6. Assessment of the arrowtooth flounder stock in the Eastern Bering Sea and Aleutian Islands

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Executive Summary

The Bering Sea and Aleutian Islands (BSAI) arrowtooth flounder (*Atheresthes stomias*) stock is managed in Tier 3a and is assessed on a biennial basis. Survey data for the BSAI comes from the BSAI shelf survey which takes place annually, the Aleutian Islands survey which is biennial, and the BSAI slope survey which is also typically biennial. In even years a full assessment of arrowtooth flounder (ATF) in the BSAI is conducted. On odd years, parameter values from the previous year's assessment model (Spies et al. 2016; 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 BSAI ATF stock for 2018 and 2019 and to calculate ABC and OFL for those years. The projection model incorporated parameter values from the 2016 assessment model (Spies et al. 2016) as well as catch information from 2016 and 2017.

Summary of Changes in Assessment Inputs

Changes in the input data:

1. The stock assessment model was not run for this update. New input data for the projection model consisted of the total catch for 2016 (11,109 t) and the current catch for 2017 (5,140 t as of September 21, 2017) extrapolated to the full year's catch.
2. Running the projection model to predict 2018 and 2019 ABC's requires estimates for the total catches in 2017 and 2018. The final catch for 2017 was estimated by calculating the proportion of catch between January 1st and September 21st from the previous five years (2012-2016), 90.2%. The total year's catch was extrapolated from the catch through September 21, 2017, for a total of 5,698 t. The 2018 catch was estimated as the average catch over the past four years, with the average catch from 2014-2016 from AKFIN, and the full year's catch estimate for 2017, for a 2018 estimate of 11,797 t. There has been a decreasing trend in ATF catch and the years selected for the 2018 catch estimate capture that trend (Figure 6.1).

Changes in the assessment methodology:

There were no changes to the assessment methodology.

Summary of Results

The estimate of total biomass in 2018 is higher than was estimated in the 2016 full assessment, 784,989 t vs. 772,153 t due to lower catch in 2017 than was predicted in 2016 (17,045 t was predicted in 2016 vs. 5,698 t extrapolated from partial catches in 2017). Possible reasons for lower catches are discussed below. Recommended ABC's for 2018 and 2019 are 65,929 t and 64,494 t, respectively, and the OFL's are 76,750 t and 67,553 t, based on the projection model results. The new ABC and OFL recommendations for 2018 are similar to those developed using the 2016 full assessment model for 2017 (65,371 t and 76,100 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: 2017	2018	*As estimated or *recommended this* year for: 2018	2019
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)	779,195	772,153	785,141	782,840
Projected Female spawning	485,802	464,066	490,663	472,562
$B_{100\%}$	530,135	530,135	530,135	530,135
$B_{40\%}$	212,054	212,054	212,054	212,054
$B_{35\%}$	185,547	185,547	185,547	185,547
F_{OFL}	0.151	0.151	0.151	0.151
$maxF_{ABC}$	0.129	0.129	0.129	0.129
F_{ABC}	0.129	0.129	0.129	0.129
OFL (t)	76,100	67,023	76,757	75,084
maxABC (t)	65,371	58,633	65,932	64,494
ABC (t)	65,371	58,633	65,932	64,494
Status	As determined *last* year for: 2015	2016	As determined *this* year for: 2016	2017
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 5,698 t for 2017 and 11,797 t for 2018.
**Natural mortality rate was fixed at 0.35 for males, 0.2 for females.

A research survey was conducted on the Eastern Bering Sea shelf in 2017. The EBS arrowtooth flounder biomass estimate was 424,194 t for 2017, which is similar to recent years (Figure 6.2). Between 2012-2016 the EBS shelf survey biomass estimate for arrowtooth flounder was between 402,887 t and 475,264 t.

Starting in the current year, "off year" assessments are required to present a catch to biomass ratio, which is calculated here as the catch divided by the total age 1+ biomass from the assessment model and 2017 total biomass from the projection model (Spies et al. 2016). The catch to biomass ratio has ranged from 0.014 to 0.044 between 1993-2017 (Table 6.1, Figure 6.3). The lowest catch to biomass ratio was in 2017 at 0.007; however it should be noted that catch in 2017 was extrapolated total year catch and the biomass estimate was based on a projection model. Therefore, the ratio may be less accurate than in previous years because it is not based on actual full year catch data.

Catches of arrowtooth flounder have been decreasing in recent years in the BSAI. (Figure 6.1) for several reasons. In 2008-2010, the walleye pollock total allowable catch (TAC) was low ($1x10^6$ t, 815,000 t, and 813,000 t in 2008, 2009, and 2010 vs. 1,394,000 t in 2007), which allowed the arrowtooth flounder TAC to be set higher (75,000 t) for each of those years. The pollock TAC increased to 1,252,000 t in 2011, which resulted in a decrease of arrowtooth TAC to 25,900 t. The year 2011 was the first year that Kamchatka flounder was split out from arrowtooth flounder, and the Kamchatka TAC was 17,700 t in that year. Prior to the Amendment 80 program which began in 2008, trawl catcher/processors could not target arrowtooth flounder because there was no halibut prohibited species catch (PSC) limit allocated to support an arrowtooth flounder directed fishery. In 2008 the Amendment 80 catcher/processors (CP) that

were in a cooperative could use their halibut PSC in any fishery, so directed fishing for arrowtooth flounder was now an option. And at approximately this time, viable products from arrowtooth flounder were developed. Part of Amendment 80 required the catcher/processor fleet to increase their retention of all species, so it made sense to retain more arrowtooth flounder. Total retained arrowtooth increased from 5,130 t in 2007 to 15,913 t in 2008. In the second half of 2014, the NPFMC put pressure on the Amendment 80 fleet to decrease their halibut PSC use, and decreasing arrowtooth flounder catch may have been a result. Decreasing PSC by catcher/processors from 2008-2017 is shown in Table 6.2.

The number of trawl catcher/processors has decreased in recent years (Table 6.2). These Amendment 80 CP's often catch arrowtooth flounder and Kamchatka flounder together. This is complicated because it is difficult to determine how much of each species the fleet will catch. If the TACs are not similar, one species may close earlier than the other. Usually the Kamchatka flounder TAC is much lower than arrowtooth so that fishery closes earlier than arrowtooth. The fleet prefers Kamchatka because it usually has a higher value, and may decide not to target arrowtooth until the Kamchatka fishery closes. Also in 2017 there was a change in vessel ownership. Several vessels and their license limitation program licenses were bought by other Amendment 80 companies. This changed how arrowtooth and Kamchatka flounder were fished in 2017. The 2017 companies wanted to keep both species open as long as possible in 2017 to reduce discards. Directed fishing closures for Kamchatka flounder are shown in Table 6.2. Directed fishing for arrowtooth was closed in 2012 and 2013 because the directed fishing allowance was reached in those years (Table 6.2).

Summary for Plan Team

Year	Age 1+ Biomass (t) [1]	Female spawning biomass (t)[1]	OFL	ABC	TAC	Catch[2]
2016	910,012	535,350	91,663	78,661	22,000	11,109
2017	779,195	485,802	76,100	65,371	14,000	5,140[2]
2018	784,989	490,662	76,750	65,929		
2019	784,238	472,562	67,553	64,494		

[1]Results from age-structured projection model.
[2] Catch as of September 21, 2017.

Literature cited

Spies, I., Wilderbuer, T., Nichol, D., Hoff, J., Palsson, W. 2016. Assessment of the arrowtooth flounder stock in the Eastern Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, P. O. Box 103136, Anchorage, AK 99510. http://www.afsc.noaa.gov/REFM/Stocks/assessments.htm

Figure 6.1. Catch estimates of arrowtooth flounder in the Bering Sea and Aleutian Islands from 1993-2018. Black circles represent the NMFS AKRO BLEND/Catch Accounting System estimates of catch through September 21, 2017. The red dots in 2017 and 2018 represent extrapolated catch estimates through December 31st for those years.

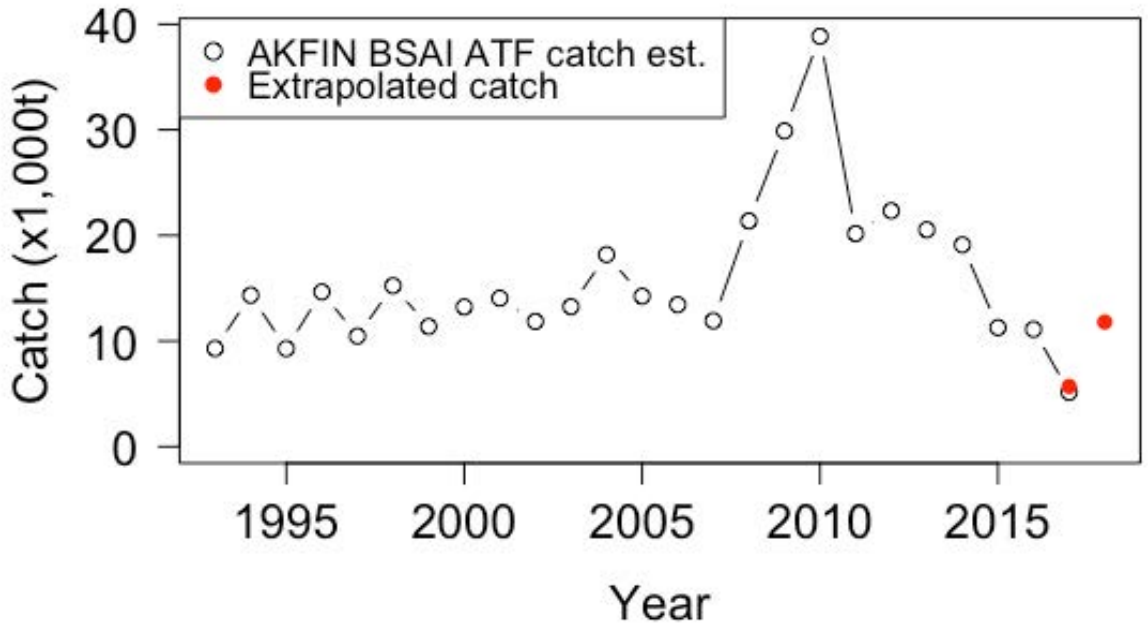

Figure 6.2. Eastern Bering Sea shelf survey biomass estimates for arrowtooth flounder, 1987-2017.

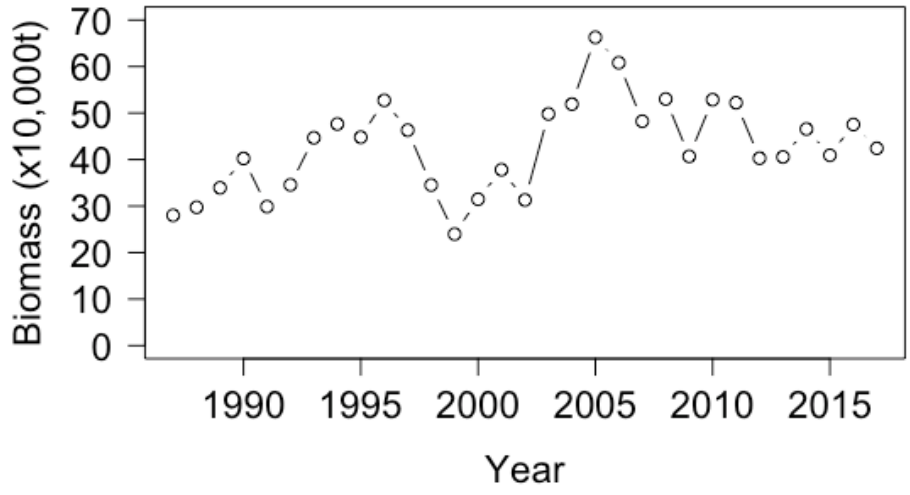

Figure 6.3. Catch to biomass ratio for BSAI arrowotooth flounder from 1993-2017.

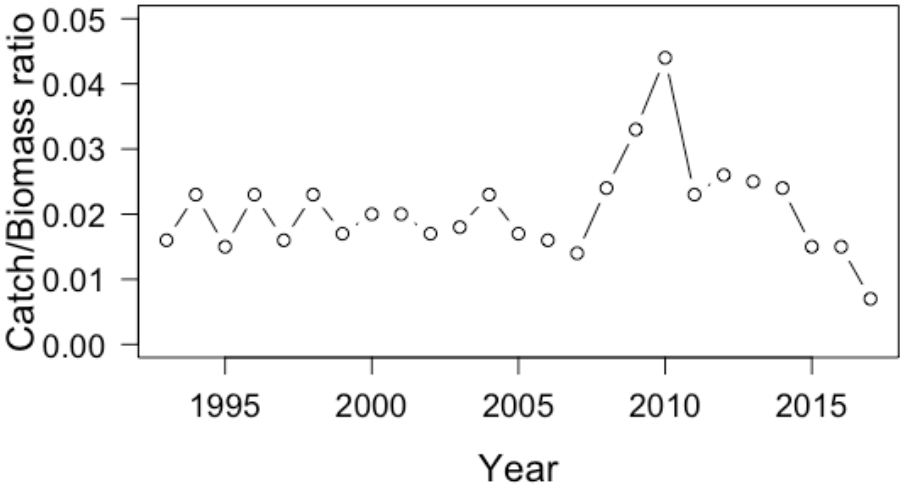

Table 6.1. Biomass estimates from the 2016 full assessment model, except for 2017 which was generated by the single species projection model. Catch data is from the NMFS AKRO BLEND/Catch Accounting System, except for 2017 which is an estimate based on the catch as of Sept. 21, 2017 extrapolated to Dec. 31, 2017 based on average catches from 2012-2016.

Year	Biomass	Catch	Catch/Biomass Ratio
1993	590,261	9,299	0.016
1994	621,176	14,338	0.023
1995	636,732	9,284	0.015
1996	649,886	14,654	0.023
1997	651,189	10,469	0.016
1998	655,984	15,237	0.023
1999	658,794	11,378	0.017
2000	672,283	13,230	0.020
2001	690,899	14,058	0.020
2002	716,031	11,855	0.017
2003	749,117	13,253	0.018
2004	784,858	18,185	0.023
2005	815,630	14,243	0.017
2006	849,607	13,442	0.016
2007	876,395	11,916	0.014
2008	899,248	21,370	0.024
2009	904,125	29,900	0.033
2010	891,490	38,855	0.044
2011	860,724	20,169	0.023
2012	845,222	22,336	0.026
2013	822,562	20,538	0.025
2014	798,002	19,108	0.024
2015	773,399	11,272	0.015
2016	762,657	11,109	0.015
2017	779,195	5,698	0.007

Table 6.2. The amount of halibut prohibited species catch (PSC) taken by catcher processors in metric tons, the number of trawl catcher/processors targeting arrowtooth, and Kamchatka and arrowtooth flounder fishery closure dates, from 2003-2017.

Year	Catcher/processor halibut PSC (t)	No. trawl CPs targeting arrowtooth	Kamchatka closure dates for A80 CPs	ATF closure dates
2003		10		
2004		12		
2005		15		
2006		13		
2007		13		
2008	128	16		
2009	237	15		
2010	186	12		
2011	181	18		
2012	425	17		August 11
2013	248	16	July 8	August 21
2014	191	17	August 23	
2015	66	12	June 6	
2016	72	12	May 25	
2017	35	9	August 1	