NOAA Technical Memorandum NMFS-AFSC-452

Results of the 2021 Eastern and Northern 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, 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, D. E. Stevenson, and L. L. Britt. 2022. Results of the 2021 eastern and northern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate fauna. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-452, 227 p.

This document is available online at:

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

NOAA FISHERIES

Results of the 2021 Eastern and Northern 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, 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-452

November 2022

Abstract

In 2021, the Resource Assessment and Conservation Engineering (RACE) division of the National Marine Fisheries Service's (NMFS) Alaska Fisheries Science Center (AFSC) conducted the 39th Eastern Bering Sea Crab/Groundfish Bottom Trawl Survey (EBS) from May to July 2021, as well as the 4th Northern Bering Sea Crab/Groundfish Survey - Eastern Bering Sea Shelf Survey Extension (NBS) from July to August 2021. The addition of the NBS survey expanded the study area to also cover 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 the Bering Strait, including Norton Sound. Two stern trawlers, the 43.9-m FV *Alaska Knight* and 37.8-m FV *Vesteraalen*, were chartered for these surveys. 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 and 144 total stations in the NBS. 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 and NBS were sampled successfully.

The recent trend of higher-than-average temperatures continued on the EBS shelf for the seventh consecutive year. In 2021, both the mean surface (7.2°C) and bottom (3.3°C) water temperatures were warmer than the survey long-term average of surface (6.7°C) and bottom (2.5°C). The 2021 mean bottom temperatures were the fifth warmest observed since the beginning of the EBS shelf bottom trawl survey time series in 1982.

A total of 118 species of fishes were identified during the EBS and NBS surveys, representing 67 genera and 24 families, as well as 256 invertebrate taxa. In total, organisms representing 12 phyla were identified in the catch.

This report compares the distribution and relative abundance of 37 fish species and two invertebrate taxa with side-by-side maps from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. For select and common fish species, abundance-at-length plots comparing the 2019 and 2021 EBS and NBS 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 (Table Appendix A2 and Appendix B2) and species encountered during the EBS and NBS surveys (Tables Appendix C1 to Appendix D9).

The total estimated animal biomass in the NBS decreased from 4.4 million metric tons (t) in 2019 to 3 million t in 2021. This decline likely represents distributional shifts of some species, which have been unusually abundant in the NBS during recent warm years, but may have shifted farther south again as the seasonal sea ice cover during the winter of 2020-21 was more extensive than in the other recent years. This annual variation underscores the need for continuing EBS and NBS surveys on a regular basis, to learn more about how fish and crab populations are responding to a dynamic and changing environment.

Contents

Introduction

The purpose of the EBS and NBS shelf bottom trawl surveys is to collect information about the fish and invertebrate populations and environmental conditions. In 2021, the Resource Assessment and Conservation Engineering (RACE) Division of National Marine Fisheries Service's (NMFS') Alaska Fisheries Science Center AFSC conducted 39th Eastern Bering Sea Crab/Groundfish Bottom Trawl Survey (EBS) from May to July 2021, as well as the 4th Northern Bering Sea Crab/Groundfish Survey - Eastern Bering Sea Shelf Survey Extension (NBS) from July to August 2021. The EBS survey has occurred annually (except in 2020 due to the COVID-19 pandemic) since 1982 and is the longest-running, standardized time series of fish and invertebrate data in the region (Conner and Lauth, 2017). The standardized NBS survey has only been conducted previously in 2010, 2017, and 2019 (Lauth, 2011). Additionally, in 2021, 20 stations in Bristol Bay were resampled for crab in August in response to low numbers of mature female red king crabs with uneyed embryos caught in Bristol Bay at the beginning of the survey in June (Zacher et al., 2021).

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 2021 EBS survey results with those from the 2019 EBS shelf bottom trawl survey and the 2021 NBS survey results with those from the 2019 NBS 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).

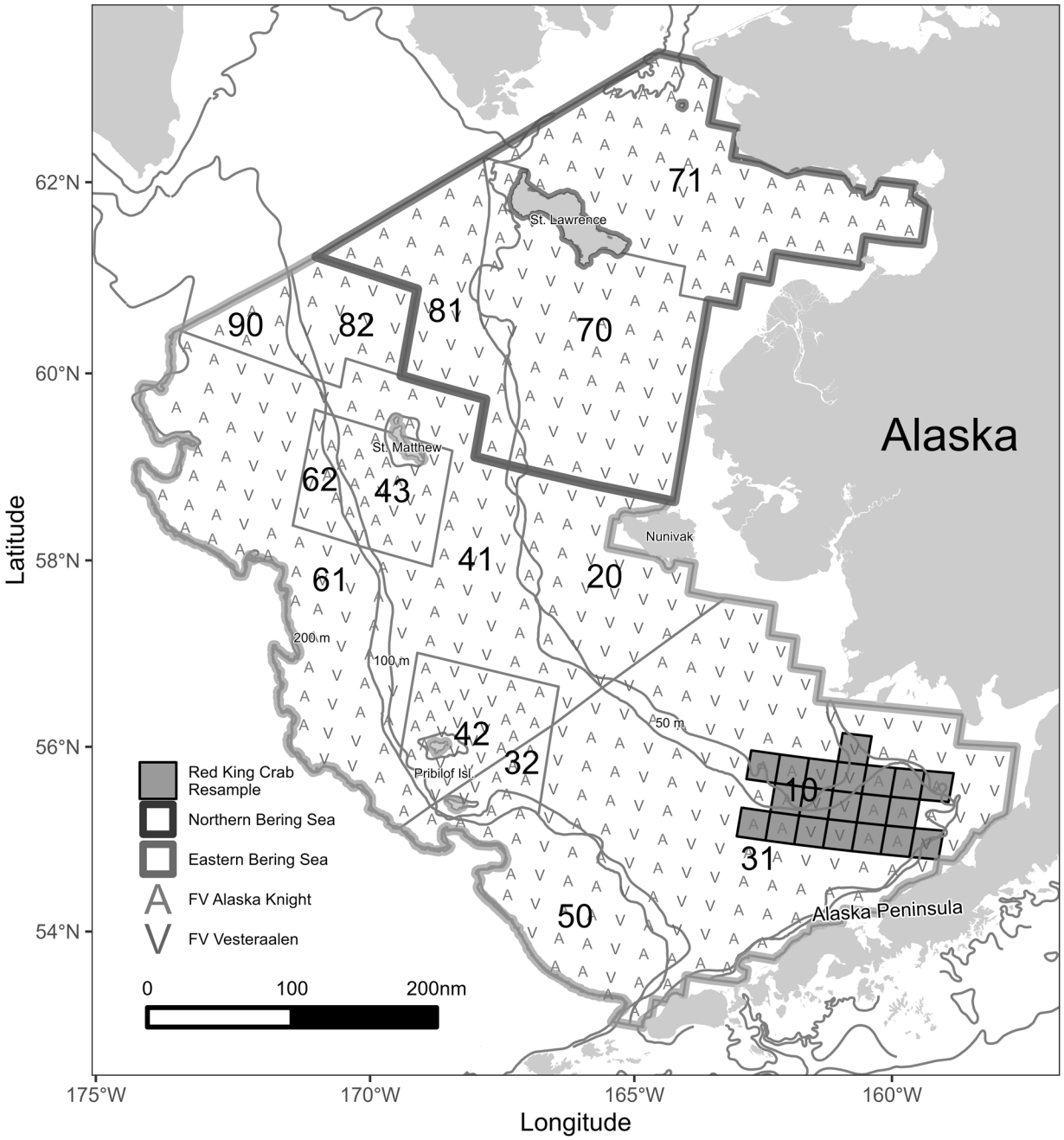

Figure 1. -- Sampled survey stations by vessel and the stratification scheme used for data analysis of the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. The map also depicts the stations sampled by the FV *Alaska Knight* (A) and FV *Vesteraalen* (V) and where Bristol Bay crab resampling was conducted.

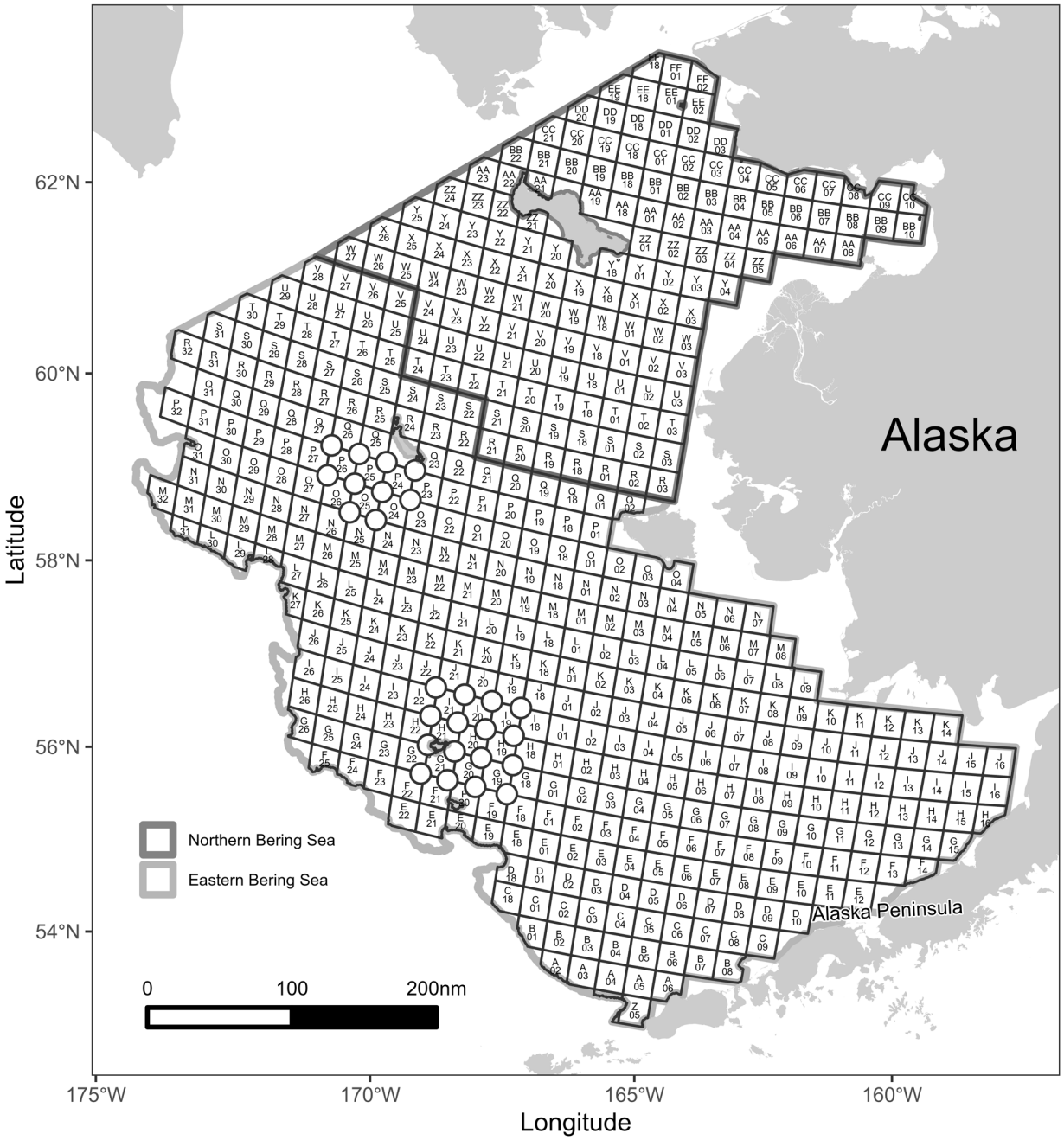

Figure 2. -- Sampling grid and station identifiers for the 2021 eastern Bering Sea and northern Bering Sea continental shelf bottom trawl surveys. Corner stations (denoted by circles) are not labeled for legibility.

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., 2021). 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 surveys 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 re-sampled 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; Hoff and Britt, 2011; Stauffer, 2004). 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 (Figs. 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 (Fig. 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, 2018, 2019 and 2021 (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 rapid response Survey are not directly comparable to the results from the 2010, 2017, 2019, and 2021 NBS surveys. In 2020, no Bering Sea surveys were conducted due to the COVID-19 pandemic.

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; Stabeno et al., 2012; Stevenson and Lauth, 2012, 2019). 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 the effects of changing ocean conditions on fish and crab distributions (Sigler et al., 2015).

Methods

Survey Area and Sampling Design

The standardized eastern and northern Bering Sea bottom trawl surveys are based on a systematic design with 376 fixed sampling stations in the EBS and 144 fixed sampling stations in the NBS 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. In addition to the EBS shelf bottom trawl survey, the 2021 NBS shelf bottom trawl survey was conducted using the same systematic sampling design for stations bounded by the U.S.-Russian Maritime Boundary, the Bering Strait, and Norton Sound.

Survey Vessels and Sampling Gear

The 2021 EBS and NBS surveys were 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.

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 two tow on the FV *Alaska Knight* and 27 tow on the FV *Vesteraalen*. In the NBS, the net mensuration system failed to record data for three tow on the FV *Vesteraalen*. 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

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

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

Figure 3. -- Fishing vessels FV *Alaska Knight* (left) and FV *Vesteraalen* (right) contracted to assist with the 2021 eastern Bering Sea and northern Bering Sea bottom trawl survey.

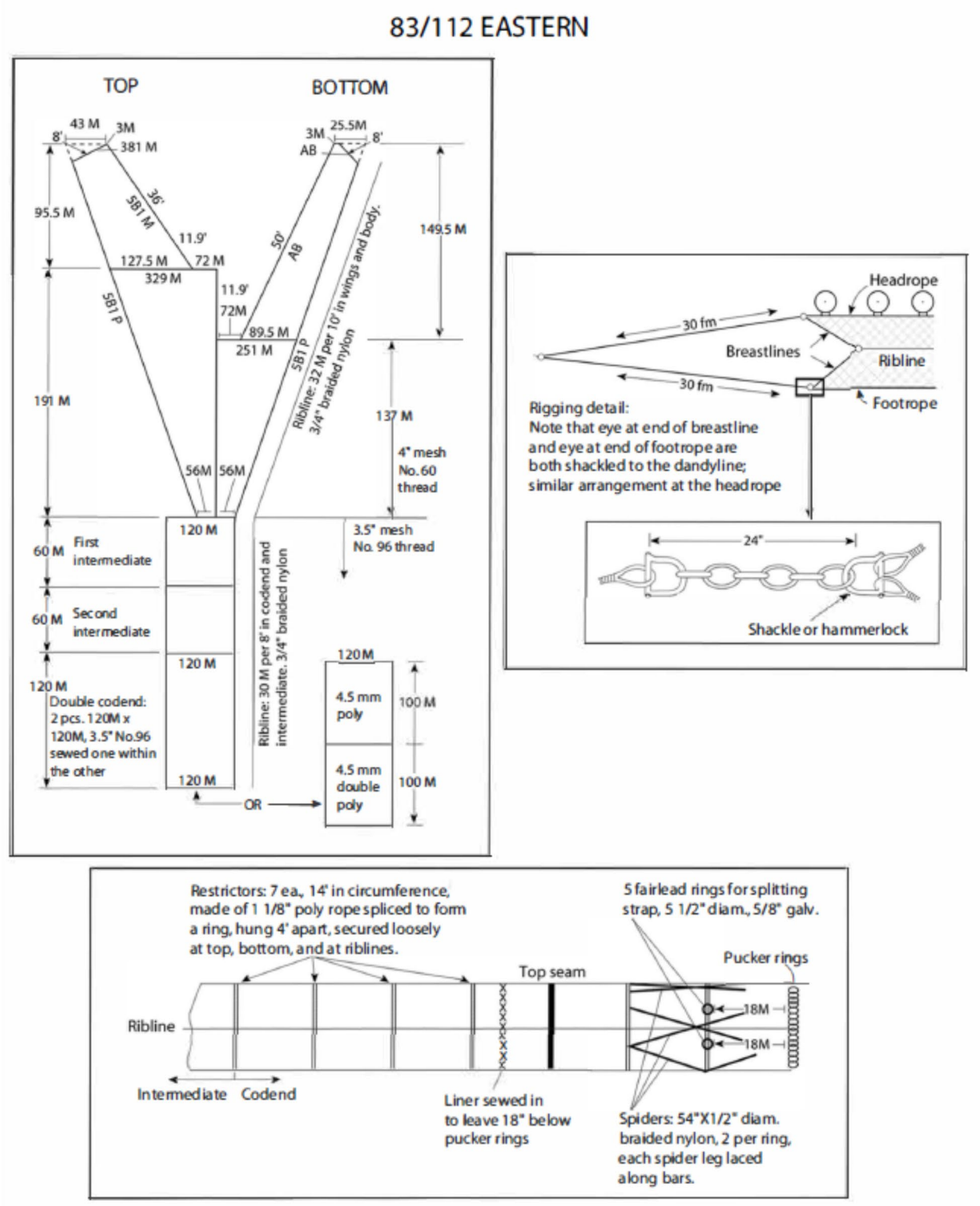

Figure 4. -- Schematic diagram of the 83-112 eastern otter trawl gear used during the 2021 eastern Bering Sea and northern Bering Sea bottom trawl surveys.

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, the FV *Vesteraalen* started sampling on May 31, 2021 and ended on July 21, 2021 and the FV *Alaska Knight* started sampling on June 1, 2021 and ended on July 22, 2021.

For design-based (as opposed to model-based) index catch analysis, the EBS shelf was divided into 12 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).

NBS Sampling Logistics and Stratification Scheme

After the completion of the EBS shelf survey, both vessels transitioned into sampling survey stations in the southwest corner of the NBS survey region. In the NBS, the sampling started on July 22, 2021 for the FV *Vesteraalen* and on July 23, 2021 for the FV *Alaska Knight* and ended for both vessels on August 16, 2021. After the NBS survey was completed, both vessels returned to Dutch Harbor. The NBS shelf was divided into three strata: one including the area north of St. Lawrence Island and Norton Sound and two others south of St. Lawrence Island separated by the 50 m isobath (Fig. 1). Sampling density was 1,367 km^2/station for stratum 70, 1,401 km^2/station for stratum 71, and 1,370 km^2/station for stratum 81 and 1,381 km^2/station for the total NBS (Table 1).

Table 1. -- Stratum areas and sampling densities used during the 2021 eastern Bering Sea and northern Bering Sea bottom trawl surveys. 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
NBS				
Shelf	70	79,261	58	1,367
	71	81,245	58	1,401
	81	38,352	28	1,370
Total		198,858	144	1,381
EBS and NBS				
Total		691,755	520	1,330

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 (Tables 2a and 2b). 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, 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 and NBS (Tables 2a, 2b, 5a, and 5b). Otolith samples were collected following length/region-stratified (cm/sex/southeast and northwest regions) and random-by-haul sampling methods in the EBS and length-stratified (cm/sex) and random-by-haul sampling methods in the NBS (Table 2a and 2b). 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 2a. -- Otolith collection types and counts during the 2021 eastern Bering Sea 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)		
northern rock sole	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
yellowfin sole	5 individuals	10
flathead sole	3 individuals	10
Bering flounder	3 individuals	10
Alaska plaice	2 individuals	1
Greenland turbot	8 adults and 1 juvenile	1
arrowtooth flounder	3 individuals	10
Kamchatka flounder	8 individuals	10
Pacific halibut	individuals	1

Table 2b. -- Otolith collection types and counts during the 2021 northern Bering Sea shelf bottom trawl survey.

Common name	Target collection number per haul	Collect when ≥ n individuals caught in each haul
length-stratified (cm/sex)		
northern rock sole	3 individuals	1
Greenland turbot	2 individuals	1
Kamchatka flounder	1 individuals	1
random-by-haul		
walleye pollock	5 adults and 1 juvenile	20
Pacific cod	4 adults and 1 juvenile	4
yellowfin sole	3 individuals	10
flathead sole	3 individuals	10
Bering flounder	3 individuals	10
Alaska plaice	2 individuals	1
arrowtooth flounder	3 individuals	10
Pacific halibut	individuals	1

Table 3. --Stomach collection targets during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl survey.

Common name	EBS	NBS
Pacific halibut	600	-
arrowtooth flounder and Kamchatka flounder	1250	-
Pacific cod	1750	600
walleye pollock	2500	1200

Catch Data Analysis

Design-based estimates of biomass, population, and size structure of fishes and invertebrate species were calculated from EBS and NBS survey data. A brief description of the procedures used in the analysis of RACE Bering Sea survey data follows (Wakabayashi, Bakkala, and Alton 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 and NBS. 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 and NBS.

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 2021 NPFMC Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region (The Plan Team for the Groundfish Fisheries of the Bering Sea and Aleutian Islands 2021).

Additional Research Projects

In addition to standard survey operations, 23 research projects were undertaken in both the EBS and NBS, and 6 research projects were undertaken in only the EBS during the 2021 survey season (Table 4). A solicitation for research proposals was issued on January 19, 2021. 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 2021, 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 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl survey, sorted by principal investigator and agency.

Project title	Principal investigator	Agency[1]
EBS		
BBRKC preliminary tagging	Allie Conrad	AFSC-RACE
Blood collection for stress physiology	Bianca Prohaska	AFSC-RACE
EBS snow crab radiometrics	Erin Fedewa	AFSC-RACE
Ovigerous snow crab collection for multi-year Kodiak OA experiments	Jen Gardner	AFSC-RACE
Eastern Bering Sea tow duration study (15/30)	Lyle Britt	AFSC-RACE
Observer crab specimen collection	Melanie Rickett	ARO-SFD
EBS & NBS		
Shark population genetics and morphometrics	Cindy Tribuzio	AFSC-ABL
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
MML food habits reference collection	Katie Luxa	AFSC-MML
Live crabs for OA experiments	Chris Long	AFSC-RACE
Juvenile flatfish habitat	Cynthia Yeung	AFSC-RACE
Observer training collection	Duane Stevenson	AFSC-RACE
Snow crab condition	Erin Fedewa	AFSC-RACE
Coral collections	Jerry Hoff	AFSC-RACE
Fish condition index-pollock/cod	Jerry Hoff	AFSC-RACE
Shell condition classification error rates in eastern Bering Sea snow crab	Jon Richar	AFSC-RACE
Length and weight collection for Arctic cod, saffron cod, rex sole, and starry flounder	Liz Dawson	AFSC-RACE
Specimen collection for outreach events	Liz Dawson	AFSC-RACE
Collection of live mature female tanner and snow crab for use in lava-culture by FBE program. Development of thermal response curves.	Louise Copeman	AFSC-RACE
Morphological and genetic identification of larval stages of sandlance species, Ammodytes hexapterus and A. personatus	Melanie Paquin	AFSC-RACE
Light meter calibration	Ned Laman	AFSC-RACE
CTD data collection	RACE	AFSC-RACE
Pacific cod satellite tagging	Susanne McDermott	AFSC-RACE
Arctic and saffron cod growth	Craig Kastelle	AFSC-REFM
Genetics collections from the NBS, EBS, and GOA surveys	Ingrid Spies	AFSC-REFM
Harmful Algal Bloom (HAB) toxins in Alaskan food webs	Kathi Lefebvre	NWFSC
Pacific lamprey collection	Laurie Weitkamp	NWFSC
Salmon shark foraging ecology	Andy Seitz	UAF
Marine ecology of Arctic and Pacific lampreys	Trent Sutton	UAF

[1]AFSC-ABL - Auke Bay Laboratories; AFSC-MACE - Midwater Assessment & Conservation Engineering Division; AFSC-MML - Marine Mammal Laboratory; AFSC-RACE - Resource Assessment & Conservation Engineering Division; AFSC-REFM - Resource Ecology & Fisheries Management Division; ARO-SFD - Sustainable Fisheries Division; NWFSC - Northwest Fisheries Science Center; UAF - University of Alaska Fairbanks

Results and Discussion

A total of 376 EBS stations and 144 NBS stations were successfully sampled in 2021 (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 2021 EBS and NBS survey ranged from 0.4° to 14°C, and near-bottom temperatures (hereafter referred to as bottom temperatures) ranged from -1.7° to 12.5°C. The mean sea surface temperature for the EBS in 2021 was 7.2°C, which was 2°C lower than 2019 (9.2°C) and 0.5°C higher than the time series mean (6.7°C; Figs. 5, 6, 7a, and 7b). In the EBS south of 60°N, surface temperatures increased from east to west across the shelf (Fig. 8b). An average of 11.9°C was observed in Norton Sound (Fig. 8b). During the EBS time series (1982–2021), mean summer bottom temperatures were highly variable, ranging from a low of 0.7°C to a high of 4.4°C. The grand mean for all years was 2.5°C (Fig. 5). The mean survey bottom temperature for the EBS in 2021 was 3.3°C (Fig. 5), which was 0.9°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, Kachel, 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 15 years, 2006-2013 were colder than average ("cold stanza"; Fig. 7a), while 2014-2019 and 2021 were warmer than average ("warm stanza"; Fig. 7b). There was no survey in 2020 due to the COVID-19 pandemic. 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 39-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 2021, the cold pool covered 58,975 km^2 (12%) of the EBS shelf survey area, which was the fourth lowest areal coverage in the 39-year time series followed by 2018 (first), 2019 (second), and 2003 (third).

The 2019 and 2021 EBS and NBS surveys provided a quasi-synoptic view of the spatial pattern of bottom temperatures across the entire EBS and NBS 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 2019 cold pool was composed of colder water that occupied 5.4% 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 2021 cold pool occupied 12% of the EBS shelf survey area (Fig. 6). The 2021 cold pool concentrated in the northwestern portion of the northern Bering Sea surrounding St. Lawrence Island and north and west of St. Matthew Island where bottom temperatures were < 2°C (Fig. 7b). In 2021, there were also warmer bottom temperatures (> 4°C) along the inner domain from Bristol Bay to Chirikov Basin compared to 2019 when slightly warmer bottom temperatures (between 6°C and 8°C) were found along the inner domain of Bristol Bay and butted against the west side of Nunivak Island (Fig. 7a). Warmer bottom temperatures across all domains in the

southeastern Bering Sea in 2021 allowed for potential north-south and east-west movement of demersal marine fauna. Warmer bottom temperatures along most of the inner domain and around Nunivak Island from 2014 to 2016 may have also increased opportunities for northward movement (Figs. 7a and 7b).

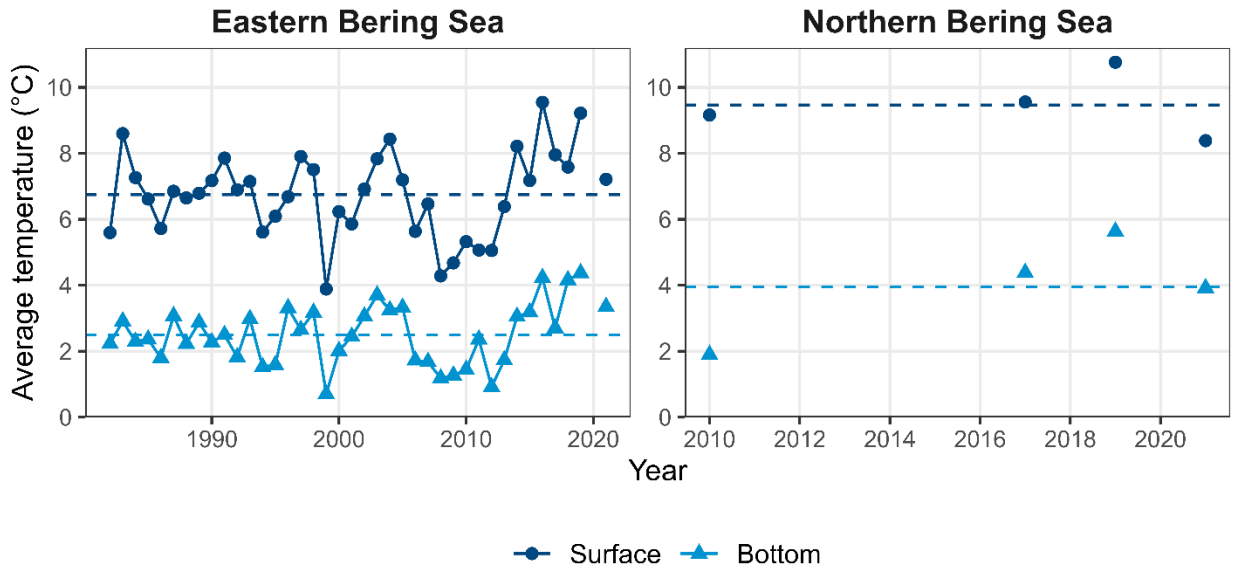

Figure 5. -- Average summer surface (light blue triangles) and bottom (dark blue circles) and time-series average surface (dark blue dashed line) and bottom (light blue dashed line) temperatures (°C) on the EBS shelf, based on data collected during standardized summer bottom trawl surveys from 1982–2021 (left), and NBS shelf based on data collected during standardized summer bottom trawl surveys (right).

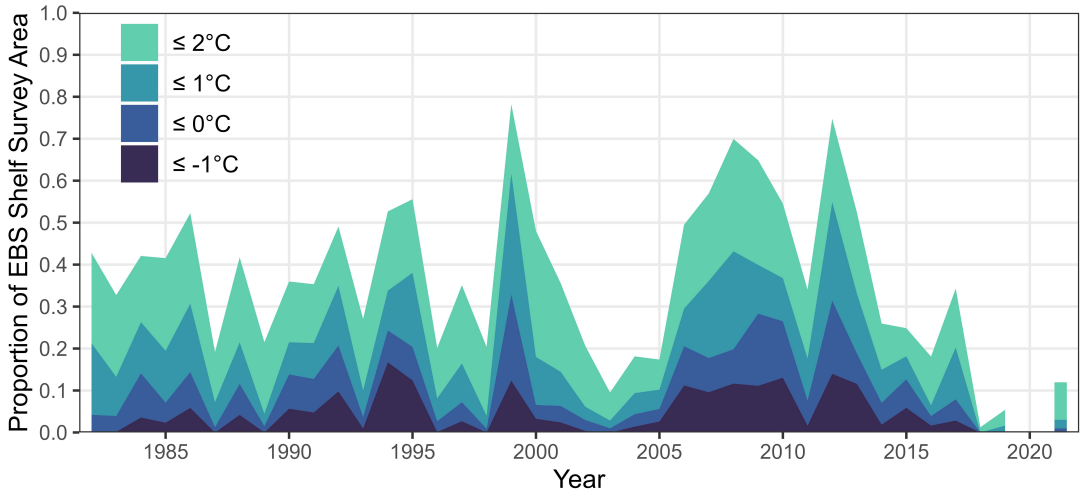

Figure 6. -- Annual summer cold pool extent on the eastern Bering Sea shelf, based on observations from the eastern Bering Sea bottom trawl survey. The extent of the cold pool is shown in proportion to the total southern EBS shelf survey area. Shading denotes near-bottom temperatures ≤ 2°C (aqua blue),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

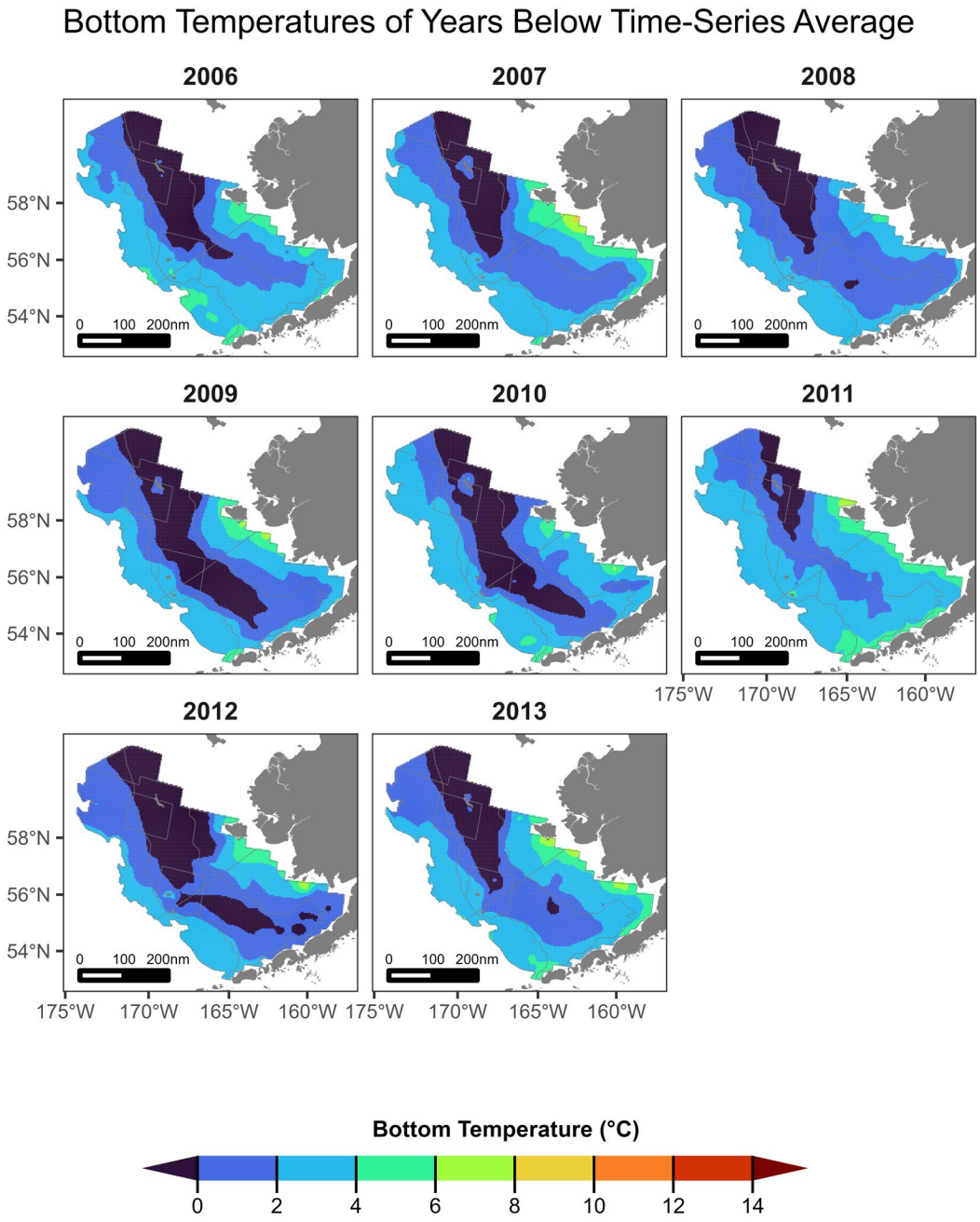

Figure 7a. -- EBS shelf bottom trawl survey near-bottom temperatures in years below the time-series average (2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013).

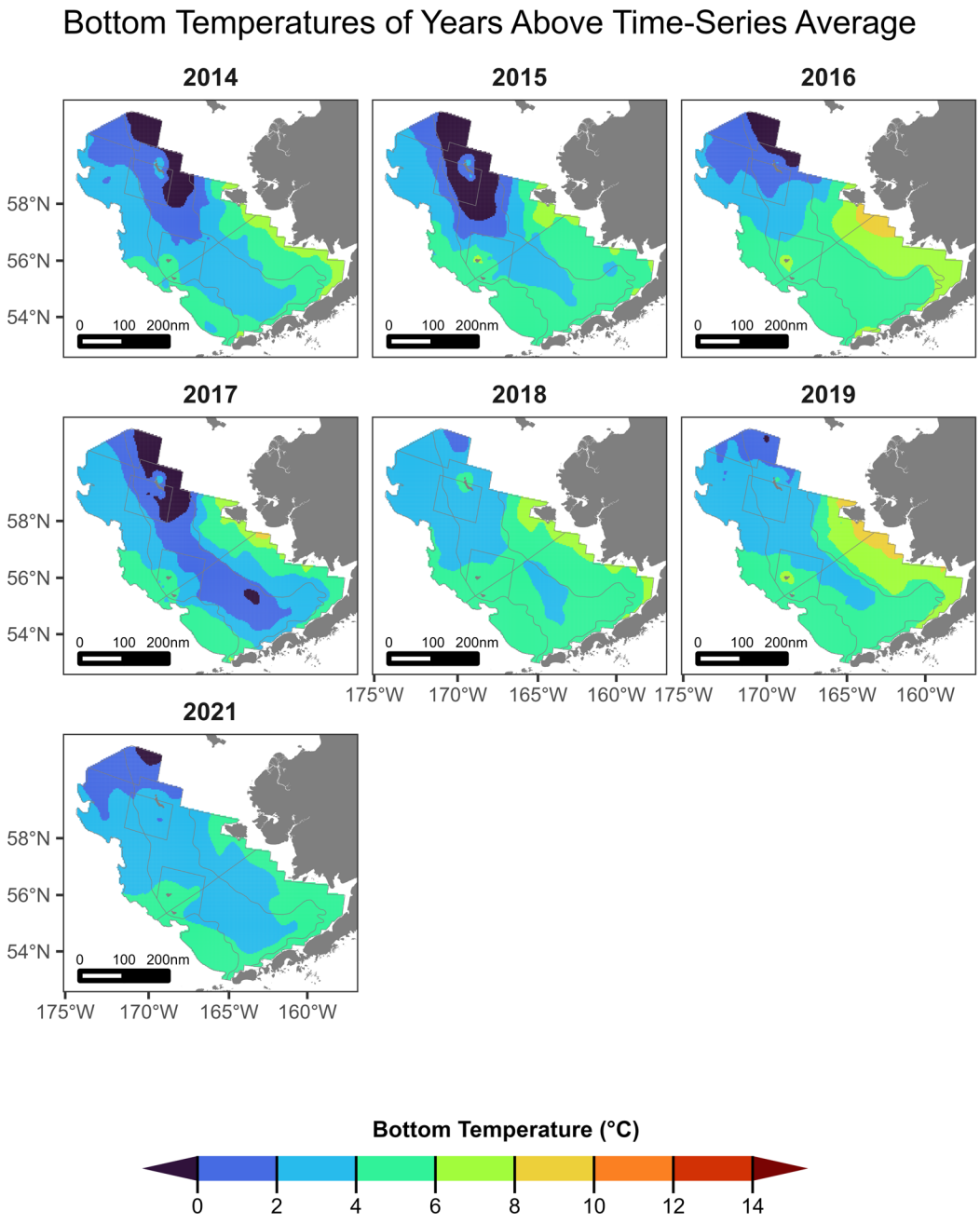

Figure 7b. -- EBS shelf bottom trawl survey near-bottom temperatures in years above the time-series average (2014, 2015, 2016, 2017, 2018, 2019, and 2021).

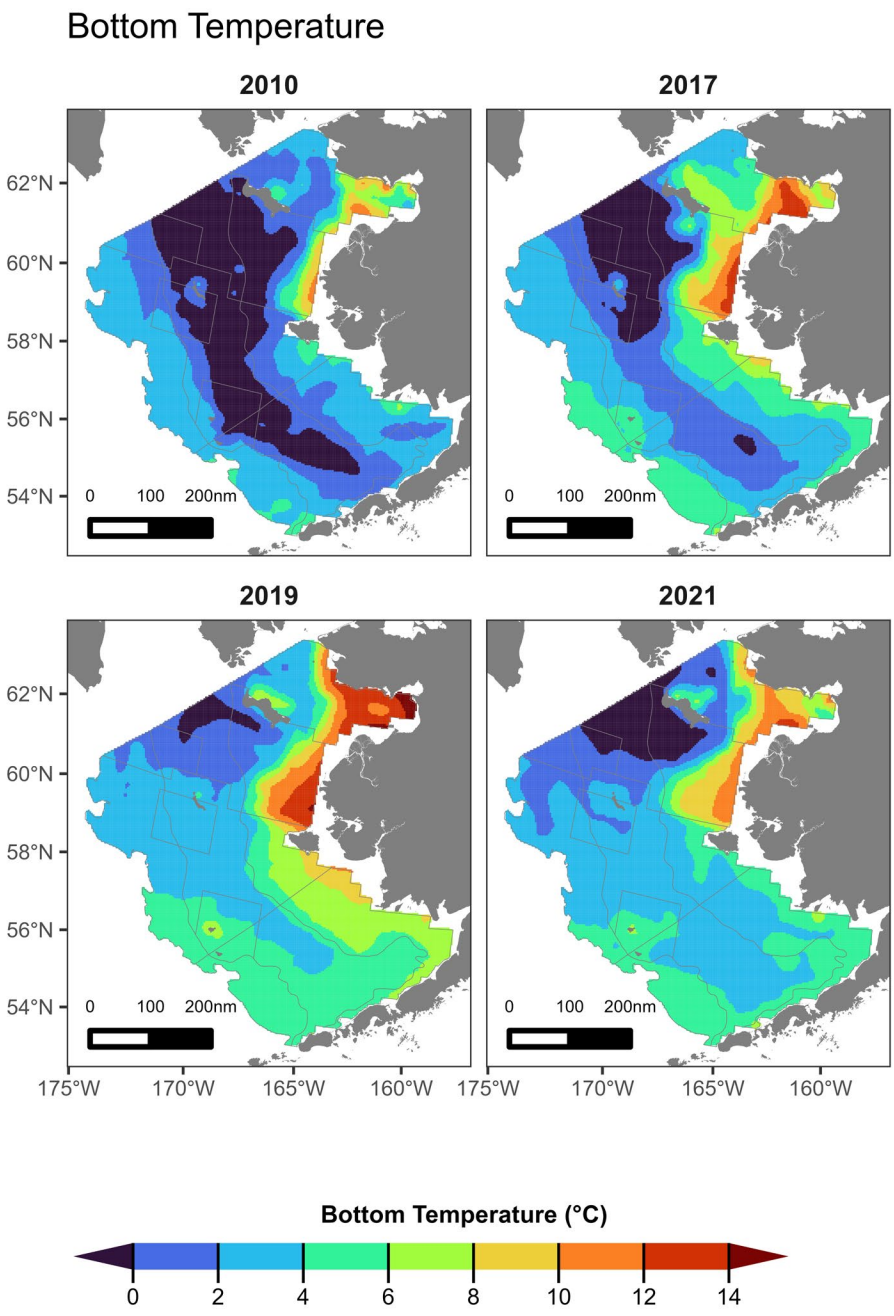

Figure 8a. -- Bottom temperatures (°C) in the NBS and EBS during the 2010, 2017, 2019, and 2021 surveys, which included the full NBS shelf bottom trawl survey.

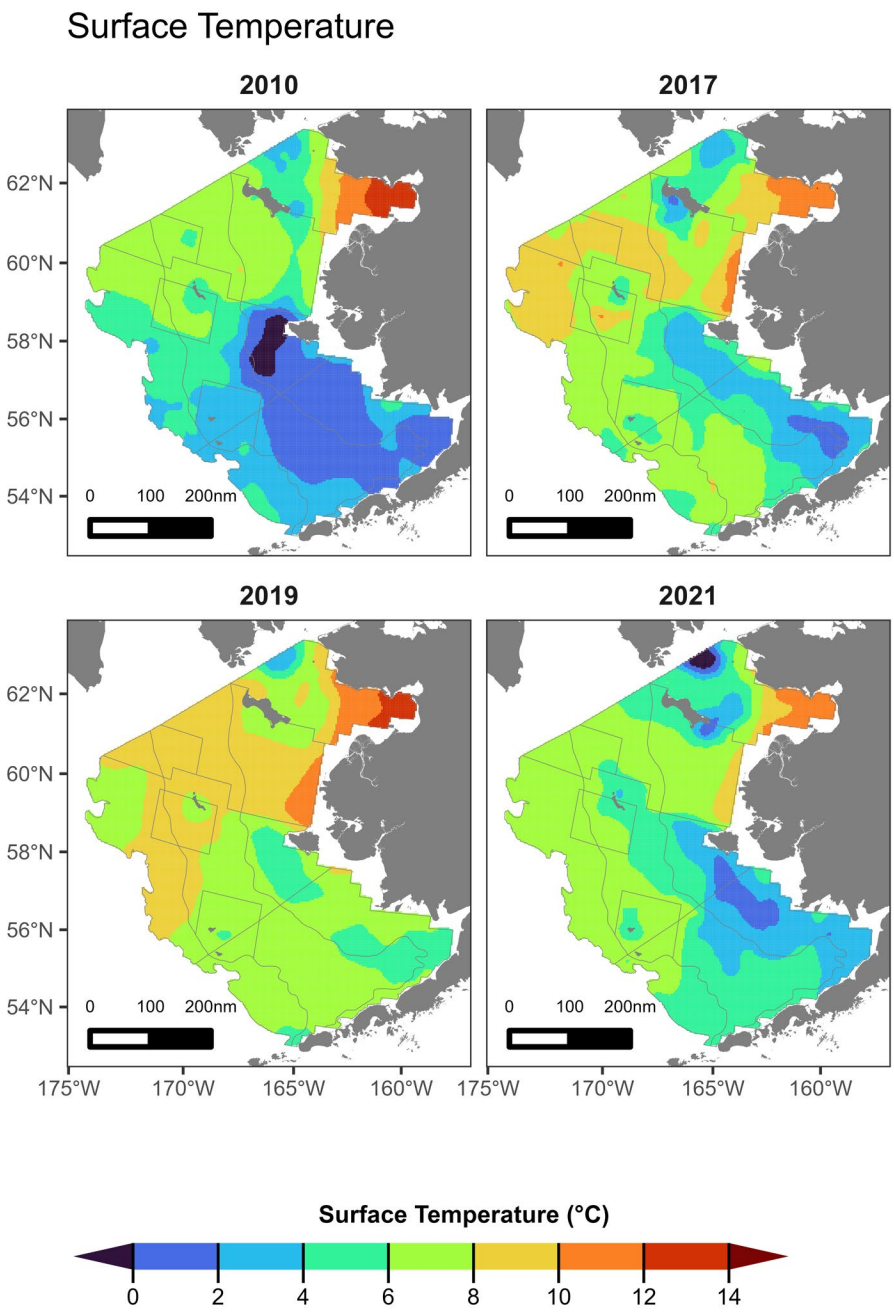

Figure 8b. -- Surface temperatures (°C) in the NBS and EBS during the 2010, 2017, 2019, and 2021 surveys, which included the full NBS shelf bottom trawl survey.

Survey Data and Specimen Collections

Specimens collected during the EBS and NBS shelf trawl survey are shown in Tables 5a and 5b. A total of 222,232 length measurements were collected from 46 fish taxa; 10,301 otolith age structure samples were collected from 11 fish taxa; 7,320 stomach samples were collected from four fish taxa; 43 stress physiology samples were collected from three fish taxa; and 224 fat meter condition samples were collected from two fish taxa. Other special collections are listed in Table 4.

Table 5a. -- Biological data collected during the 2021 eastern Bering Sea shelf bottom trawl survey. The annual crab technical memorandum produced by the shellfish assessment program summarizes crab samples collected during the survey.

EBS	Length measurements	Otolith age structure samples	Stomach samples	Stress physiology samples	Fat meter condition samples
Alaska plaice	8,530	522	-	-	-
Alaska skate	3,855	-	-	-	-
Aleutian skate	54	-	-	-	-
arrowtooth flounder	13,909	601	-	-	-
arrowtooth flounder and Kamchatka flounder	-	-	1,313	-	-
Atka mackerel	2	-	-	-	-
Bathyraja sp.	12	-	-	-	-
Bering flounder	1,192	71	-	-	-
Bering skate	204	-	-	-	-
big skate	22	-	-	-	-
bigmouth sculpin	197	-	-	-	-
blackspotted rockfish	65	-	-	-	-
butter sole	669	-	-	-	-
chinook salmon	1	-	-	-	-
chum salmon	5	-	-	-	-
Dover sole	49	-	-	-	-
flathead sole	21,273	832	-	-	-
great sculpin	637	-	-	-	-
Greenland turbot	97	96	-	-	-
Kamchatka flounder	1,678	462	-	-	-
longhead dab	1,619	-	-	-	-
mud skate	4	-	-	-	-
northern rock sole	23,458	655	-	-	-
northern rockfish	42	-	-	-	-
Pacific cod	14,040	1,366	1,598	42	100
Pacific halibut	3,614	784	288	1	-
Pacific ocean perch	176	-	-	-	-
Pacific sleeper shark	1	-	-	-	-
Pacific tomcod	1	-	-	-	-
pink salmon	1	-	-	-	-
plain sculpin	1,551	-	-	-	-
prowfish	1	-	-	-	-
rex sole	2,093	-	-	-	-
rougheye rockfish	1	-	-	-	-
sablefish	156	-	-	-	-
saffron cod	3	-	-	-	-
Sakhalin sole	3	-	-	-	-
shorthorn sculpin	56	-	-	-	-
slender sole	2	-	-	-	-
southern rock sole	138	-	-	-	-
starry flounder	815	-	-	-	-
walleye pollock	53,545	1,535	2,702	-	124

Table 5a. -- Biological data collected during the 2021 eastern Bering Sea shelf bottom trawl survey. The annual crab technical memorandum produced by the shellfish assessment program summarizes crab samples collected during the survey.

EBS	Length measurements	Otolith age structure samples	Stomach samples	Stress physiology samples	Fat meter condition samples
whiteblotched skate	1	-	-	-	-
yellow Irish lord	1,003	-	-	-	-
yellowfin sole	18,757	991	-	-	-
Total	**173,532**	**7,915**	**5,901**	**43**	**224**

Table 5b. -- Biological data collected during the 2021 northern Bering Sea shelf bottom trawl survey. The annual crab technical memorandum produced by the shellfish assessment program summarizes crab samples collected during the survey.

NBS	Length measurements	Otolith age structure samples	Stomach samples
Alaska plaice	8,058	267	-
Alaska skate	620	-	-
Arctic cod	203	-	-
arrowtooth flounder	46	6	7
Bering flounder	1,645	136	-
butterfly sculpin	3	-	-
chinook salmon	3	-	-
flathead sole	8	-	-
great sculpin	70	-	-
Kamchatka flounder	1	-	-
longhead dab	639	-	-
northern rock sole	4,294	339	-
Pacific cod	3,316	395	421
Pacific halibut	466	334	94
plain sculpin	978	-	-
saffron cod	2,021	-	-
Sakhalin sole	1,258	-	-
shorthorn sculpin	283	-	-
starry flounder	1,639	-	-
walleye pollock	10,586	526	897
yellowfin sole	12,563	383	-
Total	**48,700**	**2,386**	**1,419**

Species Composition

A total of 118 different fish species representing 24 families and 67 genera were identified during the 2021 EBS and NBS surveys (Appendix A1 and Appendix B1). In 2021, the EBS survey recorded 91 total taxa, of which 86 were identified to the species level and the NBS survey recorded 70 total taxa, of which 62 were identified to the species level. The remaining fish taxa in each survey area were identified to the genus level or higher. Of the fish species found in the EBS, 46 did not occur in the NBS (Table 6). In comparison, zero species were present in the NBS but absent in EBS (Table 6). In 2021, 11 flatfish species were present in EBS and NBS (Alaska plaice (*Pleuronectes quadrituberculatus*), arrowtooth flounder (*Atheresthes stomias*), Bering flounder (*Hippoglossoides robustus*), flathead sole (*Hippoglossoides elassodon*), Kamchatka flounder (*Atheresthes evermanni*), longhead dab (*Limanda proboscidea*), northern rock sole (*Lepidopsetta polyxystra*), Pacific halibut (*Hippoglossus stenolepis*), Sakhalin sole (*Limanda sakhalinensis*), starry flounder (*Platichthys stellatus*), and yellowfin sole (*Limanda aspera*)); six flatfish species were present in EBS but absent in NBS (butter sole (*Isopsetta isolepis*), Dover sole (*Microstomus pacificus*), Greenland turbot (*Reinhardtius hippoglossoides*), rex sole (*Glyptocephalus zachirus*), slender sole (*Lyopsetta exilis*), and southern rock sole (*Lepidopsetta bilineata*)); and two flatfish species were present in NBS but absent in EBS (Arctic flounder (*Liopsetta glacialis*) and hybrid starry flounder X Alaska plaice (*Platichthys stellatus X Pleuronectes quadrituberculatus hybrid*); Table 6).

Two hundred and fifty six different invertebrate taxa representing 13 phyla were identified during the 2021 EBS and NBS survey (Appendix A2 and Appendix B2). In 2021, the EBS survey recorded a total of 214 taxa of which 135 were identified to the species level and the NBS survey recorded a total of 153 taxa of which 100 were identified to the species level. The remaining invertebrate taxa in each survey area 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.

Table 6. -- Fish taxa from survey catches in the eastern Bering Sea shelf (EBS) and northern Bering Sea shelf (NBS).

Present in EBS but absent in NBS **Common Name *(Scientific Name)***	**Present in NBS but absent in EBS** **Common Name *(Scientific Name)***
Aleutian alligatorfish *(Aspidophoroides monopterygius)*	antlered sculpin *(Enophrys diceraus)*
Aleutian skate *(Bathyraja aleutica)*	Arctic alligatorfish *(Ulcina olrikii)*
Arctic sand lance *(Ammodytes hexapterus)*	Arctic cod *(Boreogadus saida)*
Atka mackerel *(Pleurogrammus monopterygius)*	Arctic flounder *(Liopsetta glacialis)*
Bering skate *(Bathyraja interrupta)*	Arctic sculpin *(Myoxocephalus scorpioides)*
big skate *(Beringraja binoculata)*	Arctic shanny *(Stichaeus punctatus)*
bigmouth sculpin *(Hemitripterus bolini)*	Arctic staghorn sculpin *(Gymnocanthus tricuspis)*
blackfin poacher *(Bathyagonus nigripinnis)*	bearded warbonnet *(Chirolophis snyderi)*
blackspotted rockfish *(Sebastes melanostictus)*	belligerent sculpin *(Megalocottus platycephalus)*
blotched snailfish *(Crystallichthys cyclospilus)*	bride sculpin *(Artediellus miacanthus)*
butter sole *(Isopsetta isolepis)*	eyeshade sculpin *(Nautichthys pribilovius)*
chum salmon *(Oncorhynchus keta)*	festive snailfish *(Liparis marmoratus)*
darkfin sculpin *(Malacocottus zonurus)*	hamecon *(Artediellus scaber)*
Dover sole *(Microstomus pacificus)*	hookhorn sculpin *(Artediellus pacificus)*
gray starsnout *(Bathyagonus alascanus)*	hybrid starry flounder X Alaska plaice (Pleuronectidae unid.)
Greenland turbot *(Reinhardtius hippoglossoides)*	marbled eelpout *(Lycodes raridens)*
kelp greenling *(Hexagrammos decagrammus)*	nebulous snailfish *(Liparis bathyarcticus)*
marbled snailfish *(Liparis dennyi)*	ninespine stickleback *(Pungitius pungitius)*
mud skate *(Bathyraja taranetzi)*	pighead prickleback *(Acantholumpenus mackayi)*
northern rockfish *(Sebastes polyspinis)*	polar eelpout *(Lycodes turneri)*
northern sculpin *(Icelinus borealis)*	threespine stickleback *(Gasterosteus aculeatus)*
Pacific lamprey *(Lampetra tridentata)*	
Pacific ocean perch *(Sebastes alutus)*	
Pacific sandfish *(Trichodon trichodon)*	
Pacific sleeper shark *(Somniosus pacificus)*	
Pacific tomcod *(Microgadus proximus)*	
pink salmon *(Oncorhynchus gorbuscha)*	
prowfish *(Zaprora silenus)*	
pygmy poacher *(Odontopyxis trispinosa)*	
rex sole *(Glyptocephalus zachirus)*	
rougheye rockfish *(Sebastes aleutianus)*	
sablefish *(Anoplopoma fimbria)*	
salmon snailfish *(Careproctus rastrinus)*	
sawback poacher *(Leptagonus frenatus)*	
searcher *(Bathymaster signatus)*	
shortfin eelpout *(Lycodes brevipes)*	
slender sole *(Lyopsetta exilis)*	
southern rock sole *(Lepidopsetta bilineata)*	
spatulate sculpin *(Icelus spatula)*	
spectacled sculpin *(Triglops scepticus)*	
spinycheek starsnout *(Bathyagonus infraspinatus)*	
spinyhead sculpin *(Dasycottus setiger)*	

Table 6. -- Fish taxa from survey catches in the eastern Bering Sea shelf (EBS) and northern Bering Sea shelf (NBS).

Present in EBS but absent in NBS **Common Name *(Scientific Name)***	**Present in NBS but absent in EBS** **Common Name *(Scientific Name)***
thorny sculpin *(Icelus spiniger)*	
whitebarred prickleback *(Poroclinus rothrocki)*	
whiteblotched skate *(Bathyraja maculata)*	
yellow Irish lord *(Hemilepidotus jordani)*	

Biomass, Abundance, and Catch per Unit Effort

The total demersal animal biomass for the EBS was estimated at 11.9 million t and total demersal animal biomass for the NBS was estimated at 2.9 million t. In the EBS, the proportion of fishes (75%; Table 7a) was higher than invertebrates (24%; Table 8a) and in the NBS, the proportion of fishes (65%; Table 7b) was also higher than invertebrates (32%; Table 8b). The lower relative fish biomass in the NBS than in the EBS is consistent with results of a broader analysis of all survey years in Stevenson and Lauth (2012) showing decreasing fish biomass with increasing latitude on the Bering Sea continental shelf (Tables 7a and 7b). This trend may change over time with warming ocean temperatures.

Pleuronectidae (flatfishes) and Gadidae (cods) were the fish families with greatest biomass in both the EBS (37.3% and 30.6% of the total biomass, respectively), and the NBS (34.3% and 24.6% of the total biomass, respectively; 7a and 7b). In the EBS, the family Gadidae was primarily comprised of walleye pollock (*Gadus chalcogrammus*, 25.4%) and Pacific cod (*Gadus macrocephalus*, 5.2%) the family Pleuronectidae was primarily comprised of yellowfin sole (*Limanda aspera*, 13.6%), northern rock sole (*Lepidopsetta polyxystra*, 8.7%), and flathead sole (*Hippoglossoides elassodon*, 5.7%; Table 7a and 7b). In the NBS, the family Gadidae was primarily comprised of walleye pollock (*Gadus chalcogrammus*, 16.4%), Pacific cod (*Gadus macrocephalus*, 7.8%), and other cods (0.3%) the family Pleuronectidae was primarily comprised of yellowfin sole (*Limanda aspera*, 17.1%) and northern rock sole (*Lepidopsetta polyxystra*, 2.6%; Table 7a and 7b).

Noticeable changes were observed in both the EBS and NBS the benthic communities between 2019 and 2021. The total estimated biomass in the EBS decreased from 16.3 million t in 2019 to 13.2 million t in 2021. Taxa that significantly increased in biomass included all shrimps (80%), all worms (41%), all poachers (40%), northern Neptune whelk (34%), and hermit crabs (27%; Table 9a). Large decreases in biomass were observed for walleye pollock (-44%), other crabs (-61%), shorthorn sculpin (-75%), saffron cod (-100%), and Arctic cod (-100%; Table 9a). The total estimated biomass in the NBS decreased from 4.4 million t in 2019 to 3 million t in 2021. Taxa that significantly increased in biomass included all tunicates (162%), corals (105%), all shrimps (87%), Arctic cod (77%), and starry flounder (47%; Table 9b). Large decreases in biomass were observed for walleye pollock (-59%), flathead sole (-70%), eelpouts (-75%), saffron cod (-88%), and Greenland turbot (-100%; Table 9b). 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 65% (an average of 172 kg/ha per station) of total mean fish and invertebrate CPUE (an average of 264 kg/ha per station) and 73% of total mean fish CPUE (an average of 235 kg/ha per station; Table 10a). The top 10 fish taxa in the NBS accounted for 62% (an

average of 90 kg/ha per station) of total mean fish and invertebrate CPUE (an average of 146 kg/ha per station) and 95% of total mean fish CPUE (an average of 95 kg/ha per station; Table 10a).

Table 7a. -- Biomass estimates (t) for major fish taxa collected during the 2021 eastern Bering Sea 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)		17,719 ±	2,976	0.0015	5,563	2,674	5,159	3,849	402	69	3	0
Cottidae (sculpins)		138,636 ±	22,529	0.0116	28,504	11,582	23,598	34,831	4,339	29,280	2,612	3,889
Gadidae (cods)	Pacific cod	616,267 ±	60,742	0.0516	83,288	49,319	98,634	211,668	16,275	99,267	40,980	16,835
	walleye pollock	3,034,317 ±	437,692	0.2542	144,860	88,069	728,267	644,820	120,512	971,117	201,007	135,666
	other cods	11 ±	17	<0.0001	2	0	9	0	0	0	0	0
	total Gadidae (cods)	3,650,594 ±	430,968	0.3058	228,150	137,388	826,910	856,488	136,787	1,070,384	241,987	152,501
Hexagrammidae (greenlings)		577 ±	494	<0.0001	332	18	54	14	159	0	0	0
Liparidae (snailfishes)		771 ±	526	<0.0001	2	0	2	73	7	535	40	111
Osmeridae (smelts)		772 ±	511	<0.0001	266	23	11	2	471	0	0	0
Pleuronectidae (flatfishes)	Alaska plaice	333,830 ±	57,662	0.0280	83,786	65,039	86,541	85,297	225	5,716	6,500	726
	arrowtooth flounder	459,660 ±	77,751	0.0385	1,668	218	166,589	59,338	133,703	95,560	116	2,467
	Bering flounder	9,524 ±	3,733	0.0008	3	38	2	1,623	0	22	6,607	1,228
	flathead sole	676,077 ±	153,841	0.0566	26,248	896	154,419	132,260	45,839	298,970	9,096	8,349
	Kamchatka flounder	33,011 ±	4,570	0.0028	0	0	3,389	6,074	5,401	16,600	65	1,481
	northern rock sole	1,034,224 ±	173,811	0.0866	499,847	124,815	181,538	215,276	2,564	2,344	7,315	525
	Pacific halibut	131,416 ±	20,169	0.0110	36,901	25,456	22,650	28,547	6,261	10,595	1,006	0
	yellowfin sole	1,622,913 ±	218,612	0.1360	847,760	261,908	331,218	180,738	119	8	1,163	0
	other flatfish	152,651 ±	42,911	0.0128	78,854	7,217	30,810	344	20,331	15,087	8	0
	total Pleuronectidae (flatfishes)	4,453,305 ±	328,092	0.3731	1,575,068	485,587	977,157	709,496	214,444	444,903	31,875	14,776
Rajidae (skates)	Alaska skate	467,910 ±	45,126	0.0392	82,901	68,779	80,808	99,494	42,197	77,975	7,197	8,559
	other skates	46,016 ±	14,919	0.0039	6,217	0	11,515	770	17,624	9,478	5	407
	total Rajidae (skates)	513,926 ±	46,495	0.0431	89,118	68,779	92,322	100,263	59,821	87,454	7,202	8,966
Scorpaenidae (rockfishes)	Pacific ocean perch	3,373 ±	3,675	0.0003	0	0	0	0	1,085	2,288	0	0
	other rockfish	3,237 ±	4,387	0.0003	0	0	0	0	3,237	0	0	0
	total Scorpaenidae (rockfishes)	6,610 ±	5,918	0.0006	0	0	0	0	4,322	2,288	0	0
Stichaeidae (blennies)		13 ±	8	<0.0001	0	0	6	1	0	5	0	0
Zoarcidae (eelpouts)		37,870 ±	8,258	0.0032	256	3	3,112	10,291	130	20,298	76	3,705
Other		88,461 ±	30,353	0.0074	34,647	15,473	7,996	10,634	7,389	6,908	2,733	2,680
Total		**8,909,256 ±**	**546,140**	**0.7463**	**1,961,907**	**721,527**	**1,936,327**	**1,725,943**	**428,272**	**1,662,124**	**286,529**	**186,627**

[1]Proportion of total estimated biomass is 11,937,266 t for fish and invertebrates in the EBS bottom trawl survey.

Table 7b. -- Biomass estimates (t) for major fish taxa collected during the 2021 northern Bering Sea shelf bottom trawl survey.

Taxon		Estimated total biomass (t) ± 95% confidence interval		Proportion of total animal biomass[1]	Estimated biomass by stratum (t)		
					70	71	81
Agonidae (poachers)		779 ±	284	0.0003	596	128	55
Cottidae (sculpins)		32,002 ±	6,007	0.0110	12,297	16,858	2,847
Gadidae (cods)	Pacific cod	227,577 ±	81,296	0.0785	95,851	53,808	77,917
	walleye pollock	474,448 ±	137,597	0.1636	153,802	178,531	142,115
	other cods	10,056 ±	4,137	0.0035	1,132	8,919	6
	total Gadidae (cods)	712,080 ±	156,320	0.2456	250,785	241,257	220,038
Hexagrammidae (greenlings)		154 ±	107	<0.0001	105	49	0
Liparidae (snailfishes)		329 ±	167	0.0001	61	127	141
Osmeridae (smelts)		1,950 ±	902	0.0007	1,291	646	12
Pleuronectidae (flatfishes)	Alaska plaice	344,578 ±	97,846	0.1188	256,954	50,740	36,884
	arrowtooth flounder	1,740 ±	1,769	0.0006	451	0	1,289
	Bering flounder	8,384 ±	3,685	0.0029	1,200	906	6,278
	flathead sole	138 ±	253	<0.0001	0	0	138
	Kamchatka flounder	33 ±	66	<0.0001	0	0	33
	northern rock sole	76,630 ±	30,455	0.0264	43,823	12,293	20,515
	Pacific halibut	25,995 ±	7,429	0.0090	17,941	6,643	1,411
	yellowfin sole	496,038 ±	104,337	0.1711	367,755	97,055	31,228
	other flatfish	42,268 ±	16,030	0.0146	8,493	32,772	1,004
	total Pleuronectidae (flatfishes)	995,806 ±	143,844	0.3434	696,618	200,409	98,779
Rajidae (skates)	Alaska skate	80,207 ±	32,324	0.0277	60,551	7,514	12,143
	other skates	62 ±	45	<0.0001	29	26	7
	total Rajidae (skates)	80,269 ±	31,964	0.0277	60,580	7,539	12,150
Stichaeidae (blennies)		757 ±	403	0.0003	10	747	0
Zoarcidae (eelpouts)		425 ±	347	0.0001	0	310	115
Other		61,521 ±	46,815	0.0212	40,580	14,449	6,492
Total		**1,886,072 ±**	**221,203**	**0.6504**	**1,062,923**	**482,520**	**340,629**

[1]Proportion of total estimated biomass is 2,899,793 t for fish and invertebrates in the NBS bottom trawl survey.

Table 8a. -- Biomass estimates (t) for major invertebrate taxa collected during the 2021 eastern Bering Sea 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		111,300 ±	30,169	0.0093	4,355	1,832	30,934	74,025	0	139	0	15
Coelenterata		133,077 ±	20,810	0.0111	12,757	931	53,405	34,306	15,735	6,710	6,898	2,336
Crustacea	shrimps	5,173 ±	1,819	0.0004	37	9	268	240	1,331	3,119	15	154
	other crustaceans	221 ±	221	<0.0001	112	0	36	73	0	0	0	0
	total Crustacea	5,394 ±	1,839	0.0005	149	9	304	312	1,332	3,119	15	154
Echinodermata	Asteroidea (sea stars)	1,249,027 ±	213,259	0.1046	350,060	285,667	223,025	180,395	1,050	170,716	4,683	33,432
	Echinoidea (sea urchins)	28,688 ±	18,515	0.0024	110	1	7,420	7,571	10,344	3,131	5	105
	Holothuroidea (sea cucumbers)	12,013 ±	8,550	0.0010	1,491	0	7,176	2,749	35	6	556	0
	Ophiuroidea (brittle stars)	397,029 ±	104,049	0.0333	13,018	2,431	114,356	96,875	2,214	160,093	6,710	1,332
	total Echinodermata	1,686,757 ±	237,991	0.1413	364,679	288,098	351,978	287,591	13,643	333,945	11,954	34,869
find my group		394,640 ±	63,274	0.0331	17,764	15,050	166,626	142,525	8,472	42,263	1,343	598
Mollusca	Gastropoda (snails)	467,429 ±	67,609	0.0392	13,852	5,051	175,021	152,760	8,907	95,895	3,476	12,468
	octopuses	5,061 ±	3,051	0.0004	0	0	753	804	131	3,320	0	53
	Pelecypoda (bivalves)	14,952 ±	11,932	0.0013	767	261	11,193	1,493	320	812	32	75
	squids	144 ±	208	<0.0001	0	0	1	1	108	34	0	0
	total Mollusca	487,587 ±	68,737	0.0408	14,619	5,312	186,967	155,059	9,466	100,060	3,508	12,595
Porifera (sponges)		8,883 ±	4,917	0.0007	828	191	6,660	17	835	352	0	0
Other		12,839 ±	10,010	0.0011	92	69	1,244	1,079	24	9,999	3	329
Total		**2,840,477 ±**	**259,117**	**0.2380**	**415,243**	**311,492**	**798,119**	**694,913**	**49,507**	**496,587**	**23,722**	**50,895**

[1]Proportion of total estimated biomass is 11,937,266 t for fish and invertebrates in the EBS bottom trawl survey.

Table 8b. -- Biomass estimates (t) for major invertebrate taxa collected during the 2021 northern Bering Sea shelf bottom trawl survey.

Taxon		Estimated total biomass (t) ± 95% confidence interval		Proportion of total animal biomass[1]	Estimated biomass by stratum (t)		
					70	71	81
Ascidiacea		71,506 ±	38,435	0.0247	8,274	62,414	818
Coelenterata		36,839 ±	7,171	0.0127	9,233	18,384	9,222
Crustacea	shrimps	4,561 ±	1,891	0.0016	276	4,087	199
	other crustaceans	802 ±	862	0.0003	139	662	0
	total Crustacea	5,363 ±	2,088	0.0018	415	4,749	199
Echinodermata	Asteroidea (sea stars)	349,942 ±	66,159	0.1207	144,215	193,512	12,215
	Echinoidea (sea urchins)	55,136 ±	56,199	0.0190	548	54,588	0
	Holothuroidea (sea cucumbers)	3,356 ±	3,262	0.0012	151	3,206	0
	Ophiuroidea (brittle stars)	30,820 ±	15,544	0.0106	3,844	23,423	3,554
	total Echinodermata	439,254 ±	88,200	0.1515	148,757	274,729	15,769
find my group		161,213 ±	35,831	0.0556	52,221	99,469	9,524
Mollusca	Gastropoda (snails)	158,649 ±	29,225	0.0547	65,232	67,594	25,823
	Pelecypoda (bivalves)	2,416 ±	1,184	0.0008	378	1,964	75
	other mollusks	48 ±	95	<0.0001	1	47	0
	total Mollusca	161,113 ±	29,297	0.0556	65,610	69,605	25,898
Porifera (sponges)		1,009 ±	992	0.0003	234	774	0
Other		60,115 ±	53,610	0.0207	479	59,618	18
Total		**936,413 ±**	**120,486**	**0.3229**	**285,224**	**589,742**	**61,448**

[1]Proportion of total estimated biomass is 2,899,793 t for fish and invertebrates in the NBS bottom trawl survey.

Table 9a. -- Total estimated biomass in metric tons (t) and the percent change between the 2019 and 2021 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	2019	2021	Change (2021, 2019)
all poachers	12,634	17,719	40.3%
other flatfishes	55,589	70,120	26.1%
starry flounder	65,871	82,531	25.3%
Pacific cod	516,910	616,267	19.2%
Pacific halibut	113,855	131,416	15.4%
Bering flounder	8,269	9,524	15.2%
flathead sole	611,483	676,077	10.6%
eelpouts	35,629	37,870	6.3%
northern rock sole	976,686	1,034,224	5.9%
Alaska skate	491,109	467,910	-4.7%
Alaska plaice	368,787	333,830	-9.5%
Pacific herring	76,743	67,457	-12.1%
yellowfin sole	2,006,505	1,622,913	-19.1%
arrowtooth flounder	578,390	459,660	-20.5%
Kamchatka flounder	44,870	33,011	-26.4%
plain sculpin	50,402	36,876	-26.8%
Greenland turbot	16,053	10,714	-33.3%
other sculpins	79,234	48,229	-39.1%
great sculpin	91,875	51,345	-44.1%
walleye pollock	5,458,366	3,034,317	-44.4%
shorthorn sculpin	8,795	2,185	-75.2%
saffron cod	1,370	3	-99.8%
Arctic cod	2	0	-100.0%

Invertebrate taxon	2019	2021	Change (2021, 2019)
all shrimps	2,879	5,173	79.7%
all worms	5,753	8,101	40.8%
northern Neptune whelk	52,154	69,865	34.0%
hermit crabs	298,921	380,894	27.4%
purple-orange sea star	851,636	965,611	13.4%
corals	871	941	8.1%
other sea stars	274,107	283,416	3.4%
other snails	405,435	397,565	-1.9%
all sea anemones	58,121	55,944	-3.7%
basket sea stars	305,923	286,662	-6.3%
all tunicates	131,126	111,300	-15.1%
other crabs	534,878	206,164	-61.5%

Table 9b. -- Total estimated biomass in metric tons (t) and the percent change between the 2019 and 2021 northern 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	2019	2021	Change (2021, 2019)	Invertebrate taxon	2019	2021	Change (2021, 2019)
Arctic cod	47	83	77.4%	all tunicates	27,260	71,506	162.3%
starry flounder	26,472	39,010	47.4%	corals	2,823	5,776	104.6%
arrowtooth flounder	1,443	1,740	20.5%	all shrimps	2,436	4,561	87.2%
Alaska plaice	321,571	344,578	7.2%	other sea stars	84,661	79,310	-6.3%
Pacific halibut	25,722	25,995	1.1%	other snails	47,511	44,470	-6.4%
yellowfin sole	520,029	496,038	-4.6%	all sea anemones	10,377	8,710	-16.1%
Alaska skate	95,102	80,207	-15.7%	basket sea stars	36,653	30,082	-17.9%
great sculpin	3,804	2,988	-21.5%	northern Neptune whelk	146,344	114,179	-22.0%
northern rock sole	99,040	76,630	-22.6%	hermit crabs	139,243	107,054	-23.1%
other sculpins	1,058	738	-30.3%	other crabs	191,359	132,874	-30.6%
Pacific herring	87,918	60,929	-30.7%	purple-orange sea star	414,423	270,632	-34.7%
other flatfishes	5,140	3,260	-36.6%	all worms	93,061	60,115	-35.4%
Pacific cod	364,982	227,577	-37.6%				
all poachers	1,346	779	-42.1%				
shorthorn sculpin	14,159	7,626	-46.1%				
Kamchatka flounder	61	33	-46.5%				
plain sculpin	41,636	20,651	-50.4%				
Bering flounder	18,526	8,384	-54.7%				
walleye pollock	1,167,099	474,448	-59.3%				
flathead sole	463	138	-70.2%				
eelpouts	1,707	425	-75.1%				
saffron cod	81,269	9,973	-87.7%				
Greenland turbot	424	0	-100.0%				

Table 10a. -- 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 2021 eastern Bering Sea shelf (EBS; 376 stations completed) and northern Bering Sea shelf (NBS; 144 stations completed) trawl surveys.

Species	Shelf area	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	EBS	61.48	4.40	3,030,988	216,858	2,601,609	3,460,367	374	374	373
	NBS	23.86	3.44	474,467	68,401	339,033	609,901	135	134	135
Pacific cod	EBS	12.50	0.61	616,380	30,174	556,032	676,728	368	368	367
	NBS	11.44	2.03	227,582	40,411	146,761	308,403	109	109	109
yellowfin sole	EBS	33.14	2.22	1,633,968	109,385	1,417,386	1,850,550	235	235	234
	NBS	24.94	2.61	496,045	51,865	392,315	599,775	138	138	137
northern rock sole	EBS	21.12	1.76	1,041,169	86,835	869,236	1,213,103	321	321	320
	NBS	3.85	0.76	76,631	15,139	46,354	106,908	107	107	107
flathead sole	EBS	13.69	1.54	674,745	76,153	522,439	827,051	326	326	323
	NBS	0.01	0.01	138	126	0	389	2	2	2
Bering flounder	EBS	0.19	0.04	9,511	1,853	5,686	13,336	58	58	58
	NBS	0.42	0.09	8,384	1,832	4,644	12,125	80	79	77
Alaska plaice	EBS	6.80	0.58	335,034	28,722	278,163	391,904	277	277	275
	NBS	17.33	2.45	344,581	48,637	247,306	441,856	140	140	140
Greenland turbot	EBS	0.22	0.04	10,690	1,801	7,123	14,257	48	48	48
arrowtooth flounder	EBS	9.28	0.78	457,569	38,518	380,533	534,605	254	254	254
	NBS	0.09	0.04	1,740	879	0	3,499	9	9	9
Kamchatka flounder	EBS	0.67	0.05	32,856	2,257	28,388	37,324	183	183	183
	NBS	0.00	0.00	33	33	0	98	1	1	1
Pacific halibut	EBS	2.67	0.20	131,864	10,041	111,983	151,746	271	271	271
	NBS	1.31	0.19	25,995	3,693	18,609	33,382	78	78	78
Bering skate	EBS	0.25	0.03	12,168	1,499	9,200	15,136	82	82	82
Alaska skate	EBS	9.50	0.45	468,113	22,424	423,714	512,513	356	356	356
	NBS	4.03	0.81	80,207	16,068	48,072	112,343	69	69	69
longhead dab	EBS	0.24	0.06	11,765	2,976	5,872	17,658	43	43	43
	NBS	0.07	0.02	1,384	489	405	2,363	48	48	48
starry flounder	EBS	1.69	0.39	83,295	19,127	45,042	121,548	67	67	66
	NBS	1.96	0.41	39,014	8,134	22,746	55,282	77	77	77
yellow Irish lord	EBS	0.37	0.10	18,390	5,000	7,079	29,701	92	92	92

Table 10a. -- 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 2021 eastern Bering Sea shelf (EBS; 376 stations completed) and northern Bering Sea shelf (NBS; 144 stations completed) trawl surveys.

Species	Shelf area	Mean CPUE (kg/ha)	SD CPUE	Estimated biomass	SD biomass	95% LCL	95% UCL	Hauls with weights	Hauls with counts	Hauls with lengths
plain sculpin	EBS	0.75	0.15	37,180	7,186	22,809	51,551	111	111	111
	NBS	1.04	0.11	20,652	2,246	16,159	25,145	95	95	95
great sculpin	EBS	1.04	0.14	51,319	6,759	37,937	64,702	192	192	192
	NBS	0.15	0.04	2,988	838	1,277	4,699	33	33	33
shorthorn sculpin	EBS	0.04	0.02	2,180	893	412	3,949	21	21	21
	NBS	0.38	0.10	7,627	1,892	3,803	11,451	38	38	38
Pacific ocean perch	EBS	0.07	0.04	3,342	1,811	0	6,892	13	13	13
rex sole	EBS	0.85	0.19	41,724	9,436	22,653	60,795	110	110	109
Sakhalin sole	EBS	0.00	0.00	15	10	0	35	4	4	3
	NBS	0.09	0.02	1,742	392	958	2,525	71	71	71
butterfly sculpin	NBS	0.00	0.00	6	3	0	12	3	3	3
bigmouth sculpin	EBS	0.52	0.06	25,850	3,069	19,773	31,928	93	93	93
Arctic cod	NBS	0.00	0.00	83	24	34	132	38	38	38
saffron cod	EBS	0.00	0.00	3	2	0	6	3	3	3
	NBS	0.50	0.11	9,974	2,093	5,788	14,160	57	57	57

Table 10b. -- 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 2021 eastern Bering Sea shelf (EBS; 376 stations completed) and northern Bering Sea shelf (NBS; 144 stations completed) trawl surveys.

Species	Shelf area	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	EBS	119.45	9.22	5,888,872,443	454,700,157	4,988,566,132	6,789,178,755	374	374	373
	NBS	34.16	5.18	679,335,527	103,024,038	475,347,933	883,323,122	135	134	135
Pacific cod	EBS	8.55	0.56	421,752,444	27,831,462	366,089,521	477,415,368	368	368	367
	NBS	6.52	1.43	129,700,908	28,506,091	72,688,726	186,713,091	109	109	109
yellowfin sole	EBS	154.23	10.81	7,603,199,351	533,120,526	6,547,620,709	8,658,777,992	235	235	234
	NBS	99.52	9.31	1,979,036,216	185,065,590	1,608,905,035	2,349,167,397	138	138	137
northern rock sole	EBS	129.84	9.22	6,401,138,844	454,428,844	5,501,369,733	7,300,907,955	321	321	320
	NBS	12.10	1.96	240,687,208	39,040,056	162,607,097	318,767,320	107	107	107
flathead sole	EBS	52.17	3.89	2,571,917,642	191,968,596	2,187,980,451	2,955,854,833	326	326	323
	NBS	0.02	0.02	370,872	318,755	0	1,008,382	2	2	2
Bering flounder	EBS	0.86	0.17	42,197,137	8,188,777	25,295,501	59,098,773	58	58	58
	NBS	3.11	0.70	61,873,393	13,963,917	33,359,075	90,387,712	80	79	77
Alaska plaice	EBS	11.81	0.93	582,045,700	45,620,648	491,716,817	672,374,584	277	277	275
	NBS	28.70	3.06	570,766,749	60,922,628	448,921,493	692,612,004	140	140	140
Greenland turbot	EBS	0.06	0.01	2,747,987	420,328	1,915,738	3,580,237	48	48	48
arrowtooth flounder	EBS	19.01	1.51	937,014,036	74,665,132	787,683,772	1,086,344,300	254	254	254
	NBS	0.11	0.06	2,251,036	1,141,215	0	4,533,465	9	9	9
Kamchatka flounder	EBS	1.22	0.10	60,001,892	4,940,269	50,220,160	69,783,625	183	183	183
	NBS	0.00	0.00	25,759	25,759	0	77,276	1	1	1
Pacific halibut	EBS	2.06	0.19	101,441,818	9,571,240	82,490,763	120,392,874	271	271	271
	NBS	0.71	0.10	14,118,463	1,904,029	10,310,406	17,926,520	78	78	78
Bering skate	EBS	0.12	0.02	6,001,365	748,607	4,519,123	7,483,606	82	82	82
Alaska skate	EBS	2.17	0.09	106,918,871	4,523,564	97,962,215	115,875,528	356	356	356
	NBS	0.94	0.20	18,680,667	3,937,464	10,805,738	26,555,595	69	69	69
longhead dab	EBS	3.66	0.95	180,284,188	46,945,985	87,331,137	273,237,238	43	43	43
	NBS	1.25	0.41	24,798,547	8,188,620	8,421,308	41,175,786	48	48	48
starry flounder	EBS	1.17	0.25	57,479,152	12,085,163	33,308,826	81,649,478	67	67	66
	NBS	2.98	0.61	59,208,248	12,066,167	35,075,914	83,340,582	77	77	77
yellow Irish lord	EBS	0.54	0.16	26,744,607	7,650,805	9,438,487	44,050,728	92	92	92

Table 10b. -- 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 2021 eastern Bering Sea shelf (EBS; 376 stations completed) and northern Bering Sea shelf (NBS; 144 stations completed) trawl surveys.

Species	Shelf area	Mean CPUE (no/ha)	SD CPUE	Estimated population	SD population	95% LCL	95% UCL	Hauls with weights	Hauls with counts	Hauls with lengths
plain sculpin	EBS	1.16	0.26	57,184,583	13,046,068	31,092,448	83,276,718	111	111	111
	NBS	1.56	0.17	31,116,558	3,287,869	24,540,819	37,692,297	95	95	95
great sculpin	EBS	0.36	0.04	17,544,589	2,167,928	13,252,091	21,837,087	192	192	192
	NBS	0.11	0.02	2,094,773	446,135	1,183,766	3,005,780	33	33	33
shorthorn sculpin	EBS	0.03	0.01	1,342,852	603,176	148,563	2,537,141	21	21	21
	NBS	0.46	0.12	9,175,518	2,341,428	4,443,491	13,907,545	38	38	38
Pacific ocean perch	EBS	0.16	0.08	7,845,151	4,107,585	0	15,896,017	13	13	13
rex sole	EBS	2.01	0.40	99,252,761	19,862,335	59,110,981	139,394,540	110	110	109
Sakhalin sole	EBS	0.00	0.00	200,161	132,285	0	459,439	4	4	3
	NBS	1.99	0.40	39,518,212	7,918,227	23,681,758	55,354,667	71	71	71
butterfly sculpin	NBS	0.00	0.00	90,314	51,528	0	194,453	3	3	3
bigmouth sculpin	EBS	0.11	0.01	5,470,195	601,626	4,278,975	6,661,414	93	93	93
Arctic cod	NBS	0.35	0.10	6,883,723	2,057,911	2,724,685	11,042,762	38	38	38
saffron cod	EBS	0.00	0.00	119,477	71,281	0	260,613	3	3	3
	NBS	6.82	1.62	135,690,110	32,181,970	71,326,169	200,054,051	57	57	57

Summary of Results for Selected Eastern Bering Sea and Northern 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 39 major fish species caught during the EBS and NBS continental shelf survey are presented in the subsections below (Figs. 10a to 59 and Tables 11a to 42b). 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 C1 to Appendix D9 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 and NBS continental shelf are presented below (Figs. 54 to 60 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 (Zacher et al., 2021).

The purple-orange sea star (*Asterias amurensis*) is common in the Bering and Chukchi seas (Feder et al., 2005; Hamazaki et al., 2005) and was the invertebrate taxon with the highest catch rate by weight in the EBS and NBS (Tables 9a and 9b). Catch rates for the purple-orange sea star were highest in the inner 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, 2021).

Walleye Pollock (*Gadus chalcogrammus*)

During the 2021 survey, walleye pollock were present at 99.5% of EBS stations and 93.8% of the NBS stations. Spatial patterns of pollock distribution during the summer trawl survey have varied considerably in response to cold (Figs. 7a and 10a) and warm (Figs. 7b and 10b) 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, as well as throughout the NBS when it was first surveyed in 2010 (Figs. 7a and 10a). 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 shelf survey area (Fig 10b). These distribution patterns are consistent with shoreward and northward feeding migrations typical of pollock during the spring and summer (Kotwicki et al., 2005).

In the EBS during 2021, walleye pollock were found in depths between 21 m and 175 m, and at bottom temperatures between -0.6°C and 6.9°C. In 2021, walleye pollock biomass in the EBS was concentrated in the outer and middle domain, with the highest concentration in the northern portion of the outer domain, with additional clusters to the north, east, and west of the Pribilof Islands, and to the northwest of the Alaska Peninsula (Fig 10b). Since 2002, the EBS shelf survey biomass estimate for walleye pollock has varied dramatically. Compared with 2019 (5.5 million t), walleye pollock biomass in 2021 (3 million t) in the EBS experienced a 44% decrease (Table 7a).

In the NBS during 2021, walleye pollock were found in depths between 16 m and 79 m, and at bottom temperatures between -1.7°C and 11.2°C. In 2021, walleye pollock biomass in the NBS was concentrated in the Chirikov Basin just south of the Bering Strait (Fig. 10b). Compared with 2019 (1.2 million t), walleye pollock biomass in 2021 (474,448 t) in the NBS experienced a 59% decrease (Table 7b).

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, 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 in both the EBS and NBS (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).

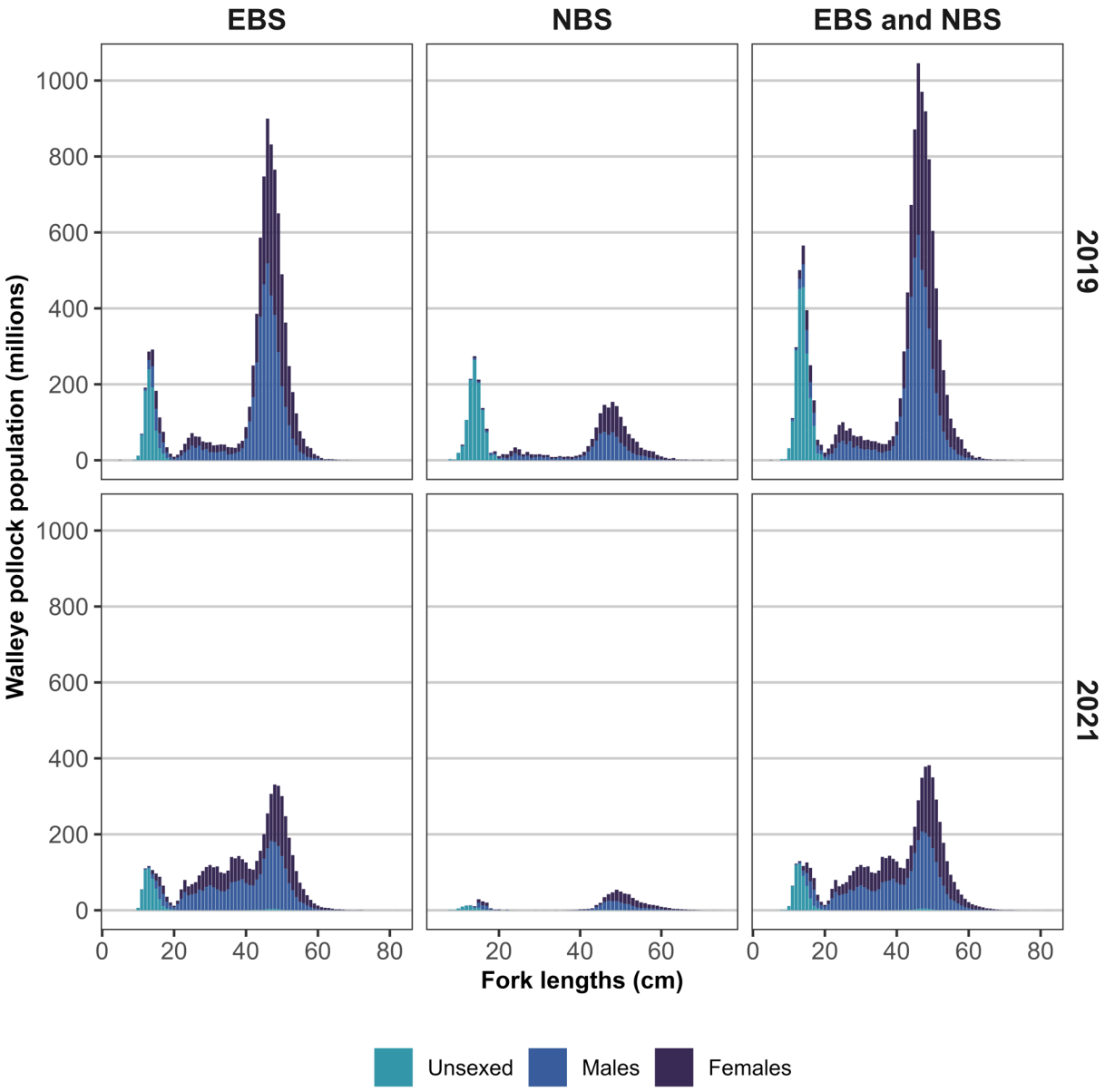

Figure 9. -- Total abundance-at-size estimates of walleye pollock (*Gadus chalcogrammus*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

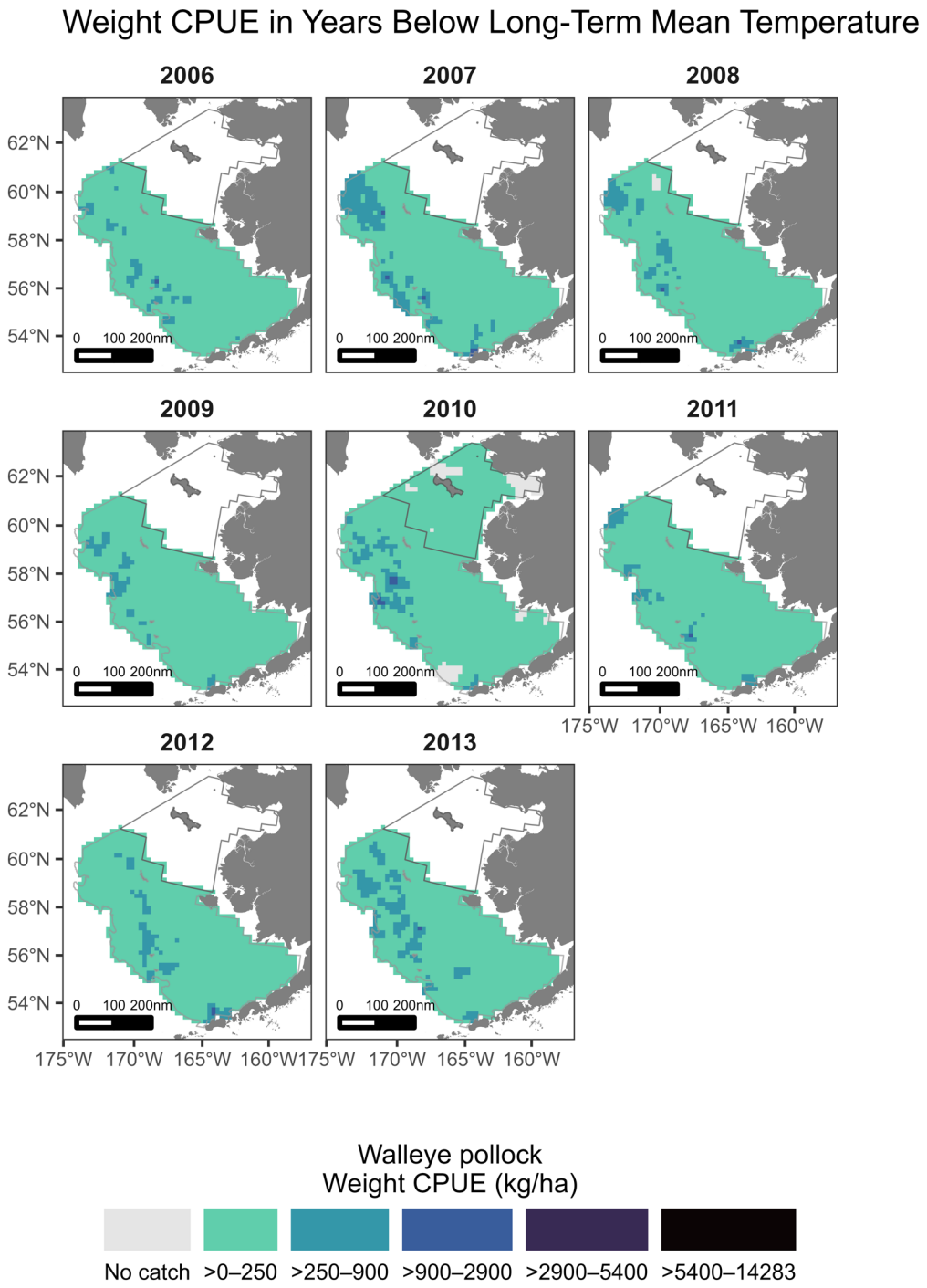

Figure 10a. -- The distribution (weight CPUE (kg/ha)) of walleye pollock (*Gadus chalcogrammus*) in years when the survey mean bottom temperature was below the long-term mean 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013 during the Bering Sea shelf bottom trawl surveys.

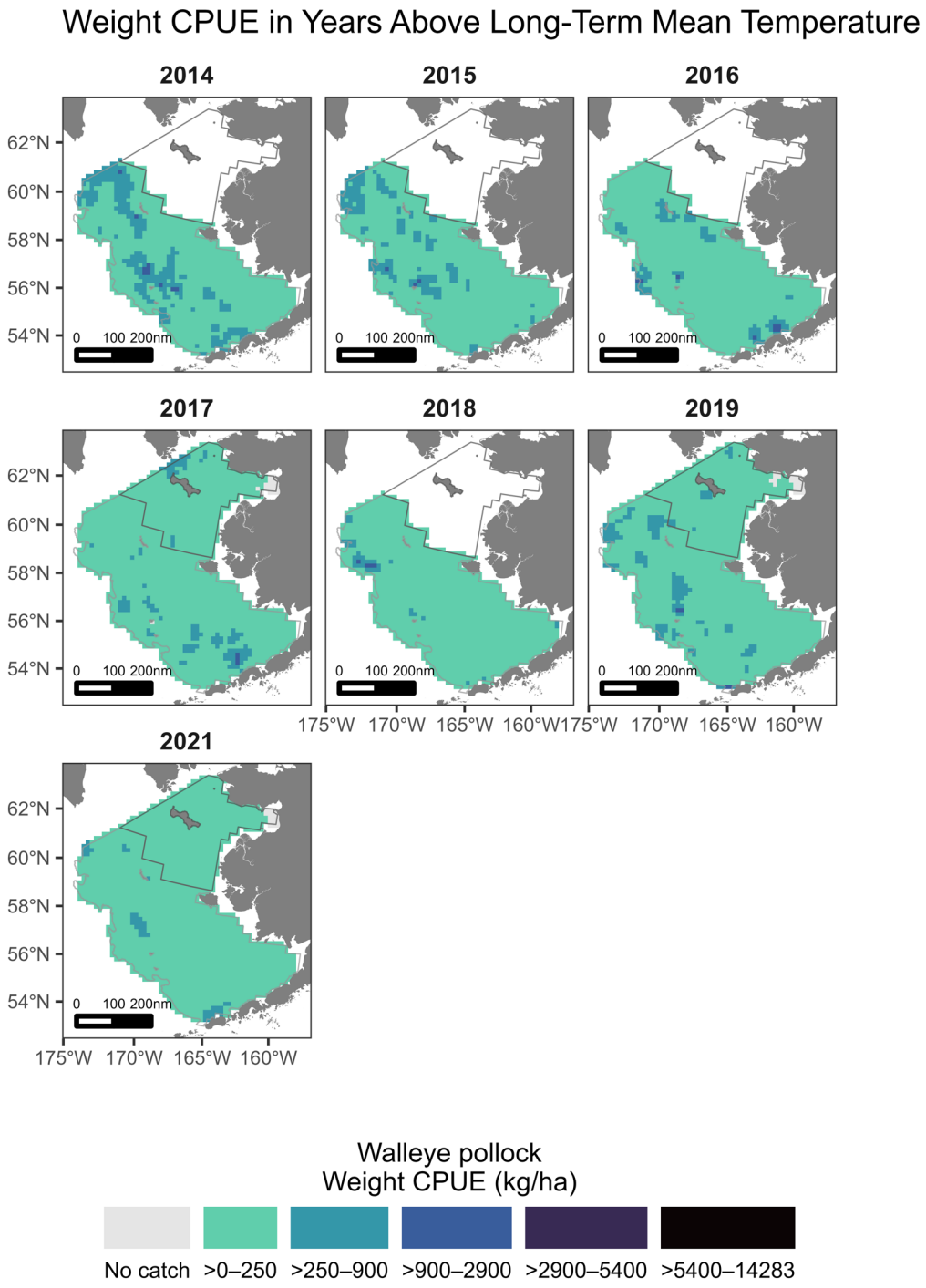

Figure 10b. -- The distribution (weight CPUE (kg/ha)) of walleye pollock (*Gadus chalcogrammus*) in years when the survey mean bottom temperature was above the long-term mean 2014, 2015, 2016, 2017, 2018, 2019, and 2021 during the Bering Sea shelf bottom trawl surveys.

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 walleye pollock (*Gadus chalcogrammus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	18.60	2.52	146.41	19.87	106.26	186.57	58	58	58
20	21.47	2.66	88.43	10.95	66.06	110.79	31	31	31
31	72.07	13.11	684.47	124.55	435.36	933.58	69	69	69
32	53.63	24.02	47.45	21.25	0.00	97.71	8	8	8
41	67.68	14.73	421.72	91.79	236.22	607.23	44	44	44
42	25.98	10.26	62.67	24.75	12.12	113.22	31	31	31
43	74.88	16.27	157.72	34.27	86.45	229.00	22	22	22
50	31.07	19.75	118.17	75.11	0.00	272.89	24	24	24
61	104.84	11.64	920.22	102.13	713.81	1,126.63	60	60	60
62	73.35	18.76	47.40	12.12	17.74	77.05	7	7	7
82	111.96	32.86	201.00	59.00	71.14	330.86	12	12	11
90	117.28	21.85	135.33	25.21	75.70	194.95	8	8	8
Total	**61.48**	**4.40**	**3,030.99**	**216.86**	**2,601.61**	**3,460.37**	**374**	**374**	**373**
NBS									
70	19.40	4.34	153.80	34.38	84.32	223.28	58	58	58
71	21.97	6.16	178.55	50.05	77.40	279.71	49	48	49
81	37.06	8.21	142.11	31.49	77.50	206.73	28	28	28
Total	**23.86**	**3.44**	**474.47**	**68.40**	**339.03**	**609.90**	**135**	**134**	**135**

Table 11b. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	33.75	6.21	265.63	48.90	166.81	364.46	58	58	58
20	55.75	12.80	229.64	52.73	121.97	337.32	31	31	31
31	124.03	24.68	1,177.98	234.44	709.09	1,646.87	69	69	69
32	67.35	29.96	59.58	26.51	0.00	122.27	8	8	8
41	141.06	28.25	878.96	176.03	523.20	1,234.72	44	44	44
42	62.06	22.01	149.71	53.09	41.29	258.12	31	31	31
43	153.25	29.37	322.79	61.86	194.13	451.46	22	22	22
50	32.73	19.21	124.51	73.08	0.00	275.07	24	24	24
61	175.09	19.75	1,536.89	173.33	1,186.59	1,887.19	60	60	60
62	187.30	58.79	121.02	37.99	28.07	213.98	7	7	7
82	345.55	144.30	620.39	259.08	50.15	1,190.62	12	12	11
90	348.17	57.03	401.76	65.81	246.11	557.40	8	8	8
Total	**119.45**	**9.22**	**5,888.87**	**454.70**	**4,988.57**	**6,789.18**	**374**	**374**	**373**
NBS									
70	34.79	9.66	275.75	76.59	120.97	430.53	58	58	58
71	25.25	6.46	205.16	52.53	99.00	311.32	49	48	49
81	51.74	11.63	198.43	44.60	106.90	289.95	28	28	28
Total	**34.16**	**5.18**	**679.34**	**103.02**	**475.35**	**883.32**	**135**	**134**	**135**

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 2021 survey, Pacific cod were present at 97.9% of stations in the EBS and 75.7% of stations in the NBS. 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. 12a). During the cold stanza in 2010, Pacific cod were caught at 44% of the NBS stations. Densities were relatively low compared to the warm stanza in 2017, when Pacific cod were caught at 78% of the NBS stations, with areas of highest density in the Chirikov Basin and just south of St. Lawrence Island (Fig. 12b). 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 Pribilofs and St. Matthew island and the lowest densities were in the southeastern EBS (Fig. 12b). A similar pattern in the EBS was observed from 2017 to 2021. 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 between the EBS and NBS survey areas (Fig. 12b). 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. 50, 51, and 52). A change was observed in the estimates of survey biomass and abundance at length that accompanied the northerly shift in Pacific cod distribution in the 2017 survey.

In 2021, Pacific cod comprised 5% (616,267 t, Table 7a) of the EBS survey biomass. Compared with 2019 (516,910 t), Pacific cod biomass in 2021 (616,267 t) in the EBS experienced a 19% increase (Table 7a). In the EBS in 2021, Pacific cod were found in waters with depths between 21 m and 175 m, and at bottom temperatures as warm as 6.9°C and as cold as -0.6°C. The fork lengths of Pacific cod measured during the 2021 EBS survey were between 4 and 112 cm.

In the NBS during 2021, Pacific cod were found in waters with depths between 21 m and 79 m, and at bottom temperatures as warm as 10.2°C and as cold as -1.7°C. The fork lengths of Pacific cod measured during the 2021 NBS survey were between 5 and 105 cm. In 2021, Pacific cod biomass in the NBS was concentrated to the southeast of St. Lawrence, and in the Chirikov Basin just south of the Bering Strait; however, the density of Pacific cod in the Chirikov Basin was not nearly as great as during 2017 and 2019 (Fig. 12b). Compared with 2019 (364,982 t), Pacific cod biomass in 2021 (227,577 t) in the NBS experienced a 38% decrease (Table 7b).

From 2010 to 2016, the estimated survey biomass and abundance of Pacific cod in the EBS shelf continued to increase 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. Moreover, unlike in 2010, the NBS population in 2017 and 2019 had almost an identical size composition to that of the EBS (Fig. 11). 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.

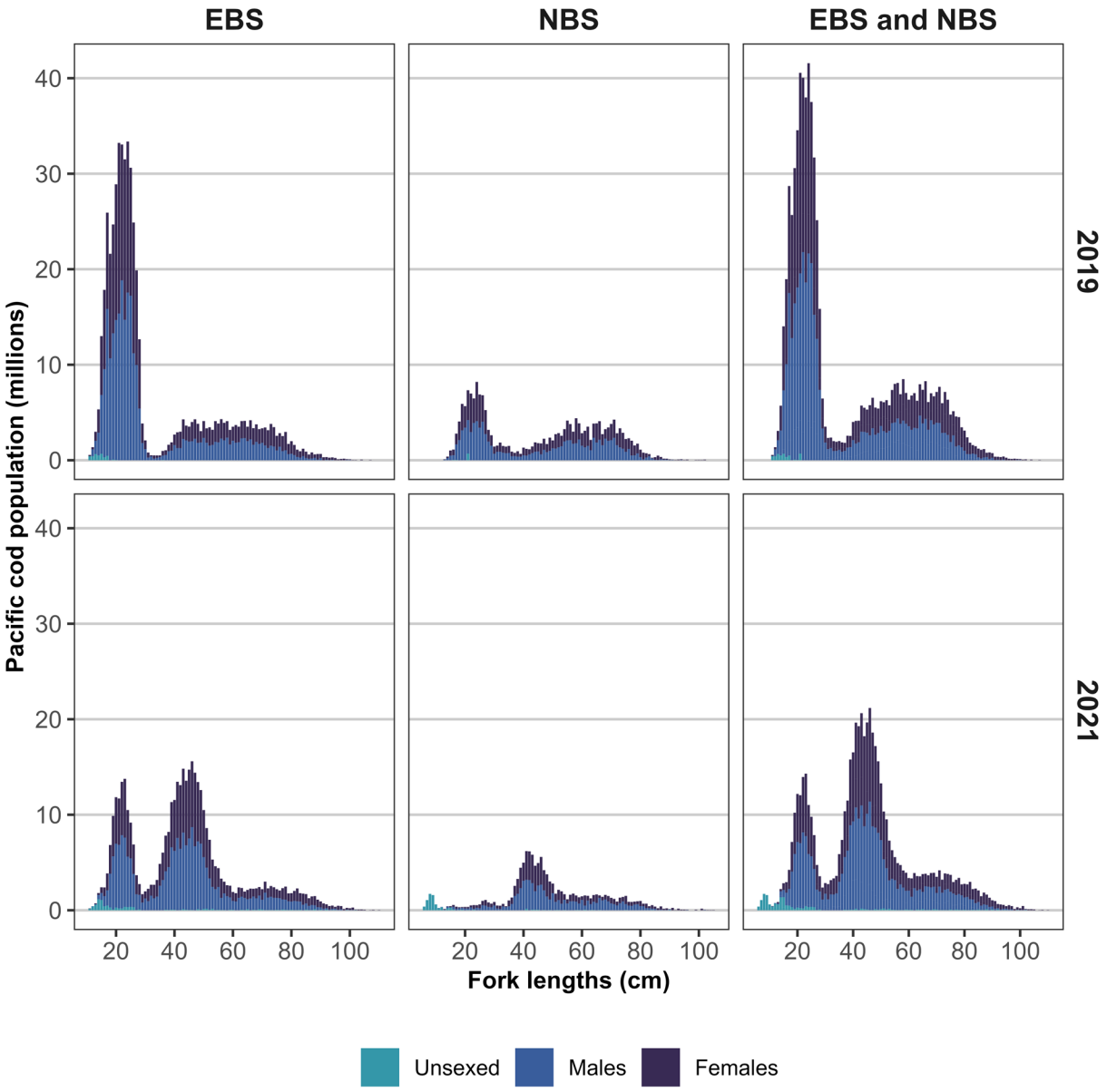

Figure 11. -- Total abundance-at-size estimates of Pacific cod (*Gadus macrocephalus*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

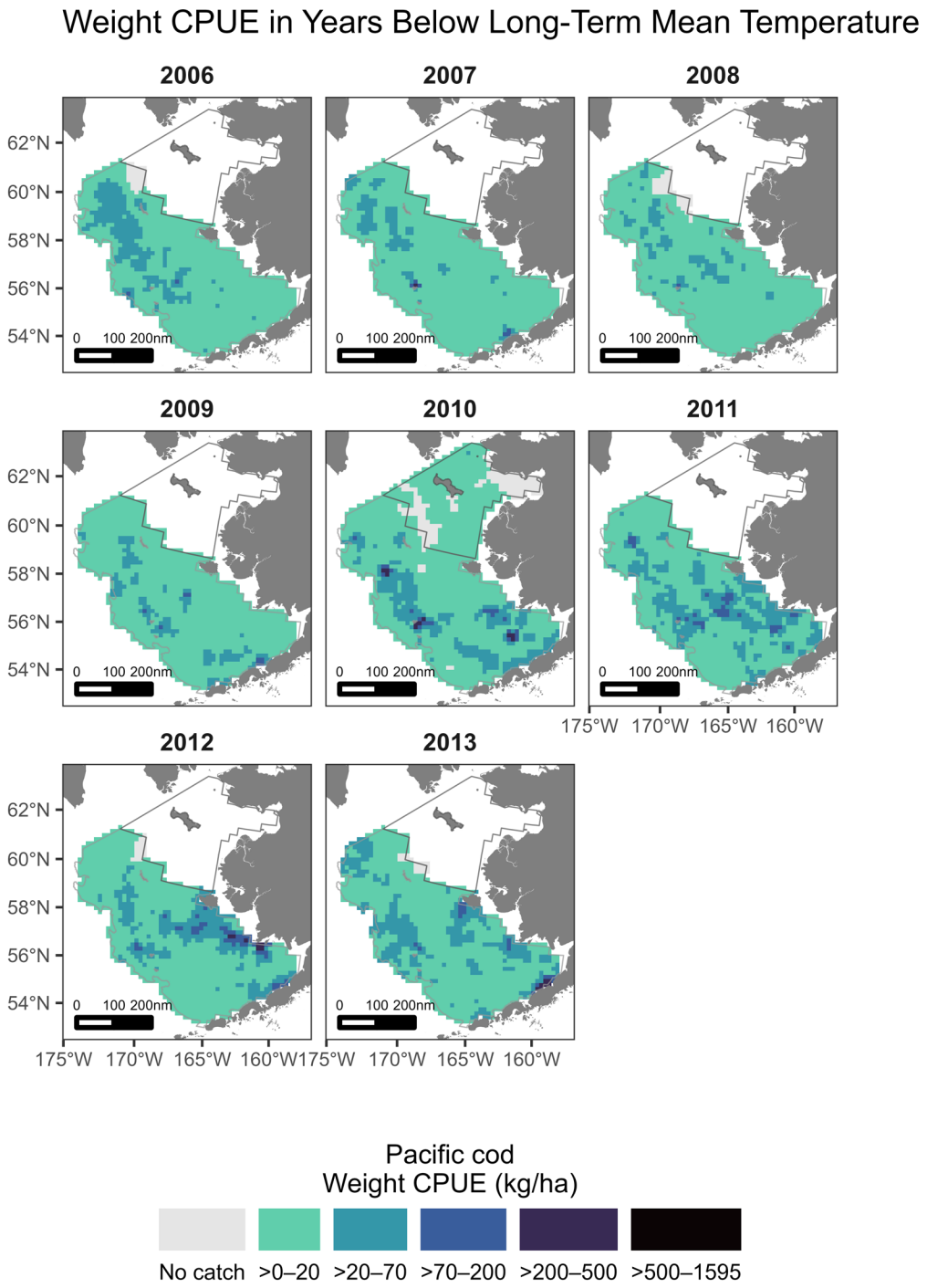

Figure 12a. -- The distribution (weight CPUE (kg/ha)) of Pacific cod (*Gadus macrocephalus*) in years when the survey mean bottom temperature was below the long-term mean 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013 during the Bering Sea shelf bottom trawl surveys.

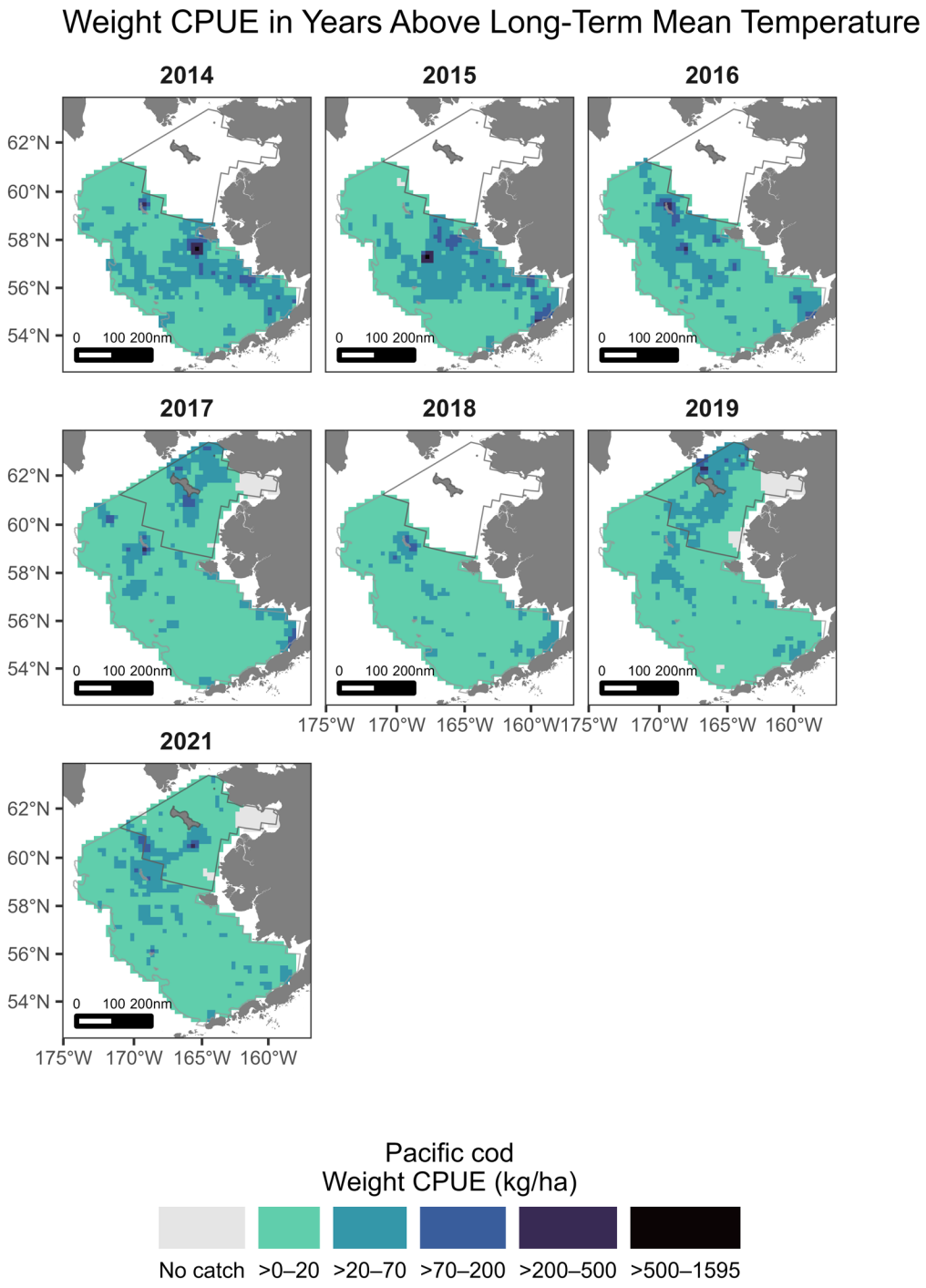

Figure 12b. -- The distribution (weight CPUE (kg/ha)) of Pacific cod (*Gadus macrocephalus*) in years when the survey mean bottom temperature was above the long-term mean 2014, 2015, 2016, 2017, 2018, 2019, and 2021 during the Bering Sea shelf bottom trawl surveys.

Table 12a. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	10.70	1.00	84.18	7.91	68.20	100.16	58	58	58
20	12.02	1.89	49.52	7.80	33.59	65.45	31	31	31
31	9.56	1.09	90.84	10.35	70.15	111.54	67	67	67
32	9.37	1.43	8.29	1.27	5.29	11.29	8	8	8
41	21.07	2.12	131.27	13.18	104.63	157.91	44	44	44
42	12.40	3.09	29.90	7.46	14.66	45.15	31	31	31
43	23.59	3.86	49.70	8.12	32.80	66.59	22	22	22
50	4.20	0.89	15.96	3.38	9.00	22.92	22	22	22
61	10.32	0.94	90.56	8.24	73.91	107.21	58	58	58
62	12.97	2.01	8.38	1.30	5.21	11.55	7	7	7
82	22.83	9.59	40.98	17.22	3.07	78.89	12	12	11
90	14.55	2.02	16.79	2.33	11.29	22.30	8	8	8
Total	**12.50**	**0.61**	**616.38**	**30.17**	**556.03**	**676.73**	**368**	**368**	**367**
NBS									
70	12.09	4.27	95.85	33.88	27.38	164.32	48	48	48
71	6.62	1.10	53.81	8.91	35.80	71.83	39	39	39
81	20.32	5.25	77.92	20.14	36.50	119.33	22	22	22
Total	**11.44**	**2.03**	**227.58**	**40.41**	**146.76**	**308.40**	**109**	**109**	**109**

Table 12b. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	14.59	1.57	114.85	12,371.29	89.84	139.85	58	58	58
20	9.99	1.78	41.15	7,342.56	26.16	56.14	31	31	31
31	7.96	1.13	75.64	10,701.30	54.24	97.05	67	67	67
32	5.28	1.21	4.67	1,072.21	2.13	7.20	8	8	8
41	11.09	1.64	69.08	10,243.19	48.38	89.78	44	44	44
42	6.59	1.56	15.88	3,771.60	8.18	23.59	31	31	31
43	16.72	5.11	35.22	10,770.13	12.82	57.62	22	22	22
50	1.67	0.37	6.35	1,423.33	3.41	9.28	22	22	22
61	2.98	0.28	26.12	2,413.94	21.24	31.00	58	58	58
62	3.96	0.54	2.56	351.89	1.70	3.42	7	7	7
82	14.32	8.04	25.70	14,437.48	0.00	57.48	12	12	11
90	3.92	0.55	4.53	632.05	3.03	6.02	8	8	8
Total	**8.55**	**0.56**	**421.75**	**27,831.46**	**366.09**	**477.42**	**368**	**368**	**367**
NBS									
70	8.68	3.33	68.77	26,382.67	15.45	122.09	48	48	48
71	2.21	0.36	17.94	2,926.35	12.03	23.86	39	39	39
81	11.21	2.71	42.99	10,391.76	21.63	64.36	22	22	22
Total	**6.52**	**1.43**	**129.70**	**28,506.09**	**72.69**	**186.71**	**109**	**109**	**109**

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 7a) and NBS (Table 7b). In 2021, the population was distributed along the inner and middle domain of the Bering Sea between Norton Sound and the Alaska Peninsula (Fig. 14); the population also shifted more towards the inner domain in 2021 than in 2019 (Fig. 14). The total estimated survey biomass in the EBS was 1.6 million t in 2021, down from 2.0 million t in 2019 (Table 13a). The 2021 NBS proportion of yellowfin sole biomass (23%) within the EBS and NBS was even greater than in 2019 (20%). The estimated 2021 survey abundance of EBS yellowfin sole was 7.5 billion yellowfin sole, which was an 18% increase since 2019 (6.4 billion). The 2021 EBS and NBS size composition estimates show prevalent size modes of yellowfin sole at 20 cm and 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 (Nichol et al., 2019; Wilderbuer et al., 2018).

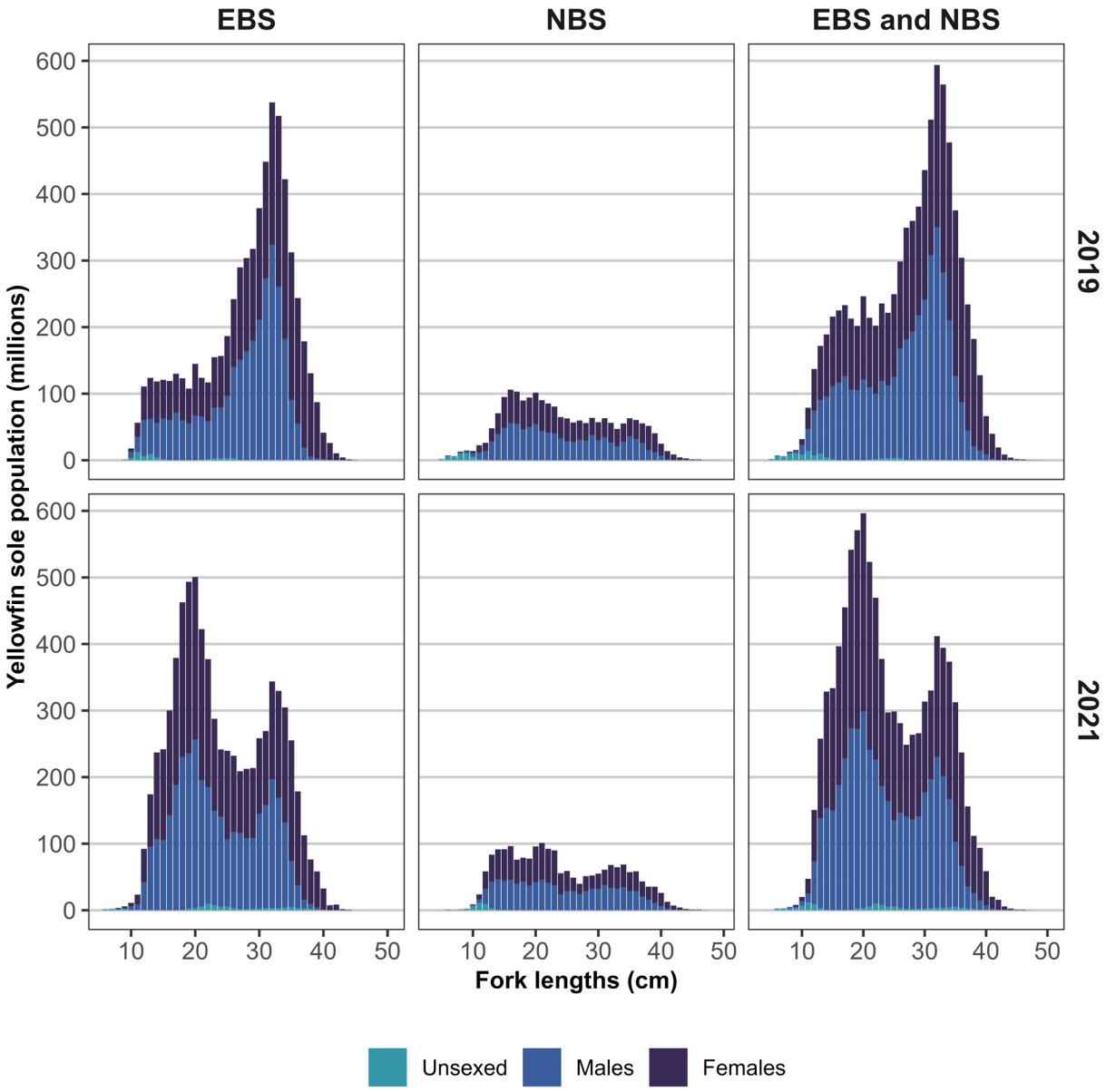

Figure 13. -- Total abundance-at-size estimates of yellowfin sole (*Limanda aspera*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

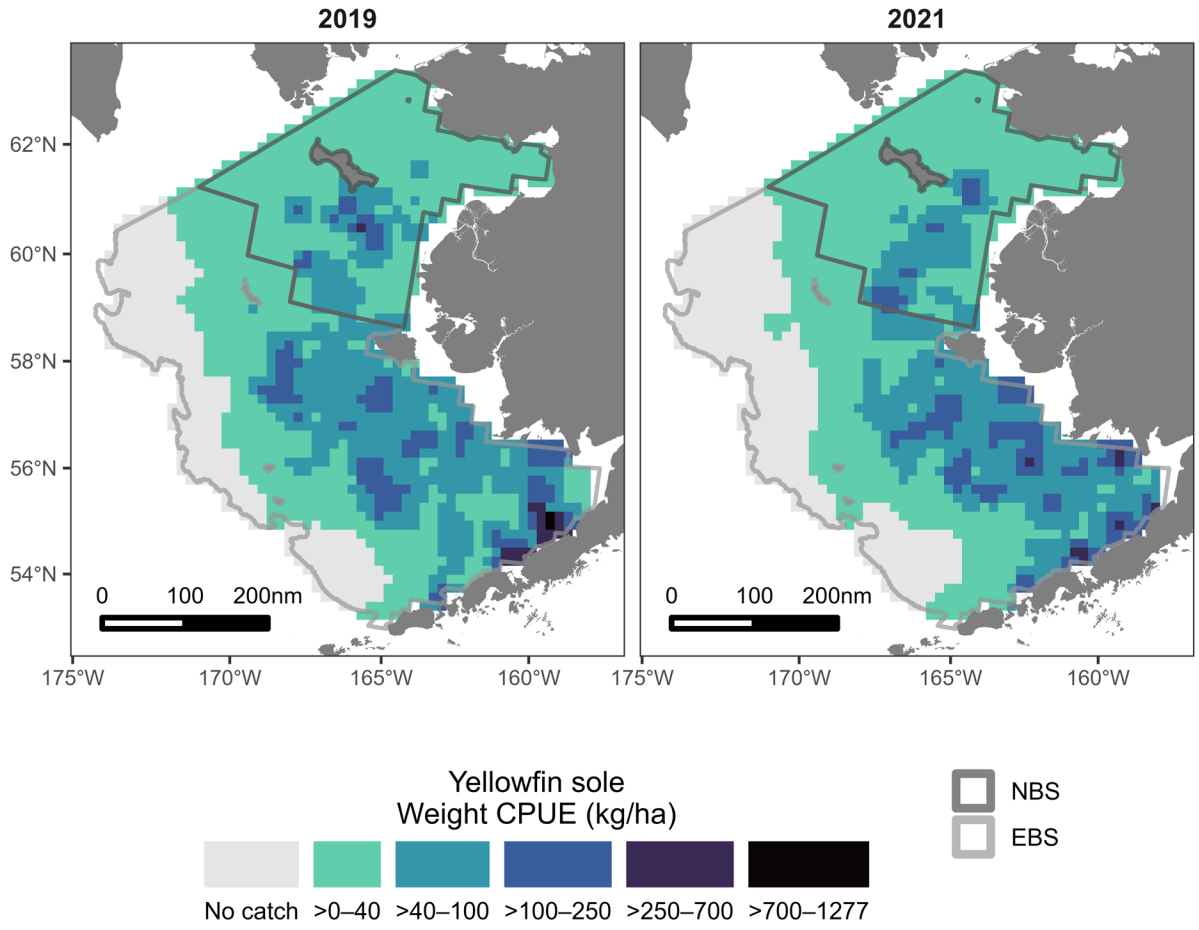

Figure 14. -- The distribution (weight CPUE (kg/ha)) of yellowfin sole (*Limanda aspera*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 yellowfin sole (*Limanda aspera*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	108.87	10.84	856,845	85,299	684,456	1,029,234	58	58	57
20	63.84	6.12	262,968	25,230	211,448	314,488	31	31	31
31	34.44	5.45	327,143	51,757	223,630	430,657	59	59	59
32	6.42	2.75	5,680	2,433	0	11,434	6	6	6
41	22.21	5.62	138,408	35,011	67,651	209,164	35	35	35
42	16.57	4.92	39,972	11,878	15,718	64,226	27	27	27
43	0.79	0.35	1,665	745	114	3,215	11	11	11
50	0.03	0.03	117	117	0	358	1	1	1
61	0.00	0.00	0	0	0	0	0	0	0
62	0.01	0.01	8	8	0	28	1	1	1
82	0.65	0.40	1,163	711	0	2,728	6	6	6
90	0.00	0.00	0	0	0	0	0	0	0
Total	**33.14**	**2.22**	**1,633,968**	**109,385**	**1,417,386**	**1,850,550**	**235**	**235**	**234**
NBS									
70	46.40	5.57	367,750	44,159	278,506	456,995	58	58	57
71	11.95	3.10	97,067	25,163	46,213	147,920	56	56	56
81	8.14	2.69	31,228	10,336	10,019	52,437	24	24	24
Total	**24.94**	**2.61**	**496,045**	**51,865**	**392,315**	**599,775**	**138**	**138**	**137**

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 yellowfin sole (*Limanda aspera*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	595.34	55.15	4,685,657.89	434,058.03	3,808,426.61	5,562,889.17	58	58	57
20	370.94	60.90	1,528,017.03	250,872.25	1,015,735.91	2,040,298.16	31	31	31
31	102.03	16.93	969,036.13	160,788.99	647,458.14	1,290,614.12	59	59	59
32	12.41	5.97	10,983.23	5,280.15	0.00	23,470.79	6	6	6
41	51.33	12.80	319,867.26	79,755.57	158,681.24	481,053.27	35	35	35
42	34.65	10.39	83,585.66	25,052.30	32,428.87	134,742.45	27	27	27
43	1.51	0.64	3,187.03	1,346.66	385.98	5,988.08	11	11	11
50	0.04	0.04	135.60	135.60	0.00	414.95	1	1	1
61	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
62	0.03	0.03	19.08	19.08	0.00	65.76	1	1	1
82	1.51	0.94	2,710.45	1,689.49	0.00	6,429.02	6	6	6
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**154.23**	**10.81**	**7,603,199.35**	**533,120.53**	**6,547,620.71**	**8,658,777.99**	**235**	**235**	**234**
NBS									
70	185.11	21.06	1,467,202.39	166,887.27	1,129,923.22	1,804,481.55	58	58	57
71	54.12	9.36	439,716.88	76,073.51	285,972.32	593,461.45	56	56	56
81	18.80	6.44	72,116.95	24,713.04	21,405.78	122,828.11	24	24	24
Total	**99.52**	**9.31**	**1,979,036.22**	**185,065.59**	**1,608,905.03**	**2,349,167.40**	**138**	**138**	**137**

Northern Rock Sole (*Lepidopsetta polyxystra*)

In 2021, 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. 16). Relatively low densities of northern rock sole were observed where bottom temperatures were < 1°C in the middle and outer domains (Fig. 16 and Tables 14a and 14b). In colder years, such as 2010, when the cold pool was large and touched the western tip of Nunivak Island (Fig. 7a), the highest concentrations of rock sole were in the southwest EBS shelf (Fig. 16). In years such as 2017-2021, when bottom temperatures along the inner domain were much higher and there was an area in the middle domain where bottom temperatures were > 1°C (Fig. 7b), high densities of rock sole were farther north around Nunivak Island and southeast of St. Lawrence Island.

Survey estimates of northern rock sole biomass in the EBS have declined between 2010 (2.1 million t) and 2021 (1.03 million t; Tables 14a). Estimates of population abundance in the EBS also declined between 2010 (9.3 billion) and 2019 (5.67 billion) but increased in 2021 (6.4 billion; Tables 14b). In contrast, biomass and abundance has increased in the NBS from 2010 (21 thousand t and 41 million) to 2019 (99 thousand t and 633 million), but then decreased in 2021 (76.6 thousand t and 241 million; Tables 14a and 14b). The increase in the NBS between 2010 and 2019 may be attributed to the presence of small 2 to 5 year-old northern rock sole at sizes 12-16 cm (Wilderbuer et al., 2018) (Fig. 15) in the inner domain (Fig. 16). This higher density of juvenile northern rock sole in the NBS may represent recruitment during the most recent warm stanza starting in 2014 (Stevenson and Lauth, 2019). Warmer bottom temperatures during the settlement phase are correlated with more northerly spatial distributions of 2 to 3 year-old rock sole (Cooper and Nichol, 2016). Thus, the warmer temperatures in the inner domain observed from 2014 to 2021 may have been favorable to settlement and recruitment into the NBS. The successful recruitment of northern rock sole to the NBS may be an indication that the population is expanding or shifting northward.

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 (Kotwicki and Lauth, 2013; Spencer, 2008).

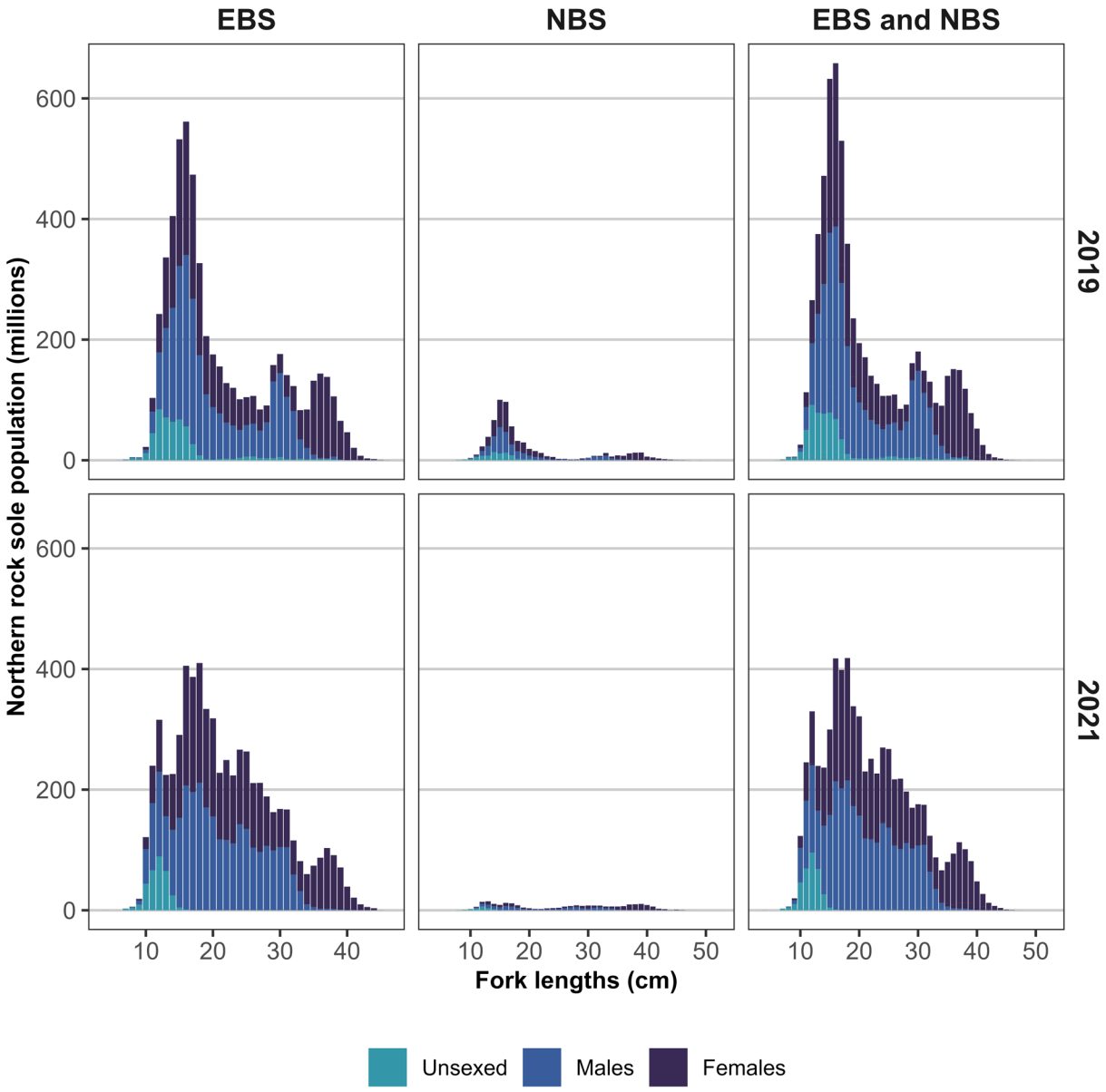

Figure 15. -- Total abundance-at-size estimates of northern rock sole (*Lepidopsetta polyxystra*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

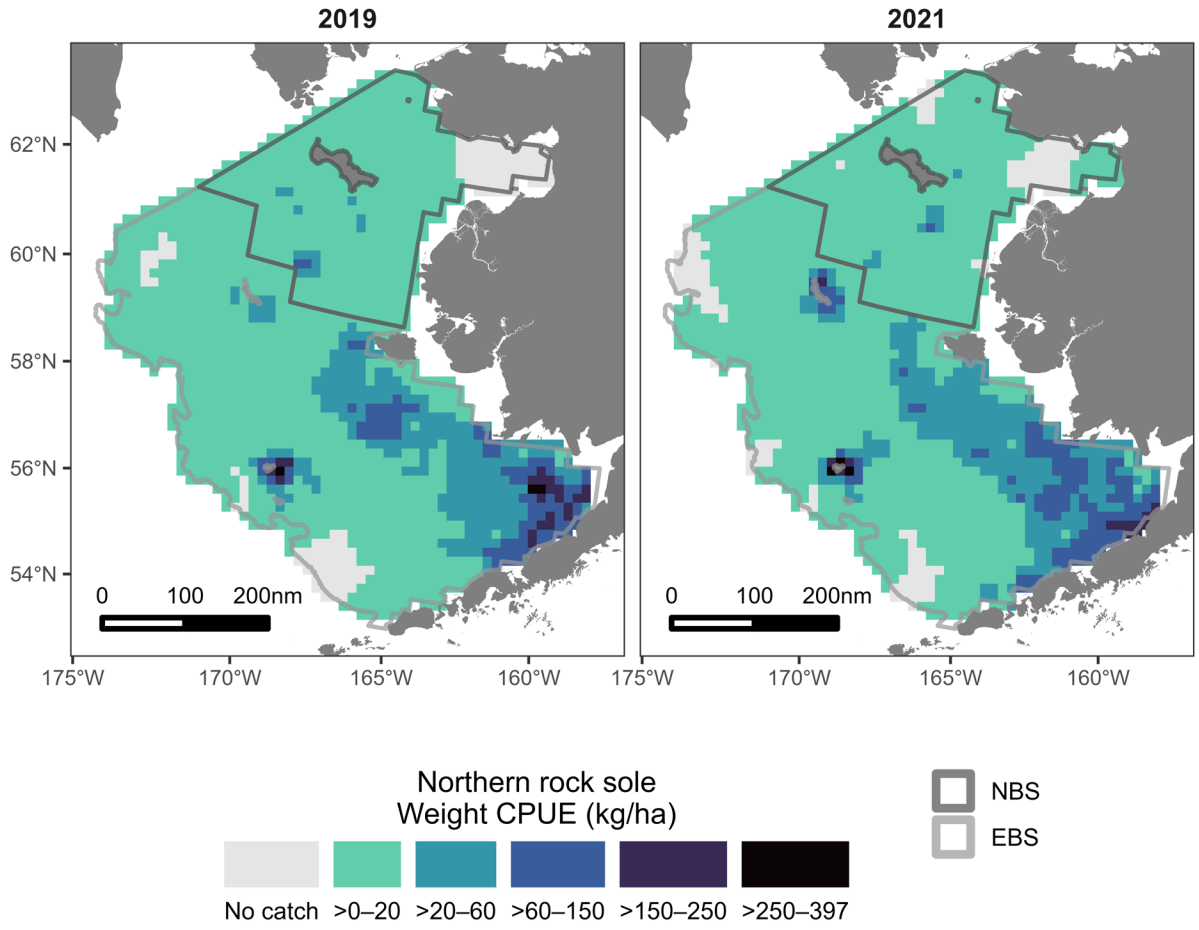

Figure 16. -- The distribution (weight CPUE (kg/ha)) of northern rock sole (*Lepidopsetta polyxystra*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 northern rock sole (*Lepidopsetta polyxystra*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	64.19	6.83	505,204	53,769	396,536	613,872	58	58	57
20	30.42	3.76	125,320	15,504	93,662	156,979	31	31	31
31	17.45	3.52	165,782	33,459	98,864	232,700	67	67	67
32	18.86	6.59	16,682	5,830	2,895	30,470	8	8	8
41	8.48	4.53	52,831	28,221	0	109,866	42	42	42
42	55.08	19.82	132,865	47,800	35,257	230,473	29	29	29
43	14.15	5.95	29,796	12,532	3,730	55,862	22	22	22
50	0.66	0.45	2,514	1,701	0	6,019	8	8	8
61	0.24	0.07	2,075	610	842	3,307	31	31	31
62	0.41	0.15	262	96	27	497	7	7	7
82	4.07	2.05	7,315	3,689	0	15,434	12	12	12
90	0.45	0.29	523	332	0	1,308	6	6	6
Total	**21.12**	**1.76**	**1,041,169**	**86,835**	**869,236**	**1,213,103**	**321**	**321**	**320**
NBS									
70	5.53	1.58	43,822	12,520	18,519	69,125	53	53	53
71	1.51	0.55	12,295	4,458	3,285	21,305	31	31	31
81	5.35	1.89	20,515	7,249	5,639	35,390	23	23	23
Total	**3.85**	**0.76**	**76,631**	**15,139**	**46,354**	**106,908**	**107**	**107**	**107**

Table 14b. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	490.12	44.60	3,857,545.79	351,058.69	3,148,056.19	4,567,035.40	58	58	57
20	202.22	29.12	833,023.10	119,953.66	588,077.72	1,077,968.48	31	31	31
31	98.55	21.18	935,975.49	201,198.47	533,578.55	1,338,372.42	67	67	67
32	85.26	36.09	75,428.46	31,925.50	0.00	150,932.26	8	8	8
41	21.28	8.42	132,572.67	52,444.83	26,581.68	238,563.67	42	42	42
42	191.85	63.80	462,776.99	153,891.05	148,531.46	777,022.52	29	29	29
43	36.58	14.08	77,051.13	29,656.06	15,366.53	138,735.74	22	22	22
50	1.35	0.89	5,140.93	3,401.02	0.00	12,147.04	8	8	8
61	0.55	0.17	4,870.36	1,503.77	1,831.24	7,909.48	31	31	31
62	1.01	0.29	654.44	190.56	188.15	1,120.73	7	7	7
82	8.39	3.85	15,059.99	6,916.58	0.00	30,283.38	12	12	12
90	0.90	0.50	1,039.49	573.38	0.00	2,395.54	6	6	6
Total	**129.84**	**9.22**	**6,401,138.84**	**454,428.84**	**5,501,369.73**	**7,300,907.96**	**321**	**321**	**320**
NBS									
70	21.85	4.30	173,197.76	34,108.99	104,263.48	242,132.03	53	53	53
71	2.27	0.75	18,424.40	6,106.06	6,084.06	30,764.74	31	31	31
81	12.79	4.69	49,065.05	17,983.84	12,162.20	85,967.90	23	23	23
Total	**12.10**	**1.96**	**240,687.21**	**39,040.06**	**162,607.10**	**318,767.32**	**107**	**107**	**107**

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 different geographic distributions and environmental associations, although they do co-occur (Fig. 18; compare with Bering flounder in Fig. 20). Bering flounder tend to occupy arctic regions, while flathead sole are more subarctic/boreal (Baker and Hollowed, 2014). In 2021, flathead sole were present at 87% of the EBS stations, as well as 1% of the NBS stations, and the highest catch rates were at depths greater than 70 m on the outer half of the EBS shelf (Fig. 18). Flathead sole in the EBS had an estimated biomass of 676,077 t (Table 15a; up from 611,483 t in 2019) and population size of 2.2 billion sole (Table 15b; up from 2.2 billion sole in 2019 (Markowitz et al., 2022)).

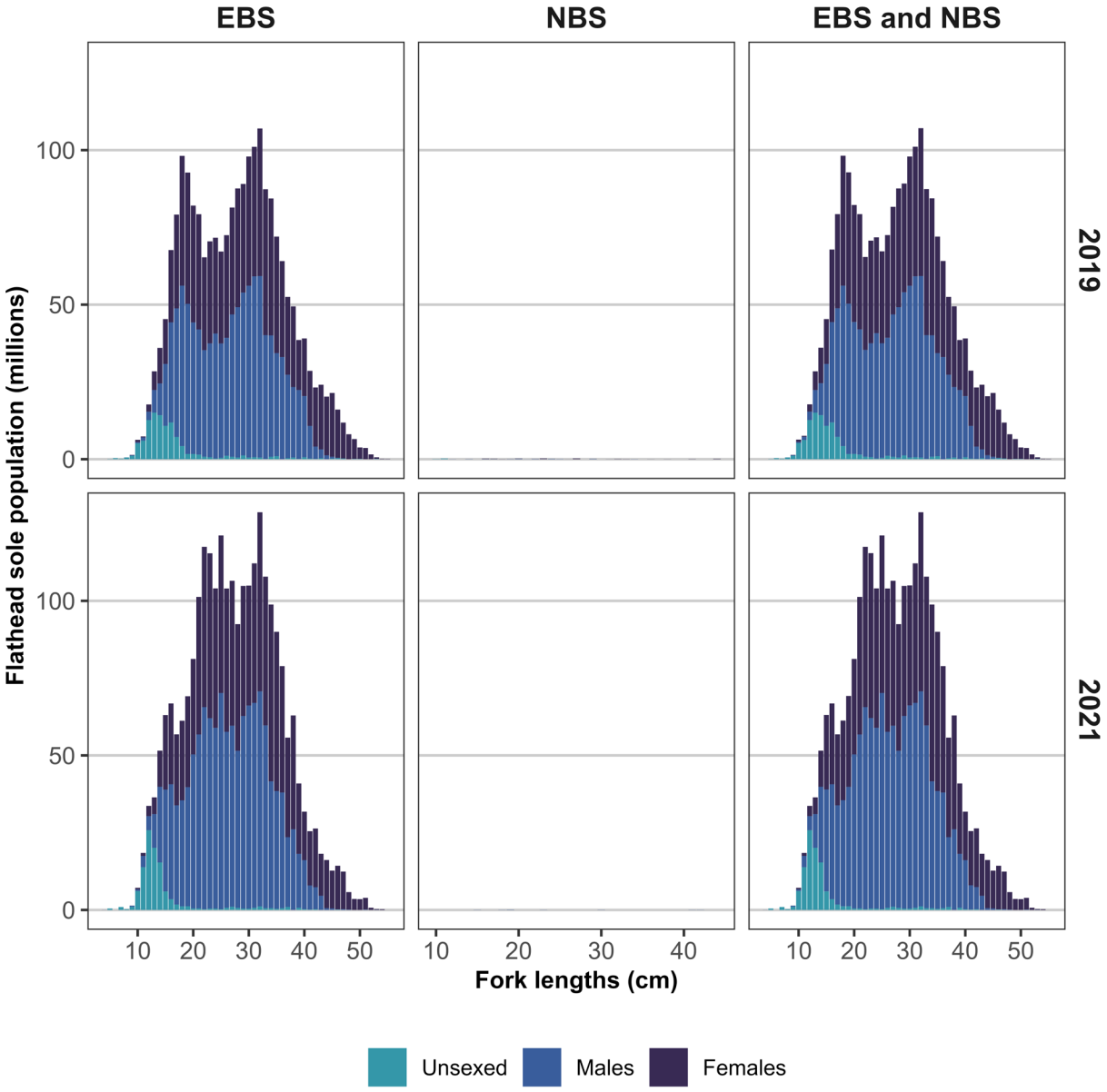

Figure 17. -- Total abundance-at-size estimates of flathead sole (*Hippoglossoides elassodon*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

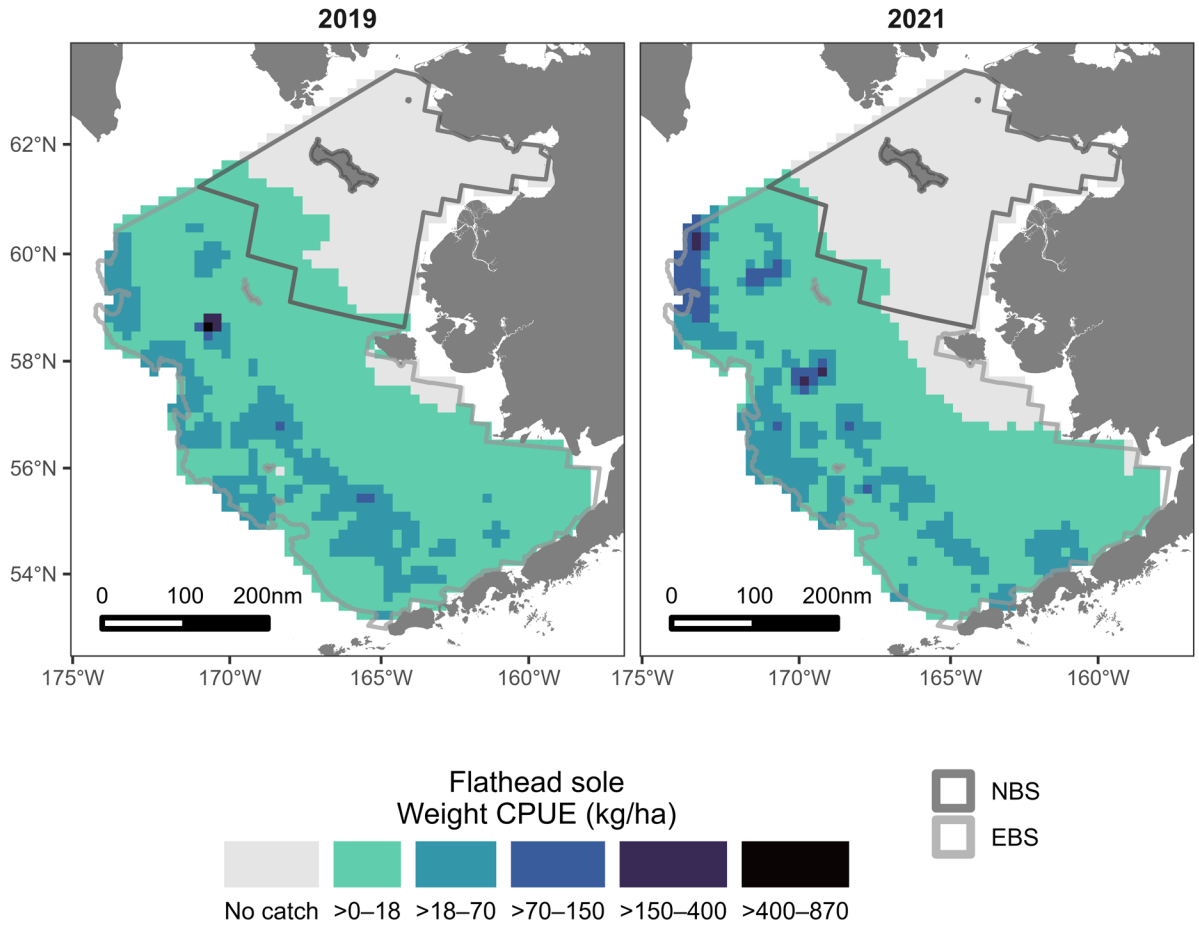

Figure 18. -- The distribution (weight CPUE (kg/ha)) of flathead sole (*Hippoglossoides elassodon*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 flathead sole (*Hippoglossoides elassodon*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	3.37	0.64	26,530	5,075	16,274	36,786	36	36	35
20	0.22	0.09	900	352	181	1,619	8	8	8
31	13.22	1.37	125,532	13,005	99,521	151,542	69	69	67
32	33.60	16.49	29,729	14,591	0	64,236	8	8	8
41	13.35	5.04	83,168	31,383	19,743	146,593	42	42	42
42	15.99	3.83	38,560	9,243	19,685	57,435	31	31	31
43	4.83	1.30	10,163	2,736	4,473	15,854	21	21	21
50	11.82	1.38	44,948	5,261	34,110	55,786	26	26	26
61	33.52	7.43	294,272	65,220	162,462	426,082	60	60	60
62	5.45	1.87	3,519	1,209	561	6,478	7	7	7
82	5.07	2.48	9,095	4,454	0	18,898	10	10	10
90	7.22	2.86	8,328	3,305	513	16,144	8	8	8
Total	**13.69**	**1.54**	**674,745**	**76,153**	**522,439**	**827,051**	**326**	**326**	**323**
NBS									
70	0.00	0.00	0	0	0	0	0	0	0
71	0.00	0.00	0	0	0	0	0	0	0
81	0.04	0.03	138	126	0	396	2	2	2
Total	**0.01**	**0.01**	**138**	**126**	**0**	**389**	**2**	**2**	**2**

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 flathead sole (*Hippoglossoides elassodon*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	8.17	1.76	64,309.36	13,888.32	36,241.07	92,377.66	36	36	35
20	0.65	0.25	2,686.62	1,036.38	570.34	4,802.90	8	8	8
31	53.70	6.33	509,993.99	60,119.61	389,754.76	630,233.22	69	69	67
32	65.69	23.77	58,114.37	21,028.15	8,382.81	107,845.94	8	8	8
41	31.74	11.49	197,743.05	71,575.81	53,088.34	342,397.75	42	42	42
42	53.86	12.96	129,910.83	31,263.08	66,071.63	193,750.03	31	31	31
43	17.44	4.66	36,733.55	9,809.51	16,329.77	57,137.34	21	21	21
50	97.08	12.70	369,294.82	48,317.71	269,760.33	468,829.30	26	26	26
61	129.25	17.55	1,134,516.76	154,076.29	823,128.58	1,445,904.94	60	60	60
62	31.77	16.15	20,525.08	10,434.59	0.00	46,058.52	7	7	7
82	11.95	6.43	21,456.10	11,544.59	0.00	46,865.73	10	10	10
90	23.08	8.15	26,633.12	9,405.64	4,388.77	48,877.46	8	8	8
Total	**52.17**	**3.89**	**2,571,917.64**	**191,968.60**	**2,187,980.45**	**2,955,854.83**	**326**	**326**	**323**
NBS									
70	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
71	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
81	0.10	0.08	370.87	318.76	0.00	1,024.96	2	2	2
Total	**0.02**	**0.02**	**370.87**	**318.76**	**0.00**	**1,008.38**	**2**	**2**	**2**

Bering Flounder (*Hippoglossoides robustus*)

In 2021, Bering flounder were most concentrated in the north and northwest regions of the entire survey area (Fig. 20). Bering flounder were present at 15.4% of the EBS stations and 55.6% of the NBS stations. The total estimated biomass for the EBS and NBS in 2021 was 9,524 t and 8,384 t, respectively (totaling 17,908 t; Table 16a), and the total population number was 42 million and 61 million, respectively (totaling about 104 billion fish; Tables 16b and 19). More than half of the total EBS and NBS population of Bering flounder occurred in the NBS during 2021. When compared to 2019, the EBS and NBS Bering flounder biomass increased by 15.2% (Tables 7a) and decreased by 54.7% (Tables 7b), respectively.

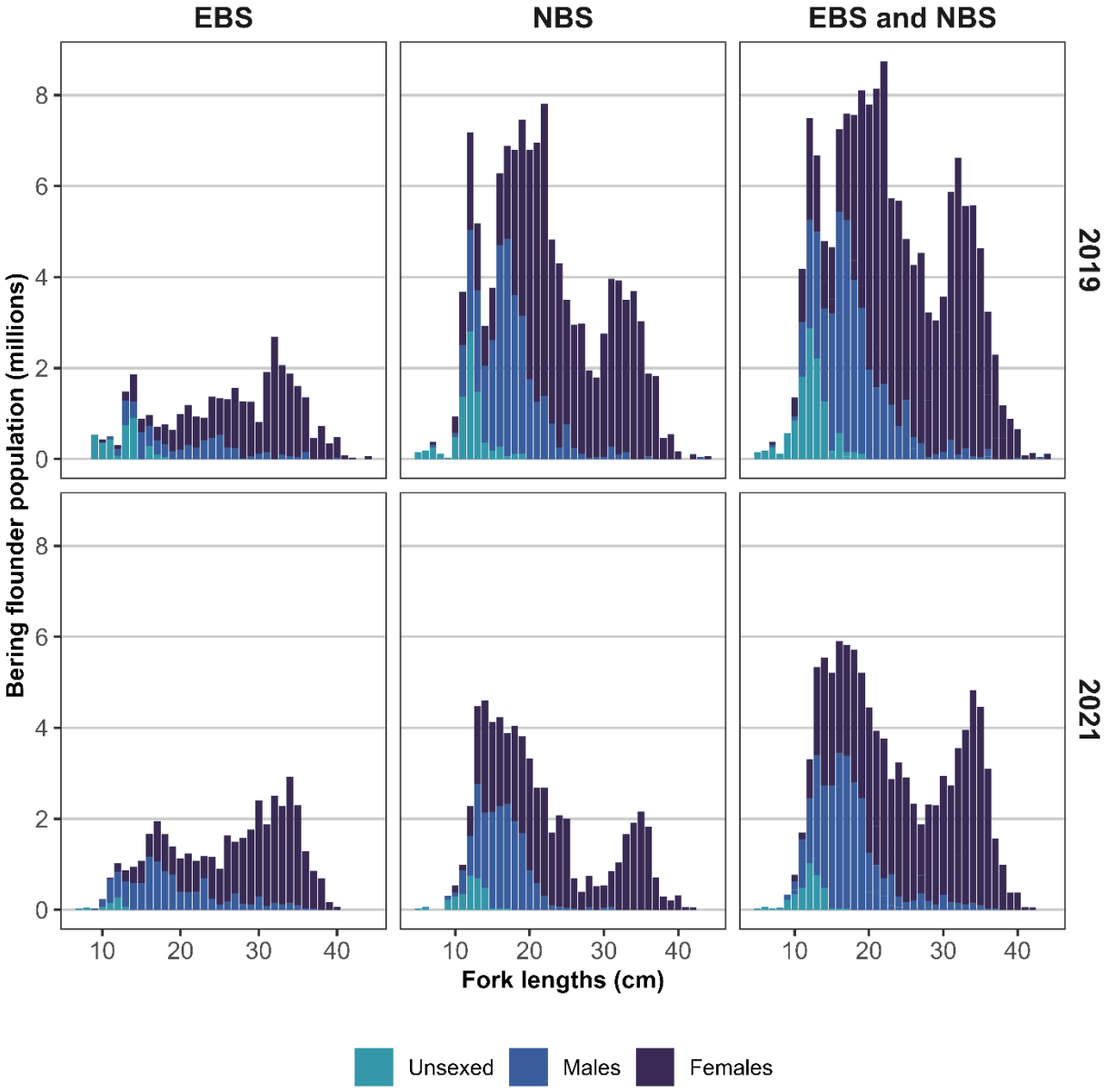

Figure 19. -- Total abundance-at-size estimates of Bering flounder (*Hippoglossoides robustus*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

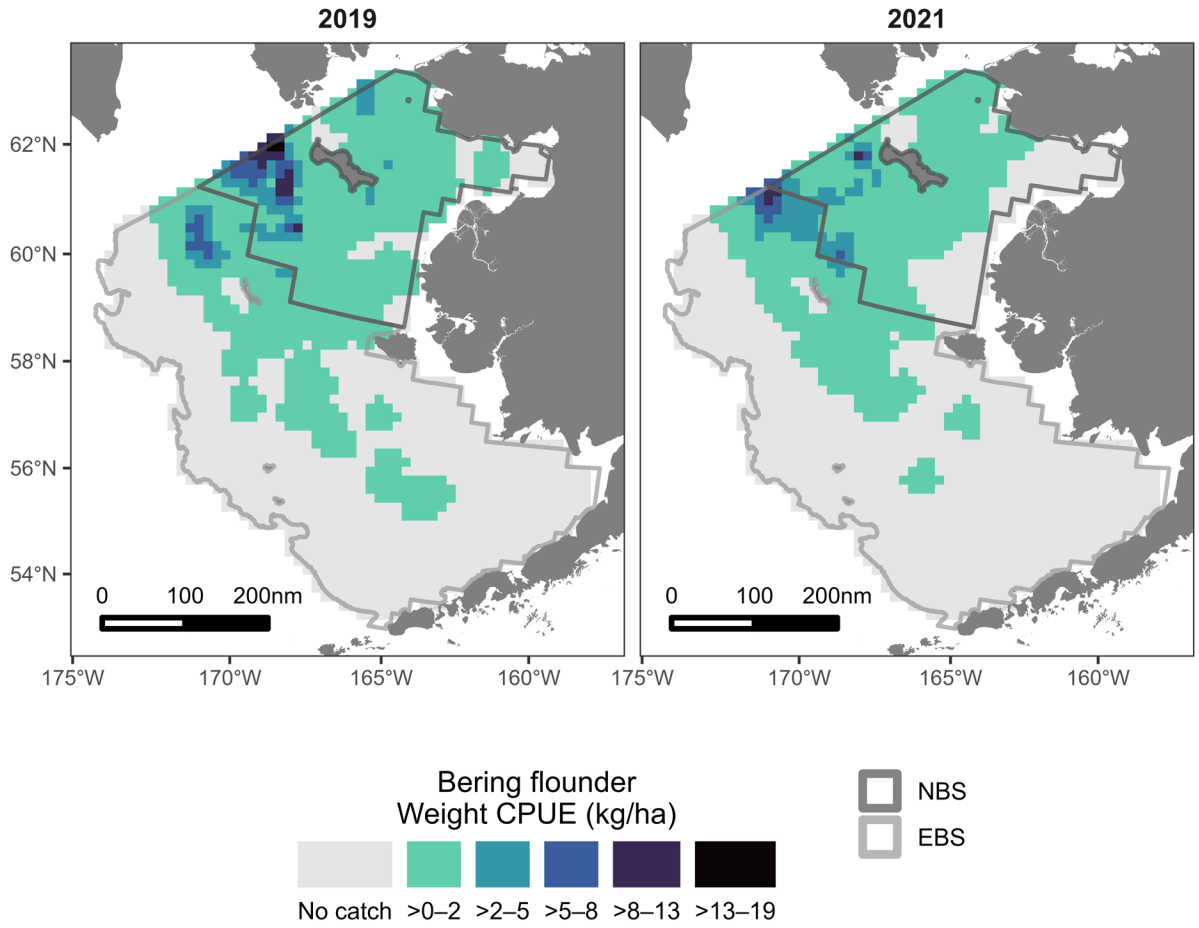

Figure 20. - The distribution (weight CPUE (kg/ha)) of Bering flounder (*Hippoglossoides robustus*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 Bering flounder (*Hippoglossoides robustus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.00	0.00	3	3	0	10	1	1	1
20	0.01	0.01	38	27	0	92	3	3	3
31	0.00	0.00	2	2	0	7	1	1	1
32	0.00	0.00	0	0	0	0	0	0	0
41	0.24	0.09	1,525	533	448	2,602	23	23	23
42	0.00	0.00	0	0	0	0	0	0	0
43	0.04	0.02	88	35	15	162	10	10	10
50	0.00	0.00	0	0	0	0	0	0	0
61	0.00	0.00	21	21	0	64	1	1	1
62	0.00	0.00	1	1	0	4	1	1	1
82	3.68	0.95	6,607	1,710	2,844	10,370	12	12	12
90	1.06	0.41	1,225	473	106	2,345	6	6	6
Total	**0.19**	**0.04**	**9,511**	**1,853**	**5,686**	**13,336**	**58**	**58**	**58**
NBS									
70	0.15	0.06	1,200	465	261	2,139	27	27	25
71	0.11	0.03	906	220	462	1,349	26	25	25
81	1.64	0.46	6,278	1,758	2,670	9,886	27	27	27
Total	**0.42**	**0.09**	**8,384**	**1,832**	**4,644**	**12,125**	**80**	**79**	**77**

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 Bering flounder (*Hippoglossoides robustus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.00	0.00	33.16	33.16	0.00	100.19	1	1	1
20	0.09	0.06	375.00	249.66	0.00	884.81	3	3	3
31	0.00	0.00	30.89	30.89	0.00	92.68	1	1	1
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	2.01	0.86	12,493.65	5,359.07	1,662.98	23,324.33	23	23	23
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.37	0.14	773.12	286.48	177.25	1,368.99	10	10	10
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.02	0.02	197.43	197.43	0.00	596.44	1	1	1
62	0.06	0.06	37.44	37.43	0.00	129.04	1	1	1
82	12.87	3.27	23,099.92	5,864.71	10,191.69	36,008.14	12	12	12
90	4.47	1.68	5,156.53	1,937.73	573.78	9,739.27	6	6	6
Total	**0.86**	**0.17**	**42,197.14**	**8,188.78**	**25,295.50**	**59,098.77**	**58**	**58**	**58**
NBS									
70	1.36	0.32	10,794.71	2,567.90	5,604.99	15,984.43	27	27	25
71	1.98	0.41	16,108.65	3,356.42	9,325.33	22,891.97	26	25	25
81	9.12	3.47	34,970.03	13,309.07	7,659.82	62,280.24	27	27	27
Total	**3.11**	**0.70**	**61,873.39**	**13,963.92**	**33,359.07**	**90,387.71**	**80**	**79**	**77**

Alaska Plaice (*Pleuronectes quadrituberculatus*)

Alaska plaice were present in patchy concentrations throughout the inner and middle domain of the survey area (Fig. 22). The highest densities of Alaska plaice in the NBS occurred just south of St. Lawrence Island in <50 m of water during both 2019 and 2021 (Fig. 22). However, concentrations in the EBS for 2021 were located southwest of Nunivak just on the 50 m contour (Fig. 22).

In 2021, the total estimated biomass of Alaska plaice in the EBS was 333,830 t and the population was approximately 579 million fish, while the estimated population of Alaska plaice in the NBS was 344,578 t and approximately 571 million fish (Tables 17a and 17b).

Alaska plaice in the EBS had a modal length range of around 33-38 cm in 2021. Alaska plaice in the NBS had a slightly wider modal length range of about 32-39 cm (Fig. 21). Overall, 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).

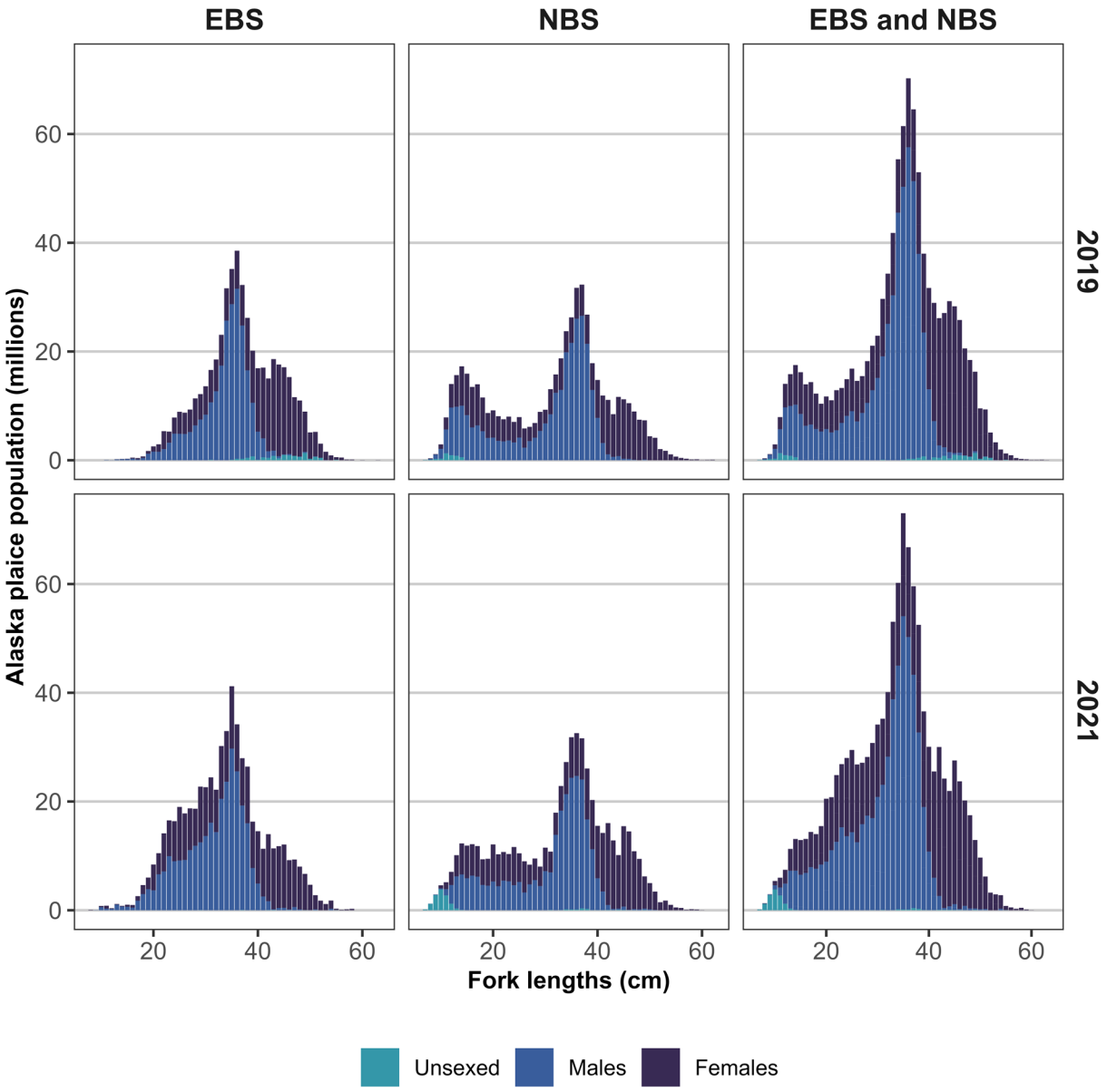

Figure 21. -- Total abundance-at-size estimates of Alaska plaice (*Pleuronectes quadrituberculatus*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

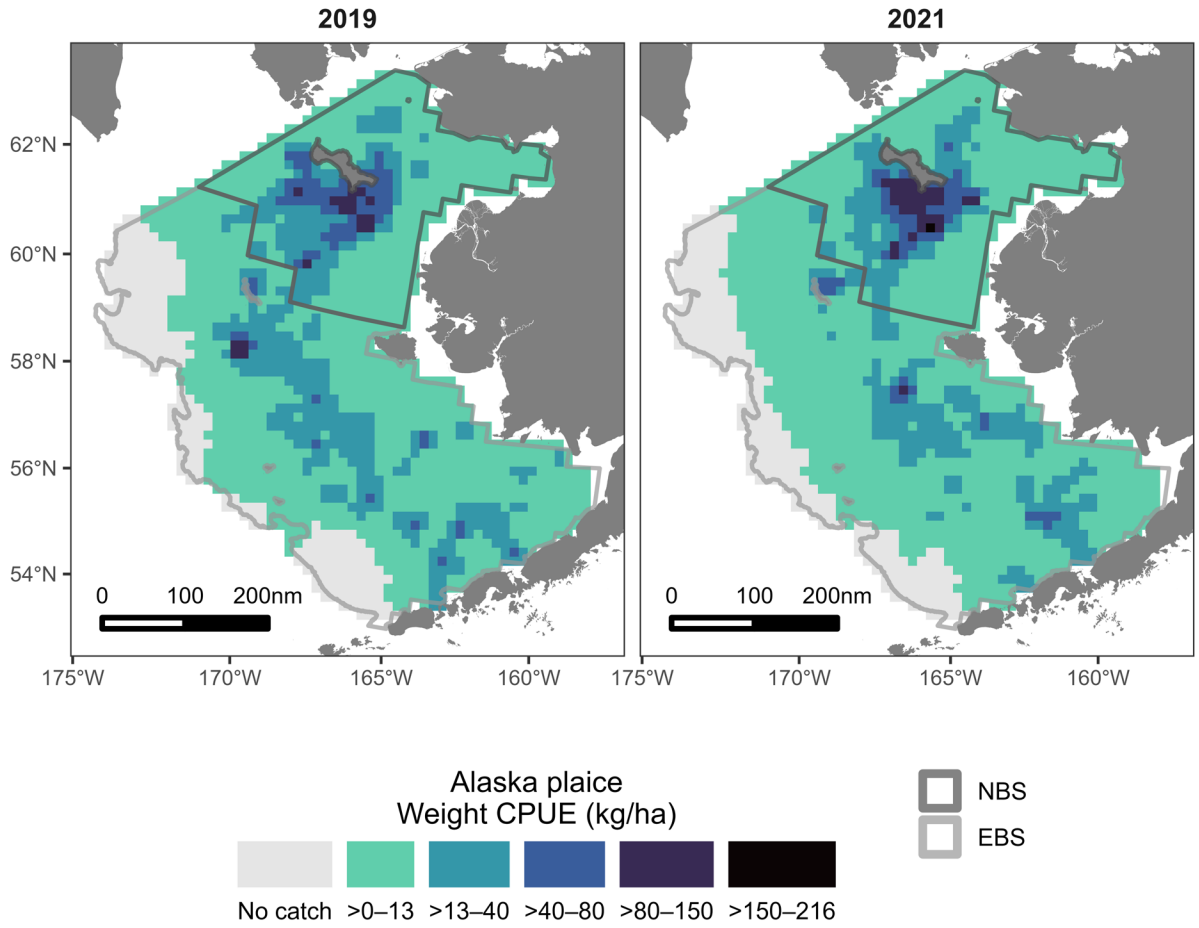

Figure 22. -- The distribution (weight CPUE (kg/ha)) of Alaska plaice (*Pleuronectes quadrituberculatus*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 Alaska plaice (*Pleuronectes quadrituberculatus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	10.76	1.50	84,684	11,810	60,816	108,552	56	56	55
20	15.85	3.65	65,303	15,021	34,630	95,975	31	31	31
31	8.78	1.57	83,426	14,876	53,673	113,179	63	63	63
32	4.00	1.61	3,542	1,428	165	6,919	8	8	7
41	10.28	2.29	64,064	14,253	35,258	92,870	39	39	39
42	4.58	1.12	11,059	2,710	5,524	16,593	25	25	25
43	4.65	1.26	9,800	2,653	4,282	15,318	21	21	21
50	0.06	0.05	221	191	0	615	2	2	2
61	0.41	0.16	3,636	1,399	809	6,463	9	9	9
62	3.21	1.50	2,076	970	0	4,448	7	7	7
82	3.62	2.22	6,500	3,979	0	15,257	12	12	12
90	0.63	0.41	724	471	0	1,839	4	4	4
Total	**6.80**	**0.58**	**335,034**	**28,722**	**278,163**	**391,904**	**277**	**277**	**275**
NBS									
70	32.42	5.89	256,951	46,699	162,573	351,329	58	58	58
71	6.25	1.38	50,746	11,205	28,102	73,391	57	57	57
81	9.62	2.01	36,884	7,699	21,086	52,682	25	25	25
Total	**17.33**	**2.45**	**344,581**	**48,637**	**247,306**	**441,856**	**140**	**140**	**140**

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 Alaska plaice (*Pleuronectes quadrituberculatus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	31.03	4.27	244,231.26	33,611.37	176,302.68	312,159.84	56	56	55
20	28.75	3.85	118,448.96	15,858.49	86,065.93	150,831.99	31	31	31
31	10.38	2.00	98,564.44	18,982.03	60,600.38	136,528.51	63	63	63
32	3.18	1.09	2,815.88	962.66	539.20	5,092.56	8	8	7
41	13.72	2.79	85,475.88	17,381.06	50,348.75	120,603.01	39	39	39
42	5.11	1.38	12,315.25	3,333.16	5,508.94	19,121.56	25	25	25
43	4.64	1.53	9,783.42	3,212.28	3,101.88	16,464.96	21	21	21
50	0.05	0.04	187.99	160.31	0.00	518.23	2	2	2
61	0.28	0.10	2,420.31	912.90	575.33	4,265.28	9	9	9
62	2.24	0.99	1,444.59	642.03	0.00	3,015.64	7	7	7
82	3.20	2.07	5,742.42	3,720.34	0.00	13,930.89	12	12	12
90	0.53	0.33	615.30	375.85	0.00	1,504.19	4	4	4
Total	**11.81**	**0.93**	**582,045.70**	**45,620.65**	**491,716.82**	**672,374.58**	**277**	**277**	**275**
NBS									
70	52.86	7.35	418,967.21	58,276.69	301,190.02	536,744.41	58	58	58
71	13.44	1.88	109,179.81	15,264.65	78,329.96	140,029.65	57	57	57
81	11.11	2.37	42,619.73	9,076.58	23,994.60	61,244.86	25	25	25
Total	**28.70**	**3.06**	**570,766.75**	**60,922.63**	**448,921.49**	**692,612.00**	**140**	**140**	**140**

Greenland Turbot (*Reinhardtius hippoglossoides*)

During the 2021 survey, Greenland turbot were present at 12.8% of stations in the EBS (48 of 376 stations), and none of the NBS stations. Greenland turbot were distributed primarily in the northwest portion of the middle and outer domains (Fig. 24), in waters with depths between 63 m and 147 m, and where bottom temperatures were between -0.3°C and 3.4°C. The fork lengths of Greenland turbot measured during the 2021 EBS survey were between 6 and 106 cm (Fig. 23).

The 2021 Greenland turbot biomass estimate decreased from 16,477 t in 2019 to 10,714 t (Table 18a) and the population estimate decreased from 5.3 million in 2019 to 2.8 million (Table 18b). 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, the 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).

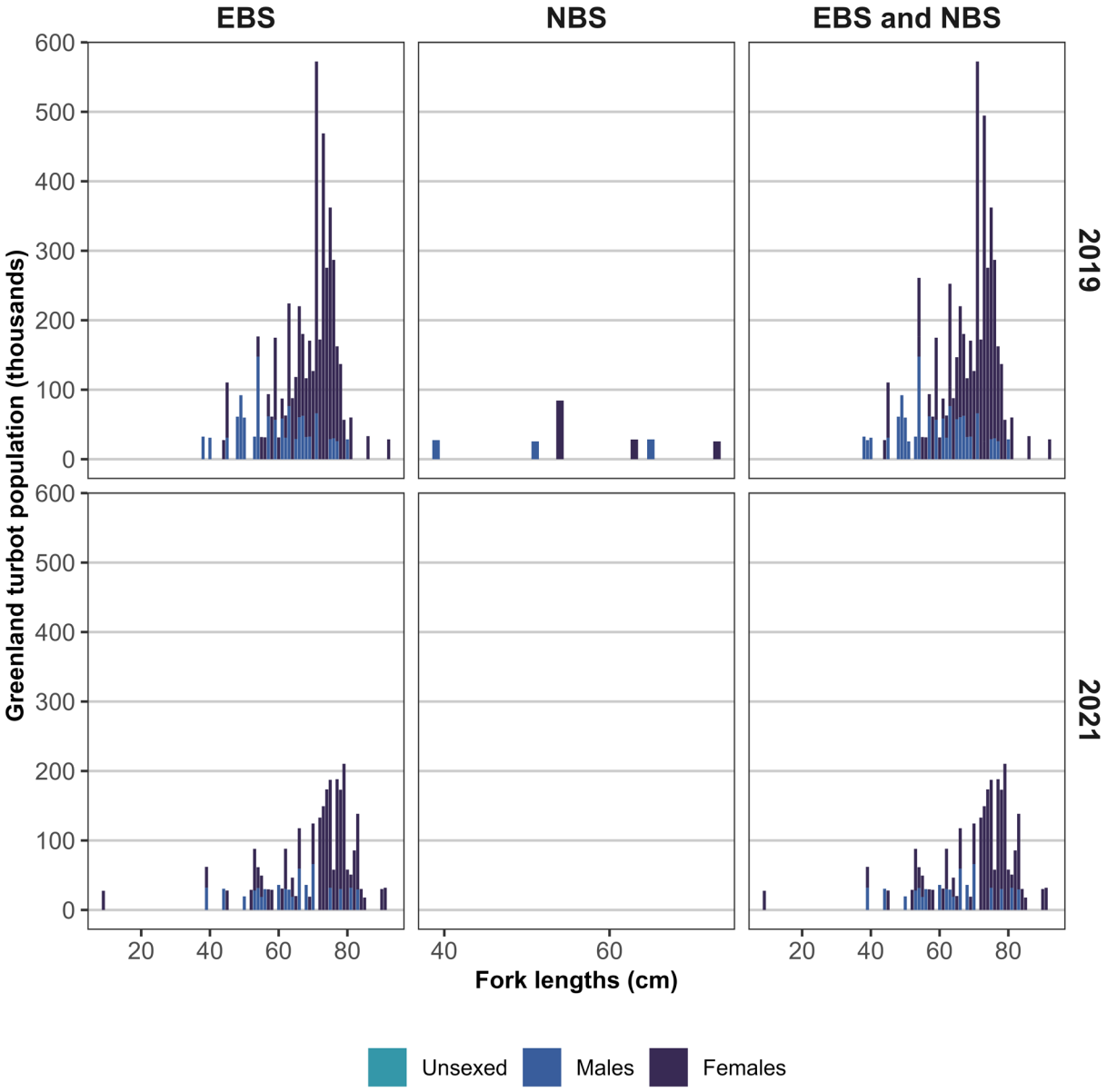

Figure 23. -- Total abundance-at-size estimates of Greenland turbot (*Reinhardtius hippoglossoides*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

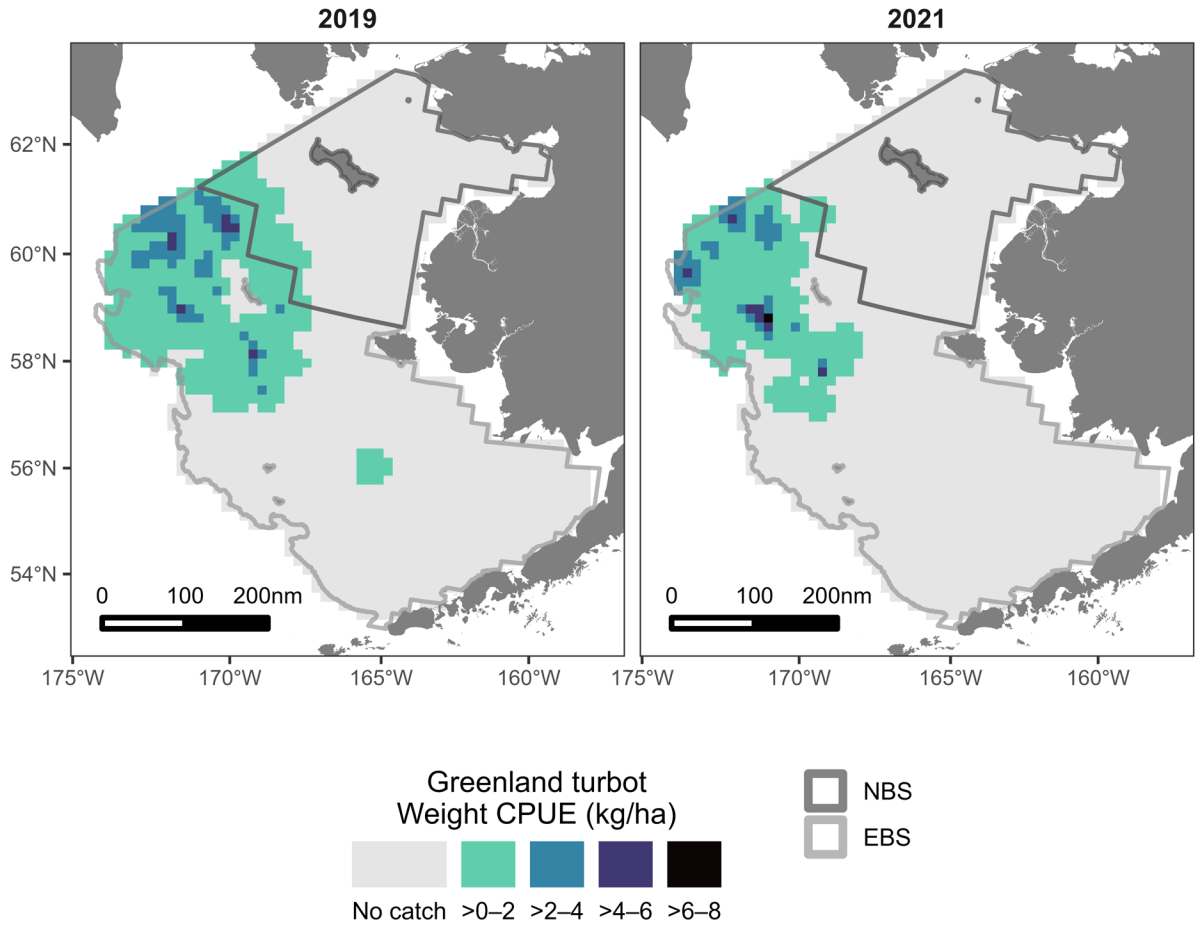

Figure 24. -- The distribution (weight CPUE (kg/ha)) of Greenland turbot (*Reinhardtius hippoglossoides*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

Table 18a. -- 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 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.23	0.11	1,406	694	5	2,808	7	7	7
42	0.00	0.00	0	0	0	0	0	0	0
43	0.26	0.12	549	253	21	1,076	6	6	6
50	0.00	0.00	0	0	0	0	0	0	0
61	0.45	0.14	3,915	1,197	1,496	6,334	17	17	17
62	2.31	0.99	1,494	637	0	3,051	6	6	6
82	0.55	0.30	991	534	0	2,165	4	4	4
90	2.02	0.66	2,336	760	540	4,132	8	8	8
Total	**0.22**	**0.04**	**10,690**	**1,801**	**7,123**	**14,257**	**48**	**48**	**48**

Table 18b. -- 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 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.06	0.03	363.68	162.51	35.25	692.10	7	7	7
42	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
43	0.06	0.02	136.30	52.10	27.92	244.67	6	6	6
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.10	0.03	833.85	227.75	373.57	1,294.13	17	17	17
62	0.48	0.17	309.10	108.68	43.17	575.04	6	6	6
82	0.19	0.09	334.10	162.72	0.00	692.24	4	4	4
90	0.67	0.21	770.96	239.57	204.37	1,337.56	8	8	8
Total	**0.06**	**0.01**	**2,747.99**	**420.33**	**1,915.74**	**3,580.24**	**48**	**48**	**48**

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 2021, arrowtooth flounder (Fig. 26) appear to occupy similar areas as Kamchatka flounder (Fig. 28), 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. Arrowtooth flounder were mostly absent from the NBS because they prefer deeper waters, further indicated by their distributions in the EBS where 99% of the total estimated biomass occurs in the middle and outer domains (Fig. 26; Table 19a). Arrowtooth flounder were more confined to the outer domain in 2010, when there was a large cold pool (Fig. 26; Lauth (2011)). In 2021, the total estimated biomass and population of arrowtooth flounder was 459,660 t and 0.9 billion fish. These estimates were a decrease from those in 2019, when the biomass and population were 578,390 t and approximately 1 billion fish, respectively (Tables 19a and 19b). 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 (Spies et al., 2018; Zimmermann and Goddard, 1996).

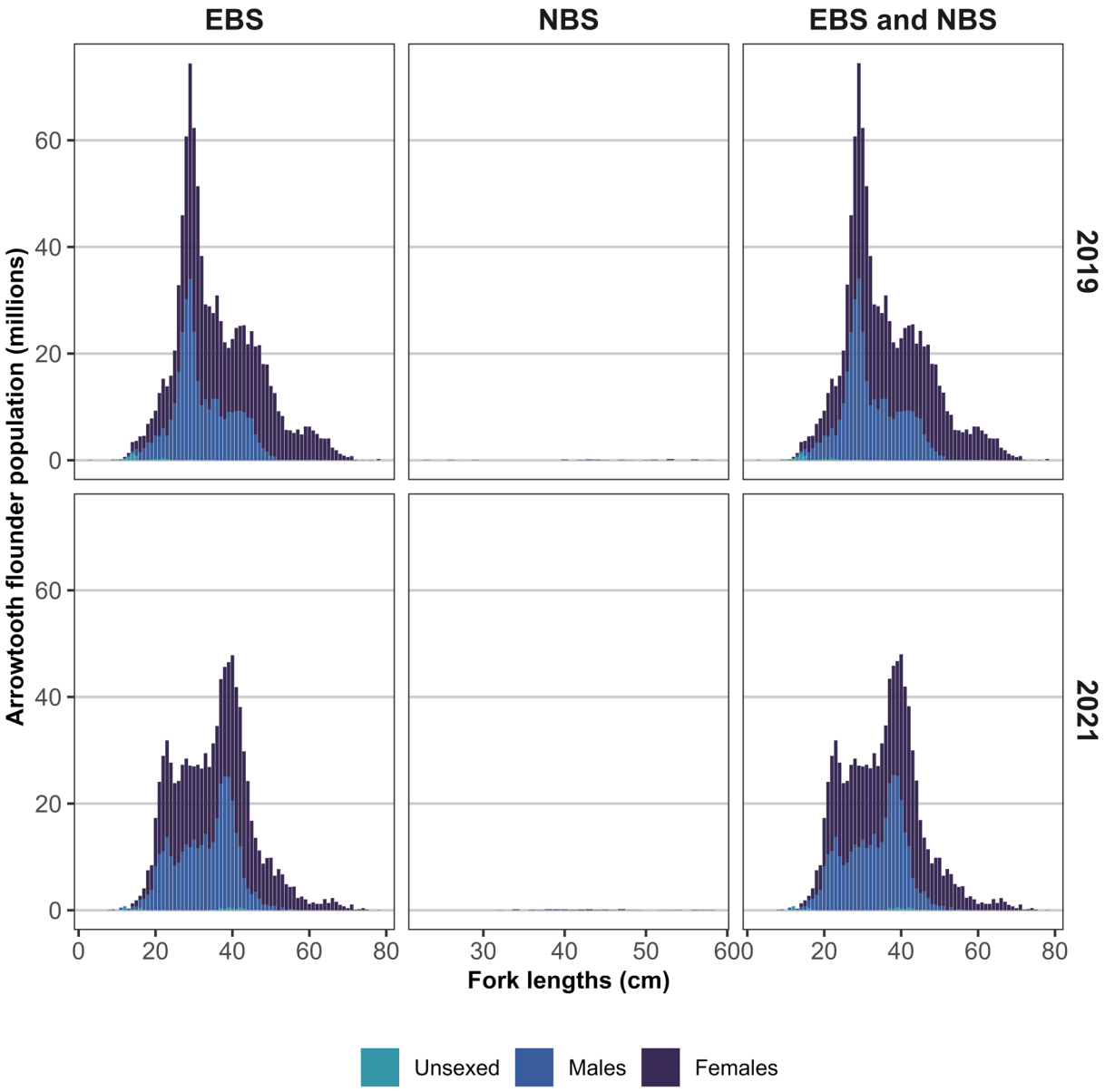

Figure 25. -- Total abundance-at-size estimates of arrowtooth flounder (*Atheresthes stomias*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

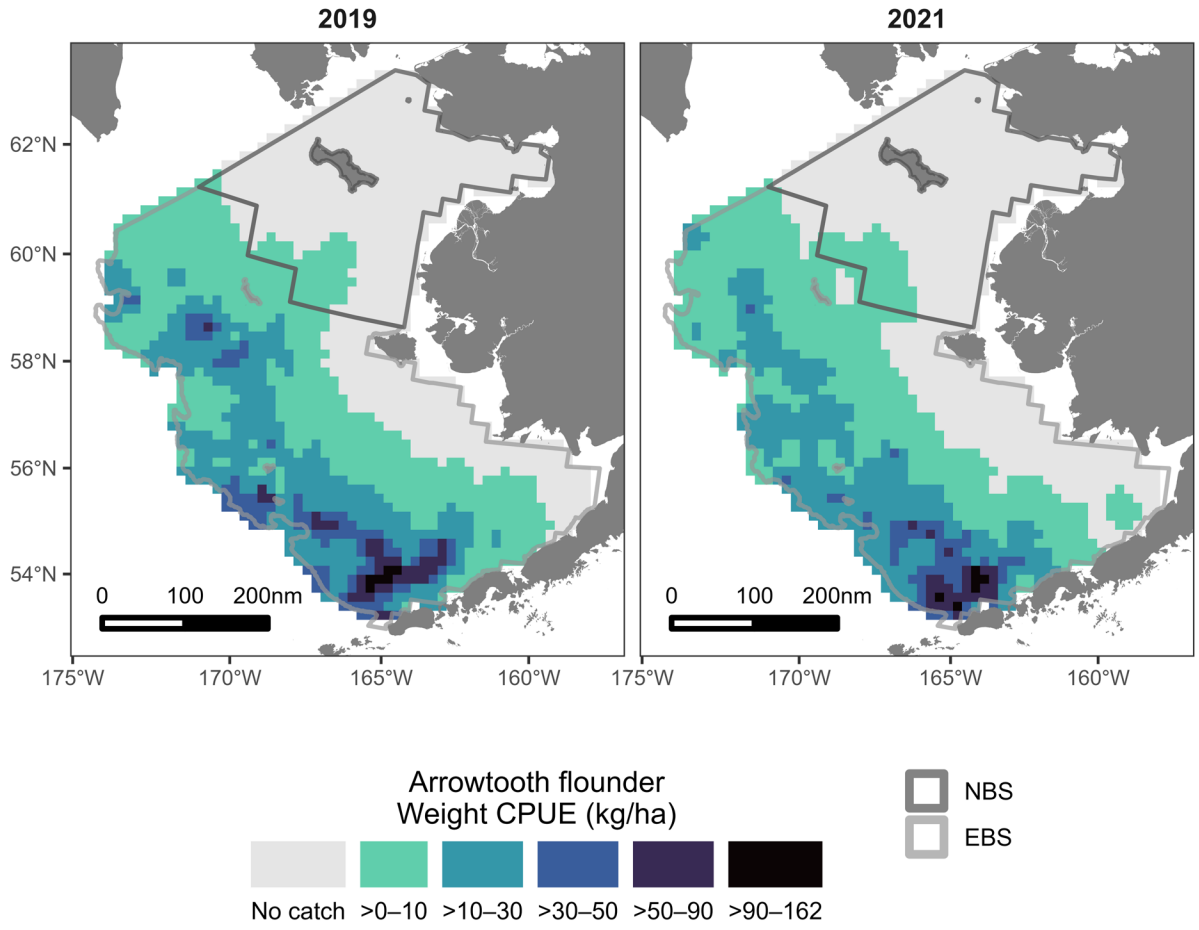

Figure 26. -- The distribution (weight CPUE (kg/ha)) of arrowtooth flounder (*Atheresthes stomias*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 arrowtooth flounder (*Atheresthes stomias*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.21	0.11	1,686	877	0	3,458	6	6	6
20	0.05	0.05	219	219	0	666	1	1	1
31	16.17	3.21	153,582	30,532	92,518	214,646	56	56	56
32	15.66	2.10	13,852	1,856	9,462	18,242	8	8	8
41	4.15	1.09	25,883	6,812	12,116	39,651	33	33	33
42	12.79	1.85	30,855	4,468	21,731	39,978	31	31	31
43	1.22	0.43	2,574	911	679	4,468	15	15	15
50	34.47	5.32	131,106	20,226	89,441	172,771	26	26	26
61	10.07	0.93	88,400	8,132	71,966	104,835	60	60	60
62	10.58	3.25	6,836	2,100	1,698	11,974	7	7	7
82	0.06	0.04	116	70	0	271	3	3	3
90	2.13	0.52	2,460	596	1,051	3,869	8	8	8
Total	**9.28**	**0.78**	**457,569**	**38,518**	**380,533**	**534,605**	**254**	**254**	**254**
NBS									
70	0.06	0.04	451	298	0	1,053	4	4	4
71	0.00	0.00	0	0	0	0	0	0	0
81	0.34	0.22	1,289	827	0	2,987	5	5	5
Total	**0.09**	**0.04**	**1,740**	**879**	**0**	**3,499**	**9**	**9**	**9**

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 arrowtooth flounder (*Atheresthes stomias*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.74	0.52	5,817.20	4,099.84	0.00	14,102.97	6	6	6
20	0.05	0.05	217.15	217.15	0.00	660.57	1	1	1
31	36.62	6.56	347,817.55	62,327.16	223,163.23	472,471.87	56	56	56
32	42.75	4.06	37,818.00	3,590.52	29,326.43	46,309.57	8	8	8
41	6.27	1.73	39,093.75	10,806.18	17,254.46	60,933.03	33	33	33
42	32.26	4.85	77,807.99	11,695.69	53,925.40	101,690.58	31	31	31
43	1.66	0.55	3,492.44	1,148.13	1,104.33	5,880.55	15	15	15
50	66.13	8.71	251,566.98	33,138.40	183,301.87	319,832.09	26	26	26
61	18.35	1.97	161,062.53	17,264.50	126,170.98	195,954.07	60	60	60
62	12.77	4.53	8,253.85	2,926.38	1,093.00	15,414.69	7	7	7
82	0.14	0.08	246.71	147.24	0.00	570.79	3	3	3
90	3.31	0.76	3,819.89	881.28	1,735.66	5,904.13	8	8	8
Total	**19.01**	**1.51**	**937,014.04**	**74,665.13**	**787,683.77**	**1,086,344.30**	**254**	**254**	**254**
NBS									
70	0.08	0.05	637.19	420.81	0.00	1,487.65	4	4	4
71	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
81	0.42	0.28	1,613.85	1,060.80	0.00	3,790.60	5	5	5
Total	**0.11**	**0.06**	**2,251.04**	**1,141.21**	**0.00**	**4,533.47**	**9**	**9**	**9**

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. 28) appeared to occupy similar areas as arrowtooth flounder in 2021 (Fig. 26), although Kamchatka flounder are much less abundant than arrowtooth flounder in the Bering Sea. From 2019 to 2021, the Kamchatka flounder biomass estimate decreased by 26% to 33,011 t (Table 20a; Markowitz et al. (2022)) and the population estimate decreased by 23% to 60.3 million fish (Table 20b; Markowitz et al. (2022)). Unlike arrowtooth flounder, the Kamchatka flounder sex ratio was roughly 1:1 (Fig. 27).

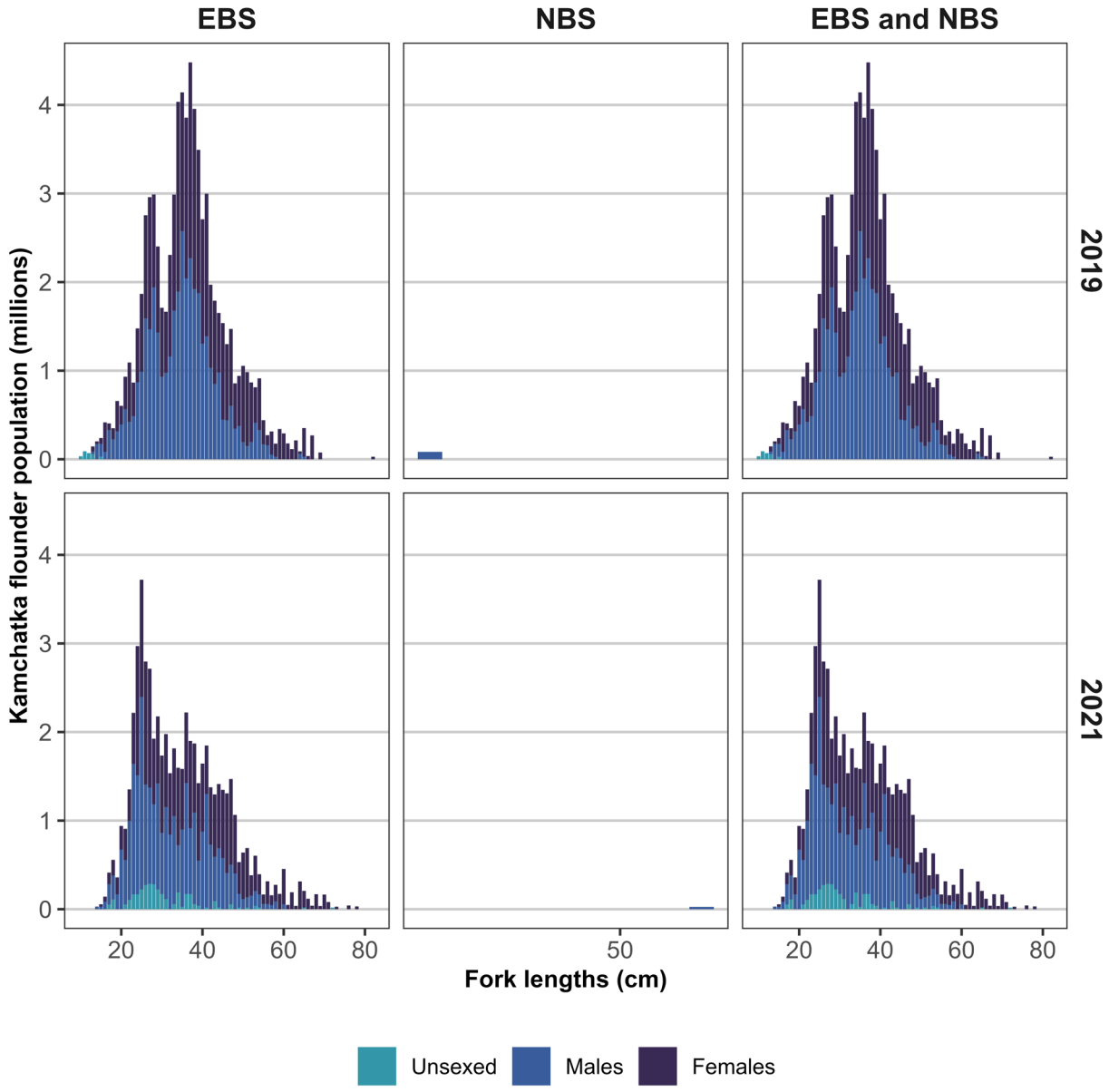

Figure 27. -- Total abundance-at-size estimates of Kamchatka flounder (*Atheresthes evermanni*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

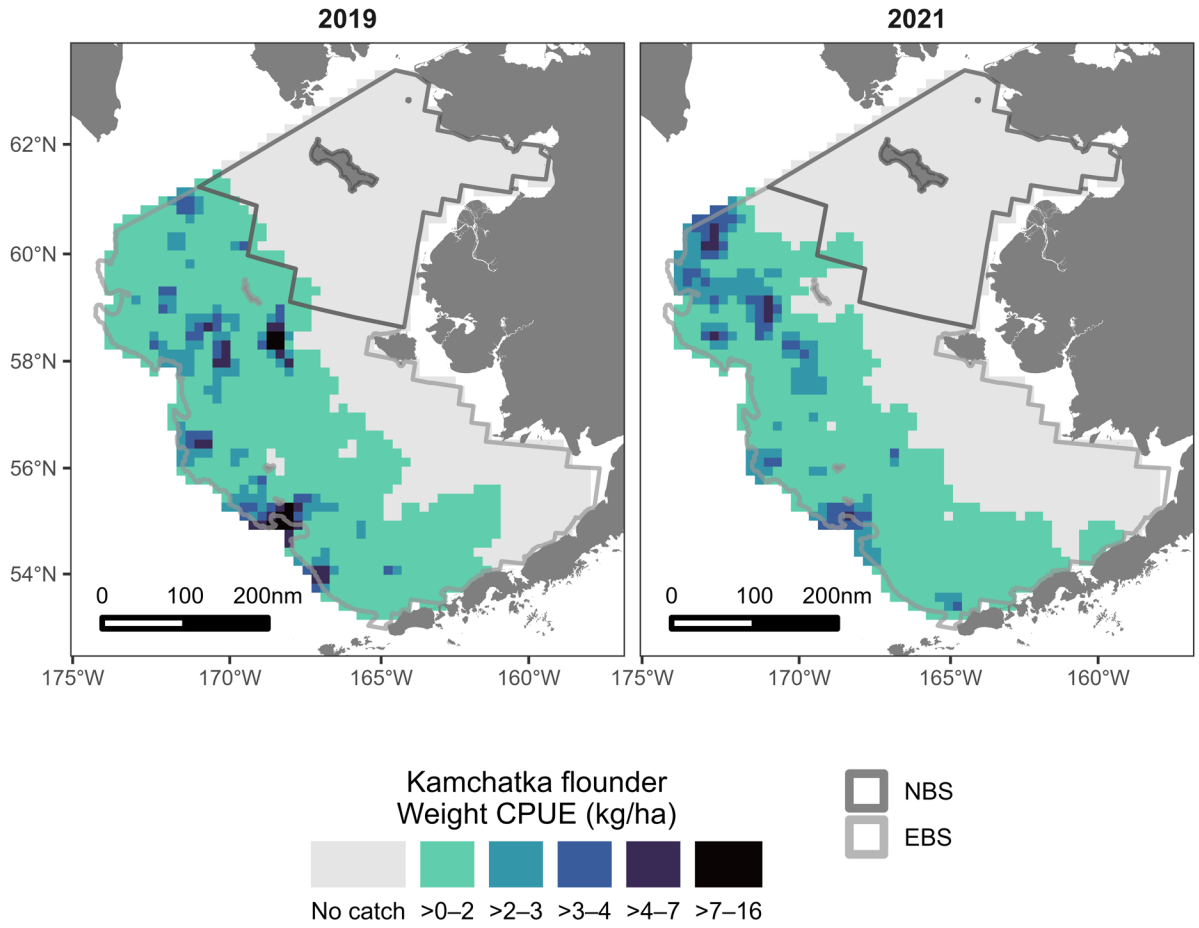

Figure 28. -- The distribution (weight CPUE (kg/ha)) of Kamchatka flounder (*Atheresthes evermanni*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

Table 20a. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
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	0.24	0.05	2,318	496	1,325	3,310	32	32	32
32	1.23	0.25	1,092	217	578	1,606	8	8	8
41	0.50	0.12	3,091	767	1,541	4,641	20	20	20
42	0.59	0.18	1,425	434	540	2,311	19	19	19
43	0.73	0.27	1,541	564	369	2,713	9	9	9
50	1.39	0.27	5,296	1,017	3,202	7,391	25	25	25
61	1.66	0.16	14,615	1,366	11,854	17,376	58	58	58
62	3.00	0.74	1,936	476	771	3,101	7	7	7
82	0.04	0.04	65	65	0	207	1	1	1
90	1.28	0.66	1,478	758	0	3,270	4	4	4
Total	**0.67**	**0.05**	**32,856**	**2,257**	**28,388**	**37,324**	**183**	**183**	**183**
NBS									
70	0.00	0.00	0	0	0	0	0	0	0
71	0.00	0.00	0	0	0	0	0	0	0
81	0.01	0.01	33	33	0	100	1	1	1
Total	**0.00**	**0.00**	**33**	**33**	**0**	**98**	**1**	**1**	**1**

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 Kamchatka flounder (*Atheresthes evermanni*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
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	0.65	0.15	6,208.80	1,408.89	3,391.03	9,026.57	32	32	32
32	4.45	1.10	3,936.60	977.18	1,625.57	6,247.64	8	8	8
41	0.40	0.10	2,502.33	600.07	1,289.59	3,715.07	20	20	20
42	1.17	0.31	2,832.61	744.82	1,311.68	4,353.53	19	19	19
43	0.51	0.19	1,066.00	398.45	237.23	1,894.77	9	9	9
50	3.27	0.84	12,421.12	3,198.09	5,833.06	19,009.18	25	25	25
61	3.24	0.35	28,434.58	3,109.13	22,151.02	34,718.14	58	58	58
62	2.47	0.63	1,597.17	406.25	603.08	2,591.26	7	7	7
82	0.02	0.02	31.57	31.58	0.00	101.07	1	1	1
90	0.84	0.50	971.11	576.45	0.00	2,334.42	4	4	4
Total	**1.22**	**0.10**	**60,001.89**	**4,940.27**	**50,220.16**	**69,783.62**	**183**	**183**	**183**
NBS									
70	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
71	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
81	0.01	0.01	25.76	25.76	0.00	78.61	1	1	1
Total	**0.00**	**0.00**	**25.76**	**25.76**	**0.00**	**77.28**	**1**	**1**	**1**

Pacific Halibut (*Hippoglossus stenolepis*)

Pacific halibut are widely distributed across the shelf. They were collected at 72.1% of the stations sampled in the EBS (271 of 376 stations) and 54.2% of stations in the NBS (78 of 144 stations). The highest density catches of Pacific halibut in 2021 were to the west, north and east of St. Paul Island, as well as to the west and north of St. Matthew Island (Fig. 30). From 2019 to 2021, the Pacific halibut biomass estimate within the EBS survey area increased 15% from 113,855 t to 131,416 t. However, in the NBS, the biomass estimate in 2021 was nearly identical to that of 2019 (Table 21a).

In 2021, Pacific halibut were found in waters with depths between 21 m and 163 m in the EBS, and between 18 m and 79 m within the NBS. Pacific halibut were found at bottom temperatures between 6.9°C and -0.6°C in the EBS, and between 10.8°C and -1.7°C in the NBS. The fork lengths of Pacific halibut measured during the 2021 survey were between 5 and 198 cm in the EBS, and between 16 and 141 cm in the NBS.

The length distributions of Pacific halibut in 2010 were bimodal. However, during 2017 and 2019, there were several modes in the size composition (Fig. 29). In 2021, the size composition of Pacific halibut was unimodal with the greatest frequency of lengths at approximately 30 to 60 cm (Fig. 29). In order 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 also categorized as unsexed.

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.

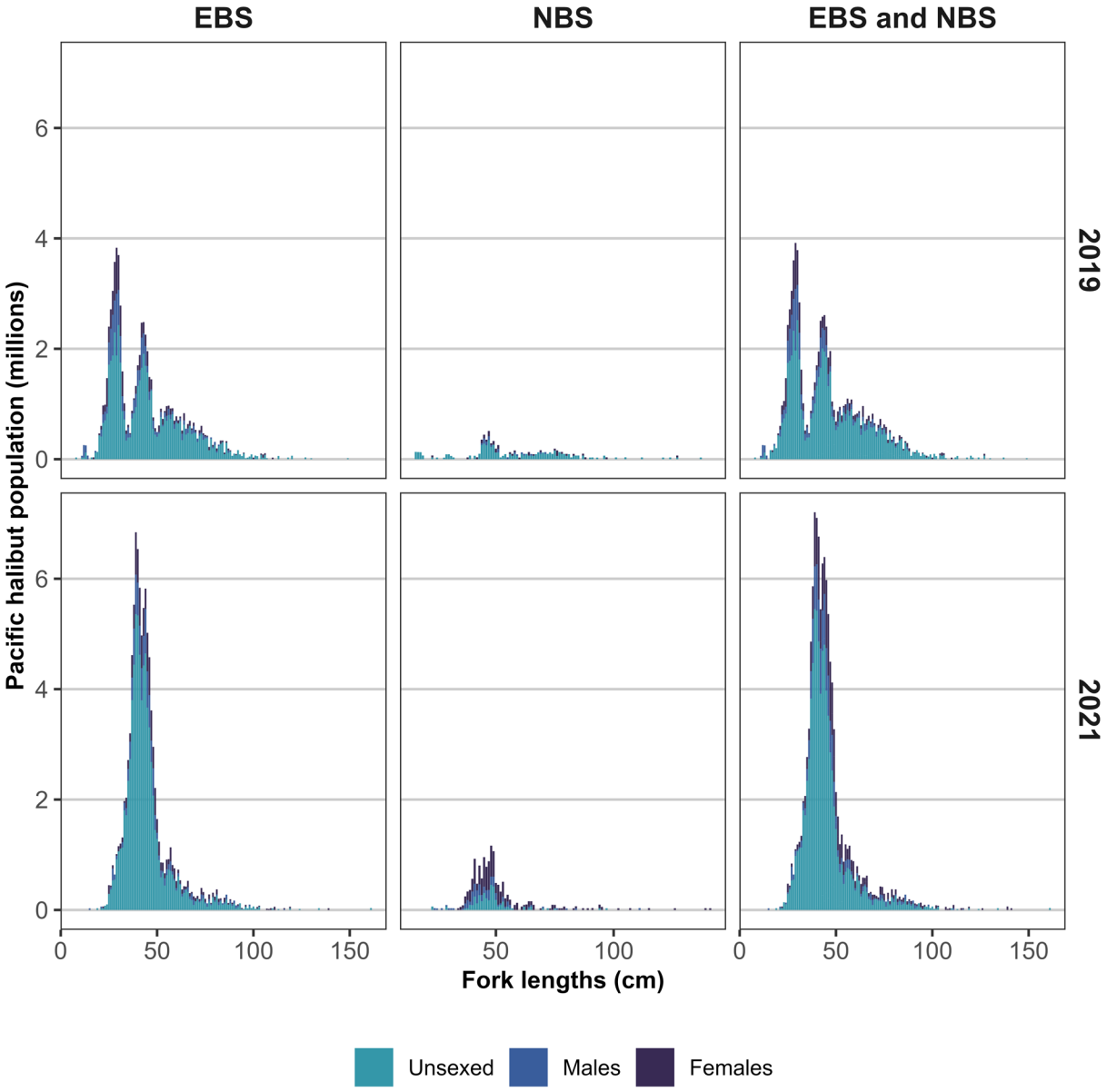

Figure 29. -- Total abundance-at-size estimates of Pacific halibut (*Hippoglossus stenolepis*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

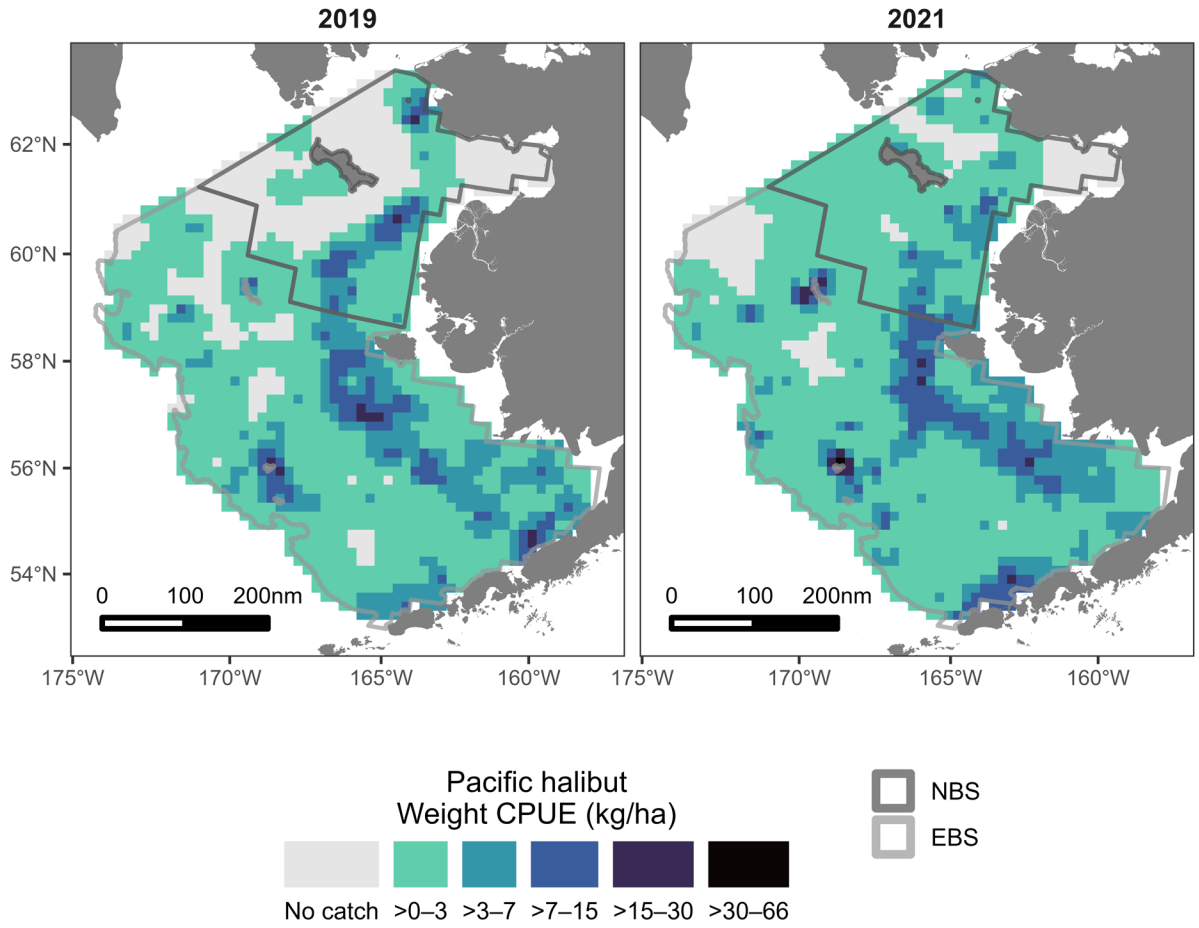

Figure 30. -- The distribution (weight CPUE (kg/ha)) of Pacific halibut (*Hippoglossus stenolepis*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 Pacific halibut (*Hippoglossus stenolepis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	4.74	0.45	37,296	3,531	30,159	44,433	58	58	58
20	6.20	0.94	25,559	3,862	17,673	33,445	30	30	30
31	2.17	0.40	20,634	3,841	12,952	28,316	55	55	55
32	2.41	1.03	2,132	911	0	4,285	5	5	5
41	1.60	0.57	9,990	3,570	2,774	17,205	32	32	32
42	6.15	2.22	14,842	5,346	3,926	25,758	28	28	28
43	1.76	1.23	3,713	2,583	0	9,086	8	8	8
50	1.61	0.46	6,139	1,755	2,524	9,755	16	16	16
61	1.19	0.29	10,409	2,556	5,242	15,575	29	29	29
62	0.22	0.12	145	79	0	339	3	3	3
82	0.56	0.27	1,006	493	0	2,091	7	7	7
90	0.00	0.00	0	0	0	0	0	0	0
Total	**2.67**	**0.20**	**131,864**	**10,041**	**111,983**	**151,746**	**271**	**271**	**271**
NBS									
70	2.26	0.39	17,941	3,121	11,633	24,248	44	44	44
71	0.82	0.24	6,644	1,931	2,742	10,546	17	17	17
81	0.37	0.11	1,411	413	562	2,259	17	17	17
Total	**1.31**	**0.19**	**25,995**	**3,693**	**18,609**	**33,382**	**78**	**78**	**78**

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 Pacific halibut (*Hippoglossus stenolepis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	5.20	0.52	40,950.88	4,105.12	32,654.43	49,247.32	58	58	58
20	5.48	1.04	22,591.11	4,283.27	13,844.67	31,337.54	30	30	30
31	1.84	0.54	17,435.93	5,100.69	7,234.54	27,637.32	55	55	55
32	0.60	0.24	526.90	210.77	28.42	1,025.38	5	5	5
41	0.78	0.30	4,878.64	1,864.98	1,109.52	8,647.75	32	32	32
42	4.13	2.12	9,954.57	5,102.04	0.00	20,372.94	28	28	28
43	0.51	0.30	1,071.20	631.82	0.00	2,385.39	8	8	8
50	0.38	0.12	1,438.61	448.65	514.38	2,362.83	16	16	16
61	0.24	0.05	2,109.28	467.13	1,165.21	3,053.35	29	29	29
62	0.08	0.04	54.42	25.67	0.00	117.23	3	3	3
82	0.24	0.08	430.28	142.95	115.65	744.92	7	7	7
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**2.06**	**0.19**	**101,441.82**	**9,571.24**	**82,490.76**	**120,392.87**	**271**	**271**	**271**
NBS									
70	1.50	0.23	11,865.05	1,829.81	8,167.01	15,563.10	44	44	44
71	0.16	0.06	1,314.01	470.25	363.63	2,264.39	17	17	17
81	0.24	0.06	939.40	236.62	453.86	1,424.94	17	17	17
Total	**0.71**	**0.10**	**14,118.46**	**1,904.03**	**10,310.41**	**17,926.52**	**78**	**78**	**78**

Bering Skate (*Bathyraja interrupta*)

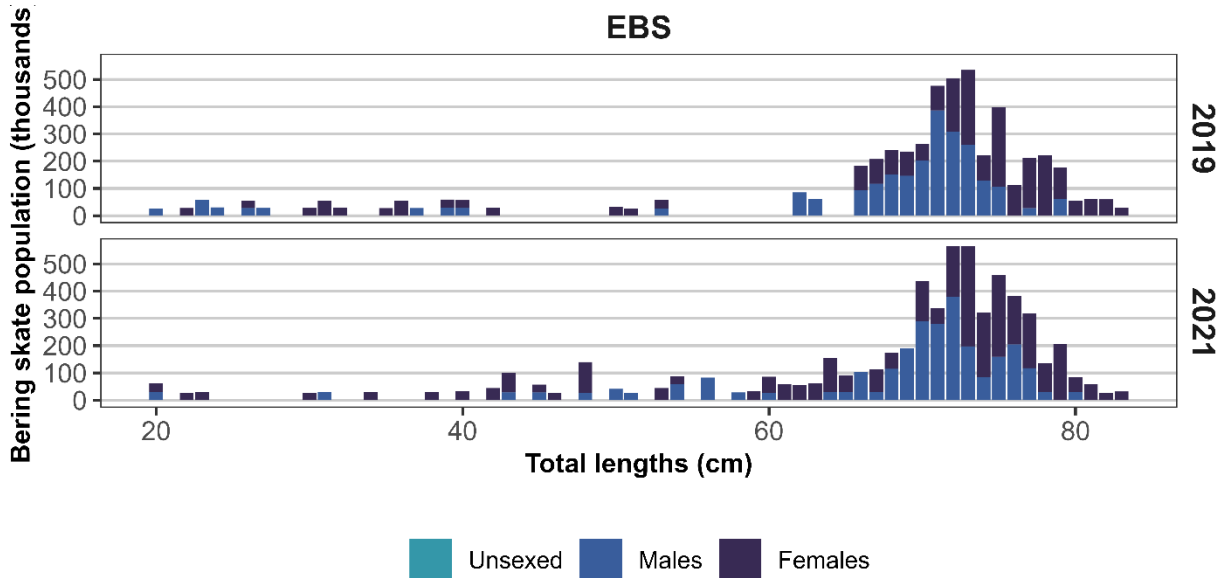

Figure 31. -- Total abundance-at-size estimates of Bering skate (*Bathyraja interrupta*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2019 and 2021 EBS shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

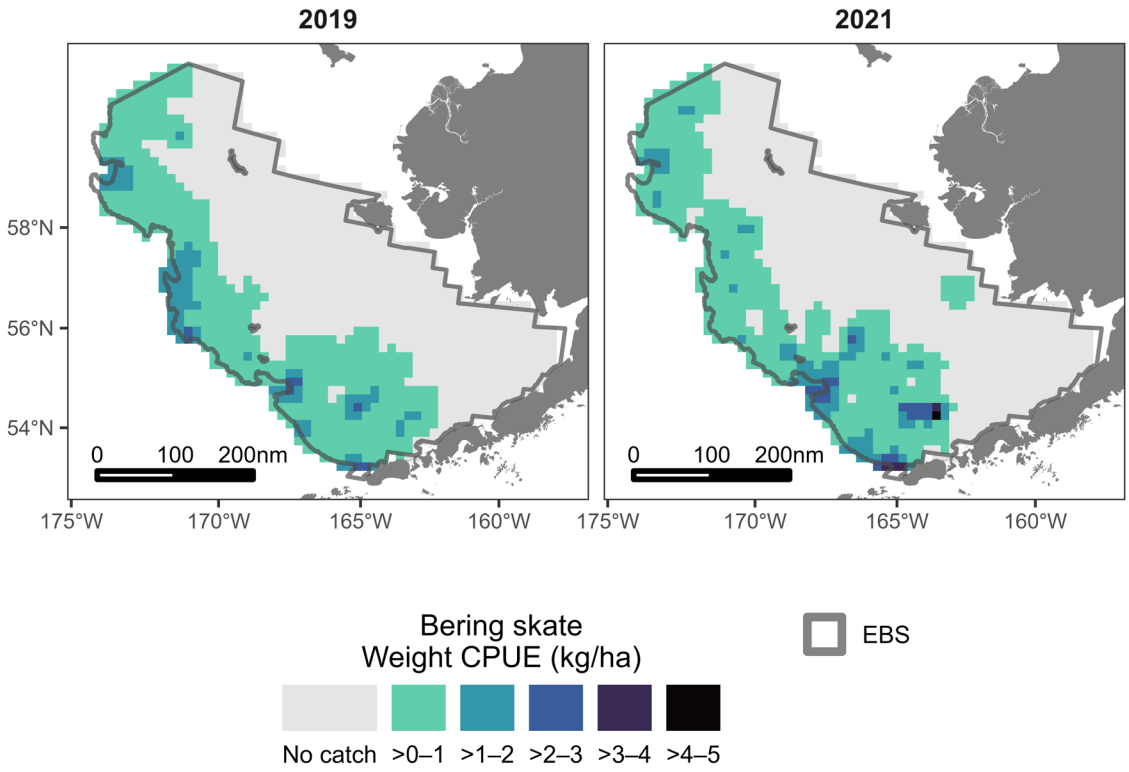

Figure 32. -- The distribution (weight CPUE (kg/ha)) of Bering skate (*Bathyraja interrupta*) from the 2019 and 2021 EBS shelf bottom trawl survey.

Table 22a. -- 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 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	143	143	0	432	1	1	1
20	0.00	0.00	0	0	0	0	0	0	0
31	0.44	0.12	4,182	1,106	1,971	6,394	21	21	21
32	0.12	0.08	104	68	0	266	2	2	2
41	0.01	0.01	75	75	0	226	1	1	1
42	0.20	0.11	494	260	0	1,025	5	5	5
43	0.00	0.00	0	0	0	0	0	0	0
50	0.89	0.20	3,387	765	1,812	4,963	16	16	16
61	0.38	0.06	3,377	538	2,289	4,465	32	32	32
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	0.35	0.20	405	226	0	939	4	4	4
Total	**0.25**	**0.03**	**12,168**	**1,499**	**9,200**	**15,136**	**82**	**82**	**82**

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 Bering skate (*Bathyraja interrupta*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	31.81	31.81	0.00	96.10	1	1	1
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.19	0.05	1,827.40	488.67	850.07	2,804.73	21	21	21
32	0.05	0.03	47.05	30.83	0.00	119.95	2	2	2
41	0.00	0.00	25.64	25.64	0.00	77.45	1	1	1
42	0.09	0.05	206.49	116.58	0.00	444.53	5	5	5
43	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
50	0.49	0.12	1,866.12	462.55	913.27	2,818.98	16	16	16
61	0.20	0.03	1,790.38	280.48	1,223.52	2,357.23	32	32	32
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	0.18	0.10	206.48	113.07	0.00	473.89	4	4	4
Total	**0.12**	**0.02**	**6,001.36**	**748.61**	**4,519.12**	**7,483.61**	**82**	**82**	**82**

Alaska Skate (*Bathyraja parmifera*)

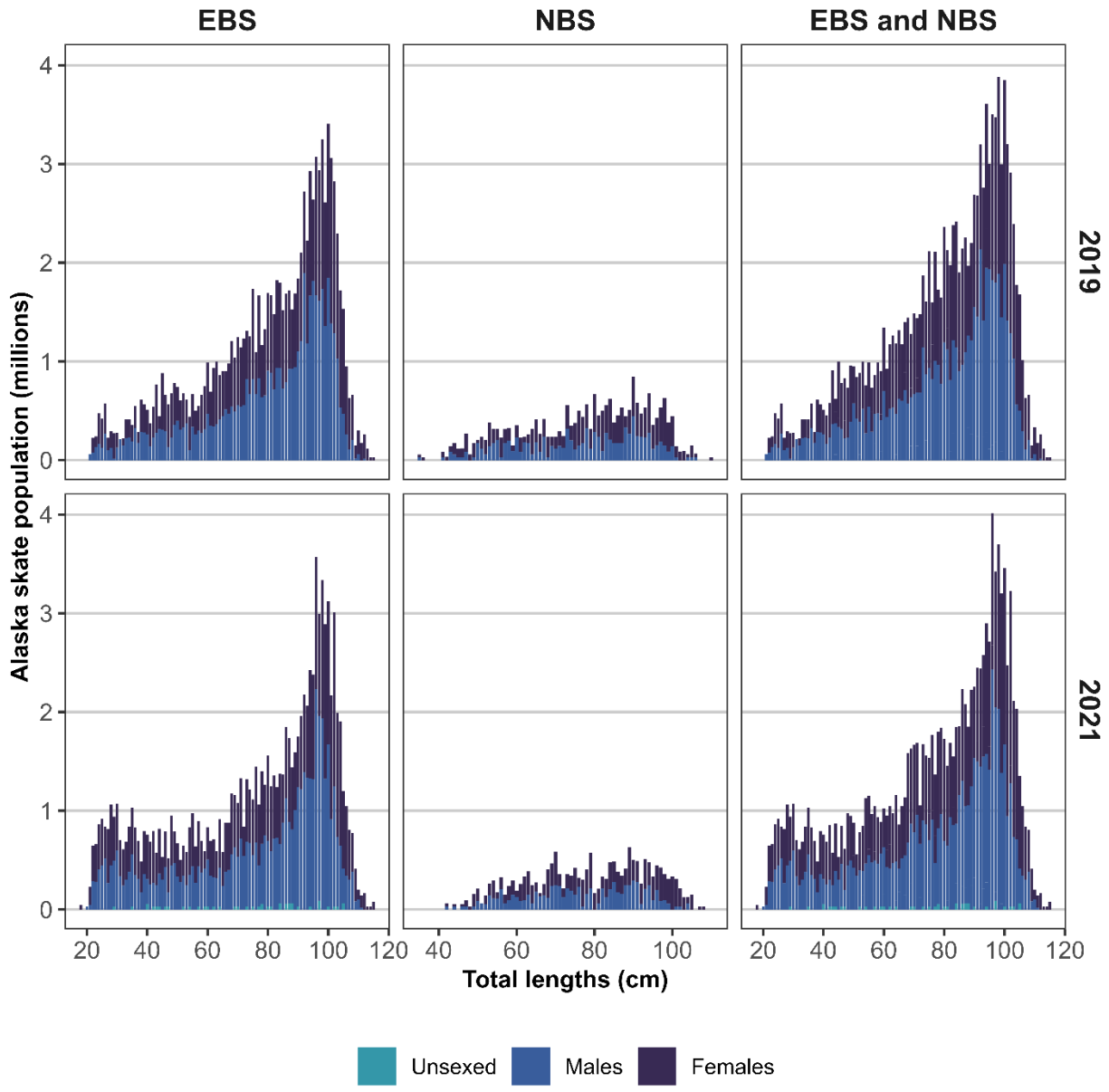

Figure 33. --Total abundance-at-size estimates of Alaska skate (*Bathyraja parmifera*) by sex (unsexed, males, and females) in centimeters (cm) observed during the 2022 and 2021 eastern Bering Sea (EBS), northern Bering Sea (NBS), and combined eastern and northern Bering Sea (EBS and NBS) shelf bottom trawl surveys. Length distributions scaled up to the total estimated population size.

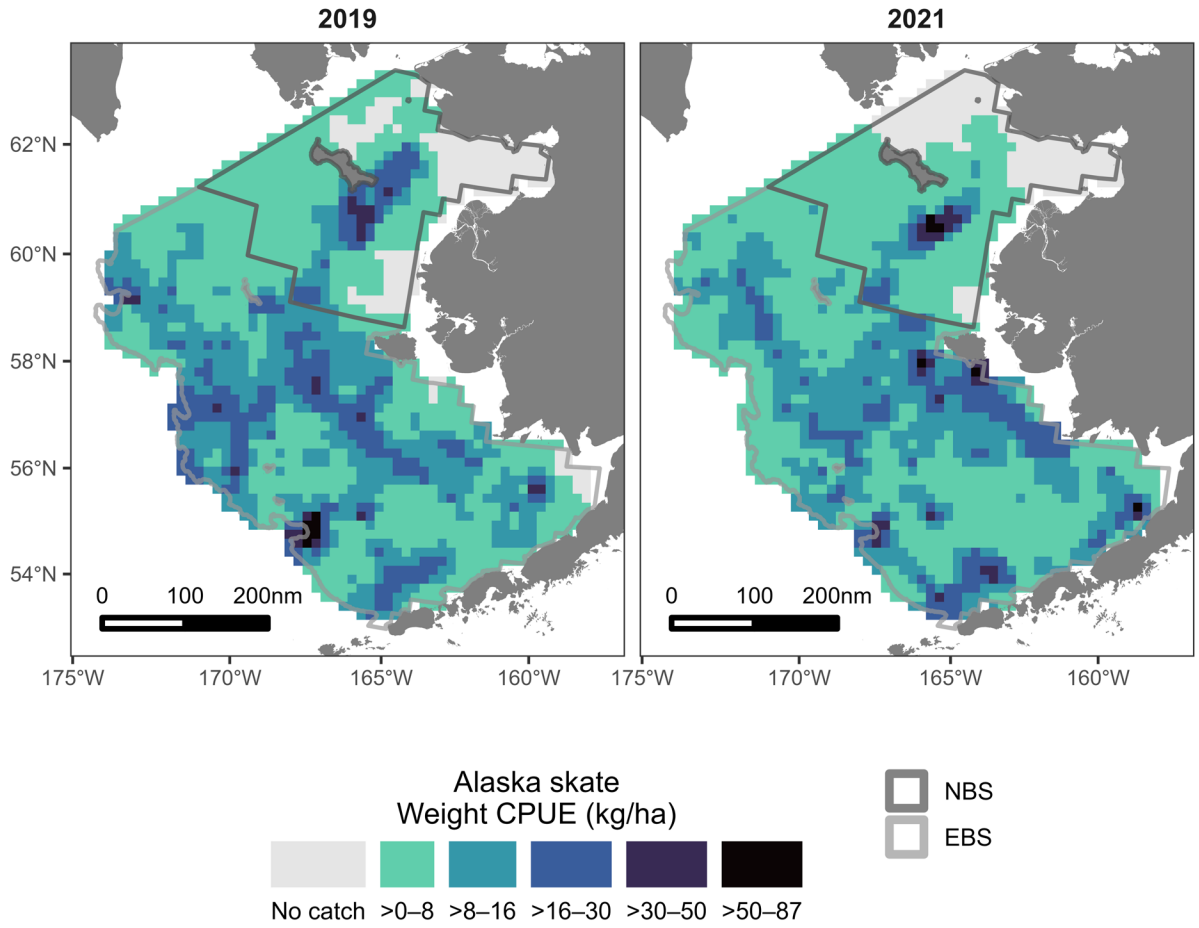

Figure 34. -- The distribution (weight CPUE (kg/ha)) of Alaska skate (*Bathyraja parmifera*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

Table 23a. -- 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 Alaska skate (*Bathyraja parmifera*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	10.65	1.32	83.79	10,420	62.73	104.85	49	49	49
20	16.76	2.46	69.06	10,118	48.40	89.72	31	31	31
31	8.02	1.09	76.17	10,341	55.49	96.86	66	66	66
32	5.69	2.01	5.04	1,776	0.84	9.24	7	7	7
41	9.95	0.92	61.98	5,747	50.36	73.59	43	43	43
42	11.62	1.33	28.04	3,218	21.47	34.61	30	30	30
43	4.37	0.65	9.19	1,372	6.34	12.05	21	21	21
50	10.88	2.37	41.38	9,001	22.84	59.92	25	25	25
61	7.97	0.80	69.95	6,983	55.84	84.06	57	57	57
62	12.05	3.00	7.78	1,941	3.03	12.53	7	7	7
82	4.01	0.84	7.20	1,507	3.88	10.51	12	12	12
90	7.40	0.73	8.54	843	6.54	10.53	8	8	8
Total	**9.50**	**0.45**	**468.11**	**22,424**	**423.71**	**512.51**	**356**	**356**	**356**
NBS									
70	7.64	1.95	60.55	15,427	29.37	91.73	41	41	41
71	0.92	0.36	7.51	2,895	1.66	13.36	8	8	8
81	3.17	0.90	12.14	3,434	5.10	19.19	20	20	20
Total	**4.03**	**0.81**	**80.21**	**16,068**	**48.07**	**112.34**	**69**	**69**	**69**

Table 23b. -- 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 Alaska skate (*Bathyraja parmifera*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	2.18	0.25	17.17	1,996.24	13.14	21.21	49	49	49
20	4.04	0.57	16.64	2,335.76	11.87	21.41	31	31	31
31	2.10	0.19	19.96	1,839.42	16.28	23.63	66	66	66
32	1.34	0.37	1.18	323.53	0.42	1.95	7	7	7
41	2.48	0.24	15.42	1,483.59	12.43	18.42	43	43	43
42	2.77	0.36	6.67	871.50	4.89	8.45	30	30	30
43	1.60	0.22	3.37	457.11	2.42	4.32	21	21	21
50	1.56	0.40	5.93	1,511.66	2.82	9.04	25	25	25
61	1.67	0.15	14.62	1,342.51	11.91	17.33	57	57	57
62	2.61	0.47	1.68	305.04	0.94	2.43	7	7	7
82	0.95	0.16	1.70	281.89	1.08	2.32	12	12	12
90	2.22	0.28	2.56	322.94	1.80	3.33	8	8	8
Total	**2.17**	**0.09**	**106.92**	**4,523.56**	**97.96**	**115.88**	**356**	**356**	**356**
NBS									
70	1.82	0.48	14.46	3,818.28	6.75	22.18	41	41	41
71	0.12	0.05	1.00	407.53	0.18	1.82	8	8	8
81	0.84	0.23	3.22	870.81	1.43	5.00	20	20	20
Total	**0.94**	**0.20**	**18.68**	**3,937.46**	**10.81**	**26.56**	**69**	**69**	**69**

Longhead Dab (*Limanda proboscidea*)

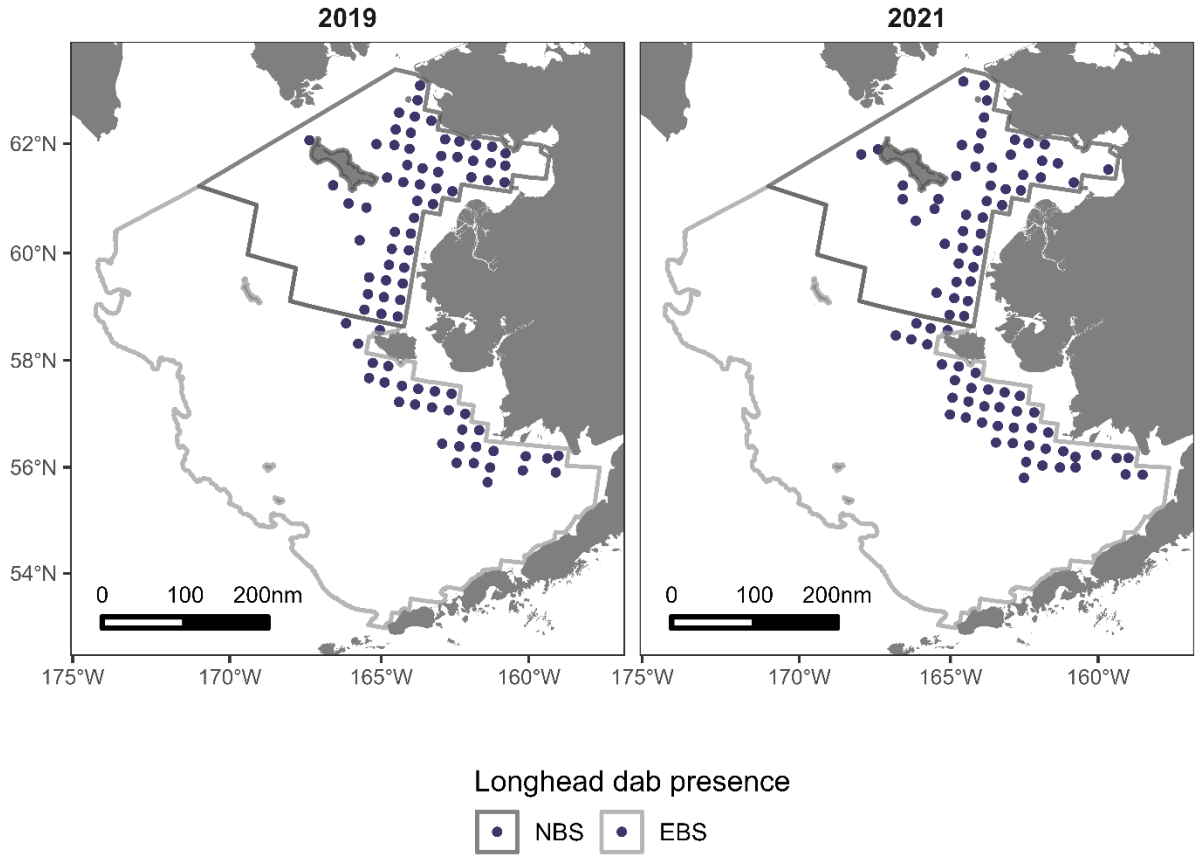

Figure 35. -- The presence of longhead dab (*Limanda proboscidea*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 24a. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	1.38	0.38	10,875	2,955	4,902	16,848	28	28	28
20	0.22	0.09	890	351	173	1,607	15	15	15
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	**0.24**	**0.06**	**11,765**	**2,976**	**5,872**	**17,658**	**43**	**43**	**43**
NBS									
70	0.14	0.06	1,131	482	157	2,106	24	24	24
71	0.03	0.01	249	84	79	419	23	23	23
81	0.00	0.00	4	4	0	13	1	1	1
Total	**0.07**	**0.02**	**1,384**	**489**	**405**	**2,363**	**48**	**48**	**48**

Table 24b. -- 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 longhead dab (*Limanda proboscidea*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	21.14	5.92	166,369.25	46,577.69	72,235.74	260,502.76	28	28	28
20	3.38	1.42	13,914.94	5,868.94	1,930.58	25,899.31	15	15	15
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	**3.66**	**0.95**	**180,284.19**	**46,945.99**	**87,331.14**	**273,237.24**	**43**	**43**	**43**
NBS									
70	2.20	0.97	17,465.27	7,700.79	1,901.97	33,028.56	24	24	24
71	0.90	0.34	7,303.62	2,783.97	1,677.23	12,930.02	23	23	23
81	0.01	0.01	29.65	29.65	0.00	90.62	1	1	1
Total	**1.25**	**0.41**	**24,798.55**	**8,188.62**	**8,421.31**	**41,175.79**	**48**	**48**	**48**

Starry Flounder (*Platichthys stellatus*)

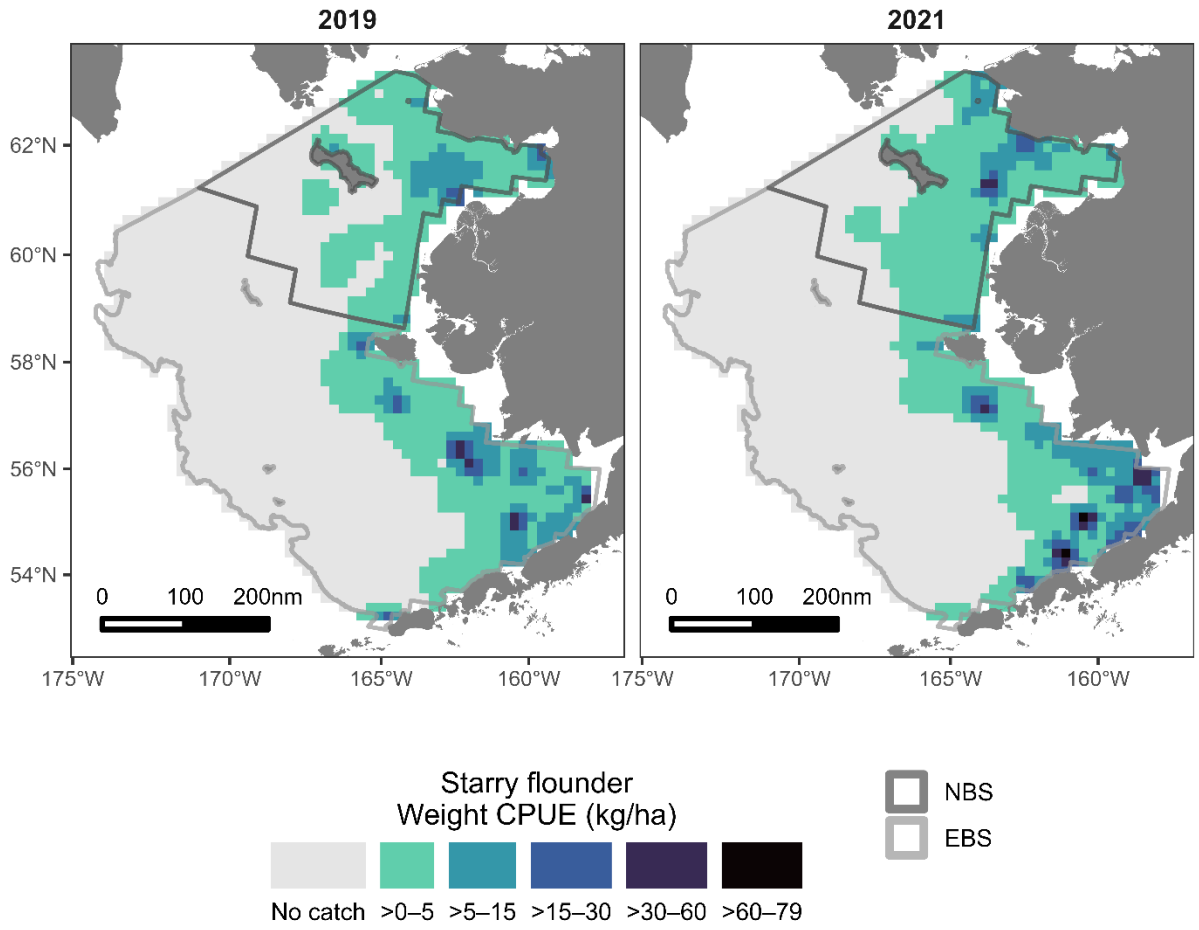

Figure 36. -- The distribution (weight CPUE (kg/ha)) of starry flounder (*Platichthys stellatus*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

Table 25a. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	8.08	1.99	63.59	15.63	32.00	95.18	39	39	39
20	1.54	0.46	6.34	1.91	2.45	10.24	16	16	15
31	1.41	1.14	13.36	10.86	0.00	35.08	12	12	12
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	**1.69**	**0.39**	**83.29**	**19.13**	**45.04**	**121.55**	**67**	**67**	**66**
NBS									
70	0.87	0.23	6.88	1.79	3.26	10.51	33	33	33
71	3.95	0.98	32.13	7.93	16.10	48.17	44	44	44
81	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**1.96**	**0.41**	**39.01**	**8.13**	**22.75**	**55.28**	**77**	**77**	**77**

Table 25b. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	5.89	1.37	46.34	10.76	24.60	68.08	39	39	39
20	1.07	0.28	4.39	1.16	2.02	6.76	16	16	15
31	0.71	0.57	6.75	5.38	0.00	17.52	12	12	12
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	**1.17**	**0.25**	**57.48**	**12.09**	**33.31**	**81.65**	**67**	**67**	**66**
NBS									
70	1.47	0.41	11.65	3.24	5.11	18.19	33	33	33
71	5.85	1.43	47.56	11.62	24.07	71.05	44	44	44
81	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**2.98**	**0.61**	**59.21**	**12.07**	**35.08**	**83.34**	**77**	**77**	**77**

Yellow Irish Lord (*Hemilepidotus jordani*)

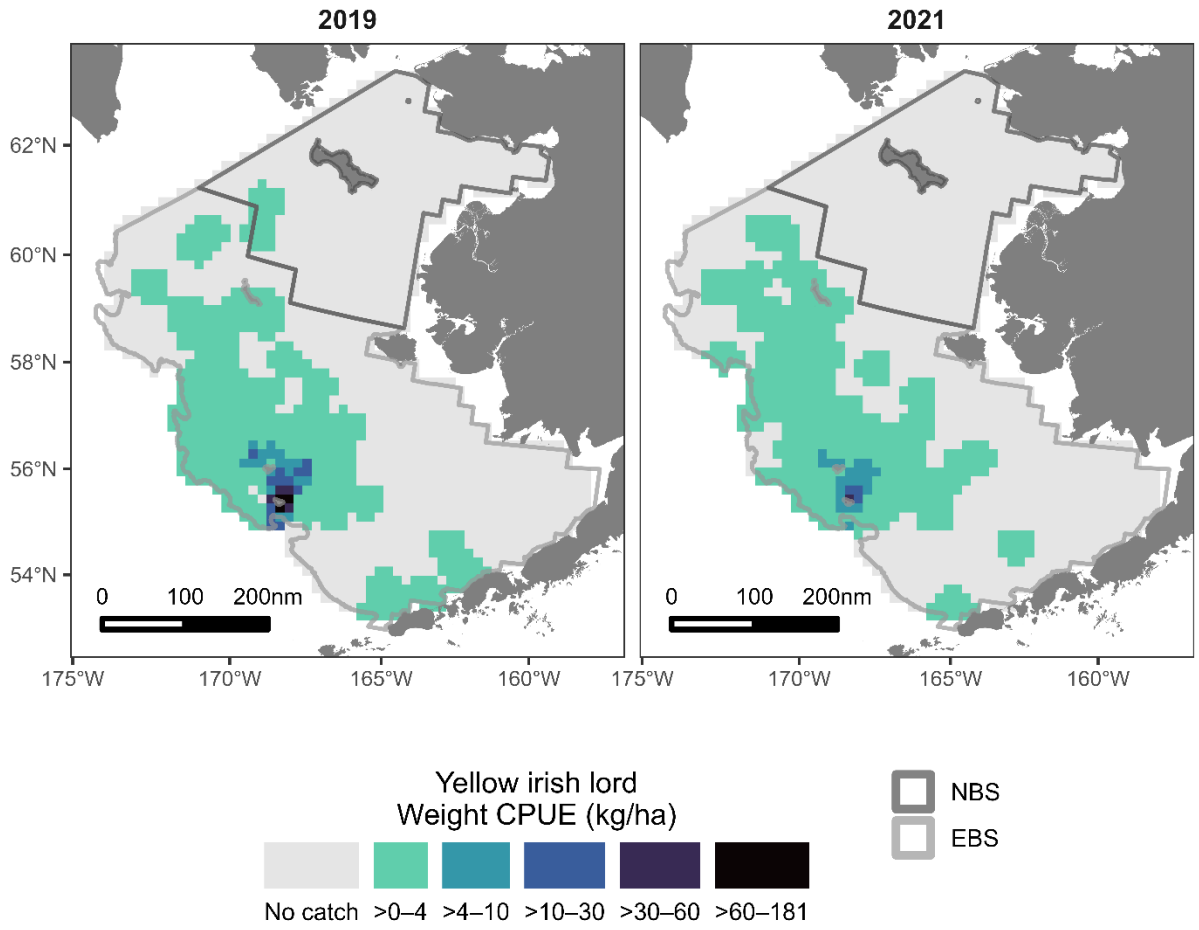

Figure 37. -- The distribution (weight CPUE (kg/ha)) of yellow Irish lord (*Hemilepidotus jordani*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 yellow Irish lord (*Hemilepidotus jordani*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	10	10	0	30	1	1	1
20	0.01	0.01	51	51	0	156	1	1	1
31	0.15	0.07	1,431	658	116	2,746	10	10	10
32	7.80	5.26	6,900	4,652	0	17,901	7	7	7
41	0.15	0.07	936	432	62	1,810	12	12	12
42	3.10	0.66	7,472	1,598	4,209	10,736	29	29	29
43	0.11	0.07	228	152	0	544	9	9	9
50	0.09	0.06	325	226	0	790	3	3	3
61	0.11	0.04	931	336	252	1,610	15	15	15
62	0.11	0.08	71	53	0	199	3	3	3
82	0.01	0.01	14	14	0	45	1	1	1
90	0.02	0.02	21	21	0	70	1	1	1
Total	**0.37**	**0.10**	**18,390**	**5,000**	**7,079**	**29,701**	**92**	**92**	**92**

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 yellow Irish lord (*Hemilepidotus jordani*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	30.19	30.19	0.00	91.20	1	1	1
20	0.01	0.01	29.13	29.13	0.00	88.60	1	1	1
31	0.19	0.08	1,780.39	788.62	203.15	3,357.63	10	10	10
32	11.42	8.11	10,106.08	7,172.81	0.00	27,069.78	7	7	7
41	0.24	0.12	1,495.54	744.20	0.00	2,999.58	12	12	12
42	4.16	0.94	10,022.74	2,256.38	5,415.20	14,630.27	29	29	29
43	0.37	0.26	774.40	550.49	0.00	1,919.43	9	9	9
50	0.12	0.08	440.09	286.86	0.00	1,031.02	3	3	3
61	0.21	0.07	1,835.46	643.62	534.70	3,136.22	15	15	15
62	0.25	0.19	163.78	122.33	0.00	463.12	3	3	3
82	0.02	0.02	30.76	30.76	0.00	98.45	1	1	1
90	0.03	0.03	36.06	36.06	0.00	121.35	1	1	1
Total	**0.54**	**0.16**	**26,744.61**	**7,650.81**	**9,438.49**	**44,050.73**	**92**	**92**	**92**

Plain Sculpin (*Myoxocephalus jaok*)

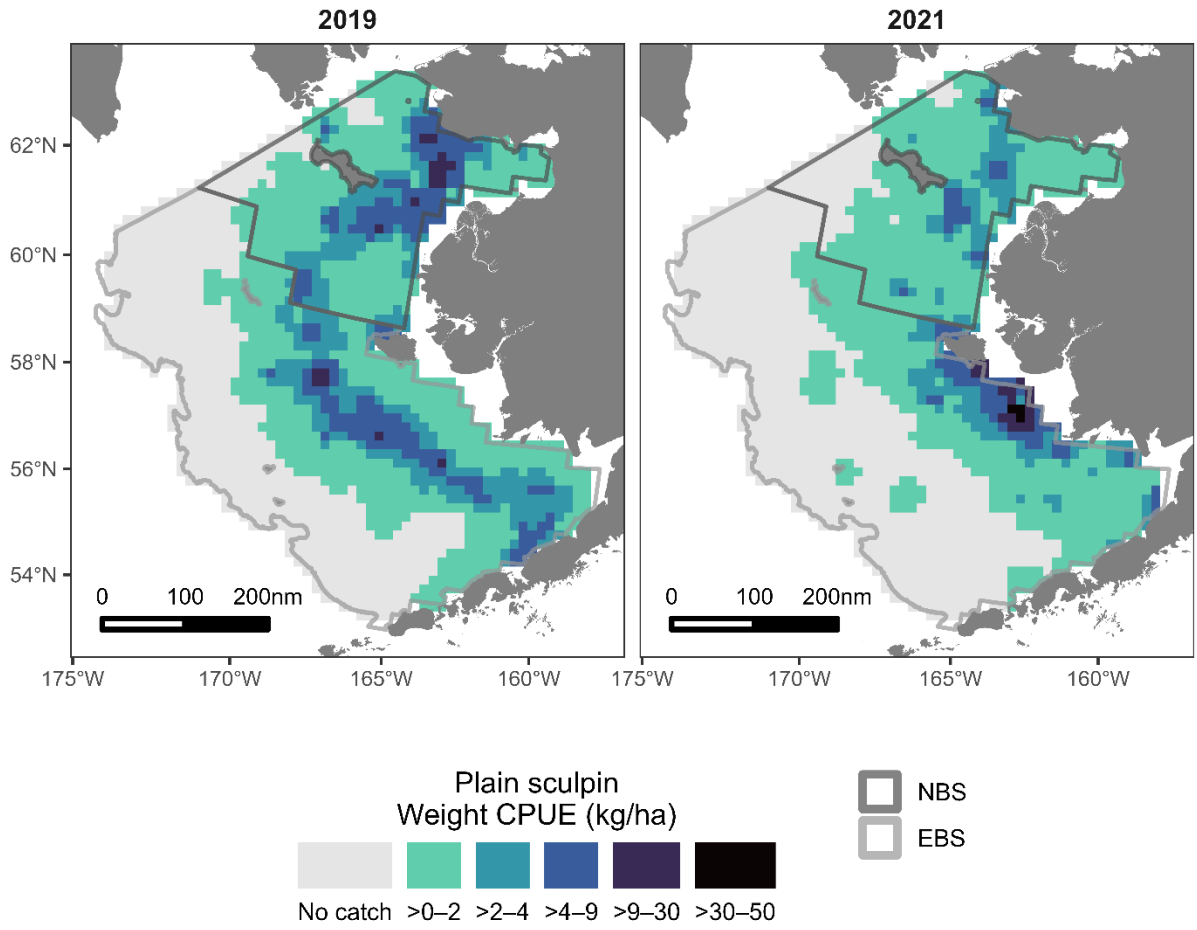

Figure 38. -- The distribution (weight CPUE (kg/ha)) of plain sculpin (*Myoxocephalus jaok*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 plain sculpin (*Myoxocephalus jaok*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	3.12	0.87	24,564	6,829	10,763	38,365	55	55	55
20	2.58	0.53	10,620	2,194	6,141	15,100	29	29	29
31	0.11	0.03	1,048	308	431	1,664	13	13	13
32	0.00	0.00	0	0	0	0	0	0	0
41	0.12	0.05	779	282	210	1,348	12	12	12
42	0.03	0.03	83	83	0	252	1	1	1
43	0.04	0.04	87	87	0	267	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	0.00	0.00	0	0	0	0	0	0	0
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.75**	**0.15**	**37,180**	**7,186**	**22,809**	**51,551**	**111**	**111**	**111**
NBS									
70	1.43	0.20	11,362	1,572	8,185	14,538	47	47	47
71	1.10	0.20	8,906	1,587	5,700	12,113	43	43	43
81	0.10	0.06	384	240	0	877	5	5	5
Total	**1.04**	**0.11**	**20,652**	**2,246**	**16,159**	**25,145**	**95**	**95**	**95**

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 plain sculpin (*Myoxocephalus jaok*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	4.95	1.58	38,966.76	12,419.14	13,867.68	64,065.84	55	55	55
20	4.11	0.97	16,912.65	3,986.07	8,773.10	25,052.19	29	29	29
31	0.07	0.02	628.59	174.68	279.24	977.94	13	13	13
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.09	0.03	540.13	190.69	154.75	925.51	12	12	12
42	0.03	0.03	71.77	71.77	0.00	218.31	1	1	1
43	0.03	0.03	64.69	64.69	0.00	199.25	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	0.00	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	**1.16**	**0.26**	**57,184.58**	**13,046.07**	**31,092.45**	**83,276.72**	**111**	**111**	**111**
NBS									
70	2.14	0.32	16,982.97	2,505.79	11,918.76	22,047.17	47	47	47
71	1.70	0.26	13,812.02	2,117.94	9,531.66	18,092.39	43	43	43
81	0.08	0.06	321.57	213.08	0.00	759.65	5	5	5
Total	**1.56**	**0.17**	**31,116.56**	**3,287.87**	**24,540.82**	**37,692.30**	**95**	**95**	**95**

Great Sculpin (*Myoxocephalus polyacanthocephalus*)

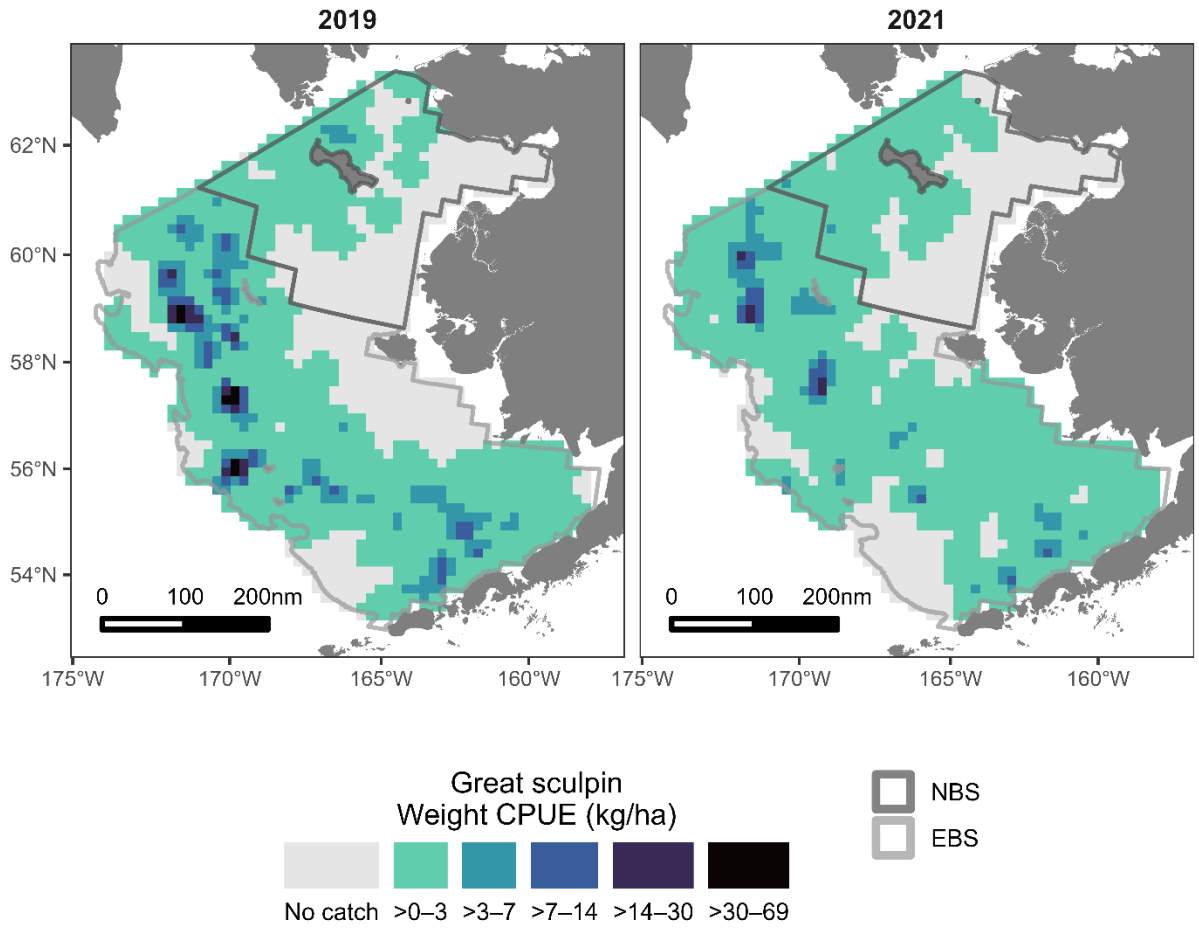

Figure 39. -- The distribution (weight CPUE (kg/ha)) of great sculpin (*Myoxocephalus polyacanthocephalus*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 great sculpin (*Myoxocephalus polyacanthocephalus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.46	0.09	3,598	725	2,132	5,064	35	35	35
20	0.21	0.10	853	413	11	1,696	9	9	9
31	1.04	0.25	9,909	2,353	5,204	14,615	38	38	38
32	0.06	0.06	53	53	0	179	1	1	1
41	1.40	0.59	8,720	3,682	1,278	16,161	23	23	23
42	1.11	0.30	2,677	722	1,204	4,150	18	18	18
43	2.25	0.51	4,736	1,078	2,493	6,979	16	16	16
50	0.00	0.00	0	0	0	0	0	0	0
61	1.63	0.54	14,275	4,774	4,627	23,923	27	27	27
62	1.20	0.19	773	125	467	1,078	7	7	7
82	1.42	0.30	2,541	532	1,369	3,713	11	11	11
90	2.76	0.92	3,185	1,057	685	5,685	7	7	7
Total	**1.04**	**0.14**	**51,319**	**6,759**	**37,937**	**64,702**	**192**	**192**	**192**
NBS									
70	0.04	0.02	317	137	39	595	8	8	8
71	0.07	0.03	544	243	54	1,035	10	10	10
81	0.55	0.21	2,127	790	502	3,751	15	15	15
Total	**0.15**	**0.04**	**2,988**	**838**	**1,277**	**4,699**	**33**	**33**	**33**

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 great sculpin (*Myoxocephalus polyacanthocephalus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.30	0.05	2,384.10	357.81	1,660.95	3,107.24	35	35	35
20	0.13	0.05	516.84	186.74	135.51	898.16	9	9	9
31	0.31	0.05	2,934.44	501.68	1,931.08	3,937.79	38	38	38
32	0.03	0.03	24.34	24.33	0.00	81.89	1	1	1
41	0.37	0.14	2,309.88	852.12	587.74	4,032.02	23	23	23
42	0.31	0.08	742.42	188.79	356.90	1,127.94	18	18	18
43	0.68	0.15	1,442.08	308.07	801.29	2,082.88	16	16	16
50	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
61	0.56	0.21	4,959.83	1,817.04	1,287.59	8,632.08	27	27	27
62	0.52	0.07	332.98	47.21	217.45	448.51	7	7	7
82	0.45	0.09	815.04	154.28	475.46	1,154.61	11	11	11
90	0.94	0.27	1,082.65	316.85	333.31	1,831.99	7	7	7
Total	**0.36**	**0.04**	**17,544.59**	**2,167.93**	**13,252.09**	**21,837.09**	**192**	**192**	**192**
NBS									
70	0.04	0.01	309.80	108.36	90.81	528.79	8	8	8
71	0.09	0.03	716.15	257.20	196.34	1,235.95	10	10	10
81	0.28	0.09	1,068.83	348.05	353.23	1,784.42	15	15	15
Total	**0.11**	**0.02**	**2,094.77**	**446.13**	**1,183.77**	**3,005.78**	**33**	**33**	**33**

Shorthorn Sculpin (*Myoxocephalus scorpius*)

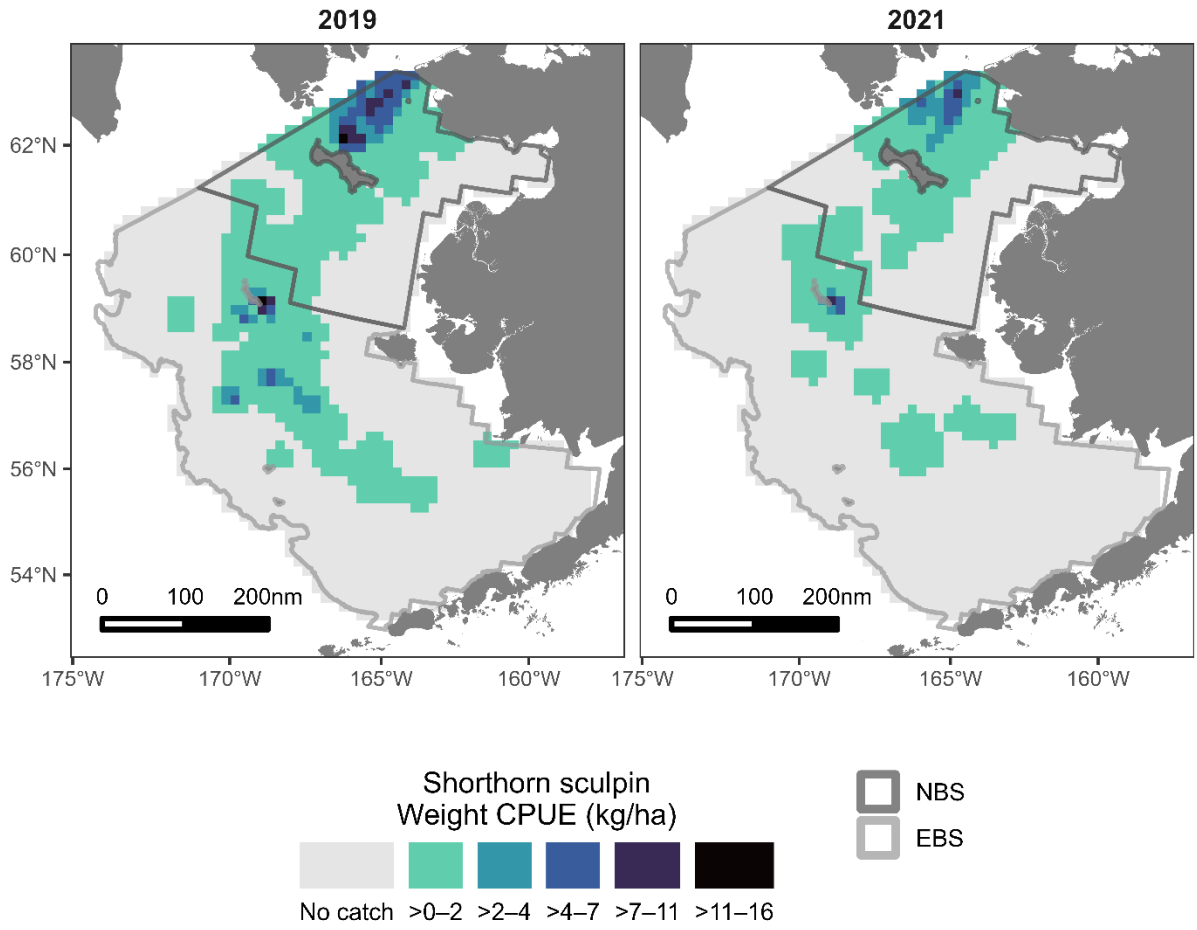

Figure 40. -- The distribution (weight CPUE (kg/ha)) of shorthorn sculpin (*Myoxocephalus scorpius*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

Table 29a. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.01	0.01	63	46	0	156	2	2	2
20	0.00	0.00	0	0	0	0	0	0	0
31	0.01	0.01	124	88	0	300	2	2	2
32	0.00	0.00	0	0	0	0	0	0	0
41	0.09	0.03	581	196	184	977	9	9	9
42	0.01	0.01	34	34	0	102	1	1	1
43	0.63	0.41	1,325	863	0	3,122	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	0.03	0.03	53	53	0	169	1	1	1
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.04**	**0.02**	**2,180**	**893**	**412**	**3,949**	**21**	**21**	**21**
NBS									
70	0.07	0.03	557	218	117	997	8	8	8
71	0.83	0.23	6,738	1,868	2,963	10,512	26	26	26
81	0.09	0.06	332	212	0	766	4	4	4
Total	**0.38**	**0.10**	**7,627**	**1,892**	**3,803**	**11,451**	**38**	**38**	**38**

Table 29b. -- 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 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.01	0.01	65.75	46.09	0.00	158.89	2	2	2
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.01	0.00	61.81	43.39	0.00	148.59	2	2	2
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
41	0.06	0.02	350.00	113.73	120.14	579.86	9	9	9
42	0.01	0.01	18.67	18.67	0.00	56.79	1	1	1
43	0.39	0.28	815.90	587.87	0.00	2,038.66	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	30.72	30.72	0.00	98.34	1	1	1
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.03**	**0.01**	**1,342.85**	**603.18**	**148.56**	**2,537.14**	**21**	**21**	**21**
NBS									
70	0.07	0.03	525.52	204.38	112.47	938.58	8	8	8
71	1.04	0.29	8,440.99	2,329.57	3,732.93	13,149.05	26	26	26
81	0.05	0.03	209.01	116.68	0.00	448.44	4	4	4
Total	**0.46**	**0.12**	**9,175.52**	**2,341.43**	**4,443.49**	**13,907.55**	**38**	**38**	**38**

Pacific Ocean Perch (*Sebastes alutus*)

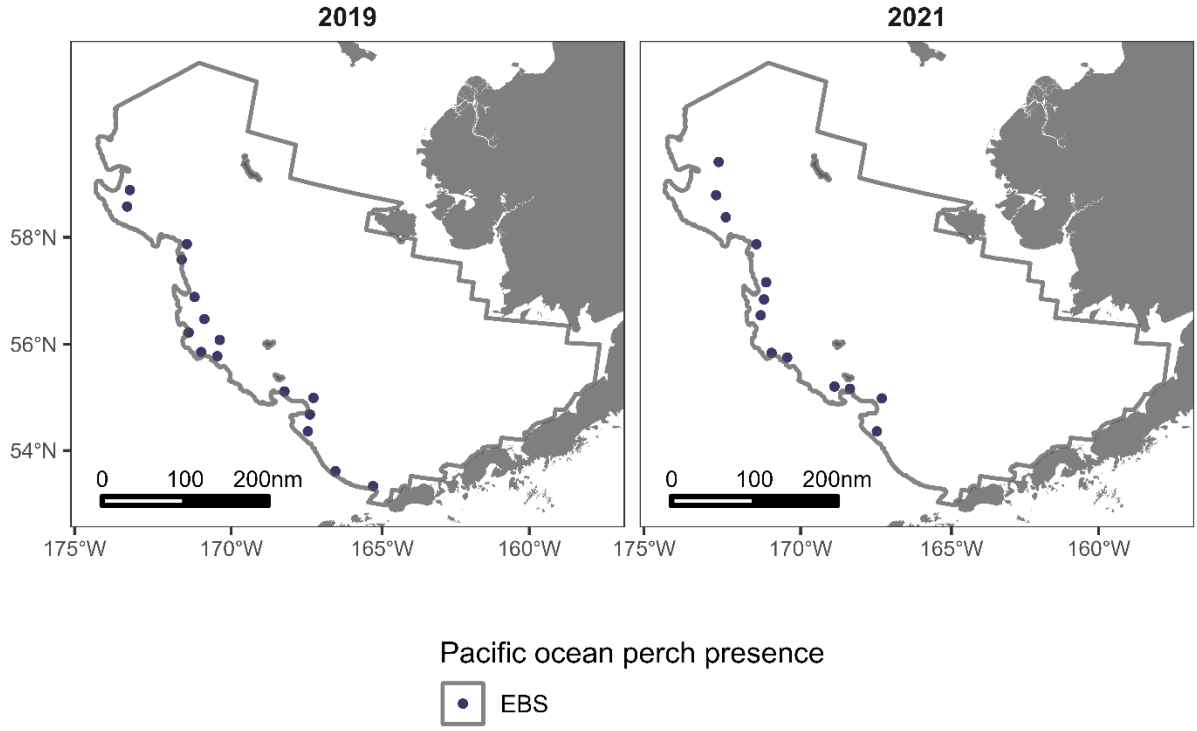

Figure 41. -- The presence of Pacific ocean perch (*Sebastes alutus*) from the 2019 and 2021 EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Table 30a. -- 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 ocean perch (*Sebastes alutus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.00	0.00	0.00	0	0.00	0.00	0	0	0
20	0.00	0.00	0.00	0	0.00	0.00	0	0	0
31	0.00	0.00	0.00	0	0.00	0.00	0	0	0
32	0.00	0.00	0.00	0	0.00	0.00	0	0	0
41	0.00	0.00	0.00	0	0.00	0.00	0	0	0
42	0.00	0.00	0.00	0	0.00	0.00	0	0	0
43	0.00	0.00	0.00	0	0.00	0.00	0	0	0
50	0.28	0.24	1.06	917	0.00	2.95	4	4	4
61	0.26	0.18	2.28	1,562	0.00	5.44	9	9	9
62	0.00	0.00	0.00	0	0.00	0.00	0	0	0
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	**0.07**	**0.04**	**3.34**	**1,811**	**0.00**	**6.89**	**13**	**13**	**13**

Table 30b. -- 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 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.90	0.82	3.44	3.13	0.00	9.88	4	4	4
61	0.50	0.30	4.41	2.66	0.00	9.79	9	9	9
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	**0.16**	**0.08**	**7.85**	**4.11**	**0.00**	**15.90**	**13**	**13**	**13**

Rex Sole (*Glyptocephalus zachirus*)

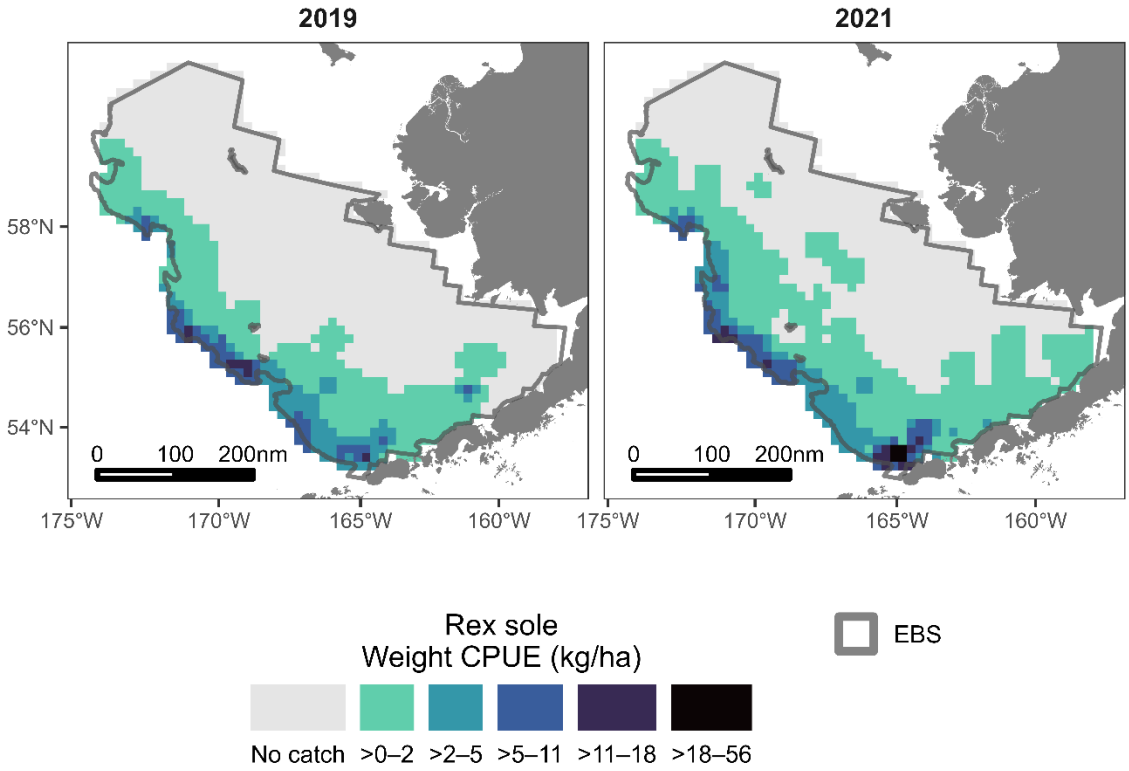

Figure 42. -- The distribution (weight CPUE (kg/ha)) of rex sole (*Glyptocephalus zachirus*) from the 2019 and 2021 EBS shelf bottom trawl survey.

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 rex sole (*Glyptocephalus zachirus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.07	0.03	515	275	0	1,070	7	7	7
20	0.00	0.00	15	15	0	47	1	1	1
31	0.64	0.28	6,048	2,699	650	11,445	26	26	25
32	0.13	0.07	115	65	0	270	4	4	4
41	0.01	0.01	78	39	0	157	4	4	4
42	0.07	0.05	176	112	0	405	6	6	6
43	0.01	0.01	16	16	0	48	1	1	1
50	5.20	2.15	19,773	8,165	2,954	36,593	26	26	26
61	1.71	0.44	14,988	3,874	7,159	22,817	35	35	35
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	**0.85**	**0.19**	**41,724**	**9,436**	**22,653**	**60,795**	**110**	**110**	**109**

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 rex sole (*Glyptocephalus zachirus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.12	0.06	977.05	452.57	62.41	1,891.70	7	7	7
20	0.01	0.01	31.02	31.02	0.00	94.37	1	1	1
31	1.20	0.45	11,421.02	4,263.21	2,894.61	19,947.43	26	26	25
32	0.39	0.19	345.78	166.56	0.00	739.69	4	4	4
41	0.04	0.02	224.33	114.80	0.00	456.34	4	4	4
42	0.16	0.10	378.50	251.50	0.00	892.06	6	6	6
43	0.01	0.01	26.95	26.95	0.00	82.99	1	1	1
50	12.76	4.39	48,524.03	16,694.95	14,132.44	82,915.62	26	26	26
61	4.25	1.12	37,324.08	9,864.36	17,388.21	57,259.95	35	35	35
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	**2.01**	**0.40**	**99,252.76**	**19,862.34**	**59,110.98**	**139,394.54**	**110**	**110**	**109**

Sakhalin Sole (*Limanda sakhalinensis*)

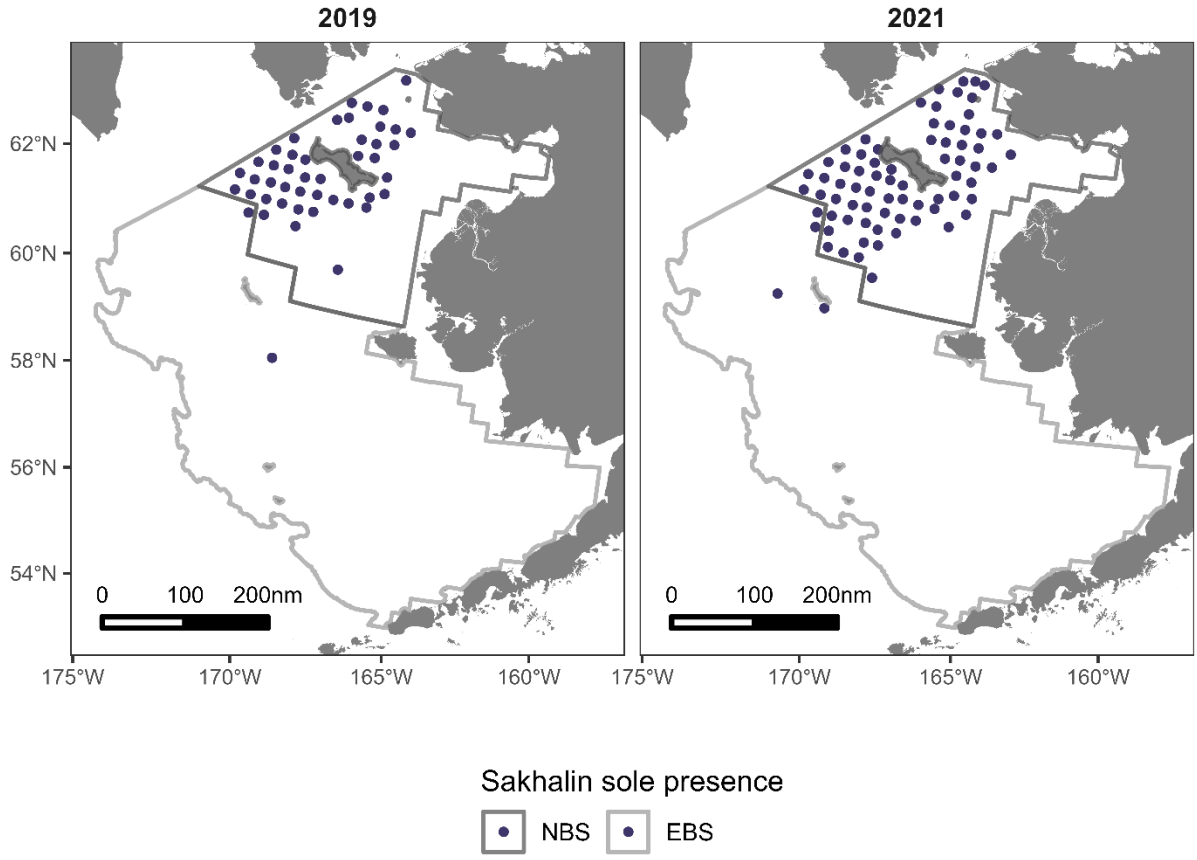

Figure 43. -- The presence of Sakhalin sole (*Limanda sakhalinensis*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

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 Sakhalin sole (*Limanda sakhalinensis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
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	0	0	0	0	0	0	0
42	0.00	0.00	0	0	0	0	0	0	0
43	0.00	0.00	8	7	0	23	2	2	2
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	8	6	0	22	2	2	1
90	0.00	0.00	0	0	0	0	0	0	0
Total	**0.00**	**0.00**	**15**	**10**	**0**	**35**	**4**	**4**	**3**
NBS									
70	0.06	0.03	480	217	42	917	22	22	22
71	0.03	0.01	263	75	112	414	25	25	25
81	0.26	0.08	999	318	347	1,652	24	24	24
Total	**0.09**	**0.02**	**1,742**	**392**	**958**	**2,525**	**71**	**71**	**71**

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 Sakhalin sole (*Limanda sakhalinensis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
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	0.02	0.01	41.63	28.75	0.00	101.42	2	2	2
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	0.07	158.53	129.12	0.00	442.73	2	2	1
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**0.00**	**0.00**	**200.16**	**132.28**	**0.00**	**459.44**	**4**	**4**	**3**
NBS									
70	1.50	0.55	11,893.40	4,325.80	3,150.97	20,635.83	22	22	22
71	0.90	0.26	7,351.75	2,088.00	3,131.89	11,571.60	25	25	25
81	5.29	1.64	20,273.07	6,294.92	7,355.88	33,190.25	24	24	24
Total	**1.99**	**0.40**	**39,518.21**	**7,918.23**	**23,681.76**	**55,354.67**	**71**	**71**	**71**

Antlered Sculpin (*Enophrys diceraus*)

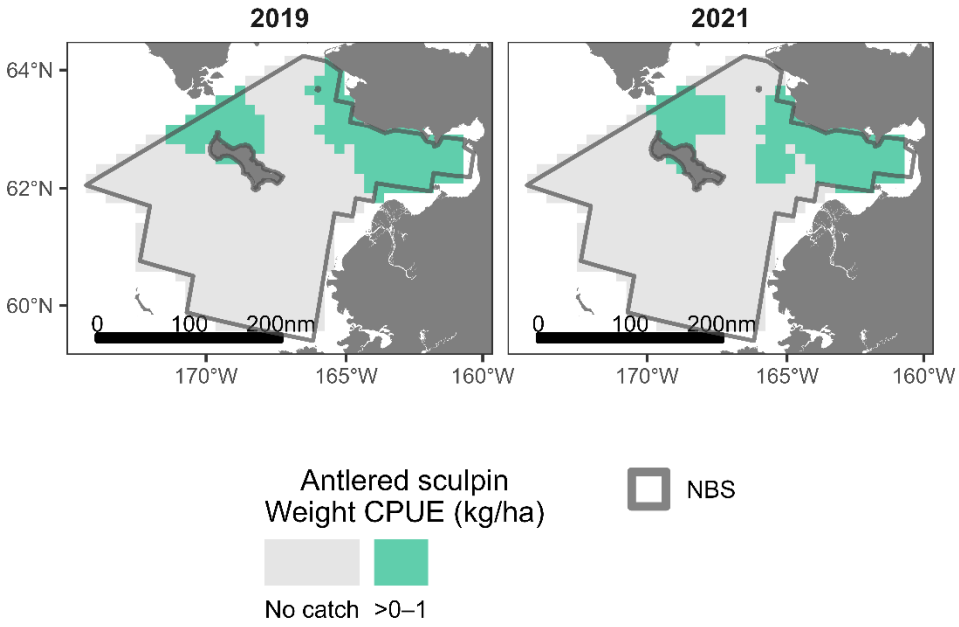

Figure 44. -- The distribution (weight CPUE (kg/ha)) of antlered sculpin (*Enophrys diceraus*) from the 2019 and 2021 NBS shelf bottom trawl survey.

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 antlered sculpin (*Enophrys diceraus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the EBS shelf 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
70	0.00	0.00	0	0	0	0	0	0
71	0.01	0.00	94	31	30	157	16	16
81	0.00	0.00	0	0	0	0	0	0
Total	**0.00**	**0.00**	**94**	**31**	**31**	**157**	**16**	**16**

Table 33b. -- 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 antlered sculpin (*Enophrys diceraus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the EBS shelf trawl survey. No lengths were collected for this taxon.

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
70	0.00	0.00	0.00	0.00	0.00	0.00	0	0
71	0.19	0.06	1.58	480.70	0.61	2.55	16	16
81	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**0.08**	**0.02**	**1.58**	**480.70**	**0.62**	**2.54**	**16**	**16**

Arctic Staghorn Sculpin (*Gymnocanthus tricuspis*)

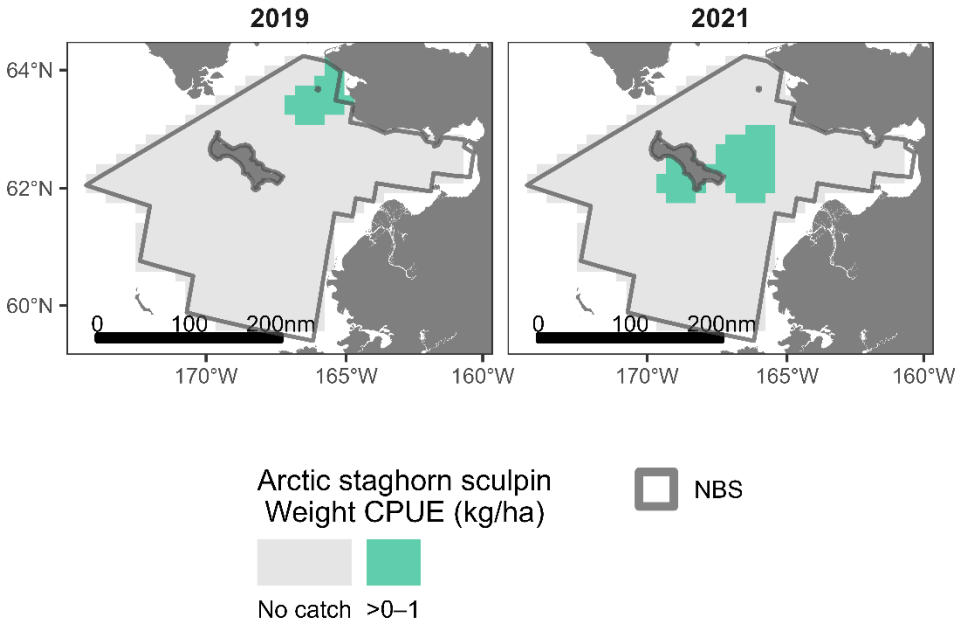

Figure 45. -- The distribution (weight CPUE (kg/ha)) of Arctic staghorn sculpin (*Gymnocanthus tricuspis*) from the 2019 and 2021 NBS shelf bottom trawl survey.

Table 34a. -- 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 Arctic staghorn sculpin (*Gymnocanthus tricuspis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the EBS shelf 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
70	0.00	0.00	0	0	0	1	1	1
71	0.00	0.00	10	6	0	22	4	4
81	0.00	0.00	0	0	0	0	0	0
Total	**0.00**	**0.00**	**10**	**6**	**0**	**23**	**5**	**5**

Table 34b. -- 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 Arctic staghorn sculpin (*Gymnocanthus tricuspis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the EBS shelf 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
70	0.00	0.00	31.38	31.38	0.00	94.80	1	1
71	0.04	0.02	287.70	163.33	0.00	617.79	4	4
81	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**0.02**	**0.01**	**319.08**	**166.31**	**0.00**	**660.36**	**5**	**5**

Butterfly Sculpin (*Hemilepidotus papilio*)

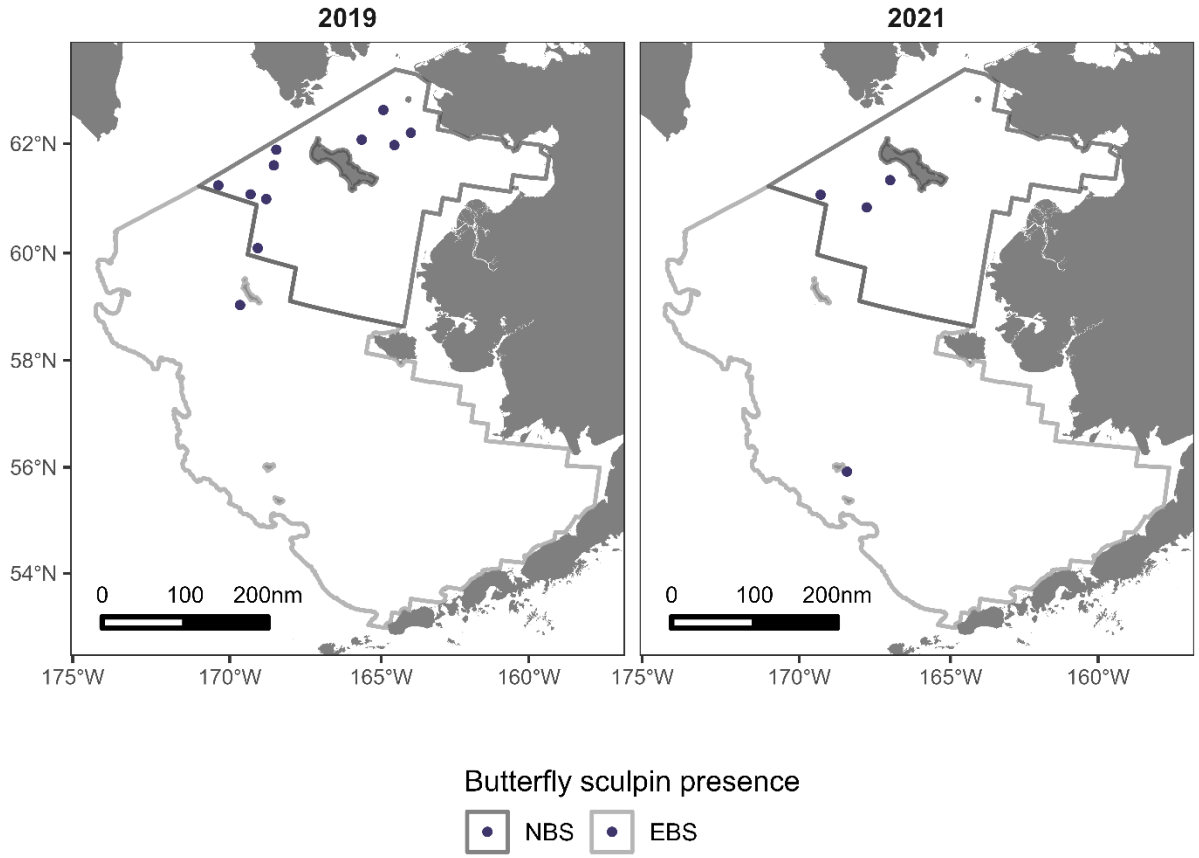

Figure 46. -- The presence of butterfly sculpin (*Hemilepidotus papilio*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

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 butterfly sculpin (*Hemilepidotus papilio*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
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	0	0	0	0	0	0	0
42	0.00	0.00	1	1	0	2	1	1	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	**0.00**	**0.00**	**1**	**1**	**0**	**2**	**1**	**1**	**0**
NBS									
70	0.00	0.00	2	2	0	5	1	1	1
71	0.00	0.00	0	0	0	0	0	0	0
81	0.00	0.00	4	3	0	10	2	2	2
Total	**0.00**	**0.00**	**6**	**3**	**0**	**12**	**3**	**3**	**3**

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 butterfly sculpin (*Hemilepidotus papilio*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
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	0.02	0.02	53.82	53.82	0.00	163.73	1	1	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	**0.00**	**0.00**	**53.82**	**53.82**	**0.00**	**159.32**	**1**	**1**	**0**
NBS									
70	0.00	0.00	31.04	31.04	0.00	93.76	1	1	1
71	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
81	0.02	0.01	59.28	41.13	0.00	143.68	2	2	2
Total	**0.00**	**0.00**	**90.31**	**51.53**	**0.00**	**194.45**	**3**	**3**	**3**

Bigmouth Sculpin (*Hemitripterus bolini*)

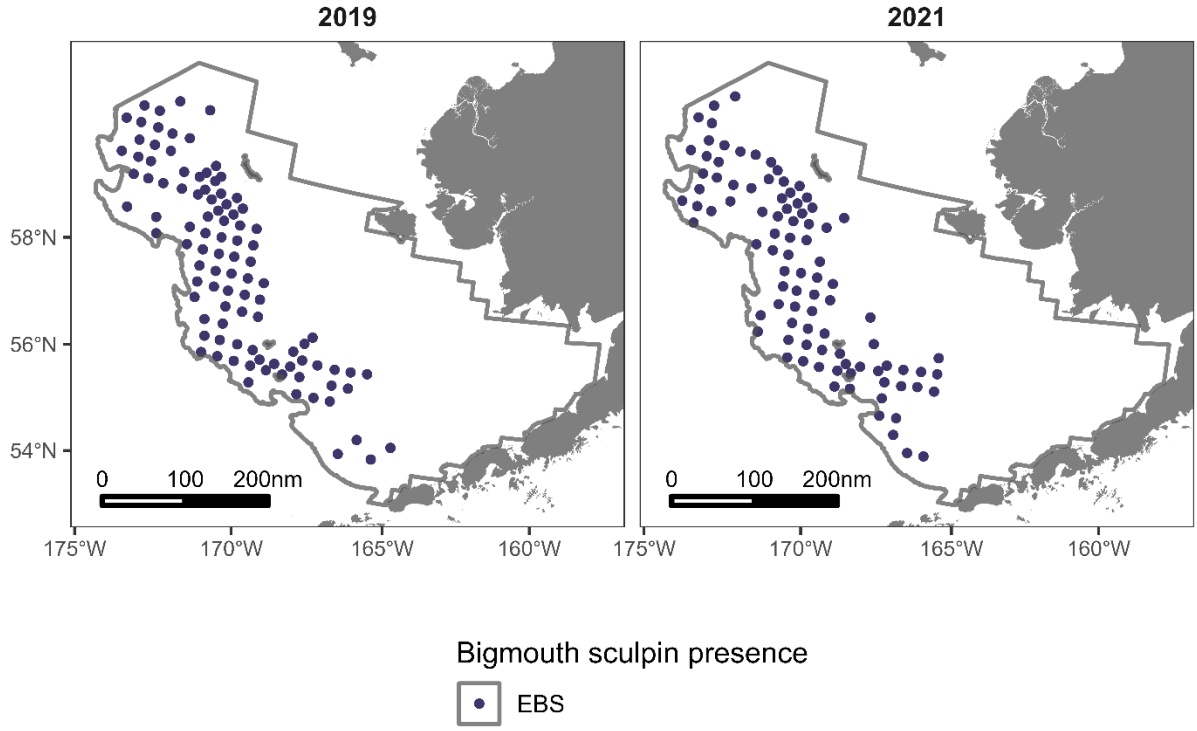

Figure 47. --The presence of bigmouth sculpin (*Hemitripterus bolini*) from the 2019 and 2021 EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

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 bigmouth sculpin (*Hemitripterus bolini*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.27	0.12	2,530	1,156	218	4,843	7	7	7
32	0.95	0.51	843	449	0	1,905	4	4	4
41	0.60	0.24	3,765	1,480	774	6,755	8	8	8
42	0.33	0.12	803	301	189	1,418	8	8	8
43	1.08	0.30	2,285	642	949	3,621	12	12	12
50	0.83	0.42	3,161	1,584	0	6,425	9	9	9
61	1.27	0.18	11,108	1,560	7,956	14,260	38	38	38
62	1.11	0.34	717	218	183	1,251	5	5	5
82	0.00	0.00	0	0	0	0	0	0	0
90	0.55	0.39	638	446	0	1,693	2	2	2
Total	**0.52**	**0.06**	**25,850**	**3,069**	**19,773**	**31,928**	**93**	**93**	**93**

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 bigmouth sculpin (*Hemitripterus bolini*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the NBS shelf 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	0.05	0.02	471.80	226.73	18.33	925.27	7	7	7
32	0.24	0.12	213.91	104.98	0.00	462.18	4	4	4
41	0.11	0.04	710.26	263.75	177.23	1,243.30	8	8	8
42	0.09	0.03	207.02	68.03	68.09	345.94	8	8	8
43	0.19	0.05	395.15	109.26	167.88	622.42	12	12	12
50	0.22	0.08	830.77	313.55	184.86	1,476.68	9	9	9
61	0.27	0.04	2,365.97	327.25	1,704.58	3,027.35	38	38	38
62	0.28	0.10	184.00	62.04	32.17	335.82	5	5	5
82	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
90	0.08	0.06	91.33	64.32	0.00	243.44	2	2	2
Total	**0.11**	**0.01**	**5,470.19**	**601.63**	**4,278.98**	**6,661.41**	**93**	**93**	**93**

Arctic Cod (*Boreogadus saida*)

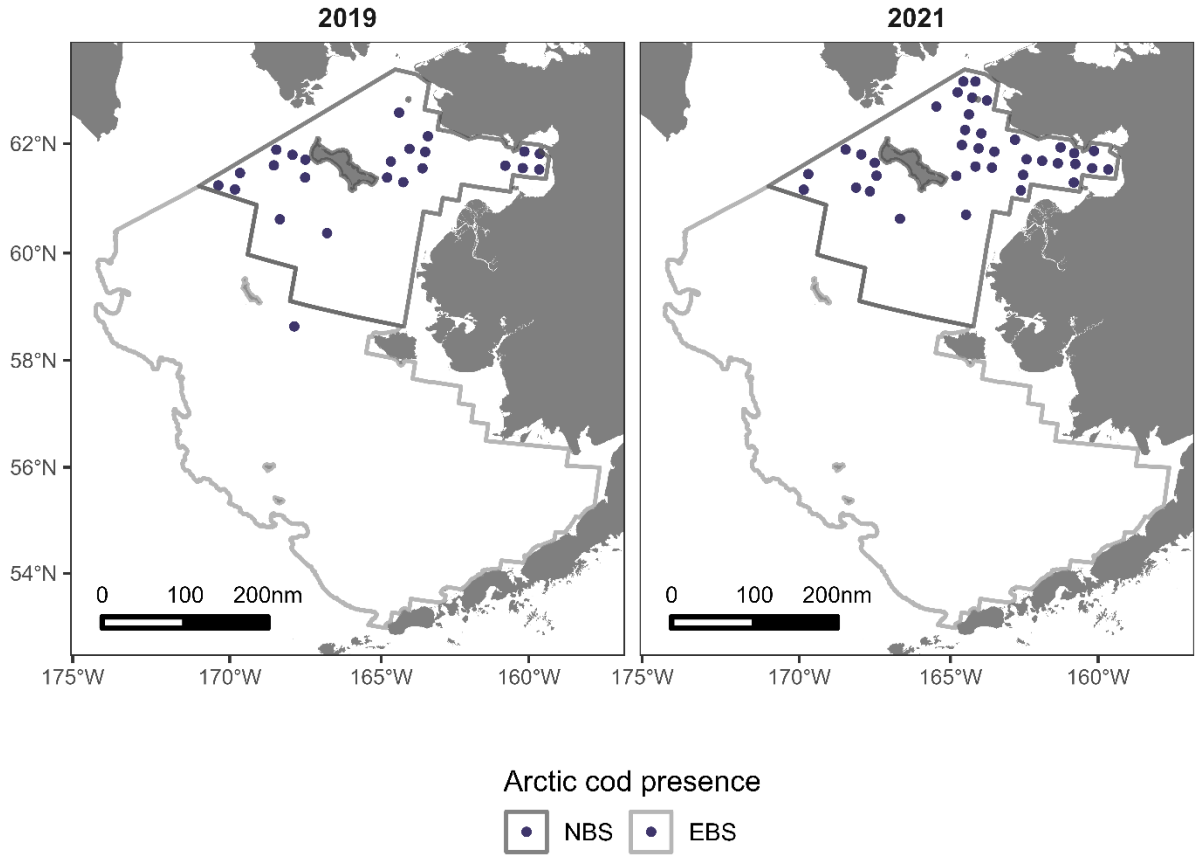

Figure 48. -- The presence of Arctic cod (*Boreogadus saida*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

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 Arctic cod (*Boreogadus saida*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the EBS shelf 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
70	0.00	0.00	3	1	0	6	5	5	5
71	0.01	0.00	74	24	26	123	28	28	28
81	0.00	0.00	6	3	0	12	5	5	5
Total	**0.00**	**0.00**	**83**	**24**	**34**	**132**	**38**	**38**	**38**

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 Arctic cod (*Boreogadus saida*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys. This species was not found in the EBS shelf 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
70	0.03	0.01	207.12	102.62	0.00	414.51	5	5	5
71	0.77	0.25	6,234.49	2,036.73	2,118.26	10,350.71	28	28	28
81	0.12	0.07	442.11	276.08	0.00	1,009.73	5	5	5
Total	**0.35**	**0.10**	**6,883.72**	**2,057.91**	**2,724.68**	**11,042.76**	**38**	**38**	**38**

Saffron Cod (*Eleginus gracilis*)

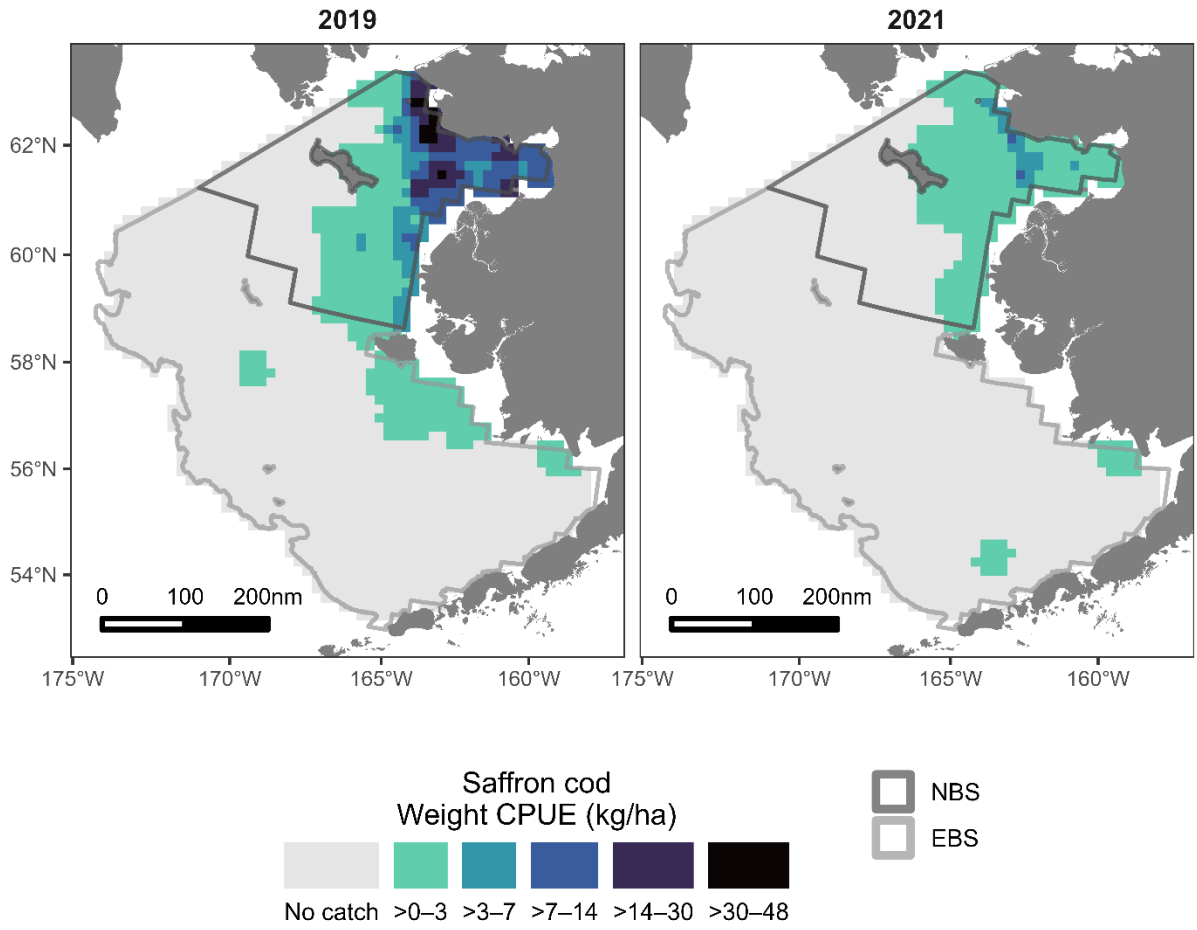

Figure 49. -- The distribution (weight CPUE (kg/ha)) of saffron cod (*Eleginus gracilis*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 saffron cod (*Eleginus gracilis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.00	0.00	2	1	0	4	2	2	2
20	0.00	0.00	0	0	0	0	0	0	0
31	0.00	0.00	1	1	0	3	1	1	1
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	**0.00**	**0.00**	**3**	**2**	**0**	**6**	**3**	**3**	**3**
NBS									
70	0.14	0.06	1,129	455	210	2,048	16	16	16
71	1.09	0.25	8,845	2,043	4,716	12,974	41	41	41
81	0.00	0.00	0	0	0	0	0	0	0
Total	**0.50**	**0.11**	**9,974**	**2,093**	**5,788**	**14,160**	**57**	**57**	**57**

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 saffron cod (*Eleginus gracilis*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS									
10	0.01	0.01	64.22	45.03	0.00	155.24	2	2	2
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
31	0.01	0.01	55.25	55.25	0.00	165.76	1	1	1
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	**0.00**	**0.00**	**119.48**	**71.28**	**0.00**	**260.61**	**3**	**3**	**3**
NBS									
70	1.93	0.83	15,279.58	6,604.95	1,930.98	28,628.18	16	16	16
71	14.82	3.88	120,410.53	31,496.89	56,755.32	184,065.74	41	41	41
81	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**6.82**	**1.62**	**135,690.11**	**32,181.97**	**71,326.17**	**200,054.05**	**57**	**57**	**57**

Pacific Herring (*Clupea pallasii*)

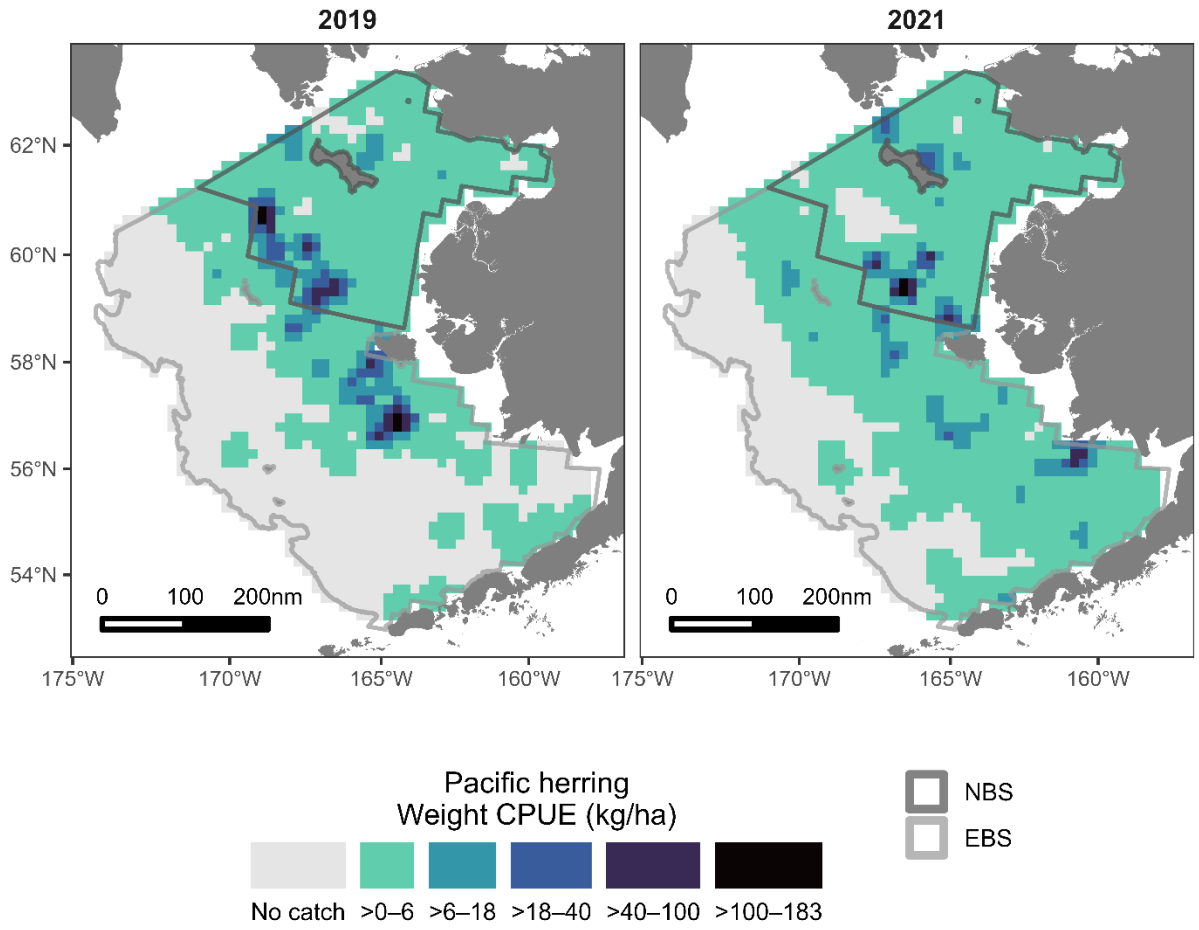

Figure 50. -- The distribution (weight CPUE (kg/ha)) of Pacific herring (*Clupea pallasii*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 Pacific herring (*Clupea pallasii*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	4.45	1.72	34,987	13,562	7,579	62,395	50	50
20	3.57	1.31	14,694	5,402	3,663	25,725	23	23
31	0.81	0.26	7,668	2,431	2,806	12,531	29	29
32	0.00	0.00	0	0	0	0	0	0
41	0.70	0.34	4,353	2,088	134	8,572	27	27
42	0.03	0.01	64	27	10	118	6	6
43	1.85	0.86	3,905	1,802	157	7,654	15	15
50	0.01	0.01	35	26	0	89	2	2
61	0.01	0.01	95	95	0	286	1	1
62	0.02	0.01	10	7	0	27	2	2
82	0.97	0.42	1,743	756	79	3,406	8	8
90	0.29	0.17	332	193	0	788	4	4
Total	**1.38**	**0.31**	**67,886**	**15,074**	**37,738**	**98,035**	**167**	**167**
NBS								
70	5.11	2.78	40,527	22,054	0	85,098	40	40
71	1.71	0.82	13,914	6,641	491	27,336	33	33
81	1.69	1.62	6,490	6,195	0	19,203	10	10
Total	**3.06**	**1.20**	**60,931**	**23,851**	**13,228**	**108,633**	**83**	**83**

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 Pacific herring (*Clupea pallasii*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	34.88	14.24	274,508.23	112,071.67	48,011.38	501,005.08	50	50
20	20.75	7.06	85,477.99	29,095.18	26,065.63	144,890.34	23	23
31	5.44	1.74	51,704.94	16,511.08	18,682.78	84,727.10	29	29
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	3.36	1.44	20,917.04	8,955.27	2,818.44	39,015.65	27	27
42	0.11	0.04	257.89	103.64	46.27	469.52	6	6
43	7.31	3.23	15,407.34	6,803.07	1,256.97	29,557.72	15	15
50	0.03	0.02	111.20	87.19	0.00	290.80	2	2
61	0.04	0.04	338.45	338.45	0.00	1,022.46	1	1
62	0.06	0.04	38.34	24.76	0.00	98.92	2	2
82	4.99	2.09	8,953.10	3,754.15	690.22	17,215.98	8	8
90	1.04	0.62	1,204.86	715.49	0.00	2,896.98	4	4
Total	**9.31**	**2.38**	**458,919.39**	**117,560.29**	**223,798.80**	**694,039.97**	**167**	**167**
NBS								
70	41.06	19.34	325,415.65	153,304.28	15,587.70	635,243.60	40	40
71	11.64	4.67	94,576.72	37,963.69	17,852.10	171,301.33	33	33
81	13.43	12.98	51,515.92	49,799.46	0.00	153,704.41	10	10
Total	**23.71**	**8.33**	**471,508.28**	**165,600.21**	**140,307.86**	**802,708.71**	**83**	**83**

Pacific Capelin (*Mallotus villosus*)

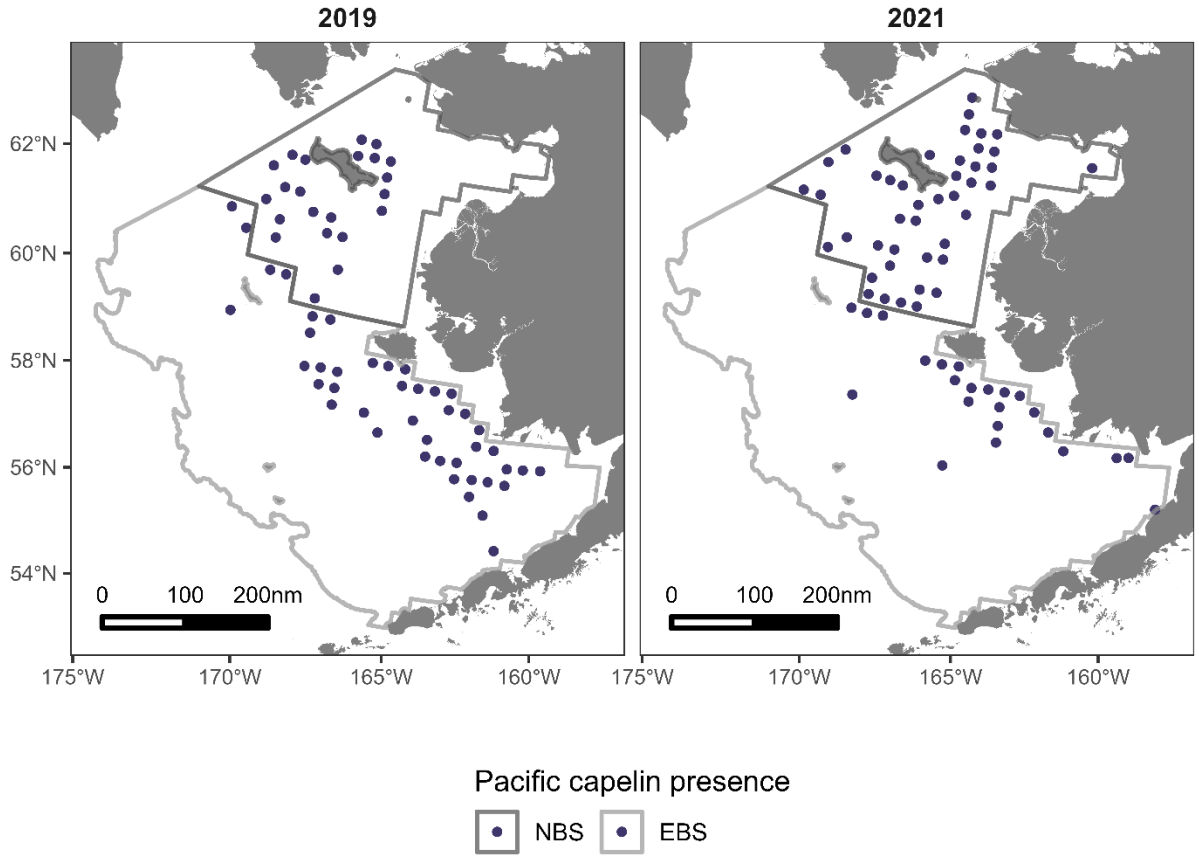

Figure 51. -- The presence of Pacific capelin (*Mallotus villosus*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

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 Pacific capelin (*Mallotus villosus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	0.00	0.00	25	9	7	42	11	11
20	0.01	0.00	21	9	2	39	8	8
31	0.00	0.00	0	0	0	1	1	1
32	0.00	0.00	0	0	0	0	0	0
41	0.00	0.00	2	1	0	4	3	3
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**	**48**	**13**	**23**	**73**	**23**	**23**
NBS								
70	0.00	0.00	37	16	5	68	19	19
71	0.00	0.00	27	10	6	48	15	15
81	0.00	0.00	12	5	2	23	9	9
Total	**0.00**	**0.00**	**76**	**19**	**37**	**115**	**43**	**43**

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 Pacific capelin (*Mallotus villosus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	0.18	0.06	1,423.58	496.53	420.10	2,427.07	11	11
20	0.25	0.09	1,014.53	374.06	250.70	1,778.36	8	8
31	0.00	0.00	29.48	29.48	0.00	88.44	1	1
32	0.00	0.00	0.00	0.00	0.00	0.00	0	0
41	0.01	0.01	89.22	50.31	0.00	190.89	3	3
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	**0.05**	**0.01**	**2,556.80**	**624.39**	**1,320.51**	**3,793.09**	**23**	**23**
NBS								
70	0.39	0.14	3,062.54	1,108.50	822.25	5,302.83	19	19
71	0.35	0.12	2,833.54	961.63	890.09	4,777.00	15	15
81	0.20	0.07	764.30	273.93	202.19	1,326.40	9	9
Total	**0.33**	**0.08**	**6,660.38**	**1,492.83**	**3,674.71**	**9,646.05**	**43**	**43**

Rainbow Smelt (*Osmerus mordax*)

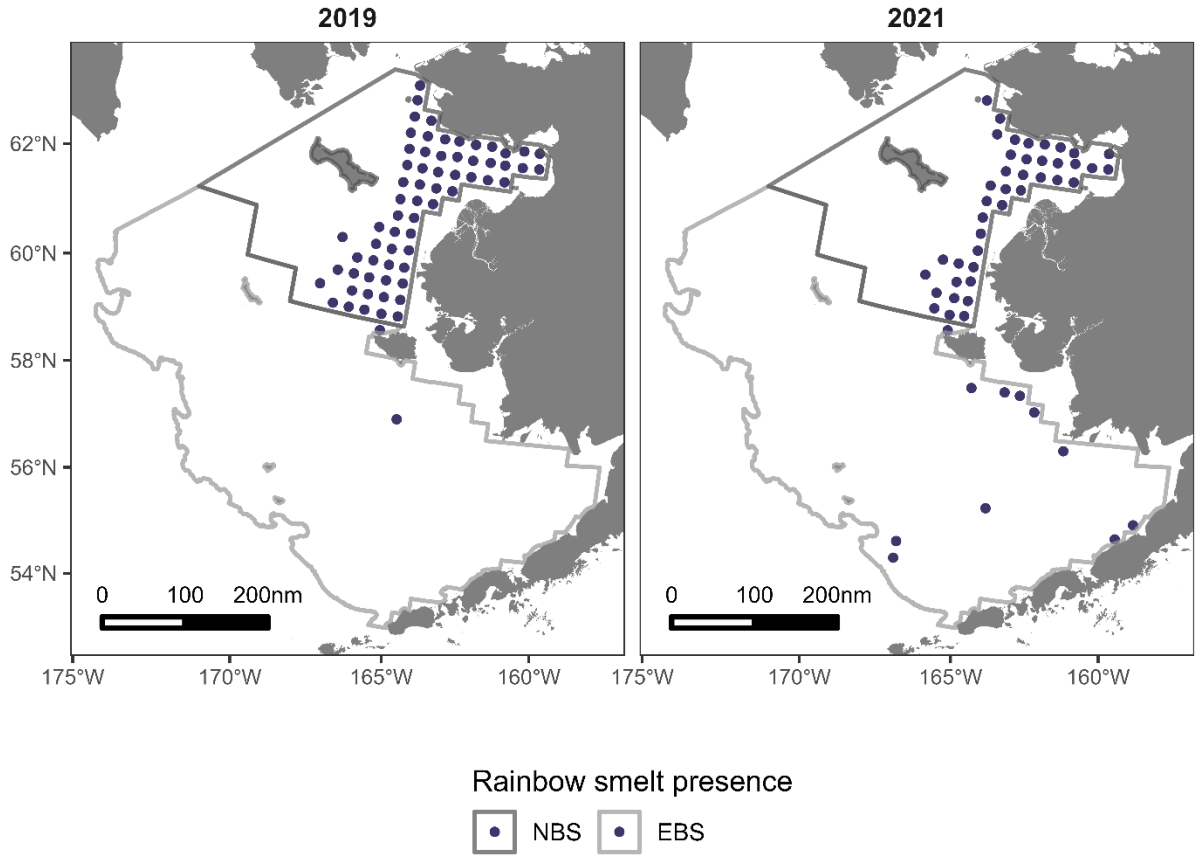

Figure 52. -- The presence of rainbow smelt (*Osmerus mordax*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

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 rainbow smelt (*Osmerus mordax*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	0.00	0.00	34	21	0	77	6	6
20	0.00	0.00	2	1	0	5	2	2
31	0.00	0.00	3	3	0	9	1	1
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	0.05	0.03	173	128	0	437	2	2
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**	**212**	**130**	**0**	**470**	**11**	**11**
NBS								
70	0.16	0.05	1,254	421	403	2,105	17	17
71	0.08	0.02	619	174	268	971	24	24
81	0.00	0.00	0	0	0	0	0	0
Total	**0.09**	**0.02**	**1,873**	**456**	**952**	**2,794**	**41**	**41**

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 rainbow smelt (*Osmerus mordax*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	0.08	0.04	603.32	325.13	0.00	1,260.40	6	6
20	0.01	0.01	56.39	39.22	0.00	136.47	2	2
31	0.00	0.00	30.15	30.15	0.00	90.45	1	1
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	0.94	0.73	3,558.98	2,780.39	0.00	9,286.58	2	2
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	**0.09**	**0.06**	**4,248.83**	**2,799.77**	**0.00**	**9,792.38**	**11**	**11**
NBS								
70	2.49	0.88	19,719.71	6,971.13	5,631.06	33,808.36	17	17
71	2.54	0.71	20,673.96	5,783.15	8,986.21	32,361.71	24	24
81	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**2.03**	**0.46**	**40,393.67**	**9,057.68**	**22,088.11**	**58,699.24**	**41**	**41**

Eulachon (*Thaleichthys pacificus*)

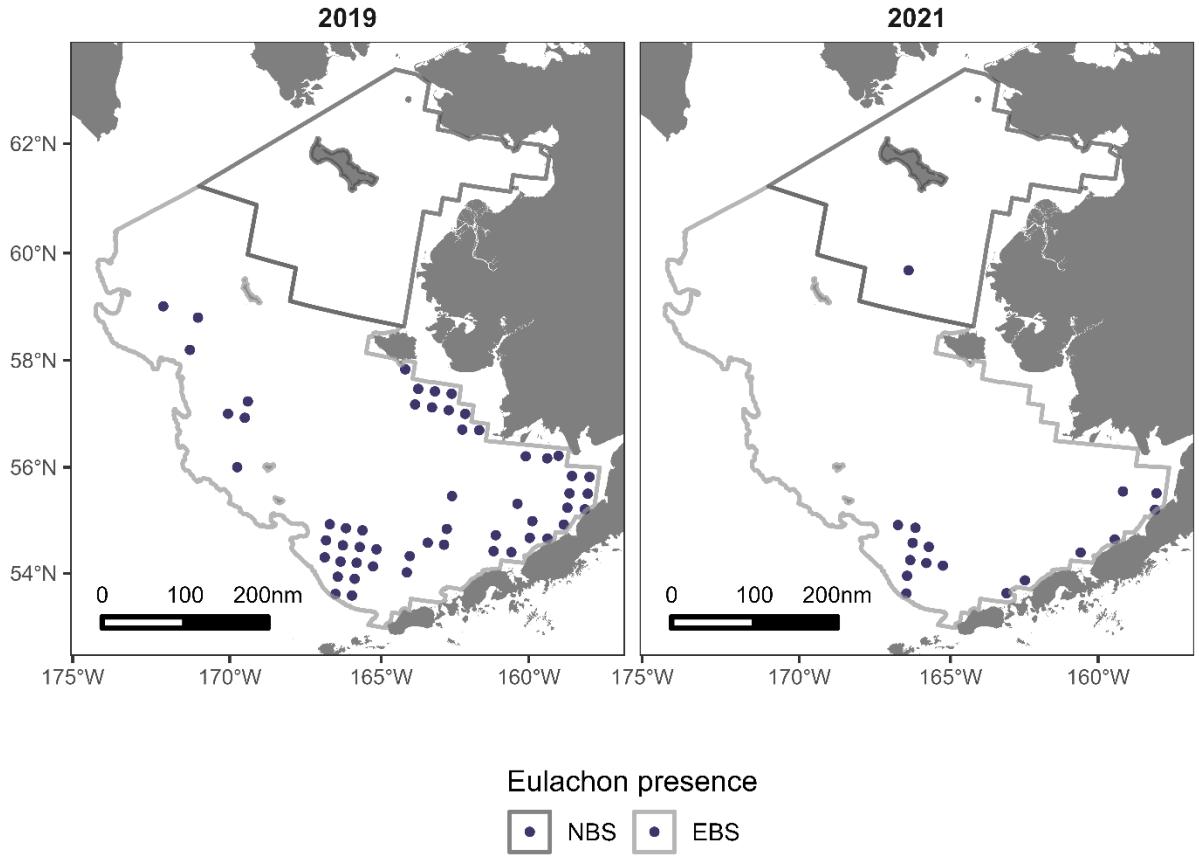

Figure 53. -- The presence of eulachon (*Thaleichthys pacificus*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

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 eulachon (*Thaleichthys pacificus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	0.03	0.02	210	120	0	452	6	6
20	0.00	0.00	0	0	0	0	0	0
31	0.00	0.00	7	7	0	22	1	1
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	0.08	0.05	289	184	0	667	9	9
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	**0.01**	**0.00**	**506**	**219**	**72**	**941**	**16**	**16**
NBS								
70	0.00	0.00	0	0	0	1	1	1
71	0.00	0.00	0	0	0	0	0	0
81	0.00	0.00	0	0	0	0	0	0
Total	**0.00**	**0.00**	**0**	**0**	**0**	**1**	**1**	**1**

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 eulachon (*Thaleichthys pacificus*) by stratum observed during the 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	0.24	0.13	1,884.51	1,037.94	0.00	3,982.19	6	6
20	0.00	0.00	0.00	0.00	0.00	0.00	0	0
31	0.01	0.01	94.20	94.20	0.00	282.60	1	1
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	1.55	0.96	5,905.45	3,666.27	0.00	13,457.97	9	9
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	**0.16**	**0.08**	**7,884.16**	**3,811.53**	**337.33**	**15,430.98**	**16**	**16**
NBS								
70	0.00	0.00	30.91	30.91	0.00	93.38	1	1
71	0.00	0.00	0.00	0.00	0.00	0.00	0	0
81	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**0.00**	**0.00**	**30.91**	**30.91**	**0.00**	**92.73**	**1**	**1**

Purple-Orange Sea Star (*Asterias amurensis*)

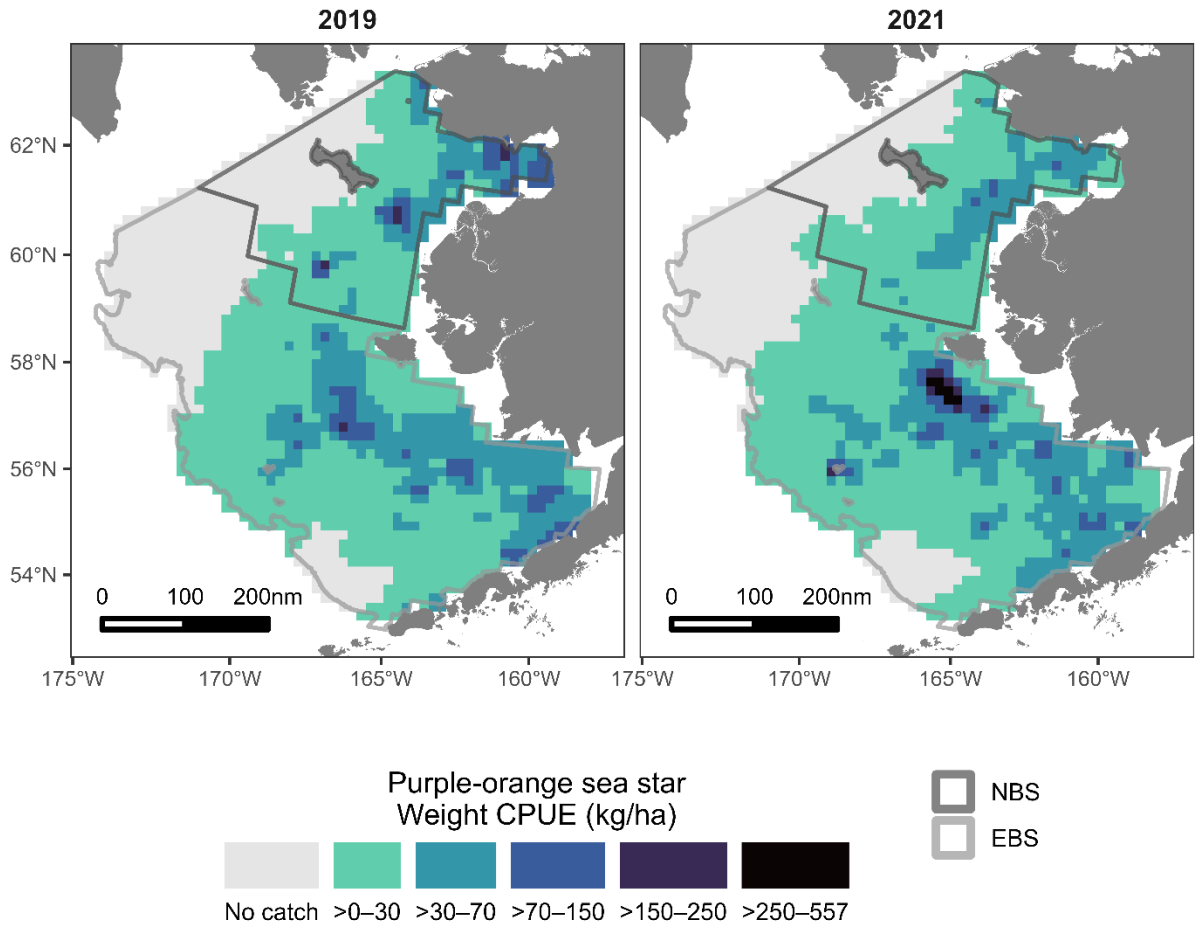

Figure 54. -- The distribution (weight CPUE (kg/ha)) of purple-orange sea star (*Asterias amurensis*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	44.75	4.35	352,226	34,214	283,080	421,372	57	54
20	69.62	20.09	286,792	82,749	117,818	455,766	31	31
31	18.35	2.79	174,283	26,495	121,293	227,272	61	59
32	6.61	2.66	5,849	2,350	290	11,408	8	7
41	9.65	1.99	60,119	12,402	35,054	85,183	37	37
42	37.03	8.52	89,315	20,544	47,365	131,266	30	30
43	0.26	0.19	552	405	0	1,395	8	8
50	0.07	0.05	253	191	0	646	3	3
61	0.23	0.14	2,002	1,187	0	4,402	16	16
62	0.00	0.00	0	0	0	0	0	0
82	0.00	0.00	6	6	0	21	1	1
90	0.00	0.00	0	0	0	0	0	0
Total	**19.70**	**1.96**	**971,398**	**96,452**	**776,469**	**1,166,327**	**252**	**246**
NBS								
70	17.39	2.47	137,838	19,558	98,312	177,365	44	44
71	16.17	3.18	131,423	25,866	79,146	183,699	35	35
81	0.36	0.23	1,385	892	0	3,220	6	6
Total	**13.61**	**1.63**	**270,646**	**32,440**	**205,765**	**335,527**	**85**	**85**

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 2021 eastern Bering Sea and northern Bering Sea 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
EBS								
10	711.87	88.05	5,602,795.34	692,996.05	4,202,250.33	7,003,340.36	57	54
20	599.81	147.07	2,470,790.95	605,832.99	1,233,679.98	3,707,901.91	31	31
31	205.13	38.40	1,948,340.38	364,730.39	1,218,879.61	2,677,801.15	61	59
32	52.87	14.94	46,775.95	13,219.40	15,512.07	78,039.84	8	7
41	62.27	15.59	388,020.19	97,121.06	191,738.54	584,301.85	37	37
42	427.03	155.48	1,030,098.42	375,059.81	264,226.27	1,795,970.55	30	30
43	1.47	1.27	3,104.56	2,666.88	0.00	8,651.66	8	8
50	1.36	1.05	5,164.49	3,983.14	0.00	13,369.77	3	3
61	1.46	0.87	12,807.70	7,660.46	0.00	28,289.49	16	16
62	0.00	0.00	0.00	0.00	0.00	0.00	0	0
82	0.02	0.02	30.81	30.81	0.00	98.62	1	1
90	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total	**233.43**	**21.57**	**11,507,928.79**	**1,063,326.93**	**9,358,945.06**	**13,656,912.53**	**252**	**246**
NBS								
70	145.55	20.87	1,153,662.54	165,383.51	819,422.47	1,487,902.62	44	44
71	147.14	27.86	1,195,599.19	226,357.93	738,129.83	1,653,068.56	35	35
81	5.36	3.96	20,545.89	15,191.17	0.00	51,778.94	6	6
Total	**119.17**	**14.12**	**2,369,807.63**	**280,749.69**	**1,808,308.25**	**2,931,307.01**	**85**	**85**

Shortfin Eelpout (*Lycodes brevipes*)

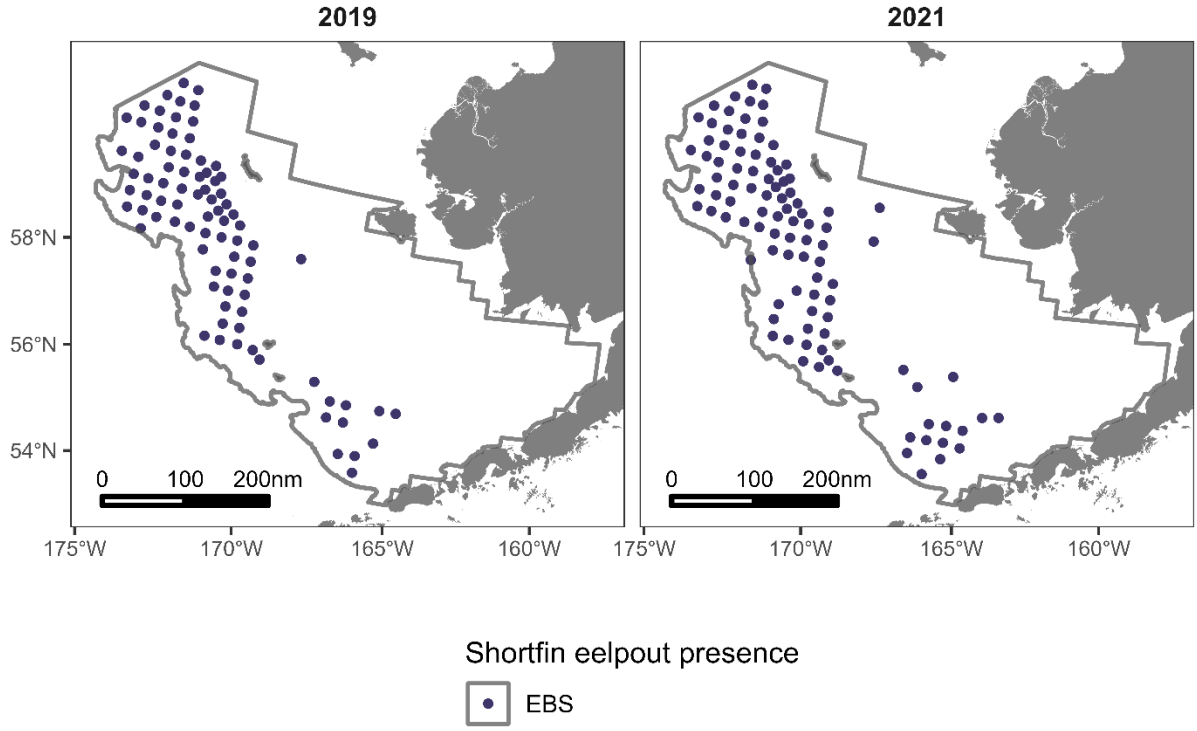

Figure 55. -- The presence of shortfin eelpout (*Lycodes brevipes*) from the 2019 and 2021 EBS shelf bottom trawl survey. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Wattled Eelpout (*Lycodes palearis*)

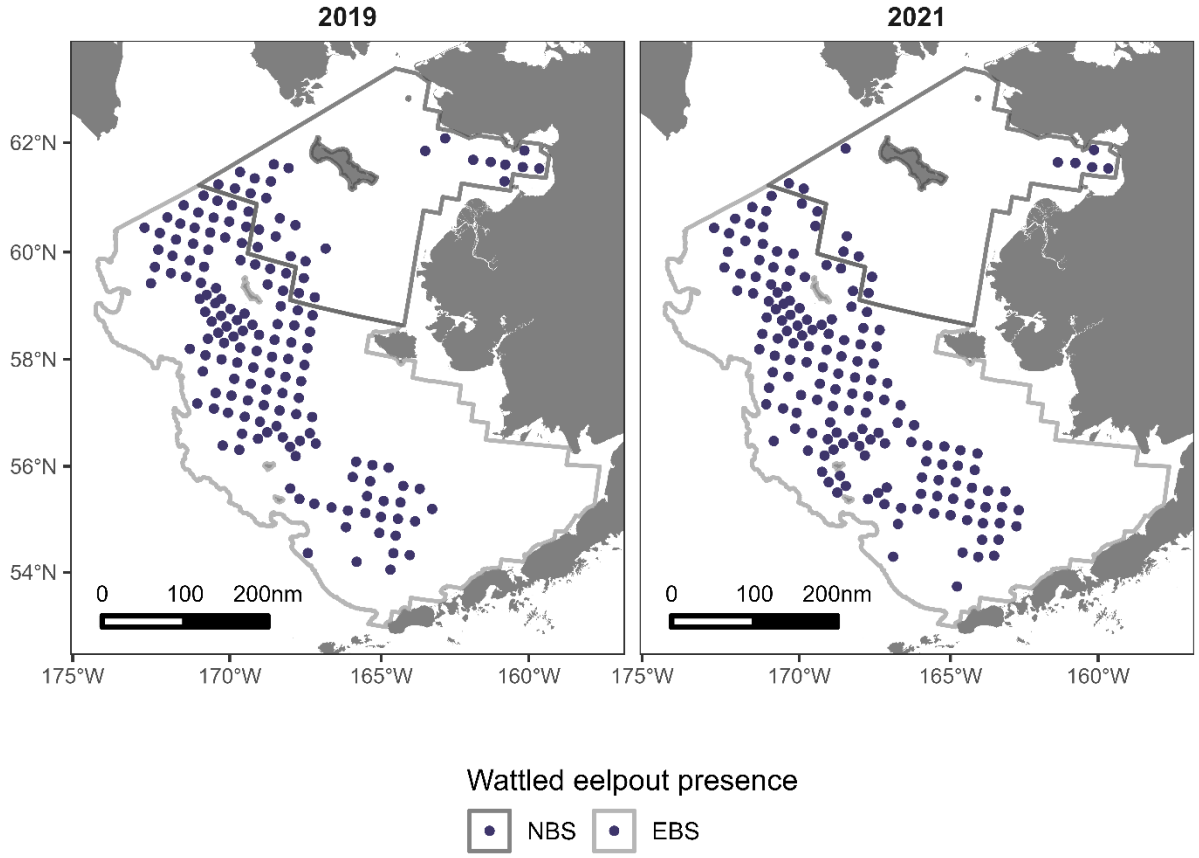

Figure 56. -- The presence of wattled eelpout (*Lycodes palearis*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys. This species has not been caught in enough quantity or at enough stations to adequately characterize a distribution.

Marbled Eelpout (*Lycodes raridens*)

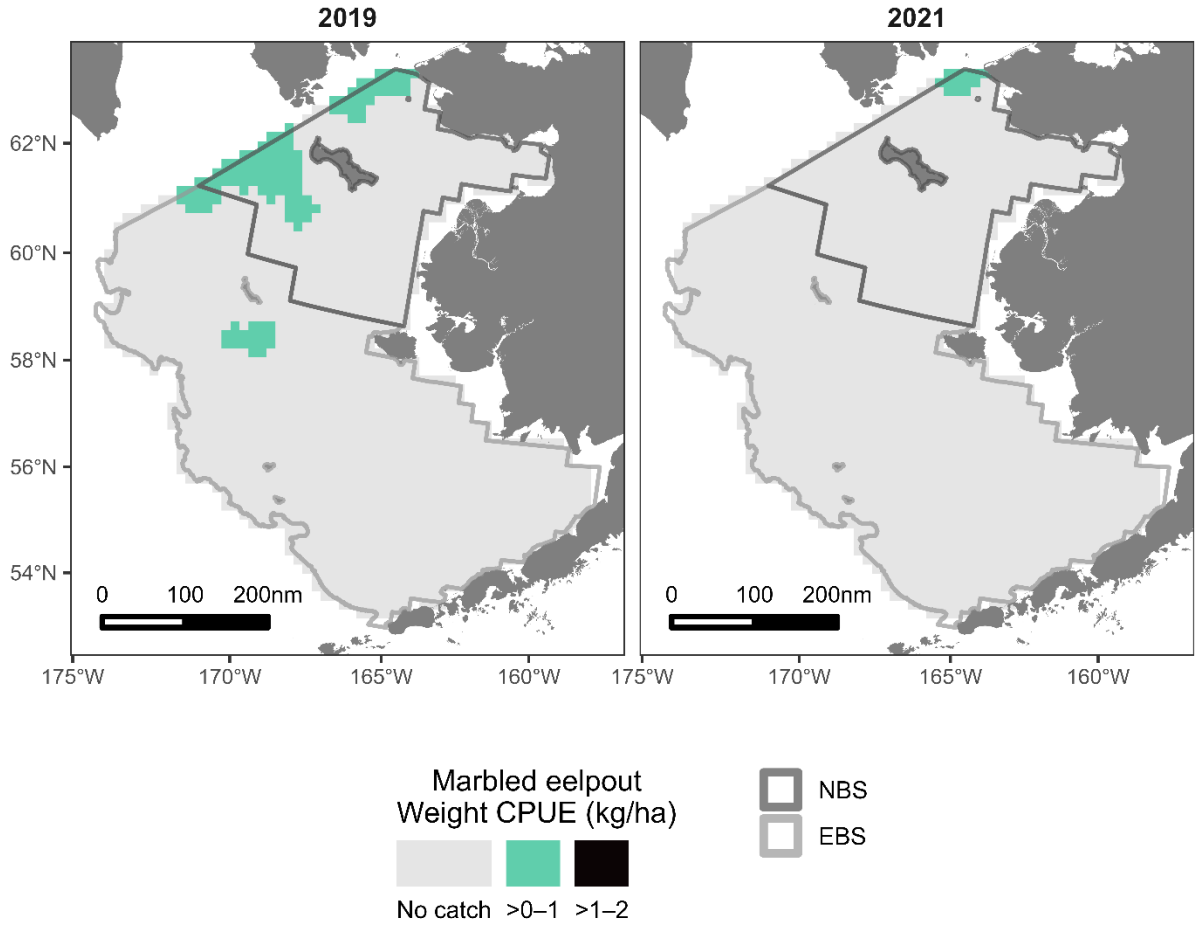

Figure 57. -- The distribution (weight CPUE (kg/ha)) of marbled eelpout (*Lycodes raridens*) from the 2019 and 2021 NBS and EBS shelf bottom trawl surveys.

Sturgeon Poacher (*Podothecus accipenserinus*)

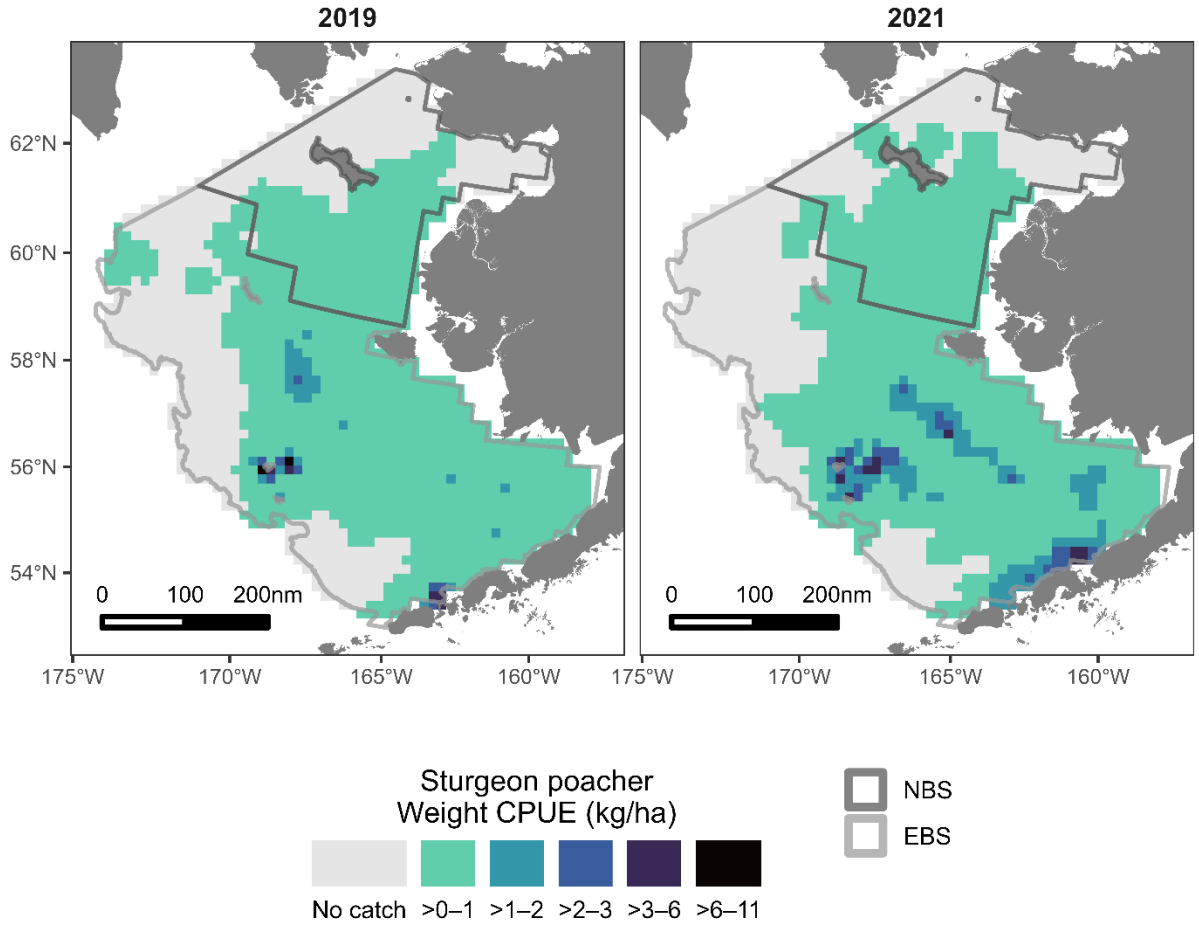

Figure 58. --The distribution (weight CPUE (kg/ha)) of sturgeon poacher (*Podothecus accipenserinus*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

Variegated Snailfish (*Liparis gibbus*)

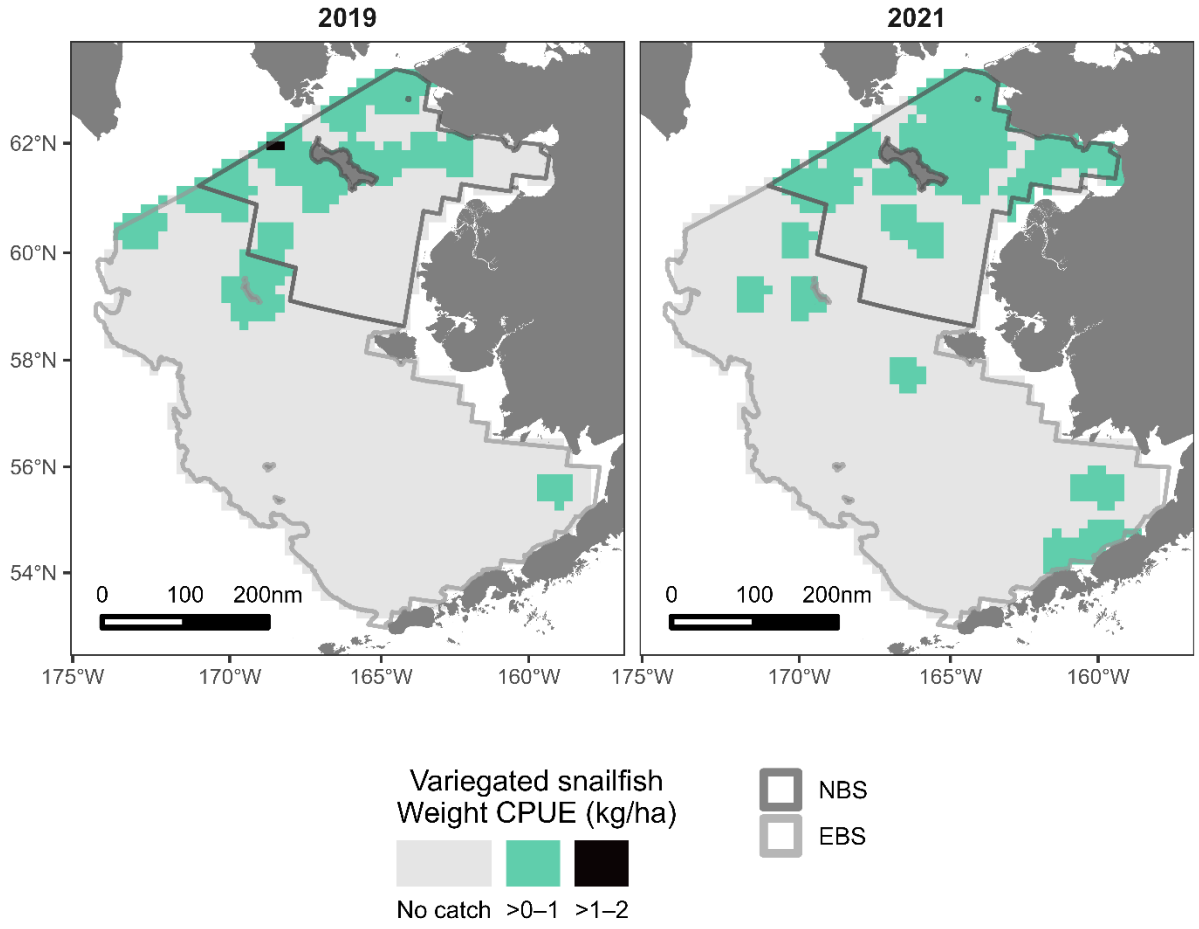

Figure 59. -- The distribution (weight CPUE (kg/ha)) of variegated snailfish (*Liparis gibbus*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

Northern Neptune Whelk (*Neptunea heros*)

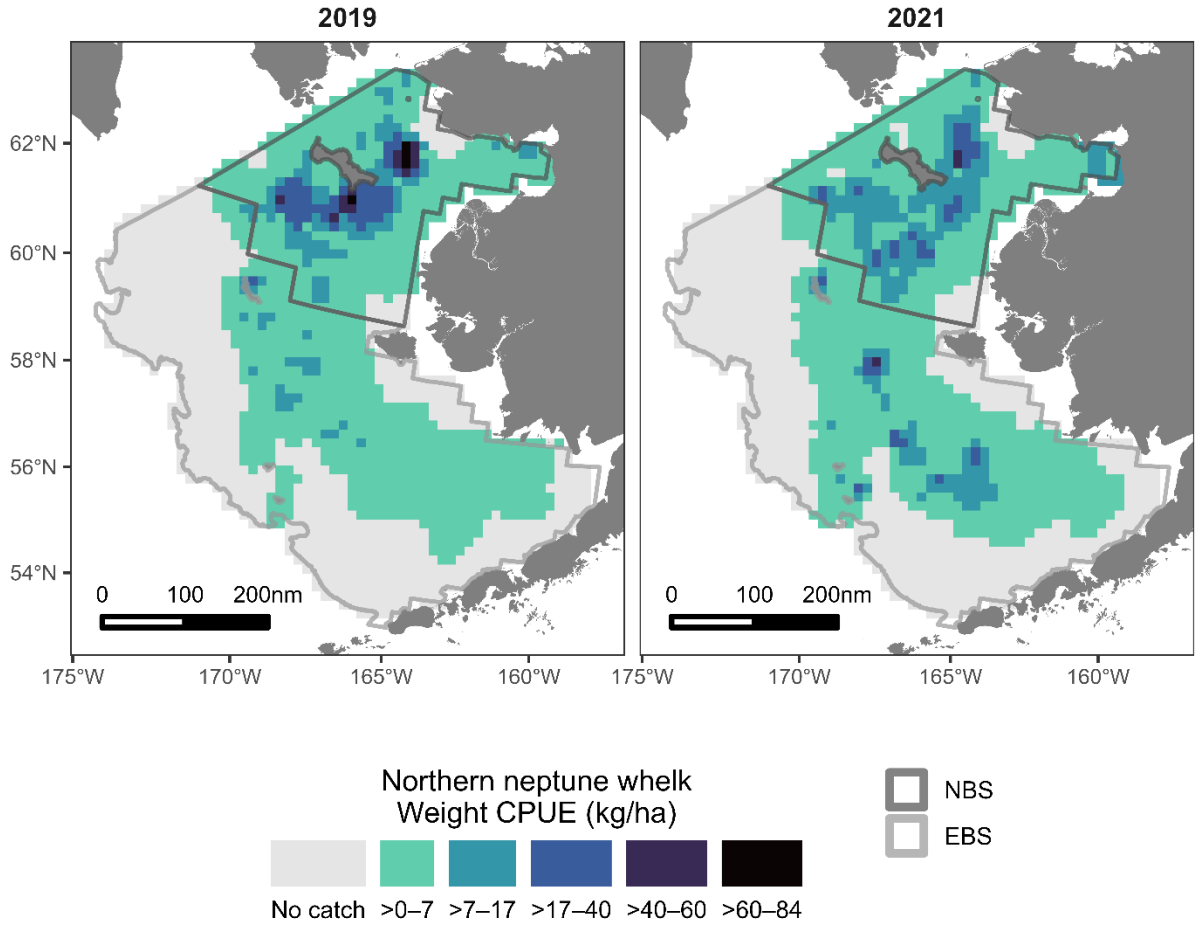

Figure 60. -- The distribution (weight CPUE (kg/ha)) of northern Neptune whelk (*Neptunea heros*) from the 2019 and 2021 eastern Bering Sea and northern Bering Sea shelf bottom trawl surveys.

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 Rebecca Haehn and Lukas DeFilippo for reviewing this document. Their excellent comments and suggestions greatly improved it.

We would also like to thank the many local and tribal communities of the Bering Strait region and their members who have helped contribute to this report. 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. 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*, 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

Cooper, D. W., and Nichol, D. G. (2016). Juvenile northern rock sole (*Lepidopsetta polyxystra*) spatial distribution and abundance patterns in the eastern Bering Sea: Spatially dependent production linked to temperature. *ICES J. Mar. Sci.*, *73*(4), p. 1138–1146. https://doi.org/10.1093/icesjms/fsw005

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.* U.S. Dep. Commer. [NOAA Professional Paper NMFS]. *19*, 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. (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. *AFSC Processed Rep. 2007-05*, 48. *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* (pp. p. 55–184). North Pacific Fishery Management Council.

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. *Fish. Bull., 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 Res. II*, *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. [NOAA Tech. Memo.]. *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*

Markowitz, E. H., Dawson, E. J., Charriere, N., Prohaska, B., Rohan, S., Stevenson, D. E., and Britt, L. L. (2022). *Results of the 2019 eastern and northern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate fauna*. U.S. Dep. Commer. [NOAA Tech. Memo.].

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.

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 Rep.].

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. *NOAA Processed Rep. 2015-01*, 11. *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* [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 anddensity-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*.

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.* U.S. Dep. Commer. [NWAFC Processed Rep.]. *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*, 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. (2021). *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, pp. 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).

Zacher, L. S., Richar, J. I., and Litzow, M. A. (2021). *The 2021 eastern Bering Sea continental shelf trawl survey: Results for commercial crab species*. U.S. Dep. Commer. [NOAA Tech. Memo.]. *https://apps-afsc.fisheries.noaa.gov/Documents/Temp-for-NOAA-IR/2021_EBS_Crab_SurveyTech_Memo_approved_draft.pdf*

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

Table Appendix A1. -- Fish taxa encountered during the 2021 eastern Bering Sea 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	55	45	147	73.6	56.3	60.7
	Bathyagonus alascanus	gray starsnout	1	85	85	85.0	56.4	56.4
	Bathyagonus infraspinatus	spinycheek starsnout	1	63	63	63.0	57.3	57.3
	Bathyagonus nigripinnis	blackfin poacher	2	68	96	82.0	56.7	57.0
	Leptagonus frenatus	sawback poacher	56	58	163	103.2	54.8	60.0
	Occella dodecaedron	Bering poacher	42	21	56	37.0	57.6	60.3
	Odontopyxis trispinosa	pygmy poacher	3	75	106	89.0	56.0	56.6
	Pallasina barbata	tubenose poacher	2	24	27	25.5	58.3	59.3
	Podothecus accipenserinus	sturgeon poacher	208	21	129	60.2	54.7	62.0
	Podothecus veternus	veteran poacher	1	157	157	157.0	54.8	54.8
Ammodytidae	*Ammodytes hexapterus*	Arctic sand lance	1	25	25	25.0	58.3	58.3
Anarhichadidae	*Anarhichas orientalis*	Bering wolffish	6	26	82	39.8	57.3	60.3
Anoplopomatidae	*Anoplopoma fimbria*	sablefish	17	54	157	120.8	54.8	56.7
Bathymasteridae	*Bathymaster signatus*	searcher	45	60	175	128.1	54.8	61.0
Clupeidae	*Clupea pallasii*	Pacific herring	167	21	118	60.7	54.7	62.0
Cottidae	*Gymnocanthus detrisus*	purplegray sculpin	2	73	115	94.0	59.7	62.0
	Gymnocanthus galeatus	armorhead sculpin	6	64	111	83.7	55.1	57.2
	Gymnocanthus pistilliger	threaded sculpin	27	21	53	31.7	55.7	60.3
	Hemilepidotus jordani	yellow Irish lord	92	42	142	85.3	54.7	61.3
	Hemilepidotus papilio	butterfly sculpin	1	48	48	48.0	57.1	57.1
	Icelinus borealis	northern sculpin	1	118	118	118.0	55.7	55.7
	Icelus spatula	spatulate sculpin	15	40	148	86.5	55.3	60.2
	Icelus spiniger	thorny sculpin	56	67	159	121.5	55.0	61.3
	Myoxocephalus jaok	plain sculpin	111	21	92	45.9	55.7	61.0
	Myoxocephalus polyacanthocephalus	great sculpin	192	21	175	77.5	55.1	62.0
	Myoxocephalus scorpius	shorthorn (=warty) sculpin	21	37	97	64.0	57.6	61.3
	Triglops macellus	roughspine sculpin	19	34	157	100.8	54.7	60.2
	Triglops pingeli	ribbed sculpin	14	43	79	66.3	56.7	60.4
	Triglops scepticus	spectacled sculpin	4	129	163	149.5	54.8	58.3
Gadidae	*Eleginus gracilis*	saffron cod	3	27	90	52.7	56.0	58.3
	Gadus chalcogrammus	walleye pollock	374	21	175	80.8	54.7	62.0
	Gadus macrocephalus	Pacific cod	368	21	175	80.0	54.7	62.0
	Microgadus proximus	Pacific tomcod	1	54	54	54.0	55.3	55.3
Hemitripteridae	*Hemitripterus bolini*	bigmouth sculpin	93	67	175	110.2	55.4	61.3

Table Appendix A1. -- Fish taxa encountered during the 2021 eastern Bering Sea 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
Hexagrammidae	*Hexagrammos decagrammus*	kelp greenling	4	76	129	93.0	54.7	56.4
	Hexagrammos stelleri	whitespotted greenling	12	23	46	33.5	56.7	60.3
	Pleurogrammus monopterygius	Atka mackerel	2	69	129	99.0	56.4	58.0
Liparidae	*Careproctus phasma*	monster snailfish	19	80	147	121.1	59.0	61.3
	Careproctus rastrinus	salmon snailfish	3	95	106	100.0	59.8	60.2
	Careproctus scottae	peachskin snailfish	11	77	147	123.0	60.0	61.7
	Careproctus sp.		1	90	90	90.0	60.4	60.4
	Crystallichthys cyclospilus	blotched snailfish	2	157	163	160.0	54.8	58.3
	Liparis dennyi	marbled snailfish	1	60	60	60.0	58.3	58.3
	Liparis gibbus	variegated snailfish	11	37	117	64.5	56.3	61.3
	Liparis tunicatus	kelp snailfish	1	53	53	53.0	57.7	57.7
Osmeridae	*Mallotus catervarius (=villosus)*	Pacific capelin	23	21	74	37.9	57.3	60.3
	Osmerus mordax	rainbow smelt	11	23	135	52.8	55.7	60.3
	Thaleichthys pacificus	eulachon	16	31	154	93.3	55.0	57.7
Petromyzontidae	*Lampetra tridentata*	Pacific lamprey	1	148	148	148.0	59.3	59.3
Pleuronectidae	*Atheresthes evermanni*	Kamchatka flounder	183	50	175	105.8	54.7	61.3
	Atheresthes stomias	arrowtooth flounder	254	44	175	96.5	54.7	61.7
	Glyptocephalus zachirus	rex sole	110	37	175	106.8	54.7	59.8
	Hippoglossoides elassodon	flathead sole	326	31	175	87.9	54.7	62.0
	Hippoglossoides robustus	Bering flounder	58	36	117	77.5	57.3	62.0
	Hippoglossus stenolepis	Pacific halibut	271	21	163	72.1	54.7	62.0
	Isopsetta isolepis	butter sole	24	37	82	61.9	54.7	57.7
	Lepidopsetta bilineata	southern rock sole	6	53	81	68.3	55.1	56.0
	Lepidopsetta polyxystra	northern rock sole	321	21	157	72.6	54.7	62.0
	Limanda aspera	yellowfin sole	235	21	110	59.4	54.7	62.0
	Limanda proboscidea	longhead dab	43	21	54	34.4	57.7	60.3
	Limanda sakhalinensis	Sakhalin sole	4	58	99	72.2	60.2	62.0
	Lyopsetta exilis	slender sole	1	139	139	139.0	55.4	55.4
	Microstomus pacificus	Dover sole	18	53	163	103.6	55.0	58.7
	Platichthys stellatus	starry flounder	67	21	91	42.8	54.7	60.3
	Pleuronectes quadrituberculatus	Alaska plaice	277	21	132	66.8	55.3	62.0

Table Appendix A1. -- Fish taxa encountered during the 2021 eastern Bering Sea 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
	Reinhardtius hippoglossoides	Greenland turbot	48	63	147	110.2	58.3	62.0
Psychrolutidae	*Dasycottus setiger*	spinyhead sculpin	82	68	155	114.2	55.0	60.7
	Malacocottus zonurus	darkfin sculpin	6	135	157	148.7	54.8	57.0
Rajidae	*Bathyraja aleutica*	Aleutian skate	21	100	163	136.4	54.8	59.7
	Bathyraja interrupta	Bering skate	82	35	175	114.5	54.7	61.3
	Bathyraja interrupta egg case	Bering skate egg case	17	67	157	122.3	54.8	60.3
	Bathyraja maculata	whiteblotched skate	1	129	129	129.0	56.4	56.4
	Bathyraja parmifera	Alaska skate	356	21	175	81.9	54.7	62.0
	Bathyraja parmifera egg case	Alaska skate egg case	39	54	175	98.1	54.8	62.0
	Bathyraja sp.		1	117	117	117.0	57.3	57.3
	Bathyraja taranetzi	mud skate	2	135	157	146.0	54.8	59.0
	Beringraja binoculata	big skate	11	53	135	74.0	54.7	58.0
	Rajiformes egg case	skate egg case unid.	4	63	148	112.8	55.3	60.3
Salmonidae	*Oncorhynchus gorbuscha*	pink salmon	1	87	87	87.0	59.0	59.0
	Oncorhynchus keta	chum salmon	3	87	109	100.7	56.0	59.0
	Oncorhynchus tshawytscha	chinook salmon	1	56	56	56.0	57.3	57.3
Scorpaenidae	*Sebastes aleutianus*	rougheye rockfish	1	144	144	144.0	55.0	55.0
	Sebastes alutus	Pacific ocean perch	13	109	156	133.6	55.7	60.0
	Sebastes melanostictus	blackspotted rockfish	9	118	144	130.4	55.0	56.4
	Sebastes polyspinis	northern rockfish	4	109	155	132.2	55.7	56.4
Somniosidae	*Somniosus pacificus*	Pacific sleeper shark	1	110	110	110.0	55.0	55.0
Stichaeidae	*Leptoclinus maculatus*	daubed shanny	14	38	137	98.1	56.3	60.0
	Lumpenus fabricii	slender eelblenny	5	30	136	96.2	56.6	59.9
	Lumpenus sagitta	snake prickleback	3	54	78	68.7	55.3	57.0
	Poroclinus rothrocki	whitebarred prickleback	5	109	136	121.0	55.6	57.0
Trichodontidae	*Trichodon trichodon*	Pacific sandfish	2	35	37	36.0	57.7	58.0
Zaproridae	*Zaprora silenus*	prowfish	2	129	154	141.5	55.0	56.4
Zoarcidae	*Lycodes brevipes*	shortfin eelpout	99	54	163	111.0	55.0	61.7
	Lycodes palearis	wattled eelpout	155	50	136	86.2	55.3	62.0

Table Appendix A2. -- Invertebrate taxa encountered during the 2021 eastern Bering Sea 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	*Aphrodita negligens*		10	107	136	122.2	56.3	60.7
	Aphrodita sp.		16	122	175	139.8	58.7	61.0
	Aphroditidae	sea mouse unid.	3	100	125	114.3	58.6	59.3
	Cheilonereis cyclurus	red and white banded sea nymph	1	74	74	74.0	58.7	58.7
	Eunoe depressa	depressed scale worm	54	40	132	83.9	56.6	61.0
	Eunoe nodosa	giant scale worm	68	52	126	76.0	56.7	62.0
	Eunoe sp.		2	135	146	140.5	59.0	60.3
	Hirudinea	leech unid.	1	60	60	60.0	58.3	58.3
	Nothria conchylega	gravel tube worm	1	120	120	120.0	59.3	59.3
	Notostomum cyclostomum	striped sea leech	17	67	136	99.2	56.7	61.0
	Notostomum sp.		1	125	125	125.0	59.7	59.7
	Polychaeta	polychaete worm unid.	7	31	106	69.4	56.0	61.3
	Polychaete tubes		18	56	155	107.5	55.3	58.0
	Serpulidae	serpulid worm	2	93	129	111.0	55.0	55.7
Arthropoda	*Argis dentata*	Arctic argid	2	78	130	104.0	56.3	57.0
	Argis lar	kuro argid	3	52	96	72.3	56.7	60.3
	Argis sp.		17	42	136	94.9	56.3	61.7
	Chionoecetes bairdi	Tanner crab	246	38	175	91.0	54.7	61.6
	Chionoecetes hybrid	hybrid Tanner crab	109	42	156	89.1	55.0	61.0
	Chionoecetes opilio	snow crab	258	42	175	91.5	55.0	62.0
	Chirona evermanni	giant barnacle	8	35	90	60.0	56.0	60.4
	Crangon sp.		78	21	136	75.8	55.4	61.3
	Elassochirus cavimanus	purple hermit	27	56	163	119.1	54.8	59.3
	Elassochirus tenuimanus	widehand hermit crab	9	53	81	62.3	55.4	57.3
	Erimacrus isenbeckii	horsehair crab	51	33	129	55.1	55.3	60.3
	Glebocarcinus oregonensis	Oregon rock crab	31	53	103	73.6	55.4	58.0
	Hyas coarctatus	circumboreal toad crab	84	26	135	63.8	56.6	62.0
	Hyas lyratus	Pacific lyre crab	109	29	157	80.7	54.8	60.7
	Isopoda	isopod unid.	1	136	136	136.0	55.7	55.7
	Labidochirus splendescens	splendid hermit	126	26	157	73.8	54.8	61.0
	Metacarcinus magister	Dungeness crab	2	54	55	54.5	55.3	56.3
	Mysida	opossum shrimps	1	98	98	98.0	61.3	61.3

Table Appendix A2. -- Invertebrate taxa encountered during the 2021 eastern Bering Sea 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
	Oregonia gracilis	graceful decorator crab	31	25	88	59.1	54.7	59.8
	Pagurus aleuticus	Aleutian hermit	140	54	157	101.2	54.8	60.3
	Pagurus brandti	sponge hermit	1	78	78	78.0	57.0	57.0
	Pagurus capillatus	hairy hermit crab	179	21	157	77.8	54.8	60.6
	Pagurus confragosus	knobbyhand hermit	93	63	163	105.7	54.7	60.3
	Pagurus ochotensis	Alaskan hermit	110	21	117	48.2	54.7	60.3
	Pagurus rathbuni	longfinger hermit	103	61	175	96.5	56.7	62.0
	Pagurus trigonocheirus	fuzzy hermit crab	162	43	175	84.9	55.0	62.0
	Pandalus eous	Alaskan pink shrimp	84	76	175	120.8	55.0	61.6
	Pandalus goniurus	humpy shrimp	13	31	106	74.5	56.7	61.7
	Pandalus jordani	ocean shrimp	1	157	157	157.0	54.8	54.8
	Pandalus sp.		3	87	92	90.3	58.7	61.0
	Paralithodes camtschaticus	red king crab	112	23	91	51.6	55.3	60.3
	Paralithodes platypus	blue king crab	17	44	95	69.4	56.8	60.7
	Telmessus cheiragonus	helmet crab	24	21	44	31.4	57.0	60.3
		empty barnacle shells	4	37	54	47.2	56.7	58.0
Bryozoa	Bryozoa	bryozoan unid.	30	23	109	57.0	55.6	60.7
Chordata	*Aplidium* sp.		39	29	102	57.3	56.7	61.0
	Ascidiacea	tunicate unid.	1	108	108	108.0	58.0	58.0
	Boltenia ovifera	sea onion	76	23	91	56.6	55.7	60.4
	Halocynthia aurantium	sea peach	37	52	103	69.3	57.0	60.4
	Styela rustica	sea potato	102	32	88	60.8	56.6	61.0
		compound ascidian unid.	22	28	107	60.3	56.6	60.0
Cnidaria	*Abietinaria* sp.		1	36	36	36.0	60.3	60.3
	Actiniaria	sea anemone unid.	76	39	175	104.9	55.0	62.0
	Aequorea sp.		18	68	148	115.1	55.3	60.7
	Aglaophenia sp.	ostrich plume hydroid	1	67	67	67.0	57.8	57.8
	Aurelia labiata		1	77	77	77.0	61.7	61.7
	Aurelia limbata	brown rimmed jelly	19	43	84	64.4	59.3	62.0
	Aurelia sp.		11	117	136	125.9	57.6	60.7
	Chrysaora melanaster		275	26	163	81.6	54.7	62.0
	Cribrinopsis fernaldi	chevron-tentacled anemone	7	91	136	118.4	56.7	57.6
	Cyanea capillata	lion's mane jelly	6	108	125	116.0	57.0	61.0

Table Appendix A2. -- Invertebrate taxa encountered during the 2021 eastern Bering Sea 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
	Gersemia rubiformis		28	29	75	57.3	56.6	60.0
	Gersemia sp.	sea raspberry	20	31	122	67.8	57.2	62.0
	Halipteris willemoesi		21	88	155	115.7	55.0	57.6
	Hydroidolina	hydroid unid.	23	26	90	60.0	57.0	61.3
	Liponema brevicorne	tentacle-shedding anemone	32	95	154	123.5	55.0	60.0
	Metridium farcimen	gigantic anemone	63	25	133	66.2	55.0	60.3
	Metridium sp.		41	26	148	72.4	55.3	60.2
	Oceanactis diomedeae	grape anemone	3	120	132	128.0	59.0	59.3
	Pennatulacea	sea whip or sea pen unid.	1	79	79	79.0	56.7	56.7
	Phacellophora camtschatica	egg yolk jelly	7	98	135	119.1	55.7	60.7
	Scyphozoa	jellyfish unid.	19	39	163	99.5	56.0	62.0
	Sertulariidae	Sertulariid hydroid	4	36	67	49.5	57.8	60.3
	Stomphia coccinea	swimming anemone	15	77	136	104.5	56.3	61.7
	Stomphia sp.		9	63	125	87.4	57.0	62.0
	Urticina crassicornis	mottled anemone	13	25	136	72.2	55.3	58.7
	Urticina sp.		46	41	136	96.7	56.7	62.0
		red striated sea anemone	1	120	120	120.0	55.4	55.4
Echinodermata	*Allocentrotus fragilis*	orange-pink sea urchin	2	122	136	129.0	56.7	57.0
	Amphiuridae	burrowing brittle star unid.	1	73	73	73.0	57.2	57.2
	Asterias amurensis	purple-orange sea star	252	21	157	65.3	54.7	61.3
	Bathyplotes sp.		1	144	144	144.0	57.6	57.6
	Ceramaster japonicus	red bat star	1	157	157	157.0	54.8	54.8
	Ceramaster stellatus		1	120	120	120.0	59.3	59.3
	Crossaster papposus	rose sea star	17	58	157	78.0	54.8	60.6
	Ctenodiscus crispatus	common mud star	74	84	175	119.1	55.0	61.7
	Cucumaria fallax	sea football	35	35	109	69.0	55.6	58.0
	Diplopteraster multipes	pincushion sea star	4	129	149	137.2	56.0	59.0
	Dipsacaster borealis	northern sea star	2	136	143	139.5	56.7	57.0
	Echinacea	sea urchin unid.	15	92	159	133.5	58.3	62.0
	Echinarachnius parma	parma sand dollar	13	21	157	81.7	54.7	61.0
	Evasterias echinosoma	giant sea star	32	31	94	67.5	56.0	59.8
	Evasterias troschelii	mottled sea star	1	50	50	50.0	57.1	57.1

Table Appendix A2. -- Invertebrate taxa encountered during the 2021 eastern Bering Sea 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
	Gorgonocephalus eucnemis	basketstar	248	35	163	84.0	55.0	62.0
	Henricia sp.		34	41	157	99.1	54.8	60.2
	Holothuroidea	sea cucumber unid.	3	60	133	100.7	56.0	58.3
	Leptasterias arctica		59	40	122	68.3	56.7	62.0
	Leptasterias groenlandica		15	58	125	82.9	58.6	62.0
	Leptasterias polaris		142	25	163	92.6	56.4	62.0
	Leptychaster anomalus		10	100	175	123.2	58.0	59.7
	Lethasterias nanimensis	blackspined sea star	95	58	156	86.0	55.4	61.0
	Myriotrochus rinkii		2	77	85	81.0	61.6	61.7
	Ophiopholis aculeata	ubiquitous brittle star	3	69	155	98.0	56.3	57.8
	Ophiura sarsii	notched brittlestar	95	50	157	79.8	54.8	62.0
	Pedicellaster magister	majestic sea star	1	157	157	157.0	54.8	54.8
	Pentamera sp.		1	68	68	68.0	57.4	57.4
	Pseudarchaster parelii	scarlet sea star	10	108	157	130.3	54.8	58.0
	Pseudarchaster sp.		2	96	157	126.5	54.8	56.0
	Psolus fabricii	brownscaled sea cucumber	2	60	75	67.5	60.0	60.4
	Psolus sp.		1	157	157	157.0	54.8	54.8
	Pteraster obscurus	obscure sea star	56	50	147	98.6	55.7	62.0
	Pteraster sp.		1	156	156	156.0	58.7	58.7
	Pteraster tesselatus		5	110	157	132.4	54.8	56.4
	Pycnopodia helianthoides	sunflower sea star	2	54	79	66.5	55.3	55.4
	Solaster sp.		4	60	157	102.2	54.8	60.3
	Strongylocentrotus droebachiensis	green sea urchin	59	25	157	93.0	54.8	61.0
	Strongylocentrotus sp.		2	143	144	143.5	57.0	57.6
Echiura	Echiura	echiuroid worm unid.	1	65	65	65.0	57.0	57.0
Ectoprocta	*Alcyonidium disciforme*	disc bryozoan	7	58	79	69.9	56.7	60.7
	Alcyonidium pedunculatum	fruit leather bryozoan	6	27	69	44.8	56.7	59.3
	Bugula pacifica		2	64	69	66.5	57.6	58.0
	Dendrobeania sp.		3	67	68	67.3	57.8	59.6
	Rhamphostomella costata	ribbed bryozoan	8	53	79	71.9	56.7	58.4
Mollusca	*Aforia circinata*	keeled Aforia	33	81	137	110.6	55.4	61.3

Table Appendix A2. -- Invertebrate taxa encountered during the 2021 eastern Bering Sea 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
	Arctomelon stearnsii	Alaska volute	2	157	163	160.0	54.8	58.3
	Benthoctopus leioderma	smoothskin octopus	3	95	129	109.3	59.7	60.6
	Benthoctopus oregonensis		1	103	103	103.0	60.3	60.3
	Beringius behringi	Bering beringius	19	54	137	97.7	55.7	61.0
	Beringius sp.		41	54	159	101.0	55.3	61.3
	Beringius stimpsoni		1	53	53	53.0	58.3	58.3
	Berryteuthis magister	magistrate armhook squid	1	157	157	157.0	54.8	54.8
	Bivalvia	bivalve unid.	1	135	135	135.0	59.0	59.0
	Boreotrophon alaskanus	Alaskan trophon	2	69	102	85.5	57.0	61.0
	Boreotrophon beringi	Bering trophon	1	126	126	126.0	56.7	56.7
	Boreotrophon sp.		3	85	109	97.0	57.4	59.0
	Buccinum angulosum	angular whelk	73	54	159	95.0	57.0	62.0
	Buccinum ciliatum		2	63	98	80.5	60.6	62.0
	Buccinum oedematum	swollen whelk	48	35	143	92.4	56.7	62.0
	Buccinum plectrum	sinuous whelk	21	40	159	115.0	55.0	61.3
	Buccinum polare	polar whelk	69	53	105	75.2	56.4	62.0
	Buccinum scalariforme	ladder whelk	149	46	175	95.9	55.6	62.0
	Buccinum solenum		1	112	112	112.0	58.6	58.6
	Buccinum sp.		12	47	157	88.9	54.7	62.0
	Chlamys sp.		5	75	129	88.4	55.7	60.0
	Ciliatoclinocardium ciliatum	hairy cockle	13	61	111	81.0	57.0	61.7
	Clinocardium sp.		15	46	101	75.4	56.3	61.3
	Clinopegma magnum	helmet whelk	49	63	147	93.5	56.7	62.0
	Colus herendeenii	thin-ribbed whelk	5	107	126	117.4	56.7	59.0
	Colus sp.		25	52	155	84.7	55.7	61.0
	Crepidula sp.	slipper shell	1	54	54	54.0	57.6	57.6
	Cryptonatica aleutica	Aleutian moonsnail	1	21	21	21.0	59.3	59.3
	Cryptonatica russa	rusty moonsnail	17	61	117	86.7	59.3	62.0
	Cryptonatica sp.		10	67	90	77.1	56.7	61.3
	Cyclocardia sp.		2	47	54	50.5	57.6	58.3
	Enteroctopus dofleini	giant octopus	40	50	163	119.4	55.0	61.3
	Fusitriton oregonensis	Oregon triton	96	54	175	112.2	54.7	60.0
	gastropod egg	snail egg	169	23	163	78.6	55.0	62.0
	Gastropoda	snail unid.	1	126	126	126.0	56.7	56.7
	Grandicrepidula grandis	great slippersnail	8	64	75	69.2	57.0	60.0

Table Appendix A2. -- Invertebrate taxa encountered during the 2021 eastern Bering Sea 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
	Lunatia pallida	pale moonsnail	13	63	101	80.2	58.4	62.0
	Lussivolutopsius filosus	threaded whelk	1	120	120	120.0	57.6	57.6
	Macoma nasuta	bent-nose Macoma	9	21	53	33.2	57.7	59.4
	Macoma sp.		13	39	106	64.6	56.3	60.7
	Mactromeris polynyma	Arctic surfclam	42	23	79	51.2	55.7	60.3
	Modiolus modiolus	northern horsemussel	8	23	69	53.6	57.0	61.7
	Musculus discors	discordant mussel	13	52	75	65.9	56.0	61.3
	Mya sp.		1	41	41	41.0	58.0	58.0
	Mytilus californianus	California mussel	2	35	46	40.5	57.7	58.0
	Naticidae	moonsnail	1	82	82	82.0	62.0	62.0
	gastropod egg	moonsnail egg unid.	6	21	78	39.8	57.0	59.4
	Neoberingius frielei		1	117	117	117.0	58.0	58.0
	Neptunea borealis		38	40	117	71.1	57.0	62.0
	Neptunea heros		130	36	96	61.5	56.7	62.0
	Neptunea lyrata	lyre whelk	90	35	156	92.4	55.0	60.7
	Neptunea pribiloffensis	Pribilof whelk	135	53	175	109.0	55.0	61.3
	Neptunea sp.		2	64	99	81.5	57.7	61.0
	Neptunea ventricosa	fat whelk	150	25	125	65.2	55.7	61.0
	Nodulotrophon coronatus		1	73	73	73.0	62.0	62.0
	Nudibranchia	nudibranch unid.	7	64	141	104.4	57.0	61.3
	Octopus sp.		3	108	119	111.7	58.0	60.7
	Onchidiopsis clarki	warty blobsnail	3	63	87	71.0	58.7	59.0
	Onchidiopsis sp.		1	75	75	75.0	60.0	60.0
	Patinopecten caurinus	weathervane scallop	22	75	149	103.9	55.3	57.0
	Plicifusus kroyeri		38	60	142	100.3	56.3	61.0
	Pododesmus macrochisma	Alaska falsejingle	1	63	63	63.0	60.3	60.3
	Pyrulofusus deformis	warped whelk	43	58	175	96.7	55.0	60.4
	Pyrulofusus dexius		1	93	93	93.0	55.7	55.7
	Pyrulofusus harpa	left-hand whelk	7	64	75	69.3	56.6	57.7
	Pyrulofusus melonis		32	58	149	101.6	55.3	60.0
	Rossia pacifica	eastern Pacific bobtail	15	96	157	128.0	54.8	60.0
	Serripes groenlandicus	Greenland cockle	1	40	40	40.0	59.3	59.3
	Serripes notabilis	oblique smoothcockle	49	28	147	76.8	56.3	61.0

Table Appendix A2. -- Invertebrate taxa encountered during the 2021 eastern Bering Sea 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
	Serripes sp.		1	42	42	42.0	59.0	59.0
	Siliqua alta	Alaska razor	8	26	41	31.9	58.3	60.3
	Tellina lutea	Alaska great-tellin	5	31	48	39.4	57.1	59.6
	Tellina sp.		1	47	47	47.0	59.0	59.0
	Tochuina gigantea	giant orange tochui	3	113	136	123.7	56.7	61.0
	Tritonia diomedea	rosy Tritonia	4	63	75	67.5	58.3	61.0
	Tritonia festiva	festive Tritonia	2	68	117	92.5	57.0	59.3
	Tritonia sp.		1	122	122	122.0	61.0	61.0
	Volutopsius fragilis	fragile whelk	29	53	159	113.6	57.0	61.3
	Volutopsius middendorffi	tulip whelk	8	98	130	111.5	57.6	61.0
	Volutopsius sp.		27	46	136	85.7	56.3	60.3
	Volutopsius stefanssoni	shouldered whelk	7	117	137	125.9	56.7	60.7
	Volutopsius trophonius	frilled whelk	1	111	111	111.0	60.4	60.4
	Yoldia hyperborea	northern Yoldia	4	60	102	76.5	59.4	61.0
	Yoldia sp.		3	40	70	59.0	57.6	61.0
		empty bivalve shells	274	21	159	76.4	55.3	62.0
		empty gastropod shells	298	21	175	80.9	55.0	62.0
Platyhelminthes	Platyhelminthes	flatworm unid.	1	65	65	65.0	57.0	57.0
Porifera	*Echinoclathria beringensis*	hat sponge	2	120	122	121.0	57.0	59.3
	Porifera	sponge unid.	54	36	157	85.4	54.7	60.3
	Suberites montalbidus	stinky sponge	5	61	91	80.0	56.0	57.0
Sipuncula	Sipuncula	peanut worm unid.	5	31	133	98.4	56.0	60.3
Other		invertebrate unid.	1	108	108	108.0	58.3	58.3

Appendix B: List of taxa encountered in the NBS

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

List of Tables

Table Appendix B1. -- Fish taxa encountered during the 2021 northern Bering Sea 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 olrikii*	Arctic alligatorfish	8	31	71	42.8	63.3	65.3
	Occella dodecaedron	Bering poacher	20	11	28	20.1	60.6	64.3
	Pallasina barbata	tubenose poacher	10	15	26	19.6	60.7	64.7
	Podothecus accipenserinus	sturgeon poacher	55	21	61	37.0	60.7	64.0
	Podothecus veternus	veteran poacher	24	23	53	36.0	62.7	65.3
Ammodytidae	*Ammodytes* sp.	sand lance unid.	2	23	33	28.0	64.0	64.1
Anarhichadidae	*Anarhichas orientalis*	Bering wolffish	5	18	36	23.6	63.7	64.7
Clupeidae	*Clupea pallasii*	Pacific herring	83	15	73	35.9	60.6	65.3
Cottidae	*Artediellus miacanthus*	bride sculpin	1	31	31	31.0	64.4	64.4
	Artediellus pacificus	hookhorn sculpin	1	35	35	35.0	64.0	64.0
	Artediellus scaber	hamecon	2	39	44	41.5	64.6	65.0
	Enophrys diceraus	antlered sculpin	16	15	40	23.6	63.7	64.7
	Gymnocanthus detrisus	purplegray sculpin	1	47	47	47.0	64.6	64.6
	Gymnocanthus galeatus	armorhead sculpin	1	43	43	43.0	62.3	62.3
	Gymnocanthus pistilliger	threaded sculpin	41	15	53	27.2	60.6	65.3
	Gymnocanthus tricuspis	Arctic staghorn sculpin	5	29	42	34.8	63.0	64.0
	Hemilepidotus papilio	butterfly sculpin	3	47	64	52.7	62.3	63.0
	Megalocottus platycephalus	belligerent sculpin	2	15	15	15.0	63.7	64.3
	Myoxocephalus jaok	plain sculpin	95	11	63	31.8	60.6	65.3
	Myoxocephalus polyacanthocephalus	great sculpin	33	21	79	48.9	61.3	65.0
	Myoxocephalus scorpioides	Arctic sculpin	2	11	21	16.0	63.7	63.7
	Myoxocephalus scorpius	shorthorn (=warty) sculpin	38	26	68	41.6	61.4	65.3
	Myoxocephalus sp.		3	31	34	33.0	64.3	65.3
	Triglops macellus	roughspine sculpin	1	22	22	22.0	60.7	60.7
	Triglops pingeli	ribbed sculpin	5	22	60	32.8	60.7	65.0
Gadidae	*Boreogadus saida*	Arctic cod	38	15	73	36.7	62.3	65.3
	Eleginus gracilis	saffron cod	57	11	53	27.2	60.7	65.3
	Gadus chalcogrammus	walleye pollock	135	16	79	40.2	60.6	65.3
	Gadus macrocephalus	Pacific cod	109	21	79	41.4	60.6	65.3
Gasterosteidae	*Gasterosteus aculeatus*	threespine stickleback	1	33	33	33.0	64.1	64.1
	Pungitius pungitius	ninespine stickleback	1	15	15	15.0	64.3	64.3
Hemitripteridae	*Nautichthys pribilovius*	eyeshade sculpin	6	18	52	32.5	64.0	65.3

Table Appendix B1. -- Fish taxa encountered during the 2021 northern Bering Sea 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
Hexagrammidae	Hexagrammidae	greenling unid.	1	23	23	23.0	64.3	64.3
	Hexagrammos stelleri	whitespotted greenling	19	17	35	22.8	60.6	64.3
Liparidae	*Careproctus phasma*	monster snailfish	1	72	72	72.0	62.3	62.3
	Careproctus scottae	peachskin snailfish	1	73	73	73.0	62.6	62.6
	Liparis bathyarcticus	nebulous snailfish	1	35	35	35.0	64.0	64.0
	Liparis gibbus	variegated snailfish	32	16	72	40.1	62.0	65.3
	Liparis marmoratus	festive snailfish	1	35	35	35.0	63.3	63.3
	Liparis sp.		1	33	33	33.0	63.7	63.7
	Liparis tunicatus	kelp snailfish	3	36	51	44.7	62.0	63.7
Osmeridae	*Mallotus catervarius (=villosus)*	Pacific capelin	43	18	73	42.3	60.7	65.0
	Osmerus mordax	rainbow smelt	41	11	34	22.5	60.6	65.0
	Thaleichthys pacificus	eulachon	1	41	41	41.0	61.3	61.3
Pleuronectidae	*Atheresthes evermanni*	Kamchatka flounder	1	63	63	63.0	61.3	61.3
	Atheresthes stomias	arrowtooth flounder	9	43	68	53.0	60.7	61.7
	Hippoglossoides elassodon	flathead sole	2	54	59	56.5	60.7	61.0
	Hippoglossoides robustus	Bering flounder	80	23	79	48.0	60.7	65.3
	Hippoglossus stenolepis	Pacific halibut	78	18	79	39.4	60.6	65.3
	Lepidopsetta polyxystra	northern rock sole	107	18	79	41.3	60.6	65.3
	Limanda aspera	yellowfin sole	138	11	79	37.8	60.6	65.3
	Limanda proboscidea	longhead dab	48	11	64	27.9	60.6	65.3
	Limanda sakhalinensis	Sakhalin sole	71	23	73	47.4	61.0	65.3
	Liopsetta glacialis	Arctic flounder	4	15	16	15.2	63.3	64.3
	Platichthys stellatus	starry flounder	77	11	53	28.5	60.6	65.3
	Platichthys stellatus X Pleuronectes quadrituberculatus hybrid	hybrid starry flounder X Alaska plaice	1	18	18	18.0	64.0	64.0
	Pleuronectes quadrituberculatus	Alaska plaice	140	11	79	38.1	60.6	65.3
Rajidae	*Bathyraja parmifera*	Alaska skate	69	22	79	44.2	60.7	64.3
	Bathyraja parmifera egg case	Alaska skate egg case	15	27	64	40.0	60.7	64.0
Salmonidae	*Oncorhynchus* sp.	salmon unid.	2	18	19	18.5	64.0	64.0
	Oncorhynchus tshawytscha	chinook salmon	3	21	38	30.7	60.7	64.1

Table Appendix B1. -- Fish taxa encountered during the 2021 northern Bering Sea 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
Stichaeidae	*Acantholumpenus mackayi*	pighead prickleback	11	11	23	18.0	61.0	64.3
	Chirolophis snyderi	bearded warbonnet	1	18	18	18.0	64.0	64.0
	Leptoclinus maculatus	daubed shanny	2	22	52	37.0	60.7	65.3
	Lumpenus fabricii	slender eelblenny	5	23	35	26.6	62.0	64.3
	Lumpenus sagitta	snake prickleback	39	15	53	27.9	61.7	65.3
	Stichaeus punctatus	Arctic shanny	4	15	21	18.2	64.0	64.3
Zoarcidae	*Lycodes palearis*	wattled eelpout	13	18	79	46.9	60.7	64.3
	Lycodes raridens	marbled eelpout	1	52	52	52.0	65.3	65.3
	Lycodes turneri	polar eelpout	6	15	53	29.8	63.7	65.3
Other	Pleuronectiformes	flatfish unid.	2	47	51	49.0	62.0	62.3

Table Appendix B2. -- Invertebrate taxa encountered during the 2021 northern Bering Sea 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	*Eunoe depressa*	depressed scale worm	10	23	63	41.2	61.0	64.0
	Eunoe nodosa	giant scale worm	3	34	56	45.7	61.3	64.0
	Eunoe sp.		6	15	71	34.7	61.7	64.3
	Notostomum cyclostomum	striped sea leech	4	47	68	57.2	61.4	63.0
	Polychaeta	polychaete worm unid.	6	26	66	43.0	60.6	63.7
	Polychaete tubes		11	17	40	27.2	60.7	63.2
Arthropoda	Amphipoda	amphipod unid.	3	40	53	46.0	62.3	63.0
	Argis dentata	Arctic argid	9	29	43	37.2	62.6	64.0
	Argis sp.		70	15	79	36.6	60.7	65.3
	Chionoecetes bairdi	Tanner crab	8	31	64	41.9	61.7	64.3
	Chionoecetes hybrid	hybrid Tanner crab	7	35	79	51.6	61.7	63.7
	Chionoecetes opilio	snow crab	102	19	79	44.7	60.7	65.3
	Chirona evermanni	giant barnacle	6	18	50	35.0	63.0	65.0
	Crangon sp.		52	11	70	26.3	60.6	65.3
	Erimacrus isenbeckii	horsehair crab	8	36	54	43.8	60.7	62.0
	Eualus sp.		2	39	52	45.5	64.6	65.3
	Eusirus cuspidatus	speckled amphipod	1	40	40	40.0	63.2	63.2
	Hapalogaster grebnitzkii	soft crab	2	19	50	34.5	64.0	64.3
	Hyas coarctatus	circumboreal toad crab	89	20	73	42.4	60.7	65.3
	Isopoda	isopod unid.	2	11	16	13.5	63.3	63.7
	Labidochirus splendescens	splendid hermit	72	15	66	34.8	60.7	65.3
	Lebbeus groenlandicus	spiny lebbeid	1	40	40	40.0	63.2	63.2
	Lebbeus polaris		1	70	70	70.0	62.7	62.7
	Pagurus capillatus	hairy hermit crab	18	20	41	30.9	61.0	64.0
	Pagurus ochotensis	Alaskan hermit	44	11	43	25.6	60.7	64.3
	Pagurus rathbuni	longfinger hermit	28	29	79	57.5	61.3	65.0
	Pagurus trigonocheirus	fuzzy hermit crab	114	11	72	39.5	60.7	65.3
	Pandalus goniurus	humpy shrimp	22	18	71	34.5	60.7	65.3
	Pandalus hypsinotus	coonstripe shrimp	6	18	34	25.3	64.0	65.0
	Paralithodes camtschaticus	red king crab	25	15	43	24.2	60.7	65.0
	Paralithodes platypus	blue king crab	21	21	71	41.0	63.2	65.3
	Sclerocrangon boreas	sculptured shrimp	10	18	35	26.0	64.0	65.0
	Sclerocrangon sp.		1	40	40	40.0	63.2	63.2

Table Appendix B2. -- Invertebrate taxa encountered during the 2021 northern Bering Sea 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
	Stegocephalus inflatus	smooth northern amphipod	1	47	47	47.0	63.0	63.0
	Telmessus cheiragonus	helmet crab	36	15	49	24.0	60.7	65.0
	Thoracica	barnacle unid.	2	15	15	15.0	63.7	64.3
		empty barnacle shells	4	29	42	36.5	62.6	63.4
Bryozoa	Bryozoa	bryozoan unid.	7	21	40	26.3	60.7	63.2
Chordata	*Aplidium* sp.		24	23	53	32.7	61.0	65.3
	Ascidiacea	tunicate unid.	2	21	23	22.0	61.0	61.0
	Boltenia ovifera	sea onion	24	21	53	35.6	60.7	65.3
	Halocynthia aurantium	sea peach	2	21	35	28.0	63.7	64.0
	Styela rustica	sea potato	68	21	61	39.2	60.7	65.0
		compound ascidian unid.	36	11	50	32.6	60.7	65.3
Cnidaria	Actiniaria	sea anemone unid.	40	11	79	43.0	60.7	65.3
	Actinostola sp.		1	40	40	40.0	63.2	63.2
	Aurelia labiata		1	23	23	23.0	62.0	62.0
	Aurelia limbata	brown rimmed jelly	13	42	68	55.2	61.3	63.0
	Chrysaora melanaster		109	18	79	43.0	60.7	65.3
	Chrysaora sp.	chrysaora jelly	1	35	35	35.0	64.0	64.0
	Gersemia sp.	sea raspberry	68	11	79	36.7	60.6	65.3
	Hydroidolina	hydroid unid.	11	15	51	26.8	61.7	64.3
	Metridium farcimen	gigantic anemone	16	22	66	32.4	60.6	64.3
	Metridium sp.		10	15	22	18.1	62.4	64.3
	Phacellophora camtschatica	egg yolk jelly	2	17	22	19.5	60.7	61.4
	Scyphozoa	jellyfish unid.	15	11	73	34.3	60.7	64.3
	Stomphia coccinea	swimming anemone	1	35	35	35.0	64.0	64.0
	Stomphia sp.		3	60	66	63.0	61.3	62.0
	Urticina sp.		9	23	66	45.2	61.7	64.0
Echinodermata	*Asterias amurensis*	purple-orange sea star	85	11	66	31.4	60.6	65.3
	Bathyplotes sp.		4	26	52	40.5	64.3	65.3
	Crossaster papposus	rose sea star	12	23	53	35.7	63.6	65.3
	Echinarachnius parma	parma sand dollar	6	31	37	34.3	62.6	64.3
	Evasterias echinosoma	giant sea star	26	15	53	25.5	63.7	65.3
	Gorgonocephalus eucnemis	basketstar	90	19	79	43.4	60.7	65.3
	Henricia sp.		18	20	54	32.9	61.7	65.3

Table Appendix B2. -- Invertebrate taxa encountered during the 2021 northern Bering Sea 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
	Holothuroidea	sea cucumber unid.	1	40	40	40.0	63.2	63.2
	Leptasterias arctica		67	15	79	40.7	60.7	65.3
	Leptasterias groenlandica		15	42	68	53.3	61.3	63.0
	Leptasterias katharinae		1	40	40	40.0	63.7	63.7
	Leptasterias polaris		94	15	79	43.9	61.3	65.3
	Leptasterias sp.		3	21	48	36.0	63.7	64.6
	Leptychaster arcticus	North Pacific sea star	2	42	47	44.5	62.3	63.0
	Lethasterias nanimensis	blackspined sea star	31	18	53	28.9	63.3	65.3
	Myriotrochus rinkii		1	47	47	47.0	63.0	63.0
	Ophiopholis kennerleyi		1	40	40	40.0	63.2	63.2
	Ophiura sarsii	notched brittlestar	21	18	79	50.5	61.7	64.3
	Ophiura sp.		1	26	26	26.0	62.0	62.0
	Psolus fabricii	brownscaled sea cucumber	9	21	40	31.6	63.2	65.0
	Psolus sp.		4	34	44	37.8	64.3	65.0
	Pteraster obscurus	obscure sea star	10	34	53	43.7	63.2	65.3
	Pteraster sp.		2	26	31	28.5	64.4	64.7
	Solaster sp.		1	50	50	50.0	64.0	64.0
	Strongylocentrotus droebachiensis	green sea urchin	12	23	51	34.6	61.7	64.3
	Strongylocentrotus sp.		36	11	53	30.7	61.7	65.3
	Synallactes challengeri		1	37	37	37.0	64.0	64.0
Ectoprocta	*Alcyonidium disciforme*	disc bryozoan	6	35	47	42.3	62.3	63.0
	Alcyonidium enteromorpha	noodle bryozoan	10	23	53	41.6	64.0	65.3
	Alcyonidium pedunculatum	fruit leather bryozoan	1	35	35	35.0	64.0	64.0
	Dendrobeania sp.		1	23	23	23.0	64.3	64.3
	Flustra serrulata	leafy bryozoan	5	18	34	24.0	61.3	65.3
	Flustrellidra corniculata		1	40	40	40.0	63.2	63.2
	Myriapora sp.		1	40	40	40.0	63.2	63.2
	Rhamphostomella costata	ribbed bryozoan	6	23	50	35.7	62.0	64.2
Mollusca	*Amicula vestita*		2	35	40	37.5	63.2	64.0
	Beringius behringi	Bering beringius	2	23	56	39.5	61.3	64.0
	Beringius sp.		8	15	39	26.9	63.0	65.3
	Buccinum angulosum	angular whelk	24	19	79	46.9	61.0	65.3

Table Appendix B2. -- Invertebrate taxa encountered during the 2021 northern Bering Sea 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
	Buccinum castaneum	chestnut whelk	4	35	47	40.5	62.6	63.0
	Buccinum glaciale	glacial whelk	2	34	47	40.5	63.0	64.0
	Buccinum moarchianum		1	40	40	40.0	62.9	62.9
	Buccinum oedematum	swollen whelk	3	47	47	47.0	62.0	63.0
	Buccinum plectrum	sinuous whelk	4	22	42	29.0	62.3	63.3
	Buccinum polare	polar whelk	57	19	79	48.4	60.7	65.3
	Buccinum scalariforme	ladder whelk	42	25	79	47.6	60.7	65.3
	Buccinum sp.		9	40	61	47.6	61.7	64.0
	Buccinum tenellum		2	45	47	46.0	62.6	63.0
	Ciliatoclinocardium ciliatum	hairy cockle	6	15	71	36.2	63.3	65.3
	Clinopegma magnum	helmet whelk	1	51	51	51.0	62.0	62.0
	Colus capponius		1	23	23	23.0	61.7	61.7
	Colus halli	shrew whelk	2	50	54	52.0	61.0	61.3
	Colus sp.		4	31	70	46.5	61.3	63.3
	Cryptonatica affinis	Arctic moonsnail	1	35	35	35.0	64.0	64.0
	Cryptonatica aleutica	Aleutian moonsnail	2	43	55	49.0	62.0	62.7
	Cryptonatica russa	rusty moonsnail	25	35	79	59.9	61.4	63.3
	Cyclocardia crebricostata	many-rib Cyclocardia	1	23	23	23.0	64.0	64.0
	gastropod egg	snail egg	91	15	79	44.1	61.0	65.3
	Gastropoda	snail unid.	1	40	40	40.0	63.2	63.2
	Hiatella arctica	Arctic Hiatella	2	36	50	43.0	63.7	64.0
	Lamellaria sp.		2	34	35	34.5	64.0	64.0
	Lamellariidae	lamellarid unid.	10	31	53	42.1	64.3	65.3
	Lunatia pallida	pale moonsnail	6	37	68	58.2	61.3	64.0
	Macoma inquinata	pointed Macoma	3	23	42	33.0	62.3	64.3
	Macoma nasuta	bent-nose Macoma	1	23	23	23.0	61.0	61.0
	Mactromeris polynyma	Arctic surfclam	2	26	31	28.5	64.0	64.6
	Modiolus modiolus	northern horsemussel	2	61	66	63.5	61.7	61.7
	Musculus discors	discordant mussel	9	23	54	38.1	61.7	64.0
	Mya sp.		2	39	42	40.5	62.0	64.3
	Mytilidae	mussel unid.	1	15	15	15.0	64.3	64.3
	Mytilus sp.		1	70	70	70.0	62.7	62.7
	gastropod egg	moonsnail egg unid.	1	28	28	28.0	62.7	62.7
	Neptunea borealis		20	25	72	48.1	61.0	63.0
	Neptunea heros		102	15	73	41.0	60.7	65.3

Table Appendix B2. -- Invertebrate taxa encountered during the 2021 northern Bering Sea 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	1	41	41	41.0	61.3	61.3
	Neptunea pribiloffensis	Pribilof whelk	1	36	36	36.0	63.0	63.0
	Neptunea ventricosa	fat whelk	64	18	53	34.7	60.7	65.3
	Nudibranchia	nudibranch unid.	13	29	79	54.0	62.3	65.3
	Onchidiopsis sp.		2	34	35	34.5	64.0	64.0
	Plicifusus kroyeri		2	31	39	35.0	64.4	64.6
	Pyrulofusus deformis	warped whelk	5	19	39	30.2	63.0	65.0
	Serripes groenlandicus	Greenland cockle	4	23	43	32.2	62.7	64.3
	Serripes notabilis	oblique smoothcockle	30	15	64	38.5	61.3	65.3
	Serripes sp.		2	33	54	43.5	61.7	63.7
	Siliqua patula	Pacific razor	1	29	29	29.0	60.7	60.7
	Tellina lutea	Alaska great-tellin	1	22	22	22.0	62.4	62.4
	Tochuina gigantea	giant orange tochui	1	40	40	40.0	63.2	63.2
	Trichotropis bicarinata	two-keel hairysnail	3	35	48	41.0	63.2	64.6
	Velutina plicatilis	oblique lamellaria	1	40	40	40.0	63.7	63.7
	Volutopsius fragilis	fragile whelk	2	34	51	42.5	62.0	65.3
	Volutopsius sp.		1	51	51	51.0	62.0	62.0
	Yoldia hyperborea	northern Yoldia	4	47	66	59.2	61.3	63.0
	Yoldia sp.		1	15	15	15.0	63.7	63.7
		empty bivalve shells	105	15	72	35.2	60.6	65.3
		empty gastropod shells	127	15	79	38.9	60.6	65.3
Porifera	*Echinoclathria beringensis*	hat sponge	1	40	40	40.0	63.2	63.2
	Halichondria panicea	barrel sponge	1	40	40	40.0	63.2	63.2
	Porifera	sponge unid.	18	15	40	26.3	60.6	65.0
Sipuncula	Sipuncula	peanut worm unid.	7	40	68	52.4	61.3	63.0

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

Appendix C presents population estimates by sex and size group from the 2021 EBS bottom trawl survey for principal fish species.

List of Tables

Table Appendix C1. -- Population estimates by sex and size for Alaska plaice (*Pleuronectes quadrituberculatus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
8	0	79,331	0	79,331	0.0001	0.0001
9	42,590	0	0	42,590	0.0001	0.0002
10	570,264	222,690	0	792,954	0.0014	0.0016
11	304,960	529,158	0	834,118	0.0014	0.0030
12	246,780	128,718	0	375,498	0.0006	0.0037
13	1,033,322	118,924	0	1,152,246	0.0020	0.0056
14	686,368	126,538	0	812,906	0.0014	0.0070
15	645,311	372,886	0	1,018,197	0.0017	0.0088
16	490,872	478,361	0	969,233	0.0017	0.0104
17	1,754,681	839,668	0	2,594,349	0.0045	0.0149
18	2,978,449	1,655,403	0	4,633,852	0.0080	0.0229
19	3,885,390	2,124,786	0	6,010,176	0.0103	0.0332
20	3,657,155	4,751,760	0	8,408,915	0.0144	0.0476
21	6,613,048	3,881,135	0	10,494,183	0.0180	0.0657
22	7,132,883	7,012,455	0	14,145,338	0.0243	0.0900
23	9,942,649	6,586,338	0	16,528,987	0.0284	0.1184
24	9,012,938	7,368,278	0	16,381,216	0.0281	0.1465
25	9,154,816	9,850,924	0	19,005,740	0.0327	0.1792
26	9,243,413	8,565,972	0	17,809,385	0.0306	0.2098
27	11,058,767	7,682,374	0	18,741,141	0.0322	0.2420
28	11,859,312	6,812,302	0	18,671,614	0.0321	0.2740
29	12,465,089	10,238,770	30,239	22,734,098	0.0391	0.3131
30	13,656,195	8,977,939	0	22,634,134	0.0389	0.3520
31	16,100,828	8,342,730	0	24,443,558	0.0420	0.3940
32	14,370,583	7,802,762	0	22,173,345	0.0381	0.4321
33	20,485,920	9,720,200	0	30,206,120	0.0519	0.4840
34	23,633,758	9,321,460	0	32,955,218	0.0566	0.5406
35	29,724,776	11,478,555	0	41,203,331	0.0708	0.6114
36	25,542,036	8,654,674	0	34,196,710	0.0588	0.6701
37	19,202,937	8,705,364	53,891	27,962,192	0.0480	0.7182
38	15,997,694	10,420,421	0	26,418,115	0.0454	0.7636
39	7,746,305	8,532,304	17,024	16,295,633	0.0280	0.7916
40	4,908,900	9,627,895	0	14,536,795	0.0250	0.8165
41	2,528,050	8,778,237	0	11,306,287	0.0194	0.8360
42	1,622,742	12,339,355	34,049	13,996,146	0.0240	0.8600
43	124,506	11,196,157	53,891	11,374,554	0.0195	0.8795
44	414,176	11,372,290	0	11,786,466	0.0203	0.8998
45	449,482	11,639,277	0	12,088,759	0.0208	0.9206
46	126,056	9,063,475	26,946	9,216,477	0.0158	0.9364
47	589,412	8,743,245	0	9,332,657	0.0160	0.9524
48	153,471	7,875,061	0	8,028,532	0.0138	0.9662
49	0	6,660,055	30,239	6,690,294	0.0115	0.9777
50	28,156	4,660,206	0	4,688,362	0.0081	0.9858
51	144,096	2,612,777	17,024	2,773,897	0.0048	0.9905
52	0	1,762,692	0	1,762,692	0.0030	0.9936
53	0	1,150,421	0	1,150,421	0.0020	0.9956
54	267,651	1,512,033	0	1,779,684	0.0031	0.9986

Table Appendix C1. -- Population estimates by sex and size for Alaska plaice (*Pleuronectes quadrituberculatus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
55	0	250,224	30,239	280,463	0.0005	0.9991
56	0	96,208	0	96,208	0.0002	0.9993
57	0	171,653	0	171,653	0.0003	0.9996
58	0	260,926	0	260,926	0.0004	1.0000
Total	**300,596,787**	**281,155,367**	**293,542**	**582,045,696**	**1.0000**	**1.0000**

Table Appendix C2. -- Population estimates by sex and size for arrowtooth flounder (*Atheresthes stomias*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
8	0	60,245	0	60,245	0.0001	0.0001
9	114,667	0	55,932	170,599	0.0002	0.0002
10	0	0	26,808	26,808	0.0000	0.0003
11	362,534	0	138,347	500,881	0.0005	0.0008
12	0	32,157	709,179	741,336	0.0008	0.0016
13	106,812	137,831	50,733	295,376	0.0003	0.0019
14	509,621	642,090	144,959	1,296,670	0.0014	0.0033
15	580,308	1,149,325	133,880	1,863,513	0.0020	0.0053
16	1,485,451	802,204	428,975	2,716,630	0.0029	0.0082
17	2,039,873	1,934,667	133,880	4,108,420	0.0044	0.0126
18	2,955,296	4,549,143	0	7,504,439	0.0080	0.0206
19	3,841,254	4,595,323	0	8,436,577	0.0090	0.0296
20	8,177,023	9,052,106	73,218	17,302,347	0.0185	0.0481
21	10,550,233	13,534,886	0	24,085,119	0.0257	0.0738
22	11,024,521	17,868,055	73,218	28,965,794	0.0309	0.1047
23	13,729,731	18,131,507	0	31,861,238	0.0340	0.1387
24	10,112,869	17,571,728	0	27,684,597	0.0295	0.1682
25	8,400,336	15,442,858	0	23,843,194	0.0254	0.1937
26	8,857,345	15,329,543	73,218	24,260,106	0.0259	0.2196
27	10,972,288	16,304,876	0	27,277,164	0.0291	0.2487
28	12,332,143	16,114,056	0	28,446,199	0.0304	0.2790
29	11,827,570	15,296,963	0	27,124,533	0.0289	0.3080
30	13,267,806	13,707,708	0	26,975,514	0.0288	0.3368
31	11,600,972	15,628,084	57,176	27,286,232	0.0291	0.3659
32	12,228,105	14,348,285	0	26,576,390	0.0284	0.3942
33	14,341,455	15,107,915	0	29,449,370	0.0314	0.4257
34	11,555,070	15,283,016	29,358	26,867,444	0.0287	0.4543
35	12,685,300	18,534,296	79,436	31,299,032	0.0334	0.4877
36	17,214,777	17,289,902	57,176	34,561,855	0.0369	0.5246
37	23,379,772	19,572,959	388,454	43,341,185	0.0463	0.5709
38	24,916,115	20,491,814	232,970	45,640,899	0.0487	0.6196
39	24,507,349	21,509,204	516,121	46,532,674	0.0497	0.6693
40	20,172,533	27,297,474	359,097	47,829,104	0.0510	0.7203
41	14,263,555	27,358,791	230,242	41,852,588	0.0447	0.7650
42	11,493,265	26,138,313	486,764	38,118,342	0.0407	0.8056
43	5,710,784	23,783,148	315,236	29,809,168	0.0318	0.8375
44	3,968,423	20,178,671	86,533	24,233,627	0.0259	0.8633
45	2,993,457	13,732,292	57,176	16,782,925	0.0179	0.8812
46	3,345,592	10,103,847	130,394	13,579,833	0.0145	0.8957
47	2,094,805	9,064,049	57,176	11,216,030	0.0120	0.9077
48	1,097,983	7,654,173	0	8,752,156	0.0093	0.9170
49	1,049,469	8,752,638	0	9,802,107	0.0105	0.9275
50	709,772	9,111,564	29,358	9,850,694	0.0105	0.9380
51	852,548	5,634,965	0	6,487,513	0.0069	0.9449
52	0	7,709,640	0	7,709,640	0.0082	0.9532
53	556,620	6,173,981	0	6,730,601	0.0072	0.9603
54	78,295	4,797,287	0	4,875,582	0.0052	0.9655

Table Appendix C2. -- Population estimates by sex and size for arrowtooth flounder (*Atheresthes stomias*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
55	107,759	4,183,880	86,533	4,378,172	0.0047	0.9702
56	137,767	4,303,745	0	4,441,512	0.0047	0.9750
57	22,261	2,280,654	0	2,302,915	0.0025	0.9774
58	0	2,572,927	0	2,572,927	0.0027	0.9802
59	50,408	1,999,025	0	2,049,433	0.0022	0.9824
60	40,796	1,156,913	0	1,197,709	0.0013	0.9836
61	0	1,469,677	0	1,469,677	0.0016	0.9852
62	0	1,209,730	0	1,209,730	0.0013	0.9865
63	62,374	1,135,501	0	1,197,875	0.0013	0.9878
64	48,265	2,048,036	0	2,096,301	0.0022	0.9900
65	0	1,363,825	0	1,363,825	0.0015	0.9915
66	0	2,294,886	0	2,294,886	0.0024	0.9939
67	0	1,597,471	0	1,597,471	0.0017	0.9956
68	0	1,019,450	0	1,019,450	0.0011	0.9967
69	0	732,389	0	732,389	0.0008	0.9975
70	0	390,702	0	390,702	0.0004	0.9979
71	0	1,087,181	0	1,087,181	0.0012	0.9991
72	0	110,504	0	110,504	0.0001	0.9992
73	0	196,004	0	196,004	0.0002	0.9994
74	0	398,427	0	398,427	0.0004	0.9998
75	0	126,164	0	126,164	0.0001	0.9999
78	0	48,488	0	48,488	0.0001	1.0000
Total	**352,533,327**	**579,239,158**	**5,241,547**	**937,014,032**	**1.0000**	**1.0000**

Table Appendix C3. -- Population estimates by sex and size for Bering flounder (*Hippoglossoides robustus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
7	0	0	31,371	31,371	0.0007	0.0007
8	0	0	54,632	54,632	0.0013	0.0020
9	29,124	0	0	29,124	0.0007	0.0027
10	175,180	0	58,838	234,018	0.0055	0.0083
11	526,021	29,124	148,603	703,748	0.0167	0.0250
12	558,272	202,756	267,363	1,028,391	0.0244	0.0493
13	568,707	236,131	59,521	864,359	0.0205	0.0698
14	595,007	351,453	0	946,460	0.0224	0.0922
15	588,981	491,285	0	1,080,266	0.0256	0.1178
16	1,157,906	515,295	0	1,673,201	0.0397	0.1575
17	1,053,035	889,299	0	1,942,334	0.0460	0.2035
18	853,043	809,848	0	1,662,891	0.0394	0.2429
19	772,334	625,753	0	1,398,087	0.0331	0.2761
20	390,024	734,165	0	1,124,189	0.0266	0.3027
21	388,064	854,421	0	1,242,485	0.0294	0.3321
22	390,637	685,390	0	1,076,027	0.0255	0.3576
23	695,127	487,136	0	1,182,263	0.0280	0.3857
24	239,743	925,328	0	1,165,071	0.0276	0.4133
25	119,094	787,489	0	906,583	0.0215	0.4348
26	178,014	1,458,263	0	1,636,277	0.0388	0.4735
27	364,295	1,127,346	0	1,491,641	0.0353	0.5089
28	139,976	1,436,998	0	1,576,974	0.0374	0.5463
29	121,647	1,644,415	0	1,766,062	0.0419	0.5881
30	290,403	2,118,495	0	2,408,898	0.0571	0.6452
31	91,193	1,790,057	0	1,881,250	0.0446	0.6898
32	148,930	2,361,090	0	2,510,020	0.0595	0.7493
33	112,314	2,175,781	0	2,288,095	0.0542	0.8035
34	143,816	2,776,210	0	2,920,026	0.0692	0.8727
35	92,219	2,212,628	0	2,304,847	0.0546	0.9273
36	28,841	1,256,978	0	1,285,819	0.0305	0.9578
37	32,079	826,845	0	858,924	0.0204	0.9781
38	0	687,737	0	687,737	0.0163	0.9944
39	0	174,040	0	174,040	0.0041	0.9986
40	0	61,027	0	61,027	0.0014	1.0000
Total	**10,844,026**	**30,732,783**	**620,328**	**42,197,137**	**1.0000**	**1.0000**

Table Appendix C4. -- Population estimates by sex and size for flathead sole (*Hippoglossoides elassodon*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
4	32,478	0	0	32,478	0.0000	0.0000
5	0	0	460,906	460,906	0.0002	0.0002
7	0	0	950,533	950,533	0.0004	0.0006
8	0	0	259,022	259,022	0.0001	0.0007
9	334,890	31,079	1,042,119	1,408,088	0.0005	0.0012
10	541,716	510,791	6,114,342	7,166,849	0.0028	0.0040
11	3,629,673	968,869	13,851,665	18,450,207	0.0072	0.0112
12	4,564,903	3,301,299	25,797,457	33,663,659	0.0131	0.0243
13	10,895,724	5,408,145	20,121,499	36,425,368	0.0142	0.0384
14	24,479,716	11,684,550	15,367,841	51,532,107	0.0200	0.0585
15	32,962,027	24,094,976	5,983,608	63,040,611	0.0245	0.0830
16	37,165,680	26,151,851	3,485,397	66,802,928	0.0260	0.1089
17	32,096,898	22,944,305	1,766,653	56,807,856	0.0221	0.1310
18	34,292,563	25,751,403	1,171,432	61,215,398	0.0238	0.1548
19	38,537,838	29,404,703	1,193,838	69,136,379	0.0269	0.1817
20	49,843,590	30,895,101	472,137	81,210,828	0.0316	0.2133
21	56,277,656	44,498,202	502,047	101,277,905	0.0394	0.2527
22	65,385,585	51,851,915	245,091	117,482,591	0.0457	0.2983
23	61,614,714	53,342,158	431,876	115,388,748	0.0449	0.3432
24	58,487,079	45,099,693	443,740	104,030,512	0.0404	0.3837
25	69,925,622	50,973,858	256,955	121,156,435	0.0471	0.4308
26	56,931,646	46,369,334	700,695	104,001,675	0.0404	0.4712
27	58,595,265	46,868,285	1,027,822	106,491,372	0.0414	0.5126
28	50,795,017	40,980,768	688,831	92,464,616	0.0360	0.5486
29	62,309,843	42,073,305	443,740	104,826,888	0.0408	0.5893
30	65,685,005	38,805,214	443,740	104,933,959	0.0408	0.6301
31	66,296,447	45,128,236	700,695	112,125,378	0.0436	0.6737
32	69,573,631	57,935,006	1,156,299	128,664,936	0.0500	0.7237
33	59,144,843	48,108,352	572,218	107,825,413	0.0419	0.7657
34	41,029,085	57,207,651	572,218	98,808,954	0.0384	0.8041
35	38,083,983	51,523,044	385,433	89,992,460	0.0350	0.8391
36	37,420,439	40,897,393	572,218	78,890,050	0.0307	0.8697
37	22,596,660	32,199,374	957,651	55,753,685	0.0217	0.8914
38	26,107,977	36,817,187	0	62,925,164	0.0245	0.9159
39	17,456,394	22,759,308	700,695	40,916,397	0.0159	0.9318
40	15,858,620	15,685,663	256,955	31,801,238	0.0124	0.9442
41	7,799,690	17,544,169	128,478	25,472,337	0.0099	0.9541
42	7,107,786	18,983,664	256,955	26,348,405	0.0102	0.9643
43	4,597,097	13,580,667	0	18,177,764	0.0071	0.9714
44	580,982	15,573,709	0	16,154,691	0.0063	0.9777
45	487,845	12,231,294	0	12,719,139	0.0049	0.9826
46	57,864	14,117,655	128,478	14,303,997	0.0056	0.9882
47	270,326	12,146,728	0	12,417,054	0.0048	0.9930
48	115,728	5,655,136	0	5,770,864	0.0022	0.9952
49	0	3,565,320	0	3,565,320	0.0014	0.9966
50	0	3,502,413	0	3,502,413	0.0014	0.9980
51	131,077	3,781,189	0	3,912,266	0.0015	0.9995

Table Appendix C4. -- Population estimates by sex and size for flathead sole (*Hippoglossoides elassodon*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
52	0	715,286	0	715,286	0.0003	0.9998
53	57,864	235,349	0	293,213	0.0001	0.9999
54	0	243,301	0	243,301	0.0001	1.0000
Total	**1,290,159,466**	**1,172,146,898**	**109,611,279**	**2,571,917,643**	**1.0000**	**1.0000**

Table Appendix C5. -- Population estimates by sex and size for Greenland turbot (*Reinhardtius hippoglossoides*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
9	0	27,625	0	27,625	0.0101	0.0101
39	32,079	29,973	0	62,052	0.0226	0.0326
44	30,503	0	0	30,503	0.0111	0.0437
45	0	27,952	0	27,952	0.0102	0.0539
50	19,553	0	0	19,553	0.0071	0.0610
52	0	28,961	0	28,961	0.0105	0.0716
53	27,952	60,015	0	87,967	0.0320	0.1036
54	31,575	29,973	0	61,548	0.0224	0.1260
55	18,717	30,756	0	49,473	0.0180	0.1440
56	29,973	0	0	29,973	0.0109	0.1549
57	0	29,693	0	29,693	0.0108	0.1657
58	0	28,961	0	28,961	0.0105	0.1762
60	36,062	0	0	36,062	0.0131	0.1893
61	0	30,756	0	30,756	0.0112	0.2005
62	30,168	57,925	0	88,093	0.0321	0.2326
63	29,244	0	0	29,244	0.0106	0.2432
64	18,831	27,669	0	46,500	0.0169	0.2602
65	0	20,064	0	20,064	0.0073	0.2675
66	59,442	58,189	0	117,631	0.0428	0.3103
68	36,062	0	0	36,062	0.0131	0.3234
69	0	19,077	0	19,077	0.0069	0.3303
70	66,035	58,384	0	124,419	0.0453	0.3756
72	0	132,922	0	132,922	0.0484	0.4240
73	0	149,312	0	149,312	0.0543	0.4783
74	0	173,557	0	173,557	0.0632	0.5415
75	31,898	155,383	0	187,281	0.0682	0.6096
76	0	57,959	0	57,959	0.0211	0.6307
77	0	188,162	0	188,162	0.0685	0.6992
78	30,168	142,859	0	173,027	0.0630	0.7622
79	0	210,367	0	210,367	0.0766	0.8387
80	0	58,053	0	58,053	0.0211	0.8598
81	31,948	18,932	0	50,880	0.0185	0.8783
82	0	85,693	0	85,693	0.0312	0.9095
83	29,469	108,927	0	138,396	0.0504	0.9599
84	0	30,239	0	30,239	0.0110	0.9709
85	0	17,849	0	17,849	0.0065	0.9774
90	0	30,168	0	30,168	0.0110	0.9884
91	0	31,948	0	31,948	0.0116	1.0000
Total	**589,679**	**2,158,303**	**0**	**2,747,982**	**1.0000**	**1.0000**

Table Appendix C6. -- Population estimates by sex and size for Kamchatka flounder (*Atheresthes evermanni*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
14	29,572	0	0	29,572	0.0005	0.0005
15	28,737	26,808	0	55,545	0.0009	0.0014
16	83,368	58,167	0	141,535	0.0024	0.0038
17	229,498	130,780	52,775	413,053	0.0069	0.0107
18	271,109	175,971	109,783	556,863	0.0093	0.0199
19	167,550	191,438	0	358,988	0.0060	0.0259
20	671,690	267,884	0	939,574	0.0157	0.0416
21	501,391	353,352	52,775	907,518	0.0151	0.0567
22	892,046	354,711	105,550	1,352,307	0.0225	0.0792
23	1,474,566	575,314	166,791	2,216,671	0.0369	0.1162
24	1,343,883	1,459,758	166,791	2,970,432	0.0495	0.1657
25	2,172,057	1,323,116	223,799	3,718,972	0.0620	0.2277
26	1,136,067	1,387,690	272,341	2,796,098	0.0466	0.2743
27	1,086,725	1,342,713	285,039	2,714,477	0.0452	0.3195
28	903,108	741,245	280,807	1,925,160	0.0321	0.3516
29	1,196,682	755,741	223,799	2,176,222	0.0363	0.3879
30	689,397	874,194	171,024	1,734,615	0.0289	0.4168
31	1,039,064	823,896	114,016	1,976,976	0.0329	0.4497
32	840,495	694,643	0	1,535,138	0.0256	0.4753
33	994,691	763,662	57,008	1,815,361	0.0303	0.5056
34	534,173	873,835	188,873	1,596,881	0.0266	0.5322
35	872,450	684,104	26,944	1,583,498	0.0264	0.5586
36	1,253,691	796,174	171,024	2,220,889	0.0370	0.5956
37	743,679	985,021	171,024	1,899,724	0.0317	0.6272
38	1,033,361	780,205	57,008	1,870,574	0.0312	0.6584
39	510,227	874,956	37,564	1,422,747	0.0237	0.6821
40	875,765	768,332	0	1,644,097	0.0274	0.7095
41	1,282,066	546,555	18,782	1,847,403	0.0308	0.7403
42	728,545	647,445	0	1,375,990	0.0229	0.7633
43	501,513	703,633	90,520	1,295,666	0.0216	0.7849
44	670,068	725,490	17,849	1,413,407	0.0236	0.8084
45	577,873	769,698	0	1,347,571	0.0225	0.8309
46	408,074	899,963	0	1,308,037	0.0218	0.8527
47	447,418	966,694	55,413	1,469,525	0.0245	0.8772
48	403,846	660,921	0	1,064,767	0.0177	0.8949
49	153,665	359,397	18,782	531,844	0.0089	0.9038
50	114,284	525,118	0	639,402	0.0107	0.9144
51	115,666	555,629	18,782	690,077	0.0115	0.9259
52	152,067	230,747	0	382,814	0.0064	0.9323
53	166,918	400,169	36,631	603,718	0.0101	0.9424
54	149,190	226,578	18,782	394,550	0.0066	0.9489
55	58,893	106,945	0	165,838	0.0028	0.9517
56	58,520	256,322	0	314,842	0.0052	0.9570
57	46,746	110,304	0	157,050	0.0026	0.9596
58	88,119	187,072	0	275,191	0.0046	0.9642
59	0	172,793	0	172,793	0.0029	0.9670
60	55,017	399,231	0	454,248	0.0076	0.9746

Table Appendix C6. -- Population estimates by sex and size for Kamchatka flounder (*Atheresthes evermanni*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
61	0	48,511	0	48,511	0.0008	0.9754
62	0	191,196	0	191,196	0.0032	0.9786
63	0	37,109	0	37,109	0.0006	0.9792
64	0	313,374	0	313,374	0.0052	0.9844
65	0	189,113	17,849	206,962	0.0034	0.9879
66	0	117,714	0	117,714	0.0020	0.9899
67	0	39,087	0	39,087	0.0007	0.9905
68	0	168,940	0	168,940	0.0028	0.9933
69	0	35,594	0	35,594	0.0006	0.9939
70	0	165,097	0	165,097	0.0028	0.9967
71	0	81,043	0	81,043	0.0014	0.9980
72	0	0	17,849	17,849	0.0003	0.9983
73	0	28,066	0	28,066	0.0005	0.9988
76	0	42,078	0	42,078	0.0007	0.9995
78	0	31,053	0	31,053	0.0005	1.0000
Total	**27,753,530**	**29,002,389**	**3,245,974**	**60,001,893**	**1.0000**	**1.0000**

Table Appendix C7. -- Population estimates by sex and size for northern rock sole (*Lepidopsetta polyxystra*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
4	0	0	155,581	155,581	0.0000	0.0000
6	0	0	33,701	33,701	0.0000	0.0000
7	0	0	2,761,628	2,761,628	0.0004	0.0005
8	146,105	947,955	4,726,395	5,820,455	0.0009	0.0014
9	6,482,697	3,036,794	9,383,192	18,902,683	0.0030	0.0043
10	57,274,219	19,773,815	44,189,183	121,237,217	0.0189	0.0233
11	111,288,432	62,129,513	66,186,152	239,604,097	0.0374	0.0607
12	140,501,610	86,131,861	89,192,755	315,826,226	0.0493	0.1100
13	90,873,509	68,578,225	65,011,854	224,463,588	0.0351	0.1451
14	108,669,270	92,569,771	24,695,591	225,934,632	0.0353	0.1804
15	148,500,448	137,588,599	4,685,052	290,774,099	0.0454	0.2258
16	205,497,096	198,599,009	1,296,018	405,392,123	0.0633	0.2892
17	196,119,091	190,824,736	0	386,943,827	0.0604	0.3496
18	211,396,851	198,576,314	0	409,973,165	0.0640	0.4136
19	170,411,296	163,385,254	0	333,796,550	0.0521	0.4658
20	155,508,393	162,721,020	0	318,229,413	0.0497	0.5155
21	117,479,849	110,431,104	0	227,910,953	0.0356	0.5511
22	116,555,701	132,555,581	0	249,111,282	0.0389	0.5900
23	110,711,241	112,850,267	29,349	223,590,857	0.0349	0.6250
24	142,532,762	123,702,258	58,698	266,293,718	0.0416	0.6666
25	134,926,101	128,275,074	58,698	263,259,873	0.0411	0.7077
26	103,664,350	107,234,169	88,047	210,986,566	0.0330	0.7406
27	96,722,700	114,527,820	0	211,250,520	0.0330	0.7737
28	106,717,974	81,921,066	0	188,639,040	0.0295	0.8031
29	99,275,319	63,376,037	58,698	162,710,054	0.0254	0.8285
30	104,713,698	63,226,532	29,349	167,969,579	0.0262	0.8548
31	104,455,426	62,603,151	29,349	167,087,926	0.0261	0.8809
32	59,059,927	56,601,204	88,047	115,749,178	0.0181	0.8990
33	31,900,782	49,547,734	0	81,448,516	0.0127	0.9117
34	9,784,478	50,159,621	29,349	59,973,448	0.0094	0.9211
35	5,250,990	68,637,817	29,349	73,918,156	0.0115	0.9326
36	2,301,274	84,750,341	88,047	87,139,662	0.0136	0.9462
37	2,439,886	100,737,951	27,366	103,205,203	0.0161	0.9623
38	2,123,486	89,200,875	0	91,324,361	0.0143	0.9766
39	1,051,477	69,844,333	56,715	70,952,525	0.0111	0.9877
40	87,694	39,042,626	0	39,130,320	0.0061	0.9938
41	309,131	20,586,666	0	20,895,797	0.0033	0.9971
42	57,584	9,760,518	0	9,818,102	0.0015	0.9986
43	0	5,392,032	0	5,392,032	0.0008	0.9994
44	0	3,382,544	0	3,382,544	0.0005	1.0000
45	0	149,644	0	149,644	0.0000	1.0000
Total	**2,954,790,847**	**3,133,359,831**	**312,988,163**	**6,401,138,841**	**1.0000**	**1.0000**

Table Appendix C8. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
11	0	29,845	168,623	198,468	0.0005	0.0005
12	31,157	0	387,358	418,515	0.0010	0.0015
13	63,979	82,821	580,093	726,893	0.0017	0.0032
14	449,059	203,480	1,152,278	1,804,817	0.0043	0.0075
15	743,585	588,435	1,069,375	2,401,395	0.0057	0.0132
16	1,062,673	908,068	419,143	2,389,884	0.0057	0.0188
17	1,596,726	1,770,864	489,026	3,856,616	0.0091	0.0280
18	3,531,986	3,008,981	292,380	6,833,347	0.0162	0.0442
19	5,564,046	4,229,412	83,698	9,877,156	0.0234	0.0676
20	6,681,337	4,866,878	286,911	11,835,126	0.0281	0.0957
21	6,649,167	4,856,342	194,956	11,700,465	0.0277	0.1234
22	7,664,869	5,589,219	194,956	13,449,044	0.0319	0.1553
23	7,252,290	6,151,207	357,420	13,760,917	0.0326	0.1879
24	5,293,834	4,872,955	324,927	10,491,716	0.0249	0.2128
25	5,074,378	3,742,845	357,420	9,174,643	0.0218	0.2345
26	3,481,509	3,078,275	324,927	6,884,711	0.0163	0.2509
27	1,641,490	1,993,876	32,493	3,667,859	0.0087	0.2596
28	1,512,136	1,131,965	97,478	2,741,579	0.0065	0.2661
29	807,886	879,355	0	1,687,241	0.0040	0.2701
30	1,237,902	740,164	0	1,978,066	0.0047	0.2748
31	955,681	1,290,338	0	2,246,019	0.0053	0.2801
32	1,528,207	1,145,104	0	2,673,311	0.0063	0.2864
33	1,253,181	1,414,383	0	2,667,564	0.0063	0.2927
34	1,433,012	1,740,661	0	3,173,673	0.0075	0.3003
35	2,566,700	2,288,368	0	4,855,068	0.0115	0.3118
36	3,164,689	2,867,582	0	6,032,271	0.0143	0.3261
37	4,017,066	3,729,955	64,985	7,812,006	0.0185	0.3446
38	4,484,740	3,686,135	32,493	8,203,368	0.0195	0.3641
39	6,524,183	4,739,967	64,985	11,329,135	0.0269	0.3909
40	6,156,011	5,330,284	59,809	11,546,104	0.0274	0.4183
41	7,573,692	5,880,234	0	13,453,926	0.0319	0.4502
42	6,408,160	6,672,427	22,716	13,103,303	0.0311	0.4813
43	8,021,291	6,685,376	113,031	14,819,698	0.0351	0.5164
44	6,736,135	6,765,303	60,397	13,561,835	0.0322	0.5486
45	7,486,201	7,205,884	27,891	14,719,976	0.0349	0.5835
46	8,671,488	6,891,569	32,493	15,595,550	0.0370	0.6204
47	6,698,549	7,701,414	0	14,399,963	0.0341	0.6546
48	7,089,788	6,214,069	120,565	13,424,422	0.0318	0.6864
49	6,945,631	5,610,029	29,358	12,585,018	0.0298	0.7163
50	5,427,090	4,929,938	133,720	10,490,748	0.0249	0.7411
51	4,299,346	4,144,041	159,192	8,602,579	0.0204	0.7615
52	3,280,629	4,040,737	57,467	7,378,833	0.0175	0.7790
53	2,294,765	2,859,967	152,028	5,306,760	0.0126	0.7916
54	2,175,876	2,403,281	29,576	4,608,733	0.0109	0.8025
55	2,384,811	1,969,356	55,808	4,409,975	0.0105	0.8130
56	1,269,569	2,015,619	27,904	3,313,092	0.0079	0.8208
57	1,738,087	1,220,113	32,493	2,990,693	0.0071	0.8279

Table Appendix C8. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
58	1,472,917	1,147,632	0	2,620,549	0.0062	0.8341
59	1,282,103	1,228,507	59,151	2,569,761	0.0061	0.8402
60	925,911	932,247	55,782	1,913,940	0.0045	0.8448
61	920,273	867,454	0	1,787,727	0.0042	0.8490
62	1,296,119	1,092,362	0	2,388,481	0.0057	0.8547
63	1,367,407	907,179	55,782	2,330,368	0.0055	0.8602
64	1,263,241	664,646	27,904	1,955,791	0.0046	0.8648
65	1,037,532	972,644	121,046	2,131,222	0.0051	0.8699
66	1,235,198	1,031,513	0	2,266,711	0.0054	0.8753
67	1,383,070	810,744	57,085	2,250,899	0.0053	0.8806
68	1,226,385	1,036,720	27,891	2,290,996	0.0054	0.8860
69	1,422,357	895,022	112,676	2,430,055	0.0058	0.8918
70	1,014,724	1,106,550	85,358	2,206,632	0.0052	0.8970
71	1,817,333	1,149,913	27,891	2,995,137	0.0071	0.9041
72	1,301,560	960,851	27,904	2,290,315	0.0054	0.9096
73	1,389,710	1,118,975	27,891	2,536,576	0.0060	0.9156
74	1,282,182	1,101,726	22,716	2,406,624	0.0057	0.9213
75	1,249,117	902,528	51,909	2,203,554	0.0052	0.9265
76	1,232,164	810,574	27,891	2,070,629	0.0049	0.9314
77	1,048,712	1,182,069	85,140	2,315,921	0.0055	0.9369
78	1,053,268	1,368,731	55,782	2,477,781	0.0059	0.9428
79	911,247	827,620	29,576	1,768,443	0.0042	0.9470
80	851,999	882,351	55,795	1,790,145	0.0042	0.9512
81	946,720	1,051,625	27,891	2,026,236	0.0048	0.9560
82	911,860	1,346,423	27,891	2,286,174	0.0054	0.9614
83	852,863	881,426	55,782	1,790,071	0.0042	0.9657
84	574,525	1,164,898	0	1,739,423	0.0041	0.9698
85	640,104	972,960	78,499	1,691,563	0.0040	0.9738
86	429,913	804,334	27,904	1,262,151	0.0030	0.9768
87	525,233	895,044	27,891	1,448,168	0.0034	0.9803
88	405,310	961,699	114,498	1,481,507	0.0035	0.9838
89	324,228	787,551	0	1,111,779	0.0026	0.9864
90	245,318	625,585	55,782	926,685	0.0022	0.9886
91	164,922	550,347	0	715,269	0.0017	0.9903
92	133,518	405,624	83,674	622,816	0.0015	0.9918
93	87,747	356,322	0	444,069	0.0011	0.9928
94	121,566	340,249	29,193	491,008	0.0012	0.9940
95	138,468	195,933	27,891	362,292	0.0009	0.9948
96	59,558	409,548	0	469,106	0.0011	0.9960
97	107,613	329,254	0	436,867	0.0010	0.9970
98	0	135,959	0	135,959	0.0003	0.9973
99	26,555	195,248	29,358	251,161	0.0006	0.9979
100	31,322	180,821	0	212,143	0.0005	0.9984
101	28,204	255,248	0	283,452	0.0007	0.9991
102	0	47,775	27,891	75,666	0.0002	0.9993
103	0	75,096	0	75,096	0.0002	0.9994
104	0	84,940	0	84,940	0.0002	0.9996

Table Appendix C8. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
105	0	56,243	0	56,243	0.0001	0.9998
107	0	18,717	0	18,717	0.0000	0.9998
108	0	45,321	0	45,321	0.0001	0.9999
110	0	28,224	0	28,224	0.0001	1.0000
Total	**215,664,663**	**196,368,093**	**9,719,688**	**421,752,444**	**1.0000**	**1.0000**

Table Appendix C9. -- Population estimates by sex and size for walleye pollock (*Gadus chalcogrammus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
8	0	0	31,811	31,811	0.0000	0.0000
9	0	0	237,934	237,934	0.0000	0.0000
10	0	0	6,378,313	6,378,313	0.0011	0.0011
11	423,834	544,141	54,128,828	55,096,803	0.0094	0.0105
12	1,844,572	1,451,559	106,956,799	110,252,930	0.0187	0.0292
13	3,542,073	2,602,939	110,289,471	116,434,483	0.0198	0.0490
14	11,735,058	11,029,337	83,236,265	106,000,660	0.0180	0.0670
15	20,893,941	18,808,306	57,166,362	96,868,609	0.0164	0.0834
16	33,606,763	25,171,473	29,363,579	88,141,815	0.0150	0.0984
17	31,927,928	21,838,124	11,009,197	64,775,249	0.0110	0.1094
18	17,457,219	13,341,234	4,832,743	35,631,196	0.0061	0.1154
19	10,298,695	7,862,407	2,352,650	20,513,752	0.0035	0.1189
20	7,466,007	3,706,920	675,127	11,848,054	0.0020	0.1209
21	15,812,095	9,123,512	301,312	25,236,919	0.0043	0.1252
22	30,124,463	24,823,636	43,573	54,991,672	0.0093	0.1346
23	47,820,893	31,803,977	81,817	79,706,687	0.0135	0.1481
24	39,177,928	23,565,090	112,875	62,855,893	0.0107	0.1588
25	42,035,067	26,443,451	178,337	68,656,855	0.0117	0.1704
26	44,397,573	29,448,249	87,145	73,932,967	0.0126	0.1830
27	54,169,905	37,267,531	259,893	91,697,329	0.0156	0.1986
28	51,409,647	52,070,689	87,145	103,567,481	0.0176	0.2161
29	61,508,894	52,234,759	85,602	113,829,255	0.0193	0.2355
30	66,288,743	52,794,675	54,544	119,137,962	0.0202	0.2557
31	60,615,562	52,501,141	56,087	113,172,790	0.0192	0.2749
32	55,067,486	60,300,446	55,393	115,423,325	0.0196	0.2945
33	50,378,099	49,308,616	168,962	99,855,677	0.0170	0.3115
34	49,901,247	47,425,149	24,335	97,350,731	0.0165	0.3280
35	55,447,562	49,078,590	56,087	104,582,239	0.0178	0.3458
36	73,321,919	66,900,555	0	140,222,474	0.0238	0.3696
37	75,460,678	61,254,197	58,330	136,773,205	0.0232	0.3928
38	77,910,632	64,917,455	27,272	142,855,359	0.0243	0.4171
39	82,229,277	51,975,306	120,446	134,325,029	0.0228	0.4399
40	70,859,008	54,501,425	585,052	125,945,485	0.0214	0.4613
41	66,260,221	42,575,875	491,878	109,327,974	0.0186	0.4798
42	63,955,330	41,829,162	1,136,109	106,920,601	0.0182	0.4980
43	79,338,098	49,083,193	1,624,201	130,045,492	0.0221	0.5201
44	93,997,410	61,788,886	876,534	156,662,830	0.0266	0.5467
45	134,673,965	64,218,604	1,398,772	200,291,341	0.0340	0.5807
46	159,711,754	91,922,511	3,480,534	255,114,799	0.0433	0.6240
47	179,087,090	123,910,956	3,602,528	306,600,574	0.0521	0.6761
48	175,678,630	151,307,703	4,108,791	331,095,124	0.0562	0.7323
49	166,098,397	158,820,173	2,975,841	327,894,411	0.0557	0.7880
50	141,209,556	157,871,417	1,584,644	300,665,617	0.0511	0.8390
51	109,445,285	137,602,685	589,689	247,637,659	0.0421	0.8811
52	70,469,969	119,561,058	808,236	190,839,263	0.0324	0.9135
53	52,655,592	91,917,070	607,220	145,179,882	0.0247	0.9381
54	34,256,901	68,357,857	590,769	103,205,527	0.0175	0.9557

Table Appendix C9. -- Population estimates by sex and size for walleye pollock (*Gadus chalcogrammus*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
55	22,323,696	50,005,687	325,324	72,654,707	0.0123	0.9680
56	18,406,735	37,236,686	226,580	55,870,001	0.0095	0.9775
57	12,851,366	26,789,979	59,873	39,701,218	0.0067	0.9842
58	8,253,599	19,046,016	28,815	27,328,430	0.0046	0.9889
59	4,869,987	13,061,773	31,058	17,962,818	0.0031	0.9919
60	3,139,285	9,107,683	90,312	12,337,280	0.0021	0.9940
61	1,657,059	6,555,129	0	8,212,188	0.0014	0.9954
62	1,174,284	5,344,189	63,963	6,582,436	0.0011	0.9965
63	1,167,293	4,892,875	0	6,060,168	0.0010	0.9976
64	907,775	3,269,628	0	4,177,403	0.0007	0.9983
65	624,414	1,710,109	31,058	2,365,581	0.0004	0.9987
66	620,139	1,873,571	0	2,493,710	0.0004	0.9991
67	343,405	1,367,249	0	1,710,654	0.0003	0.9994
68	347,606	411,253	0	758,859	0.0001	0.9995
69	154,184	369,993	0	524,177	0.0001	0.9996
70	56,425	378,017	0	434,442	0.0001	0.9997
71	136,191	466,710	0	602,901	0.0001	0.9998
72	250,734	532,773	0	783,507	0.0001	0.9999
73	0	135,020	0	135,020	0.0000	0.9999
74	0	28,655	0	28,655	0.0000	0.9999
75	0	63,469	0	63,469	0.0000	1.0000
76	0	66,482	0	66,482	0.0000	1.0000
79	0	85,144	0	85,144	0.0000	1.0000
82	0	121,151	0	121,151	0.0000	1.0000
Total	**2,847,255,143**	**2,547,781,280**	**493,836,015**	**5,888,872,438**	**1.0000**	**1.0000**

Table Appendix C10. -- Population estimates by sex and size for yellowfin sole (*Limanda aspera*) from the 2021 eastern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
6	0	0	1,674,264	1,674,264	0.0002	0.0002
7	0	0	2,252,425	2,252,425	0.0003	0.0005
8	2,871,676	0	837,132	3,708,808	0.0005	0.0010
9	1,445,405	2,690,778	1,785,824	5,922,007	0.0008	0.0018
10	6,095,098	5,020,633	0	11,115,731	0.0015	0.0032
11	8,317,860	14,599,349	578,161	23,495,370	0.0031	0.0063
12	41,620,748	50,316,902	280,294	92,217,944	0.0121	0.0185
13	95,880,704	78,339,766	0	174,220,470	0.0229	0.0414
14	106,873,897	130,188,905	0	237,062,802	0.0312	0.0726
15	105,214,050	136,677,414	0	241,891,464	0.0318	0.1044
16	142,794,403	157,448,583	0	300,242,986	0.0395	0.1439
17	188,316,363	190,801,316	0	379,117,679	0.0499	0.1937
18	230,073,838	232,201,529	433,805	462,709,172	0.0609	0.2546
19	233,008,161	257,833,827	2,571,532	493,413,520	0.0649	0.3195
20	253,106,348	244,049,038	3,470,444	500,625,830	0.0658	0.3853
21	190,002,839	226,659,543	5,629,038	422,291,420	0.0555	0.4409
22	175,104,426	192,168,931	9,977,526	377,250,883	0.0496	0.4905
23	141,762,873	138,116,116	7,798,065	287,677,054	0.0378	0.5283
24	135,141,943	101,213,072	5,195,232	241,550,247	0.0318	0.5601
25	100,880,667	133,097,743	5,618,604	239,597,014	0.0315	0.5916
26	114,116,042	114,479,776	3,460,010	232,055,828	0.0305	0.6221
27	114,293,131	92,822,218	1,735,222	208,850,571	0.0275	0.6496
28	106,050,806	104,650,691	1,735,222	212,436,719	0.0279	0.6775
29	106,630,062	104,865,312	2,148,160	213,643,534	0.0281	0.7056
30	142,518,454	113,336,314	2,597,396	258,452,164	0.0340	0.7396
31	155,285,104	110,977,530	3,015,771	269,278,405	0.0354	0.7750
32	193,523,265	146,824,087	3,397,409	343,744,761	0.0452	0.8202
33	165,722,430	160,481,394	3,397,409	329,601,233	0.0434	0.8636
34	128,054,230	172,534,846	4,244,153	304,833,229	0.0401	0.9037
35	69,200,116	180,967,903	5,090,897	255,258,916	0.0336	0.9373
36	34,257,736	140,866,093	3,407,843	178,531,672	0.0235	0.9607
37	13,108,403	97,495,390	2,116,860	112,720,653	0.0148	0.9756
38	7,392,986	66,800,043	2,127,293	76,320,322	0.0100	0.9856
39	3,092,341	54,391,800	846,744	58,330,885	0.0077	0.9933
40	367,478	31,898,203	423,372	32,689,053	0.0043	0.9976
41	107,177	7,471,110	0	7,578,287	0.0010	0.9986
42	17,743	8,502,512	0	8,520,255	0.0011	0.9997
43	0	1,632,842	0	1,632,842	0.0002	0.9999
44	0	666,121	0	666,121	0.0001	1.0000
46	0	16,811	0	16,811	0.0000	1.0000
Total	**3,512,248,803**	**4,003,104,441**	**87,846,107**	**7,603,199,351**	**1.0000**	**1.0000**

Appendix D: Population estimates by sex and size group for principal fish species in the NBS

Appendix D presents population estimates by sex and size group from the 2021 NBS bottom trawl survey for principal fish species.

List of Tables

Table Appendix D1. -- Population estimates by sex and size for Alaska plaice (*Pleuronectes quadrituberculatus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
7	0	0	158,189	158,189	0.0003	0.0003
8	32,085	0	1,182,420	1,214,505	0.0021	0.0024
9	76,118	28,971	2,795,913	2,901,002	0.0051	0.0075
10	187,836	570,106	3,829,936	4,587,878	0.0080	0.0155
11	1,146,156	1,275,284	2,733,100	5,154,540	0.0090	0.0246
12	3,435,082	2,423,221	1,205,595	7,063,898	0.0124	0.0369
13	5,905,956	3,901,315	320,395	10,127,666	0.0177	0.0547
14	6,524,577	5,708,627	57,943	12,291,147	0.0215	0.0762
15	5,890,259	6,001,501	0	11,891,760	0.0208	0.0970
16	6,371,768	5,774,538	0	12,146,306	0.0213	0.1183
17	6,174,869	5,630,685	0	11,805,554	0.0207	0.1390
18	4,658,028	4,717,309	0	9,375,337	0.0164	0.1554
19	4,510,176	4,956,166	0	9,466,342	0.0166	0.1720
20	5,283,744	6,820,929	0	12,104,673	0.0212	0.1932
21	4,421,997	5,874,211	0	10,296,208	0.0180	0.2113
22	5,446,747	5,268,885	0	10,715,632	0.0188	0.2300
23	5,313,793	5,031,079	0	10,344,872	0.0181	0.2482
24	4,601,009	7,031,175	0	11,632,184	0.0204	0.2685
25	5,198,815	5,274,292	0	10,473,107	0.0183	0.2869
26	3,269,730	5,736,922	0	9,006,652	0.0158	0.3027
27	4,769,262	3,615,533	0	8,384,795	0.0147	0.3174
28	5,544,058	3,977,058	0	9,521,116	0.0167	0.3340
29	4,456,532	3,577,362	0	8,033,894	0.0141	0.3481
30	7,187,011	4,327,364	0	11,514,375	0.0202	0.3683
31	6,912,431	3,814,159	57,244	10,783,834	0.0189	0.3872
32	13,872,788	4,073,649	0	17,946,437	0.0314	0.4186
33	18,289,991	4,535,652	28,622	22,854,265	0.0400	0.4587
34	21,176,983	5,910,440	171,731	27,259,154	0.0478	0.5064
35	24,213,621	7,464,263	143,109	31,820,993	0.0558	0.5622
36	24,558,527	7,873,108	143,109	32,574,744	0.0571	0.6193
37	23,704,892	7,577,668	343,463	31,626,023	0.0554	0.6747
38	16,447,680	9,367,686	257,597	26,072,963	0.0457	0.7203
39	11,196,706	9,054,989	28,622	20,280,317	0.0355	0.7559
40	5,850,520	9,646,855	28,622	15,525,997	0.0272	0.7831
41	3,422,068	10,772,296	28,622	14,222,986	0.0249	0.8080
42	911,067	15,063,719	57,244	16,032,030	0.0281	0.8361
43	215,667	12,598,871	28,622	12,843,160	0.0225	0.8586
44	216,375	9,848,603	85,866	10,150,844	0.0178	0.8764
45	611,856	14,791,067	57,244	15,460,167	0.0271	0.9035
46	48,978	14,420,121	28,622	14,497,721	0.0254	0.9289
47	185,386	10,637,010	28,622	10,851,018	0.0190	0.9479
48	166,789	9,279,305	0	9,446,094	0.0165	0.9644
49	237,593	5,933,002	57,244	6,227,839	0.0109	0.9753
50	166,789	4,828,477	0	4,995,266	0.0088	0.9841
51	68,611	3,365,907	0	3,434,518	0.0060	0.9901
52	0	1,475,581	0	1,475,581	0.0026	0.9927
53	0	1,774,912	0	1,774,912	0.0031	0.9958

Table Appendix D1. -- Population estimates by sex and size for Alaska plaice (*Pleuronectes quadrituberculatus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
54	0	996,900	0	996,900	0.0017	0.9975
55	0	513,907	0	513,907	0.0009	0.9984
56	0	428,360	0	428,360	0.0008	0.9992
57	0	99,561	0	99,561	0.0002	0.9994
58	0	191,406	0	191,406	0.0003	0.9997
59	0	137,180	0	137,180	0.0002	0.9999
60	0	30,941	0	30,941	0.0001	1.0000
Total	**272,880,926**	**284,028,128**	**13,857,696**	**570,766,750**	**1.0000**	**1.0000**

Table Appendix D2. -- Population estimates by sex and size for arrowtooth flounder (*Atheresthes stomias*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
32	43,378	0	0	43,378	0.0193	0.0193
34	142,760	43,378	0	186,138	0.0827	0.1020
36	71,431	26,581	0	98,012	0.0435	0.1455
37	77,753	0	0	77,753	0.0345	0.1800
38	213,561	0	0	213,561	0.0949	0.2749
39	198,763	0	0	198,763	0.0883	0.3632
40	120,492	43,378	0	163,870	0.0728	0.4360
41	49,691	49,691	0	99,382	0.0441	0.4802
42	0	136,447	0	136,447	0.0606	0.5408
43	0	179,825	0	179,825	0.0799	0.6207
44	44,214	43,378	0	87,592	0.0389	0.6596
45	88,427	43,378	0	131,805	0.0586	0.7181
46	0	43,378	0	43,378	0.0193	0.7374
47	120,492	99,381	0	219,873	0.0977	0.8351
48	43,378	0	0	43,378	0.0193	0.8543
49	44,214	0	0	44,214	0.0196	0.8740
52	0	27,035	0	27,035	0.0120	0.8860
53	49,691	0	0	49,691	0.0221	0.9081
54	0	43,378	0	43,378	0.0193	0.9273
56	0	70,492	0	70,492	0.0313	0.9587
57	0	43,378	0	43,378	0.0193	0.9779
58	0	49,691	0	49,691	0.0221	1.0000
Total	**1,308,245**	**942,789**	**0**	**2,251,034**	**1.0000**	**1.0000**

Table Appendix D3. -- Population estimates by sex and size for Bering flounder (*Hippoglossoides robustus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
5	0	0	35,709	35,709	0.0006	0.0006
6	0	0	62,128	62,128	0.0010	0.0016
9	79,676	0	226,544	306,220	0.0049	0.0065
10	93,151	155,207	289,330	537,688	0.0087	0.0152
11	524,621	127,207	341,669	993,497	0.0161	0.0313
12	869,974	657,370	753,310	2,280,654	0.0369	0.0681
13	2,063,775	1,714,714	697,062	4,475,551	0.0723	0.1405
14	1,661,521	2,460,248	481,504	4,603,273	0.0744	0.2149
15	2,123,294	1,979,598	27,334	4,130,226	0.0668	0.2816
16	2,255,564	1,945,863	27,334	4,228,761	0.0683	0.3500
17	2,305,931	1,551,246	27,334	3,884,511	0.0628	0.4127
18	1,942,766	2,106,830	0	4,049,596	0.0654	0.4782
19	1,681,654	2,128,825	0	3,810,479	0.0616	0.5398
20	866,803	2,459,889	0	3,326,692	0.0538	0.5936
21	593,801	2,094,437	0	2,688,238	0.0434	0.6370
22	301,420	2,387,460	0	2,688,880	0.0435	0.6805
23	92,186	1,604,947	0	1,697,133	0.0274	0.7079
24	58,016	2,021,541	0	2,079,557	0.0336	0.7415
25	46,623	1,959,273	0	2,005,896	0.0324	0.7739
26	29,547	662,541	0	692,088	0.0112	0.7851
27	0	390,965	0	390,965	0.0063	0.7914
28	56,311	688,300	0	744,611	0.0120	0.8035
29	0	526,240	0	526,240	0.0085	0.8120
30	43,486	492,567	0	536,053	0.0087	0.8206
31	71,456	778,812	0	850,268	0.0137	0.8344
32	0	1,041,797	0	1,041,797	0.0168	0.8512
33	0	1,662,906	0	1,662,906	0.0269	0.8781
34	0	1,912,509	0	1,912,509	0.0309	0.9090
35	0	2,157,781	0	2,157,781	0.0349	0.9439
36	0	1,820,842	0	1,820,842	0.0294	0.9733
37	0	712,852	0	712,852	0.0115	0.9848
38	0	298,883	0	298,883	0.0048	0.9896
39	0	207,759	0	207,759	0.0034	0.9930
40	0	318,524	0	318,524	0.0051	0.9981
41	0	57,873	0	57,873	0.0009	0.9991
42	0	56,749	0	56,749	0.0009	1.0000
Total	**17,761,576**	**41,142,555**	**2,969,258**	**61,873,389**	**1.0000**	**1.0000**

Table Appendix D4. -- Population estimates by sex and size for flathead sole (*Hippoglossoides elassodon*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
15	45,149	0	0	45,149	0.1217	0.1217
18	45,149	0	0	45,149	0.1217	0.2435
19	90,297	0	0	90,297	0.2435	0.4869
23	45,149	0	0	45,149	0.1217	0.6087
30	54,831	0	0	54,831	0.1478	0.7565
41	45,149	0	0	45,149	0.1217	0.8783
42	45,149	0	0	45,149	0.1217	1.0000
Total	**370,873**	**0**	**0**	**370,873**	**1.0000**	**1.0000**

Table Appendix D5. -- Population estimates by sex and size for Kamchatka flounder (*Atheresthes evermanni*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
53	25,759	0	0	25,759	1.0000	1.0000
Total	**25,759**	**0**	**0**	**25,759**	**1.0000**	**1.0000**

Table Appendix D6. -- Population estimates by sex and size for northern rock sole (*Lepidopsetta polyxystra*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
8	0	0	275,182	275,182	0.0011	0.0011
9	114,264	32,397	722,431	869,092	0.0036	0.0048
10	398,738	28,742	1,586,048	2,013,528	0.0084	0.0131
11	1,320,226	1,424,005	2,952,272	5,696,503	0.0237	0.0368
12	4,282,351	3,351,438	6,368,289	14,002,078	0.0582	0.0950
13	5,824,191	5,618,062	3,439,421	14,881,674	0.0618	0.1568
14	5,053,777	3,781,051	1,748,561	10,583,389	0.0440	0.2008
15	4,775,261	4,167,492	0	8,942,753	0.0372	0.2379
16	6,979,945	5,247,999	0	12,227,944	0.0508	0.2887
17	5,955,874	5,450,677	139,508	11,546,059	0.0480	0.3367
18	3,989,537	4,247,546	32,782	8,269,865	0.0344	0.3711
19	2,374,356	2,120,490	0	4,494,846	0.0187	0.3897
20	1,306,264	1,994,834	0	3,301,098	0.0137	0.4034
21	1,278,333	919,400	0	2,197,733	0.0091	0.4126
22	930,920	1,160,358	0	2,091,278	0.0087	0.4213
23	1,389,329	1,765,469	0	3,154,798	0.0131	0.4344
24	1,629,790	1,929,631	0	3,559,421	0.0148	0.4492
25	1,850,915	2,259,414	0	4,110,329	0.0171	0.4662
26	3,500,193	2,582,214	0	6,082,407	0.0253	0.4915
27	4,711,088	2,249,897	0	6,960,985	0.0289	0.5204
28	4,859,643	3,324,617	0	8,184,260	0.0340	0.5544
29	3,122,710	4,127,441	0	7,250,151	0.0301	0.5846
30	2,607,085	5,243,956	0	7,851,041	0.0326	0.6172
31	4,246,013	3,526,373	0	7,772,386	0.0323	0.6495
32	4,658,979	3,075,849	0	7,734,828	0.0321	0.6816
33	3,278,094	2,960,669	0	6,238,763	0.0259	0.7075
34	2,804,682	3,460,776	0	6,265,458	0.0260	0.7336
35	1,106,101	5,106,811	0	6,212,912	0.0258	0.7594
36	780,143	6,020,025	0	6,800,168	0.0283	0.7876
37	381,138	9,233,380	0	9,614,518	0.0399	0.8276
38	577,464	9,348,545	0	9,926,009	0.0412	0.8688
39	94,816	10,397,594	0	10,492,410	0.0436	0.9124
40	367,584	8,343,329	0	8,710,913	0.0362	0.9486
41	0	6,148,506	0	6,148,506	0.0255	0.9741
42	69,672	2,466,608	0	2,536,280	0.0105	0.9847
43	0	1,793,744	0	1,793,744	0.0075	0.9921
44	0	446,961	0	446,961	0.0019	0.9940
45	0	923,530	0	923,530	0.0038	0.9978
46	0	439,888	0	439,888	0.0018	0.9997
47	0	48,949	0	48,949	0.0002	0.9999
48	0	34,570	0	34,570	0.0001	1.0000
Total	**86,619,476**	**136,803,237**	**17,264,494**	**240,687,207**	**1.0000**	**1.0000**

Table Appendix D7. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
6	0	0	382,552	382,552	0.0029	0.0029
7	0	0	1,065,817	1,065,817	0.0082	0.0112
8	0	0	1,714,195	1,714,195	0.0132	0.0244
9	0	0	1,590,080	1,590,080	0.0123	0.0366
10	0	0	613,989	613,989	0.0047	0.0414
11	31,807	0	209,821	241,628	0.0019	0.0432
12	33,951	0	309,572	343,523	0.0026	0.0459
13	31,756	66,697	34,360	132,813	0.0010	0.0469
14	174,714	34,612	206,159	415,485	0.0032	0.0501
15	0	126,847	301,818	428,665	0.0033	0.0534
16	263,483	192,600	97,691	553,774	0.0043	0.0577
17	156,596	215,326	0	371,922	0.0029	0.0606
18	186,293	97,371	32,397	316,061	0.0024	0.0630
19	178,578	91,521	64,795	334,894	0.0026	0.0656
20	186,835	157,951	0	344,786	0.0027	0.0682
21	149,930	163,344	32,397	345,671	0.0027	0.0709
22	300,778	203,998	0	504,776	0.0039	0.0748
23	90,321	385,436	64,795	540,552	0.0042	0.0790
24	267,130	264,399	0	531,529	0.0041	0.0831
25	209,473	403,206	0	612,679	0.0047	0.0878
26	520,338	461,372	0	981,710	0.0076	0.0954
27	484,094	592,920	0	1,077,014	0.0083	0.1037
28	351,401	467,641	0	819,042	0.0063	0.1100
29	312,372	380,212	0	692,584	0.0053	0.1153
30	496,401	370,060	0	866,461	0.0067	0.1220
31	184,240	312,267	0	496,507	0.0038	0.1258
32	140,159	337,847	0	478,006	0.0037	0.1295
33	394,068	274,721	0	668,789	0.0052	0.1347
34	336,553	87,878	0	424,431	0.0033	0.1379
35	409,613	613,281	0	1,022,894	0.0079	0.1458
36	658,680	672,398	0	1,331,078	0.0103	0.1561
37	1,491,038	1,062,157	0	2,553,195	0.0197	0.1758
38	1,722,917	1,556,520	0	3,279,437	0.0253	0.2011
39	2,316,099	2,136,836	0	4,452,935	0.0343	0.2354
40	3,086,348	1,898,579	0	4,984,927	0.0384	0.2738
41	3,035,081	2,999,967	156,581	6,191,629	0.0477	0.3216
42	3,162,724	3,005,038	0	6,167,762	0.0476	0.3691
43	2,777,274	2,974,144	62,633	5,814,051	0.0448	0.4139
44	1,933,571	2,664,919	62,633	4,661,123	0.0359	0.4499
45	2,532,092	2,350,953	61,149	4,944,194	0.0381	0.4880
46	2,675,545	2,906,487	0	5,582,032	0.0430	0.5310
47	2,057,487	2,112,950	29,832	4,200,269	0.0324	0.5634
48	1,441,821	2,323,694	0	3,765,515	0.0290	0.5924
49	1,102,668	1,876,508	29,832	3,009,008	0.0232	0.6156
50	1,787,735	1,007,076	0	2,794,811	0.0215	0.6372
51	848,241	856,777	29,832	1,734,850	0.0134	0.6506
52	1,038,404	1,068,842	31,316	2,138,562	0.0165	0.6671

Table Appendix D7. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
53	681,972	1,299,078	0	1,981,050	0.0153	0.6823
54	1,067,975	579,517	29,832	1,677,324	0.0129	0.6953
55	711,570	441,841	0	1,153,411	0.0089	0.7042
56	938,078	686,437	0	1,624,515	0.0125	0.7167
57	947,181	795,480	0	1,742,661	0.0134	0.7301
58	872,388	643,193	31,316	1,546,897	0.0119	0.7420
59	675,463	652,233	29,832	1,357,528	0.0105	0.7525
60	1,077,013	383,938	0	1,460,951	0.0113	0.7638
61	432,233	1,054,072	62,633	1,548,938	0.0119	0.7757
62	1,018,993	489,737	0	1,508,730	0.0116	0.7874
63	615,028	600,135	31,316	1,246,479	0.0096	0.7970
64	865,334	696,621	31,316	1,593,271	0.0123	0.8092
65	766,117	890,540	0	1,656,657	0.0128	0.8220
66	1,250,343	273,627	31,316	1,555,286	0.0120	0.8340
67	1,032,052	377,181	0	1,409,233	0.0109	0.8449
68	1,133,567	475,304	0	1,608,871	0.0124	0.8573
69	934,540	556,278	0	1,490,818	0.0115	0.8688
70	717,350	581,636	0	1,298,986	0.0100	0.8788
71	635,304	551,714	0	1,187,018	0.0092	0.8879
72	510,163	401,124	0	911,287	0.0070	0.8950
73	733,774	584,772	0	1,318,546	0.0102	0.9051
74	933,271	462,413	0	1,395,684	0.0108	0.9159
75	609,919	860,642	31,316	1,501,877	0.0116	0.9275
76	491,893	391,974	0	883,867	0.0068	0.9343
77	461,580	409,562	0	871,142	0.0067	0.9410
78	592,400	314,701	0	907,101	0.0070	0.9480
79	626,730	316,630	0	943,360	0.0073	0.9553
80	434,300	539,727	0	974,027	0.0075	0.9628
81	420,609	266,676	0	687,285	0.0053	0.9681
82	221,084	468,165	0	689,249	0.0053	0.9734
83	218,871	205,342	0	424,213	0.0033	0.9767
84	142,953	360,868	29,832	533,653	0.0041	0.9808
85	153,128	230,559	0	383,687	0.0030	0.9837
86	32,085	176,687	0	208,772	0.0016	0.9853
87	58,357	343,849	0	402,206	0.0031	0.9884
88	31,555	126,718	0	158,273	0.0012	0.9897
89	29,275	170,956	0	200,231	0.0015	0.9912
90	58,002	31,555	29,832	119,389	0.0009	0.9921
91	0	249,538	0	249,538	0.0019	0.9941
92	0	31,014	0	31,014	0.0002	0.9943
93	0	165,122	0	165,122	0.0013	0.9956
94	0	71,470	0	71,470	0.0006	0.9961
95	0	68,969	0	68,969	0.0005	0.9967
96	30,455	31,623	0	62,078	0.0005	0.9971
99	0	64,369	0	64,369	0.0005	0.9976
101	0	161,540	0	161,540	0.0012	0.9989
102	31,014	26,964	0	57,978	0.0004	0.9993

Table Appendix D7. -- Population estimates by sex and size for Pacific cod (*Gadus macrocephalus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
103	0	30,169	0	30,169	0.0002	0.9996
104	0	26,964	0	26,964	0.0002	0.9998
105	0	31,014	0	31,014	0.0002	1.0000
Total	**62,752,528**	**59,425,590**	**7,522,787**	**129,700,905**	**1.0000**	**1.0000**

Table Appendix D8. -- Population estimates by sex and size for walleye pollock (*Gadus chalcogrammus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
6	0	0	31,638	31,638	0.0000	0.0000
7	0	0	63,276	63,276	0.0001	0.0001
8	0	0	1,017,323	1,017,323	0.0015	0.0016
9	0	0	961,335	961,335	0.0014	0.0031
10	0	29,505	4,777,572	4,807,077	0.0071	0.0101
11	60,474	29,505	9,521,088	9,611,067	0.0141	0.0243
12	210,983	209,316	12,123,680	12,543,979	0.0185	0.0427
13	511,728	503,312	11,917,784	12,932,824	0.0190	0.0618
14	1,910,064	1,578,275	7,134,461	10,622,800	0.0156	0.0774
15	13,330,577	8,929,095	6,764,478	29,024,150	0.0427	0.1201
16	11,207,784	10,147,696	2,090,608	23,446,088	0.0345	0.1547
17	10,748,257	8,618,520	785,775	20,152,552	0.0297	0.1843
18	2,318,492	2,108,718	778,805	5,206,015	0.0077	0.1920
19	941,054	682,807	102,896	1,726,757	0.0025	0.1945
20	780,005	1,174,052	222,097	2,176,154	0.0032	0.1977
21	172,458	226,523	0	398,981	0.0006	0.1983
22	1,139,963	252,069	0	1,392,032	0.0020	0.2004
23	0	196,054	0	196,054	0.0003	0.2007
24	166,372	84,023	0	250,395	0.0004	0.2010
25	28,008	0	0	28,008	0.0000	0.2011
26	58,231	0	0	58,231	0.0001	0.2011
27	133,639	0	0	133,639	0.0002	0.2013
29	194,380	0	0	194,380	0.0003	0.2016
31	211,262	28,008	0	239,270	0.0004	0.2020
32	0	105,631	0	105,631	0.0002	0.2021
33	28,008	0	0	28,008	0.0000	0.2022
34	222,628	166,372	0	389,000	0.0006	0.2028
36	166,372	116,997	0	283,369	0.0004	0.2032
37	445,257	116,997	0	562,254	0.0008	0.2040
38	116,997	550,092	0	667,089	0.0010	0.2050
39	711,777	433,891	0	1,145,668	0.0017	0.2067
40	1,646,609	867,408	0	2,514,017	0.0037	0.2104
41	969,867	1,813,620	70,037	2,853,524	0.0042	0.2146
42	1,688,895	1,765,309	0	3,454,204	0.0051	0.2197
43	3,338,208	1,881,450	140,074	5,359,732	0.0079	0.2275
44	8,110,648	5,350,550	350,186	13,811,384	0.0203	0.2479
45	13,789,410	5,088,069	770,409	19,647,888	0.0289	0.2768
46	20,752,533	12,990,358	770,409	34,513,300	0.0508	0.3276
47	24,573,308	17,173,447	630,335	42,377,090	0.0624	0.3900
48	22,882,229	23,178,046	1,050,558	47,110,833	0.0693	0.4593
49	23,546,022	29,534,158	980,521	54,060,701	0.0796	0.5389
50	20,042,412	28,407,923	770,409	49,220,744	0.0725	0.6114
51	16,717,917	26,694,748	490,260	43,902,925	0.0646	0.6760
52	15,946,954	25,998,913	140,074	42,085,941	0.0620	0.7379
53	11,311,724	21,100,675	103,092	32,515,491	0.0479	0.7858
54	7,623,260	18,301,403	103,092	26,027,755	0.0383	0.8241
55	6,372,096	14,428,847	0	20,800,943	0.0306	0.8547

Table Appendix D8. -- Population estimates by sex and size for walleye pollock (*Gadus chalcogrammus*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
56	6,001,222	12,544,050	136,148	18,681,420	0.0275	0.8822
57	5,141,069	9,921,527	33,055	15,095,651	0.0222	0.9045
58	4,542,553	9,403,364	0	13,945,917	0.0205	0.9250
59	3,581,992	8,492,353	33,055	12,107,400	0.0178	0.9428
60	2,750,748	6,204,258	136,148	9,091,154	0.0134	0.9562
61	1,528,513	6,061,634	33,055	7,623,202	0.0112	0.9674
62	1,210,586	4,752,398	70,037	6,033,021	0.0089	0.9763
63	1,033,539	2,714,459	0	3,747,998	0.0055	0.9818
64	511,702	2,985,270	33,055	3,530,027	0.0052	0.9870
65	531,993	2,176,653	0	2,708,646	0.0040	0.9910
66	214,367	1,820,301	70,037	2,104,705	0.0031	0.9941
67	226,114	1,040,445	0	1,266,559	0.0019	0.9960
68	67,974	1,043,498	0	1,111,472	0.0016	0.9976
69	140,358	510,930	0	651,288	0.0010	0.9985
70	0	257,686	0	257,686	0.0004	0.9989
71	0	166,446	0	166,446	0.0002	0.9992
72	0	92,148	0	92,148	0.0001	0.9993
73	0	237,344	0	237,344	0.0003	0.9997
74	0	132,666	0	132,666	0.0002	0.9999
75	0	99,254	0	99,254	0.0001	1.0000
Total	**272,609,592**	**341,519,066**	**65,206,862**	**679,335,520**	**1.0000**	**1.0000**

Table Appendix D9. -- Population estimates by sex and size for yellowfin sole (*Limanda aspera*) from the 2021 northern Bering Sea bottom trawl survey.

Length (cm)	Males	Females	Unsexed	Total	Proportion	Cumulative proportion
4	0	0	36,629	36,629	0.0000	0.0000
5	0	0	157,070	157,070	0.0001	0.0001
6	385,805	0	499,426	885,231	0.0004	0.0005
7	0	0	595,471	595,471	0.0003	0.0008
8	357,768	0	902,427	1,260,195	0.0006	0.0015
9	103,543	503,574	1,557,939	2,165,056	0.0011	0.0026
10	888,623	1,233,104	6,718,990	8,840,717	0.0045	0.0070
11	5,250,568	7,370,081	11,171,657	23,792,306	0.0120	0.0191
12	22,429,737	26,840,718	9,142,551	58,413,006	0.0295	0.0486
13	39,603,116	40,942,091	2,971,340	83,516,547	0.0422	0.0908
14	46,066,873	44,974,909	419,662	91,461,444	0.0462	0.1370
15	44,337,725	47,304,861	94,329	91,736,915	0.0464	0.1834
16	45,417,759	50,865,047	125,771	96,408,577	0.0487	0.2321
17	39,911,152	36,045,382	34,360	75,990,894	0.0384	0.2705
18	42,950,281	35,875,806	65,803	78,891,890	0.0399	0.3103
19	36,958,003	40,605,365	31,443	77,594,811	0.0392	0.3495
20	42,215,460	53,642,753	0	95,858,213	0.0484	0.3980
21	45,515,959	55,554,513	31,443	101,101,915	0.0511	0.4491
22	40,999,353	51,229,415	97,246	92,326,014	0.0467	0.4957
23	37,120,217	52,761,734	31,443	89,913,394	0.0454	0.5411
24	24,057,017	31,548,151	0	55,605,168	0.0281	0.5692
25	28,341,608	30,641,683	31,443	59,014,734	0.0298	0.5991
26	28,948,938	20,089,122	31,443	49,069,503	0.0248	0.6239
27	24,451,212	15,261,642	31,443	39,744,297	0.0201	0.6439
28	28,604,901	22,488,503	125,771	51,219,175	0.0259	0.6698
29	31,926,007	20,165,533	188,657	52,280,197	0.0264	0.6962
30	32,291,405	22,731,713	62,886	55,086,004	0.0278	0.7241
31	38,156,392	22,621,158	125,771	60,903,321	0.0308	0.7548
32	33,576,840	34,312,043	128,688	68,017,571	0.0344	0.7892
33	32,459,030	32,063,815	163,048	64,685,893	0.0327	0.8219
34	34,442,330	34,025,889	191,574	68,659,793	0.0347	0.8566
35	28,501,197	28,646,752	125,771	57,273,720	0.0289	0.8855
36	28,734,320	29,681,988	94,329	58,510,637	0.0296	0.9151
37	20,292,631	22,661,400	314,429	43,268,460	0.0219	0.9370
38	15,978,430	19,415,685	62,886	35,457,001	0.0179	0.9549
39	10,930,809	24,422,953	31,443	35,385,205	0.0179	0.9728
40	6,388,590	19,576,957	68,720	26,034,267	0.0132	0.9859
41	2,550,493	10,050,020	65,803	12,666,316	0.0064	0.9923
42	1,050,130	6,044,314	68,720	7,163,164	0.0036	0.9959
43	365,465	3,639,460	103,080	4,108,005	0.0021	0.9980
44	0	1,848,985	34,360	1,883,345	0.0010	0.9990
45	31,761	846,314	137,439	1,015,514	0.0005	0.9995
46	0	785,787	34,360	820,147	0.0004	0.9999
47	0	218,491	0	218,491	0.0001	1.0000
Total	**942,591,448**	**999,537,711**	**36,907,064**	**1,979,036,223**	**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