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 (consisting of Dover sole, Greenland turbot, and deepsea sole) is assessed every four years and was last assessed in 2015. In other years, we present an executive summary to recommend harvest levels for the next two years. Please refer to the 2015 full stock assessment report for further information regarding the assessment model (McGilliard and Palsson, 2015, available online at http://www.afsc.noaa.gov/REFM/Docs/2015/GOAdeepflat.pdf). A full stock assessment document with updated assessment and projection model results will be presented in 2019.

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 2015 Dover sole assessment model (McGilliard and Palsson 2015), together with updated catch information for 2015-2017, to predict stock status for Dover sole in 2018 and 2019 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 is used 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 2016), the species-level ABC is 179 t for Greenland turbot and the OFL is 238 t for both 2018 and 2019. The species-level ABC for deepsea sole is 4 t and the OFL is 6 t for both 2018 and 2019. The species-level ABC for Dover sole is 9,202 t in 2018 and 9,316 t in 2019 and the OFL is 11,050 t in 2018 and 11,187 t in 2019.

Based on the updated projection model results, the recommended complex-level ABC's for 2018 and 2019 are 9,385 t and 9,499 t, and the OFL's are 11,294 t and 11,431 t. The new ABC recommendation and OFL for 2017 are similar to those developed in 2016 (9,382 t and 11,290 t). The principal reference values are shown in the following table:

Species	Quantity	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
		2017	2018	2018*	2019*
Dover sole	*M* (natural mortality rate)	0.085	0.085	0.085	0.085
	Tier	3a	3a	3a	3a
	Projected total (3+) biomass (t)	143,333	144,611	144,654	145,899
	Projected Female spawning biomass (t)	49,331	49,347	49,366	49,373
	$B_{100\%}$	57,871	57,871	57,871	57,871
	$B_{40\%}$	23,148	23,148	23,148	23,148
	$B_{35\%}$	20,255	20,255	20,255	20,255
	F_{OFL}	0.12	0.12	0.12	0.12
	$maxF_{ABC}$	0.1	0.1	0.1	0.1
	F_{ABC}	0.1	0.1	0.1	0.1
	OFL (t)	10,938	11,046	11,050	11,187
	maxABC (t)	9,109	9,199	9,202	9,316
	ABC (t)	9,109	9,199	9,202	9,316
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)	11,182	11,290	11,294	11,431
	maxABC (t)	9,292	9,382	9,385	9,499
	ABC (t)	9,292	9,382	9,385	9,499
	Status	As determined in 2016 for:		As determined in 2017 for:	
		2015	2016	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 232 t and 265 t used in place of maximum permissible ABC for 2017 and 2018-2019, respectively. The 2017 projected catch was calculated as the current catch as of October 8, 2017 added to the average October 8 – December 31 catches over the 5 previous years. The 2018-2019 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 and deepsea sole found within each management area from 2001-2017 and an estimate of 2018-2019 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 2018 and 2019 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 Dover sole and Greenland turbot. Greenland turbot were found exclusively in the Western region by the survey over the period 2001-2015.

Species	Year	Western	Central	West Yakutat	Southeast	Total
		2.5%	36.9%	35.2%	25.3%	100.0%
Dover Sole	2018	234	3,397	3,238	2,332	9,202
	2019	237	3,439	3,278	2,361	9,316
		100.0%	0.0%	0.0%	0.0%	100.0%
Greenland Turbot	2018	179	0	0	0	179
	2019	179	0	0	0	179
		0.7%	72.9%	15.3%	11.0%	100.0%
Deepsea Sole	2018	0	3	1	0	4
	2019	0	3	1	0	4
Deepwater Flatfish	**2018**	**413**	**3,400**	**3,239**	**2,332**	**9,385**
	2019	**416**	**3,442**	**3,279**	**2,361**	**9,499**

Figures

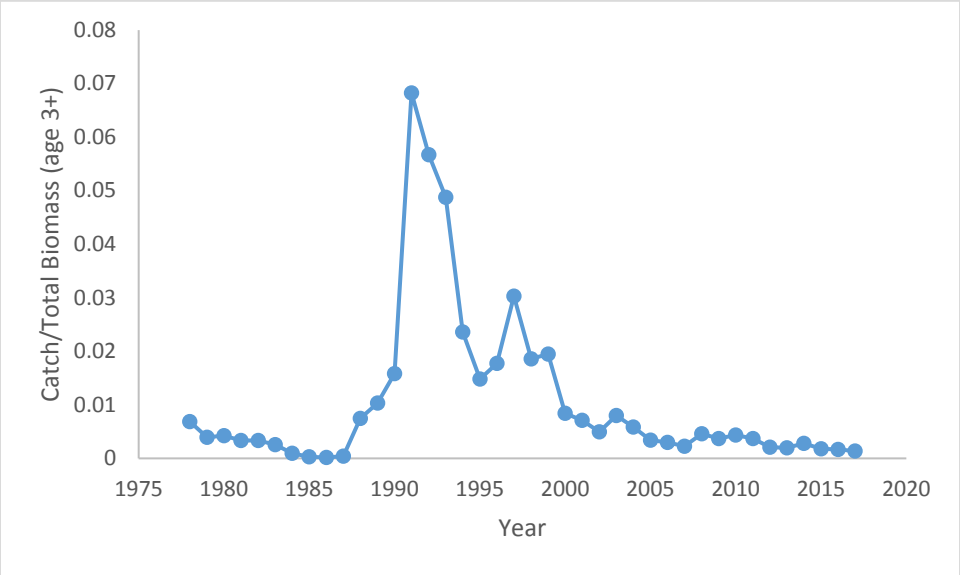

Figure 1. Catch:total biomass ratio using total biomass for age 3+ individuals for Dover sole only.

Tables

Table 1. Total catch of Dover sole, deepsea sole, and Greenland turbot and for the deepwater flatfish complex in total. Catch for 2017 is current up to October 8, 2017.

Year	Dover Sole	Deepsea Sole	Greenland Turbot	Total
1978	827	5	51	883
1979	530	5	24	559
1980	570	2	57	629
1981	457	8	8	473
1982	457	31	23	511
1983	354	11	145	510
1984	132	1	18	151
1985	43	3	0	46
1986	23	0	0	23
1987	56	0	44	100
1988	1,087	0	256	1,343
1989	1,521	0	56	1,577
1990	2,348	30	0	2,378
1991	10,067	1	127	10,196
1992	8,266	3	226	8,495
1993	6,675	6	24	6,706
1994	3,040	3	34	3,077
1995	1,865	1	345	2,211
1996	2,177	0	13	2,191
1997	3,642	1	16	3,659
1998	2,210	37	39	2,286
1999	2,261	0	22	2,283
2000	964	1	16	981
2001	801	0	2	804
2002	550	0	8	559
2003	934	0	17	951
2004	685	1	1	686
2005	413	0	5	418
2006	364	4	38	406
2007	281	0	0	281
2008	570	0	3	573
2009	466	7	3	476
2010	545	0	0	545
2011	465	0	1	466
2012	261	0	0	262
2013	240	1	1	242
2014	340	1	14	355
2015	251	1	4	256
2016	234	2	2	238
2017	198	1	2	200

Table 2. Dover sole survey biomass by area and depth. Depth is reported as maximum depth in meters (e.g. “200” indicates depths of 101-200 m).

Year	Depth	Western	Central	Eastern	Total
1984		**4,460**	**52,469**	**11,592**	**68,521**
	100	34	1,870	925	2,829
	200	725	24,506	4,989	30,220
	300	355	5,598	1,975	7,928
	500	1,138	4,039	1,645	6,822
	700	1,290	5,147	1,728	8,166
	1000	919	11,309	330	12,557
1987		**2,623**	**34,577**	**26,194**	**63,394**
	100	5	1,260	3,137	4,401
	200	108	12,728	12,995	25,831
	300	32	8,587	3,419	12,039
	500	1,103	3,706	4,126	8,934
	700	1,267	6,757	2,518	10,542
	1000	108	1,539		1,647
1990		**1,649**	**71,109**	**23,839**	**96,597**
	100	161	11,233	896	12,290
	200	716	42,188	14,869	57,774
	300	50	15,644	4,290	19,985
	500	721	2,043	3,784	6,549
1993		**2,379**	**43,515**	**39,664**	**85,557**
	100	180	3,937	651	4,768
	200	1,044	24,054	18,901	43,999
	300	154	10,883	8,893	19,930
	500	1,001	4,640	11,219	16,861
1996		**1,458**	**37,144**	**40,928**	**79,531**
	100	134	1,674	4,753	6,561
	200	337	21,452	16,066	37,856
	300	290	8,691	9,121	18,101
	500	698	5,327	10,988	17,013
1999		**1,442**	**34,155**	**38,648**	**74,245**
	100	7	3,619	2,806	6,431
	200	56	14,068	14,425	28,549
	300	43	8,085	11,448	19,576
	500	651	4,779	6,887	12,317
	700	685	2,889	2,476	6,049
	1000	0	716	606	1,323
2001		**895**	**31,529**		**32,424**
	100	18	3,785		3,803
	200	53	16,241		16,294
	300	188	7,303		7,491
	500	636	4,200		4,836
2003		**3,149**	**49,283**	**46,865**	**99,297**
	100	194	2,842	7,119	10,154
	200	541	23,005	21,636	45,181
	300	270	10,070	7,491	17,832
	500	811	4,629	8,153	13,593
	700	1,333	8,738	2,466	12,537
2005		**2,832**	**38,881**	**38,847**	**80,560**
	100	475	4,255	1,924	6,654

	200	468	19,805	12,340	32,613
	300	275	6,691	10,732	17,697
	500	455	4,742	12,577	17,774
	700	312	1,617	1,206	3,134
	1000	848	1,772	69	2,689
2007		**2,325**	**43,404**	**25,740**	**71,469**
	100	78	1,748	903	2,728
	200	405	22,417	6,887	29,709
	300	110	9,543	9,945	19,598
	500	468	4,437	6,430	11,335
	700	208	3,604	1,298	5,109
	1000	1,056	1,655	278	2,989
2009		**5,067**	**35,820**	**35,389**	**76,277**
	100	154	2,372	4,008	6,534
	200	565	15,668	10,253	26,486
	300	88	12,619	10,979	23,685
	500	548	3,158	5,595	9,300
	700	3,712	1,769	4,144	9,625
	1000	0	236	411	646
2011		**833**	**35,548**	**41,150**	**77,531**
	100	235	1,810	2,377	4,422
	200	146	14,528	10,065	24,739
	300	8	15,131	11,102	26,241
	500	134	2,578	16,704	19,416
	700	311	1,501	902	2,714
2013		**979**	**23,180**	**58,580**	**82,739**
	100	0	1,196	23,355	24,551
	200	627	7,789	7,928	16,344
	300	126	9,896	11,178	21,201
	500	84	2,026	14,994	17,104
	700	142	2,273	1,125	3,540
2015		**336**	**20,067**	**32,667**	**53,069**
	100	0	730	2,094	2,824
	200	85	7,284	10,225	17,594
	300	34	6,044	5,254	11,332
	500	157	2,885	12,796	15,838
	700	60	1,222	2,256	3,538
	1000	0	1,901	42	1,943
2017		**260**	**20,495**	**37,552**	**58,307**
	100	37	170	678	885
	200	134	7,753	20,583	28,470
	300	62	10,143	5,475	15,680
	500	27	1,663	10,398	12,089
	700	0	765	419	1,184

Literature Cited

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