Appendix. Forage species report for the Gulf of Alaska

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Report overview

The format of this report varies according to new developments in forage fish research and data availability. The 2014 report contains extensive information regarding the distribution of different forage species in the GOA, which is not repeated in this report. The 2016 report focuses on three areas of interest regarding GOA forage species:

1) Data regarding incidental catches of forage fishes in federal groundfish fisheries in Alaska
2) Data from the GOA Assessment Survey conducted in the eastern GOA during 2011-2013
3) A summary of GOAIERP research regarding forage fishes

The overview section of the report is similar to the 2014 report and is included here to provide an introduction to forage species and management in the GOA.

Overview of forage species and their management

Defining "forage species" can be a difficult task, as most fish species experience predation at some point in their life cycle. A forage fish designation is sometimes applied only to small, energy-rich, schooling fishes like sardines and herring (e.g. Lenfest 2012), but in most ecosystems this is too limiting a description. Generally, forage species are those whose primary ecosystem role is as prey and that serve a critical link between lower and upper trophic levels. For this report, the following species or groups of species are considered to be critical components of the forage base in the Gulf of Alaska:

- members of the "forage fish group" listed in the GOA Fishery Management Plan (FMP)
- Pacific herring *Clupea pallasii*
- juvenile groundfishes and salmon
- shrimps
- squids

<u>Forage fish group in the FMP</u>
Prior to 1998, forage fishes in the GOA were either managed as part of the Other Species group (nontarget species caught incidentally in commercial fisheries) or were classified as "nonspecified" in the FMP, with no conservation measures. In 1998 Amendment 39 to the GOA FMP created a separate forage

fish category, with conservation measures that included a ban on directed fishing. Beginning in 2011, members of this forage fish group (the "FMP forage group" in this report) are considered "ecosystem components". The group is large and diverse, containing over fifty species from these taxonomic groups (see the appendix at the end of this report for a full list of species):

- Osmeridae (smelts; eulachon *Thaleichthys pacificus* and capelin *Mallotus villosus* are the principal species)
- Ammodytidae (sand lances; Pacific sand lance *Ammodytes hexapterus* is the only species commonly observed in the GOA and BSAI)
- Trichodontidae (sandfishes; Pacific sandfish *Trichodon trichodon* is the main species)
- Stichaeidae (pricklebacks)
- Pholidae (gunnels)
- Myctophidae (lanternfishes)
- Bathylagidae (blacksmelts)
- Gonostomatidae (bristlemouths)
- Euphausiacea (krill; these are crustaceans, not fish, but are considered essential forage)

The primary motivation for the creation of the FMP forage group was to prevent fishing-related impacts to the forage base in the GOA; it was an early example of ecosystem-based fisheries management (Livingston et al. 2011). The management measures for the group are specified in section 50 CFR 679b20.doc of the federal code:

50 CFR 679b20.doc § 679.20 General limitations
(i) Forage fish
(1) Definition. See Table 2c to this part.
(2) Applicability.
The provisions of § 679.20 (i) apply to all vessels fishing for groundfish in the BSAI or GOA, and to all vessels processing groundfish harvested in the BSAI or GOA.
(3) Closure to directed fishing.
Directed fishing for forage fish is prohibited at all times in the BSAI and GOA.
(4) Limits on sale, barter, trade, and processing.
The sale, barter, trade, or processing of forage fish is prohibited, except as provided in paragraph (i)(5) of this section.
(5) Allowable fishmeal production.
Retained catch of forage fish not exceeding the maximum retainable bycatch amount may be processed into fishmeal for sale, barter, or trade.

Directed fishing for species in the FMP forage fish group is prohibited, catches are limited by a maximum retention allowance (MRA) of 2% by weight of the retained target species, and processing of forage fishes is limited to fishmeal production. While the basis for a 2% MRA is not entirely clear, it appears this percentage was chosen to accommodate existing levels of catch that were believed to be sustainable (Federal Register, 1998, vol. 63(51), pages 13009-13012). The intent of amendment 36 was thus to prevent an increase in forage fish removals, not to reduce existing levels of catch. In 1999, the state of Alaska adopted a statute with the same taxonomic groups and limitations, except that no regulations were passed regarding the processing of forage fishes. This exception has caused some confusion regarding the

onshore processing of forage fishes for human consumption (J. Bonney, pers. comm., Alaska Groundfish Databank, Kodiak, Alaska).

Pacific herring

Herring are abundant and ubiquitous in Alaska marine waters. Commercial fisheries, mainly for herring roe, exist throughout the GOA. Sitka Sound in Southeast Alaska and Kodiak Island had the highest commercial catches during 2007-2011 (19,429 and 2,937 short tons, respectively, in 2011). Herring stocks in Prince William Sound fell dramatically following the Exxon Valdez Oil Spill and have yet to recover sufficiently to permit a directed fishery. The herring fishery is managed by the Alaska Department of Fish & Game (ADFG), which uses a combination of various types of surveys and population modeling to set catch limits. In federal groundfish fisheries, herring are managed as Prohibited Species, where directed fishing is banned and any bycatch must be returned to the sea immediately. The amount of herring bycatch allowed is also capped, and if the cap is exceeded the responsible target fishery is closed to limit further impacts to the species.

Juvenile groundfishes and salmon

Members of this group, particularly age-0 and age-1 walleye pollock *Theragra chalcogramma*, are key forage species in some parts of the GOA. As they are early life stages of important commercially fished species, however, their status depends almost entirely on the assessment and management of the recruited portion of the population. Information regarding these species is available in NPFMC stock assessments and ADFG reports.

Shrimps

A variety of shrimps occur in the GOA. Four species are targeted by commercial fisheries: northern (*Pandalus borealis*), coonstripe (*Pandalus hypsinotis*), spot (*Pandalus platyceros*), and sidestripe (*Pandalopsis dispar*). Large fisheries, mainly for northern shrimp, used to occur in the central and western GOA, but populations declined and fishing for shrimp has been closed since 1984 in these areas. Currently, almost all of the commercial catch occurs in Southeast Alaska. Detailed information on shrimps in waters off Alaska is available from ADFG. This report includes incidental catch data of shrimps in federal fisheries as well as an overview of the commercial catch.

Squids

The GOA may be inhabited by up to 15 species of squids, which are mainly distributed along the shelf break. Although no directed fisheries currently exist for squids, they are managed as “in the fishery” due to high levels of incidental catch, mainly in the fisheries for walleye pollock. This report contains limited information regarding squids; detailed information regarding GOA squids can be found in the GOA stock assessment report.

Bycatch and other conservation issues

FMP forage group

Data regarding incidental catches of this group exist from 2003 and are maintained by the Alaska Regional Office (Table 1). Prior to 2005, species identification by observers was unreliable and many smelt catches were recorded as “other osmerid”. While identification has improved since then, smelts in catches are often too damaged for accurate identification and much of the catch is still reported as “other osmerid”. Eulachon are the most abundant forage fish in catches, and it is likely that they make up the

majority of the "other osmerid" catch. Most of the osmerid bycatch occurs in the central GOA (Table 2 & Fig. 1) in the vicinity of Shelikof Strait. Almost all of the bycatch is in the pelagic trawl fishery for walleye pollock (Table 3) and is concentrated in the southeastern Bering Sea. Catches of eulachon & "other osmerids" were particularly high in 2005 & 2008.

Shrimps

The bycatch of pandalid shrimps in federal fisheries is generally low (Table 4 & Fig. 2) but is also highly variable. Catches occur mainly in the central GOA.

Pacific herring

Data regarding the Prohibited Species Catch (PSC) of herring exist from 1991 and are maintained by the Alaska Regional Office (Table 5 & Fig. 3). The PSC is generally low but was exceptionally high in 1994 and 2004. Recently, most catches have occurred in the central GOA.

GOA Assessment Survey

General Description: The GOA Assessment survey is a Recruitment Process Alliance Fisheries Oceanographic survey that employs standard sampling protocols that were originally developed and refined from the Bering-Aleutian, Salmon International Survey (BASIS) style surveys. These surveys are designed to sample a host of physical and biological oceanographic attributes; phytoplankton, zooplankton, and ichthyoplankton communities; and pelagic fish abundance and distribution. Fish are sampled in the epipelagic zone with a rope trawl with coarse mesh in the wings and panels, and fine mesh the cod end. This net was originally designed by Canadian biologists to sample adult and juvenile salmon. Forage fish are readily captured by the net but given the small body size of age-0 forage fish and narrow body size of some species such as sand lance, we cannot provide an accurate measure of abundance. However, we feel confident that catch values from this survey can adequately represent relative abundance and distribution.

Sampling Methodology: Forage fish were captured with other neritic species in the eastern GOA (EGOA) and central GOA (CGOA) during July and August 2011 -2013 using a modified pelagic rope trawl (Cantrawl model # 400) designed to sample the surface of the ocean. The Cantrawl is a 198-m long mid-water rope trawl with hexagonal mesh wings and body and a 1.2-cm mesh liner in the codend, and was towed at gridded survey stations along a series of long transects located in the eastern Gulf of Alaska and the central Gulf of Alaska. It was towed at 3-7 km hour-1 at an average of 5 km hour-1 at or near the surface, had an average horizontal spread of 40 m, and an average vertical spread of 35 m. All tows lasted 30 minutes and covered a distance of 1 – 4 km. After the trawl was retrieved, the catch was emptied onto a sorting table where fish were sorted according to species and age-class. Forage fish were then counted, measured (fork length, mm), and weighed (g).

Results: In the GOA assessment survey, capelin are more often encountered in the CGOA, and CPUEs in the CGOA are generally greater (Figure 4). Herring are more widespread and tend to occur at the stations closer to shore (Figure 5). These results are consistent with other finding regarding capelin and herring distribution in the GOA (see following section on GOAIERP results). Pacific sand lance were infrequently encountered in the GOA Assessment Survey.

GOAIERP findings regarding forage species in the GOA

The GOA Integrated Ecosystem Research Program (GOAIERP) was a multi-year interdisciplinary study of the GOA ecosystem funded primarily by the North Pacific Research Board (NPRB). The program lasted from 2010-2015, with main field years in 2011 & 2013. A related synthesis project is currently underway and will be completed in 2018. An overview of the project and detailed GOAIERP findings are available in the final reports referenced in this section; they will be available on the NPRB website in December 2016 at www.nprb.org.

Three of the GOAIERP research activities produced results regarding GOA forage species:

1) Offshore surface trawl surveys (described above in the section "GOA Assessment Survey")
2) Offshore acoustic surveys conducted simultaneously with the surface trawl effort on the same vessel
3) Inshore multi-gear surveys that sampled 11 sites in the EGOA and CGOA

If forage fishes are considered in the broader sense described in the overview section of this report (e.g. including juvenile pollock), much of the GOAIERP fish research was oriented towards the GOA forage base. In this section we discuss the description of the GOA shelf forage community from the offshore acoustic survey, and then focus on several "classical" forage fishes, capelin and herring, that occurred in both inshore and offshore areas.

Forage fishes in the offshore acoustic survey

Offshore forage fish distribution patterns varied within and between regions due to intra- and interspecific differences in horizontal and vertical distributions that were strongly correlated with bottom depth ranges (Figure 6). Offshore forage fish densities were significantly higher for all species in 2013 compared to 2011. Age-0 pollock were nearly absent throughout 2011, but were abundant across both study regions in summer 2013 and limited to coastal waters in the subsequent fall. Capelin were the dominant forage fish over the western-region shelf in the summer and fall of both years. Dense aggregations of herring were observed over the eastern-region shelf in fall of both years, but were absent in summer and rarely observed in the western region. Mesopelagics (Myctophidae) were the only forage fish category present during all surveys, yet their density and vertical distribution varied between regions both seasonally and between years. There is evidence that the low abundance of forage fishes in 2011 coincided with low productivity and a weak spring bloom in the GOA (Hopcroft et al. 2016).

Capelin

The offshore acoustic surveys and the retrospective analysis of capelin data from other surveys (Ormseth et al. 2016, Chapters 1 & 8, respectively) suggest that capelin abundance is centered in the CGOA. Capelin is an important forage species for many fish, seabird, and marine mammals in the GOA and commercial fishing for this species is prohibited. Capelin was the most abundant forage fish species in the CGOA, characterized by highly patchy distributions that were primarily aggregated over shallow (<100 m) waters near the edges of banks (Figure 6). They were encountered infrequently in the EGOA in the Cross Sound area. The retrospective analysis of data from bottom trawl surveys, federal acoustic surveys, and larval surveys also indicated that the center of abundance of capelin was centered around Kodiak Island (Figure 7). Capelin were rarely observed in inshore catches (Ormseth et al. 2016, Chapter 4) but when they did occur it was in the west. Although capelin were not observed in EGOA inshore catches,

they are common in southeast Alaska inside waters (Arimitsu et al. 2008) and regularly occur in seabird chick diets in Sitka Sound (Leslie Slater, U.S. Fish & Wildlife Service, personal communication). However the main part of the population appears to be in the CGOA.

Pacific herring

In contrast to capelin, Pacific herring appear to be distributed mainly in the eastern GOA and inshore. Herring is the principal forage species available in much of the GOA and supports valuable commercial fisheries, as well as subsistence use (Alaska Dept. of Fish & Game Wildlife Notebook; http://www.adfg.alaska.gov/static/education/wns/pacific_herring.pdf). In the offshore survey herring occurred mainly in the eastern region in the fall (Ormseth et al. 2016, Chapter 1; Figure 7; Moss et al. 2016). In the inshore surveys they occurred in both regions but constituted a larger portion of the fish community in the eastern region (Ormseth et al. 2016, Chapter 4). The inshore surveys encounter all life stages of herring, and the abundance and life stage of herring varied substantial among inshore sites, seasons, and years (Ormseth et al. 2016, Chapter 2). While age-0 herring (~50 mm) were typically encountered during summer, herring of the same size were also encountered in Islas bay (eastern region) in fall. In some bays, young age-0 herring of identical size (~30 mm) were captured in huge abundance (e.g. an estimated 2.0×10^5 in a single purse seine haul). At other sites 2 or 3 length modes were identified for age-0 herring, and age-0 and older juvenile herring co-occurred in several bays. Spawning herring were encountered in Kiliuda Bay in spring 2011. These results suggest complex patterns of population structure and phenology. Diversity in the ecology of clupeid species has been suggested as the reason for their ubiquity and abundance in many parts of the world (Blaxter 1985), and herring in Alaska seem to share this variability with other clupeids.

Literature Cited

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Table 1. Incidental catches (t) of fishes in the GOA "FMP forage" group, 2003-2016. Data are from the Alaska Regional Office. "Osmerid" in the bottom 2 rows of the table indicates the combination of eulachon, other osmerids, capelin, and surf smelt.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	***2016****
Eulachon	18.1	173.9	835.5	390.4	226.7	752.4	222.0	213.9	285.0	188.0	26.5	249.5	97.2	*93.6*
Other osmerids	353.1	66.4	182.0	178.9	50.4	403.2	172.2	6.8	69.0	82.0	11.2	77.8	17.7	*9.9*
Gunnels	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	5.4	0.0	0.3	*1.7*
Stichaeidae	0	0.1	2.1	0.8	0.3	0.1	2.5	0.8	0.5	0.1	0.7	0.5	0.7	*0.2*
Lanternfishes	0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.1*
Capelin	0.5	68.4	2.8	0.1	0.0	0.0	0.0	0.0	6.2	0.0	0.0	5.2	4.2	*0.0*
Pacific Sand lance	0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*
Pacific Sandfish	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	*0.0*
Surf smelt	0	0.4	0.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*
Total	**378**	**309**	**1,023**	**570**	**277**	**1,156**	**397**	**221**	**361**	**272**	**44**	**333**	**120**	***106***
% osmerid	99.9%	99.9%	99.8%	99.8%	99.9%	100.0%	99.3%	99.6%	99.9%	99.4%	85.8%	99.8%	99.0%	*98.1%*
% eulachon in osmerid	4.80%	56.3%	81.9%	68.6%	81.8%	65.1%	56.3%	96.9%	79.1%	69.6%	70.1%	75.0%	81.6%	*90.4%*

* 2016 data are incomplete; retrieved October 16, 2016. Data are from the Alaska Regional Office.

Table 2. Incidental catches (t) of "osmerids", which includes the following groups: eulachon, capelin, surf smelt, and "other osmerids", by GOA regulatory area and NMFS statistical area, 2003-2016. Data are from the Alaska Regional Office.

		2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	***2016****
WGOA	610	46.2	11.7	48.8	33.4	62.8	272.8	27.7	33.3	34.6	37.9	1.1	6.6	11.0	*3.8*
CGOA	620	264.8	224.1	847.1	432.8	147.4	667.8	283.1	171.6	291.2	205.0	33.0	231.6	55.5	*83.6*
	630	57.6	70.3	103.9	89.1	64.1	189.7	71.6	6.9	22.7	15.4	2.3	88.2	49.3	*13.1*
EGOA	640	4.9	1.2	18.6	5.5	0.5	15.9	4.3	3.6	3.7	2.3	1.2	1.5	0.2	*0.0*
	649	4.0	1.8	2.3	8.5	2.3	9.5	7.6	5.3	7.9	9.4	0.1	4.6	3.1	*3.0*
total		**377.0**	**309.2**	**1,020.6**	**569.3**	**277.2**	**1,155.8**	**394.3**	**220.7**	**360.2**	**270.0**	**37.8**	**332.5**	**119.1**	***103.6***

* 2016 data are incomplete; retrieved October 4, 2016.

Table 3. Incidental catches (t) of "osmerids", which includes the following groups: eulachon, capelin, surf smelt, and "other osmerids", by target fishery, 2003-2016. Data are from the Alaska Regional Office.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	***2016****
pollock	373.0	304.0	986.4	549.7	275.0	1,154.5	359.3	215.7	337.1	263.4	36.3	326.7	96.7	*92.9*
ATF	0.3	0.5	13.8	1.9	0.7	0.6	32.5	3.8	22.9	6.4	0.9	5.3	15.1	*10.3*
flathead sole	3.2	4.3	19.9	14.8		0.2	0.1	0.3	0.1	0.0	0.4		7.2	*0.2*
rockfish	0.6	0.3	0.1	0.5	0.1	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	*0.1*
Pacific cod	0.2	0.0	0.4	2.5	0.0	0.5		0.6		0.0		0.2	0.0	*0.0*
other target	0.7													*0.0*
shallow flatfish	0.1	0.0			0.1	0.0	1.3	0.1			0.0	0.2		*0.0*
rex sole	0.1		0.0		0.9	0.0	0.8	0.2	0.0	0.1	0.0	0.0	0.0	
sablefish					0.3	0.0	0.1	0.0		0.0	0.0			
total	**377.0**	**309.2**	**1,020.6**	**569.3**	**277.2**	**1,155.8**	**394.3**	**220.7**	**360.2**	**270.0**	**37.8**	**332.5**	**119.1**	***103.6***

* 2016 data are incomplete; retrieved October 4, 2016. Data are from the Alaska Regional Office.

Table 4. Incidental catches (t) of pandalid shrimps in the GOA, by NMFS statistical area, 2003-2016. Data are from the Alaska Regional Office.

		2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	***2016****
WGOA	610	0.10	0.08	0.72	1.52	1.01	0.31	0.02	0.27	0.05	0.01	0.00	0.00	0.01	*0.01*
CGOA	620	0.76	0.98	6.67	1.56	0.90	0.47	0.21	0.84	0.46	0.28	0.32	0.31	0.91	*0.44*
	630	2.55	4.87	2.94	0.96	0.43	0.49	0.99	2.09	4.69	3.68	3.17	4.91	8.18	*5.16*
EGOA	640	0.02	0.01	0.20	0.02	0.02	0.02	0.01	0.15	0.02	0.00	0.00	0.02	0.00	*0.00*
	649	0.00	0.00	0.01		0.00	0.01	0.05	0.02	0.00	0.00	0.00	0.00	0.00	*0.00*
total		**3.42**	**5.94**	**10.55**	**4.06**	**2.36**	**1.30**	**1.28**	**3.38**	**5.22**	**3.96**	**3.49**	**5.24**	**9.10**	***5.61***

*2016 data are incomplete; retrieved October 4, 2016. Data are from the Alaska Regional Office.

Table 5. Prohibited Species Catch (t) of herring in federal fisheries in the GOA, by NMFS regulatory and statistical areas, 1991- 2016. Data are from the Alaska Regional Office.

	WGOA	CGOA		EGOA		total GOA
	610	620	630	640	650	
1991	0.63	0.01	0.61	0.00	0.00	1.26
1992	17.27	8.38	1.06	0.04	0.03	26.79
1993	0.66	0.57	5.02	0.04		6.29
1994	78.19	19.62	2.35	0.00		100.16
1995	2.14	43.47	1.48	0.10	0.19	47.38
1996	1.52	0.63	1.31	0.14		3.60
1997	1.42	5.83	1.96	0.01	0.01	9.24
1998	0.30	2.79	17.14	0.00	0.00	20.22
1999	0.66	8.51	1.61	0.01		10.79
2000	1.39	2.19	1.68	0.00		5.27
2001	0.54	4.91	1.48			6.93
2002	0.04	1.38	0.74			2.16
2003	0.00	0.00	0.00	0.00	0.00	0.00
2004	9.14	167.89	90.80	0.03	0.00	267.85
2005	0.98	10.55	0.10	0.60	0.00	12.24
2006	0.21	7.88	0.74	0.02	0.00	8.86
2007	1.40	5.16	14.71	0.01	0.00	21.28
2008	0.15	0.30	0.57	0.00	0.00	1.03
2009	0.08	7.85	0.63	0.06	0.00	8.63
2010	0.18	0.69	0.97	0.10	0.00	1.94
2011	0.81	9.42	0.00	0.12	0.00	10.35
2012	0.02	1.32	0.02	0.00	0.00	1.35
2013	0.05	8.78	1.64	0.09	0.00	10.55
2014	0.01	4.57	0.91	0.00	0.00	5.48
2015	0.85	52.61	23.65	0.15	0.00	77.26
*2016**	*9.68*	*3.17*	*133.17*	*0.00*	*0.00*	*146.02*

*2016 data are incomplete; retrieved November 3, 2016. Data are from the Alaska Regional Office.

Table 6. Prohibited Species Catch (t) of herring in federal fisheries in the GOA, by target fishery, 1991-2016. Data are from the Alaska Regional Office.

	ATF	Flathead Sole	Pacific Cod	Pollock	Rex Sole	Rockfish	Sable-fish	Shallow Flatfish	total
1991			0.11	1.01		0.14			1.26
1992				26.50		0.16		0.13	26.79
1993	0.07		0.03	6.19					6.29
1994	0.06		0.11	99.98				0.01	100.16
1995	0.03			46.99	0.02			0.34	47.38
1996	0.05			2.74		0.02		0.78	3.60
1997		0.38		7.49	0.01	0.83		0.51	9.24
1998		0.22	0.05	19.08	0.00			0.87	20.22
1999	0.01		1.03	9.74				0.00	10.79
2000	0.37	0.01		4.66		0.06		0.17	5.27
2001		0.12	0.05	6.57	0.03	0.09		0.05	6.93
2002		0.04		2.03				0.09	2.16
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.02	267.83	0.00	0.00	0.00	0.00	267.85
2005	0.04	0.00	0.00	12.12	0.01	0.00	0.00	0.06	12.24
2006	0.05	0.00	0.00	8.79	0.00	0.00	0.00	0.02	8.86
2007	0.00	0.00	0.00	21.15	0.00	0.02	0.00	0.10	21.28
2008	0.01	0.00	0.00	0.91	0.00	0.04	0.03	0.05	1.03
2009	0.01	0.00	0.01	7.79	0.00	0.00	0.00	0.82	8.63
2010	0.04	0.80	0.00	0.86	0.05	0.15	0.00	0.04	1.94
2011	0.00	0.00	0.00	10.35	0.00	0.00	0.00	0.00	10.35
2012	0.07	0.00	0.02	1.27	0.00	0.00	0.00	0.00	1.35
2013	0.00	0.00	0.00	10.47	0.00	0.00	0.00	0.09	10.55
2014	0.07	0.00	0.00	4.57	0.00	0.00	0.00	0.85	5.48
2015	0.10	0.00	0.06	75.71	0.00	0.00	0.00	1.38	77.26
*2016**	*0.29*	*0.00*	*0.00*	*145.22*	*0.00*	*0.00*	*0.00*	*0.51*	*146.02*

*2016 data are incomplete; retrieved November 3, 2016. Data are from the Alaska Regional Office.

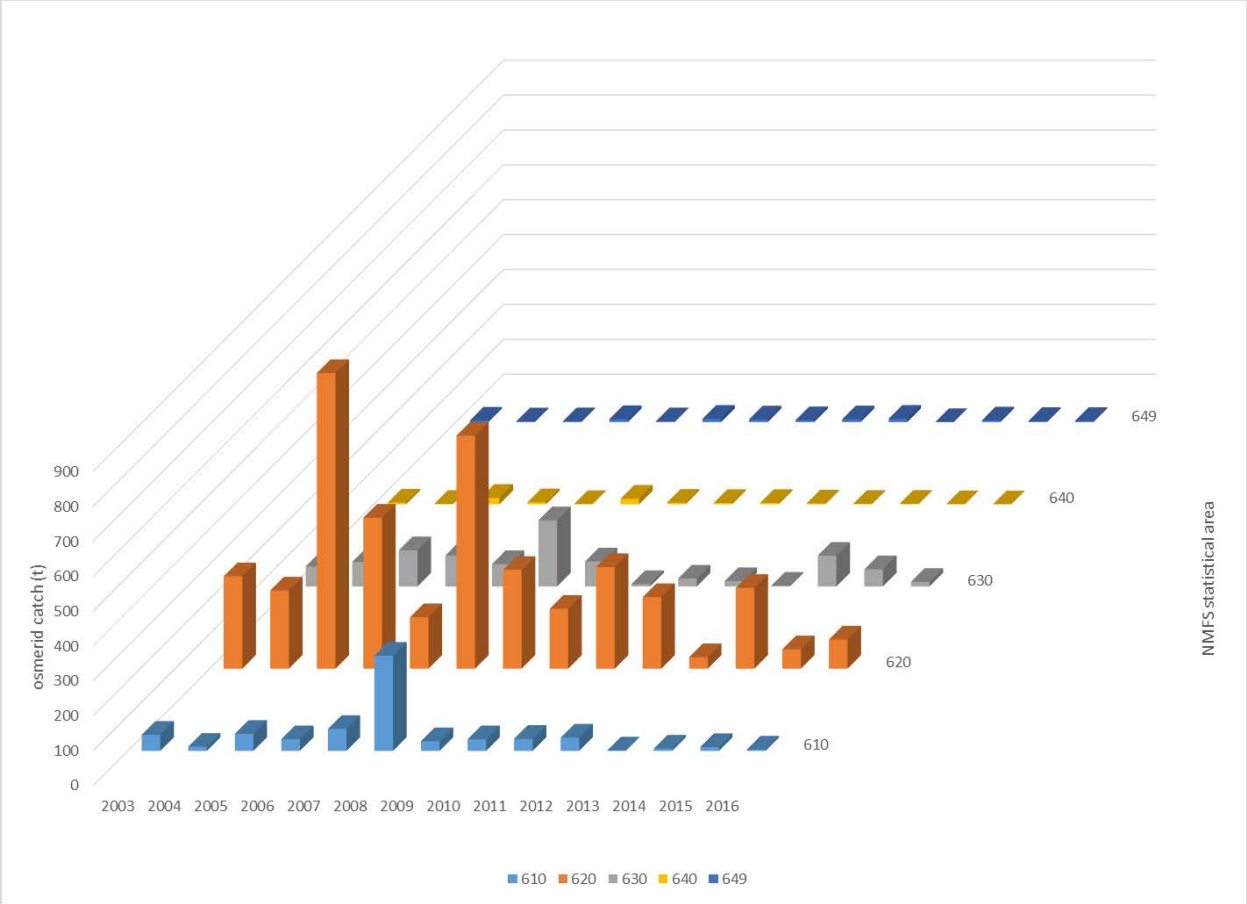

Figure 1. Incidental catches (t) of eulachon & "other osmerids" in the GOA, by NMFS statistical area, 2003-2016. The 2016 data are incomplete; retrieved October 4, 2016. Data are from the Alaska Regional Office.

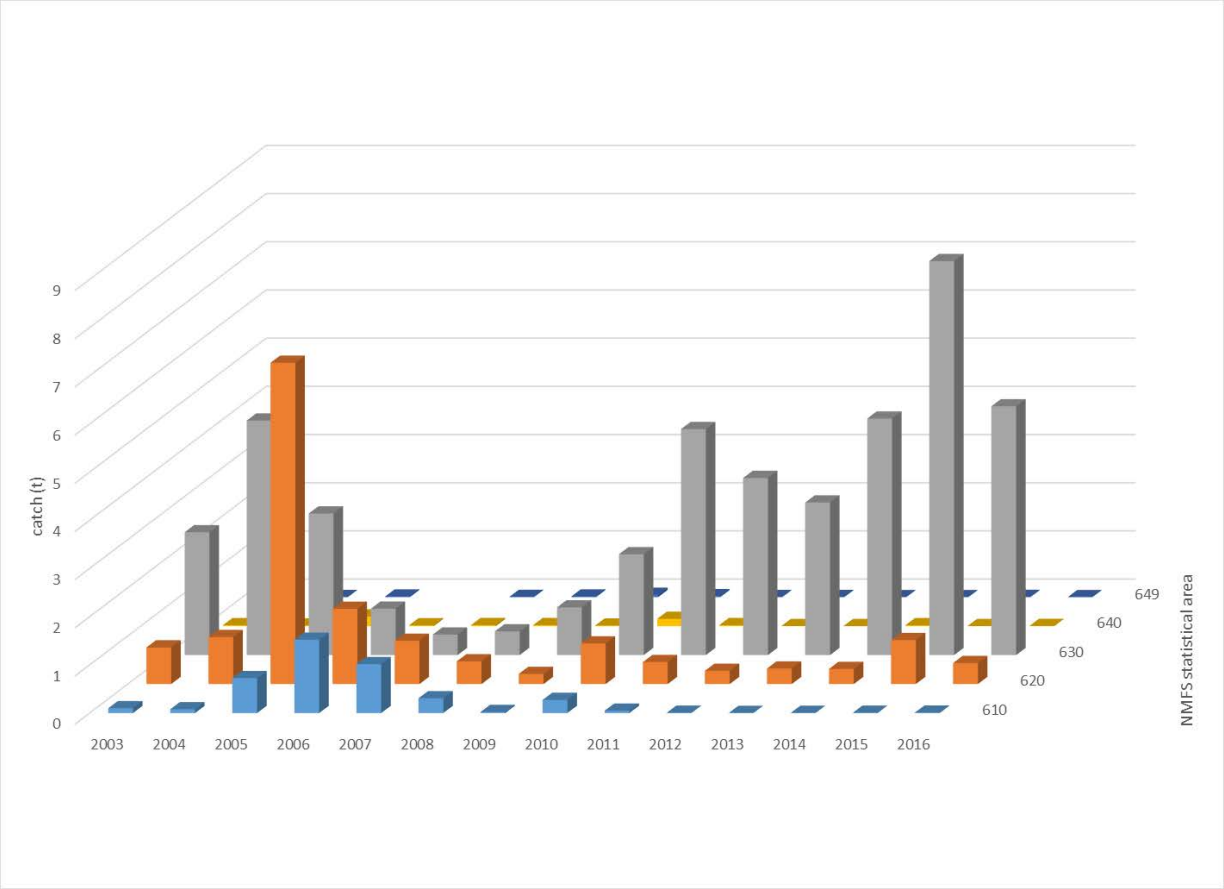

Figure 2. Incidental catches (t) of pandalid shrimps in the GOA, by NMFS statistical area, 2003-2016. The 2016 data are incomplete; retrieved October 4, 2016. Data are from the Alaska Regional Office.

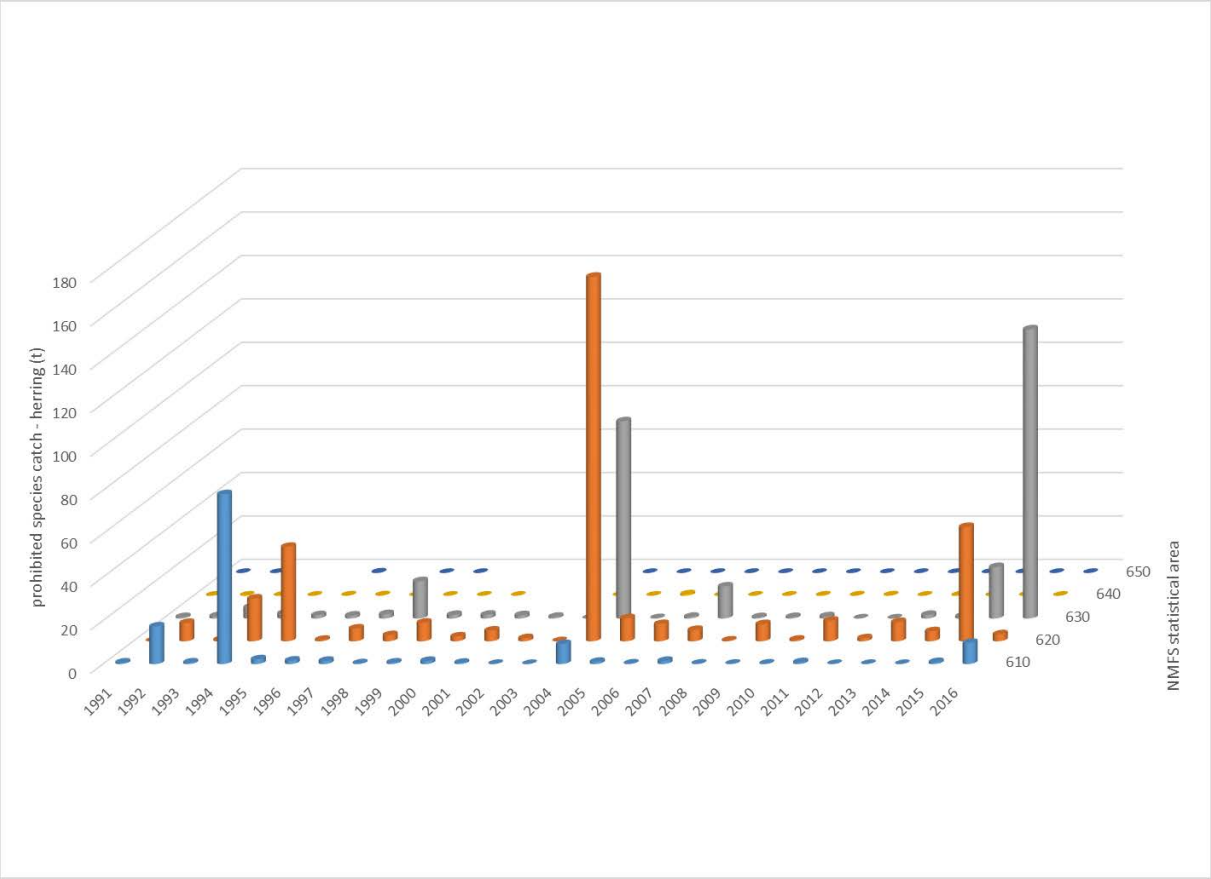

Figure 3. Prohibited Species Catch (t) of herring in federal fisheries in the GOA, by NMFS statistical area, 1991- 2016. Data are from the Alaska Regional Office.

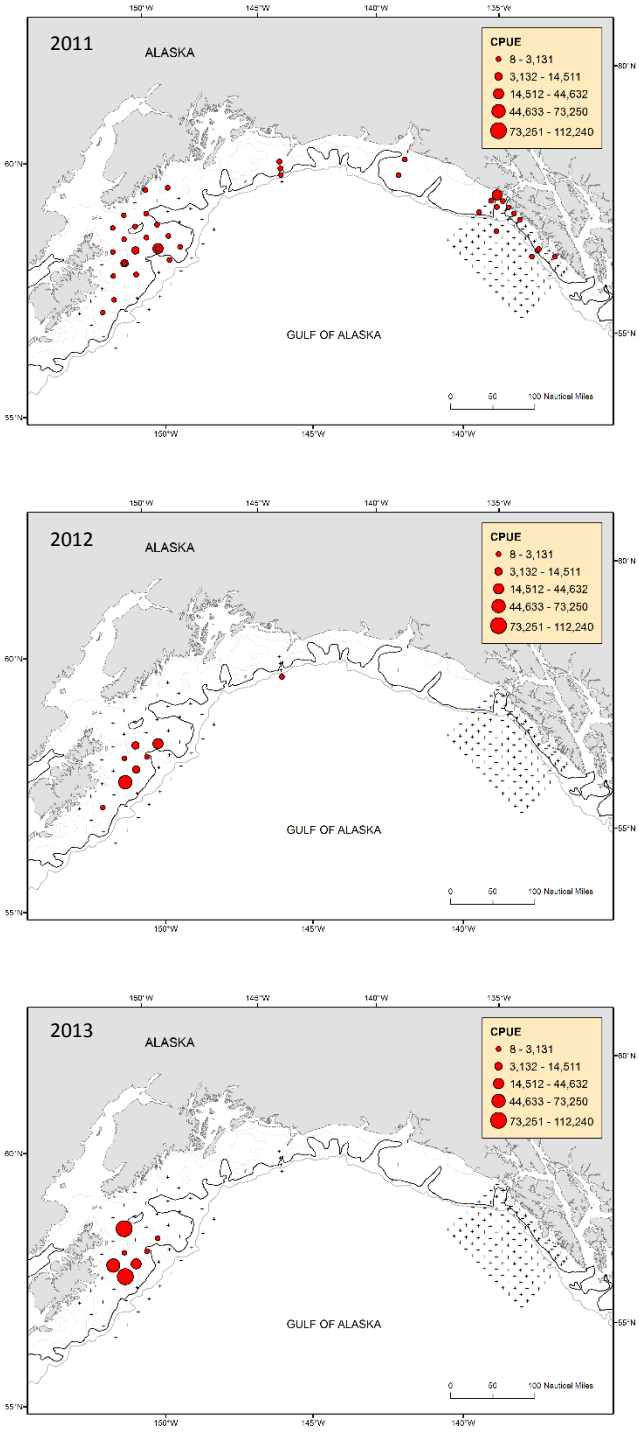

Figure 4. Capelin CPUE from the GOA Assessment Survey during 2011-2013.

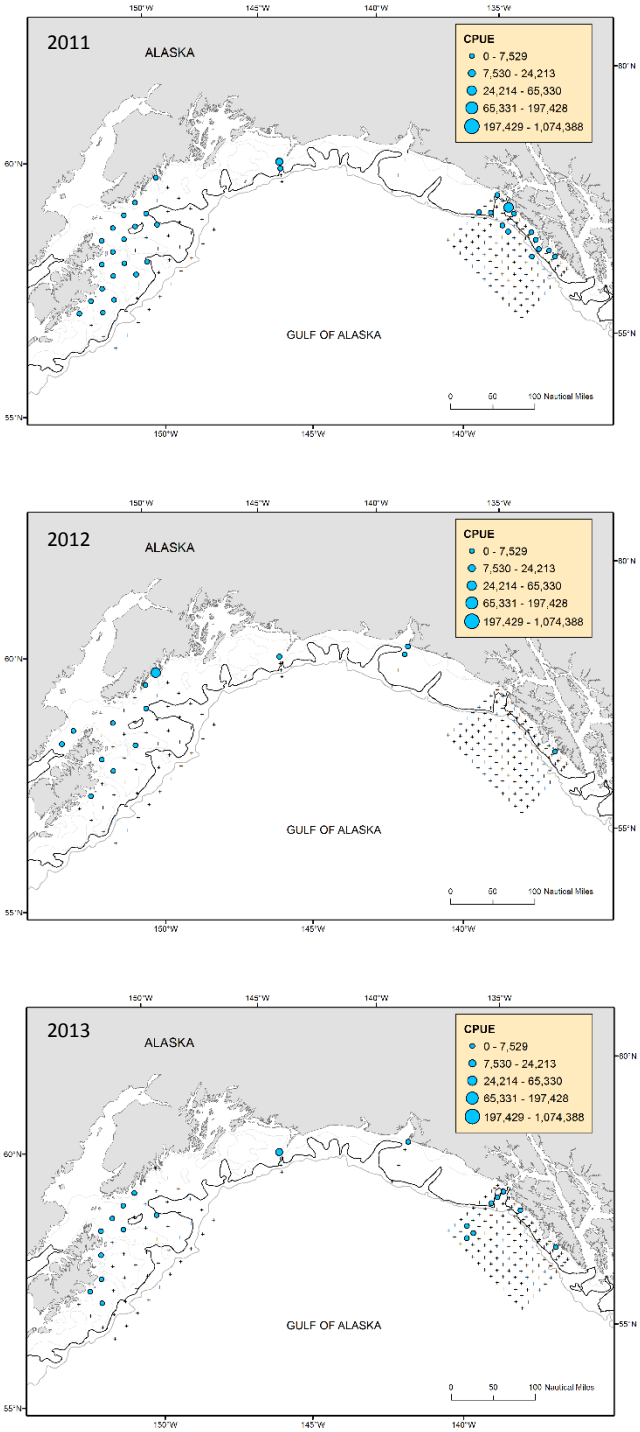

Figure 5. Pacific herring CPUE from the GOA Assessment Survey during 2011-2013.

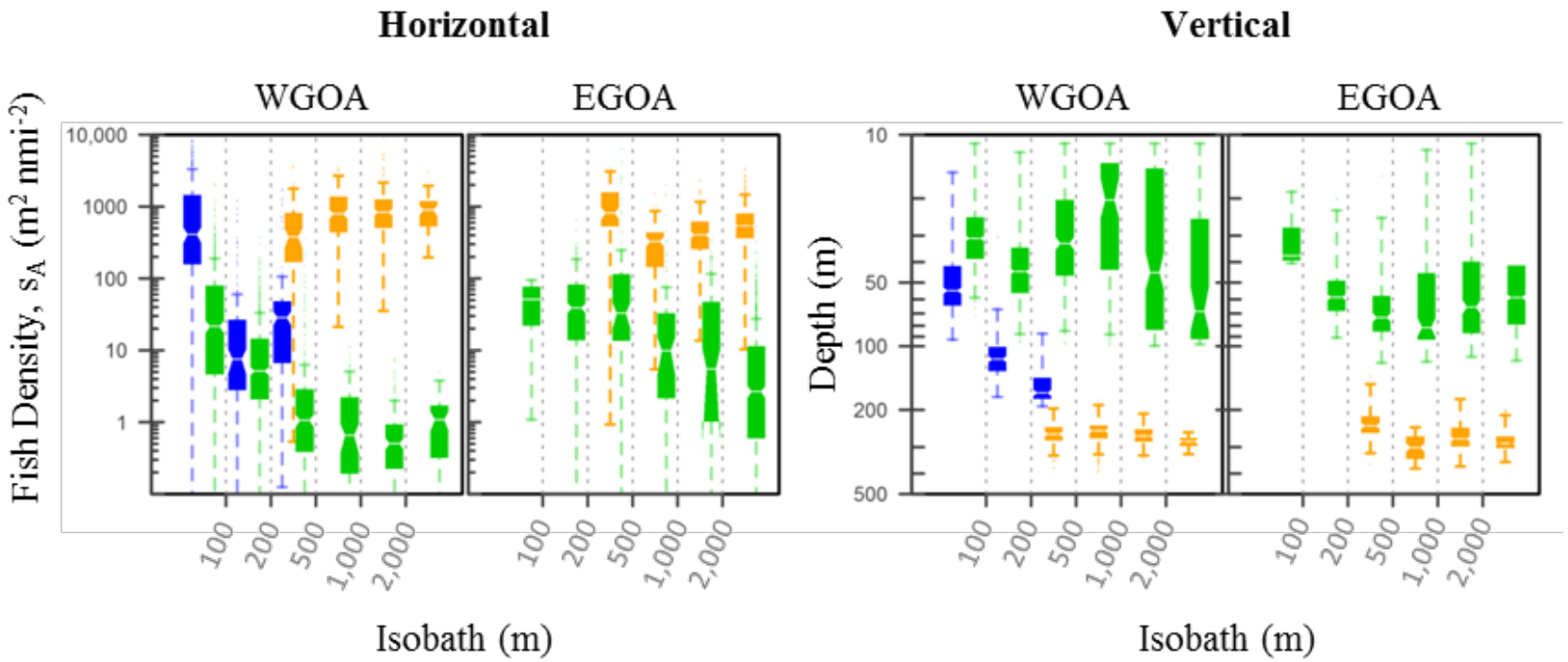

Figure 6. Acoustic measurements of offshore horizontal and vertical distributions between major isobaths by study region in summer 2013 for capelin (blue), age-0 pollock (green), and mesopelagics (yellow). Boxplots to left show horizontal distributions of nonzero acoustic densities (i.e. where fish were present, $s_A > 0$ m^2 nmi^{-2}). Boxplots to right show vertical distributions weighted by density (i.e. center of mass, m). Note, density and depths are on log scales and box plot notches that do not overlap indicate strong evidence of differences between medians at the 95% confidence level.

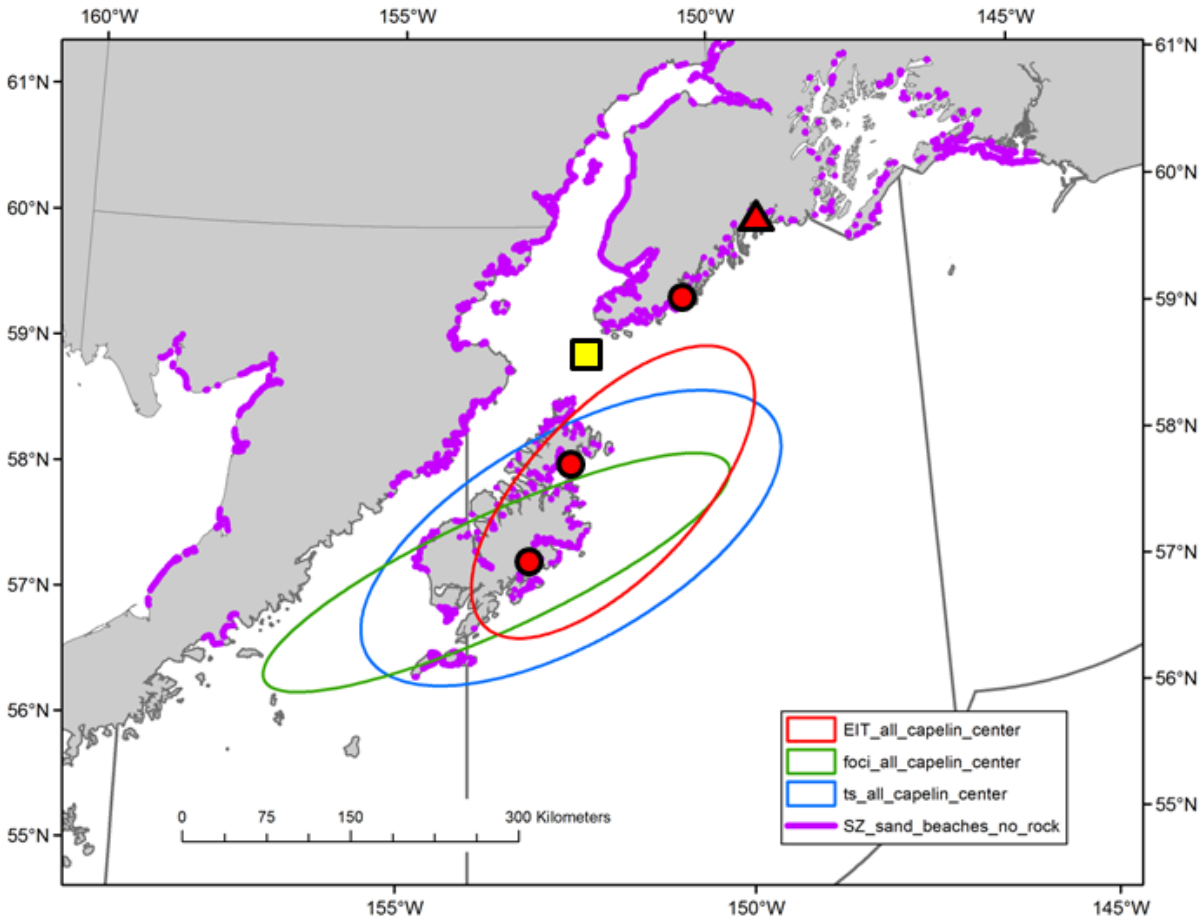

Figure 7: Standard deviational ellipses for 3 survey datasets, with sites visited during the survey (circles- no juvenile capelin observed; square- area described in this paper; triangle – juvenile capelin observed but much lower densities and hard to quantify. Purple shows Shorezone sand areas.

Appendix: List of scientific and common names of species contained within the "FMP forage fish" category. Data sources: BSAI FMP, Fishes of Alaska (Mecklenburg et al. 2002).

Scientific Name	**Common Name**
Family Osmeridae	smelts
Mallotus villosus	capelin
Hypomesus pretiosus	surf smelt
Osmerus mordax	rainbow smelt
Thaleichthys pacificus	eulachon
Spirinchus thaleichthys	longfin smelt
Spirinchus starksi	night smelt
Family Myctophidae	lanternfish
Protomyctophum thompsoni	bigeye lanternfish
Benthosema glaciale	glacier lanternfish
Tarletonbeania taylori	taillight lanternfish
Tarletonbeania crenularis	blue lanternfish
Diaphus theta	California headlightfish
Stenobrachius leucopsarus	northern lampfish
Stenobrachius nannochir	garnet lampfish
Lampanyctus jordani	brokenline lanternfish
Nannobrachium regale	pinpoint lampfish
Nannobrachium ritteri	broadfin lanternfish
Family Bathylagidae	blacksmelts
Leuroglossus schmidti	northern smoothtongue
Lipolagus ochotensis	popeye blacksmelt
Pseudobathylagus milleri	stout blacksmelt
Bathylagus pacificus	slender blacksmelt
Family Ammodytidae	sand lances
Ammodytes hexapterus	Pacific sand lance
Family Trichodontidae	sandfish
Trichodon trichodon	Pacific sandfish
Arctoscopus japonicus	sailfin sandfish
Family Pholidae	gunnels
Apodichthys flavidus	penpoint gunnel
Rhodymenichthys dolichogaster	stippled gunnel
Pholis fasciata	banded gunnel
Pholis clemensi	longfin gunnel
Pholis laeta	crescent gunnel
Pholis schultzi	red gunnel

Scientific Name	Common Name
Family Stichaeidae	pricklebacks
Eumesogrammus praecisus	fourline snakeblenny
Stichaeus punctatus	arctic shanny
Gymnoclinus cristulatus	trident prickleback
Chirolophis tarsodes	matcheek warbonnet
Chirolophis nugatory	mosshead warbonnet
Chirolophis decoratus	decorated warbonnet
Chirolophis snyderi	bearded warbonnet
Bryozoichthys lysimus	nutcracker prickleback
Bryozoichthys majorius	pearly prickleback
Lumpenella longirostris	longsnout prickleback
Leptoclinus maculates	daubed shanny
Poroclinus rothrocki	whitebarred prickleback
Anisarchus medius	stout eelblenny
Lumpenus fabricii	slender eelblenny
Lumpenus sagitta	snake prickleback
Acantholumpenus mackayi	blackline prickleback
Opisthocentrus ocellatus	ocellated blenny
Alectridium aurantiacum	lesser prickleback
Alectrias alectrolophus	stone cockscomb
Anoplarchus purpurescens	high cockscomb
Anoplarchus insignis	slender cockscomb
Phytichthys chirus	ribbon prickleback
Xiphister mucosus	rock prickleback
Xiphister atropurpureus	black prickleback
Family Gonostomatidae	bristlemouths
Sigmops gracilis	slender fangjaw
Cyclothone alba	white bristlemouth
Cyclothone signata	showy bristlemouth
Cyclothone atraria	black bristlemouth
Cyclothone pseudopallida	phantom bristlemouth
Cyclothone pallida	tan bristlemouth
Order Euphausiacea	krill