

# Status of forage species in the Gulf of Alaska region

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## Report overview

A report on the status of forage species in the Gulf of Alaska (GOA) region is prepared on a biennial basis and presented to the GOA Plan Team and the North Pacific Fishery Management Council (NPFMC) in even years. This report is not intended as a formal stock assessment, although forage populations are analyzed if data are available. The two main objectives of the report are to 1) investigate trends in the abundance and distribution of forage populations, and 2) describe interactions between federal fisheries and species that make up the forage base (i.e. to monitor potential impacts of bycatch). The report's structure is as follows:

- 1) Report summary and responses to Plan Team & SSC comments
- 2) Overview of forage species and their management
- 3) Trends in abundance and spatial distribution
- 4) Bycatch and other impacts of federal fisheries on forage species
- 5) Data gaps and research priorities
- 6) Appendix

Because forage species are a fundamental component of the ecosystems in the GOA, there is potential for overlap between the data presented here and the considerable amount of forage-related information reported in the Ecosystem Considerations report published annually by the NPFMC (<https://access.afsc.noaa.gov/reem/ecoweb/index.php>). To minimize duplication of efforts, this report relies mainly on data from the bottom trawl surveys in the GOA as well as acoustic-survey results where applicable. The Ecosystem Considerations report contains results from the surface-trawl surveys conducted by the Ecosystem Monitoring and Assessment (EMA) program, as well as estimates of euphausiid abundance from acoustic surveys. Indirect indicators of forage species abundance and prey availability, such as seabird breeding success and groundfish predator diets, are also described in the Ecosystem Considerations report. A brief summary of relevant findings from that report are included in this document's "Summary of findings" section below, and in other relevant sections of the report.

## Summary

### *This report*

- 1) This report now includes detailed information on squids, which have recently been classified as Ecosystem Components.
- 2) Bottom-trawl and acoustic-trawl surveys suggest that capelin were abundant in 2013 and largely absent in 2015, and that the population may have rebounded to some degree in 2017.
- 3) New analysis of catch trends relative to the historical mean indicate that incidental catches of major forage species were low in 2017 & 2018.

## *Ecosystem Considerations report*

- 1) From the 2017 western GOA report card: “Trends in capelin as sampled by seabirds and groundfish have indicated that capelin were abundant from 2008 to 2013, but declined during the warm years of 2015-2016. Their apparent abundance coincided with the period of cold water temperatures in the Gulf of Alaska. Preliminary reports suggest that predators were again foraging on capelin in 2017.” This is consistent with observations from the bottom trawl and summer acoustic surveys.
- 2) The surface-trawl survey in the eastern GOA (GOA Assessment Survey) encountered large numbers of squids during 2014, and squids were distributed farther north than usual in that year. Because this survey samples surface waters, these squids are likely different species and/or life stages than the squids encountered by the bottom trawl survey and fishery.

## **Responses to Plan Team and SSC comments**

### From the November 2016 GOA Plan Team minutes:

“The Team discussed whether or not we have a cause for concern for forage fish. This led to a discussion of what data is useful...The author noted that he would be alarmed if he saw a series of years in a row with high bycatch amounts relative to historical values. This warrants comparison to a temporal mean with some uncertainty.”

*Response:* The report now includes analysis of temporal means and uncertainty for the main species/species groups for which catch is reported (osmerids, squids, pandalid shrimps, and Pacific herring).

“The Team then discussed the value of having the forage fish chapter in with the Ecosystem chapter since greater meaning could be gained from just looking at catch trends- for example food availability for birds. To avoid duplication, and increase the interpretability of the forage fish data, the Team recommends that the forage fishes report be incorporated into the Ecosystem Chapter...”

*Response:* The author is ambivalent on this question, but the SSC has strongly indicated they would prefer a separate forage report (see below).

### From the December 2016 SSC minutes:

“The SSC acknowledges the Plan Team’s concern that forage fish information is contained in two places (the Forage Fish chapter and the Ecosystem chapter), but recommends that the Forage fish chapter be retained as a separate chapter due to (1) the different purposes of the two chapters and (2) concern over losing information if it is incorporated into the Ecosystem chapter (due to the brevity necessary for the Ecosystem chapter)... Recognizing that forage fish contributions are included in more than one SAFE document, the SSC recommends that authors state the types of information that are contained in each at the start of the chapter (e.g., this chapter includes distribution, abundance and catch information for forage fishes, this chapter includes summaries of interactions of forage fishes with other members of the

ecosystem) and cross-list where other contributions are located. This would help make readers aware that there are several efforts to assess interannual forage fish information.”

*Response:* The author has made additional strides towards reducing duplication and confusion between this report and the Ecosystem chapter. For example, the document now cross-references information that is in the Ecosystem chapter.

## 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, 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)
- squids
- shrimps
- Pacific herring *Clupea pallasii*
- juvenile groundfishes and salmon

### Forage fish group in the FMP

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).

### Squids

The GOA may be inhabited by up to 15 species of squids, which are mainly distributed along the shelf break. Before 2011 squids were managed as part of the Other Species complex; beginning in 2011 they were managed as a target stock complex with annual harvest specifications. In June 2017, the North Pacific Fishery Management Council (NPFMC) took final action to amend the fishery management plans (FMPs) for the Bering Sea and Aleutian Islands (BSAI; Amendment 117) and GOA (Amendment 106) regions and move the squid stock complex into the Ecosystem Component category. The rationales for this decision included (1) the lack of a directed fishery for squids in the BSAI or GOA, (2) because squids are highly productive, there is little risk of overfishing in the absence of a directed fishery, and (3) current incidental fishing mortality is considered insignificant at a population level.

The FMP amendments were implemented in the Federal Register on July 6, 2018 with an effective date of August 8, 2018 (Federal Register, Volume 83, Number 130, July 6 2018, pages 31460-31470. 50 CFR

679, docket # 170714670-8561-02. <https://www.federalregister.gov/d/2018-14457>). Briefly, the amendments accomplish the following:

- Place squids in the Ecosystem Component category of the FMP
- Prohibit directed fishing for squid
- Establish a 20% maximum retention allowance (MRA)
- Retain recordkeeping and recording requirements

The new management regime will be implemented in January 2019. For 2018, the Alaska Regional Office has maintained the harvest specifications and catch accounting for squids. As of the fall 2018 assessment cycle there is no longer a need for annual catch limits for squids or a formal stock assessment and fishery evaluation (SAFE) report. However the amendments, as well as the Plan Teams and SSC, call for monitoring of squid catches and regular reporting on squid status. As of 2018 squids are included in this report as this seems the most efficient means for reporting.

### 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.

### 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. Herring fisheries are 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. Data regarding incidental catches of herring in federal fisheries are included in this report.

### 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 the Ecosystem Considerations chapter, NPFMC stock assessments, and ADFG reports.

## Trends in abundance and spatial distribution

### FMP forage fish group

Reliable information regarding abundance and distribution is scarce for members of the FMP forage fish group. Existing bottom trawl surveys do not sample the water column where many of these species reside, are not designed for capturing small fishes, and do not sample in areas (e.g. very shallow or very deep waters) where many of these species are found. Acoustic surveys provide some information on pelagic fishes but are oriented towards assessing walleye pollock. Therefore this section of the report focuses on only two species in this group, capelin and eulachon.

#### *Capelin*

Capelin are a very important forage species in the GOA. Due to survey limitations a reliable abundance estimate for capelin has been elusive. The GOA mass-balance ecosystem model produced a static biomass estimate of 2 million tons, and the Ecosystem Considerations chapter uses predator diet information to estimate trends in capelin abundance. The summer acoustic surveys conducted by the AFSC in the central and western GOA have the best potential for providing abundance estimates. These surveys produced biomass estimates for 2003 and 2005 and have been conducted regularly on a biennial basis since 2011, so a time series of abundance from this survey is finally beginning to develop. In addition as part of the recently-concluded GOA Integrated Ecosystem Research Program, a major synthesis of knowledge regarding the abundance and distribution of capelin in the GOA has been completed. One outcome of this work is a set of specific recommendations for enhancing the utility of current AFSC survey resources for monitoring capelin.

The AFSC bottom trawl survey is a poor sampler of capelin but does yield some information that is consistent with other data. Increases in biomass estimates from the bottom-trawl survey coincide with peaks in acoustic-survey estimates of abundance in 2003 and 2013 (Table 1 and Figure 1). Frequency of occurrence (FO) in the bottom trawl survey has ranged from 2% to 25% (Table 1) and has increased substantially since the 1990s. Biomass estimates from the acoustic survey have varied by two orders of magnitude between 2003 and 2017 (Table 1 and Figure 1). In 2015, acoustic sign attributed to capelin was low and highly dispersed; no biomass estimate was made but the available data suggest that capelin abundance was very low in this year. The dearth of capelin in the acoustic survey, low abundance and FO in the bottom trawl survey, and information from seabirds and other predators suggest that the capelin population was negatively impacted by the warm-water anomaly that occurred in the GOA during 2014-2016. All of these indices also suggest some level of rebound in the capelin population in 2017.

#### *Eulachon*

Eulachon are larger than capelin and are distributed closer to the seafloor, so the bottom trawl surveys are a more reliable sampler of this species. Because they lack swim bladders, eulachon are not detected in acoustic surveys. Similar to capelin, the bottom trawl biomass estimate for eulachon fluctuates with particular years producing especially high estimates (Table 1). The FO of eulachon is more consistent, ranging from 19% to 40%. As the FO data suggest eulachon are found throughout the GOA survey area but the highest CPUEs are observed in the central GOA, particularly in the vicinity of Shelikof Strait

(Figure 2). Shelikof Strait is also the location of most of the incidental catches of eulachon in federal fisheries. Eulachon spawn in freshwater streams and rivers in the central and eastern GOA, and spawning aggregations are targeted by predators including humans. It is unclear how the eulachon observed in AFSC surveys and federal fisheries are related to these aggregations. The Alaska Department of Fish & Game (ADFG) has recently begun studying the spawning populations in Upper Cook Inlet (Figure 2), which are targeted by endangered beluga whales and by small-scale commercial and subsistence fishers. Using larval densities and stream discharge data, they recently estimated a spawning biomass of 48,000 t in this area for 2016 (<http://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2016-2017/uci/AR12.pdf>). This is within the range of the 2013-2017 biomass estimates from the AFSC survey.

### Squid

The bottom trawl survey regularly encounters adult *Berryteuthis magister*, likely due to the relative large size of this species and its distribution close to the bottom (Table 2). Smaller squid species and juvenile squids are mainly found in surface waters and not well sampled by the survey. Squids are regularly encountered by the survey in bottom depths of 200-300 m, resulting in relatively low uncertainty estimates (Table 2). Similar to other short-lived species the biomass estimates for squids vary substantially on an annual basis.

## **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 3). 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”, so catch reporting here is based on an aggregate osmerid group containing eulachon, capelin, surf smelt and “other osmerids”. Osmerids regularly make up the vast majority (93% to 99%) of FMP forage fish group catches (Table 1). Eulachon are the most abundant osmerid in catches, and it is likely that they make up the majority of the “other osmerid” catch.

Between 2003 and 2018 osmerid catch has been highly variable and is characterized by multiple years of low catches punctuated by occasional high-catch years (2005 & 2008; Table 3 and Figure 3). Since 2014, osmerid catches have been well below the 2003-2018 mean catch of 355 t. Most of the osmerid bycatch occurs in the central GOA, although high-catch years in the central GOA are matched by higher catches in the other areas (Table 4 & Fig. 3). Almost all of the bycatch is in the trawl fisheries for walleye pollock (Table 5).

### Squids

Catches of squids are generally low relative to population size (1990-2018 mean = 192 t; Table 6 and Figure 4), but in 2006 a very large catch of 1,516 t occurred. The 2017 catch was well below the mean and it appears the 2018 catch will also be especially low. Similar to osmerids, most of the squid catch occurs in the central GOA (Table 7 and Figure 4) and in the walleye pollock fishery (Table 8).

### Shrimps

The bycatch of pandalid shrimps in federal fisheries is generally low (2003-2018 mean = 4.2 t; Table 9 and Figure 5) but is also highly variable. Catches occur mainly in the central GOA (Table 9).

### Pacific herring

Data regarding the Prohibited Species Catch (PSC) of herring exist from 1991 and are maintained by the Alaska Regional Office. The PSC is generally low (1991-2018 mean = 30.4 t) but was exceptionally high in 1994, 2004, and 2016 (Table 10 and Figure 6). Recently, most catches have occurred in the central GOA (Table 10). The majority of herring PSC occurs in walleye pollock fisheries (Table 11).



## Tables

Table 1. Survey biomass estimates (t) for **eulachon** and **capelin** in the Gulf of Alaska, 1984-2017. “Biomass” and “CV” refer to the AFSC bottom trawl survey (BTS) biomass estimate and its coefficient of variability, respectively; “FO” refers to frequency of occurrence in BTS hauls; “AT” refers to biomass estimates from the AFSC summer acoustic-trawl survey.

	eulachon			capelin			AT
	biomass (t)	CV	FO	biomass (t)	CV	FO	
1984	7,105	0.14	19%	430	0.72	2%	
1987	16,314	0.19	29%	51	0.31	4%	
1990	27,988	0.14	40%	151	0.34	5%	
1993	35,003	0.16	38%	123	0.50	7%	
1996	32,248	0.16	34%	1,479	0.49	14%	
1999	14,690	0.10	36%	241	0.29	13%	
2001	51,928	0.19	24%	279	0.29	17%	
2003	113,482	0.19	28%	7,588	0.68	19%	115,979
2005	55,072	0.16	31%	1,016	0.30	12%	13,729
2007	51,810	0.18	29%	791	0.42	13%	
2009	87,227	0.22	27%	488	0.19	16%	
2011	71,507	0.15	30%	491	0.38	17%	27,920
2013	46,873	0.14	27%	3,683	0.55	25%	493,106
2015	108,649	0.20	28%	142	0.32	14%	0
2017	16,859	0.16	31%	156	0.31	12%	27,473

Table 2. Survey biomass estimates (t) and coefficients of variation (CV) for **squids** in the Gulf of Alaska, 1984-2017. Data are from the AFSC bottom trawl survey.

	<i>Berryteuthis magister</i>		miscellaneous squids		all squids	
	biomass (t)	CV	biomass (t)	CV	biomass (t)	CV
1984	2,762	0.15	546	0.35	3,308	0.14
1987	4,506	0.34	577	0.30	5,083	0.30
1990	4,033	0.17	276	0.43	4,309	0.16
1993	8,447	0.13	1,029	0.73	9,476	0.14
1996	4,884	0.14	26	0.28	4,911	0.14
1999	1,873	0.13	254	0.46	2,127	0.13
2001	5,909	0.30	703	0.62	6,612	0.27
2003	6,251	0.18	71	0.23	6,322	0.18
2005	4,654	0.18	249	0.51	4,903	0.18
2007	11,681	0.20	359	0.49	12,040	0.20
2009	8,415	0.16	188	0.61	8,603	0.16
2011	4,040	0.13	401	0.64	4,440	0.13
2013	9,675	0.16	568	0.80	10,243	0.16
2015	13,692	0.12	387	0.65	14,079	0.12
2017	2,042	0.15	253	0.51	2,296	0.15

Table 3. Incidental catches (t) of fishes in the GOA “FMP forage” group, 2003-2018. Data are from the Alaska Regional Office. “Osmerid” in the right-most column indicates the combination of eulachon, other osmerids, capelin, and surf smelt.

	eulachon	other osmerids	capelin	eelpouts	gunnels	myctophid	Pacific sand lance	Pacific sandfish	stichaeid	surf smelt	total	% osmerid
2003	18.1	353.1	6.2	2.6	0.011	0.004	0.003		0.490		380.6	99.2%
2004	169.6	66.2	68.0	1.7		0.000	0.009		0.110	0.442	306.1	99.4%
2005	852.1	185.7	2.8	11.6		0.149	0.003		2.200	0.411	1,055.1	98.7%
2006	397.7	183.5	0.1	0.7	0.028	0.012	0.011		0.906		582.9	99.7%
2007	229.1	51.8		0.9		0.001			0.327		282.2	99.6%
2008	760.9	406.1	0.0	0.5	0.043	0.001	0.004		0.143	0.163	1,167.8	99.9%
2009	223.5	174.0	0.0	2.2		0.001	0.196		2.759		402.6	98.7%
2010	213.9	6.8	0.0	12.6		0.003			0.805		234.1	94.3%
2011	285.0	69.0	6.2	8.2			0.007		0.475		368.8	97.6%
2012	188.3	82.0	0.0	0.7	1.522		0.005	0.004	0.095		272.7	99.1%
2013	26.4	11.2	0.0	34.7	5.393	0.002	0.004	0.115	0.749		78.6	47.9%
2014	249.5	77.9	5.2	0.7		0.002	0.025		0.528		333.8	99.6%
2015	97.2	17.7	4.2	1.6	0.330	0.043		0.100	0.721		121.8	97.7%
2016	95.0	8.9	0.0	0.8		0.138	0.003		0.392		105.3	98.7%
2017	44.0	2.7	0.1	2.5	0.001	0.003	0.011		0.925		50.2	93.1%
2018*	18.7	24.2	3.1	0.7		0.003	0.221		1.628		48.6	94.7%

\* 2018 data are incomplete; retrieved September 27, 2018.

Table 4. 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, 2003-2018. Data are from the Alaska Regional Office.

	WGOA	CGOA		EGOA				total
	610	620	630	640	649	650	659	
2003	46.2	264.8	57.6	4.9	4.0	0.0	0.0	377.5
2004	12.0	224.6	64.8	1.2	1.8	0.0	0.0	304.3
2005	49.3	864.8	106.0	18.6	2.4	0.0	0.0	1,041.1
2006	34.1	440.9	92.1	5.6	8.5	0.0	0.0	581.3
2007	63.1	149.9	65.1	0.5	2.3	0.0	0.0	280.9
2008	273.0	678.1	190.6	15.9	9.6	0.0	0.0	1,167.1
2009	27.8	284.5	73.3	4.3	7.6	0.0	0.0	397.4
2010	33.3	171.6	6.9	3.6	5.3	0.0	0.0	220.7
2011	34.6	291.2	22.7	3.7	7.9	0.0	0.0	360.1
2012	37.9	205.0	15.8	2.3	9.4	0.0	0.0	270.3
2013	1.1	32.9	2.4	1.2	0.1	0.0	0.0	37.7
2014	6.6	231.6	88.3	1.5	4.6	0.0	0.0	332.6
2015	11.0	55.5	49.3	0.2	3.1	0.0	0.0	119.1
2016	2.8	83.8	15.2	0.0	2.1	0.0	0.0	103.9
2017	1.1	30.8	14.3	0.1	0.5	0.0	0.0	46.8
2018*	0.5	30.3	14.3	0.0	1.0	0.0	0.0	46.1

\* 2018 data are incomplete; retrieved September 27, 2018.

Table 5. Incidental catches (t) of **osmerids**, which includes the following groups: eulachon, capelin, surf smelt, and “other osmerids”, by target fishery, 2003-2018. Data are from the Alaska Regional Office.

	Pacific cod	shallow flatfish	rockfish	flathead sole	other	sablefish	ATF	rex sole	pollock	total
2003	0.0	0.0	0.6	3.2	0.7		0.3	0.1	372.6	377.5
2004	0.0	0.0	0.4	0.0			0.5		303.3	304.3
									1,005.	1,041.
2005	0.4		0.1	20.4			14.4	0.0	8	1
2006	2.5		0.6	15.5			2.1		560.5	581.3
2007	0.0	0.1	0.1			0.3	0.8	0.9	278.7	280.9
									1,165.	1,167.
2008	0.6	0.0	0.0	0.2		0.0	0.6	0.0	6	1
2009		1.6	0.2	0.1		0.1	33.8	0.8	360.9	397.4
2010	0.6	0.1	0.0	0.3		0.0	3.8	0.2	215.7	220.7
2011			0.0	0.1			22.8	0.0	337.1	360.1
2012	0.0		0.0	0.0		0.0	6.7	0.1	263.4	270.3
2013		0.0	0.1	0.4		0.0	0.9	0.0	36.2	37.7
2014	0.2	0.2	0.0				5.4	0.0	326.7	332.6
2015	0.0		0.0	7.2			15.1	0.0	96.7	119.1
2016	0.0	0.1	0.1	0.2	0.0		11.2	0.0	92.4	103.9
2017	0.0	0.0	0.2				5.8	0.0	40.7	46.8
2018*			0.1				10.1		35.9	46.1

\* 2018 data are incomplete; retrieved September 27, 2018.

Table 6. Estimated total catches (t) of **squids** (all species) and estimated retention rates in Gulf of Alaska groundfish fisheries, 1990-2018 (1990 is the earliest year for which GOA squid catch data are available). This table also includes annual TACs for the Other Species (OS) complex and estimated OS catch, 1990-2010, as well as specifications for the squid complex beginning in 2011. **Squid catch reported here does not include catches in NMFS statistical areas 649 & 659.** Data are from the Alaska Regional Office.

	squid catch (t)	% retained	Other Species catch (t)	Other Species TAC (t)	squid TAC (t)	squid ABC (t)	squid OFL (t)	management method
1990	60	-	6,289	n/a				OS TAC
1991	117	-	5,700	n/a				OS TAC (incl. Atka)
1992	88	-	12,313	13,432				OS TAC (incl. Atka)
1993	104	-	6,867	14,602				OS TAC (incl. Atka)
1994	39	-	2,721	14,505				OS TAC
1995	25	-	3,421	13,308				OS TAC
1996	42	-	4,480	12,390				OS TAC
1997	97	-	5,439	13,470				OS TAC
1998	59	-	3,748	15,570				OS TAC
1999	41	-	3,858	14,600				OS TAC
2000	19	-	5,649	14,215				OS TAC
2001	91	-	4,804	13,619				OS TAC
2002	43	-	3,748	11,330				OS TAC
2003	77	46%	6,266	11,260				OS TAC
2004	157	69%	1,705	12,942				OS TAC (no skates)
2005	632	88%	2,513	13,871				OS TAC (no skates)
2006	1,516	84%	3,881	13,856				OS TAC (no skates)
2007	412	91%	3,035	4,500				OS TAC (no skates)
2008	84	91%	2,967	4,500				OS TAC (no skates)
2009	337	87%	3,188	4,500				OS TAC (no skates)
2010	131	91%	1,724	4,500				OS TAC (no skates)
2011	232	77%			1,148	1,148	1,530	squid complex
2012	18	28%			1,148	1,148	1,530	squid complex
2013	321	92%			1,148	1,148	1,530	squid complex
2014	94	77%			1,148	1,148	1,530	squid complex
2015	411	78%			1,148	1,148	1,530	squid complex
2016	239	59%			1,148	1,148	1,530	squid complex
2017	39	31%			1,137	1,137	1,516	squid complex
2018*	42	10%			1,137	1,137	1,516	squid complex

\*2018 data are incomplete; retrieved October 31, 2018.

Table 7. Estimated catch (t) of all **squid** species in the Gulf of Alaska combined by NMFS statistical area, 1997-2018. Data are from the Alaska Regional Office.

	WGOA	CGOA		EGOA				
	610	620	630	640	649	650	659	total
2003	18.6	42.5	13.4	2.1	20.0	0	0	96.6
2004	15.2	129.0	10.8	1.6	5.2	0	0.1	161.9
2005	13.1	606.6	10.6	2.0	3.5	0	0	635.8
2006	11.7	1,484.8	14.4	5.0	13.9	0	0	1,529.9
2007	2.7	403.5	4.7	0.4	4.8	0.5	0.0	416.5
2008	4.0	77.3	2.3	0.3	13.9	0	0	97.9
2009	11.8	314.8	9.6	1.3	7.3	0	0	344.7
2010	3.3	120.6	5.2	1.9	7.8	0	0	138.9
2011	8.3	201.0	18.5	4.1	6.8	0.0	0.0	238.7
2012	5.0	6.0	5.5	1.9	3.7	0	0	22.1
2013	0.8	278.3	40.1	2.2	39.1	0	0	360.5
2014	5.0	69.5	17.1	2.3	78.1	0.0	0.0	172.1
2015	5.9	295.9	107.4	2.2	109.4	0.0	0.0	520.9
2016	11.4	119.3	105.7	2.9	20.4	0	0	259.7
2017	7.2	25.9	4.2	2.1	0.1	0	0.0	39.5
2018*	13.2	19.8	4.7	4.1	0.7	0	0.0	42.4

\*2018 data are incomplete; retrieved October 31, 2018.

Table 8. Estimated catch (t) of all **squid** species in the Gulf of Alaska by target fishery, 2003-2018. ATF = arrowtooth flounder; “others” includes all target fisheries not listed individually. Data are from the Alaska Regional Office.

	pollock	ATF	rockfish	others	total
2003	68.3	2.8	9.1	16.3	96.6
2004	144.5	0.8	11.9	4.7	161.9
2005	631.5	2.1	1.8	0.3	635.8
2006	1,517.8	1.4	10.2	0.5	1,529.9
2007	410.0	1.9	3.1	1.6	416.5
2008	91.8	0.3	5.2	0.5	97.9
2009	320.9	6.8	13.9	3.0	344.7
2010	129.0	2.0	4.4	3.5	138.9
2011	208.8	17.0	12.0	0.9	238.7
2012	6.7	0.3	14.6	0.4	22.1
2013	346.2	0.2	10.0	4.1	360.5
2014	143.5	8.5	19.3	0.8	172.1
2015	465.3	24.9	24.0	6.6	520.9
2016	182.2	64.9	11.7	0.9	259.7
2017	15.5	1.4	22.0	0.6	39.5
2018*	9.5	3.0	28.7	1.3	42.4

\*2018 data are incomplete; retrieved October 31, 2018.

Table 9. Incidental catches (t) of **pandalid shrimps** in the GOA, by NMFS statistical area, 2003-2018. Data are from the Alaska Regional Office.

	EGOA	CGOA		EGOA				total
	610	620	630	640	649	650	659	
2003	0.10	0.76	2.55	0.02	0.00	0.00	0.00	3.42
2004	0.08	1.01	1.68	0.01	0.00	0.00	0.00	2.79
2005	0.73	6.78	3.07	0.20	0.01	0.00	0.00	10.80
2006	1.54	1.61	1.01	0.02	0.00	0.00	0.00	4.18
2007	1.02	0.92	0.45	0.02	0.00	0.00	0.00	2.41
2008	0.31	0.49	0.52	0.02	0.01	0.00	0.00	1.35
2009	0.02	0.21	1.04	0.01	0.05	0.00	0.00	1.34
2010	0.27	0.84	2.09	0.15	0.02	0.00	0.00	3.38
2011	0.05	0.46	4.67	0.02	0.00	0.00	0.00	5.19
2012	0.01	0.28	3.68	0.00	0.00	0.00	0.00	3.96
2013	0.00	0.32	3.17	0.00	0.00	0.00	0.00	3.49
2014	0.00	0.31	4.98	0.02	0.00	0.00	0.00	5.32
2015	0.01	0.91	8.18	0.00	0.00	0.00	0.00	9.10
2016	0.01	1.07	5.43	0.01	0.00	0.00	0.00	6.51
2017	0.01	1.30	1.21	0.01	0.00	0.00	0.00	2.53
2018*	0.00	0.38	0.60	0.00	0.01	0.00	0.00	0.99

\*2018 data are incomplete; retrieved September 27, 2018.



Table 10. Prohibited Species Catch (t) of **Pacific herring** in federal fisheries in the GOA, by NMFS regulatory and statistical areas, 1991- 2018. Data are from the Alaska Regional Office.

	WGOA	CGOA		EGOA				total
	610	620	630	640	649	650	659	GOA
1991	0.63	0.01	0.61	0.00	0.00	0.00	0.00	1.3
1992	17.27	8.38	1.06	0.04	0.00	0.03	0.00	26.8
1993	0.66	0.57	5.02	0.04	0.00	0.00	0.00	6.3
1994	78.19	19.62	2.35	0.00	0.00	0.00	0.00	100.2
1995	2.14	43.47	1.48	0.10	0.00	0.19	0.00	47.4
1996	1.52	0.63	1.31	0.14	0.00	0.00	0.00	3.6
1997	1.42	5.83	1.96	0.01	0.00	0.01	0.00	9.2
1998	0.30	2.79	17.14	0.00	0.00	0.00	0.00	20.2
1999	0.66	8.51	1.61	0.01	0.00	0.00	0.00	10.8
2000	1.39	2.19	1.68	0.00	0.00	0.00	0.00	5.3
2001	0.54	4.91	1.48	0.00	0.00	0.00	0.00	6.9
2002	0.04	1.38	0.74	0.00	0.00	0.00	0.00	2.2
2003	0.01	0.11	11.72	0.00	0.00	0.00	0.00	11.8
2004	9.14	167.89	90.80	0.03	0.00	0.00	0.00	267.8
2005	0.98	10.55	0.10	0.60	0.00	0.00	0.00	12.2
2006	0.21	7.88	0.74	0.02	0.00	0.00	0.00	8.9
2007	1.40	5.16	14.71	0.01	0.00	0.00	0.00	21.3
2008	0.15	0.30	0.57	0.00	0.00	0.00	0.00	1.0
2009	0.08	7.85	0.63	0.06	0.00	0.00	0.00	8.6
2010	0.18	0.69	0.97	0.10	0.00	0.00	0.00	1.9
2011	0.81	9.42	0.00	0.12	0.00	0.00	0.00	10.4
2012	0.02	1.32	0.02	0.00	0.00	0.00	0.00	1.4
2013	0.05	8.73	1.64	0.09	0.00	0.00	0.00	10.5
2014	0.01	4.57	0.91	0.00	0.00	0.00	0.00	5.5
2015	0.85	52.61	23.65	0.15	0.00	0.00	0.00	77.3
2016	11.01	2.93	133.97	0.00	0.00	0.00	0.00	147.9
2017	1.49	3.57	1.01	0.00	0.00	0.00	0.00	6.1
2018*	0.03	2.92	14.88	0.00	0.00	0.00	0.00	17.8

\*2018 data are incomplete; retrieved November 1, 2018.

Table 11. Prohibited Species Catch (t) of **Pacific herring** in federal fisheries in the GOA, by target fishery, 1991- 2018. “All others” includes all target fisheries except those listed individually. Data are from the Alaska Regional Office.

	pollock	shallow flatfish	ATF	all others	total
1991	1.01			0.25	1.3
1992	26.50	0.13		0.16	26.8
1993	6.19		0.07	0.03	6.3
1994	99.98	0.01	0.06	0.11	100.2
1995	46.99	0.34	0.03	0.02	47.4
1996	2.74	0.78	0.05	0.02	3.6
1997	7.49	0.51		1.22	9.2
1998	19.08	0.87		0.27	20.2
1999	9.74	0.00	0.01	1.03	10.8
2000	4.66	0.17	0.37	0.07	5.3
2001	6.57	0.05		0.29	6.9
2002	2.03	0.09		0.04	2.2
2003	11.65	0.00	0.00	0.18	11.8
2004	267.83	0.00	0.00	0.02	267.8
2005	12.12	0.06	0.04	0.01	12.2
2006	8.79	0.02	0.05	0.00	8.9
2007	21.15	0.10	0.00	0.02	21.3
2008	0.91	0.05	0.01	0.07	1.0
2009	7.79	0.82	0.01	0.02	8.6
2010	0.86	0.04	0.04	1.00	1.9
2011	10.35	0.00	0.00	0.00	10.4
2012	1.27	0.00	0.07	0.02	1.4
2013	10.41	0.09	0.00	0.00	10.5
2014	4.57	0.85	0.07	0.00	5.5
2015	75.72	1.38	0.10	0.06	77.3
2016	147.04	0.53	0.30	0.05	147.9
2017	5.38	0.07	0.57	0.05	6.1
2018*	15.45	1.96	0.40	0.01	17.8

\*2018 data are incomplete; retrieved November 1, 2018.

## Figures

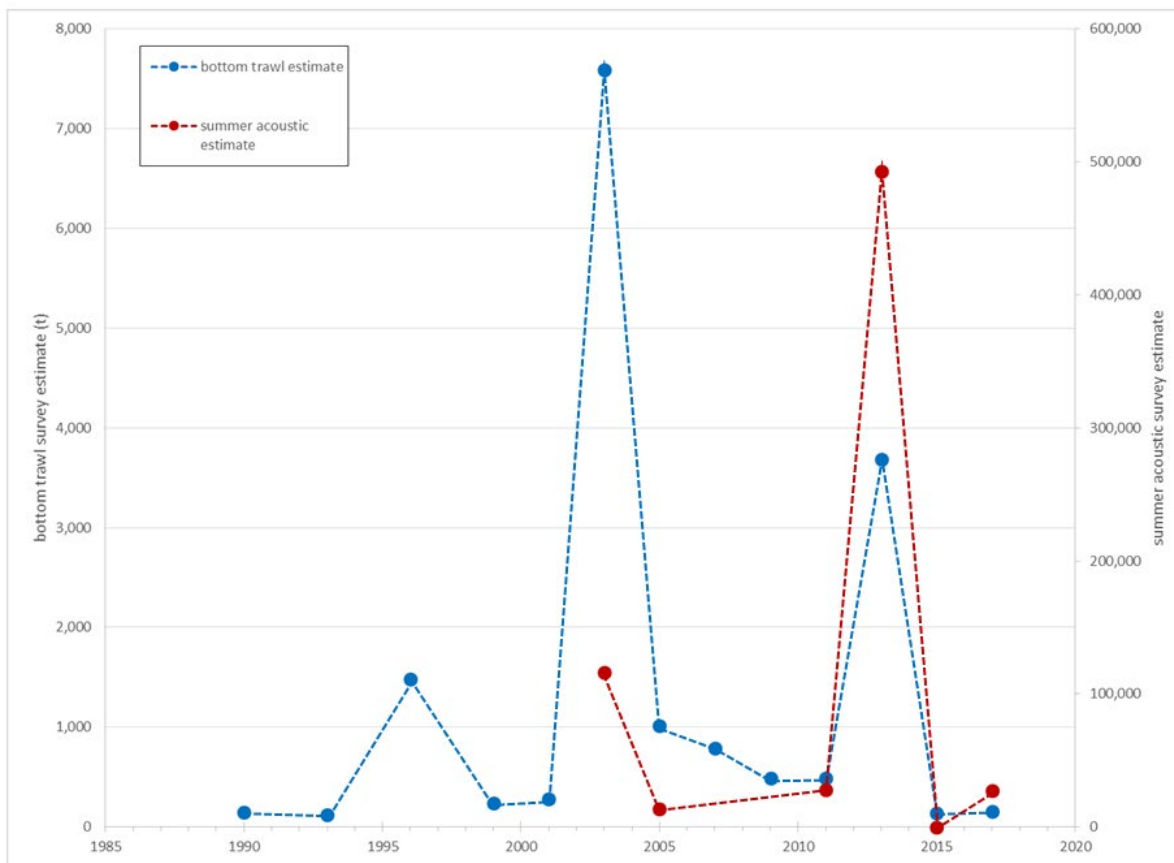


Figure 1. Survey biomass estimates for **capelin** in the Gulf of Alaska, 1990-2017. Data are from the AFSC bottom trawl surveys (“bottom trawl estimate”) and the AFSC summer acoustic surveys (“summer acoustic estimate”). For clarity, estimates of uncertainty are omitted; these can be found in Table 1.

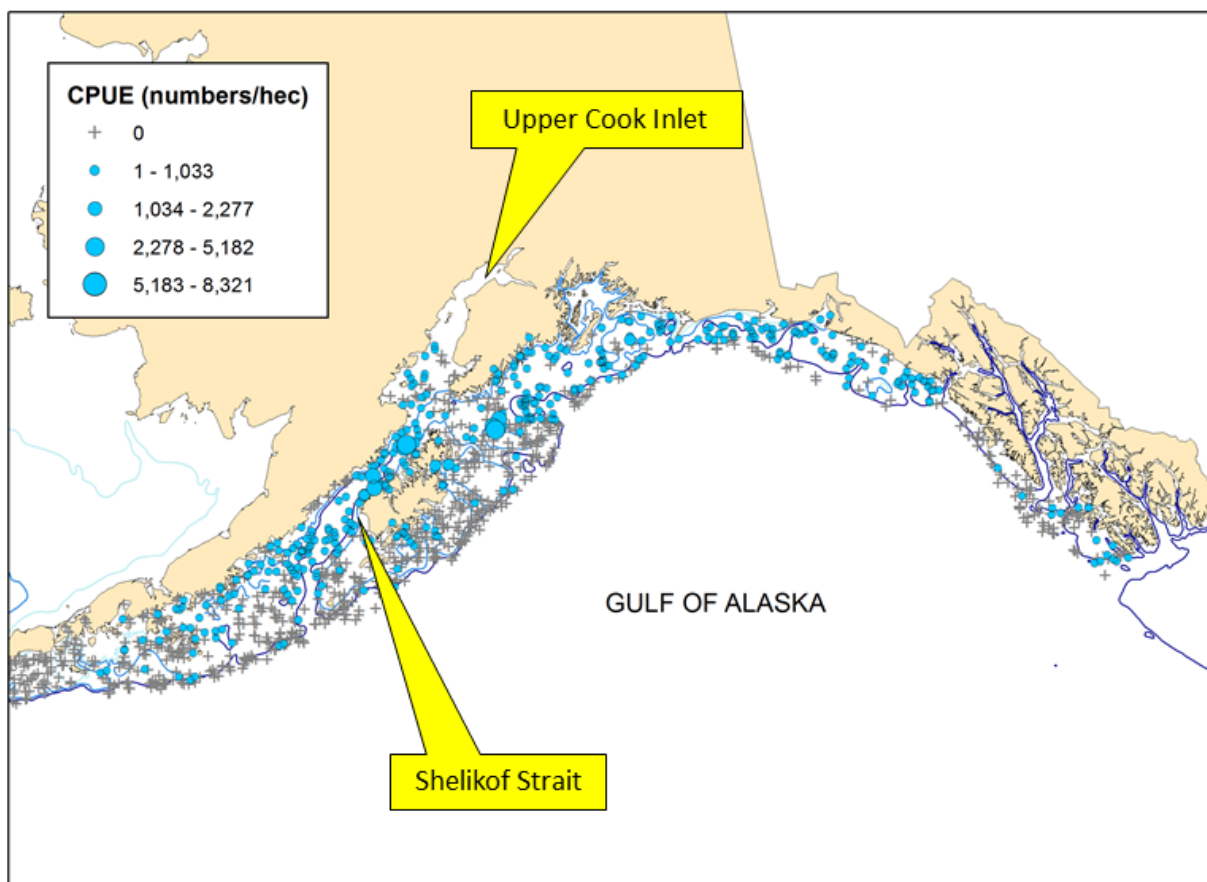


Figure 2. Distribution of **eulachon** in AFSC bottom trawl surveys of the Gulf of Alaska in 2015 and 2017. Data from both surveys were aggregated.

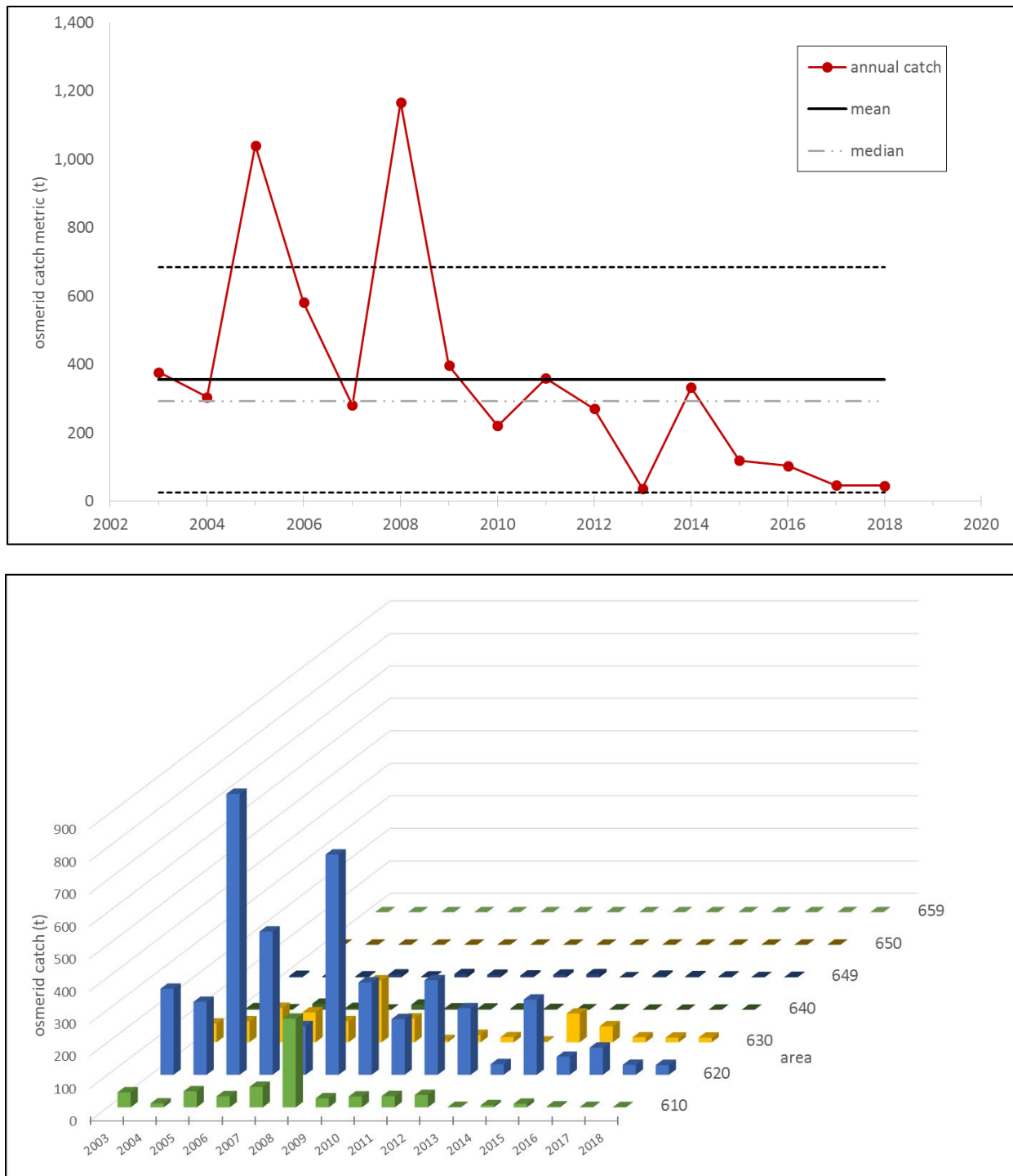


Figure 3. Incidental catches (t) of **osmerids** in the Gulf of Alaska (GOA). *Top panel*: total annual catches, mean and median catch 2003-2018; dashed black lines are mean  $\pm$  1 SD. *Bottom panel*: total annual catches by NMFS statistical area. The 2018 data are incomplete; retrieved September 27, 2018. Data are from the Alaska Regional Office.

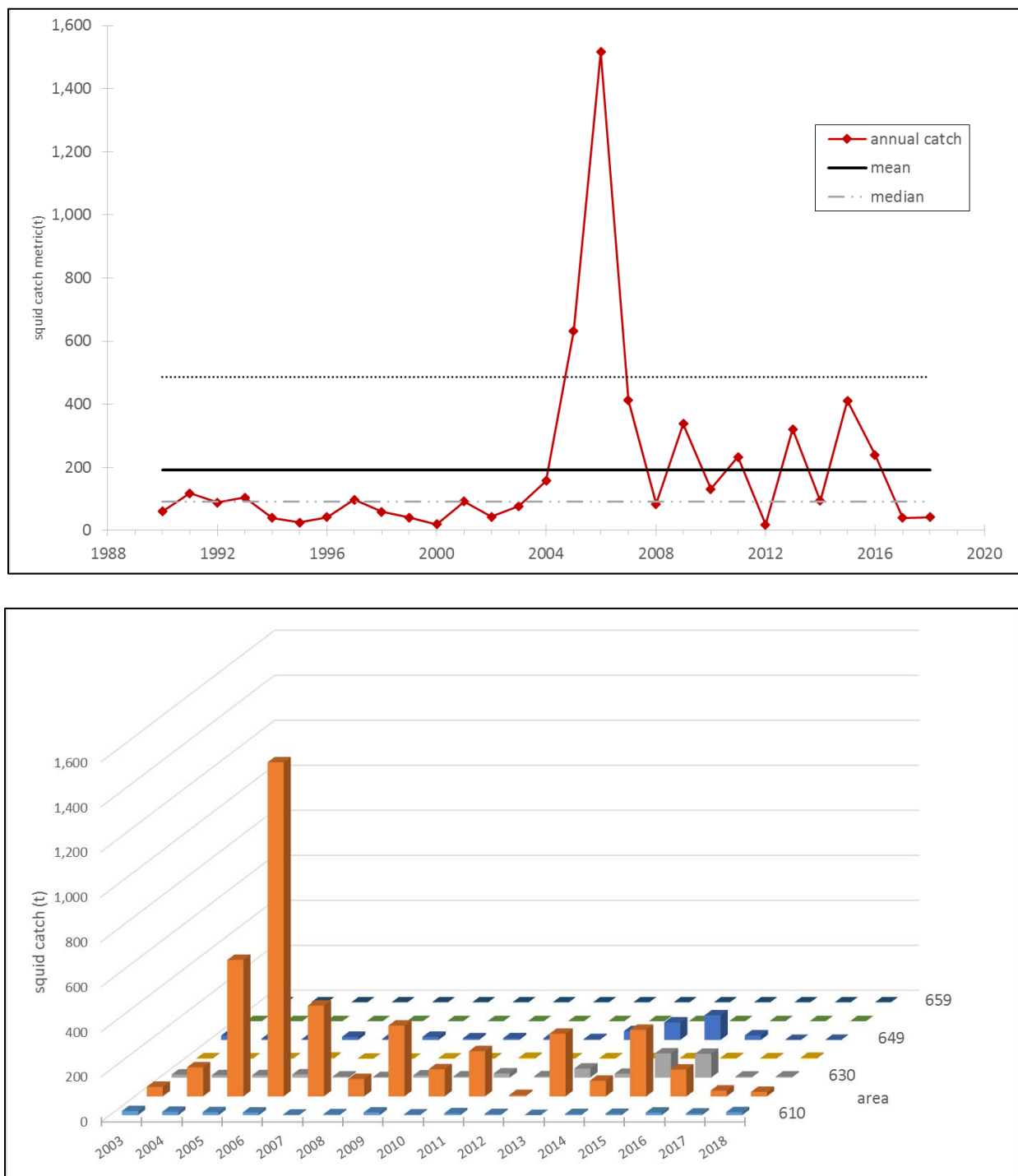


Figure 4. Incidental catches (t) of **squids** in the Gulf of Alaska. *Top panel*: total annual catches, mean and median catch 2003-2018; dashed black lines are mean  $\pm$  1 SD. *Bottom panel*: total annual catches by NMFS statistical area. Note that the timespan differs between panels. The 2018 data are incomplete; retrieved October 31, 2018. Data are from the Alaska Regional Office.

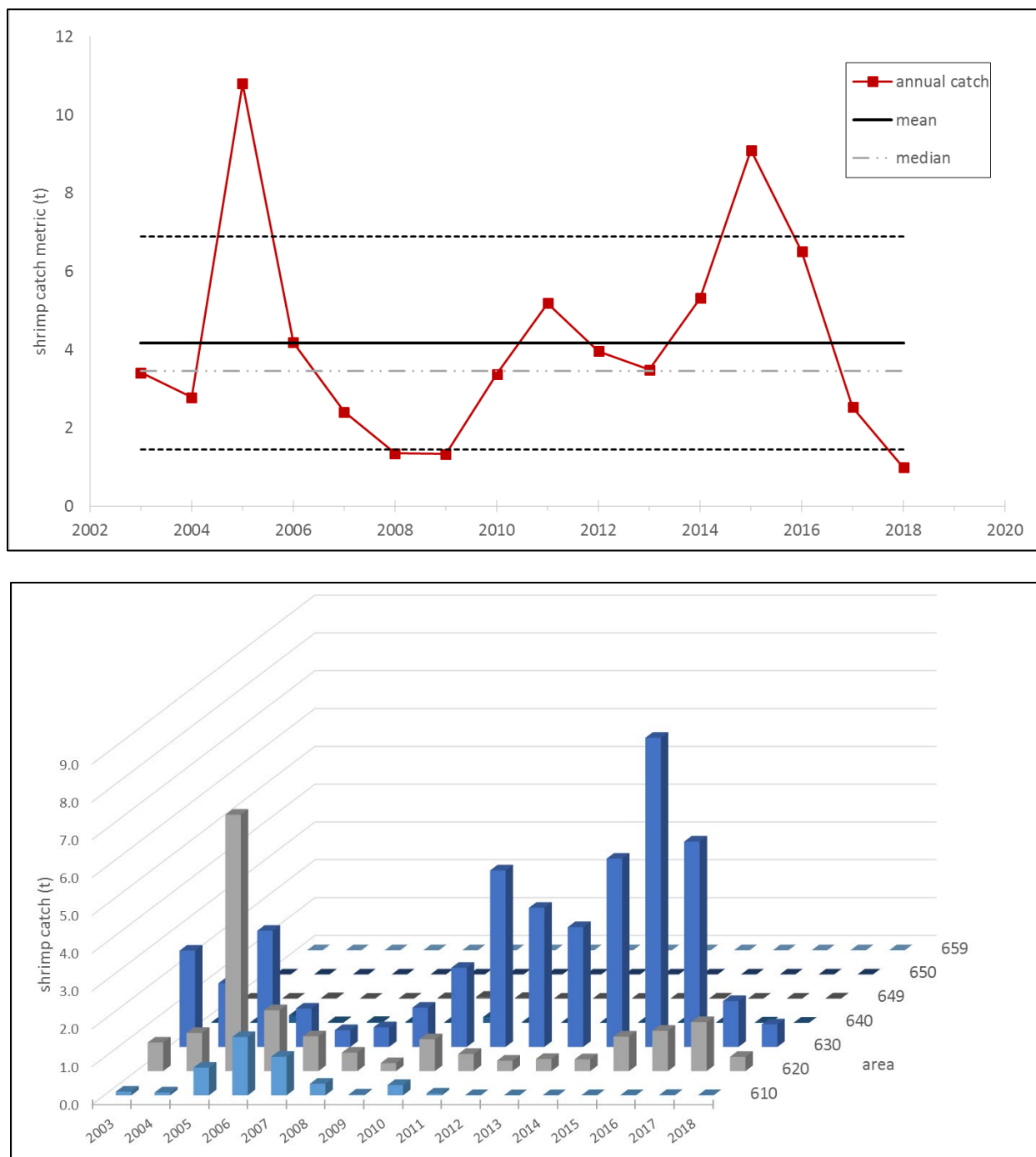


Figure 5. Incidental catches (t) of **pandalid shrimps** in the Gulf of Alaska. *Top panel*: total annual catches, mean and median catch 2003-2018; dashed black lines are mean  $\pm$  1 SD. *Bottom panel*: total annual catches by NMFS statistical area. The 2018 data are incomplete; retrieved September 27, 2018. Data are from the Alaska Regional Office.

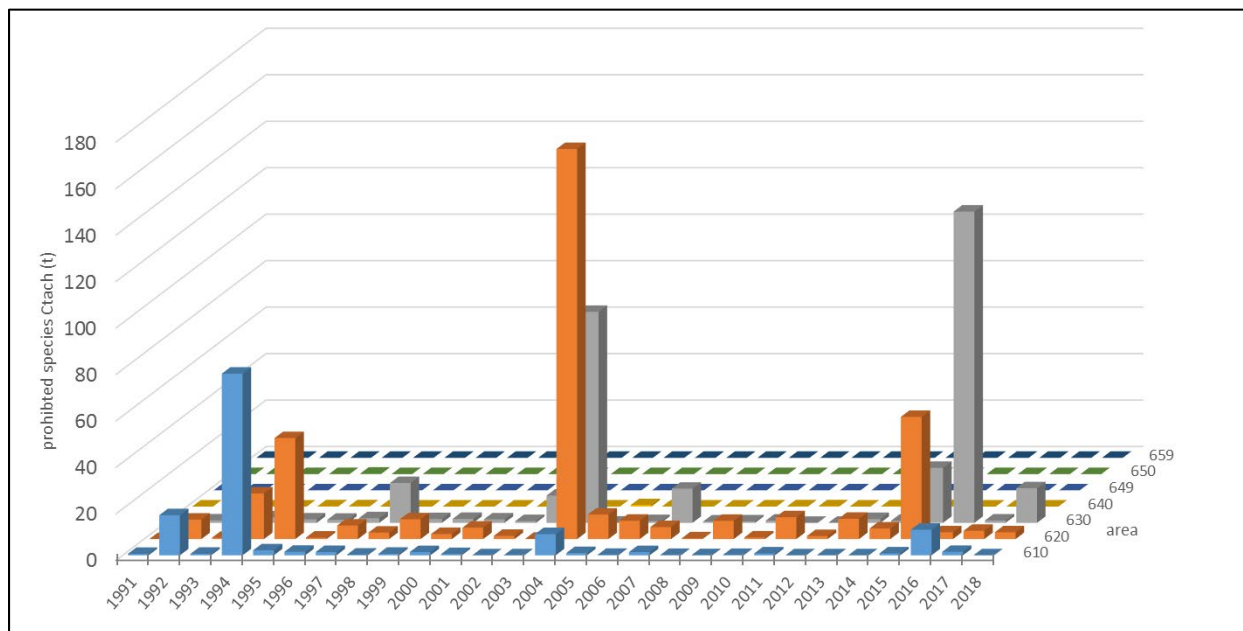
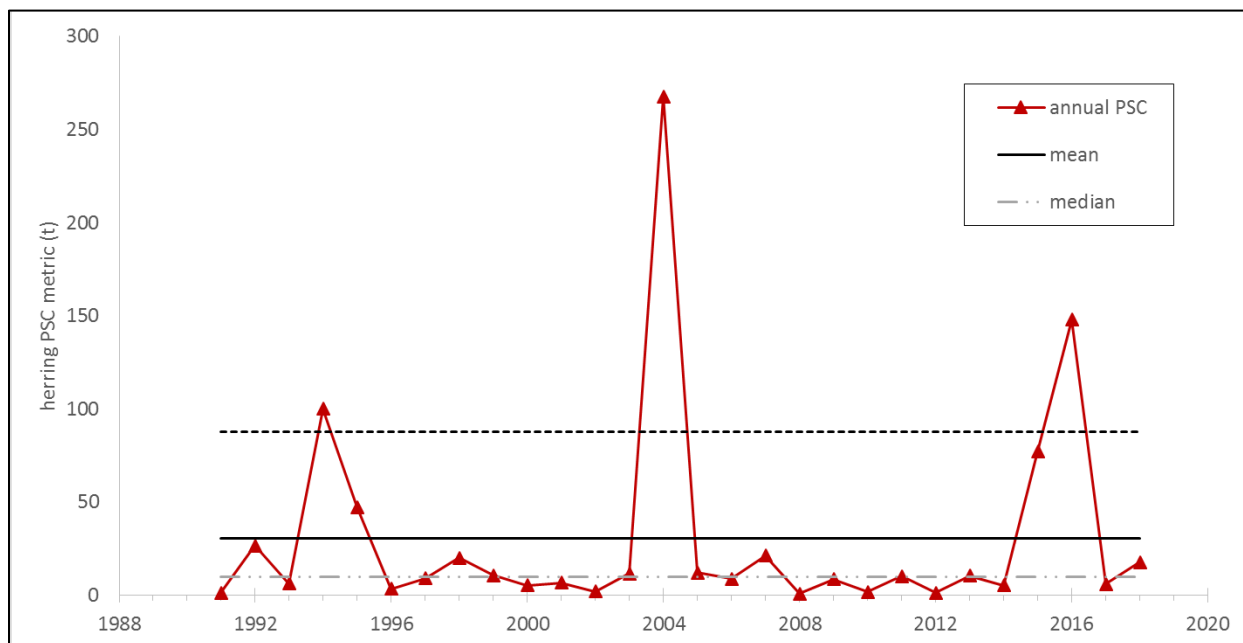


Figure 6. Prohibited Species Catch (t) of **Pacific herring** in federal fisheries in the Gulf of Alaska. *Top panel*: total annual catches, mean and median catch 2003-2018; dashed black lines are mean  $\pm$  1 SD. *Bottom panel*: total annual catches by NMFS statistical area. Note that the timespan differs between panels. The 2018 data are incomplete; retrieved November 1, 2018. Data are from the Alaska Regional Office.



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).

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

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