

**Addendum to the
Report of the 2008 U.S. / Canada Pacific Hake (Whiting)
Stock Assessment Review (STAR) Panel -
STAR Panel Response to the Minority Report**

Review Panelists:

David Sampson, Panel chair and representative for the Scientific and Statistical
Committee of the Pacific Fishery Management Council (PFMC)

Malcolm Haddon, Center for Independent Experts

Noel Cadigan, Fisheries and Oceans, Canada

Introduction

The Canadian component of the Pacific hake stock assessment team filed a Minority Report to express reservations about the STAR Panel Report and the process followed at the 2008 review. The three reviewers on the STAR Panel offer the following information to clarify events that transpired during the review and to lay bare how the panel arrived at its decision to recommend using only the Stock Synthesis II (SS2) model to develop a base model and decision table for use by the Pacific Fishery Management Council. The STAR Panel gave due consideration to all three models brought to the STAR Panel Meeting; the Panelists chose the model that they considered to provide the best representation of the Pacific hake stock and the uncertainties inherent in the available data.

The Data

The STAR Panel commends the three sets of analysts for the care they took to use the same input data in their separate assessment models. Differences observed in the results from the three models (SS2, ADAPT / VPA, TINSS) can thus be ascribed to differences in approach to data aggregation and assumptions about model structure. One general finding of the explorations that occurred during the STAR Panel Meeting was that the three modeling platforms could be configured to produce very similar estimated biomass trajectories. Differences in results were driven primarily by assumptions about model structure.

The following sets of compositional data were available to the SS2 analytical team, the ADAPT / VPA analytical team, and the TINSS analyst: length composition data for the US fishery, length composition data for the Canadian fishery, length composition data for the acoustic / midwater trawl survey, age-at-length composition data for the US fishery, age-at-length composition data for the Canadian fishery, age-at-length composition data for the acoustic / midwater trawl survey. The SS2 model maintained these data components separately, thus allowing full exploration and measurement of any lack of agreement among these separate data sources. The ADAPT / VPA and TINSS models collapsed the length and age-at-length compositions to two sets of age composition estimates, one for a combined US / Canadian

fishery and a second for the acoustic / midwater trawl survey. Through a series of likelihood profiles the SS2 analytical team showed that there was a clear lack of agreement between the US versus Canadian age composition data. This lack of agreement is incorporated into the SS2 model's estimates of uncertainty, whereas it is ignored by the TINSS model because this model combined the separate fisheries. The ADAPT / VPA model gives no consideration to measurement error in the catch-at-age data.

The SS2 model included a transition matrix to reflect imprecision in age-reading data so that uncertainty due to age reading imprecision would be incorporated into estimates of uncertainty in the SS2 assessment results. The SS2 model also incorporated the uncertainty associated with deriving age-composition estimates from the application of age-length keys to length composition data. Further, the SS2 model included uncertainty in the growth-in-length function due to measurement error and time-variation in growth. In contrast, the ADAPT / VPA and TINSS models assumed there was no age-reading error, no imprecision in the derivation of age from length, and no uncertainty in average weight-at-age by year.

It was (and remains) the Panel's opinion that the SS2 model made better use of the available data to reflect known and potentially influential sources of uncertainty.

Structural Assumptions

It was also the Panel's opinion that the SS2 model was superior to the two other models in its structural accommodation of several processes known to be potentially influential, including the shape of the selection curves (free to be domed in SS2; assumed to be asymptotic in the ADAPT / VPA and TINSS models) and temporal variation in selection (assumed to be time-varying in SS2 and ADAPT / VPA, but time-invariant in TINSS). The SS2 and TINSS models both allowed some flexibility in the natural mortality coefficient (M) and incorporated this uncertainty into the final assessment results, whereas the ADAPT / VPA had a fixed value for M and thus ignored this important source of uncertainty. The SS2 model generally made less restrictive assumptions than the other models regarding the degree of measurement error in different data sources. For example, the SS2 model assumed that the acoustic / midwater trawl survey estimates of biomass in the first half of the time-series were much less certain than the estimates during the second half, to reflect the major expansion in spatial coverage by the survey starting in 1992. The ADAPT / VPA and TINSS models, in contrast, assumed uniform variation in measurement error by the survey for the entire duration of the time series, thus giving much greater (and undue) leverage to the survey estimates from the early portion of the time series.

Rationale Leading to Acceptance of the Final SS2 Base Model

During the STAR Panel Meeting the STAR Panel requested a number of exploratory runs with all three of the assessment models in an attempt to better understand the causes of the similarities and differences among the models. The fundamental task of the meeting, however, was to develop a single best model to represent conditions in the stock and the uncertainty associated with stock status. To that end the Panel requested a series of refinements in the structural assumptions of the SS2 model that had been brought to the STAR Panel Meeting. The Minority Report criticizes the STAR Panel Report for not providing "any technical or statistical justification for their selected base model." The sequence of steps leading to the final SS2 base model was described in the STAR Panel Report and is repeated below, but with additional

information regarding goodness-of-fit of the different model configurations that were examined. This information on goodness-of-fit of different model configurations was discussed during the STAR Panel meeting but was not included in the STAR Panel Report.

The initial draft of the assessment document for the SS2 model proposed an initial base model and high and low alternatives, where the feature distinguishing the three configurations was the survey selection coefficient for the age-15+ fish. In terms of the negative log-likelihood values associated with the three configurations, the high alternative, which had the "Final survey selex" parameter fixed at 0.3, provided a much better fit to the data (92 log-likelihood units better than the initial base model) (Table 1, part A). When the constraints on the natural mortality coefficient (M) were relaxed (STAR Request 1 from Tuesday afternoon) there was a large improvement in fit (decrease in the negative log-likelihood) (Table 1, part B). The SS2 analytical team felt there was insufficient justification for freeing up M given the maximum age that has been observed for Pacific hake (about 25 years). The STAR concurred. The next step of "fiddling with the SS2 assessment model formulation" was the introduction of an age-dependent formulation for M, whereby M was fixed at 0.23^{-y^t} (as in the initial base model) for ages up to 13 and then followed a linear ramp for ages-14 and 15+ (Table 1, part C). This slight change in the model configuration resulted in an even larger improvement in fit relative to the initial base model.

The final fiddle with the SS2 model configuration was the free estimation of the parameter for the survey selection coefficient for the oldest fish (Table 1, part D), which had taken fixed values in previous model configurations. The main goal of this step was to move to a base model configuration that would encompass the original high and low alternatives, but without artificial constraints, to facilitate construction of a decision table. The posterior probability density function derived from the base model configuration would be used to assign the alternative states of nature associated with the upper and lower 25% probabilities and the set of base model parameters (and derived management quantities) associated with the central 50% probability. Relative to the initial base model that had been brought to the STAR Panel Meeting, the STAR Panel's fiddling with the SS2 model configuration resulted in a final base model that provided a major improvement in fit to the data (258 log-likelihood units) at the expense of only two additional estimated parameters (M for the oldest fish, and the final survey selection coefficient). Given the rule-of-thumb that one new parameter is worth keeping if it produces an improvement in log-likelihood of at least two units, there should be no doubt that the improvement in fit to the data provided clear support for the final base model.

The SS2 Model's Severely Biased Retrospective Pattern

The SS2 analytical team commented on the retrospective pattern shown by the SS2 model and explained that it was likely due to the increasing influence of the early biomass index values from the acoustic / midwater trawl survey, which the final base model did not provide a good fit to. As the later biomass index values were successively removed, the model provided better fits to the early biomass index values, the estimates of the survey catchability coefficient decreased, and the estimated stock biomass was scaled upwards. The STAR Panelists concurred that this was a plausible explanation for what otherwise would be a troublesome feature of the SS2 model.

Global Convergence of the SS2 Model

Figure 25 of the STAR Panel report and the analysis on which the figure was based showed that none of the "jittered" runs produced a better fit than that provided by the final base model. While this does not constitute "proof" of convergence, it clearly refutes the Minority Report statement that "the SS2 model did not reach global convergence." That there may be a ridge in the likelihood surface is neither a surprise nor a cause for concern. The uncertainty that this ridge produces should in theory be accounted for in the SS2 model's estimates of uncertainty and in the posterior distribution generated by the MCMC runs.

Membership of the STAR Panel

The Minority Report states that the Canadian members were surprised that Mr. Waldeck was a member of the Panel. The "Terms of Reference for STAR Panels and Their Meetings" indicates "the groundfish management team (GMT) and the groundfish advisory panel (GAP) will designate one person each to participate in the review." The first page of the STAR Panel Report lists Dan Waldeck as the "Representative for the PFMC Groundfish Advisory Panel" and John Wallace as the "Representative for the PFMC Groundfish Management Team".

The STAR Panel Report should also have included Jeff Fargo, who served on the Panel as the representative of Fisheries and Oceans Canada. He was included in the list of STAR Panelists at the end of the STAR Panel Report. We regret that his name was inadvertently left off the list on the first page.

Harvest Management Advice

The Minority Report states that "it seems prudent to forecast the ABC at a lower exploitation rate than what has been estimated for the past several years." The Report expresses frustration that the STAR Panel vetoed their advice "on the grounds that it had to do with policy and not science." The role of the STAR Panel is to review the assessment data and models for their accuracy and scientific merit. There is nothing in the terms of reference asking the STAR Panel to evaluate target exploitation rates. To the contrary, the Council has an adopted policy that Pacific hake assessments should do catch forecasts based on an F40% rate of fishing mortality as adjusted by the 40-10 harvest control rule. The STAR Panel Report lists various risk factors that the Council may choose to consider in its deliberations regarding an optimum yield (OY) value for 2008. The STAR Panel Report identifies as its highest priority the need for a Management Strategy Evaluation to determine whether the current harvest policy is appropriate for Pacific hake.

Table 1. Goodness-of-fit and maximum likelihood estimates of management quantities from the set of SS2 model runs explored during the STAR Panel Meeting.

A. The initial set of SS2 model runs brought to the STAR Panel Meeting. The information is equivalent to the upper section of Fig. 12 in the STAR Panel Report.

Derived Parameter	Initial base model Final survey selex=0.5			Alt. Low Final survey selex=0.7			Alt. High Final survey selex=0.3		
	Asymptotic			Asymptotic			Asymptotic		
	MLE	95% CI		MLE	95% CI		MLE	95% CI	
Neg log likelihood	14595			14665			14503		
number parameters	88			88			88		
2007 Depletion	0.437	0.293	0.581	0.291	0.212	0.370	0.570	0.418	0.723
2008 Depletion	0.429	0.254	0.604	0.292	0.156	0.428	0.597	0.413	0.782
MSY	346,130	247,101	445,159	219,270	153,310	285,230	467,030	320,273	613,787
B _{MSY}	637,580	359,397	915,763	434,510	248,255	620,765	917,560	504,980	1,330,140
SPR _{MSY}	0.234	0.107	0.360	0.248	0.104	0.393	0.247	0.108	0.385
2008 Catch	401,720	190,765	612,675	111,090	22,335	199,845	750,820	411,034	1,090,606
Rzero (billions)	1.210	1.010	1.410	0.787	0.700	0.874	1.674	1.376	1.971
Bzero (millions, mt)	1.836	1.531	2.141	1.193	1.060	1.326	2.538	2.086	2.989

B. Revised initial set of SS2 model runs with M (all ages) estimated with a constraining prior. The information is equivalent to the lower section of Fig. 12 of the STAR Panel Report.

Derived Parameter	Revised base model (1) Final survey selex=0.5			Alt. Low Final survey selex=0.7			Alt. High Final survey selex=0.3		
	Asymptotic			Asymptotic			Asymptotic		
	MLE	95% CI		MLE	95% CI		MLE	95% CI	
Neg log likelihood	14484			14425			14440		
number parameters	89			89			89		
2007 Depletion	0.472	0.324	0.620	0.307	0.213	0.400	0.568	0.417	0.720
2008 Depletion	0.485	0.302	0.668	0.271	0.147	0.395	0.603	0.417	0.789
MSY	406,060	275,863	536,257	284,320	189,227	379,413	476,520	321,950	631,090
B _{MSY}	742,810	400,535	1,085,085	516,020	281,878	750,162	932,550	510,464	1,354,636
SPR _{MSY}	0.242	0.106	0.378	0.239	0.104	0.374	0.248	0.110	0.386
2008 Catch	532,400	251,160	813,640	180,080	28,264	331,896	770,080	414,399	1,125,761
Rzero (billions)	1.503	1.170	1.835	1.043	0.788	1.297	1.728	1.362	2.095
Bzero (millions, mt)	2.086	1.692	2.480	1.461	1.188	1.734	2.567	2.088	3.047

Table 1. (continued) Goodness-of-fit and maximum likelihood estimates of management quantities from the set of SS2 model runs explored during the STAR Panel Meeting.

C. Revised initial set of SS2 model runs with an age-dependent M (ramp starting at age 13). The old-M parameter was estimated; the young-M parameter was fixed. The information is equivalent to Fig. 20 of the STAR Panel Report.

Derived Parameter	Revised base model (2) Final survey selex=0.5			Alt. Low Final survey selex=0.7			Alt. High Final survey selex=0.3		
	Asymptotic			Asymptotic			Asymptotic		
	MLE	95% CI		MLE	95% CI		MLE	95% CI	
Neg log likelihood	14362			14391			14340		
number parameters	89			89			89		
2007 Depletion	0.353	0.240	0.466	0.324	0.225	0.423	0.386	0.254	0.519
2008 Depletion	0.357	0.217	0.497	0.322	0.197	0.447	0.398	0.237	0.559
MSY	452,320	237,151	667,489	423,950	248,467	599,433	499,660	238,568	760,752
B _{MSY}	1,191,500	629,294	1,753,706	1,045,200	561,394	1,529,006	1,350,100	704,280	1,995,920
SPR _{MSY}	0.332	0.114	0.550	0.317	0.116	0.517	0.337	0.115	0.559
2008 Catch	463,510	154,144	772,876	370,290	127,132	613,448	591,290	170,008	1,012,572
Rzero (billions)	1.858	1.532	2.185	1.682	1.430	1.933	2.083	1.612	2.553
Bzero (millions, mt)	2.631	2.171	3.092	2.379	2.024	2.734	2.958	2.293	3.623

D. The SS2 model runs, but with an age-dependent M (old-M estimated; young-M fixed) and two alternative configurations for survey selection: fixed to be asymptotic versus freely estimated. The information is equivalent to Fig. 24 of the STAR Panel Report.

Derived Parameter	Revised base model (2) Final survey selex=0.5			Asymptotic survey selex			Final base model Final survey selex estimated		
	Asymptotic			Asymptotic			Asymptotic		
	MLE	95% CI		MLE	95% CI		MLE	95% CI	
Neg log likelihood	14362			14436			14337		
number parameters	89			89			88		
2007 Depletion	0.353	0.240	0.466	0.265	0.193	0.337	0.362	0.236	0.489
2008 Depletion	0.357	0.217	0.497	0.248	0.151	0.345	0.372	0.217	0.527
MSY	452,320	237,151	667,489	383,790	263,961	503,619	466,270	212,391	720,149
B _{MSY}	1,191,500	629,294	1,753,706	796,640	428,101	1,165,179	1,343,800	712,602	1,974,998
SPR _{MSY}	0.332	0.114	0.550	0.277	0.108	0.445	0.352	0.121	0.582
2008 Catch	463,510	154,144	772,876	216,180	65,131	367,229	527,180	141,707	912,653
Rzero (billions)	1.858	1.532	2.185	1.403	1.254	1.552	1.728	1.362	2.095
Bzero (millions, mt)	2.631	2.171	3.092	1.987	1.776	2.198	2.567	2.088	3.047