Appendix B
2006 GOA Sculpins

Rebecca Reuter, Todd TenBrink, Sarah Gaichas and Sandra Lowe

September 2006

16.4.0 Executive Summary

The following appendix summarizes the information currently known about sculpins (Families: Cottidae, Hemitripteridae, Psychrolutdiae, and Rhamphocottidae) in the Gulf of Alaska (GOA).

Summary of Major Changes

1. Total fishery catch data from 2005 and partial 2006 data are presented for the sculpin complex. Data are available for the following genera: *Hemilepidotus, Myoxocephalus, Hemitripterus.* The rest of the sculpin species found in the GOA are reported as "sculpin unidentified" or "other sculpins". Their data are also presented.
2. Information on total sculpin catch by target fishery and gear type is available for 2005.
3. Biomass estimates from the GOA are presented for selected sculpin species from triennial and biennial Alaska Fisheries Science Center (AFSC) bottom trawl surveys.
4. Length frequencies of the 4 most abundant sculpin species are presented from AFSC survey data of the GOA.

Region	M	Exploitable biomass (mt)	F_{ABC}	ABC (mt)	F_{OFL}	OFL (mt)
GOA	0.19	30,368	0.1425	4,327	0.19	5,770

16.4.1 Introduction

<u>Description, scientific names, and general distribution</u>

Sculpins are relatively small, benthic-dwelling predatory teleost fish, with many species in Alaskan waters. Sculpin species have been identified in the AFSC surveys since 2001. During AFSC surveys of the Gulf of Alaska, only 39 of 46 listed species of sculpins have been identified. It is not clear whether the other 7 species do not exist in the GOA or just haven't been identified. Sculpin diversity remains high in the GOA and many of these species are also found in the Bering Sea (Table 16.4.1). Considered as a species complex, sculpins are broadly distributed throughout all benthic habitats from shallow to deep, over all substrate types in the GOA. In this assessment, we mainly focus on large sculpin species from the genera *Myoxocephalus*, *Hemitripterus*, and *Hemilepidotus* where observers from the North Pacific Groundfish Observer Program have recently begun to identify sculpin catch to genus. According to total catch figures for 2004 from the NMFS Alaska Regional Office (AKRO), the aforementioned large sculpin genera contributed nearly 93% of all sculpin catch in the GOA region. Data for 2005 indicates a similar trend.

Management units

Sculpins are managed as part of the GOA Other species complex. This means that their catch is reported in aggregate as "other" along with the catch of skates, sharks, and octopi and squid (GOA). Because catch is officially reported within the Other species complex, independent estimates of sculpin catch were made for each year using observer data. In the GOA, the TAC of other species has been established as 5% of the sum of the TACs for all other assessed target species in the GOA Fishery Management Plan (FMP). Sculpins are currently taken only as bycatch so future catch of sculpins depends on the TAC and spatial temporal limitations placed on target fisheries. Life history characteristics indicate that sculpins as a group might be managed separately and catch could be constrained efficiently within a spatial context.

Life history and stock structure (general)

Despite their abundance and diversity, sculpin life histories are poorly understood in Alaska. Much of the life history information comes from studies in the western North Pacific. Sculpins are different from many target groundfish species in that they 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. This type of reproductive strategy may make sculpin populations more sensitive to changes in benthic habitats than other groundfish species such as pollock, which are broadcast spawners with pelagic eggs. Some larger sculpin species such as the great sculpin, *Myoxocephalus polyacanthocephalus*, reach sizes greater than 80 cm in the eastern Bering Sea. In the western Pacific, great sculpins are reported to have late ages at maturity (5-8 years, Tokranov, 1985) despite being relatively short-lived (13-15 years), which suggests a limited reproductive portion of the lifespan relative to other groundfish species. Fecundity for the great sculpin off East Kamchatka waters ranged from 48,000 to 415,000 eggs (Tokranov, 1985). In addition, the diversity of sculpin species in the FMP areas suggests that each sculpin population might react to similar environmental changes (whether natural or fishing induced) in different ways. Within each sculpin species, observed spatial differences in fecundity, egg size, and other life history characteristics suggest local population structure (Tokranov, 1985).

Life history (GOA-specific)

Information such as depth range, distribution, and maximum length has been collected for several years for many species during surveys. There are no GOA-specific age and growth, maturity data for sculpins identified in this management region. There is some preliminary information on reproduction for bigmouth sculpin (*Hemitripterus bolini*) in the Gulf of Alaska. Fecundity for bigmouth sculpin averaged 2283 eggs and spawning season is estimated to be in the spring (Morgan Busby, AFSC, personal comm.). Known life history characteristics for selected sculpin species in the GOA are presented in Table 16.4.2. With the exception of bigmouth fecundity all fecundity and maturity data in Table 16.4.2 are from outside GOA region.

16.4.2 Fishery

There is no directed fishing for any sculpin species in the GOA at this time. Sculpins constitute between 19-26% of the GOA other species catches from 2005-2006 and 7-21%, prior to 2005, when skates were still included in the complex (Table 16.4.3). Sculpins are caught incidentally by a wide variety of fisheries. Based on data from the NMFS AKRO the main fisheries are the trawl fisheries for flatfish, Pacific cod, and rockfish, and Pacific cod pot fishery (Table 16.4.4). It is likely that the larger sculpin species (Irish lords, *Hemilepidotus* spp., great sculpin and plain sculpins, *Myoxocephalus* spp., and bigmouth sculpin *Hemitripterus bolini*), which contribute to the majority of sculpin biomass on surveys, are the species commonly encountered incidentally in groundfish fisheries. It is unclear which sculpin species were commonly taken in GOA groundfish fisheries prior to 2004, because observers did not regularly identify animals in these groups to species. Only small amounts (<2%) of sculpin catch in past years were identified to species, although observers were not specifically trained for this level of identification.

In 2002-2003, the observer program of AFSC initiated a species identification project prompted by the need to gather basic population data for groups in the Other species complex. Beginning in January 2004, sculpin catch was identified to genus for the larger sculpin species: *Hemilepidotus, Myoxocephalus, and Hemitripterus.* Several species of *Hemilepidotus* and *Myoxocephalus* have been identified from surveys. In Alaskan waters, *Hemitripterus* probably represents only one species, the bigmouth sculpin (Stevenson 2004). Another member of this genus that may occur in Alaskan waters, the sea raven (*H. villosus*), has never been identified in any of the GOA trawl surveys conducted by AFSC. It is reasonable to assume that all sculpins identified by observers as *Hemitripterus* sculpins were bigmouth sculpins.

Table 16.4.5 shows that *Hemilepidotus* spp. make up 61% of the sculpin total observed catch. *Hemitripterus* spp. (bigmouth sculpin) makes up about 18% of the total observed catch of sculpins. Similar catch estimate proportions are found in the 2005 catch data through early October.

16.4.3 Survey

Biomass trend

Aggregate sculpin biomass in the GOA shows no clear trend, and should probably not be used as an indicator of population status for a complex with so much species diversity (Table 16.4.6). Trends in biomass were available for only selected sculpin species for the period 1984-2005 due to difficulties with species identification and survey priorities. Species specific biomass estimates are available for the 2001, 2003 and 2005 surveys. The species composition of the sculpin complex as estimated by bottom trawl surveys of the GOA demonstrates the diversity of this complex. Almost 95% of the sculpin biomass is dominated by the larger sculpin species in the GOA: yellow Irish lord (*Hemilepidotus jordani*) being the most common (~45.5% of the sculpin biomass), followed by the genera *Myoxocephalus* at ~27% and bigmouth sculpin (*Hemitripterus bolini*) at ~22% of the sculpin biomass (Table.16.4.7).

Biomass trends show that the bigmouth sculpin declined between 1984 and 2001, but remains stable over the last 2 surveys (Figure 16.4.1). Sculpins that show an increase since 1984 are the plain sculpin, and yellow Irish lord, spinyhead, great and darkfin sculpins show no real trend in biomass through the years (Figure 16.4.1). The coefficient of variations (CVs) for the survey biomass estimates of 7 out of 12 sculpins species are below 0.3, suggesting that the GOA survey is doing an adequate job assessing the biomass of the more abundant species (Table 16.4.7).

Length frequency

Length measurements (fork length, FL in mm) have been collected for a variety of sculpin species during AFSC surveys. The four most abundant species from the GOA survey have been measured annually since 2003: yellow Irish lord, plain sculpin, great sculpin and bigmouth sculpin (Figure 16.4.2). Year by year analysis shows that the length composition by species is consistent. One interesting observation is that the surveys tend to catch bigmouth sculpins on the higher side of the length range, similar to the length observations of bigmouth from the eastern Bering Sea (EBS) shelf survey. Although little information is known about bigmouth sculpin life history, this may suggest that the younger or smaller bigmouth sculpins occur in areas not sampled well by the surveys.

Sample sizes for length frequency analysis for GOA:

Species	2003	2005
Yellow Irish Lord	917	1034
Plain sculpin	81	126
Great sculpin	208	201
Bigmouth sculpin	81	61

16.4.4 Analytical Approach

For the purpose of this assessment the anlalytical approach consisted of evaluating natural mortality and comparing with survey biomass. The following methods were employed to evaluate natural mortality with life history parameters: Alverson and Carney 1975, Pauly 1980, Charnov 1993, Hoenig 1983, , Rikhter and Efanov 1976. Little information was available for sculpin stocks in the GOA FMP area, so M was estimated using the methods as applied to data for Russian sculpin species. Considering the uncertainty inherent in applying this method to sculpin species and stocks not found in the GOA, as well as that great and plain sculpin are the most abundant in the GOA and have estimates of M in the literature, we elected to use the lowest estimate of M, 0.19, which is one of the estimates for great sculpin (Table 16.4.8). Choosing the lowest estimate of M is considered conservative because it will result in the lowest estimates of ABC and OFL under Tier 5. Yellow Irish Lord maximum age is approximately 13, given the estimates from specimens in Kamchatka (Table 16.4.2).

16.4.5 ABC and OFL recommendations

The sculpin assemblage represents 40 species of which 16-20 regularly occur in the AFSC surveys. Because their life history is so different from sharks, squid and octopi, we recommend a sculpin level ABC and OFL. There is a reliable biomass time series for the sculpin complex as a whole, and recently reliable estimates of biomass for each species within the complex. We feel that our conservative estimate of M is the best available for managing this species complex until further information is available.

For the time being, we recommend a Tier 5 approach be applied to the sculpin complex within the GOA as long as the catch remains incidental and no target fishery develops. We further recommend using an average of the 3 most recent survey biomass estimates to capture recent biomass trends. Applying the M estimate of 0.19 to the average survey biomass estimates, we calculate an ABC of 0.75 * 0.19 * (30,368) = 4,327 mt for the GOA. Using the same method to calculate OFL, 0.19 * (30,368) = 5,770 mt for the GOA. Tier 6 options for sculpin management are not recommended.

In the unlikely event that target fisheries develop for some sculpin species, we recommend that each targeted sculpin species be managed separately, and that directed fishing only be allowed when sufficient life history information becomes available to make reasonable species specific estimates of productivity. Given that the most probable targeted sculpin species would be the most abundant, managing as single species may not be problematic under the current TAC setting regime if the species was being identified to species level by the observer program. If a targeted species of sculpin is one with a low abundance thus low TACs then alternative management strategies such as closed areas should be considered.

16.4.6 Ecosystem Considerations

16.4.6.1 Ecosystem Effects on Stock

Little is known about sculpin food habits in the GOA, especially during fall and winter months. Limited information indicates that in the GOA the larger sculpin species prey on shrimp and other benthic invertebrates, as well as some juvenile walleye pollock (Figure 16.4.3). In the GOA the main predator of large sculpins are Pacific halibut, pinnipeds, small demersal fish and sablefish (Figure 16.4.3). Other sculpins in the GOA feed mainly on shrimp and benthic crustaceans (Figure 16.4.4). Other sculpins are mainly preyed upon by Pacific cod and is the main source of mortality (Figure 16.4.4). Source of above information from Aydin et al. (in review).

16.4.6.2 Fishery Effects on the Ecosystem

Analysis of ecosystem considerations for those fisheries that effect the stocks within this complex (see Table 16.4.4) is given in the respective fisheries SAFE chapter. The GOA Sculpin complex is not a targeted fishery, therefore reference to the effects of the fishery on the ecosystem will be described in those chapters of the fisheries that catch sculpins incidentally.

Ecosystem effects on *Sculpin complex*			
Indicator	Observation	Interpretation	Evaluation
Prey availability or abundance trends			
Zooplankton	Stomach contents, ichthyoplankton surveys, changes mean wt-at-age	No affect	Probably no concern
a. Predator population trends			
Marine mammals	Fur seals declining, Steller sea lions increasing slightly	No affect	Probably no concern
Birds	Stable, some increasing some decreasing	No affect	Probably no concern
Fish (Pollock, Pacific cod, halibut)	Stable to increasing	Affects not known	Probably no concern
b. Changes in habitat quality			
Temperature regime	None	Affects not known	Unknown
Winter-spring environmental conditions	None	Probably a number of factors	Unknown
Production	Fairly stable nutrient flow from upwelled BS Basin	Inter-annual variability low	No concern
***Targeted fisheries* effects on ecosystem (see relative chapters)**			

16.4.6.3 Data gaps and research priorities

Severe data gaps exist in sculpin species life history characteristics, spatial distribution and abundance in Alaskan waters. These data are necessary in deciding creative management strategies for non-target species. 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. It is essential that we continue to improve species identifications as well as collecting life history information important for effective stock management. Over 90% of all sculpins caught in the fisheries of the GOA in 2004 were from the genera *Myoxocephalus*, *Hemitripterus*, and *Hemilepidotus*. At this time, there is no GOA-specific age and growth and maturity data for any species in these genera.

16.4.7 Summary

Below are the recommendations for 2007 ABC and OFL for a GOA sculpin complex.

Summary Table for Tier 5 Sculpin Complex

Region	**M**	**Exploitable biomass (mt)**	**F_{ABC}**	**ABC (mt)**	**F_{OFL}**	**OFL (mt)**
GOA	0.19	30,368	0.1425	4,327	0.19	5,770

16.4.7 Literature Cited

Alverson, D.L., and M.J. Carney. 1975. A graphic review of the growth and decay of population cohorts. J. Cons. Int. Explor. Mer 36:133-143.

Aydin, K., S. Gaichas, I. Ortiz, D. Kinzey, and N. Friday. In review. A comparison of the Bering Sea, Gulf of Alaska, and Aleutian Islands large marine ecosystems through food web modeling. NOAA Tech Memo.

Charnov, E.L. 1993. Life history invariants some explorations of symmetry in evolutionary ecology. Oxford University Press Inc., New York. 167p.

Eschmeyer, W.N., E.S. Herald, and H. Hammann, 1983. A field guide to Pacific coast fishes of North America. Houghton Mifflin Co., Boston: 336 pp.

Gaichas, S.K., L.W. Fritz, and J.N, Ianelli, 1999. Other species considerations for the Gulf of Alaska. Appendix D In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Gaichas, S.K., D. Courtney, T. TenBrink, M. Nelson, S. Lowe, J. Hoff, B. Matta and J. Boldt. 2004. BSAI Squid and Other species stock assessment. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82: 898-903.

Markevich, A. 2000. Spawning of the sea raven *Hemitripterus villosus* in Peter the Great Bay, Sea of Japan. Russian Journal of Marine Biology 26(4): 283-285.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J. Cons. Int. Explor. Mer 39(2):175-192.

Rikhter, V.A., and V.N. Efanov. 1976. On one of the approaches to estimation of natural mortality of fish populations. ICNAF Res. Doc. 76/VI/8. Serial N. 3777. 13p.

Roff, D.A. 1986. The evolution of life history parameters in teleosts. Can. J. Fish. Aquat. Sci. 41:989-1000.

Stevenson, D.E. 2004. Identification of skates, sculpins, and smelts by observers in North Pacific groundfish fisheries (2002-2003). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-142, 67p.

Tokranov, A.M., 1985. Reproduction of great sculpin, *Myoxocephalus polyacanthocephalus* (Cottidae) in Kamchatka waters. J. Ichthyol. 24(4):119-127.

Table 16.4.1. Sculpin species observed during the years 1995-2005 on the Gulf of Alaska bottom trawl surveys.

Family	**Scientific name**	**Common name**	**93**	**96**	**99**	**01**	**03**	**05**
Cottidae	*Artediellus pacificus*	Pacific hookear sculpin			x			
	Artedius lateralis	Smoothhead sculpin						
	Bolinia euryptera	Broadfin sculpin						x
	Enophyrs bison	Buffalo sculpin						
	Enophrys diceraus	Antlered sculpin			x	x		
	Gymnocanthus galeatus	Armorhead sculpin	x	x	x	x	x	x
	Gymnocanthus pistilliger	Threaded sculpin	x	x		x	x	x
	Hemilepidotus hemilepidotus	Red Irish Lord	x	x	x	x	x	x
	Hemilepidotus jordani	Yellow Irish Lord	x	x	x	x	x	x
	Hemilepidotus papilio	Butterfly sculpin		x	x			
	Hemilepidotus spinosus	Brown Irish lord					x	
	Hemilepidotus zapus	Longfin Irish lord			x		x	x
	Icelinus borealis	Northern sculpin		x	x	x		x
	Icelinus burchami	Dusky sculpin			x		x	
	Icelinus filamentosus	Threadfin sculpin						
	Icelinus tenuis	Spotfin sculpin		x			x	
	Icelus spatula	Spatulate sculpin			x	x		
	Icelus spiniger	Thorny sculpin	x	x		x	x	x
	Icelus uncinalis	Uncinate sculpin			x			
	Jordania zonope	Longfin sculpin						
	Leptocottus armatus	Pacific staghorn sculpin			x	x		x
	Microcottus sellaris	Brightbelly sculpin						
	Myoxocephalus jaok	Plain sculpin	x	x	x	x	x	x
	Myoxocephalus polyacanthocephalus	Great sculpin	x	x	x	x	x	x
	Myoxocephalus verrucocus	Warty sculpin				x		
	Paricelinus hopliticus	Thornback sculpin			x			
	Radulinus asprellus	Slim sculpin					x	
	Rastrinus scutiger	Roughskin sculpin						x
	Thecopterus aleuticus	Whitetail sculpin						
	Thyriscus anoplus	Sponge sculpin		x				x
	Triglops forficatus	Scissortail sculpin	x	x	x	x	x	x
	Triglops macellus	Roughspine sculpin	x	x	x	x	x	x
	Triglops metopias	Crescent-tail sculpin					x	
	Triglops pingelii	Ribbed sculpin	x	x	x	x	x	x
	Triglops septicus	Spectacled sculpin	x	x	x	x	x	x
Hemitripteridae	*Blepsias bilobus*	Crested sculpin	x			x		
	Hemitripterus bolini	Bigmouth sculpin	x	x	x	x	x	x
	Nautichthys oculofasciatus	Sailfin sculpin		x		x	x	
	Nautichthys pribilovius	Eyeshade sculpin		x				
Psychrolutidae	*Dasycottus setiger*	Spinyhead sculpin	x	x	x	x	x	x
	Eurymen gyrinus	Smoothcheek sculpin		x	x	x		x
	Malacoccottus zonurus	Darkfin sculpin	x	x	x	x	x	x
	Malacocottus kincaidi	Blackfin sculpin						
	Psychrolutes paradoxus	Tadpole sculpin	x	x	x	x	x	x
	Psychrolutes phrictus	Blob sculpin						x
Rhamphocottidae	*Rhamphocottus richardsoni*	Grunt sculpin	x	x	x	x	x	x

Table 16.4.2. Selected life history information available for selected GOA sculpin species.

Species	Common Name	Maximum Length (cm)		Maximum Age		Fecundity (x1000)	Age at 50% Maturity
		Elsewhere	GOA	Elsewhere	GOA		
Myoxocephalus joak	Plain sculpin	75	59	15		25.4 - 147	5 - 8
M. polyacanthocephalus	Great sculpin	82	72	13		48 - 415	6 - 8
M. verrucosus	Warty sculpin	78				2.7	
Hemitripterus bolini	Bigmouth sculpin	83	86			2.3	
Hemilepidotus jordani	Yellow Irish lord	65	50	13		25 - 241	6 - 7
H. papilio	Butterfly sculpin	38					
Gymnocanthus pistilliger	Threaded sculpin	27		13		5 - 41	
G. galeatus	Armorhead sculpin	46	28	13		12 - 48	
Dasycottus setiger	Spinyhead sculpin	45	22	11			
Icelus spiniger	Thorny sculpin	17					
Triglops pingeli	Ribbed sculpin	20		6		1.8	
T. forficate	Scissortail sculpin	30	28	6		1.7	
T. scepticus	Spectacled sculpin	25		8		3.1	

References: AFSC; Panchenko 2002; Panchenko 2003; Tokranov 1985; Andriyashev 1954; Tokranov 1988a; Tokranov 1988b; Tokranov 1995; Tokranov and Orlov 2001; Busby, AFSC, personal comm.

Notes: Estimate of Natural mortality (M) is the lowest estimate of M derived from several methods as presented in Gaichas et al. (2004); blanks indicate no life history data found.

Table 16.4.3. GOA total catch of other species (including skates) and sculpin complex 1997-2006*. Source: Catch Accounting system, AKRO.

Year	Other species total catch	Sculpin complex total catch	Percent of other species catch
1997	4,823	898	19%
1998	7,422	526	7%
1999	3,788	544	14%
2000	5,455	940	17%
2001	3,383	587	17%
2002	8,162	919	11%
2003	5,132	632	12%
2004	3,399	697	21%
*2005	2,313	610	26%
**2006	2,780	528	19%

*Skates removed from Other species complex
**2006 data as of August 2006

Table 16.4.4. Catch (mt) of large sculpins and other sculpins in the Gulf of Alaska by target fishery and gear type from 2005. *Source: NMFS AK regional office catch accounting system. Note: Large sculpin category is analogous to sculpin species in the genera Hemilepidotus, Hemitripterus and Myoxocephalus.*

2005

Gulf of Alaska

Large Sculpins

Target fishery	Gear type: Bottom Trawl	Pelagic Trawl	Pot	Longline
Pacific Cod	88	-	151	57
Flatfish	218	-	-	18
Rockfish	16	-	-	-
Sablefish	-	-	-	15.5

Other Sculpins

Target fishery	Gear type: Bottom Trawl	Pelagic Trawl	Pot	Longline
Pacific Cod	<1	-	9	7
Flatfish	6	-	-	9
Rockfish	14.5	-	-	-
Sablefish	<1	-	-	<1

Table 16.4.5. Observed catch (mt) of *Hemilepidotus* spp., *Hemitripterus* spp., *Myoxocephalus* and sculpin unidentified. *Source: NMFS AFSC Fishery Monitoring and Assessment Program (observer samples).*

Gulf of Alaska	2004 Sculpin catch (tons)	% of sculpin	2005* Sculpin catch (tons)	% of sculpin
Hemitripterus spp.**	20	18%	14	16%
Hemilepidotus spp.	68	61%	60	67%
Myoxocephalus spp.	8	7%	6	7%
Sculpin unidentified	16	14%	9	10%

*Data reported through 12/2005

**Hemitripterus spp. probably represents only one species (big mouth sculpin).

Table 16.4.6 Sculpin complex biomass estimates based on NMFS bottom-trawl surveys, 1984-2005.

Year	Biomass	CV
1984	44,162	0.08
1987	31,811	0.12
1990	26,777	0.18
1993	25,558	0.13
1996	31,726	0.30
1999	30,871	0.11
2001	30,590	0.28
2003	26,632	0.10
2005	33,881	0.09

Table 16.4.7. Sculpin complex biomass (mt) from the 1993-2005 GOA trawl survey.

Species	**Common Name**			**Biomass**				**CV**
		1993	**1996**	**1999**	**2001**	**2003**	**2005**	**2005**
Blepsias bilobus	Crested sculpin	1	-	-	6	-	-	-
Dasycottus setiger	Spinyhead sculpin	553	278	271	690	608	463	0.27
Enophrys diceraus	Antlered sculpin	-	-	-	1	-	-	-
Gymnocanthus galeatus	Armorhead sculpin	16	13	15	60	78	28	0.32
Gymnocanthus pistilliger	Threaded sculpin	<1	3	-	21	<1	2	0.99
Hemilepidotus jordani	Yellow Irish lord	11813	17804	20255	20945	12064	15952	0.13
Hemilepidotus papilio	Butterfly sculpin		<1	1	-	-	-	-
Hemitripterus bolini	Bigmouth sculpin	5584	4246	3983	3471	5767	5543	0.18
Icelus spiniger	Thorny sculpin	<1	1	-	1	<1	<1	1.36
Leptocottus armatus	Pacific staghorn sculpin	-	-	1	2	-	14	0.99
Malacocottus zonurus	Darkfin sculpin	348	477	371	335	607	944	0.22
Myoxocephalus jaok	Plain sculpin	461	1015	1692	932	1220	3912	0.36
Myoxocephalus polyacanthocephalus	Great sculpin	5893	7326	3913	3540	6037	6574	0.24
Myoxocephalus verrucosus	Warty sculpin	-	-	-	339	-	-	-
Triglops forficata	Scissortail sculpin	49	60	47	62	94	23	0.28
Triglops scepticus	Spectacled sculpin	52	90	233	12	40	105	0.63

Table 16.4.8. List of available natural mortality information for sculpins.

Species	Area	Sex	Hoenig	Rikhter & Efanov	Alverson & Carney	Charnov
Arctic staghorn sculpin	W. Bering Sea	*males*	0.53			
	W. Bering Sea	*females*	0.47			
				0.41		
Common staghorn sculpin	Kamchatka	*males*	0.32	0.32		
	Kamchatka	*females*	0.25	0.26		
Red Irish Lord	Puget Sound		0.70			
Threaded sculpin	E. Bering Sea	*males*	0.42		0.36	0.65
		females	0.47		0.58	0.40
Armorhead sculpin	Kamchatka	*males*	0.38			
	Kamchatka	*females*	0.32			
Great sculpin	Kamchatka	*males*	0.47	0.32		
	Kamchatka	*males*		0.26		
	Kamchatka	*females*	0.32	0.22		
	Kamchatka	*females*		**0.19**		
Plain sculpin	Sea of Japan	*males*	0.35	0.41		
	Sea of Japan	*males*		0.32		
	Sea of Japan	*females*	0.28	0.26		
	Sea of Japan	*females*		0.22		

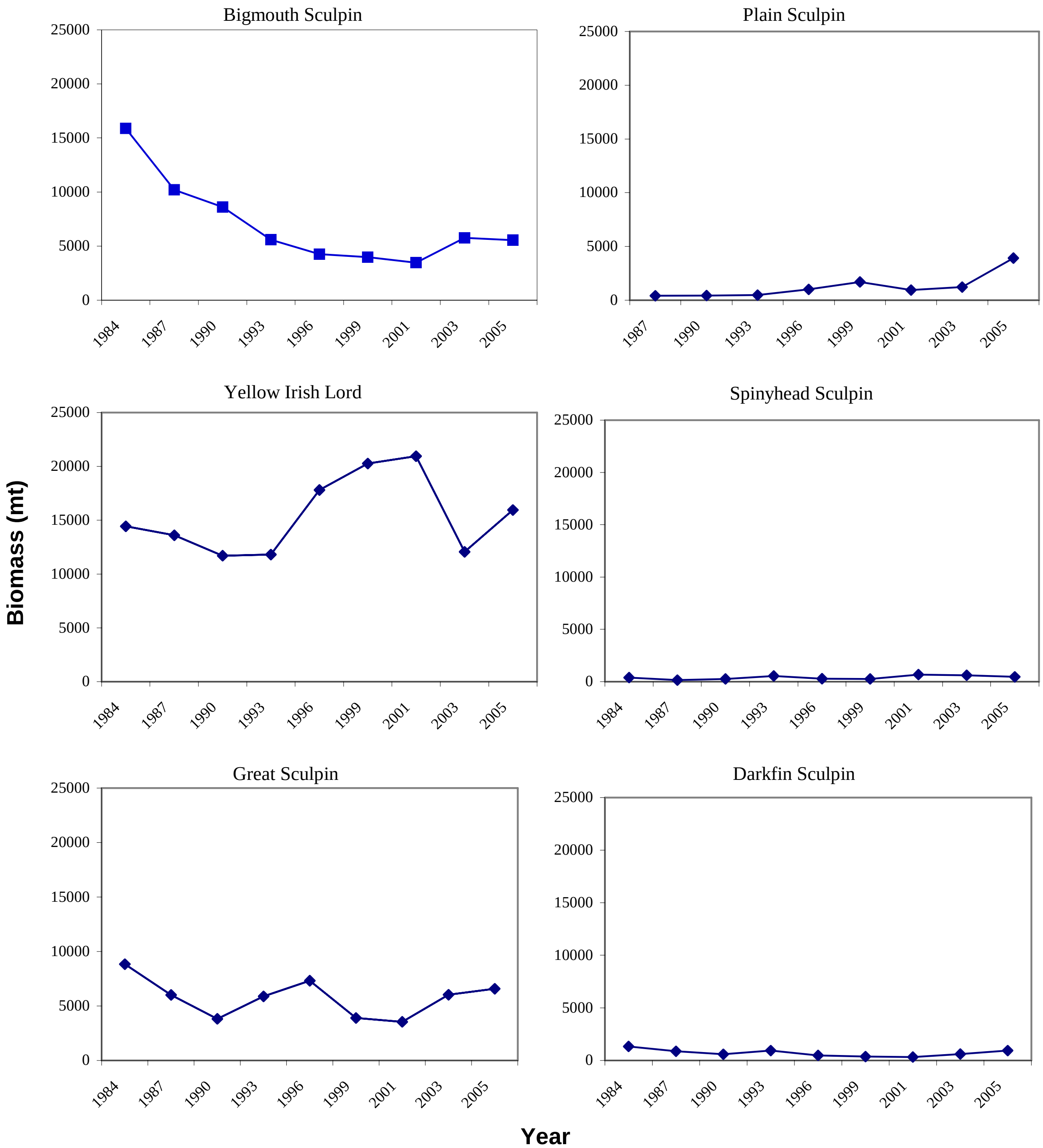

Figure 16.4.1. Biomass time series from GOA bottom trawl surveys for selected sculpin species, 1984-2005.

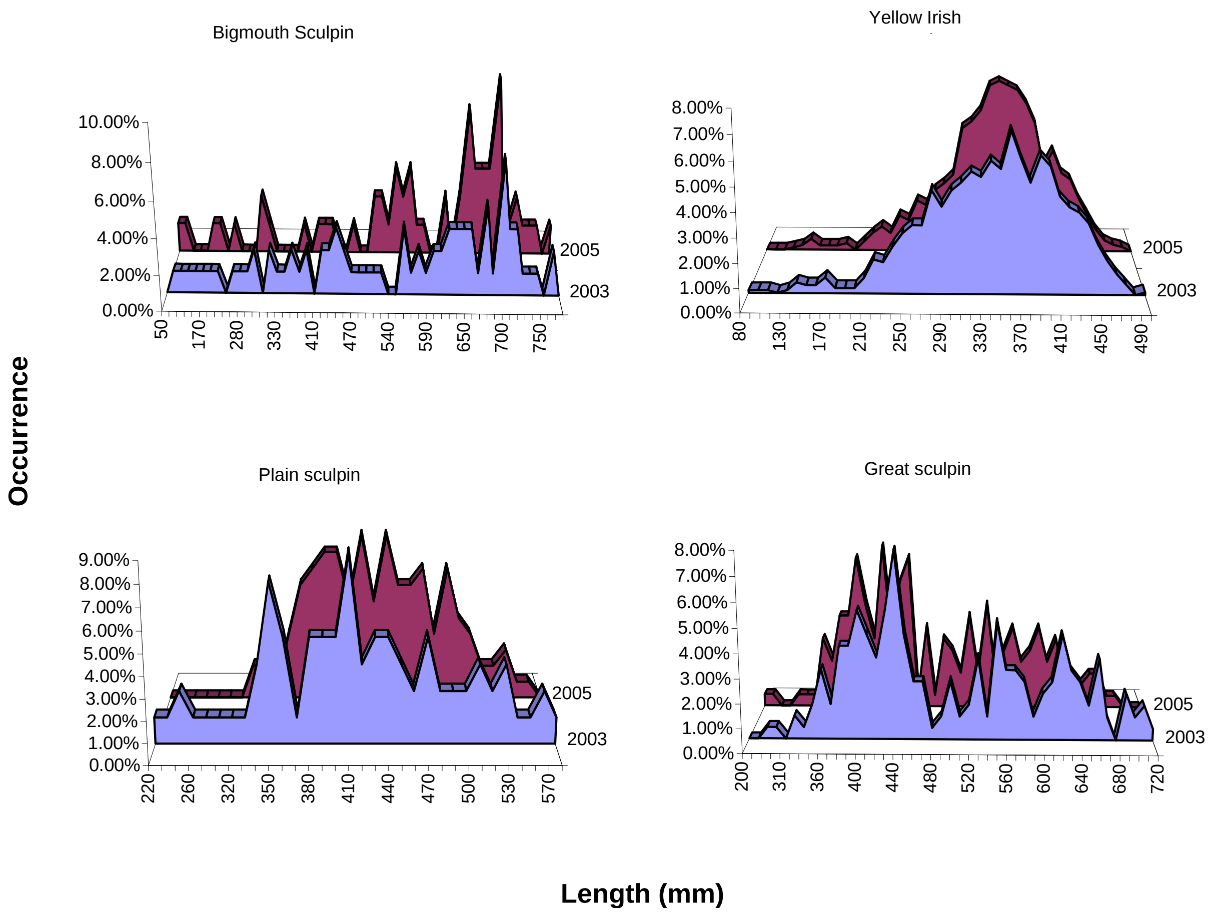

Figure 16.4.2. Length frequencies (fork length, FL in mm) from survey data for the 4 most abundant sculpin species in GOA.

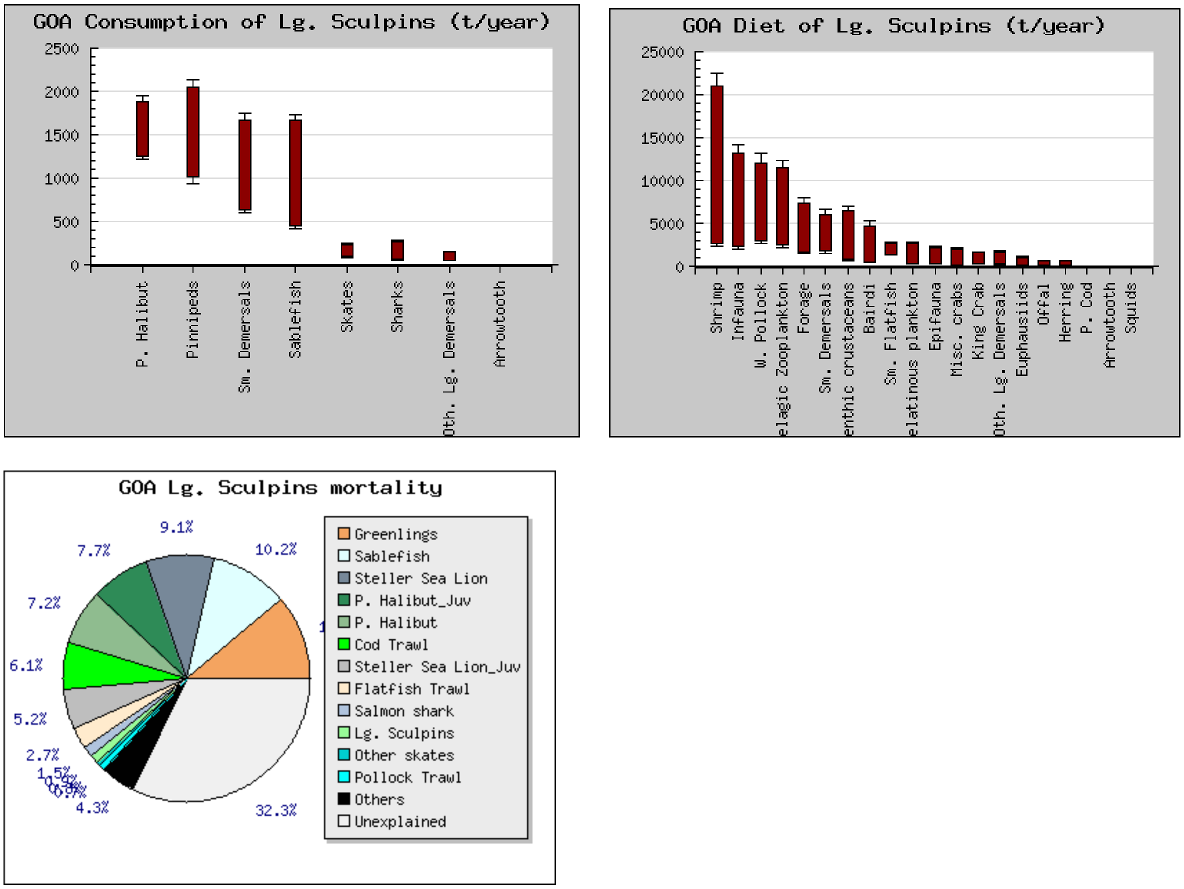

Figure 16.4.3 Diet, consumption and mortality information for Large sculpins in the GOA.

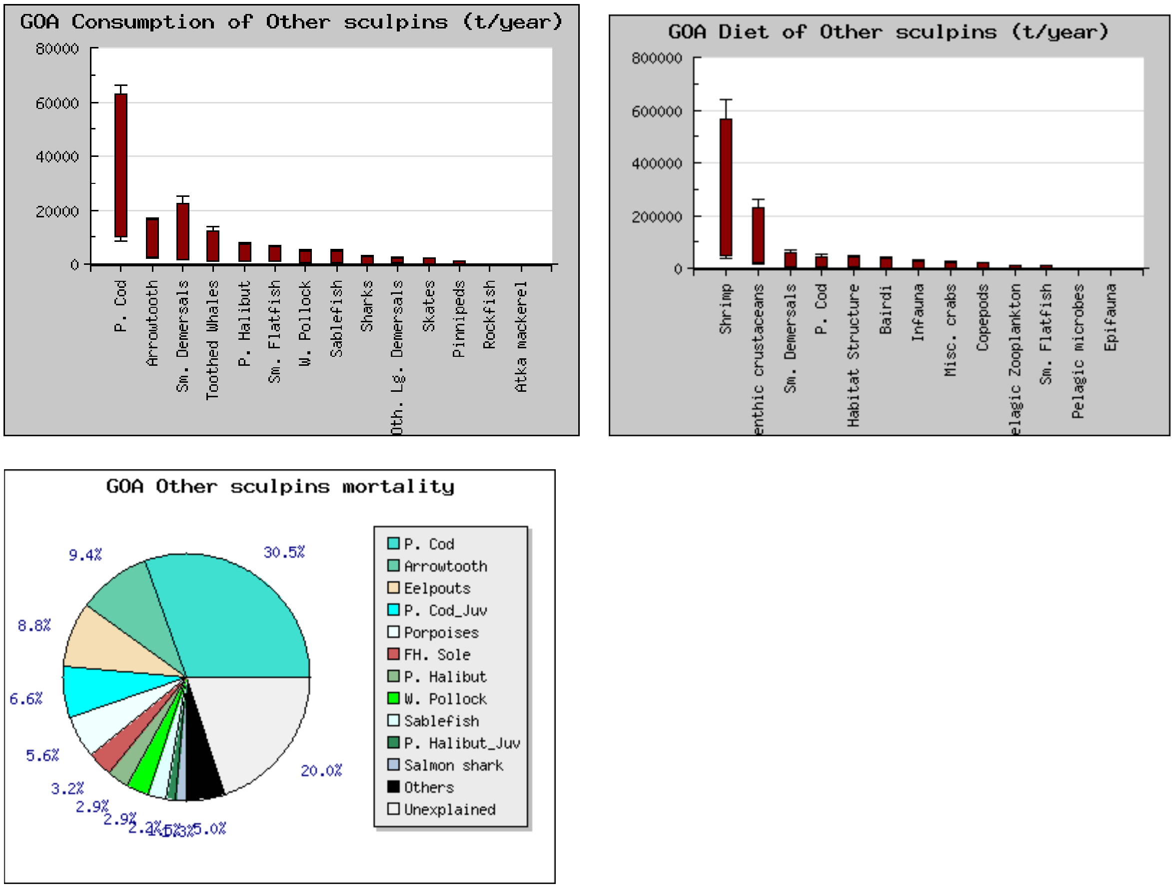

Figure 16.4.4 Diet, consumption and mortality information for Other sculpins in the GOA.

(This page intentionally left blank)