7. Assessment of the Arrowtooth Flounder Stock in the Gulf of Alaska

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Executive Summary

The Gulf of Alaska (GOA) arrowtooth flounder (*Atheresthes stomias*) stock is managed in Tier 3a and is assessed on a biennial basis to coincide with the annual GOA groundfish trawl survey. These surveys occur in odd years, and for these years a full assessment of arrowtooth flounder in the GOA area is conducted. On even years, parameter values from the previous year's assessment model (Spies et al. 2015; http://www.afsc.noaa.gov/REFM/Stocks/assessments.htm) and total catch information for the current and previous year are used to make projections and to recommend ABC and OFL for the following two years.

A single species projection model was used to predict the status of the GOA ATF stock for 2017 and 2018 and to calculate ABC for those years. The projection model incorporated parameter values from the 2015 assessment model (Spies et al. 2015) as well as catch information from 2015 and 2016.

Summary of Changes in Assessment Inputs

Changes in the input data: The stock assessment model was not run for this update. New input data for the projection model consisted of the total catch for 2015 (19,054 t) and the current catch for 2016 (17,859 t as of October 21, 2016). Running the projection model to predict 2017 and 2018 ABC's requires estimates for the total catches in 2016 and 2017. The final catch for 2016 was estimated by adding the average catch between October 21 and December 31 from the previous four years (2012-2015) to the 2016 catch through October 21, for a total of 21,080 t. The 2017 catch was estimated as the average catch over the past five years (2012-2016, utilizing the full year's catch estimate for 2016), 23,720 t.

Summary of Results

Based on the projection model results, recommended ABC's for 2017 and 2018 are 186,093 t and 188,867 t, respectively, and the OFL's are 219,327 t and 196,635 t. The new ABC and OFL recommendations for 2017 are similar to those developed using the 2015 full assessment model (189,332 t and 196,714 t). The stock is not overfished, and is not approaching a condition of being overfished. Reference values are presented in the following table.

Quantity	As estimated or *specified last* year for: 2016	2017	*As estimated or *recommended this* year for: 2017	2018
M (natural mortality rate)**	0.35, 0.2	0.35, 0.2	0.35, 0.2	0.35, 0.2
Tier	3a	3a	3a	3a
Projected total (age 1+) biomass (t)	2,103,860	2,083,450	2,103,090	2,079,029
Projected Female spawning	1,175,240	1,157,520	1,174,400	1,154,310
$B_{100\%}$	992,272	992,272	992,272	992,272
$B_{40\%}$	396,909	396,909	396,909	396,909
$B_{35\%}$	347,295	347,295	347,295	347,295
F_{OFL}	0.204	0.204	0.204	0.204
$maxF_{ABC}$	0.171	0.171	0.171	0.171
F_{ABC}	0.171	0.171	0.171	0.171
OFL (t)	219,430	196,714	219,327	196,635
maxABC (t)	186,188	170,578	186,093	170,510
ABC (t)	186,188	170,578	186,093	170,510
Status	As determined *last* year for: 2014	2015	As determined *this* year for: 2015	2016
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

*Projections are based on estimated catches of 21,080 t for 2016 and 23,720 t for 2017.
**Natural mortality rate is 0.35 for males, 0.2 for males.

Area Apportionment

The following table shows recommended area apportionments for 2017 and 2018, based on the proportion of survey biomass projected for each area using the survey averaging random effects model developed by the survey averaging working group. The recommended area apportionment percentages are found in the introduction to the 2015 SAFE document (www.afsc.noaa.gov/REFM/Docs/2015/GOAintro.pdf).

	Western	Central	West Yakutat	East Yakutat/SE	Total
2015 Area Apportionment	15.1%	58.0%	20.1%	6.8%	100%
2017 ABC (t)	28,100	107,934	37,405	12,654	186,093
2018 ABC (t)	28,519	109,543	37,962	12,843	188,867

Summary for Plan Team

Year	Age 1+ Biomass (t)[1]	Female spawning biomass (t)[1]	OFL	ABC	TAC	Catch[2]
2015	1,957,970	1,189,120	226,390	192,921	103,300	19,054
2016	2,103,860	1,175,240	219,430	186,188	103,300	17,859[2]
2017	2,103,090	1,174,400	219,327	186,093		
2018	2,079,029	1,154,310	196,635	188,867		

[1]Results from age-structured projection model.
[2] Catch as of October 21, 2016.

Responses to SSC and Plan Team Comments on Assessments in General

October 2016 SSC
The SSC reminds groundfish and crab stock assessment authors to follow their respective guidelines for SAFE preparation.
Authors' response: Noted.

Responses to SSC and Plan Team Comments Specific to this Assessment

December 2014 SSC
The Plan Teams recommended (and SSC concurred) comparison of logistic and non-parametric selectivity models for the fishery and survey. For the selectivity-by-age model, the sensitivity to the weightings for the smoothing penalties should also be explored.

Author's response: These suggestions will be examined in 2017, the next full assessment cycle for GOA arrowtooth flounder.

December 2015 SSC
The SSC supports the PT's recommendations that future arrowtooth flounder assessments consider the following:
1. Fit growth curves and age-length transition matrix such that the effect of length-stratified otolith sampling on estimated size at age is removed.
2. Weight-at-age appears to be decreasing over time for most male and females between 1 and 10. Evaluate models which allow time-varying size at age.
3. The design-based variances may be underestimates, evaluate additional variance components.
4. Use the IPHC longline survey data as an additional tuning index.
5. Examine potential for iteratively reweighting age and length composition data, potentially with one of the methods described in Francis (2011).
6. Re-evaluate sex ratios and sex-specific natural mortality rates. The natural mortality for one sex could be fixed and the other estimated (similar to NRS).
7. The hypothesis that males are in deeper water and thus less available to the survey and fishery should be re-examined.

The SSC supports the PT's recommendation to evaluate standardizing the surveys from the 1960s and 1970s with the more recent NMFS trawl survey estimates or, alternatively, removing the older surveys from the model. The trawl survey biomass estimates are obtained from several sources, including IPHC surveys in the 1960s and exploratory NMFS surveys in the 1970s. The estimated variances for several survey biomass estimates appear to be small.

The SSC echoes the PT and encourages analysis of the previous herding and escapement studies for arrowtooth for the purpose of justifying/improving estimates of selectivity and catchability. Further, a correlation between bottom temperatures and catchability has been observed in BSAI arrowtooth flounder and other flatfish. A similar relationship may exist for GOA arrowtooth flounder and should be investigated to provide information for the estimation of catchability. These issues are highly relevant to the SSC's general recommendation for a focused workshop on estimates of catchability.

Author's response: These suggestions will be examined in 2017, the next full assessment cycle for GOA arrowtooth flounder. Also, authors offer a correction to point 2 above; a significant decline in length-at-

age was observed based on GOA age data from 1976-2015 for ages 1-4.

November 2014 Plan Team

The market is improving for arrowtooth flounder. "Arrowshimi" is being marketed successfully from arrowtooth flounder. In general, for all flatfish assessments, the Team recommends that new maturity information be evaluated and incorporated as appropriate.

Author's response: Note: "arrowshimi" is being tested as a marketable product, but is not in full production. Also, the comment about maturity has been noted and new maturity studies will be incorporated as they become available.

Literature cited

Spies, I., Ianelli, J., Kingham, A., Narita, R. and Palsson,W. 2015. Assessment of the arrowtooth flounder stock in the Gulf of Alaska. North Pacific Fishery Management Council, P. O. Box 103136, Anchorage, AK 99510.