

6. Assessment of the Rex Sole Stock in the Gulf of Alaska

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Executive Summary

Introduction

The Gulf of Alaska rex sole stock is assessed every four years and was last assessed in 2017. In between the full assessment years, we present an executive summary to recommend harvest levels for the next two years. Please refer to the 2017 full stock assessment report for further information regarding the assessment model (McGilliard and Palsson, 2017, available online at <https://www.afsc.noaa.gov/REFM/Docs/2017/GOArex.pdf>). A full stock assessment document with updated assessment and projection model results will be presented in 2021.

Rex sole is assessed using an age-structured model and Tier 3 determination within the context of a two-area model. The Western-Central GOA and Eastern GOA are modeled as separate areas with distinct growth patterns estimated by area. Thus, the single species projection model was run separately for the two areas using parameter values from the accepted 2017 rex sole assessment model (McGilliard and Palsson 2017), together with updated catch information for 2017-2018, to predict stock status for rex sole in 2019 and 2020 and to make ABC recommendations for those years. Projections are conducted using numbers-at-age for rex sole from age 3-20+ by area and historical recruitment of age 3 individuals by area to calculate OFL's and ABC's.

Summary of Results

Based on the updated projection model results, the recommended ABC's for 2019 and 2020 in the Western-Central GOA are 11,308 t and 11,327 t, and the OFL's are 13,755 t and 13,788 t. The new ABC recommendation and OFL for the Western-Central GOA in 2019 are similar to those developed in 2018 (11,145 t and 13,558 t). The recommended ABC's for 2019 and 2020 in the Eastern GOA are 3,384 t and 3,398 t, and the OFL's are 4,134 t and 4,154 t. The new ABC recommendation and OFL for the Eastern GOA in 2019 are exactly the same as those developed in 2018 because realized and projected catches as estimated last year and this year were less than 2 t. The principal reference values are shown in the following three tables. The first table shows quantities for the entire GOA, the second table shows quantities for the Western-Central GOA, and the third table shows quantities for the Eastern GOA. The Western-Central and Eastern GOA are based on a Tier 3a approach, and the entire GOA table is simply the sum of the two areas.

Quantity	As estimated or <i>specified this year for:</i>		As estimated or <i>recommended this year for:</i>	
	2018	2019	2019*	2020*
<i>M</i> (natural mortality rate)	0.17	0.17	0.17	0.17
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	97,982	97,967	98,818	99,383
Female spawning biomass (t)	45,750	43,575	44,072	43,392
<i>B</i> _{100%}	See area-specific tables below		See area-specific tables below	
<i>B</i> _{40%}				
<i>B</i> _{35%}				
<i>F</i> _{OFL}				
<i>maxF</i> _{ABC}				
<i>F</i> _{ABC}				
OFL (t)	18,706	17,692	17,889	17,942
maxABC (t)	15,373	14,529	14,692	14,725
ABC (t)	15,373	14,529	14,692	14,725
Status	As determined <i>last</i> year for:		As determined <i>this</i> year for:	
	2016	2017	2017	2018
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

Quantity: (Western-Central GOA)	As estimated or specified this year for:		As estimated or recommended this year for:	
	2018	2019	2019*	2020*
M (natural mortality rate)	0.17	0.17	0.17	0.17
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	76,644	76,631	77,483	77,939
Female spawning biomass (t)	36,374	34,569	35,066	34,484
$B_{100\%}$	48,138	48,138	48,138	48,138
$B_{40\%}$	19,255	19,255	19,255	19,255
$B_{35\%}$	16,848	16,848	16,848	16,848
F_{OFL}	0.29	0.29	0.29	0.29
$maxF_{ABC}$	0.23	0.23	0.23	0.23
F_{ABC}	0.23	0.23	0.23	0.23
OFL (t)	14,375	13,558	13,755	13,788
maxABC (t)	11,825	11,145	11,308	11,327
ABC (t)	11,825	11,145	11,308	11,327
Status	As determined last year for:		As determined this year for:	
	2016	2017	2017	2018
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 the final catch of 2017 from the Western and Central GOA of 1,483 t and estimated catches of 1,673 t and 2,494 t that were used in place of maximum permissible ABC for 2018 and 2019, respectively. The 2018 projected catch was calculated as the current catch of GOA rex sole in the Western and Central GOA as of October 6, 2018 added to the average October 6 – December 31 GOA rex sole catches over the 5 previous years. The 2019-2020 projected catch was calculated as the average catch over the previous five years.

Quantity: (Eastern GOA)	As estimated or <i>specified this year for:</i>		As estimated or <i>recommended this year for:</i>	
	2018	2019	2019*	2020*
<i>M</i> (natural mortality rate)	0.17	0.17	0.17	0.17
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	21,338	21336	21,335	21,444
Female spawning biomass (t)	9,376	9,006	9,006	8,908
<i>B</i> _{100%}	9,597	9,597	9,597	9,597
<i>B</i> _{40%}	3,839	3,839	3,839	3,839
<i>B</i> _{35%}	3,359	3,359	3,359	3,359
<i>F</i> _{OFL}	0.31	0.31	0.31	0.31
<i>maxF</i> _{ABC}	0.25	0.25	0.25	0.25
<i>F</i> _{ABC}	0.25	0.25	0.25	0.25
OFL (t)	4,331	4,134	4,134	4,154
maxABC (t)	3,548	3,384	3,384	3,398
ABC (t)	3,548	3,384	3,384	3,398
Status	As determined <i>last</i> year for:		As determined <i>this</i> year for:	
	2016	2017	2017	2018
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 the final catch of 2017 from the Eastern GOA of 1.8 t and estimated catches of 1.8 t and 1.2 t that were used in place of maximum permissible ABC for 2018 and 2019, respectively. The 2018 projected catch was calculated as the current catch of GOA rex sole in the Eastern GOA as of October 6, 2018. The 2019-2020 projected catch was calculated as the average catch over the previous five years. In many years catches from the Eastern GOA are small and confidential.

Area Apportionment

The table below shows apportionment of the 2019 and 2020 ABCs among areas. The ABCs calculated for the Western-Central area (based on model estimates) are apportioned based on random effects model predictions of the proportion of Western-Central survey biomass in the Western and Central areas, respectively, in 2019-2020. Likewise, the ABC calculated for the Eastern area (based on model estimates) are apportioned based on random effects model predictions of the proportion Eastern survey biomass in the West Yakutat and Southeast areas, respectively.

Quantity	Western	Central	Total Western-Central	West Yakutat	Southeast	Total Eastern
Area Apportionment	26.10%	73.90%	100.00%	48.96%	51.04%	100.00%
2019 ABC (t)	2,951	8,357	11,308	1,657	1,727	3,384
2020 ABC (t)	2,956	8,371	11,327	1,664	1,734	3,398

Figures

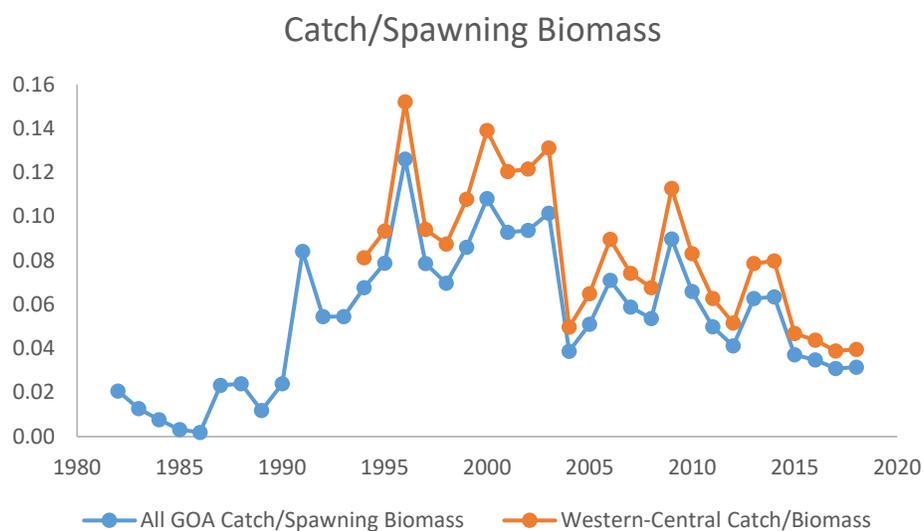


Figure 1. GOA rex sole catch:female spawning biomass ratio using spawning biomass for the entire GOA (blue line) and for the Western-Central region (orange line).

Tables

Table 1. Fishery catches for GOA rex sole by management area. Catch for 2018 is through October 6, 2018.

Year	Total Catch	Western Gulf	Central Gulf	Eastern Gulf
1982	959			
1983	595			
1984	365			
1985	154			
1986	93			
1987	1151			
1988	1192			
1989	599			
1990	1269			
1991	4636			
1992	3000			
1993	3000			
1994	3642	49	3508	85
1995	4021	220	3628	174
1996	5945	552	5202	191
1997	3296	681	2438	177
1998	2671	440	2195	36
1999	3059	603	2393	63
2000	3592	883	2702	Confidential
2001	2943	435	2507	Confidential
2002	3017	398	2619	Confidential
2003	3499	772	2726	2
2004	1467	527	940	0
2005	2180	576	1603	Confidential
2006	3295	350	2944	0
2007	2851	411	2438	1
2008	2707	185	2522	Confidential
2009	4753	342	4410	1
2010	3633	134	3498	2
2011	2877	131	2745	1
2012	2443	215	2228	Confidential
2013	3707	104	3603	0
2014	3577	126	3450	1
2015	1957	76	1881	Confidential
2016	1748	172	1574	3
2017	1483	48	1433	Confidential
2018	1444	48	1394	2

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

	Regulatory Area			
	Central	Eastern	Western	Total
1984	40,688	13,311	6,672	60,670
1	1,423	2,235	329	3,987
101	26,777	7,519	2,744	37,040
201	8,557	2,041	2,485	13,083
301	2,900	1,223	1,038	5,161
501	689	292	76	1,057
701	342	0	0	342
1987	39,722	15,304	8,801	63,826
1	2,504	2,246	941	5,691
101	24,515	9,351	6,379	40,244
201	11,537	2,031	940	14,508
301	711	767	335	1,812
501	426	909	207	1,542
701	30		0	30
1990	75,147	16,313	6,765	98,225
1	8,717	5,472	1,272	15,460
101	48,066	8,049	3,718	59,833
201	17,970	2,097	1,724	21,791
301	394	696	51	1,140
1993	55,310	20,901	10,760	86,911
1	4,980	3,143	3,170	11,233
101	36,890	11,115	6,059	54,064
201	11,665	4,754	577	16,995
301	1,775	1,889	954	4,619
1996	43,778	19,560	9,419	72,757
1	4,421	2,460	3,522	10,403
101	29,214	10,784	3,421	43,419
201	9,049	4,036	1,844	14,929
301	1,094	2,280	632	4,006
1999	42,750	19,464	12,755	74,969
1	2,677	4,365	7,640	14,682
101	30,570	7,271	2,399	40,239
201	8,231	6,142	1,393	15,766
301	1,001	1,523	1,317	3,841
501	271	163	6	440
701	0	0	0	0
2001	41,687		9,571	51,258
1	6,458		1,284	7,742
101	24,792		4,414	29,206
201	8,964		2,081	11,045
301	1,473		1,793	3,265
2003	57,973	28,659	13,265	99,897
1	6,220	7,411	3,898	17,529
101	37,610	14,832	6,345	58,787
201	13,078	3,668	2,348	19,094
301	985	2,368	664	4,017
501	81	380	9	470
2005	60,600	27,795	12,766	101,161
1	8,142	4,061	2,580	14,783
101	40,766	15,392	8,902	65,060
201	10,457	5,241	939	16,637
301	1,136	3,063	335	4,535
501	98	29	9	136
701	0	10	0	10

	Regulatory Area			
	Central	Eastern	Western	Total
2007	76,514	15,672	11,614	103,800
1	4,505	2,022	2,577	9,105
101	55,711	9,466	6,338	71,514
201	13,371	3,050	1,947	18,368
301	2,803	948	752	4,504
501	124	186	0	309
701	0	0	0	0
2009	82,091	22,873	19,780	124,744
1	8,533	3,419	4,065	16,017
101	52,749	13,539	13,375	79,662
201	19,267	3,801	1,964	25,032
301	1,332	1,272	376	2,980
501	211	843	0	1,054
701	0	0	0	0
2011	63,490	18,681	12,964	95,134
1	4,614	3,421	3,934	11,969
101	39,259	7,942	5,998	53,199
201	18,749	3,980	2,442	25,171
301	726	3,027	590	4,342
501	143	311	0	454
2013	64,188	22,913	13,877	100,978
1	4,784	7,110	837	12,731
101	47,669	10,460	10,307	68,435
201	10,686	2,998	1,899	15,583
301	782	1,659	835	3,276
501	267	686	0	952
2015	48,903	22,474	15,936	87,286
1	5,116	7,437	2,839	15,365
101	33,365	9,593	9,733	52,691
201	9,431	2,890	3,096	15,416
301	906	1,919	269	3,093
501	85	636	0	721
701	0	0	0	0
2017	57,176	20,352	20,192	97,720
1	3,837	1,291	7,916	13,044
101	30,580	10,837	10,132	51,550
201	21,392	4,288	1,498	27,179
301	1,276	3,813	646	5,736
501	90	123	0	213

Literature Cited

McGilliard, C.R. and Palsson, W. 2017. 6. Assessment of the rex sole stock in the Gulf of Alaska. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. pp. 657-742. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage AK 99510.