20. 2007 BSAI Sculpins

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Executive Summary

The following appendix of the Other species chapter summarizes the information currently known about sculpins (Families Cottidae, Hemitripteridae, Psychrolutidae, and Rhamphocottidae) in the Bering Sea/Aleutian Islands (BSAI) FMP.

a) Summary of Major Changes

1. Total fishery catch data from 2006 and 2007 to date are presented for the sculpin complex. Data are broken down for sculpins from the following genera: *Hemilepidotus, Myoxocephalus, Hemitripterus.* Data for the rest of the sculpin species found in the BSAI are presented and reported as sculpin unidentified.
2. Information on total sculpin catch by target fishery and gear type for 2006.
3. Biomass estimates from the 2007 Bering Sea Shelf Survey are reported.
4. Authors present information for recommending the splitting of the BSAI sculpin complex into a Bering Sea Shelf assemblage, a Bering Sea Slope assemblage and an Aleutian Island assemblage. Therefore, we suggest separate ABCs and OFLs for each region.
5. Authors present new estimates of natural mortality for four species from the EBS shelf. New ABC/OFL recommendations based on new estimates of M are presented as an alternative to status quo calculations of ABC and OFL.

Alternative ABC/OFL recommendation for Tier 5 Sculpin Complex for 2008-2009

Region	M	Exploitable biomass (mt)	F_{ABC}	ABC (mt)	F_{OFL}	OFL (mt)
EBS_{Warty}	0.13	13,886	0.0975	1,354	0.13	1,805
EBS_{Great}	0.26	60,236	0.195	11,746	0.26	15,661
$EBS_{Threaded}$	0.36	2,077	0.27	561	0.36	748
EBS_{YIL}	0.08	23,352	0.06	1,401	0.08	1,868
$EBS_{Other\ Sculpins}$	0.28	106,755	0.21	22,418	0.28	29,891
EBS slope	0.08	5,953	0.06	357	0.08	476
EBS total				**37,837**		**50,450**
AI	0.16	16,737	0.12	**2,008**	0.16	**2,678**
BSAI		228,995		**39,845**		**53,128**

Status quo recommendation for ABC/OFL for Tier 5 Sculpin Complex for 2008-2009

Region	M	Exploitable biomass (mt)	F_{ABC}	ABC (mt)	F_{OFL}	OFL (mt)
BSAI	0.19	228,995	0.1425	**32,632**	0.19	**43,509**
EBS	0.19	212,258	0.1425	**30,247**	0.19	**40,329**
AI	0.19	16,737	0.1425	**2,385**	0.19	**3,180**

b) Responses to SSC Comments

There were no directed comments from the SSC in 2006 for the BSAI sculpin complex.

Introduction

Description, scientific names, and general distribution

Sculpins are relatively small, benthic-dwelling, teleost fish. This group is especially speciose; during cooperative U.S.-Japan trawl surveys, 41 species of sculpins were identified in the Eastern Bering Sea (EBS) and 22 species in the Aleutian Islands (AI) region. Sculpin diversity remains high in recent surveys of both areas (Table 20.1). Considered as a species complex, sculpins are distributed throughout all benthic habitats from shallow to deep, rocky to flat in the Bering Sea and Aleutian Islands (BSAI), such that they would cover any map of the area completely. In this assessment, we focus on species from the genera *Myoxocephalus*, *Hemitripterus*, and *Hemilepidotus* that observers from the North Pacific Groundfish Observer Program have begun to identify to genus in commercial catches. According to observer catch totals for 2006, these genera contributed nearly 90% of all sculpin catch in the BSAI.

Management units

Sculpins are managed as part of the BSAI Other species complex. This means that their catch is reported in aggregate as “other” along with the catch of sharks, skates, and octopi (BSAI) and squid (GOA). Because catch is officially reported within the Other species complex, estimates of sculpin catch must be made independently for each year using observer data. In the BSAI, catch of Other species is limited by a Total Allowable Catch (TAC) which is based on an Allowable Biological Catch (ABC) estimated by summing the TACs of all Other species groups (Gaichas et al., 2005). Sculpins are currently taken only as bycatch in fisheries directed at target species in the BSAI, so future catch of sculpins is more dependent on the distribution and limitations placed on target fisheries than on any harvest level established for this category. The Other species assessment is also presented in response to a draft revision to the National Standard Guidelines (NSG1, 70 FR 36240, June 22, 2005) of the Magnuson-Stevens Act that call for species assemblage management and the possibility of partitioning the Other species chapter into species assemblage management units.

Life history and stock structure (general)

Despite their abundance and diversity, sculpin life histories are not well known in Alaska. Much of the life history information comes from studies in the western North Pacific. In terms of life history, 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 of greater then 80 cm in the eastern Bering Sea. In the western Pacific, great sculpins are reported to have relatively 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 influenced) 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), which is very different from wide ranging species such as sharks. All of these characteristics indicate that sculpins as a group might be managed separately from the Other species complex, and perhaps most efficiently within a spatial context rather than with a global annual aggregate TAC.

Life history (BSAI-specific)

Information such as depth range, distribution, and maximum length has been collected for several years for many species during surveys. There is limited BSAI-specific age and growth, maturity, or reproductive biology data for sculpins identified in this management region. New age and growth information is now available for the great sculpin, Yellow Irish Lord and Warty sculpin based on samples collected from the 2005-2007 EBS shelf survey. In addition, age and growth, maturity, and diet information are currently being collected for several species as part of a comprehensive study investigating what we call “large sculpins” in the BSAI: great sculpin (*Myoxocephalus polyacanthocephalus*), plain and warty sculpin (*Myoxocephalus jaok* and *M. verrucosus)*, bigmouth sculpin (*Hemitripterus bolini)*, and yellow Irish lord (*Hemilepidotus jordani*). Known life history characteristics for the most abundant sculpin species along the EBS shelf are presented in Table 20.2.

Fishery

Directed fishery

There is no directed fishing for any sculpin species in the BSAI at this time although there has been anecdotal evidence of retention in a processing plant in Dutch Harbor AK (A. Hollowed, personal communication). The authors are working on getting retention/discard rates for large sculpins and other sculpin species of the BSAI.

Background on sculpin bycatch

Skates and sculpins constitute the bulk of the Other species catches, accounting for between 66-96% of the estimated totals in 1992-1997. Based on total catch estimates from 1997-2007 (Table 20.3), sculpins comprised an average of 25% of the total Other species catch during this time period (skates, approx. 70%). Sculpins are caught by a wide variety of fisheries, but trawl fisheries for yellowfin sole, Pacific cod, walleye pollock, Atka mackerel and flathead sole, and Pacific cod hook-n-line fishery catch the most (Table 20.4).

It is likely that the “large sculpin” species (i.e., Yellow Irish lords, great sculpin, plain sculpins,, and bigmouth sculpin; see above), which contribute to the majority of sculpin biomass on surveys, are the species that comprise most of the sculpin catch in groundfish fisheries. It is unclear which sculpin species were commonly taken in BSAI groundfish fisheries up to 2004, because observers did not regularly identify animals in these groups to species. At least 80% (by weight) of the observed sculpin catch in past years was recorded as "sculpin unidentified", with the remainder of catch identified to the genus level (i.e., *Hemilepidotus, Myoxocephalus,* *Gymnocanthus, etc.*). 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 the AFSC initiated a species identification project which was 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 the BSAI region, *Hemitripterus* probably represents only one species, the bigmouth sculpin (Stevenson 2004). Another member of this genus, the sea raven (*H. villosus*), may occur in Alaskan waters but has never been identified in any of the BSAI shelf and slope trawl surveys conducted by AFSC. It is reasonable to assume that all sculpins identified by observers as *Hemitripterus* sculpins were bigmouth sculpins.

Data

Fishery Catch

Catch trend by genus is not available before 2004. Refer to Table 20.3 for total sculpin catch from 1997-2007. Table 20.5 shows that in 2006 *Myoxocephalus* spp. make up 53% of the sculpin total catch in the EBS. *Hemilepidotus* spp. make up 21% of the total sculpin catch in the EBS. *Hemitripterus* spp. (bigmouth sculpin) is primarily caught in the EBS. All other sculpin species, identified as “sculpin unidentified’ contributed only 14% of the total EBS sculpin catch in 2006. It is reasonable to assume that more *Myoxocephalus* sculpins are caught because they constitute nearly 70% of the biomass along the continental shelf, where the majority of fishing occurs. Fishery catch of sculpins is shelf-wide with the majority of the catch along the middle (50-100m) and outer shelf (100-200m) areas. The catch to biomass ratio of the 2006 total catch of sculpin by genus group, relative to the 2007 biomass estimates for the EBS (2006 for the AI) from the surveys is shown in the following table:

Catch/Biomass ratio		
Genus	**EBS (shelf)**	**AI**
Myoxocephalus spp.	0.02	0.11
Hemitripterus spp.	0.02	0.04
Hemilepidotus spp.	0.04	0.03

Total sculpin catch, within the large sculpin group, was calculated by genus for each target fishery and gear type responsible for sculpin bycatch (Table20.4). This analysis indicates that in the Aleutian Islands both the Pacific cod and Atka mackerel bottom trawl fisheries were the main fisheries that caught all three genera of sculpin. In the EBS the Pacific cod bottom trawl and longline fisheries were the main fisheries that caught all three genera of sculpin. In general, gear type rather than target fishery may be the main determinant for sculpin bycatch since bottom trawl gear accounted for much of the sculpin bycatch regardless of fishery.

Survey Biomass trend

Aggregate sculpin biomass in the BSAI shows no clear trend, and should probably not be used as an indicator of population status for a complex with so much species diversity. Trends in biomass are available for only a few sculpin species for the period 1982-2007 due to difficulties with species identification and survey priorities. The species composition of the sculpin complex as estimated by bottom trawl surveys of the EBS shelf, EBS slope, and AI demonstrates the diversity of this complex and the regional differences in its composition. The larger species dominate the EBS shelf, with *Myoxocephalus* spp. being the most common, followed by bigmouth sculpins and yellow Irish lords (Table.20.6). A low coefficient of variation for the biomass estimates of these more abundant species reflects that the EBS shelf bottom trawl survey adequately estimates the biomass of these species. It is interesting to note that the 2006 and 2007 biomass estimates for butterfly sculpin (*H. papilio*) were substantially higher than in previous years (Table 20.6). This may be in response to cooler waters observed in the Bering Sea in 2006 and 2007 since it is thought that this species follows the cold pool north, to areas that aren't surveyed, during warmer years. Biomass estimates for the 5 most abundant sculpin species in the Eastern Bering Sea shelf seem to be relatively stable (Figure 20.1). Two trawl surveys have also been conducted on the EBS slope (in 2002 and 2004), but no biomass trends for sculpin were apparent in this short time series.

Sculpin species identification was only recently implemented in the AI survey. Each of the six most abundant species of sculpin in the AI have estimates at least since 1997, with the yellow Irish lord, bigmouth sculpin, and darkfin sculpin having reliable estimates since 1982. In the AI, yellow Irish lord account for the highest proportion of sculpin biomass, followed by darkfin sculpin, great sculpin, spectacled sculpin, bigmouth sculpin and scissortail sculpin (Table 20.7). The spectacled and scissortail sculpins are two species not found on EBS surveys. The AI survey adequately assesses the biomass of the 5 most abundant sculpin species, which are the larger species of sculpin. Due to varying rates of selectivity, the biomass estimates for the less abundant, smaller species of sculpin are probably not reliable (CV range from 0.31 to 1.00). The smaller sculpin species may be less vulnerable to capture by the gear used during the bottom trawl survey. Biomass trends of sculpin species in the AI seem to be stable with an increase in yellow Irish lord biomass since 1991. (Figure 20.2).

<u>Length frequency and sample size</u>

Eastern Bering Sea

Length measurements (fork length, FL) have been collected for a variety of sculpin species during AFSC surveys. The five most abundant species from the EBS shelf survey have been measured annually since 2000: yellow Irish lord, plain sculpin, warty sculpin, great sculpin and bigmouth sculpin (Figure 20.3). Year by year analysis shows that the length composition by species is generally consistent. However, yellow Irish lord showed more small fish in the earlier years, and there was a conspicuous absence of fish <300 mm in 2007. One interesting observation is that the surveys tend to catch bigmouth sculpins on the higher side of the length range. 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 or they are not fully selected by the gear. Fishery length data may be available for some sculpin species beginning in 2007 through a special project with the AFSC observer program.

Sample sizes for length frequency analysis for EBS:

Species	2000	2001	2002	2003	2004	2005	2006	2007
Yellow Irish Lord				369	516	604	492	272
Plain sculpin	1044	1263	997	1218	1736	1786	1778	1541
Warty sculpin	178	288	130	192	245	323	383	224
Great sculpin	338	327	346	635	681	786	845	749
Big mouth sculpin	50	157	231	179	342	187	207	125

Aleutian Islands

In the AI, few samples have been taken for great and bigmouth sculpin, thus the length frequency analysis does not yield a complete representation of the sculpin species population's size composition. Yellow Irish lords have 5 survey years of data and show a consistent size composition (Figure 20.4). Darkfin and spectacled sculpin only have length data collected from the 2002 survey. Specimens smaller than 70 mm have not been collected for many sculpins, but this may be a factor of size selectivity of the survey gear.

Sample sizes for length frequency analysis for AI

Species	2000	2002	2004	2006
Yellow Irish Lord	170	567	986	1,099
Great sculpin	12	23	58	65
Big mouth sculpin	8	29	27	41

Length at age and weight at age

In 2007, the Age and Growth group at the AFSC has worked up ages for the following species of sculpin from the Eastern Bering Sea shelf survey: Great (max age = 16), Yellow Irish Lord (max age = 24), and Warty (max age = 17).

Analytical Approach and Results

The available data do not currently support population modeling for sculpins in the BSAI, although natural mortality (M) was estimated for several species of sculpin in various regions including the Eastern Bering Sea.

Parameters Estimated Independently

Natural Mortality

An analysis was undertaken to explore alternative methods to estimate natural mortality (M) for sculpin species found in the BSAI. Several methods were employed based on correlations of M with life history parameters including growth parameters (Alverson and Carney 1975, Pauly 1980, Charnov 1993), longevity (Hoenig 1983), and reproductive potential (Rikhter and Efanov 1976). Prior to 2007 little information was available for sculpin stocks in the BSAI FMP area, so M was estimated using reproductive potential methods applied to data for Russian sculpin species (Rikhter and Efanov 1976). In 2007, natural mortality estimates have been calculated for some sculpin species from the EBS shelf (Warty sculpin (0.13), Great Sculpin (0.26), Threaded Sculpin (0.36) and Yellow Irish Lord(0.08); Table 20.8). Due to this new information, the most conservative estimates of M, with respect to species, will be used. For other sculpin species that may not have an estimate of M for the BSAI, we elected to use a proxy for M from the resultant most abundant species (Plain sculpin in the EBS shelf (0.28), Yellow Irish Lord for the EBS slope (0.08) and a preliminary M for Yellow Irish Lord in the AI (0.16)) (Table 20.8). Choosing the lowest estimate of M is considered conservative because it will result in the lowest estimates of ABC and OFL under Tier 5. Until we find better information on sculpin productivity in the BSAI, this is still the best interim measure balancing sculpin conservation and allowing for historical levels of incidental catch in target groundfish fisheries. However, new data from an on-going sculpin study in the BSAI may allow for more region-specific M estimates in the future.

Assemblage analysis and recommendations

Currently all sculpin species from the BSAI are lumped into one complex. Analysis of species composition, abundance and occurrence of endemic species within the EBS and AI was done to determine if the complex should be split by region. Results of this analysis indicated that species composition in the EBS and AI is different(Figure 20.5). Although a few species such as *Myoxocephalus polyacanthocephalus*, *Hemilepidotus jordani*, and *Hemitripterus bolini* occur in both the EBS and AI regions, their proportion of biomass relative to the complex vary greatly (Table 20.6 and 20.7). In both regions endemic species are also found. *Myoxocephalus jaok* and *M. verucosus* only occur on the EBS shelf. In the AI *Artediellus forficata* and *Enophrys diceraus* may be endemic. Splitting the biomass to obtain separate ABC and OFL for each region will allow for adequate monitoring of those species in the AI.

ABC and OFL recommendations

Leaving sculpins within the larger aggregate of the Other species complex provides no benefit to the resource or to the fisheries that might wish to retain some other species but cannot when the aggregate TAC is exceeded, as it was in 2004. For 2006, the Other species TAC was set at 29,000 mt and 99% of the TAC was caught. Currently, as of 10/06/2007, 81% of the Other species TAC has been caught according to the NMFS Alaska Regional Office (http://www.fakr.noaa.gov/2007/car110_bsai_with_cdq.pdf). Because sculpins are such a diverse category themselves, and because their life history is so different from skates, sharks, and octopi as described above, we recommend that they be managed separately from the Other species complex. 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 estimates of M are the best available for managing this species complex until the research initiated in the Bering Sea is completed.

We recommend a Tier 5 approach be applied to the sculpin complex within the EBS and AI regions as long as the catch remains incidental and no target fishery develops. We further recommend using a 6 year average of aggregate biomass so that we may include multiple estimates from each of the EBS shelf, slope, and AI bottom trawl surveys, but can still capture recent biomass trends.

This year the authors would like to suggest an alternative method to calculating the ABC and OFL of the BSAI sculpin complex. Since estimates of M for a few sculpin species from the EBS shelf have been estimated in 2007, then we suggest that the average EBS shelf biomass and their respective estimate of M be used to calculate their respective ABC and OFL. Therefore, Sculpin EBS $_{ABC}$ is defined as (Warty$_{ABC}$ + Great$_{ABC}$ + Threaded$_{ABC}$ + Yellow Irish Lord $_{ABC}$ + Other Sculpins$_{ABC}$ + EBS slope $_{ABC}$), likewise for EBS $_{OFL}$. In tier 5, F_{ABC} is defined to be <=0.75 x M and F_{OFL} is defined to be equal to M. Applying the M estimate for those sculpins in the EBS with an estimate to their respective 6 year (2002 – 2007 for EBS shelf; 2000-2006 AI; 2002, 2004 for EBS slope) average of bottom trawl survey biomass estimates by region, we calculate a sculpin EBS ABC of [{Warty (13,886*(0.75 * 0.13))} + {Great (60,236*(0.75*0.26))}+ Threaded(2,077*(0.75*0.36))}+ Yellow Irish Lord (23,352*(0.75*0.08))}+ Other sculpins (106,755*(0.75*0.28))} + EBS slope (5,953 mt*(0.75*0.08))} = **37,837 mt for the EBS** and we calculate an ABC of 0.75 * 0.16 * (AI biomass; 16,737) = **2,008 mt for the AI**. Using the same method to calculate OFL, (EBS shelf + EBS slope+ AI biomass) = **53,127 mt for the BSAI**.

The status quo method would apply the M estimate of 0.19 (the most conservative estimate of M prior to 2007) to the 6 year (2002 – 2007 for EBS shelf; 2000-2006 AI; 2002, 2004 for EBS slope) average of bottom trawl survey biomass estimates by region, we calculate an ABC of (0.75 * 0.19) * (EBS shelf (206,305 mt)+ EBS slope (5,953 mt) = 212,258 mt) = 30,247mt for the EBS and we calculate an ABC of 0.75 * 0.19 * (AI biomass; 16,737) = 2,385 mt. Using the same method to calculate OFL, 0.19 * (EBS shelf + EBS slope+ AI biomass = 228,995 mt) = 43,509 mt for the BSAI.

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 specfic 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, assuming the species was being identified to species level by the observer program. If a targeted species of sculpin is one with a low abundance and thus low TACs, then alternative management strategies such as closed areas should be considered.

Ecosystem Considerations

Ecosystem Effects on Stock

Little is known about sculpin food habits in the BSAI, especially during fall and winter months. Aydin et al. (in review) has produced some diet analyses and consumption/predation tables based on ecosystem modeling and direct species data for the BSAI. Limited information indicates that in the EBS the larger sculpin species prey on shrimp and other benthic invertebrates, as well as some juvenile walleye pollock (Figure 20.6). In the EBS the main predator of large sculpins are Pacific cod (Figure 20.6). Although the greatest mortality of large sculpins is unexplained, their fishing mortality is due to the flatfish bottom trawl fishery and Pacific Cod longline, trawl and pot fisheries as supported by data in Table 20.4. Other sculpins in the EBS feed mainly on shrimp and benthic amphipods (Figure 20.7). Other sculpins are preyed upon by pinnipeds, Pacific cod and small demersal fish, but their main source of mortality is from consumption by eelpouts, wintering seals and the Alaska skate (Figure 20.7). In the AI large sculpin have a different diet than in the EBS, consisting of crabs, Atka mackerel and miscellaneous shallow water fish (Figure 20.8). Large sculpins in the AI are preyed upon mainly by Pacific halibut, but the main source of their mortality is from “other” groundfish bottom trawl fishery (Figure 20.8). Diet of other sculpins in the AI consists of polychaetes and benthic amphipods (Figure 20.9).

Pacific cod and walleye pollock are the main predators of other sculpins and are the main source of mortality of other sculpins in the AI (Figure 20.9).

Fishery Effects on the Ecosystem

Analysis of ecosystem considerations for those fisheries that affect the stocks within this complex (see Table 20.5) is given in the respective fisheries SAFE chapter. The BSAI 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 effect	Probably no concern
a. Predator population trends			
Marine mammals	Fur seals declining, Steller sea lions increasing slightly	No effect	Probably no concern
Birds	Stable, some increasing some decreasing	No effect	Probably no concern
Fish (Pollock, Pacific cod, halibut)	Stable to increasing	effects not known	Probably no concern
b. Changes in habitat quality			
Temperature regime	Butterfly sculpin biomass increases during years the cold pool extends throughout EBS shelf.	Warming of EBS shelf may shift population northward	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)**			

Data gaps and research priorities

Sculpin life history has been studied more extensively in the western Bering Sea and associated waters. Life history data gaps continue to persist in the eastern Bering Sea and Aleutian Island regions. These data are necessary to improve management strategies and stock assessments for this non-target species group. A newly funded study concentrating on large sculpins (great sculpin, plain sculpins, bigmouth sculpin, and yellow Irish lord) addresses some of these data gaps. Age and growth, maturity, and diet information is being investigated for populations inhabiting both the eastern Bering Sea shelf and the Aleutian Islands. Data collection began in 2006 and will continue through April 2008. Age and growth analysis of some of these species will also include prior years. Some preliminary results from this study should be available for use in the 2007 SAFE.

Summary

Below are the recommendations for ABC and OFL for an EBS sculpin complex and AI sculpin complex. BSAI numbers are shown for reference.

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Table 20.1. Members of the Sculpin complex observed during eastern Bering Sea and Aleutian Islands bottom trawl surveys. Updated 2004.

Family	Scientific name	Common name
Cottidae	*Archistes biseriatus*	Scaled sculpin
	Artediellus miacanthus	Bride sculpin
	Artediellus pacificus	Pacific hookear sculpin
	Bolinia euryptera	Broadfin sculpin
	Enophrys diceraus	Antlered sculpin
	Enophrys lucasi	Leister sculpin
	Gymnocanthus detrisus	Purplegray sculpin
	Gymnocanthus galeatus	Armorhead sculpin
	Gymnocanthus pistilliger	Threaded sculpin
	Gymnocanthus tricuspis	Arctic staghorn sculpin
	Hemilepidotus gilberti	Banded Irish lord
	Hemilepidotus hemilepidotus	Red Irish Lord
	Hemilepidotus jordani	Yellow Irish Lord
	Hemilepidotus papilio	Butterfly sculpin
	Hemilepidotus zapus	Longfin Irish lord
	Icelinus borealis	Northern sculpin
	Icelus canaliculatus	Blacknose sculpin
	Icelus euryops	Wide-eye sculpin
	Icelus spatula	Spatulate sculpin
	Icelus spiniger	Thorny sculpin
	Icelus uncinalis	Uncinate sculpin
	Jordania zonope	Longfin sculpin
	Leptocottus armatus	Pacific staghorn sculpin
	Myoxocephalus jaok	Plain sculpin
	Myoxocephalus polyacanthocephalus	Great sculpin
	Myoxocephalus quadricornis	Fourhorn sculpin
	Myoxocephalus verrucocus	Warty sculpin
	Radulinus asprellus	Slim sculpin
	Rastrinus scutiger	Roughskin sculpin
	Thyriscus anoplus	Sponge sculpin
	Triglops forficatus	Scissortail sculpin
	Triglops macellus	Roughspine sculpin
	Triglops metopias	Crescent-tail sculpin
	Triglops pingelii	Ribbed sculpin
	Triglops septicus	Spectacled sculpin
	Triglops xenostethus	Scalybreasted sculpin
	Zesticelus profundorum	Flabby sculpin
Hemitripteridae	*Blepsias bilobus*	Crested sculpin
	Hemitripterus bolini	Bigmouth sculpin
	Nautichthys oculofasciatus	Sailfin sculpin
	Nautichthys pribilovius	Eyeshade sculpin
Psychrolutidae	*Dasycottus setiger*	Spinyhead sculpin
	Eurymen gyrinus	Smoothcheek sculpin
	Malacoccottus zonurus	Darkfin sculpin
	Malacocottus kincaidi	Blackfin sculpin
	Psychrolutes paradoxus	Tadpole sculpin
	Psychrolutes phrictus	Blob sculpin
Rhamphocottidae	*Rhamphocottus richardsoni*	Grunt sculpin

Table 20.2. Life history information available for selected BSAI sculpin species.

Species	Common Name	Maximum Length (cm)			Maximum Age		Fecundity (x1000)	Age at 50% Maturity
		Other	AI	EBS	Other	BSAI		
Myoxocephalus joak	Plain sculpin	75	NA	63	15		25.4 - 147	5 - 8
M. polyacanthocephalus	Great sculpin	82	76	82	13	16	48 - 415	6 - 8
M. verrucosus	Warty sculpin	78	NA	78		17	2.7	
Hemitripterus bolini	Bigmouth sculpin	83	83	78				
Hemilepidotus jordani	Yellow Irish lord	65	65	50	13	24	25 - 241	6 - 7
H. papilio	Butterfly sculpin	38		38				
Gymnocanthus pistilliger	Threaded sculpin	27		20	13	10	5 - 41	
G. galeatus	Armorhead sculpin	46		36	13		12 - 48	
Dasycottus setiger	Spinyhead sculpin	45		34	11			
Icelus spiniger	Thorny sculpin	17		17				
Triglops pingeli	Ribbed sculpin	20			6		1.8	
T. forficata	Scissortail sculpin	30		30	6		1.7	
T. scepticus	Spectacled sculpin	25	25	NA	8		3.1	
Malacoccottus zonurus	Darkfin sculpin		30	NA				

References: AFSC; Panchenko 2001; Panchenko 2002; Tokranov 1985; Andriyashev 1954; Tokranov 1988; Tokranov 1989; Tokranov 1995; Hoff 2000; Tokranov and Orlov 2001.

Table 20.3. Total catch (mt) of sculpin complex compared to Other species catch (including squid), 1997-2007.

Year	Other species ABC	Other species TAC	Other species OFL	BSAI Other species catch	EBS Sculpin catch	AI Sculpin Catch	BSAI Sculpin Catch	% of Sculpin in Other spp. catch (BSAI)
1997	25,800	25,800		25,176	6,707	771	7,478	30%
1998	25,800	25,800	134,000	25,531	5,204	1,081	6,285	25%
1999	32,860	32,860	129,000	20,562	4,503	967	5,470	27%
2000	31,360	31,360	71,500	26,108	5,673	1,413	7,086	27%
2001	33,600	26,500	69,000	27,178	6,067	1,603	7,670	28%
2002	39,100	30,825	78,900	28,619	6,043	1,133	7,176	25%
2003	43,300	32,309	81,100	27,356	5,350	598	5,948	22%
2004	46,810	27,205	81,150	30,530	5,258	887	6,145	20%
2005	53,860	29,000	87,920	30,609	5,094	676	5,770	19%
2006*	58,882	29,000	89,404	28,202	4,887	912	5,799	21%
2007**	68,800	37,355	91,700	23,766	6,061	681	6,742	28%

Data sources: Other species ABC, TAC, OFL, and catch from AKRO website
2007 Other species catch updated October 6, 2007
, * 2006 data updated and is now complete
**2007 sculpin data complete as of October 10, 2007

Table 20.4 Total catch (mt) of Large sculpins (*Hemilepidotus* spp., *Hemitripterus* spp. *and Myoxocephalus* spp.) by target fishery and gear, from 2006 for Aleutian Islands and Eastern Bering Sea. *Source: NMFS AK regional office catch accounting system. Note: Amounts below do not add up to the total catch of the Sculpin complex.*

2006
Aleutian Islands

Large Sculpins

Target fishery	Gear type			
	Bottom Trawl	Pelagic Trawl	Pot	Longline
Atka Mackerel	369	-	-	-
Pacific Cod	176	-	21	112
Flatfish	-	-	-	-
Rockfish	10	-	-	-
Sablefish	-	-	<1	<1
Pollock	<1	<1	-	-

2006
Eastern Bering Sea

Large sculpins

Target fishery	Gear type			
	Bottom Trawl	Pelagic Trawl	Pot	Longline
Pacific Cod	884	-	266	761
Flatfish	2,126*	-	-	<1
Pollock	<1	152	-	-
Sablefish	-	-	<1	<1
Rockfish	<1	-	-	-
Atka Mackerel	25	-	-	-

- 51% of sculpin catch in the flatfish bottom trawl is from Yellowfin Sole fishery, followed by 24% in the flathead sole fishery and 22% in the Rock sole fishery.

Table 20.5. Extrapolated total catch (mt) of Large sculpins (*Hemilepidotus* spp., *Hemitripterus* spp. *and Myoxocephalus* spp.) based on proportion of observed catch. *Source: NMFS AK regional office catch accounting system.*

2007*	**Eastern Bering Sea**	**Aleutian Islands**
Myoxocephalus spp.	3,758	13
Hemilepidotus spp.	1,098	533
Hemitripterus spp. Bigmouth sculpin	413	45
Sculpin unidentified	792	91
Total	**6,061**	**682**

*As of October 5, 2007

2006	**Eastern Bering Sea**	**Aleutian Islands**
Myoxocephalus spp.	2,575	83
Hemilepidotus spp.	1,008	424
Hemitripterus spp. Bigmouth sculpin	641	184
Sculpin unidentified	663	222
Total	**4,887**	**913**

Table 20.6. Sculpin complex biomass (mt) from the 2001-2007 Bering Sea shelf survey. CV = coeficient of variation.

		Biomass						CV
Sculpin species	**common**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2007**
Myoxocephalus jaok	plain	52,525	79,337	68,671	76,540	66,819	77,836	0.11
Myoxocephalus polyacanthocephalus	great	64,881	64,486	58,505	55,957	54,456	63,132	0.12
Hemitripterus bolini	bigmouth	32,178	29,274	34,748	31,002	30,116	27,859	0.18
Hemilepidotus jordani	yellow Irish lord	9,430	14,220	33,630	27,380	31,684	23,765	0.34
Myoxocephalus verrucosus	warty	10,801	7,058	10,089	25,897	16,099	13,370	0.27
Gymnocanthus pistilliger	threaded	1,560	1,137	1,275	1,977	2,385	4,126	0.41
Dasycottus setiger	spinyhead	1,194	1,274	1,019	4,469	2,479	1,949	0.18
Gymnocanthus galeatus	armorhead	1,708	720	785	1,551	1,732	990	0.78
Icelus spiniger	thorny	767	715	616	543	596	478	0.23
Triglops pingeli	ribbed	155	142	556	264	400	309	0.46
Hemilepidotus papilio	butterfly	686	628	379	370	1,491	1,653	0.49
Malacocottus zonurus	darkfin	529	11	122	35	69	46	0.89
Triglops macellus	roughspine	3	10	62	111	168	57	0.59
Triglops scepticus	spectacled	255	298	29	112	365	217	0.79
Icelus spatula	spatulate	19	3	13	20	46	49	0.19
sculpin unid (all others)		2	0	10	0	0	0	-
Artediellus pacificus	hookear	2	0	trace	3	1	4	0.72
Triglops forficata	scissortail	0	0	0	0	0	0	-
Leptocottus armatus	staghorn	0	0	0	210	91	0	-
Enophrys diceraus	antlered	0	0	0	0	0	0	-
Blepsias bilobus	crested					23	0	-
Hemilepidotus Hemilepidotus	Red Irish lord						5	1.00
Nauticthys pribilovius	eyeshade						1	1.00
Eurymen gyrinus	smoothcheek						4	0.88
Total		**176,695**	**199,313**	**210,509**	**226,441**	**209,020**	**215,850**	**0.07**

Table 20.7. Sculpin complex biomass (mt) from the 1997-2006 Aleutian Islands trawl survey. CV = coefficient of variation.

Species	Common Name	Biomass					CV
		1997	2000	2002	2004	2006	2006
Hemilepidotus jordani	Yellow Irish lord	4,667	6,624	4,282	8,361	10,797	0.16
Malacocottus zonurus	Darkfin sculpin	3,442	2,533	3,971	4,493	4,520	0.17
Myoxocephalus polyacanthocephalus	Great sculpin	2,138	1,161	1,547	1,519	2,121	0.20
Triglops scepticus	Spectacled sculpin	1,344	1,121	2,393	1,038	993	0.29
Hemitripterus bolini	Bigmouth sculpin	1,617	1,026	1,191	790	1,647	0.32
T. forficata	Scissortail sculpin	219	66	442	2,073	136	0.43
Gymnocanthus galeatus	Armorhead sculpin	105	287	207	506	424	0.34
Sculpin unid. (all others)		75	49	137	101	181	0.31
Dasycottus setiger	Spinyhead sculpin	71	19	23	72	12	0.62
Enophrys diceraus	Antlered sculpin	0	0	20	17	8	1.00
Myoxocephalus jaok	Plain sculpin	0	0	32	0	0	
Leptocottus armatus	Pacific staghorn sculpin	0	0	0	9	0	
Total		**13,678**	**12,886**	**14,245**	**18,979**	**20,839**	

Table 20.8. List of available natural mortality information for sculpins.

Species	Area	Sex	Hoenig	Rikhter & Efanov	Alverson & Carney	Charnov
Red Irish lord	Puget Sound		0.70			
Longfin Irish lord	Kuril Islands	*F*	0.47		0.70	0.22
Yellow Irish lord	Kamchatka	*M*	0.32	0.24		
	Kamchatka	*F*	0.35	0.24		
	E. Bering Sea**	*M*	0.17		0.13	0.33
	E. Bering Sea**	*F*	0.17		**0.08**	0.45
	Aleutian Is.*	*M*	0.21		0.20	0.29
	Aleutian Is.*	*F*	0.16		0.12	0.31
Pacific staghorn sculpin	California	*F*	0.42			
Threaded sculpin	E. Bering Sea**	*M*	0.42		0.36	0.65
	E. Bering Sea**	*F*	0.47		0.58	0.40
Armorhead sculpin	Kamchatka	*M*	0.38			
	Kamchatka	*F*	0.32			
Great sculpin	Kamchatka	*M*	0.47	0.26		
	Kamchatka	*F*	0.32	0.19		
	E. Bering Sea**	*M*	0.28			
	E. Bering Sea**	*F*	0.26		0.29	0.30
Plain sculpin	Sea of Japan	*M*	0.35	0.29		
	Sea of Japan	*F*	0.28	0.22	0.38	0.20
	Kamchatka	*M*	0.47	0.32		
	Kamchatka	*F*	0.35	0.22		
Warty sculpin	E. Bering Sea**	*M*	0.28		0.13	0.73
	E. Bering Sea**	*F*	0.25		0.16	0.50

References: AFSC; Panchenko 2001; Panchenko 2002; Tokranov 1985; Tokranov 1988; Tokranov 1989; Tokranov 1995; Hoff 2000; Tokranov and Orlov 2001, Tokranov et al. 2003; Weiss 1969

*Natural Mortality rates from the Aleutian Islands are preliminary.

** Natural mortality estimates new for 2007.

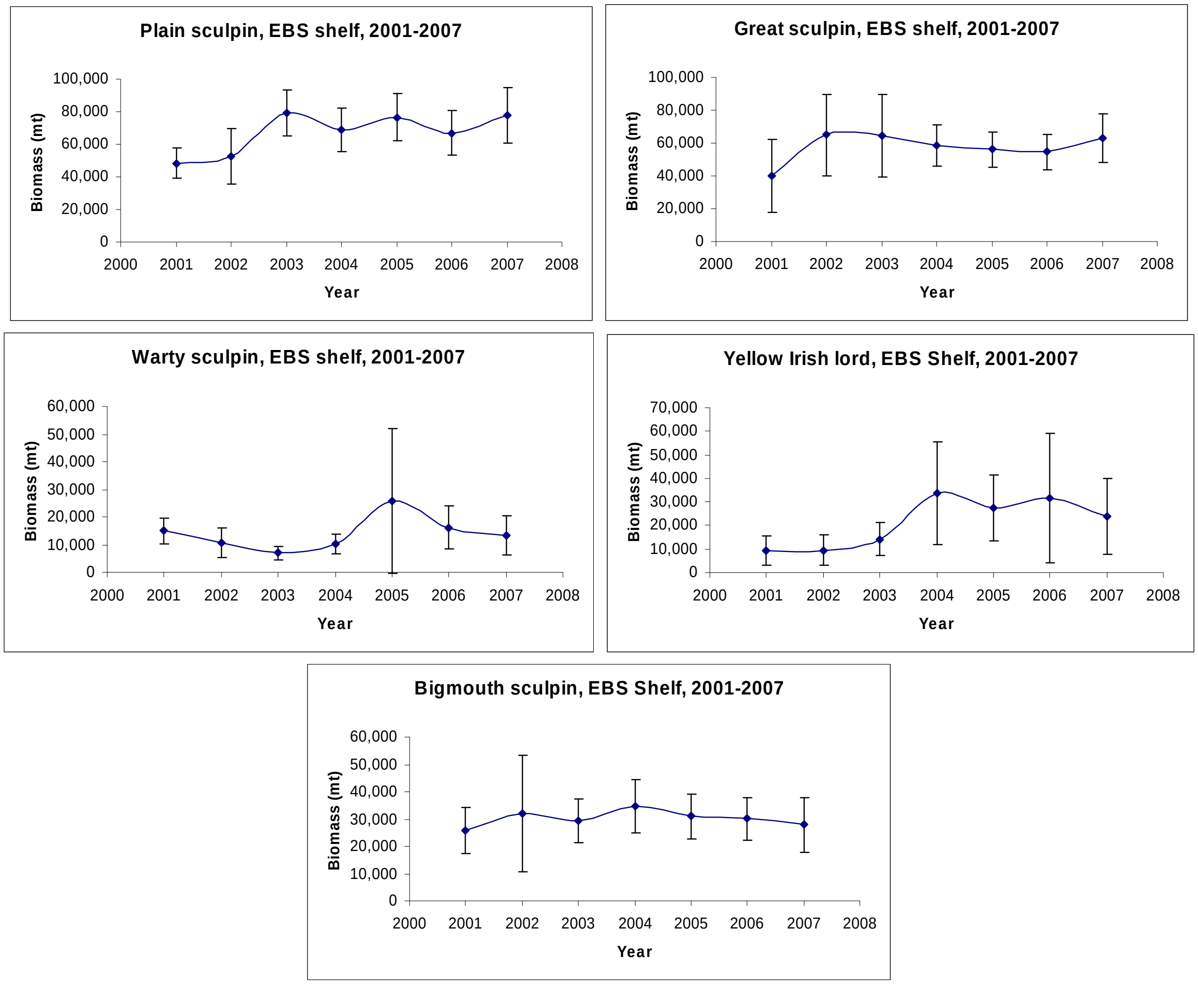

Figure 20.1. Biomass time series (with 95% Confidence Intervals) from annual EBS shelf bottom trawl surveys for selected sculpin species, 2001-2007.

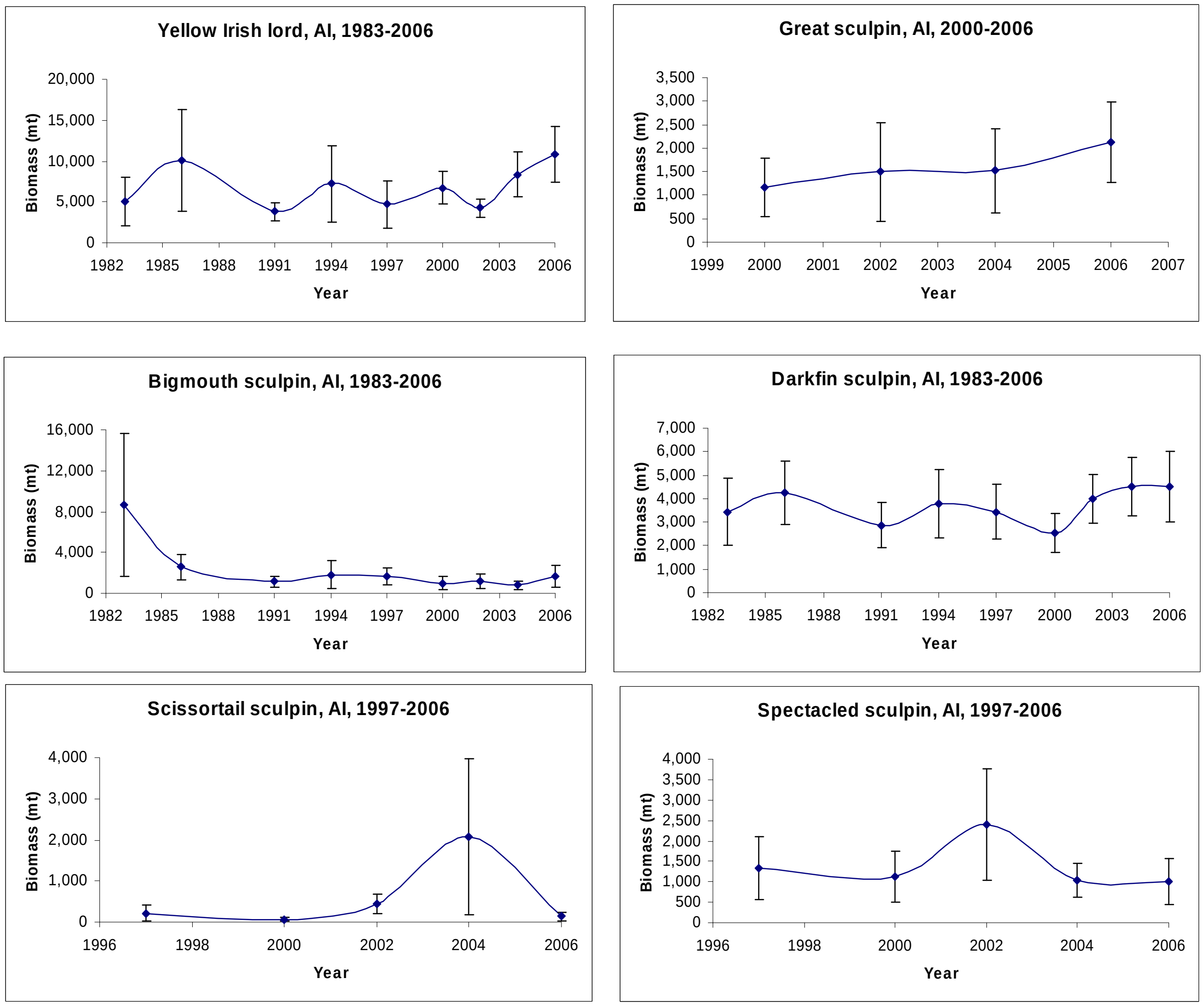

Figure 20.2. Biomass time series (with 95% Confidence Intervals) for the six most abundant sculpin species in Aleutian Islands trawl survey 1980-2006. Note: Some sculpin species were not regularly identified to species-level until recent surveys.

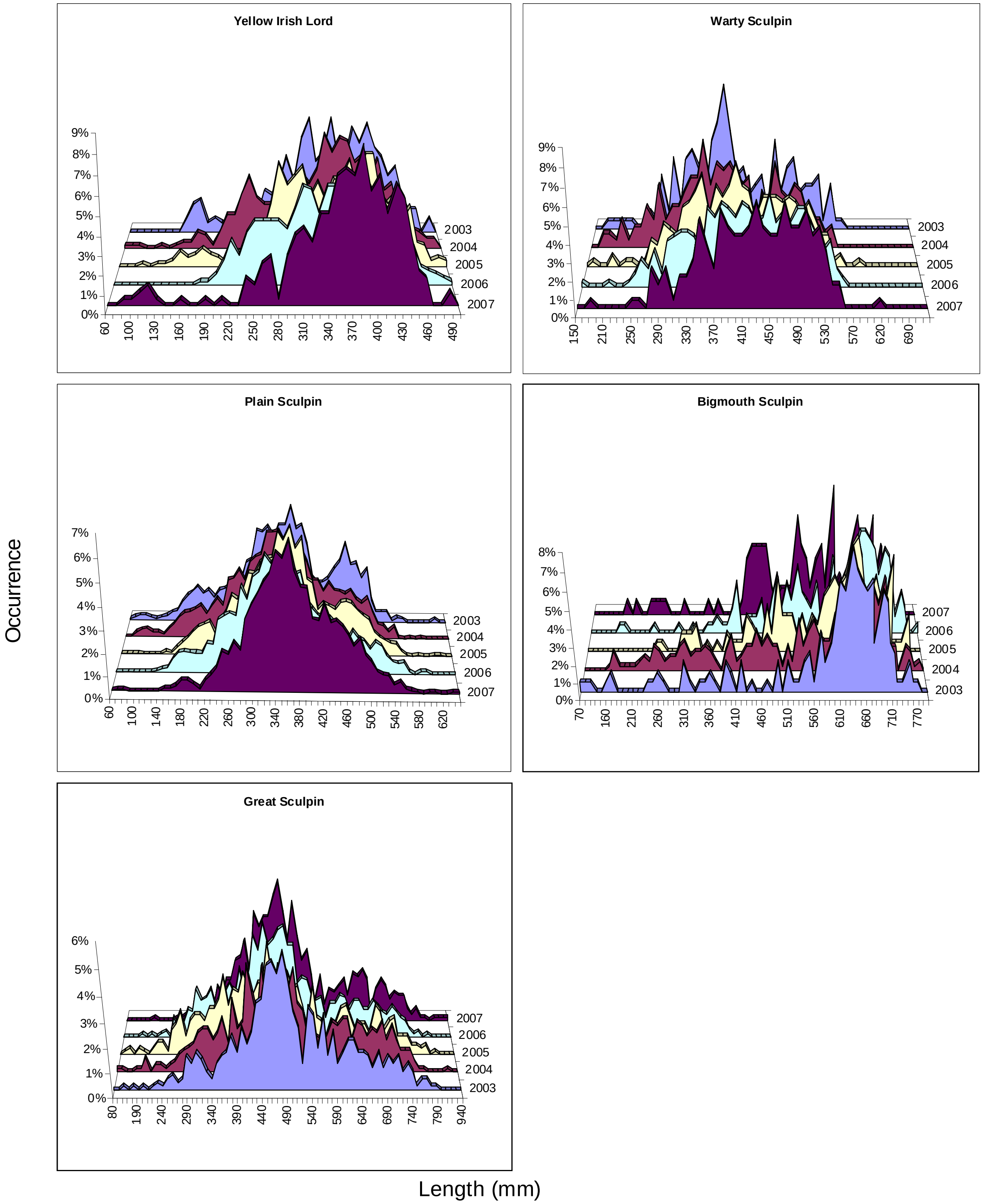

Figure 20.3. Length frequencies (fork length, FL in mm) from survey data for the five most abundant sculpin species in EBS. Note: Plain and warty sculpins found only on EBS shelf.

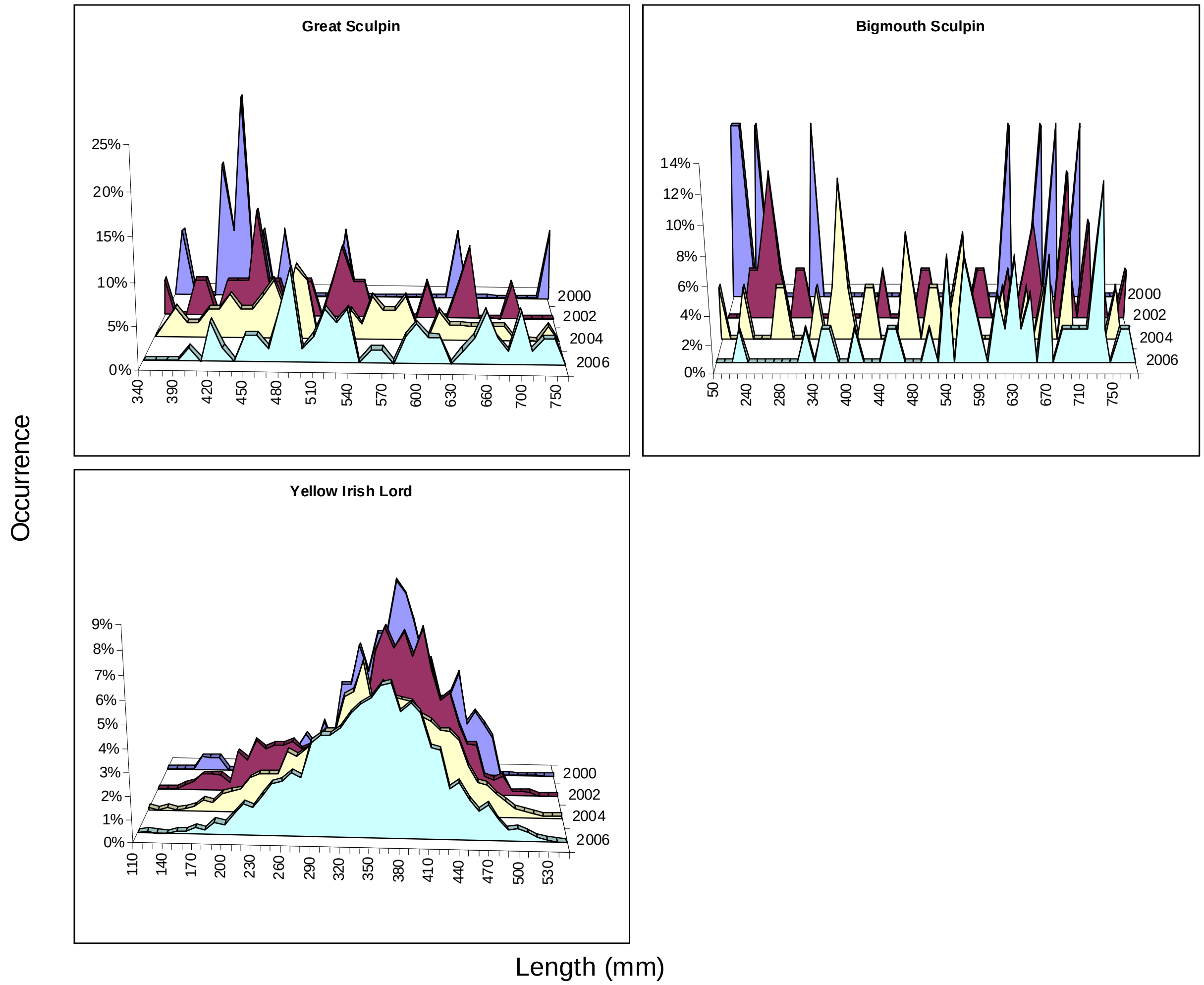

Figure 20.4. Length frequencies (fork length, FL in mm) from survey data for the 3 most abundant sculpin species in AI.

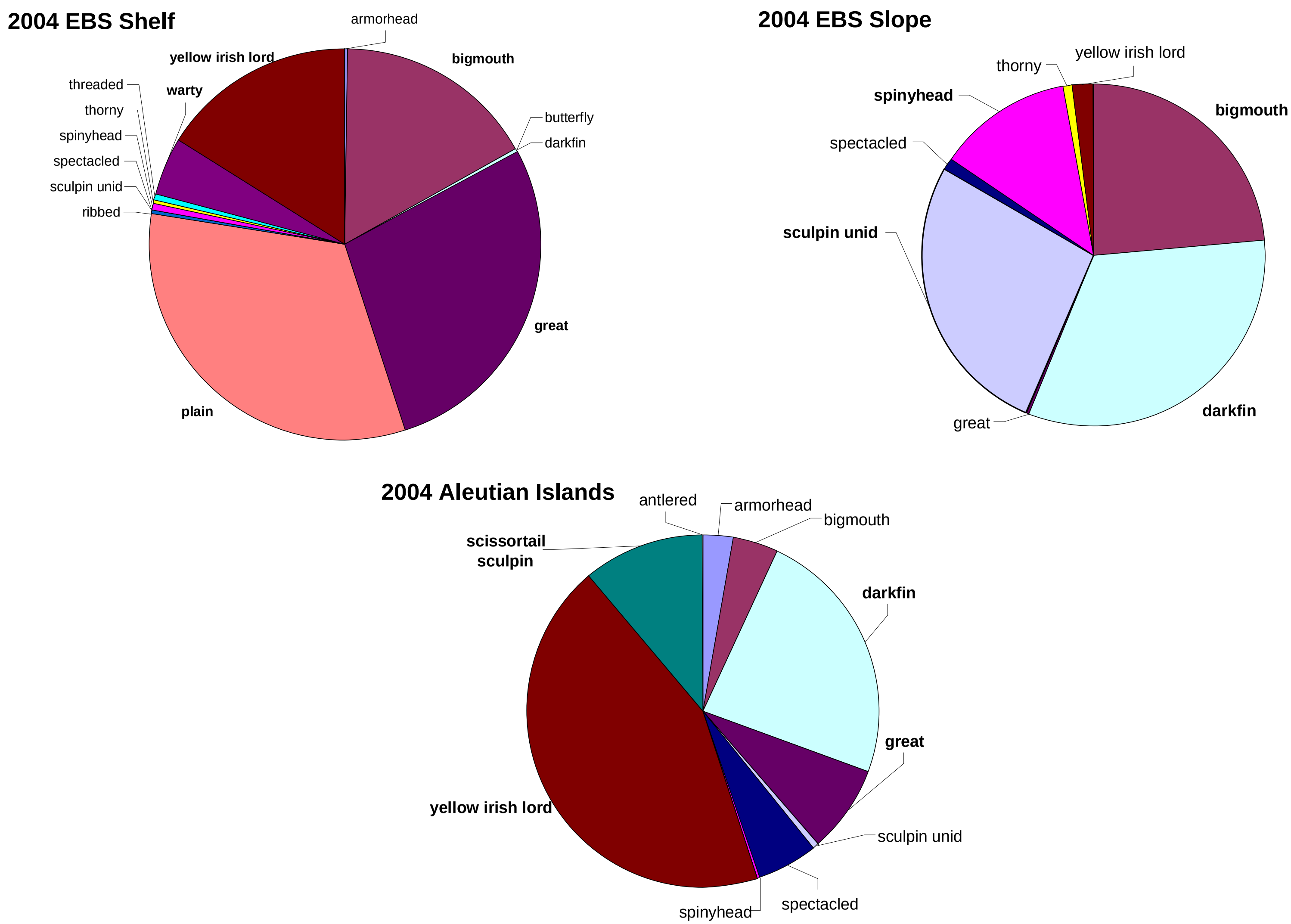

Figure 20.5. 2004 Sculpin Biomass estimates from the EBS shelf, EBS slope and AI surveys to show differences in species composition.

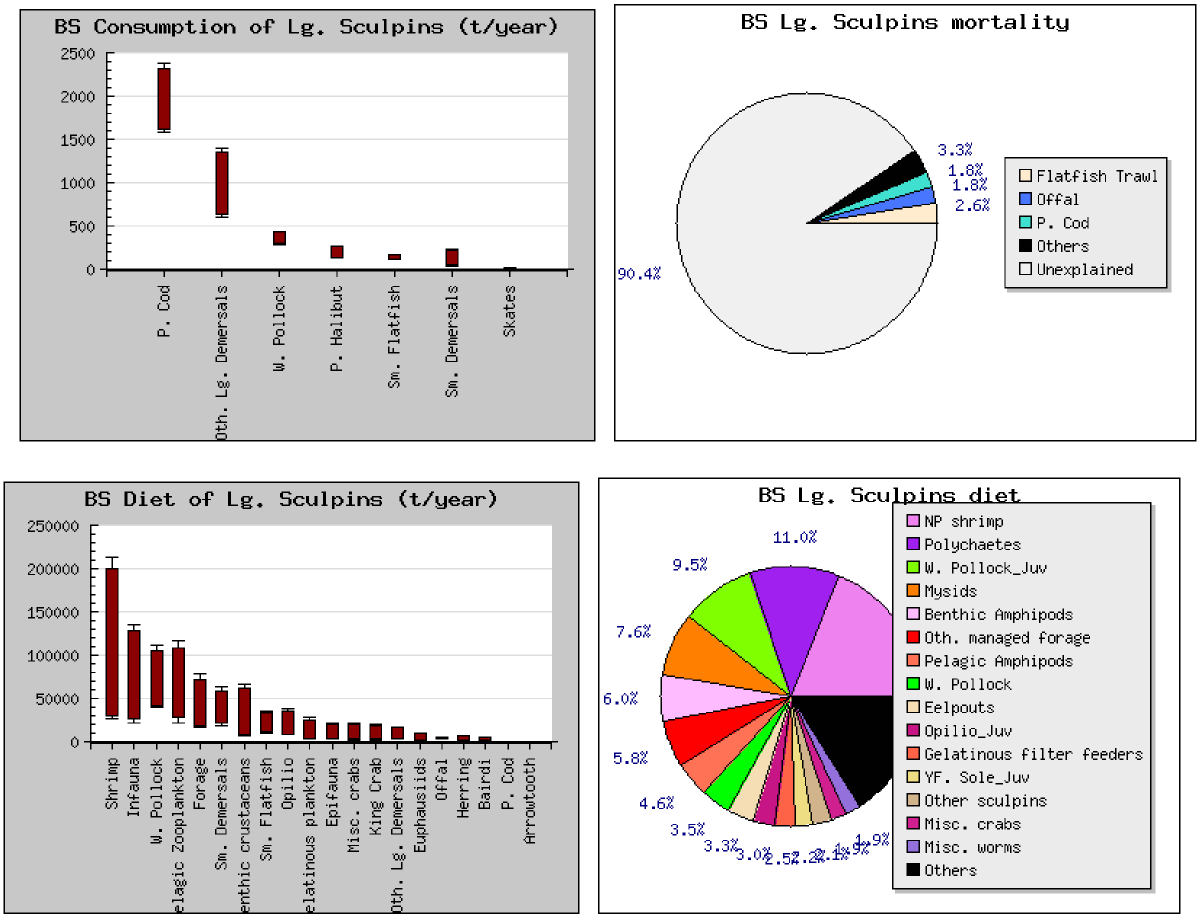

Figure 20.6. Figures showing Consumption, mortality, and diet of large sculpins from the Bering Sea. Source: REEM ecosystem website.

*Disclaimer: The above figures are in part the result of ecosystem modeling. The use of direct diet data for sculpins in the BSAI is limited.

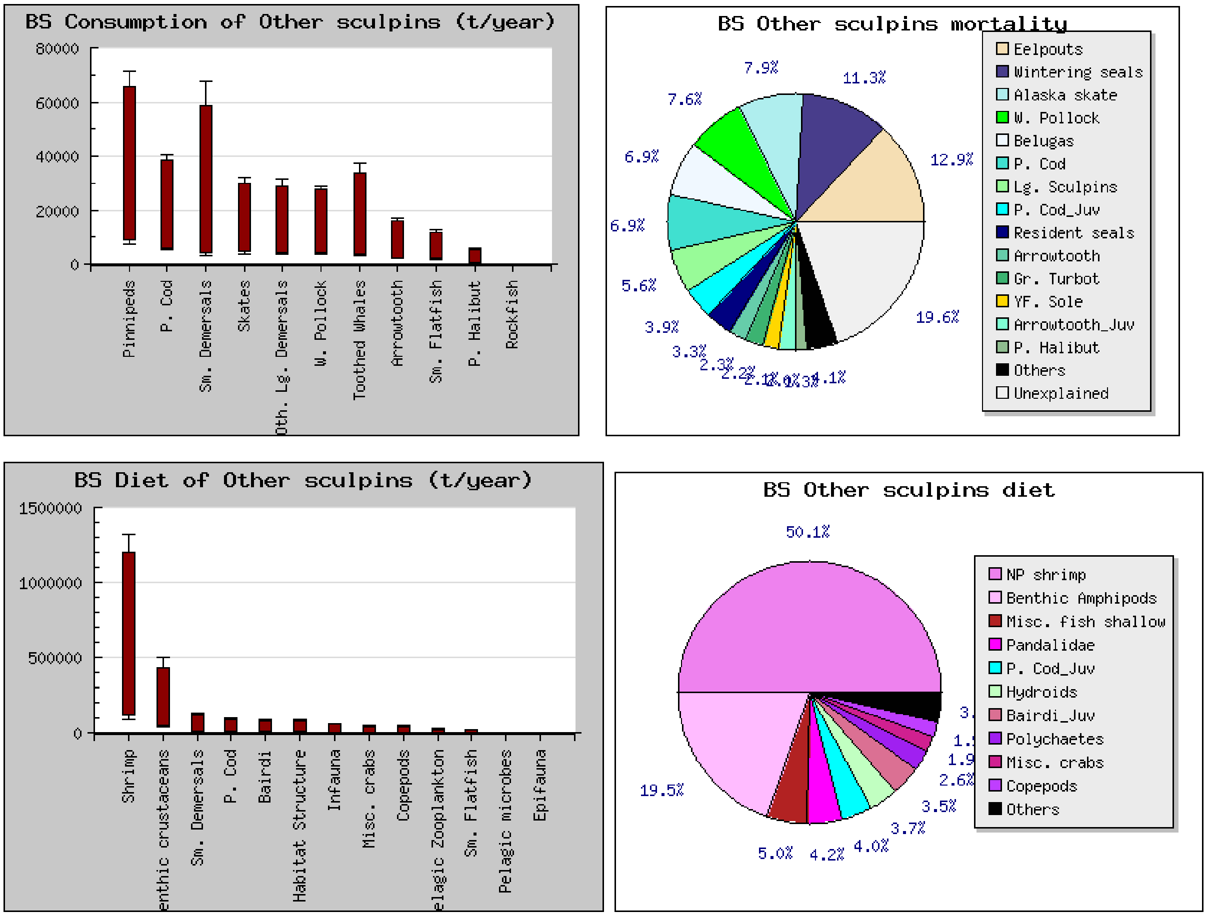

Figure 20.7. Figures showing Consumption, mortality, and diet of other sculpins from the Bering Sea. Source: REEM ecosystem website.
*Disclaimer: The above figures are in part the result of ecosystem modeling. The use of direct diet data for sculpins in the BSAI is limited.

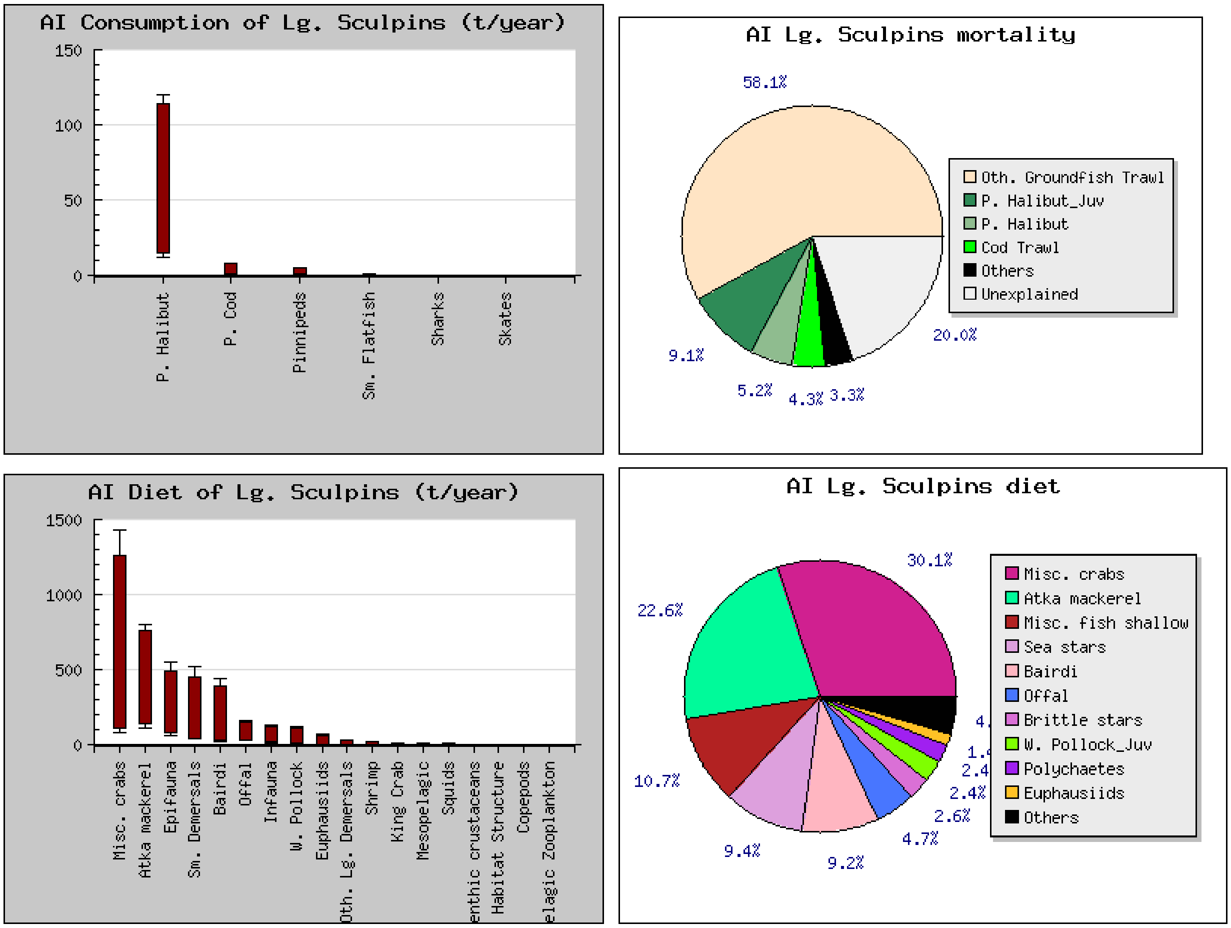

Figure 20.8. Figures showing Consumption, mortality, and diet of large sculpins from the Aleutian Islands. Source: REEM ecosystem website.
*Disclaimer: The above figures are in part the result of ecosystem modeling. The use of direct diet data for sculpins in the BSAI is limited.

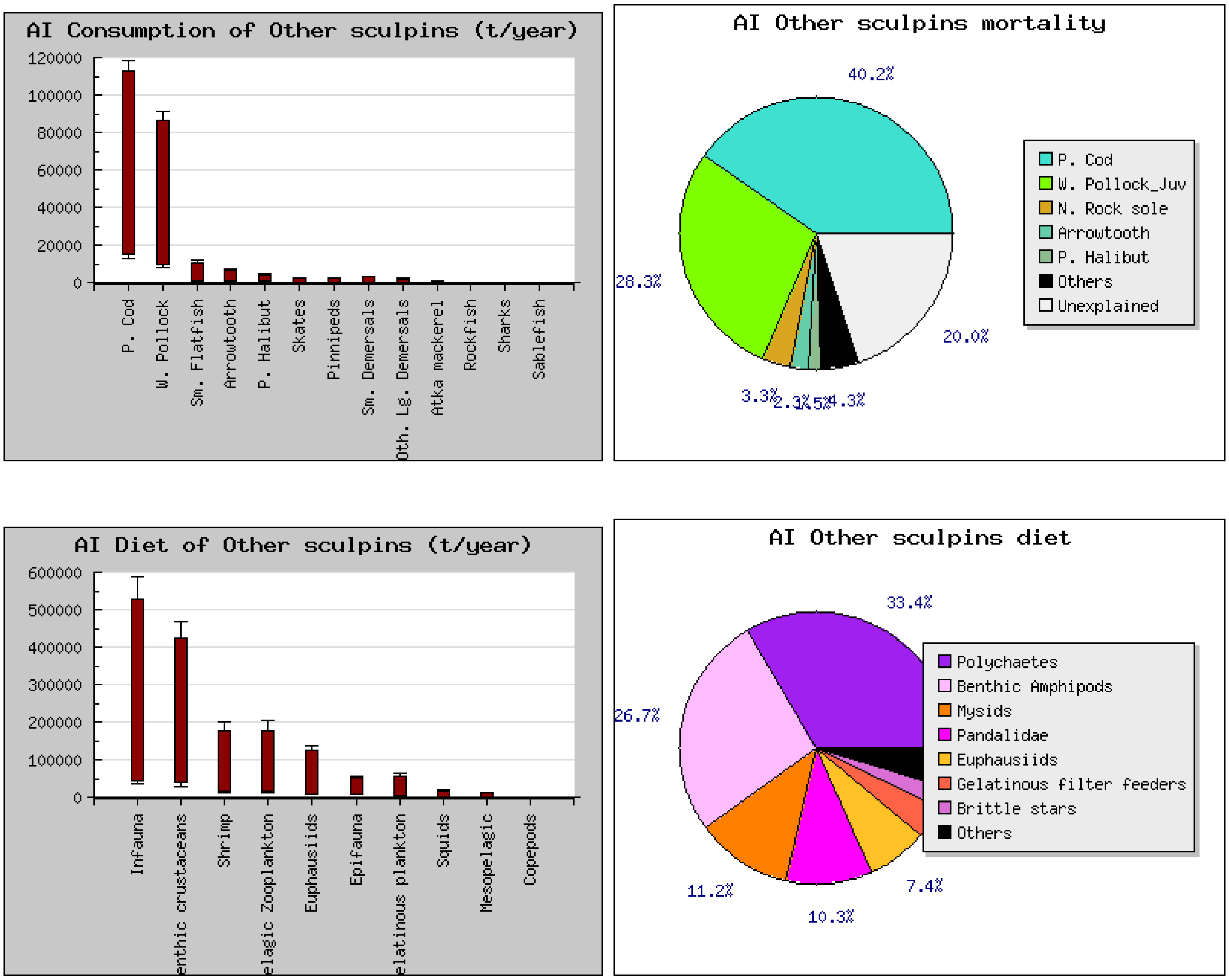

Figure 20.9. Figures showing Consumption, mortality, and diet of other sculpins from the Aleutian Islands. Source: REEM ecosystem website.

*Disclaimer: The above figures are in part the result of ecosystem modeling. The use of direct diet data for sculpins in the BSAI is limited.

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