NOAA Technical Memorandum NMFS-AFSC-450

Results of the 2018 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Fauna

E. H. Markowitz, E. J. Dawson, N. E. Charriere,
B. K. Prohaska, S. K. Rohan, R. A. Haehn,
D. E. Stevenson, and L. L. Britt

November 2022

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

The National Marine Fisheries Service's Alaska Fisheries Science Center uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series reflect sound professional work and may be referenced in the formal scientific and technical literature.

The NMFS-AFSC Technical Memorandum series of the Alaska Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest Fisheries Center. The NMFS-NWFSC series is currently used by the Northwest Fisheries Science Center.

This document should be cited as follows:

Markowitz, E. H., E. J. Dawson, N. E. Charriere, and B. K. Prohaska, S. K. Rohan, R. A. Haehn, D. E. Stevenson, and L. L. Britt. 2022. Results of the 2018 eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate fauna. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-450, 183 p.

This document is available online at:

Document available: https://repository.library.noaa.gov

NOAA FISHERIES

Results of the 2018 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Fauna

E. H. Markowitz, E. J. Dawson N. E. Charriere,
B. K. Prohaska, S. K. Rohan, R. A. Haehn,
D. E. Stevenson, and L. L. Britt

Resource Assessment and Conservation Engineering Division
Alaska Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE
Seattle WA 98115

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

NOAA Technical Memorandum NOAA-TM-AFSC-450

November 2022

Abstract

In 2018, the Resource Assessment and Conservation Engineering (RACE) division of the National Marine Fisheries Service's (NMFS) Alaska Fisheries Science Center (AFSC) conducted the 37th Eastern Bering Sea Crab/Groundfish Bottom Trawl Survey (EBS) from June to July 2018. The EBS bottom trawl survey covers the Bering Sea continental shelf (bottom depths between approximately 20 and 200 m) from the Alaska coastline to the U.S.-Russia Maritime Boundary between the Alaska Peninsula and roughly 62° N latitude. Two stern trawlers, the 43.9-m FV *Alaska Knight* and 37.8-m FV *Vesteraalen*, were chartered for the survey. Demersal populations of fishes and invertebrates were sampled by trawling for 30 minutes at stations arranged on a systematic grid, which consisted of 376 total stations in the EBS. At each station, species composition, length distribution, and age structure samples were collected from ecologically and commercially important species. All survey stations in the EBS were sampled successfully.

The recent trend of higher-than-average temperatures continued on the EBS shelf for the fifth consecutive year. In 2018, both the mean surface (7.6°C) and bottom (4.2°C) water temperatures were warmer than the survey long-term average of surface (6.7°C) and bottom (2.4°C). The 2018 mean bottom temperatures were the second warmest observed since the beginning of the EBS shelf bottom trawl survey time series in 1982.

A total of 94 species of fishes were identified during the EBS survey, representing 57 genera and 23 families, as well as 241 invertebrate taxa. In total, organisms representing 13 phyla were identified in the catch.

This report compares the distribution and relative abundance of 34 fish species and six invertebrate taxa with side-by-side maps from the 2016 and 2018 EBS shelf bottom trawl surveys. For select and common fish species, abundance-at-length plots comparing the 2016 and 2018 EBS surveys are also presented. Survey results reported herein include estimates of bottom trawl survey biomass for most fishes and invertebrates, and estimates of population size, geographic distributions, and abundance-at-length of select fish species. Appendices provide tables listing population estimates by sex and size group for principal fish species (Appendix Table A2) and species encountered during the EBS survey (Appendix Tables B1 to B10).

In 2018, a portion of the Northern Bering Sea (NBS) was also sampled during a rapid response survey due to changes in historical fish and invertebrate distributions in association with unusually warm seafloor temperatures. Results of this NBS rapid response survey are not covered in this report.

Contents

Introduction

The purpose of the EBS shelf bottom trawl survey is to collect information about the fish and invertebrate populations and environmental conditions. In 2018, the Resource Assessment and Conservation Engineering (RACE) Division of National Marine Fisheries Service's (NMFS') Alaska Fisheries Science Center AFSC conducted 37th Eastern Bering Sea Crab/Groundfish Bottom Trawl Survey (EBS) from June to July 2018. The EBS survey has occurred annually since 1982 and is the longest-running, standardized time series of fish and invertebrate data in the region (Conner and Lauth 2017). Additionally, in 2018, an NBS rapid response survey was conducted for the first time due to warmer-than-average seafloor water temperatures and changes in historical fish and invertebrate distribution patterns observed during the EBS survey (Lauth 2011).

The 2018 NBS Rapid Response Survey had a modified station grid resulting in 49 sampling locations. The NBS is a region of critical importance for increased scientific monitoring because the area is a transitional zone between the EBS and Arctic Ocean that is transforming with the changing climate (Sigler et al. 2015). Results from the NBS rapid response survey will not be covered in this report.

The data collected during these bottom trawl surveys are vital for managing fisheries resources and for ecosystem monitoring. Fishery-independent abundance estimates, in addition to other biological and oceanographic information from Bering Sea shelf bottom trawl surveys, are used by the AFSC, North Pacific Fishery Management Council (NPFMC), and the Alaska Department of Fish and Game (ADF&G). These organizations utilize the survey data products to manage groundfish and crab stocks, as well as conduct ecosystem forecast modeling, which are requirements of the Bering Sea and Aleutian Island (BSAI) Fishery Management Plan (FMP) established under the Magnuson-Stevens Fishery Conservation and Management Act (https://www.fisheries.noaa.gov/topic/laws-policies).

Effective management of fisheries resources and healthy ecosystems are especially important to Alaska Native communities and to the tens of thousands of people who are employed by the Alaska fishing industry. The commercial fishing industry in Alaska generates billions of dollars for the U.S. economy annually (https://www.fisheries.noaa.gov/alaska/socioeconomics/alaska-economic-and-social-sciences-research; https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-economics-united-states).

In this document, we compare the most recent and similar surveys within the same regions. Therefore, we compare the 2018 EBS survey results with those from the 2016 EBS shelf bottom trawl survey (Conner and Lauth 2017). For data referenced from previous surveys, refer to the AFSC Technical Memoranda here at the end of the report and listed on the AFSC website (https://www.fisheries.noaa.gov/resource/publication-database/alaska-fisheries-science-center-technical-memorandums).

History of Bering Sea Bottom Trawl Surveys

The Bering Sea continental shelf supports several of the most productive groundfish and crab fisheries in the world (Fissel et al. 2019). Although many species of groundfish are caught commercially in the Bering Sea, groundfish such as walleye pollock (*Gadus chalcogrammus*), Pacific cod (*Gadus macrocephalus*) and yellowfin sole (*Limanda aspera*) have been the primary target species among commercial catches. Of these catches, walleye pollock is the most abundant species. Commercial catches ranged from 0.8 million metric tons (t) in 2009 to 1.5 million t from 2003-2006 per year over the course of the EBS survey, and the marketed products represented 40% of the global whitefish market (Ianelli et al. 2017). Commercial crab

stocks on the Bering Sea shelf include Tanner crab (*Chionoecetes bairdi*), snow crab (*Chionoecetes opilio*), red king crab (*Paralithodes camtschaticus*), blue king crab (*Paralithodes platypus*), and hair crab (*Erimacrus isenbeckii*; Lang et al. 2019).

The federal government has conducted bottom trawl surveys of the eastern Bering Sea continental shelf since the 1940s. These early surveys were often exploratory efforts to locate commercial fisheries resources (Zimmermann et al. 2009) and led to the development of a valuable red king crab fishery. Bottom trawl surveys by the U.S. continued into the 1970s with private industry involvement to study the biology, distribution, abundance, and best fishing practices for red king crab (Zimmermann et al. 2009). The first large-scale survey of the Bering Sea shelf was conducted in 1975 under contract from the U.S. Bureau of Land Management. The purpose was to collect baseline data for assessing the potential impact of the growth in the offshore oil industry on the development of Bering Sea groundfish and crab fishery resources (Pereyra et al. 1976). During the 1975 baseline survey, sampling was conducted over the shelf between the 20 m and 200 m isobaths from the Alaska Peninsula north to approximately 62°N.

In subsequent years, the areal coverage of the annual survey was reduced. However, in 1979, a comprehensive survey of the Bering Sea shelf was undertaken in cooperation with the Japan Fisheries Agency (Bakkala and Wakabayashi 1985). That survey encompassed the entire region sampled in the 1975 baseline study and included the upper continental slope waters between St. Matthew and St. Lawrence islands.

Following the 1979 survey, annual bottom trawl surveys have resampled the same areas and stations established during the 1975 survey with slight modifications in sampling design in some years. Beginning in 1979 and continuing triennially until 1991, the survey was extended to include bottom trawl sampling of the continental slope and in the region between St. Matthew and St. Lawrence islands. After a hiatus from 1992 to 1999 due to lack of funding, the Bering Sea slope survey was resumed in 2002 as an independent, standardized bottom trawl survey series that has been conducted on a quasi-biennial basis dependent on funding (Hoff 2016; Stauffer 2004; Hoff and Britt 2011). The most recent slope survey was conducted in 2016 (Hoff 2016).

The current EBS shelf survey design has been used since 1982 and was marked by the standardization of bottom trawl gear (Stauffer 2004), survey methods, temporal stationarity, and a systematic grid design that included 356 stations arranged on a regularly-spaced 37.04 × 37.04 km (20 × 20 nautical mile) sampling grid (Figures 2 and 1; Bakkala 1993). For these reasons, 1982 is considered to be the start of the survey time series. Beginning in 1987, 20 new stations that comprise Strata 82 and 90 (Figure 2) were added to monitor more northerly distributions of snow crab and walleye pollock. The Bering Sea shelf region continues to be surveyed annually because the area encompasses major portions of the commercially exploited Bering Sea groundfish and crab populations that require management actions under the BSAI FMP.

The NBS shelf was also surveyed in 2010, 2017, and 2018 (Lauth 2011). However, the 2018 NBS survey was a rapid response survey, and did not employ the same sampling design as 2010 and 2017. Therefore, the survey results from the 2018 NBS survey are not directly comparable to the results from the 2010 and 2017 NBS surveys.

The most comprehensive bottom trawl survey coverage of the Bering Sea in a single year was in 2010 when three surveys (the EBS slope (Hoff and Britt 2011), the EBS shelf, and the NBS) were conducted in the Bering Sea region (Fig. 2; Lauth 2011). The NBS survey consisted of 144 additional bottom trawl stations, which extended the EBS survey grid northward to the Bering Strait and the U.S.-Russia Maritime

Boundary; the region also included all of Norton Sound and the Chirikov Basin (Fig. 2). The NBS survey was initiated by the AFSC as part of the Loss of Sea Ice (LOSI) Research Plan to study the impacts of diminished sea ice on the marine ecosystem (Hollowed et al. 2007). The objective of the LOSI Research Plan was to monitor long-term climate trends in the transition zone between the temperate waters of the eastern Bering Sea and the Arctic waters of the Chukchi Sea, where climate change can have a significant effect on physical and biological ecosystem processes (Hunt Jr. et al. 2011; Stevenson and Lauth 2012, Stevenson and Lauth 2019; Stabeno et al. 2012). Although LOSI funding for the NBS extension was discontinued after the 2010 NBS survey, the survey was reimplemented as a biennial survey in 2017 due to effects of changing ocean conditions on fish and crab distributions (Sigler et al. 2015).

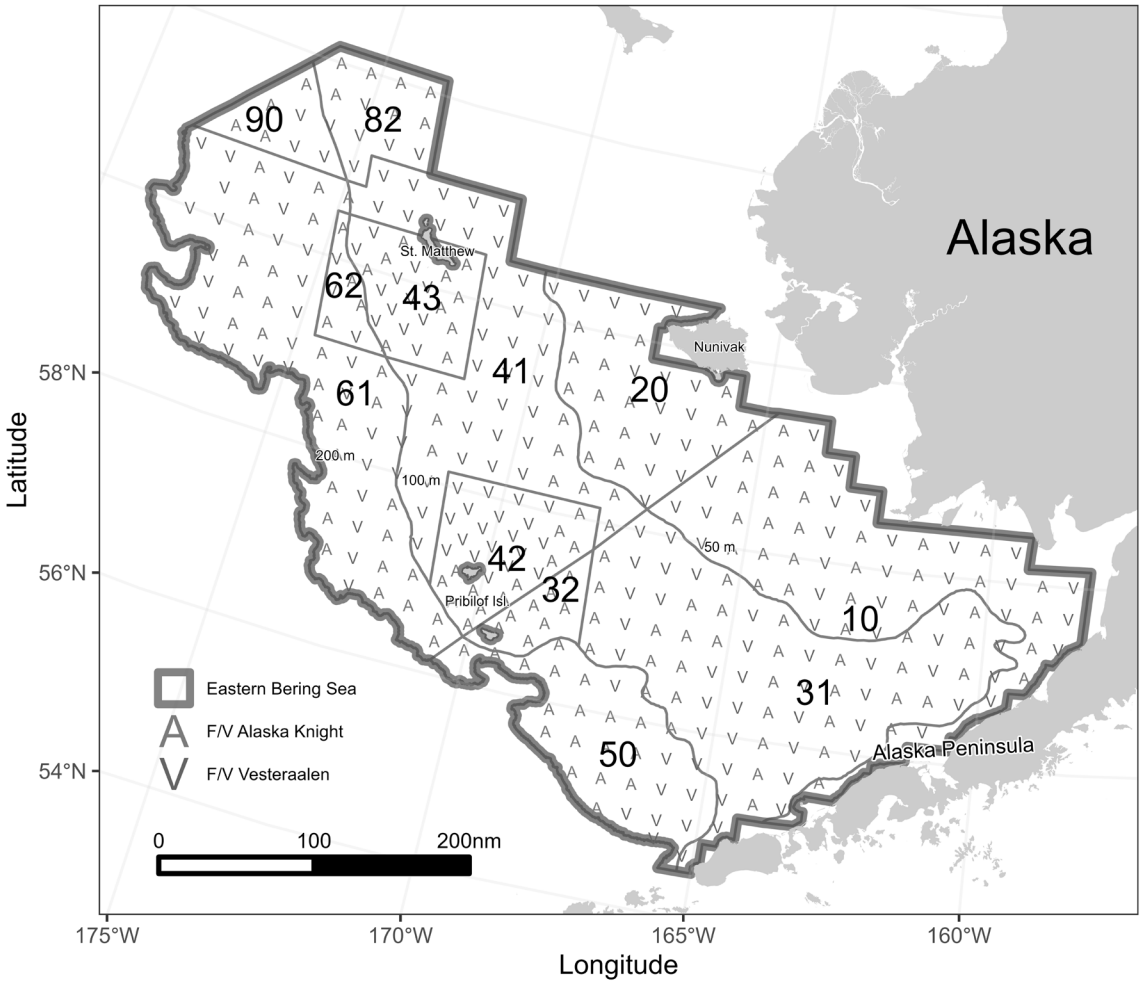

Figure 1. -- Sampled survey stations by vessel and the stratification scheme used for data analysis of the 2018 EBS shelf bottom trawl survey. The map also depicts the stations sampled by the FV *Alaska Knight* (A) and FV *Vesteraalen* (V).

Figure 2. -- Sampling grid and station identifiers for the 2018 EBS continental shelf bottom trawl survey. Corner stations (denoted by circles) are not labeled for legibility.

Methods

Survey Area and Sampling Design

The standardized eastern Bering Sea bottom trawl survey is based on a systematic design with 376 fixed sampling stations centered within 37.04 × 37.04 km (20 × 20 nautical mile) grid squares (Fig. 2). Additional stations, called “corner stations”, were added to the survey design in 1990 to better sample regions of historically high blue king crab abundances. There are 26 corner stations located at the intersections of the grid lines in the waters surrounding St. Matthew and the Pribilof islands (Fig. 2). These corner stations are sampled in addition to the centers of the grid cells.

Survey Vessels and Sampling Gear

The 2018 EBS survey was conducted aboard the chartered commercial stern-trawlers FV *Alaska Knight* and FV *Vesteraalen* (Fig. 3). Both vessels are house-forward trawlers with stern ramps. The length overall of the FV *Alaska Knight* is 43.9 m (144 ft) and the FV *Vesteraalen* is 37.8 m (124 ft). All fishing operations were conducted in compliance with national and regional protocols detailed in Stauffer (2004). Trawl sampling was conducted using 83-112 eastern otter trawls, each with a 25.3 m (83 ft) headrope and 34.1 m (112 ft) footrope (Fig. 4). The net was attached to tail chains with 54.9 m (30 fm) paired dandylines. Each lower dandyline had a 0.61 m chain extension connected to the lower wing edge to improve bottom tending. Steel “V” doors measuring 1.8 × 2.7 m (6 × 9 ft) and weighing 816 kg (1,800 lbs) each were used for spreading the net opening while the trawl was fishing on the seafloor.

Figure 3. -- Fishing vessels FV *Alaska Knight* (left) and FV *Vesteraalen* (right) contracted to assist the 2018 Eastern Bering Sea bottom trawl survey.

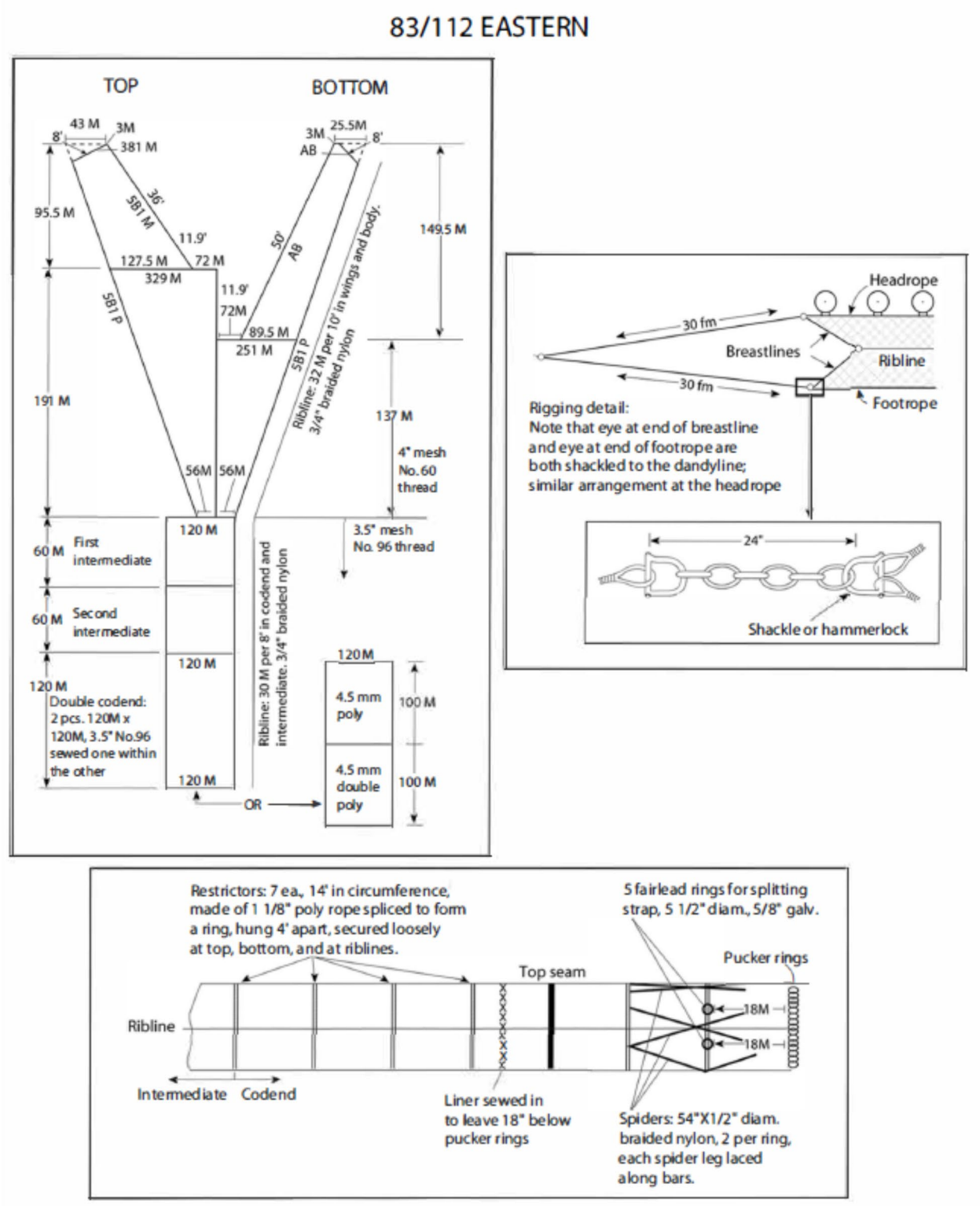

Figure 4. -- Schematic diagram of the 83-112 eastern otter trawl gear used during the 2018 EBS bottom trawl survey.

The Marport Deep Sea Technologies Inc. net mensuration system was used during each tow to record net spread and net height. Net spread was measured as the horizontal distance between two sensors attached immediately forward of the junction of the upper breastline and the dandyline, and net height was measured from the headrope to the seafloor. Mean net spread values for estimating area swept per tow were calculated according to methods described by Lauth and Kotwicki (2014). A custom-made AFSC bottom contact sensor (accelerometer) attached to the center of the footrope was used to determine tow duration based on footrope contact with the seafloor.

Temperature and depth profiles were recorded using a Sea-Bird SBE-39 temperature-depth recorder (Sea-Bird Electronics Inc., Bellevue, WA) attached to the headrope of the trawl. Observations were made at 3-second intervals at each station. Average bottom depth was calculated by adding the average net height to the average depth of the headrope.

In the EBS, the net mensuration system failed to record data for one tow on the FV *Alaska Knight*. To estimate missing net width values, the mgcv package in R (Wood 2004) was used to relate mean net width with the inverse scope (m) and mean net height (m) from valid tows following the relationship investigated by Rose and Walters (1990), where w is the net width (m), h is the net height (m), s is the scope, and ϵ represents the modeled error

$$w \sim s^{-1} + h + \frac{h}{s} + \epsilon$$

$$\epsilon \sim N(0, \sigma^2) .$$

EBS Sampling Logistics and Stratification Scheme

At the beginning of the survey, scientists boarded the chartered vessels (FV *Alaska Knight* and FV *Vesteraalen*) in Dutch Harbor, Alaska, and transited to eastern Bristol Bay to begin sampling. From Bristol Bay, the survey proceeded westward completing north-south columns of grid cells to the shelf edge (Fig. 1). The east-to-west survey progression is intended to ensure the survey moves in the opposite direction of the seasonal on-shelf (eastward) migration patterns typical of yellowfin sole and other species. This strategy reduces the likelihood of encountering a portion of these populations multiple times (Smith and Bakkala 1982; Nichol et al. 2019). In the EBS, FV *Vesteraalen* and FV *Alaska Knight* started sampling on 3 June 2018 and ended sampling on 31 July 2018.

For design-based (as opposed to model-based) index catch analysis, the EBS shelf was divided into twelve strata bounded by the 20 m, 50 m, 100 m, and 200 m isobaths and a geographic stratum line separating the northwest and southeast shelf (Fig. 1). The stratum boundaries correspond with oceanographic domains and different biological communities. This stratification scheme reflects some differences observed in Bering Sea groundfish distributions across the oceanographic domains, while the overall intention of the design was to reduce the variances of population and biomass estimates (Bakkala 1993). The purpose of high-density sampling in strata 32, 42, 43, and 62 is to increase sampling resolution and thereby reduce variance estimates for blue king crab (Stevens and MacIntosh 1990). Sampling density across the EBS shelf was one station per 1,311 km^2, ranging from one station per 775 km^2 (Stratum 42) to one per 1,496 km^2 (Stratum 82; Table 1). For some analyses (e.g., abundance-at-length), the high-density strata were grouped, resulting in eight subareas: 10, 20, 30 (31+32), 40 (41+42+43), 50, 60 (61+62), 82, and 90 (Fig. 1; Table 1).

Table 1. -- Stratum areas and sampling densities used during the 2018 EBS bottom trawl survey. Stratum areas were calculated in 2019.

	Stratum	Representative area (km^2)	Stations successfully sampled	Sampling density (km^2/Stations successfully sampled)
EBS				
Inner Shelf	10	77,871	58	1,343
	20	41,027	31	1,323
Middle Shelf	31	94,526	69	1,370
	32	8,774	8	1,097
	41	62,703	44	1,425
	42	24,011	31	775
	43	21,108	22	959
	82	17,954	12	1,496
Outer Shelf	50	38,792	26	1,492
	61	88,134	60	1,469
	62	6,429	7	918
	90	11,568	8	1,446
Total		492,897	376	1,311

Catch Sampling Procedures

Standard catch sampling procedures used in RACE Bering Sea assessment surveys are described in detail by Wakabayashi, Bakkala, and Alton (1985) and Stauffer (2004). In summary, samples were collected by trawling near the center of each grid square (or intersection of grid lines, in the case of high-density corner stations) for a target fishing time of 30 minutes at a speed of 1.54 m/sec (3 knots). If a station was not considered trawlable due to obstructions visible on the depth sounder, the nearest trawlable site within the same grid square was used. Hauls that resulted in significant gear damage or contained debris, such as derelict crab pots, generating visible changes in net mensuration were redeployed to obtain a successful sample.

Catches estimated to be less than approximately 1,200 kg (2,650 lbs) were entirely sorted and enumerated, while larger catches were weighed in aggregate or volumetrically measured and subsampled before sorting. The goal of subsampling is to obtain a representative sample, which requires some variation in catch processing methods among hauls and is dependent on the overall size and species composition of the catches. After sorting subsampled catches, individual species were weighed and counted in aggregate, and these weights and numbers were then expanded proportionally to the total catch. Fish and invertebrate species were sorted and identified to the lowest, reliable taxonomic level.

All commercial crab species were weighed and enumerated from each catch. Other select species including Pacific halibut (*Hippoglossus stenolepis*), Greenland turbot (*Reinhardtius hippoglossoides*), large skates, rockfish (*Sebastes spp.*), Atka mackerel (*Pleurogrammus monopterygius*), prowfish (*Zaprora silenus*), Bering wolffish (*Anarhichas orientalis*), giant wrymouth (*Cryptacanthodes giganteus*), Pacific cod (*Gadus macrocephalus*), some sculpins, sharks, and any other large, rare species that are not represented in the subsample were completely sorted from the catch in most cases.

Length measurements were obtained from a random subsample of select fish species from every haul (Table 2). The number of fish in a random length subsample for a species was dependent on the size range of that species in the haul, up to a maximum target of 300 specimens. For each fish in a length subsample, sex was determined and then the fork length or total length (depending on the species) was measured to the nearest 1.0 cm. Unless retained for biological sampling by the International Pacific Halibut Commission (IPHC), Pacific halibut were measured to fork length upon capture and 50% were randomly selected to receive a preopercle tag, then immediately returned to the sea in an effort to reduce mortality. The weights of all Pacific halibut were estimated using an IPHC length-weight regression (Courcelles 2011).

Sagittal otoliths were collected from 11 fish species in the EBS (Tables 2 and 5). Otolith samples were collected following length/region-stratified (cm/sex/southeast and northwest regions) and random-by-haul sampling methods in the EBS (Table 2). Otoliths were preserved in a glycerol-thymol solution and then later shipped to the Age and Growth Program of the AFSC's Resource Ecology and Fisheries Management (REFM) division for age determination. Individual fish weights and lengths were collected for each fish from which age structures were taken. For walleye pollock, age structure sampling effort was further divided into low-density and high-density regions based on historical population densities and an isobath of approximately 70 m.

Stomachs were collected in the field from four fish species (Table 3) and were preserved in the field in 10% formalin. Arrowtooth flounder and Kamchatka flounder (*Atheresthes* spp.) stomachs were collected as one genus because they occupy a similar trophic niche in the Bering Sea.

Table 2. -- Otolith collection types and counts during the 2018 EBS shelf bottom trawl survey.

Common name	Target collection number per haul	Collect when ≥ n individuals caught in each haul
length/region-stratified (cm/sex/southeast and northwest regions)		
yellowfin sole	5 individuals	1
northern rock sole	3 individuals	1
Alaska plaice	3 individuals	1
Greenland turbot	3 individuals	1
Kamchatka flounder	2 individuals	1
yellow Irish lord	3 individuals	1
random-by-haul		
walleye pollock	3 adults and 1 juvenile in low-density area, and 5 adults and 1 juvenile in high-density area	20
Pacific cod	4 adults and 1 juvenile	4
flathead sole	3 individuals	10
arrowtooth flounder	3 individuals	10
Pacific halibut	% of individuals caught	1

Table 3. -- Stomach collection targets during the 2018 EBS shelf bottom trawl survey.

Common name	EBS
Pacific halibut	600
arrowtooth flounder and Kamchatka flounder	1250
Pacific cod	1750
walleye pollock	2500

Catch Data Analysis

Design-based estimates of biomass, population, and size structure of fishes and invertebrate species were calculated from EBS survey data. A brief description of the procedures used in the analysis of RACE Bering Sea survey data follows (Wakabayashi et al. 1985). Some species were grouped by family for catch data analysis because of their limited commercial value or an inability to identify to lower taxonomic level while in the field.

Mean catch per unit effort (CPUE) for each species was calculated in kilograms per hectare (1 ha = 10,000 m^2) and number of fish per hectare for each stratum (Alverson and Pereyra 1969; Lauth and Kotwicki 2014). Area swept (hectares) was computed as the linear distance towed multiplied by the mean net width (Alverson and Pereyra 1969; Lauth and Kotwicki 2014). Mean CPUE was calculated for individual strata and summed proportionally for the overall survey area. Design-based biomass and population estimates were calculated for each stratum by multiplying the stratum mean CPUE by the stratum area. Stratum estimates were then summed for total survey area estimates in the EBS. Disparities between the number of hauls when a species was weighed, counted, and measured may occur due to processing errors during sampling.

For size composition estimates, the proportion of fish at each centimeter length interval (from subsamples at each station), weighted by CPUE (number of fish/ha), was expanded to the stratum population. Stratum abundance-at-length estimates were summed for the total estimated size composition for the overall survey area in the EBS.

Otolith samples collected during the survey were read for age estimates by Age and Growth Program staff in the AFSC's REFM division for all fish except for Pacific halibut, whose otoliths are processed by the IPHC. The most current information about age, growth, and population analyses are presented in the 2018 NPFMC Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region (Groundfish Fisheries of the Bering Sea and Aleutian Islands 2018).

Additional Research Projects

In addition to standard survey operations, 23 research projects were undertaken in the EBS during the 2018 survey season (Table 4). A solicitation for research proposals was issued on January 24, 2018. Project requests were prioritized and modified based on their potential support of AFSC strategic science plans and mission and their expected impact on survey resources and available time to complete the project. Some of the approved projects were new for 2018, while many continued multi-year observations of supplementary data. Data for additional research projects were collected at sea and disseminated to the requesting principal investigator(s). To acquire the details about a special project or collection, please contact the investigator(s) designated in Table 4.

Table 4. -- Special projects and collections undertaken during the 2018 EBS shelf bottom trawl survey, sorted by principal investigator and agency.

Project title	Principal investigator	Agency[1]
EBS		
Bering Sea Pribilof Islands science education	Lauren Divine	ACSPI
Crabs for outreach	Laura Slater	ADF&G
Genetics of mating dynamics in EBS snow crab	Tyler Jackson	ADF&G
Population genomic structure of eastern Bering Sea tanner crab	Tyler Jackson	ADF&G
Shark population genetics and age structure sampling	Cindy Tribuzio	AFSC-ABL
Genetics analysis of salmon	Jeff Guyon	AFSC-ABL
Observer training collection	Duane Stevenson	AFSC-FMA
Use of EBS bottom trawl survey acoustic data to augment the MACE acoustic-trawl survey time series of walleye pollock abundance ("AVO"; Acoustic vessels of opportunity)	MACE	AFSC-MACE
Temporal-spatial variation of juvenile flatfish condition	Cynthia Yeung	AFSC-RACE
Fishermen's Fall Festival collection	Jason Conner	AFSC-RACE
Proportion of female snow crab that are on an annual vs. biennial reproductive cycle	Jen Newby	AFSC-RACE
Identification and mapping of muscles controlling iris function in snailfishes	Lyle Britt	AFSC-RACE
Measuring light intensity on bottom trawl surveys	Ned Laman	AFSC-RACE
Bitter crab syndrome in eastern Bering Sea Chionoecetes spp.	Pam Jensen	AFSC-RACE
Experimental estimation of catchability of the combined bottom trawl and acoustic survey for walleye pollock (Gadus chalcogrammus) in the eastern Bering Sea.	Stan Kotwicki	AFSC-RACE
Pacific cod tissue collection	Ingrid Spies	AFSC-REFM
Arctic and saffron cod growth	Tom Helser	AFSC-REFM
Population genomics of red king crab	Jon-Ivan Westgaard	IMR
IPHC Pacific halibut data collection and tagging on NMFS trawl surveys	Lauri Sadorus	IPHC
Molecular species identification of deepwater corals	Ewann Berntson	NWFSC
Pacific lamprey collection	Laurie Weitkamp	NWFSC
CTD oceanographic sampling	Ned Cokelet	PMEL
Mollusk collection	Roger Clark	SBMNH

[1]ACSPI - Aleut Community of St. Paul Island; ADF&G - Alaska Department of Fish & Game; AFSC-ABL - Auke Bay Laboratories; AFSC-FMA - Fisheries Monitoring & Assessment Division; AFSC-RACE - Resource Assessment & Conservation Engineering Division; AFSC-REFM - Resource Ecology & Fisheries Management Division; IMR - Institute of Marine Research, Norway; IPHC - International Pacific Halibut Commission; NWFSC - Northwest Fisheries Science Center; PMEL - Pacific Marine Environmental Laboratory; SBMNH - Santa Barbara Museum of Natural History

Results and Discussion

A total of 376 EBS stations were successfully sampled in 2018 (Fig. 1). Haul and catch sample data for successfully trawled stations used in the analyses can be found and downloaded from the Fisheries One Stop Shop (https://www.fisheries.noaa.gov/foss/f?p=215:200:1099772399154:Mail:NO:::).

Ocean Temperatures and the Cold Pool

Sea surface temperatures recorded during the 2018 EBS survey ranged from 4.5° to 10.1°C, and near-bottom temperatures (hereafter referred to as bottom temperatures) ranged from 1.6° to 7.7°C. The mean sea surface temperature for the EBS in 2018 was 7.6°C, which was 0.4°C lower than 2017 (8°C) and 0.9°C higher than the time series mean (6.7°C; Figs. 5, 6, 7a, and 7b). During the EBS time series (1982–2018), mean summer bottom temperatures were highly variable, ranging from a low of 0.7°C to a high of 4.2°C. The grand mean for all years was 2.4°C (Fig. 5). The mean survey bottom temperature for the EBS in 2018 was 4.2°C (Fig. 5), which was 1.7°C warmer than the long term mean (Rohan et al. in review).

The size of the cold pool each summer is defined by the extent of bottom temperatures below 2°C and depends on sea ice coverage from the previous winter, the timing of sea ice retreat during the spring and early summer, as well as other oceanographic and meteorological conditions (Wyllie-Echeverria and Wooster 1998). During the coldest years, sea ice extended farther south and lasted later into spring resulting in cold pools that extended farther south through the middle domain into Bristol Bay and near the Alaska Peninsula (Figs. 7a and 7b). Interannual variability in the dynamics of seasonal ice is a major environmental driver on the Bering Sea shelf (Stabeno et al. 2001; Stabeno, Farley Jr, et al. 2012; Stabeno et al. 2012) that can change recruitment and migration patterns, as well as cause major distributional shifts in groundfish and crab species (Kotwicki and Lauth 2013; Nichol et al. 2019; Stevenson and Lauth 2019).

During the last 13 years, 2006-2013 were colder than average (“cold stanza”; Fig. 7a), while 2014-2018 were warmer than average (“warm stanza”; Fig. 7b). The highly variable survey bottom temperatures in the EBS shelf are related to the area occupied by the summer cold pool (Fig. 6). Over the period of the 37-year time series, the areal coverage of the summer survey cold pool in the EBS has varied in size from 6,150 km^2 in 2018 to 385,975 km^2 in 1999, respectively comprising 1.2% to 78.2% of EBS shelf area (Fig. 6). In 2018, the cold pool covered 6,150 km^2 (1.2%) of the EBS shelf survey area, which was the lowest areal coverage in the 37-year time series.

The 2016 and 2018 EBS surveys provided a quasi-synoptic view of the spatial pattern of bottom temperatures across the entire EBS shelf, providing an index of annual differences in demersal fauna distribution patterns. The seasonal cold pool, which is a cold water mass that occupies the middle domain of the EBS shelf annually to a varying extent, may play a role in restricting the movements of some species both across the shelf (east-west) and along the inner domain of the shelf (north-south). Thus, tracking the position and spatial extent of this water mass is critically important.

The 2016 cold pool was composed of colder water that occupied 18.1% of the EBS shelf survey area (Fig. 6), with < 1°C bottom temperatures extending north of St. Lawrence Island into Chirikov Basin, east to Nunivak Island, and south to the Alaska Peninsula (Figs. 7a and 7b). The 2018 cold pool occupied 1.2% of the EBS shelf survey area (Fig. 6). The 2018 cold pool was isolated to the very northwestern corner of the EBS survey area, while higher temperatures >4°C were found in Bristol Bay and surrounding the Pribilof Islands (Fig. 7b). In 2018, temperatures between 2°C and 8°C were found west of Nunivak Island (Fig. 7a).

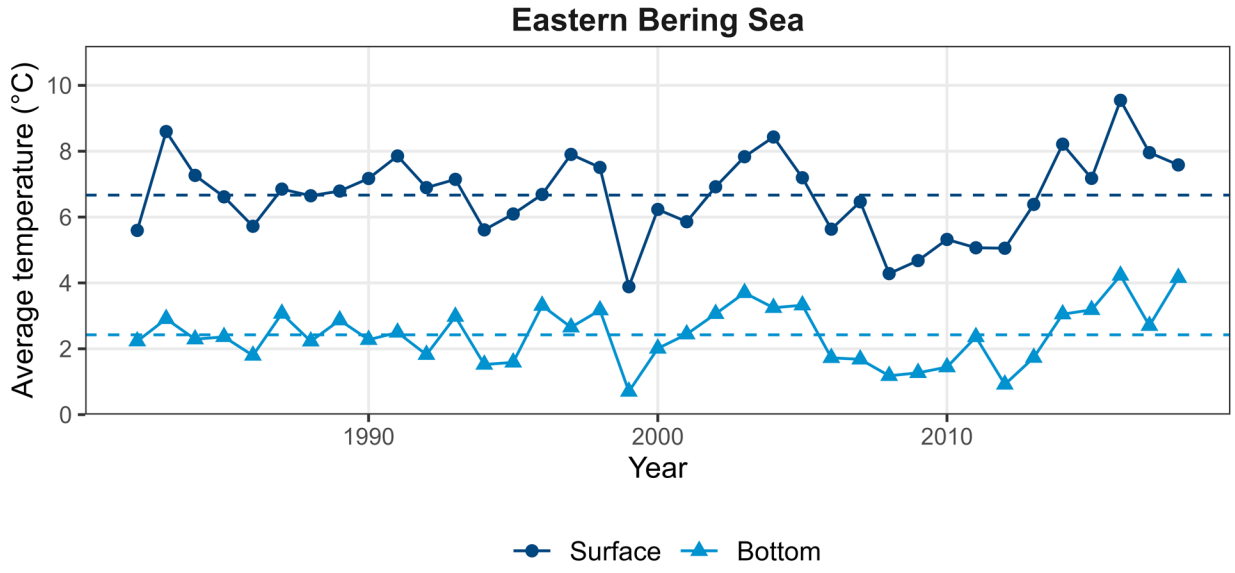

Figure 5. -- Average summer surface (light blue triangles) and bottom (dark blue circles) and long-term mean surface (dark blue dashed line) and bottom (light blue dashed line) temperatures (°C) on the EBS shelf, based on data collected during standardized summer bottom trawl surveys from 1982–2018.

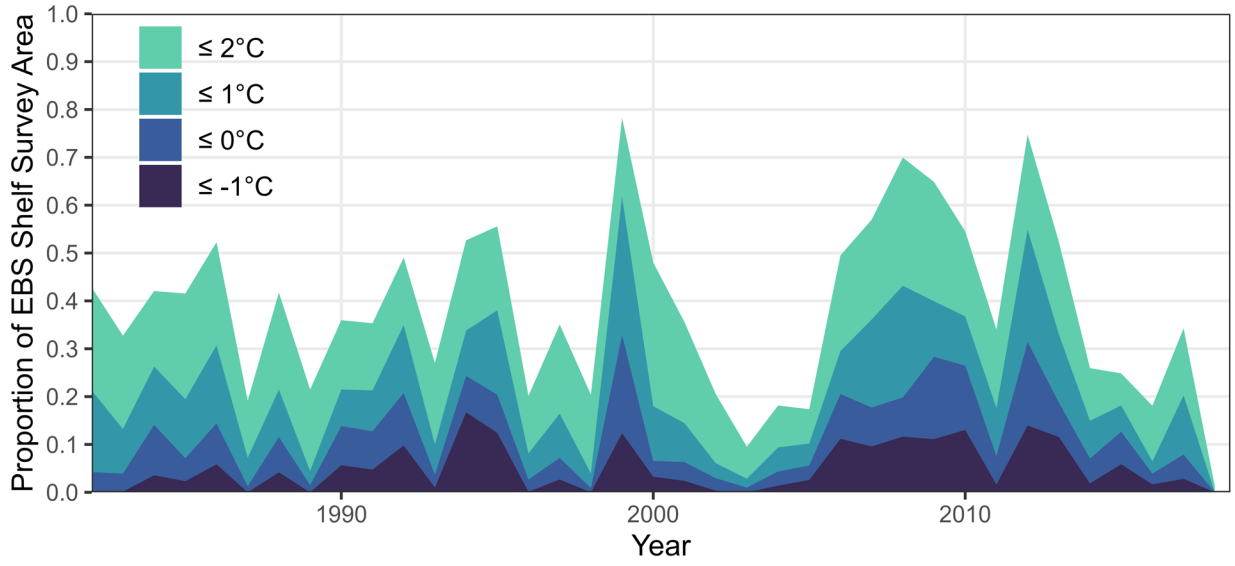

Figure 6. -- Annual cold pool extent on the EBS shelf, based on observations from the EBS bottom trawl survey. Extent of the cold pool is shown in proportion to the total southern EBS shelf survey area. Shading denotes near-bottom temperatures ≤ 2°C (aqua blue), ≤ 1°C (cerulean blue), ≤ 0°C (cobalt blue), and ≤ -1°C (dark navy blue).

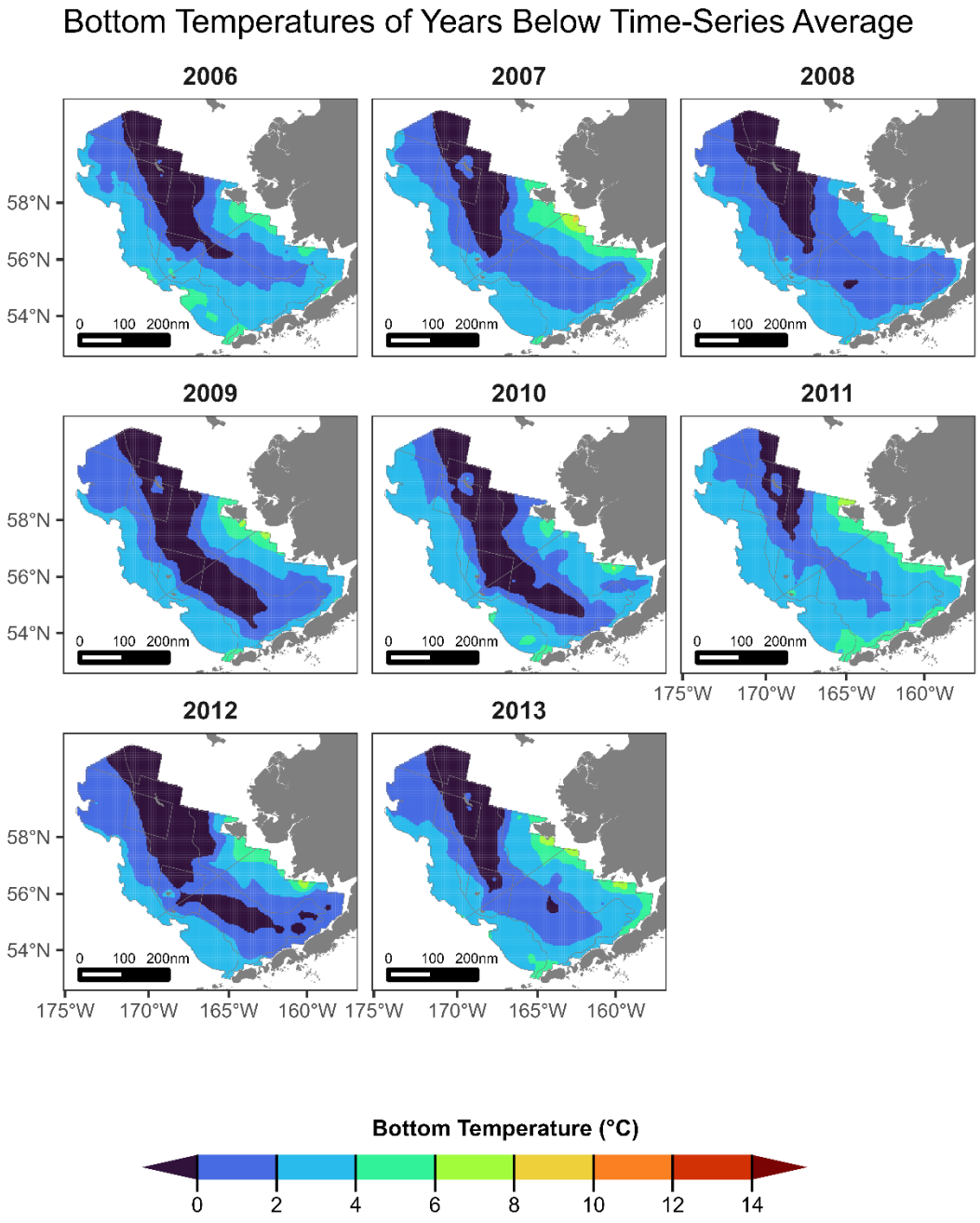

Figure 7a. -- EBS shelf bottom trawl survey near-bottom temperatures in years below the long-term mean (2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013).

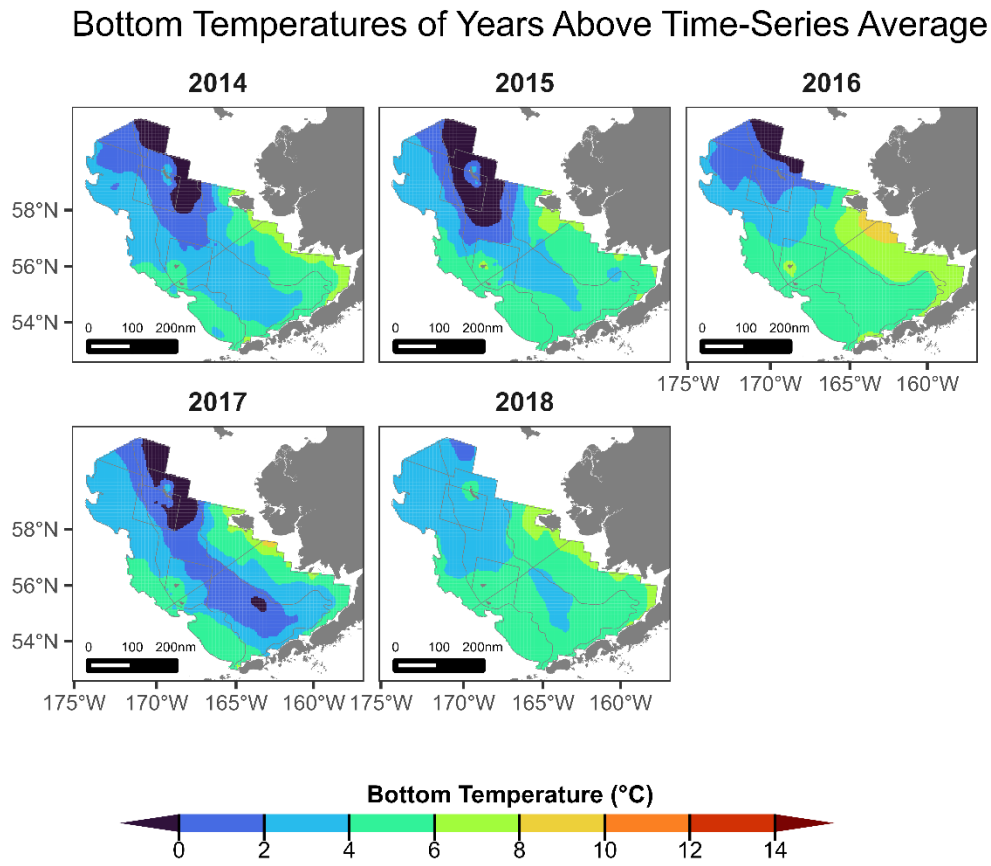

Figure 7b. -- EBS shelf bottom trawl survey near-bottom temperatures in years above the long-term mean (2014, 2015, 2016, 2017, and 2018).

Survey Data and Specimen Collections

Specimens collected during the EBS shelf trawl survey are shown in Table 5. A total of 237,591 lengths were collected from 50 taxa; 7,181 otolith age structures were collected from 12 taxa; 7,285 stomach samples were collected from four taxa; and 1,179 pathobiology blood samples were collected from one taxon. Other special collections are listed in Table 4.

Table 5. -- Biological data collected during the 2018 eastern Bering Sea (EBS) shelf bottom trawl survey.

EBS	Length measurements	Otolith age structure measurements	Stomach samples	Pathobiology blood samples
Alaska plaice	12,038	472	-	-
Alaska skate	4,593	-	-	-
Aleutian skate	61	-	-	-
arrowtooth flounder	18,744	804	-	-
arrowtooth flounder and Kamchatka flounder	-	-	2,078	-
Atka mackerel	85	-	-	-
Bering flounder	1,451	-	-	-
Bering skate	265	-	-	-
big skate	39	-	-	-
bigmouth sculpin	346	-	-	-
blackspotted rockfish	15	-	-	-
blue king crab	201	-	-	-
butter sole	725	-	-	-
butterfly sculpin	36	-	-	-
chinook salmon	1	1	-	-
Chionoecetes spp.	-	-	-	1,179
chum salmon	8	-	-	-
Dover sole	6	-	-	-
dusky rockfish	27	-	-	-
English sole	2	-	-	-
flathead sole	26,826	805	-	-
great sculpin	782	-	-	-
Greenland turbot	249	203	-	-
horsehair crab	119	-	-	-
hybrid starry flounder X Alaska plaice	1	-	-	-
hybrid Tanner crab	695	-	-	-
Kamchatka flounder	2,736	485	-	-
longhead dab	498	-	-	-
longnose skate	2	-	-	-
mud skate	10	-	-	-
northern rock sole	25,857	571	-	-
northern rockfish	164	-	-	-
Pacific cod	8,806	1,352	2,141	-
Pacific halibut	1,833	-	183	-
Pacific ocean perch	599	-	-	-
Pacific sleeper shark	1	-	-	-
plain sculpin	1,899	-	-	-
prowfish	5	-	-	-
red king crab	814	-	-	-
rex sole	2,425	-	-	-
sablefish	182	4	-	-
saffron cod	123	-	-	-
Sakhalin sole	41	-	-	-
shorthorn sculpin	223	-	-	-

Table 5. -- Biological data collected during the 2018 eastern Bering Sea (EBS) shelf bottom trawl survey.

EBS	Length measurements	Otolith age structure measurements	Stomach samples	Pathobiology blood samples
snow crab	30,473	-	-	-
southern rock sole	195	-	-	-
starry flounder	1,024	-	-	-
Tanner crab	15,052	-	-	-
walleye pollock	48,673	1,502	2,883	-
whiteblotched skate	2	-	-	-
yellow Irish lord	1,354	258	-	-
yellowfin sole	27,285	724	-	-
Total	**237,591**	**7,181**	**7,285**	**1,179**

Species Composition

A total of 94 different fish species representing 23 families and 57 genera were identified during the 2018 EBS survey (Appendix A1). In 2018, the EBS survey recorded 94 total taxa, of which 84 were identified to the species level. The remaining fish taxa were identified to the genus level or higher.

Two hundred and forty one different invertebrate taxa representing 13 phyla were identified during the 2018 EBS survey (Appendix A2), of which 147 were identified to the species level. The remaining invertebrate taxa were identified to the genus level or higher. The lack of species level identifications among invertebrates was due to a variety of factors that are outlined in Stevenson and Hoff (2009) and Stevenson et al. (2016). Additionally, trawl catchability of small invertebrates is not known.

Biomass, Abundance, and Catch per Unit Effort

The total demersal animal biomass for the EBS was estimated at 12.9 million t. In the EBS, the proportion of fishes (73%; Table 6) was higher than invertebrates (27%; Table 7).

Noticeable changes were observed in the EBS the benthic communities between 2016 and 2018. The total estimated biomass in the EBS decreased from 16.3 million t in 2016 to 13 million t in 2018. Taxa that significantly increased in biomass included Pacific herring (706%), snow crab (204%), all worms (53%), all shrimps (20%), and other sea stars (19%; Table 8). Large decreases in biomass were observed for red king crab (-51%), all poachers (-55%), Bering flounder (-65%), corals (-71%), and saffron cod (-85%; Table 8). While all efforts are made at standardizing catch processing over time, some inconsistencies may exist between years, vessels, and crews which may affect the interpretation of these differences.

The top 10 fish taxa in the EBS accounted for 67% (an average of 177 kg/ha per station) of total mean fish and invertebrate CPUE (an average of 265 kg/ha per station) and 93% of total mean fish CPUE (an average of 190 kg/ha per station; Table 9a).

Table 6. -- Biomass estimates (t) for major fish taxa collected during the 2018 EBS shelf bottom trawl survey.

Taxon		Estimated total biomass (t) ± 95% confidence interval		Proportion of total animal biomass[1]	Estimated biomass by stratum (t)							
					10	20	30	40	50	60	82	90
Agonidae (poachers)		9,493 ±	2,062	0.0007	3,001	2,393	1,713	1,895	379	88	9	15
Cottidae (sculpins)		173,751 ±	26,683	0.0135	24,549	9,900	44,045	52,103	4,450	31,021	4,212	3,473
Cyclopteridae (lumpsuckers)		110 ±	178	<0.0001	0	85	0	25	0	0	0	0
Gadidae (cods)	Pacific cod	506,943 ±	59,217	0.0394	85,589	34,766	97,354	175,073	20,507	69,065	12,924	11,665
	walleye pollock	3,112,797 ±	796,350	0.2419	465,086	148,307	499,639	515,435	99,103	1,288,041	32,929	64,256
	other cods	295 ±	351	<0.0001	190	101	0	3	0	0	0	0
	total Gadidae (cods)	3,620,035 ±	778,822	0.2813	550,866	183,174	596,993	690,511	119,610	1,357,107	45,853	75,921
Hexagrammidae (greenlings)		5,433 ±	9,661	0.0004	132	238	0	3	5,036	24	0	0
Liparidae (snailfishes)		1,118 ±	407	<0.0001	0	36	0	276	8	322	350	125
Osmeridae (smelts)		729 ±	313	<0.0001	191	40	28	11	447	13	0	0
Pleuronectidae (flatfishes)	Alaska plaice	419,509 ±	74,927	0.0326	51,258	40,804	134,604	186,925	216	1,196	4,241	265
	arrowtooth flounder	511,192 ±	71,319	0.0397	7,087	1,488	158,674	112,757	102,653	110,852	2,827	14,855
	Bering flounder	12,995 ±	5,297	0.0010	0	21	0	3,365	0	138	6,199	3,272
	flathead sole	492,623 ±	75,552	0.0383	13,650	345	161,123	77,784	61,510	170,477	2,179	5,554
	Kamchatka flounder	44,000 ±	4,610	0.0034	93	498	6,106	12,717	4,517	16,010	1,608	2,449
	northern rock sole	1,051,503 ±	230,713	0.0817	536,625	115,494	176,126	208,007	4,597	7,486	2,623	545
	Pacific halibut	125,957 ±	17,022	0.0098	31,869	24,342	25,371	17,086	12,138	15,151	0	0
	yellowfin sole	1,892,925 ±	232,132	0.1471	656,251	297,783	585,222	347,770	2,149	9	3,741	0
	other flatfish	118,930 ±	39,865	0.0092	76,218	5,589	19,764	11	10,440	6,798	111	0
	total Pleuronectidae (flatfishes)	4,669,636 ±	345,159	0.3629	1,373,051	486,364	1,266,990	966,423	198,220	328,118	23,530	26,940
Rajidae (skates)	Alaska skate	545,994 ±	53,125	0.0424	107,390	74,860	98,495	107,417	53,299	85,210	9,811	9,512
	other skates	64,382 ±	27,082	0.0050	7,528	6	26,401	1,381	14,840	14,145	3	76
	total Rajidae (skates)	610,376 ±	58,480	0.0474	114,918	74,866	124,897	108,798	68,139	99,356	9,814	9,588
Scorpaenidae (rockfishes)	Pacific ocean perch	52,610 ±	80,495	0.0041	0	0	0	0	42,834	9,777	0	0
	other rockfish	50,737 ±	93,082	0.0039	0	0	0	0	50,540	197	0	0
	total Scorpaenidae (rockfishes)	103,347 ±	126,974	0.0080	0	0	0	0	93,374	9,973	0	0
Stichaeidae (blennies)		51 ±	30	<0.0001	0	4	8	19	2	17	0	1
Zoarcidae (eelpouts)		39,434 ±	8,074	0.0031	8	0	2,356	13,121	186	16,283	1,298	6,182
Other		132,810 ±	48,283	0.0103	50,120	47,034	3,994	7,041	8,672	6,712	5,972	3,264
Total		**9,366,322 ±**	**865,851**	**0.7279**	**2,116,836**	**804,133**	**2,041,024**	**1,840,225**	**498,522**	**1,849,033**	**91,038**	**125,509**

[1]Proportion of total estimated biomass is 12,867,723 t for fish and invertebrates in the EBS bottom trawl survey.

Table 7. -- Biomass estimates (t) for major invertebrate taxa collected during the 2018 EBS shelf bottom trawl survey.

Taxon		Estimated total biomass (t) ± 95% confidence interval		Proportion of total animal biomass[1]	Estimated biomass by stratum (t)							
					10	20	30	40	50	60	82	90
Ascidiacea		182,801 ±	50,010	0.0142	11,435	5,377	55,660	110,322	4	0	3	0
Coelenterata		174,787 ±	104,612	0.0136	12,287	687	101,919	26,875	20,174	8,961	3,005	878
Crustacea	crabs	1,171,888 ±	170,616	0.0911	31,541	24,060	115,062	710,211	19,346	118,993	118,030	34,645
	shrimps	3,528 ±	1,052	0.0003	9	25	71	795	296	1,641	21	671
	other crustaceans	2,099 ±	2,513	0.0002	236	74	253	188	83	1,265	0	0
	total Crustacea	1,177,514 ±	170,531	0.0915	31,786	24,159	115,386	711,193	19,725	121,899	118,051	35,316
Echinodermata	Asteroidea (sea stars)	1,019,401 ±	136,324	0.0792	314,625	145,921	192,997	207,145	712	134,011	3,754	20,236
	Echinoidea (sea urchins)	46,684 ±	35,123	0.0036	140	0	21,079	13,758	8,721	2,981	0	6
	Holothuroidea (sea cucumbers)	15,979 ±	18,101	0.0012	1,498	0	2,806	11,673	2	0	0	0
	Ophiuroidea (brittle stars)	406,333 ±	110,657	0.0316	19,936	3,406	103,951	98,957	2,334	173,445	2,941	1,363
	total Echinodermata	1,488,398 ±	179,698	0.1157	336,199	149,327	320,834	331,533	11,769	310,436	6,695	21,605
Mollusca	Gastropoda (snails)	399,769 ±	54,392	0.0311	10,738	6,280	136,896	141,245	6,870	87,860	3,707	6,173
	octopuses	5,242 ±	2,734	0.0004	559	0	1,453	1,255	1	1,811	37	127
	Pelecypoda (bivalves)	10,079 ±	3,124	0.0008	1,269	599	3,182	4,398	353	220	16	41
	squids	28 ±	33	<0.0001	0	0	0	0	5	24	0	0
	total Mollusca	415,118 ±	54,554	0.0323	12,566	6,878	141,532	146,898	7,229	89,915	3,760	6,342
Porifera (sponges)		52,498 ±	38,381	0.0041	1,509	435	46,687	1,733	1,783	350	0	0
Other		10,288 ±	3,606	0.0008	625	118	2,702	3,209	352	2,692	8	582
Total		**3,501,403 ±**	**282,231**	**0.2721**	**406,407**	**186,982**	**784,719**	**1,331,762**	**61,035**	**534,253**	**131,523**	**64,722**

[1]Proportion of total estimated biomass is 12,867,723 t for fish and invertebrates in the EBS bottom trawl survey.

Table 8. -- Total estimated biomass in metric tons (t) and the percent change between the 2016 and 2018 eastern Bering Sea shelf bottom trawl surveys for predominant fish and invertebrate taxa. Crab data is summarized under other crustaceans and discussed in detail in the annual crab technical memorandum produced by the shellfish assessment program.

Fish taxon	2018	2016	Change (2018, 2016)	Invertebrate taxon	2018	2016	Change (2018, 2016)
Pacific herring	101,314	12,573	705.8%	other crabs	884,329	437,109	102.3%
other flatfishes	32,327	16,257	98.8%	all worms	10,288	6,734	52.8%
flathead sole	492,623	439,296	12.1%	all shrimps	3,528	2,931	20.3%
arrowtooth flounder	511,192	475,264	7.6%	other sea stars	229,537	192,551	19.2%
starry flounder	86,604	82,249	5.3%	all sea anemones	55,740	47,631	17.0%
great sculpin	54,828	53,282	2.9%	hermit crabs	287,559	254,284	13.1%
other sculpins	73,662	73,180	0.7%	other snails	330,199	317,035	4.2%
Alaska skate	545,994	550,892	-0.9%	basket sea stars	323,351	318,659	1.5%
Alaska plaice	419,509	425,217	-1.3%	purple-orange sea star	789,864	856,225	-7.8%
Pacific halibut	125,957	153,704	-18.1%	northern Neptune whelk	69,570	109,374	-36.4%
Greenland turbot	18,017	22,429	-19.7%	all tunicates	182,801	290,849	-37.1%
Kamchatka flounder	44,000	55,324	-20.5%	corals	1,866	6,457	-71.1%
eelpouts	39,434	50,621	-22.1%				
northern rock sole	1,051,503	1,461,272	-28.0%				
plain sculpin	37,301	53,570	-30.4%				
yellowfin sole	1,892,925	2,859,811	-33.8%				
walleye pollock	3,112,797	4,910,080	-36.6%				
Pacific cod	506,943	986,013	-48.6%				
shorthorn sculpin	7,961	16,052	-50.4%				
all poachers	9,493	21,006	-54.8%				
Bering flounder	12,995	37,624	-65.5%				
saffron cod	295	2,023	-85.4%				

Table 9a. -- Mean CPUE by weight (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL) and upper (UCL) confidence limits for other common groundfish species for the 2018 eastern Bering Sea shelf (EBS; 376 stations completed) trawl surveys.

Species	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass	SD biomass	95% LCL	95% UCL	Hauls with weights	Hauls with counts	Hauls with lengths
walleye pollock	63.15	8.03	3,112,797	395,624	2,321,548	3,904,045	370	370	370
Pacific cod	10.29	0.60	506,943	29,419	448,694	565,193	364	364	364
yellowfin sole	38.40	2.34	1,892,925	115,323	1,664,586	2,121,264	263	263	262
northern rock sole	21.33	2.33	1,051,503	114,618	822,268	1,280,739	339	339	338
flathead sole	9.99	0.76	492,623	37,534	418,305	566,941	340	340	339
Bering flounder	0.26	0.05	12,995	2,631	7,677	18,313	78	78	78
Alaska plaice	8.51	0.76	419,509	37,223	345,807	493,212	281	281	280
Greenland turbot	0.37	0.04	18,017	2,011	14,036	21,998	77	77	77
arrowtooth flounder	10.37	0.72	511,192	35,431	440,330	582,054	322	322	320
Kamchatka flounder	0.89	0.05	44,000	2,290	39,465	48,534	275	275	274
Pacific halibut	2.56	0.17	125,957	8,456	109,214	142,701	256	256	256
Bering skate	0.30	0.03	14,564	1,539	11,516	17,612	98	98	98
Alaska skate	11.08	0.54	545,994	26,393	493,737	598,251	363	363	363
longhead dab	0.04	0.01	1,735	542	662	2,809	26	26	26
starry flounder	1.76	0.39	86,604	19,333	47,939	125,269	69	69	69
yellow Irish lord	0.64	0.19	31,627	9,223	10,765	52,490	85	85	85
plain sculpin	0.76	0.08	37,301	4,005	29,291	45,312	120	120	120
great sculpin	1.11	0.16	54,828	7,726	39,530	70,126	198	198	198
shorthorn sculpin	0.16	0.04	7,961	1,880	4,239	11,682	48	48	48
Pacific ocean perch	1.07	0.81	52,610	39,990	0	134,829	15	15	15
rex sole	0.41	0.09	20,350	4,514	11,322	29,379	86	86	86
Sakhalin sole	0.00	0.00	116	109	0	332	7	7	7
butterfly sculpin	0.00	0.00	236	75	87	385	18	18	18
bigmouth sculpin	0.81	0.09	39,910	4,512	30,975	48,844	119	119	119
saffron cod	0.01	0.00	295	174	0	640	9	9	9

Table 9b. -- Mean CPUE by number (no./ha) with standard deviation, and estimated population with standard deviation and 95% lower (LCL) and upper (UCL) confidence limits for other common groundfish species for the 2018 eastern Bering Sea shelf (EBS; 376 stations completed) trawl surveys.

Species	Mean CPUE (no/ha)	SD CPUE	Estimated population	SD population	95% LCL	95% UCL	Hauls with weights	Hauls with counts	Hauls with lengths
walleye pollock	121.15	14.51	5,971,611,178	715,013,593	4,541,583,992	7,401,638,364	370	370	370
Pacific cod	5.04	0.36	248,541,924	17,714,364	213,467,483	283,616,365	364	364	364
yellowfin sole	132.86	10.31	6,548,788,298	508,073,161	5,542,803,438	7,554,773,158	263	263	262
northern rock sole	93.94	7.26	4,630,299,431	358,049,147	3,914,201,137	5,346,397,725	339	339	338
flathead sole	47.26	3.86	2,329,666,697	190,119,612	1,953,229,866	2,706,103,529	340	340	339
Bering flounder	1.24	0.25	61,151,760	12,100,660	36,696,325	85,607,194	78	78	78
Alaska plaice	11.56	0.89	569,753,582	43,967,485	482,697,961	656,809,202	281	281	280
Greenland turbot	0.15	0.02	7,360,930	801,072	5,774,808	8,947,053	77	77	77
arrowtooth flounder	22.05	2.03	1,086,952,560	99,924,701	887,103,157	1,286,801,963	322	322	320
Kamchatka flounder	1.90	0.12	93,721,290	5,862,101	82,114,330	105,328,249	275	275	274
Pacific halibut	1.02	0.09	50,501,944	4,321,050	41,946,264	59,057,623	256	256	256
Bering skate	0.16	0.02	7,694,849	858,698	5,994,627	9,395,070	98	98	98
Alaska skate	2.57	0.11	126,778,143	5,487,418	115,913,056	137,643,230	363	363	363
longhead dab	0.44	0.14	21,760,388	6,744,765	8,405,753	35,115,024	26	26	26
starry flounder	1.42	0.41	69,896,728	20,156,821	29,583,085	110,210,371	69	69	69
yellow Irish lord	0.84	0.24	41,547,925	11,940,008	14,539,626	68,556,224	85	85	85
plain sculpin	1.11	0.14	54,824,597	6,814,738	41,195,122	68,454,073	120	120	120
great sculpin	0.47	0.08	23,343,069	3,807,438	15,804,343	30,881,796	198	198	198
shorthorn sculpin	0.12	0.03	6,044,696	1,572,738	2,930,675	9,158,716	48	48	48
Pacific ocean perch	1.76	1.43	86,804,507	70,245,561	0	231,229,379	15	15	15
rex sole	1.83	0.30	90,320,708	14,738,475	60,843,759	119,797,658	86	86	86
Sakhalin sole	0.03	0.02	1,272,464	1,101,717	0	3,453,865	7	7	7
butterfly sculpin	0.02	0.01	864,516	273,262	323,456	1,405,575	18	18	18
bigmouth sculpin	0.18	0.02	8,941,878	1,005,282	6,951,419	10,932,337	119	119	119
saffron cod	0.21	0.17	10,394,714	8,272,314	0	26,773,896	9	9	9

Summary of Results for Selected Eastern Bering Sea Fish and Invertebrate Fauna

An interactive map of species CPUE can be found at https://apps-st.fisheries.noaa.gov/dismap/. The CPUE data with associated station information including position, surface and bottom temperatures, and bottom depth can be downloaded from the NOAA Fisheries One Stop Shop data platform (FOSS; https://www.fisheries.noaa.gov/foss/f?p=215:200:1099772399154:Mail:NO:::). Users can interactively select, view, and download data on the platform for this survey and others.

Selected Fish Species Estimates

Plots of the spatial distribution and tables of CPUE (kg/hectare and no./hectare) for 32 major fish species caught during the EBS continental shelf survey are presented in the subsections below (Figs. 8a to 54 and Tables 10a to 43b). Differences in sums of estimates and totals are due to rounding. Total abundance-at-length and mean length estimates for major fish species are also presented in the subsections below (Figs. 9 to 33). Appendix Tables B1 to B10 contain population estimates by sex and size class for 11 fish species.

Selected Invertebrates Estimates

Plots of spatial distribution and tables of CPUE (kg/hectare and no./hectare) for two major invertebrate species caught during the EBS continental shelf are presented below (Figs. 54 and 55 and Tables 43a and 43b). Differences in sums of estimates and totals are due to rounding. The crab species listed in this report and others are discussed and analyzed in more detail in a report prepared by the AFSC Shellfish Assessment Program (Lang et al. 2018b).

The purple-orange sea star (*Asterias amurensis*) is common in the Bering and Chukchi seas (Hamazaki et al. 2005; Feder et al. 2005) and was the invertebrate taxon with the highest catch rate by weight in the EBS (Table 8). Catch rates for the purple-orange sea star were highest in the middle shelf (Fig. 54 and Tables 43a and 43b).

Detailed information on bottom trawl survey results for commercial crab species are reported elsewhere (Chilton et al., 2011; Lang et al., 2018; Zacher et al., 2021). Commercial crab stocks are managed by the ADF&G with federal oversight by NOAA Fisheries. The most recent modeling results on the status of these commercial crab stocks are reported in the annual Stock Assessment and Fishery Evaluation report prepared by the NPFMC (The Plan Team for the Groundfish Fisheries of the Bering Sea and Aleutian Islands 2018).

Walleye Pollock (*Gadus chalcogrammus*)

During the 2018 survey, walleye pollock were present at 98.4% of EBS stations. Spatial patterns of pollock distribution during the summer trawl survey have varied considerably in response to cold (Figures 7a and 8a) and warm (Figs. 7b and 8b) stanzas. During the colder years (2006 to 2013), the highest densities of pollock were observed along the outer half of the EBS shelf (> 70 m) and the lowest densities of pollock were along the inner half of the shelf (Figs. 7a and 8a). Since 2014, and during the warm stanza from 2002 to 2005, pollock were more spread out across the shelf compared to cold years. In these instances, high catch densities sometimes reached into the inner domain close to Nunivak Island and up against the northern edge of the standard EBS survey area (Fig. 8b). These distribution patterns are consistent with shoreward and northward feeding migrations typical of pollock during the spring and summer (Kotwicki et al. 2005). Despite the bottom temperatures of 2018 being above the long-term mean of the survey, the distribution pattern of walleye pollock in 2018 appears more similar to that of a colder year.

In 2018, walleye pollock biomass in the EBS was concentrated in the outer domain, with the highest concentration in the outer west domain, with additional clusters to the north, east, and west of the Pribilof Islands, and to the northwest of the Alaska Peninsula (Fig. 8b). Since 2002, the EBS shelf survey biomass estimate for walleye pollock has varied dramatically. Compared with 2016 (4.9 million t), walleye pollock biomass in 2018 (3.1 million t) (Table 10a) in the EBS experienced a 37% decrease (Table 8). In 2018, walleye pollock were found in depths between 22 m and 205 m, and at bottom temperatures between 1.6°C and 7.7°C.

The vertical availability of pollock to the survey trawl depends on environmental factors and can be affected by bottom depth, light conditions, fish size, and fish density (Kotwicki et al. 2014; Kotwicki et al. 2015). Pollock in the 20-35 cm size range (representing 2-3 year-olds) are generally absent or in low abundance from survey catch samples (Fig. 9) because they typically occupy a position much higher in the water column where they are unavailable to the survey trawl (Kotwicki et al. 2015).

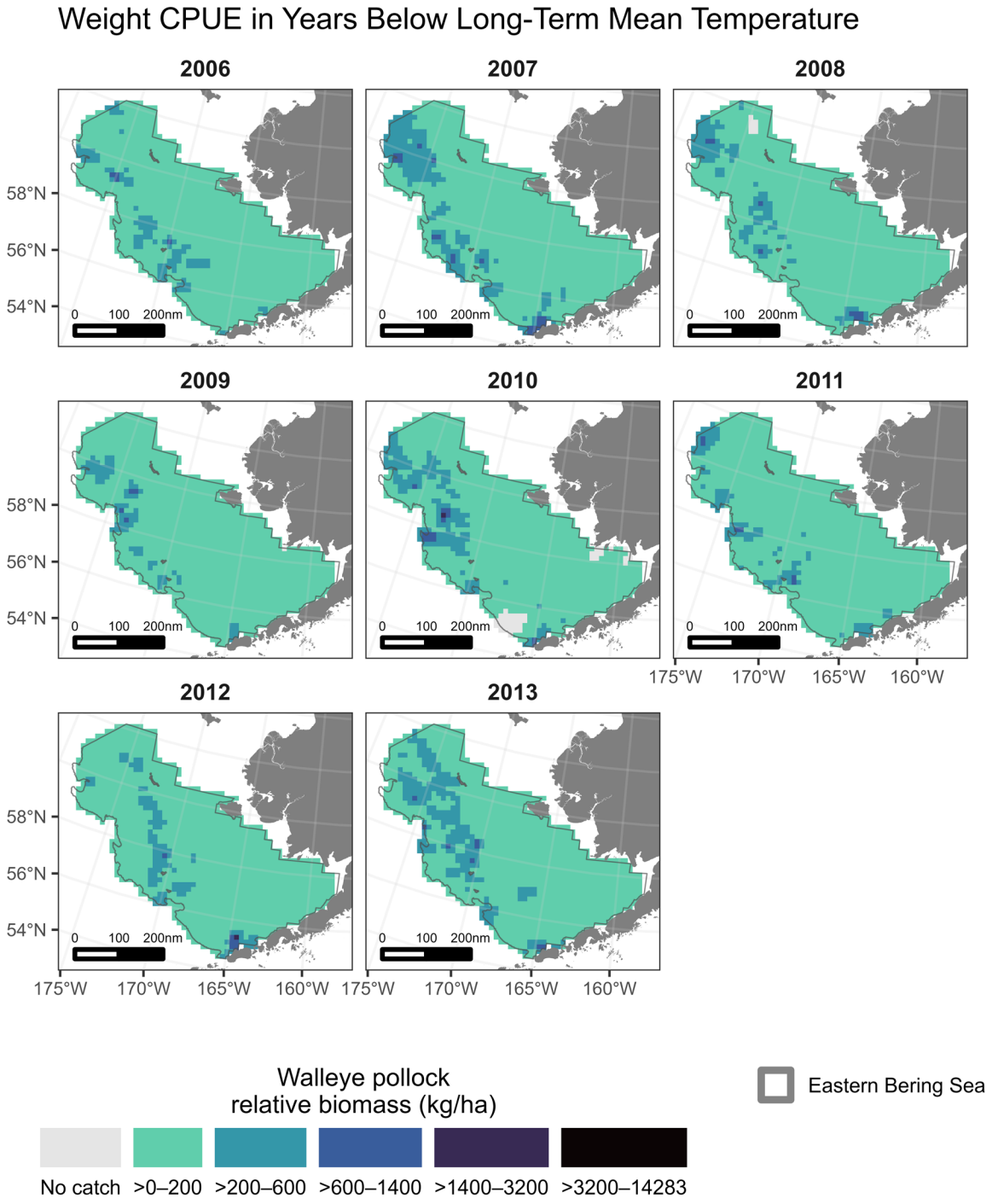

Figure 8a. -- Walleye pollock (*Gadus chalcogrammus*) distribution and weight CPUE (kg/ha) in years when the survey mean bottom temperature was below the long-term mean 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013 during the Bering Sea shelf bottom trawl survey.

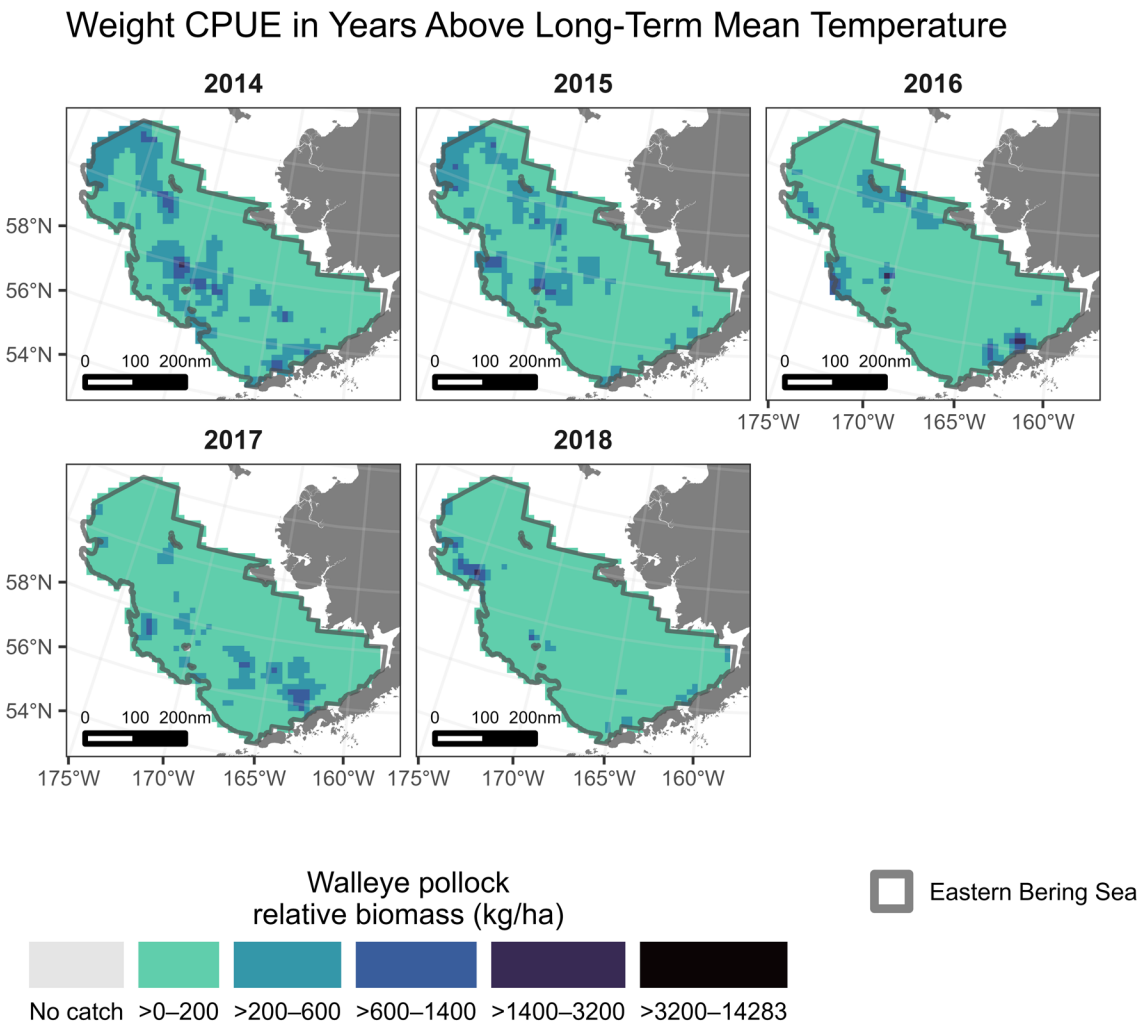

Figure 8b. -- Walleye pollock (*Gadus chalcogrammus*) distribution and weight CPUE (kg/ha) in years when the survey mean bottom temperature was above the long-term mean 2014, 2015, 2016, 2017, and 2018 during the Bering Sea shelf bottom trawl survey.

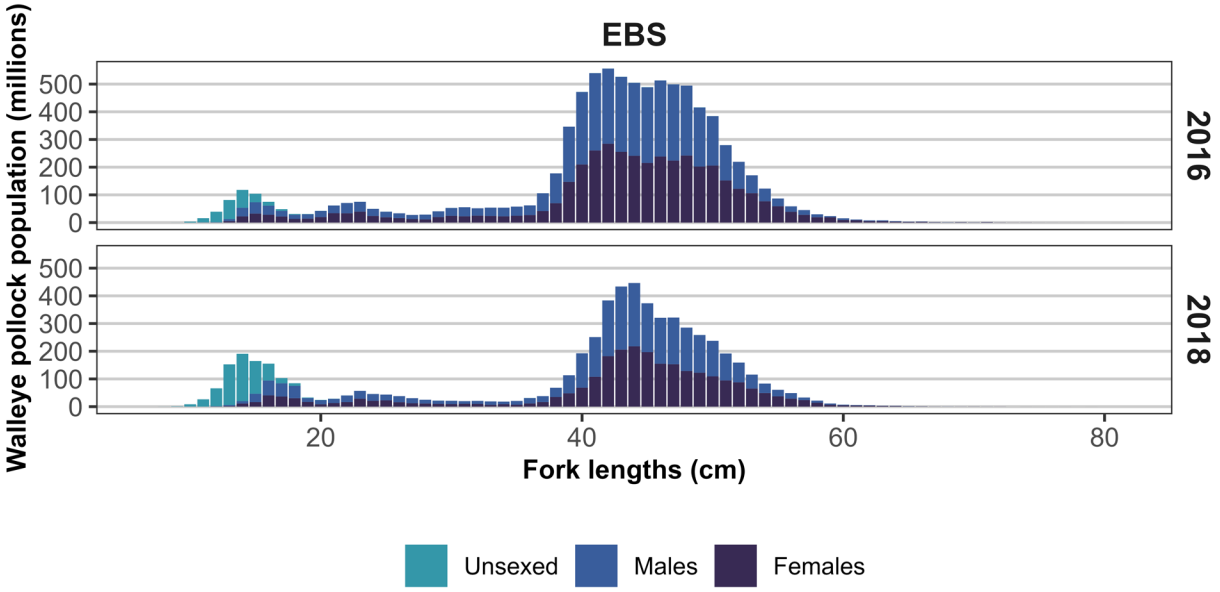

Figure 9. -- Total abundance-at-length estimates of walleye pollock (*Gadus chalcogrammus*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 10a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (thousand t) with standard deviation (thousands) and 95% lower (LCL; thousand t) and upper (UCL; thousand t) confidence limits for walleye pollock (*Gadus chalcogrammus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (thousand t)	SD biomass (thousands)	95% LCL (thousand t)	95% UCL (thousand t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	59.73	10.29	465.09	80.15	303.10	627.07	58	58	58
20	36.15	6.31	148.31	25.88	95.38	201.23	31	31	31
31	50.90	8.43	481.14	79.68	321.79	640.49	69	69	69
32	21.08	15.89	18.50	13.95	0.00	52.62	8	8	8
41	34.07	5.62	213.61	35.22	142.44	284.78	44	44	44
42	87.32	32.22	209.66	77.35	51.71	367.62	30	30	30
43	43.66	15.59	92.16	32.91	23.70	160.62	22	22	22
50	25.55	14.62	99.10	56.73	0.00	215.96	21	21	21
61	143.28	41.07	1,262.82	361.96	531.30	1,994.34	60	60	60
62	39.23	11.48	25.22	7.38	7.17	43.27	7	7	7
82	18.34	4.33	32.93	7.78	15.61	50.25	12	12	12
90	55.55	13.04	64.26	15.08	28.59	99.92	8	8	8
Total	**63.15**	**8.03**	**3,112.80**	**395.62**	**2,321.55**	**3,904.05**	**370**	**370**	**370**

Table 10b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (millions) with standard deviation (millions) and 95% lower (LCL; millions) and upper (UCL; millions) confidence limits for walleye pollock (*Gadus chalcogrammus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (millions)	SD population (millions)	95% LCL (millions)	95% UCL (millions)	Hauls with weights	Hauls with counts	Hauls with lengths
10	101.53	14.97	790.64	116.57	555.05	1,026.23	58	58	58
20	92.53	15.12	379.61	62.02	252.77	506.44	31	31	31
31	78.03	12.35	737.54	116.77	504.00	971.08	69	69	69
32	39.60	27.92	34.75	24.50	0.00	94.70	8	8	8
41	96.78	16.08	606.82	100.84	403.02	810.63	44	44	44
42	173.20	58.56	415.88	140.61	128.74	703.01	30	30	30
43	89.19	30.35	188.27	64.06	55.02	321.51	22	22	22
50	34.35	19.16	133.25	74.34	0.00	286.40	21	21	21
61	249.31	73.65	2,197.29	649.08	885.49	3,509.08	60	60	60
62	66.52	17.88	42.76	11.50	14.63	70.89	7	7	7
82	96.39	38.77	173.06	69.60	17.99	328.14	12	12	12
90	234.92	101.25	271.75	117.13	0.00	548.76	8	8	8
Total	**121.15**	**14.51**	**5,971.61**	**715.01**	**4,541.58**	**7,401.64**	**370**	**370**	**370**

Pacific Cod (*Gadus macrocephalus*)

Pacific cod are a highly mobile, semi-pelagic fish whose spatial distribution can vary with bottom temperature and abundance (Kotwicki and Lauth 2013). During the 2018 survey, Pacific cod were present at 96.8% of stations in the EBS. Pacific cod were generally absent from the northern middle domain during the cold stanza and concentrated along the perimeter of the cold pool where bottom temperatures were greater than 0°C (Fig. 10a). During the previous warm stanza from 2002 to 2005, the highest densities of Pacific cod were observed in the northern half of the EBS survey area surrounding the Pribilof Islands and St. Matthew Island and the lowest densities were in the southeastern EBS (Fig. 10b). A similar pattern in the EBS was observed in 2017 and again in 2018 (Fig. 10b). However, 2017 was preceded by three warm years when Pacific cod abundance and biomass were relatively high and large aggregations were present in the middle and inner domains close to the northern border (Fig. 10b). During the latter warm stanza, higher than average bottom temperatures in the southeastern shelf created thermal corridors (between 1° and 6°C) for Pacific cod to move into the middle and inner domains, where they likely fed on capelin (Ciannelli and Bailey 2005). Forage fish species such as capelin, Pacific herring, and smelt were found in high density in the inner domain (Figs. 48, 49, and 50). A change was observed in the estimates of survey biomass and abundance at length that accompanied a northerly shift in Pacific cod distribution in 2017.

In 2018, Pacific cod comprised 4% (506,943 t, Table 8) of the EBS survey biomass. Compared with 2016 (986,013 t), Pacific cod biomass in 2018 (506,943 t) in the EBS experienced a 49% decrease (Table 8). In 2018, Pacific cod were found in waters with depths between 22 m and 205 m, and at bottom temperatures as warm as 7.7°C and as cold as 1.6°C. The fork lengths of Pacific cod measured during the 2018 EBS survey were between 4 and 112 cm.

From 2010 to 2016, the estimated survey biomass and abundance of Pacific cod in the EBS shelf increased, reaching maximums of 1.1 million t (2014-2015) and 1.1 trillion cod (2014). However, in 2017, both biomass and abundance declined to 0.64 million t and 364 billion cod. This decline in the EBS biomass was accompanied by an increase in the NBS survey biomass (0.3 million t) and abundance (133 million) in 2010. The decreased Pacific cod abundance in the EBS, along with the concomitant increase of the same-sized Pacific cod in the adjacent NBS, was likely a result of migration from the EBS (Stevenson and Lauth 2019). These migrations to the NBS were potentially already taking place prior to 2017, as high densities of Pacific cod were observed along the northern edge of the EBS survey area during 2014-2016.

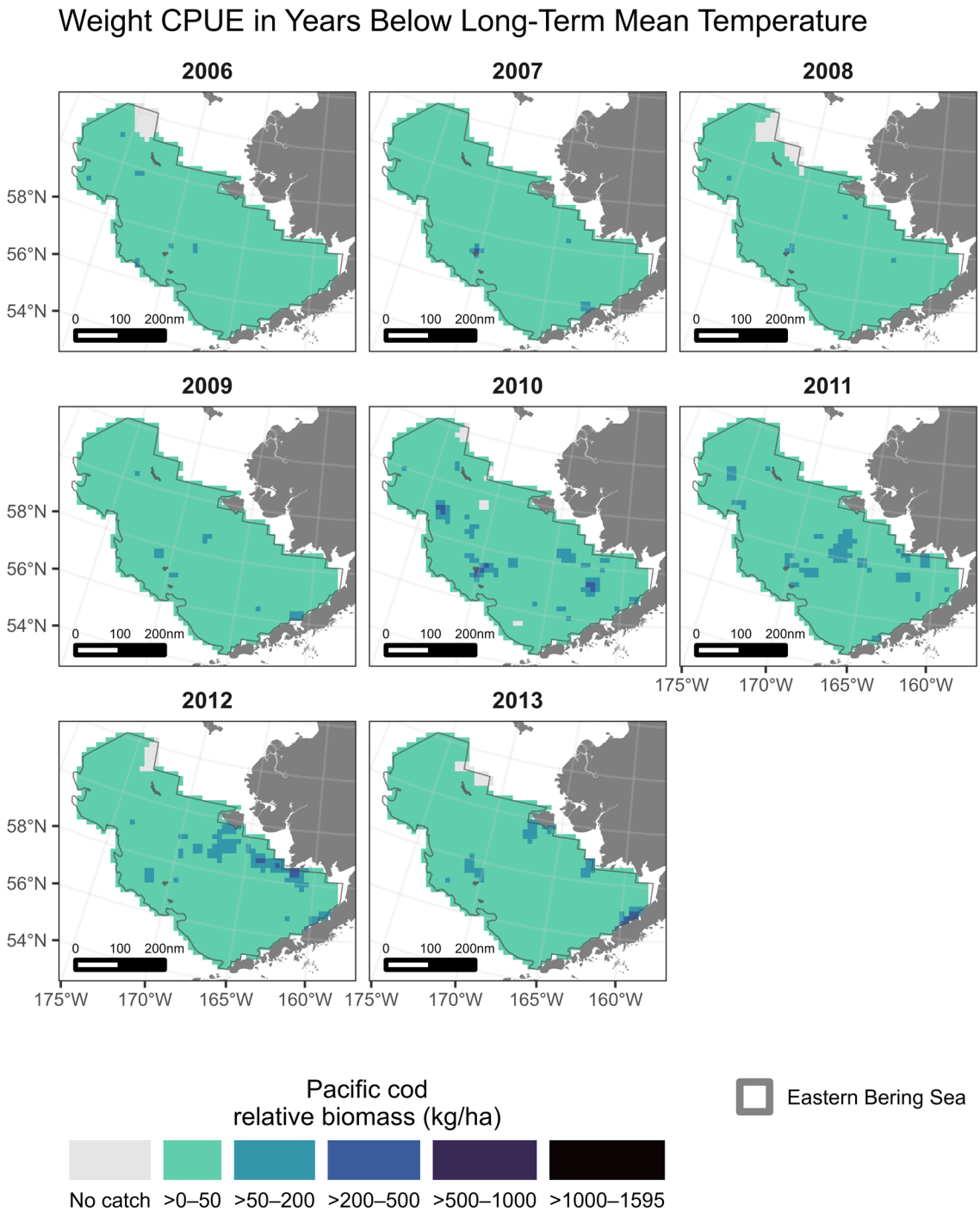

Figure 10a. -- Pacific cod (*Gadus macrocephalus*) distribution and weight CPUE (kg/ha) in years when the survey mean bottom temperature was below the long-term mean 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013 during the Bering Sea shelf bottom trawl survey.

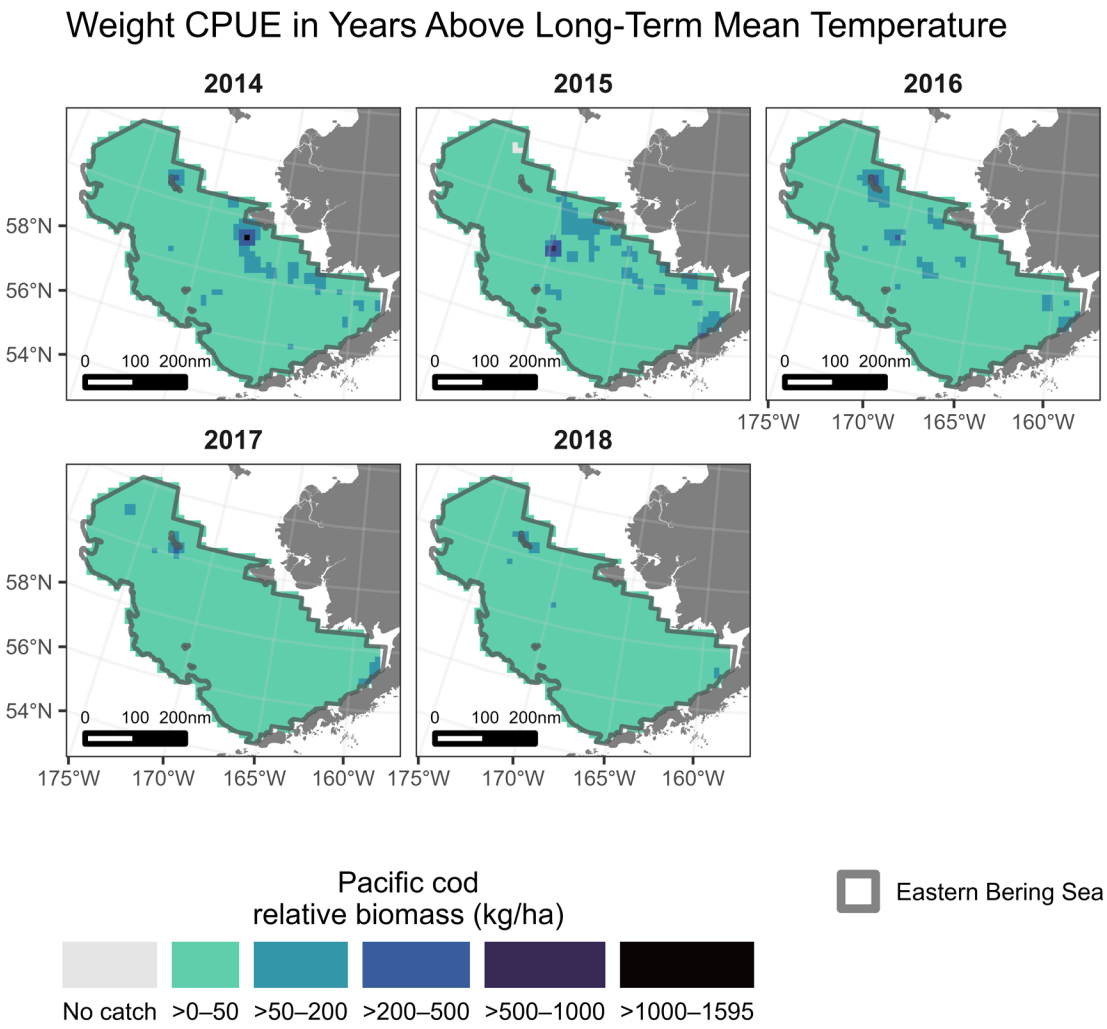

Figure 10b. -- Pacific cod (*Gadus macrocephalus*) distribution and weight CPUE (kg/ha) in years when the survey mean bottom temperature was above the long-term mean 2014, 2015, 2016, 2017, and 2018 during the Bering Sea shelf bottom trawl survey.

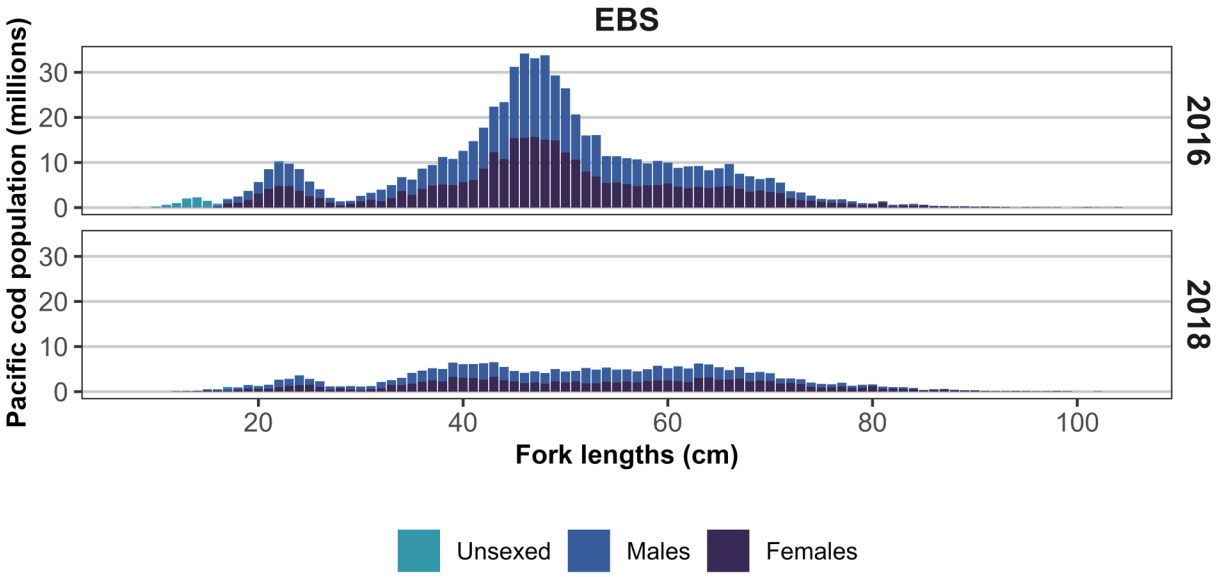

Figure 11. -- Total abundance-at-length estimates of Pacific cod (*Gadus macrocephalus*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 11a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (thousand t) with standard deviation (thousands) and 95% lower (LCL; thousand t) and upper (UCL; thousand t) confidence limits for Pacific cod (*Gadus macrocephalus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (thousand t)	SD biomass (thousands)	95% LCL (thousand t)	95% UCL (thousand t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	10.99	1.67	85.59	12.99	59.34	111.84	57	57	57
20	8.47	1.02	34.77	4.20	26.19	43.34	31	31	31
31	9.27	1.03	87.64	9.74	68.16	107.12	67	67	67
32	11.07	1.18	9.72	1.03	7.18	12.25	8	8	8
41	13.99	2.50	87.71	15.69	56.00	119.42	43	43	43
42	11.11	1.26	26.68	3.02	20.52	32.84	31	31	31
43	28.75	7.32	60.69	15.45	28.55	92.82	22	22	22
50	5.29	1.67	20.51	6.49	7.14	33.88	21	21	21
61	6.90	0.67	60.78	5.87	48.93	72.64	57	57	57
62	12.88	3.51	8.28	2.25	2.77	13.80	7	7	7
82	7.20	1.30	12.92	2.34	7.71	18.14	12	12	12
90	10.08	1.25	11.67	1.45	8.12	15.21	8	8	8
Total	**10.29**	**0.60**	**506.94**	**29.42**	**448.69**	**565.19**	**364**	**364**	**364**

Table 11b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (millions) with standard deviation (thousands) and 95% lower (LCL; millions) and upper (UCL; millions) confidence limits for Pacific cod (*Gadus macrocephalus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (millions)	SD population (thousands)	95% LCL (millions)	95% UCL (millions)	Hauls with weights	Hauls with counts	Hauls with lengths
10	8.15	1.10	63.48	8,600.01	46.10	80.86	57	57	57
20	5.96	0.77	24.45	3,177.43	17.97	30.94	31	31	31
31	4.21	0.49	39.75	4,625.05	30.50	49.00	67	67	67
32	3.85	0.67	3.37	586.79	1.94	4.81	8	8	8
41	6.27	1.28	39.29	8,000.72	23.12	55.46	43	43	43
42	4.89	0.96	11.73	2,301.67	7.03	16.43	31	31	31
43	16.48	5.41	34.79	11,414.85	11.05	58.53	22	22	22
50	1.76	0.58	6.84	2,250.22	2.21	11.48	21	21	21
61	1.77	0.18	15.64	1,552.58	12.50	18.78	57	57	57
62	3.12	0.83	2.01	533.01	0.70	3.31	7	7	7
82	2.42	0.39	4.35	705.20	2.78	5.92	12	12	12
90	2.45	0.33	2.83	379.01	1.90	3.76	8	8	8
Total	**5.04**	**0.36**	**248.54**	**17,714.36**	**213.47**	**283.62**	**364**	**364**	**364**

Yellowfin Sole (*Limanda aspera*)

Yellowfin sole is a target of the largest commercial flatfish fishery in the world (Wilderbuer et al. 2018) and is one of the most abundant flatfish species in the EBS (Table 6). In 2018, the population was distributed along the inner and middle domain of the Eastern Bering Sea (Fig. 12). In cold years, such as 2010, the population is usually concentrated more towards the inner domain (Fig. 12) than during warm years, such as in 2017 and 2018 (Fig. 12). The total estimated survey biomass in the EBS decreased from 2.8 million t in 2017 to 1.9 million t in 2018 (Table 12a). The estimated survey abundance of EBS yellowfin sole was 9.7 billion yellowfin sole in 2017, and 6.5 billion yellowfin sole in 2018. The 2018 EBS size composition estimates show prevalent size modes of yellowfin sole at 12-14 cm and 32-33 cm (Fig. 13).

The cross-shelf distribution of yellowfin sole, and the availability of sexually mature males and females to the summer bottom trawl survey, varies from year to year because of temperature-mediated differences in their spring-summer spawning migration into shallow waters (Nichol et al. 2019), where most spawning activity occurs at bottom depths less than 30 m (Nichol 1995) outside of the minimum bottom trawl survey depth (50 m). Size segregation among spawning and non-spawning portions of the population can also affect the spatial distribution of yellowfin sole (Nichol et al. 2019). This segregation occurs because length or age at sexual maturity differs for males and females (Nichol 1998) and sexually immature individuals undergo a gradual (multi-year) ontogenetic migration away from the nearshore that differs from the annual spawning migrations of mature individuals (Nichol 1997). Interannual differences in the proportion of the yellowfin sole population that is available to the EBS survey, as well as the sex and size composition of this available population may bias survey estimates. Bottom temperature and the survey start date are both used in the stock assessment model to adjust the catchability (q) parameter (Wilderbuer et al. 2018; Nichol et al. 2019).

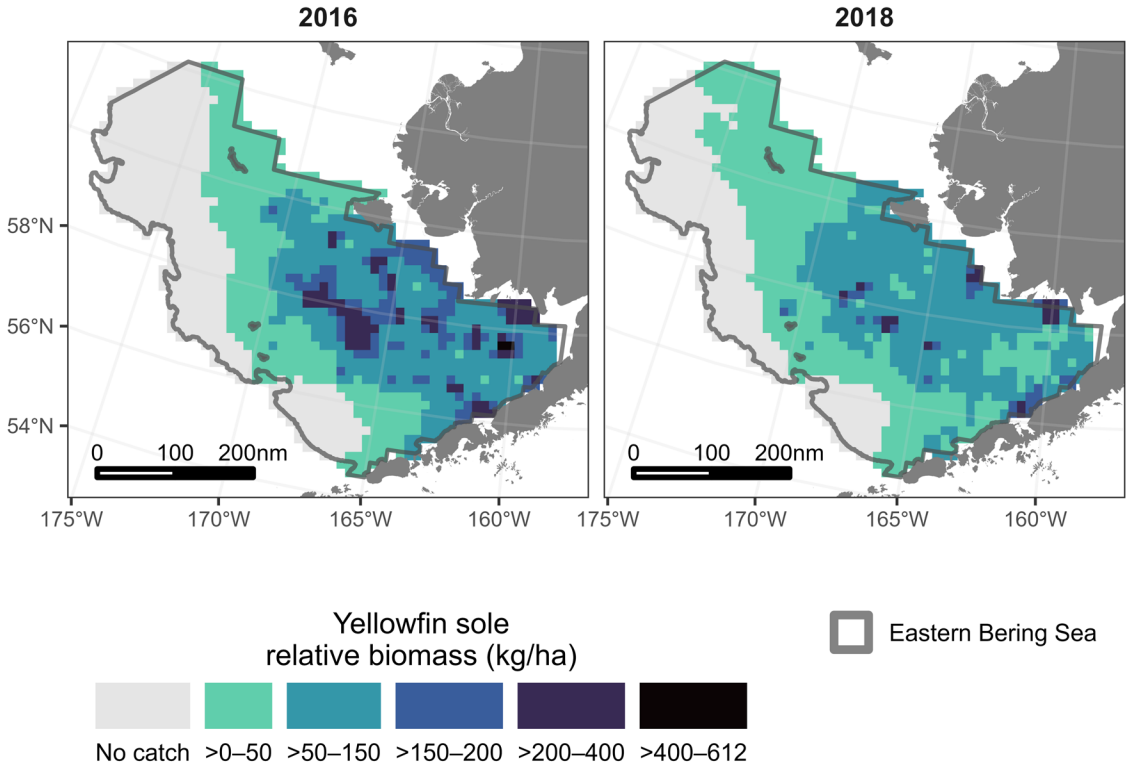

Figure 12. -- Yellowfin sole (*Limanda aspera*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

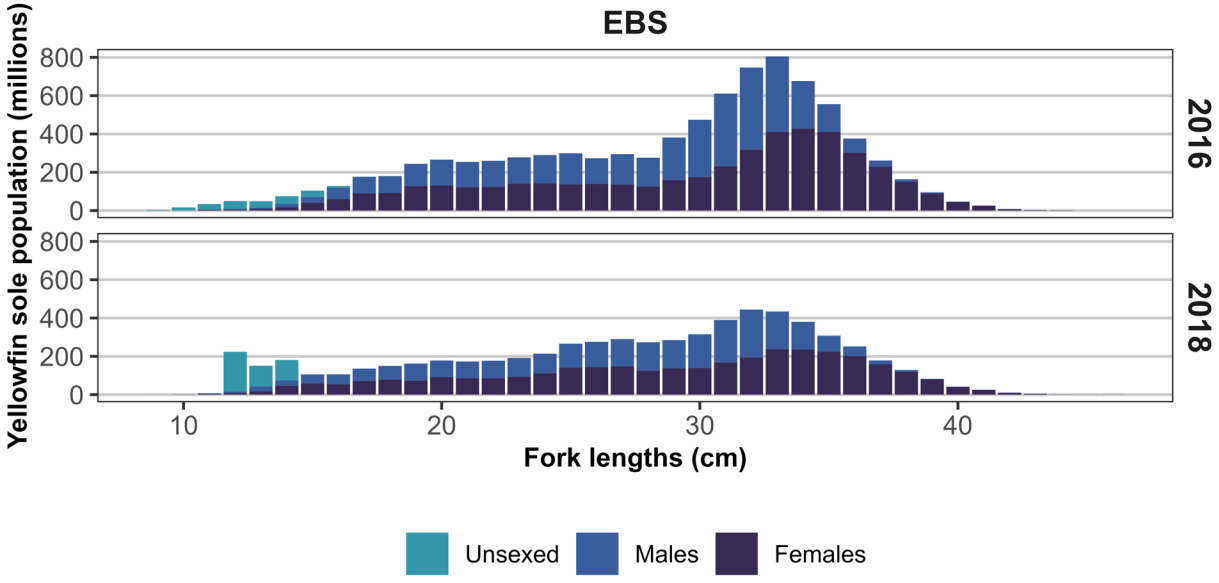

Figure 13. --Total abundance-at-length estimates of yellowfin sole (*Limanda aspera*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 12a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for yellowfin sole (*Limanda aspera*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	84.27	8.81	656,251	68,618	517,574	794,928	58	58	57
20	72.58	5.76	297,783	23,622	249,475	346,090	31	31	31
31	59.13	7.33	558,901	69,248	420,405	697,396	67	67	67
32	30.00	11.36	26,321	9,968	2,746	49,896	8	8	8
41	36.65	7.80	229,829	48,931	130,939	328,719	40	40	40
42	44.40	11.23	106,598	26,954	51,558	161,638	28	28	28
43	5.37	1.49	11,343	3,145	4,802	17,884	19	19	19
50	0.55	0.48	2,149	1,854	0	5,968	3	3	3
61	0.00	0.00	9	9	0	27	1	1	1
62	0.00	0.00	0	0	0	0	0	0	0
82	2.08	1.14	3,741	2,039	0	8,229	8	8	8
90	0.00	0.00	0	0	0	0	0	0	0
Total	**38.40**	**2.34**	**1,892,925**	**115,323**	**1,664,586**	**2,121,264**	**263**	**263**	**262**

Table 12b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for yellowfin sole (*Limanda aspera*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	369.95	54.29	2,880,863.22	422,731.76	2,026,522.32	3,735,204.11	58	58	57
20	268.39	33.86	1,101,119.62	138,907.35	817,054.08	1,385,185.16	31	31	31
31	175.88	21.28	1,662,497.76	201,119.49	1,260,258.78	2,064,736.73	67	67	67
32	61.41	24.29	53,885.55	21,315.03	3,475.50	104,295.60	8	8	8
41	92.14	20.08	577,752.05	125,880.16	323,348.24	832,155.86	40	40	40
42	96.94	23.88	232,768.11	57,348.36	115,662.77	349,873.46	28	28	28
43	13.78	4.18	29,081.30	8,828.52	10,717.98	47,444.63	19	19	19
50	1.00	0.84	3,880.20	3,274.92	0.00	10,626.53	3	3	3
61	0.00	0.00	31.94	31.94	0.00	96.50	1	1	1
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	3.85	2.10	6,908.54	3,774.26	0.00	15,215.68	8	8	8
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**132.86**	**10.31**	**6,548,788.30**	**508,073.16**	**5,542,803.44**	**7,554,773.16**	**263**	**263**	**262**

Northern Rock Sole (*Lepidopsetta polyxystra*)

In 2018, the highest densities of northern rock sole were observed in the southeast portion of the inner domain, in the vicinity of the Pribilof and St. Matthew Islands, and along the Alaska Peninsula (Fig. 14). Although very few bottom temperatures between 0°C and 2°C were recorded during 2018 survey and those that were recorded were restricted to the very northern area of the EBS survey area, historically relatively low densities of northern rock sole are observed where bottom temperatures were < 1°C in the middle and outer domains (Fig. 14 and Tables 13a and 13b). Survey estimates of northern rock sole biomass in the EBS have declined between 2016 (1.5 million t) and 2018 (1.1 million t; Tables 13a and 13b).

While spawning and feeding migrations for northern rock sole are poorly understood, northern rock sole are believed to use active tidal stream transport during nighttime hours (Nichol and Somerton 2009) to migrate from shallow summer feeding grounds to deep winter and spring spawning grounds (Fadeev 1965; Shubnikov and Lisovenko 1964). Northern rock sole are affected by bottom temperatures < 1°C and are typically distributed more southwest during colder years (Spencer 2008; Kotwicki and Lauth 2013).

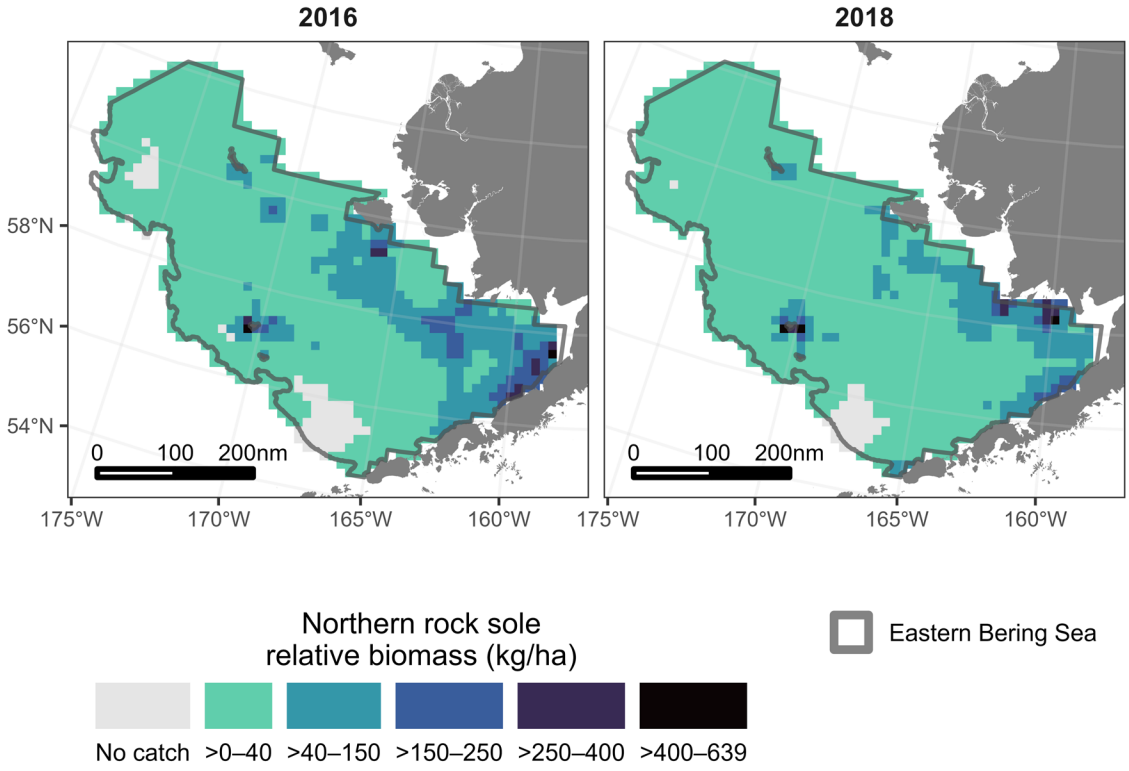

Figure 14. -- Northern rock sole (*Lepidopsetta polyxystra*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

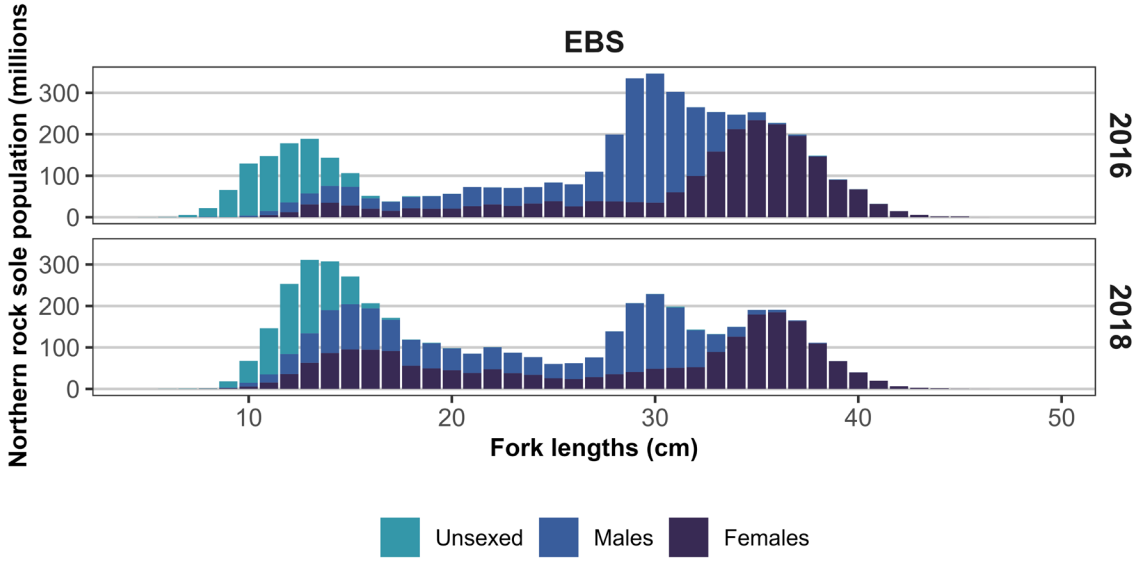

Figure 15. -- Total abundance-at-length estimates of northern rock sole (*Lepidopsetta polyxystra*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 13a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for northern rock sole (*Lepidopsetta polyxystra*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	68.91	11.86	536,625	92,370	349,945	723,305	58	58	58
20	28.15	3.35	115,494	13,727	87,463	143,526	31	31	31
31	15.84	2.95	149,705	27,916	93,873	205,537	69	69	68
32	30.11	10.53	26,421	9,235	4,579	48,263	8	8	8
41	4.44	0.84	27,849	5,259	17,222	38,477	44	44	44
42	60.67	24.29	145,683	58,323	26,586	264,779	31	31	31
43	16.33	4.89	34,475	10,318	13,014	55,935	22	22	22
50	1.18	0.90	4,597	3,498	0	11,803	8	8	8
61	0.75	0.17	6,645	1,467	3,680	9,609	44	44	44
62	1.31	0.82	842	526	0	2,129	6	6	6
82	1.46	0.69	2,623	1,241	0	5,388	11	11	11
90	0.47	0.11	545	122	256	834	7	7	7
Total	**21.33**	**2.33**	**1,051,503**	**114,618**	**822,268**	**1,280,739**	**339**	**339**	**338**

Table 13b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for northern rock sole (*Lepidopsetta polyxystra*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	311.55	33.53	2,426,049.94	261,116.83	1,898,332.83	2,953,767.05	58	58	58
20	212.67	27.31	872,540.24	112,036.23	643,762.27	1,101,318.22	31	31	31
31	63.09	10.51	596,399.41	99,380.19	397,639.02	795,159.79	69	69	68
32	87.64	29.54	76,898.40	25,922.93	15,590.66	138,206.13	8	8	8
41	22.31	8.43	139,902.64	52,841.54	33,109.90	246,695.39	44	44	44
42	174.18	76.28	418,223.30	183,148.74	44,233.58	792,213.03	31	31	31
43	33.82	10.51	71,376.92	22,191.91	25,217.74	117,536.10	22	22	22
50	2.79	2.27	10,804.58	8,822.00	0.00	28,977.90	8	8	8
61	1.30	0.28	11,452.51	2,449.96	6,501.14	16,403.88	44	44	44
62	1.94	1.14	1,248.39	731.74	0.00	3,038.95	6	6	6
82	2.52	1.12	4,531.23	2,017.68	35.84	9,026.61	11	11	11
90	0.75	0.19	871.87	221.56	347.88	1,395.87	7	7	7
Total	**93.94**	**7.26**	**4,630,299.43**	**358,049.15**	**3,914,201.14**	**5,346,397.72**	**339**	**339**	**338**

Flathead Sole (*Hippoglossoides elassodon*)

Flathead sole and Bering flounder (*Hippoglossoides robustus*) are congeners and can be difficult to distinguish from each other based on morphology in the field. Consequently, the accuracy of their identification in commercial fishery data is unknown and the two species are combined into a single stock assessment by the NPFMC (McGilliard et al. 2018). However, since bottom trawl survey scientists are trained to make reliable field identifications for flathead sole and Bering flounder, the results here are presented by species. Despite belonging to the same genus and having a similar appearance, the two species have differing geographic distributions and environmental associations, although they do co-occur (Fig. 16; compare with Bering flounder in Figure 18). Bering flounder tend to occupy arctic regions, while flathead sole are more subarctic/boreal (Baker and Hollowed 2014). In 2018, flathead sole were present at 90% of the EBS stations and the highest catch rates were at depths greater than 70 m in the outer half of the EBS shelf (Fig. 16). Flathead sole in the EBS had an estimated biomass of 492 thousand t (Table 14a) and population size of 2.3 billion sole (Table 14b).

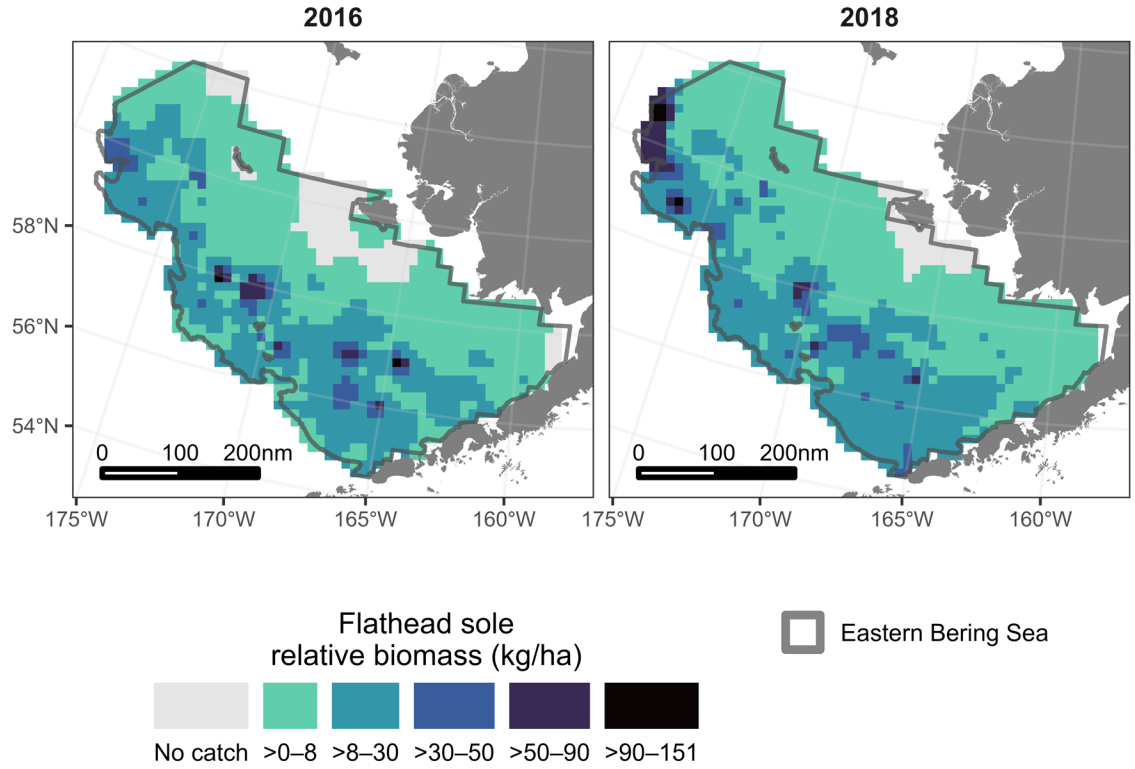

Figure 16. -- Flathead sole (*Hippoglossoides elassodon*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

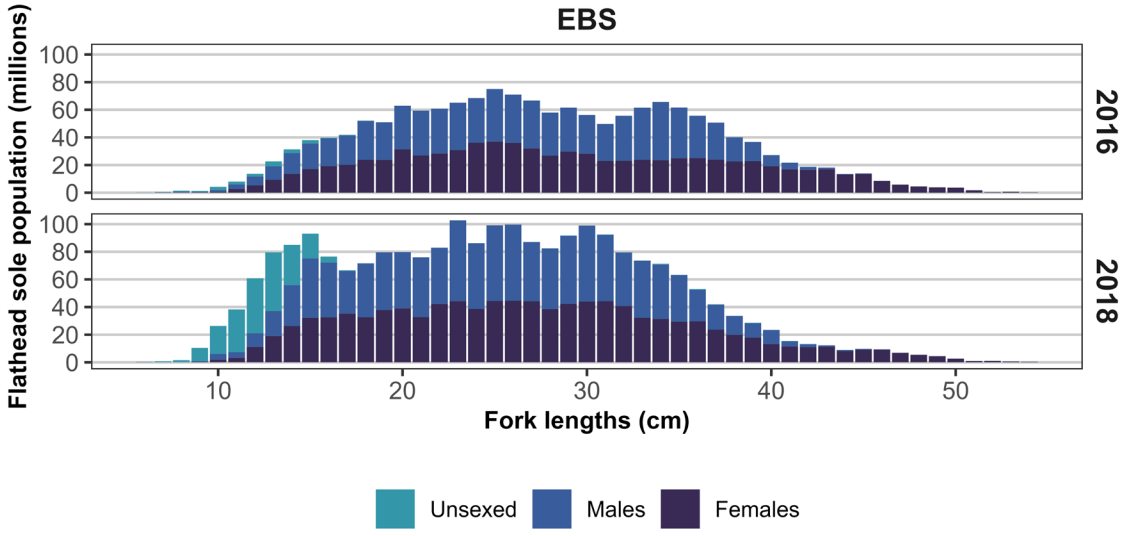

Figure 17. -- Total abundance-at-length estimates of flathead sole (*Hippoglossoides elassodon*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 14a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for flathead sole (*Hippoglossoides elassodon*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	1.75	0.35	13,650	2,737	8,120	19,181	46	46	45
20	0.08	0.03	345	130	80	609	15	15	15
31	14.08	1.52	133,088	14,348	104,392	161,783	69	69	69
32	31.95	9.65	28,036	8,463	8,020	48,051	8	8	8
41	2.90	0.64	18,200	4,012	10,092	26,307	41	41	41
42	18.59	3.30	44,631	7,914	28,447	60,816	28	28	28
43	7.08	3.08	14,953	6,497	1,439	28,467	21	21	21
50	15.86	2.14	61,510	8,295	44,388	78,632	26	26	26
61	18.58	3.45	163,790	30,403	102,346	225,234	60	60	60
62	10.40	4.62	6,687	2,969	0	13,953	7	7	7
82	1.21	0.45	2,179	812	369	3,988	11	11	11
90	4.80	0.46	5,554	529	4,302	6,806	8	8	8
Total	**9.99**	**0.76**	**492,623**	**37,534**	**418,305**	**566,941**	**340**	**340**	**339**

Table 14b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (millions) with standard deviation (thousands) and 95% lower (LCL; millions) and upper (UCL; millions) confidence limits for flathead sole (*Hippoglossoides elassodon*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (millions)	SD population (thousands)	95% LCL (millions)	95% UCL (millions)	Hauls with weights	Hauls with counts	Hauls with lengths
10	4.68	0.94	36.47	7,282.09	21.75	51.18	46	46	45
20	0.85	0.21	3.50	881.70	1.70	5.30	15	15	15
31	55.17	6.07	521.50	57,348.62	406.80	636.20	69	69	69
32	52.92	10.11	46.44	8,874.05	25.45	67.42	8	8	8
41	10.30	2.10	64.56	13,195.93	37.90	91.23	41	41	41
42	55.26	12.53	132.69	30,075.38	71.18	194.19	28	28	28
43	27.67	8.83	58.41	18,639.69	19.64	97.18	21	21	21
50	123.20	17.58	477.91	68,193.41	337.16	618.66	26	26	26
61	103.45	18.49	911.75	162,982.35	582.36	1,241.14	60	60	60
62	51.98	11.60	33.42	7,456.22	15.17	51.66	7	7	7
82	3.91	1.52	7.02	2,734.66	0.93	13.11	11	11	11
90	31.12	3.99	36.00	4,613.68	25.09	46.91	8	8	8
Total	**47.26**	**3.86**	**2,329.67**	**190,119.61**	**1,953.23**	**2,706.10**	**340**	**340**	**339**

Bering Flounder (*Hippoglossoides robustus*)

Bering flounder were most concentrated in the northwest middle domain survey area of the EBS (Fig. 18). This species was present at 20.7% of the EBS stations and found in bottom temperatures as warm as 6°C and as cold as 1.6°C. In 2018 in the EBS, Bering flounder was estimated at biomass of 12,995 t (Table 15a) and 61 billion fish (Tables 15b and 19), which was a 65% decrease when compared to the Bering flounder biomass in 2016 (Table 8).

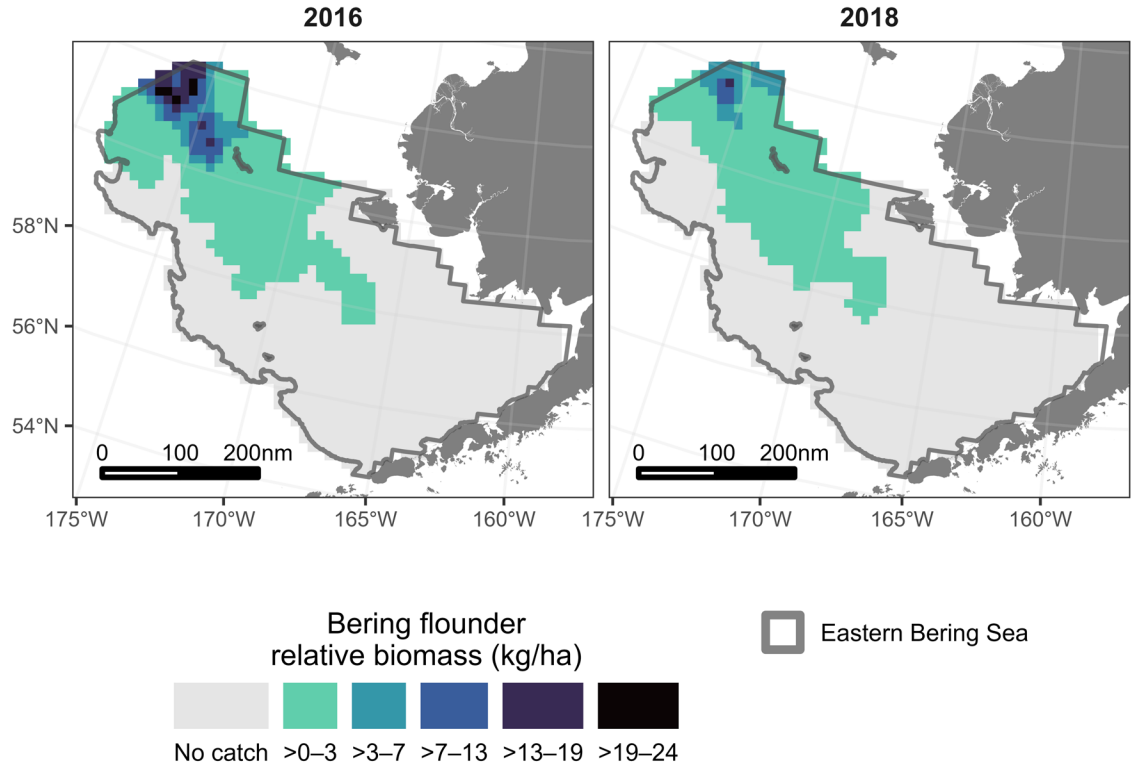

Figure 18. -- Bering flounder (*Hippoglossoides robustus*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

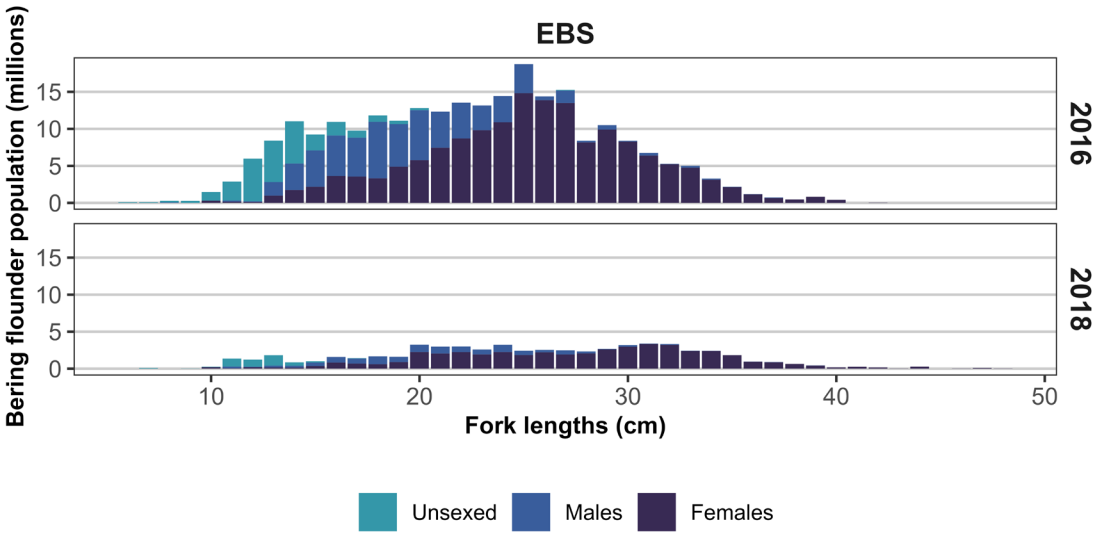

Figure 19. -- Total abundance-at-length estimates of Bering flounder (*Hippoglossoides robustus*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 15a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Bering flounder (*Hippoglossoides robustus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0	0	0	0	0	0	0
20	0.01	0.00	21	19	0	59	3	3	3
31	0.00	0.00	0	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0	0
41	0.46	0.09	2,911	553	1,794	4,029	29	29	29
42	0.00	0.00	0	0	0	0	0	0	0
43	0.21	0.05	454	107	232	676	18	18	18
50	0.00	0.00	0	0	0	0	0	0	0
61	0.01	0.01	87	52	0	193	3	3	3
62	0.08	0.03	51	22	0	106	5	5	5
82	3.45	1.19	6,199	2,140	1,490	10,909	12	12	12
90	2.83	1.23	3,272	1,423	0	6,754	8	8	8
Total	**0.26**	**0.05**	**12,995**	**2,631**	**7,677**	**18,313**	**78**	**78**	**78**

Table 15b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Bering flounder (*Hippoglossoides robustus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.03	0.02	128.12	75.14	0.00	281.56	3	3	3
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	2.30	0.57	14,412.15	3,567.69	7,201.85	21,622.45	29	29	29
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	1.21	0.30	2,559.71	624.78	1,256.42	3,863.00	18	18	18
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.09	0.05	773.85	455.40	0.00	1,694.22	3	3	3
62	0.54	0.30	349.58	190.95	0.00	816.83	5	5	5
82	16.08	5.68	28,864.42	10,200.20	6,413.77	51,315.07	12	12	12
90	12.16	4.66	14,063.93	5,386.42	883.35	27,244.50	8	8	8
Total	**1.24**	**0.25**	**61,151.76**	**12,100.66**	**36,696.32**	**85,607.19**	**78**	**78**	**78**

Alaska Plaice (*Pleuronectes quadrituberculatus*)

Alaska plaice were distributed throughout the middle and inner domain of the EBS survey area, with the highest densities located southeast of St. Matthew Island (Fig. 20). Comparing the 2016 and 2018 distribution plots, Alaska plaice densities were highest between 50 m and 100 m bottom depths during both years, but their distribution may have been broader in 2018 (Fig. 20; O'Leary et al. 2022).

In 2018, the total biomass and population of Alaska plaice was estimated to be around 419,509 t (Table 16a) and 570 million fish (Table 16b), respectively. Biomass of Alaska plaice comprised 3% of the total survey biomass in both 2016 to 2018 (Table 16a), and biomass of Alaska plaice only slightly decreased between the two years (1.3%; Table 8). Not only were the 2016 and 2018 EBS survey biomass estimates similar, but the modal length of Alaska plaice for those two years were within 1 cm of each other (34 cm and 35 cm for 2016 and 2018, respectively; Fig. 21). Alaska plaice are sexually dimorphic and females can attain a maximum length about 10 cm greater than males (Zhang et al.1998). In addition, the size and sex composition of Alaska plaice varies by depth in the EBS, with males more prevalent in the inner domain and females more prevalent in the middle and outer domains increasing in average size with depth (Zhang et al. 1998).

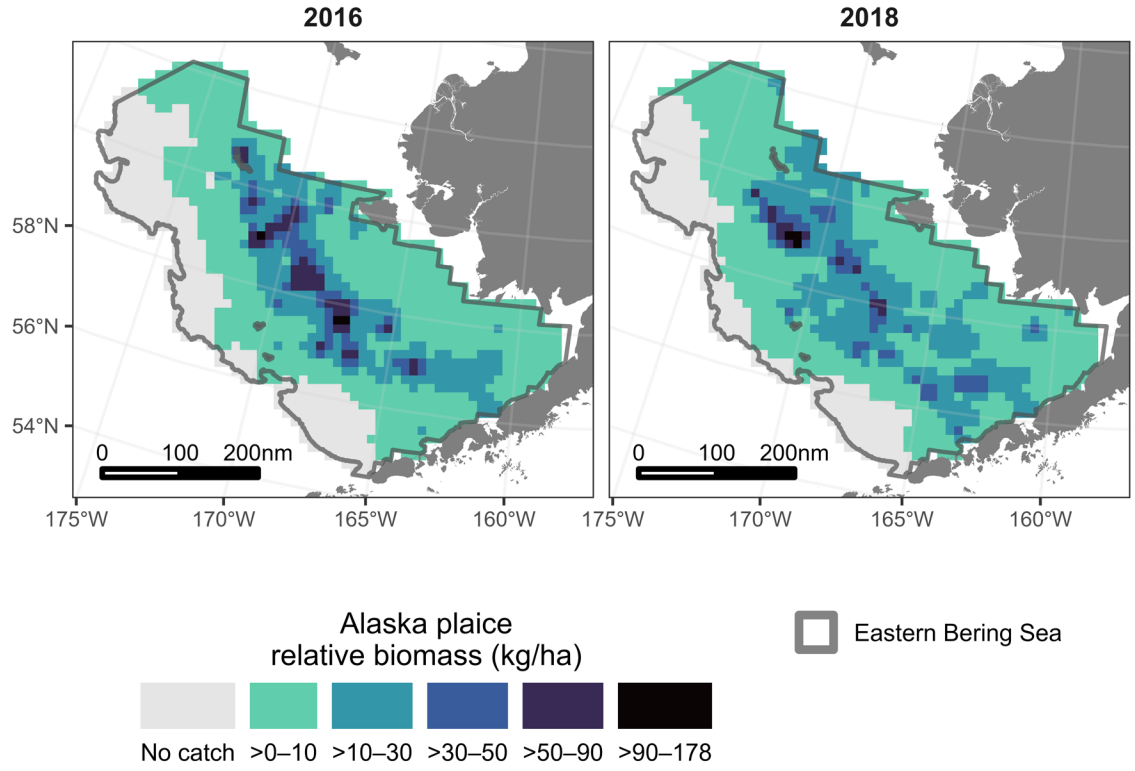

Figure 20. -- Alaska plaice (*Pleuronectes quadrituberculatus*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

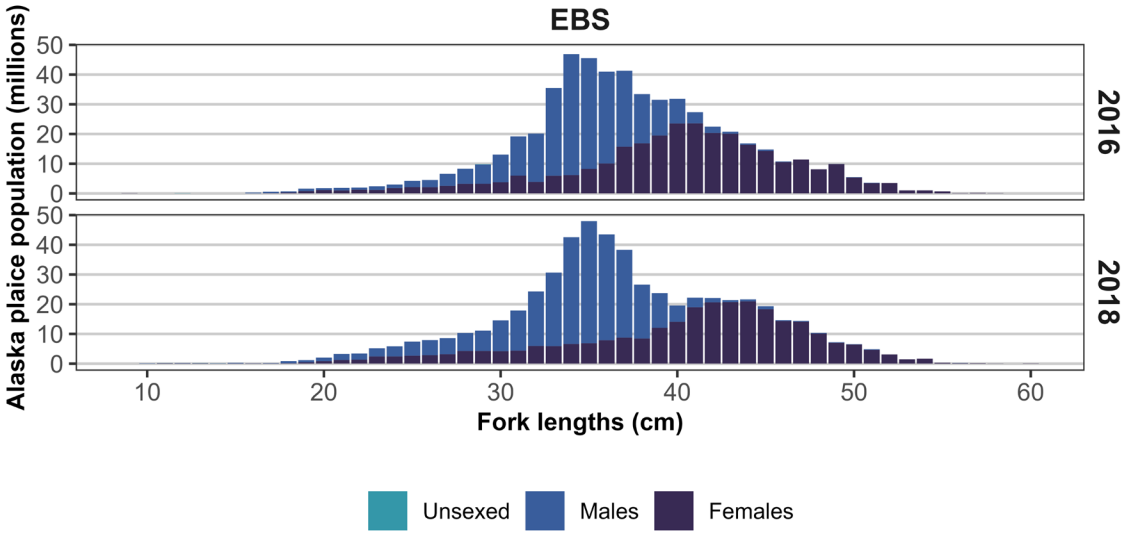

Figure 21. -- Total abundance-at-length estimates of Alaska plaice (*Pleuronectes quadrituberculatus*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 16a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Alaska plaice (*Pleuronectes quadrituberculatus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	6.58	1.16	51,258	9,045	32,978	69,538	57	57	56
20	9.95	1.91	40,804	7,852	24,747	56,862	31	31	31
31	13.44	2.00	127,000	18,940	89,120	164,879	63	63	63
32	8.67	2.01	7,604	1,760	3,442	11,766	8	8	8
41	19.81	4.39	124,235	27,547	68,563	179,907	42	42	42
42	12.90	2.47	30,970	5,937	18,829	43,111	29	29	29
43	15.03	4.28	31,720	9,026	12,946	50,495	22	22	22
50	0.06	0.06	216	216	0	660	1	1	1
61	0.08	0.03	734	286	156	1,312	9	9	9
62	0.72	0.51	462	330	0	1,310	4	4	4
82	2.36	1.18	4,241	2,123	0	8,972	10	10	10
90	0.23	0.08	265	93	45	485	5	5	5
Total	**8.51**	**0.76**	**419,509**	**37,223**	**345,807**	**493,212**	**281**	**281**	**280**

Table 16b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Alaska plaice (*Pleuronectes quadrituberculatus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	15.34	2.69	119,472.23	20,958.81	77,114.47	161,829.99	57	57	56
20	19.07	3.10	78,252.77	12,710.27	52,260.27	104,245.27	31	31	31
31	15.59	2.28	147,341.82	21,527.89	104,286.05	190,397.60	63	63	63
32	7.06	1.81	6,195.55	1,585.47	2,445.92	9,945.17	8	8	8
41	24.25	4.44	152,040.21	27,840.64	95,774.28	208,306.14	42	42	42
42	13.60	2.41	32,646.83	5,775.89	20,835.13	44,458.53	29	29	29
43	14.03	3.54	29,613.68	7,482.48	14,050.12	45,177.24	22	22	22
50	0.05	0.05	179.59	179.59	0.00	549.55	1	1	1
61	0.06	0.02	551.81	209.32	128.78	974.85	9	9	9
62	0.38	0.23	246.26	149.42	0.00	630.42	4	4	4
82	1.69	0.75	3,031.09	1,342.17	40.74	6,021.44	10	10	10
90	0.16	0.05	181.75	62.30	34.39	329.10	5	5	5
Total	**11.56**	**0.89**	**569,753.58**	**43,967.49**	**482,697.96**	**656,809.20**	**281**	**281**	**280**

Greenland Turbot (*Reinhardtius hippoglossoides*)

During the 2018 EBS survey, Greenland turbot were present at 20.5% of stations (77 of 376 stations). Greenland turbot were distributed primarily in the northwest portion of the middle and outer domains (Fig. 22), in waters with depths between 60 m and 205 m, and where bottom temperatures were between 1.6°C and 4.1°C. The fork lengths of Greenland turbot measured during the 2018 EBS survey were between 6 and 106 cm.

The 2018 Greenland turbot biomass estimate decreased slightly from 22,429 t in 2016 to 18,017 t (Table 17a) and the population estimate decreased from 14.1 million in 2016 to 7.4 million (Table 17b). In 2010, a strong year class was observed as 12-16 cm juveniles, and this cohort has been observed in subsequent years as it recruited to the fishery (Fig. 23). Greenland turbot are typically most abundant on the upper continental slope outside of the standard EBS survey area, although juveniles may spend several years on the continental shelf before moving to deeper water (Sohn et al. 2010; Vestfals et al. 2016). Thus, order of magnitude decrease in estimated population since 2010 may be attributed in part to the ontogenetic movement of this year class out of the survey area and into the upper continental slope waters (Alton et al. 1998).

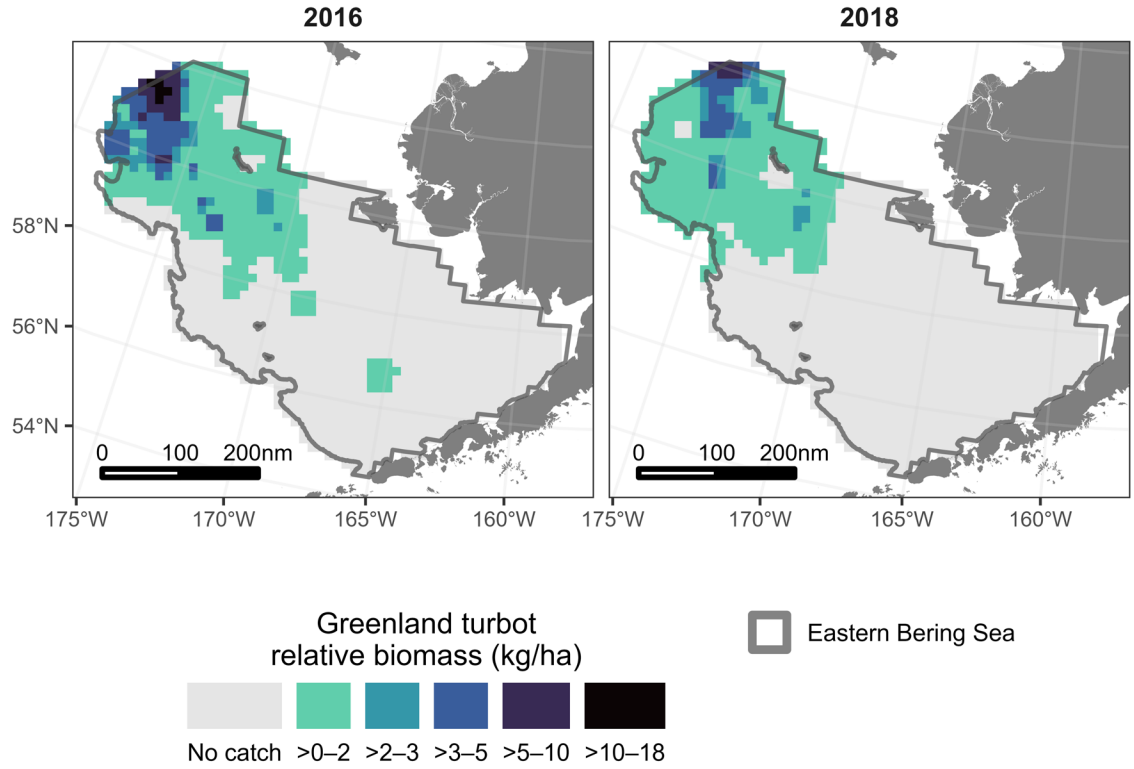

Figure 22. -- Greenland turbot (*Reinhardtius hippoglossoides*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

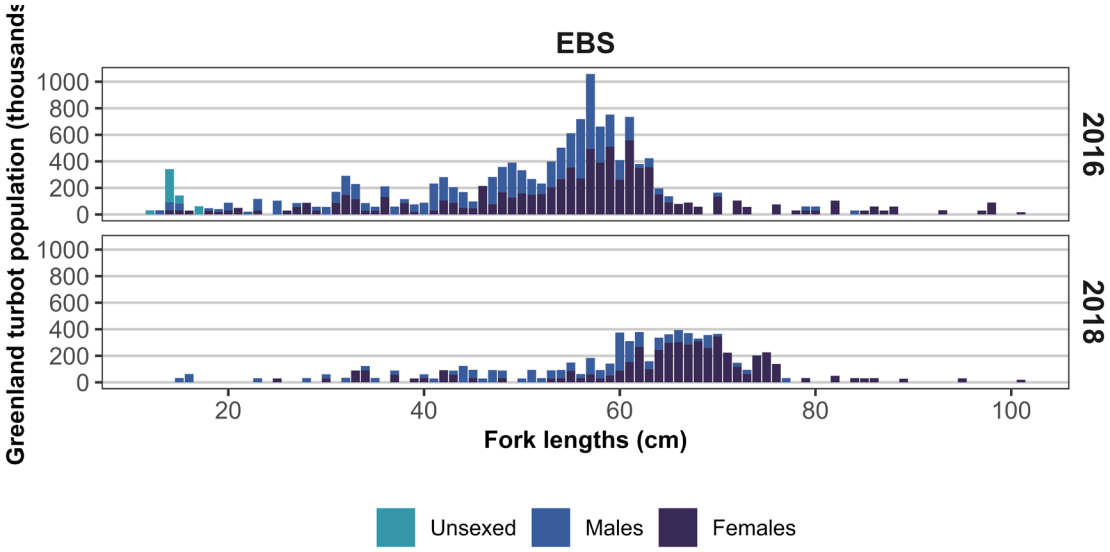

Figure 23. -- Total abundance-at-length estimates of Greenland turbot (*Reinhardtius hippoglossoides*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 17a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Greenland turbot (*Reinhardtius hippoglossoides*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0	0	0	0	0	0	0
20	0.00	0.00	0	0	0	0	0	0	0
31	0.00	0.00	0	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0	0
41	0.62	0.13	3,901	826	2,232	5,571	19	19	19
42	0.00	0.00	0	0	0	0	0	0	0
43	0.61	0.16	1,292	341	583	2,001	11	11	11
50	0.00	0.00	0	0	0	0	0	0	0
61	0.51	0.13	4,515	1,165	2,161	6,869	22	22	22
62	0.70	0.27	452	174	25	879	5	5	5
82	2.63	0.71	4,729	1,270	1,900	7,558	12	12	12
90	2.70	0.43	3,128	495	1,957	4,298	8	8	8
Total	**0.37**	**0.04**	**18,017**	**2,011**	**14,036**	**21,998**	**77**	**77**	**77**

Table 17b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Greenland turbot (*Reinhardtius hippoglossoides*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.26	0.06	1,650.74	357.66	927.92	2,373.57	19	19	19
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.19	0.05	391.72	102.91	177.66	605.78	11	11	11
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.16	0.05	1,430.82	412.26	597.63	2,264.00	22	22	22
62	0.17	0.05	112.47	34.86	27.18	197.76	5	5	5
82	1.28	0.25	2,292.50	447.76	1,294.90	3,290.11	12	12	12
90	1.28	0.31	1,482.68	362.69	624.91	2,340.44	8	8	8
Total	**0.15**	**0.02**	**7,360.93**	**801.07**	**5,774.81**	**8,947.05**	**77**	**77**	**77**

Arrowtooth Flounder (*Atheresthes stomias*)

Arrowtooth flounder are similar in appearance to the congeneric Kamchatka flounder (Yang 1988), and it wasn't until 1994 that field characteristics were established to reliably distinguish between the two species during AFSC bottom trawl surveys. In 2018, arrowtooth flounder (Fig. 24) appear to occupy similar areas as Kamchatka flounder (Fig. 26), although arrowtooth flounder are much more abundant than Kamchatka flounder.

Arrowtooth flounder are generally a deeper water species as adults, but primarily occupy the shelf waters until age four. As individuals mature, they begin to recruit to the upper continental slope waters (Spies et al. 2018). Thus, the shelf survey estimates are not synoptically inclusive of the entire population. In 2018, 98.4% of the total estimated biomass of arrowtooth flounder in the EBS was distributed in the middle and outer domains (Fig. 24; Table 18a). Arrowtooth flounder biomass in the EBS was also estimated at 511 thousand t and population was estimated at 1.087 billion fish (Tables 18a and 18b). As with all previous years, females outnumbered males, at a rate of approximately 2:1, with females attaining larger average sizes (Fig. 25). This disparity in sex ratio has been attributed to sex-specific differences in natural mortality rates, but the issue requires further research (Zimmermann and Goddard 1996; Spies et al. 2018).

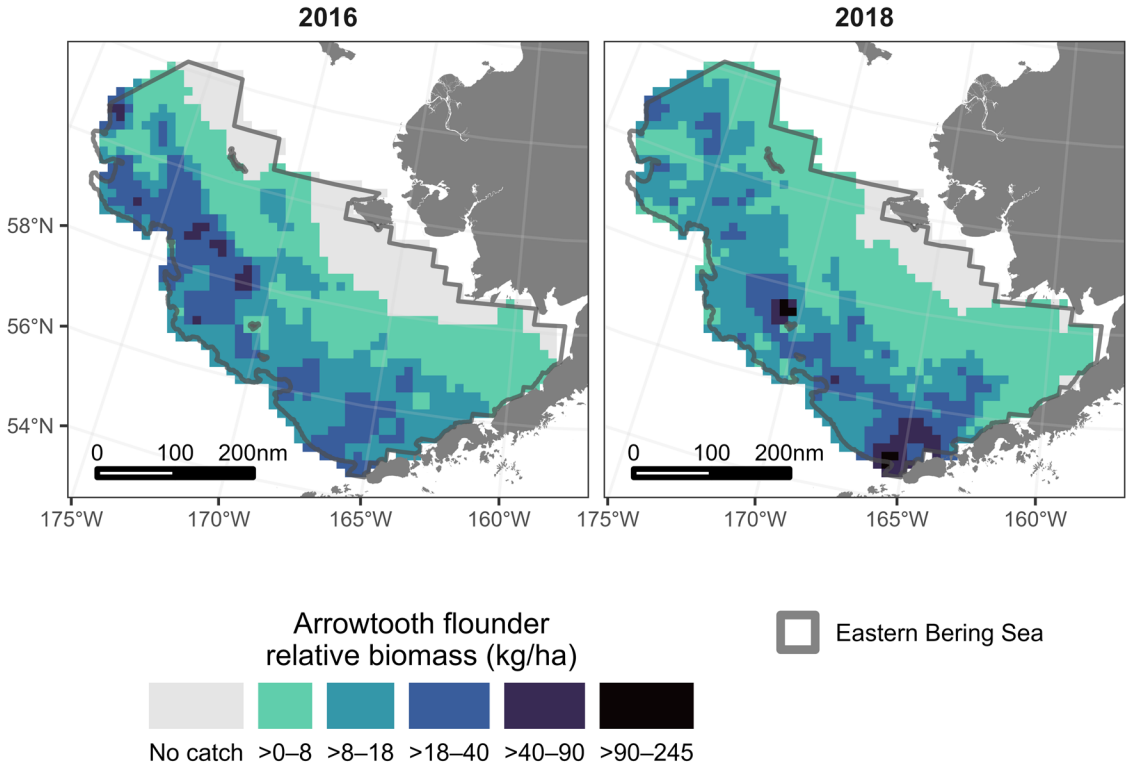

Figure 24. -- Arrowtooth flounder (*Atheresthes stomias*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

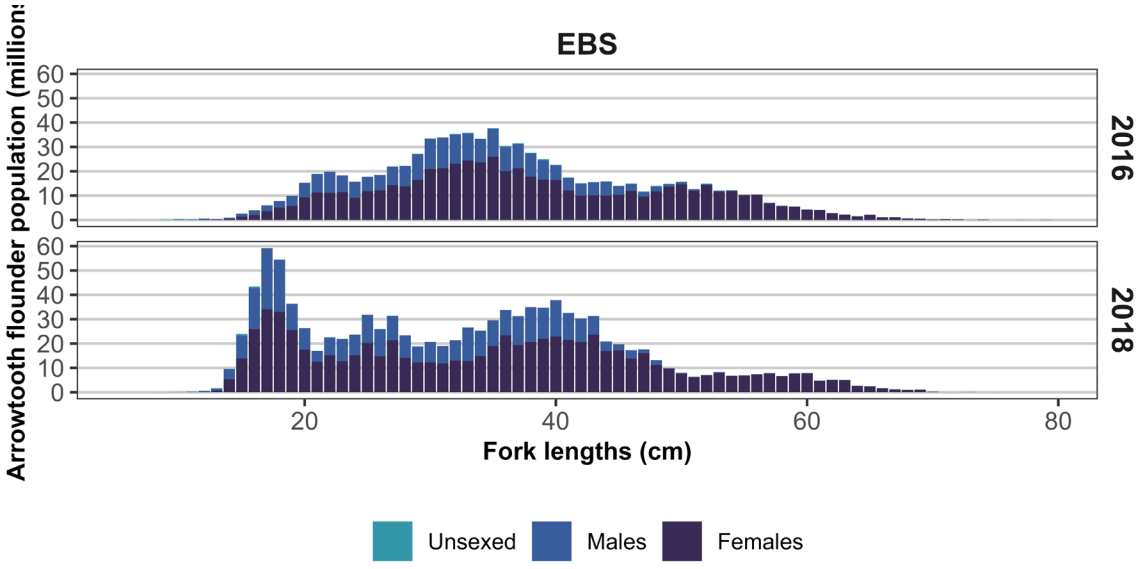

Figure 25. -- Total abundance-at-length estimates of arrowtooth flounder (*Atheresthes stomias*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 18a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (thousand t) with standard deviation and 95% lower (LCL; thousand t) and upper (UCL; thousand t) confidence limits for arrowtooth flounder (*Atheresthes stomias*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (thousand t)	SD biomass	95% LCL (thousand t)	95% UCL (thousand t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.91	0.23	7.09	1,777	3.50	10.68	26	26	25
20	0.36	0.14	1.49	586	0.29	2.68	10	10	10
31	14.83	1.81	140.15	17,085	105.98	174.32	69	69	69
32	21.12	3.19	18.53	2,799	11.91	25.15	8	8	8
41	6.46	0.92	40.51	5,796	28.79	52.22	44	44	44
42	21.91	7.62	52.61	18,291	15.26	89.96	31	31	31
43	9.31	1.12	19.64	2,374	14.69	24.59	22	22	22
50	26.46	5.86	102.65	22,717	55.86	149.45	26	26	26
61	11.70	0.83	103.09	7,327	88.28	117.90	60	60	60
62	12.07	2.07	7.76	1,330	4.50	11.01	7	7	7
82	1.57	0.89	2.83	1,594	0.00	6.38	11	11	10
90	12.84	1.79	14.86	2,069	9.96	19.75	8	8	8
Total	**10.37**	**0.72**	**511.19**	**35,431**	**440.33**	**582.05**	**322**	**322**	**320**

Table 18b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (millions) with standard deviation (thousands) and 95% lower (LCL; millions) and upper (UCL; millions) confidence limits for arrowtooth flounder (*Atheresthes stomias*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (millions)	SD population (thousands)	95% LCL (millions)	95% UCL (millions)	Hauls with weights	Hauls with counts	Hauls with lengths
10	2.27	0.88	17.69	6,828.69	3.89	31.49	26	26	25
20	0.48	0.18	1.99	745.35	0.47	3.51	10	10	10
31	35.22	4.64	332.96	43,874.46	245.22	420.71	69	69	69
32	63.98	25.72	56.14	22,571.29	2.76	109.52	8	8	8
41	8.66	1.30	54.32	8,136.93	37.88	70.77	44	44	44
42	62.23	25.70	149.43	61,719.69	23.40	275.46	31	31	31
43	12.47	1.55	26.31	3,280.78	19.47	33.16	22	22	22
50	71.17	15.15	276.10	58,752.80	155.07	397.13	26	26	26
61	16.47	1.42	145.18	12,479.03	119.96	170.40	60	60	60
62	11.31	1.09	7.27	703.18	5.55	8.99	7	7	7
82	1.71	1.00	3.06	1,791.52	0.00	7.05	11	11	10
90	14.26	2.07	16.49	2,390.20	10.84	22.15	8	8	8
Total	**22.05**	**2.03**	**1,086.95**	**99,924.70**	**887.10**	**1,286.80**	**322**	**322**	**320**

Kamchatka Flounder (*Atheresthes evermanni*)

Kamchatka flounder are similar in appearance to the congeneric arrowtooth flounder (Yang 1988), and it wasn't until 1994 that field characteristics were established to reliably distinguish between the two species during AFSC bottom trawl surveys. Kamchatka flounder (Fig. 26) appeared to occupy similar areas as arrowtooth flounder in 2018 (Fig. 24), although Kamchatka flounder are much less abundant than arrowtooth flounder in the Bering Sea. In 2018, the Kamchatka flounder biomass was estimated at 44,000 t and abundance was estimated at 93.721 million fish (Table 19a; Table 19b). Unlike arrowtooth flounder, the Kamchatka flounder sex ratio was roughly 1:1 (Fig. 27).

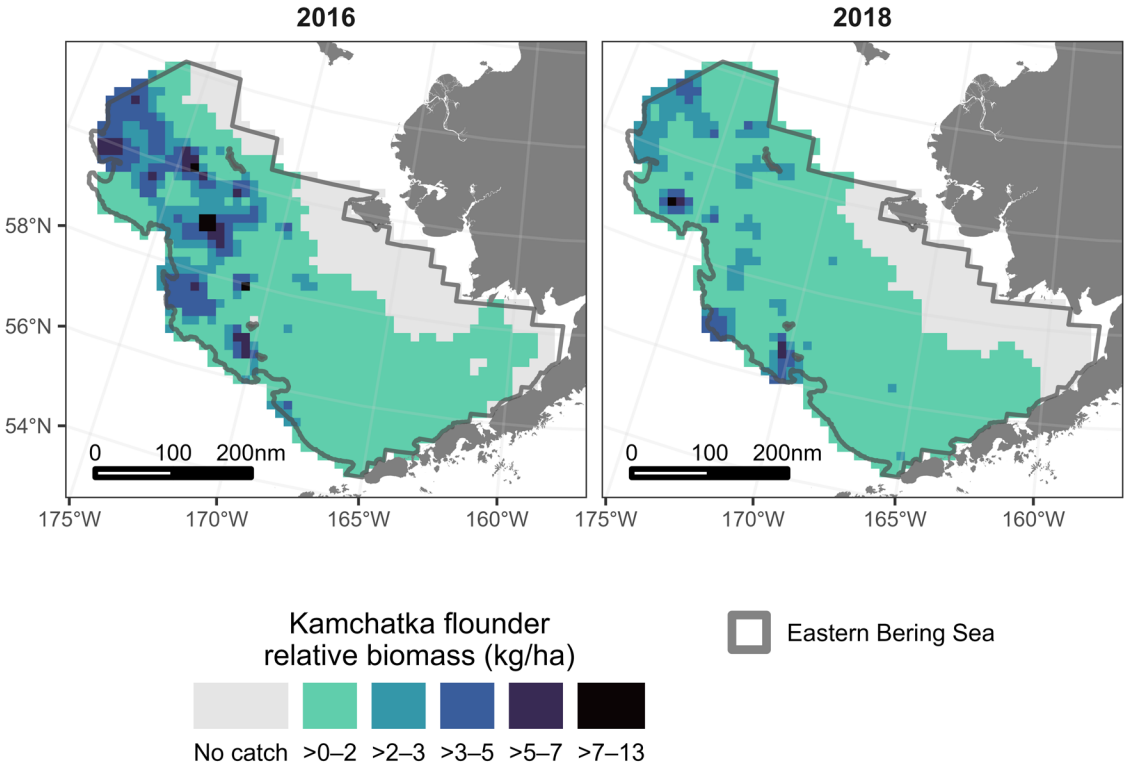

Figure 26. -- Kamchatka flounder (*Atheresthes evermanni*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

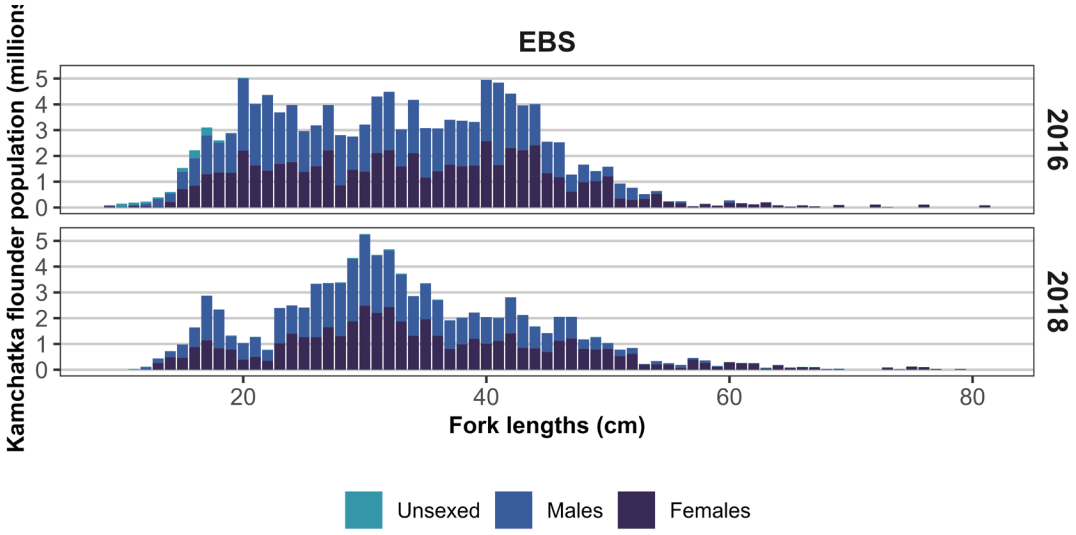

Figure 27. -- Total abundance-at-length estimates of Kamchatka flounder (*Atheresthes evermanni*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 19a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Kamchatka flounder (*Atheresthes evermanni*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.01	0.01	93	69	0	233	3	3	3
20	0.12	0.06	498	249	0	1,007	7	7	7
31	0.56	0.07	5,301	646	4,009	6,593	56	56	56
32	0.92	0.29	806	257	198	1,413	8	8	8
41	1.07	0.13	6,683	798	5,070	8,296	42	42	41
42	1.12	0.33	2,682	788	1,072	4,293	28	28	28
43	1.59	0.20	3,352	429	2,458	4,246	21	21	21
50	1.16	0.15	4,517	564	3,354	5,679	26	26	26
61	1.74	0.18	15,378	1,604	12,137	18,619	58	58	58
62	0.98	0.11	632	73	445	820	7	7	7
82	0.90	0.22	1,608	402	712	2,504	11	11	11
90	2.12	0.38	2,449	442	1,403	3,495	8	8	8
Total	**0.89**	**0.05**	**44,000**	**2,290**	**39,465**	**48,534**	**275**	**275**	**274**

Table 19b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Kamchatka flounder (*Atheresthes evermanni*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.02	0.01	178.92	113.81	0.00	408.93	3	3	3
20	0.15	0.08	614.92	314.91	0.00	1,257.97	7	7	7
31	1.68	0.21	15,898.41	2,000.03	11,898.34	19,898.47	56	56	56
32	3.66	1.14	3,210.73	1,001.77	841.55	5,579.91	8	8	8
41	1.24	0.12	7,804.94	771.48	6,245.78	9,364.10	42	42	41
42	1.88	0.32	4,523.07	773.52	2,941.22	6,104.91	28	28	28
43	1.67	0.22	3,526.62	463.29	2,560.20	4,493.03	21	21	21
50	4.97	0.95	19,291.12	3,704.26	11,660.34	26,921.90	26	26	26
61	3.88	0.42	34,185.23	3,723.14	26,660.75	41,709.70	58	58	58
62	1.39	0.22	894.69	142.57	528.14	1,261.24	7	7	7
82	0.73	0.18	1,313.81	318.57	604.04	2,023.58	11	11	11
90	1.97	0.32	2,278.84	367.58	1,409.50	3,148.17	8	8	8
Total	**1.90**	**0.12**	**93,721.29**	**5,862.10**	**82,114.33**	**105,328.25**	**275**	**275**	**274**

Pacific Halibut (*Hippoglossus stenolepis*)

Pacific halibut are widely distributed across the shelf. They were collected at 68.1% of the stations sampled in the EBS (256 of 376 stations). The highest density catches in the EBS in 2018 were north of the Pribilof Islands (Fig. 28). From 2016 to 2018, the Pacific halibut biomass estimate within the EBS survey area decreased 18% from 153,704 t to 125,957 t (Table 20a) and the population estimate decreased from 66 million to 51 million (Table 20b).

In 2018, Pacific halibut were found in waters with depths between 22 m and 205 m, and at bottom temperatures as warm as 7.7°C and as cold as 2.5°C. The fork lengths of Pacific halibut measured during the 2018 EBS survey were between 5 and 198 cm.

The length distributions of Pacific halibut in 2015 and 2016 were bimodal and in 2017 there were several modes. However, in 2018, the size composition was bimodal again (Fig. 29). To ensure a majority of the halibut caught at sea could be released alive, many of these animals were deliberately left unsexed by survey teams. As a result, the abundance-at-length data are categorized as unsexed because the sex of the majority of Pacific halibut caught was catagorized as unsexed. Lethal sampling for otoliths and sex was only conducted by the IPHC sampler on a subset of Pacific halibut caught on one vessel.

The EBS bottom trawl survey provides annual estimates of biomass, population, and length composition for Pacific halibut on the EBS shelf (Stewart and Martell 2015). Management of Pacific halibut stocks is the purview of the IPHC, and their stock assessments include all available fisheries and scientific survey data from both the United States and Canada, including a longline survey they conduct.

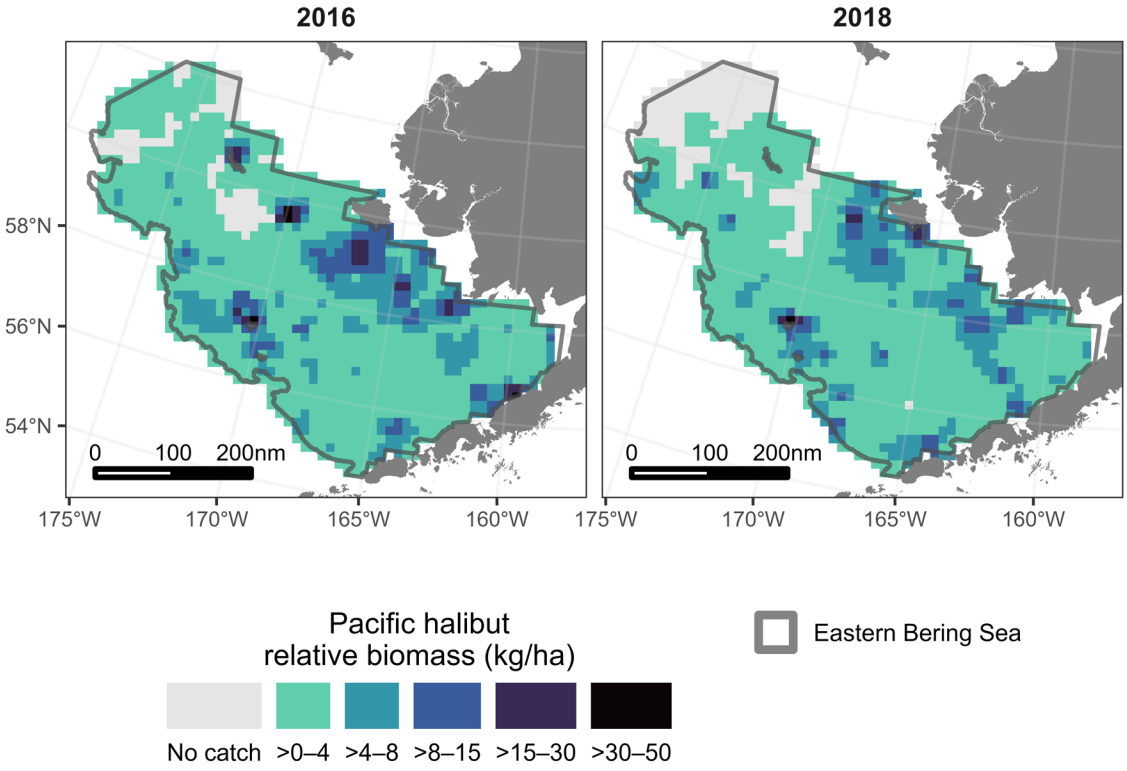

Figure 28. -- Pacific halibut (*Hippoglossus stenolepis*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

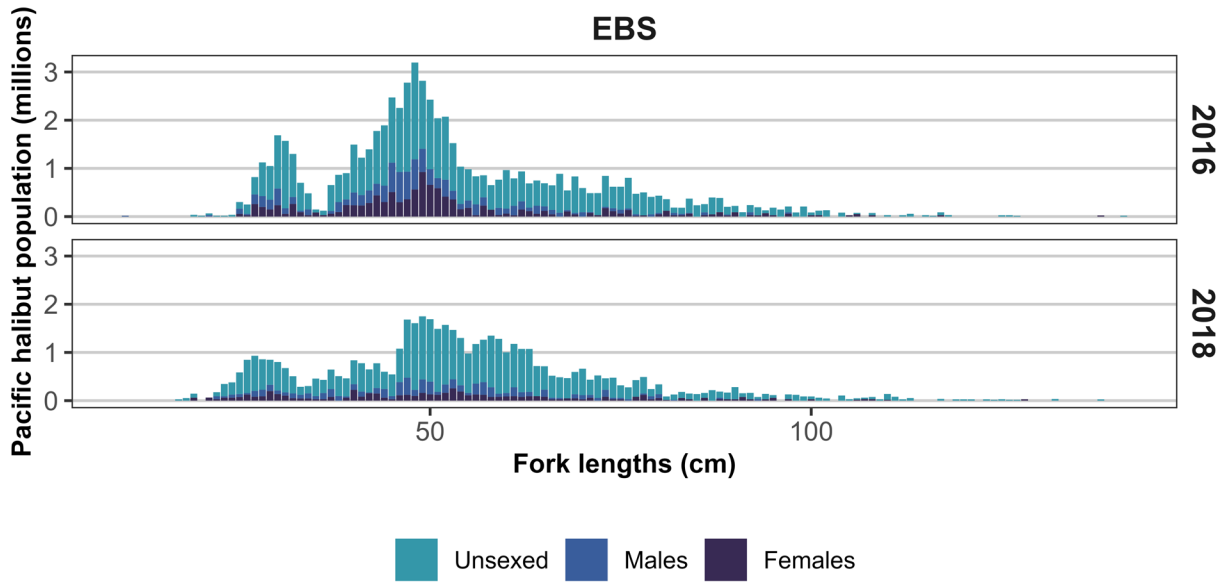

Figure 29. -- Total abundance-at-length estimates of Pacific halibut (*Hippoglossus stenolepis*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys. Sexed length data were collected on only one of the two vessels; the other collected unsexed lengths.

Table 20a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (thousand t) with standard deviation and 95% lower (LCL; thousand t) and upper (UCL; thousand t) confidence limits for Pacific halibut (*Hippoglossus stenolepis*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (thousand t)	SD biomass	95% LCL (thousand t)	95% UCL (thousand t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	4.09	0.44	31.87	3,419	24.96	38.78	56	56	56
20	5.93	0.97	24.34	3,994	16.19	32.50	30	30	30
31	2.19	0.39	20.74	3,671	13.39	28.08	51	51	51
32	5.28	1.07	4.63	935	2.42	6.85	8	8	8
41	0.66	0.19	4.12	1,193	1.70	6.53	20	20	20
42	4.71	1.54	11.30	3,697	3.75	18.85	25	25	25
43	0.79	0.28	1.67	594	0.43	2.91	9	9	9
50	3.13	0.58	12.14	2,250	7.50	16.77	21	21	21
61	1.60	0.34	14.09	2,963	8.10	20.08	32	32	32
62	1.65	0.75	1.06	480	0.00	2.24	4	4	4
82	0.00	0.00	0.00	0	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0	0.00	0.00	0	0	0
Total	**2.56**	**0.17**	**125.96**	**8,456**	**109.21**	**142.70**	**256**	**256**	**256**

Table 20b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Pacific halibut (*Hippoglossus stenolepis*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	2.42	0.36	18,845.32	2,796.37	13,193.85	24,496.79	56	56	56
20	3.05	0.56	12,512.04	2,311.24	7,792.48	17,231.59	30	30	30
31	0.79	0.15	7,467.40	1,398.75	4,669.90	10,264.89	51	51	51
32	1.04	0.33	913.93	290.89	225.97	1,601.89	8	8	8
41	0.19	0.04	1,178.62	255.43	662.39	1,694.85	20	20	20
42	1.74	0.72	4,172.06	1,718.69	662.50	7,681.62	25	25	25
43	0.14	0.05	289.62	98.38	84.99	494.25	9	9	9
50	0.71	0.14	2,743.65	550.02	1,610.62	3,876.69	21	21	21
61	0.25	0.04	2,232.93	364.11	1,497.06	2,968.80	32	32	32
62	0.23	0.11	146.38	69.94	0.00	317.52	4	4	4
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.02**	**0.09**	**50,501.94**	**4,321.05**	**41,946.26**	**59,057.62**	**256**	**256**	**256**

Bering Skate (*Bathyraja interrupta*)

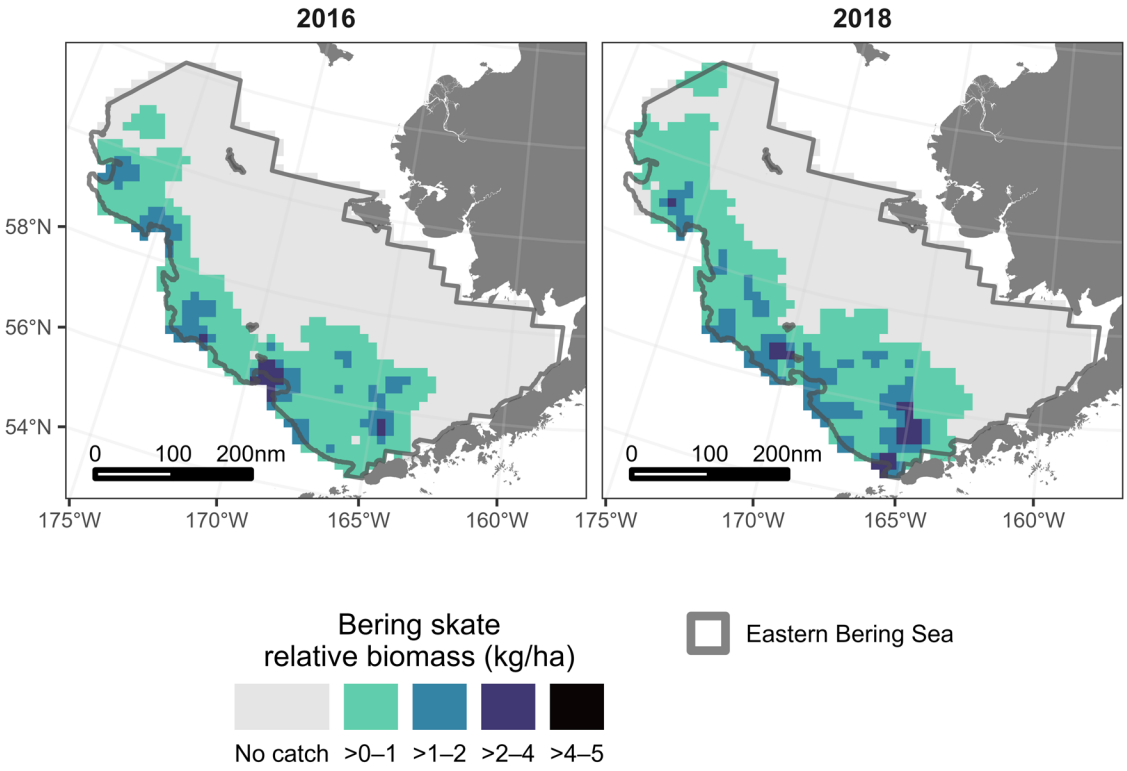

Figure 30. -- Bering skate (*Bathyraja interrupta*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

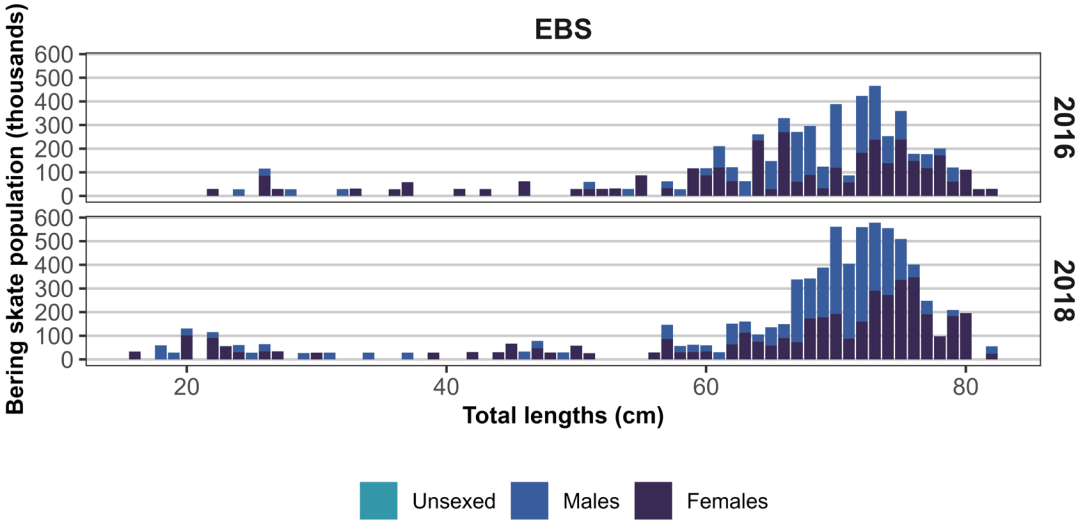

Figure 31. -- Total abundance-at-length estimates of Bering skate (*Bathyraja interrupta*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 21a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Bering skate (*Bathyraja interrupta*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0	0	0	0	0	0	0
20	0.00	0.00	0	0	0	0	0	0	0
31	0.41	0.09	3,899	888	2,122	5,676	22	22	22
32	0.74	0.24	649	208	156	1,141	6	6	6
41	0.08	0.05	487	309	0	1,111	3	3	3
42	0.32	0.16	774	392	0	1,575	6	6	6
43	0.00	0.00	0	0	0	0	0	0	0
50	0.94	0.22	3,665	856	1,901	5,429	21	21	21
61	0.56	0.08	4,978	740	3,482	6,474	38	38	38
62	0.06	0.06	39	39	0	138	1	1	1
82	0.00	0.00	0	0	0	0	0	0	0
90	0.06	0.06	75	75	0	252	1	1	1
Total	**0.30**	**0.03**	**14,564**	**1,539**	**11,516**	**17,612**	**98**	**98**	**98**

Table 21b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Bering skate (*Bathyraja interrupta*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.21	0.05	2,002.37	491.76	1,018.85	2,985.88	22	22	22
32	0.33	0.15	291.61	130.12	0.00	599.34	6	6	6
41	0.03	0.02	199.84	128.66	0.00	459.86	3	3	3
42	0.13	0.07	321.70	162.52	0.00	654.04	6	6	6
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	0.65	0.15	2,540.32	572.55	1,360.88	3,719.77	21	21	21
61	0.26	0.04	2,289.46	326.35	1,629.90	2,949.02	38	38	38
62	0.03	0.03	17.83	17.83	0.00	63.66	1	1	1
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.03	0.03	31.72	31.72	0.00	106.74	1	1	1
Total	**0.16**	**0.02**	**7,694.85**	**858.70**	**5,994.63**	**9,395.07**	**98**	**98**	**98**

Alaska Skate (*Bathyraja parmifera*)

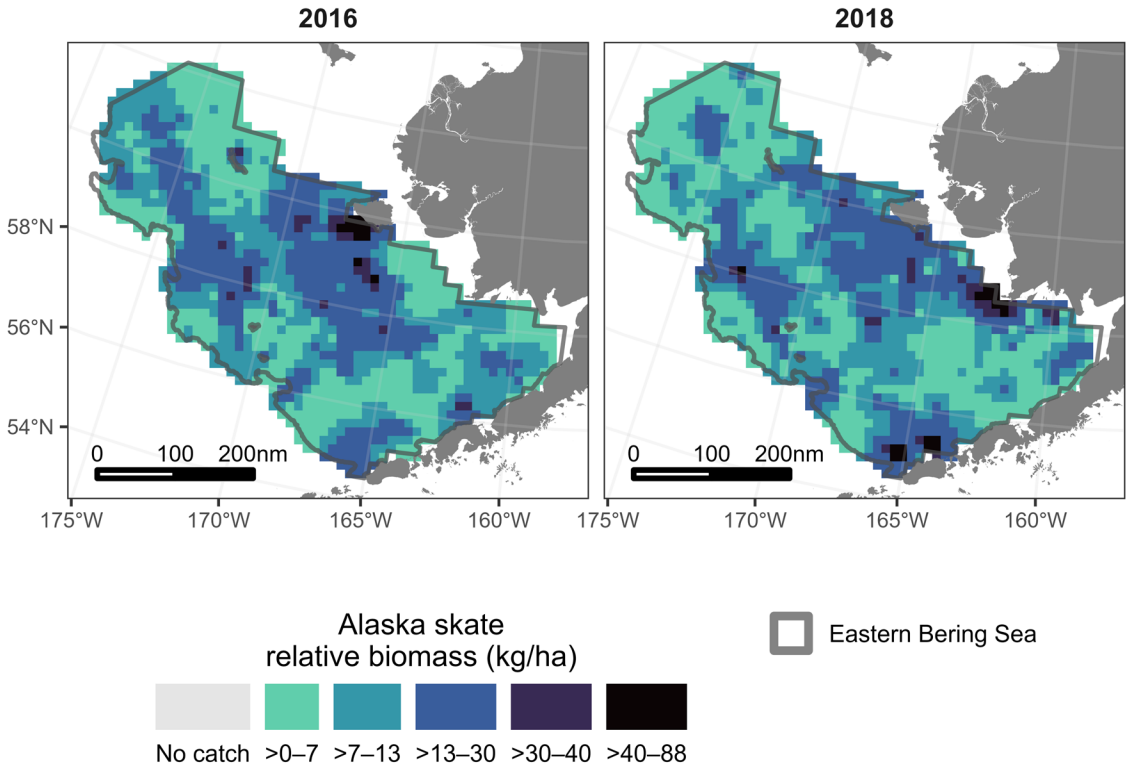

Figure 32. -- Alaska skate (*Bathyraja parmifera*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

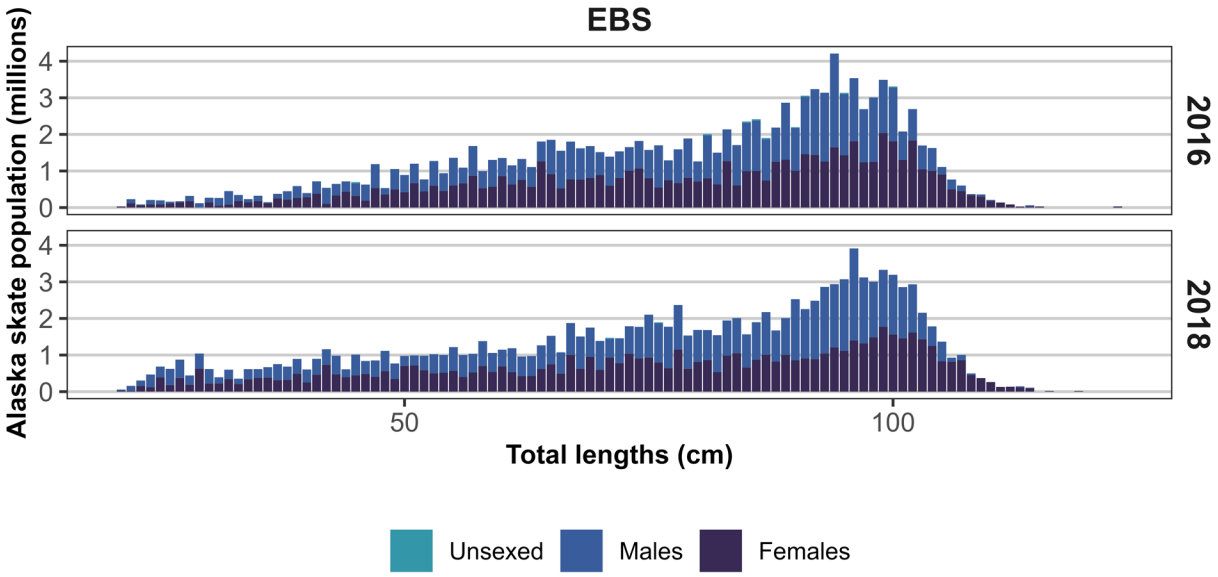

Figure 33. -- Total abundance-at-length estimates of Alaska skate (*Bathyraja parmifera*) by sex (males, females, and unsexed) observed during the 2016 and 2018 EBS shelf bottom trawl surveys.

Table 22a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (thousand t) with standard deviation (thousands) and 95% lower (LCL; thousand t) and upper (UCL; thousand t) confidence limits for Alaska skate (*Bathyraja parmifera*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (thousand t)	SD biomass (thousands)	95% LCL (thousand t)	95% UCL (thousand t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	13.79	1.69	107.39	13.14	80.84	133.94	53	53	53
20	18.25	1.47	74.86	6.03	62.52	87.20	31	31	31
31	9.93	1.20	93.85	11.37	71.11	116.59	69	69	69
32	5.29	1.70	4.64	1.49	1.11	8.18	7	7	7
41	10.44	0.93	65.48	5.82	53.71	77.24	43	43	43
42	10.57	1.42	25.37	3.41	18.39	32.35	31	31	31
43	7.85	1.60	16.57	3.37	9.56	23.57	22	22	22
50	13.74	3.45	53.30	13.38	25.68	80.92	26	26	26
61	8.94	1.14	78.75	10.01	58.52	98.97	54	54	54
62	10.05	1.93	6.46	1.24	3.27	9.66	7	7	7
82	5.46	1.16	9.81	2.09	5.16	14.46	12	12	12
90	8.22	3.24	9.51	3.75	0.64	18.38	8	8	8
Total	**11.08**	**0.54**	**545.99**	**26.39**	**493.74**	**598.25**	**363**	**363**	**363**

Table 22b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Alaska skate (*Bathyraja parmifera*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	2.76	0.30	21,498.34	2,352.12	16,744.71	26,251.97	53	53	53
20	4.31	0.36	17,687.06	1,476.35	14,667.92	20,706.20	31	31	31
31	2.19	0.24	20,748.03	2,294.73	16,158.56	25,337.49	69	69	69
32	0.90	0.28	788.08	249.64	197.68	1,378.49	7	7	7
41	3.15	0.28	19,757.84	1,762.98	16,194.85	23,320.83	43	43	43
42	2.77	0.29	6,648.51	702.05	5,212.80	8,084.21	31	31	31
43	3.58	0.95	7,562.30	1,996.04	3,410.53	11,714.07	22	22	22
50	1.87	0.46	7,240.65	1,789.22	3,547.69	10,933.61	26	26	26
61	2.01	0.24	17,687.07	2,153.46	13,334.92	22,039.22	54	54	54
62	2.20	0.36	1,412.32	228.70	824.32	2,000.31	7	7	7
82	1.32	0.27	2,362.82	486.41	1,279.09	3,446.55	12	12	12
90	2.93	1.01	3,385.13	1,165.66	628.36	6,141.91	8	8	8
Total	**2.57**	**0.11**	**126,778.14**	**5,487.42**	**115,913.06**	**137,643.23**	**363**	**363**	**363**

Longhead Dab (*Limanda proboscidea*)

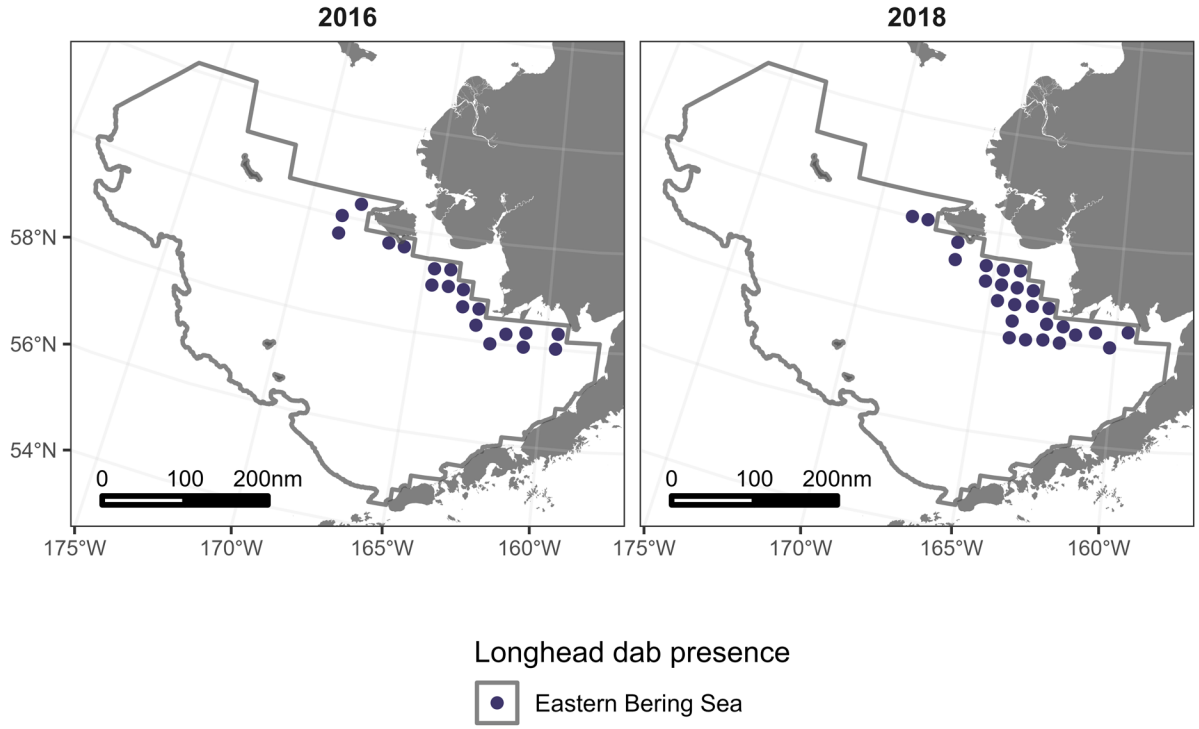

Figure 34. -- Longhead dab (*Limanda proboscidea*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 23a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for longhead dab (*Limanda proboscidea*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.20	0.07	1,550	523	492	2,607	21	21	21
20	0.05	0.03	186	142	0	475	5	5	5
31	0.00	0.00	0	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0	0
41	0.00	0.00	0	0	0	0	0	0	0
42	0.00	0.00	0	0	0	0	0	0	0
43	0.00	0.00	0	0	0	0	0	0	0
50	0.00	0.00	0	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0	0
62	0.00	0.00	0	0	0	0	0	0	0
82	0.00	0.00	0	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.04**	**0.01**	**1,735**	**542**	**662**	**2,809**	**26**	**26**	**26**

Table 23b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (millions) with standard deviation (millions) and 95% lower (LCL; millions) and upper (UCL; millions) confidence limits for longhead dab (*Limanda proboscidea*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (millions)	SD population (millions)	95% LCL (millions)	95% UCL (millions)	Hauls with weights	Hauls with counts	Hauls with lengths
10	2.41	0.82	18.73	6.37	5.85	31.61	21	21	21
20	0.74	0.54	3.03	2.21	0.00	7.55	5	5	5
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.44**	**0.14**	**21.76**	**6.74**	**8.41**	**35.12**	**26**	**26**	**26**

Starry Flounder (*Platichthys stellatus*)

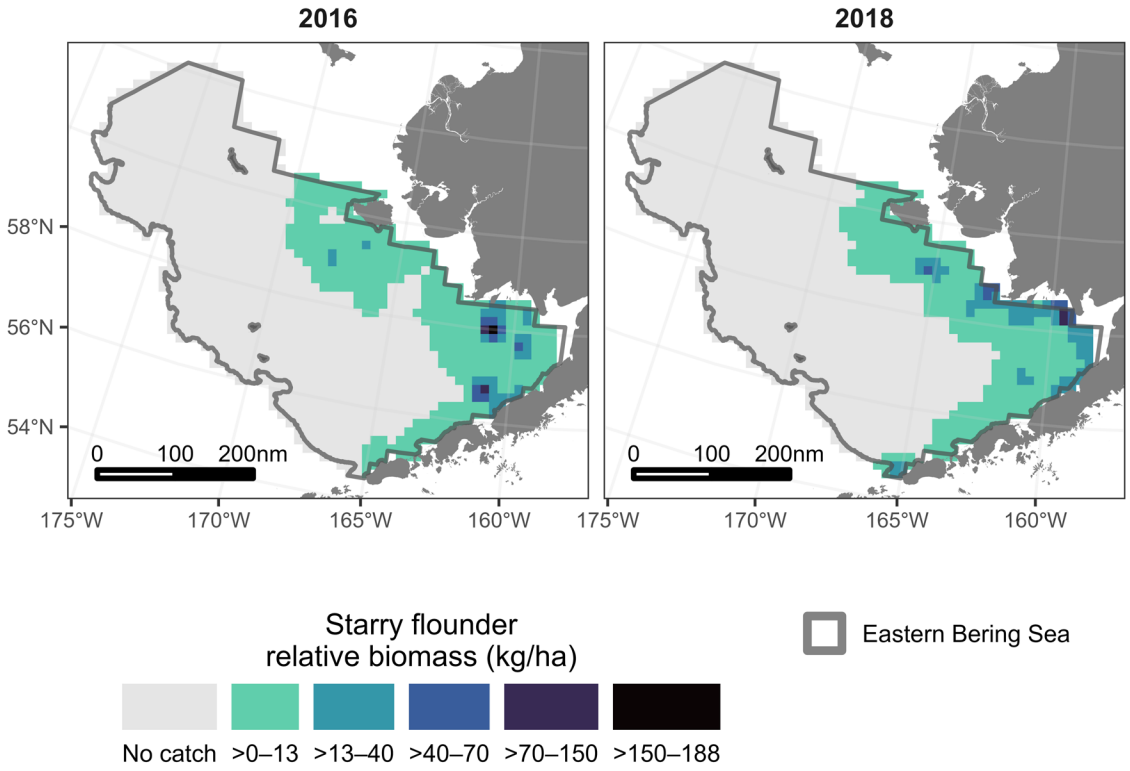

Figure 35. -- Starry flounder (*Platichthys stellatus*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 24a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (thousand t) with standard deviation (thousands) and 95% lower (LCL; thousand t) and upper (UCL; thousand t) confidence limits for starry flounder (*Platichthys stellatus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (thousand t)	SD biomass (thousands)	95% LCL (thousand t)	95% UCL (thousand t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	9.20	2.38	71.67	18.53	34.22	109.12	40	40	40
20	1.31	0.38	5.39	1.54	2.24	8.54	15	15	15
31	1.01	0.56	9.54	5.29	0.00	20.13	14	14	14
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.76**	**0.39**	**86.60**	**19.33**	**47.94**	**125.27**	**69**	**69**	**69**

Table 24b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (millions) with standard deviation (millions) and 95% lower (LCL; millions) and upper (UCL; millions) confidence limits for starry flounder (*Platichthys stellatus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (millions)	SD population (millions)	95% LCL (millions)	95% UCL (millions)	Hauls with weights	Hauls with counts	Hauls with lengths
10	7.82	2.56	60.91	19.92	20.64	101.17	40	40	40
20	0.93	0.28	3.83	1.16	1.46	6.20	15	15	15
31	0.55	0.30	5.16	2.82	0.00	10.81	14	14	14
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.42**	**0.41**	**69.90**	**20.16**	**29.58**	**110.21**	**69**	**69**	**69**

Yellow Irish Lord (*Hemilepidotus jordani*)

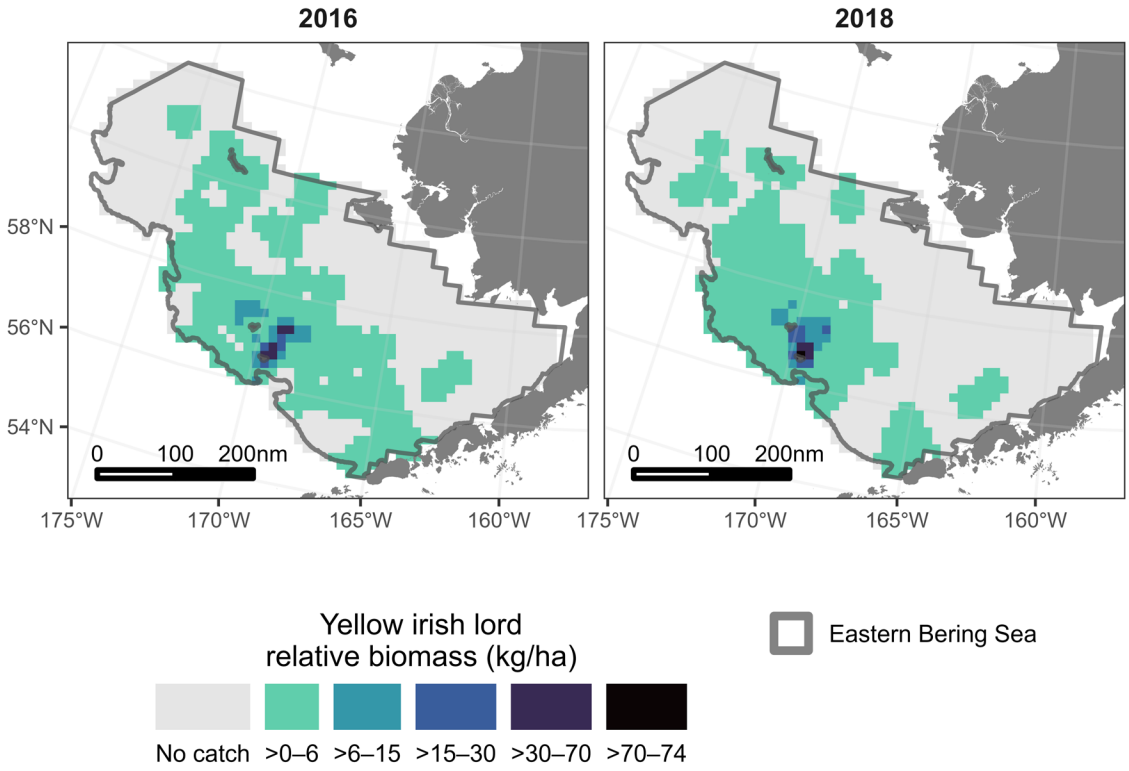

Figure 36. -- Yellow Irish lord (*Hemilepidotus jordani*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 25a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for yellow Irish lord (*Hemilepidotus jordani*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0	0	0	0	0	0	0
20	0.01	0.01	45	43	0	134	2	2	2
31	0.19	0.09	1,811	886	39	3,583	10	10	10
32	17.28	9.80	15,159	8,603	0	36,210	8	8	8
41	0.09	0.06	589	353	0	1,302	8	8	8
42	5.37	1.32	12,885	3,166	6,419	19,350	27	27	27
43	0.03	0.02	59	40	0	142	5	5	5
50	0.10	0.06	391	226	0	858	5	5	5
61	0.08	0.03	680	267	140	1,219	19	19	19
62	0.01	0.01	8	8	0	29	1	1	1
82	0.00	0.00	0	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.64**	**0.19**	**31,627**	**9,223**	**10,765**	**52,490**	**85**	**85**	**85**

Table 25b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for yellow Irish lord (*Hemilepidotus jordani*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.01	0.01	55.04	38.59	0.00	133.96	2	2	2
31	0.26	0.12	2,419.41	1,138.17	143.06	4,695.76	10	10	10
32	21.11	12.38	18,524.18	10,865.74	0.00	45,112.64	8	8	8
41	0.16	0.09	1,013.47	576.17	0.00	2,177.90	8	8	8
42	7.43	1.98	17,835.22	4,758.75	8,117.85	27,552.58	27	27	27
43	0.05	0.02	114.14	48.97	11.98	216.30	5	5	5
50	0.14	0.08	545.95	300.53	0.00	1,165.04	5	5	5
61	0.12	0.04	1,021.07	363.05	287.35	1,754.80	19	19	19
62	0.03	0.03	19.46	19.46	0.00	69.48	1	1	1
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.84**	**0.24**	**41,547.93**	**11,940.01**	**14,539.63**	**68,556.22**	**85**	**85**	**85**

Plain Sculpin (*Myoxocephalus jaok*)

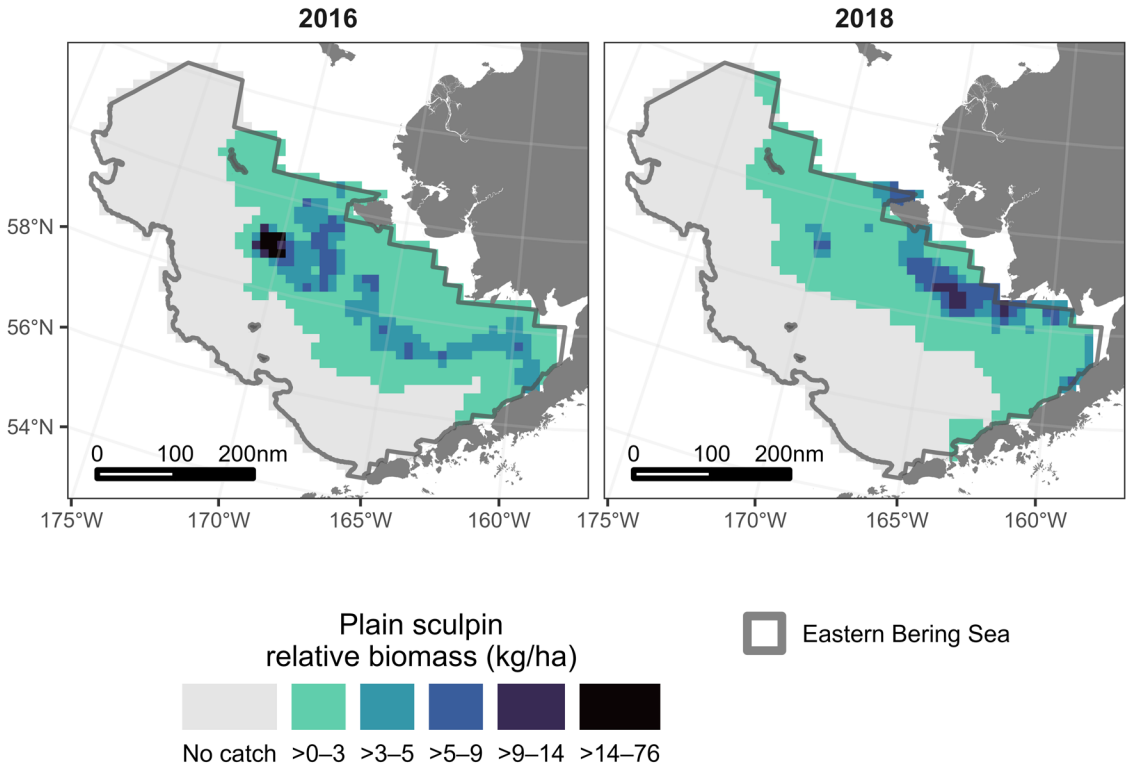

Figure 37. -- Plain sculpin (*Myoxocephalus jaok*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 26a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for plain sculpin (*Myoxocephalus jaok*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	2.83	0.46	22,072	3,605	14,786	29,357	52	52	52
20	2.27	0.28	9,329	1,160	6,961	11,698	31	31	31
31	0.02	0.01	176	93	0	362	4	4	4
32	0.00	0.00	0	0	0	0	0	0	0
41	0.88	0.21	5,543	1,299	2,918	8,168	26	26	26
42	0.00	0.00	0	0	0	0	0	0	0
43	0.07	0.03	142	56	25	260	6	6	6
50	0.00	0.00	0	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0	0
62	0.00	0.00	0	0	0	0	0	0	0
82	0.02	0.02	39	39	0	126	1	1	1
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.76**	**0.08**	**37,301**	**4,005**	**29,291**	**45,312**	**120**	**120**	**120**

Table 26b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for plain sculpin (*Myoxocephalus jaok*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	4.61	0.83	35,896.46	6,487.47	22,785.28	49,007.64	52	52	52
20	3.59	0.46	14,731.81	1,906.01	10,839.74	18,623.88	31	31	31
31	0.02	0.01	147.84	77.40	0.00	302.64	4	4	4
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.62	0.13	3,876.26	843.00	2,172.55	5,579.97	26	26	26
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.07	0.03	140.72	53.56	29.31	252.13	6	6	6
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.02	0.02	31.50	31.50	0.00	101.69	1	1	1
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.11**	**0.14**	**54,824.60**	**6,814.74**	**41,195.12**	**68,454.07**	**120**	**120**	**120**

Great Sculpin (*Myoxocephalus polyacanthocephalus*)

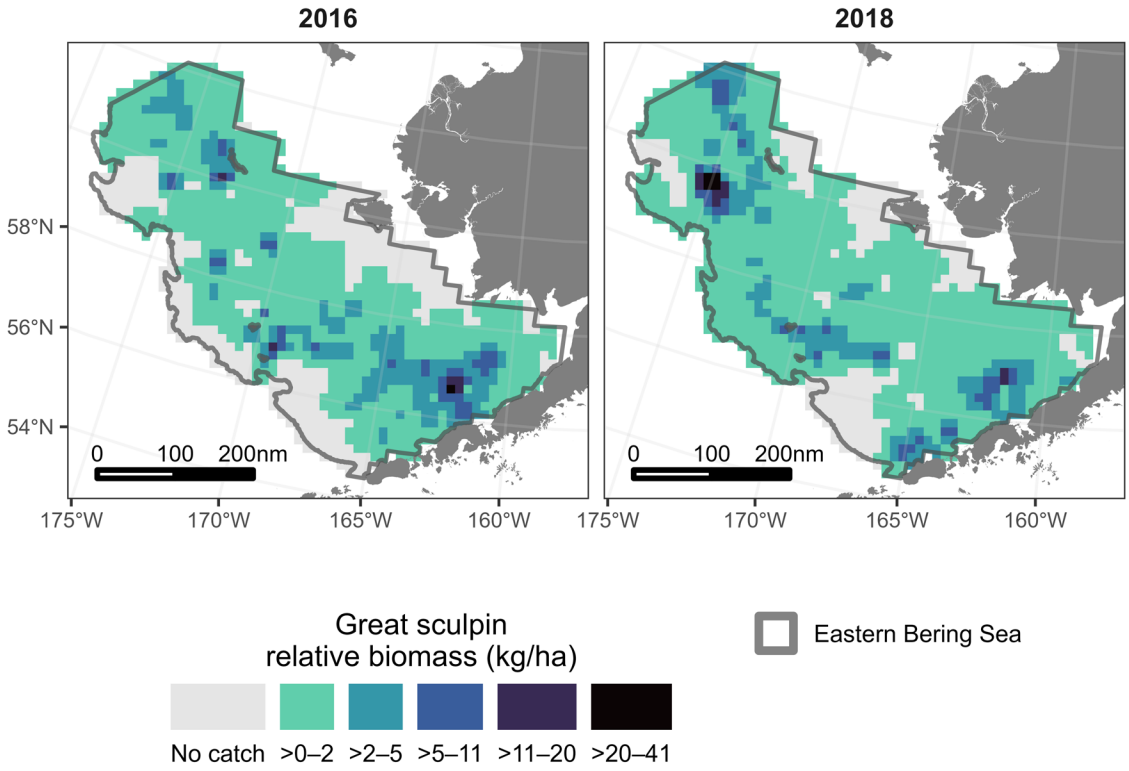

Figure 38. -- Great sculpin (*Myoxocephalus polyacanthocephalus*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 27a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for great sculpin (*Myoxocephalus polyacanthocephalus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.31	0.08	2,399	588	1,211	3,587	26	26	26
20	0.07	0.03	293	119	50	536	7	7	7
31	1.67	0.35	15,812	3,268	9,277	22,348	46	46	46
32	3.52	0.64	3,089	559	1,767	4,411	7	7	7
41	0.64	0.20	4,023	1,244	1,509	6,536	21	21	21
42	1.44	0.39	3,460	933	1,552	5,367	18	18	18
43	1.61	0.41	3,391	876	1,570	5,213	17	17	17
50	0.58	0.45	2,235	1,759	0	5,859	3	3	3
61	1.28	0.68	11,289	5,954	0	23,322	31	31	31
62	5.32	3.01	3,419	1,935	0	8,154	5	5	5
82	2.09	0.78	3,744	1,404	616	6,872	11	11	11
90	1.45	0.82	1,674	950	0	3,998	6	6	6
Total	**1.11**	**0.16**	**54,828**	**7,726**	**39,530**	**70,126**	**198**	**198**	**198**

Table 27b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for great sculpin (*Myoxocephalus polyacanthocephalus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.19	0.04	1,459.54	303.35	846.48	2,072.61	26	26	26
20	0.06	0.02	265.44	100.10	60.73	470.14	7	7	7
31	0.51	0.08	4,825.63	793.83	3,237.98	6,413.28	46	46	46
32	0.78	0.17	685.60	152.99	323.78	1,047.43	7	7	7
41	0.29	0.08	1,801.49	471.94	847.70	2,755.29	21	21	21
42	0.45	0.11	1,087.71	262.17	551.57	1,623.86	18	18	18
43	1.08	0.36	2,272.95	754.46	703.67	3,842.24	17	17	17
50	0.14	0.11	541.90	433.39	0.00	1,434.67	3	3	3
61	0.65	0.38	5,707.01	3,371.03	0.00	12,519.86	31	31	31
62	2.51	1.31	1,616.74	844.51	0.00	3,683.25	5	5	5
82	1.26	0.36	2,266.63	654.33	808.79	3,724.47	11	11	11
90	0.70	0.37	812.42	432.78	0.00	1,871.43	6	6	6
Total	**0.47**	**0.08**	**23,343.07**	**3,807.44**	**15,804.34**	**30,881.80**	**198**	**198**	**198**

Shorthorn Sculpin (*Myoxocephalus scorpius*)

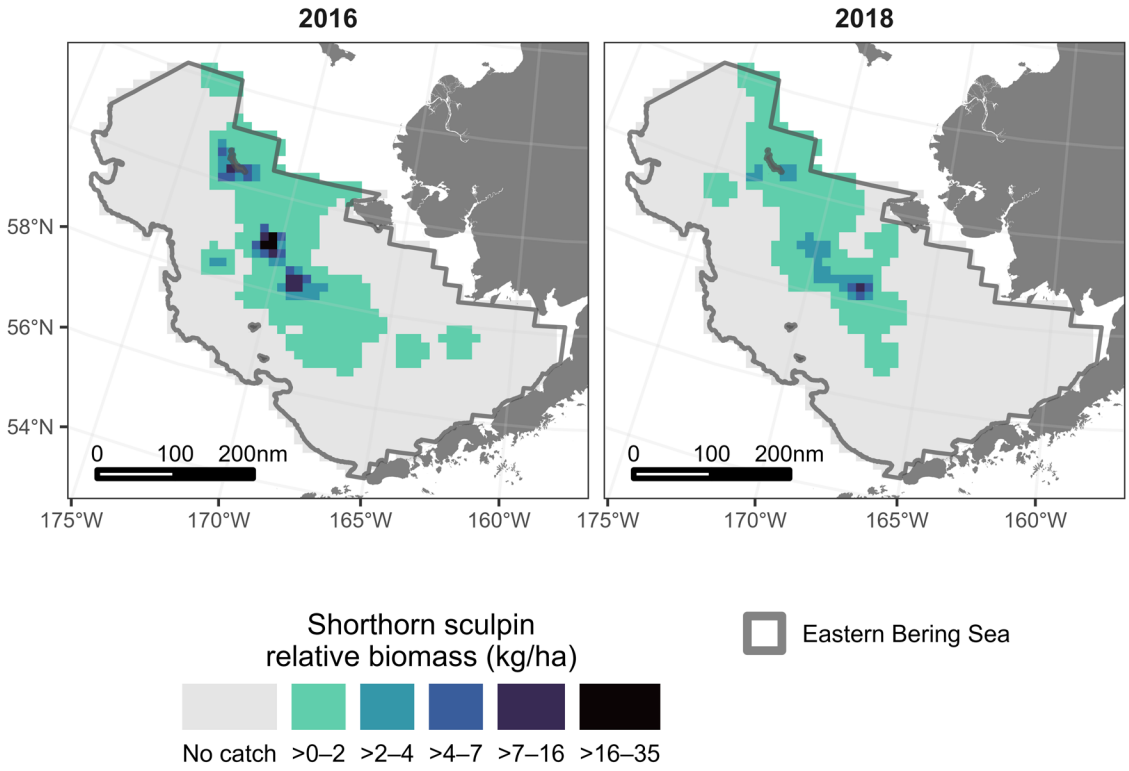

Figure 39. -- Shorthorn sculpin (*Myoxocephalus scorpius*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 28a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for shorthorn sculpin (*Myoxocephalus scorpius*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0	0	0	0	0	0	0
20	0.06	0.03	228	139	0	512	5	5	5
31	0.03	0.01	255	125	4	506	5	5	5
32	0.00	0.00	0	0	0	0	0	0	0
41	0.94	0.28	5,893	1,769	2,317	9,469	26	26	26
42	0.01	0.01	36	36	0	109	1	1	1
43	0.66	0.28	1,391	601	142	2,640	7	7	7
50	0.00	0.00	0	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0	0
62	0.05	0.05	35	35	0	125	1	1	1
82	0.07	0.04	123	68	0	273	3	3	3
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.16**	**0.04**	**7,961**	**1,880**	**4,239**	**11,682**	**48**	**48**	**48**

Table 28b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for shorthorn sculpin (*Myoxocephalus scorpius*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.05	0.03	220.58	104.93	6.32	434.84	5	5	5
31	0.03	0.02	280.33	144.19	0.00	568.71	5	5	5
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.70	0.24	4,406.53	1,498.36	1,378.35	7,434.70	26	26	26
42	0.01	0.01	16.96	16.96	0.00	51.61	1	1	1
43	0.47	0.21	1,002.55	439.69	88.00	1,917.10	7	7	7
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.03	0.03	19.46	19.46	0.00	69.48	1	1	1
82	0.05	0.03	98.29	51.37	0.00	211.36	3	3	3
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.12**	**0.03**	**6,044.70**	**1,572.74**	**2,930.68**	**9,158.72**	**48**	**48**	**48**

Pacific Ocean Perch (*Sebastes alutus*)

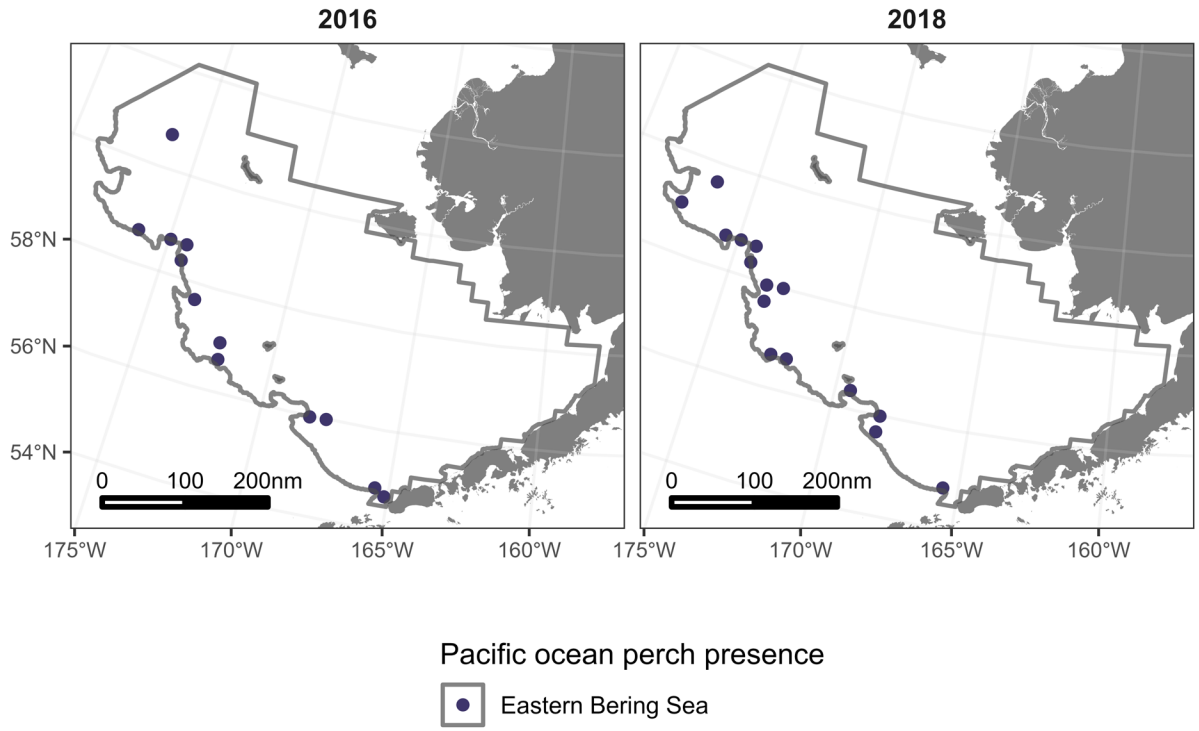

Figure 40. -- Pacific ocean perch (*Sebastes alutus*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 29a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (thousand t) with standard deviation (thousands) and 95% lower (LCL; thousand t) and upper (UCL; thousand t) confidence limits for Pacific ocean perch (*Sebastes alutus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (thousand t)	SD biomass (thousands)	95% LCL (thousand t)	95% UCL (thousand t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	11.04	10.20	42.83	39.55	0.00	124.31	4	4	4
61	1.11	0.67	9.78	5.92	0.00	21.74	11	11	11
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.07**	**0.81**	**52.61**	**39.99**	**0.00**	**134.83**	**15**	**15**	**15**

Table 29b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (millions) with standard deviation (millions) and 95% lower (LCL; millions) and upper (UCL; millions) confidence limits for Pacific ocean perch (*Sebastes alutus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (millions)	SD population (millions)	95% LCL (millions)	95% UCL (millions)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	18.99	18.00	73.66	69.84	0.00	217.53	4	4	4
61	1.49	0.86	13.14	7.55	0.00	28.40	11	11	11
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.76**	**1.43**	**86.80**	**70.25**	**0.00**	**231.23**	**15**	**15**	**15**

Rex Sole (*Glyptocephalus zachirus*)

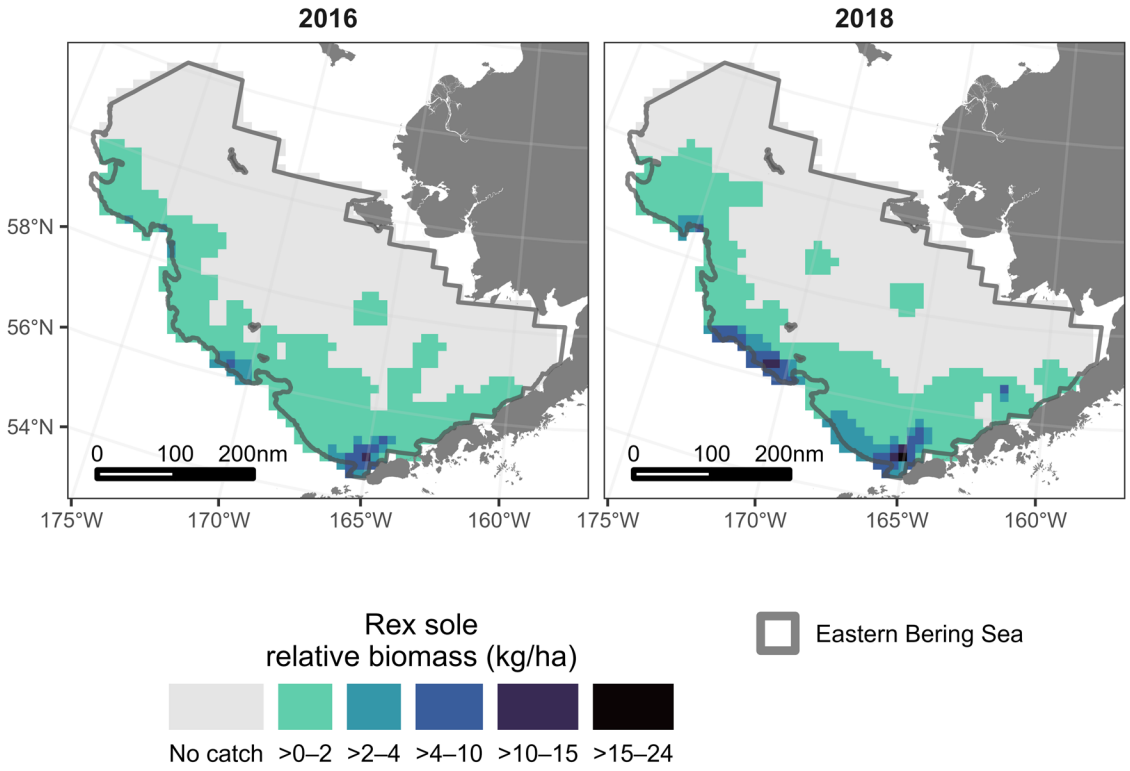

Figure 41. -- Rex sole (*Glyptocephalus zachirus*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 30a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for rex sole (*Glyptocephalus zachirus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	21	12	0	46	4	4	4
20	0.00	0.00	0	0	0	0	0	0	0
31	0.31	0.16	2,955	1,476	3	5,907	18	18	18
32	0.16	0.08	141	71	0	309	3	3	3
41	0.00	0.00	1	1	0	3	1	1	1
42	0.00	0.00	5	3	0	11	2	2	2
43	0.00	0.00	0	0	0	1	1	1	1
50	2.69	0.88	10,430	3,431	3,363	17,497	26	26	26
61	0.77	0.29	6,796	2,535	1,673	11,918	29	29	29
62	0.00	0.00	2	2	0	6	2	2	2
82	0.00	0.00	0	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.41**	**0.09**	**20,350**	**4,514**	**11,322**	**29,379**	**86**	**86**	**86**

Table 30b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for rex sole (*Glyptocephalus zachirus*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.02	0.01	181.16	104.54	0.00	392.43	4	4	4
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.82	0.30	7,716.77	2,802.46	2,111.85	13,321.69	18	18	18
32	1.12	0.57	982.48	496.48	0.00	2,156.64	3	3	3
41	0.01	0.01	60.17	60.17	0.00	181.77	1	1	1
42	0.02	0.01	46.20	33.47	0.00	114.53	2	2	2
43	0.01	0.01	18.73	18.73	0.00	57.70	1	1	1
50	11.90	2.19	46,146.65	8,502.05	28,632.43	63,660.88	26	26	26
61	3.99	1.33	35,131.27	11,697.05	11,491.53	58,771.00	29	29	29
62	0.06	0.04	37.29	24.10	0.00	96.26	2	2	2
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.83**	**0.30**	**90,320.71**	**14,738.47**	**60,843.76**	**119,797.66**	**86**	**86**	**86**

Sakhalin Sole (*Limanda sakhalinensis*)

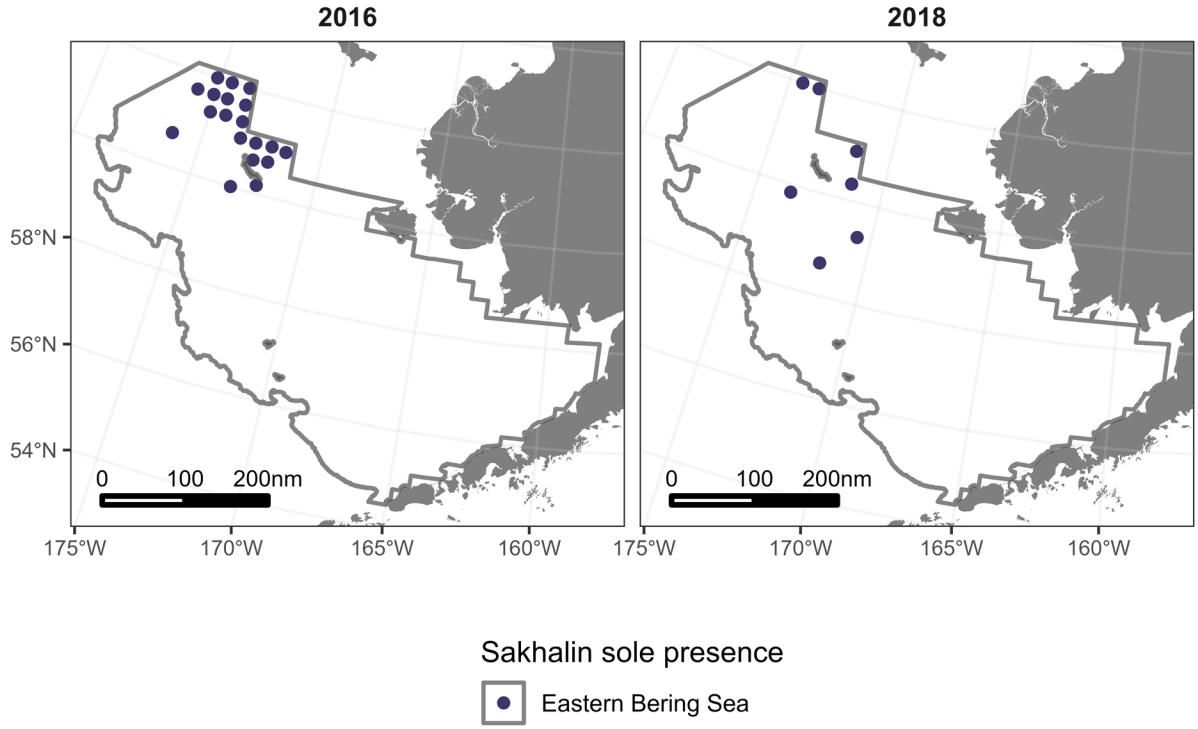

Figure 42. --Sakhalin sole (*Limanda sakhalinensis*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 31a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Sakhalin sole (*Limanda sakhalinensis*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0	0	0	0	0	0	0
20	0.00	0.00	0	0	0	0	0	0	0
31	0.00	0.00	0	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0	0
41	0.00	0.00	4	2	0	9	4	4	4
42	0.00	0.00	0	0	0	0	0	0	0
43	0.00	0.00	1	1	0	2	1	1	1
50	0.00	0.00	0	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0	0
62	0.00	0.00	0	0	0	0	0	0	0
82	0.06	0.06	111	109	0	354	2	2	2
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.00**	**0.00**	**116**	**109**	**0**	**332**	**7**	**7**	**7**

Table 31b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Sakhalin sole (*Limanda sakhalinensis*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.02	0.01	118.60	57.24	2.92	234.27	4	4	4
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.01	0.01	18.74	18.74	0.00	57.73	1	1	1
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.63	0.61	1,135.12	1,100.07	0.00	3,586.08	2	2	2
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.03**	**0.02**	**1,272.46**	**1,101.72**	**0.00**	**3,453.86**	**7**	**7**	**7**

Sturgeon Poacher (*Podothecus accipenserinus*)

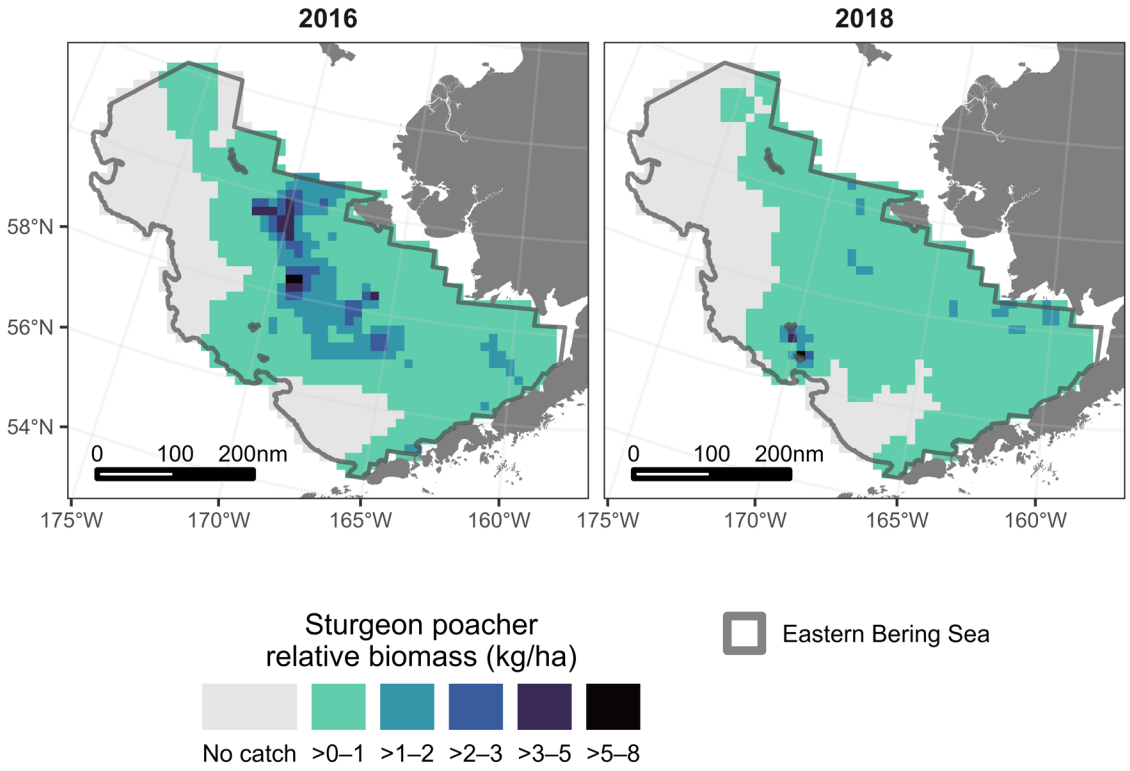

Figure 43. --Sturgeon poacher (*Podothecus accipenserinus*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 32a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for sturgeon poacher (*Podothecus accipenserinus*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	0.38	0.06	2,974	505	1,953	3,994	55	55
20	0.58	0.07	2,390	277	1,825	2,955	31	31
31	0.08	0.02	764	211	342	1,187	40	40
32	0.85	0.77	748	672	0	2,337	6	6
41	0.10	0.02	658	155	346	971	26	26
42	0.41	0.18	975	440	76	1,874	24	24
43	0.02	0.01	52	20	10	94	8	8
50	0.00	0.00	10	9	0	28	2	2
61	0.00	0.00	1	1	0	4	1	1
62	0.00	0.00	0	0	0	0	0	0
82	0.00	0.00	1	1	0	2	2	2
90	0.00	0.00	0	0	0	0	0	0
Total	**0.17**	**0.02**	**8,573**	**1,022**	**6,507**	**10,640**	**195**	**195**

Table 32b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for sturgeon poacher (*Podothecus accipenserinus*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	4.68	0.71	36,411.24	5,493.30	25,309.27	47,513.21	55	55
20	9.95	1.71	40,814.61	7,001.68	26,517.19	55,112.04	31	31
31	1.65	0.59	15,567.42	5,579.71	4,407.99	26,726.84	40	40
32	10.98	9.59	9,630.21	8,415.15	0.00	29,532.04	6	6
41	2.17	0.56	13,634.31	3,515.53	6,529.43	20,739.19	26	26
42	6.31	2.47	15,147.50	5,934.04	3,030.20	27,264.81	24	24
43	0.55	0.22	1,155.21	467.21	183.43	2,127.00	8	8
50	0.04	0.03	160.90	134.02	0.00	436.98	2	2
61	0.00	0.00	31.21	31.21	0.00	94.30	1	1
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0
82	0.03	0.02	61.09	41.21	0.00	152.91	2	2
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**2.69**	**0.31**	**132,613.72**	**15,131.37**	**102,033.21**	**163,194.22**	**195**	**195**

Butterfly Sculpin (*Hemilepidotus papilio*)

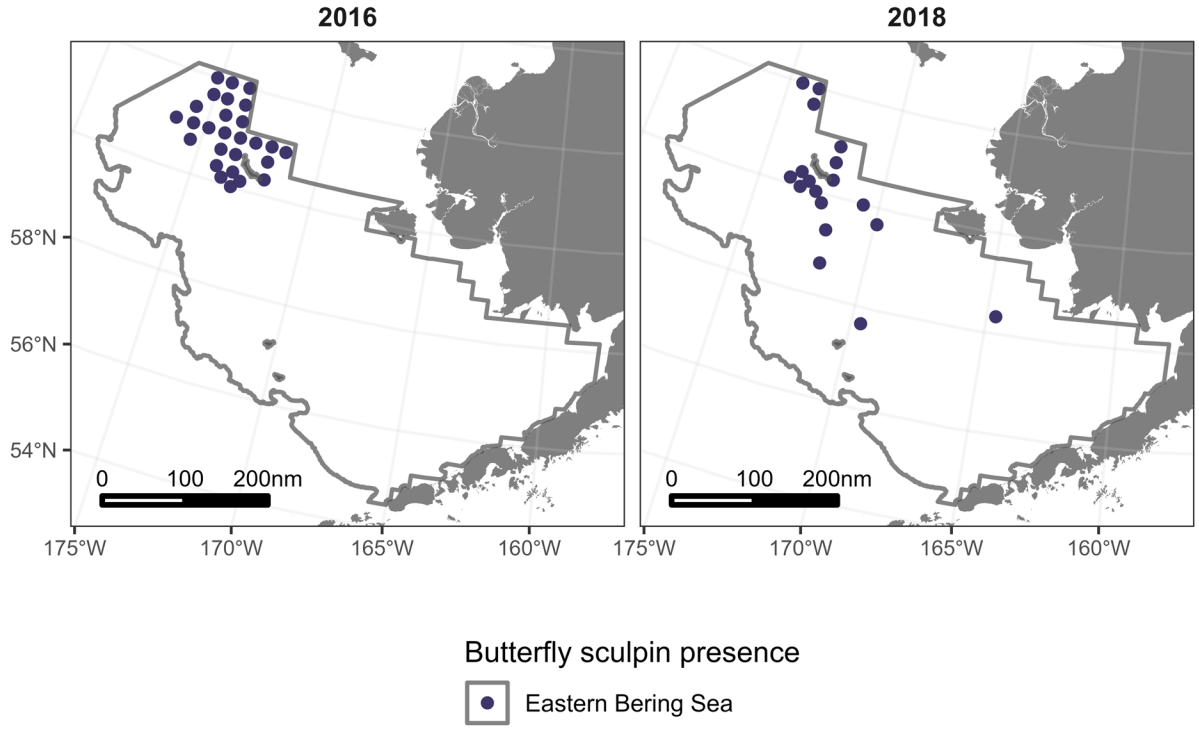

Figure 44. -- Butterfly sculpin (*Hemilepidotus papilio*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 33a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for butterfly sculpin (*Hemilepidotus papilio*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	12	12	0	36	1	1	1
20	0.00	0.00	0	0	0	0	0	0	0
31	0.00	0.00	0	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0	0
41	0.01	0.00	46	20	5	87	5	5	5
42	0.00	0.00	2	2	0	8	1	1	1
43	0.05	0.03	109	54	0	223	8	8	8
50	0.00	0.00	0	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0	0
62	0.00	0.00	0	0	0	0	0	0	0
82	0.04	0.03	66	47	0	170	3	3	3
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.00**	**0.00**	**236**	**75**	**87**	**385**	**18**	**18**	**18**

Table 33b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for butterfly sculpin (*Hemilepidotus papilio*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.01	0.01	55.21	55.21	0.00	166.79	1	1	1
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.03	0.01	179.91	81.72	14.76	345.07	5	5	5
42	0.01	0.01	16.11	16.11	0.00	49.05	1	1	1
43	0.21	0.11	451.99	234.25	0.00	940.64	8	8	8
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.09	0.06	161.29	99.06	0.00	382.00	3	3	3
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.02**	**0.01**	**864.52**	**273.26**	**323.46**	**1,405.58**	**18**	**18**	**18**

Bigmouth Sculpin (*Hemitripterus bolini*)

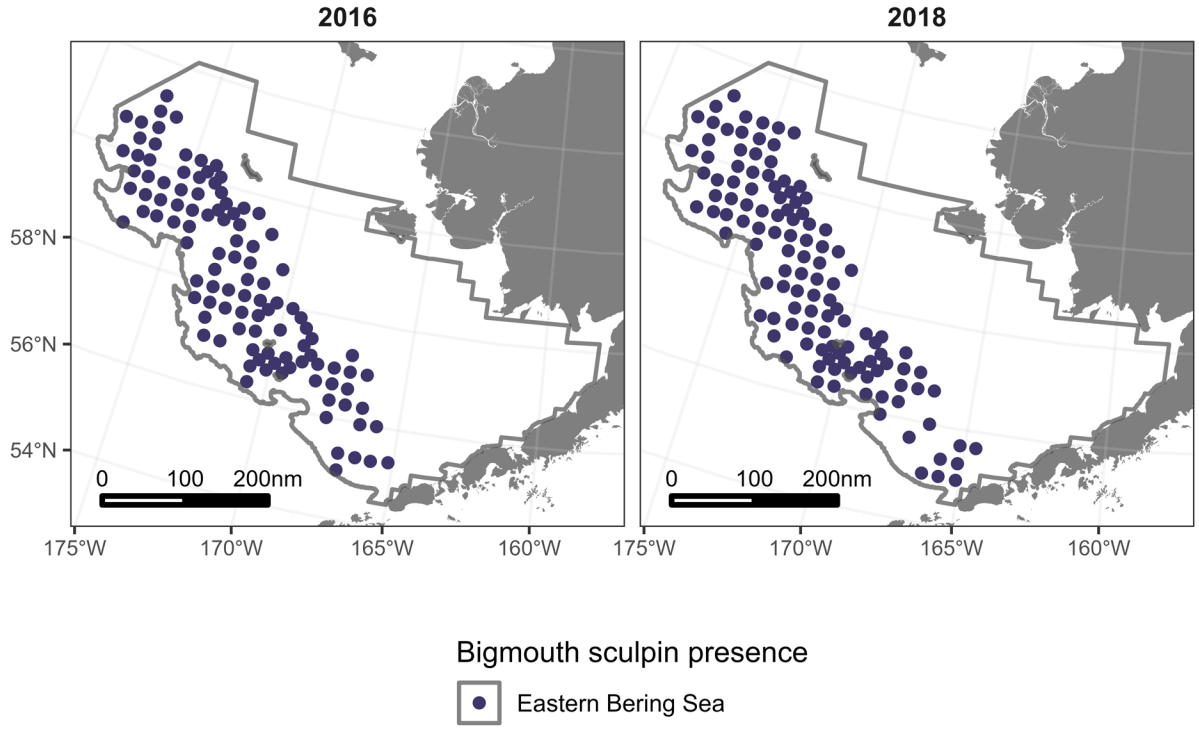

Figure 46. -- Bigmouth sculpin (*Hemitripterus bolini*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 35a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for bigmouth sculpin (*Hemitripterus bolini*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0	0	0	0	0	0	0
20	0.00	0.00	0	0	0	0	0	0	0
31	0.53	0.24	5,014	2,260	493	9,535	8	8	8
32	2.56	0.93	2,244	820	305	4,182	7	7	7
41	0.98	0.37	6,165	2,319	1,478	10,852	12	12	12
42	2.09	0.73	5,012	1,745	1,449	8,575	15	15	15
43	1.47	0.45	3,096	949	1,122	5,070	10	10	10
50	0.43	0.11	1,651	423	779	2,524	12	12	12
61	1.54	0.24	13,550	2,076	9,353	17,746	44	44	44
62	1.85	0.53	1,190	344	306	2,074	6	6	6
82	0.13	0.13	237	237	0	767	1	1	1
90	1.51	0.66	1,751	768	0	3,631	4	4	4
Total	**0.81**	**0.09**	**39,910**	**4,512**	**30,975**	**48,844**	**119**	**119**	**119**

Table 35b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for bigmouth sculpin (*Hemitripterus bolini*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.10	0.05	954.38	429.77	94.84	1,813.92	8	8	8
32	0.48	0.16	416.87	143.34	77.88	755.87	7	7	7
41	0.24	0.09	1,527.45	593.24	328.52	2,726.38	12	12	12
42	0.44	0.16	1,062.65	381.73	283.16	1,842.15	15	15	15
43	0.31	0.09	653.92	196.02	246.20	1,061.64	10	10	10
50	0.11	0.03	421.21	105.35	203.78	638.65	12	12	12
61	0.37	0.05	3,254.76	476.19	2,292.38	4,217.14	44	44	44
62	0.45	0.12	288.53	75.44	94.56	482.50	6	6	6
82	0.02	0.02	31.79	31.79	0.00	102.61	1	1	1
90	0.29	0.14	330.31	157.21	0.00	715.00	4	4	4
Total	**0.18**	**0.02**	**8,941.88**	**1,005.28**	**6,951.42**	**10,932.34**	**119**	**119**	**119**

Saffron Cod (*Eleginus gracilis*)

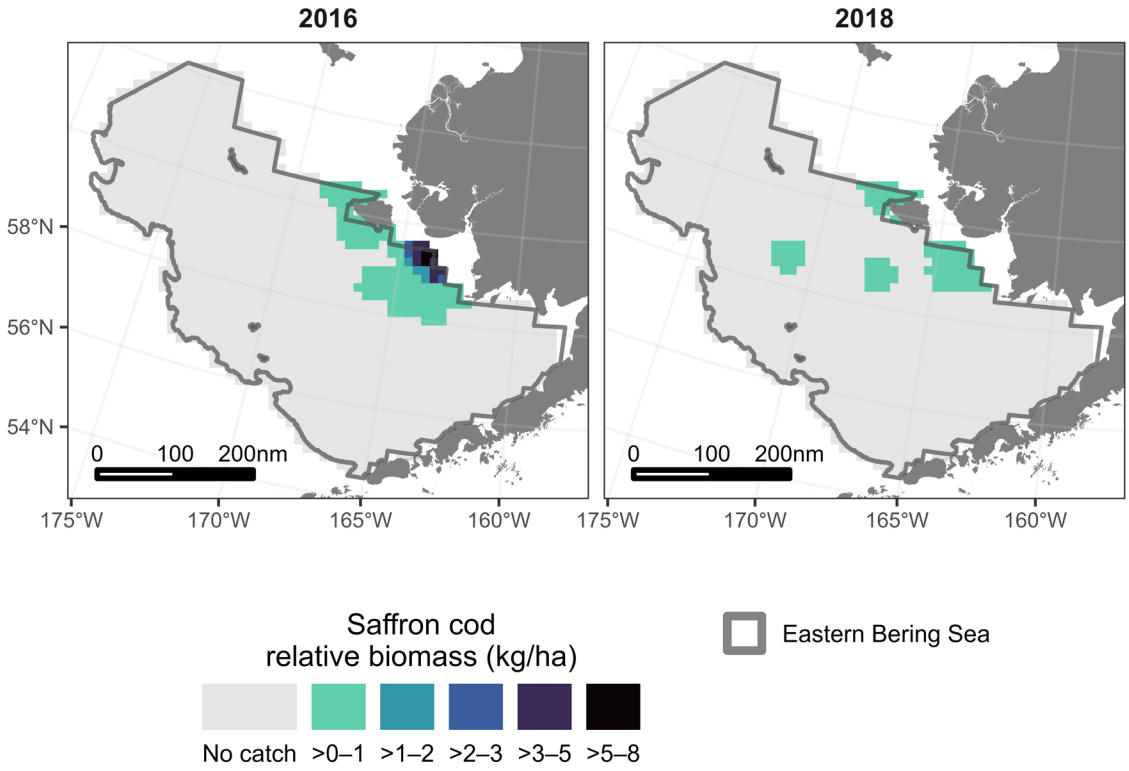

Figure 47. -- Saffron cod (*Eleginus gracilis*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 36a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for saffron cod (*Eleginus gracilis*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts	Hauls with lengths
10	0.02	0.02	190	150	0	493	5	5	5
20	0.02	0.02	101	89	0	283	3	3	3
31	0.00	0.00	0	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0	0
41	0.00	0.00	3	3	0	10	1	1	1
42	0.00	0.00	0	0	0	0	0	0	0
43	0.00	0.00	0	0	0	0	0	0	0
50	0.00	0.00	0	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0	0
62	0.00	0.00	0	0	0	0	0	0	0
82	0.00	0.00	0	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.01**	**0.00**	**295**	**174**	**0**	**640**	**9**	**9**	**9**

Table 36b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for saffron cod (*Eleginus gracilis*) by stratum observed during the 2018 EBS shelf bottom trawl survey.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts	Hauls with lengths
10	1.24	1.06	9,678.42	8,248.43	0.00	26,348.50	5	5	5
20	0.17	0.15	688.31	627.56	0.00	1,969.80	3	3	3
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.00	0.00	27.98	27.98	0.00	84.52	1	1	1
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.21**	**0.17**	**10,394.71**	**8,272.31**	**0.00**	**26,773.90**	**9**	**9**	**9**

Pacific Herring (*Clupea pallasii*)

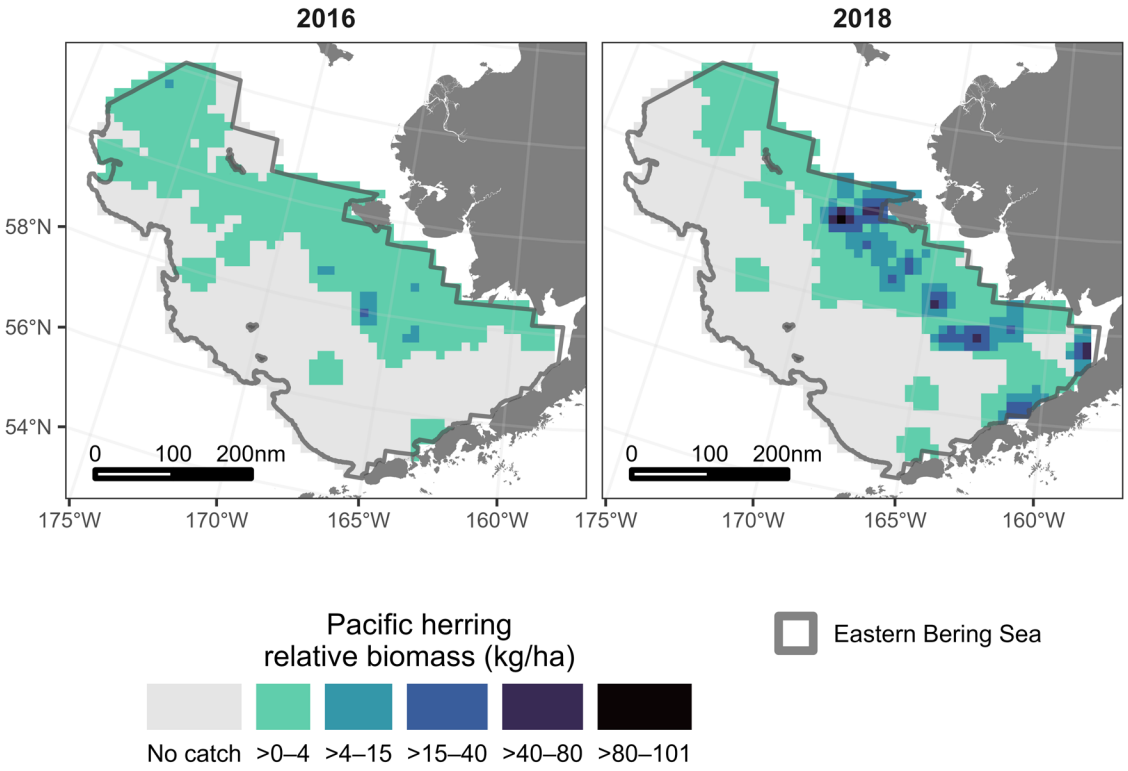

Figure 48. -- Pacific herring (*Clupea pallasii*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 37a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Pacific herring (*Clupea pallasii*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	6.43	2.24	50,084	17,426	14,866	85,302	32	32
20	11.38	4.04	46,693	16,574	12,798	80,587	25	25
31	0.16	0.10	1,500	986	0	3,471	7	7
32	0.00	0.00	0	0	0	0	0	0
41	0.26	0.10	1,655	648	346	2,965	13	13
42	0.01	0.01	18	18	0	54	1	1
43	0.01	0.01	30	15	0	61	4	4
50	0.00	0.00	0	0	0	0	0	0
61	0.00	0.00	28	21	0	70	2	2
62	0.00	0.00	0	0	0	0	0	0
82	0.69	0.34	1,243	605	0	2,591	8	8
90	0.05	0.05	62	62	0	214	1	1
Total	**2.06**	**0.49**	**101,314**	**24,086**	**53,142**	**149,486**	**93**	**93**

Table 37b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Pacific herring (*Clupea pallasii*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	36.33	12.57	282,869.89	97,849.72	85,115.60	480,624.17	32	32
20	104.99	41.38	430,743.00	169,776.37	83,550.32	777,935.69	25	25
31	0.98	0.66	9,231.22	6,281.43	0.00	21,794.07	7	7
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	1.13	0.50	7,064.81	3,105.03	789.54	13,340.07	13	13
42	0.02	0.02	49.11	49.11	0.00	149.39	1	1
43	0.04	0.02	80.58	37.38	2.83	158.33	4	4
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0
61	0.01	0.00	61.76	43.33	0.00	149.33	2	2
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0
82	2.14	1.09	3,839.65	1,952.01	0.00	8,188.72	8	8
90	0.13	0.13	154.53	154.53	0.00	532.65	1	1
Total	**14.89**	**3.98**	**734,094.55**	**196,090.60**	**341,913.36**	**1,126,275.74**	**93**	**93**

Pacific Capelin (*Mallotus villosus*)

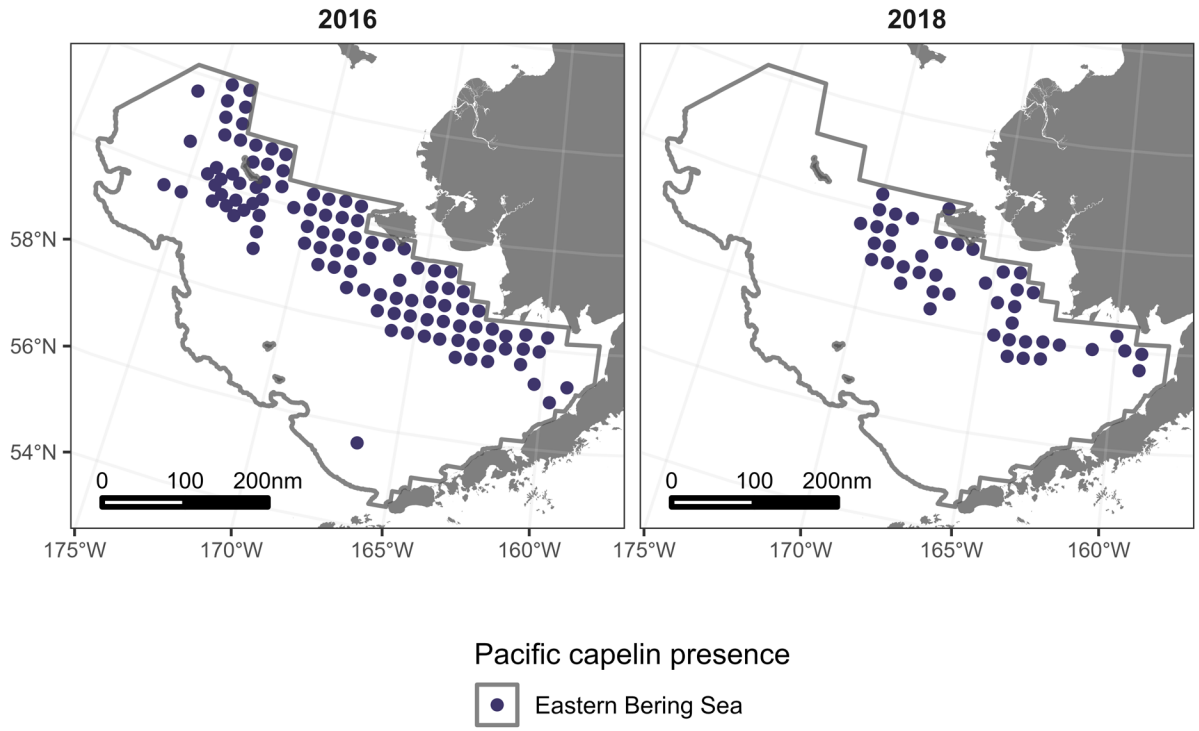

Figure 49. -- Pacific capelin (*Mallotus villosus*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 38a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for Pacific capelin (*Mallotus villosus*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	0.01	0.00	39	10	18	60	21	21
20	0.01	0.00	28	7	14	43	17	17
31	0.00	0.00	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0
41	0.00	0.00	6	3	1	12	6	6
42	0.00	0.00	0	0	0	0	0	0
43	0.00	0.00	0	0	0	0	0	0
50	0.00	0.00	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0
62	0.00	0.00	0	0	0	0	0	0
82	0.00	0.00	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0
Total	**0.00**	**0.00**	**74**	**13**	**49**	**100**	**44**	**44**

Table 38b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for Pacific capelin (*Mallotus villosus*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	0.29	0.08	2,229.72	587.82	1,041.74	3,417.71	21	21
20	0.50	0.12	2,050.05	508.85	1,009.46	3,090.64	17	17
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	0.07	0.03	416.66	178.22	56.47	776.85	6	6
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**0.10**	**0.02**	**4,696.43**	**797.64**	**3,117.11**	**6,275.75**	**44**	**44**

Rainbow Smelt (*Osmerus mordax*)

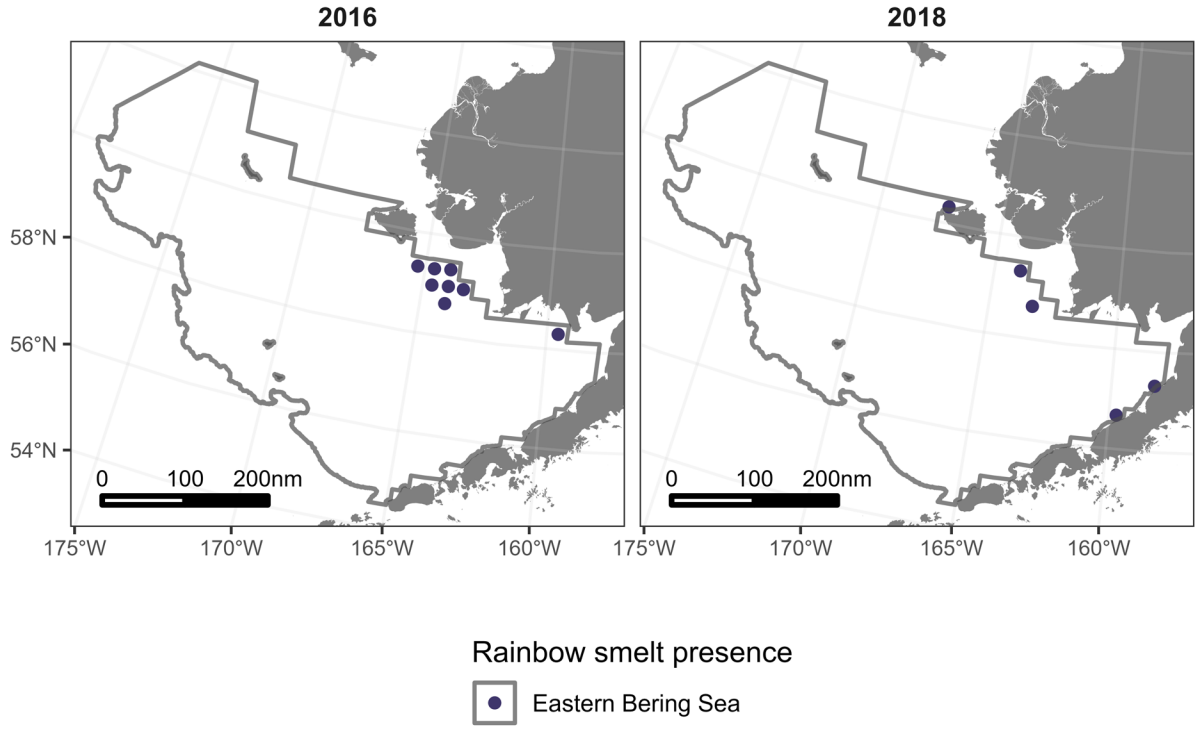

Figure 50. -- Rainbow smelt (*Osmerus mordax*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 39a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for rainbow smelt (*Osmerus mordax*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	0.01	0.00	52	37	0	127	4	4
20	0.00	0.00	10	10	0	32	1	1
31	0.00	0.00	0	0	0	0	0	0
32	0.00	0.00	0	0	0	0	0	0
41	0.00	0.00	0	0	0	0	0	0
42	0.00	0.00	0	0	0	0	0	0
43	0.00	0.00	0	0	0	0	0	0
50	0.00	0.00	0	0	0	0	0	0
61	0.00	0.00	0	0	0	0	0	0
62	0.00	0.00	0	0	0	0	0	0
82	0.00	0.00	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0
Total	**0.00**	**0.00**	**62**	**39**	**0**	**139**	**5**	**5**

Table 39b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for rainbow smelt (*Osmerus mordax*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	0.10	0.06	761.98	453.63	0.00	1,678.77	4	4
20	0.02	0.02	99.19	99.19	0.00	301.72	1	1
31	0.00	0.00	0.00	0.00	0.00	0.00	0	0
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	0.00	0.00	0.00	0.00	0.00	0.00	0	0
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**0.02**	**0.01**	**861.17**	**464.35**	**0.00**	**1,780.58**	**5**	**5**

Eulachon (*Thaleichthys pacificus*)

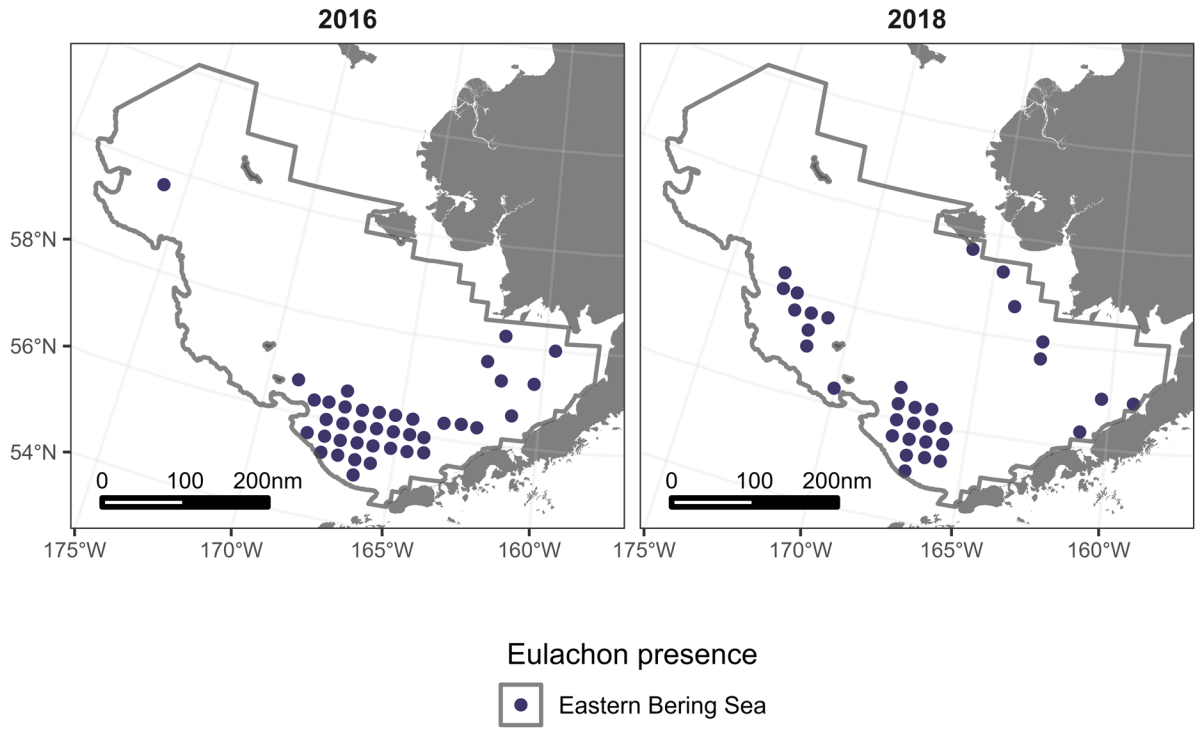

Figure 51. -- Eulachon (*Thaleichthys pacificus*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 40a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for eulachon (*Thaleichthys pacificus*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	0.01	0.01	100	53	0	206	6	6
20	0.00	0.00	1	1	0	3	1	1
31	0.00	0.00	28	16	0	60	4	4
32	0.00	0.00	0	0	0	0	0	0
41	0.00	0.00	3	2	0	8	2	2
42	0.00	0.00	1	1	0	3	1	1
43	0.00	0.00	0	0	0	0	0	0
50	0.12	0.04	447	143	152	741	14	14
61	0.00	0.00	13	6	1	25	5	5
62	0.00	0.00	0	0	0	0	0	0
82	0.00	0.00	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0
Total	**0.01**	**0.00**	**592**	**153**	**283**	**902**	**33**	**33**

Table 40b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for eulachon (*Thaleichthys pacificus*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	0.18	0.09	1,426.76	724.25	0.00	2,890.47	6	6
20	0.01	0.01	51.77	51.77	0.00	157.50	1	1
31	0.05	0.03	435.07	257.13	0.00	949.33	4	4
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	0.01	0.01	83.15	60.96	0.00	206.35	2	2
42	0.01	0.01	14.83	14.83	0.00	45.14	1	1
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0
50	2.19	0.71	8,494.03	2,750.24	2,817.54	14,170.53	14	14
61	0.03	0.02	283.07	134.08	12.10	554.04	5	5
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**0.22**	**0.06**	**10,788.70**	**2,859.91**	**5,008.83**	**16,568.57**	**33**	**33**

Shortfin Eelpout (*Lycodes brevipes*)

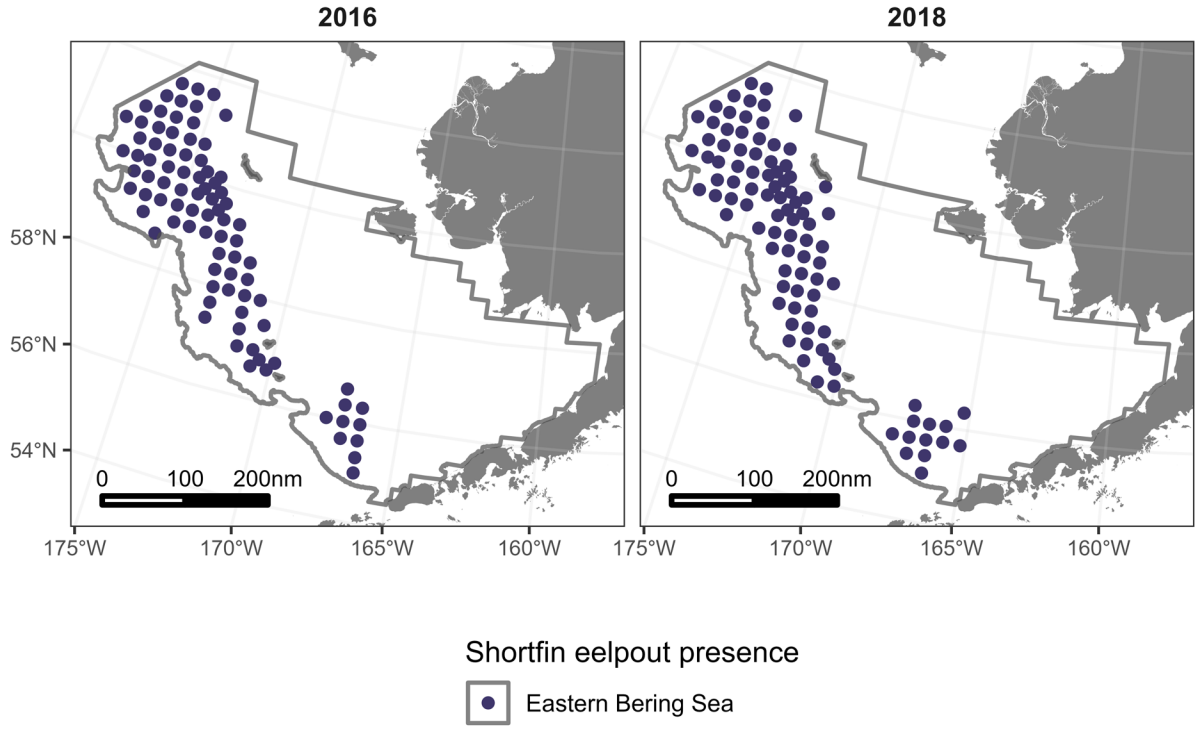

Figure 52. -- Shortfin eelpout (*Lycodes brevipes*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 41a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for shortfin eelpout (*Lycodes brevipes*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	0.00	0.00	0	0	0	0	0	0
20	0.00	0.00	0	0	0	0	0	0
31	0.00	0.00	5	3	0	12	3	3
32	0.00	0.00	0	0	0	0	0	0
41	0.08	0.03	491	217	52	930	10	10
42	0.01	0.01	26	14	0	53	4	4
43	0.13	0.04	264	78	101	428	13	13
50	0.04	0.02	169	76	12	326	11	11
61	1.47	0.37	12,956	3,217	6,455	19,458	39	39
62	0.99	0.40	636	258	0	1,300	6	6
82	0.04	0.04	78	77	0	249	2	2
90	2.77	0.94	3,205	1,092	622	5,789	8	8
Total	**0.36**	**0.07**	**17,830**	**3,417**	**10,996**	**24,663**	**96**	**96**

Table 41b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for shortfin eelpout (*Lycodes brevipes*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	0.00	0.00	0.00	0.00	0.00	0.00	0	0
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0
31	0.02	0.01	143.39	93.53	0.00	330.45	3	3
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	2.05	0.89	12,883.71	5,589.09	1,588.15	24,179.27	10	10
42	0.27	0.14	649.90	330.82	0.00	1,325.44	4	4
43	2.55	0.75	5,384.67	1,575.29	2,098.63	8,670.72	13	13
50	0.89	0.39	3,446.25	1,497.50	355.41	6,537.10	11	11
61	17.20	3.66	151,597.15	32,282.15	86,354.94	216,839.37	39	39
62	18.75	7.31	12,053.69	4,698.54	0.00	24,133.62	6	6
82	1.16	1.14	2,082.50	2,049.23	0.00	6,648.19	2	2
90	43.78	13.90	50,642.30	16,079.79	12,613.59	88,671.01	8	8
Total	**4.85**	**0.75**	**238,883.58**	**36,919.54**	**165,044.50**	**312,722.66**	**96**	**96**

Wattled Eelpout (*Lycodes palearis*)

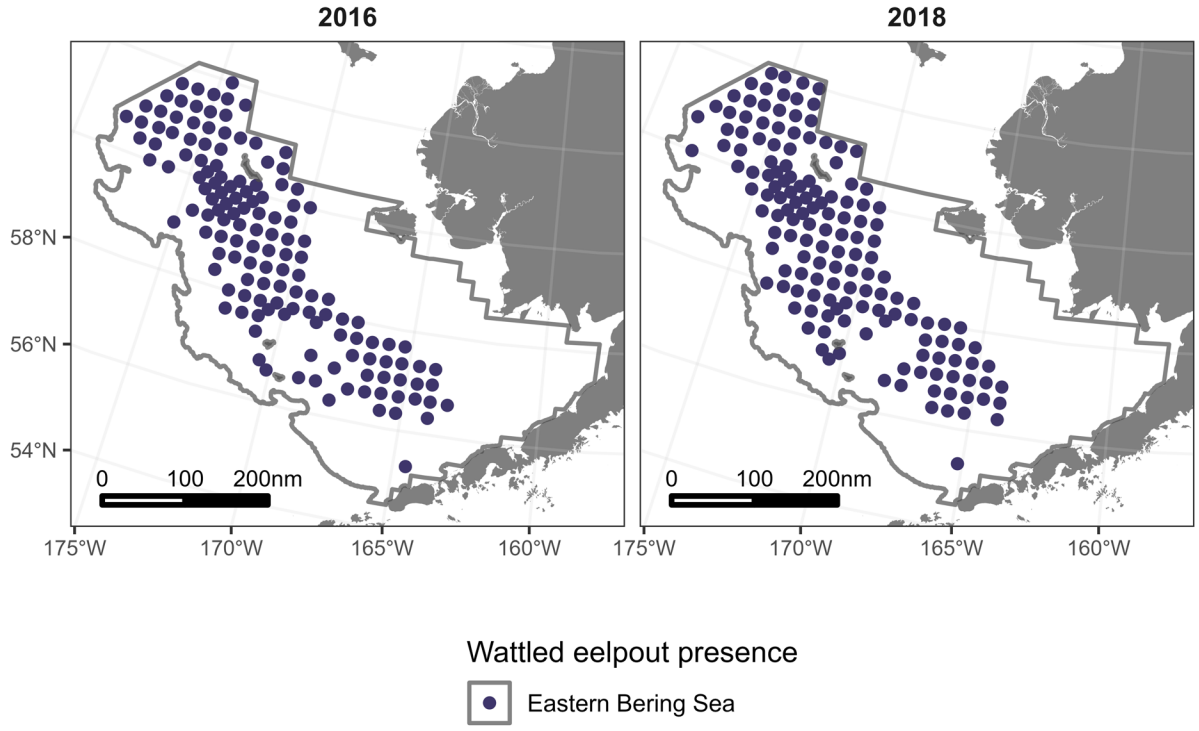

Figure 53. -- Wattled eelpout (*Lycodes palearis*) presence from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 42a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for wattled eelpout (*Lycodes palearis*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	0.00	0.00	8	8	0	23	1	1
20	0.00	0.00	0	0	0	0	0	0
31	0.25	0.07	2,351	615	1,121	3,582	28	28
32	0.00	0.00	0	0	0	0	0	0
41	1.36	0.23	8,550	1,429	5,663	11,438	40	40
42	0.20	0.07	481	179	115	847	14	14
43	1.50	0.34	3,177	709	1,702	4,652	19	19
50	0.00	0.00	17	13	0	44	2	2
61	0.21	0.11	1,855	933	0	3,739	20	20
62	1.30	0.39	836	251	190	1,483	7	7
82	0.40	0.09	718	169	343	1,094	12	12
90	2.19	0.80	2,533	925	270	4,795	8	8
Total	**0.42**	**0.04**	**20,526**	**2,184**	**16,201**	**24,850**	**151**	**151**

Table 42b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for wattled eelpout (*Lycodes palearis*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	0.00	0.00	32.26	32.25	0.00	97.44	1	1
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0
31	1.03	0.24	9,740.48	2,250.95	5,238.58	14,242.38	28	28
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	7.00	1.03	43,888.82	6,440.14	30,873.30	56,904.34	40	40
42	0.76	0.28	1,830.49	662.77	475.13	3,185.85	14	14
43	8.94	1.84	18,860.32	3,880.98	10,787.88	26,932.76	19	19
50	0.01	0.01	57.55	39.91	0.00	139.92	2	2
61	0.92	0.51	8,073.64	4,452.29	0.00	17,071.72	20	20
62	4.86	1.55	3,122.55	997.36	558.33	5,686.77	7	7
82	4.51	0.93	8,089.36	1,668.22	4,372.57	11,806.15	12	12
90	13.28	4.58	15,366.30	5,303.27	2,389.21	28,343.40	8	8
Total	**2.21**	**0.22**	**109,061.78**	**10,666.36**	**87,942.38**	**130,181.18**	**151**	**151**

Purple-Orange Sea Star (*Asterias amurensis*)

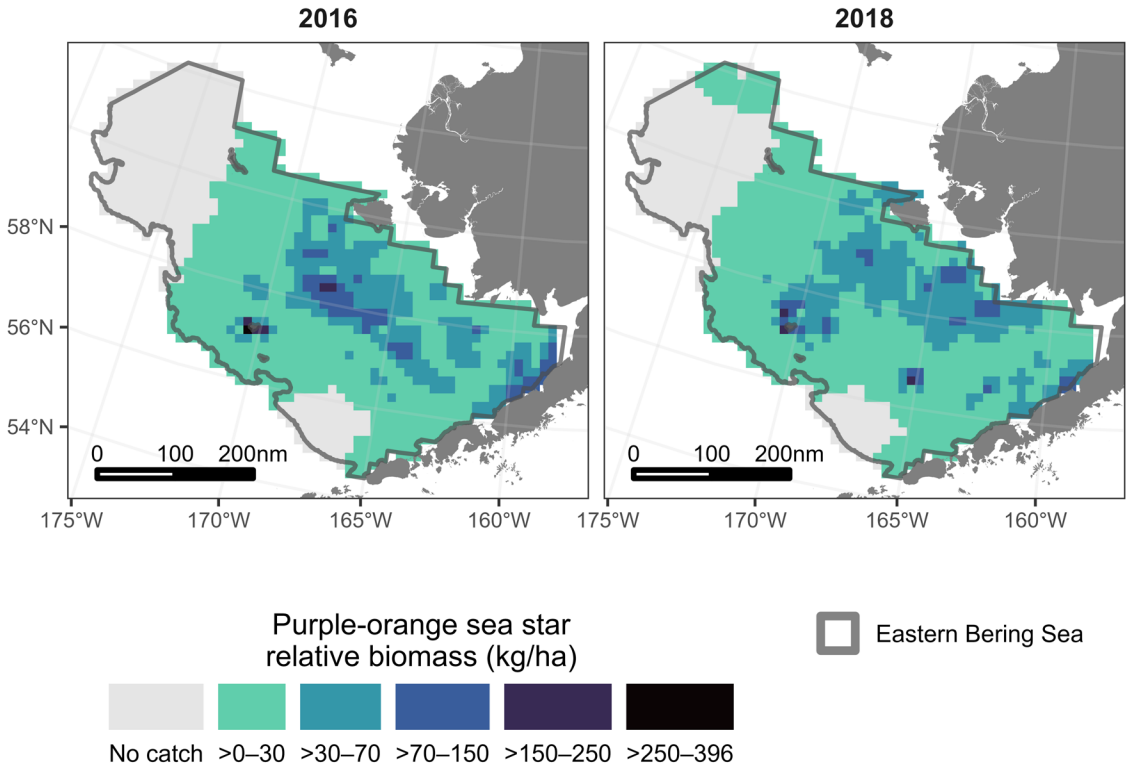

Figure 54. -- Purple-orange sea star (*Asterias amurensis*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) EBS shelf bottom trawl survey.

Table 43a. -- Mean weight CPUE (kg/ha) with standard deviation, and estimated biomass (t) with standard deviation and 95% lower (LCL; t) and upper (UCL; t) confidence limits for purple-orange sea star (*Asterias amurensis*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass (t)	SD biomass	95% LCL (t)	95% UCL (t)	Hauls with weights	Hauls with counts
10	39.98	4.45	311,343	34,668	241,278	381,408	58	58
20	35.55	3.90	145,841	16,021	113,079	178,603	31	31
31	14.97	3.36	141,536	31,748	78,041	205,031	65	65
32	16.72	4.82	14,674	4,232	4,664	24,683	8	8
41	9.75	2.34	61,146	14,664	31,510	90,782	37	37
42	46.85	9.56	112,488	22,948	65,628	159,347	31	31
43	0.11	0.05	231	113	0	466	11	11
50	0.04	0.03	173	126	0	434	3	3
61	0.28	0.09	2,427	767	876	3,977	17	17
62	0.00	0.00	0	0	0	0	0	0
82	0.00	0.00	6	4	0	16	2	2
90	0.00	0.00	0	0	0	0	0	0
Total	**16.02**	**1.15**	**789,864**	**56,803**	**677,393**	**902,335**	**263**	**263**

Table 43b. -- Mean Number CPUE (no./ha) with standard deviation, and estimated population (thousands) with standard deviation (thousands) and 95% lower (LCL; thousands) and upper (UCL; thousands) confidence limits for purple-orange sea star (*Asterias amurensis*) by stratum observed during the 2018 EBS shelf bottom trawl survey. No lengths were collected for this taxon.

Stratum	Mean CPUE (no./ha)	SD CPUE	Estimated population (thousands)	SD population (thousands)	95% LCL (thousands)	95% UCL (thousands)	Hauls with weights	Hauls with counts
10	484.74	67.12	3,774,736.53	522,692.44	2,718,375.11	4,831,097.95	58	58
20	347.39	40.91	1,425,234.29	167,830.56	1,082,020.80	1,768,447.78	31	31
31	118.56	20.10	1,120,673.90	190,008.79	740,656.31	1,500,691.49	65	65
32	122.22	37.05	107,238.09	32,509.50	30,353.12	184,123.06	8	8
41	58.23	15.38	365,124.09	96,439.42	170,220.03	560,028.15	37	37
42	412.82	115.02	991,221.38	276,177.33	427,267.26	1,555,175.49	31	31
43	0.40	0.19	835.41	398.20	4.77	1,666.05	11	11
50	0.56	0.47	2,156.22	1,832.53	0.00	5,938.56	3	3
61	1.92	0.61	16,961.72	5,376.51	6,095.80	27,827.63	17	17
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0
82	0.03	0.02	59.53	40.16	0.00	149.01	2	2
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**158.33**	**13.21**	**7,804,241.16**	**651,261.54**	**6,514,743.30**	**9,093,739.01**	**263**	**263**

Northern Neptune Whelk (*Neptunea heros*)

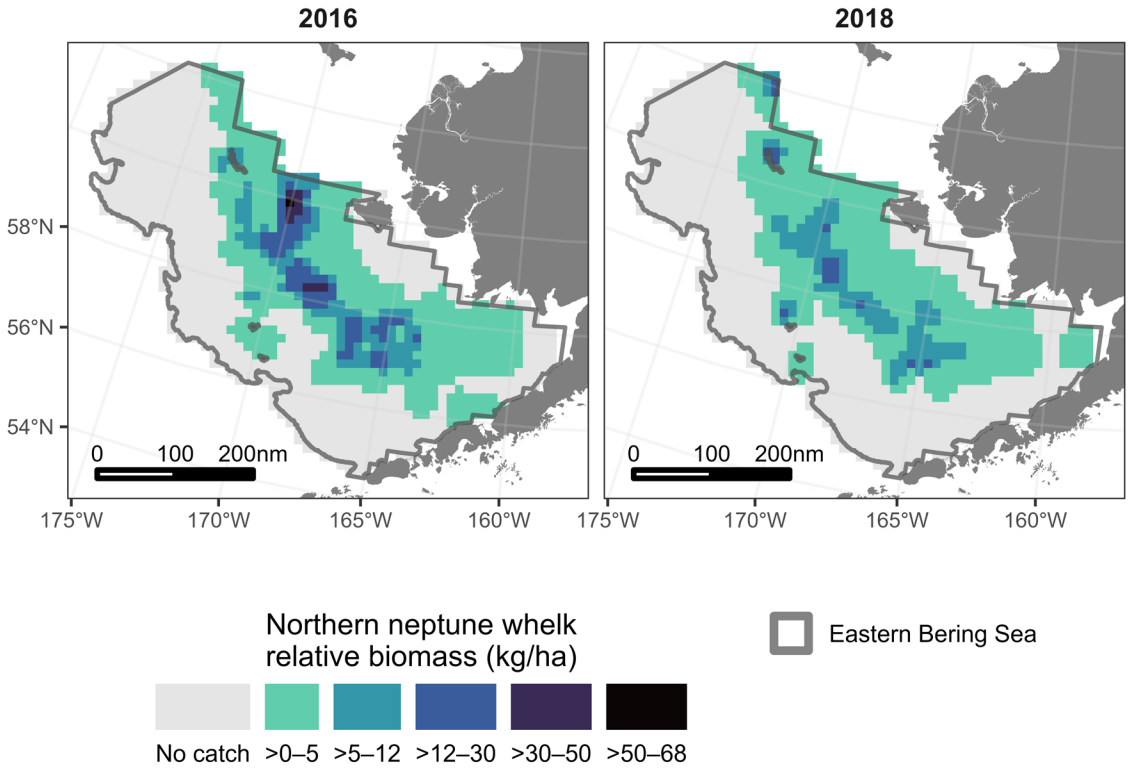

Figure 55. -- Northern Neptune whelk (*Neptunea heros*) distribution and relative biomass (kg/ha) from the 2016 (left) and 2018 (right) eastern Bering Sea shelf bottom trawl survey.

Data Sources

This report was generated in the R environment using R Markdown. The R Markdown framework allows for reproducible and documentable reporting. Many of the data sources and tools used to develop the plots and content of this report have been developed by members of the AFSC's Groundfish Assessment Program. The data collection efforts that constitute the annual Bering Sea bottom trawl survey take place over each summer by the Groundfish Assessment Program's Bering Sea Team. These data are then extrapolated to catch per unit effort (CPUE), population-level abundance, and biomass estimates by the Bering Sea Team.

Bering Sea group members are also working to develop several public-serving data products to increase transparency and accessibility to Bering Sea ecosystem data. The *akgfmaps* R package (https://github.com/afsc-gap-products/akgfmaps), developed by Sean Rohan, was used for producing the species distribution plots and maps for this report. The *coldpool* R package (https://github.com/afsc-gap-products/coldpool), developed by Sean Rohan and Lewis Barnett, uses newly developed and reproducible interpolation techniques to better understand changes in surface temperature, bottom temperature, and the cold pool in the Bering Sea.

The CPUE data with associated station information including position, surface and bottom temperatures, and bottom depth can be downloaded from the Fisheries One Stop Shop (https://www.fisheries.noaa.gov/foss/f?p=215:200:1099772399154:Mail:NO:::). There, users can interactively select, view, and download data for this and other surveys conducted by our team. An interactive map of species CPUE can be found at https://apps-st.fisheries.noaa.gov/dismap/.

Acknowledgments

Recognition and appreciation is extended to the captains and crew of the FV *Alaska Knight* and FV *Vesteraalen*. Without their expertise, goodwill, and sacrifice, this survey would not be possible. Thank you to United States Seafoods and Vesteraalen LLC for making the vessels available and always maintaining safety as a top priority. Great appreciation is also extended to all the scientists, researchers, contractors, interns, and volunteers who worked tirelessly aboard each vessel to complete the survey in a safe and successful manner. Thanks also to Norton Sound Economic Development Corporation and Kawerak, Inc. The survey would not have been possible without the major contributions from other AFSC groups including the Net Shed, Research Survey Support Team, Data Management Group, and the Administrative Team. Finally, appreciation is extended to Sean Rohan for reviewing this document. His excellent comments and suggestions greatly improved it.

We would also like to thank the many local and tribal communities of the Bering Strait region. The knowledge, experiences, and insights of the people of the Bering Strait region have been instrumental in expanding the scope of our science and knowledge to encompass the many issues that face this important ecosystem. We appreciate feedback from those residing in the region that are willing to share insights into the region, including the local names used for the species covered by this report, identifying species of interest or concern that should be included in this report, and participating in an open dialog about how we can improve our collective knowledge of the ecosystem and the region.

Citations

Alton, M. S., Bakkala, R. G., E., W. G., and Munro, P. T. (1998). Greenland turbot (*Reinhardtius hippoglossoides*) of the eastern Bering Sea and Aleutian Islands region. U.S. Dep. Commer. NOAA Tech. Rep. NMFS-71. https://spo.nmfs.noaa.gov/content/tr-71-greenland-turbot-reinhardtius-hippoglossoides-eastern-bering-sea-and-aleutian-islands

Alverson, D. L., and Pereyra, W. T. (1969). Demersal fish explorations in the northeastern Pacific Ocean – an evaluation of exploratory fishing methods and analytical approaches to stock size and yield forecasts. J. Fish. Res. Bd. Can., 26(8), p. 1985–2001. https://doi.org/10.1139/f69-188

Baker, M. R., and Hollowed, A. B. (2014). Delineating ecological regions in marine systems: Integrating physical structure and community composition to inform spatial management in the eastern Bering Sea. Deep-Sea Res. Pt. II, 109, p. 215–240. https://doi.org/10.1016/j.dsr2.2014.03.001

Bakkala, R. G. (1993). Structure and historical changes in the groundfish complex of the eastern Bering Sea. U.S. Dep. Commer. NOAA Tech. Rep. NMFS-114. https://spo.nmfs.noaa.gov/sites/default/files/tr114opt.pdf

Bakkala, R. G., and Wakabayashi, K. (1985). Results of cooperative U.S.-Japan groundfish investigations in the Bering Sea during May-August 1979. International North Pacific Fisheries Commission Bulletin, 44, 252 p.

Chilton, E. A., Armistead, C. E., and Foy, R. J. (2011). The 2010 eastern Bering Sea continental shelf bottom trawl survey: Results for commercial crab species. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-216; pp. 62 p. https://repository.library.noaa.gov/view/noaa/3776

Ciannelli, L., and Bailey, K. M. (2005). Landscape dynamics and resulting species interactions: The cod-capelin system in the southeastern Bering Sea. Mar. Ecol. Prog. Ser., 291, p. 227–236. https://doi.org/10.3354/meps291227

Conner, J., and Lauth, R. R. (2017). Results of the 2016 eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate resources. U.S. Dep. Commer. NOAA Tech. Memo. NOAA-AFSC-352. https://doi.org/10.7289/V5/TM-AFSC-352

Courcelles, D. (2011). Re-evaluation of the length-weight relationship of Pacific halibut (*Hippoglossus stenolepis*). International Pacific Halibut Commission Report of Assessment and Research Activities, p. 459–470.

Drumm, D. T., Maslenikov, K. P., Van Syoc, R., Orr, J. W., Lauth, R. R., Stevenson, D. E., and Pietsch, T. W. (2016). An annotated checklist of the marine macroinvertebrates of Alaska. NOAA Professional Paper NMFS. Vol. 19, pp. 289 p. https://doi.org/10.7755/PP.19

Fadeev, N. S. (1965). Comparative outline of the biology of flatfishes in the southeastern part of the Bering Sea and condition of their resources. Soviet Fisheries Investigations in the Northeastern Pacific, 4, p. 112–129.

Feder, H. M., Jewett, S. C., and Blanchard, A. (2005). Southeastern Chukchi Sea (Alaska) epibenthos. Polar Biol., 28, p. 402–421. https://doi.org/10.1007/s00300-004-0683-4

Fissel, B. E., Dalton, M., Garber-Yonts, B., Haynie, A., Kasperski, S., Lee, J., Lew, D., Seung, C., Sparks, K., Szymkowiak, M., and Wise, S. (2019). Economic status of the groundfish fisheries off Alaska, 2018. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pacific Fishery Management Council.

Fissel, B. E., Dalton, M., Garber-Yonts, B., Haynie, A., Kasperski, S., Lee, J., Lew, D., Seung, C., Sparks, K., Szymkowiak, M., and Wise, S. (2021). Economic status of the groundfish fisheries off Alaska, 2019. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pacific Fishery Management Council.

Fricke, R., Eschmeyer, W. N., and Laan, R. van der. (2022). Eschmeyer's catalog of fishes: Genera, species, references. https://www.calacademy.org/scientists/projects/eschmeyers-catalog-of-fishes

Hamazaki, T., Fair, L., Watson, L., and Brennan, E. (2005). Analyses of Bering Sea bottom-trawl surveys in norton sound: Absence of regime shift effect on epifauna and demersal fish. ICES J. Mar. Sci., 62(8), p. 1597–1602. https://doi.org/10.1016/j.icesjms.2005.06.003

Hoff, G. R. (2016). Results of the 2016 eastern Bering Sea upper continental slope survey of groundfishes and invertebrate resources U.S. Dep. Commer. NOAA Tech. Memo. NOAA-AFSC-339. https://doi.org/10.7289/V5/TM-AFSC-339

Hoff, G. R., and Britt, L. L. (2011). Results of the 2010 eastern Bering Sea upper continental slope survey of groundfish and invertebrate resources. U.S. Dep. Commer. NOAA Tech. Rep. https://apps-afsc.fisheries.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-227.pdf

Hollowed, A. B., Angliss, R. P., Sigler, M. F., Megrey, B. A., and Ito, D. H. (2007). Implementation plan for loss of sea ice (LOSI) program. U.S. Dep. Commer. AFSC Processed Report 2007-05, 48 p. https://repository.library.noaa.gov/view/noaa/8607

Hunt Jr., G. L., Coyle, K. O., Eisner, L. B., Farley, E. V., Heintz, R. A., Mueter, F., Napp, J. M., Overland, J. E., Ressler, P. H., and Salo, S. (2011). Climate impacts on eastern Bering Sea foodwebs: A synthesis of new data and an assessment of the oscillating control hypothesis. ICES J. Mar. Sci., 68(6), p. 1230–1243. https://doi.org/10.1093/icesjms/fsr036

Ianelli, J. N., Kotwicki, S., Honkalehto, T., Holsman, K., and Fissel, B. E. (2017). Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, December 2017. North Pacific Fishery Management Council, p. 55–184.

Kotwicki, S., Buckley, T. W., Honkalehto, T., and Walters, G. (2005). Variation in the distribution of walleye pollock (*Theragra chalcogramma*) with temperature and implications for seasonal migration. Fishery Bulletin, U.S., 103(4), p. 574–587. https://spo.nmfs.noaa.gov/content/variation-distribution-walleye-pollock-theragra-chalcogramma-temperature-and-implications

Kotwicki, S., Horne, J. K., Punt, A. E., and Ianelli, J. N. (2015). Factors affecting the availability of walleye pollock to acoustic and bottom trawl survey gear. ICES J. Mar. Sci., 72(5), p. 1425–1439. https://doi.org/10.1093/icesjms/fsv011

Kotwicki, S., Ianelli, J. N., and Punt, A. E. (2014). Correcting density-dependent effects in abundance estimates from bottom-trawl surveys. ICES J. Mar. Sci., 71(5), p. 1107–1116. https://doi.org/10.1093/icesjms/fst208

Kotwicki, S., and Lauth, R. R. (2013). Detecting temporal trends and environmentally-driven changes in the spatial distribution of bottom fishes and crabs on the eastern Bering Sea shelf. Deep Sea Research Part II: Topical Studies in Oceanography, 94, p. 231–243. https://doi.org/10.1016/j.dsr2.2013.03.017

Lang, C. A., Richar, J. I., and Foy, R. J. (2018). The 2017 eastern Bering Sea continental shelf and northern Bering Sea bottom trawl surveys: Results for commercial crab species. U.S. Dep. Commer. Report NMFS-AFSC-372. https://repository.library.noaa.gov/view/noaa/17434

Lang, C. A., Richar, J. I., and Foy, R. J. (2019). The 2018 eastern Bering Sea continental shelf and northern Bering Sea trawl surveys: Results for commercial crab species U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-386. https://doi.org/10.25923/X2FK-CJ60

Lauth, R. R. (2011). Results of the 2010 eastern and northern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate fauna. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-227. https://apps-afsc.fisheries.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-227.pdf

Lauth, R. R., and Kotwicki, S. (2014). A calibration function for correcting mean net spread values obtained from Marport spread sensors used in conjunction with the Marport MK II receiver. U.S. Dep. Commer. AFSC Processed Rep. NMFS-AFSC-2014-02. https://apps-afsc.fisheries.noaa.gov/Publications/ProcRpt/PR2014-02.pdf

McGilliard, C. R., Nichol, D. G., and Palsson, W. A. (2018). Assessment of the flathead sole-Bering flounder stock in the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council.

Nichol, D. G. (1995). Spawning and maturation of female yellowfin sole in the eastern Bering Sea. Proceedings of the International Flatfish Symposium; October 1994, Anchorage, Alaska, p. 35–50.

Nichol, D. G. (1997). Effects of geography and bathymetry on growth and maturity of yellowfin sole, *Pleuronectes asper*, in the eastern Bering Sea. Oceanographic Literature Review, 12(44), 1548 p. https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/1997/953/nichol.pdf

Nichol, D. G. (1998). Annual and between-sex variability of yellowfin sole, *Pleuronectes asper*. Fish. Bull., U.S., 96, p. 547–561. https://spo.nmfs.noaa.gov/content/annual-and-between-sex-variability-yellowfin-sole-pleuronectes-aspe-spring-summer

Nichol, D. G., Kotwicki, S., Wilderbuer, T. K., Lauth, R. R., and Ianelli, J. N. (2019). Availability of yellowfin sole (*Limanda aspera*) to the eastern Bering Sea trawl survey and its effect on estimates of survey biomass. Fish. Res., 211, p. 319–330. https://doi.org/10.1016/j.fishres.2018.11.017

Nichol, D. G., and Somerton, D. A. (2009). Evidence of the selection of tidal streams by northern rock sole (*Lepidopsetta polyxystra*) for transport in the eastern Bering Sea. Fish. Bull., U.S., 107(2), p. 221–234.

O'Leary, C. A., DeFilippo, L. V., Thorson, J. T., Kotwicki, S., Hoff, G. R., Kulik, V. V., Ianelli, J. N., and Punt, A. E. (2022). Understanding transboundary stocks' availability by combining multiple fisheries-independent surveys and oceanographic conditions in spatiotemporal models. ICES J. Mar. Sci., p. 1–12. https://doi.org/10.1093/icesjms/fsac046

Pereyra, W. T., Reeves, J. E., and Bakkala, R. G. (1976). Demersal fish and shellfish resources of the eastern Bering Sea in the baseline year 1975. U.S. Dep. Commer. NOAA Processed Report.

Rohan, S., Barnett, L., and Charriere, N. (in review). Evaluating approaches to estimating mean temperatures and cold pool area from AFSC bottom trawl surveys of the eastern Bering Sea. U.S. Dep. Commer. NOAA Tech. Memo.

Rose, C. S., and Walters, G. E. (1990). Trawl width variation during bottom trawl surveys: Causes and consequences [Conference Proceedings]. Proceedings of the Symposium on Application of Stock Assessment Techniques Applies to Gadids, 50, p. 57–67.

Shubnikov, D. A., and Lisovenko, L. A. (1964). Data on the biology of rock sole of the southeastern Bering Sea. Soviet Fisheries Investigations in the Northeast Pacific, 2, p. 220–226.

Sigler, M. F., Aydin, K. Y., Boveng, P. L., Farley Jr., E. V., Heintz, R. A., and Lauth, R. R. (2015). Alaska fisheries science center loss of sea ice (LOSI) plan for FY15-FY19. AFSC Processed Rep. 2015-01, 11 p. https://apps-afsc.fisheries.noaa.gov/Publications/ProcRpt/PR2015-01.pdf

Smith, G. B., and Bakkala, R. G. (1982). Demersal fish resources of the eastern Bering Sea: Spring 1976. U.S. Dep. Commer. NOAA Tech. Rep. NMFS-SSRF-754; 129 p. https://spo.nmfs.noaa.gov/content/demersal-fish-resources-eastern-bering-sea-spring-1976

Sohn, D., Ciannelli, L., and Duffy-Anderson, J. T. (2010). Distribution and drift pathways of Greenland halibut (*Reinhardtius hippoglossoides*) during early life stages in the eastern Bering Sea and Aleutian Islands. Fish. Oceanogr., 19(5), p. 339–353. https://doi.org/10.1111/j.1365-2419.2010.00549.x

Spencer, P. D. (2008). Density-independent and density-dependent factors affecting temporal changes in spatial distributions of eastern Bering Sea flatfish. Fish. Oceanogr., 17(5), p. 396–410. https://doi.org/10.1111/j.1365-2419.2008.00486.x

Spies, I., Wilderbuer, T. K., Nichol, D. G., Hoff, J., and Palsson, W. (2018). Assessment of the arrowtooth flounder stock in the eastern Bering Sea and Aleutian Islands. North Pacific Fishery Management Council.

Stabeno, P. J., Bond, N. A., Kachel, N. B., Salo, S. A., and Schumacher, J. D. (2001). On the temporal variability of the physical environment over the south-eastern Bering Sea. Fish. Oceanogr., 10(1), p. 81–98. https://doi.org/10.1046/j.1365-2419.2001.00157.x

Stabeno, P. J., Farley Jr., E. V., Kachel, N. B., Moore, S., Mordy, C. W., Napp, J. M., Overland, J. E., Pinchuk, A. I., and Sigler, M. F. (2012). A comparison of the physics of the northern and southern shelves of the eastern Bering Sea and some implications for the ecosystem. Deep-Sea Res. II, 65, p. 14–30. https://doi.org/10.1016/j.dsr2.2012.02.019

Stabeno, P. J., Kachel, N. B., Moore, S. E., Napp, J. M., Sigler, M., Yamaguchi, A., and Zerbini, A. N. (2012). Comparison of warm and cold years on the southeastern Bering Sea shelf and some implications for the ecosystem. Deep-Sea Res. II, 65, p. 31–45. https://doi.org/10.1016/j.dsr2.2012.02.020

Stauffer, G. D. (compiler). (2004). NOAA protocols for groundfish bottom trawl surveys of the nation's fishery resources, March 16, 2003. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SPO-65; 205 p. https://spo.nmfs.noaa.gov/content/tech-memo/noaa-protocols-groundfish-bottom-trawl-surveys-nations-fishery-resources-march-16

Stevens, B. G., and MacIntosh, R. A. (1990). Report to industry on the 1990 eastern Bering Sea crab survey. NWAFC Processed Report. NOAA-NWAFC-90-09.

Stevenson, D. E., and Hoff, G. R. (2009). Species identification confidence in the eastern Bering Sea shelf survey (1982-2008) U.S. Dep. Commer. AFSC Processed Rep. NOAA-AFSC-2009-04. https://repository.library.noaa.gov/view/noaa/11979

Stevenson, D. E., and Lauth, R. R. (2012). Latitudinal trends and temporal shifts in the catch composition of bottom trawls conducted on the eastern Bering Sea shelf. Deep-Sea Res. II, 65, p. 251–259. https://doi.org/10.1016/j.dsr2.2012.02.021

Stevenson, D. E., and Lauth, R. R. (2019). Bottom trawl surveys in the northern Bering Sea indicate recent shifts in the distribution of marine species. Polar Biol., 42(2), p. 407–421. https://doi.org/10.1007/s00300-018-2431-1

Stevenson, D. E., Weinberg, K. L., and Lauth, R. R. (2016). Estimating confidence in trawl efficiency and catch quantification for the eastern Bering Sea shelf survey. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-335; pp. 51 p. https://doi.org/10.7289/V5/TM-AFSC-335

Stewart, I. J., and Martell, S. J. D. (2015). Reconciling stock assessment paradigms to better inform fisheries management. ICES J. Mar. Sci., 72, p. 2187–2196. https://doi.org/10.1093/icesjms/fsv061

The Plan Team for the Groundfish Fisheries of the Bering Sea and Aleutian Islands. (2018). Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. https://www.fisheries.noaa.gov/alaska/population-assessments/north-pacific-groundfish-stock-assessments-and-fishery-evaluation

Vestfals, C. D., Ciannelli, L., and Hoff, G. R. (2016). Changes in habitat utilization of slope-spawning flatfish across a bathymetric gradient. ICES J. Mar. Sci., 73(7), p. 1875–1889. https://doi.org/10.1093/icesjms/fsw112

Wakabayashi, K. R., Bakkala, G., and Alton, M. S. (1985). Methods of the U.S.-Japan demersal trawl surveys. In R. G. Bakkala and K. Wakabayashi (Eds.), Results of cooperative U.S.-Japan groundfish investigations in the Bering Sea during May-August 1979, Vol. 44, p. 7–29. International North Pacific Fisheries Commission.

Wilderbuer, T. K., Nichol, D. G., and Ianelli, J. (2018). Chapter 4: Yellowfin sole. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pacific Fishery Management Council.

Wood, S. N. (2004). Stable and efficient multiple smoothing parameter estimation for generalized additive models. J. Am. Stat. Assoc., 99(467), p. 673–686. https://doi.org/10.1198/016214504000000980

Wyllie-Echeverria, T., and Wooster, W. S. (1998). Year-to-year variations in Bering Sea ice cover and some consequences for fish distributions. Fish. Oceanogr., 7(2), p. 159–170. https://doi.org/10.1046/j.1365-2419.1998.00058.x

Yang, M. S. (1988). Morphological differences between two congeneric species of pleuronectid flatfishes: Arrowtooth flounder, *Atheresthes stomias*, and Kamchatka flounder, *A. evermanni*. Fish. Bull., U.S., 86(608-611).

Zhang, C. I., Wilderbuer, T. K., and Walters, G. E. (1998). Biological characteristics and fishery assessment of Alaska plaice, *Pleuronectes quadrituberculatus*, in the eastern Bering Sea. Mar. Fish. Rev., 60(4), p. 16–27. https://spo.nmfs.noaa.gov/content/mfr/biological-characteristics-and-fishery-assessment-alaska-plaice-pleuronectes

Zimmermann, M., Dew, C. B., and Malley, B. A. (2009). History of Alaska red king crab, *Paralithodes camtschaticus*, bottom trawl surveys, 1940–61. Mar. Fish. Rev., 71(1), p. 1–22. https://spo.nmfs.noaa.gov/content/history-alaska-red-king-crab-paralithodes-camtschaticus-bottom-trawl-surveys-1940-61

Zimmermann, M., and Goddard, P. (1996). Biology and distribution of arrowtooth, *Atheresthes stomias*, and Kamchatka, *A. evermanni*, flounders in Alaskan waters. Oceanographic Literature Review, 98, p. 358–370. https://spo.nmfs.noaa.gov/content/biology-and-distribution-arrowtooth-atheresthes-stomias-and-kamchatka-evermanni-flounders

Appendices

Appendix A: List of taxa encountered in the EBS

Appendix A lists all fish and invertebrate taxa taken during the AFSC's EBS bottom trawl survey.

List of Tables

Appendix Table A1. -- Fish taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by family.

Family	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
Agonidae	*Aspidophoroides monopterygius*	Aleutian alligatorfish	46	47	111	70.9	56.7	60.4
	Bathyagonus alascanus	gray starsnout	9	75	118	96.7	56.0	59.6
	Bathyagonus infraspinatus	spinycheek starsnout	1	93	93	93.0	56.0	56.0
	Bathyagonus sp.	starsnout poacher unid.	1	71	71	71.0	57.0	57.0
	Leptagonus frenatus	sawback poacher	116	51	205	97.3	54.8	61.7
	Leptagonus leptorhynchus	longnose poacher	1	80	80	80.0	56.7	56.7
	Occella dodecaedron	Bering poacher	21	22	68	39.5	56.7	60.3
	Odontopyxis trispinosa	pygmy poacher	3	84	118	100.0	58.0	58.3
	Percis japonicus	dragon poacher	1	62	62	62.0	62.0	62.0
	Podothecus accipenserinus	sturgeon poacher	195	22	114	57.6	54.7	62.0
Ammodytidae	*Ammodytes* sp.	sand lance unid.	6	22	49	28.3	57.3	60.0
Anarhichadidae	*Anarhichas orientalis*	Bering wolffish	2	32	65	48.5	55.0	60.3
Anoplopomatidae	*Anoplopoma fimbria*	sablefish	19	45	156	113.5	54.7	58.0
Bathymasteridae	*Bathymaster signatus*	searcher	37	86	205	126.7	54.8	60.7
Clupeidae	*Clupea pallasii*	Pacific herring	93	22	107	53.5	55.3	62.0
Cottidae	*Artediellus pacificus*	hookhorn sculpin	8	59	73	66.6	57.3	60.3
	Artediellus sp.		1	72	72	72.0	56.8	56.8
	Gymnocanthus detrisus	purplegray sculpin	3	63	102	88.0	57.3	59.5
	Gymnocanthus galeatus	armorhead sculpin	4	51	80	72.0	56.7	61.3
	Gymnocanthus pistilliger	threaded sculpin	22	22	50	33.3	55.7	59.6
	Hemilepidotus jordani	yellow Irish lord	85	46	149	88.4	55.0	60.4
	Hemilepidotus papilio	butterfly sculpin	18	44	93	67.8	57.7	62.0
	Icelus spatula	spatulate sculpin	51	59	140	95.8	57.0	62.0
	Icelus spiniger	thorny sculpin	48	68	154	117.8	55.0	61.0
	Myoxocephalus jaok	plain sculpin	120	22	82	47.2	55.7	62.0
	Myoxocephalus polyacanthocephalus	great sculpin	198	26	205	81.4	55.0	62.0
	Myoxocephalus scorpius	shorthorn (=warty) sculpin	48	32	115	65.3	57.0	62.0
	Triglops macellus	roughspine sculpin	10	80	156	116.3	54.8	58.0
	Triglops pingeli	ribbed sculpin	10	26	80	59.1	56.7	60.3
	Triglops scepticus	spectacled sculpin	9	129	205	152.9	54.8	60.0
Cyclopteridae	*Aptocyclus ventricosus*	smooth lumpsucker	2	48	95	71.5	59.7	60.0
Gadidae	*Eleginus gracilis*	saffron cod	9	22	82	34.4	58.7	60.3

Appendix Table A1. -- Fish taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by family.

Family	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Gadus chalcogrammus	walleye pollock	370	22	205	80.3	54.7	62.0
	Gadus macrocephalus	Pacific cod	364	22	205	80.1	54.7	62.0
Hemitripteridae	*Hemitripterus bolini*	bigmouth sculpin	119	48	168	106.7	55.0	61.3
	Nautichthys pribilovius	eyeshade sculpin	1	74	74	74.0	57.0	57.0
Hexagrammidae	*Hexagrammos decagrammus*	kelp greenling	2	80	129	104.5	56.4	59.3
	Hexagrammos stelleri	whitespotted greenling	10	22	49	31.7	56.7	60.3
	Pleurogrammus monopterygius	Atka mackerel	2	105	129	117.0	56.4	58.0
Liparidae	*Careproctus phasma*	monster snailfish	53	61	144	96.6	57.7	62.0
	Careproctus scottae	peachskin snailfish	30	63	144	101.7	59.3	62.0
	Crystallichthys cyclospilus	blotched snailfish	1	156	156	156.0	54.8	54.8
	Liparis gibbus	variegated snailfish	10	32	101	70.4	58.7	62.0
	Liparis tunicatus	kelp snailfish	1	59	59	59.0	60.2	60.2
Osmeridae	*Mallotus catervarius (=villosus)*	Pacific capelin	44	22	66	42.5	57.6	60.3
	Osmerus mordax	rainbow smelt	5	22	38	30.4	56.7	60.3
	Thaleichthys pacificus	eulachon	33	22	154	98.7	55.0	59.6
Pleuronectidae	*Atheresthes evermanni*	Kamchatka flounder	275	44	205	93.7	54.7	62.0
	Atheresthes stomias	arrowtooth flounder	322	36	205	88.6	54.7	62.0
	Glyptocephalus zachirus	rex sole	86	44	205	116.0	54.8	60.0
	Hippoglossoides elassodon	flathead sole	340	26	205	85.7	54.7	62.0
	Hippoglossoides robustus	Bering flounder	78	44	134	82.5	58.0	62.0
	Hippoglossus stenolepis	Pacific halibut	256	22	205	74.6	54.7	61.0
	Isopsetta isolepis	butter sole	23	38	85	61.9	54.7	57.7
	Lepidopsetta bilineata	southern rock sole	6	50	85	68.7	54.7	55.7
	Lepidopsetta polyxystra	northern rock sole	339	22	168	75.2	54.7	62.0
	Limanda aspera	yellowfin sole	263	22	110	63.0	54.7	62.0
	Limanda proboscidea	longhead dab	26	22	51	32.8	58.0	60.0
	Limanda sakhalinensis	Sakhalin sole	7	60	94	73.6	58.7	62.0
	Microstomus pacificus	Dover sole	7	56	156	113.1	54.8	57.3
	Parophrys vetulus	English sole	1	76	76	76.0	55.3	55.3
	Platichthys stellatus	starry flounder	69	22	89	43.4	54.7	60.3

Appendix Table A1. -- Fish taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by family.

Family	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Platichthys stellatus X Pleuronectes quadrituberculatus hybrid	hybrid starry flounder X Alaska plaice	1	26	26	26.0	60.0	60.0
	Pleuronectes quadrituberculatus	Alaska plaice	281	22	126	66.4	55.3	62.0
	Reinhardtius hippoglossoides	Greenland turbot	77	60	205	100.6	58.3	62.0
Psychrolutidae	*Dasycottus setiger*	spinyhead sculpin	60	74	156	116.9	54.8	61.0
	Malacocottus zonurus	darkfin sculpin	4	122	152	141.0	56.0	60.0
	Psychrolutes paradoxus	tadpole sculpin	1	80	80	80.0	56.7	56.7
Rajidae	*Bathyraja aleutica*	Aleutian skate	24	74	205	135.3	54.8	60.0
	Bathyraja interrupta	Bering skate	98	68	168	113.3	54.7	61.7
	Bathyraja interrupta egg case		24	70	205	128.3	54.7	60.3
	Bathyraja maculata	whiteblotched skate	2	129	136	132.5	55.7	56.4
	Bathyraja parmifera	Alaska skate	363	22	205	80.9	54.7	62.0
	Bathyraja parmifera egg case	Alaska skate egg case	48	36	156	91.9	54.7	62.0
	Bathyraja sp.		3	85	156	123.3	54.7	55.0
	Bathyraja taranetzi	mud skate	4	129	152	139.5	56.3	59.0
	Bathyraja taranetzi egg case	mud skate egg case	1	129	129	129.0	56.4	56.4
	Beringraja binoculata	big skate	13	47	85	63.5	54.7	58.0
	Raja rhina	longnose skate	2	110	147	128.5	55.0	55.4
		skate egg case unid.	8	60	144	99.5	56.0	61.0
Salmonidae	*Oncorhynchus keta*	chum salmon	7	74	134	95.4	54.7	61.3
	Oncorhynchus tshawytscha	chinook salmon	1	55	55	55.0	57.3	57.3
Scorpaenidae	*Sebastes alutus*	Pacific ocean perch	15	108	205	142.3	54.8	59.6
	Sebastes melanostictus	blackspotted rockfish	6	131	149	137.7	55.3	56.0
	Sebastes polyspinis	northern rockfish	5	127	149	136.0	55.3	56.7
	Sebastes variabilis	dusky rockfish	2	129	149	139.0	56.0	56.4
Somniosidae	*Somniosus pacificus*	Pacific sleeper shark	1	156	156	156.0	54.8	54.8
Stichaeidae	*Leptoclinus maculatus*	daubed shanny	19	74	136	95.9	55.3	59.4
	Lumpenus fabricii	slender eelblenny	28	26	137	95.1	55.7	61.7
	Lumpenus sagitta	snake prickleback	3	60	144	90.0	60.7	61.0

Appendix Table A1. -- Fish taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by family.

Family	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Poroclinus rothrocki	whitebarred prickleback	6	102	154	125.8	55.0	57.0
Trichodontidae	*Trichodon trichodon*	Pacific sandfish	1	38	38	38.0	56.7	56.7
Zaproridae	*Zaprora silenus*	prowfish	4	72	205	140.5	55.7	58.7
Zoarcidae	*Lycodes brevipes*	shortfin eelpout	96	58	160	111.9	55.0	61.7
	Lycodes palearis	wattled eelpout	151	55	160	86.3	55.3	62.0
	Lycodes raridens	marbled eelpout	9	62	102	81.0	59.0	62.0
	Lycodes turneri	polar eelpout	1	63	63	63.0	60.3	60.3
Other		fish egg unid.	4	43	66	52.2	57.0	60.3

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
Annelida	Annelida	worm unid.	6	39	94	58.5	55.7	58.7
	Aphrodita negligens		20	92	160	129.7	56.3	61.3
	Aphrodita sp.		1	129	129	129.0	55.0	55.0
	Aphroditidae	sea mouse unid.	1	93	93	93.0	56.0	56.0
	Eunoe depressa	depressed scale worm	40	41	127	79.6	55.7	59.9
	Eunoe nodosa	giant scale worm	86	47	156	84.3	56.3	62.0
	Eunoe sp.		15	60	129	88.5	56.3	58.0
	Hirudinea	leech unid.	12	66	152	97.4	56.3	60.1
	Notostomum cyclostomum	striped sea leech	6	70	103	87.8	58.0	59.7
	Polychaeta	polychaete worm unid.	2	50	60	55.0	57.7	61.0
	Polychaete tubes		6	80	136	114.8	57.0	61.0
	Polynoidae	scale worm unid.	2	56	61	58.5	57.3	57.3
	Serpulidae	serpulid worm	2	71	121	96.0	57.3	57.4
		tube worm unid.	33	31	154	98.0	55.0	60.1
Arthropoda	*Argis* sp.		26	55	148	105.3	55.7	62.0
	Balanus sp.		1	31	31	31.0	58.3	58.3
	Chionoecetes bairdi	Tanner crab	260	38	205	88.5	54.7	61.0
	Chionoecetes hybrid	hybrid Tanner crab	101	50	156	97.8	55.0	62.0
	Chionoecetes opilio	snow crab	224	43	160	89.3	55.0	62.0
	Chirona evermanni	giant barnacle	8	52	142	85.2	55.7	58.3
	Crangon alaskensis	shell shrimp	11	22	74	51.3	55.7	59.3
	Crangon sp.		75	26	154	88.8	55.0	62.0
	Elassochirus cavimanus	purple hermit	33	53	205	113.8	54.7	59.3
	Elassochirus tenuimanus	widehand hermit crab	2	50	76	63.0	55.3	55.7
	Erimacrus isenbeckii	horsehair crab	48	36	127	58.1	55.3	62.0
	Eualus sp.		2	74	110	92.0	58.0	59.3
	Eualus suckleyi	shortscale eualid	1	85	85	85.0	57.7	57.7
	Glebocarcinus oregonensis	Oregon rock crab	35	50	102	72.8	55.3	57.7
	Hippolytidae	hippolytid shrimp unid.	1	68	68	68.0	57.6	57.6
	Hyas coarctatus	circumboreal toad crab	166	32	144	66.6	55.3	62.0
	Hyas lyratus	Pacific lyre crab	110	24	166	83.2	54.8	60.3
	Isopoda	isopod unid.	6	54	88	72.3	57.0	60.1

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Labidochirus splendescens	splendid hermit	193	24	166	75.8	54.7	61.7
	Lebbeus sp.		1	99	99	99.0	57.7	57.7
	Oregonia gracilis	graceful decorator crab	27	26	128	57.1	56.3	60.3
	Paguridae	hermit crab unid.	1	40	40	40.0	58.0	58.0
	Pagurus aleuticus	Aleutian hermit	133	32	156	101.2	54.8	60.7
	Pagurus capillatus	hairy hermit crab	197	22	156	71.7	54.8	60.3
	Pagurus confragosus	knobbyhand hermit	102	68	205	109.7	54.7	59.7
	Pagurus ochotensis	Alaskan hermit	110	22	90	46.5	54.7	60.3
	Pagurus rathbuni	longfinger hermit	118	60	160	96.2	56.7	62.0
	Pagurus sp.		3	34	108	72.3	56.7	58.3
	Pagurus trigonocheirus	fuzzy hermit crab	175	36	168	84.2	56.0	62.0
	Pandalus eous	Alaskan pink shrimp	104	53	205	112.4	54.8	61.7
	Pandalus goniurus	humpy shrimp	15	56	102	83.9	57.3	62.0
	Pandalus sp.		5	41	56	47.6	57.3	60.0
	Paralithodes camtschaticus	red king crab	94	34	90	56.5	55.3	60.3
	Paralithodes platypus	blue king crab	20	44	95	72.8	56.8	60.7
	Placetron wosnessenskii	scaled crab	1	136	136	136.0	55.7	55.7
	Rocinela angustata	sea cockroach	3	62	140	112.0	55.3	57.3
	Telmessus cheiragonus	helmet crab	21	22	44	30.1	56.7	60.3
	Thoracica	barnacle unid.	16	31	149	65.6	56.0	60.3
		empty barnacle shells	4	37	72	49.8	57.7	58.0
Brachiopoda	Brachiopoda	lampshell unid.	1	59	59	59.0	60.3	60.3
Bryozoa	Bryozoa	bryozoan unid.	43	26	156	62.5	54.8	62.0
Chordata	*Aplidium* sp.		63	22	128	56.9	56.3	61.7
	Boltenia ovifera	sea onion	124	22	118	55.3	55.7	60.3
	Boltenia sp.		4	22	62	41.5	57.3	59.3
	Halocynthia aurantium	sea peach	39	40	74	66.3	57.0	61.0
	Halocynthia sp.	sea peach unid.	2	69	78	73.5	57.3	59.0
	Styela rustica	sea potato	116	34	100	59.5	56.7	62.0
Cnidaria	Actiniaria	sea anemone unid.	92	22	168	95.8	55.7	61.7
	Actinostolidae		1	108	108	108.0	58.3	58.3
	Aequorea sp.		53	73	166	118.2	57.0	62.0
	Aurelia aurita		3	52	103	73.7	58.3	60.3
	Aurelia labiata		4	105	118	111.5	56.3	58.0

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Aurelia limbata	brown rimmed jelly	2	114	144	129.0	56.3	57.6
	Aurelia sp.		5	63	136	96.2	58.0	61.0
	Chrysaora melanaster		193	28	166	80.8	55.0	62.0
	Chrysaora sp.	chrysaora jelly	24	37	120	82.3	54.7	60.3
	Cribrinopsis fernaldi	chevron-tentacled anemone	11	68	140	91.5	58.0	60.0
	Cribrinopsis sp.		1	205	205	205.0	58.7	58.7
	Cyanea capillata	lion's mane jelly	7	73	122	92.1	60.2	61.3
	Gersemia sp.	sea raspberry	99	24	108	59.6	56.0	62.0
	Halipteris willemoesi		13	80	136	115.0	55.7	57.3
	Hydroidolina	hydroid unid.	60	22	88	53.9	56.0	60.3
	Liponema brevicorne	tentacle-shedding anemone	37	92	168	124.9	54.8	59.7
	Metridium farcimen	gigantic anemone	16	30	85	58.2	57.2	60.3
	Metridium sp.		71	30	129	65.7	55.0	61.0
	Phacellophora camtschatica	egg yolk jelly	11	115	149	134.8	57.6	60.0
	Scyphozoa	jellyfish unid.	57	41	168	94.0	55.0	61.3
	Stomphia coccinea	swimming anemone	19	62	137	104.5	59.0	62.0
	Stomphia sp.		18	54	137	88.6	55.0	60.3
	Urticina crassicornis	mottled anemone	8	31	102	67.4	55.3	57.3
	Urticina sp.		34	52	166	93.6	56.7	62.0
	Virgularia sp.	smoothstem seawhip	2	109	119	114.0	56.7	57.0
	Virgulariidae		3	122	141	132.7	56.7	60.0
		red striated sea anemone	1	31	31	31.0	57.3	57.3
Echinodermata	*Allocentrotus fragilis*	orange-pink sea urchin	1	142	142	142.0	57.0	57.0
	Asterias amurensis	purple-orange sea star	263	22	152	66.0	55.0	61.7
	Ceramaster japonicus	red bat star	1	154	154	154.0	55.0	55.0
	Crossaster papposus	rose sea star	27	58	156	82.1	54.8	61.0
	Ctenodiscus crispatus	common mud star	85	61	160	115.5	55.0	61.7
	Cucumaria fallax	sea football	36	38	94	68.3	55.7	59.7
	Diplopteraster multipes	pincushion sea star	6	135	205	158.5	54.8	58.7
	Dipsacaster borealis	northern sea star	3	135	205	168.7	58.3	58.7
	Echinarachnius parma	parma sand dollar	16	40	114	79.5	54.7	61.0
	Evasterias echinosoma	giant sea star	31	34	97	68.3	55.3	59.8

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Evasterias retifera		1	48	48	48.0	57.1	57.1
	Gorgonocephalus eucnemis	basketstar	243	37	166	81.5	55.0	62.0
	Henricia sp.		43	44	205	100.6	54.8	60.7
	Holothuroidea	sea cucumber unid.	1	31	31	31.0	58.7	58.7
	Leptasterias arctica		82	43	148	69.1	56.7	61.7
	Leptasterias coei		1	71	71	71.0	57.4	57.4
	Leptasterias groenlandica		22	58	144	83.6	56.7	62.0
	Leptasterias katharinae		1	55	55	55.0	58.0	58.0
	Leptasterias polaris		143	34	160	89.7	56.3	62.0
	Leptasterias sp.		2	63	93	78.0	59.5	60.3
	Leptychaster anomalus		12	93	149	112.8	55.0	59.5
	Leptychaster arcticus	North Pacific sea star	1	156	156	156.0	54.8	54.8
	Leptychaster pacificus		1	156	156	156.0	54.8	54.8
	Lethasterias nanimensis	blackspined sea star	91	50	152	82.5	56.0	60.3
	Molpadia intermedia	sweet sea potato	2	127	131	129.0	55.4	55.7
	Odontohenricia sp.		5	74	144	119.2	57.0	60.0
	Ophiopholis japonica		4	72	129	105.0	56.4	57.2
	Ophiopholis kennerleyi		2	70	71	70.5	57.5	57.8
	Ophiura sarsii	notched brittlestar	99	49	134	80.1	56.7	62.0
	Ophiura sp.		2	36	66	51.0	59.7	59.7
	Ophiuroidea	brittlestar unid.	2	86	156	121.0	54.8	56.3
	Pentamera sp.		5	53	75	66.8	56.7	57.7
	Pseudarchaster alascensis		2	118	144	131.0	57.6	58.0
	Pseudarchaster parelii	scarlet sea star	12	122	166	140.6	54.8	58.7
	Psolus fabricii	brownscaled sea cucumber	1	59	59	59.0	60.3	60.3
	Psolus squamatus	whitescaled sea cucumber	3	71	93	79.3	57.4	60.0
	Pteraster jordani		2	80	156	118.0	54.8	56.7
	Pteraster militaris	wrinkled star	1	94	94	94.0	55.7	55.7
	Pteraster obscurus	obscure sea star	62	61	160	101.6	55.7	62.0
	Pteraster sp.		3	100	129	114.7	56.4	59.7
	Pteraster F (Clark) sp.		1	129	129	129.0	56.4	56.4
	Pteraster tesselatus		1	156	156	156.0	58.7	58.7

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Pycnopodia helianthoides	sunflower sea star	2	54	80	67.0	55.3	56.7
	Solaster sp.		2	129	156	142.5	54.8	56.4
	Solaster F (Clark) sp.	Fisher sun star	4	59	95	76.2	60.0	60.3
	Strongylocentrotus droebachiensis	green sea urchin	32	43	166	98.7	54.8	60.7
	Strongylocentrotus sp.		40	34	205	112.5	55.3	61.0
Echiura	Echiura	echiuroid worm unid.	2	31	38	34.5	57.3	58.7
Ectoprocta	*Alcyonidium pedunculatum*	fruit leather bryozoan	16	38	137	65.1	56.3	61.7
	Dendrobeania sp.		7	41	74	58.7	57.0	60.0
	Flustra serrulata	leafy bryozoan	21	36	85	59.1	56.7	60.1
	Rhamphostomella costata	ribbed bryozoan	29	44	128	76.4	56.0	60.3
Mollusca	*Aforia circinata*	keeled Aforia	34	80	148	117.1	55.3	61.3
	Arctomelon sp.		2	78	156	117.0	54.8	57.0
	Arctomelon stearnsii	Alaska volute	4	111	205	142.2	58.7	61.3
	Astarte sp.		3	31	128	75.3	56.3	57.5
	Benthoctopus leioderma	smoothskin octopus	13	85	148	113.4	56.7	61.3
	Beringius behringi	Bering beringius	23	59	156	112.5	56.3	61.3
	Beringius sp.		24	46	160	101.3	54.8	61.0
	Beringius J (McLean and Clark) sp.		1	80	80	80.0	56.7	56.7
	Beringius stimpsoni		1	59	59	59.0	60.3	60.3
	Bivalvia	bivalve unid.	4	40	49	43.2	57.3	58.3
	Boreotrophon alaskanus	Alaskan trophon	2	87	154	120.5	55.0	58.0
	Boreotrophon beringi	Bering trophon	1	49	49	49.0	57.3	57.3
	Boreotrophon sp.		2	71	94	82.5	57.5	59.8
	Buccinum angulosum	angular whelk	99	32	160	92.6	56.3	62.0
	Buccinum oedematum	swollen whelk	15	68	140	112.8	57.3	61.3
	Buccinum plectrum	sinuous whelk	13	28	113	73.9	55.3	60.7
	Buccinum polare	polar whelk	80	52	127	79.7	56.7	62.0
	Buccinum scalariforme	ladder whelk	138	36	156	95.1	55.0	62.0
	Buccinum sp.		16	30	107	59.8	55.3	61.0
	Chlamys sp.		5	59	129	86.2	56.0	60.3
	Ciliatoclinocardium ciliatum	hairy cockle	37	29	135	76.3	55.3	61.0
	Clinocardium sp.		8	27	135	60.4	55.7	59.0

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Clinopegma magnum	helmet whelk	46	40	148	96.7	56.3	62.0
	Colus halli	shrew whelk	8	51	109	95.8	56.3	61.0
	Colus herendeenii	thin-ribbed whelk	2	72	136	104.0	57.0	60.0
	Colus hypolispus		1	71	71	71.0	57.0	57.0
	Colus jordani		1	131	131	131.0	55.4	55.4
	Colus sp.		20	61	154	104.5	55.0	61.0
	Crepidula sp.	slipper shell	17	52	73	64.6	57.3	60.3
	Cryptonatica aleutica	Aleutian moonsnail	7	66	114	85.6	56.3	62.0
	Cryptonatica russa	rusty moonsnail	23	26	134	88.5	55.0	62.0
	Cryptonatica sp.		1	68	68	68.0	56.7	56.7
	Cyclocardia crassidens	thick carditid	1	63	63	63.0	60.3	60.3
	Cyclocardia sp.		4	37	80	50.8	57.0	60.0
	Decapodiformes	squid unid.	1	149	149	149.0	56.0	56.0
	Dendronotus dalli	Dall dendronotid	9	69	137	91.1	59.0	60.0
	Enteroctopus dofleini	giant octopus	51	48	148	107.6	54.7	61.7
	Fusitriton oregonensis	Oregon triton	110	44	205	109.2	54.7	59.7
	gastropod egg	snail egg	231	22	166	77.3	55.0	62.0
	Grandicrepidula grandis	great slippersnail	1	65	65	65.0	57.7	57.7
	Hiatella sp.		10	22	120	66.9	56.3	59.9
	Lamellaria sp.		1	80	80	80.0	57.0	57.0
	Lunatia pallida	pale moonsnail	6	24	114	65.3	56.3	61.0
	Macoma nasuta	bent-nose Macoma	1	45	45	45.0	58.0	58.0
	Macoma sp.		8	31	106	62.9	56.7	59.9
	Mactromeris polynyma	Arctic surfclam	62	22	82	51.4	55.7	59.7
	Modiolus modiolus	northern horsemussel	15	31	166	64.1	57.3	61.7
	Musculus discors	discordant mussel	22	40	71	57.6	57.3	60.0
	Musculus niger	black mussel	1	30	30	30.0	59.0	59.0
	Musculus sp.		2	75	83	79.0	61.0	61.0
	Mya sp.		1	49	49	49.0	57.3	57.3
	Mytilidae	mussel unid.	3	50	61	54.7	56.3	57.7
	Mytilus sp.		2	31	63	47.0	58.3	61.0
	Mytilus trossulus	foolish mussel	1	114	114	114.0	56.7	56.7
	gastropod egg	moonsnail egg unid.	2	77	97	87.0	60.7	61.7
	Neoberingius frielei		14	68	154	98.1	55.0	59.0
	Neptunea borealis		60	37	119	69.2	56.7	62.0
	Neptunea heros		126	34	93	59.6	56.7	62.0

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Neptunea lyrata	lyre whelk	117	32	160	95.3	54.7	61.7
	Neptunea pribiloffensis	Pribilof whelk	148	50	205	110.4	55.0	61.7
	Neptunea sp.		4	41	74	50.5	57.0	58.7
	Neptunea ventricosa	fat whelk	135	30	94	59.2	55.7	60.7
	Nodulotrophon coronatus		1	72	72	72.0	57.0	57.0
	Nudibranchia	nudibranch unid.	10	69	135	90.8	56.7	61.7
	Onchidiopsis sp.		9	52	95	70.4	57.4	59.8
	Patinopecten caurinus	weathervane scallop	12	90	136	106.1	55.3	57.3
	Peltodoris nobilis	Pacific sea lemon	1	86	86	86.0	56.3	56.3
	Plicifusus kroyeri		48	59	142	103.2	56.7	61.0
	Plicifusus sp.		5	72	144	90.0	56.7	57.6
	Pododesmus cepio	abalone jingle	1	87	87	87.0	59.3	59.3
	Pododesmus macrochisma	Alaska falsejingle	2	68	109	88.5	57.0	57.3
	Pyrulofusus deformis	warped whelk	50	53	156	95.6	55.0	60.3
	Pyrulofusus dexius		1	144	144	144.0	57.6	57.6
	Pyrulofusus melonis		48	61	149	111.5	55.0	60.3
	Pyrulofusus sp.		10	59	137	104.2	57.9	60.7
	Rossia pacifica	eastern Pacific bobtail	11	108	166	140.9	55.4	59.3
	Serripes groenlandicus	Greenland cockle	11	47	118	73.8	57.0	60.3
	Serripes notabilis	oblique smoothcockle	42	30	136	81.6	55.7	61.7
	Serripes sp.		39	24	88	48.0	56.3	60.3
	Siliqua alta	Alaska razor	15	22	45	30.9	58.0	60.0
	Siliqua sp.		1	37	37	37.0	58.0	58.0
	Tachyrhynchus erosus	eroded turretsnail	2	28	34	31.0	59.0	59.0
	Tellina lutea	Alaska great-tellin	12	22	43	33.7	56.7	59.3
	Tellina sp.		26	24	80	44.3	56.3	60.1
	Trichotropis bicarinata	two-keel hairysnail	1	63	63	63.0	60.3	60.3
	Tritonia diomedea	rosy Tritonia	26	55	120	82.4	56.7	60.0
	Tritonia festiva	festive Tritonia	7	59	94	75.3	59.0	62.0
	Tritonia sp.		6	65	120	89.8	56.3	59.3
	Volutopsius fragilis	fragile whelk	16	56	136	91.4	55.7	58.0
	Volutopsius middendorffi	tulip whelk	2	63	68	65.5	57.6	58.0
	Volutopsius sp.		36	63	160	112.9	56.3	60.7
	Volutopsius stefanssoni	shouldered whelk	15	61	78	69.5	57.0	60.0

Appendix Table A2. -- Invertebrate taxa encountered during the 2018 EBS bottom trawl survey listed alphabetically by phylum.

Phylum	Scientific name	Common name	Number stations present	Bottom depth (m)			Latitude range	
				Min.	Max.	Avg.	N	S
	Yoldia hyperborea	northern Yoldia	2	59	66	62.5	57.4	60.3
	Yoldia sp.		18	34	82	65.4	55.7	60.1
		empty bivalve shells	289	22	166	77.8	55.0	62.0
		empty gastropod shells	351	22	205	81.0	54.8	62.0
Nemertea	Nemertea	nemertean worm unid.	1	108	108	108.0	58.0	58.0
Porifera	*Aphrocallistes vastus*	clay pipe sponge	1	156	156	156.0	58.7	58.7
	Mycale loveni	tree sponge	1	129	129	129.0	56.4	56.4
	Mycale sp.		1	205	205	205.0	58.7	58.7
	Polymastia fluegeli	Flugel nippled sponge	1	128	128	128.0	56.3	56.3
	Porifera	sponge unid.	110	24	205	72.8	54.8	61.0
	Suberites domuncula	hermit sponge	11	43	94	71.7	55.3	57.7
	Suberites montalbidus	stinky sponge	4	72	96	82.8	55.7	56.7
	Suberites sp.		1	118	118	118.0	57.0	57.0
Sipuncula	Sipuncula	peanut worm unid.	9	36	127	68.7	56.7	61.7

Appendix B: Population estimates by sex and size group for principal fish species in the EBS

Appendix B presents population estimates by sex and size group from the 2018 EBS bottom trawl survey for principal fish species.

List of Tables

Appendix Table B1. -- Population estimates by sex and size for Alaska plaice (*Pleuronectes quadrituberculatus*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
10	132,308	0	0	132,308	0.0002	0.0002
11	66,154	141,156	24,660	231,970	0.0004	0.0006
12	141,156	90,893	0	232,049	0.0004	0.0010
13	66,154	107,550	59,094	232,798	0.0004	0.0015
14	80,199	33,062	59,094	172,355	0.0003	0.0018
15	239,498	50,749	0	290,247	0.0005	0.0023
16	75,488	80,199	0	155,687	0.0003	0.0025
17	169,879	50,749	0	220,628	0.0004	0.0029
18	722,309	133,051	0	855,360	0.0015	0.0044
19	719,018	451,521	0	1,170,539	0.0021	0.0065
20	1,174,544	838,117	0	2,012,661	0.0035	0.0100
21	2,038,032	1,212,908	0	3,250,940	0.0057	0.0157
22	2,079,547	1,306,711	0	3,386,258	0.0059	0.0217
23	2,750,516	2,417,394	0	5,167,910	0.0091	0.0307
24	3,401,718	2,428,769	0	5,830,487	0.0102	0.0410
25	4,726,931	2,663,218	0	7,390,149	0.0130	0.0539
26	5,067,452	2,842,638	0	7,910,090	0.0139	0.0678
27	5,409,876	3,160,219	0	8,570,095	0.0150	0.0829
28	6,052,672	4,280,275	0	10,332,947	0.0181	0.1010
29	6,829,125	4,280,135	0	11,109,260	0.0195	0.1205
30	10,331,193	4,215,484	0	14,546,677	0.0255	0.1460
31	13,496,999	4,378,462	0	17,875,461	0.0314	0.1774
32	18,372,567	5,927,665	0	24,300,232	0.0427	0.2201
33	24,743,507	5,879,785	0	30,623,292	0.0537	0.2738
34	35,932,744	6,606,739	0	42,539,483	0.0747	0.3485
35	41,082,017	6,858,040	0	47,940,057	0.0841	0.4326
36	35,614,681	7,869,539	0	43,484,220	0.0763	0.5089
37	29,540,873	8,763,687	0	38,304,560	0.0672	0.5762
38	18,125,552	8,452,683	0	26,578,235	0.0466	0.6228
39	11,699,130	12,030,737	0	23,729,867	0.0416	0.6645
40	5,511,832	14,061,401	0	19,573,233	0.0344	0.6988
41	3,237,059	18,977,973	0	22,215,032	0.0390	0.7378
42	1,455,074	20,600,235	0	22,055,309	0.0387	0.7765
43	689,186	20,672,806	0	21,361,992	0.0375	0.8140
44	664,526	20,968,643	0	21,633,169	0.0380	0.8520
45	1,003,834	18,307,623	0	19,311,457	0.0339	0.8859
46	266,919	14,338,317	0	14,605,236	0.0256	0.9115
47	297,112	14,083,933	0	14,381,045	0.0252	0.9367
48	274,821	10,082,538	0	10,357,359	0.0182	0.9549
49	178,316	7,017,302	0	7,195,618	0.0126	0.9676
50	97,026	6,434,200	0	6,531,226	0.0115	0.9790
51	262,978	4,597,007	0	4,859,985	0.0085	0.9875
52	0	3,090,220	0	3,090,220	0.0054	0.9930
53	0	1,456,662	0	1,456,662	0.0026	0.9955
54	0	1,667,887	0	1,667,887	0.0029	0.9985
55	0	322,642	0	322,642	0.0006	0.9990
56	74,278	175,198	0	249,476	0.0004	0.9995

Appendix Table B1. -- Population estimates by sex and size for Alaska plaice (*Pleuronectes quadrituberculatus*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
57	0	175,592	0	175,592	0.0003	0.9998
58	0	47,172	0	47,172	0.0001	0.9998
60	0	86,449	0	86,449	0.0002	1.0000
Total	**294,894,800**	**274,715,935**	**142,848**	**569,753,583**	**1.0000**	**1.0000**

Appendix Table B2. -- Population estimates by sex and size for arrowtooth flounder (*Atheresthes stomias*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
8	0	0	36,613	36,613	0.0000	0.0000
9	29,907	0	22,404	52,311	0.0000	0.0001
10	0	67,260	0	67,260	0.0001	0.0001
11	89,664	100,455	95,872	285,991	0.0003	0.0004
12	349,496	149,452	114,087	613,035	0.0006	0.0010
13	709,624	740,782	226,099	1,676,505	0.0015	0.0025
14	4,053,542	5,371,651	184,794	9,609,987	0.0088	0.0114
15	9,309,619	13,967,307	658,187	23,935,113	0.0220	0.0334
16	16,811,899	25,970,381	631,567	43,413,847	0.0399	0.0733
17	25,136,509	34,056,406	0	59,192,915	0.0545	0.1278
18	21,400,979	33,078,767	0	54,479,746	0.0501	0.1779
19	10,683,107	25,659,549	0	36,342,656	0.0334	0.2113
20	8,840,928	17,505,309	0	26,346,237	0.0242	0.2356
21	4,436,989	12,506,199	59,288	17,002,476	0.0156	0.2512
22	7,305,169	15,253,098	0	22,558,267	0.0208	0.2720
23	9,049,335	12,835,175	49,160	21,933,670	0.0202	0.2921
24	8,429,815	15,238,993	0	23,668,808	0.0218	0.3139
25	11,595,534	20,202,774	0	31,798,308	0.0293	0.3432
26	11,144,548	14,783,648	0	25,928,196	0.0239	0.3670
27	10,001,809	21,402,412	0	31,404,221	0.0289	0.3959
28	9,166,368	14,182,883	0	23,349,251	0.0215	0.4174
29	6,628,414	12,196,945	0	18,825,359	0.0173	0.4347
30	8,340,473	12,348,432	0	20,688,905	0.0190	0.4538
31	7,069,480	11,930,736	0	19,000,216	0.0175	0.4712
32	8,265,659	13,084,070	0	21,349,729	0.0196	0.4909
33	13,688,314	12,922,785	0	26,611,099	0.0245	0.5154
34	10,479,412	14,846,067	0	25,325,479	0.0233	0.5387
35	10,551,261	19,000,645	0	29,551,906	0.0272	0.5658
36	10,358,300	23,402,346	0	33,760,646	0.0311	0.5969
37	11,832,196	19,449,198	0	31,281,394	0.0288	0.6257
38	14,225,384	20,727,747	0	34,953,131	0.0322	0.6578
39	12,695,624	21,987,363	0	34,682,987	0.0319	0.6898
40	14,874,487	22,920,617	49,160	37,844,264	0.0348	0.7246
41	10,957,070	21,609,582	0	32,566,652	0.0300	0.7545
42	9,642,857	20,645,930	0	30,288,787	0.0279	0.7824
43	7,668,582	23,658,840	0	31,327,422	0.0288	0.8112
44	3,923,258	16,934,317	0	20,857,575	0.0192	0.8304
45	2,491,855	17,221,863	0	19,713,718	0.0181	0.8485
46	3,375,030	13,878,327	0	17,253,357	0.0159	0.8644
47	1,461,612	16,115,331	0	17,576,943	0.0162	0.8806
48	1,924,781	11,247,988	0	13,172,769	0.0121	0.8927
49	236,451	9,674,660	0	9,911,111	0.0091	0.9018
50	479,335	7,556,179	0	8,035,514	0.0074	0.9092
51	225,699	6,155,571	0	6,381,270	0.0059	0.9151
52	49,701	7,030,151	0	7,079,852	0.0065	0.9216
53	331,968	7,982,011	0	8,313,979	0.0076	0.9292
54	122,062	6,664,327	0	6,786,389	0.0062	0.9355

Appendix Table B2. -- Population estimates by sex and size for arrowtooth flounder (*Atheresthes stomias*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
55	107,012	6,847,444	0	6,954,456	0.0064	0.9419
56	119,288	7,298,447	0	7,417,735	0.0068	0.9487
57	243,610	7,664,235	0	7,907,845	0.0073	0.9560
58	57,171	6,592,273	0	6,649,444	0.0061	0.9621
59	129,002	7,639,092	0	7,768,094	0.0071	0.9693
60	103,514	7,764,310	0	7,867,824	0.0072	0.9765
61	60,349	4,707,989	0	4,768,338	0.0044	0.9809
62	57,171	5,052,736	49,160	5,159,067	0.0047	0.9856
63	28,856	5,057,068	0	5,085,924	0.0047	0.9903
64	28,586	2,614,280	0	2,642,866	0.0024	0.9927
65	57,171	2,430,403	0	2,487,574	0.0023	0.9950
66	41,060	1,642,099	0	1,683,159	0.0015	0.9966
67	0	1,217,990	0	1,217,990	0.0011	0.9977
68	0	984,663	0	984,663	0.0009	0.9986
69	28,586	1,107,730	0	1,136,316	0.0010	0.9996
70	0	254,066	0	254,066	0.0002	0.9999
71	0	27,923	0	27,923	0.0000	0.9999
72	0	16,548	0	16,548	0.0000	0.9999
73	0	70,315	0	70,315	0.0001	1.0000
75	0	16,548	0	16,548	0.0000	1.0000
Total	**341,505,482**	**743,270,688**	**2,176,391**	**1,086,952,561**	**1.0000**	**1.0000**

Appendix Table B3. -- Population estimates by sex and size for Bering flounder (*Hippoglossoides robustus*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
7	0	0	95,257	95,257	0.0016	0.0016
9	0	0	28,008	28,008	0.0005	0.0020
10	18,743	201,203	53,090	273,036	0.0045	0.0065
11	229,303	60,823	1,069,150	1,359,276	0.0222	0.0287
12	99,511	179,474	958,046	1,237,031	0.0202	0.0489
13	245,289	160,440	1,419,904	1,825,633	0.0299	0.0788
14	244,137	144,637	476,520	865,294	0.0141	0.0929
15	484,236	354,638	156,262	995,136	0.0163	0.1092
16	747,772	836,673	0	1,584,445	0.0259	0.1351
17	677,363	687,096	61,005	1,425,464	0.0233	0.1584
18	1,058,368	612,421	0	1,670,789	0.0273	0.1858
19	718,185	894,981	0	1,613,166	0.0264	0.2121
20	987,809	2,256,187	0	3,243,996	0.0530	0.2652
21	936,305	2,056,630	0	2,992,935	0.0489	0.3141
22	765,781	2,246,240	0	3,012,021	0.0493	0.3634
23	669,163	1,923,677	0	2,592,840	0.0424	0.4058
24	980,724	2,252,994	0	3,233,718	0.0529	0.4587
25	583,838	1,850,712	0	2,434,550	0.0398	0.4985
26	322,337	2,211,888	0	2,534,225	0.0414	0.5399
27	571,227	1,914,872	0	2,486,099	0.0407	0.5806
28	257,039	2,071,138	0	2,328,177	0.0381	0.6186
29	62,425	2,617,314	0	2,679,739	0.0438	0.6625
30	221,107	2,967,705	0	3,188,812	0.0521	0.7146
31	67,531	3,332,886	0	3,400,417	0.0556	0.7702
32	111,164	3,216,810	0	3,327,974	0.0544	0.8246
33	49,756	2,387,536	0	2,437,292	0.0399	0.8645
34	31,764	2,387,461	0	2,419,225	0.0396	0.9041
35	0	1,832,392	0	1,832,392	0.0300	0.9340
36	18,105	935,630	0	953,735	0.0156	0.9496
37	31,439	871,639	0	903,078	0.0148	0.9644
38	0	649,704	0	649,704	0.0106	0.9750
39	30,905	411,885	0	442,790	0.0072	0.9822
40	0	176,704	0	176,704	0.0029	0.9851
41	0	269,720	0	269,720	0.0044	0.9895
42	0	166,140	0	166,140	0.0027	0.9923
43	0	30,503	0	30,503	0.0005	0.9928
44	0	282,484	0	282,484	0.0046	0.9974
46	0	29,522	0	29,522	0.0005	0.9979
47	0	100,767	0	100,767	0.0016	0.9995
48	0	29,660	0	29,660	0.0005	1.0000
Total	**11,221,326**	**45,613,186**	**4,317,242**	**61,151,754**	**1.0000**	**1.0000**

Appendix Table B4. -- Population estimates by sex and size for flathead sole (*Hippoglossoides elassodon*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
6	164,546	0	87,881	252,427	0.0001	0.0001
7	61,304	0	646,477	707,781	0.0003	0.0004
8	82,319	0	1,410,028	1,492,347	0.0006	0.0011
9	398,722	411,294	9,613,563	10,423,579	0.0045	0.0055
10	4,307,187	1,854,504	20,168,015	26,329,706	0.0113	0.0168
11	4,120,809	3,258,606	30,848,020	38,227,435	0.0164	0.0332
12	10,053,123	11,087,952	39,711,453	60,852,528	0.0261	0.0594
13	18,016,245	18,990,806	42,546,332	79,553,383	0.0341	0.0935
14	29,600,094	26,287,847	29,097,792	84,985,733	0.0365	0.1300
15	42,978,116	32,259,364	17,848,391	93,085,871	0.0400	0.1699
16	39,670,241	32,522,667	4,332,596	76,525,504	0.0328	0.2028
17	30,809,195	35,217,191	614,773	66,641,159	0.0286	0.2314
18	38,980,464	32,660,195	56,297	71,696,956	0.0308	0.2622
19	41,670,135	37,904,276	0	79,574,411	0.0342	0.2963
20	40,652,645	39,010,835	61,761	79,725,241	0.0342	0.3306
21	43,270,974	32,764,227	0	76,035,201	0.0326	0.3632
22	40,760,226	42,200,402	30,881	82,991,509	0.0356	0.3988
23	58,409,674	44,311,989	31,727	102,753,390	0.0441	0.4429
24	47,453,069	38,730,794	0	86,183,863	0.0370	0.4799
25	54,749,353	44,383,736	0	99,133,089	0.0426	0.5225
26	55,099,197	44,630,981	0	99,730,178	0.0428	0.5653
27	42,753,370	44,319,527	63,454	87,136,351	0.0374	0.6027
28	43,879,632	38,468,456	95,181	82,443,269	0.0354	0.6381
29	49,247,818	42,248,369	302,761	91,798,948	0.0394	0.6775
30	54,815,667	44,005,835	175,853	98,997,355	0.0425	0.7200
31	47,890,625	44,269,446	383,434	92,543,505	0.0397	0.7597
32	38,683,965	40,718,243	175,853	79,578,061	0.0342	0.7938
33	41,318,707	32,194,034	183,107	73,695,848	0.0316	0.8255
34	39,325,201	31,399,073	566,541	71,290,815	0.0306	0.8561
35	33,636,135	29,439,518	207,580	63,283,233	0.0272	0.8832
36	22,948,014	29,631,861	446,887	53,026,762	0.0228	0.9060
37	18,133,617	23,641,074	207,580	41,982,271	0.0180	0.9240
38	13,651,316	19,922,663	63,454	33,637,433	0.0144	0.9385
39	10,330,123	17,903,027	358,961	28,592,111	0.0123	0.9507
40	10,214,508	13,201,394	0	23,415,902	0.0101	0.9608
41	3,709,583	11,475,559	246,561	15,431,703	0.0066	0.9674
42	2,194,330	10,941,257	95,181	13,230,768	0.0057	0.9731
43	1,006,768	11,234,105	31,727	12,272,600	0.0053	0.9784
44	918,657	8,030,079	31,727	8,980,463	0.0039	0.9822
45	616,318	9,116,825	0	9,733,143	0.0042	0.9864
46	87,789	9,274,361	0	9,362,150	0.0040	0.9904
47	0	6,837,876	0	6,837,876	0.0029	0.9933
48	32,277	5,386,576	0	5,418,853	0.0023	0.9957
49	0	4,484,407	0	4,484,407	0.0019	0.9976
50	0	2,618,961	0	2,618,961	0.0011	0.9987
51	0	956,942	0	956,942	0.0004	0.9991
52	0	1,036,820	0	1,036,820	0.0004	0.9996

Appendix Table B4. -- Population estimates by sex and size for flathead sole (*Hippoglossoides elassodon*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
53	0	605,745	0	605,745	0.0003	0.9998
54	0	373,109	0	373,109	0.0002	1.0000
Total	**1,076,702,058**	**1,052,222,808**	**200,741,829**	**2,329,666,695**	**1.0000**	**1.0000**

Appendix Table B5. -- Population estimates by sex and size for Greenland turbot (*Reinhardtius hippoglossoides*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
15	31,942	0	0	31,942	0.0043	0.0043
16	62,412	0	0	62,412	0.0085	0.0128
23	30,637	0	0	30,637	0.0042	0.0170
25	0	29,092	0	29,092	0.0040	0.0209
28	31,439	0	0	31,439	0.0043	0.0252
30	31,942	29,092	0	61,034	0.0083	0.0335
32	34,219	0	0	34,219	0.0046	0.0381
33	0	89,092	0	89,092	0.0121	0.0502
34	31,942	91,218	0	123,160	0.0167	0.0670
35	32,570	0	0	32,570	0.0044	0.0714
37	30,905	58,184	0	89,089	0.0121	0.0835
39	0	29,092	0	29,092	0.0040	0.0875
40	28,781	31,942	0	60,723	0.0082	0.0957
41	28,899	0	0	28,899	0.0039	0.0996
42	0	91,245	0	91,245	0.0124	0.1120
43	30,905	57,726	0	88,631	0.0120	0.1241
44	123,945	0	0	123,945	0.0168	0.1409
45	63,509	30,905	0	94,414	0.0128	0.1537
46	28,899	0	0	28,899	0.0039	0.1577
47	92,216	0	0	92,216	0.0125	0.1702
48	57,427	31,682	0	89,109	0.0121	0.1823
50	28,899	0	0	28,899	0.0039	0.1862
51	93,958	0	0	93,958	0.0128	0.1990
52	31,332	0	0	31,332	0.0043	0.2032
53	60,928	29,092	0	90,020	0.0122	0.2155
54	61,357	31,332	0	92,689	0.0126	0.2281
55	61,542	87,604	0	149,146	0.0203	0.2483
56	30,707	31,682	0	62,389	0.0085	0.2568
57	123,659	60,400	0	184,059	0.0250	0.2818
58	63,527	28,781	0	92,308	0.0125	0.2943
59	88,712	52,303	0	141,015	0.0192	0.3135
60	286,561	88,556	0	375,117	0.0510	0.3645
61	156,724	154,131	0	310,855	0.0422	0.4067
62	111,833	266,535	0	378,368	0.0514	0.4581
63	59,663	99,788	0	159,451	0.0217	0.4798
64	91,789	244,945	0	336,734	0.0457	0.5255
65	63,509	298,657	0	362,166	0.0492	0.5747
66	90,984	302,983	0	393,967	0.0535	0.6282
67	85,614	285,931	0	371,545	0.0505	0.6787
68	19,211	310,419	0	329,630	0.0448	0.7235
69	96,680	259,074	0	355,754	0.0483	0.7718
70	19,329	345,710	0	365,039	0.0496	0.8214
71	0	223,766	0	223,766	0.0304	0.8518
72	30,073	117,570	0	147,643	0.0201	0.8719
73	30,908	63,711	0	94,619	0.0129	0.8847
74	0	202,253	0	202,253	0.0275	0.9122
75	0	226,074	0	226,074	0.0307	0.9429

Appendix Table B5. -- Population estimates by sex and size for Greenland turbot (*Reinhardtius hippoglossoides*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
76	0	138,446	0	138,446	0.0188	0.9617
77	31,800	0	0	31,800	0.0043	0.9660
79	0	31,721	0	31,721	0.0043	0.9703
82	0	49,382	0	49,382	0.0067	0.9771
84	0	31,332	0	31,332	0.0043	0.9813
85	0	29,960	0	29,960	0.0041	0.9854
86	0	31,332	0	31,332	0.0043	0.9896
89	0	27,296	0	27,296	0.0037	0.9933
95	0	29,552	0	29,552	0.0040	0.9974
101	0	19,458	0	19,458	0.0026	1.0000
Total	**2,591,888**	**4,769,046**	**0**	**7,360,934**	**1.0000**	**1.0000**

Appendix Table B6. -- Population estimates by sex and size for Kamchatka flounder (*Atheresthes evermanni*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
11	0	0	30,202	30,202	0.0003	0.0003
12	92,621	0	30,202	122,823	0.0013	0.0016
13	174,554	265,712	0	440,266	0.0047	0.0063
14	213,559	485,774	30,576	729,909	0.0078	0.0141
15	518,524	461,196	0	979,720	0.0105	0.0246
16	761,492	878,154	0	1,639,646	0.0175	0.0421
17	1,730,278	1,143,135	0	2,873,413	0.0307	0.0727
18	1,505,167	828,482	0	2,333,649	0.0249	0.0976
19	513,868	786,704	30,576	1,331,148	0.0142	0.1118
20	642,309	394,194	0	1,036,503	0.0111	0.1229
21	762,915	501,191	16,548	1,280,654	0.0137	0.1366
22	411,921	349,748	16,548	778,217	0.0083	0.1449
23	1,370,780	1,024,256	0	2,395,036	0.0256	0.1704
24	1,099,131	1,396,823	0	2,495,954	0.0266	0.1970
25	1,150,412	1,260,975	0	2,411,387	0.0257	0.2228
26	2,074,999	1,260,991	0	3,335,990	0.0356	0.2584
27	1,699,967	1,649,004	16,548	3,365,519	0.0359	0.2943
28	2,051,962	1,306,107	33,097	3,391,166	0.0362	0.3305
29	2,419,613	1,881,335	33,097	4,334,045	0.0462	0.3767
30	2,750,562	2,482,519	33,097	5,266,178	0.0562	0.4329
31	2,217,101	2,207,265	33,097	4,457,463	0.0476	0.4805
32	2,191,910	2,432,274	49,645	4,673,829	0.0499	0.5303
33	1,817,793	1,878,697	33,097	3,729,587	0.0398	0.5701
34	1,526,884	1,317,482	16,548	2,860,914	0.0305	0.6006
35	1,369,706	1,956,425	33,097	3,359,228	0.0358	0.6365
36	1,375,701	1,316,496	33,097	2,725,294	0.0291	0.6656
37	1,102,972	814,022	0	1,916,994	0.0205	0.6860
38	1,024,996	983,385	16,548	2,024,929	0.0216	0.7076
39	1,017,776	1,201,221	0	2,218,997	0.0237	0.7313
40	1,026,666	1,013,217	0	2,039,883	0.0218	0.7531
41	886,364	1,117,726	16,548	2,020,638	0.0216	0.7746
42	1,402,413	1,410,138	0	2,812,551	0.0300	0.8046
43	1,278,786	845,922	0	2,124,708	0.0227	0.8273
44	835,718	832,088	16,548	1,684,354	0.0180	0.8453
45	730,369	692,707	0	1,423,076	0.0152	0.8605
46	928,840	1,122,755	0	2,051,595	0.0219	0.8824
47	836,242	1,214,800	0	2,051,042	0.0219	0.9042
48	365,602	813,730	0	1,179,332	0.0126	0.9168
49	455,755	787,309	33,097	1,276,161	0.0136	0.9304
50	226,685	807,326	0	1,034,011	0.0110	0.9415
51	259,546	521,250	0	780,796	0.0083	0.9498
52	222,201	621,658	0	843,859	0.0090	0.9588
53	19,770	204,159	0	223,929	0.0024	0.9612
54	127,636	207,640	0	335,276	0.0036	0.9648
55	59,207	195,947	0	255,154	0.0027	0.9675
56	114,051	72,334	0	186,385	0.0020	0.9695
57	64,664	394,108	0	458,772	0.0049	0.9744

Appendix Table B6. -- Population estimates by sex and size for Kamchatka flounder (*Atheresthes evermanni*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
58	99,020	262,729	0	361,749	0.0039	0.9782
59	26,609	119,426	0	146,035	0.0016	0.9798
60	0	295,306	0	295,306	0.0032	0.9829
61	0	249,728	16,548	266,276	0.0028	0.9858
62	31,121	230,156	0	261,277	0.0028	0.9886
63	0	51,691	33,097	84,788	0.0009	0.9895
64	0	172,804	16,548	189,352	0.0020	0.9915
65	0	74,052	16,548	90,600	0.0010	0.9925
66	0	97,507	16,548	114,055	0.0012	0.9937
67	0	91,179	16,548	107,727	0.0011	0.9948
68	0	18,334	16,548	34,882	0.0004	0.9952
69	0	27,807	16,548	44,355	0.0005	0.9957
73	0	77,660	16,548	94,208	0.0010	0.9967
74	0	18,105	0	18,105	0.0002	0.9969
75	0	125,637	0	125,637	0.0013	0.9982
76	0	102,069	0	102,069	0.0011	0.9993
77	0	32,790	0	32,790	0.0003	0.9997
79	0	31,897	0	31,897	0.0003	1.0000
Total	**45,586,738**	**47,417,258**	**717,294**	**93,721,290**	**1.0000**	**1.0000**

Appendix Table B7. -- Population estimates by sex and size for northern rock sole (*Lepidopsetta polyxystra*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
6	0	0	472,997	472,997	0.0001	0.0001
7	0	0	1,054,344	1,054,344	0.0002	0.0003
8	0	662,805	769,014	1,431,819	0.0003	0.0006
9	1,538,082	1,816,703	14,994,839	18,349,624	0.0040	0.0046
10	9,189,313	5,619,105	52,802,647	67,611,065	0.0146	0.0192
11	19,712,413	15,302,008	111,145,130	146,159,551	0.0316	0.0508
12	48,336,207	35,773,003	169,001,309	253,110,519	0.0547	0.1054
13	71,059,161	62,926,620	177,248,831	311,234,612	0.0672	0.1727
14	103,507,021	86,439,030	117,495,905	307,441,956	0.0664	0.2390
15	108,947,745	95,157,027	67,060,809	271,165,581	0.0586	0.2976
16	99,489,845	94,643,162	12,617,220	206,750,227	0.0447	0.3423
17	75,173,227	91,299,867	4,851,429	171,324,523	0.0370	0.3793
18	62,240,087	55,958,304	846,021	119,044,412	0.0257	0.4050
19	60,435,229	49,681,151	1,271,787	111,388,167	0.0241	0.4290
20	52,310,074	45,062,610	1,009,401	98,382,085	0.0212	0.4503
21	46,524,437	38,418,918	183,814	85,127,169	0.0184	0.4687
22	53,103,251	47,297,545	424,331	100,825,127	0.0218	0.4904
23	49,639,911	37,835,530	157,889	87,633,330	0.0189	0.5094
24	42,748,234	34,001,350	131,296	76,880,880	0.0166	0.5260
25	34,547,024	25,638,107	136,565	60,321,696	0.0130	0.5390
26	38,162,779	23,855,005	105,370	62,123,154	0.0134	0.5524
27	47,425,022	28,584,827	52,852	76,062,701	0.0164	0.5688
28	103,206,506	35,421,473	263,593	138,891,572	0.0300	0.5988
29	165,868,464	40,823,333	422,149	207,113,946	0.0447	0.6436
30	180,348,313	48,326,136	528,187	229,202,636	0.0495	0.6931
31	145,368,981	51,002,446	1,980,784	198,352,211	0.0428	0.7359
32	89,216,935	52,347,648	1,637,412	143,201,995	0.0309	0.7668
33	42,525,625	89,107,530	739,261	132,372,416	0.0286	0.7954
34	23,206,665	126,107,792	422,483	149,736,940	0.0323	0.8278
35	11,064,443	179,588,258	131,630	190,784,331	0.0412	0.8690
36	6,085,719	184,860,187	131,630	191,077,536	0.0413	0.9102
37	1,853,389	163,528,038	26,259	165,407,686	0.0357	0.9460
38	1,764,122	109,557,181	52,852	111,374,155	0.0241	0.9700
39	59,867	67,078,036	79,111	67,217,014	0.0145	0.9845
40	268,056	39,816,753	0	40,084,809	0.0087	0.9932
41	0	19,746,149	0	19,746,149	0.0043	0.9974
42	39,708	6,611,819	0	6,651,527	0.0014	0.9989
43	0	2,836,215	0	2,836,215	0.0006	0.9995
44	0	1,693,207	0	1,693,207	0.0004	0.9999
45	0	481,737	0	481,737	0.0001	1.0000
46	0	125,751	0	125,751	0.0000	1.0000
48	0	20,165	0	20,165	0.0000	1.0000
49	0	31,897	0	31,897	0.0000	1.0000
Total	**1,794,965,855**	**2,095,084,428**	**740,249,151**	**4,630,299,434**	**1.0000**	**1.0000**

Appendix Table B8. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
12	0	77,363	0	77,363	0.0003	0.0003
13	77,363	58,676	0	136,039	0.0005	0.0009
14	0	151,653	0	151,653	0.0006	0.0015
15	215,202	293,448	17,748	526,398	0.0021	0.0036
16	243,466	240,991	51,986	536,443	0.0022	0.0057
17	409,473	198,258	437,842	1,045,573	0.0042	0.0100
18	366,089	486,055	103,972	956,116	0.0038	0.0138
19	729,630	680,489	86,904	1,497,023	0.0060	0.0198
20	563,313	634,044	71,401	1,268,758	0.0051	0.0249
21	788,196	673,901	86,904	1,549,001	0.0062	0.0312
22	1,657,404	968,646	34,135	2,660,185	0.0107	0.0419
23	1,500,757	1,338,641	17,068	2,856,466	0.0115	0.0534
24	2,145,721	1,465,168	17,068	3,627,957	0.0146	0.0680
25	1,267,244	1,560,597	0	2,827,841	0.0114	0.0793
26	1,228,008	1,077,783	0	2,305,791	0.0093	0.0886
27	693,033	473,007	0	1,166,040	0.0047	0.0933
28	373,580	796,074	0	1,169,654	0.0047	0.0980
29	678,803	555,251	0	1,234,054	0.0050	0.1030
30	781,250	334,436	31,800	1,147,486	0.0046	0.1076
31	636,279	603,703	0	1,239,982	0.0050	0.1126
32	1,368,435	776,354	0	2,144,789	0.0086	0.1212
33	1,073,159	1,464,454	29,406	2,567,019	0.0103	0.1315
34	1,588,758	1,472,111	0	3,060,869	0.0123	0.1438
35	2,420,146	1,746,529	0	4,166,675	0.0168	0.1606
36	2,420,178	2,228,883	17,350	4,666,411	0.0188	0.1794
37	2,651,380	2,534,473	0	5,185,853	0.0209	0.2003
38	2,697,940	2,330,302	0	5,028,242	0.0202	0.2205
39	3,168,352	3,274,510	0	6,442,862	0.0259	0.2464
40	2,978,540	3,116,287	0	6,094,827	0.0245	0.2709
41	3,077,817	3,047,606	0	6,125,423	0.0246	0.2956
42	3,615,667	2,674,695	0	6,290,362	0.0253	0.3209
43	3,198,823	3,329,666	0	6,528,489	0.0263	0.3472
44	2,905,531	2,573,218	0	5,478,749	0.0220	0.3692
45	2,265,156	2,326,000	0	4,591,156	0.0185	0.3877
46	2,244,369	1,928,013	0	4,172,382	0.0168	0.4045
47	2,437,282	2,044,211	29,406	4,510,899	0.0181	0.4226
48	2,327,078	1,807,960	0	4,135,038	0.0166	0.4392
49	2,697,729	2,317,719	0	5,015,448	0.0202	0.4594
50	2,448,953	1,993,419	29,406	4,471,778	0.0180	0.4774
51	2,290,523	2,277,989	58,812	4,627,324	0.0186	0.4960
52	3,328,569	1,857,204	88,218	5,273,991	0.0212	0.5173
53	3,001,600	1,864,534	29,406	4,895,540	0.0197	0.5369
54	3,027,561	2,216,356	117,624	5,361,541	0.0216	0.5585
55	2,694,735	2,077,834	147,030	4,919,599	0.0198	0.5783
56	2,591,246	2,262,718	88,218	4,942,182	0.0199	0.5982
57	2,380,626	2,116,231	0	4,496,857	0.0181	0.6163
58	2,556,861	2,355,064	58,812	4,970,737	0.0200	0.6363

Appendix Table B8. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
59	3,203,436	2,539,852	0	5,743,288	0.0231	0.6594
60	2,705,516	2,484,763	0	5,190,279	0.0209	0.6803
61	3,144,191	2,367,554	120,018	5,631,763	0.0227	0.7029
62	2,991,994	2,133,721	29,406	5,155,121	0.0207	0.7237
63	3,108,801	3,084,370	58,812	6,251,983	0.0252	0.7488
64	2,898,602	3,135,310	0	6,033,912	0.0243	0.7731
65	2,701,793	2,674,275	58,812	5,434,880	0.0219	0.7950
66	2,036,328	2,720,025	31,800	4,788,153	0.0193	0.8142
67	2,545,322	2,885,697	58,812	5,489,831	0.0221	0.8363
68	1,855,330	2,341,935	0	4,197,265	0.0169	0.8532
69	1,818,365	2,505,682	61,206	4,385,253	0.0176	0.8709
70	1,731,865	2,350,136	0	4,082,001	0.0164	0.8873
71	1,144,386	1,777,609	0	2,921,995	0.0118	0.8990
72	955,830	1,965,295	0	2,921,125	0.0118	0.9108
73	1,052,624	1,707,993	0	2,760,617	0.0111	0.9219
74	872,732	1,131,079	0	2,003,811	0.0081	0.9300
75	756,228	955,642	0	1,711,870	0.0069	0.9369
76	609,406	1,002,168	31,800	1,643,374	0.0066	0.9435
77	769,145	1,186,486	31,800	1,987,431	0.0080	0.9515
78	443,763	870,821	0	1,314,584	0.0053	0.9568
79	545,601	980,397	0	1,525,998	0.0061	0.9629
80	367,540	1,252,810	0	1,620,350	0.0065	0.9694
81	446,186	675,392	0	1,121,578	0.0045	0.9739
82	292,204	711,778	0	1,003,982	0.0040	0.9780
83	324,215	664,559	0	988,774	0.0040	0.9819
84	214,029	571,030	31,800	816,859	0.0033	0.9852
85	95,192	276,698	0	371,890	0.0015	0.9867
86	94,013	439,778	0	533,791	0.0021	0.9889
87	75,923	523,305	0	599,228	0.0024	0.9913
88	83,379	324,837	0	408,216	0.0016	0.9929
89	53,160	262,522	0	315,682	0.0013	0.9942
90	0	297,963	0	297,963	0.0012	0.9954
91	47,811	118,328	0	166,139	0.0007	0.9961
92	0	119,292	0	119,292	0.0005	0.9965
93	0	113,116	0	113,116	0.0005	0.9970
94	0	131,978	0	131,978	0.0005	0.9975
95	0	110,013	0	110,013	0.0004	0.9980
96	0	81,604	0	81,604	0.0003	0.9983
97	0	93,918	0	93,918	0.0004	0.9987
98	0	138,784	0	138,784	0.0006	0.9992
99	0	107,241	0	107,241	0.0004	0.9997
100	0	19,253	0	19,253	0.0001	0.9997
102	0	62,875	0	62,875	0.0003	1.0000
Total	**123,796,735**	**122,580,408**	**2,164,782**	**248,541,925**	**1.0000**	**1.0000**

Appendix Table B9. -- Population estimates by sex and size for walleye pollock (*Gadus chalcogrammus*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
7	0	0	24,642	24,642	0.0000	0.0000
8	0	0	192,521	192,521	0.0000	0.0000
9	0	0	1,076,238	1,076,238	0.0002	0.0002
10	197,620	124,657	8,202,830	8,525,107	0.0014	0.0016
11	30,707	73,822	26,349,650	26,454,179	0.0044	0.0061
12	741,090	651,804	64,715,295	66,108,189	0.0111	0.0171
13	3,665,598	2,128,072	146,816,599	152,610,269	0.0256	0.0427
14	8,511,054	11,216,279	171,193,826	190,921,159	0.0320	0.0747
15	30,253,327	16,248,379	118,232,796	164,734,502	0.0276	0.1023
16	53,694,606	40,500,167	60,941,998	155,136,771	0.0260	0.1282
17	47,877,034	36,483,239	18,736,354	103,096,627	0.0173	0.1455
18	44,816,300	30,381,858	9,292,858	84,491,016	0.0141	0.1597
19	13,865,755	16,927,609	2,163,307	32,956,671	0.0055	0.1652
20	14,781,082	8,532,390	1,114,758	24,428,230	0.0041	0.1693
21	15,425,260	12,777,463	558,758	28,761,481	0.0048	0.1741
22	23,884,416	16,323,851	220,627	40,428,894	0.0068	0.1808
23	28,312,782	28,583,779	30,426	56,926,987	0.0095	0.1904
24	24,605,797	21,054,486	125,693	45,785,976	0.0077	0.1980
25	21,007,915	22,569,714	0	43,577,629	0.0073	0.2053
26	22,011,043	15,940,429	0	37,951,472	0.0064	0.2117
27	18,376,136	12,199,291	0	30,575,427	0.0051	0.2168
28	13,590,985	11,334,747	0	24,925,732	0.0042	0.2210
29	11,641,923	9,953,164	226,633	21,821,720	0.0037	0.2246
30	11,942,171	9,257,319	0	21,199,490	0.0036	0.2282
31	9,433,226	10,408,323	0	19,841,549	0.0033	0.2315
32	10,882,904	9,859,082	0	20,741,986	0.0035	0.2350
33	12,370,006	6,602,462	0	18,972,468	0.0032	0.2382
34	9,435,016	8,804,174	0	18,239,190	0.0031	0.2412
35	13,569,978	6,968,492	0	20,538,470	0.0034	0.2447
36	19,455,216	11,487,949	401,550	31,344,715	0.0052	0.2499
37	21,320,304	16,602,385	0	37,922,689	0.0064	0.2563
38	33,364,246	34,828,812	0	68,193,058	0.0114	0.2677
39	65,254,944	47,969,792	0	113,224,736	0.0190	0.2866
40	124,217,236	68,479,934	0	192,697,170	0.0323	0.3189
41	143,221,773	107,850,630	0	251,072,403	0.0420	0.3610
42	201,208,752	182,211,887	0	383,420,639	0.0642	0.4252
43	227,916,423	205,754,252	0	433,670,675	0.0726	0.4978
44	228,636,734	217,693,241	0	446,329,975	0.0747	0.5725
45	176,530,883	196,744,724	0	373,275,607	0.0625	0.6350
46	165,917,913	154,957,853	0	320,875,766	0.0537	0.6888
47	168,676,765	152,986,655	0	321,663,420	0.0539	0.7426
48	156,721,868	128,622,681	0	285,344,549	0.0478	0.7904
49	136,028,738	122,512,165	256,748	258,797,651	0.0433	0.8338
50	128,198,610	109,385,672	0	237,584,282	0.0398	0.8735
51	97,320,107	94,607,979	0	191,928,086	0.0321	0.9057
52	71,293,851	87,779,861	0	159,073,712	0.0266	0.9323
53	50,388,671	65,252,152	0	115,640,823	0.0194	0.9517

Appendix Table B9. -- Population estimates by sex and size for walleye pollock (*Gadus chalcogrammus*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
54	34,346,819	48,928,453	0	83,275,272	0.0139	0.9656
55	23,599,287	37,196,878	0	60,796,165	0.0102	0.9758
56	20,120,915	28,771,057	0	48,891,972	0.0082	0.9840
57	9,376,667	23,573,074	0	32,949,741	0.0055	0.9895
58	7,801,507	13,956,024	0	21,757,531	0.0036	0.9932
59	4,494,952	6,833,405	0	11,328,357	0.0019	0.9951
60	2,270,050	4,839,049	0	7,109,099	0.0012	0.9962
61	1,560,503	4,083,993	0	5,644,496	0.0009	0.9972
62	1,312,384	3,758,011	0	5,070,395	0.0008	0.9980
63	717,344	2,579,054	0	3,296,398	0.0006	0.9986
64	735,419	2,212,856	0	2,948,275	0.0005	0.9991
65	712,927	783,175	0	1,496,102	0.0003	0.9993
66	274,181	861,644	0	1,135,825	0.0002	0.9995
67	146,290	409,409	0	555,699	0.0001	0.9996
68	298,655	165,427	0	464,082	0.0001	0.9997
69	126,779	248,104	0	374,883	0.0001	0.9998
70	120,977	423,892	0	544,869	0.0001	0.9999
71	91,412	201,760	0	293,172	0.0000	0.9999
72	18,106	238,082	0	256,188	0.0000	0.9999
74	0	91,412	0	91,412	0.0000	1.0000
75	0	56,928	0	56,928	0.0000	1.0000
76	0	38,013	0	38,013	0.0000	1.0000
77	0	74,290	0	74,290	0.0000	1.0000
79	0	57,466	0	57,466	0.0000	1.0000
Total	**2,788,721,939**	**2,552,015,132**	**630,874,107**	**5,971,611,178**	**1.0000**	**1.0000**

Appendix Table B10. -- Population estimates by sex and size for yellowfin sole (*Limanda aspera*) from the 2018 EBS bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
9	287,366	0	0	287,366	0.0000	0.0000
10	257,011	793,426	0	1,050,437	0.0002	0.0002
11	3,555,730	3,322,693	704,674	7,583,097	0.0012	0.0014
12	7,617,056	8,214,771	207,808,483	223,640,310	0.0341	0.0355
13	25,799,345	17,454,800	107,812,149	151,066,294	0.0231	0.0586
14	28,961,463	46,019,898	105,757,290	180,738,651	0.0276	0.0862
15	47,270,110	58,290,099	182,728	105,742,937	0.0161	0.1023
16	51,503,126	54,328,826	0	105,831,952	0.0162	0.1185
17	64,757,122	71,078,594	182,728	136,018,444	0.0208	0.1393
18	71,615,935	78,095,975	0	149,711,910	0.0229	0.1621
19	88,707,170	73,206,593	0	161,913,763	0.0247	0.1868
20	86,830,017	91,320,168	0	178,150,185	0.0272	0.2140
21	86,954,770	86,012,522	0	172,967,292	0.0264	0.2405
22	91,202,830	85,676,395	175,590	177,054,815	0.0270	0.2675
23	98,215,418	92,917,577	0	191,132,995	0.0292	0.2967
24	102,938,028	110,676,354	175,590	213,789,972	0.0326	0.3293
25	124,536,123	140,829,215	711,537	266,076,875	0.0406	0.3700
26	131,936,281	143,248,364	970,335	276,154,980	0.0422	0.4121
27	141,625,750	148,033,566	354,239	290,013,555	0.0443	0.4564
28	147,796,579	125,078,923	625,271	273,500,773	0.0418	0.4982
29	146,010,183	137,634,375	1,416,957	285,061,515	0.0435	0.5417
30	174,998,886	139,324,576	1,327,632	315,651,094	0.0482	0.5899
31	221,337,025	167,204,120	1,595,606	390,136,751	0.0596	0.6495
32	249,675,215	193,921,879	619,154	444,216,248	0.0678	0.7173
33	195,761,547	237,309,275	1,500,164	434,570,986	0.0664	0.7837
34	142,374,634	235,938,417	2,297,967	380,611,018	0.0581	0.8418
35	81,529,539	224,182,244	2,920,180	308,631,963	0.0471	0.8889
36	48,684,922	201,273,620	2,304,084	252,262,626	0.0385	0.9274
37	19,759,883	158,021,285	1,512,398	179,293,566	0.0274	0.9548
38	8,858,285	118,897,421	1,429,191	129,184,897	0.0197	0.9745
39	1,235,829	80,718,977	890,186	82,844,992	0.0127	0.9872
40	1,116,960	40,431,000	267,973	41,815,933	0.0064	0.9936
41	575,916	25,127,429	178,649	25,881,994	0.0040	0.9975
42	0	10,169,664	0	10,169,664	0.0016	0.9991
43	0	4,165,997	0	4,165,997	0.0006	0.9997
44	0	985,354	0	985,354	0.0002	0.9999
45	0	273,258	0	273,258	0.0000	0.9999
46	0	603,841	0	603,841	0.0001	1.0000
Total	**2,694,286,054**	**3,410,781,491**	**443,720,755**	**6,548,788,300**	**1.0000**	**1.0000**

U.S. Secretary of Commerce
Gina M. Raimondo

Under Secretary of Commerce for Oceans and Atmosphere
Dr. Richard W. Spinrad

Assistant Administrator, National Marine Fisheries Service. Also serving as Acting Assistant Secretary of Commerce for Oceans and Atmosphere, and Deputy NOAA Administrator
Janet Coit

November 2022

www.nmfs.noaa.gov

OFFICIAL BUSINESS

National Marine Fisheries Service
Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Seattle, WA 98115-6349