Shortspine Thornyhead

Stock Assessment Review (STAR) Panel Report

NOAA Fisheries
Northwest Fisheries Science Center
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Overview

A draft assessment of the shortspine thornyhead (*Sebastolobus alascanus*) off the U.S. west coast was reviewed by the STAR panel during July 22-26, 2013. This assessment was presented to the STAR Panel by Dr. Ian Taylor (lead STAT author) and used the Stock Synthesis platform (version 3.24o). Previous stock assessments of shortspine thornyhead were carried out by Jacobsen (1990, 1991), Ianelli et al (1994), Rogers et al (1997, 1998), Piner and Methot (2001), and Hamel (2005). This Panel also reviewed the longspine thornyhead assessment during the same week (see separate Longspine Thornyhead STAR Panel Report) and to the extent possible, strove to ensure a consistent treatment of the catch data, influence of fishery regulations, and population vital rates.

Shortspine thornyhead are found in the waters off of the West Coast of the United States from northern Baja California to the Bering Sea. The majority of the spawning biomass occurs in the oxygen minimum zone between 600 and 1,400 meters, where longspine thornyheads are most abundant. Shortspine thornyhead are believed to have ontogenetic migration down the slope, although large individuals are found across the depth range. Additionally, they do not appear to be distributed evenly across the West Coast, with higher densities in shallower depths (under 500 meters) off of Oregon and Washington, and higher densities in deeper depths off of California. They are associated with Dover sole, sablefish and longspine thornyhead.

Dr. Taylor reviewed the fisheries, the data used in the analysis, and the Stock Synthesis (SS3) modeling approach. Following the initial presentation and discussion of the assessment, the Panel made written requests to the STAT for additional analyses. Upon completion, the STAT presented the results to the Panel which in turn, made additional requests related to the questions and issues arising from the new material. This process was repeated five times during the week until a base case was achieved and the uncertainty was fully characterized, to the extent possible given the time available.

Stock depletion in 2013 (SSB_{2013}/SSB_0) is estimated to be 0.742 with a slightly declining trend in SSB during recent years. The stock status appears to be healthy and robust to the data and modeling scenarios explored by the Panel. Recent fishing mortality rates are less than the F_{MSY} proxy and recent SSB are well above the target and limit reference points. However, important fishery data (historical catches and discards) and key population vital rates (maturity, age and growth) are particularly lacking for shortspine thornyhead, making the stock assessment only marginally sufficient to estimate the status of the resource. In particular although the SSB trend is fairly robust, the data and modeling are not informative as to the scale of SSB. R_0 is used as a proxy to bracket the uncertainty in the decision table.

The Panel commends the high quality of the draft assessment document, and greatly appreciated the STAT's patience and efficiency in responding to the Panel's many requests for additional analyses. The Panel also valued the many contributions from the GMT and GAP advisors. The STAR panel concluded that the shortspine thornyhead assessment was based on the best

available data, and that this new assessment constitutes the best available information on shortspine thornyhead off the U.S. west coast.

Discussion and Additional Analyses Requested by the STAR Panel

1. Determine why Slide 15 of the presentation (comparing GLMM lognormal, GLMM gamma and design based) and slide 19 of the presentation (NWFSC Combo survey) do not match. *Rationale: They are supposed to show the same data, but the trends are different.*
   Response: Slide 15 mistakenly showed LST GLMM results rather than the intended SST results. A corrected figure was presented.

2. Remove the Pikitch discard data for the south. *Rationale: The study did not cover the southern area and information from the fishery suggested that there was no reason to discard (i.e., Eureka fisheries had a market for all its fish).*
   Response: These data were removed and the estimated discard fraction for the southern trawl fishery decreased slightly (from ~16% to 14%). Little or no effects were found in the results or model diagnostics.

3. For the AFSC triennial shelf survey, only include 1995 LF and index onwards without the extra variance. *Rationale: This will provide consistent sampling over depth and area to have a more consistent index.*
   Response: The SSB trend was not affected but the absolute SSB level was reduced approximately 20%. [It was decided to use this as a sensitivity case while leaving the complete time series in the base case.]
4. Provide a graph of the trends (year effect) by stratum for the NWFSC Combo survey to verify that there is no regional difference in stock trends. *Rationale: To consider if there is a need for the management line at 34°27' and if there is any biological justification for the line.*
   Response: There was no apparent trend with respect to year, suggesting there is no scientific evidence to maintain this management line.

5. Begin estimating recruitment deviations in 1930 rather than 1850. *Rationale: There are no size data until 1978. The initial population structure is actually pretty close to equilibrium. This should affect the uncertainties more than the population size estimates.*
   Response: Beginning the process of estimating recruitment deviations later had no effect on model results. [It was decided to maintain the full time series in the base case.]

6. With the Pikitch data being removed for the south, estimate discards in 2 blocks: up until 2004 and 2005 onwards. *Rationale: This is when the WGCOP survey began and the first discard information available.*
   Response: It was discovered that discard length compositions for the south do not begin until 2006; thus blocking has little or no effect. The discard fraction here was around 2%. The STAT came up with an alternative run with blocking beginning in 2007 and an additional block beginning in 2011 when catch shares began and had 100% observer coverage. This blocking increased the discard fraction from approximately 2% to 3% in the south.

7. With the entire time series of the AFSC triennial shelf survey included in the base case, exclude the size compositions for 1980 and 1983. *Rationale: These years had low sample sizes with only 1 haul per year.*
   Response: This made no difference in results. [Include in new base.]

8. Use the old maturity function from the previous assessment until the new data are more thoroughly analyzed. *Rationale: The maturity ogive developed from the work of Pearson and Gunderson (2003) that was used in the last assessment appeared to be more realistic and samples from this study were collected during the shortspine thornyhead spawning season. The new information was collected outside of their peak spawning season and should be evaluated further.*
   Response: This increased SSB but did not change depletion. [Include in new base.]

9. Provide a sensitivity using the old versus the new maturity curve.
   Response: same as #3 above.

10. Remove the trawl north LF for 1994-1995. *Rationale: Because of poor fit and low sample sizes for these years (outliers).* **Response: Improved fits and there were no changes in management results such as depletion. [Include in new base.]**

11. Block on fishery selectivity beginning in 1992. *Rationale: There was a concern that the fishery appears to be selecting the same or smaller sizes than the survey which uses much smaller mesh size. Minimum mesh size changed in 1992 from 3 to 4.5".* **Response: Trawl-North selectivity showed that smaller fish were more selected after moving to larger mesh which is counterintuitive. Alternative retention blocking (2007-10 and 2011-12) did not rectify this anomaly.**

12. Explore asymptotic selectivity for NWFSC Combo survey. *Rationale: The fishery trawl has higher selectivity for larger fish than the survey has. (Could be that fishery fishes closer to rocky areas where the survey may not go.)*
    Response: The ascending limb did not change and did not affect overall selectivity. The trend in SSB was similar but the scale was reduced by ~50%. Depletion was still above management target. Total likelihood increased 54 units (poorer fit) and was therefore not recommended for the base model.

13. When looking at sensitivities also include yield estimates and other parameters, not only SSB. *Rationale: More diagnostics are needed to determine influences and model stability.*
    Response: This additional information was presented to the Panel for the remainder of the review.

14. Use the reconstructed catches by California and Oregon. Make a graph of the two series of catch estimates as well. *Rationale: Since efforts have been made to improve historical catches and these reconstructed estimates have been used for other assessments this year, this request could not be ignored.*

Response: The reconstructed SST catch prior to the 1970s are quite small relative to the catch history used in the 2005 assessment. This difference in catch history does not have significant effects on the results. [For consistency with LST, do not use the reconstructed catch as part of the base case.]

15. Implement Second Round of conclusions, i.e., 1) Remove the Pikitch discard data for the south, 2) Include entire time series from the AFSC triennial shelf, excluding the size compositions for 1980 and 1983, 3) Use the maturity ogive from the previous assessment until the new data are more thoroughly analyzed, and 4) Remove the trawl north LF for 1994-1995 because of poor fit and small sample sizes. Further, steepness should be fixed at 0.6. Also use the reconstructed catch series with the addition of the estimated foreign fleet catches from the 2005 assessment, which was not included in the previous request. *Rationale: To evaluate these changes in full.*
    Response: Model responded as anticipated. Adding the foreign catches caused the reconstructed catch series and that used in the last assessment to be quite similar.

16. Blocks for retention curve:
    - Trawl north: 1901-2006, 2007-2010, from 2011 onward
    - Trawl south: 1901 to 2006, 2007-2010, from 2011 onward
    - Non-trawl north: no blocks
        - This fleet is minimal with no reason to treat with blocking scheme
    - Non-trawl south: 1901 to 2006, from 2007

    Rationale: The draft assessment initially had 7 retention time blocks, with no supporting evidence for the blocks presented. This was an attempt to reduce parameters being estimated in the model. The splits from 2007 on were based on available length data. For the trawl fleets, the additional blocking represents the beginning of the catch shares program and 100% observer coverage in those years. (A decrease in discards during these years has been observed.) For the non-trawl north fleet, there was no evident reason to treat this fleet with a blocking scheme.
    Response: The new retention functions were reasonable. This blocking better reflects the fishery practices and regulations. SSB trend was not affected but the SSB scaling was reduced approximately 50%. Subject to several additional requests (see below), consider this run as the candidate base case. [This new blocking also seemed to fix the scaling problem that arose when "ballpark F" was turned off.]

17. If blocks for retention produce SSB in the 400,000 mt range, constrain the catchability for the NWFSC Combo survey between 0.50 and 2.0. *Rationale: to evaluate the scaling problem.*
    Response: This run was not needed based on the results of #2 request above.

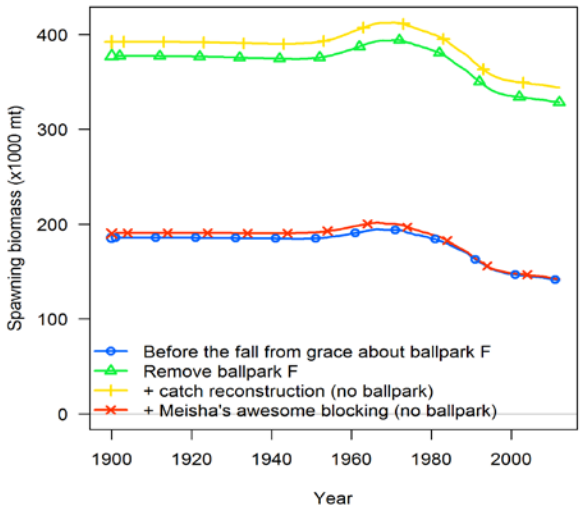
18. Add an additional retention time block for the trawl north fleet: 1901-1991, 1992-2006, 2007-2010, from 2011 as a sensitivity. *Rationale: To see if the mesh size had an effect beginning in 1992. [This time block was deemed appropriate in the longspine thornyhead assessment.]*

Response: This run may not have converged. Results were difficult to interpret. The additional block did not improve the model fit and therefore concluded not necessary to include in the base model.

19. Mimic the 2005 assessment's implementation of the ballpark F. *Rationale: The 2005 assessment employed the Ballpark F option in SS, i.e., F was fixed at an input value for all phases of the optimization through the penultimate phase and then F was freely estimated in the last phase. The STAT intended to use Ballpark F in the same way for this assessment but unbeknownst to the STAT, the new version of SS3 continues to fix F in the last phase.* **Response: SSB trend was not affected but the SSB scaling was affected - SSB approximately doubled.**

20. Redo the profiling on log(R_0) (figure 48 of original document) and jitter. *Rationale: To update and evaluate changes to new base model.*
Response: Profiling on log(R_0) showed a fairly flat total likelihood. The base case estimated log(R_0) = 10.3 (was 9.8 in draft base case). A 2 likelihood unit change from the minimum gives a range of log(R_0) from approximately 9.8 to a value greater than 12 (12 was the largest value used in the profile). This is a wide range of estimates for R_0 across a small range of likelihoods, suggesting that there is little data informing the scale of the population. This further explains why the ballpark F treatment had such large scaling effects. Jittering showed all runs returning to the same place.

21. Modify the phasing and see if we get the same results (red line in figure below). *Rationale: To check the influence of alternative phasing.*
Response: Using the original phasing produced nearly identical results.



22. Check to see if you get yellow (catch reconstruction, no ballpark F) or green lines (removing ballpark f) if ballpark F is phased out instead of simply turned off. *Rationale: To check the effect of correcting the Ballpark F in conjuction with the new blocking.*

Response: Phasing out the ballpark F parameter had no effect on results. This request and the above (#2) illustrated that the new retention blocking solved the scaling issues and better fit the available data.

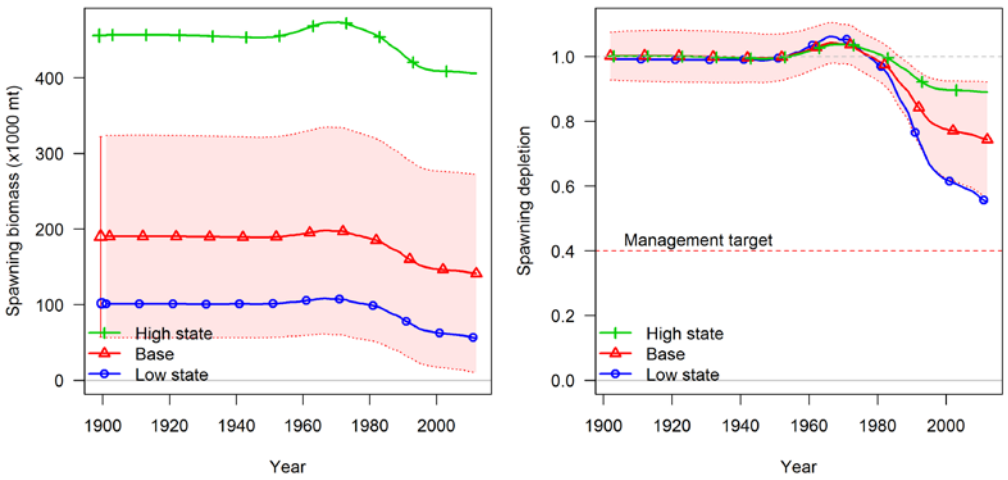
23. Show fits to indices and length frequencies. *Rationale: To evaluate based on changes for a new base model.*
    Response: This was done and presented to the Panel. Satisfactory results.

24. Remove historical reconstructed catches and replace with 2005 assessment catches. *Rationale: After noticing a discrepancy in the early reconstructed catches in the longspine thornyhead review, for consistency, go back to the 2005 assessment estimates.*
    Response: This was done and had no effect on the results.

25. Remove 1994 and 1995 Trawl north LF. *Rationale: There was no effect in an earlier sensitivity, but these had been overlooked and still had not been removed at this point.*
    Response: This was done and had no effect on the results.

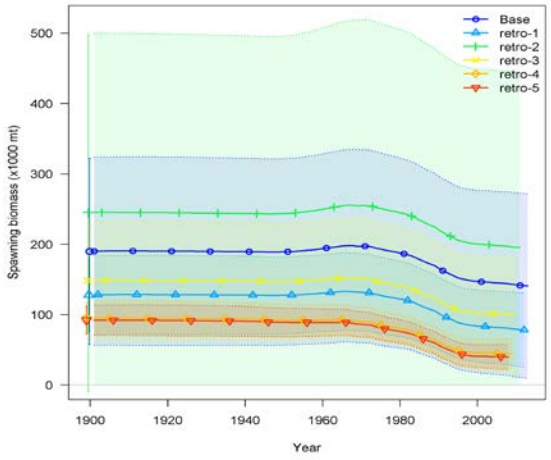
26. Uncertainty boundaries (low and high states of nature):
    a. Take the 12.5% quantile in 2013 spawning biomass estimate from the base model as the low state of nature (from the Delta Method normal approximation of variance).
    b. Calculate the approximate R0 value associated with it from the likelihood profile on R_0.
    c. Determine the change in likelihood at the alternative R_0 value.
    d. Add the change in the likelihood to the base model to determine the upper R_0 value from the likelihood profile to get the high state of nature. If the upper state of nature is over 600,000 mt (largest reasonable value from sensitivity runs) then instead choose an R_0 value That represents a change in likelihood of 1.2 units from the low state of nature (the distance in log likelihood space from the 12.5% to 87.5% quantiles).

    Rationale: The 12.5% quantile in 2013 spawning biomass estimate from the base case model appears to provide a reasonable low state of nature (given the suite of sensitivity runs examined by the Panel). Due to the normality assumption of the delta method and the consequent symmetric confidence interval, however, the 87.5% quartile does not adequately represent a high state of nature. Using the likelihood profile on log(R_0) to better characterize the asymmetric confidence interval should provide a more appropriate high state of nature.
    Response: The base case estimate of SSB in 2013 was 141,000 mt (depletion=0.74). The low state of nature SSB in 2013 was 56,000 mt (depletion=0.55), and the high state of nature SSB in 2013 was 405,000 mt (depletion=0.89). These runs appear to adequately capture the uncertainty in the assessment.



27. Plot actual biomass (SSB) estimates from previous assessments and from this one. *Rationale: To compare results from the two assessments.*
Response: The plot showed a similar trend, with the SSB time series from the 2005 assessment scaled at a lower biomass.

28. Do the retrospective with the new base case. *Rationale: To evaluate the effects of removing data, one year at a time.*
Response: A 5-step retrospective analysis was presented, i.e. successively dropping the years 2012, 2011, 2010, 2009, 2008. SSB trends were similar among the five retrospective runs and the base case but the scale of the SSB varied greatly among the runs. Despite the wide range of SSB estimates from the retrospective runs, a clear retrospective pattern did not emerge, e.g. no tendency to successively underestimate or overestimate SSB. Although all of the retrospective runs fell within the range of uncertainty identified in Request 3, above, the runs clearly demonstrate the difficulties in establishing SSB scale in the assessment and the tendency for small changes in model configuration to lead to important changes in model results.



Description of Base Model and Alternative Models Used to Bracket Uncertainty

Data used in the base model:

- Full catch history (with discard estimates) from 1901-2012 and fishery length frequency data (as available).
- Five surveys along with their respective length frequency data:
    - AFSC Triennial Shelf (100-366 m): 1980-2004
    - AFSC Triennial Shelf (366-500 m): 1995-2004
    - AFSC Slope: 1997, 1999-2001
    - NWFSC Slope: 1998-2002
    - NWFSC Shelf/Slope Combo: 2003-2012

Model structure:

- Single stock in USA waters – Canadian border to Mexican border
- Four fisheries: trawl-north, trawl-south, non-trawl-north, non-trawl-south
- Begin model in 1901
- Recruitment deviations estimated from 1850+
- Beverton-Holt stock recruit relationship
- M = 0.0505 fixed
- h = 0.6 fixed
- sigma-R = 0.5 fixed
- All von Bertalanffy growth parameters fixed
- Selectivities estimated for all fisheries and surveys

Starting with the model configuration described in the draft assessment document, the following changes were made to create a new base case:

- Errors were corrected (selectivity parameters and ballpark F fixed) – the former had little effect but the latter was important.
- Pikitch discard data for Trawl South was removed (few samples & not representative) – little effect.
- Remove 1980 and 1983 size comps from the Triennial Shelf Survey (small sample size) – little effect.
- Remove the trawl north LF for 1994-1995 because of poor fit– little effect.
- Change steepness to h=0.6 (consistent with 2005 assessment).
- Use old maturity ogive.
- Use three selectivity blocks for the trawl fishery– important effect.

Uncertainty was characterized by identifying two scenarios that represented low and high states of nature using the following algorithm:

a. Take the 12.5% quantile in 2013 spawning biomass estimate from the base model as the low state of nature (from the Delta Method normal approximation of variance).

b. Calculate the approximate R_0 value associated with it from the likelihood profile on R_0.
c. Determine the change in likelihood at the alternative R_0 value.
d. Add the change in the likelihood to the base model to determine the upper R_0 value from the likelihood profile to get the high state of nature. If the upper state of nature is over the largest reasonable value from sensitivity runs, then instead choose an R_0 value that represents a change in likelihood of 1.2 units from the low state of nature (the distance in log likelihood space from the 12.5% to 87.5% quantiles).

Comments on the Technical Merits of the Assessment

The STAR panel agreed that this stock assessment is based on the best available data and best available science. Important fishery data (historical catches and discards) and key population vital rates (maturity, age and growth) are particularly lacking for shortspine thornyhead, making the stock assessment only marginally sufficient to estimate the status of the resource.

This Panel suggests not conducting another full stock assessment on this stock until pertinent information is available for improvement. In the meantime, using an index of abundance (i.e., NWFSC Combo survey) to detect trends should be sufficient.

Areas of Disagreement

There were no areas of disagreement among the Panel members nor between the Panel and the STAT.

Unsolved Problems and Major Uncertainties

- Scaling issues. The ballpark F and the retrospective analysis had the biggest effect on the scale of the biomass.
- Sensitivity of results to small changes in model specifications.
- Lack of age data in the model.
- The need to fix all growth parameters outside the model. The current model has no information to provide a means of estimating important parameters. Uncertainty is likely underestimated due to fixing growth, M, *h*, and sigmaR.

Concerns Raised by the GMT and GAP Advisors During the Meeting

GAP Advisor Comments

The stability of the model was a cause for concern. Small adjustments to the model caused large changes in SSB which could have potential management implications. The concerns are particularly related to selectivity. Some examples are as follows: 1) there should have been greater separation between survey and the fishery, 2) estimated selectivity went in the opposite

direction of what was expected when mesh size changed in the fishery in 1992, and 3) selectivity of 20 cm shortspine and longspine thornyheads should have been similar.

GMT Advisor Comments

The GMT Advisor shared many of the GAP Advisor's concerns about the sensitivity of the model to assumptions about selectivity and retention. There is not much if any information available on how selectivity and retention may have changed over time or how it varied between areas, ports, and even buyers. Market conditions are thought to have determined largely whether fish were discarded or kept in the past yet such past conditions are not documented. The GMT Advisor supported the STAR Panel and STAT recommendation to reduce the number of retention curve blocks in the trawl fisheries.

The GMT representative also had questions about the advantage of estimating discards over simpler approaches that have been used in many assessments (e.g. using the estimates of discard in years where data is available and assuming a constant discard proportion where it is not). In this assessment, the discard percentage ("fraction") jumped substantially between runs, especially for the Trawl South fishery. The model fit to the observer-based discards estimates was also poor in many years. Despite these concerns, the GMT Advisor was satisfied that the states of nature recommended by the Panel would cover the uncertainty added by uncertainty in historical discard and total catch.

Likewise, the GMT supported the use of the STAT's catch history given the time constraints yet hopes the catch reconstruction can be better resolved for the next assessment.

Research Recommendations

1. Ageing to help estimate pertinent parameters in the model (e.g. M, growth), perhaps including new methods such as tagging. Tagging studies would also further investigate the assumption of an ontogenetic movement pattern seen for this species.
2. Maturity ogive to evaluate the pattern seen in the most recent data collected.
3. More efforts to reconstruct historical catches for thornyheads.
4. Investigate alternative, simpler methods that may be more robust.

References

Pearson, K. E. and D. R. Gunderson. 2003. Reproductive biology and ecology of shortspine thornyhead rockfish, *Sebastolobus alascanus*, and longspine thornyhead rockfish, *S. altivelis*, from the northeastern Pacific Ocean. Environmental Biology of Fishes 67: 117-136.

Ralston, S., D.E. Pearson, J.C. Field, and M. Key. 2010. Documentation of the California catch reconstruction project. NOAA Technical Memorandum. NMFS, NOAA-TM-NMFS-SWFSC-461.