Sablefish

STAR Panel Meeting Report
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NOAA Fisheries
Northwest Fisheries Science Center
Hatfield Marine Science Center
Newport, Oregon

STAR Panel:
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Selina Heppell – Oregon State University
Bob Mohn – Center of Independent Experts (outside reviewer)
Stephen Smith – Center of Independent Experts (outside reviewer)
Grant Thompson (Rapporteur) – NOAA Fisheries, AFSC

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Overview

The model for sablefish, *Anoplopoma fimbria*, assesses the stock extending from the southern border of the Conception INPFC area through the northern border of the U.S. Vancouver INPFC area. Sablefish are taken in the commercial fishery with hook and line, pot, and trawl gear. Landings, age composition, and length composition data were retrieved from the Sablefish Port database maintained at the NWFSC. Estimates of landings by gear are available beginning in 1915. As in previous assessments, this year's assessment makes use of several abundance indices: the 1980-2004 AFSC triennial shelf survey, the 1971-1991 AFSC pot survey, the 1997-2001 AFSC slope survey, the 1984-2004 NWFSC slope survey, and the 1978-1988 logbook CPUE index. The assessment software used was Stock Synthesis 2, version 1.19 (April 27, 2005). Prior to the STAR Panel meeting, four model configurations were developed by the STAT. Model 1 was the STAT's attempt to reproduce the previous assessment model as closely as possible given the change in assessment software from Stock Synthesis 1 to Stock Synthesis 2. Model 2 included use of sea level data to model recruitment deviations and sea surface temperature data to model discard mortality rates. Model 3 extended the time series of historical landings from 1956 back to 1900 (catch in the 1900-1915 period was assumed to increase linearly from zero in 1900 to the reported level in 1915). Model 4, which was the STAT's proposed base model, included the changes introduced by both Models 2 and 3.

The Panel commends the high quality of the draft assessment, and appreciated the STAT's patience and efficiency in responding to the many requests for further analysis.

Analyses requested by the STAR Panel

Round 1 Requests

1.1) The previous assessment fixed the "steepness" parameter h in the Beverton-Holt stock-recruitment relationship at a value of 0.4. In sharp contrast, Model 4 resulted in an h estimate of 0.2, implying that the stock cannot sustain any level of fishing in the absence of environmental effects on recruitment. These contrasting values were associated with very different approaches to the treatment of prior uncertainty. Because the previous assessment fixed h at 0.4, complete prior certainty was implied. In the STAT's proposed base model, a noninformative prior was used, implying complete prior ignorance. To explore a possible compromise between these two extremes of complete prior certainty and complete prior ignorance, the STAR Panel requested the STAT to conduct an alternative run with an informative prior on h. For similar reasons, the STAR Panel requested that the alternative run include an informative prior on the natural mortality rate M. In the previous assessment, M was fixed at 0.07. Specifically, the STAR Panel requested that the new run include the following priors:

a) normal prior on M with mean = 0.07 and standard deviation = 0.021 (CV=30%)
b) normal prior on h with mean = 0.40 and standard deviation = 0.12 (CV=30%)

1.2) To enable a more complete evaluation of model results, the STAR Panel requested that the STAT include an expanded table of outputs for all model runs, including key parameters and results such as spawning stock biomass (SSB) for the current year, recruitment for the current year, equilibrium unfished spawning biomass (B0), equilibrium unfished recruitment, the ratio of current SSB to B0 (referred to as "depletion"), and error bars on all of the above.

1.3) To understand the growth of sablefish more fully, the STAR Panel requested the STAT to provide a plot of the length-at-age relationship.

1.4) The STAT's proposed base model estimates a relationship between sea level and recruitment deviations for the period 1973-2003 and extrapolates that relationship to the remainder of the time series. To test the sensitivity of model results to this extrapolation, the STAR Panel requested the STAT to conduct an alternative run with this relationship "turned off" for the years outside the period within which the environment-recruitment relationship was estimated.

1.5) In reviewing model results presented by the STAT, it appeared that some values (e.g., log likelihood values) in Table 8 of the draft assessment did not correspond to the current set of model runs. The STAR Panel therefore requested the STAT to update Table 8, including the correct results for the STAT's four model configurations and any others requested by the STAR Panel.

1.6) For reasons similar to those given in (1.1) above, the STAR Panel requested the STAT to conduct another alternative run with the following priors, bounded at zero in each case:

a) normal prior on M with mean = 0.07 and standard deviation = 0.14 (200% CV)
b) normal prior on h with mean = 0.40 and standard deviation = 0.80 (200% CV)

Round 1 Responses

The STAT responded to all Round 1 requests.

Length-at-age plots were presented. Fish of both sexes reach asymptotic length fairly early in life (by age 10 or so).

A new set of tables, labeled "Appendix Tables 1-8," provided the outputs listed in Request 1.2.

A new version of Table 8 was provided. For runs STAR1 (corresponding to Request 1.1) and STAR6 (corresponding to Request 1.6), inclusion of a prior on M changed the point estimate of M, but inclusion of a prior on h did not change the point estimate of h. Runs STAR1 and STAR6 both estimate M at a value of 0.058 and h at a value of 0.2.

Run STAR4e (responding to Request 1.4, with the environmental component of the stock-recruitment relationship "turned off" during years outside the range within which

the environmental effect was actually estimated) gives a much lower initial biomass than Model 4 in the early portion of the time series, but the biomass levels are similar in later years. In terms of depletion, run STAR4e is much higher than Model 4 in the middle portion of the time series, but only slightly higher than Model 4 in later years. Run STAR4e gives an intermediate case between inclusion of all years of environmental data and only the later portion of the environmental time series. Overall, the STAR Panel was supportive of the STAT's efforts to include an environmental component to the stock-recruitment relationship.

Round 2 Requests

2.1) The STAR Panel noted that priors and something called "forecast recruitment" are both included in the objective function. Because the objective function is labeled "likelihood," it is difficult to tell how much of the objective function value consists of true likelihood and how much consists of priors and "forecast recruitment." Moreover, the STAR Panel was concerned that recruitment forecasts, which have no data component, may be influencing parameter estimates. The STAR Panel therefore requested the STAT to re-run Models 3 and 4 with "forecast recruitment" turned off, to see if the parameter estimates change.

2.2) The STAR Panel discussed the contribution of the Conception area to the biomass. Table 9 on page "Tables-22" in the draft assessment document, which summarizes biomass estimates from a GLM analysis that are used as data in the assessment, indicates that the Conception area provides a substantial proportion of the biomass. Moreover, the non-Conception part appears to be increasing more steadily since 2001 than the overall area. An investigation of the NWFSC survey data for sablefish reviewed at this STAR panel indicated that the use of the mean density in the area north of Point Conception to estimate densities in the south for years that the survey did not go below the point was not supported by recent data. Biomass indices from this survey series were recalculated with the Conception stratum being confined to the area north of Point Conception. The STAR Panel therefore requested that the STAT develop two new analyses designed to examine the possible impacts of the GLM's estimates of biomass in the Conception area. The first of these analyses should use the method employed by the shortspine thornyhead STAT to partition the GLM-estimated Conception area biomass north and south of Point Conception. The second analysis should consist of a new model run with the Conception portion of the survey biomass time series removed.

2.3) To facilitate comparison of the various survey time series in common units, the STAR Panel requested the STAT to produce a "q-corrected" plot of the various survey time series.

Round 2 Responses

The STAT responded to all Round 2 requests.

The STAT reported that turning off "forecast recruitment" had no effect on parameter estimates, and that the "true" total log likelihood can be determined by subtracting the "forecast recruitment" log likelihood from the total.

The STAT reported that about 27% of the 100-299 m depth stratum in the Conception area lies north of Point Conception, compared to 21% of the 300-700 m depth stratum. The STAT used these percentages to apportion the pre-2002 GLM biomasses within the Conception area. For 2002-2004, the actual survey (not GLM) biomass splits north and south of Point Conception are available. For the 2002-2004 period, the north part of the area consistently has at least twice as much sablefish biomass as the south part of the area in both depth zones.

The STAT provided a pair of model results, with and without the slope survey biomass from the Conception area. Trends between the two models are similar, with biomass about 10% higher in the current year without the Conception area biomass and "depletion" about 2% higher without the Conception area biomass. The main difference in fits is a slight degradation of the survey biomass fit in a couple of years when the Conception area biomass is omitted. Survey catchability goes from 0.37 with the Conception area biomass to 0.20 without.

The STAR Panel called Tom Helser, the author of the GLM analysis, and he agreed that we had identified a possible problem with the Conception area estimates. The possibility of re-running the GLM, with both the area and data south of Point Conception removed, was discussed. Tom indicated that this could be done quickly.

The STAT provided a "q-corrected" survey biomass comparison plot. The differences between the selectivity patterns associated with the various surveys makes interpretation of the plot somewhat difficult. The model's overall biomass trace is smoother than the trend in any of the data sets and does not show a couple of recent upward trends found in a couple of the data sets. These upward trends in the data could reflect recruits that have not yet had much effect on the overall biomass trend.

Round 3 Requests

Given that the GLM would be re-run with the south Conception area omitted, the STAR Panel requested three new runs based on the new GLM, with both M and h estimated:

3.1) No informative priors, with h and M estimated. The STAR Panel was interested in this run because the STAT obtained an h estimate greater than 0.2 when a comparable model run was made with the original GLM.

3.2) Prior on h with mean = 0.4 and standard deviation = 0.06, no informative prior on M. The STAR Panel was interested in this run for two reasons: First, the standard deviation of 0.12 used in the prior distribution for h in Star1 does not really correspond to the intended CV of 30% because h is logically bounded at 0.2, not 0 (given an origin of 0.2 and a mean of 0.4, a standard deviation of 0.12 corresponds to the intended CV of 30%).

Second, the STAR Panel found it odd that setting priors on h and M did not pull h away from 0.2, but the STAT's run with no informative priors on M or h did pull h away from 0.2.

3.3) Prior on h with mean = 0.4 and standard deviation = 0.06, prior on M as in STAR1. The STAR Panel was interested in this for the same two reasons given in (3.2) above. Regarding the second reason, the STAR Panel was interested in determining whether placing priors on both h and M would somehow counteract the effect of placing a prior on h only.

Round 3 Responses

The STAT responded to all Round 3 requests.

Tom Helser provided results of the new GLM with the area and data south of Point Conception omitted. The time series of biomass in the new "north Conception" area is smoother than the previous time series of biomass in the overall Conception area. The STAR Panel concluded that the results of the new GLM appear sensible.

The STAT presented the results of the new runs. In the process of developing these runs, the STAT discovered that the earlier runs had inadvertently included a lower bound on M of 0.05. This bound was moved to a value of 0.01 in the current runs. Results of the new runs (labeled NC1 through NC3, corresponding to Requests 3.1-3.3) were very different from those of previous runs:

NC1) h = 1.0000, M = 0.0370, current SSB = 137088, depletion = 0.6189
NC2) h = 0.4085, M = 0.0457, current SSB = 127676, depletion = 0.5426
NC3) h = 0.4045, M = 0.0462, current SSB = 126877, depletion = 0.5392

It was noted that all of the above estimates of M are substantially lower than the value of 0.07 traditionally used in this assessment and much lower than the value of 0.10 traditionally used in the assessment of the Alaska stock of sablefish. The relationship between steepness and the strength of the environmental effect on recruitment was also discussed.

Round 4 Requests

4.1) The STAR Panel requested the STAT to re-run the new Model NC1 with the south Conception data added back in (the new run to be labeled NC0), to facilitate a determination as to how much of the change in results is due to the change in data and how much is due to the change in the lower bound on M.

4.2) In order to understand more fully the differences between the new model runs and the previous assessment, the STAR Panel requested the STAT to run a new model (to be called NC4) with h and M fixed at 0.40 and 0.07, as in the previous assessment.

4.3) To enable a more complete evaluation of the new model runs, the STAR Panel requested the STAT to present the estimated value of q (for the NWFSC slope survey)

and the values of the individual likelihood components for all the new runs NC0 through NC4.

Round 4 Responses

The STAT responded to all Round 4 requests.

New run NC0 gave the following results: h = 0.2372, M = 0.0512, curSSB = 128514, depletion = 0.3852, q = 0.2768. Comparing these results to those from NC1 shows that removal of the south Conception biomass has a big effect on steepness and depletion.

New run NC4 gave the following results: h = 0.4, M = 0.07, curSSB = 119018, depletion = 0.5042, q = 0.2019. The biomass time trend is parallel to that from the previous assessment, but shifted upward. Although the loss of the south Conception biomass might have been expected to shift the biomass downward, the new estimate of q is much less than in the previous assessment, more than offsetting the loss of the south Conception biomass.

In the process of developing runs NC0 and NC4, the STAT discovered that a lower bound of 0.2 had been set on q and that this bound was being approached in all runs NC1-NC4. The STAR Panel discussed the appropriateness of this lower bound. The following points were noted in support of the idea that q might be well less than unity: A) the survey does not cover the entire depth distribution of the stock, B) the omission of the south Conception area means that the survey does not cover the entire latitudinal range of the stock, and C) large sablefish may be able to outswim a 15-minute survey tow. Although a value of q less than unity seems reasonable, it appears difficult to find empirical support for setting an absolute bound at 0.2.

The STAT also provided results of two runs not requested by the STAR panel. Run NC5 freed h but fixed M at 0.07, giving h = 0.2, M = 0.07, curSSB = 116771, depletion = 0.3095, and q = 0.2019. Run NC6 used the prior on h from NC3 but with M fixed at 0.07. Run NC6 gave identical results to run NC5. It appears that the data are strongly inclined to drive steepness to the limiting value of 0.2 if M is fixed at the traditional value of 0.07. The STAR Panel chair noted that there is strong precedent to keep values of critical parameters such as M unchanged between assessments unless there are compelling reasons to change them.

Round 5 Requests

5.1) Because of the precedent set by the value of M assumed in the previous assessment, the STAR Panel requested the STAT to develop a new run with a prior on M with mean = 0.07 and standard deviation of 0.007 (corresponding to a 10% CV).

5.2) Because of the precedent set by the value of q estimated in the previous assessment and because of the fact that q in the new set of model runs is hitting a bound that is difficult to justify, the STAR Panel requested the STAT to develop a new run with the

prior on M described in (5.1) above and a prior on q with a CV of 20% and a mean of 0.386, the latter quantity obtained by multiplying the estimate of q from the previous assessment (0.46) by the recent average ratio of the survey biomass for the total area with south Conception removed to the survey biomass for the total area (0.84).

Round 5 Responses

The STAT responded to all Round 5 requests, except that the run described in Request 5.1 was not conducted. Instead, a second version of the run described in Request 5.2, but with a 10% CV in the prior on q, was conducted. This substitution was acceptable to the STAR Panel.

Run NC7 (prior on M with mean = 0.07 and standard deviation = 0.007 (10% CV), prior on q with mean = 0.386 and standard deviation = 0.077 (20% CV)) gave the following results: h = 0.2052, M = 0.0594, q = 0.2584, curSSB = 95181, depletion =0.28.

Run NC8 (prior on M with mean = 0.07 and standard deviation = 0.007 (10% CV), prior on q with mean = 0.386 and standard deviation = 0.039 (10% CV)) gave the following results: h = 0.2193, M = 0.0584, q = 0.3305, curSSB = 74061, depletion = 0.25.

It was noted that the estimates of h in both NC7 and NC8 are approaching the limiting value of 0.2 and that these estimates imply a large change in h relative to the value assumed in the previous assessment (0.4).

Round 6 Requests

6.1) Because no previous run had employed non-uniform priors on h, M, and q simultaneously, because the estimates of h are approaching the limiting value in runs NC7 and NC8, and because the estimates of h in NC7 and NC8 are vastly different from the value assumed in the previous assessment, the STAR Panel requested the STAT to develop a new model run (NC9), adding the prior on h from NC3 to the priors on M and q from NC8.

Round 6 Responses

The STAT responded to the Round 6 request.

Run NC9 (prior on h with mean = 0.4 and standard deviation = 0.06 (30% CV, given an origin of 0.2), prior on M with mean = 0.07 and standard deviation = 0.007 (10% CV), prior on q with mean = 0.386 and standard deviation = 0.039 (10% CV)) gave the following results: h =0.3426, M=0.0499, q =0.3326, curSSB=75070, depletion=0.34. The STAR Panel noted that this model run seems to fit the data about as well as any other run, none of the three key parameters (h, M, and q) is bounded, and the estimated values of h, M, and q maintain continuity with the previous assessment. The STAR Panel adopted run NC9 as the final base model.

The STAR Panel had an extensive discussion regarding potential dimensions of uncertainty that could be used to structure a decision table. Among these were the effect of the environment on recruitment, model structure, and values of key parameters (h, M, and q) in the final base model.

Round 7 Requests

7.1) To develop possible states of nature for the decision table, the STAR Panel requested the STAT to estimate the upper and lower 10% quantiles for h and q and use these to describe three states of nature: 1) low h, high q; 2) point estimates of h and q from the final base model; and 3) high h, low q.

7.2) To develop possible management alternatives for the decision table, the STAR Panel requested the STAT to compute the catch time series corresponding to the 40:10 rule for each of the three states of nature, with the understanding that other management alternatives may be necessary in the event that the 40:10 rule proves infeasible for one or more states of nature.

7.3) To augment the decision table with other useful information related to uncertainty in the final base model, the STAR Panel requested the STAT to estimate the probability that depletion is less than 25%.

Round 7 Responses

The STAT responded to all Round 7 requests.

The STAT provided a draft decision table with the states of nature and management alternatives described in Requests 7.1 and 7.2. The STAR Panel also discussed the extent to which allocation among gears might influence the projections. The STAT noted that only h and q were fixed in the alternative states of nature; all other parameters were estimated for each state of nature conditional on the assumed values of h and q.

Using the inverted Hessian matrix from the final base model to estimate uncertainty, the STAT estimated a 2% probability that depletion is currently less than 25%.

Final base model description

The final base model was identical to the STAT's proposed base model, with the following exceptions: 1) the original slope survey biomass data were replaced by the estimates obtained from the revised GLM with the south Conception area omitted; 2) the lower bounds on M and q were reduced to nonconstraining levels; and 3) informative priors were placed on h (mean = 0.4, standard deviation = 0.06), M (mean = 0.07, standard deviation = 0.007), and NWFSC slope survey q (mean = 0.386, standard deviation = 0.039). The STAR Panel concurred with the STAT's use of an environmental covariate to model recruitment deviations.

A decision table was produced in which the states of nature were based on the upper and lower 10% quantiles from the marginal posterior distributions of h and q and all other parameters estimated conditionally on those values. The states of nature were: 1) low h, high q; 2) point estimates of h and q; and 3) high h, low q. Each of these states of nature assumed that the state of the environment will be constant at the historic average level throughout the projection period. The alternative management decisions consisted of the catch time series corresponding to the 40:10 rule for each of the three states of nature.

Comments on the technical merits and/or deficiencies in the assessment

Overall, the STAR Panel concluded that the STAT did an excellent job of preparing the assessment and of responding to STAR Panel requests, including those related to the possible bias in the original GLM estimates of survey biomass in the Conception area, the discovery of which occurred very late in the assessment process.

The STAT did a good job of attempting to fit a very large number of diverse data sources, most or all of which provide only a partial picture of the status and dynamics of the sablefish stock. Unfortunately, it appears that these data are not highly informative with respect to some key parameters. For example, the posterior estimates of h and q in the final base model are only about 1 standard deviation removed from their respective prior means even though the maximum likelihood estimates of these parameters are extremely different from their respective prior means. On the other hand, the posterior estimate of M is about 3 standard deviations removed from its prior mean, indicating that the data strongly support a value of M lower than the value of 0.07 traditionally assumed.

It should be emphasized that any estimates of uncertainty taken from the final base model are conditioned by the prior distributions placed on all parameters, including the informative priors placed on h, M, and q and the noninformative priors placed on all other parameters. The informative priors placed on h, M, and q have fairly small coefficients of variation, ranging from 10% to 30%. Larger coefficients of variation would probably lead to larger estimates of uncertainty in the posterior distribution. Also, it should be noted that use of the MCMC algorithm to develop estimates of uncertainty has not been explored in the assessment.

A great deal of effort has been expended in attempting to ensure that the age composition data and length composition data are representative. However, the sample sizes specified for these data in the model do not appear to have been thoroughly evaluated. This could result in the model giving inappropriate emphasis (either too much or too little) to fitting the age or length composition data.

Responding to a request from the STAT, the STAR Panel discussed how ABC should be estimated for the coast-wide stock now that the model omits the survey biomass estimate from a small portion of the latitudinal range. The STAR Panel's initial impression was that the ABC from the model would not need to be adjusted for the missing survey biomass because the catch data used in the model include catches from the south Conception area and because q is estimated.

Explanation of areas of disagreement regarding STAR Panel recommendations

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

Unresolved problems and major uncertainties

1) Without informative priors on h, M, and q, the estimates of these parameters tend toward very low values.
2) The contribution of the south Conception area to overall biomass is highly uncertain.

Recommendations (not prioritized) for future research and data collection

1) Expanded survey coverage of the south Conception area
2) Ability to make stochastic projections with SS2
3) Apportionment of catch among gear types in projections
4) Simulation testing of methods for estimating environmental, as well as stock, effects on recruitment in the context of stock assessment modeling
5) Research and data collection pertaining to environmental effects on growth, maturity, and natural mortality
6) Interannual variability in spatial distribution of the stock
7) Field research on survey catchability and selectivity