Report

of the

Joint Canadian and U.S. Pacific Hake/Whiting Stock Assessment Review Panel

conducted on

February 1-3, 2005

Northwest Fisheries Science Center
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Overview

On February 1st-3rd a joint Canada-US Pacific Hake/Whiting STAR Panel met in Seattle, WA to review the stock assessment by Helser et al. (2005). The Panel operated according toTerms of Reference for STAR Panels (SSC 2004), but the Panel attempted to adhere to the spirit of the Treaty on Pacific Hake/Whiting. As was the case in 2004, both a Panel member and Advisor from Canada participated in the review (see List of Attendees). The revised stock assessment and the STAR Panel review will be forwarded to the Pacific Fishery Management Council, council advisory groups, and to Canadian DFO managers and the PSARC Groundfish Sub-committee. The STAT Team was represented at the meeting by Thomas Helser, Guy Fleischer, Nathan Taylor and Steve Martell. Public comment was entertained during the meeting.

The STAR Panel members received a draft of the assessment 13 days prior to the meeting, which was sufficient time to adequately review the assessment. The meeting commenced on February 1, 2005 with introductions followed by a presentation by Guy Fleischer reviewing the 2003 acoustic survey. No new acoustic survey data was available since the last assessment. After the acoustic survey presentation, Tom Helser presented a detailed description of the stock assessment. Following that, Steve Martell presented the results of an analysis entitled "Estimating selectivity and natural mortality in the statistical catch-at-age model for Pacific hake *Merluccius productus* " (Martell et al 2005). On the second day, a presentation was given by Vidar Wespestad on the Pacific Whiting Conservation Cooperative pre-recruit survey. Panel discussion continued until the meeting was adjourned on February 3rd. The Panel recognized and appreciated the contributions of the STAT team.

The 2005 assessment used the same age structured assessment model developed in AD Model Builder and used in 2004. Major differences between the 2004 assessment and the 2005 assessment included the addition of 2004 fishery age composition and catch, and 2004 Santa Cruz juvenile rockfish survey data. While there is room for improvement in the assessment model, as detailed below (see Research Recommendations) the Panel concurred that the assessment conforms to the Terms of Reference for Expedited Stock Assessment Updates (SSC 2004) and is suitable for use by the Council and advisory bodies for ABC projections. As done previously in 2004, the two models carried forward for ABC projections were defined by differences in assumed acoustic survey catchability (q=0.6 and q=1.0) and were intended to serve as plausible lower and upper bounds on stock status. STAR Panel viewed both models (q=0.6 and q=1.0) as equally likely.

The STAR Panel commends the STAT team for the quality of the document provided for review and their cooperation in performing additional analyses requested during the meeting (see List of New Analyses Requested by the STAR Panel).

Summary of stock assessment

Stock size in 2004 was estimated to range from 2.5 to 3.8 million mt (age 3+ biomass) for the q=1.0 and q=0.6 model scenarios, respectively (Figure 1-Top). Both model scenarios allowed dome-shaped selectivity to be fit for the acoustic survey, thus allowing for even lower effective Q levels for young and old fish. Stock depletion in 2004 was estimated to range from 50% to 59% of an unfished stock (q=1.0 and q=0.6, respectively) (Figure 1-Bottom). Primarily due to the decay of the stronger than average 1999 year class, the spawning stock biomass is projected to again decline within the precautionary zone (25% - 40% of the unfished spawning biomass level) by 2006-2007. A sharp increase followed by a gradual decline in biomass is a pattern typical of stocks like Pacific whiting, with highly variable recruitment.

List of New Analyses Requested by the STAR Panel

The following list describes each request made of the STAT team, followed by the reason for the request and outcomes of the analysis:

Request: The Panel requested that the STAT team de-emphasize the Santa Cruz juvenile rockfish survey for the stock projections.
Reason: The results of a similar survey conducted jointly by the Northwest Fisheries Science Center (NWFSC) and the Pacific Whiting Conservation Cooperative (PWCC) (which covers a larger geographic area) appeared to conflict with the Santa Cruz survey. The PWCC survey results were presented to the STAR Panel but were not used in the assessment. The Santa Cruz survey was de-emphasized to examine the sensitivity to the projection results to this data source.
Outcome: With the Santa Cruz survey de-emphasized, the projections become driven by log mean recruitment. The result is a somewhat more optimistic projection trajectory.
Conclusion: The Panel recommends using the results with the Santa Cruz survey included, and to report the de-emphasized projection model runs as a sensitivity analysis. Due to uncertainty in this data source, the projections should be treated with caution. The Panel noted that, as the time series lengthens, the PWCC survey could serve as an additional data source that could be used in the future to improve model projections.

***Request*:** Examine using an alternative time period to derive average weight-at-age to use in forecasting. The panel requested using, as the alternative, the most recent 10 years of data.
***Reason*:** The panel wanted to determine how sensitive the projections were to the length of time used to estimate mean weight-at-age. The panel noted that the weight-at-age for some age-classes indicated that 1-2 year older fish were lighter. This may be biologically plausible if there were density-dependent or cohort-specific influences on growth.
***Outcome*:** Spawning biomass increased modestly when the 10 year averaging period was employed for weight at age.
***Conclusion*:** The panel agrees with using the average of the last 3 years of data from the fishery and the most contemporary survey data to estimate the weight-at-age for

projections. This approach is the most consistent with past forecasting and is likely to be more representative of recent growth.

Request: The STAR Panel requested that the final document should include a table showing the results of the MCMC uncertainty analysis for harvest projections under the assumption of F40% (in addition to the F45% table provided in the draft assessment document).
Reason: This table is required for use by managers as per Article III.1 of the Treaty on Pacific Hake/Whiting.
Outcome: The STAT team assured the Panel that the table will be provided in the final stock assessment document.

Request: The STAR Panel requested that a sensitivity analysis be conducted to examine alternative time periods of recruitment history in the calculation of B_0.
Reason: The Panel noted that the value of B_0 has changed over the course of several assessments.
Outcome*:* Time constraints prevented this from being done during the meeting. It was recommended as an item for future research (see Research Recommendations).

Technical merits and deficiencies

Acoustic survey

As noted in the 2004 STAR Panel report, the acoustic-trawl survey data were used in the assessment to provide biomass indices and estimates of proportion at age. The surveys are triennial from 1977 to 2001, with the latest survey in 2003. The surveys from 1977 to 1989 cover a smaller depth range than the later surveys and the 1977 to 1992 surveys do not go as far north as the later surveys. Deep water and northern expansion factors were applied to the appropriate surveys in an attempt to make the whole time series consistent. Otherwise, the survey design appeared to have been relatively consistent from year to year. Transects were typically east to west generally running between 50 m and 1500 m depth contours. Transects were allowed to be extended to deeper water if fish densities were high near the normal stopping point. Transects were done during the day with most trawling also conducted during the day for target identification and collection of biological samples.

Catch and catch at age

Total catch was available from 1966-2004 by nation and fishery. The Panel discussed the sensitivity of the model to the combined coastwide catch at age data. The Panel made a recommendation for future research on this topic (see Research Recommendations).

Recruitment indices

The Santa Cruz juvenile rockfish survey was used to provide a recruitment index from 1983 to 2004 and was also used as the basis for stock projections for 2005 and 2006. The results of a similar survey conducted jointly by the Northwest Fisheries Science Center (NWFSC) and the Pacific Whiting Conservation Cooperative (PWCC), which covers a larger geographic area, were presented to the STAR Panel but were not used in this stock assessment update.

The Panel noted that the data from the 2003 surveys were markedly different in the two data sources, which could be the result of a more northern spawning incident in that year. The Panel explored discarding the 2003 data from the Santa Cruz juvenile rockfish survey, but decided not to do so as: 1) the Terms of Reference for Expedited Stock Assessment Updates (SSC 2005) precludes introduction of new data sources, 2) the Santa Cruz juvenile rockfish survey covers more years, and 3) these data do not affect the estimate of current whiting abundance. However, because these data have a major influence on future stock size projections, the Panel recommends that managers exercise caution in relying on the future year projections presented in the assessment. The Panel concluded that, as new data are added from future surveys, the PWCC index (with greater spatial coverage than the Santa Cruz juvenile rockfish survey) should be evaluated for use in future stock assessments.

Biological parameters

Year specific weights at age were used in all years for each fishery and survey. A constant female maturity at age vector was also used. The Panel made a recommendation to explore year specific maturity at age in future assessments (see Research Recommendations).

Stock assessment model and estimation procedure

The single-sex age structured model uses standard population dynamics equations. The Canadian and U.S. fisheries are modeled as distinct year-round fisheries. Fishing selectivity patterns are year specific (constrained by a random walk) to allow for changes in fleet composition and shifts of fish distribution (across the border). The acoustic time series is modeled using a single selectivity pattern which applies to both the biomass indices and the estimated proportions at age. The estimation procedure is essentially maximum likelihood with Bayesian extensions for estimating parameter uncertainty. The Panel supported the use of the general modeling and estimation procedure and had some recommendations for future improvement. The Panel supported the development of a more parsimonious model as an alternative (see Research Recommendations).

The STAT team and STAR Panel noted that the present model differed from the 2004 model in that the value of initial F was previously set at 0.001, which did not result in a starting year biomass completely in equilibrium with B_0. Correction of this oversight resulted in a nominal positive effect on contemporary depletion levels.

Areas of Major Uncertainty

While there is uncertainty in both data and the model structure, the Panel concluded that the major source of uncertainty lies in the assumption of acoustic survey q. Future work is needed to help resolve the q issue (see Research Recommendations). Following the recommendation of the 2004 STAR Panel, the 2005 Panel and STAT team again bounded uncertainty with q=0.6 and q=1.0 and assigned the differential survey CV values used in 2004. The Panel and STAT team concluded that sufficient information was not available at the meeting to determine q more precisely.

The STAT team provided a simulation analysis exploring the estimability of dome-shaped selectivity concurrently with age-specific M (Martell et al. 2005). After considerable discussion on this topic, the Panel concluded that the true form of the selectivity function remains unclear. Results from the Martell et al. (2005) simulation experiments demonstrated a confounding problem between M and the descending portion of the dome-shaped selectivity curve. The age-specific natural mortality rate (M) was negatively correlated with the selectivity shape parameter that describes how rapidly selectivity drops with older age groups. Thus, if dome-shaped selectivity is the true state of nature, for all fisheries harvest and survey sampling gears, there is not sufficient information in the age composition data to reliably estimate age-specific natural mortality. The use of an environmental correlate in the model simulations reduced bias and greatly improved precision in estimated parameters. The Panel recommended future work to resolve the shape of the selectivity function (see Research Recommendations).

Areas of Disagreement

There were no substantial areas of disagreement between the STAT team and the STAR Panel.

Research Recommendations

The Panel considered the topic of research recommendations in two parts: 1) review of status of old recommendations (made by the 2004 STAR Panel) and 2) development of new recommendations. The Panel prioritized each of the old recommendations as "S" (short term; to be addressed in the 2006 assessment), "M" (medium term; to be addressed by the 2007 assessment), and "L" (long term; to be addressed by the 2008 assessment and beyond).

I. Recommendations from the 2004 STAR Panel

1. Acoustic survey recommendations:

a. Determine whether there are differences in survey performance between the WE Ricker & Miller Freeman. These include differences in mid-water and bottom trawl efficiency as well as differences in acoustic capabilities between the vessels. Analyze the available data to determine if we can continue to accept the null hypothesis that there is no difference in survey performance between these vessels. **(L)**

b. Perform a detailed meta-analysis across all survey years: compare spatial distributions of hake across all years and between bottom trawl and acoustic surveys to estimate changes in catchability/availability across years. **(M-in progress)**

c. Generate appropriate estimates of variability for every survey year. **(S-in progress)**

d. Review the methods used to estimate proportions at age for the acoustic survey with particular regard to the representativeness of trawl samples. **(S-will help to resolve the asymptotic vs. dome-shaped selectivity issue)**

2. Estimation of target strength:

a. Evaluate the current target strength for possible biases, particularly the use of nighttime experiments which are applied to daytime survey transects. Explore alternative methods for estimating target strength. **(S)**

b. Assess the value of the recent Canadian hake target strength observations and, if these are assessed to be useable, add these into the target strength model. **(S-in progress)**
c. Commission the acquisition of additional in-situ observations to increase the model sample size. **(S)**
3. Model enhancements:
a. Add in bias correction for log-normal distribution in appropriate likelihoods. **(Remove)**
b. Recode the model so that projections are done as a post-MCMC procedure. **(Completed)**
c. Develop an informed prior for the acoustic *q*. This prior should be used in the model when estimating the q parameter. **(M)**
d. Consider the development of a sex-structured model. **(M-investigate via simulation)**
e. Investigate alternative methods to model annual variability in fishery selectivity. Identify the covariates that influence fishery selectivity. **(Completed)**
f. Investigate the interaction of the dome-shaped selectivity functions with the fixed value of M. This investigation should include determining whether there is a trade-off between M and the declining limb of the selectivity function. Investigate the possibility of age-specific M. **(Completed)**
g. Investigate alternatives to applying a single estimated acoustic selectivity based on trawl samples to the acoustic biomass indices. **(Remove)**
4. The STAR Panel had difficulty completing its assigned task during a three day review. At least a full week is needed for a more thorough review of the input data and the assessment model. **(The Panel concurred that a full week would likely be required to review a new (full) assessment. The three day meeting provided adequate time to review the present stock assessment update.)**

New Research

1) Review the acoustic data to assess whether there are spatial trends in the acoustic survey indices that are not being captured by the model. The analysis should include investigation of the migration (expansion/contraction) of the stock in relation to variation in environmental factors. This would account for potential lack of availability of older animals and how it affects the selectivity function. **(M)**

2) Initiate analysis of the acoustic survey data to determine variance estimates for application in the assessment model. The analysis would provide a first cut to define the appropriate CV for the weighting of the acoustic data. **(S-in progress)**

3) Deconstruct the existing stock assessment model to investigate the factors that are most strongly affecting survey *q*. Examine what happens to the model parameters and biomass trends if the age-structure data is removed from the analysis. Attempt to reconcile the effects of the two main data sources, acoustic data versus age composition data. **(S)**

4) Review hake abundance data available from trawl surveys to assess the relative abundance of older fish in the population. The intent is to address the appropriateness of the asymptotic versus dome-shaped selectivity function. **(S)**

5) Investigate the efficacy of the current management procedure (F40%/F45%) through simulation/evaluation to examine whether the current harvest policy is robust to highly variable recruitment and the uncertainties with the Pacific hake assessment and whether alternative approaches are more robust to the uncertainties. This addresses the 2004 STAR Panel harvest policy issue that "a new examination of the harvest policy that takes into account this [high recruitment variability]". **(M-important)**

6) Investigate aspects of the life history characteristics for Pacific hake and their possible effects on the interrelationship of growth rates and maturity at age. **(L)**

7) Investigate modeling the hake stock with a more parsimonious parameterization. For example, investigate the possibility of combining Canadian and US catch at age data and modeling the stock with one fishery. **(S)**

8) In future assessments, down-weight effective sample sizes of the multinomial age data in the early years of the acoustic survey to make them consistent with the higher CV's used for the biomass estimates in early years, to account for the spatial expansion factor. **(S)**

Panel Findings

1) For whiting, with its particularly high recruitment variability, it would be advisable to utilize projections with time horizons shorter than 10 years. A reasonable projection time frame would be 3-4 years.

2) The STAR Panel agrees with the recommendation of the 2004 STAR Panel that a full week is needed to conduct a through review for a full stock assessment. The three day meeting provided adequate time to review the present stock assessment update.

List of Attendees

2005 Whiting/Hake STAR Panel

Name	Affliation	Role
Tom Jagielo	SSC, WDFW	Panel Chair
Jake Schweigert	DFO	Panel Participant
Kevin Piner	SWFSC	Panel Participant
Graham Pilling	CEFAS	CIE Reviewer
Jeff Fargo	DFO	Advisor
Rod Moore	GAP	Advisor
Jim Hastie	GMT	Advisor
Tom Helser	NWFSC	Lead Author
Guy Fleischer	NWFSC	Co-Author
Steve Martell	UBC	Co-Author
Nathan Taylor	UBC	Co-Author

Brad Pettinger (Oregon Trawl Commission)
Jim Colbert (Oregon State University)
Vera Agostini (University of Washington)
Ian Stewart (University of Washington)
Vidar Wespestad (Pacific Whiting Conservation Cooperative)
Rick Dunn (Hake Consortium of BC)
Steve Joner (Makah Tribe)
Mike Buston (Leader Fishing)
Stacey Miller (NWFSC, Stock Assessment Coordinator)
Elizabeth Clarke (NWFSC)
Dan Waldeck (Pacific Whiting Conservation Cooperative)
Bruce Turris (CGRCS)
Joe Bersch (SAS)
Bill Clingan (Ocean Gold)
Barry Ackerman (DFO)
Carrie Nordeen (NMFS/NWR)
Mark Saelens (ODFW/GMT)

References

Martell, S., Taylor, N., Helser, T. and Guy Fleischer. 2005. Estimating selectivity and natural mortality in the statistical catch-at-age model for Pacific hake *Merluccius productus.* Appendix A to: Stock Assessment of Pacific Hake (Whiting) in U.S. and Canadian Waters in 2004.

Helser, T.E., Fleischer, G.W., Martell, S., and Nathan Taylor. 2005. Stock Assessment of Pacific Hake (Whiting) in U.S. and Canadian Waters in 2004.

SSC. 2005. Groundfish stock assessment and review process for 2005-2006. Pacific FisheryManagement Council.

STAR Panel. 2004. STAR Panel report on the stock assessment of Pacific Hake (Whiting) in US and Canadian Waters in 2003.

Figure 1. (Top) Model estimates of Pacific Hake recruitment and age 3+ biomass. (Bottom) Trend in depletion level under model scenarios where q=1.0 and q=0.6.