KELP GREENLING

STAR Panel Report

Southwest Fisheries Science Center
Santa Cruz, California
August 1-5, 2005

STAR Panel members:

André Punt (Chair), University of Washington, SSC representative
Mark Maunder (rapporteur), Center for Independent Experts
Robert Mohn, Center for Independent Experts
Tony Smith, Commonwealth Scientific and Industrial Research Organization
Michael Schirripa, Northwest Fisheries Science Center

Susan Ashcraft, GMT representative
Peter Leipzig, GAP representative
John Field, GMT representative

STAT members present:

Jason M. Cope, University of Washington
Alec D. MacCall, Southwest Fisheries Science Center

Overview

The STAR Panel convened the week of August 1-5, 2005 at the Southwest Fisheries Science Center, Santa Cruz Laboratory to review a draft assessment by the STAT for kelp greenling. A draft report was provided to the STAR Panel in advance of the meeting and was updated during the meeting

The STAR Panel evaluated this first assessment of kelp greenling based on the Terms of Reference for Full Stock Assessments. The assessment was carried out using Stock Synthesis 2. Kelp greenling was assessed as two independent sub-stocks divided at the California-Oregon border, i.e. based on data availability rather than biological considerations. There are substantial differences between the assessments for the two sub-stocks in assessment period, model assumptions, data available, results, and uncertainties. An important difference between the two sub-stocks is the first year for which historical catch data are available (1916 for California and 1981 for Oregon). Much effort went into re-constructing the historical catch time-series for the California sub-stock. The Oregon sub-stock has some age-at-length data, which were included in the assessment and provide information on growth and variation in length-at-age.

The STAR Panel and STAT agreed that the Oregon assessment is the best available, and is suitable for the provision of management advice. The estimates of depletion for the Oregon sub-stock are more certain than the estimates of absolute abundance, which are highly imprecise. The Panel cautions that any yield estimates will therefore be subject to considerable uncertainty.

For the California sub-stock, considerable effort was made to identify a model formulation that simultaneously estimated realistic historical exploitation rates, was internally consistent, fitted the available data, and led to plausible selectivity patterns for the major fishing sectors. However, no such model could be identified. Despite providing a comprehensive summary and model-based synthesis of available biological and fishery information, the STAR Panel concluded that the results for the California sub-stock are inadequate as the basis for the provision of management advice. However, the results of the model runs do provide the basis for the identification of data needs and future research directions for the California sub-stock.

Analyses requested by the STAR Panel

Both sub-stocks

1) **Are the assessment model results consistent with the trends in the abundance indices? Fit a linear regression to the CPUE abundance indices to determine the recent trends.**

The linear regression showed that the trend in abundance for the California sub-stock was flat and that for the Oregon sub-stock was slightly declining. These trends are consistent with outcomes from the assessment models.

Oregon sub-stock

1) **Are the assumed values of *M* and estimated levels of total mortality consistent with the Oregon catch-at-age data? Determine the sampling design of the catch-at-age data and conduct a catch-curve analysis.**

The STAT obtained the length-frequency sample associated with the Oregon age-frequency sample. The sampling design appears to have involved taking about 15 fish from each length category, or less if 15 fish were not available from that category. The STAT raised the age-frequency data using the length-frequency data and conducted a catch curve analysis. The estimates of total mortality were about $0.1 yr^{-1}$. These estimates are much lower than the values of natural mortality used in the assessment and are inconsistent with estimates based on other methods (e.g. maximum age and correlations with biological parameters). The Panel noted that catch curve analysis was probably inappropriate for these data because it does not account for selectivity and variation in year-class strength, factors explicitly included in the stock assessment model.

2) **The estimates of growth for Oregon are uncertain and selectivity may bias the estimates. The STAR Panel requested that the conditional age-at-length data be integrated into the assessment.**

The STAT included the age-at-length data in the assessment, which allowed growth to be estimated from the information in the length-frequency and age-at-length data. The length-at-age CVs had to be pre-specified because the model would not converge when these parameters were treated as estimable. Length-at-age was lower than when the growth curve was estimated outside the model, as was expected due to the automatic correction for selectivity bias, but the estimated growth curve nevertheless provided an adequate fit to the length-at-age data. The revised base-case model estimates the growth curve parameters (but not the length-at-age CVs) and includes the conditional age-at-length data.

3) **Determine the sensitivity of the assessment results to *M*; estimate *M* separately for male and females, and when male *M* equals female *M*.**

The STAT provided the results of many sensitivity analyses based on varying the assumed values for *M* by sex, an assumed value for sex-independent *M*, and when *M* is treated as estimable. The data support a sex-independent value for *M* based on likelihood considerations, and the STAR Panel and STAT agreed that *M* (sex-independent) be set to $0.26 yr^{-1}$ in the revised base-case model. Sensitivity tests for this base-case model exhibited less variation than models with sex-specific *M*.

California sub-stock

1) **Explore the behavior of the model for the California sub-stock**

A profile for R_0 using a stock reduction model showed that, given the catch history, the population should increase sharply in recent years. This suggests that the additional data are providing information that reduces this increase in biomass. Removal of the length-frequency data led to more pessimistic results while removal of the catch-rate indices led to more optimistic results.

2) Identify a revised base-case model

The STAT and STAR Panel identified the following as desirable features that an acceptable model formulation should exhibit:

a) the selectivity pattern for the recreational shore fishery should be domed-shaped;
b) the results should not be sensitive to slight changes to the parameter and data inputs;
c) the exploitation rates for the recreational shore fishery should not be excessive; and
d) the model should provide reasonable fits to all of the major data sources.

The STAT and STAR Panel examined many model formulations based on different specifications for growth curves, natural mortality, σ_R, selectivity, and removal of indices and length-composition data, but none exhibited all four of these features simultaneously. Many of these model formulations involved fixing the selectivity pattern for the recreational shore fishery to that for the recreational beach/bank fishery in Oregon, which is dome-shaped. Despite satisfying a)-c), these analyses led to poor fits to the length-composition data for the recreational shore fishery in California.

Final base-case model and quantification of uncertainty

The revised base-case assessment for the Oregon sub-stock included the following specifications:

- a 1981–2004 assessment period;
- a sex-independent M = 0.26y^{-1};
- conditional sex-specific age-at-length data;
- estimated sex-specific growth;
- iterated effective sample sizes and standard deviations for likelihood functions ;
- fixed values for the CVs of length-at-age (0.1 for age 2 and 0.09 for age 10);
- $\sigma_R = 1$;
- recruitment deviations estimated for 1981–2003;
- an initial (equilibrium) F estimated for all fleets except the live-fish fleet, with the equilibrium catches by fleet set to the average catches over 1981–89;
- logistic selectivity for the non-live, CPFV, PBR fleets; and
- double logistic selectivity for the live-fish, man-made, and beach/bank fleets.

Uncertainty for the Oregon model was bracketed noting that the largest uncertainty related to absolute abundance. The bounds of the 75% confidence interval for the logarithm of the virgin recruitment (R_0) were used as fixed values in the assessment to represent the range of uncertainty in the absolute biomass. The base-case model was given a probability of 0.5 and each of the sensitivity analyses was given a probability of 0.25. The uncertainty in biomass (as represented by R_0) was underestimated because M was fixed in the base-case model.

Technical merits and/or deficiencies in assessments

The STAT is commended for their effort in collating all the data for this first assessment of kelp greenling, and for the large number of analyses carried out in preparation for, and during, the STAR Panel.

Areas of disagreement regarding STAR Panel recommendations

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

Unresolved problems and major uncertainties

Both sub-stocks

The assessment was based on two sub-stocks, divided at the California-Oregon border. This division was based primarily on data availability considerations. However, the appropriate number of population segments and how they should be delineated remains uncertain.

Information on age and growth for both sub-stocks is very limited. The growth curve for Oregon is based on only 254 female and 187 male age-length points while the growth curve for California is based on the results of a thesis conducted during the 1980s. The lack of adequate information to parameterize length-at-age and its variation is a major concern for an assessment which is based almost exclusively on length-composition data.

The RecFIN length-composition and catch-effort data used in the assessment are based on spatially-aggregated information. The inability to access the raw data on which the summary information is based precluded the detailed analysis of the data and, in the case of the catch-effort data, the application of the delta-GLM method of catch-rate standardization. Furthermore, unless spatially-disaggregated data are available, it will be impossible to conduct assessments at finer resolutions than the regional level.

The indices of abundance used in the assessment are subject to considerable uncertainty owing to small sample sizes (e.g. CPFV) and the use of spatially-aggregated catch and effort information. Furthermore, without access to the individual records, it is impossible to determine how many zero catches are available, and to apply the Stephens-MacCall method to select records for inclusion in a catch-effort standardization[1]. Changes to management regulations have affected, and will continue to, affect the recreational fishery, potentially impacting the relationship between catch rates and abundance.

It was not possible to include the recreational weight-frequency data in an SS2-based assessment, except in the form of mean weight information which reduced its information content.

The results for both sub-stocks are sensitive to the assumptions regarding natural mortality, the steepness of the stock-recruitment relationship, growth, and the extent of variability in recruitment, among other things.

California sub-stock

[1] Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. *Fish. Res.* 70: 295-306.

The estimates of the harvest rates for the shore-based recreational fishery are very high compared to what would be reasonable for this fishery. Either the estimates are too high due to model misspecification or they represent local depletion. The selectivity curve for this fishery is estimated to be asymptotic, which is considered unrealistic and not consistent with the dome-shaped selectivity curve estimated for the Oregon sub-stock. If the Oregon dome-shaped selectivity curve is assumed for this fishery, the estimated exploitation rates are more reasonable, but the fit to the length-frequency data for the shored-based fishery is poor. This problem could be caused be spatial-variability in growth rates.

Recommendations for future research

Specific to kelp greenling

The assessments of both sub-stocks are highly uncertain and relatively small increases in data could lead to substantial improvements in the assessments. The STAR Panel focused on research and data to resolve the major sources of uncertainty.

A) Improvements to these assessments are dependent on increased availability of sex-specific age-length data. Even just one additional year of data may reduce uncertainty substantially.
B) More sampling of the recreational catch, particularly the shore-based sector, is required to provide catch-at-length information and ageing structures. This will require a modification to the current program which does not collect ageing structures for kelp greenling. Sex for kelp greenling is relatively easy to determine externally, and efforts should be made to include information on sex when collecting length frequency data.
C) Given data at appropriate spatial resolution, efforts should be made to conduct assessments based on sub-stocks separated biogeographically. Evidence reviewed by the STAR Panel indicated biological similarity between kelp greenling in Oregon and northern California, which suggests that there is value in attempting an assessment in which the data for these two areas are analyzed together.
D) Tagging studies, either traditional or archival, should be evaluated in relation to their ability to provide information on movement, sub-stock structure, age validation, and exploitation rates.
E) There is need to consider alternative techniques for monitoring the abundance of kelp greenling such as industry co-operative surveys.

Generic recommendations

A) There should be further consideration of the implications of using the prior on steepness derived by He *et al*. (in review), including its implications for species with other life history characteristics.
B) The approach used to estimate B_0 for widow rockfish had been modified from the 2003 assessment to be consistent with that on which rebuilding analyses are based (multiplying average recruitment in the early years of the fishery by unfished spawning biomass per recruit). This led to a change to the current depletion of 10%. There is a need for more explicit guidance regarding determination of B_0 in assessments and in rebuilding analyses.

C) There is a need for a series of cut-off dates for data to be included in assessments, with cut-offs dependent on the type of data. The lack of such dates means that assessment authors may be forced to revise decisions on base-case models very close to the date the assessment needs to be submitted to the STAR Panel, and even revise the draft assessment after this. Given that documents are supplied to reviewers two weeks in advance of meetings, major changes in assessments thereafter could compromise the integrity of the review.

D) Several of the 2005 assessments have conducted historical catch reconstructions. An effort needs to be made to develop a consistent approach to reconstructing catch histories. The ideal outcome would be a single document outlining the best reconstructed catch histories for each species (c.f. Rogers (2003)[2] that lists foreign catches). The California landing receipts on microfilm back to 1950 should be incorporated into the landings database.

E) There is still some inconsistency in how assessment authors decide whether to include or exclude recreational indices in assessments. Attempts to provide guidelines for the development and use of indices of abundance based on recreational catch and effort data would be worthwhile.

F) Stock Synthesis 2 should be extended to: a) allow assessment authors to include weight-frequency data in assessments; b) estimate the parameters of the ageing error matrix; and c) estimate the extent of overdispersion of the indices.

G) The raw data on which recreational length-frequency and catch-effort information are based should be made available to assessment authors in a convenient format. This will allow more detailed examination of the spatial patterns, and allow more sophisticated analyses of the catch-effort information; at present it is impossible to distinguish between lack of data and zero catch records.

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[2] Rogers, J.B. 2003. Species allocation of Sebastes and Sebastolobus sp. Caught by foreign countries of Washington, Oregon, and California, U.S.A. in 1965-1976. NMFS, Northwest Science Center.