19. Assessment of the sculpin stock complex in the Gulf of Alaska

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Executive Summary

The Gulf of Alaska (GOA) sculpin complex is managed in Tier 5 and is assessed on a biennial basis to coincide with the biennial GOA groundfish trawl survey. These surveys occur in odd years, and for these years a full assessment of the sculpin stock complex is conducted. The 2015 full assessment can be found at http://www.afsc.noaa.gov/REFM/stocks/assessments.htm. This document consists of an executive summary because no new survey data are available.

Summary of Changes in Assessment Inputs

Changes in the input data:
1). There is no new survey data.
2). Complete catch is included for 2014, as well as partial catch for 2016 (through October 16, 2016).

Changes in the assessment methodology:
There are no changes in the assessment methodology.

Summary of Results

	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
Quantity	2016	2017	2017	2018
M (natural mortality rate)[1]	0.21	0.21	0.21	0.21
Tier	5	5	5	5
Biomass (t)	34,943	34,943	34,943	34,943
F_{OFL}	0.21	0.21	0.21	0.21
$maxF_{ABC}$	0.16	0.16	0.16	0.16
F_{ABC}	0.16	0.16	0.16	0.16
OFL (t)	7,338	7,338	7,338	7,338
maxABC (t)	5,591	5,591	5,591	5,591
ABC (t)	5,591	5,591	5,591	5,591
	As determined *last* year for:		As determined *this* year for:	
Status	2014	2015	2015	2016
Overfishing		n/a		n/a

[1] *This is a sculpin complex average mortality rate, a biomass-weighted average of the instantaneous natural mortality rates for the four most abundant sculpins in the GOA: bigmouth (Hemitripterus bolini), great (Myoxocephalus polyacanthocephalus), plain (Myoxocephalus jaok), and yellow Irish lord (Hemilepidotus jordani).*

Area apportionment

GOA sculpins are managed with a single total allowable catch (TAC) for the entire Gulf of Alaska region; there is no area apportionment.

Summary for Plan Team

Year	Biomass	OFL	ABC	TAC	Catch[1]
2015	33,550	7,448	5,569	5,569	1,207
2016	34,943	7,338	5,591	5,591	1,207[1]
2017	34,943	7,338	5,591	5,591	
2018	34,943	7,338	5,591	5,591	

[1] Current as of October 16, 2016, Source: NMFS AKRO Blend/Catch Accounting System.

Responses to SSC and Plan Team Comments on Assessments in General

October 2016 SSC

The SSC reminds groundfish and crab stock assessment authors to follow their respective guidelines for SAFE preparation.

Authors' response: Noted.

October 2016 SSC

The SSC requests that stock assessment authors bookmark their assessment documents and commends those that have already adopted this practice.

Authors' response: Noted.

Responses to SSC and Plan Team Comments Specific to this Assessment

November 2015 Plan Team

The Team had the following recommendations for GOA sculpins:
1. Calculate OFL/ABC for species as product of species-specific *M* and biomass,
2. Apply average *M* to "other sculpins",
3. Examine whether a combination of low fecundity and fishing mortality explain long-term decline of bigmouth sculpin.

Authors' response: Points 1 and 2 will be applied to the next full GOA sculpin assessment in 2017. Point 3 is addressed in this document following the SSC comment below.

December 2015 SSC

The SSC agrees with the PT recommendations for harvest specifications, specifically the use of the RE model biomass time series and the biomass-weighted natural mortality (M = 0.222). These result in the harvest specifications in the table below. We also agree with the PT in requesting possible explanations

for the decline of bigmouth sculpin since the 1980s, including, but not limited, to low fecundity of bigmouth sculpin and fishing mortality. The SSC would also like to note the decline in survey biomass of the plain sculpin. We also suggest that investigations into the maximum age and natural mortality of the four primary sculpin species in this complex be added to research priorities.

Assemblage	Area	OFL	ABC	OFL	ABC
sculpins	GOA-wide	7,338	5,591	7,338	5,591

Authors' response: The authors would like to provide some clarification of the numbers presented in the December 2015 SSC comments. The table above contains slightly different values for ABC and OFL than the 2015 assessment. This is due to differences in rounding estimates of natural mortality. The table above is based on the 2015 estimated total sculpin biomass, with natural mortality rounded to two significant digits: OFL=34,943t*0.21=7,338t, the OFL value of 0.16 is based on 0.21*0.75=0.16, and the ABC is based on 34,943t*0.16=5,591t. The biomass-weighted natural mortality specified in the SSC minutes is from the 2013, 2014 assessment. The biomass-weighted natural mortality specified in 2015 was 0.21.

Research on maximum age and natural mortality of the four primary sculpin species in this complex in the GOA was added to research priorities, which is included in this update. Current estimates of maximum age and natural mortality come from sculpins sampled in the Bering Sea.

Biomass estimates of bigmouth sculpins in the GOA have declined from over 15,000 t in 2003 to below 5,000 t in 2015. Plain sculpin appear to have increased from low levels in 1990 to a peak in 2007 at approximately 4 t, and have subsequently declined to 1990's levels. Two tables are included in this update to provide information regarding whether declines in bigmouth or plain sculpin may be due to fishing. Table 1 shows that estimates of fishing mortality in bigmouth and plain sculpin are well below estimates of F_{ABC}, which for Tier 5 stocks is based on 0.75*M. Data in Table 2 indicates that bigmouth sculpins are taken by the fishery in similar proportions as the GOA survey. Bigmouth sculpin represented 10-19% of the fishery catch of sculpin from 2012-2016, and represented 13% of the 3-survey average GOA sculpin complex. Plain sculpin represent a lower proportion of the fishery catch (<1%) than is estimated by the GOA survey (9%).

Some information exists that suggests sculpins may be particularly vulnerable to fishing. Most sculpins lay adhesive eggs in nests, and many exhibit parental care for eggs (Eschemeyer et al. 1983). Markevich (2000) observed the sea raven, *Hemitripterus villosus*, releasing eggs into crevices of boulders and stones in shallow waters in Peter the Great Bay, Sea of Japan. These types of reproductive strategies may make sculpin populations more sensitive to changes in benthic habitats than other groundfish species such as walleye pollock, which are broadcast spawners with pelagic eggs. The Japanese sculpin (*Cottus hilgendorfi*) has been referred to as a k-strategist species (Ito, 1980), characterized as producing few, slowly developing young (Pianka, 1970). In the western Pacific, great sculpins (*Myoxocephalus polyacanthocephalus*) are reported to have relatively late ages at maturity (5-8 years, Tokranov, 1985) despite being relatively short-lived (13-15 years). This suggests a limited reproductive portion of the lifespan relative to other groundfish species.

Table 1. Estimated catch for bigmouth sculpin, yellow Irish lords, plain sculpin, and unidentified scupins of genus Myoxocephalus (Myoxo. unid.), which includes both plain and great sculpin. New estimates of biomass are generated in odd years and are carried forward to the subsequent even year. Fishing mortality (*F*) was calculated as the ratio of catch and estimated biomass, *M* is an estimate of natural mortality.

Species or group	Fishery catch[1]			Assessed biomass		Fishing mortality (*F*~catch/biomass)			Species specific *M**0.75
Year	2014	2015	2016	2013, 2014	2015, 2016	F 2014	F 2015	F 2016	
bigmouth sculpin	69.8	75.5	81.8	3,455	4,469	0.020	0.017	0.018	0.1575
yellow Irish lord	859.4	562.5	681.3	19,138	21,614	0.045	0.026	0.032	0.1275
Myoxo. unid.	18.0	62.7	17.5						
plain sculpin	3.0	1.3	2.4	3303	747	0.001	0.002	0.003	0.3000
Myoxo. unid.+plain	21.0	64.0	19.9			0.006	0.086	0.027	

[1]Current as of October 19, 2016 from NMFS AKRO Catch Accounting System, Nontarget Estimates.

Table 2. Composition of observed fishery catches, 2012-2016, and species composition of sculpin complex biomass, by species and/or genus, based on the 3 most recent GOA survey biomass estimates. Fishery catch proportions are based on fishery observer data. *Source: NORPAC database.*

Taxon	Fishery catch composition					Proportion of average survey biomass
	2012	2013	2014	2015	2016	
Hemitripterus* spp.*						
H. bolini (bigmouth)	17%	14%	10%	15%	19%	13%
***Hemilepidotus* spp.**						
Hemilepidotus unidentified	11%	24%	26%	22%	21%	-
H. hemilepidotus (RIL)	<1%	1%	< 1%	<1%	<1%	-
H. jordani (YIL)	61%	51%	54%	46%	46%	55%
H. spinosus (BIL)	<1%	< 1%	< 1%	< 1%	< 1%	-
***Myoxocephalus* spp.**						
Myoxocephalus unidentified	1%	1%	<1%	5%	1%	-
M. verrucosus (warty)	<1%	<1%	<1%	< 1%	< 1%	-
M. jaok (plain)	<1%	<1%	<1%	< 1%	< 1%	9%
M. polyacanthocephalus (great)	10%	9%	8%	10%	11%	23%
Malacottus spp. *M. zonurus* (darkfin)	<1%	<1%	1%	1%	1%	0%

** *Hemitripterus* spp. is likely all *H. bolini.*

§ Miscellaneous sculpins comprises unidentified sculpins as well as a number of minor sculpin species.

Data Gaps and Research Priorities

Data gaps exist in sculpin species life history characteristics, spatial distribution and abundance in Alaskan waters. Most importantly no data on maximum age or natural mortality exists for the four main sculpin species in the GOA. Therefore, collections for age data and natural mortality research on yellow Irish lord, great sculpin, bigmouth sculpin and plain sculpin are needed from the GOA. Over 90% of all sculpins caught in the fisheries of the GOA in surveys from 2004-2016 were from the genera *Myoxocephalus*, *Hemitripterus*, and *Hemilepidotus*. Collecting seasonal food habits data (with additional summer collections) would help to clarify the role of both large and small sculpin species within the GOA ecosystem.

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