

Assessment of the Flathead Sole-Bering flounder Stock in the Bering Sea and Aleutian Islands

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Executive Summary

"Flathead sole" as currently managed by the North Pacific Fishery Management Council (NPFMC) in the Bering Sea and Aleutian Islands (BSAI) represents a two-species complex consisting of true flathead sole (*Hippoglossoides elassodon*) and its morphologically-similar congener Bering flounder (*H. robustus*). In 2012, the BSAI Groundfish Plan Team moved flathead sole to a biennial stock assessment schedule because it has historically been lightly exploited. A full stock assessment report was produced in 2020 (Monnahan and Haehn, 2020, available online at <https://apps-afsc.fisheries.noaa.gov/refm/docs/2020/BSAIfathead.pdf>). This year, a partial assessment is presented. In partial assessment years, an executive summary is presented to recommend harvest levels for the next two years, along with trends in catch and biomass.

Flathead sole is assessed using an age-structured model and Tier 3 determination. The single species projection model is run using parameter values from the accepted 2020 assessment model, together with updated catch information for 2020 and estimated catches for 2021 and 2022-2023, to predict stock status for flathead sole in 2022 and 2023 and make ABC recommendations for those years.

Summary of Changes in Assessment Inputs

Changes in input data: The updated information for this partial assessment includes replacing the estimated 2020 catch with the final catch value from the Alaska Regional Office (https://www.fisheries.noaa.gov/sites/default/files/akro/car110_goa2020.html) (9,392 t), and estimating the 2021-2023 catches. The 2021 projected catch was calculated using the current catch as of 10/28/2021 added to the average October 28 – December 31 catches over the previous 5 years (totaling 9,807 t). The 2022 and 2023 projected catches were calculated as the average catch over the years 2016-2020 (11,141 t).

Summary of Results

The ABC for the BSAI flathead Sole complex is 64,288 t in 2022 and 65,988 t in 2023 and the OFL is 77,967 t in 2022 and 80,034 t in 2023. The new ABC recommendation and OFL values are similar to those developed in 2020 for 2022 (64,119 t and 77,763 t, respectively). The principal reference values are shown in the following table.

Quantity	As estimated or <i>specified last year for:</i>		As estimated or <i>recommended this year for:</i>	
	2021	2022	2022*	2023*
	<i>M</i> (natural mortality rate)	0.2	0.2	0.2
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	602,497	608,576	608,631	612,001
Projected Female spawning biomass (t)	150,433	154,906	155,379	160,748
<i>B</i> _{100%}	203,658	203,658	203,658	203,658
<i>B</i> _{40%}	81,463	81,463	71,280	71,280
<i>B</i> _{35%}	71,280	71,280	81,463	81,463
<i>F</i> _{OFL}	0.46	0.46	0.46	0.46
<i>maxF</i> _{ABC}	0.37	0.37	0.37	0.37
<i>F</i> _{ABC}	0.37	0.37	0.37	0.37
OFL (t)	75,863	77,763	77,967	80,034
maxABC (t)	62,567	64,119	64,288	65,988
ABC (t)	62,567	64,119	64,288	65,988
Status	As determined <i>last year for:</i>		As determined <i>this year for:</i>	
	2019	2020	2020	2021
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 9,807 t used in place of maximum permissible ABC for 2021 and 11,141 t used in place of maximum permissible ABC for 2022 and 2023. The final catch for 2021 was estimated by taking the average tons caught between October 28 and December 31 over the previous 5 years (2016-2020) and adding this average amount to the catch-to-date as of October 28, 2021. The 2022 and 2023 catch was estimated as the average of the total catch in each of the last 5 years (2016-2020).

Literature Cited

Monnahan, C., and Haehn, R. 2020. 9. Assessment of the flathead sole-Bering flounder stock complex in the Bering Sea and Aleutian Islands. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, Alaska 99510.

Tables

Table 1. Catch (in tons) of flathead sole and Bering flounder combined (*Hippoglossoides* spp.), flathead sole only, and Bering flounder only in the BSAI as of October 28, 2021. Observer data on species-specific extrapolated weight in each haul was summed over hauls within each year and used to calculate the proportion of the total *Hippoglossoides* spp. catch that was flathead sole or Bering flounder. Proportions were multiplied by the total *Hippoglossoides* spp. (flathead sole and Bering flounder combined) catches reported by AKFIN to obtain total catch of flathead sole separately from that of Bering flounder. Bolded years are not used in base model.

Year	Total (<i>Hippo. spp.</i>)	Flathead sole	Bering Flounder
1964	12,315		
1965	3,449		
1966	5,086		
1967	11,218		
1968	12,606		
1969	9,610		
1970	21,050		
1971	26,108		
1972	10,380		
1973	17,715		
1974	13,198		
1975	5,011		
1976	7,565		
1977	7,909		
1978	13,864	13,734	130
1979	6,042	6,042	0
1980	8,600	8,026	574
1981	10,609	10,599	10
1982	8,417	8,397	20
1983	5,518	5,509	9
1984	4,458	4,395	63
1985	5,636	5,626	10
1987	3,595	3,479	116
1988	6,783	6,697	86
1989	3,604	3,594	10
1990	20,245	19,264	981
1991	14,197	14,176	21
1992	14,407	14,347	60
1993	13,574	13,463	111
1994	17,006	16,987	19
1995	14,715	14,710	4
1996	17,346	17,341	5
1997	20,683	20,678	5
1998	24,387	24,381	7

Year	Total (<i>Hippo. spp.</i>)	Flathead sole	Bering Flounder
1999	18,573	18,553	20
2000	20,441	20,408	33
2001	17,811	17,795	16
2002	15,575	15,550	25
2003	13,785	13,767	18
2004	17,398	17,374	24
2005	16,108	16,077	31
2006	17,981	17,975	6
2007	18,958	18,952	6
2008	24,540	24,526	14
2009	19,558	19,530	28
2010	20,127	20,101	26
2011	13,558	13,538	20
2012	11,368	11,362	6
2013	17,355	17,275	80
2014	16,512	16,479	33
2015	11,308	11,274	33
2016	10,313	10,301	12
2017	9,111	9,108	3
2018	11,007	11,001	5
2019	15,880	15,879	1
2020	9,392	9,389	3
2021*	9,609	9,696	2

*2021 catches are current as of October 29, 2021

Table 2. Survey biomass in tons and coefficient of variation (CV) of *Hippoglossoides* spp. combined (flathead sole and Bering flounder) across the entire BSAI; flathead sole only in the Aleutian Islands, *Hippoglossoides* spp. combined in the Eastern Bering Sea (EBS) shelf survey, flathead sole only in EBS shelf survey, and Bering flounder only in the EBS shelf survey. The base assessment model used a single survey index of "total" *Hippoglossoides* spp. biomass that included the EBS "standard" survey areas and AI survey areas for the years 1982-2018 (Table 2). As in the 2020 assessment, a linear regression is used to estimate a relationship between EBS shelf *Hippoglossoides* spp. survey biomass estimates and AI survey biomass estimates; this relationship is used to estimate AI survey biomass in years when no AI survey occurred (by using the linear equation to find an AI biomass estimate in a particular year based on the EBS biomass estimate for that year). There was no AI survey conducted in 2021 and AI biomass was estimated with the linear equation. The 2021 total BSAI estimate was 671,580 t, an increase over the 2019 estimate of 604,446 t. Slight discrepancies in totals may occur due to rounding. Bolded years are not included in base model.

Year	<i>Hippoglossoides</i> spp. EBS-AI Combined (used in assessment)		Aleutian Islands		<i>Hippoglossoides</i> spp. EBS Only		EBS Flathead Sole Only		EBS Bering Flounder Only	
	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV
1982	195,048	0.09			192,037	0.09	192,037	0.09	0	
1983	272,185	0.10	1,213	0.19	270,972	0.10	252,612	0.11	18,359	0.20
1984	290,513	0.08			285,849	0.08	270,794	0.09	15,054	0.21
1985	269,732	0.07			265,428	0.07	252,046	0.08	13,382	0.12
1986	363,208	0.09	5,245	0.16	357,963	0.09	344,002	0.09	13,962	0.17
1987	400,150	0.09			393,588	0.09	379,394	0.10	14,194	0.14
1988	571,393	0.08			561,868	0.09	538,770	0.09	23,098	0.22
1989	529,948	0.08			521,140	0.08	502,310	0.09	18,830	0.20
1990	603,587	0.09			593,504	0.09	574,174	0.09	19,331	0.15
1991	552,949	0.08	6,939	0.20	546,010	0.08	518,380	0.08	27,630	0.22
1992	628,857	0.10			618,338	0.11	603,140	0.11	15,198	0.21
1993	618,057	0.07			607,724	0.07	585,400	0.07	22,324	0.21
1994	700,088	0.07	9,935	0.22	690,153	0.07	664,396	0.07	25,757	0.19
1995	604,520	0.09			594,421	0.09	578,945	0.09	15,476	0.18
1996	626,947	0.09			616,460	0.09	604,427	0.09	12,034	0.20
1997	795,463	0.21	11,554	0.23	783,909	0.21	769,783	0.21	14,126	0.19
1998	695,296	0.20			683,627	0.20	675,766	0.21	7,861	0.21
1999	407,889	0.09			401,194	0.09	387,995	0.09	13,199	0.18
2000	401,723	0.09	8,906	0.23	392,817	0.09	384,592	0.09	8,225	0.19
2001	524,068	0.10			515,362	0.10	503,943	0.11	11,419	0.21
2002	563,230	0.17	9,898	0.24	553,333	0.18	548,401	0.18	4,932	0.19
2003	523,566	0.10			514,868	0.10	509,156	0.11	5,712	0.21
2004	625,587	0.08	13,298	0.14	612,289	0.09	604,186	0.09	8,103	0.31
2005	622,883	0.08			612,467	0.09	605,350	0.09	7,116	0.28
2006	644,948	0.09	9,665	0.17	635,283	0.09	621,390	0.09	13,893	0.31
2007	572,105	0.09			562,568	0.09	552,114	0.09	10,453	0.21
2008	554,706	0.14			545,470	0.14	535,359	0.14	10,111	0.19
2009	425,818	0.12			418,812	0.12	412,163	0.12	6,649	0.17
2010	507,047	0.14	11,812	0.30	495,235	0.15	488,626	0.15	6,610	0.15
2011	593,203	0.18			583,300	0.18	576,498	0.19	6,802	0.15
2012	387,043	0.11	5,566	0.15	381,477	0.12	374,842	0.12	6,635	0.14
2013	499,472	0.17			491,191	0.17	485,486	0.17	5,705	0.14
2014	532,886	0.13	13,436	0.14	519,450	0.14	509,801	0.14	9,649	0.17
2015	399,748	0.11			393,194	0.11	382,173	0.12	11,021	0.17
2016	453,060	0.07	6,759	0.15	446,300	0.07	433,469	0.07	12,831	0.23
2017	549,717	0.08			540,567	0.08	531,291	0.08	9,275	0.22
2018	495,345	0.08	6,930	0.11	488,415	0.08	484,890	0.08	3,524	0.16
2019	604,445	0.14			594,348	0.14	592,257	0.14	2,092	0.32
2021	671,580	0.11			660,321	0.12	658,632	0.12	1,688	0.31

Table 3. Northern Bering Sea survey biomass (t) and coefficient of variation (CV) for flathead sole, Bering flounder, and the two combined (*Hippoglossoides* spp.). Data accessed via Oracle database query on 05 October, 2021. These data are not included in the base model and are presented here for reference only.

Year	<i>Hippoglossoides</i> spp.		Flathead sole		Bering Flounder	
	Biomass	CV	Biomass	CV	Biomass	CV
2010	12,355	0.17			12,355	0.17
2017	19,882	0.21	79	0.65	19,803	0.21
2019	18,989	0.18	463	0.33	18,526	0.19
2021	8,522	0.21	138	0.78	8,384	0.22

Figures

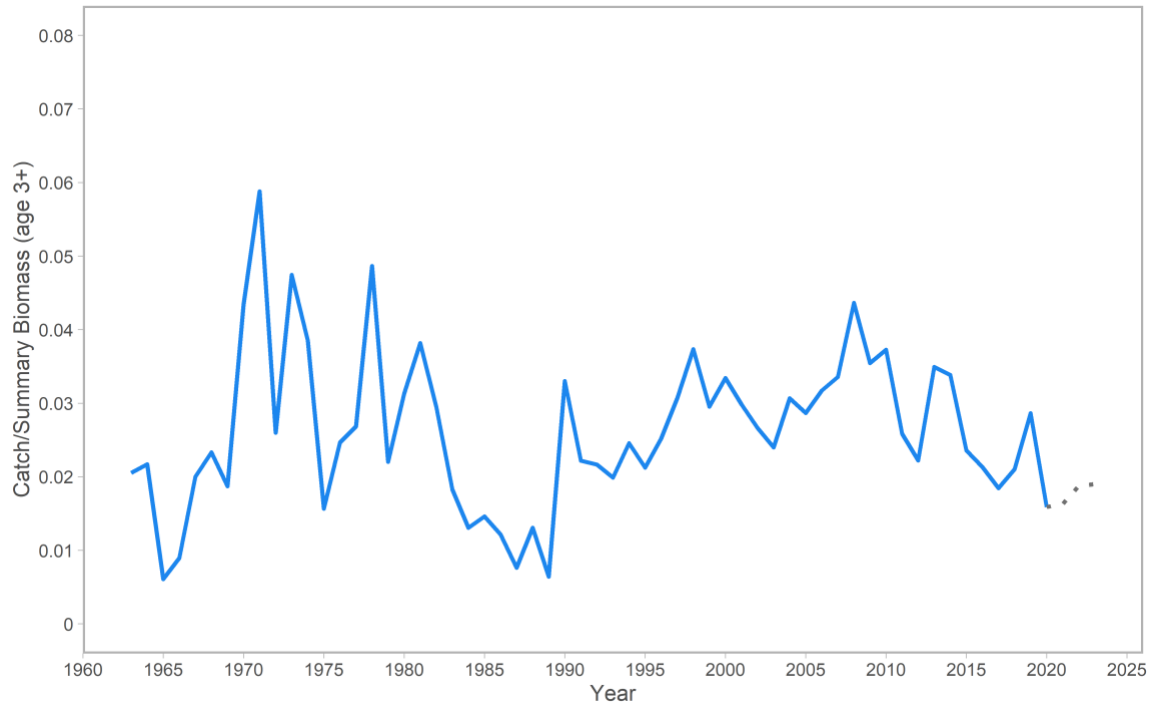


Figure 1. Catch to total biomass ratio using total biomass for age 3+ individuals for flathead sole in the Bering Sea and Aleutian Islands. Dotted grey lines represent observed catches for 2020 and projected catches for 2021-2023.

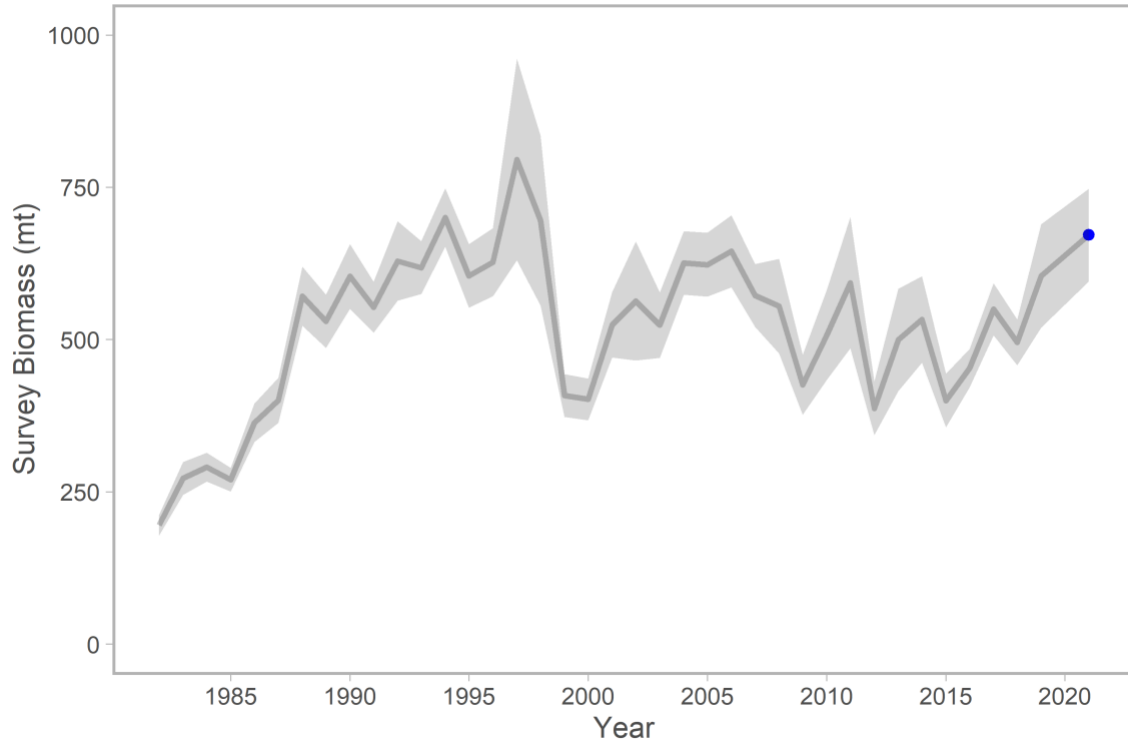


Figure 2. Survey biomass from the EBS shelf and Aleutian Islands surveys for station depths less than or equal to 200 meters. A linear regression is used to estimate a relationship between EBS shelf *Hippoglossoides spp.* survey biomass estimates and AI survey biomass estimates; this relationship is used to estimate AI survey biomass in years when no AI survey occurred (by using the linear equation to find an AI biomass estimate in a particular year based on the EBS biomass estimate for that year). Grey shading indicates ± 1 standard error. The blue point was the observed survey biomass in 2021, which is not included in the base assessment model.