PACIFIC OCEAN PERCH
STAR Panel Meeting Report

Northwest Fisheries Science Center
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STAR Panel Members
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Overview

The STAR panel (Panel) reviewed stock assessments of Pacific ocean perch (POP) and widow rockfish over the course of a 5-day meeting in Seattle, WA (14-18 April 2003) – see separate Panel report on the widow assessment. This POP assessment employs a model similar to that used in the previous stock assessment (June 2000), and incorporates updates to survey and fishery data. The assessment region covers the Columbia and Vancouver INPFC areas ranging from southern Oregon to the USA-Canada border. This area encompasses the most southern part of the range of POP. Linkages with POP in British Columbia (via movement of adults or larval transport) are assumed to be negligible in this assessment. The methods and results were presented clearly in the assessment document. The Panel commends the stock assessment team for their work, and on their cooperation in conducting additional analyses and revisions in response to this review.

Major sources of information include:

1. Landed catch, as recorded by comprehensive catch landing receipts and historical data from foreign and domestic fisheries.
2. Age and size composition of the landed catch.
3. Bottom trawl research surveys conducted triennially (1977-2001) in the 30-200 fathom depth range provide the primary, long-term index of POP abundance ("shelf survey"). Additional indices of abundance from (i) deep water (100-700 fa) trawl surveys conducted annually since the mid-1990's ("slope survey"); (ii) trawl surveys targeted on POP in 1979 and 1985; and (iii) a fishery logbook CPUE index covering early years of the target fishery (1956-73).
4. Age and size composition from the shelf and slope surveys.

The overall conclusion is that the stock is relatively stable at a low level of abundance with some slight increase in recent years. The current (2003) spawning stock biomass is near 25% of the unfished biomass (B_0) – the PFMC threshold for designating a stock as overfished – and well below the rebuilding target (40% of B_0). POP fisheries have a history of being sustained by large, but infrequently occurring year-classes. There appears to be no evidence of a strong year-class in recent years.

The assessment model explicitly estimates maximum sustainable yield (MSY) and the biomass that would produce MSY (B_{MSY}). The reliability of a predictive stock-recruit relationship is critical for good model-based estimates of these important management reference points. While MSY and B_{MSY} model-based estimates are informative and consistent with the assumptions and structure used in the model, the estimates can vary considerably in successive stock assessments. For operational management purposes, stability in MSY and B_{MSY} estimates is critical. To date, the PFMC has employed proxies for MSY-based reference points (rather than assessment model-based estimates) for all groundfish, including POP. For reasons of both stability and consistency, the Panel recommends that the proxies continue to be used for POP management.

List of Analyses Requested by the STAR Panel

The draft assessment report assumed age at 50% maturity was 10 years, but a more appropriate estimate is 8 years, as recommended by the 2000 STAR Panel. *At the request of the Panel, the maturity schedule was revised to reflect 50% maturity at age-eight for final model runs.*

A highly informative prior on M was used in the assessment document. Based on a sensitivity run made during the Panel meeting that indicated the prior was not influential, the Panel requested a run using a non-informative prior on M for the base case. *The STAT reported that after further consideration of the issue, the informative prior on M was preferable when estimating M in the model. This was acceptable to the Panel.*

For the base case run, the Panel requested the full list of all parameters estimated (including derived parameters), their MLE's, CV's, and indication when bounds are hit. Additionally, to provide median and mean of posterior for those parameters with MCMC results available; to provide the correlation matrix for final base case in electronic form. *Due to the volume of information, it proved impractical to provide these data during the meeting. However, these items should be provided in next draft of the assessment document.*

The Panel requested a series of runs designed to explore the effect of various model structures and assumptions employed in the draft POP assessment (see list below). *For the most part, the STAT carried out all of the requested model runs and summarized the results during the Panel meeting.*

(a) use uniform prior (in log-space) on survey catchability
(b) correct prior on steepness from Dorn's meta-analysis
(c) use uniform prior on steepness
(d) set serial correlation parameter on recruitment to zero (from 0.4)
(e) set standard deviation about spawner-recruit relationship to 1.0 (from 0.76)
(f) increase maximum age of fishery selectivity to 22 (from 14)
(g) use uniform prior on natural mortality
(h) use uniform prior (in log-space) for catchability of all surveys
(I) no recruitment bias correction for full time series
(j) no recruitment bias correction for equilibrium period
(k) correct q estimates for POP and slope surveys (were too small by factor of approx. 1.8)
(l) run new base case incorporating (b), (c), (d), (h), (j), and (k)
(m) run MCMC for new base case

Comments on Technical Merits:

(1) STOCK BOUNDARIES – The Panel noted that POP fishery and survey catches are continuously distributed across the USA-Canada boundary. The current assessment considers only the USA resource, and does not include Canadian data. The POP resource in Canadian waters is thought to be considerably larger than that in USA waters (at least 2 times larger, *cf.* Schnute et al., CSAS Res. Doc. 2001/138). The effects of movement of POP and their larvae into or out of the assessed USA area are unknown.

(2) STOCK-RECRUITMENT RELATIONSHIP – A Beverton-Holt stock-recruitment relationship (B-H SR) is an integral part of the stock assessment model. Its parameters are estimated as part of the suite of 250+ parameters in the model. It plays a key role in estimating recruitment in all years and particularly, in establishing the equilibrium age structure and recruitment for the early period (1935-56 and perhaps several years afterwards) – where catch-at-age data do not exist. It is central to the estimation of unfished biomass (B_0) in this assessment. If used in updating the POP rebuilding plan, it will be quite influential there as well. Other stock-recruitment relationships may be as appropriate for POP, e.g. the Ricker stock-recruitment relationship. Recognizing the possible effects of POP concentrations in Canadian waters on this assessment – see Item (1), above – and, in particular, the potential misunderstanding of the true spawner-recruit relationship derived from USA data alone, the Panel felt that further examination and sensitivity analysis of other SR relationships during the Panel meeting would not be productive. Further, the Panel cautions against use of the fitted BH S-R outside of the context of the stock assessment model. Rather, the fitted relationship should be considered a loose proxy for a suite of variables that contribute to the abundance of age 3 POP found in USA waters. Among other factors, these variables may include spawners in Canadian waters, environmental effects on survival of larvae and juveniles, etc. In particular, if recruitment in recent decades is low because of hydro-climatically unproductive conditions, the compensation implied by the fitted SR relationship may overestimate the rate of POP rebuilding if these conditions persist or underestimate if the future climate shifts to a more productive state for POP.

(3) CATCHABILITY OF THE SHELF SURVEY – The catchability (q) of the triennial shelf survey is an influential parameter in the POP assessment model. Largely because this survey represents the only long-term index of abundance for POP, its q is the key factor in estimating absolute biomass. In the previous assessment, difficulties were encountered in obtaining reasonable estimates of q. Through a reformulation of the selectivity function and consequent change in the definition of q, the estimation was much improved in this year's assessment. However, the estimated $q = 0.25$ is smaller than most other west coast rockfish (especially darkblotched) taken in the same survey. Further, POP surveys in the Gulf of Alaska and the Aleutian Islands – using similar design, gear, and analysis methods – have estimated a much larger catchability ($q \approx 1.5$).

(4) MCMC ANALYSIS – For many important management-related parameters, the maximum likelihood estimates (MLE) in the draft assessment document differed

appreciably from the median of the posterior and from the mean of the posterior – the latter two estimated via Markov Chain Monte Carlo (MCMC) analysis. The Panel explored these differences as a modelling diagnostic and through this discussion, an inconsistency in the MLE estimation was discovered during the meeting. After code modifications, subsequent runs showed much smaller differences than those in the draft document. A larger issue remains, however, in that some differences are expected even with technically sound models, and it is not clear which of these measures should be used as the point estimates required by the PFMC process. The MCMC approach is technically sound and better characterizes uncertainty than *ad hoc* approaches used in the past. The Panel endorses its use in deriving management-related state variables and the uncertainty associated with them. However, the use of MCMC in conjunction with MLE-based assessment models does cause some ambiguity. The PFMC will need advise – perhaps from the SSC – on whether to use the (i) MLE, (ii) median of the posterior, or (iii) mean of the posterior when point estimates are needed.

(5) INTERMEDIATE RESULTS AND DIAGNOSTICS - The Panel had difficulty providing critical peer review of the POP assessment model in the available time. The POP assessment model is more complex than other models used for PFMC assessments. The large number of parameters estimated (>250) coupled with a variety of priors, penalty functions, and constraints tax the ability of reviewers to fully understand the nuances of model behavior using only the traditional tables and figures provided in stock assessment documents. Further, the use of numerically intensive MCMC analysis for estimation of posterior distributions (used for quantifying uncertainty and central tendency) further exacerbates the problem. While the Panel encourages this type of "cutting edge" modelling, there is concomitant responsibility to provide a broader suite of intermediate results and model diagnostics in addition to those provided when less complex models are used for assessment. Because the volume of these data can be quite large, providing them in electronic form is more practical than via traditional hard copy, e.g. creating a data CD to accompany and to be referenced from the assessment document. Appendix A provides a partial list of intermediate results and diagnostics that should be provided. Assessment authors with experience using these more complex models are encouraged to augment the Appendix A list with diagnostics and other output data summarizations that they have found useful in understanding the behavior of their own models.

(6) TREATMENT OF BIAS IN RECRUITMENT ESTIMATES – During the Panel meeting, an inconsistency in recruitment estimates was noted for the equilibrium period (prior to 1956) for which no ageing information is available and the post-1956 years for which age composition samples have some influence – see Item (4), above. The "quick fix" for the problem during the Panel meeting was to (log) bias correct the expected value for the post-1956 estimates while using uncorrected estimates for the equilibrium period. Further research is needed to ensure that this is the best solution for the problem.

(7) HISTORICAL RECRUITMENT PATTERN – The model-based estimate of the long-term recruitment pattern, 1956-2003, may be problematic due to sparse and biased POP age composition samples. During the early period, 1956-65, no age samples were taken.

Ageing work carried out on fishery samples during 1966-80 was subsequently determined to be biased. No fishery age samples are available from the period 1981-98. Unbiased fishery age samples were taken during 1999-2002. Some age composition samples were taken on research surveys, 1985-2002, to augment the fishery samples. However, the surveys were generally carried out on a triennial basis with limited age samples taken.

Areas of Disagreement:

All potential areas of disagreement were resolved, and the Panel reached consensus for all conclusions.

Unresolved Problems and Major Uncertainties:

In general, the Panel concluded that the large variance in some parameter estimates (e.g. SSB in 2003) and moderate sensitivity to modeling assumptions (e.g., the difference between results from alternative model scenarios) are to be expected given the sparseness of fishery data and nonexistence of surveys in the early period; followed by both low fishery sampling intensity and low frequency of surveys in subsequent years.

Recommendations for Future Research:

1. The accuracy and precision of stock status evaluations would be increased if more resources were devoted to data collection. For example, the assessment would improve if the 1995 survey ages were processed. While data collection and sampling have improved within the past few years, it is critically important to maintain these levels into the future. More specifically, discard rates must be monitored, age composition of catch must be sampled, and the increased frequency of surveys must be maintained.

2. The feasibility of assessing the resource as a trans-boundary stock should be considered.

3. Develop model diagnostics and tools for analysis of voluminous model output to better understand model performance and to better convey results to reviewers and to user groups.

4. Explore the use of constant fishery selectivity, versus changes in selectivity indexed to known events such as mesh size changes, versus constrained time-varying fishery selectivity. Investigation and guidance on these two issues would be useful for all assessments that use similar models.

5. Research on POP maturity should be carried. There remains considerable uncertainty regarding the maturity ogive used in the current model.

6. If the spawner-recruit relationship is to be used in future modelling, an exploration of the

effects on recruitment of factors other than SSB in USA waters should be carried out. Among other factors, environmental changes and the potential contribution of spawners in Canadian waters should be explored.

7. Weighting of the various indices, including iterative re-weighting of the series and the weights of individual points within each series, should be investigated further. Extend inverse weighting to age and size compositions.

8. Sample sizes for age compositions should be specified and their effect explored.

9. The Soviet exploratory fishing data from 1953 to 1978 has some potential to be processed into an index of POP distribution and abundance. The geographic coverage was somewhat inconsistent between years and the information has not been quantitatively included in the assessment, but the data are consistent with a substantial decrease in stock biomass in late 1960s, as indexed by the domestic CPUE series. Analysis of these data may also provide better understanding of the POP stock structure at that time.

10. For future STAR Panel reviews, a local area network (LAN) should be set up in the meeting room. This will allow for better dissemination of the results of model runs made during the meeting, facilitate distribution and editing of the draft Panel report, and provide high-speed internet access for work carried out during the meeting.

APPENDIX A

Intermediate Results and Diagnostics Needed for Future STAR Panel Review of POP Stock Assessment Modelling Results

[1] Matrix of predicted catch numbers by age and year. Similar matrices for stock numbers and instantaneous fishing mortality rates. Observed catch numbers at age for years with age composition data.

[2] Table of parameters estimated, values at the global solution, CVs, flags identifying parameters that hit constraints or significant penalties.

[3] Details of the phased estimation of parameters. Trace of initial parameter values at the beginning of each phase plus values of parameters (estimated and fixed) and likelihood components at the end of each stage of estimation (including at the global solution).

[4] Correlation matrix for estimated and derived parameters. Correlation among selected parameter estimates should be examined carefully. Particularly those parameters directly related to management advice, e.g. recent-period estimates of recruitment, catchability, selectivity, spawning biomass, etc.

[5] Examination of the response surface at the global solution - especially with respect to changes in key management parameters. For example, convergence checks using different initial value vectors. Likelihood profiling on key management parameters can also be informative here.

[6] Residuals summarized and plotted by various types (including but not limited to size/age composition residuals).

[7] Influence of priors. Plot priors vs. their respective posterior, including implied priors for key management parameters.

[8] Compare and contrast results obtained from other assessment methods, e.g. by applying commonly used age-structured models to the predicted catch-at-age data from more complex models.

[9] Provide MCMC diagnostics:
- for key management parameters, plot of prior and posterior with the value of the MLE, mean of the posterior, and median of the posterior shown;
- autocorrelation at various lags.