Pacific Whiting

Joint U.S.-Canada STAR Panel Report

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Review Panel Members

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

Joint Stock Assessment Team (Joint STAT) Members

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

Pacific hake / Whiting Acoustic Survey Team Presenters

Rebecca Thomas, NWFSC
Dezhang Chu, NWFSC

STAR Panel Advisors

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

Overview

During 7-11 February 2011, a Joint Canada-U.S. Pacific hake / whiting Stock Assessment Review (STAR) Panel met in Seattle, Washington, to review a draft stock assessment document that had been prepared by the Joint Canada-US stock assessment team. The Panel operated under the U.S. Pacific Fishery Management Council's Terms of Reference for the Groundfish Stock Assessment and Review Process for 2011-2012 (PFMC 2010). As in previous years, the Panel attempted to adhere to the spirit of the Canada-U.S. Treaty on Pacific hake / whiting (Bush 2004). The revised stock assessment and the STAR Panel Report will be forwarded to the Pacific Fishery Management Council (PFMC) and its advisory groups, and to the Canadian Department of Fisheries and Oceans (DFO) managers and the Groundfish Sub-committee of PSARC (Pacific Scientific Advice Review Committee).

The Panel convened at 9AM Monday, February 7, 2011 with a welcome from Tom Jagielo (Panel Chair) and a round of introductions. Mr. Jagielo then gave a brief overview of the STAR process and reviewed the terms of reference (PFMC 2010). The agenda was subsequently reviewed and adopted for the STAR Panel.

Presentations began with Dr. Ian Stewart giving an overview of the acoustic survey. Past concerns were identified and actions taken in 2010 to rectify them were discussed. The primary questions were: 1) what is the survey biomass variance, 2) how sensitive are the survey results to the analysis methods, 3) what are the implications of sparse haul sampling, and 4) is post-stratification of the haul sampling appropriate. Dr. Stewart summarized progress made in 2010, including: 1) the raw acoustic data were re-analyzed, 2) biomass estimates and characterization of uncertainty were improved using the method of kriging, 3) uncertainty in the 2009 estimate due to the presence of squid in 2009 was evaluated, 4) new sampling failed to reveal a systematic bias in trawl samples, and 5) the analysis results were robust to post stratification. A major difference in the 2011 assessment is that the survey data prior to 1995 are not included due to limited spatial and bathymetric coverage.

Dr. Dezhang Chu followed up with a more detailed presentation of the acoustic survey design and historical database and a discussion of the data explorations done since last year (Chu and Thomas 2011). Questions from the STAR Panel focused on the companion trawl survey and the selectivity of the gear used to verify the species composition of the acoustic backscatter and to obtain biological samples. It was noted that there was a change in the mid-water trawl on the U.S. survey vessel after 2001; although no comparative tows were made, it was indicated that selectivities of the two gears were probably similar. The STAR Panel questioned the use of the Traynor (1996) target strength relationship; given more recent research results are available (Henderson and Horne 2007). The Acoustics Team indicated that although there was uncertainty in both relationships, it continued to use the Traynor relationship as it was more consistent with other available information. The Acoustics Team noted the importance of continued target strength research and the STAR Panel endorsed this as an important recommendation.

Next, Dr. Chu gave a presentation on the reprocessing of historical acoustic survey data and kriging (Chu 2011). Data re-processing focused on the years from 1995 forward, due to problems with incomplete data and lack of full spatial and depth coverage into Canada in the earlier years. Reprocessing with the new EchoPro software resulted in estimates which showed

minor discrepancies when compared to the previous values; in part this resulted from improved treatment of the bottom algorithm. The technique of kriging was used to derive estimates of total biomass from the transect data. Kriging is a geo-spatial analysis method that has been used extensively in the mining industry. Kriging estimates are consistently larger than original estimates because this method includes area beyond the transect extent. One set of semi-variograms (along and across isobaths) is produced for each survey year over the entire survey area, and semi-variograms were shown to be similar between surveys. It was pointed out that one set of coastwide semi-variograms per year assumes the same spatial structure throughout, yet age structure is known to vary by latitude. The STAR Panel discussed the possibility of using a regression model to assist characterization of the spatial structure, considering the large area covered and the lack of homogeneity over the range. Dr. Chu pointed out that the method they employed strived to minimize subjectivity, which can be a factor when employing regression methods. It was agreed that this would be a good area for future research in a sensitivity analysis. Previous STAR panels have asked for an analysis of the factors affecting the spatial distribution of the stock, and it was noted that Melissa Haltuch is currently preparing a report on this subject that is not yet ready for distribution.

Dr. Rebecca Thomas followed with a presentation on the re-analysis of the 2009 acoustic survey data and the challenges of dealing with the unusually large numbers of Humboldt squid seen in the survey in that year. Approximately 39% of the estimated 2009 hake biomass came from "challenging transects" where squid occurred with hake. Stratification by depth of the two species was observed in the survey, with squid often found above hake in the water column. Bootstrapping analyses were conducted to evaluate the sensitivity of the survey results to assumptions including: 1) choice of depth threshold, 2) species composition in trawl sets, and 3) expert opinion in identifying squid. Re-analysis of the 2009 survey left the point estimate of hake biomass unchanged, but resulted in higher uncertainty. The highest uncertainty (species composition in trawl sets) was added to survey uncertainty.

Dr. Thomas continued with a presentation on haul representativeness in the acoustic survey. Trawl sampling experiments were conducted in 2010 in U.S. and Canadian waters to begin to evaluate the variability of repeated hauls on fish aggregations. The survey team had difficulty in finding suitable schools of hake in 2010 for the evaluation. Sample sizes were small and variability was high among hauls (especially in the US zone), with no clear patterns evident. Statistical analysis of post-stratification indicates model results are insensitive to post-stratification of survey data. The acoustic survey team emphasized that more work of this kind in the future will help to validate haul representativeness for the survey.

Presentations were given on the 2010 fishery in Canada by Chris Grandin and in the US by Ian Stewart. A relatively large number of age 2 fish (2008 year class) were observed in U.S. and Canadian waters in 2010. Industry participants at the meeting noted that behavior of the fishery (particularly in U.S. waters) may have been influenced by the active avoidance of the 2008 year class in 2010.

Summary of data and assessment models

Dr. Stewart gave a presentation on the data sources evaluated and those ultimately used in the current stock assessment (JHTWG 2011). Improved collaboration occurred between the Canada

and the US members of the Joint Technical team in 2010. All data inputs were reviewed and revised from raw data and a single set of input data was used for the first time in both assessment models. Fishery data were dis-aggregated and looked at for the first time by season for the individual fishery sectors. Fishery-dependent data include catch data back to 1966 and age data back to 1975. U.S. and Canada catches were modeled in one fleet rather than as separate fleets as was done in the past.

Explorations of age-at-length data showed a dramatic shift in growth rates between more recent data and the historical data prior to 1991. Growth rates are faster now but maximum length is smaller. It is unclear whether there is a fishery effect as the target fisheries developed in the 1990s or whether there was an environmental shift influencing those observations.

Ageing precision was addressed in the new assessment with an exploration of the "cohort effect" where the age of dominant cohorts tend to be assigned more frequently. Pooled samples that had been previously read (2003-2009) were read again and compared to past age assignments. As expected, fewer age assignments were made to dominant cohorts when pooled samples were re-read.

Maturity schedules have not been updated for many years. The existing maturity schedule is based on visual examination of gonads from samples collected from 1990-1992 (Dorn and Saunders 1997) and these data have not been revisited since 2006. The Joint STAT recommended collection and re-analysis of maturity data as a high research priority.

Sensitivity analyses of disaggregated fishery landings and composition data (seven fishery sectors with seasonal strata) indicated within-season growth for dominant cohorts with differences in growth trajectories evident among the dominant cohorts. Modeling of this complexity was problematic; however, it was found from a sensitivity analysis (where a seasonal time step was modeled in SS) that stratification did not make a significant difference to the model result. This analysis provided some assurance that the current assessment results are not sensitive to the observed recent shift to later season fishing.

On day two of the meeting, the Joint STAT team gave presentations describing the TINSS and SS model structures. Dr. Stewart pointed out that this is the first year in which close collaboration in data preparation resulted in both models using the same fishery and survey data inputs. Specifically, the SS and TINSS models share the same: 1) annual catch, 2) weight-at-age, 3) acoustic survey biomass index time series, and 4) acoustic survey age frequency distributions. Structurally, the models both: 1) model combined genders, 2) use an annual time step, 3) take population weight-at-age data directly from the data (growth is not parametric), 4) estimate M using the same informative prior, 5) use the same acoustic sampling variance component, 6) model time-invariant asymptotic selectivity, and 7) do not assume equilibrium conditions at the beginning of the modeled era.

Dr. Stewart noted that in SS: 1) age frequency data are modeled with a multinomial likelihood, 2) age composition data sample sizes are derived from the haul/trip data and are iteratively re-weighted, 3) fishery and survey selectivity estimates are age specific and are held constant for ages 5+, 4) the acoustic survey is modeled with a log-normal likelihood, 5) recruitment

deviations are modeled with a penalty based on sigma R, and 6) the prior on steepness in SS is somewhat higher than the implied prior on steepness in TINSS.

Dr. Robyn Forrest reported that an error in coding of the Baranov catch equation influenced the results originally distributed in the draft stock assessment document prior to the STAR Panel meeting. The problem was corrected and the revised TINSS and SS base models agreed more closely with respect to key outputs. The TINSS base model: 1) employs a log of mean recruitment parameter, 2) uses a multivariate logistic function to model the age compositions, 3) weights the acoustic survey index scaled relative to the 1998 value, 4) bins age composition data for small sample sizes, 5) assumes logistic and fishery survey selectivity (holding the parameters fixed for the survey), and 6) uses the same prior for MSY but a somewhat broader prior for F_{msy} compared to the 2010 model. Dr. Forrest reported that, for the current TINSS base model: 1) some poorly characterized year classes (e.g., 1984/1985 and 2006/2007) appeared to be the result of the binning structure, 2) auto-correlation was evident in the MCMC chain results, and 3) sensitivity was evident to selectivity parameters and the choice of priors on the MSY and F_{msy} parameters.

The Panel discussed key differences between the current TINSS and SS base models, and discussed how best to proceed with the review. It was decided that the next step would be to identify ways the two models could be standardized (if possible) with regard to basic assumptions and inputs, with the notion that this could assist in guiding the direction for formulating alternative model runs and sensitivity requests for the Joint STAT. To this end, the Panel requested that the Joint STAT provide a list of priors, key assumptions, and critical differences in model structures between the TINSS and SS models (see Request No. 1, below).

The Joint STAT responded by providing a table with the requested information (Appendix 1, attached). Items identified as potentially important included differences between the models with respect to: 1) likelihoods used for the age composition data, 2) weighting among years for age composition data, 3) the binning of small age frequency observations in TINSS, and 4) informative priors used in the estimation of various parameters; in particular: steepness, F_{msy}, MSY, acoustic q, total precision (observation error and recruitment variability), and the ratio of observation error to recruitment variability. Structurally, the models also differed in that fishery selectivity was estimated using a logistic function in TINSS, with the logistic parameter values fixed at the 2010 values for the acoustic survey. Following review and discussion of the identified model differences, the Panel made a set of additional requests of the Joint STAT (see requests No. 2-8, below); these focused on: 1) some items that appeared to be relatively straightforward to standardize (i.e., housekeeping issues), and 2) other items that could potentially help to better understand the differences in the model outputs.

The Joint STAT response to the additional requests resulted in a closer agreement between model outputs (due to changes made in the TINSS model). The new TINSS base model included: 1) correction of an error discovered in the age composition likelihood computation, 2) removal of the age binning structure, 3) estimation of the survey selectivity parameters that were previously fixed, 4) timing of acoustic survey aligned with SS (to middle of year), and 5) weight--at-age in forecast set to the average of the most recent six years (to align with SS). The Joint

STAT reported that the fit to the age composition was good and characterization of the 1984, 1985, 2006, 2007, and 2008 year classes was substantially improved.

The Joint STAT and STAR Panel discussed features of the new TINSS and SS base models. Specifically, comparisons of the updated TINSS and SS model revealed that: 1) agreement in fit to the acoustic survey biomass was better, 2) there was a closer alignment in the spawning biomass trajectories and their associated confidence intervals, 3) depletion at the beginning of the time series became closer (while depletion at the end of the time series became more divergent), 4) the agreement in the recruitment time series was much improved, 5) recruitment deviations in log space showed much closer agreement, and 6) the fishing intensity time series showed much closer agreement. Overall, it was observed that current spawning biomass estimates and the associated confidence intervals showed good agreement although uncertainty remained large for both models. Though estimates of B_0 were still quite different, those differences were likely driven by prior selection and structural differences including: 1) priors on leading parameters, and 2) other differences between the two models including differences in modeling the age composition error structure, how the age composition data were weighted, how selectivity of the fishery and acoustic trawl survey were modeled, and parameterization of the initial age structure of the models.

The Joint STAT and the STAR Panel discussed whether the current configurations of the TINSS and SS models represented the best base-case models for development of management advice. The general consensus was "yes". The group recognized, however, that uncertainty in the strength of the 2008 year class is very high and alternative model structures (such as parameterizations with time-varying selectivity) could be put forward that would very likely give less optimistic characterizations of current stock status. It was decided that: 1) outputs from both the TINSS and SS base models would form the basis of a revised set of decision tables (with the strength of the 2008 year class as the primary axis of uncertainty), and 2) uncertainty in the true state of nature would be further (but not fully) characterized by an updated set of sensitivity model runs.

Requests by the STAR Panel and Responses by the Joint STAT
February 8, 2011

Request No. 1:
The Panel requested that the Joint STAT provide a list of priors, key assumptions, and critical differences in model structures between the TINSS and SS models.
Rationale: This will guide the decision for formulating alternative model runs and sensitivity requests for the Joint STAT.
Joint STAT Response: A detailed table was provided (see Appendix I).

Request No. 2:
Change the survey and fishery age composition binning in TINSS to try to resolve "problem" year class estimations (such as 2007). Also look at selectivity and catchability. Plot selectivities against SS values for direct comparison of the two models.
Rationale: Basic housekeeping.

Joint STAT Response: The binning structure was removed from TINSS and characterization of the problematic year classes was much improved. A plot was also prepared comparing selectivity estimates from the two models. Closer agreement in survey and fishery selectivity was evident, with the TINSS curves to the right of the SS estimates of selectivity at age.

Request No. 3:
Standardize the weight-at-age assumption in the stock forecast and estimation of MSY for both models.
Rationale: Basic housekeeping.
Joint STAT Response: This was done in stock forecast but not in estimation of MSY due to fundamental differences in the SS and TINSS model parameterizations.

Request No. 4:
Standardize the treatment of survey timing for both models.
Rationale: Basic housekeeping.
Joint STAT Response: Done.

Request No. 5:
Look at what model components affect differences in B_0 between models, i.e., produce numbers at age (at B_0) for the two models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: Done. The vectors were similar and differed mainly in scale. It was noted that looking at the 1966 vectors may provide additional insight into differences between the models.

Request No. 6:
Decide if ageing error and selectivity should be handled the same way in both models. If so, standardize for both models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: The Joint STAT reported that some differences exist in this area with regard to modeling philosophy. There was not time to fully evaluate the differences during this meeting.

Request No. 7:
Decide if model age composition weights should be handled the same way for both models. If so, standardize for both models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: There was not enough time to do this at this meeting. Further exploration of age composition likelihood functions should form a research recommendation.

Request No. 8:
Examine sensitivity to selection of maturity schedules for both models.
Rationale: Try to better understand reasons for differences in model outputs.
Joint STAT Response: The Joint STAT found that it was not easy to align these at this time, and noted that this should be revisited when the maturity data are updated. Updating the maturity schedules should form a research recommendation.

February 9, 2011

Request No. 9:
Update the set of sensitivity runs for TINSS. Provide tables and figures for the Panel to review.
Rationale: The TINSS model has changed since the original draft report.
Joint STAT Response: Done. The updated results were presented by Dr. Forrest and will be included in the final stock assessment document.

Request No. 10:
Update the decision tables. Provide tables for the Panel to review.
Rationale: The TINSS model has changed since the original draft report.
Joint STAT Response: Done. The updated results were presented by the Joint STAT and will be included in the final stock assessment document.

Request No. 11:
Update the stock assessment document Executive Summary section and distribute.
Rationale: The results have changed since the original draft report.
Joint STAT Response: Done. The updated results were presented by the Joint STAT and will be included in the final stock assessment document.

Description of the base model and alternative models used to bracket uncertainty

This is discussed above under the "Summary of data and assessment models" section, and given in detail in the updated stock assessment document. The final decision tables employed the updated TINSS and SS base models and used the strength of the 2008 year class as the primary axis of uncertainty.

Technical merits

Improved collaboration by the Joint STAT resulted in the sharing of the same input dataset by TINSS and SS for the first time. The collaboration resulted in greatly improved joint stock assessment modeling overall. Efficiency was improved and one collaborative document was presented to the STAR Panel for review. Both models are informative and offer unique perspectives.

Technical deficiencies

No obvious pathologies were evident. Structurally, the base models do not address time-varying selectivity. Some feel this is an improvement from the perspective of parsimony; others feel that this overlooks an important property of the data.

Areas of disagreement regarding STAR Panel recommendations

Among STAR Panel members (including GAP and GMT representatives): None.
Between the STAR Panel and Joint STAT Team: None.

Management, data, or fishery issues raised by the GMT or GAP representatives during the STAR Panel Meeting

The PFMC management representative (Mr. John DeVore) noted that deciding the acceptable biological catch (ABC) would be aided if the two models could be aligned with respect to assumptions of the value of stock recruitment steepness. He asked if using the SS model would be the better model for deciding the ABC with respect to the default $F_{40\%}$ proxy. Panel discussion followed on this issue. The DFO Panel Advisor (Mr. Greg Workman) pointed out that uncertainty of the strength of the 2008 year class is large and is not necessarily fully characterized in the decision tables; for example, time-varying fishery selectivity remains an uncertainty.

Managers, the Joint STAT, and others present at the meeting pointed out that stock assessment authors need more time to obtain the needed data following the fishery, and more time to fully analyze the data to ensure adequate time prior to reviews to adequately prepare the assessment and report the results.

Unresolved problems and major uncertainties

A key source of uncertainty in the determination of current stock status is the absolute magnitude of the 2008 year class. At present, there is information only from the age composition of the 2010 fishery, since there was no acoustic survey in 2010. The strength of the 2008 year class will be better known subsequent to the 2011 acoustic survey and fishery.

It is noteworthy that the acoustic survey is the only fishery independent index, and while the new treatment of the data included an accounting of uncertainty based upon survey design and other sources, additional uncertainty is likely present due to factors such as survey timing, target strength, and depth distribution.

The biological data indicate dramatic changes in growth in the early 1990s and the effects this change may have had on maturity have not been evaluated.

Basic ecosystem information is lacking on hake as predators or prey, and the resulting impact this may have on modeling the stock is unknown. Work is underway that could contribute new information in the future.

Recommendations for future research and data collection (not prioritized)

The Panel reviewed and endorses the full set of research recommendations presented by the Joint STAT (JHTWG 2011). The following list includes items specifically brought up at the meeting.

Conduct the acoustic survey annually. Reason: the survey is now biennial. An annual survey would help to the reduce CI on the current biomass estimate. Consideration should be given to a joint government / industry survey.

Conduct target strength research. Reason: the relationship used in the biomass estimate calculations is dated and more recent research indicates substantial differences in the target strength / fish length relationship.

Conduct further work to validate haul representativeness and sampling design of the trawling component of the acoustic survey. Reason: uncertainty remains in the representativeness of the hauls used to characterize the biological composition of the acoustic survey.

Explore alternative spatial analyses using different regression techniques with the kriging data. Reason: Spatial and temporal variation of hake influence the level of homogeneity in the acoustic biomass estimates.

Explore fundamental differences in assumptions that drive output differences in the TINSS and SS models. Reason: the fundamental structure of the two models differs and an explicit evaluation of assumptions will help to evaluate reasons for differences in the resulting advice for management coming from the two models.

Further evaluate the method of age composition weighting and the different approaches taken in TINSS and SS models.

Further explore time-varying growth and alternate model structures, as appropriate, to characterize this phenomenon.

Further explore time-varying selectivity and alternate model structures, as appropriate, to characterize this phenomenon.

Produce an age 0 or age 1 recruit index. Reason: recruitment variability is a major driver in the uncertainty of the hake assessment.

Update the maturity-at-age relationship by collecting new data and using histological analysis techniques. Reason: substantial changes in growth in early 1990s may have resulted in maturation changes.

Explore the role of ecological covariates that could inform the stock assessment.

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Appendix I

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	Relative Potential Importance
Data use			
Likelihood for age-composition data	Multivariate logistic	Multinomial (0.001 added to obs. and exp.)	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 and precision	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 priors to age 5)	1
Age-based survey selectivity	Logistic fixed	Non-parametric (non informative priors to age 5)	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