

7. Assessment of the arrowtooth flounder stock in the Gulf of Alaska

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Executive Summary

The scheduled frequency for some stock assessments was recently changed in response to the National Stock Assessment Prioritization effort (Methot 2015; Hollowed et al. 2016). In previous years, all Gulf of Alaska (GOA) rockfish stocks were assessed on a biennial stock assessment schedule to coincide with the availability of new survey data. There was no change in this schedule for the arrowtooth flounder stock. For this off-cycle (even) year, we present a partial assessment consisting of an executive summary with recent fishery catch and survey trends as well as recommend harvest levels for the next two years. In on-cycle (odd) years, we will present a full stock assessment document with updated assessment and projection model results to recommend harvest levels for the next two years. Please refer to last year's full stock assessment and fishery evaluation (SAFE) report for further information regarding the stock assessment ([Shotwell et al., 2021](#)).

We use a statistical age-structured model as the primary assessment tool for the Gulf of Alaska (GOA) arrowtooth flounder (*Atheresthes stomias*) stock which qualifies as a Tier 3 stock. This assessment consists of a population model, which uses survey and fishery data to generate a historical time series of population estimates, and a projection model, which uses results from the population model to predict future population estimates and recommended harvest levels. The data sets used in this assessment include total catch biomass, fishery size compositions, bottom trawl survey abundance estimates, bottom trawl survey age compositions, and bottom trawl survey size compositions when age compositions are not available. For an off-cycle year, we do not re-run the assessment model, but do update the projection model with new catch information. This incorporates the most current catch information without re-estimating model parameters and biological reference points. As with last year, we use the full assessment base model from 2019 (Model 19.0).

Summary of Changes in Assessment Inputs

Changes in the input data:

There were no changes made to the assessment model inputs since this was an off-cycle year. New data added to the projection model included an updated 2021 catch estimate of 9,988 t and new catch estimates for 2022-2023. We estimated the 2022 catch by increasing the official catch as of October 15, 2022, by an expansion factor of 1.12, which represents the average fraction of catch taken after October 15 in the last five complete years (2017-2021). This resulted in an estimated catch for 2022 of 12,233 t. To estimate future catches, we updated the yield ratio to 0.14, which was the average of the ratio of catch to ABC for the last five complete catch years (2017-2021). This yield ratio was multiplied by the projected ABCs from the updated projection model to generate catches of 16,382 t in 2023 and 14,292 t in 2024.

Changes in the assessment methodology:

There were no changes to the assessment methodology since this was an off-cycle year.

Summary of Results

Based on the projection model results, recommended ABCs for 2023 and 2024 are 119,485 t and 118,014 t, respectively, and the OFLs are 142,749 t and 141,008 t. The new ABC and OFL recommendations for 2023 are similar to the 2022 ABCs and OFL developed using the 2021 full assessment model. 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 <i>specified last year for:</i>		<i>*As estimated or recommended this year for:</i>	
	2022	2023	2023	2024
<i>M</i> (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)	1,268,140	1,270,850	1,265,950	1,269,510
Projected Female spawning	703,853	691,941	702,074	690,799
<i>B</i> _{100%}	1,018,700	1,018,700	1,018,700	1,018,700
<i>B</i> _{40%}	407,478	407,478	407,478	407,478
<i>B</i> _{35%}	356,544	356,544	356,544	356,544
<i>F</i> _{OFL}	0.225	0.225	0.225	0.225
<i>maxF</i> _{ABC}	0.185	0.185	0.185	0.185
<i>F</i> _{ABC}	0.185	0.185	0.185	0.185
OFL (t)	143,100	141,231	142,749	141,008
maxABC (t)	119,779	118,201	119,485	118,014
ABC (t)	119,779	118,201	119,485	118,014
Status	As determined <i>last year for:</i>		As determined <i>this year for:</i>	
	2020	2021	2021	2022
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 12,233 t for 2022, 16,382 t for 2023, and 14,292 t for 2024.

**Natural mortality rate is 0.35 for males, 0.2 for females.

The stock is not being subject to overfishing, is not currently overfished, nor is it approaching a condition of being overfished. The tests for evaluating these three statements on status determination require examining the official total catch from the most recent complete year and the current model projections of spawning biomass relative to *B*_{35%} for 2022 and 2024. The official total catch for 2021 is 9,988 t, which is less than the 2021 OFL of 143,100 t; therefore, the stock is not being subjected to overfishing. The estimates of spawning biomass for 2022 and 2024 from the current year (2022) projection model are 717,761 t and 690,799 t, respectively. Both estimates are well above the estimate of *B*_{35%} at 356,544 t and, therefore, the stock is not currently overfished nor approaching an overfished condition.

Fishery Trends

Updated catch data (t) for arrowtooth flounder in the Gulf of Alaska as of October 15, 2022 (NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database, <http://www.akfin.org>) are summarized in the following table:

Year	Western	Central	West Yakutat	East Yakutat/SE	Gulfwide Total	Gulfwide ABC	Gulfwide TAC
2021	361	9,485	81	61	9,988	126,970	97,372
2022	425	10,444	29	53	10,951	119,779	96,501

Catch of arrowtooth flounder increased slightly in western and central GOA but decreased in west Yakutat and east Yakutat/southeast in 2022 compared to 2021 and is now the second lowest in the time series (but not a complete year). About 61% of the catch is in the arrowtooth trawl fishery, with 24% in the rockfish fishery, and the remainder mainly in the pollock bottom trawl, pollock midwater trawl, rex sole, sablefish and shallow water flatfish fisheries. Currently, “off year” assessments are required to present a catch to biomass ratio, which is calculated as the catch divided by the total age 1+ biomass from the assessment model and 2022 total biomass from the projection model (Shotwell et al., 2021). The catch to biomass ratio for 1991-2022 has ranged from 0.008 in 2021 to 0.024 in 2014 (Table 7.1, Figure 7.1). The arrowtooth flounder catch/biomass ratio steadily increased until 2014, then declined steadily to the time series low in 2021 and also low in 2022 (Figure 7.1). The catch to biomass ratio in 2022 was 0.010.

Area Allocation of Harvests

The following table shows recommended area apportionments for 2023 and 2024, 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 last full assessment (<https://apps-afsc.fisheries.noaa.gov/refm/docs/2019/GOAatf.pdf>).

	Western	Central	West Yakutat	East Yakutat/SE	Total
2021 Area Apportionment	25.5%	54.4%	6.6%	13.5%	100%
2023 ABC (t)	30,469	65,000	7,886	16,130	119,485
2024 ABC (t)	30,094	64,200	7,789	15,932	118,014

Summaries for Plan Team

Species	Year	Biomass ¹	OFL	ABC	TAC	Catch ²
Arrowtooth Flounder	2021	1,321,700	151,723	126,970	97,372	9,988
	2022	1,268,140	143,100	119,779		10,951
	2023	1,265,950	142,749	119,485		
	2024	1,269,510	141,008	118,014		

Stock	Area	2022				2023		2024	
		OFL	ABC	TAC	Catch ²	OFL	ABC	OFL	ABC
Arrowtooth Flounder	W		33,658	14,500	425		30,469		30,094
	C		68,394	68,394	10,444		65,000		64,200
	WY		6,707	6,707	29		7,886		7,789
	EY		11,020	6,900	53		16,130		15,932
	Total		143,100	119,779	96,501	10,951	142,749	119,485	141,008

¹Results from age-structured projection model for age 1+

²Catch as of October 15, 2022.

Responses to SSC and Plan Team Comments on Assessments in General

“The Teams recommend that, for ESPs in general, when a fishery performance indicator may have ambiguous interpretations, no traffic light color coding should be assigned, but the scoring (which is indicative of a trend, but not the relationship of the indicator to stock health) should be maintained.” (Joint Plan Team, November 2021)

An ecosystem and socioeconomic profile or ESP has not been created for this stock at this time. If an ESP is generated in the future we will use the standardized format which no longer includes a traffic light color coding for fishery performance indicators. This was instituted in the 2022 ESPs for several groundfish stocks and allows for the scoring to be maintained without the ambiguous color interpretations.

“The Team recommends that the AFSC prioritize research on best practices for specifying the selectivity schedules used in projections for Tier 1-3 stocks in general.” (BSAI Plan Team, November 2021)

“The Team recommends all GOA authors evaluate any bottom trawl survey information used in their assessment prior to 1990 including the 1984 and 1987 surveys and conduct sensitivity analyses to evaluate their usefulness to the assessment. This may apply for Aleutian Islands surveys but this was only raised during GOA assessment considerations.” (GOA Plan Team, November 2021)

We plan to consult the Groundfish Assessment Program (GAP) regarding the appropriate starting year for arrowtooth flounder biomass estimates from the Gulf of Alaska bottom trawl survey (GOA BTS) for the next full assessment.

“With respect to Risk Tables, the SSC would like to highlight that “risk” is the risk of the ABC exceeding the true (but unknown) OFL, as noted in the October 2021 SSC Risk Table workshop report. Therefore, for all stocks with a risk table, assessment authors should evaluate the risk of the ABC exceeding the true (but unknown) OFL and whether a reduction from maximum ABC is warranted, even if past TACs or exploitation rates are low.” (SSC, December 2021)

Since this is a partial assessment year for GOA arrowtooth flounder, we do not provide a risk table at this time. In the next full assessment we plan to include formatting as recommended by the SSC and the table ranking descriptions for completeness.

“The SSC recommends that groundfish, crab and scallop assessment authors do not change recommendations in documents between the Plan Team and the SSC meetings, because it makes it more difficult to understand the context of the Plan Team’s rationale and seems counter to the public process without seeing a revision history of the document.”

“The SSC recommends a working group be formed to explore options for altering the timing of reviews of select crab and groundfish assessments to address this timing issue”

(SSC, December 2021)

We do not plan to change the recommendations in this SAFE document between the Plan Team and the SSC meetings and did not change the SAFE document from the last full assessment between meetings.

“The Teams recommended that stock assessment authors transition from the ADMB random-effects survey smoother to this package which implements the same model with several improvements.” (Joint Plan Team, September 2022)

“The SSC supports the JGPT’s recommendation that stock assessment authors transition from the ADMB RE variants to the rema framework, which implements the same model variants in a single framework with several improvements.” (SSC, October 2022)

We plan to use the *rema* R package for apportionment of arrowtooth flounder in the next full assessment.

Responses to SSC and Plan Team Comments Specific to this Assessment

“The Team discussed the use of non-standardized surveys including the 1984 and 1987 surveys that historically have been used in many assessments but were cooperative surveys with Japan and not comparable to our domestic survey index starting in 1990. Considering the length of the bottom trawl survey time series, it is no longer common practice to use any of these non-standardized surveys as part of the time series.” (GOA Plan Team, November 2021)

We plan to consult the Groundfish Assessment Program (GAP) regarding the appropriate starting year for arrowtooth flounder biomass estimates from the Gulf of Alaska bottom trawl survey (GOA BTS) for the next full assessment.

“The SSC notes that the arrowtooth flounder assessment extrapolates current year catch in October using the average of catch taken between October 17 and December 31 in the last five complete catch years (e.g., 2016-2020). Given changes in arrowtooth harvest due to fluctuations in markets and “top-off” fisheries, the SSC requests the authors consider whether other projection methods would better reflect fishery changes.” (SSC, December 2021)

We plan to consider whether other projection methods would better reflect fishery changes in the next full assessment.

Literature cited

- Hollowed, A.B., K. Aydin, K. Blackhart, M. Dorn, D. Hanselman, J. Heifetz, S. Kasperski, S. Lowe, and K. Shotwell. 2016. Discussion paper stock assessment prioritization for the North Pacific Fishery Management Council: Methods and Scenarios. Report to NPFMC Groundfish Plan Teams. September 2016. https://www.npfmc.org/wp-content/PDFdocuments/meetings/AFSC-HQ_Discussion_Paper.pdf.
- Methot Jr., Richard D. (editor). 2015. Prioritizing fish stock assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-152, 31 p.
- Shotwell, S.K., I. Spies, J.N., Ianelli, K. Aydin, D.H. Hanselman, W. Palsson, K. Siwicke, J. Sullivan, and E. Yasumiishi. 2021. Assessment of the arrowtooth flounder stock in the Gulf of Alaska. North Pacific Fishery Management Council, P. O. Box 103136, Anchorage, AK 99510.

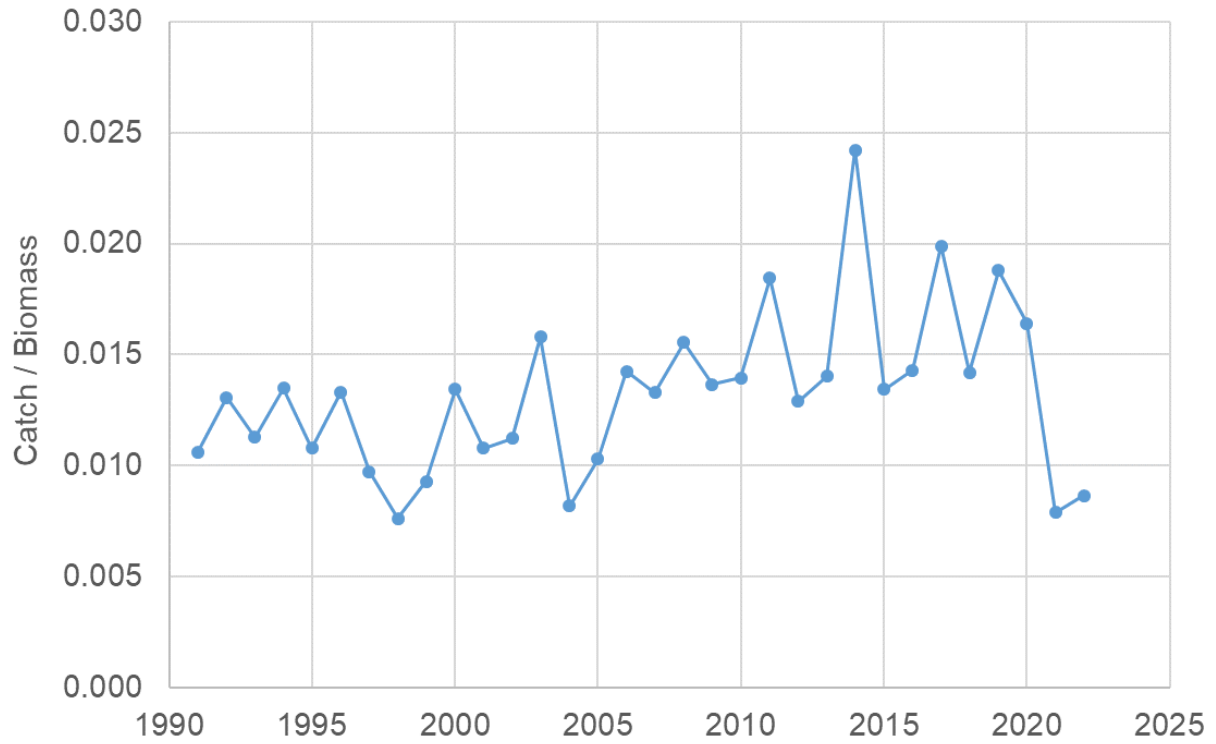


Figure 7.1 Catch to biomass ratio for Gulf of Alaska arrowtooth flounder from 1991-2022. Values for 2022 are based on projected estimates. 2022 catch as of October 15, 2022 increased by 10% from last year to this year.

Table 7.1 Biomass estimates from the 2021 full assessment model, except for 2022, which was generated by the single species projection model. *Catch data is from the NMFS AKRO BLEND/Catch Accounting System, except for 2022 which is an estimate based on the catch as of October 15, 2022 extrapolated to Dec. 31, 2022 based on average catches from 2017-2021.

Year	Biomass	Catch	Catch/Biomass Ratio
1991	1,640,990	17,388	0.011
1992	1,677,300	21,916	0.013
1993	1,692,930	19,078	0.011
1994	1,699,800	22,918	0.013
1995	1,695,590	18,279	0.011
1996	1,689,520	22,484	0.013
1997	1,683,200	16,363	0.010
1998	1,700,040	12,958	0.008
1999	1,736,690	16,142	0.009
2000	1,800,450	24,211	0.013
2001	1,846,490	19,926	0.011
2002	1,889,030	21,213	0.011
2003	1,916,920	30,254	0.016
2004	1,926,290	15,758	0.008
2005	1,943,540	19,989	0.010
2006	1,945,340	27,739	0.014
2007	1,919,540	25,508	0.013
2008	1,882,570	29,270	0.016
2009	1,823,200	24,912	0.014
2010	1,755,930	24,496	0.014
2011	1,687,840	31,139	0.018
2012	1,618,680	20,886	0.013
2013	1,566,580	21,967	0.014
2014	1,513,960	36,662	0.024
2015	1,446,290	19,418	0.013
2016	1,402,090	20,057	0.014
2017	1,363,850	27,144	0.020
2018	1,336,650	18,965	0.014
2019	1,314,850	24,714	0.019
2020	1,294,430	21,243	0.016
2021	1,267,240	9,988	0.008
2022	1,267,240	12,233	0.010