R0	0
Ageing error	None	Base plus cohort	0
Age-based fishery selectivity	Logistic (estimated)	Non-parametric (non informative pr	1
Age-based survey selectivity	Logistic fixed	Non-parametric (non informative pr	1
Catch removal	Baranov catch equation	Pope's approximation	0
Timing of acoustic survey	Beginning of year	Middle of year	0
Weight-at-age for forecast	Terminal year	Average of most recent 6 years	0
Weight-at-age for *MSY*	Average over time series	Average of most recent 6 years	0

Reference list

Ciannelli, L., Fauchald, P., Chan, K.S., Agostini, V.N., Dingsør, G.E. 2008. Spatial fisheries ecology: Recent progress and future prospects. Journal of Marine Systems 71: 223-236.

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Attachment A: Statement of Work for Dr. Massimiliano Cardinale

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 **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

Support Personnel:

William Michaels, Program Manager, COTR
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1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
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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

Attachment B: List of main documents provided as background material or presented during the meeting

Cover Letter for the Pacific hake (Whiting) review panel
Tentative Meeting Agenda
List of Participants for the Stock Assessment Review Pacific hake
Pacific Fishery Management Council. 2010. Terms of Reference for the Groundfish Stock Assessment and Review Process for 2011-2012.

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.*

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.

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_3.20

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

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.
7. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

Attachment C: Tentative Agenda
Joint US-Canada Technical Review Panel for the Pacific Hake / Whiting Stock Assessment

February 7-11, 2011
Hotel Deca
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
	o Canadian Waters (Chris Grandin, DFO)
	o 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.

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

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.

Attachment D: Participants for the Joint US-Canadian Review Panel of the Pacific hake / Whiting Stock Assessment

February 7-11, 2011,
Hotel Decca
4507 Brooklyn Avenue N.E.
Seattle, WA 98105

Technical Reviewers
Tom Jagielo, Scientific and Statistical Committee (SSC), Panel Chair
Yan Jiao, Center for Independent Experts (CIE)
Massimiliano (Max) Cardinale, Center for Independent Experts (CIE)
John Wheeler, Center for Independent Experts (CIE)

Panel Advisors
John DeVore, Pacific Fishery Management Council (PFMC) Staff
Dan Waldeck, PFMC Groundfish Advisory Subpanel (GAP)
Rob Jones, PFMC Groundfish Management Team (GMT)
Greg Workman, Department of Fisheries and Oceans (DFO)

Stock Assessment (STAT) Team
Ian Stewart, Owen Hamel, Ian Taylor, and Allan Hicks, National Marine Fisheries Service (NMFS)
Robyn Forrest and Chris Grandin, Department of Fisheries and Oceans (DFO)
Steve Martell, University of British Columbia (UBC)

Pacific hake / Whiting Acoustic Survey Team Presenters
Dezhang Chu and Rebecca Thomas, National Marine Fisheries Service (NMFS)

Attachment E: Additional documentations and presentation were available at:

ftp://ftp.pcouncil.org/pub/Hake_STAR_2011/ and

ftp://ftp.pcouncil.org/pub/Hake_STAR_2011/Hake%20STAR%20presentations/