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

(Executive Summary)

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9.1 Introduction

"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 been lightly exploited for a substantial period of time (BSAI Plan Team, 2012). A discussion at the September 2006 Groundfish Plan Team meetings concluded the following two important points for updating information in off-year assessments:

1) Anytime the assessment model is re-run and presented in the SAFE Report, a full assessment document **must** be produced.
2) The single-species projection model **may** be re-run using new catch data without re-running the assessment model.

Thus, on alternate (even) years, parameter values from the previous year’s assessment model and total catch information for the current and previous year are used to make projections via the single species projection model for the following two years and to recommend ABC levels for those years.

Because 2015 is an “off” year in the assessment cycle for flathead sole, option 2 above was followed to update information for the 2015 stock assessment. Thus, the single species projection model was run using parameter values from the accepted 2015 assessment model (McGilliard et. al.2014), together with updated catch information for 2014 and 2015, to predict stock status for flathead sole in 2016 and 2017 and to make ABC recommendations for those years.

9.2 Updated catch and projection

The 2015 EBS Groundfish Survey was conducted this summer. A preliminary examination of results from the survey indicates that survey biomass of flathead sole in the standard survey area decreased by 25% from 509,801 t in 2014 to 382,173 t in 2015. Biomass of Bering flounder in the standard survey area increased by 14% from 9,649 t in 2014 to 11,021 t in 2015.

Flathead sole is managed in Tier 3a. New information available to update the projection model consists of the total catch for 2014 (16,514 t) and the current catch for 2015 (10,397 t as of October 17, 2015). To run the projection model to predict ABC’s for 2016 and 2017, estimates are required for the total catches in 2015 and 2016. The final catch for 2015 was estimated by adding the average catch between October 17 and December 31 over the years 2010-2014 to the current catch. The 2016 catch was estimated as the average catch over the previous 5 years (2010-2014). Based on the updated projection model results, the recommended ABC’s for 2016 and 2017 are 66,250 t and 64,580 t, respectively, and the OFL’s are 79,562 t and 77,544 t. The new ABC recommendation and OFL for 2016 are similar to those developed using the 2014 full assessment model (63,711 t and 79,562 t). The principal reference values are shown in the following table, with the recommended values in bold:

Quantity	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
	2015	2016	2016*	2017*
M (natural mortality rate)	0.2	0.2	0.2	0.2
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	736,947	741,446	737,777	747,389
Projected Female spawning biomass (t)	233,736	221,982	240,427	231,139
$B_{100\%}$	319,206	319,206	319,206	319,206
$B_{40\%}$	127,682	127,682	127,682	127,682
$B_{35\%}$	111,722	111,722	111,722	111,722
F_{OFL}	0.35	0.35	0.35	0.35
$maxF_{ABC}$	0.28	0.28	0.28	0.28
F_{ABC}	0.28	0.28	0.28	0.28
OFL (t)	79,419	76,504	79,562	77,544
maxABC (t)	66,130	63,711	66,250	64,580
ABC (t)	66,130	63,711	66,250	64,580
Status	As determined in 2014 for:		As determined in 2015 for:	
	2013	2014	2014	2015
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 11,188t and 15,074.6 used in place of maximum permissible ABC for current year + 1 and current year + 2. The 2015 projected catch was calculated as the current catch of BSAI flathead sole as of October 17, 2015 added to the average October 17 – December 31 BSAI flathead sole catches over the 5 previous years. The 2016 projected catch was calculated as the average catch from 2010-2014.

9.3 Research Priorities

A main research priority is to investigate the potential causes of systematic mismatches between observed and estimated male survey and fishery length composition. These systematic mismatches may be the result of mis-specification of growth, selectivity, or ageing error. The paragraphs below describe future work that would improve the current assessment model. Stock Synthesis (SS3) is a flexible assessment framework that would allow for many of the topics below to be explored without the need for an extensive expansion of the current model code. SS3 or some other flexible assessment framework should be considered for use to conduct future assessments such that improvements to the assessment can be made in a timely manner.

Future research should be conducted to estimate growth using updated data; currently, the most recent year of data used in growth estimates is 2000. Estimating growth within the assessment model using raw age data within each length bin (conditional age-at-length) should be considered in future assessments, such that uncertainty in growth is propagated through the model and represented in uncertainty bounds for quantities such as spawning biomass and reference points. Use of conditional age-at-length data allows for use of both length and age data in the assessment without "double counting."

Alternative methods for estimating selectivity should be explored. The current assessment uses logistic, length-based selectivity curves that are not sex-specific and are time-invariant. Age-based, sex-specific, or dome-shaped selectivity could be considered. Also, it is possible that time-varying fishery selectivity occurs, which can be seen as changes in the fishery age and length compositions among years. In addition, halibut bycatch rates fell after changes to fisheries management in 2008, indicating fishing behavior (and thus potentially selectivity) may have changed. Up to 30% of the catch was taken by pelagic trawls in some years; future assessments could model the pelagic trawl fishery as a separate fleet, which may have different selectivity than non-pelagic trawls.

A new ageing error matrix should be estimated using updated data and methods described in Punt et al. (2008).

Estimation of natural mortality and mean catchability, perhaps with development of a prior for each of these two parameters should be explored in future assessments to better represent uncertainty in biomass and management quantities. Uncertainty bounds are small in the current assessment and overstate our knowledge of stock status.

Further research priorities include the following ideas. An analysis of appropriate effective sample sizes could be conducted for weighting data within and among data sources. Early recruitment deviations could be estimated to inform initial estimates of age composition. An exploration of the use of stock-recruitment relationships (Ricker, Beverton-Holt) could be considered, in response to previous GPT and SSC comments. Lastly, an exploration of alternative ways to incorporate Aleutian Islands data into the assessment could be conducted. Aleutian Islands data could be used as a second survey, and AI length- and age-composition data could be incorporated. Alternatively, a survey averaging approach could be used instead of the linear regression to interpolate AI survey biomass in years without an AI survey. Advantages would be improved estimates of uncertainty about interpolated AI survey biomass estimates, and the assumption that interpolated biomass estimates are more closely related to survey biomass in the AI in surrounding years (rather than related to survey biomass in the EBS in those years). However, the contribution of AI biomass to the survey biomass index is a very small fraction of the total biomass and therefore alternative methods for including AI data may not have a large influence on results.

Summary for Plan Team

Year	Biomass[1]	ABC[2]	TAC[2]	OFL[2]	Catch[3]
2014	249,629	66,293	24,500	79,633	16,514
2015	240,427	66,130	24,250	79,419	10,344
2016	231,139	66,250		79,562	
2017	214,551	64,580		77,544	

References

McGilliard, C.R. ,Nichol, D., Palsson, W., and Stockhausen, W. 2014. 9. Assessment of the Flathead Sole-Bering flounder Stock in the Bering Sea and Aleutian Islands. In Stock Assessment and

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Punt, A.E., Smith, D.C., Krusic-Golub, K., Robertson, S. 2008. Quantifying age-reading error for use in fisheries stock assessments, with application to species in Australia's southern and eastern scalefish and shark fishery. Can. J. Fish. Aquat. Sci. 65(9): 1991-2005.

Table 1.

	Hippogloissoides spp.				Bering Flounder		Flathead Sole	
YEAR	EBS Biomass	CV	AI Biomass	CV	EBS Biomass	CV	EBS Biomass	CV
1982	192,037	0.089					192,037	0.089
1983	270,972	0.101	1,213	0.195644	18,359	0.204	252,612	0.107
1984	285,849	0.083			15,054	0.217	270,794	0.087
1985	265,428	0.073			13,382	0.118	252,046	0.076
1986	357,963	0.088	5,245	0.162272	13,962	0.168	344,002	0.091
1987	393,588	0.094			14,194	0.144	379,394	0.098
1988	561,868	0.087			23,098	0.222	538,770	0.090
1989	521,140	0.084			18,830	0.201	502,310	0.087
1990	593,504	0.090			19,331	0.147	574,174	0.093
1991	546,010	0.077	6,939	0.197304	27,630	0.218	518,380	0.081
1992	618,338	0.106			15,198	0.211	603,140	0.108
1993	607,724	0.072			22,324	0.211	585,400	0.074
1994	690,153	0.070	9,935	0.225628	25,757	0.191	664,396	0.072
1995	594,421	0.088			15,476	0.180	578,945	0.091
1996	616,460	0.091			12,034	0.202	604,427	0.092
1997	783,909	0.213	11,554	0.235867	14,126	0.189	769,783	0.217
1998	683,627	0.205			7,861	0.213	675,766	0.207
1999	401,194	0.088			13,199	0.180	387,995	0.091
2000	392,817	0.088	8,950	0.227677	8,225	0.189	384,592	0.089
2001	515,362	0.105			11,419	0.209	503,943	0.107
2002	553,333	0.178	9,898	0.243554	4,932	0.195	548,401	0.180
2003	514,868	0.104			5,712	0.215	509,156	0.106
2004	612,289	0.086	13,298	0.144472	8,103	0.315	604,186	0.087
2005	612,467	0.086			7,116	0.283	605,350	0.087
2006	635,283	0.089	9,665	0.176017	13,893	0.322	621,390	0.091
2007	562,568	0.092			10,453	0.217	552,114	0.093
2008	545,470	0.142			10,111	0.188	535,359	0.145
2009	418,812	0.118			6,649	0.166	412,163	0.119
2010	495,235	0.149	11,812	0.30519	6,610	0.155	488,626	0.151
2011	583,300	0.186			6,802	0.149	576,498	0.188
2012	381,477	0.115	5,566	0.150585	6,635	0.144	374,842	0.117
2013	491,191	0.172			5,705	0.145	485,486	0.174
2014	519,450	0.137	13,436	0.139096	9,649	0.176	509,801	0.139
2015	393,194	0.112			11,021	0.174	382,173	0.115

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