2022Northern Bering Sea Groundfish and Crab Trawl Survey Highlights

DRAFT: September 03, 2023

Introduction

In 2022, NOAA Fisheries' Alaska Fisheries Science Center conducted two surveys within U.S. territorial waters of the Bering Sea: the southeastern Bering Sea (EBS) shelf bottom trawl survey and the northern Bering Sea (NBS) bottom trawl survey. This is the 40th year of the EBS shelf survey and the fifth year of NBS survey using standardized sampling protocols. A rapid response survey for the NBS region was also conducted in 2018 using a modified spatial extent and sampling procedure and will not be covered here. The NBS survey region contains 144 stations in an area bounded by the Bering Strait, Norton Sound, and the U.S.–Russia Maritime Boundary (Fig. @ref(fig:fig_sample_grid)). While the NBS region has been surveyed sporadically in the past, 2010 is considered the survey's inaugural year because it was the first year the region was sampled using the same standardized sampling methods as the EBS shelf survey.

This region is a fundamental part of the Alaska Fisheries Science Center Loss of Sea Ice (LOSI) research plan, the primary purpose of which is to study the impacts of diminished sea ice on the marine ecosystem. In the NOAA LOSI research plan, the NBS was identified as a region of critical importance for increased scientific monitoring because this marine ecosystem may be rapidly altered by the changing climate. This survey represents one component of a multi-faceted research plan to create a long-term time series designed to identify, as well as track, environmental and ecological change throughout the Bering Sea. Beyond the potential impacts of climate change, the scale and extent of fish and crab movements may also vary from year to year in response to a variety of biological or environmental processes. These movements cause changes in distribution and abundance that extend beyond the traditional survey boundaries (e.g., EBS) and ultimately create an additional need for survey data that provides comprehensive coverage of the entire Bering Sea.

Here, we provide some of the results of the 2022 NBS survey and compare these to observations from the 2010, 2017, 2019, and 2021 surveys. Continuation of the survey effort for a combined EBS and NBS bottom trawl survey will provide more comprehensive information to investigate how fishes, crabs, and other bottom dwellers respond to biological and environmental changes on a large spatial scale over a multi-year time period.

Survey Design, Execution, and Analysis

The 2022 EBS shelf and NBS bottom trawl surveys were conducted aboard the chartered commercial stern-trawlers FV *Vesteraalen* and FV *Alaska Knight* (Fig. @ref(fig:fig-vessels)). For the EBS shelf survey, the FV *Vesteraalen* started sampling on May 30, 2022 and ended on July 29, 2022 and the FV *Alaska Knight* started sampling on May 31, 2022 and ended on July 28, 2022. After the completion of the EBS shelf survey, both vessels transitioned into sampling survey stations in the southwest corner of the NBS survey region. The NBS shelf survey started for both vessels on July 29, 2022 and ended on August 19, 2022 for the FV *Vesteraalen* and on August 20, 2022 for the FV *Alaska Knight*. After the NBS survey was completed, both vessels returned to Dutch Harbor to offload survey equipment and biological samples. 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 (164-ft) isobath.

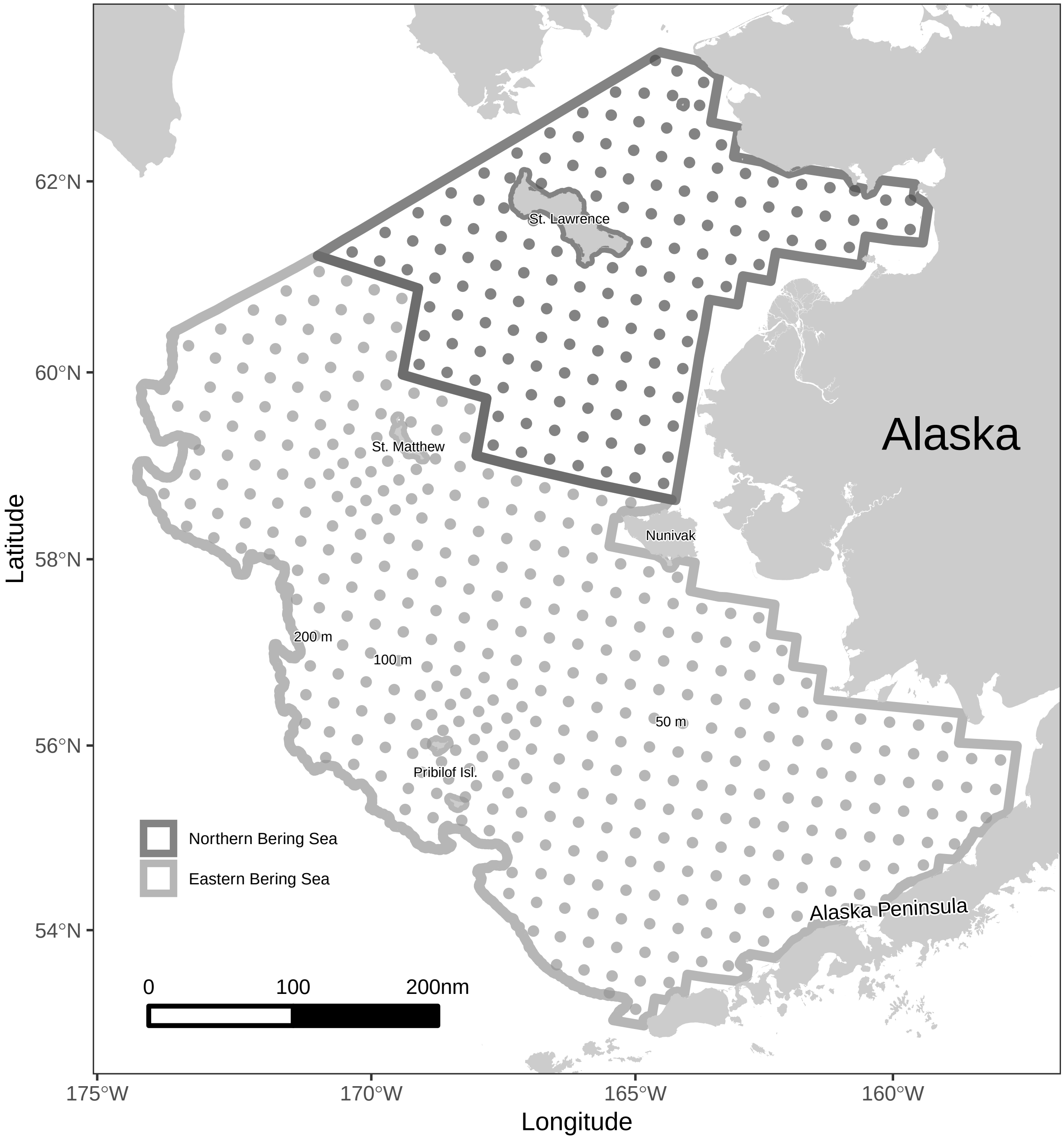

Figure 1: Map of 2022 eastern and northern Bering Sea surveys sampling stations. The area enclosed within the light gray line contains the eastern Bering Sea shelf stations that have been sampled annually since 1982, whereas the area outlined by the dark gray line contains the northern Bering Sea stations that were sampled in 2022. The dots within each area indicate station locations.

Figure 2: Fishing vessels FV *Alaska Knight* (left) and FV *Vesteraalen* (right) contracted to conduct the 2022 eastern and northern Bering Sea bottom trawl survey.

Scientists from the Alaska Fisheries Science Center, Alaska Department of Fish and Game, International Pacific Halibut Commission, Bigelow Laboratory for Ocean Sciences, A.I.S. Inc., University of Alaska Fairbanks, and volunteers from the University of Southern California and the University of Alaska Southeast participated in the survey. Lead scientist profiles can be found at the end of this document.

The same NBS stations were surveyed in 2022 as in 2021. The NBS survey was designed as a continuation of the systematic 20 × 20 nautical mile (nmi) sampling grid that was coordinated along latitudinal and longitudinal axes and established for the annual EBS shelf survey, and has been used since 1982. This design resulted in a systematic grid of 144 stations in which each sampling station represents a geo-referenced area of 400 square nautical miles (nmi^2; 1,372 km^2) distributed throughout the nmi^2 (198,867 km^2) that defines the NBS survey area. The EBS shelf survey area contains 376 stations distributed over nmi^2 (492,990 km^2). The addition of the NBS survey expanded the overall survey coverage in the Bering Sea to nmi^2 (691,857 km^2). In 2022, the NBS stations had bottom depths ranging from ∞ ft (∞ m) to $-\infty$ ft ($-\infty$ m).

In the EBS shelf survey, sampling was typically conducted at a fixed sampling station located at the center of each grid cell (Fig. @ref(fig:fig-sample-grid)). While this approach was also used for the NBS survey, shallow depths and untrawlable bottom types were encountered in some grid cells, which required the sampling location to be moved elsewhere within the cell (Fig. @ref(fig:fig-sample-grid)). All stations were sampled during daylight hours.

Both vessels sampled using an 83/112 Eastern otter trawl that has been historically used for EBS shelf, Chukchi, and Beaufort Sea surveys (Fig. @ref(fig:fig-trawl-gear-alt)). This trawl is significantly smaller and weighs less than trawls used for commercial fishing in Alaska. One 30-minute tow, at a target vessel speed of 3 knots, was conducted at 144 stations. The cumulative area sampled by trawls at the 144 stations was approximately 0 nmi^2 (0 km^2), covering NaN% of the total area of the NBS.

Catches of less than approximately 1,200 kg (2,500 lbs) were sorted and weighed in their entirety and larger catches were subsampled. Fishes, crabs, and other invertebrates were identified and sorted by species to the greatest extent possible. In cases where species identification was unknown, specimens were collected and returned to the lab for expert identification. After sorting, all caught species (except colonial species that cannot be individually counted) were counted and weighed. For the predominant fish species encountered, a subsample was weighed, sorted by sex, and the fork length of all specimens in the subsample was measured to the nearest centimeter (cm). For the predominant crab species encountered, carapace width (snow crab) or length (king crabs) was measured to the nearest millimeter (mm). Some of the species caught were grouped into higher taxa groups (common names for an assemblage of species) for analysis either because the catch size was very small for individual species or due to questionable identification. Samples of some species of

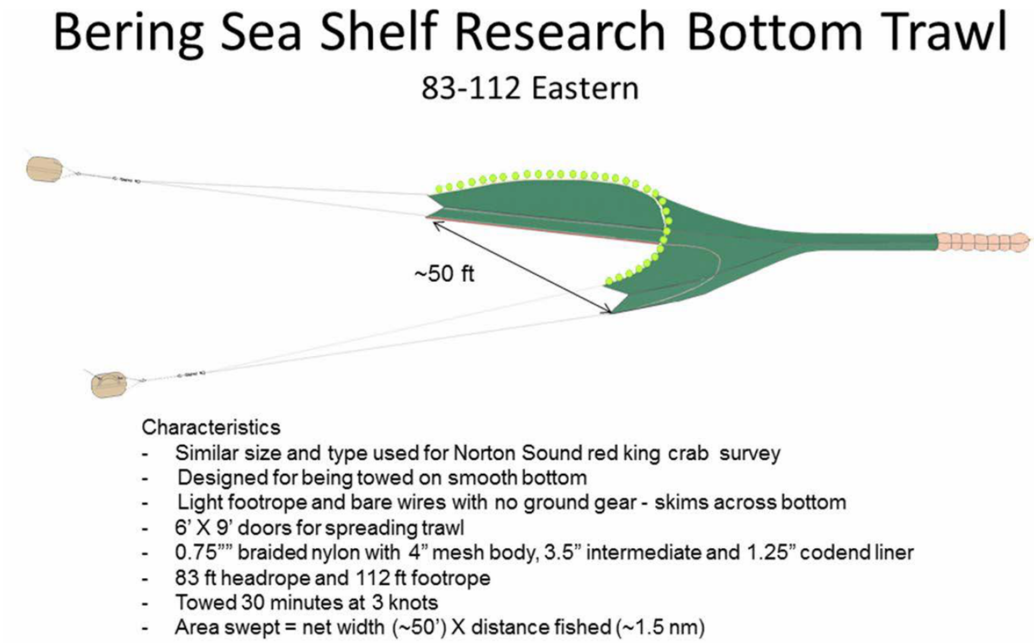

Figure 3: Diagram of the 83/112 Eastern trawl net.

fishes, crabs, and other invertebrates were also retained to gather additional information that included their size, weight, sex, age, reproductive state, genetics, health (condition factor), and stomach content/diet.

Trawl survey catch data were used to estimate catch-per-unit-effort (CPUE), population biomass, population abundance, and population abundance by size class for measured species. CPUE can be used as a measurement of the density of a caught species. CPUE is the estimated catch of organisms caught (in kilograms, kg, or number of individuals) per amount of effort (generally, effort is a combination of gear type, gear size, and length of time the gear is used). For these surveys, effort is estimated as the area sampled, or area swept (1 ha = 10,000 m^2 = 0.003 nmi^2). This area is computed by multiplying trawl tow distance by the mean width of the net during the tow. Net width during the tow was measured by acoustic sensors attached to the net. The same gear is used throughout the survey and type does not change. Mean CPUE values were calculated for the overall survey areas. Biomass and population estimates were derived for each survey area by multiplying the mean CPUE by the total survey area. For size composition estimates, the proportion of fish at each 1-cm length interval or crab at each 1-mm carapace width or length interval (collected from subsamples at each station) was weighted based upon the mean CPUE (number of a taxon per square kilometer) and then expanded to the total population for the NBS survey area.

Environmental data, including water temperature in degrees Celsius (°C), depth in meters (m), salinity (parts per thousand), and underwater downwelling light were also recorded at each sampling station. Water column profiles of temperature and salinity at each trawl location were measured using a trawl-mounted conductivity, temperature, and depth profiler (CTD).

2022 Survey Results with Snapshot Comparisons to 2021

Seafloor Bottom Temperature

Water temperatures near the bottom (Figs. @ref(fig:fig-temperature-bt-1) and @ref(fig:fig-temperature-bt-2)) and near the surface (Figs. @ref(fig:fig-temperature-st-1) and @ref(fig:fig-temperature-st-2)) varied over space and among years due to variation in atmospheric and oceanic conditions that influence temperature patterns in the EBS (Stabeno et al., 2012). Within years, the warmest bottom temperatures were observed in the inner domain (bottom depths <50 m) along the Alaska mainland where the water column is fully mixed throughout the summer, which allows solar heating throughout the water column (Coachman, 1986). The coldest bottom temperatures typically occurred in the middle domain (50–100 m bottom depth) where strong two-layer stratification during summer inhibits heat transfer to the bottom layer, which allows a seasonal 'cold pool' (bottom temperatures 2°C) to persist from spring though the end of fall. In the southeastern Bering Sea, surface temperatures generally increased from the interior of Bristol Bay to the northwestern outer shelf and into Norton Sound. These temperature patterns reflect seasonal warming that occurs over the duration of the survey (Cokelet, 2016).

The mean EBS shelf bottom temperature was 2.6°C in 2022, which was near the 2.5°C time-series average from 1982 to 2022 (Fig. @ref(fig:fig-mean-temperature)). The near-average bottom temperature in 2022 represents a departure from recent years (2016–2021), which included four of the five warmest years in the 40-year time series. Over the 40-year time series (1982–2022) of the EBS shelf bottom trawl survey, annual mean summer bottom temperatures have ranged from 0.7°C to 4.4°C and surface temperatures have ranged from 3.9°C to 9.5°C. The 2022 mean EBS shelf surface temperature (7.5°C) was warmer than the times-series average surface temperature (6.8°C) and mean surface temperature in 2021 (7.2°C). During the last 16 years, bottom temperatures from 2006-2013 were colder than average ("cold stanza"), while 2014-2019 and 2021 were warmer than average ("warm stanza").

Over the time series (2010, 2017, 2019, 2021, and 2022) of the NBS shelf bottom trawl survey, annual mean summer bottom temperatures have ranged from 1.9°C to 5.6°C and surface temperatures have ranged from 8.1°C to 10.8°C. Water temperatures observed in the NBS in 2022 were similar to those observed in 2021. The mean NBS bottom temperature in 2022 was 3.9°C, which was within 0.01°C of mean bottom temperature in 2021 (Fig. (**ref?**)(fig:fig-mean-temperature)). The mean NBS surface temperature was 8.1°C, slightly cooler than the mean surface temperature in 2021 (8.4°C).

The cold pool area is defined as the extent (in square kilometers) of the eastern Bering Sea bottom trawl survey area with bottom temperatures 2°C (Rohan et al., 2022). The size and location of the cold pool is primarily influenced by the extent of seasonal sea ice cover during the preceding winter and spring and the timing of sea ice retreat during spring (Stabeno and Bell, 2019). The cold pool is primarily found in the middle domain (50–100 m bottom depth), which is fully mixed during the winter and has two-layer stratification during the summer. Years with extensive sea ice that persists into spring have a larger cold pool that can extend into Bristol Bay and as far south as the Alaska Peninsula. Years with smaller sea ice extent result in smaller cold pools that are limited to the northern edge of the EBS shelf survey area. Cold pool area is strongly correlated ($r^2 = 0.94$) with mean bottom temperature on the EBS shelf.

The cold pool covered nearly the entire middle domain north of 57°N in 2022 and was larger than in 2021 (12.0%; 58,975 km^2; Fig. @ref(fig:fig-temperature-bt-1)). The spatial footprint of the cold pool was similar to the most recent near-average year in 2017 (34.2%; 169,150 km^2). In 2022, the cold pool covered 36.2% (178,625 km^2) of the EBS shelf survey area and was near the time series mean (36.6%; 181,018 km^2; Fig. @ref(fig:fig-cold-pool-area)). During the 40-year time series, the cold pool area has ranged from a minimum of 6,150 km^2 in 2018 to a maximum of 385,975 km^2 in 1999, respectively comprising 1.2% to 78.2% of the total EBS shelf area.

Interannual variation in bottom temperature and cold pool area influences the distribution (Kotwicki and Lauth, 2013; Stevenson et al., 2022; Stevenson and Lauth, 2019; Thorson et al., 2020), migration (Nichol et al., 2019), recruitment (Cooper et al., 2020), and biological productivity (Grüss et al., 2021) of fishes and crabs in the Bering Sea. The size of the cold pool influences the availability of demersal species to bottom-trawl surveys by mediating migration between the EBS shelf, NBS, western Bering Sea, and EBS continental slope (O'Leary et al., 2022; Zador et al., 2011). Subarctic fish species tend to avoid areas with bottom temperatures below 0°C or 1°C, depending on the species (Baker, 2021; Eisner et al., 2020). Meanwhile, colder temperatures may also provide a habitat refuge for cold-adapted species (Fedewa et al., 2020). Similar to 2017, the cold pool likely did not pose a major temperature barrier to the northward migration of mobile subarctic species from the EBS shelf to the NBS, such as walleye pollock and Pacific cod.

Survey Data and Specimen Collections

From the EBS and NBS shelf trawl surveys, length measurements were collected from 80,017 individual fish representing 44 fish taxa. Additionally, 8,338 age structures (otoliths) were collected from 10 fish taxa; 4,233 stomach samples were collected from five fish taxa; 60 stress physiology samples were collected from Pacific halibut; 85 antifreeze blood samples were collected from Pacific cod; 348 fat-meter condition samples were collected from Pacific cod and walleye pollock; two genetic samples were collected from Pacific sleeper shark, and 104 genetic fin clip samples were collected from four fish taxa.

Estimates of Fishes and Invertebrates

From 2021 to 2022, 23 fishes and three invertebrates experienced decreasing CPUE, 15 fishes and 24 invertebrates experienced increasing CPUE, and 27 fishes and six invertebrates experienced no notable change in CPUE. Prominent fish species that exhibited no change between 2021 and 2022, included yellowfin sole, yellowfin sole, starry flounder, skate egg cases, sand lances, marbled eelpout, other flatfishes, other flatfishes, Atka mackerel, Greenland turbot, lumpsuckers, lumpsuckers, shortfin eelpout, eelpouts, eelpouts, Pacific capelin, flathead sole, flathead sole, longhead dab, Pacific halibut, Pacific halibut, wolffishes, Alaska plaice, Alaska plaice, walleye pollock, walleye pollock, and all pricklebacks (within ± 25% change from the previous survey year) in CPUE. Between 2021 and 2022, the largest increases in CPUE were seen in Arctic staghorn sculpin (1,500%), all sponges (1,436%), all sponges (1,436%), chitons (1,296%), and all sea anemones (677%); the largest decreases in CPUE were seen in great sculpin (-82%), hydroids (-98%), Kamchatka flounder (-100%), Kamchatka flounder (-100%), all sticklebacks (-100%), and eulachon (-100%).

In 2022, the total bottom-dwelling organismal biomass of the EBS shelf was estimated at 29.2 million metric tons (t) and the NBS shelf was estimated at 6.7 mmt. Previously, the total bottom-dwelling animal biomass of the 2021 EBS shelf was estimated at 24.1 million t, 2021 NBS shelf was estimated at 5.9 million t, 2019 EBS shelf was estimated at 30.1 million t, 2019 NBS shelf was estimated at 8.5 million t, 2017 EBS shelf was estimated at 32.5 million t, 2017 NBS shelf was estimated at 8.8 million t, 2010 EBS shelf was estimated at 30.2 million t, and 2010 NBS shelf was estimated at 5.5 million t. The percent change in biomass varied by fish and invertebrate taxon (Table @ref(tab:tab-majortaxa-pchange)).

Calculated biomass decreased for 21 taxa and increased for 33 taxa from 2021 (warm-stanza year) to 2022. Some of the largest increases in biomass from 2021 to 2022 were observed in the Kamchatka flounder (NA%), lumpsuckers (NA%), lumpsuckers (NA%), snailfishes (NA%), and other crabs (NA%) groups. Decreases in biomass were observed in the walleye pollock (NA%), Alaska plaice (NA%), Pacific halibut (NA%), eelpouts (NA%), and Alaska skate (NA%) groups (Table @ref(tab:tab-majortaxa-pchange)).

Species groups that previously exhibited a decreasing trend in biomass from 2019 to 2021 but an increasing trend in biomass from 2021 to 2022 include Pacific ocean perch, sponges, other poachers, sea urchins, clams, mussels, scallops, other poachers, greenlings, snailfishes, other flatfishes, jellyfish, sponges, walleye pollock, other sea stars, sea urchins, jellyfish, yellowfin sole, Alaska plaice, arrowtooth flounder, yellowfin sole, other crabs, other snails, other snails, other flatfishes, and Kamchatka flounder (Table @ref(tab:tab-majortaxa-pchange)). Species groups that previously exhibited an increasing trend in biomass from 2019 to 2021 but a decreasing trend in biomass from 2021 to 2022 include other sea stars, clams, mussels, scallops, Pacific halibut, Alaska plaice, snailfishes, greenlings, Bering flounder, other sculpins, squids, and arrowtooth flounder (Table @ref(tab:tab-majortaxa-pchange)).

In 2022, (%) together comprised over 50% of the total estimated biomass in the NBS. Previously, in 2021, (%); in 2019, (%); in 2017, (%); and in 2010, (%) together comprised over 50% of the total estimated biomass in the NBS. Saffron cod and Arctic cod accounted for of the total biomass in . Invertebrates (i.e., shrimps, sea squirts, sea stars, jellyfish, crabs, and urchins) made up 10% of the biomass in 2022, 9% of the biomass in 2021, 9% of the biomass in 2019, 9% of the biomass in 2017, and 9% of the biomass in 2010.

On average, NBS survey catches were smaller than those from the EBS. Distributions of some of the predominant species, such as Alaska plaice, Alaska skate, Pacific cod, Pacific halibut, Pacific herring, all sea anemones, all sponges, basket sea stars, clams, mussels, scallops, empty shells and debris, hermit crabs,

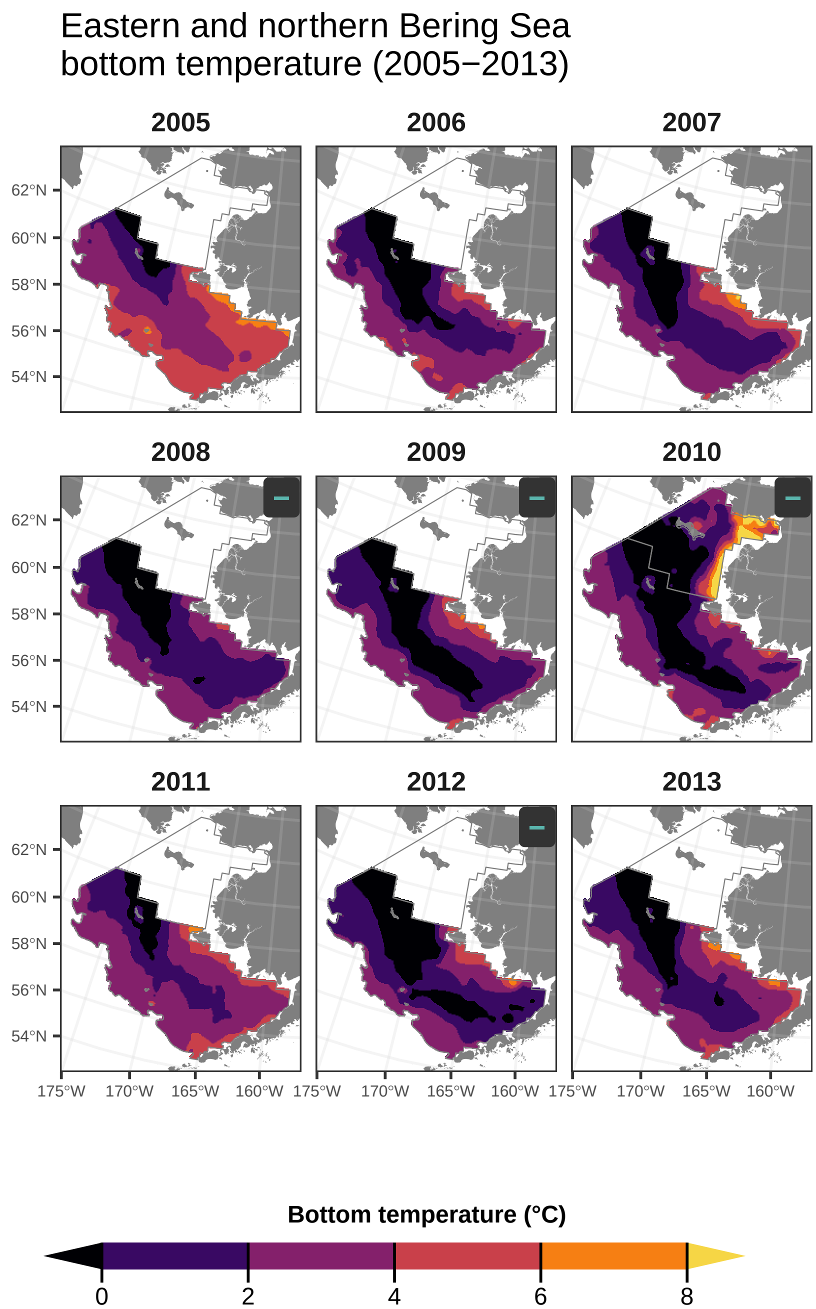

Figure 4: Bottom temperatures (°C) during the 2005-2013 eastern and northern Bering Sea shelf bottom trawl surveys. Years in which the mean bottom temperature is 1 or more standard deviations above or below the time-series mean bottom temperature are denoted with '+' and '-' in the upper right-hand corner of each subplot, respectively.

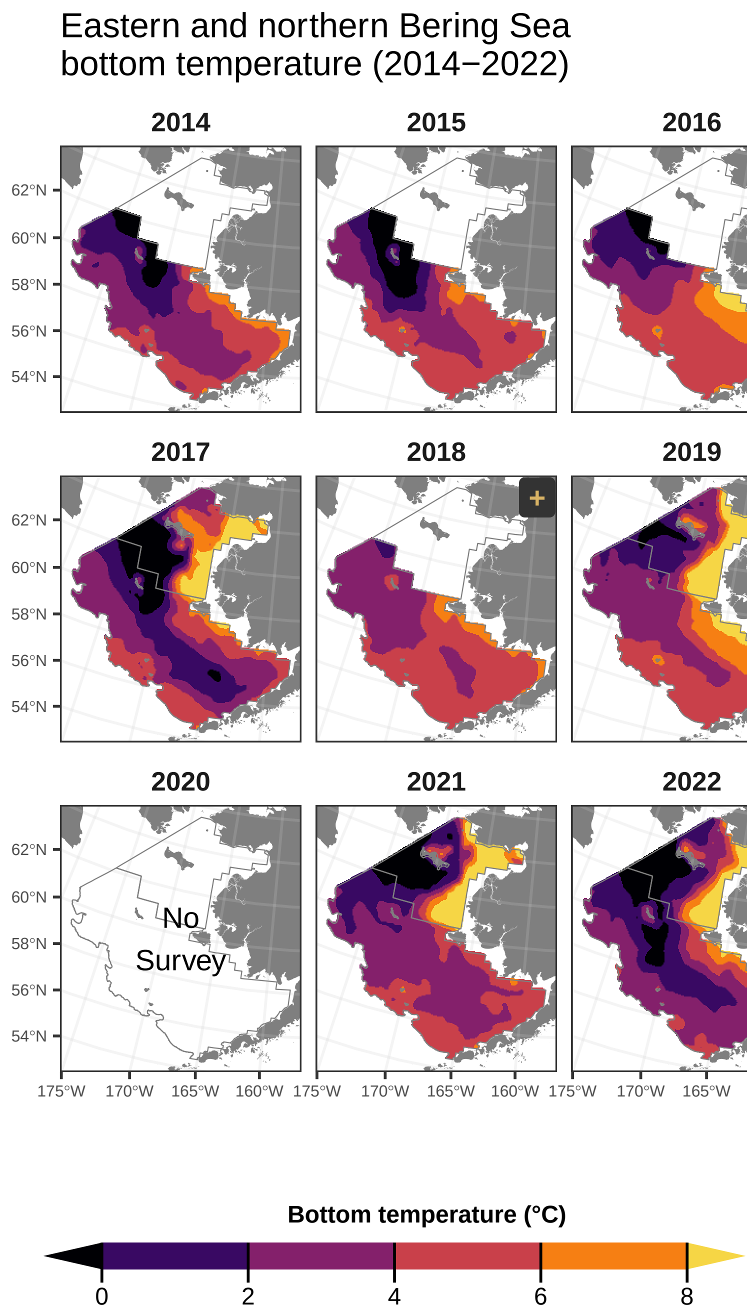

Figure 5: Bottom temperatures (°C) during the 2014-2022 eastern and northern Bering Sea shelf bottom trawl surveys. Years in which the mean bottom temperature is 1 or more standard deviations above or below the time-series mean bottom temperature are denoted with '+' and '-' in the upper right-hand corner of each subplot, respectively.

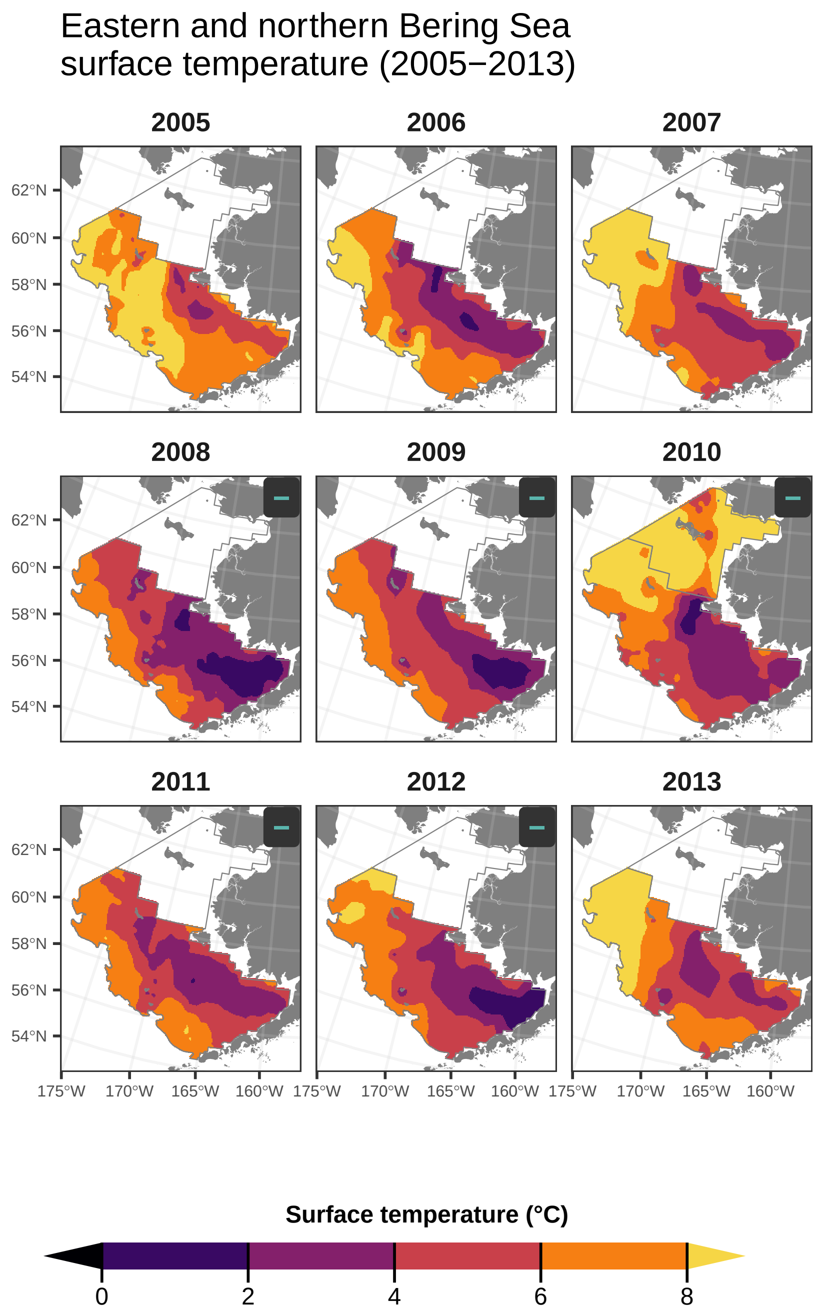

Figure 6: Surface temperatures (°C) during the 2005-2013 eastern and northern Bering Sea shelf bottom trawl surveys. Years in which the mean surface temperature is 1 or more standard deviations above or below the time-series mean surface temperature are denoted with '+' and '-' in the upper right-hand corner of each subplot, respectively.

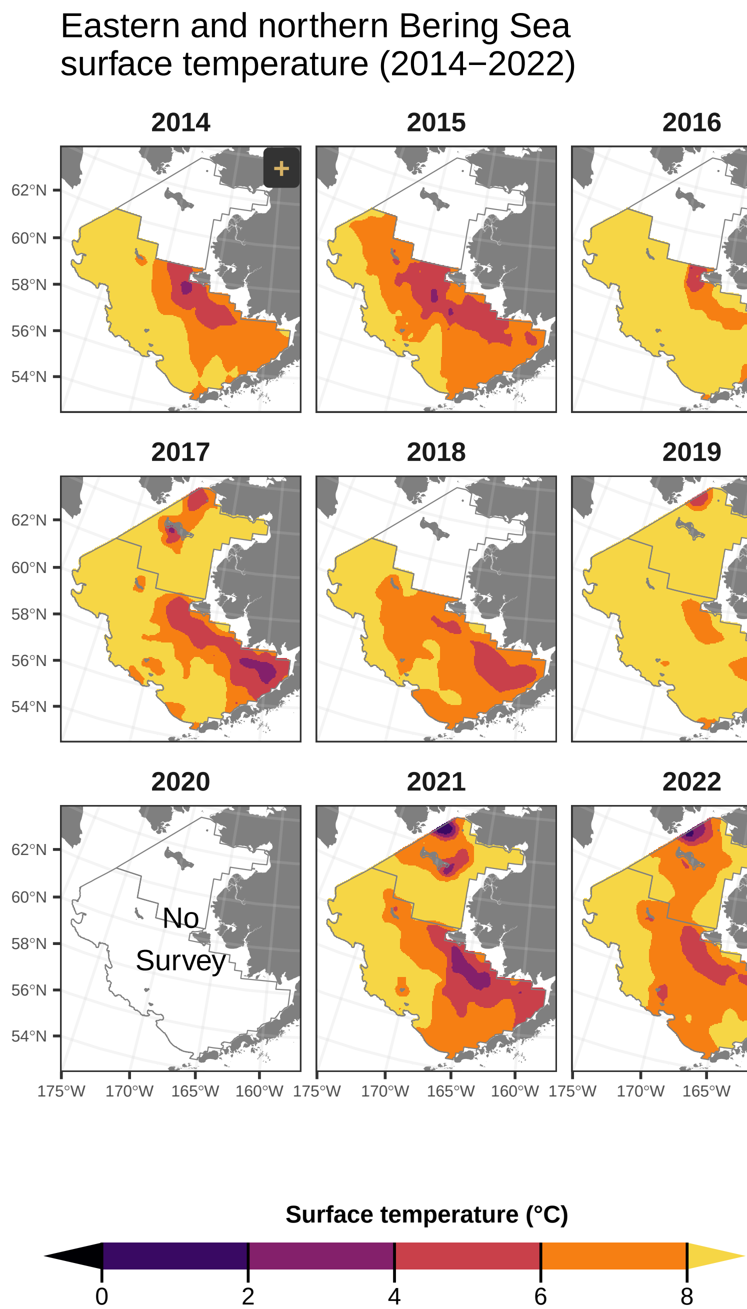

Figure 7: Surface temperatures (°C) during the 2014-2022 eastern and northern Bering Sea shelf bottom trawl surveys. Years in which the mean surface temperature is 1 or more standard deviations above or below the time-series mean surface temperature are denoted with '+' and '-' in the upper right-hand corner of each subplot, respectively.

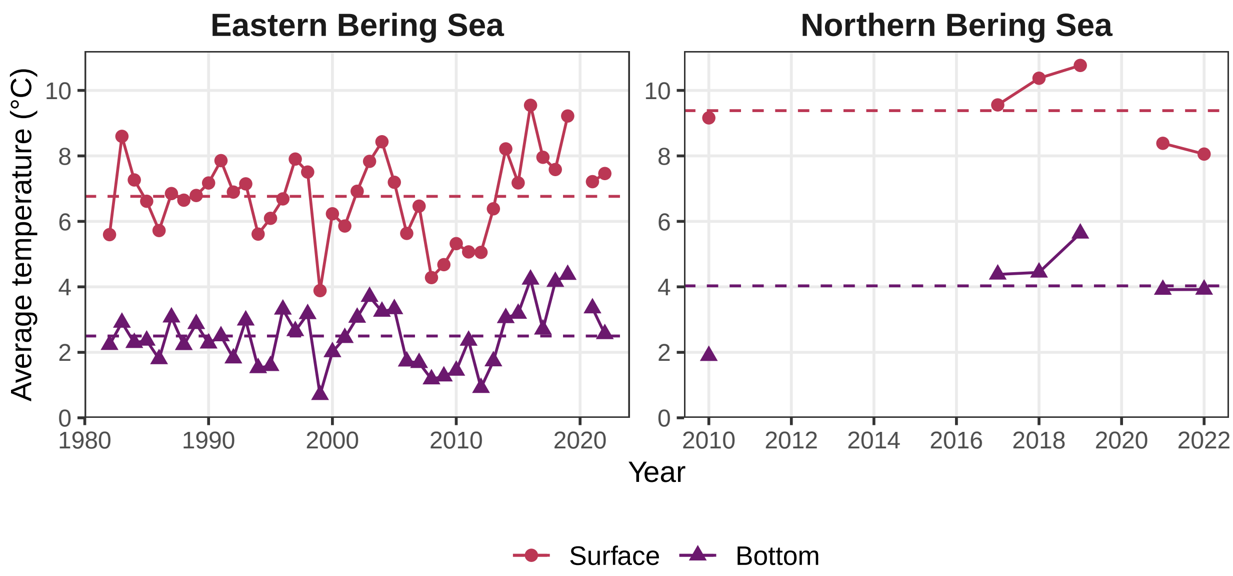

Figure 8: Average summer surface and bottom and time-series average surface and bottom (dashed lines) temperatures (°C) on the eastern Bering Sea shelf, based on data collected during standardized summer bottom trawl surveys from 1982–2022 (left), and northern Bering Sea shelf based on data collected during standardized summer bottom trawl surveys (right).

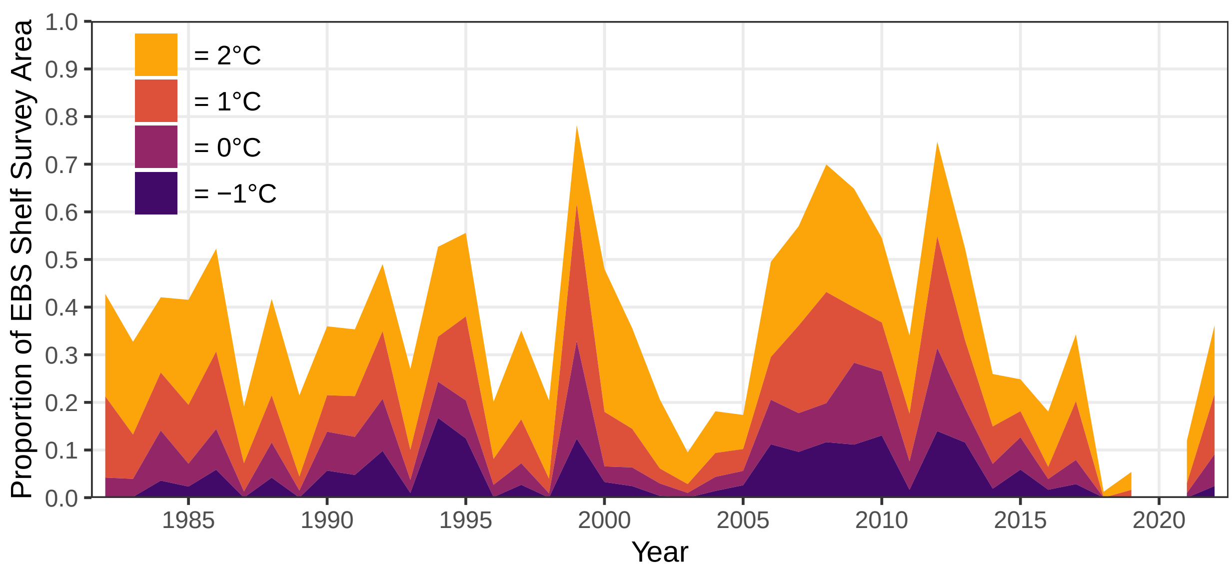

Figure 9: Annual summer cold pool extent on the EBS shelf, based on observations from the EBS bottom trawl survey. The extent of the cold pool is shown as a percentage of the total southern EBS shelf survey area. Shading denotes near-bottom temperatures 2°C, 1°C, 0°C, and -1°C.

jellyfish, northern Neptune whelk, northern rock sole, other crabs, other sea stars, other snails, other tunicates, plain sculpin, purple-orange sea star, sea urchins, snow crab, starry flounder, walleye pollock, and yellowfin sole, extended throughout much of both survey regions. Several key fish species were found in the NBS in greater numbers than the EBS, including Alaska plaice, Arctic cod, Bering flounder, Pacific capelin, Sakhalin sole, all pricklebacks, greenlings, rainbow smelt, saffron cod, sand lances, shorthorn sculpin, smelts (*Osmeridae*) include eulachon, capelin, and rainbow smelt, snailfishes, starry flounder, variegated snailfish, and wolffishes.

Detailed summary profiles outlining several of the species showing ecologically significant trends are discussed in Table @ref(tab:tab-majortaxa-pchange).

Table 1: Total estimated biomass in metric tons (t) and the percent change between the 2021 and 2022 northern Bering Sea shelf bottom trawl surveys for predominant fish and invertebrate taxa. Crab data are summarized under other crabs and discussed in detail in the annual crab Technical Memorandum produced by the Shellfish Assessment Program.

Common name	**2010**	**2017**	**2019**	**2021**	**2022**
all sponges	15,655	23,569	2,368	1,009	15,558
other poachers	193	767	379	157	454
sea urchins	50,258	166,765	89,965	54,751	155,790
clams, mussels, scallops	2,475	4,993	6,662	2,417	6,348
greenlings	34	353	1,496	154	316
snailfishes	3,305	4,864	777	329	630
other crabs	62,763	33,861	27,911	54,166	85,003
other sculpins	984	1,509	587	628	870
other sea stars	106,616	103,126	84,669	79,318	107,545
jellyfish	12,862	66,295	88,795	21,959	28,510
yellowfin sole	427,374	434,088	520,031	496,045	548,027
other snails	42,473	73,193	47,515	44,473	46,891
other flatfishes	37	401	1,266	134	136
eelpouts	10,666	9,760	1,707	425	417
flathead sole	-	79	463	138	126
Pacific halibut	23,333	18,508	25,722	25,995	22,940
Alaska plaice	302,979	330,733	321,575	344,581	299,028
walleye pollock	21,142	1,319,140	1,167,131	474,467	394,585
smelts	16,378	5,260	4,891	1,950	1,439
Bering flounder	12,355	19,804	18,526	8,384	5,913
Pacific cod	29,126	287,551	365,005	227,582	153,735
Alaska skate	76,942	83,255	95,104	80,207	48,920
northern rock sole	21,256	55,467	99,040	76,631	46,443

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Common name	2010	2017	2019	2021	2022
arrowtooth flounder	-	-	1,443	1,740	409

Table 2: Total estimated biomass in metric tons (t) and the percent change between the 2021 and 2022 eastern Bering Sea shelf bottom trawl surveys for predominant fish and invertebrate taxa. Crab data are summarized under other crabs and discussed in detail in the annual crab Technical Memorandum produced by the Shellfish Assessment Program.

Common name	2010	2017	2019	2021	2022
Pacific ocean perch	341	33,661	5,367	3,342	126,805
other poachers	874	756	1,462	1,149	2,595
other flatfishes	2,173	11,387	24,253	16,419	28,431
jellyfish	182,179	40,476	247,056	74,162	126,395
all sponges	175,294	143,533	60,086	8,907	14,644
walleye pollock	3,729,191	4,815,704	5,452,009	3,030,988	4,153,971
sea urchins	43,886	34,960	31,304	22,076	29,150
yellowfin sole	2,388,161	2,805,165	2,017,620	1,633,968	2,039,968
northern rock sole	2,081,754	1,341,346	983,377	1,041,169	1,294,581
eelpouts	30,238	45,870	35,486	37,776	45,571
Alaska plaice	499,392	491,978	369,436	335,034	385,294
arrowtooth flounder	525,732	422,368	576,230	457,569	521,615
Pacific halibut	196,385	127,124	114,266	131,864	149,064
other crabs	42,189	42,669	18,170	13,797	14,933
Pacific cod	872,777	644,508	517,141	616,380	647,400
other snails	249,575	472,833	405,210	397,589	416,964
flathead sole	487,954	537,693	611,245	674,745	703,375
Alaska skate	366,930	545,059	490,420	468,113	463,017
other sea stars	150,949	250,525	273,453	282,839	271,651
clams, mussels, scallops	5,588	10,569	7,085	15,000	14,259
Kamchatka flounder	58,102	47,893	44,636	32,856	29,699
snailfishes	4,104	1,580	645	769	630

Table 2: Total estimated biomass in metric tons (t) and the percent change between the 2021 and 2022 eastern Bering Sea shelf bottom trawl surveys for predominant fish and invertebrate taxa. Crab data are summarized under other crabs and discussed in detail in the annual crab Technical Memorandum produced by the Shellfish Assessment Program.

Common name	2010	2017	2019	2021	2022
greenlings	385	1,452	359	578	439
smelts	9,904	1,966	1,961	766	561
Bering flounder	11,826	27,340	8,251	9,511	6,237
other sculpins	8,309	3,387	2,224	3,953	2,497
squids	51	53	35	142	39

Table 3: Total estimated biomass in metric tons (t) and the percent change between the 2021 and 2022 northern Bering Sea shelf bottom trawl surveys for predominant fish and invertebrate taxa. Crab data are summarized under other crabs and discussed in detail in the annual crab Technical Memorandum produced by the Shellfish Assessment Program.

Common name	2010	2017	2019	2021	2022
all sponges	15,655	23,569	2,368	1,009	15,558
other poachers	193	767	379	157	454
sea urchins	50,258	166,765	89,965	54,751	155,790
clams, mussels, scallops	2,475	4,993	6,662	2,417	6,348
greenlings	34	353	1,496	154	316
snailfishes	3,305	4,864	777	329	630
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jellyfish	12,862	66,295	88,795	21,959	28,510
yellowfin sole	427,374	434,088	520,031	496,045	548,027
other snails	42,473	73,193	47,515	44,473	46,891
other flatfishes	37	401	1,266	134	136
eelpouts	10,666	9,760	1,707	425	417
flathead sole	-	79	463	138	126
Pacific halibut	23,333	18,508	25,722	25,995	22,940
Alaska plaice	302,979	330,733	321,575	344,581	299,028
walleye pollock	21,142	1,319,140	1,167,131	474,467	394,585

Table 3: Total estimated biomass in metric tons (t) and the percent change between the 2021 and 2022 northern Bering Sea shelf bottom trawl surveys for predominant fish and invertebrate taxa. Crab data are summarized under other crabs and discussed in detail in the annual crab Technical Memorandum produced by the Shellfish Assessment Program.

Common name	2010	2017	2019	2021	2022
smelts	16,378	5,260	4,891	1,950	1,439
Bering flounder	12,355	19,804	18,526	8,384	5,913
Pacific cod	29,126	287,551	365,005	227,582	153,735
Alaska skate	76,942	83,255	95,104	80,207	48,920
northern rock sole	21,256	55,467	99,040	76,631	46,443
arrowtooth flounder	-	-	1,443	1,740	409

Summary Results for Select Major Taxa[1]

Survey results for select taxa are presented with a photograph of the species or taxonomic group, maps of geographic distribution of CPUE (kg/ha), total abundance-at-size plots, and text summaries of results. Geographic maps of species distributions include both the EBS and NBS survey regions to better illustrate patterns and trends in fish distribution and movement. For comparison, distribution maps and abundance-at-size plots show survey data for the 2010, 2017, 2019, 2021, and 2022 surveys.

[1] You can help us with this document by providing names in local language(s) and cultural or traditional uses for each fish and invertebrate species reviewed in this report.