2023 Bering Sea and Aleutian Islands forage report

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Contents

Executive summary

This forage species report for the Bering Sea and Aleutian Islands (BSAI) region is prepared and presented to the BSAI Plan Team and the North Pacific Fishery Management Council (NPFMC) in odd years. This report is not a formal stock assessment; it is a presentation of the available data on trends in abundance and distribution of forage populations and a description of their interactions with federal fisheries through bycatch.

Forage species are a fundamental component of the BSAI ecosystem, so there is overlap between the information presented here and in the Ecosystem Considerations report (https://access.afsc.noaa.gov/reem/ecoweb/index.php). This forage report primarily displays data from the BSAI bottom trawl surveys and BASIS surface water surveys. The Ecosystem Considerations report contains euphausiid abundances from acoustic surveys and indirect indicators of forage species abundance such as seabird breeding success and groundfish predator diets.

Estimated capelin and eulachon density and prevalence from the NMFS bottom trawl surveys were near all time lows in 2023. Pacific herring density and prevalence has been above average for the last several years. Shrimp densities have been trending upward since the mid-1990s; prevalence peaked in 2010. Magistrate armhook squid density in the Aleutian Islands was near average in 2022. The Bering Arctic Subarctic Integrated Survey (BASIS) forage index was near all-time lows in 2023.

Total incidental catches of the FMP forage group were low in 2022 and 2023 compared to historical values. Total shrimp catches decreased in 2022, but were near all time highs in 2023. Prohibited species catch of herring has been higher than average since 2020, with the third highest catches ever observed in 2023.

A. Forage species and their management

Defining 'forage species' can be difficult. Small, energy-rich schooling fishes like sardines or herring are the classic 'forage fish', but most fish species experience predation in their life cycle. Forage species can be thought of as those whose primary ecosystem role is as prey and serve as a link between lower and upper trophic levels. The following species or groups are defined as components of the forage base in the BSAI: members of the 'forage fish group' listed in the BSAI Fishery Management Plan, squids, shrimps, Pacific herring (*Clupea pallasii*), Arctic cod (*Boreogadus saida*), and juvenile groundfishes and salmon.

Forage fish groups

Forage fishes in the BSAI were either managed as part of the Other Species group (non-target species caught incidentally in commercial fisheries) or were classified as "non-specified" in the Fishery Management Plan (FMP), with no conservation measures prior to 1998. Amendment 36 to the BSAI FMP created a separate forage fish category in 1998, with conservation measures that included a ban on directed fishing. Members of this forage fish group (the "FMP forage group" in this report) are considered "Ecosystem Components" beginning in 2011. The group is large and diverse, containing over fifty species from these taxonomic groups (see the appendix at the end of this report for a full list of species), but some of the key groups include:

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

The primary motivation for the creation of the FMP forage group was to prevent fishing-related impacts to the forage base in the BSAI. This was an early example of ecosystem-based fisheries management (Livingston et al. 2011). Two key management measures for the group are specified in section 50 CFR 679b20.doc of the federal code: a closure to direct fishing and a prohibition of the sale, barter, trade or processing of forage species. Fishmeal production and sale from forage species is allowed provided it does not exceed the maximum retainable bycatch. Catches are limited to a maximum retention allowance (MRA) of 2% by weight of the retained target species.

It appears the figure of '2%' was chosen to accommodate existing levels of catch that were believed to be sustainable (Federal Register, 1998, vol. 63(51), pages 13009-13012), which suggests the intent of amendment 36 was to prevent an increase in forage fish removals, not to reduce existing levels of catch. In 1999, the state of Alaska adopted a statute with the same taxonomic groups and limitations, except that no regulations were passed regarding the processing of forage fishes. This exception has caused some confusion regarding the onshore processing of forage fishes for human consumption (J. Bonney, pers. comm., Alaska Groundfish Databank, Kodiak, Alaska).

Pacific herring

Herring are abundant in Alaska marine waters. Commercial fisheries in the BSAI, mainly for herring roe, exist along the western coast of Alaska from Port Moller north to Norton Sound (Figure 1). These fisheries target herring returning to nearshore waters for spawning, and herring in different areas are managed as separate stocks. The largest stock in the BSAI spawns in Togiak Bay in northern Bristol Bay; the next largest stock is in Norton Sound (data can be retrieved at www.adfg.alaska.gov). Herring are hypothesized to migrate seasonally between their spawning grounds and two overwintering areas in the outer domain of the eastern Bering Sea (EBS) continental shelf (Figure 1; Tojo et al. 2007). The herring fisheries are managed by the Alaska Department of Fish & Game (ADFG) which uses a combination of various types of surveys and population modeling to set catch limits. In federal fisheries, herring are managed as Prohibited Species, which means directed fishing is banned and any bycatch must be returned to the sea immediately. The amount of herring bycatch allowed is also capped and if the cap is exceeded the responsible target fishery is closed in special Herring Savings Areas (Figure 2) to limit further impacts. In the BSAI, the Prohibited Species Catch Quota for herring is calculated as 1% of the estimated annual biomass of herring in the eastern Bering Sea.

Juvenile groundfishes and salmon

Members of this group, particularly age-0 and age-1 walleye pollock, *Gadus chalcogrammus*, are key forage species in the BSAI. As they are early life stages of important commercially fished species, however, their status is dependent on the assessment and management of the recruited portion of the population. Detailed information regarding these species is available in NPFMC stock assessments (http://www.afsc.noaa.gov/refm/stocks/assessments.htm) and ADFG reports (www.adfg.alaska.gov). These fishes are also included in the BASIS survey to some extent, described below.

Shrimp

A variety of shrimps occur in the BSAI. Members of the family Pandalidae are generally found in offshore waters while shrimps of the family Crangonidae are distributed mainly in nearshore waters. Commercial fisheries for shrimps are managed by ADFG and are currently closed in the BSAI. Further information on shrimps in Alaska waters is available from ADFG (www.adfg.alaska.gov). This report includes data regarding catches of pandalid shrimps in federal groundfish fisheries.

Squids

Several species of squid inhabit the BSAI, mainly along the shelf break. Squids were managed as part of the 'Other Species' complex before 2011; starting in 2011, they were managed as a target stock complex with annual harvest specifications. However, in June 2017, the NPFMC amended the FMP for the Bering Sea and Aleutian Islands (BSAI; Amendment 117) and BSAI (Amendment 106) to move the squid stock complex into the Ecosystem Component category. The rationales for this decision included: the lack of a directed fishery for squid, low risk of overfishing given high productivity and no directed fishery, and small incidental fishing mortality.

The amendments were implemented in the Federal Register with an effective date of August 8, 2018 (Federal Register, Volume 83, Number 130, July 6 2018, pages 31460-31470). The amendments placed squid in the Ecosystem Component category, prohibited a directed fishery for squid, established a 20% maximum retention allowance, and established record keeping requirements. The new management regime was implemented in January 2019.

Arctic cod

Arctic cod is not currently included in the FMP for the BSAI. It is primarily a cold-water species with a northern distribution in the EBS, generally captured in bottom trawl surveys north of 59°N latitude. In the Alaskan Arctic it is likely the dominant prey species, and the Arctic FMP prohibits directed fishing for Arctic cod due to ecosystem concerns. As fish distributions and fishing locations shift, conservation measures for Arctic cod in the BSAI may become necessary. Further information is available at http://www.npfmc.org/arctic-fishery-management/.

B. Trends in density, prevalence, and distribution

Information content of data sources

The primary data source for this report is the bottom trawl survey, but this survey is not aimed at sampling the water column (where many forage species reside) and is not designed to capture small fish. Consequently, measures of density, prevalence, and distribution are uncertain. The goal of this report is to present the data from the bottom trawl survey for forage species while understanding the potential shortcomings of the survey for this task. The BASIS survey samples surface waters and presumably samples pelagic forage species better than the bottom trawl, but it has not been performed as long so does not provide the contrast the bottom trawl might.

Methods

NMFS bottom trawl surveys

For most of this section, data are from bottom trawl surveys conducted by the AFSC on the EBS shelf (annual), the EBS slope (biennial) and in the AI (biennial; methods and data at: http://www.afsc.noaa.gov/RACE/groundfish/default.php). The standardized EBS shelf survey began in 1982 but some work using similar gear was conducted prior to 1982; the EBS slope and AI surveys have occurred biennially since the early 2000s. These surveys are conducted from May to August. The survey was expanded to the north in 1987, so densities and prevalence before 1988 should be considered with this in mind. In 2010, the AFSC began to conduct an additional survey to the north of the 1987 survey area, comprising all waters south of Bering Strait including Norton Sound. Due to the loss of seasonal sea ice and corresponding changes in fish distribution this northern survey is conducted regularly as of 2017 and will likely be increasingly important in ecosystem understanding.

Surface trawl surveys are also conducted by the AFSC Ecosystem Monitoring and Assessment (EMA) program (Yasumiishi et al. 2017). This survey has been conducted every year since 2003, although the extent and density of stations sampled has varied among years. The abundance index derived from this survey for forage species is a standardized geostatistical index (VAST) developed by Thorson et al. (2015) to estimate indices of abundance for stock assessments. The survey occurs primarily in September, with sampling during August and October in some years.

BASIS surveys

Annual indices of juvenile groundfish, juvenile salmon, forage fish, and jellyfish biomass (metric tonnes) and abundance (numbers) of juvenile sockeye salmon (*O. nerka*) in surface waters were estimated for the Alaska Fisheries Science Centers' (AFSC) Bering Arctic Subarctic Integrated Survey (BASIS). BASIS is an integrated fisheries oceanography survey in the south- and northeastern Bering Sea during late summer, 2003-2023. Primary fish caught include age-0 Pacific cod (*Gadus macrocephalus*), age-0 pollock (*Gadus chalcogrammus*), capelin (*Mallotus villosus*), Pacific herring (*Clupea pallasii*), juvenile Chinook salmon (*Oncorhynchus tshawytscha*), juvenile sockeye (*O. nerka*), juvenile chum salmon (*O. keta*), juvenile pink salmon (*O. gorbuscha*), juvenile coho salmon (*O. kisutch*), and saffron cod (*Eleginus gracilis*), also used as the index for total forage fish.

Pelagic fish were sampled using a trawl net towed in the upper 25 m. For the estimates of species abundance, the BASIS survey (373,404 km2) was south to north from 54.54° to 59.50° west to east from -173.08° to -159.00° for years 2002-2012, 2014, 2016, 2018, and 2022. The northern Bering Sea survey (197,868 km2) was within the region south to north from 59.97° to 65.50° west to east from -172.00° to -161.50° for years 2003-2007, 2009-2019, 2021-2023. A trawl was towed for approximately 30 minutes. Area swept was estimated from horizontal net opening and distance towed. Next year, authors plan to present density rather than biomass and abundance estimates to account for differences in survey area in the north and south

Annual indices of relative biomass and numbers (abundance) were estimated using a single-species spatio-temporal model with the VAST package version 3.10.1, INLA version 22.04.16, TMB version 1.9.2, FishStatsUtils version 2.12.1, R software version 4.11.3, and RStudio version 2023.06.1 (R Core Team 2023, Thorson 2015; Thorson and Kristensen 2016, Thorson 2019). We used the VAST package to reduce bias in biomass estimates due to spatially unbalanced sampling across years, while propagating uncertainty resulting from predicting density in unsampled areas. Spatial and spatio-temporal variation for both encounter probability and positive catch rate components were specified at a spatial resolution of 500 knots. We used a Poisson-link, or conventional, delta model and a gamma distribution to model positive catch rates and specified a bias-corrected estimate (Thorson 2019). Parameter estimates were within the upper and lower bounds and final gradients were less than 0.0005. Julian day was added as a normalized covariate with a spatially constant and linear response due to changes in the timing of the survey among years. Time series estimates of capelin and herring abundance changed due to a change in model specification in 2023 from a log normal to gamma distribution for positive catch rates.

Pacific capelin

Capelin are distributed primarily in the inner domain of the EBS shelf (Figure 3). The pattern of CPUE varies substantially between the surface and bottom trawl surveys, with catches in the BASIS survey occurring further north than in the EBS trawl survey (Yasumiishi et al. 2017). The reason for these differences is not clear. In the bottom trawl survey, biomass estimates are variable but there also appear to be decadal signals in density (Figure 4). Recent densities and prevalence in the bottom trawl survey were near or at all-time lows (Figure 4).

Eulachon

Eulachon tend to occur deeper in the water column and are more likely to be associated with the bottom than other forage species. As a result the bottom trawl surveys sample eulachon more effectively than other forage species, and eulachon are essentially absent from the BASIS surface trawls. Eulachon are consistently distributed in the extreme southern portion of the outer EBS shelf (Figure 5). Decadal signals also appear in survey density estimates for eulachon (Figure 6). Recent densities and prevalence for eulachon in the bottom trawl survey were at or near all-time lows (Figure 6).

Rainbow smelt

Rainbow smelt are rare in the bottom trawl survey, unless the northern Bering Sea (NBS) data are included (Figure 7). The highest abundance of rainbow smelt is in the NBS and particularly Norton Sound (Figure 8). Rainbow smelt are often found in shallow nearshore waters, so this apparent distribution may not be fully representative. For example, nearshore studies in northern Bristol Bay (Nushagak and Togiak bays) captured large number of rainbow smelt in multiple size classes (Ormseth, unpublished data). Prevalence and densities in the bottom trawl survey depend strongly on whether or not the NBS is sampled (Figure 8).

Pacific sand lance

Sand lances are difficult to sample due to their patchiness and behavior, which entails spending much of their time burrowed into sand. As a result, information for Pacific sand lance in the BSAI is limited. The bottom trawl survey suggests that they have a primarily inshore distribution in the EBS, particularly in areas with extensive sandy bottom substrates (Figure 9). They also occur in the AI, particularly in the islands west of Amchitka Pass (Figure 9). Densities and prevalence of sand lance have risen slightly since all-time lows in 2016, but are still beneath the long-term average (Figure 10).

Pacific sandfish

Similar to sand lance, sandfishes burrow into sandy substrates. This is reflected in their distribution which is centered in the shallow inshore waters of the EBS, in Bristol Bay and along the northern shore of the Alaska Peninsula (Figure 11). The BASIS surveys suggest a similar distribution (Yasumiishi et al. 2017). Unlike most of the other forage species, neither survey has found them north of Cape Romanzof (61°47' N), so this is likely the northern extent of their range. This is confirmed by historical reports (Mecklenburg et al. 2002). Densities and prevalence of sandfish have been beneath long-term averages for the last decade (Figure 12).

Lanternfishes

Myctophids are generally deep-water fishes (> 200 m depth), although diel migrations can bring them into surface waters. This is consistent with their distribution observed in BSAI survey data, where they occur on the EBS slope and along the shelf break and slope in the AI (Figure 13).

Pricklebacks, gunnels, blacksmelts, bristlemouths, eelblennies

These species occur infrequently in the AFSC surveys, either due to their small size or their preference for unsurveyed habitats (e.g. nearshore areas or deep pelagic waters). Several species of pricklebacks and eelblennies are observed in the bottom trawl surveys and are combined here to present more complete picture of their distributions and abundance. Pricklebacks and eelblennies appear to be more prevalent in the northern Bering Sea (Figure 14 & Figure 16). Prevalence and density of both pricklebacks and eeblennies are low outside of the NBS (Figure 15 & Figure 17).

Pacific herring

The spatial distribution of herring in the BSAI described by the bottom trawl survey and the BASIS survey differ and may result from seasonal herring movement. The bottom trawl survey occurs primarily in June and July and is likely capturing herring that are out-migrating from nearshore spawning areas; the areas of high CPUEs on the southern edge of the EBS and around Nunivak Island (Figure 18) are consistent with the movement patterns in (Figure 2). Herring density estimates and prevalence display high interannual variability with less of a decadal signal than other forage species and are both above the long-term mean over this biennial cycle (Figure 19).

Squid

Magistrate armhook squid (*Berryteuthis magister*) are regularly encountered by the Aleutian Islands bottom trawl survey because of their relatively large size (Figure 20; maximum mantle length of ~28 cm, Sealifebase.com). Smaller species and juvenile squid are mainly found near surface waters. Density and prevalence are strongly related to whether or not the Aleutian Islands are sampled (Figure 21). Recent densities are up slightly from values observed in 2000s, but prevalence has not markedly increased (Figure 21).

Shrimp

Observations of several shrimps are reported in the bottom trawl survey, including: unidentified pandalid shrimp, ocean shrimp, Alaska pink shrimp, sculptured shrimp, skeleton shrimp, coonstrip shrimp, humpy shrimp, opossum shrimp, Greenland shrimp, Aleutian coastal shrimp, sidestripe shrimp, and seven spine bay shrimp (among others). For this report, all shrimp were lumped together to represent the Bering Sea wide dynamics of shrimp. The highest densities of shrimp are consistently in the outer domain in deep waters (Figure 22). Average densities have trended upwards since the 1980s and prevalence peaked in the late-2000s (Figure 23).

BASIS forage index

During 2023, the biomass of forage fishes was low in pelagic waters of the northeastern Bering Sea during late summer, but increased slightly from 2022 (Figure 24). Temporal trends in forage fish biomass indicated higher productivity during the recent warm years (2014-2018) and lower during the cold years (2007-2013), especially for the southern forage fish. In the southern region, the trends in biomass were dominated by age-0 pollock (2004, 2005) and juvenile sockeye salmon (2014-2018) in the south and herring (2014-2019) in the northern region.

C. Bycatch and other conservation issues

FMP forage group

Osmerids regularly make up the vast majority of FMP forage fish group catches (Figure 25). Eulachon are the most abundant osmerid catch and it is likely that they make up the majority of the 'other osmerid' catch. Osmerid catches (and consequently total FMP forage group catches) have been low relative to historical levels (Figure 25). Other osmerids and shrimp accounted for almost all of the incidental catch in 2023. Squid catches since 2019 have been twice the historical maximums (Figure 26).

Pacific herring

The Prohibited Species Catch (PSC) of herring is generally low, with occasional larger catches (e.g. 1991, 2004, 2012, and 2020; Figure 27). Herring PSC in 2022 and 2023 was above the long-term mean. Most of the herring bycatch occurs in the midwater trawls for walleye pollock in the BSAI (Figure 27).

D. Future research directions

Given the change in authorship for the forage report, the goal for this year's report was to replicate the previous report with updated data with some small additions. However, future efforts will be aimed at developing synthetic (i.e. incorporating multiple data sources) indices of forage base and linking spatio-temporal changes in these indices to environmental variables.

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Table 1: A list of species designated as forage species.

Scientific.name	Common.name
Mallotus villosus	capelin
Hypomesus pretiosus	surf smelt
Osmerus mordax	rainbow smelt
Thaleichthys pacificus	eulachon
Spirinchus thaleichthys	longfin smelt
Spirinchus starksi	night smelt
Protomyctophum thompsoni	bigeye lanternfish
Benthosema glaciale	glacier lanternfish
Tarletonbeania taylori	taillight lanternfish
Tarletonbeania crenularis	blue lanternfish
Diaphus theta	California headlightfish
Stenobrachius leucopsarus	northern lampfish
Stenobrachius nannochir	garnet lampfish
Lampanyctus jordani	brokenline lanternfish
Nannobrachium regale	pinpoint lampfish
Nannobrachium ritteri	broadfin lanternfish
Leuroglossus schmidti	northern smoothtongue
Lipolagus ochotensis	popeye blacksmelt
Pseudobathylagus milleri	stout blacksmelt
Bathylagus pacificus	slender blacksmelt
Ammodytes hexapterus	Arctic sand lance
Ammodytes personatus	Pacific sand lance
Trichodon trichodon	Pacific sandfish
Arctoscopus japonicus	sailfin sandfish
Apodichthys flavidus	penpoint gunnel
Rhodymenichthys dolichogaster	stippled gunnel
Pholis fasciata	banded gunnel
Pholis clemensi	longfin gunnel
Pholis laeta	crescent gunnel
Pholis schultzi	red gunnel
Eumesogrammus praecisus	fourline snakeblenny
Stichaeus punctatus	arctic shanny
Gymnoclinus cristulatus	trident prickleback
Chirolophis tarsodes	matcheek warbonnet
Chirolophis nugatory	mosshead warbonnet
Chirolophis decoratus	decorated warbonnet
Chirolophis snyderi	bearded warbonnet
Bryozoichthys lysimus	nutcracker prickleback
Bryozoichthys majorius	pearly prickleback
Lumpenella longirostris	longsnout prickleback
Leptoclinus maculates	daubed shanny
Poroclinus rothrocki	whitebarred prickleback
Anisarchus medius	stout eelblenny
Lumpenus fabricii	slender eelblenny
Lumpenus sagitta	snake prickleback
Acantholumpenus mackayi	blackline prickleback
Opisthocentrus ocellatus	ocellated blenny
Alectridium aurantiacum	lesser prickleback
Alectrias alectrolophus	stone cockscomb
Anoplarchus purpurescens	high cockscomb

Scientific.name	Common.name
Anoplarchus insignis	slender cockscomb
Phytichthys chirus	ribbon prickleback
Xiphister mucosus	rock prickleback
Xiphister atropurpureus	black prickleback
Sigmops gracilis	slender fangjaw
Cyclothone alba	white bristlemouth
Cyclothone signata	showy bristlemouth
Cyclothone atraria	black bristlemouth
Cyclothone pseudopallida	phantom bristlemouth
Cyclothone pallida	tan bristlemouth
Euphausia pacifica	krill

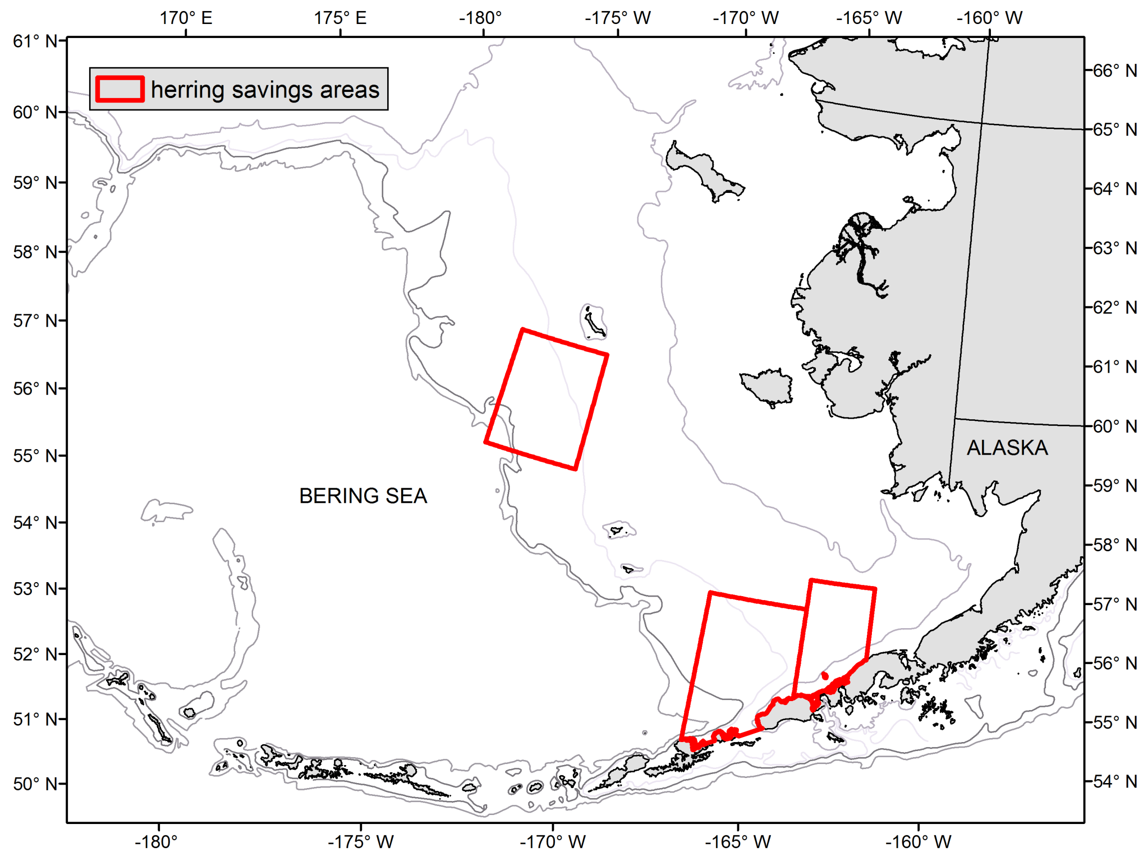

Figure 1: Locations of Pacific herring fisheries in the Bering Sea/Aleutian Islands region (yellow dots) and Herring Savings Areas (red-outlined polygons). The two largest herring fisheries are labeled by name; the larger dot at Togiak indicates that this is by far the biggest fishery.

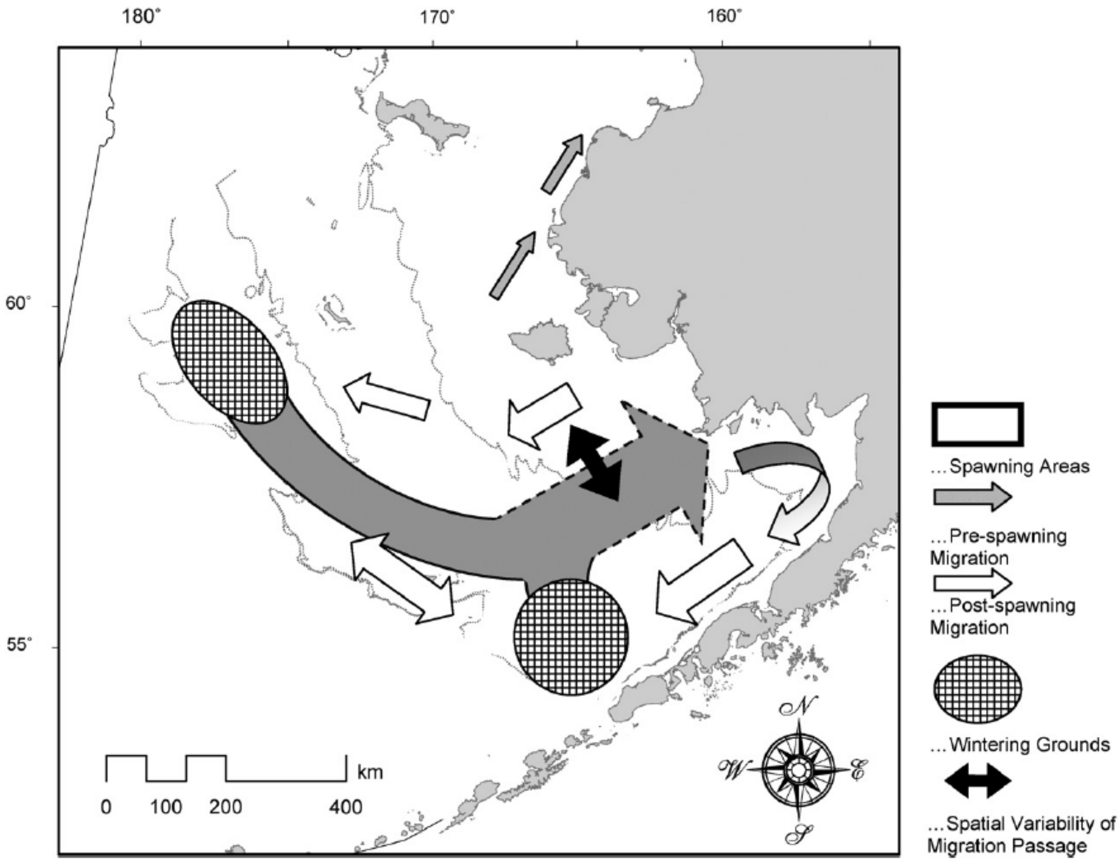

Figure 2: Hypothesized migration routes and seasonal distributions of Pacific herring in the eastern Bering Sea. Figure is from Tojo et al. 2007.

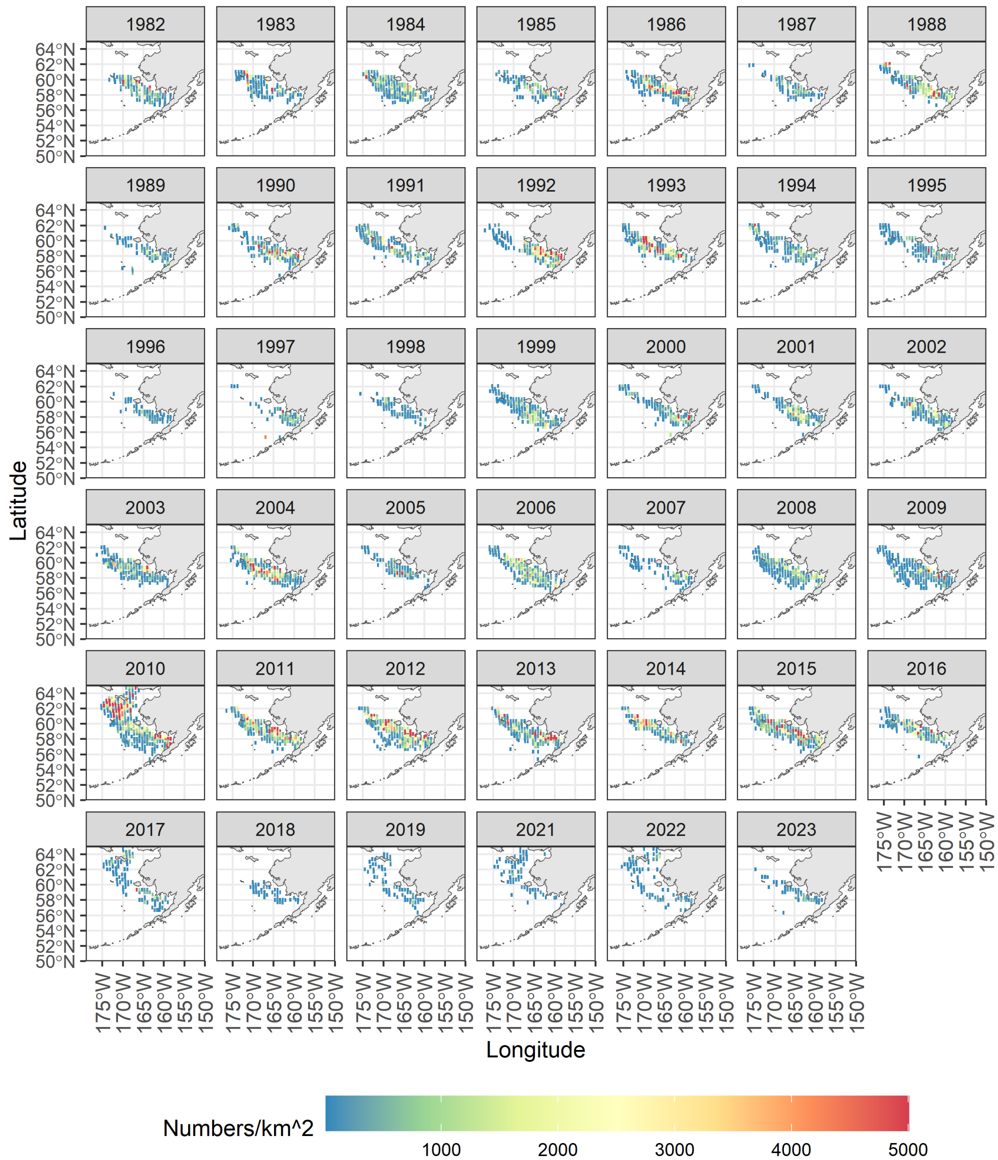

Figure 3: Map of distribution of prevalence and density from the all BSAI surveys for Pacific capelin (zoom for detail).

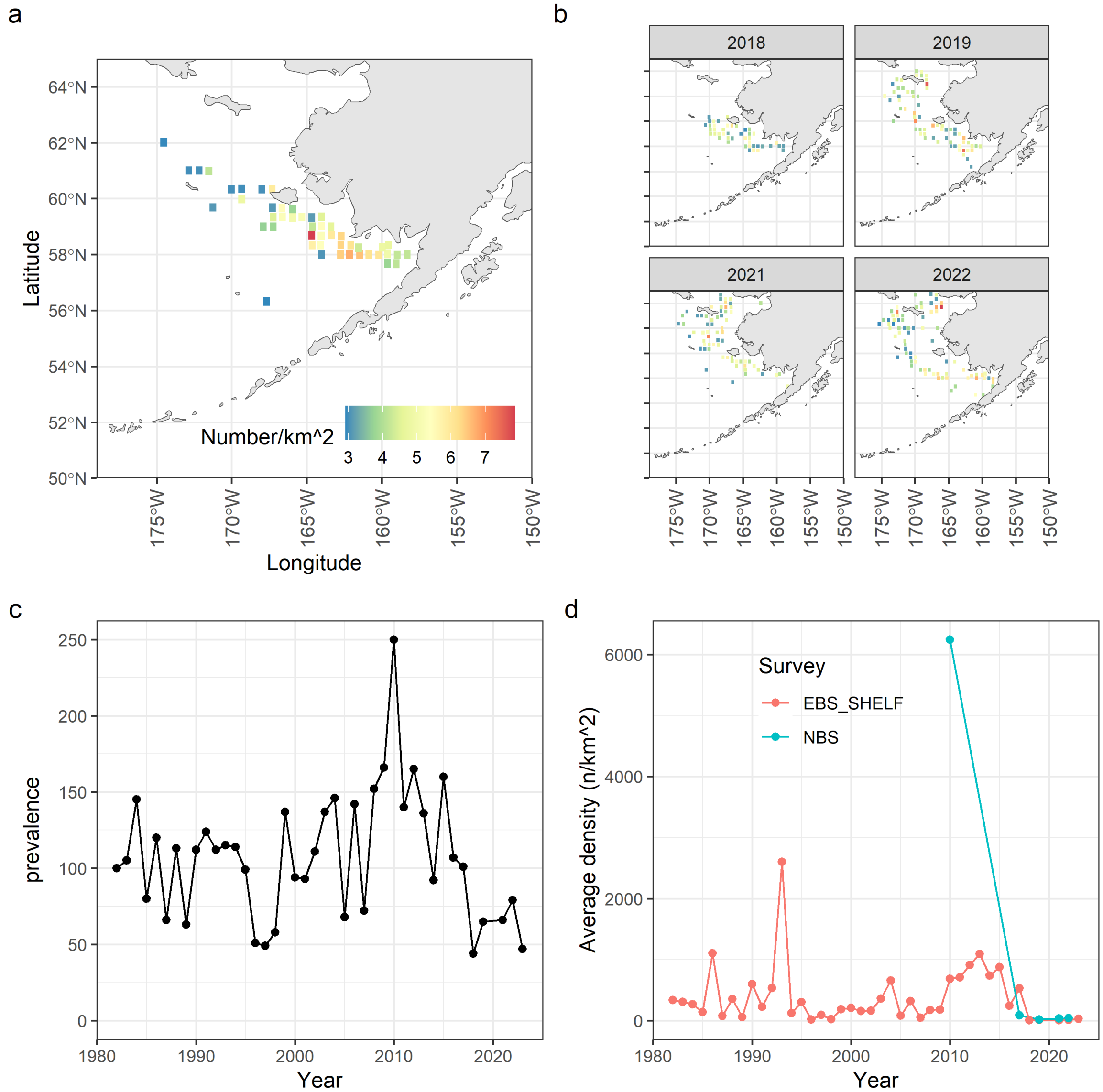

Figure 4: Pacific capelin survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

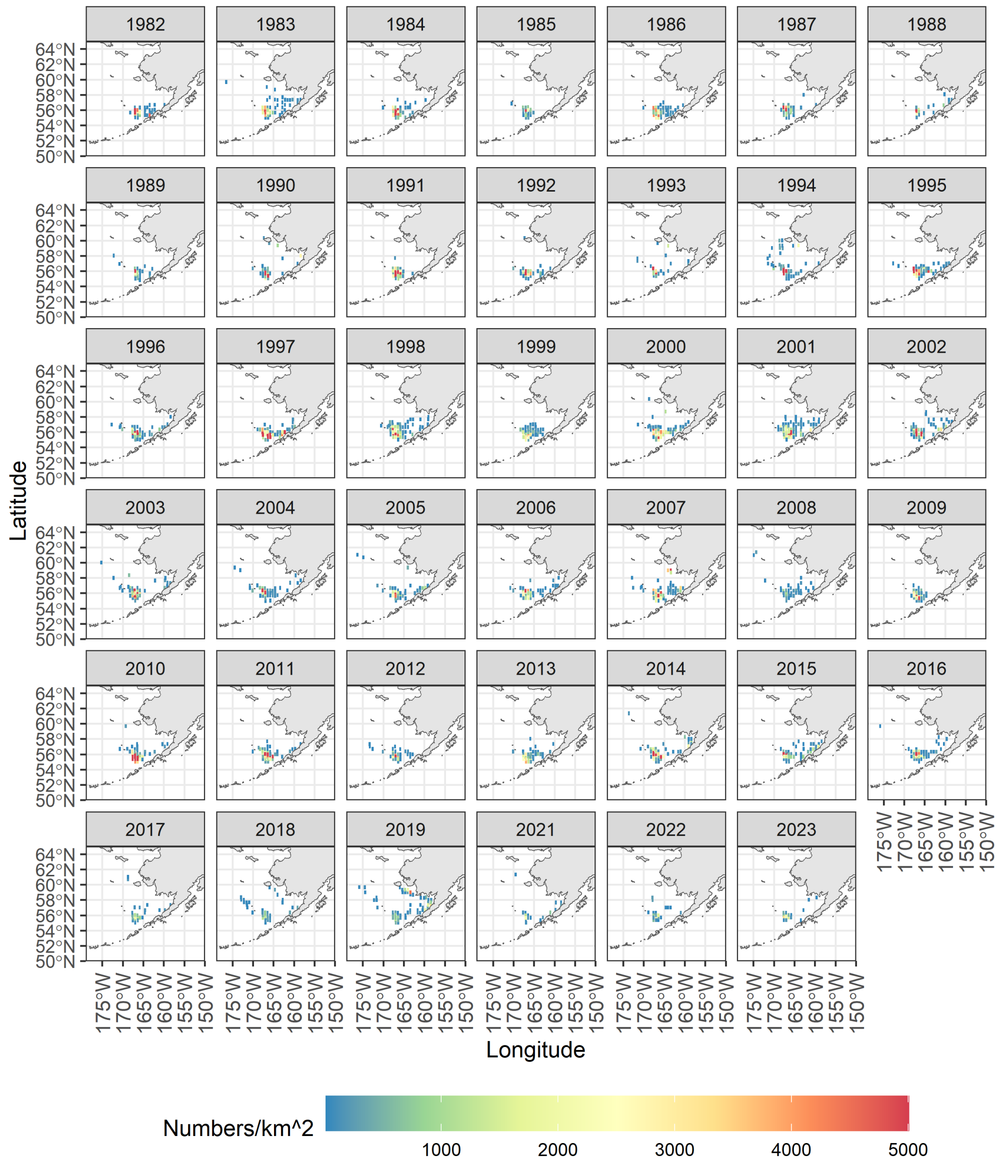

Figure 5: Map of distribution of prevalence and density from the all BSAI surveys for eulachon (zoom for detail).

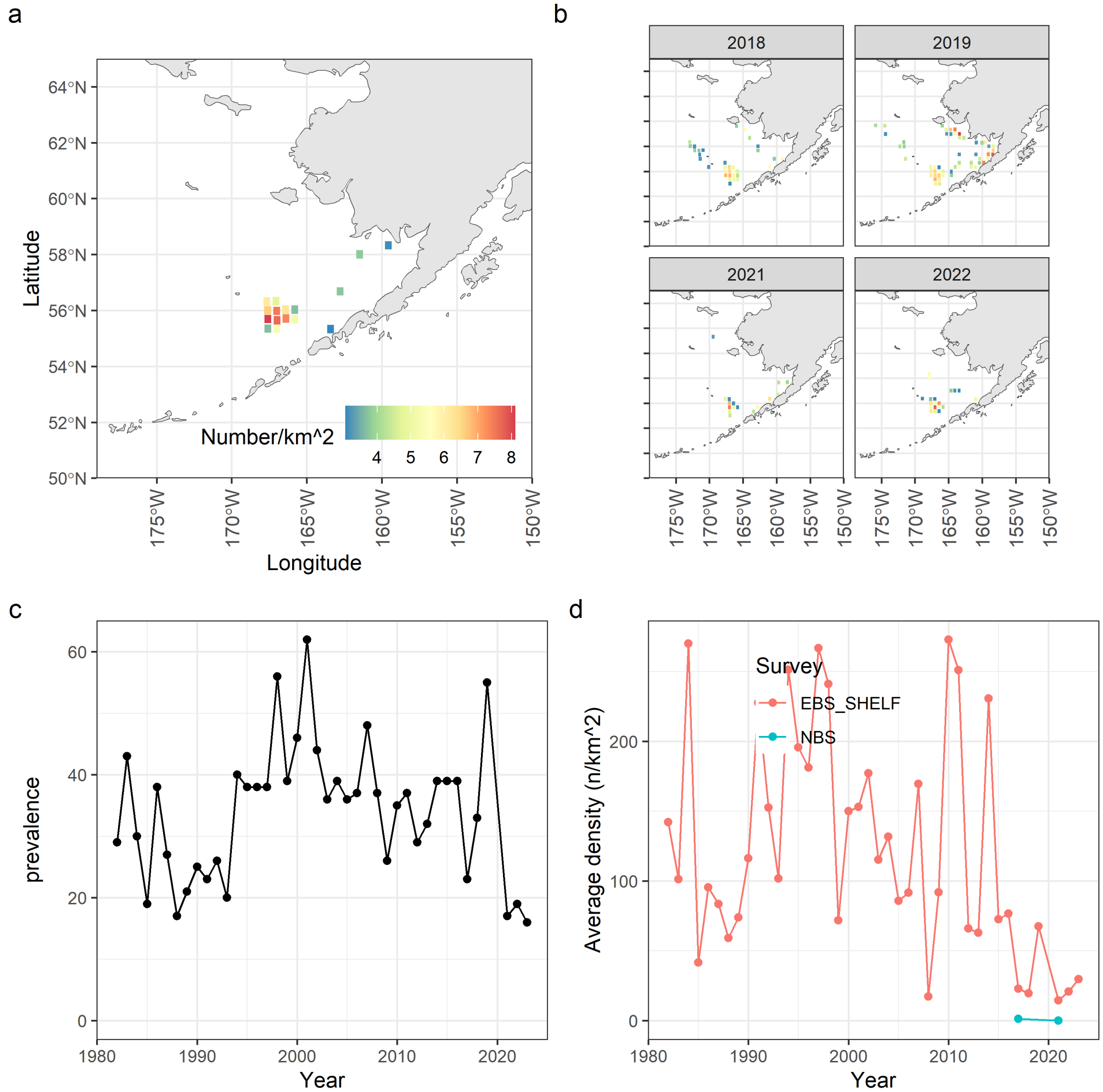

Figure 6: Eulachon survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

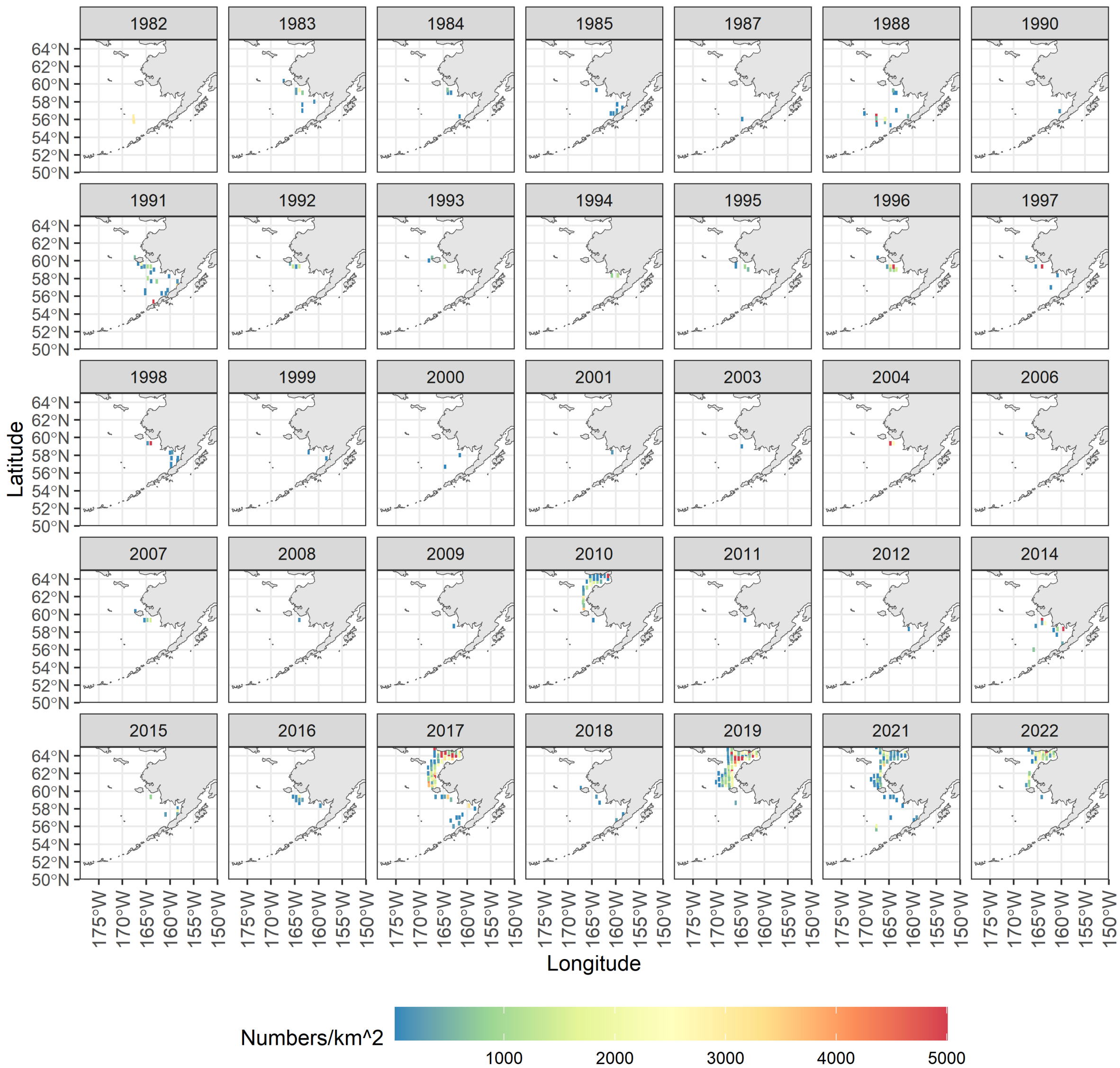

Figure 7: Map of distribution of prevalence and density from the all BSAI surveys for rainbow smelt(zoom for detail).

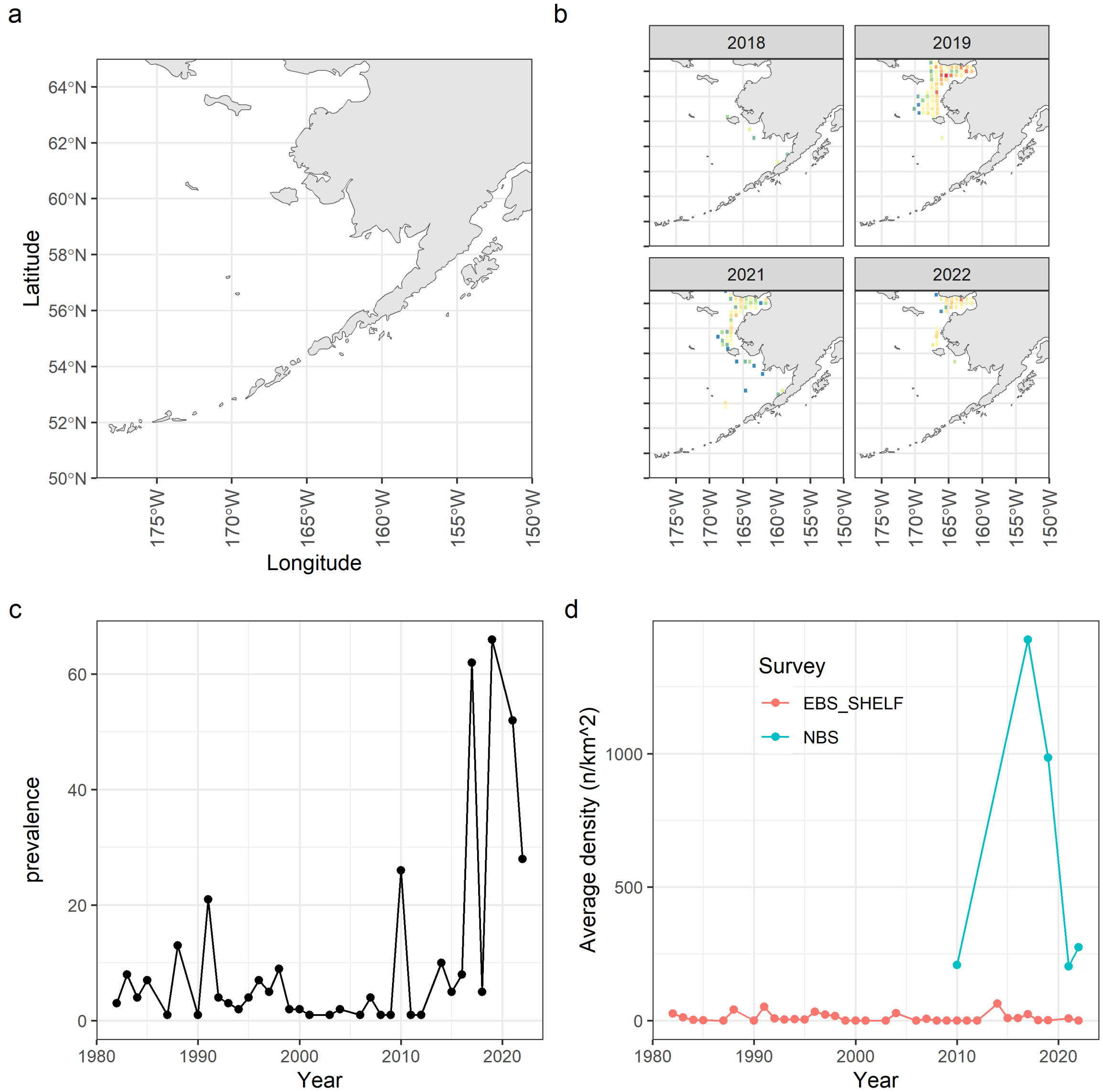

Figure 8: Rainbow smelt survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

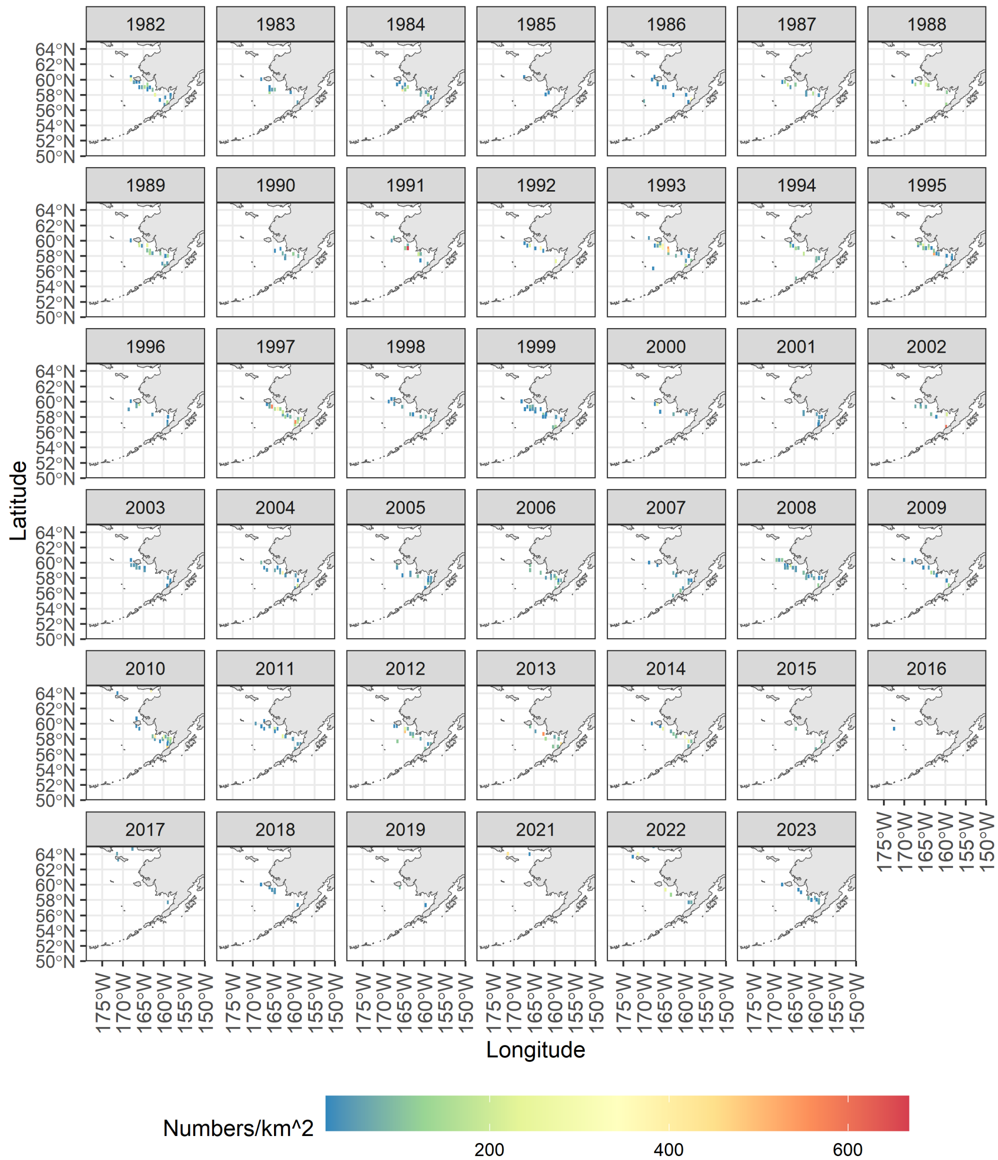

Figure 9: Map of distribution of prevalence and density from the all BSAI surveys for rainbow smelt(zoom for detail).

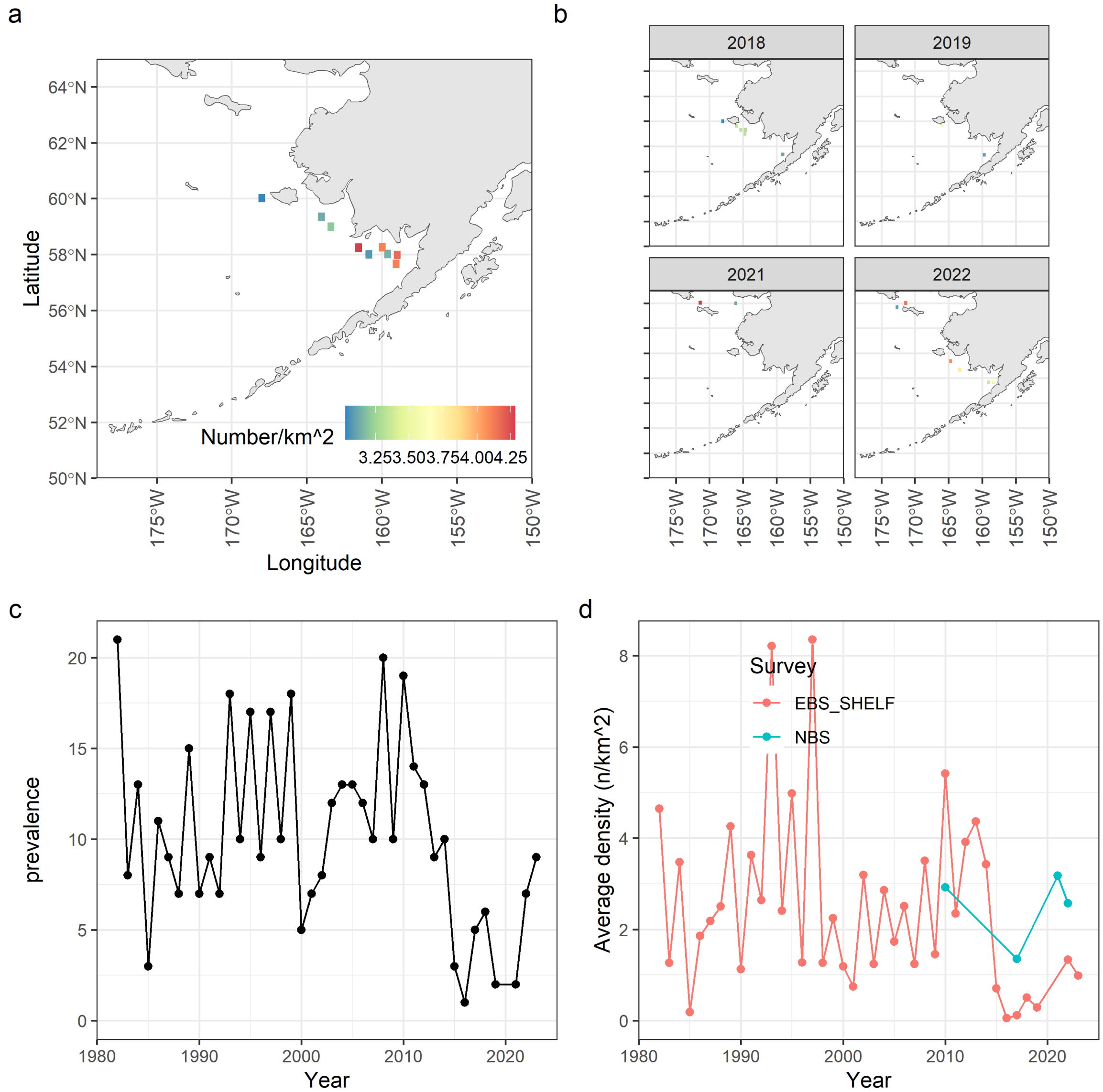

Figure 10: Pacific sand lance survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

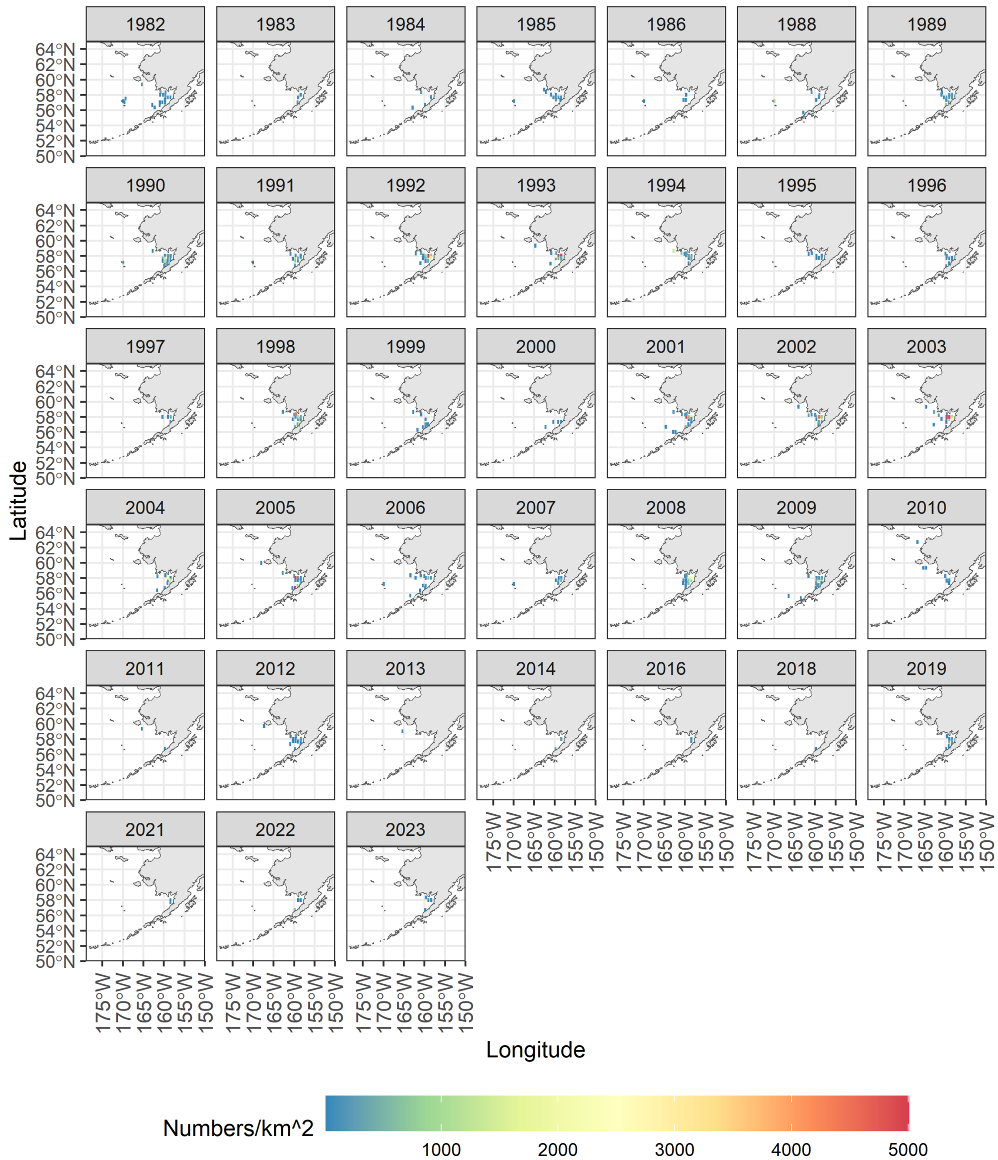

Figure 11: Map of distribution of prevalence and density from the all BSAI surveys for Pacific sandfish(zoom for detail).

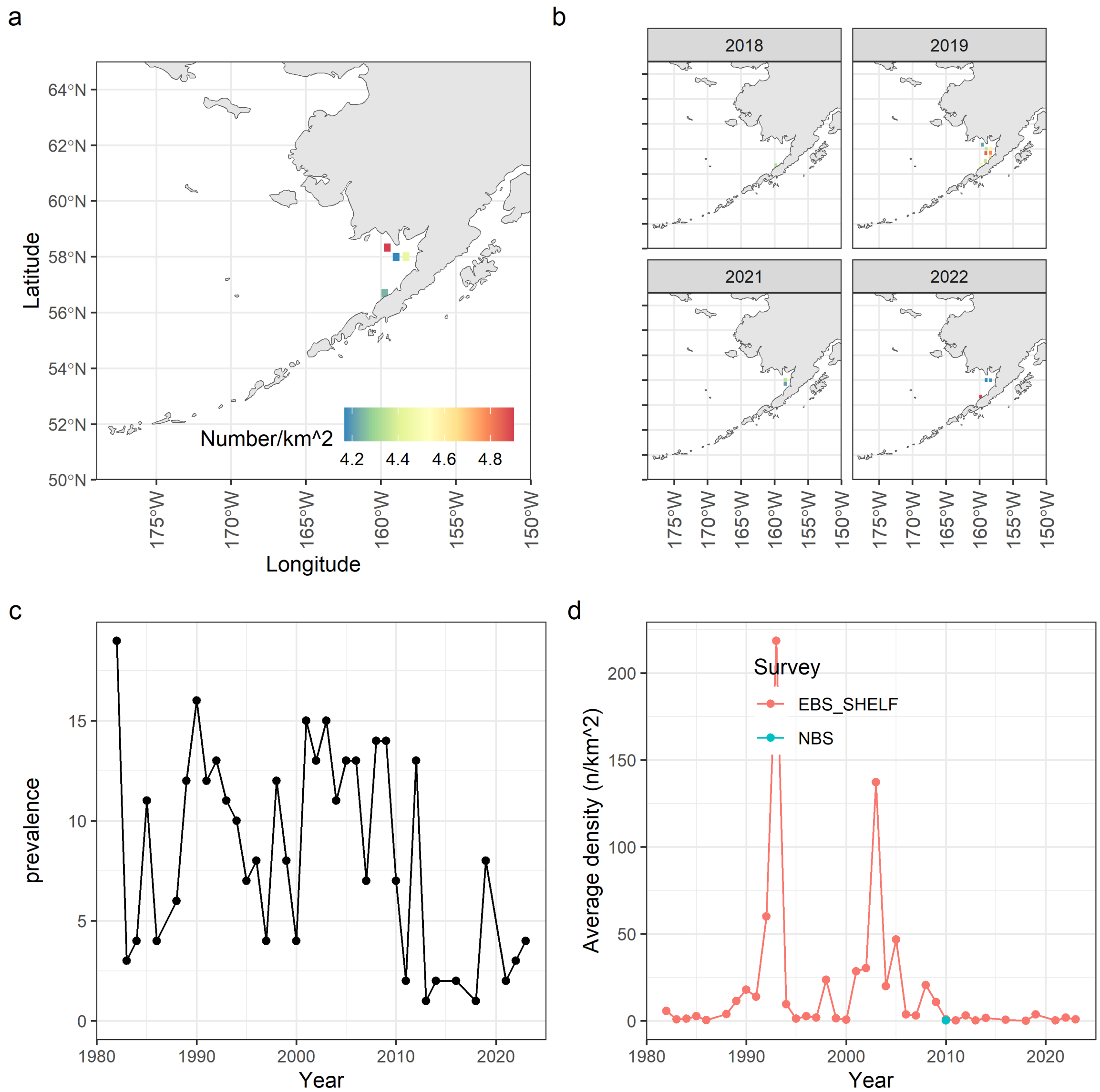

Figure 12: Pacific sandfish survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

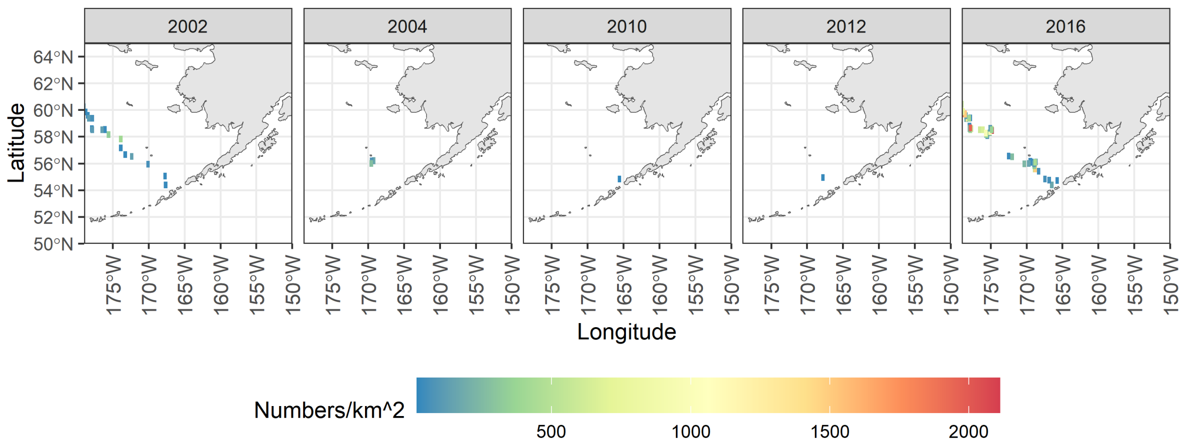

Figure 13: Map of distribution of prevalence and density from the all BSAI surveys for Pacific sandfish(zoom for detail).

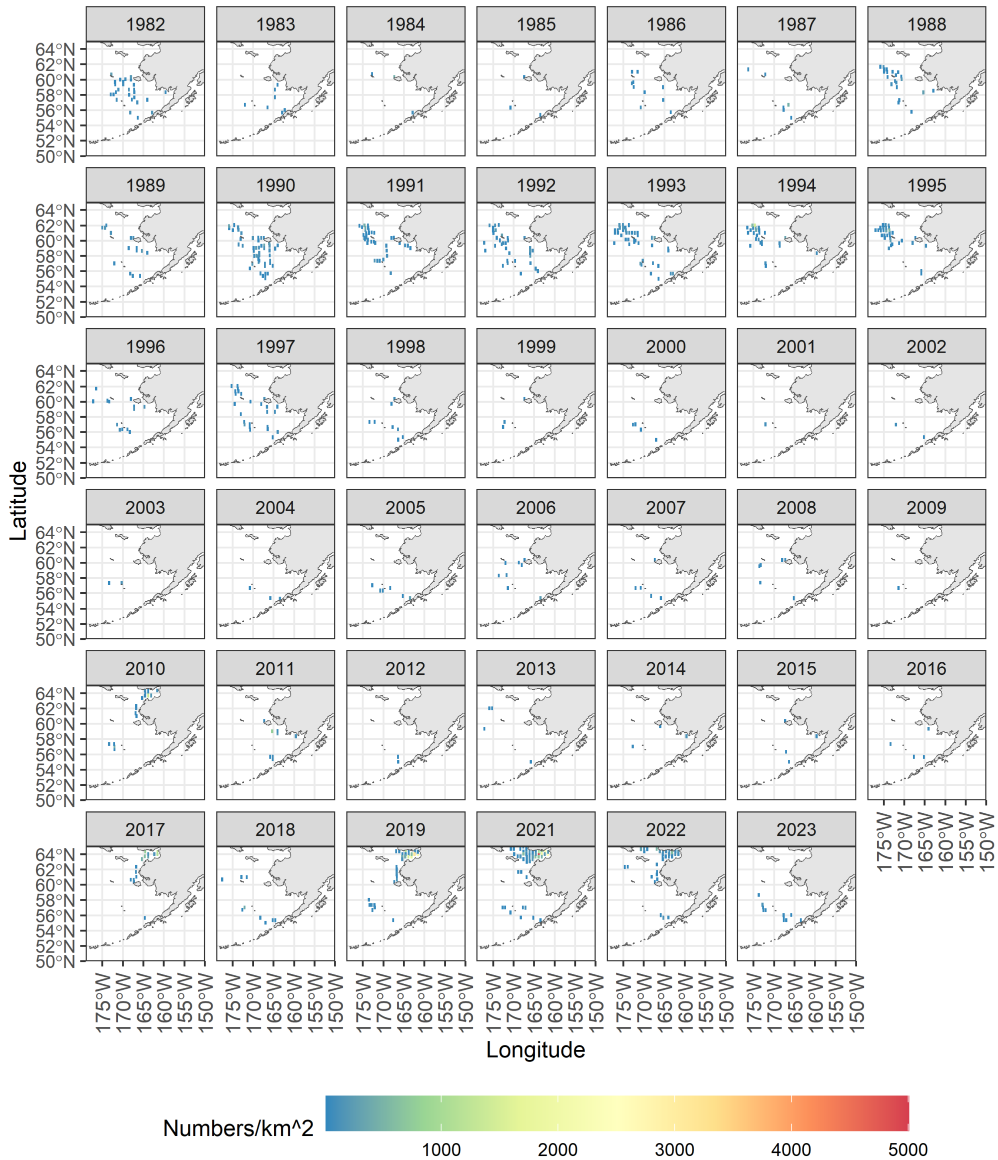

Figure 14: Map of distribution of prevalence and density from the all BSAI surveys for pricklebacks (zoom for detail).

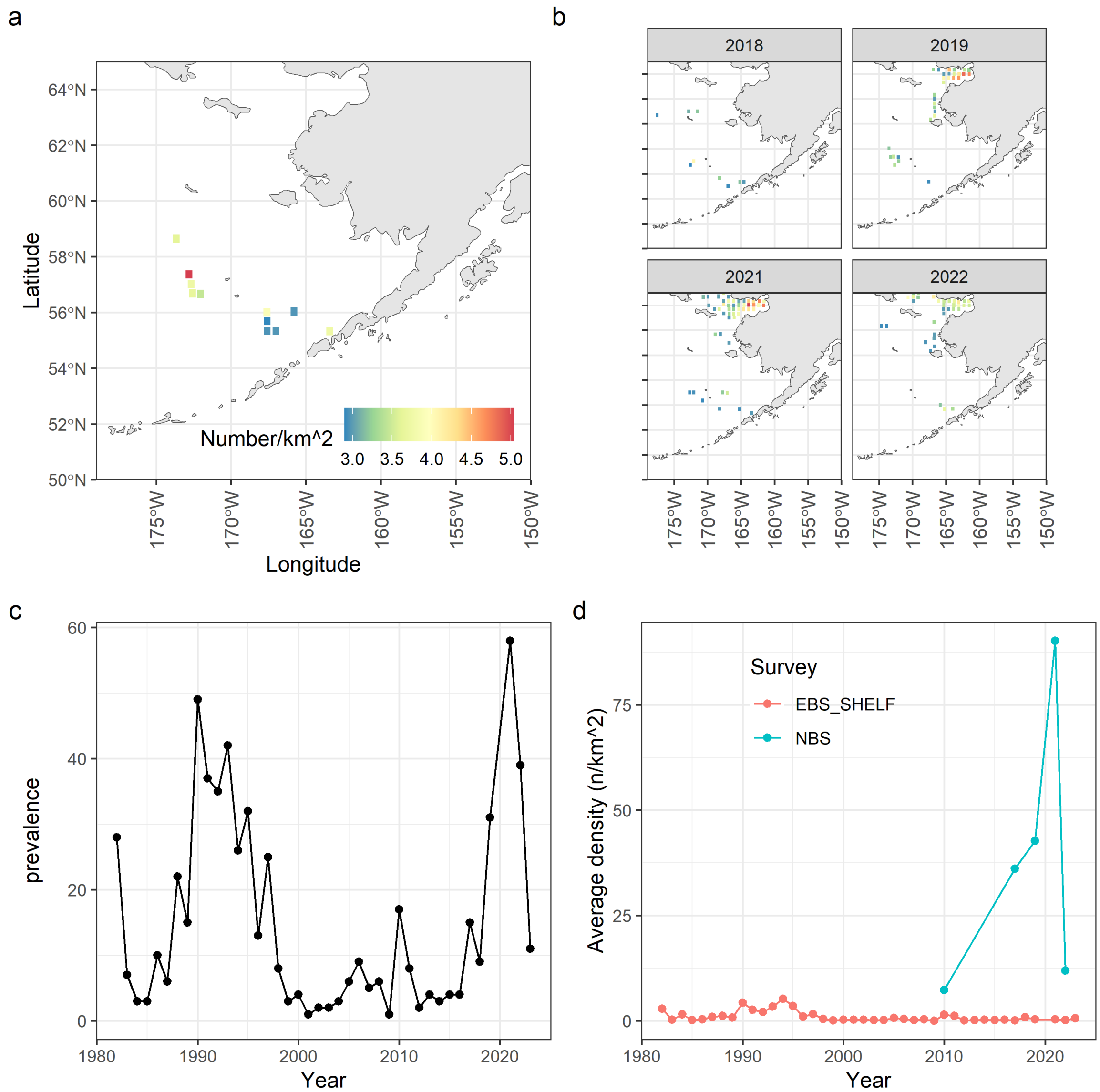

Figure 15: Prickleback survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

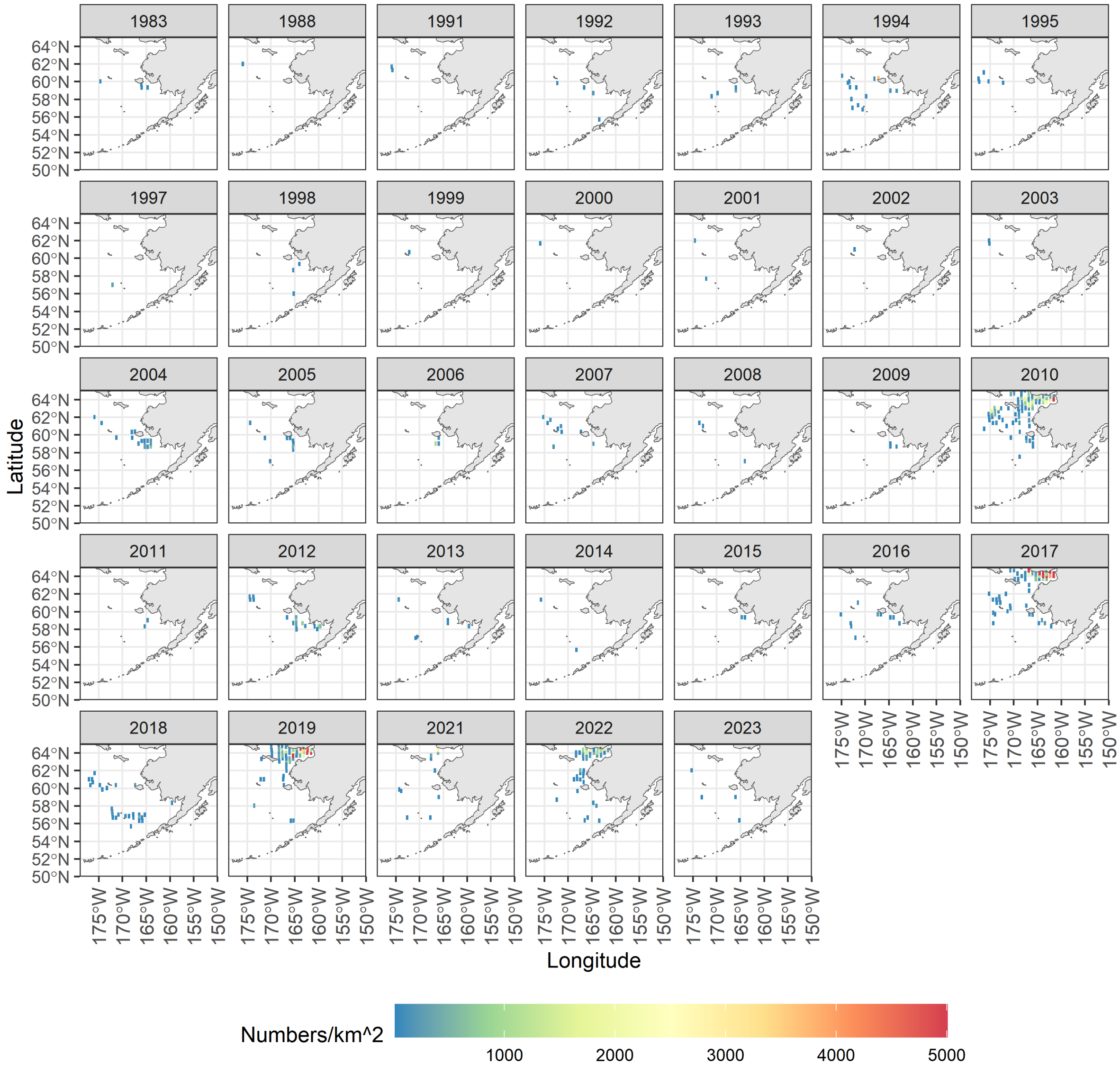

Figure 16: Map of distribution of prevalence and density from the all BSAI surveys for eelblennies (zoom for detail).

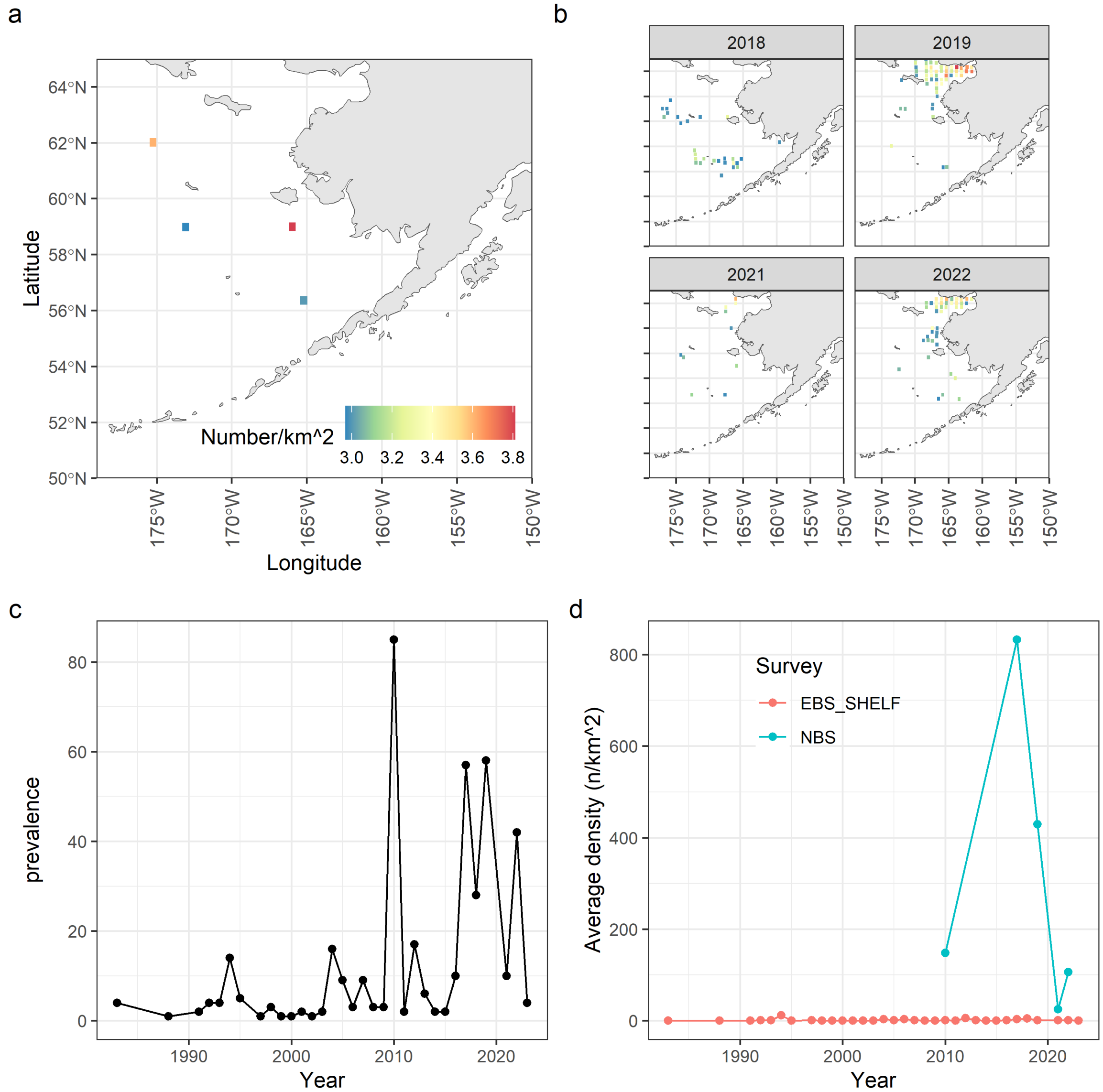

Figure 17: Eelblenny survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

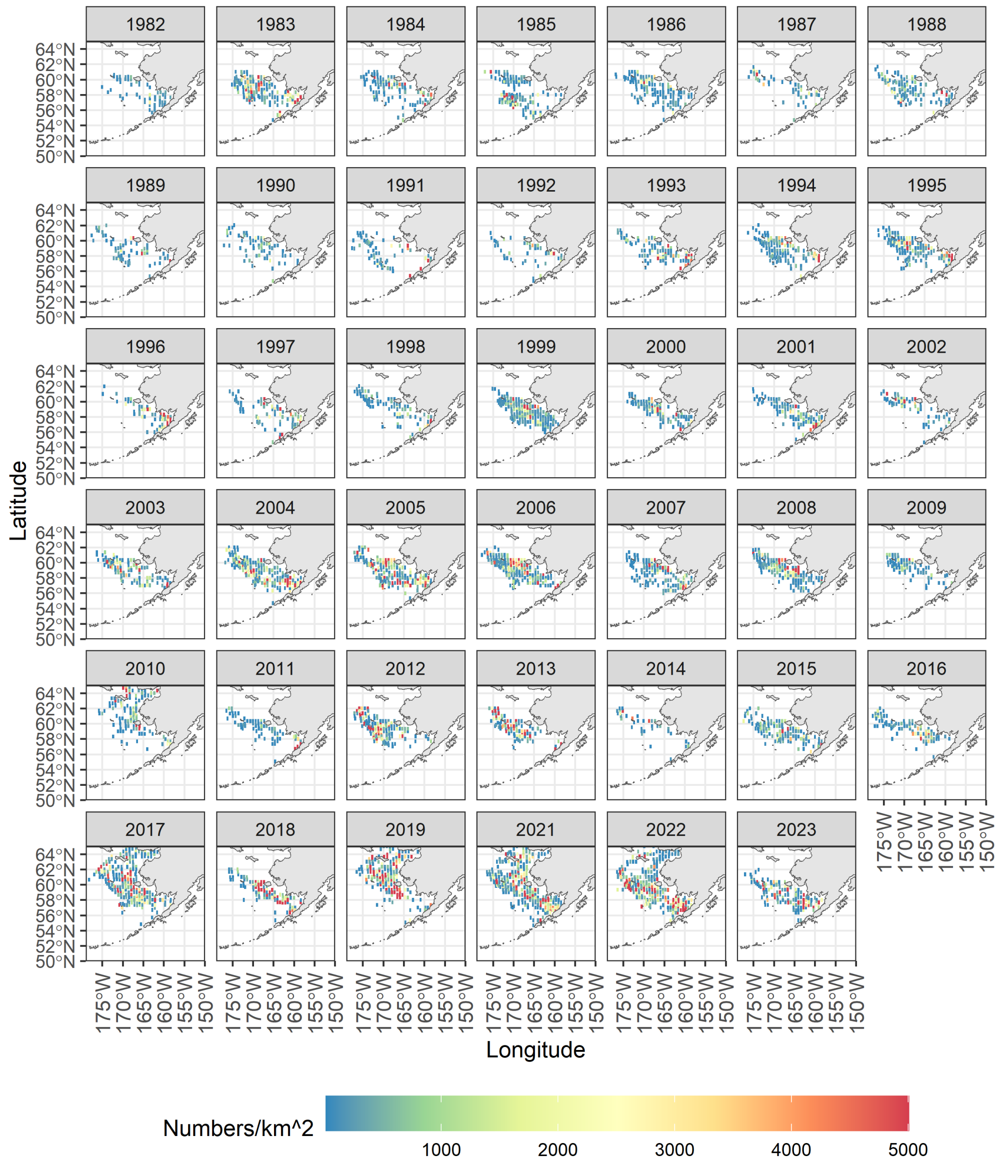

Figure 18: Map of distribution of prevalence and density from the all BSAI surveys for Pacific herring (zoom for detail).

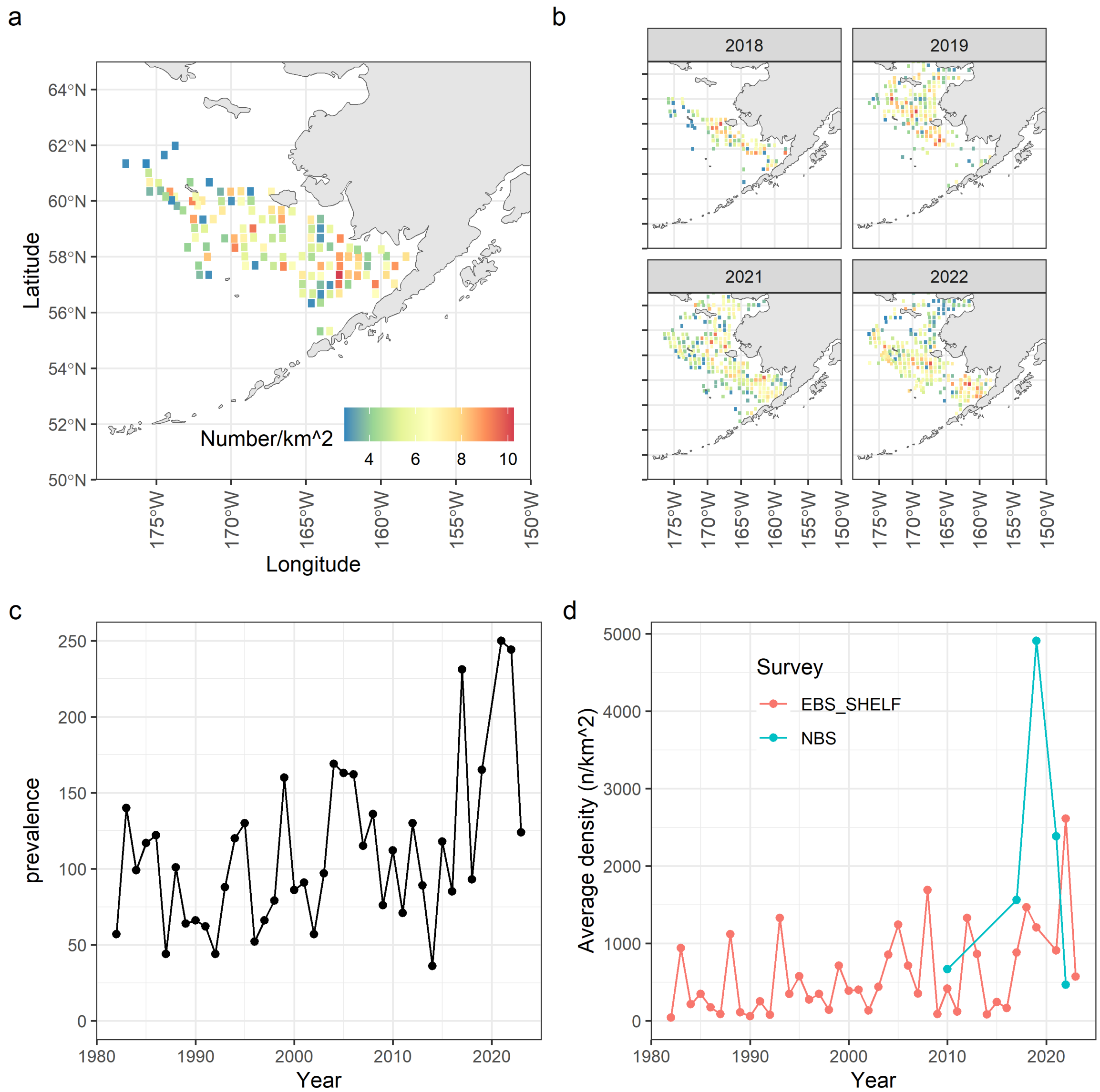

Figure 19: Pacific herring survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

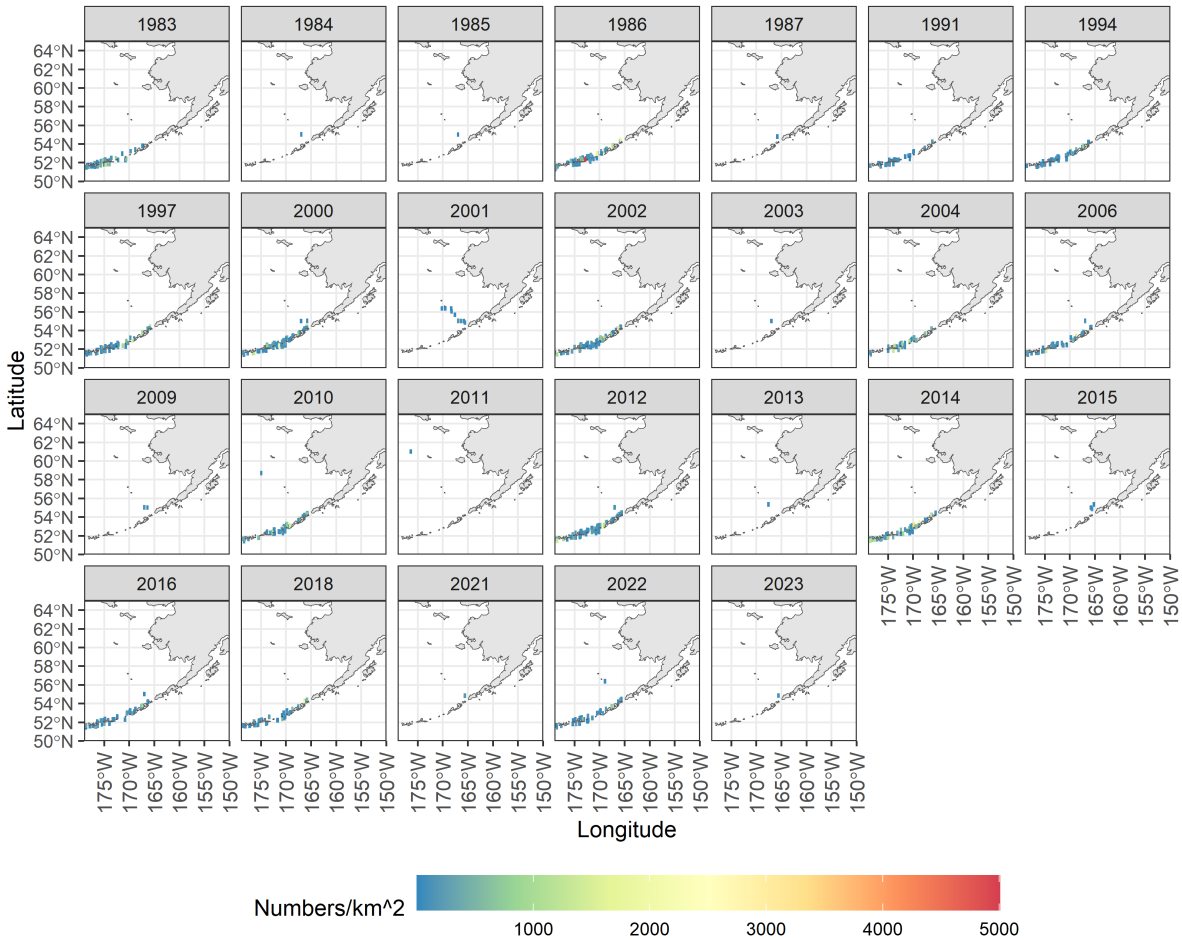

Figure 20: Map of distribution of prevalence and density from the all BSAI surveys for squid (zoom for detail).

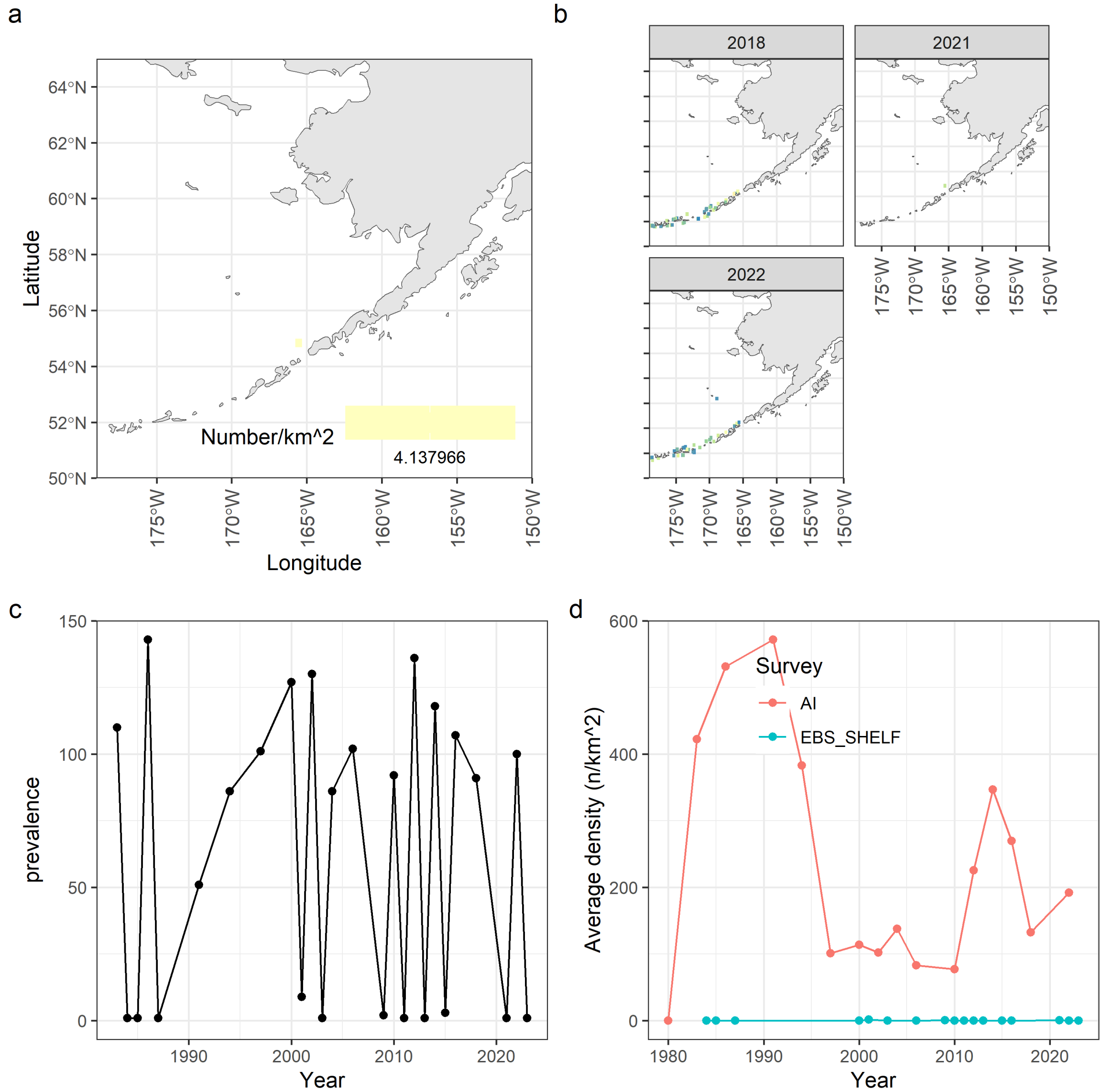

Figure 21: Squid survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

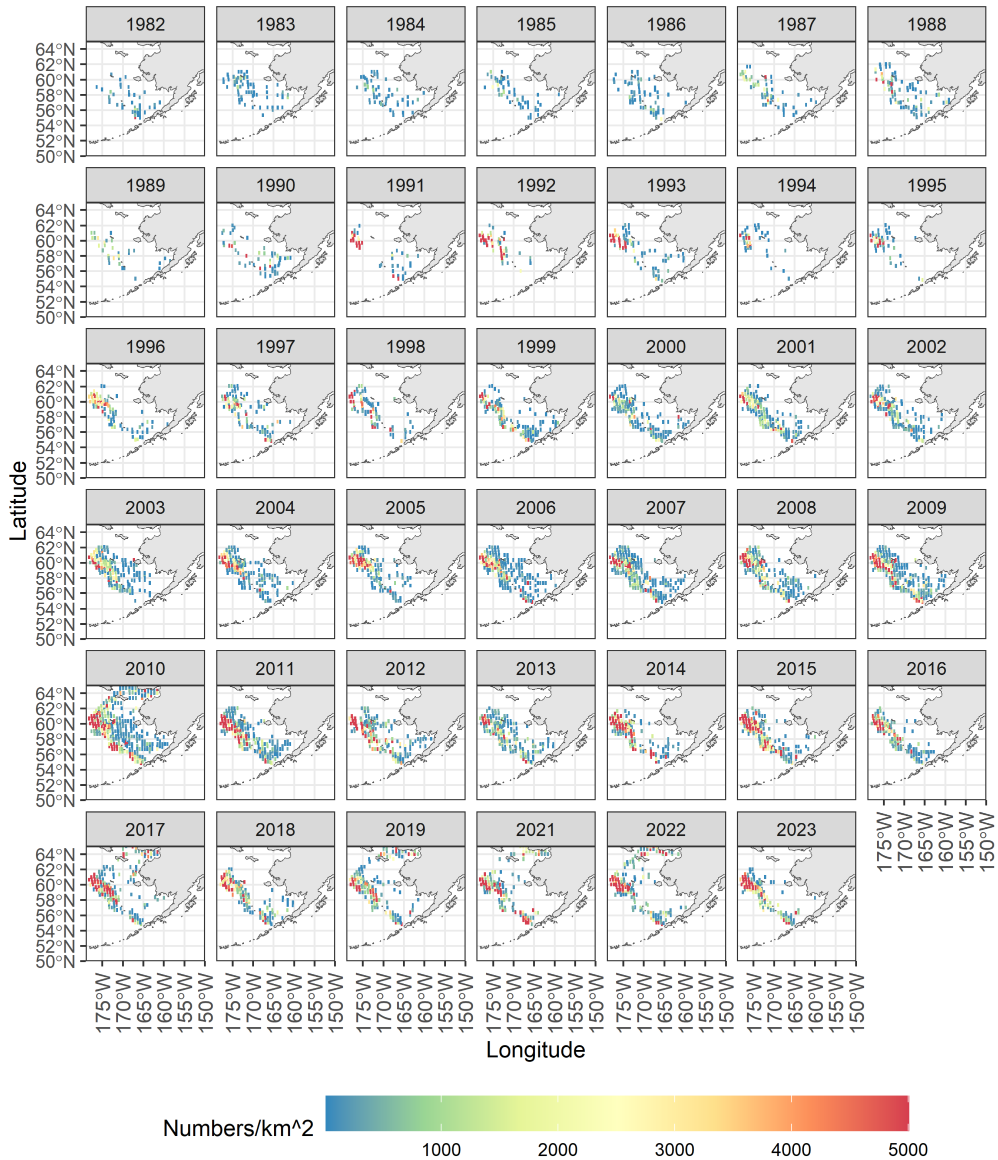

Figure 22: Map of distribution of prevalence and density from the all BSAI surveys for shrimp (zoom for detail).

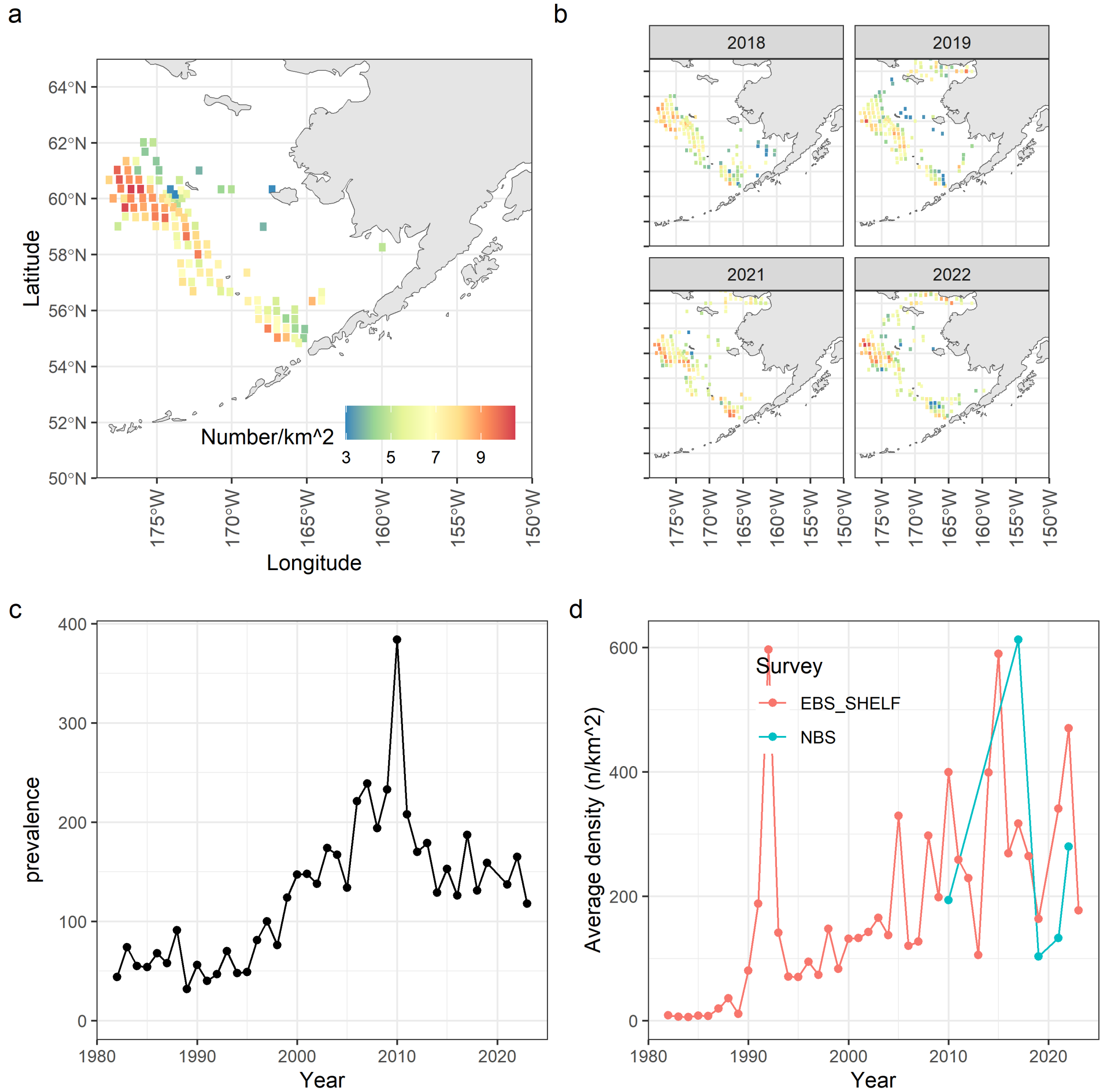

Figure 23: Shrimp survey data. Spatial density in BSAI surveys (a), spatial densities in the previous four years for which survey data was available (b), prevalence in terms of the number of survey stations that returned positive tows for this species (c), and average densities split by survey location in the BSAI (d).

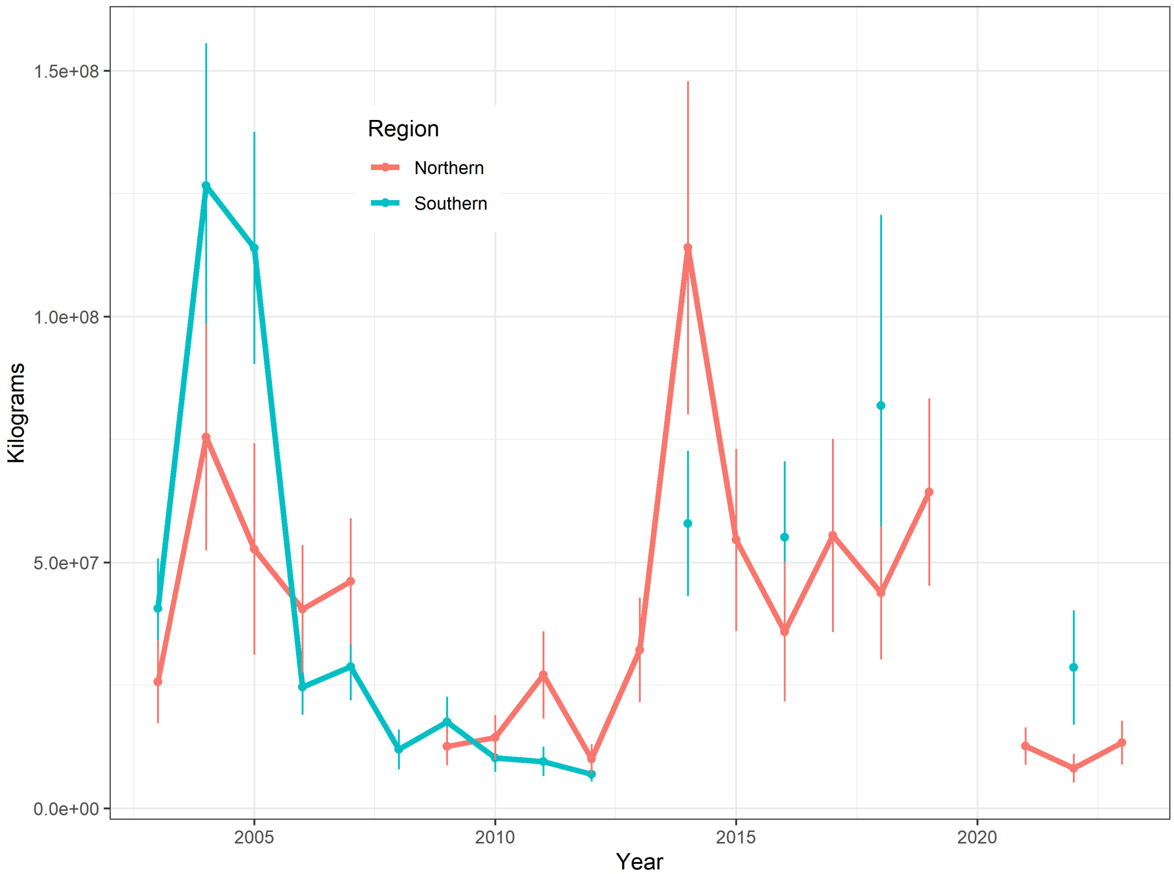

Figure 24: Index of forage abundance developed based on the BASIS surface trawls.

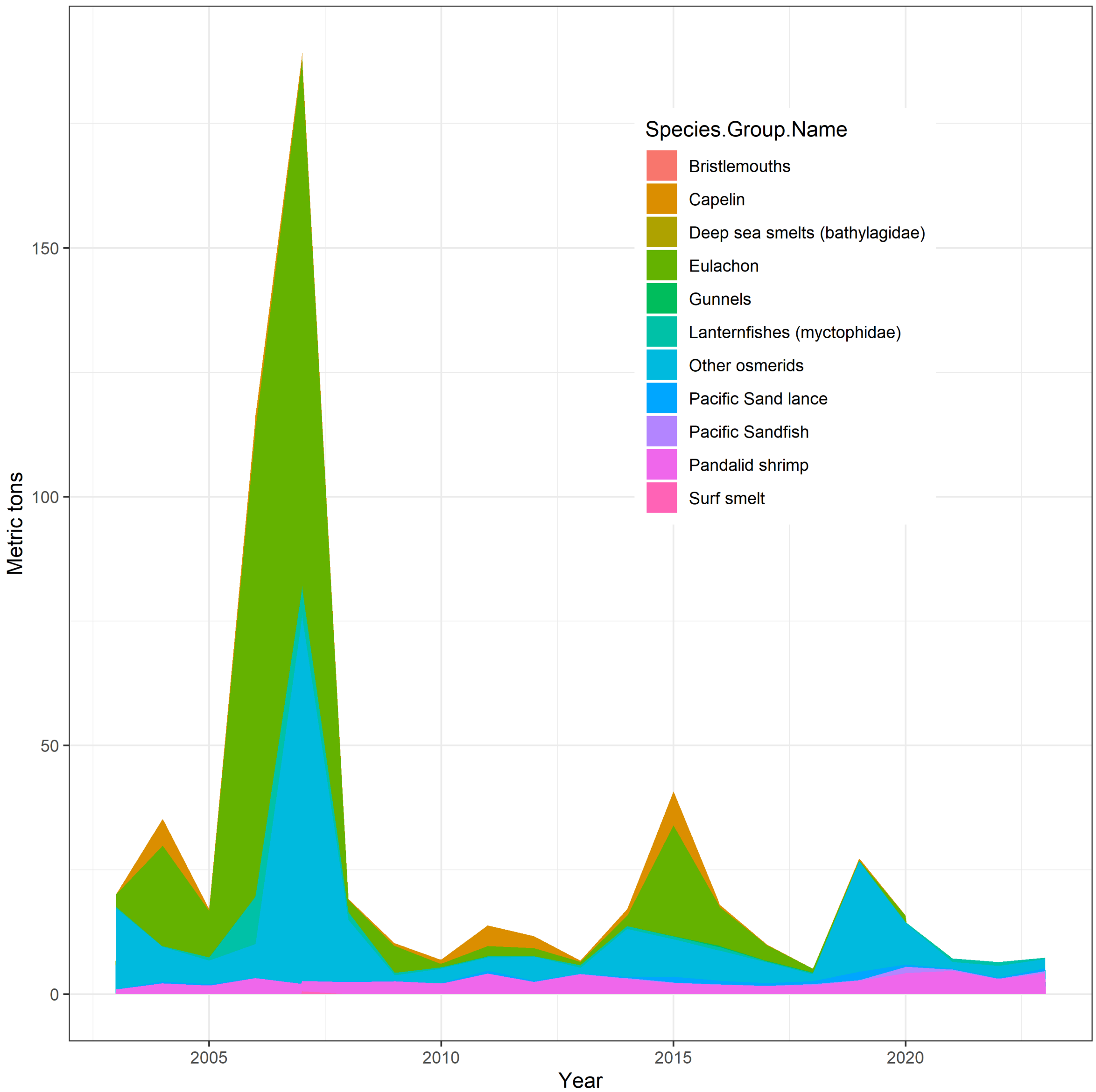

Figure 25: Incidental catches of fishes in the BSAI FMP forage group (2003-2023).

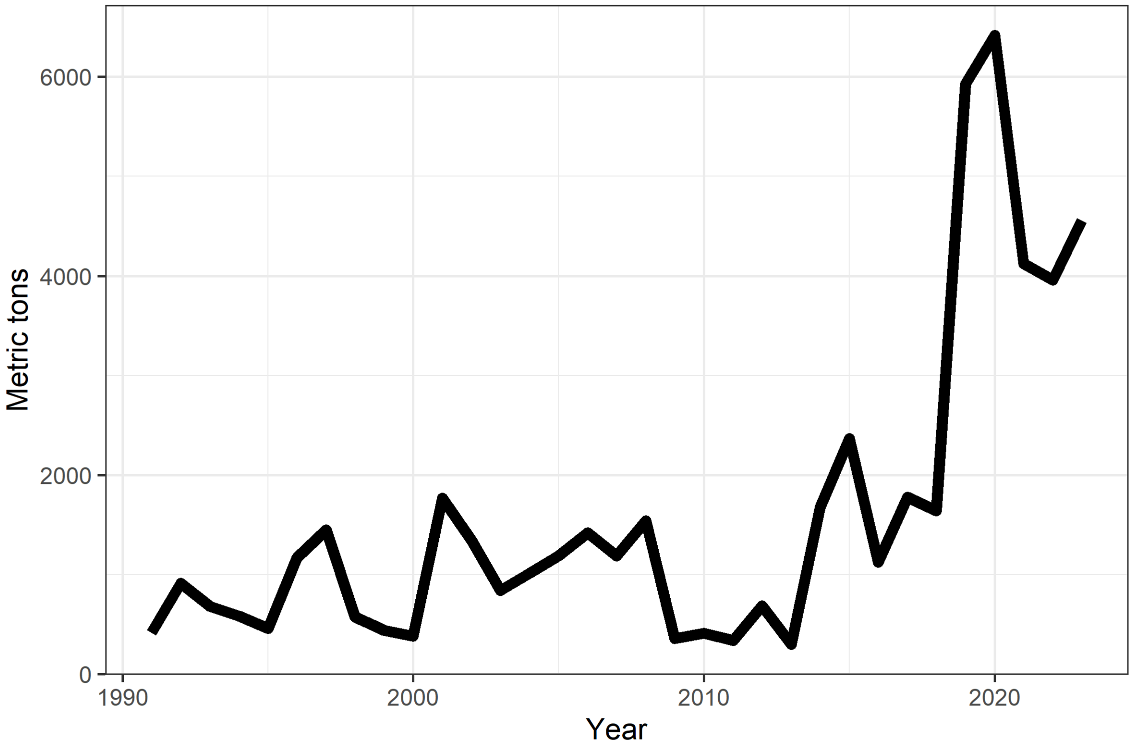

Figure 26: Catches of squid in the BSAI.

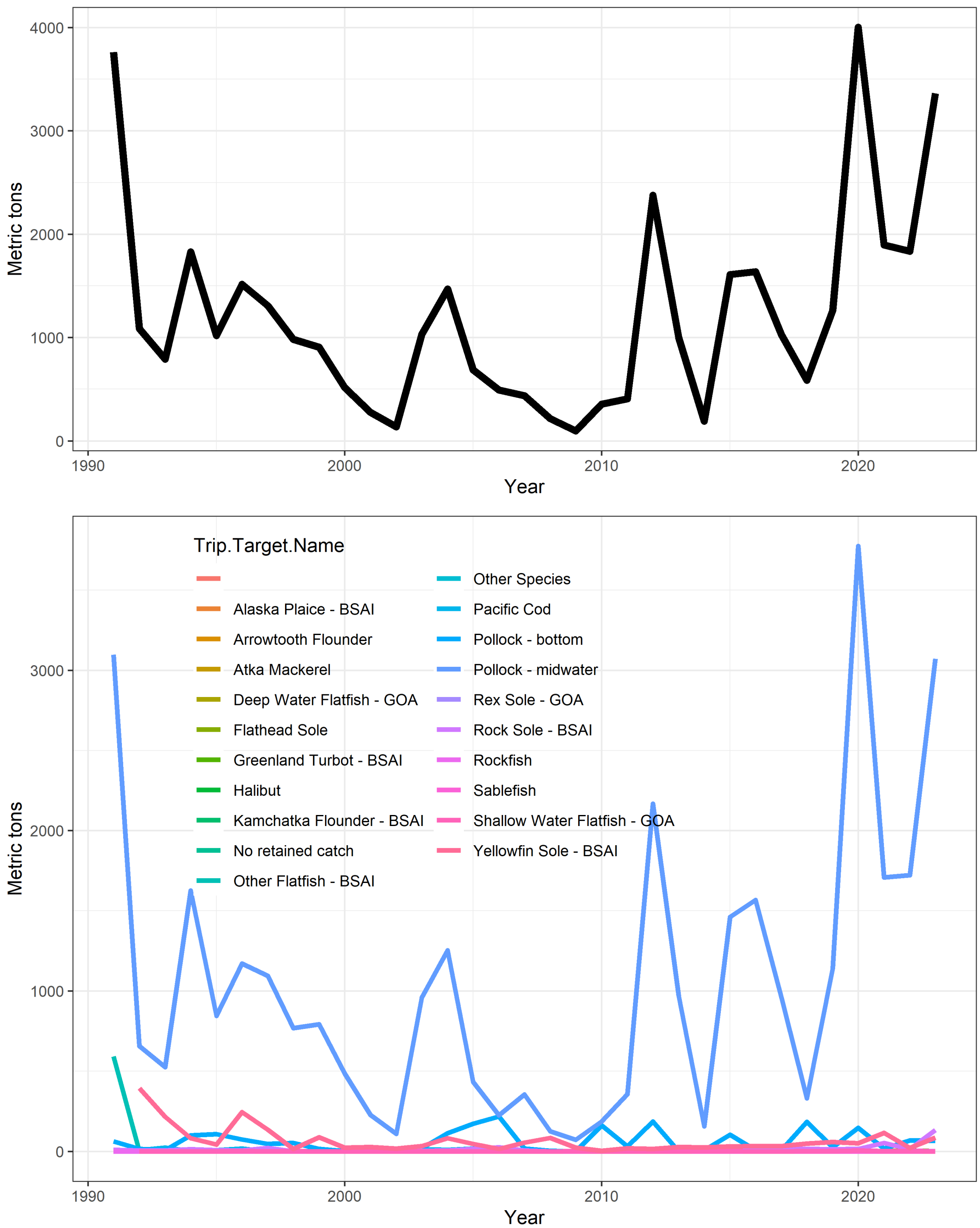

Figure 27: Catches of Pacific herring in the BSAI.