5. Assessment of the Deepwater Flatfish Stock Complex in the Gulf of Alaska

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Executive Summary

Introduction

The Gulf of Alaska deepwater flatfish complex is assessed every four years and was last assessed in 2019. In years without an assessment, we present an executive summary to recommend harvest levels for the next two years. Please refer to the 2019 full stock assessment report for further information regarding the assessment model (McGilliard and Palsson, 2019, available online at https://apps-afsc.fisheries.noaa.gov/refm/docs/2019/GOAdeepflat.pdf). A full stock assessment document with updated assessment and projection model results will be presented in 2023.

The deepwater flatfish complex consists of Dover sole, Greenland turbot, and deepsea sole. The catch of Kamchatka flounder in the GOA is recorded as deepwater flatfish in the AKRO Catch Accounting System, but has not been assessed, assigned a Tier, or included in species-level calculations of the deepwater flatfish ABC in the past. The catch time series for Kamchatka flounder dates back to 2011, when it was separated from arrowtooth flounder in catch accounting and arrowtooth flounder was removed from the deepwater flatfish complex. In 2019 the GOA Plan Team and SSC recommended assigning Kamchatka flounder a species-level OFL of 69 t (the maximum historical catch) as part of the deepwater flatfish complex. Here we present specification tables with Kamchatka flounder and include specification tables without Kamchatka flounder in the Appendix.

Dover sole is assessed using an age-structured model and Tier 3 determination. Thus, the single species projection model was run using parameter values from the accepted 2019 Dover sole assessment model (McGilliard and Palsson 2019), together with updated catch information for 2019-2021, to predict stock status for Dover sole in 2022 and 2023 and to make ABC recommendations for those years. Projections are conducted using numbers-at-age for Dover sole from age 3-59+ and historical recruitment of age 3 individuals from 1978-2019 to calculate OFL's and ABC's. Greenland turbot and deepsea sole fall under Tier 6. ABC's and OFL's for Tier 6 species are based on historical catch levels (average catch over the years 1978-1995) and therefore these quantities cannot be updated. ABC's and OFL's for the individual species in the deepwater flatfish complex are determined only as an intermediate step for the purpose of calculating complex-level OFL's and ABC's.

Summary of Results

As in previous years (McGilliard and Palsson 2019), the species-level ABC is 179 t for Greenland turbot and the OFL is 238 t for both 2022 and 2023. The species-level ABC for deepsea sole is 4 t and the OFL is 6 t for both 2022 and 2023. The species-level ABC for Dover sole is 5,673 t in 2022 and 5,583 t in 2023 and the OFL is 6,713 t in 2022 and 6,607 t in 2023.

Based on the updated projection model results, the recommended complex-level ABC's for 2022 and 2023 are 5,856 t and 5,766 t, and the OFL's are 6,957 t and 6,851 t. The new ABC recommendation and OFL for 2022 are similar to those developed in 2019 and used in 2020 (5,856 t and 5,766 t). The principal reference values are shown in the following table:

Species	Quantity	As estimated or *specified last* year for: 2021	2022	As estimated or *recommended this* year for: 2022*	2023
Dover sole	*M* (natural mortality rate)	0.113(f), 0.119(m)	0.113(f), 0.119(m)	0.113(f), 0.119(m)	0.113(f), 0.119(m)
	Tier	3a	3a		
	Projected total (3+) biomass (t)	84,771		83,131	81,350
	Projected Female spawning biomass (t)	27,011		26,349	25,727
	$B_{100\%}$	19,032	19,032	19,032	19,032
	$B_{40\%}$	7,613	7,613	7,613	7,613
	$B_{35\%}$	6,661	6,661	6,661	6,661
	F_{OFL}	0.11	0.11	0.11	0.11
	$maxF_{ABC}$	0.09	0.09	0.09	0.09
	F_{ABC}	0.09	0.09	0.09	0.09
	OFL (t)	6,796	6,796	6,713	6,607
	maxABC (t)	5,743	5,743	5,673	5,583
	ABC (t)	5,743	5,743	5,673	5,583
Greenland turbot	Tier	6	6	6	6
	OFL (t)	238	238	238	238
	maxABC (t)	179	179	179	179
	ABC (t)	179	179	179	179
Kamchatka flounder	Tier			6	6
	OFL (t)			69	69
	maxABC (t)			52	52
	ABC (t)			52	52
Deepsea sole	Tier	6	6	6	6
	OFL (t)	6	6	6	6
	maxABC (t)	4	4	4	4
	ABC (t)	4	4	4	4
Deepwater Flatfish Complex	OFL (t)	7,040	7,040	7,026	6,920
	maxABC (t)	5,926	5,926	5,908	5,818
	ABC (t)	5,926	5,926	5,908	5,818
	Status	As determined *last* year for: 2019	2020	As determined *this* year for: 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 realized catches of 92 t and 97 t used in place of maximum permissible ABC for 2019 and 2020. Estimated catches of 97 t, 151 t, and 151 t were used in place of maximum permissible ABC for 2021, 2022, and 2023, respectively. The 2021 projected catch was calculated as the current catch as of September 26, 2021 added to the average September 26 – December 31 catches over the 5 previous years. The 2022-2023 projected catch was calculated as the average catch over the previous 5 years.

Area Apportionment

Area apportionment for ABC of deepwater flatfish is currently based on the proportion of survey biomass of Greenland Turbot, Kamchatka flounder, and deepsea sole found within each management area from 2001-2021 and estimates of 2022 and 2023 survey biomass for Dover sole in each management area based on results from the random effects model. An ABC exists only at the level of the complex (deepwater flatfish) and not for each species individually. The ABC by area for the deepwater flatfish complex is then the sum of the species-specific portions of the ABC.

The random effects model is used to fill in depth and area gaps in the Dover sole survey biomass by area and to calculate an area- and depth-specific estimate of 2022 and 2023 survey biomass. These estimates are summed over depths and the resulting relative biomass in each management area is used as the basis for apportionment of the Dover sole portion of the deepwater complex. This method of conducting area apportionment for deepwater flatfish was recommended by the GOA Plan Team in 2016 (McGilliard 2016). The method was chosen because it accounts for time and area gaps in the survey for Dover sole, which comprises nearly all of the deepwater flatfish catch and moves to deeper waters ontogenetically, and explicitly accounts for differences in the spatial distributions of the component species. For instance, Greenland turbot are found exclusively in the Western region by the survey.

Species	Year	Western	Central	West Yakutat	Southeast	Total
		0.8%	37.3%	25.2%	36.7%	100.0%
Dover Sole	2022	45	2,116	1,430	2,082	5,673
	2023	45	2,082	1,407	2,049	5,583
		100.0%	0.0%	0.0%	0.0%	100.0%
Greenland Turbot	2022	179	0	0	0	179
	2023	179	0	0	0	179
		62.0%	38.0%			100.0%
Kamchatka Flounder	2022	32	20	0	0	52
	2023	32	20	0	0	52
		0.6%	71.8%	14.7%	12.9%	100.0%
Deepsea Sole	2022	0	3	1	0	4
	2023	0	3	1	0	4
Deepwater Flatfish	**2022**	**256**	**2,139**	**1,431**	**2,082**	**5,908**
	2023	**256**	**2,105**	**1,408**	**2,049**	**5,818**

Figures

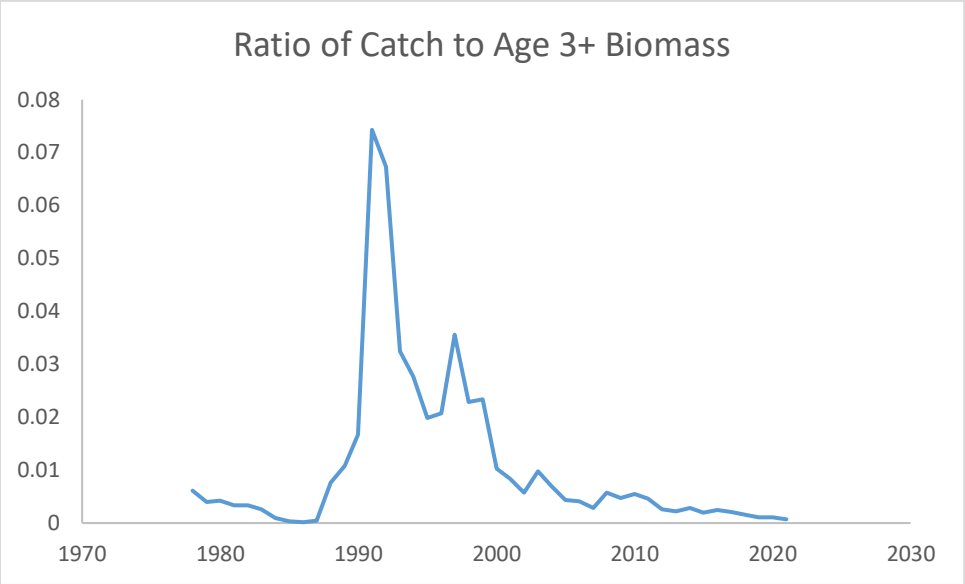

Figure 1. Ratio of catch to age 3+ biomass for Dover sole and unidentified species together (catches of Dover sole in the assessment are assumed to be those recorded as Dover and unidentified deepwater flatfish). The two highest historical catches (1991-1992) are recorded as unidentified deepwater flatfish.

Tables

Table 1. Total catch of species in the deepwater flatfish complex as of Nov 5, 2021.

Year	Greenland turbot	Dover sole	Unidentified	Total
1978	51	827		878
1979	24	530		554
1980	57	570		627
1981	8	457		465
1982	23	457		480
1983	145	354		499
1984	18	132		150
1985	0	43		43
1986	0	23		23
1987	44	56		100
1988	256	1,087		1,343
1989	56	1,521		1,577
1990	0	2,348		2,348
1991			10,196	10,196
1992			8,497	8,497
1993	19	1,869	1,935	6,706
1994	3	2,538	537	3,078
1995	78	1,416	721	2,215
1996	6	1,485	704	2,195
1997	3	2,676	996	3,674
1998	10	2,111	168	2,289
1999	6	1,833	447	2,285
2000	5	813	167	985
2001	4	654	146	804
2002	4	411	146	560
2003	3	899	51	902
2004	1	646	41	647
2005	1	378	41	379
2006	10	327	74	337
2007	1	235	47	236
2008	4	517	53	521
2009	0	435	42	435
2010	0	546		546

Year	Greenland turbot	Dover sole	Kamchatka Flounder	Total
2011	3	453	12	467
2012	0	260	4	265
2013	15	216	15	245
2014	3	284	69	356
2015	26	198	35	259
2016	4	231	5	240
2017	8	188	67	263
2018	3	144	40	186
2019	7	92	12	111
2020	0	97	11	108
2021	10	61	18	89

Table 2. Survey biomass for each of the component species in the deepwater flatfish complex.

Year	Dover sole	Greenland turbot	Kamchatka flounder	deepsea sole
1990	96,597	-	-	-
1993	85,557	-	-	-
1996	79,531	-	197	-
1999	74,245	-	90	97
2001	32,424	-	33	52
2003	99,297	109	125	180
2005	80,560	-	10	262
2007	71,469	122	-	270
2009	76,277	-	4	249
2011	77,531	-	10	41
2013	82,739	-	-	74
2015	53,069	-	117	453
2017	58,307	-	11	31
2019	47,983	-	8	122
2021	46,079	-	6	173

Literature Cited

McGilliard, C.R. and Palsson, W. 2019. 5. Gulf of Alaska Deepwater Flatfish. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. pp. 649-656. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage AK 99510.

McGilliard, C.R. and Palsson, W. 2015. 5. Gulf of Alaska Deepwater Flatfish. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. pp. 563-624. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage AK 99510.

Appendix

Below are executive summary tables and area apportionment tables excluding Kamchatka flounder, as has been done in previous deepwater flatfish SAFE reports.

Species	Quantity	As estimated or *specified last* year for: 2021	2022	As estimated or *recommended this* year for: 2022*	2023
Dover sole	*M* (natural mortality rate)	0.113(f), 0.119(m)	0.113(f), 0.119(m)	0.113(f), 0.119(m)	0.113(f), 0.119(m)
	Tier	3a	3a		
	Projected total (3+) biomass (t)	84,771		83,131	81,350
	Projected Female spawning biomass (t)	27,011		26,349	25,727
	$B_{100\%}$	19,032	19,032	19,032	19,032
	$B_{40\%}$	7,613	7,613	7,613	7,613
	$B_{35\%}$	6,661	6,661	6,661	6,661
	F_{OFL}	0.11	0.11	0.11	0.11
	$maxF_{ABC}$	0.09	0.09	0.09	0.09
	F_{ABC}	0.09	0.09	0.09	0.09
	OFL (t)	6,796	6,796	6,713	6,607
	maxABC (t)	5,743	5,743	5,673	5,583
	ABC (t)	5,743	5,743	5,673	5,583
Greenland turbot	Tier	6	6	6	6
	OFL (t)	238	238	238	238
	maxABC (t)	179	179	179	179
	ABC (t)	179	179	179	179
Deepsea sole	Tier	6	6	6	6
	OFL (t)	6	6	6	6
	maxABC (t)	4	4	4	4
	ABC (t)	4	4	4	4
Deepwater Flatfish Complex	OFL (t)	7,040	7,040	6,957	6,851
	maxABC (t)	5,926	5,926	5,856	5,766
	ABC (t)	5,926	5,926	5,856	5,766
	Status	As determined *last* year for: 2019	2020	As determined *this* year for: 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 realized catches of 92 t and 97 t used in place of maximum permissible ABC for 2019 and 2020. Estimated catches of 97 t, 151 t, and 151 t were used in place of maximum permissible ABC for 2021, 2022, and 2023, respectively. The 2021 projected catch was calculated as the current catch as of September 26, 2021

added to the average September 26 – December 31 catches over the 5 previous years. The 2022-2023 projected catch was calculated as the average catch over the previous 5 years.

Area apportionment excluding Kamchatka flounder:

Species	Year	Western	Central	West Yakutat	Southeast	Total
		0.81%	37.31%	25.21%	36.68%	100.0%
Dover Sole	2022	46	2,117	1,430	2,080	5,673
	2023	45	2,083	1,407	2,048	5,583
		100.0%	0.0%	0.0%	0.0%	100.0%
Greenland Turbot	2022	179	0	0	0	179
	2023	179	0	0	0	179
						0.0%
Kamchatka Flounder	2022	0	0	0	0	
	2023	0	0	0	0	
		0.6%	71.8%	14.7%	12.9%	100.0%
Deepsea Sole	2022	0	3	1	0	4
	2023	0	3	1	0	4
Deepwater Flatfish	**2022**	**225**	**2,120**	**1,431**	**2,080**	**5,856**
	2023	**224**	**2,086**	**1,408**	**2,048**	**5,766**