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

S. Kalei Shotwell, Dana H. Hanselman, Paul von Szalay, and Benjamin C. Williams

November 2023

Executive Summary

The scheduled frequency for some stock assessments was recently changed in response to a review of the National Stock Assessment Prioritization effort (Methot 2015; Hollowed et al. 2016). In previous years, Gulf of Alaska (GOA) flatfish stocks were assessed on a biennial stock assessment schedule to coincide with the availability of new survey data. Following the prioritization review, it was recommended that GOA arrowtooth flounder (*Atheresthes stomias*) change to a quadrennial stock assessment schedule with a full stock assessment produced every four years and a harvest projection produced in alternate years. For this off-cycle year, we present a harvest projection assessment consisting of an executive summary with recent fishery catch and survey trends as well as recommend harvest levels for the next two years. Please refer to last 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 GOA arrowtooth flounder 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 biomass 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 2018 (Model 18.9).

Description of Updated Catch

There were no changes from the 2021 assessment model (Shotwell *et al.*, 2021) as this is an off-cycle year. New data added to the projection model included updated catch data from 2021-2022 and new estimated catches for 2023-2025. Catch data were loaded on October 23, 2023. The 2023 catch was estimated by increasing the observed catch by an expansion factor of 1.038, which accounts for the average fraction of catch taken after October 23 in the last three complete years (2020-2022). This expansion factor decreased from last year's expansion factor of 1.12 and resulted in an estimated catch for 2023 of 9,029 t. To estimate future catches, we updated the yield ratio to 0.15, which was the average ratio of catch to ABC for the last three complete catch years. This yield ratio increased from last year's

yield ratio of 0.14 and was multiplied by the projected ABCs from the updated projection model to generate catches of 17,576 t in 2024 and 15,516 t in 2025.

Summary of Results

ABC recommendation

The projected total biomass for 2024 is 1,295,410 t. The recommend ABC for 2024 is 119,249 t, the maximum allowable ABC under Tier 3a. This ABC is a 0.2% decrease compared to the 2023 ABC of 119,485 and a 1% increase from the projected 2024 ABC from the last year's assessment.

The 2024 GOA-wide OFL for arrowtooth flounder is 142,485 t.

Reference values for arrowtooth flounder are summarized in the following table:

| Quantity/Status | As estimated or *specified* | | As estimated or | |
	2023	2024	2024[*]	2025[*]
M (natural mortality)	0.2	0.2	0.2	0.2
Tier	3a	3a	3a	3a
Projected total (age 1+) biomass (t)	1,265,950	1,269,510	1,295,410	1,311,810
Projected female spawning biomass (t)	702,074	690,799	698,842	695,299
$B_{100\%}$	1,018,700	1,018,700	1,018,700	1,018,700
$B_{40\%}$	407,478	407,478	407,478	407,478
$B_{35\%}$	356,544	356,544	356,544	356,544
F_{OFL}	0.225	0.225	0.225	0.225
$maxF_{ABC}$	0.185	0.185	0.185	0.185
F_{ABC}	0.185	0.185	0.185	0.185
OFL (t)	142,749	141,008	**142,485**	142,074
*max*ABC (t)	119,485	118,014	119,249	118,912
ABC (t)	119,485	118,014	**119,249**	118,912
Status	As determined *last* year for:		As determined *this* year for:	
	2022	2023	2023	2024
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 an estimated catch of 9,029 t for 2023 and estimates of 17,576 t and 15,516 t used in place of maximum permissible ABC for 2024 and 2025.

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 2023 and 2025. The official total catch for 2022 is 11,631 t, which is less than the 2022 OFL of 143,100 t; therefore, the stock is not being subjected to overfishing. The estimates of spawning biomass for 2023 and 2025 from the current year (2023) projection model are 696,871 t and 695,299 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 23, 2023 (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
2022	441	11,093	37	60	11,631	119,779	96,501
2023	346	8,275	37	37	8,695	119,485	94,286

Catch of arrowtooth flounder decreased in all areas except west Yakutat where it stayed the same in 2023 compared to 2022. The central GOA catch is the lowest in the time series while catch in the other areas were all well below the long-term mean. About 76% of the catch was in the Arrowtooth flounder fishery, 9% in the rockfish fisheries, 8% in the pollock fishery, 2% in the sablefish fishery, 1% in the Pacific cod fishery, and the remainder in other 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 for 2022 and 2023 total biomass is used from the projection model (Shotwell et al. 2021). The catch to biomass ratio for 1991-2023 has ranged from 0.0071 in 2023 to 0.024 in 2014 (Figure 7.1). The arrowtooth flounder catch/biomass ratio had been steadily increasing for most of the time series until 2021 where there was a sharp decline (Figure 7.1).

Survey Trends

The Alaska Fisheries Science Center (AFSC) GOA bottom trawl survey was conducted in 2023. The GOA arrowtooth flounder biomass estimate was 1,192,608 (t) for 2023, which was 5% higher than the 2021 survey, but still below the long-term average for the time series (Figure 7.2). Geostatistical model (vector autoregressive spatio-temporal or VAST with lognormal observation error) estimates were also provided for arrowtooth flounder from the GOA bottom trawl survey. These estimates were very similar in trend to the design-based estimates but had reduced error over most years.

Area Apportionment

The following table shows the recommended ABC apportionment for 2024 and 2025. Please refer to the *Area Allocation of Harvests* section of the last full assessment (Shotwell *et al.* 2021) for information regarding the apportionment rationale for GOA arrowtooth flounder.

		Western	Central	West Yakutat	East Yakutat	Total
Area Apportionment		25.5%	54.4%	6.6%	13.5%	100%
2024	ABC (t)	30,408	64,871	7,870	16,099	119,249
2024	OFL (t)					142,485
2025	ABC (t)	30,094	64,200	7,789	15,935	118,912
2025	OFL (t)					142,074

References

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., Hanselman, D., Siwicke, K., Spies, I. and Sullivan, J. (2022) Assessment of the arrowtooth flounder stock in the Gulf of Alaska. *In*: Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska. North Pacific Fishery Management Council, Anchorage, AK.

Shotwell, S., Spies, I., JN, I., et al. (2021) Assessment of the arrowtooth flounder stock in the Gulf of Alaska. *In*: Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska. North Pacific Fishery Management Council, Anchorage, AK.
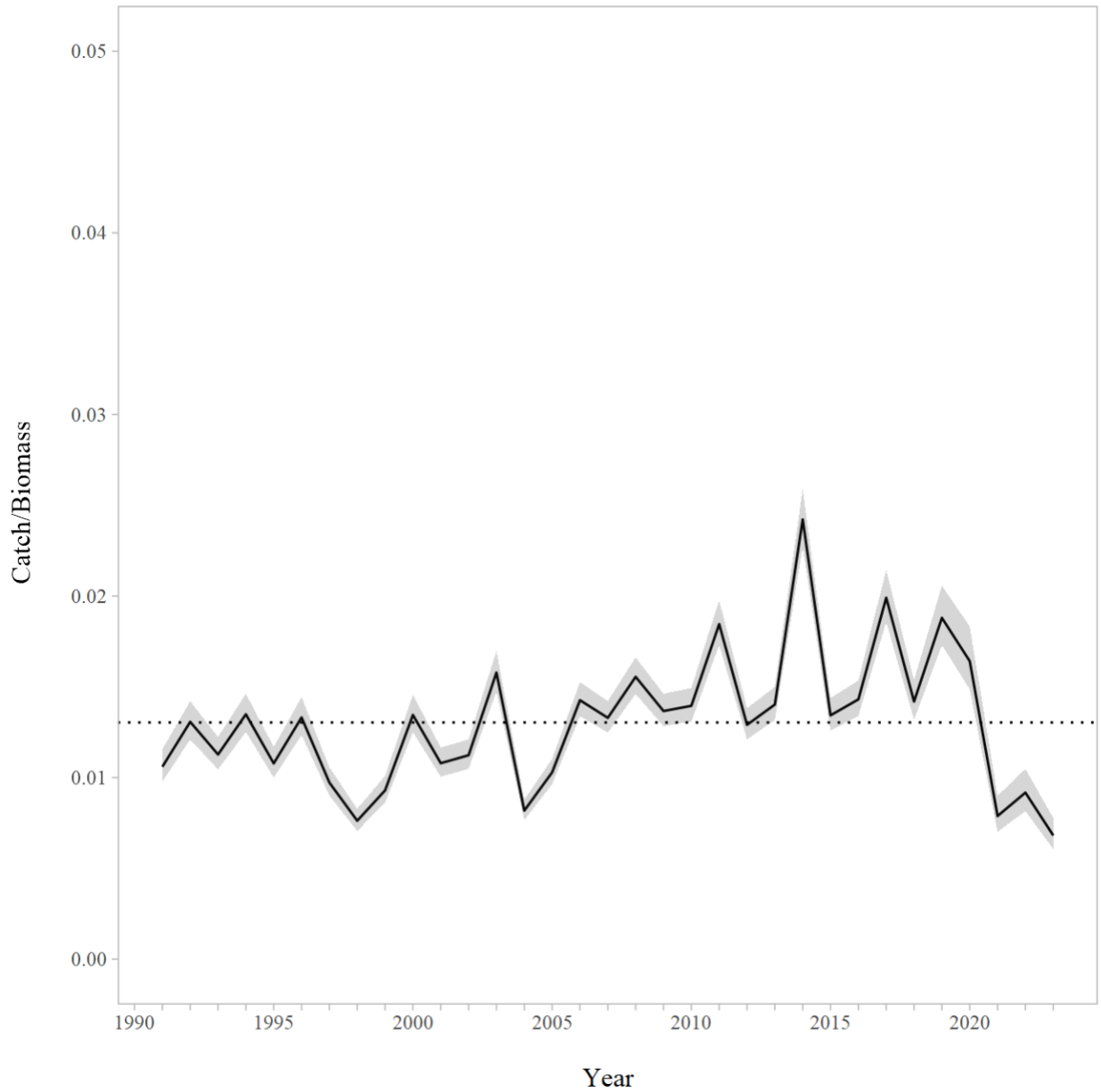
Figures

Figure 7.1. Gulf of Alaska arrowtooth catch/age 1+ biomass ratio with approximate 95% confidence intervals. Observed catch values were used for 1991-2022, the 2023 catch values were estimated using an expansion factor. The horizontal dashed line is the mean value for the entire dataset.
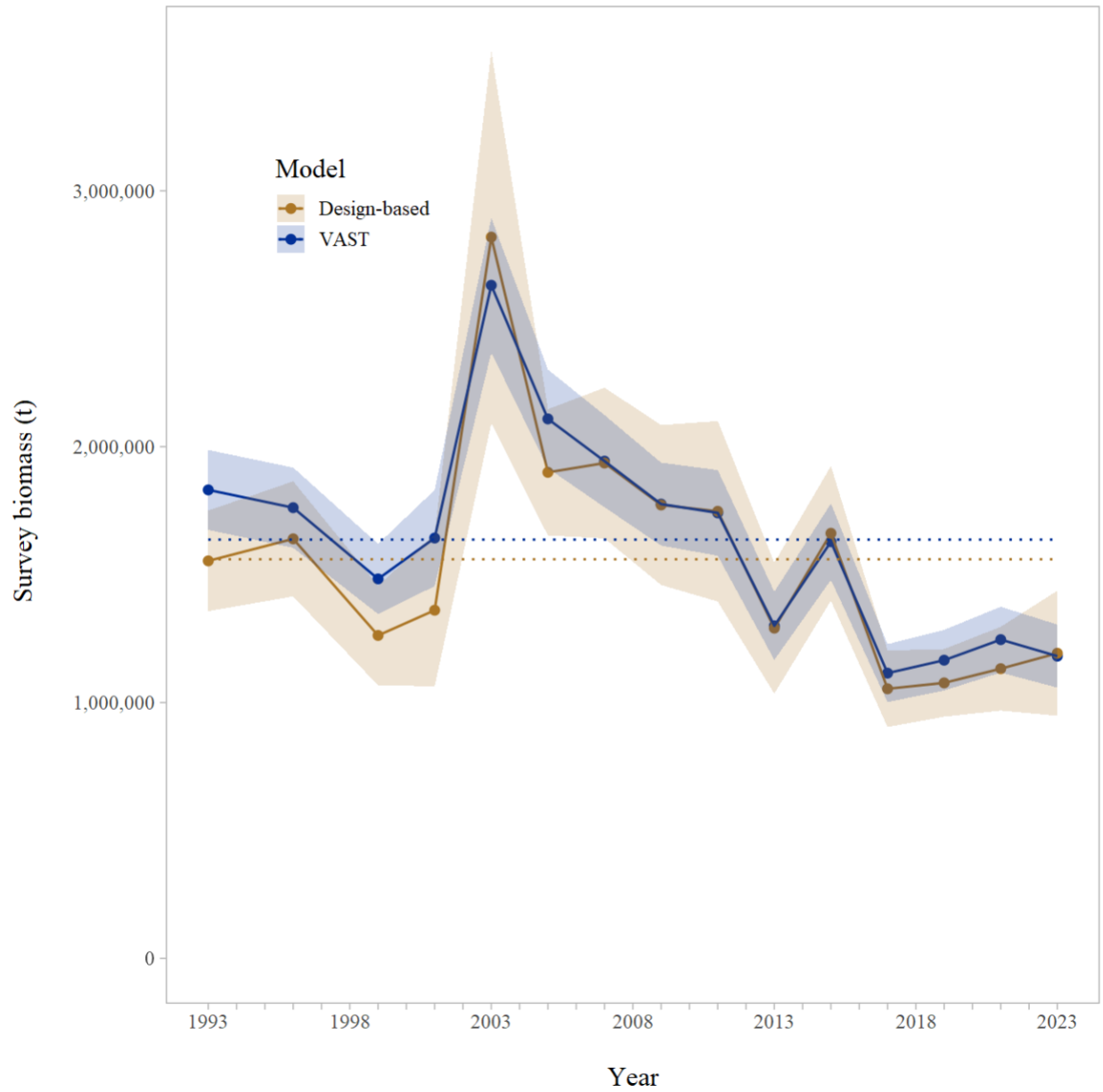
Figure 7.2. Geostatistical model (VAST) and design-based model estimates of trawl survey abundance for arrowtooth flounder in the Gulf of Alaska. Shaded areas are 95% confidence intervals, the dashed lines are the data means.