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Eastern Gulf of Alaska Ecosystem Assessment, July through August 2017

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Abstract

The goal of the Gulf of Alaska Ecosystem Assessment is to characterize ecosystem function and status in the eastern Gulf of Alaska. This survey is a coordinated research effort, conducted by the Recruitment Processes Alliance within the Alaska Fisheries Science Center. The scientific objectives of the survey are to assess age-0 groundfish, juvenile salmon, zooplankton, and oceanographic conditions in the coastal, shelf, slope, and offshore waters of the eastern Gulf of Alaska. This information is used to describe species distributions, ecosystem processes, marine productivity, and recruitment processes in response to changes in climate patterns and temperature anomalies (i.e., “The Blob”, and El Niño).

Contents

Introduction

The Gulf of Alaska (GOA) Assessment is a fisheries and oceanographic survey conducted in the eastern GOA during the summer season. The survey is designed to characterize ecosystem status and function and is a coordinated research effort among scientists within the Recruitment Processes Alliance at the Alaska Fisheries Science Center (AFSC), National Oceanic and Atmospheric Administration (NOAA). The survey has sampled in the eastern GOA each year since 2010 and is a continuation of the monitoring efforts established by the GOA Integrated Ecosystem Research Project (GOAIERP; https://www.nprb.org/gulf-of-alaska-project/about-the-project/). The scientific objectives of the survey are to assess age-0 groundfish, juvenile salmon, zooplankton, and oceanographic conditions in the coastal, shelf, slope, and offshore waters of the eastern GOA. This information is used to describe species distributions, ecosystem structure, and marine productivity in response to changes in climate patterns and temperature anomalies (e.g., The Blob, and El Niño). In 2017, sampling for fish, plankton, and oceanography was completed at pre-determined and opportunistic station locations onboard the chartered fishing vessel *Northwest Explorer* (B&N Fisheries).

Specific Objectives Listed in the Cruise Plan

1) Observe epipelagic fish communities by sampling with a rope trawl. Fish species of interest retained from the trawl included age-0 arrowtooth flounder (*Atheresthes stomias*), age-0 rockfish species (*Sebastes* spp.), age-0 walleye pollock (*Gadus chalcogrammus*), age-0 Pacific cod (*Gadus macrocephalus*), age-0 sablefish (*Anoplopoma fimbria*), juvenile Pacific salmon (*Oncorhynchus* spp.), and forage fishes

2) Collect physical oceanographic data including CTD (conductivity-temperature-depth) vertical profiles, salinity, light transmission, chlorophyll-a (*Chl-a*) fluorescence, nutrients, and photosynthetically available radiation (PAR).

3) Collect biological oceanographic samples with oblique bongo tows (mesozooplankton) and water sampling via carousel and Niskin bottles.

4) Return 500+ live age-0 sablefish to Auke Bay Laboratories, AFSC, for laboratory growth experiment.

5) Tag live age-0 sablefish as part of a pilot study to quantify initial tag injury/mortality and release a small number of tagged fish into the wild.

Methods

There were a total of 36 designated sampling days on two separate cruises (NW1702 and NW1704). Typically, four stations were expected to be occupied per day, resulting in a maximum of 144 stations potentially occupied. Due to weather, travel, and gear constraints, a total of 123 stations were occupied. The number of stations sampled per day decreased with distance between stations. The first leg began in the north on the YBE transect and the survey continued to the south (Table 1, Fig. 1).

Typical Station Order of Operations:

1) CTD cast

2) Bongo tow

3) Rope trawl

Survey Design

Survey transect lines ran parallel to one another and perpendicular to the coast (Fig. 1, Table 1). Transect lines were spaced 20 nmi apart along the coast. Over the shelf, stations were spaced 10 nmi apart, over the slope and basin, stations were spaced 20 nmi apart. In the areas south of Yakutat Valley and north of Yakobi Island (south end of Cross Sound), transect lines stretched to 100 nmi offshore. In 2016, an additional offshore grid, not part of the standard GOAIERP sampling plan, was added to extend the survey out to the Exclusive Economic Zone (EEZ) for age-0 rockfishes and sablefish. This extended grid was resampled in 2017. Spacing of the additional stations followed the same conventions as the standard GOAIERP grid. Operations

were typically completed between 0700 and 1900 daily. The main survey stations (continuation of GOAIERP) within 100 nmi from shore were sampled during NW1702 (July). The additional offshore grid and opportunistic stations were sampled during NW1704 (August), targeting live age-0 sablefish (Fig. 1). After sampling the planned station grid for NW1704, opportunistic stations were sampled with the goal of sampling live age-0 sablefish to return to the lab. These stations were selected based upon previous catch data (Ecosystem Monitoring and Assessment, AFSC), published data, and personal communication about current feeding habits of seabirds on Middleton Island (Scott Hatch, Middleton Island Seabird Project).

Oceanography

Where possible, CTD casts occurred at each station on legs NW1702 and NW1704 (Tables 2 and 3). Instruments added to the Seabird Electronics 9 CTD included a photosynthetically available radiation (PAR) sensor, fluorometer, transmissometer, and dissolved oxygen sensors. Casts were to "bottom" (5-10 m from bottom) or 200 m (if bottom depths were > 200 m) during NW1702; 50 m casts were made during NW1704. Water samples were taken at six depths (0, 10, 20, 40, 50 m, and "bottom"). Nutrients and *Chl-a* samples were taken at six depths. Water was typically taken for a salinity sample once a day, alternating between the surface bottle and the deepest bottle (Tables 2 and 3). Water samples for oxygen were not taken, due to restrictions on available areas for required hazmat materials.

Zooplankton

A bongo plankton net tow was conducted to collect mesozooplankton at each survey station during NW1702 when possible (barring weather or gear restrictions). Zooplankton was collected at approximately every 2nd station to maximize spatial coverage during the NW1704

planned station grid. Zooplankton was typically not collected during the opportunistic portion of NW1704. The standard gear for plankton sampling was a 60-cm bongo frame with 505-µm mesh nets paired with a 20-cm bongo frame with 153-µm mesh nets. A Seabird Electronics FastCat (49) was mounted above the bongo net to provide real time depth, temperature, and salinity data. Casts were to "bottom" (5-10 m from bottom) or 200 m (if bottom depths were > 200 m) during NW1702, and to 50 m during NW1704. Samples were preserved in a buffered 5% formaldehyde seawater solution.

Fish

Trawl Sampling - Surface trawling was conducted with a Nordic 264 rope trawl with 7/8" TS2 Silver Spectra bridles and 3-m foam-filled Lite trawl doors. The trawl was modified with a panel of 10.2-cm mesh sewn to the jib lines along the head rope to reduce the loss of fishes in the neuston. Two 50-kg chain-link weights were added to the corners of the foot rope as the trawl was deployed to maximize fishing depth. The codend was composed of a knotless liner with a mesh of 0.8 cm. To keep the trawl head rope fishing at the surface, two clusters of three A-4 Polyform buoys were clipped on to the opposing corner wingtips of the head rope prior to deployment. The vessel provided a Simrad FS-70 3rd wire net sounder for net mensuration. This trawl and rigging was used in 2010 and for some surveys in 2016. From 2011 to 2016, a CanTrawl 400/601 was used (Strasburger et al. 2018). An average of four surface trawl stations were completed per day. Surface trawl duration was standardized to 30 minutes during NW1702, beginning when the doors were fully deployed. Trawl duration was extended (1-2 hours fishing time) during the opportunistic stations sampled during NW1704. To retain live sablefish during the opportunistic portion of NW1704, an aquarium codend (livebox) measuring 2.7 * 1.3 * 1 m was attached to the trawl liner by gore lines that run along the seams of the trawl. The codend of

the trawl liner was attached to the opening of the livebox which allowed water to pass through while channeling fish and invertebrates into a non-turbulent holding compartment. Six live tanks were set up along the trawl alley of the vessel to contain the live age-0 sablefish after capture. The majority of these fish were retained and brought to Auke Bay Laboratories, NOAA, NMFS, Juneau, for use in growth experiments. A small number of the sablefish were used shipboard as part of a pilot effort to measure tag retention in live age-0 sablefish for future studies to track movement and survival over time.

Fish Sample Collection - At each station, up to 50 individuals of all species were randomly selected to be measured (mm) and weighed (kg) at sea. Bulk weights were recorded when individual fish were too small to record an accurate weight (< 8 g).

At Each Station - Sub-samples of fish from each trawling station were individually bagged and tagged and stored in a -40 °C freezer for energetic analysis, including whole age-0 walleye pollock (n = 5), Pacific cod (n = 5), sablefish (n = 50), and arrowtooth flounder (n =5). Up to 50 age-0 rockfish were sub-sampled for energetic and RNA/DNA analysis, the first 5 were individually bagged and tagged, while the remaining 45 were stored between individual layers of plastic wrap and stored at -40°C. When catch size allowed for sampling beyond these requests, stomach samples were collected for all above species (n = 10) during NW1702, as well as age-0 sablefish during NW1704 (if not retained live). Stomach samples were preserved in a buffered 10% formalin seawater solution. Additional stomachs were opportunistically collected for other species of interest, mainly forage fishes. Note that age-0 rockfish species could not be positively identified to species in the field.

Each juvenile salmon species typically has a specific sampling protocol. Juvenile Chinook salmon were sub-sampled for energetic (n = 5), otolith (n = all), and genetic (n = 10)

analysis. Juvenile Chinook and coho salmon were scanned for the presence of coded wire tags, all tagged fish were retained. Whole bodies of juvenile coho salmon (n = 2) were retained at each station for energetic analysis. Juvenile chum, pink, and sockeye salmon were sub-sampled for energetic (n = 2) and genetic (n = 8) analysis. An additional 18 juvenile sockeye heads were retained, where available, for otolith analysis. Whole individuals and tissue samples were stored in the ship's chest freezers at -18° C. Stomach samples were collected (n = 10) for each species/life history stage of Pacific salmon and preserved in a 10% buffered formalin seawater solution.

Sablefish Tagging Methods NW1704 - Once the livebox was brought onboard, jellyfish and other species on the tank surface were removed as quickly as possible using dip nets as sablefish generally gravitated to the bottom of the tank. Any sablefish in the net that had not made it into the live box (still in trawl webbing) were moved to the live box if they were alive. Sablefish were retained in the live box until the tagger was ready to begin, usually 5-15 minutes, depending on the amount of jellyfish and other species in the catch.

The tagging station was set up on top of a live tank and consisted of a small measuring cradle, a ~2 gallon tote with seawater with a small net suspended over the tote and into the water, two tag guns, and extra tags in sequence. There was one tagger, one data recorder, and one fish runner bringing fish from the live box to the tagging station, though not all were present at each tagging event. Next to the tagging station was a large recovery tank with flowing seawater.

Once the tagging station was set up, 1-3 fish were brought in a small tote at the tagging station. In some cases, tagging occurred while the other parts of the catch were processed. In those instances, the tagger would also record data and fish were brought to the tagging station opportunistically.

Each fish was measured (fork length, mm) and a small, ½ inch Floy-type tag was inserted into the left dorsal muscle tissue using a tag gun. After the tag was inserted, fish were released into the recovery tank for monitoring and recovery. If the tag did not insert cleanly on the first attempt, a decision was made regarding whether a second attempt should be made, or if the fish should be retained for the energetics study. If the fish was small or the first attempt made a visible hole, a second tag was not attempted. Fish were not anesthetized during tagging.

Once all fish were processed they were retained in the live tank for ~24 hours. Holding time was dependent upon transit or fishing operations. Release while underway would likely have a negative effect, including tag loss and or mortality. Release while actively towing the trawl poses a high probability of unintended recapture. There was no tagging mortality in the time fish were held prior to release.

Due to the large freeboard (~6 m), a method was devised to carefully released tagged fish. Tagged fish were released by partially filling a 5 gallon bucket with seawater, adding the fish to be released, then lowering it over the side of the boat to the water. A second line tied to the bottom of the bucket allowed the bucket to be tipped, releasing the fish into the ocean.

A total of 46 age-0 and 1 age-1+ sablefish were tagged and released. The age-0 fish ranged from 140-184 mm (FL), the age-1+ fish was 390 mm. Mean length of tagged age-0 fish was 160 mm (SD = 11). Larger fish (>165 mm) were substantially easier to tag because they had more dorsal muscle. A few of the tagged fish showed small amounts of bleeding at the tag injection site, appearing for less than 1 hour. By the time they were released all fish were swimming actively and up off the bottom of the recovery tank.

Data Analysis

The depth of the pycnocline was calculated for each station by locating the depth where $d\sigma_t/dz$ was at a maximum (σ_t = density – 1,000, kg m^{-3}; z = depth, m). Mean water-column temperature and salinity above and below the pycnocline were then interpolated and plotted (SURFER 12, Golden Software) over the sampling area (Fig. 2). Temperature and salinity was averaged over the top 10 m to provide a constant depth for spatial comparison (Tables 4 and 5). Temperature and salinity cross sections (through the water column) were produced for two survey transects, one north of Cross Sound and one south of Cross Sound (Fig. 3). Temperature and salinity data presented here are from the Seabird Electronics FastCat 49 deployed during zooplankton collections. Discrete *Chl-a* samples from Niskin bottles (total from Whatman GF/F filters [0.7 µm] and >10 µm size fractions from polycarbonate membrane filters) were vacuum filtered and frozen at -80 ºC prior to analysis using standard fluorometric methods (Parsons et al. 1984). *Chl-a* data had been processed for NW1702 (Table 6, Fig. 4) at the time this report was produced, but not for NW1704.

In the laboratory, each mesozooplankton sample was poured into a sorting tray and large organisms, such as shrimp and jellyfish, were removed and counted. The sample was then sequentially split using a Folsom splitter until the smallest subsample contained approximately 200 specimens of the most abundant taxa. All taxa in the smallest subsamples were identified, staged, counted, and weighed. Each larger subsample was examined to identify, count, and weigh the larger, less abundant taxa. Blotted wet weights for each taxa and stage were determined as outlined in Coyle et al. 2008 and 2011. All animals were identified to the lowest taxonomic and life history category possible. Biomass values by station were summed for each

species (pooled across all stages) in mg m^{-3} (Table 7). In order to produce this volume of data within 2 months of the survey, only data from the 60 cm bongo is being considered, and approximately every other station was processed. Zooplankton biomass plots were produced with the same routines in SURFER® 12 used for physical variables (Figs. 5-9).

Total counts for all fish were summed by survey (Tables 8 and 9). Total weight of invertebrates from the trawl were summed by survey (Tables 10 and 11). Frequency of occurrence for all species in the trawl was calculated across all stations occupied and survey legs (Table 12). The distribution and abundance of focal species (age-0 walleye pollock, age-0 Pacific cod, juvenile Chinook salmon, juvenile chum salmon, age-0 rockfishes, age-0 sablefish, and age-0 arrowtooth flounder) are reported here as the number of individuals per square kilometer sampled by survey (Figs. 10 and 11). This is a species-specific value, calculated as the number of individuals sampled during a standard 30 minute tow (longer during portions of NW1704) divided by area swept by the Nordic Trawl (distance of the tow in km multiplied by the average horizontal spread of the net in km). Trawl distance was estimated using the haversine formula for great circle distance. Length frequencies were generated for each of the focal species (Fig. 12).

Biomass and distribution (center of gravity and area occupied, 2010 - 2017) were estimated using the multispecies VAST package (Thorson et al. 2015; Thorson et al. 2016 a, b, c). This package generates a standardized geostatistical index, used for estimating abundance for stock assessments. We specified a gamma distribution and estimated spatial and spatio-temporal variation for both encounter probability and positive catch rate components at a spatial resolution of 100 knots (100 model units). Parameter estimates were within the upper and lower bounds and final gradients were less than 0.0005. If no positive catches occurred for a species within a year, an artificial minimum value was inserted, allowing the model to run. It is important to note, that no age-0 Pacific cod were sampled in 2016. This resulted in very large confidence intervals on a low point.

Results and Discussion

The total sampling effort during 2017 included 123 occupied stations where fish sampling occurred. A total of 107 casts were made with a SeaBird Electronics 9 CTD. A total of 82 bongo tows were made using the standard bongo array. A total of 592 *Chl-a*, 548 nutrient, and 24 salinity samples were collected, with the majority being collected during NW1702 (Tables 2 and 3).

Ocean Conditions

Average surface temperature and salinity (top 10 m) ranged from 11.31º to 15.42 ºC to 27.46 ppt to 32.78 ppt (Tables 4 and 5). Surface temperatures rose in 2014, and continue to be elevated through the 2017 survey season. Maximum observed surface temperature (top 10 m) at a single station occurred during 2016 at 16.3° C. Maximum *Chl-a* consistently occurred in the 20-m depth bin of station profiles, and elevated values were found near the presumably nutrient-rich outflows from the Alsek and Situk rivers and Cross Sound (Table 6, Fig. 3). Processed data from water sampling (all Seabird 9 collected electronic data, nutrients, and salinity voucher data) were not available at the time of this report.

Zooplankton

Similar to previous work in the Gulf of Alaska (Coyle and Pinchuk, 2003), salinity appears to be the largest factor influencing distribution and biomass of the mesozooplankton community. Additionally, the lack of a distinct frontal structure (Fig. 3) and the ability of certain species to rapidly react to temperature and salinity differences appear to have shaped the zooplankton community in July of 2017. Nearshore communities over the northern portion of the

grid were shaped by a freshwater plume emanating from the Alsek and Situk rivers, south of Yakutat (Fig. 2). The largest proportion of Cnidarian (hydrozoan jellyfish) biomass was within and bordering this freshwater influence (Fig. 5). Total zooplankton biomass had two large peaks, one oceanic and one over the shelf (Fig. 6). The oceanic zooplankton biomass peak was due to a very high biomass of tunicates (doliolids and salps, Fig. 6), while the nearshore zooplankton biomass peak was due to a high number of small (< 0.25 mm) juvenile shelled pteropods, *Limacina helicina*, at a single station (Fig. 5). Other selected species were influenced by salinity above the pycnocline, with increased biomass in offshore and shelf areas along with intrusions of oceanic water (Figs. 7-9). Some mixing of oceanic and shelf species assemblages occurred during July of 2017, likely resulting from weak horizontal density gradients (Mundy 2005), and an underdeveloped Alaska Coastal Current (Fig. 4).

Approximately 40% of the total zooplankton biomass is attributable to Cnidaria and Tunicata (hydrozoan jellyfish, doliolids, and salps). Above-average sea surface temperatures (July) have been observed on this survey since 2014. Asexual and sexual reproduction increase with temperature in many cnidarian and tunicate species, allowing these zooplanktors to quickly respond to favorable conditions (Purcell, 2005). This is exemplified by the peak in Cnidaria biomass centered on the outflow of the Alsek and Situk rivers (Fig. 5). We have observed an apparent increase in the abundance and prevalence of pelagic tunicates (doliolids and salps) during the summer season of the past few years. This may have been caused by advection from offshore during The Blob (Bond et al. 2015), or from the south (Li et al. 2016). In addition to the high proportion of gelatinous biomass, other ecologically important species have markedly declined. As an example in critical species abundance reduction, the average abundance per cubic meter for *Calanus marshallae* in 2012 was nearly 500% more than the average abundance

in 2017 (similar survey grid and timing). The average abundance of *C. marshallae* in 2012 was regularly above 100 ind. m^{-3}, a level not reached in any of the 2017 samples. In fact, 22 of 32 stations processed from the 2017 survey had an abundance of less than 10 ind. m^{-3}. This decline may be due to a negative response to increasing temperatures, as seen in other studies for this species (Coyle et al. 2008, 2011).

The elevated biomass of cnidarians and tunicates suggests the potential for a large proportion of primary production to be consumed by these animals. Trawl samples (and other anecdotal evidence) included pyrosomes in 2017 and increased numbers of gymnosomes since 2014. Both of these are highly efficient filter feeders, likely advected from other areas. Shunting of pelagic production to the benthos occurs via fecal pellets and dead falls (Richardson et al. 2009; Henschke et al. 2016). Given the prevalence of these species, there is a high potential for the removal of a large fraction of primary productivity from the pelagic ecosystem (Li et al. 2016). Removal of the base of the food chain may have large implications for zooplankton, forage fishes, age-0 marine groundfishes, juvenile and immature salmon, and other consumers such as seabirds and marine mammals. It is likely that these patterns in zooplankton have existed since the summer of 2014, when the shift to warmer conditions occurred. The catch of juvenile salmon and age-0 marine groundfishes during the July 2017 survey was very low. While some of this difference is possibly attributable to a trawl gear change (CanTrawl 400/601 to the Nordic 264, summer 2017), it is likely to be the result of this shift in prey fields and primary producers. In contrast, the shunting of pelagic primary production to the benthos may stimulate benthic production and somatic growth or oogenesis/vitellogenesis in demersal species of fishes.

Fish

Age-0 Groundfish

Abundance and Distribution - 2017 estimates indicate an above average biomass of age-0 arrowtooth flounder, and below-average biomass of age-0 Pacific cod, age-0 walleye pollock, and age-0 rockfish. Temporal trends in the estimated biomass of these groundfish species seem to be generally out of phase (Figs. 13-17, Table 13). During the preceding year (201 age-0 rockfish were the most abundant age-0 marine fish species in 2016 followed by walleye pollock and arrowtooth flounder.

Distribution of groundfish in pelagic waters varied among species and years (Figs. 14-17). Age-0 Pacific cod were commonly predicted to be over the shelf (50-200 m bottom depth) and within 20 nautical miles (nmi) from shore. Age-0 walleye pollock were more widely distributed, occupying shelf, slope, and basin domains (50-2,000 m bottom depth). Age-0 rockfish had the most variable distribution in the eastern Gulf of Alaska; occupying shelf, slope, and basin domains up to 100 nmi from shore. Arrowtooth flounder were typically found offshore, with the exception of 2012. In 2017, Pacific cod were found off of Yakutat Bay and Baranof Island, age-0 walleye pollock were found north and offshore, age-0 arrowtooth flounder in the northern region of the survey area, and rockfish fairly evenly distributed across the shelf (Figs. 14-17).

Center of gravity indicated that all species were distributed farther north in 2017. Age-0 Pacific cod were distributed farther north during recent warm years (2014-2015), whereas age-0 walleye pollock, age-0 arrowtooth flounder, and age-0 rockfish did not expand northward until

2017 (Fig. 18). Range expansion or contraction occurred for all species in 2017 relative to 2016, except for walleye pollock (Fig. 19).

Generally lower groundfish abundances in pelagic waters during 2017 (exception arrowtooth flounder) are believed to be in response to poor primary production (Strom et al. 2016) and an increased abundance of salps (Li et al. 2016), which further reduced the amount of plankton available to transfer energy to upper trophic levels. Piscivorous predators not common to the eastern GOA (e.g., Pacific pomfret) were present in the eastern GOA during 2014 and 2015, presumably in response to unprecedented warming in the eastern Pacific Ocean commonly referred to as the The Blob (Bond et al. 2015). Additional predation pressure by these warm water predators may have reduced the amount of age-0 marine fish that would have otherwise been present.

Lower groundfish abundances in surface waters during 2017 indicate a change in productivity in pelagic waters that affected many species of age-0 marine fish. Warm conditions during 2014 and 2015 appeared to initially benefit age-0 walleye pollock and Pacific cod and in more recent years benefited age-0 arrowtooth flounder and rockfish. No age-0 Pacific cod were caught during 2016. Additionally, age-0 Pacific cod were low for 2010-2013 year classes in the survey area, a period of cool temperatures

A total of 46 live age-0 and 1 age-1+ sablefish were tagged and released. The age-0 fish ranged from 140 to 184 mm (FL) and the age-1+ fish was 390 mm. Mean length of tagged age-0 fish was 160 mm (SD = 11). Larger fish (>165 mm) were substantially easier to tag because they had more dorsal muscle. A few of the tagged fish showed small amounts of bleeding at the tag injection site, appearing for less than 1 hour. By the time they were released all fish were swimming actively and up off the bottom of the recovery tank.

A total of 533 live age-0 sablefish were successfully returned to ABL for laboratory growth studies.

Juvenile Salmon

Temporal trends in the estimated biomass of juvenile salmon in the EGOA shelf survey area indicated a decrease in the productivity of juvenile salmon (Fig. 20, Table 14). Abundances were low for juvenile Chinook, coho, pink, and sockeye salmon, and moderate for juvenile chum salmon (Fig. 20). Both juvenile pink and chum salmon had an alternating year pattern with higher abundances in even-numbered years. Juvenile salmon were distributed nearshore in waters above the continental shelf (Figs. 21-25). Juvenile salmon were distributed farther south and east in 2017 relative to 2016 (Fig. 26). In 2017, a contracted area was occupied by Chinook, while an approximately average area was occupied by coho, sockeye, pink, and chum salmon (Fig. 27).

Lower abundances of juvenile salmon during 2017 were likely due to a combination of lower odd-brood-year pink salmon production, continuation of warm waters, and low and patchy ocean productivity. Recent decreases in the abundance of juvenile salmon in our survey area during summer implies a decline in conditions for growth and survival of salmon from southeast Alaska, British Columbia, and the Pacific Northwest lakes and rivers and/or a change in the distribution of juvenile salmon into our survey area during July. Juvenile salmon length has also decreased during this survey. Juvenile indices may be an early indication for the numbers of returning adults to the region of origin.

Squid

Within the EGOA survey years (2010 – 2017), squid were most abundant in 2014. Otherwise, squid have remained relatively stable in the GOA since 2011 (Fig. 28; Table 15). There appears to have been a slight decline in 2017, relative to 2016.

Distribution of squid varied by year. Squid were distributed across the shelf but farther offshore during 2011 - 2015 and nearshore in 2016 and 2017 (Fig. 29). During the 2014-2017 warm years, squid were generally distributed farther north (Fig. 30) and over a smaller area (Fig. 31).

Squid abundance was lowest during 2011, which seems to be correlated to poor primary production in that year. Predators not common to the eastern GOA were present in the eastern GOA during 2014 and 2015, presumably in response to The Blob. Additional predation pressure by these warm water predators may have reduced the amount of squid that would have otherwise been present. We hypothesize that forage such as squid may have attracted predators to the eastern GOA shelf.

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Citations

Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophys. Res. Lett. 42(9): 3414-3420.

Chuchukalo, V. I., and A. F. Volkov. 1986. Manual for the study of fish diets. Izv. TINRO, Vladivostok. 32 p. (In Russian).

Coyle, K. O. and A. I. Pinchuk. 2003. Annual cycle of zooplankton abundance, biomass and production on the northern Gulf of Alaska shelf, October 1997 through October 2000. Fish. Oceanogr. 12(4/5):327-338.

Coyle, K. O., A. I. Pinchuk, L. B. Eisner, J. M. Knapp. 2008. Zooplankton species composition abundance and biomass on the eastern Bering Sea shelf during summer: The potential role of water-column stability and nutrients in structuring the zooplankton community. Deep-sea Res. II 55(16/17):1775-1791.

Coyle, K. O., L. B. Eisner, F. J. Mueter, A. I. Pinchuk, M. A. Janout, K. D. Cieciel, E. V. Farley, and A. G. Andrews. 2011. Climate change in the southeastern Bering Sea: impacts on pollock stocks and implications for the oscillating control hypothesis. Fish. Oceanogr. 20(2):139-156.

Hensche, N., J. D. Everett, A. J. Richardson, and I. M. Suthers. 2016. Rethinking the role of salps in the ocean. Trends Ecol. Evolut. 31(9):720-733.

Li, K., A. J. Doubleday, M. D. Galbraith, and R. D. Hopcroft. 2016. High abundance of salps in the Gulf of Alaska during 2011: First record of bloom occurrence for the northern Gulf. Deep-sea Res. II 132: 136-145.

Moss, J. H., E. V. Farley, A. M. Feldmann, and J. N. Ianelli. 2009. Spatial distribution, energetic status, and food habits of eastern Bering Sea age-0 walleye pollock. Trans. Am. Fish. Soc. 138: 497-505.

Parsons, T. R., Y. Maita, and C. M. Lalli. 1984. A manual of chemical and biological methods for seawater analysis. Pergamon Press, Oxford. 173p.

Purcell, J. E. 2005. Climate effects on formation of jellyfish and ctenophore blooms: a review. J. Mar. Biol. Ass. U.K. 85:461-476.

Richardson, A. J., A. Bakun, G. C. Hays, M. J. Gibbons. 2009. The jellyfish joyride: Causes, consequences and management responses to a more gelatinous future. Trends Ecol. Evolut. 24:312-322.

Strasburger, W. W., J. H. Moss, K. A. Siwicke, and E. M. Yasumiishi. 2018. Results from the eastern Gulf of Alaska ecosystem assessment, July through August 2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-363, 90 p.

Strom, S. L., K. A. Fredrickson, and K. J. Bright. 2016. Spring phytoplankton in the eastern coastal Gulf of Alaska: Photosynthesis and production during high and low bloom years. Deep-sea Res. II 132:107-121.

Thorson, J. T., A. O. Shelton, E. J. Ward, and H. J. Skaug. 2015. Geostatistical delta-generalized linear mixed models improve precision for estimated abundance indices for West Coast groundfishes. ICES J. Mar. Sci. 75:1297-1310.

Thorson, J. T., and K. Kristensen. 2016a. Implementing a generic method for bias correction in statistical models using random effects, with spatial and population dynamics examples. Fish. Res. 175: 66-74.

Thorson, J. T., M. L. Pinsky, and E. J. Ward. 2016b. Model-based inference for estimating shifts in species distribution, area occupied, and center of gravity. Meth. Ecol. Evol. 7(8): 990-1008.

Thorson, J. T., A. Rindorf, J. Gao, D. H. Hanselman, and H. Winker. 2016c. Density-dependent changes in effective area occupied for sea-bottom-associated marine fishes. Proc. R. Soc. B. 283(1840): 10.1098/rspb.2016.1853.

Volkov, A. F., A.Ya. Efimkin, and N. A. Kuznetsova. 2007. Results of the BASIS studies on Pacific salmons feeding habits in 2002–2006. Izv. TINRO 151: 365–402. [In Russian with English abstract]

R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

URL: https://www.R-project.org/.

Tables

Table 1. -- Occupied station coordinates for all survey legs.

Station	Longitude	Latitude	Continued	Station	Longitude	Latitude
YBE40	-141.146	59.113	-	SEK40	-137.733	57.618
YBE30	-140.967	59.254	-	SEK30	-137.469	57.701
YBE20	-140.83	59.385	-	SEK20	-137.194	57.785
YBE10	-140.637	59.529	-	SEK10	-136.942	57.874
YBE0	-140.502	59.65	-	SEK0	-136.679	57.943
YBC0	-139.916	59.499	-	SEM0	-136.963	58.252
YBC10	-140.062	59.348	-	SEM10	-137.214	58.158
YBC20	-140.247	59.208	-	SEM20	-137.531	58.081
YBC30	-140.44	59.075	-	SEM30	-137.767	58.006
YBC40	-140.603	58.934	-	SEM40	-138.034	57.913
YBC50	-140.778	58.794	-	SEK30	-137.644	57.858
YBC70	-141.138	58.532	-	SEL20	-137.374	57.94
YBC90	-141.491	58.255	-	SEL10	-137.094	58.015
YBA70	-140.953	58.063	-	SEL0	-136.809	58.088
YBA70	-140.628	58.336	-	SEI120	-139.575	56.69
YBA50	-140.292	58.607	-	SEI140	-140.09	56.53
YBA40	-140.086	58.747	-	SEI160	-140.615	56.374
YBA30	-139.904	58.885	-	SEI180	-141.143	56.211
YBA20	-139.722	59.023	-	SEI200	-141.579	56.063
YBA10	-139.557	59.175	-	SEK200	-141.992	56.334
YBA0	-139.367	59.307	-	SEK180	-141.484	56.494
SERO	-138.839	59.12	-	SEK160	-140.931	56.652
SER10	-138.998	58.976	-	SEK140	-140.419	56.808
SER20	-139.21	58.851	-	SEK120	-139.891	56.972
SER30	-139.355	58.703	-	SEM120	-140.222	57.251
SER40	-139.533	58.567	-	SEM140	-140.723	57.096
SER50	-139.742	58.427	-	SEM160	-141.266	56.934
SER70	-140.071	58.154	-	SEM180	-141.807	56.773
SER90	-140.421	57.882	-	SEM200	-142.336	56.61
SEQ90	-139.901	57.691	-	SEO190	-142.712	56.903
SEK70	-139.568	57.961	-	SEO170	-142.181	57.058
SEQ50	-139.209	58.258	-	SEO150	-141.645	57.22

Table 1. – Continued.

SEQ40	-139.037	58.391	-	LB1	-142.183	57.993
SEQ30	-138.855	58.507	-	LB2	-138.795	57.298
SEQ20	-138.652	58.648	-	LB3	-138.344	57.258
SEQ10	-138.466	58.781	-	LB4	-137.332	57.157
SEQ0	-138.285	58.916	-	LB5	-136.206	56.87
SEM60	-138.612	57.75	-	LB6	-136.422	57.196
SEM80	-139.141	57.575	-	LB7	-136.652	57.431
SEM100	-139.674	57.404	-	LB8	-137.262	57.712
SEI0	-137.943	57.938	-	LB9	-139.5	58.319
SEI10	-136.649	57.572	-	LB10	-139.713	58.431
SEE10	-136.054	56.996	-	LB11	-139.5	58.535
SEE20	-136.311	56.911	-	LB12	-139.243	58.546
SEE50	-136.569	56.824	-	LB13	-139.758	58.411
SEG30	-136.871	57.121	-	LB14	-141.006	59.306
SEG20	-136.551	57.206	-	LB15	-141.631	58.997
SEG10	-136.314	57.283	-	LB16	-141.061	59.095
SEG0	-136.063	57.36	-	LB17	-142.516	59.571
SEI0	-136.357	57.654	-	LB18	-143.051	59.744
SEI10	-136.619	57.573	-	LB19	-144.309	59.694
SEI20	-136.89	57.493	-	LB20	-144.323	59.689
SEI30	-137.16	57.413	-	LB21	-144.388	59.591
SEI40	-137.428	57.333	-	LB22	-144.304	59.666
SEI60	-137.95	57.176	-	LB23	-144.369	59.511
SEI80	-138.474	57.004	-	LB24	-144.303	59.689
SEI100	-139.03	56.843	-	LB25	-144.789	59.566
SEK100	-139.322	57.124	-	LB26	-144.309	59.685
SEK80	-138.791	57.295	-	LB27	-144.33	59.711
SEK60	-138.26	57.459	-	LB28	-144.202	59.753

Table 2. -- NW1702 completed operations for each station (Trawl – Bongo), and number of samples collected at each station (*Chl-a* – Salinity). – indicates not collected.

Date	Station	Trawl	CTD	FastCat	Bongo	*Chl-a*	Nutrients	Salinity
7/4/2017	YBE40	1	1	1	1	7	7	-
7/4/2017	YBE30	1	1	1	1	8	7	1
7/4/2017	YBE20	1	1	1	1	7	7	-
7/5/2017	YBE10	1	1	1	1	7	7	-
7/5/2017	YBE0	1	1	1	1	7	7	-
7/5/2017	YBC0	1	-	-	-	-	-	-
7/5/2017	YBC10	1	-	-	-	-	-	-
7/5/2017	YBC20	1	1	1	1	7	6	1
7/6/2017	YBC30	1	1	1	1	7	7	-
7/6/2017	YBC40	1	1	1	1	7	7	-
7/6/2017	YBC50	1	1	1	1	7	7	-
7/6/2017	YBC70	1	1	1	1	8	7	1
7/7/2017	YBC90	1	1	1	1	7	7	-
7/7/2017	YBA90	1	1	1	1	8	7	1
7/8/2017	YBA70	1	1	1	1	7	7	-
7/8/2017	YBA50	1	1	1	1	7	7	-
7/8/2017	YBA40	1	1	1	1	8	7	1
7/8/2017	YBA30	1	1	1	1	7	7	-
7/9/2017	YBA20	1	1	1	1	7	7	-
7/9/2017	YBA10	1	1	1	1	7	7	1
7/9/2017	YBA0	1	1	1	1	7	6	-
7/9/2017	SERO	1	1	1	1	7	6	-
7/10/2017	SER10	1	1	1	1	8	7	1
7/10/2017	SER20	1	1	1	1	7	7	-
7/10/2017	SER30	1	1	1	1	7	7	-
7/10/2017	SER40	1	1	1	1	8	7	1
7/11/2017	SER50	1	1	1	1	7	7	-
7/11/2017	SER70	1	1	1	1	7	7	-
7/11/2017	SER90	1	1	1	1	8	7	1
7/12/2017	SEQ90	1	1	1	1	7	7	-
7/12/2017	SEK70	1	1	1	1	7	7	-
7/12/2017	SEQ50	1	1	1	1	8	7	1
7/12/2017	SEQ40	1	1	1	1	7	7	-
7/13/2017	SEQ30	1	1	1	1	7	7	-
7/13/2017	SEQ20	1	1	1	1	8	7	1
7/13/2017	SEQ10	1	1	1	1	7	7	-

Table 2. – Continued.

7/13/2017	SEQ0	1	1	1	1	7	7	-
7/15/2017	SEM60	1	1	1	1	7	7	-
7/15/2017	SEM80	1	1	1	1	8	7	1
7/15/2017	SEM100	1	1	1	1	6	6	-
7/16/2017	SEM40A	1	1	1	1	-	-	-
7/16/2017	SEI10A	1	1	1	1	-	-	-
7/18/2017	SEE10	1	1	1	1	7	7	-
7/18/2017	SEE20	1	1	1	1	7	7	-
7/18/2017	SEE30	1	1	1	1	7	6	1
7/19/2017	SEG30	1	1	1	1	7	7	-
7/19/2017	SEG20	1	1	1	1	7	7	1
7/19/2017	SEG10	1	1	1	1	7	7	-
7/19/2017	SEG0	1	1	1	1	8	7	-
7/20/2017	SEI0	1	1	1	1	7	7	-
7/20/2017	SEI10	1	1	1	1	7	7	-
7/20/2017	SEI20	1	1	1	1	6	6	-
7/20/2017	SEI30	1	1	1	1	8	7	1
7/21/2017	SEI40	1	1	1	1	7	7	-
7/21/2017	SEI60	1	1	1	1	7	7	-
7/21/2017	SEI80	1	1	1	1	7	7	-
7/22/2017	SEI100	1	1	-	-	-	-	-
7/22/2017	SEK100	1	1	1	1	8	7	1
7/22/2017	SEK80	1	1	1	1	7	7	-
7/23/2017	SEK60	1	1	1	1	7	7	-
7/23/2017	SEK40	1	1	1	1	7	7	-
7/23/2017	SEK30	1	1	1	1	7	7	-
7/23/2017	SEK20	1	1	1	1	8	7	1
7/24/2017	SEK10	1	1	1	1	7	7	-
7/24/2017	SEK0	1	1	1	1	7	7	-
7/24/2017	SEM0	1	1	1	1	7	7	-
7/24/2017	SEM10	1	1	1	1	8	7	1
7/25/2017	SEM20	1	1	1	1	7	7	-
7/25/2017	SEM30	1	1	1	1	8	7	1
7/25/2017	SEM40	1	1	1	1	7	7	-
7/27/2017	SEL30	1	1	1	1	7	7	-
7/27/2017	SEL20	1	1	1	1	7	7	-
7/27/2017	SEL10	1	1	1	1	8	7	1
7/28/2017	SEL0	1	1	1	1	7	7	-

Table 3. -- NW1704 completed operations for each station (Trawl – Bongo), and number of samples collected at each station (*Chl-a* – Salinity). – indicates not collected.

Date	Station	Trawl	CTD	FastCat	Bongo	*Chl-a*	Nutrients	Salinity
8/4/2017	SEI120	1	1	1	1	7	6	1
8/4/2017	SEI140	1	1	-	-	8	6	-
8/5/2017	SEI160	1	1	1	1	8	6	-
8/5/2017	SEI180	1	1	-	-	8	6	-
8/5/2017	SEI200	1	1	1	1	8	6	-
8/5/2017	SEK200	1	1	-	-	2	1	-
8/6/2017	SEK180	1	1	1	1	-	-	-
8/6/2017	SEK160	1	1	-	-	-	-	-
8/6/2017	SEK140	1	1	1	1	-	-	-
8/6/2017	SEK120	1	1	-	-	-	-	-
8/7/2017	SEM120	1	1	1	1	8	6	-
8/7/2017	SEM140	1	1	-	-	8	6	-
8/7/2017	SEM160	1	1	1	1	8	6	1
8/7/2017	SEM180	1	1	-	-	8	6	-
8/8/2017	SEM200	1	1	1	1	8	6	-
8/8/2017	SEO190	1	1	-	-	-	-	-
8/8/2017	SEO170	1	1	1	1	-	-	-
8/8/2017	SEO150	1	1	-	-	-	-	-
8/9/2017	LB1	1	1	1	1	8	6	1
8/9/2017	LB2	1	1	-	-	-	-	-
8/9/2017	LB3	1	1	-	-	-	-	-
8/10/2017	LB4	1	1	-	-	-	-	-
8/10/2017	LB5	1	1	-	-	-	-	-
8/10/2017	LB6	1	1	-	-	-	-	-
8/10/2017	LB7	1	1	-	-	-	-	-
8/11/2017	LB8	1	1	-	-	-	-	-
8/11/2017	LB9	1	1	-	-	-	-	-
8/11/2017	LB10	1	1	-	-	-	-	-
8/11/2017	LB11	1	1	-	-	-	-	-
8/12/2017	LB12	1	-	-	-	-	-	-
8/12/2017	LB13	1	-	-	-	-	-	-
8/12/2017	LB14	1	-	-	-	-	-	-
8/12/2017	LB15	1	-	-	-	-	-	-

Table 3. – Continued.

8/13/2017	LB16	1	-	-	-	-	-	-
8/13/2017	LB17	1	1	-	-	-	-	-
8/13/2017	LB18	1	1	-	-	-	-	-
8/14/2017	LB19	1	1	-	-	-	-	-
8/14/2017	LB20	1	1	-	-	-	-	-
8/14/2017	LB21	1	-	-	-	-	-	-
8/15/2017	LB22	1	-	-	-	-	-	-
8/15/2017	LB23	1	-	-	-	-	-	-
8/15/2017	LB24	1	1	-	-	-	-	-
8/15/2017	LB25	1	-	-	-	-	-	-
8/16/2017	LB26	1	-	-	-	-	-	-
8/16/2017	LB27	1	1	1	1	5	4	1
8/16/2017	LB28	1	-	-	-	-	-	-

Table 4. -- NW1702 Average temperature (T, ^{0}C) and salinity (S, ppt) above and below the pycnocline. Data is only available at stations where a bongo occurred (Seabird 49).

MasterStation	Ttop	Tbottom	S.top	S.bottom
YBE40	11.31	7.03	32.37	32.62
YBE30	11.88	7.28	32.16	32.43
YBE20	11.38	6.63	32.15	32.3
YBE10	13.4	7.62	30.93	32.1
YBE0	11.8	8.53	27.54	31.78
YBC20	11.56	7.22	32.04	32.26
YBC30	11.76	7.16	32.11	32.34
YBC40	11.71	7.33	32.18	32.49
YBC50	11.4	7.08	32.48	32.62
YBC70	12.82	7.87	32.14	32.36
YBC90	11.74	6.62	32.22	32.33
YBA90	12.26	7.05	32.15	32.38
YBA70	11.67	6.93	32.18	32.41
YBA50	12.93	8.11	32.22	32.54
YBA40	12.58	7.67	31.84	32.24
YBA30	13.09	8.47	31.96	32.21
YBA20	13.05	8.24	30.2	32.14
YBA10	13.25	8.24	27.46	32.04
YBA0	12.37	9.92	25.71	31.83
SERO	12.74	10.05	27.94	31.94
SER10	12.37	8.12	29.52	32.12
SER20	12.53	7.98	30.92	32.17
SER30	13.05	8.1	32.21	32.26
SER40	12.57	7.78	32.3	32.44
SER50	13.15	7.87	32.13	32.42
SER70	12.8	7.8	32.06	32.4
SER90	12.88	7.54	32.29	32.53
SEQ90	13	7.31	32.13	32.43
SEK70	13.29	8.13	32.25	32.62
SEQ50	12.55	8.3	31.94	32.19
SEQ40	12.48	8.75	32	32.1
SEQ30	13.23	8.57	32.05	32.25
SEQ20	13.04	9.04	31.96	32.2
SEQ10	13.34	8.19	31.9	32.13

Table 4. – Continued.

SEQ0	13.68	10.08	31.59	32.04
SEM60	13.05	7.37	32.23	32.64
SEM80	13.14	6.93	32.29	32.69
SEM100	13.62	7.33	32.23	32.62
SEE10	13.39	8.15	31.59	32.26
SEE20	13.21	7.33	32.27	32.56
SEE30	12.23	7.09	32.49	32.74
SEG30	13.81	7.6	32.42	32.59
SEG20	14.12	8.15	32.02	32.57
SEG10	13.67	8.4	31.7	32.2
SEG0	13.98	8.99	31.36	32.08
SEI0	13.58	9.71	31.64	32.04
SEI10	12.69	7.78	31.74	32.19
SEI20	13.35	7.42	32.26	32.61
SEI30	14	7.98	32.18	32.61
SEI40	13.8	8.19	32.26	32.58
SEI60	13.24	7.8	31.93	32.35
SEI80	12.9	7.86	32.04	32.35
SEK100	12.99	7.67	32.49	32.75
SEK80	13.24	7.78	32.45	32.68
SEK60	13.94	7.38	32.3	32.65
SEK40	14.41	8.41	32.17	32.61
SEK30	14.11	7.69	32.28	32.67
SEK20	14.51	8.19	32.24	32.55
SEK10	14.26	8.37	31.59	32.13
SEK0	13.12	9.21	31.61	32.05
SEM0	13.23	8.49	31.83	32.03
SEM10	13.18	8.5	31.77	32.53
SEM20	13.9	7.87	32.09	32.61
SEM30	14.38	8.7	31.82	32.51
SEM40	14.14	8.07	31.84	32.29
SEL30	14.7	8.12	32.31	32.62
SEL20	14.53	9.17	31.94	32.38
SEL10	12.45	8.12	31.82	32.15

Table 5. -- NW1704 Average temperature (T, ˚C) and salinity (S, ppt) above and below the pycnocline. Data is only available at stations where a bongo occurred (Seabird 49).

MasterStation	Ttop	Tbottom	S top	S bottom
SEI120	13.44	9.14	32.46	32.59
SEI160	14.03	8.99	31.94	32.07
SEI200	13.29	8.49	32.49	32.69
SEK180	13.75	9.18	32.21	32.15
SEK140	14.98	9.66	32.18	32.37
SEM120	15.29	9.77	32.24	32.46
SEM160	14.81	9.29	32.24	32.42
SEM200	14.12	9.95	32.41	32.52
SEO170	15.42	10.25	32.18	32.28
LB1	15.22	8.14	32.18	32.29
LB27	13.9	9.21	31.63	32.15

Table 6. -- NW1702 chlorophyll a concentration (*Chl-a*, µg/liter) by depth in meters and filter size fraction, glass fiber filter (GFF) and a 10 µm filter (>10). – indicates missing value.

Station	0 m GFF	10 m >10	10 m GFF	20 m GFF	30 m GFF	40 m GFF	50 m GFF
SEE10	1.2879	0.0046	1.0099	0.5997	0.4631	0.1142	0.2231
SEE20	0.4637	0.0338	0.4889	0.7277	1.671	0.3439	0.2283
SEE30	1.0841	0.1682	0.6377	0.8757	0.7252	0.4009	-
SEG0	0.3069	0.0521	0.7597	0.7851	0.8456	0.1995	0.0796
SEG10	0.4669	0.0074	0.5872	1.6307	0.2261	0.0926	0.0286
SEG20	0.3236	0.0558	0.5191	1.0528	1.3102	0.7646	0.2827
SEG30	0.4224	0.1228	0.7877	0.8652	0.9624	0.5753	0.3706
SEI0	0.356	0.0857	0.4779	1.1313	0.9503	0.1464	0.0949
SEI10	0.387	0.006	0.4088	2.1478	0.5001	0.1725	0.0589
SEI20	0.8568	0.1498	0.8875	2.3993	0.8746	1.1276	0.6578
SEI40	0.3672	0.0676	0.3798	0.5278	0.8259	0.4879	0.2911
SEI60	0.2626	-	0.202	0.7362	0.3313	0.1954	0.0664
SEI80	0.5416	0.0105	0.5254	0.8226	0.558	0.2079	0.0584
SEK0	1.3621	1.2458	2.0254	2.5682	0.9145	0.1123	0.2181
SEK10	0.435	0.0082	0.5979	1.9142	0.4581	0.0963	0.0593
SEK100	0.1827	0.0677	0.2236	0.423	1.7465	0.4739	0.3468
SEK20	0.3427	0.0407	0.3439	0.5925	1.2028	0.8814	0.1784
SEK30	0.513	0.1145	0.6752	1.2963	0.8125	0.501	0.1471
SEK40	0.6297	0.0886	0.6024	0.992	0.6345	0.3381	0.2052
SEK60	0.4868	0.1288	0.4895	1.187	0.9997	0.6183	0.3227
SEK70	0.5291	0.1324	0.5614	1.4541	0.4683	0.2443	0.2054
SEK80	0.4758	0.167	0.4729	0.2681	0.3315	0.3878	0.2633
SEL0	0.4648	0.0056	0.623	1.7063	0.7921	0.239	0.1407
SEL10	0.9484	0.0105	0.8777	1.4106	1.1717	0.4135	0.1081
SEL20	0.4501	0.0638	0.5666	1.2996	0.9472	0.2854	0.2874
SEL30	0.7567	0.1469	0.6879	0.6824	0.6978	0.52	0.3127
SEM0	0.8732	0.0292	1.1944	0.6161	0.5131	0.5394	0.5027
SEM10	0.4852	0.0076	0.6299	1.387	1.3092	0.9651	1.4049
SEM100	0.2853	0.0437	0.387	1.358	-	0.3274	0.2439
SEM20	0.3668	0.0295	0.4129	0.5265	0.831	0.3626	0.1906

Table 6.—Continued.

SEM30	0.3855	0.04	1.1205	1.1624	0.8173	0.4751	0.2662
SEM40	0.4344	0.0173	0.5246	0.9676	0.2427	0.1145	0.064
SEM60	0.3631	0.0862	0.4536	1.0896	0.7422	0.4705	0.2614
SEM80	0.4138	0.1223	0.4929	1.1982	0.6465	0.3707	0.4874
SEQ0	0.4154	0.1572	0.3611	0.8982	2.3352	0.5296	0.1277
SEQ10	0.3349	0.0663	0.3857	1.3266	0.6836	0.2969	0.0981
SEQ20	0.4232	0.1308	0.423	0.7241	0.912	0.8158	0.1456
SEQ30	0.4957	0.0176	0.4856	0.7163	0.7603	0.2579	0.1601
SEQ40	0.3883	0.0146	0.4286	1.3623	1.1712	0.2628	0.1212
SEQ50	0.5317	0.0226	0.5794	0.9388	1.4962	0.2116	0.1308
SEQ90	0.2586	0.0087	0.3084	1.7555	1.1148	0.2413	0.109
SER10	3.2354	0.2528	0.593	0.2965	0.3112	0.0627	0.0807
SER20	0.6259	0.0208	1.0782	0.4037	0.3453	0.2291	0.0665
SER30	0.5116	0.0476	0.6635	1.4133	0.8661	0.4196	0.1303
SER40	0.4613	0.0533	1.2236	1.3218	0.5673	0.3376	0.1839
SER50	0.3857	0.0246	0.3926	1.4535	1.5869	0.7986	0.2491
SER70	0.478	0.0433	0.4443	0.9781	0.3965	0.0954	0.0543
SER90	0.8695	0.1492	0.8925	3.2163	0.6626	0.3984	0.1299
SERO	1.3245	0.0911	0.5974	0.2458	0.1059	0.082	0.0909
YBA0	0.5774	0.0419	0.5922	0.6001	0.2346	0.1447	0.1195
YBA10	0.4579	0.0752	0.4874	0.4894	0.3526	0.2295	0.2074
YBA20	0.3955	0.0292	0.5012	0.8199	0.8287	0.4553	0.2013
YBA30	0.5072	0.0202	0.4306	1.3317	1.1793	0.649	0.4354
YBA40	0.2969	0.036	0.5289	0.9183	0.399	0.1934	0.0719
YBA50	0.8619	0.3772	1.1038	1.0748	0.79	0.35	0.2566
YBA70	0.2682	0.0193	0.288	0.6977	1.0696	0.3587	0.0998
YBA90	0.3584	0.0396	0.4082	1.5117	0.643	0.253	0.2443
YBC20	0.2277	0.0109	0.3221	0.5269	-	1.3233	0.197
YBC30	0.3333	0.0185	0.4099	1.6368	0.5796	0.4959	0.1273
YBC40	0.8303	0.0355	0.4637	0.3464	0.5695	0.2994	0.0896
YBC50	0.6649	0.112	0.4517	0.94	0.6943	0.3261	0.3054
YBC70	0.223	0.0227	0.2684	0.9366	0.6875	0.3265	0.2281

Table 6. – Continued.

YBC90	0.6262	0.077	0.8225	1.0226	0.5977	0.3777	0.2184
YBE0	0.5867	0.209	1.0179	1.0274	0.4793	0.4072	0.3444
YBE10	0.1445	0.0069	0.2107	0.6219	0.6973	0.3433	0.1408
YBE20	0.6221	0.2043	0.8912	1.4971	0.5852	0.3846	0.2202
YBE30	0.5088	0.0386	0.5257	2.172	1.2653	0.2164	0.0964
YBE40	0.6804	0.2486	0.8352	0.743	0.7007	0.2909	0.222

Table 7. -- NW1702 selected zooplankton biomass (mg m^{-3}) summed across life history stages from 60 cm bongo, 505 µm.

Station	*Calanus marshallae*	*Calanus pacificus*	Doliolidae	*Eucalanus bungii*	*Limacina helicina*	*Metridia pacifica*	*Neocalanus cristatus*	*Neocalanus flemingeri*	*Neocalanus plumchrus*	*Themisto pacifica*	Siphonophora
YBE40	0.9133	2.917	0.3685	10.71	1.344	2.868	127.2	30.18	0.3178	0.5344	0.00875
YBE20	13.66	2.717	11.64	11.29	2.339	2.239	12.77	144.3	0.9986	0.2271	5.965
YBE0	2.527	0	0	4.67	14.43	0.6158	0	0.8021	0	0.3088	4.011
YBC20	34.91	0.728	0	11.61	3.712	0	4.087	5.898	0	0.7907	4.25
YBC40	11.07	2.755	3.383	24.48	1.653	12.28	38.14	17.66	0.1741	0.3618	1.426
YBC70	3.734	1.995	32.93	9.591	6.313	9.932	3.914	1.053	0.3386	1.11	2.475
YBA90	17.82	1.214	10.01	19.43	1.556	0	18.22	1.215	0.1538	0.7008	0.3917
YBA50	0	3.476	32.52	28.61	2.042	1.834	5.952	0.9695	0.9349	2.585	6.599
YBA30	29.48	1.14	0.03536	4.428	0.1317	7.665	0.2024	6.488	0.8746	0.6884	2.764
YBA10	114.1	0	0.04059	14.51	0.552	2.567	9.26	4.403	0.4718	0.7123	1.224
SERO	0.3005	0	0	0.7168	1.319	0.237	0	0	0	0.4455	2.83
SER20	14.14	0.2066	0	13.21	0.1984	3.729	0.7567	0	0.5638	0.2886	2.037
SER40	24.79	3.004	0.2772	34.68	0.3377	3.186	12.44	15.27	1.636	0.895	0.3918
SER90	10.09	2.535	1.038	13.07	0.5678	10.19	2.956	3.019	0.1618	1.458	0.4309
SEQ90	8.096	2.518	20.5	2.672	2.837	4.56	5.458	0.9291	1.195	1.357	0.4493
SEQ40	12.18	0.904	0	0.1676	0.4514	0	0.1635	0.6182	0	0.926	5.117
SEQ20	5.535	0.7262	0	1.48	612.6	1.519	0	0.4579	0	0.2528	1.407
SEQ0	0.6388	0	0	0.7974	14.37	0	0	0	0	0.07726	0.4918
SEM60	1.774	2.839	3.187	3.673	0.5941	11.88	3.995	0.4973	0	2.795	0.2292
SEM100	7.463	3.872	15.98	3.751	0.8736	5.154	56.69	0	0.6752	2.533	0.605
SEE20	0.9671	3.484	0.02794	7.932	1.32	0.5123	2.198	0.5374	0	1.688	0.6295
SEG20	0.8052	1.744	0.03898	16.97	1.455	1.387	8.306	0	0	4.55	0.6015
SEG0	21.84	0.4318	0	2.127	0.2736	0.4074	0.218	0	0.2651	0.05792	0.285
SEI0	49.44	3.144	0.5406	0.6815	2.464	0.5294	2.483	0	0	0.8339	0.8426
SEI20	0	2.086	0.125	1.711	1.067	2.014	2.451	0	0.08047	0.1141	0.5865
SEI40	0.1159	1.533	5.38	8.286	1.579	3.704	16.48	0	0.4528	1.714	0.2886
SEI60	7.02	7.364	6.689	3.596	7.03	7.23	7.461	0	0.3005	0.5459	44.18

Table 7. – Continued.

SEI80	10.58	2.705	602.7	6.199	18.63	3.234	6.343	0	0	5.992	0.2452
SEK60	11.11	2.473	0.5091	3.421	0.8817	6.37	5.628	0.3593	0	0.3524	0.7819
SEK40	3.68	8.901	0.7345	8.082	0.8438	3.246	2.622	0	0.1666	0.3394	3.172
SEK20	0	2.802	0.4226	9.253	0.304	0.419	2.205	0	0.2436	0.5141	3.069
SEK0	22.55	2.68	0	4.672	1.036	0.7534	4.288	0	0.3361	0.6245	0.09553
SEM0	7.628	1.053	0	1.096	0.09843	3.789	3.15	0.6952	0	0.9689	2.35
SEM20	1.154	2.08	0.3134	2.38	0.4889	1.11	0.464	0.3453	0	0.07944	3.565
SEM40	5.202	0.8508	0.00636	12.41	0.3986	0.5595	1.187	0	0	0.6553	0.04473

Table 8. -- Fish catch in surface trawls for NW1702. Common name is followed by a life history designator. A0 = age-0, IM = immature/maturing, J = juvenile or first ocean year Pacific salmon, U = unspecified, A1+ = all age classes above A0.

Common name	Scientific name	Count
Arrowtooth flounder A0	*Atheresthes stomias*	351
Black rockfish U	*Sebastes melanops*	1
Chinook salmon IM	*Oncorhynchus tshawytscha*	1
Chinook salmon J	*Oncorhynchus tshawytscha*	5
Chum salmon IM	*Oncorhynchus keta*	72
Chum salmon J	*Oncorhynchus keta*	1,375
Coho salmon IM	*Oncorhynchus kisutch*	16
Coho salmon J	*Oncorhynchus kisutch*	287
Daggertooth U	*Anotopterus nikparini*	1
Flatfish unident. U	Pleuronectiformes	43
Gonatus kamtschaticus U	*Gonatus kamtschaticus*	124
Greenling unident. U	Hexagrammidae	29
Lanternfish unident. U	Myctophidae	2
Lingcod U	*Ophiodon elongatus*	344
Minimal armhook squid U	*Berryteuthis anonychus*	510
Pacific cod A0	*Gadus macrocephalus*	9
Pacific herring U	*Clupea pallasii*	43
Pacific sanddab U	*Citharichthys sordidus*	1
Pink salmon IM	*Oncorhynchus gorbuscha*	15
Pink salmon J	*Oncorhynchus gorbuscha*	700
Poacher unident. U	Agonidae	1
Pollock A0	*Gadus chalcogrammus*	11
Prickleback unident. U	Stichaeidae	12
Prowfish U	*Zaprora silenus*	5
Rex sole U	*Glyptocephalus zachirus*	17
Rockfish unident. A0	*Sebastes* spp.	455
Sablefish A0	*Anoplopoma fimbria*	235
Sablefish A1+	*Anoplopoma fimbria*	295
Sculpin unident. U	Cottidae	2
Smooth lumpsucker U	*Aptocyclus ventricosus*	1
Sockeye salmon IM	*Oncorhynchus nerka*	3
Sockeye salmon J	*Oncorhynchus nerka*	294
Spiny dogfish U	*Squalus suckleyi*	51
Wolf-eel U	*Anarrhichthys ocellatus*	4

Table 9. -- Fish catch in surface trawls for NW1704. Common name is followed by a life history designator. A0 = age-0, IM = immature/maturing, J = juvenile or first ocean year Pacific salmon, U = unspecified, A1+ = all age classes above A0. Surface trawls were completed with a Nordic 264 rope trawl.

Common name	Scientific name	Count
Blue shark U	*Prionace glauca*	1
Chinook salmon J	*Oncorhynchus tshawytscha*	3
Chum salmon IM	*Oncorhynchus keta*	25
Chum salmon J	*Oncorhynchus keta*	332
Coho salmon IM	*Oncorhynchus kisutch*	12
Coho salmon J	*Oncorhynchus kisutch*	121
Daggertooth U	*Anotopterus nikparini*	2
Gonatus kamtschaticus U	*Gonatus kamtschaticus*	8
Greenling unident. U	Hexagrammidae	2
Lanternfish unident. U	Myctophidae	8
Minimal armhook squid U	*Berryteuthis anonychus*	258
Pacific pomfret U	*Brama japonica*	7
Pacific sanddab U	*Citharichthys sordidus*	4
Pacific saury U	*Cololabis saira*	672
Pink salmon IM	*Oncorhynchus gorbuscha*	3
Pink salmon J	*Oncorhynchus gorbuscha*	17
Prowfish U	*Zaprora silenus*	2
Rex sole U	*Glyptocephalus zachirus*	2
Rockfish unident. A0	*Sebastes* spp.	6,081
Sablefish A0	*Anoplopoma fimbria*	684
Sablefish A1+	*Anoplopoma fimbria*	1
Salmon shark U	*Lamna ditropis*	1
Sockeye salmon J	*Oncorhynchus nerka*	9
Steelhead IM	*Oncorhynchus mykiss*	1
Wolf-eel U	*Anarrhichthys ocellatus*	1

Table 10. -- Invertebrate catch in surface trawls for NW1702. Life history classes are not recorded for invertebrate catch.

Common name	Scientific name	Weight (kg)
Aequorea sp. U	*Aequorea* sp.	789.327
Moon jelly U	*Aurelia labiata*	4.104
California market squid U	*Doryteuthis opalescence*	1.749
Carinaria japonica U	*Carinaria japonica*	0.001
Northern sea nettle U	*Chrysaora melanaster*	18.324
Corolla spectabilis U	*Corolla spectabilis*	2.688
Fried egg jelly U	*Phacellophora camtchatica*	54.720
Hormiphora cucumis U	*Hormiphora cucumis*	166.674
Jellyfish unident. U	Schyphozoa	0.012
Lions mane U	*Cyanea capillata*	124.620
Pyrosoma atlanticum U	*Pyrosoma atlanticum*	0.730
Salps unident. U	Salpida	0.019

Table 11. -- Invertebrate catch in surface trawls for NW1704. Life history classes are not recorded for invertebrate catch.

Common name	Scientific name	Weight (kg)
Aequorea sp. U	*Aequorea* sp.	2,937.105
Moon jelly U	*Aurelia labiata*	12.118
Carinaria japonica U	*Carinaria japonica*	0.394
Northern sea nettle U	*Chrysaora melanaster*	7.984
Corolla spectabilis U	*Corolla spectabilis*	16.305
Fried egg jelly U	*Phacellophora camtchatica*	16.433
Hormiphora cucumis U	*Hormiphora cucumis*	62.560
Lions mane U	*Cyanea capillata*	64.312
Pyrosoma atlanticum U	*Pyrosoma atlanticum*	0.155

Table 12. -- Frequency of occurrence for each species across all survey legs. Number of stations with positive catch (Num. Stn), and percent frequency of occurrence (Percent). A total of n =123 stations were sampled with a surface trawl.

Common name	Scientific name	Num. Stn	Percent
Aequorea sp. U	*Aequorea* sp.	117	95.1
Arrowtooth flounder A0	*Atheresthes stomias*	35	28.5
Moon jelly U	*Aurelia labiata*	28	22.8
Black rockfish U	*Sebastes melanops*	1	0.8
Blue shark U	*Prionace glauca*	1	0.8
California market squid U	*Doryteuthis opalescence*	10	8.1
Carinaria japonica U	*Carinaria japonica*	9	7.3
Chinook salmon IM	*Oncorhynchus tshawytscha*	1	0.8
Chinook salmon J	*Oncorhynchus tshawytscha*	6	4.9
Northern sea nettle U	*Chrysaora melanaster*	28	22.8
Chum salmon IM	*Oncorhynchus keta*	18	14.6
Chum salmon J	*Oncorhynchus keta*	35	28.5
Coho salmon IM	*Oncorhynchus kisutch*	21	17.1
Coho salmon J	*Oncorhynchus kisutch*	44	35.8
Corolla spectabilis U	*Corolla spectabilis*	87	70.7
Daggertooth U	*Anotopterus nikparini*	3	2.4
Flatfish unident. U	Pleuronectiformes	25	20.3
Fried egg jelly U	*Phacellophora camtchatica*	23	18.7
Gonatus kamtschaticus U	*Gonatus kamtschaticus*	27	22.0
Greenling unident. U	Hexagrammidae	10	8.1
Hormiphora cucumis U	*Hormiphora cucumis*	115	93.5
Jellyfish unident. U	Schyphozoa	1	0.8
Lanternfish unident. U	Myctophidae	4	3.3
Lingcod U	*Ophiodon elongatus*	14	11.4
Lions mane U	*Cyanea capillata*	58	47.2
Minimal armhook squid U	*Berryteuthis anonychus*	41	33.3
Pacific cod A0	*Gadus macrocephalus*	5	4.1
Pacific herring U	*Clupea pallasii*	4	3.3
Pacific pomfret U	*Brama japonica*	2	1.6
Pacific sanddab U	*Citharichthys sordidus*	4	3.3
Pacific saury U	*Cololabis saira*	13	10.6
Pink salmon IM	*Oncorhynchus gorbuscha*	18	14.6
Pink salmon J	*Oncorhynchus gorbuscha*	27	22.0
Poacher unident. U	Agonidae	1	0.8
Pollock A0	*Gadus chalcogrammus*	9	7.3
Prickleback unident. U	Stichaeidae	8	6.5

Table 12. – Continued.

Prowfish U	*Zaprora silenus*	6	4.9
Pyrosoma atlanticum U	*Pyrosoma atlanticum*	20	16.3
Rex sole U	*Glyptocephalus zachirus*	11	8.9
Rockfish unident. A0	*Sebastes* spp.	78	63.4
Sablefish A0	*Anoplopoma fimbria*	24	19.5
Sablefish A1+	*Anoplopoma fimbria*	18	14.6
Salmon shark U	*Lamna ditropis*	1	0.8
Salps unident. U	Salpida	3	2.4
Sculpin unident. U	Cottidae	1	0.8
Smooth lumpsucker U	*Aptocyclus ventricosus*	1	0.8
Sockeye salmon IM	*Oncorhynchus nerka*	3	2.4
Sockeye salmon J	*Oncorhynchus nerka*	26	21.1
Spiny dogfish U	*Squalus suckleyi*	9	7.3
Steelhead IM	*Oncorhynchus mykiss*	1	0.8
Wolf-eel U	*Anarrhichthys ocellatus*	5	4.1

Table 13. -- Index of biomass (estimated metric tonnes) ± 1 standard error for age-0 groundfish in pelagic waters of the eastern Gulf of Alaska during summer, 2010-17.

Common name	Year	Tonnes	SE
Arrowtooth flounder	2010	0.06	0.11
Arrowtooth flounder	2011	0.04	0.07
Arrowtooth flounder	2012	2.46	1.91
Arrowtooth flounder	2013	0.05	0.07
Arrowtooth flounder	2014	0.04	0.06
Arrowtooth flounder	2015	0.11	0.05
Arrowtooth flounder	2016	0.27	0.17
Arrowtooth flounder	2017	6.16	1.31
Pacific cod	2010	0.03	0.04
Pacific cod	2011	0	0
Pacific cod	2012	0.03	0.05
Pacific cod	2013	0	0
Pacific cod	2014	0.79	0.2
Pacific cod	2015	0.85	0.48
Pacific cod	2016	0.1	0.18
Pacific cod	2017	0.15	0.14
Walleye pollock	2010	0.37	0.56
Walleye pollock	2011	0	0.01
Walleye pollock	2012	2.96	1.56
Walleye pollock	2013	16.18	6.14
Walleye pollock	2014	51.23	10.98
Walleye pollock	2015	6.11	2.08
Walleye pollock	2016	5.26	1.59
Walleye pollock	2017	0.48	0.29
Rockfish	2010	0.05	0.09
Rockfish	2011	0.03	0.06
Rockfish	2012	0.45	0.43
Rockfish	2013	3.07	1.51
Rockfish	2014	23.86	6.77
Rockfish	2015	15.5	5.91
Rockfish	2016	401.5	109.4
Rockfish	2017	5.17	1.39

Table 14. -- Index of biomass (estimated metric tonnes) ± 1 standard error (SE) for juvenile Pacific salmon in the eastern Gulf of Alaska during summer, 2010-17.

Year	Chinook	Chum	Coho	Pink	Sockeye
2010	182 (91)	343 (117)	882 (275)	1,926 (635)	470 (149)
2011	223 (71)	80 (30)	695 (132)	53 (22)	168 (50)
2012	561 (123)	350 (133)	1,008 (208)	432 (175)	851 (320)
2013	386 (89)	162 (74)	1,737 (308)	37 (24)	189 (71)
2014	193 (38)	271 (60)	1,202 (132)	1,097 (252)	210 (48)
2015	192 (51)	206 (66)	756 (154)	231 (101)	1,150 (281)
2016	169 (44)	661 (150)	1,073 (186)	1,824 (441)	956 (214)
2017	25 (17)	348 (100)	552 (116)	100 (36)	175 (56)

Table 15. -- Index of biomass (estimated metric tonnes) ± 1 standard error for squid in the eastern Gulf of Alaska during summer, 2011-17.

Year	Tonnes	SE
2011	9.52	9.10
2012	54.44	18.55
2013	90.10	31.32
2014	511.12	77.78
2015	83.99	26.74
2016	112.93	30.18
2017	38.44	9.87

Figures

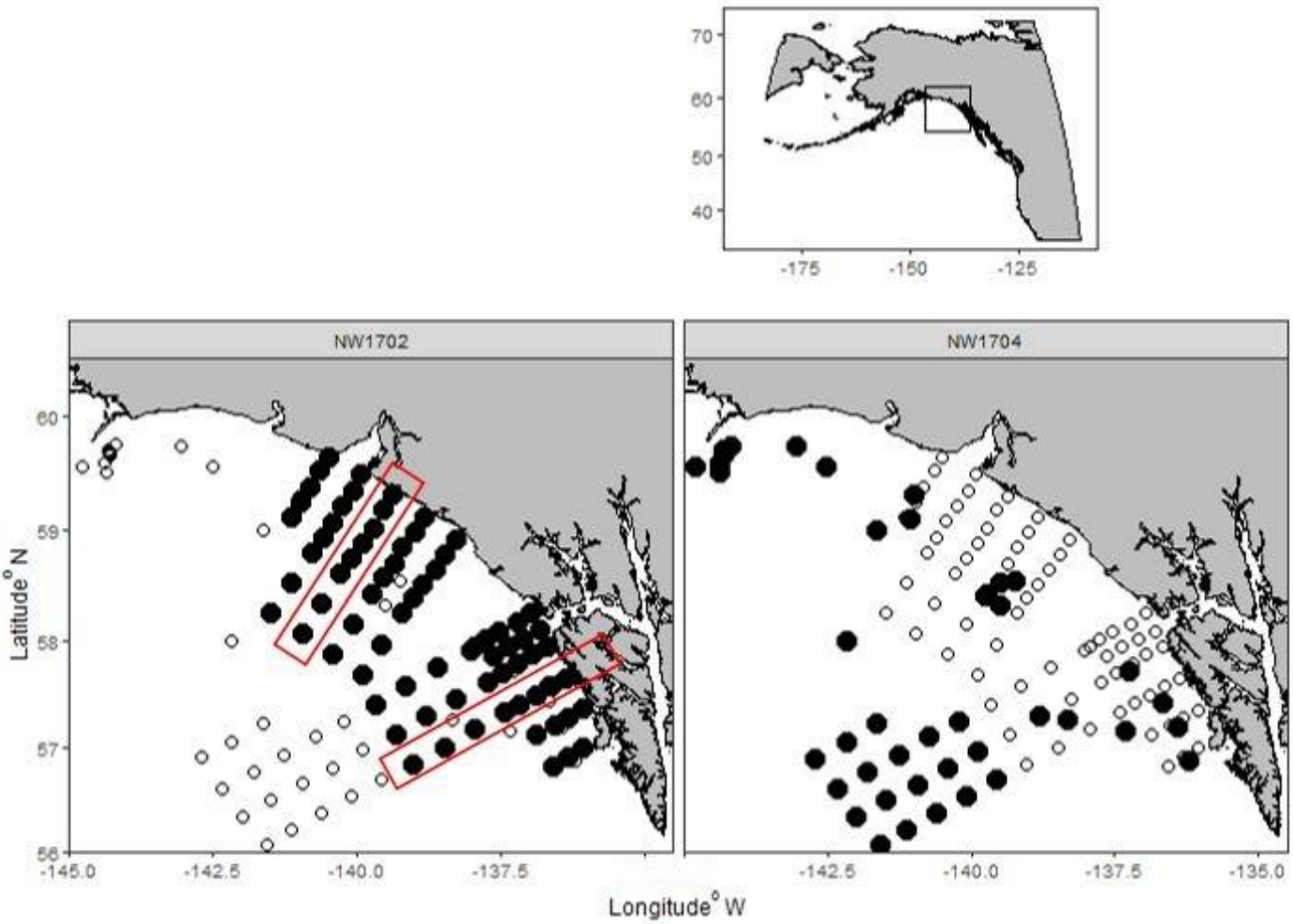


Figure 1. -- Gulf of Alaska station grid. Stations occupied by survey leg NW1702, NW1704 are solid. Red boxes outline transects in Figure 3.

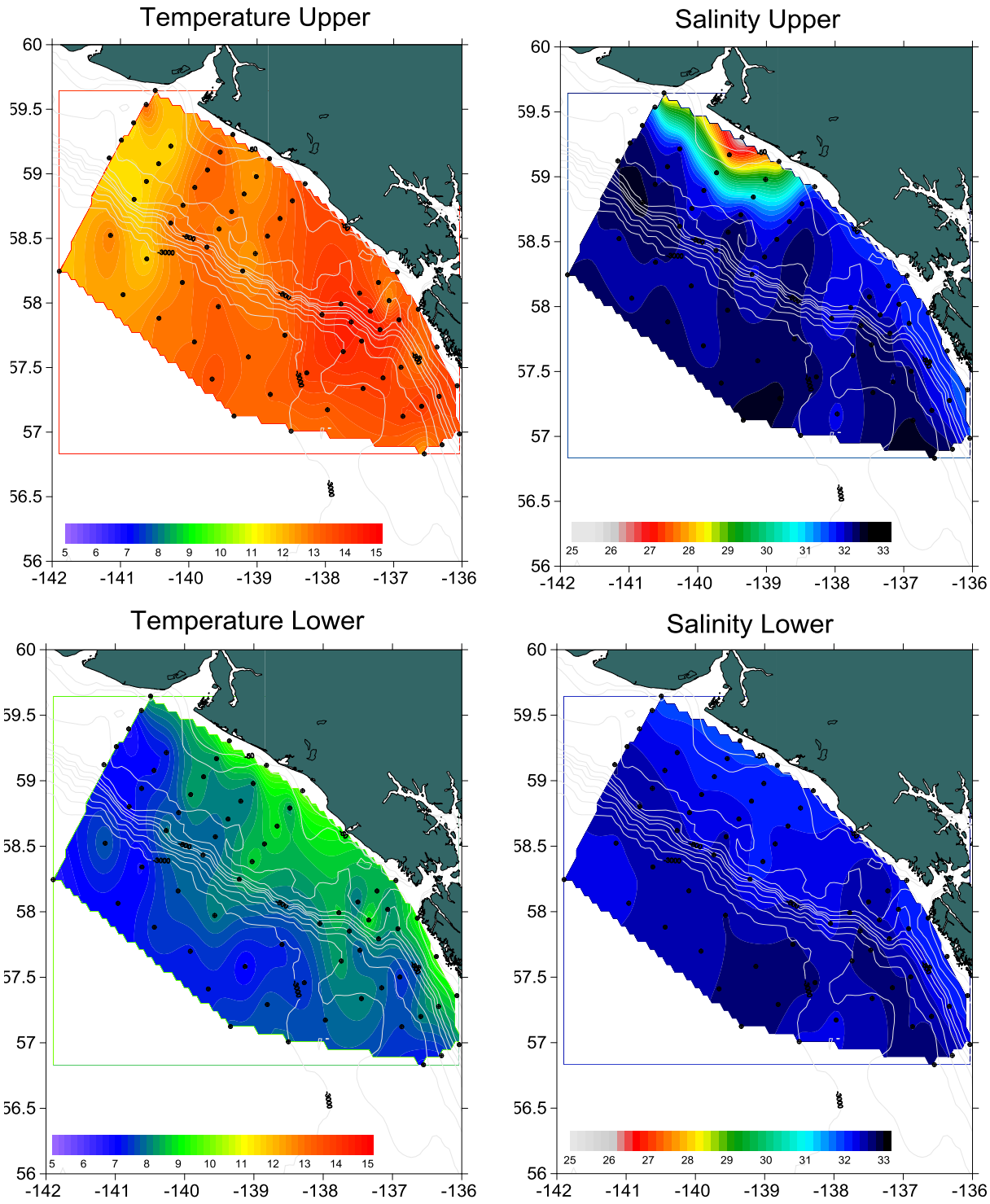


Figure 2. -- Physical properties above and below the pycnocline in the eastern Gulf of Alaska NW1702, July 2017. Temperatures are reported in ˚Celsius, salinity units are ppt.

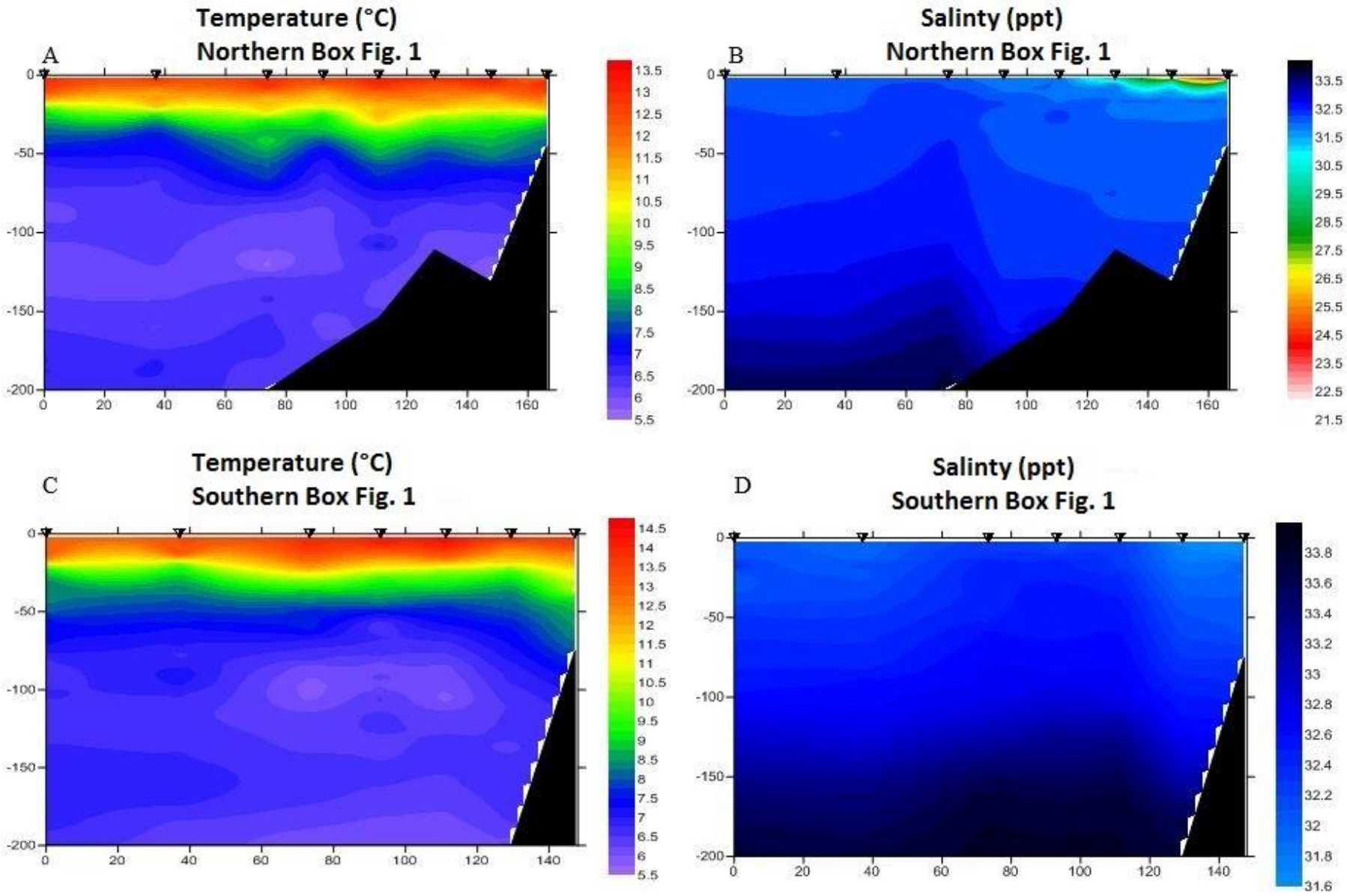


Figure 3. -- Temperature and salinity cross sections from NW1702 survey transects, one north of Cross Sound (A & B), one south of Cross Sound (C and D). The Y axis is depth in meters, the X axis is km from shore. Panels A and C are temperature in degrees Celsius, B and D are salinity in ppt.

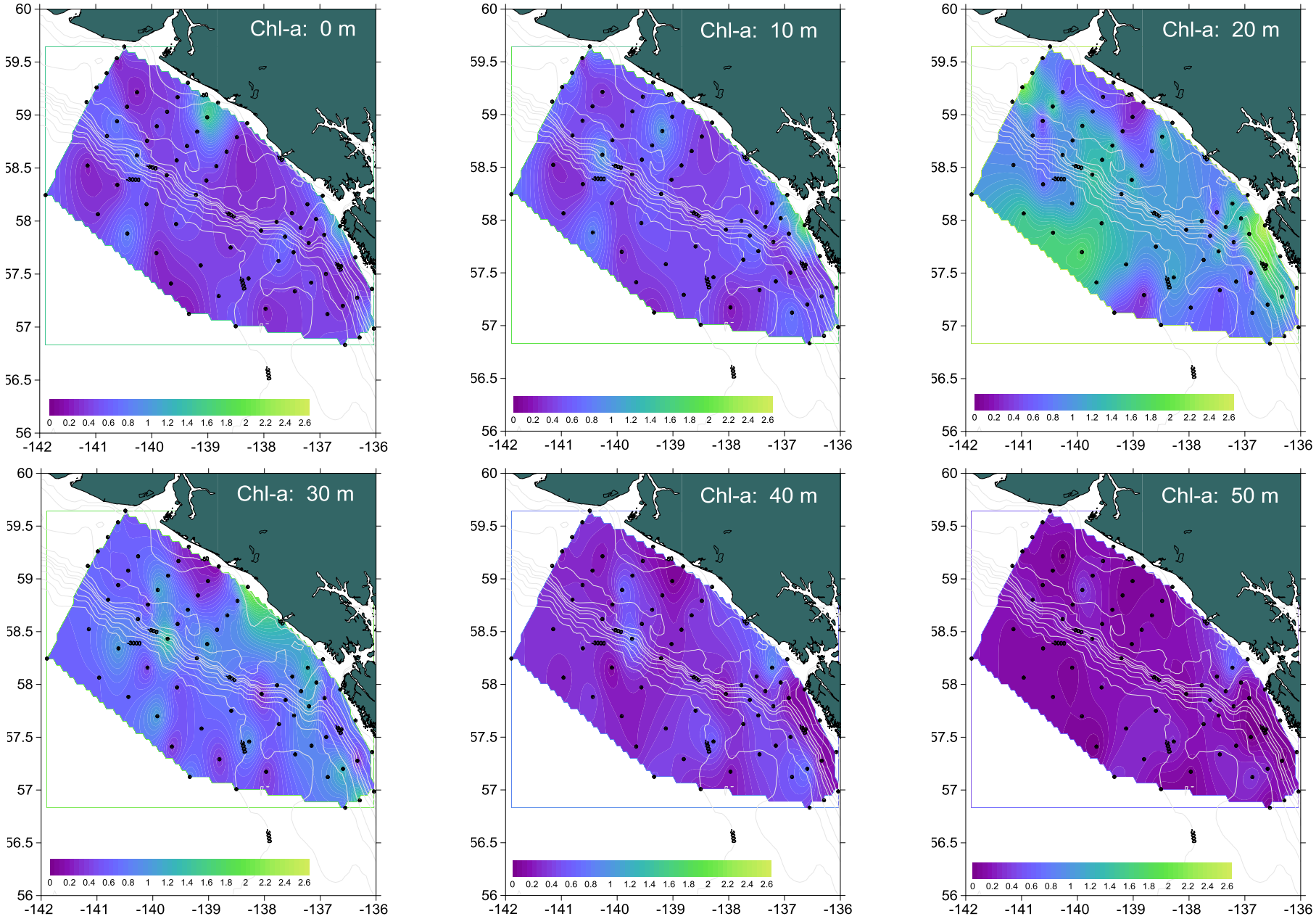


Figure 4. – Chlorophyll-*a* concentration (µg/liter) by depth during NW1702.

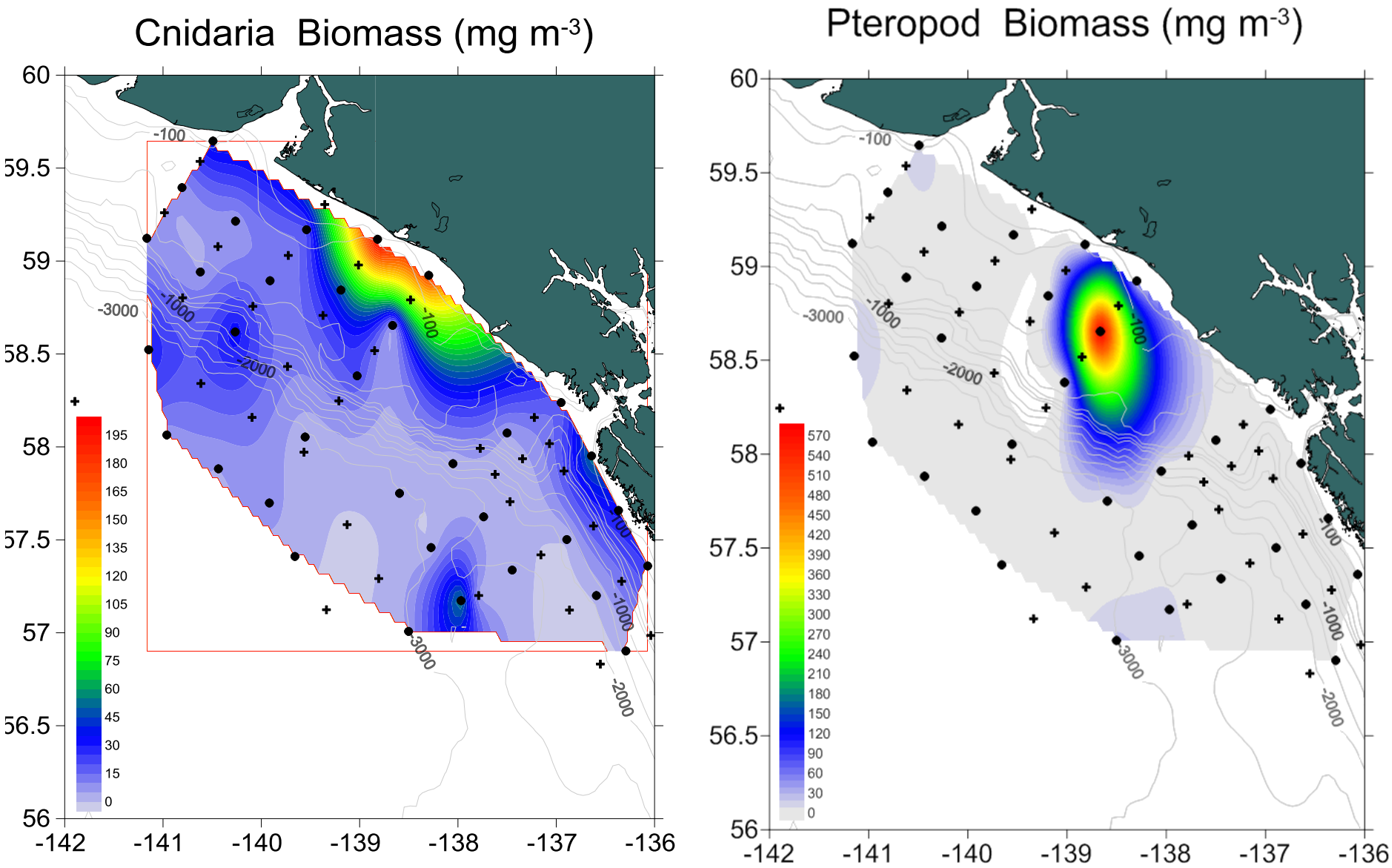


Figure 5. -- Kriging surface of biomass for Cnidarians (hydrozoan jellyfish) and all pteropods in the eastern Gulf of Alaska NW1702, July 2017. Note the difference in scale by species. Circle points were processed in the lab, plus signs are still being processed.

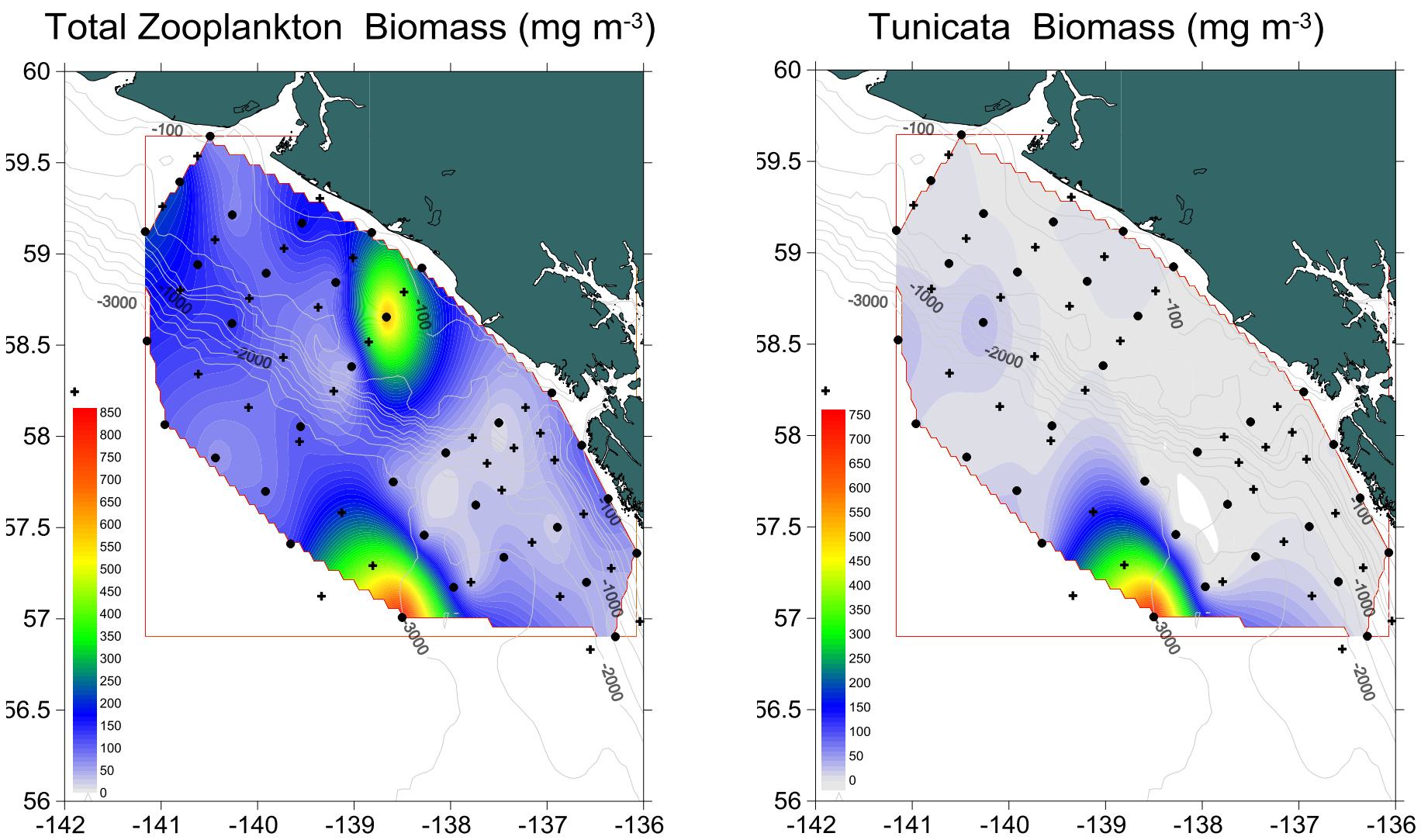


Figure 6. -- Kriging surface of biomass for total zooplankton and tunicates (salps) in the eastern Gulf of Alaska NW1702, July 2017. Note the difference in scale by species. Circle points were processed in the lab, plus signs are still being processed.

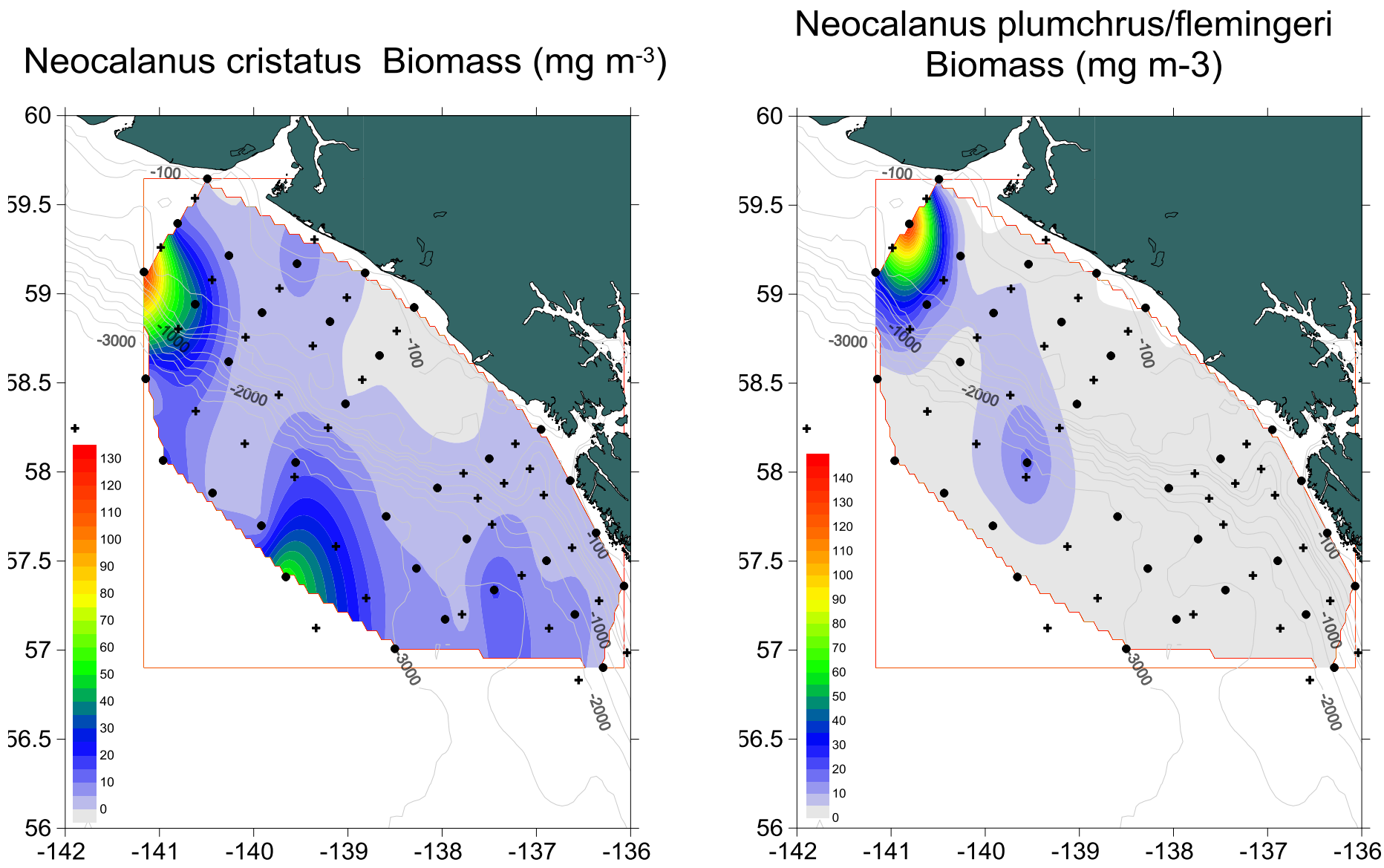


Figure 7. -- Kriging surface of biomass for *Neocalanus cristatus* and *Neocalanus plumchrus/flemengeri* in the eastern Gulf of Alaska NW1702, July 2017. Note the difference in scale by species. Circle points were processed in the lab, plus signs are still being processed.

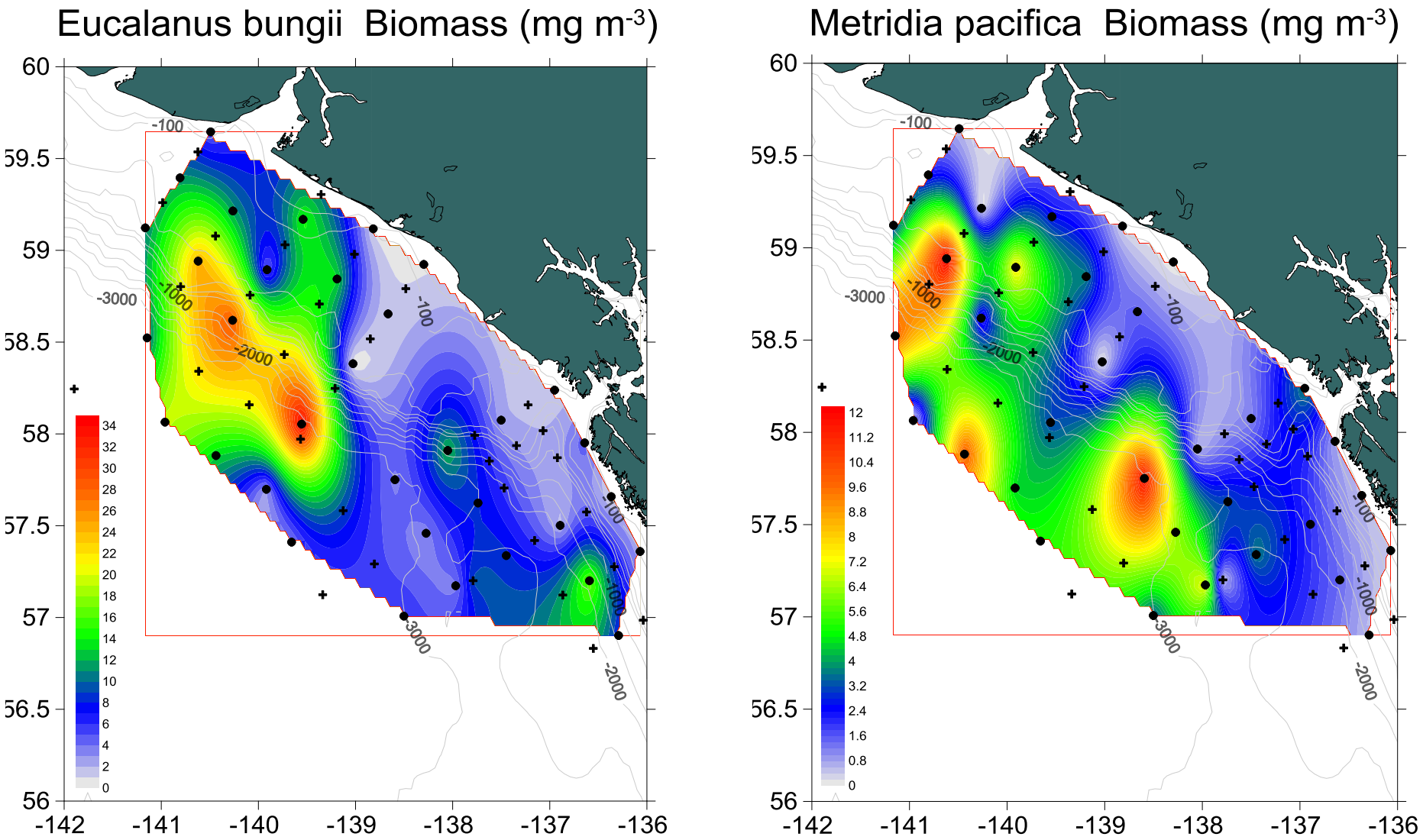


Figure 8. -- Kriging surface of biomass for *Eucalanus bungii* and *Metridia pacifica* in the eastern Gulf of Alaska NW1702, July 2017. Note the difference in scale by species. Circle points were processed in the lab, plus signs are still being processed.

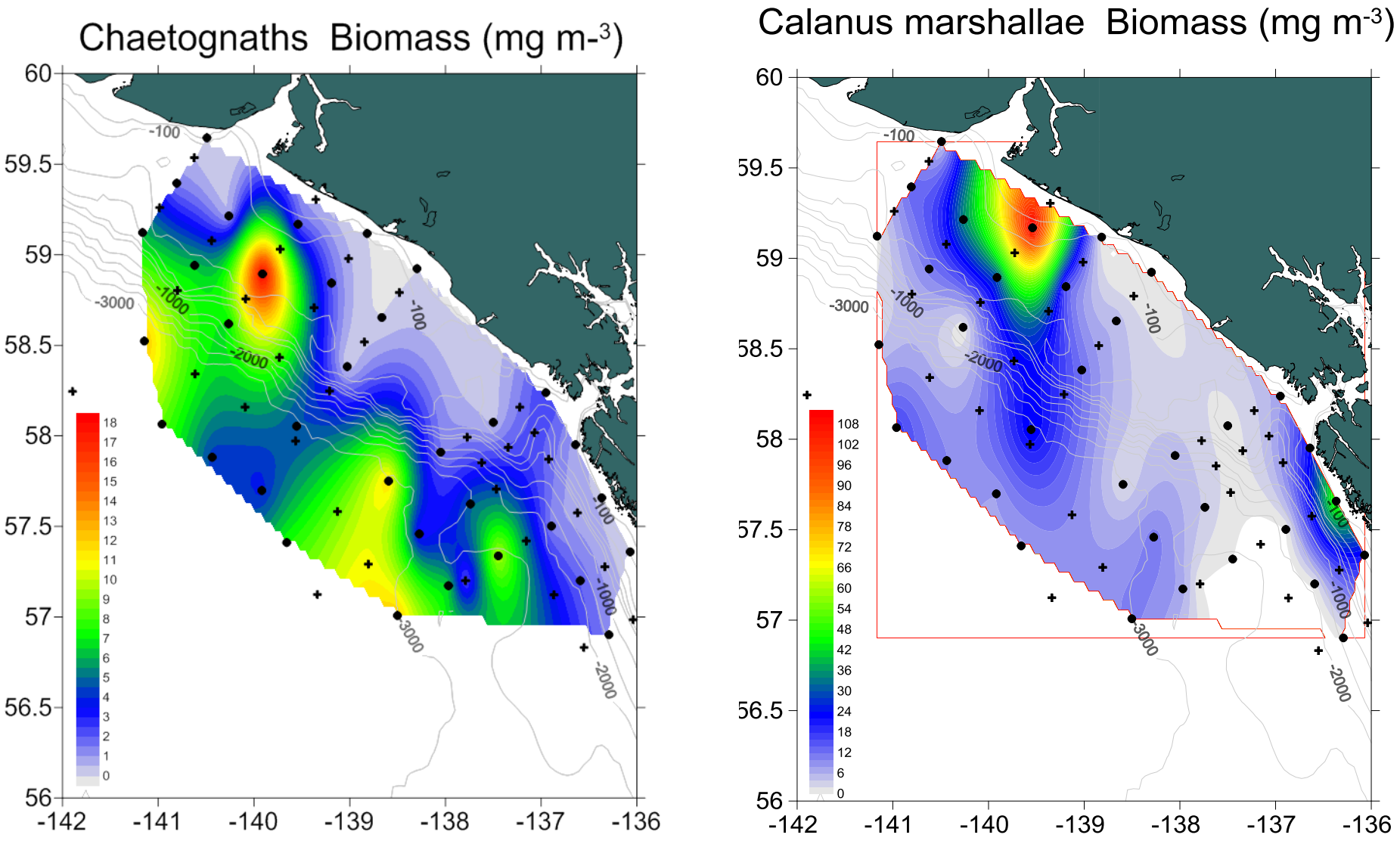


Figure 9. -- Kriging surface of biomass for Chaetognaths and *Calanus marshallae* in the eastern Gulf of Alaska NW1702, July 2017. Note the difference in scale by species. Circle points were processed in the lab, plus signs are still being processed.

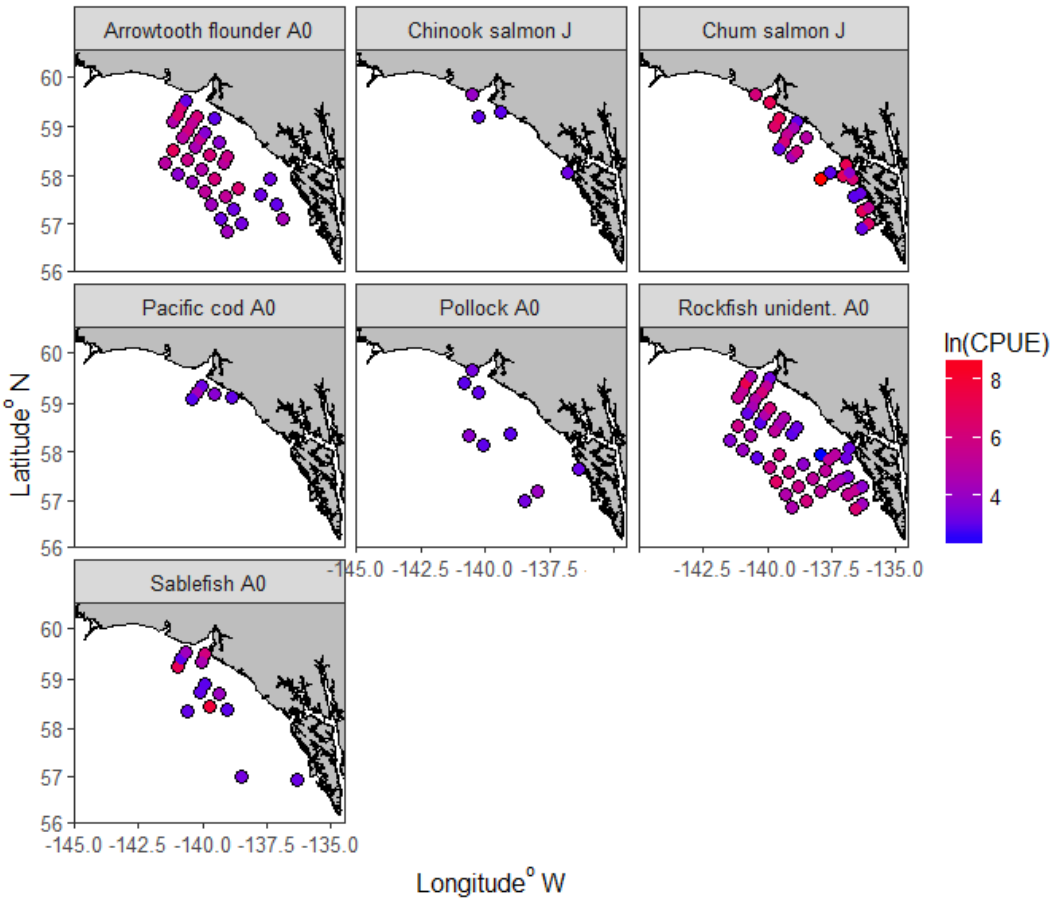


Figure 10. -- Natural log of catch per unit effort = (#/km^2) sampled with the Nordic264 (surface trawls) during the NW1702 survey.

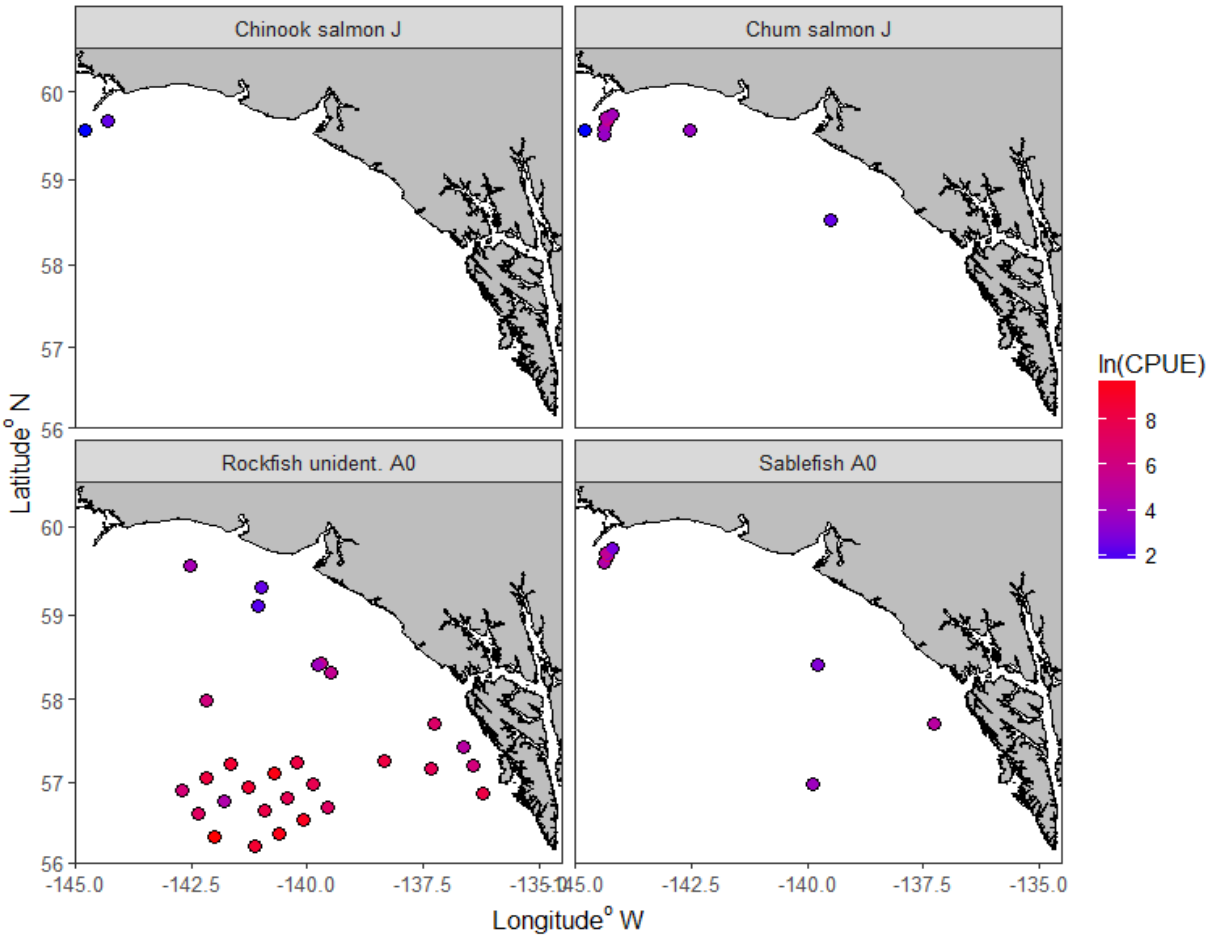


Figure 11. -- Natural log of catch per unit effort CPUE = (#/km^2) sampled with the Nordic 264 (surface trawls) during the NW1704 survey.

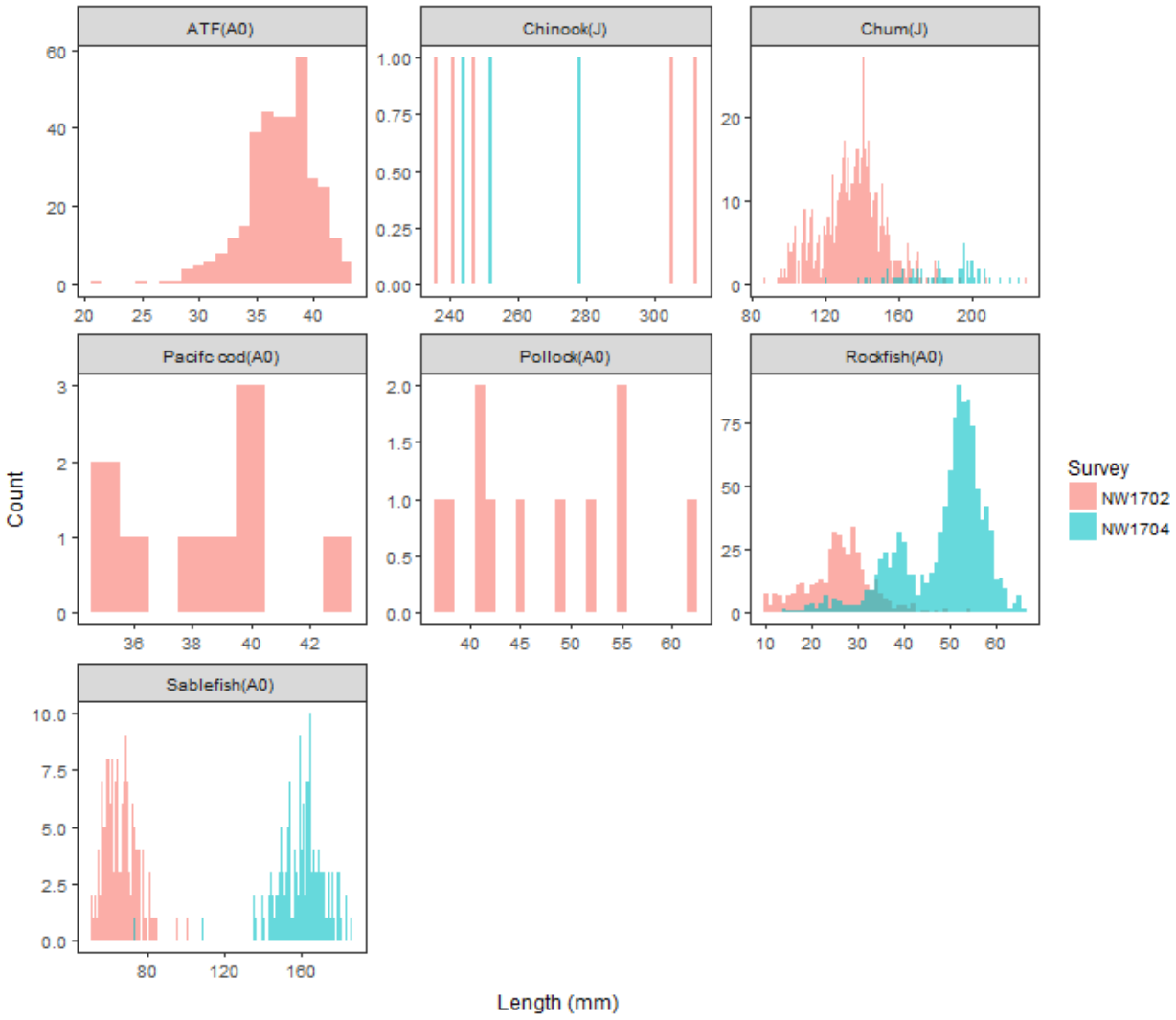


Figure 12. -- Focal fish species length frequency by survey. Standard length (mm) was measured for Arrowtooth flounder (ATF), Pacific cod (P.cod), walleye pollock (Pollock), and rockfish. Fork length (mm) was measured for Chinook salmon, chum salmon, and sablefish). A0 indicates age-0, J indicates juvenile.

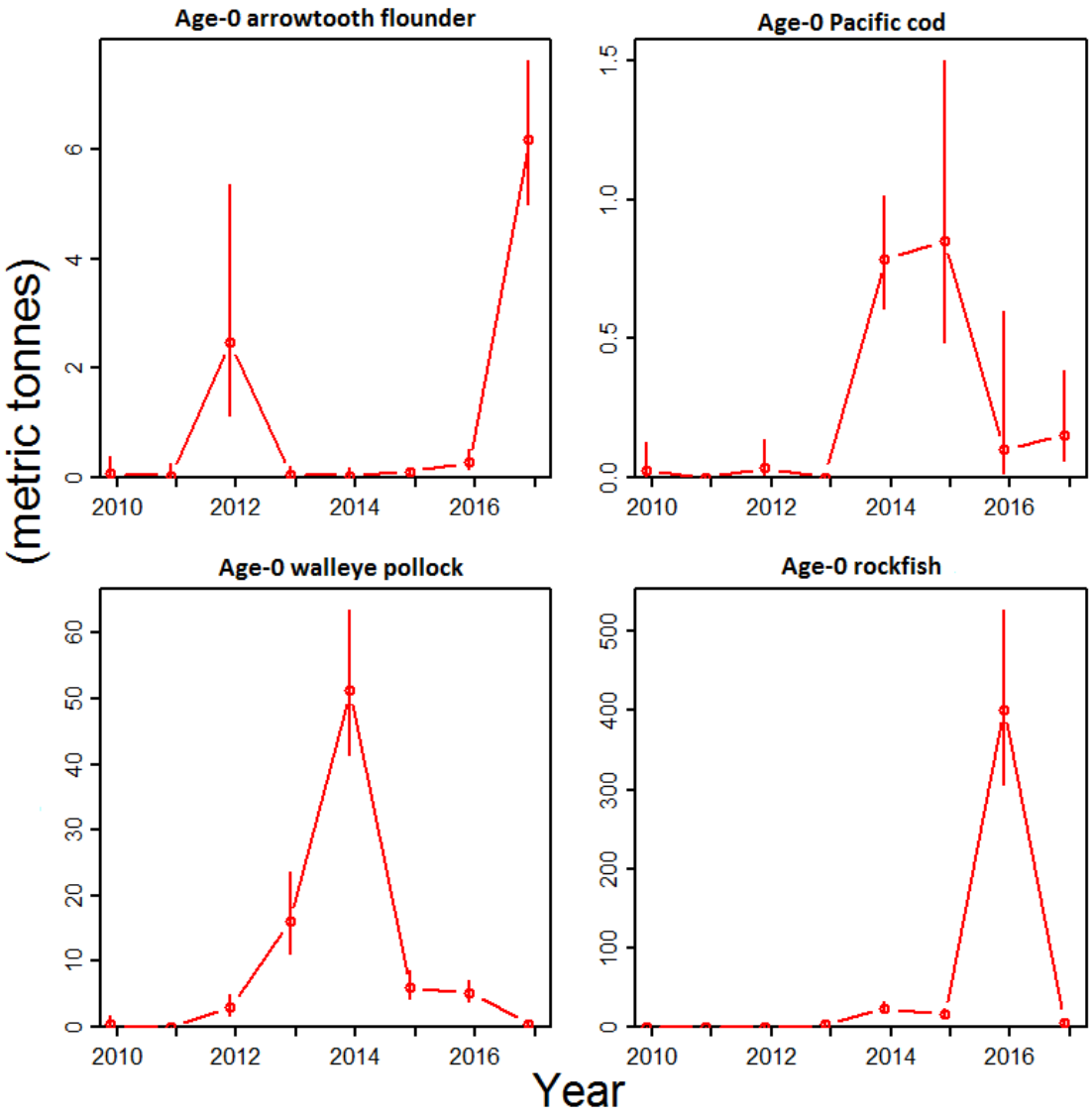


Figure 13. -- Index of biomass (estimated metric tonnes) ±1 standard error for age-0 groundfish species in pelagic waters of the eastern Gulf of Alaska during summer, 2010-17.

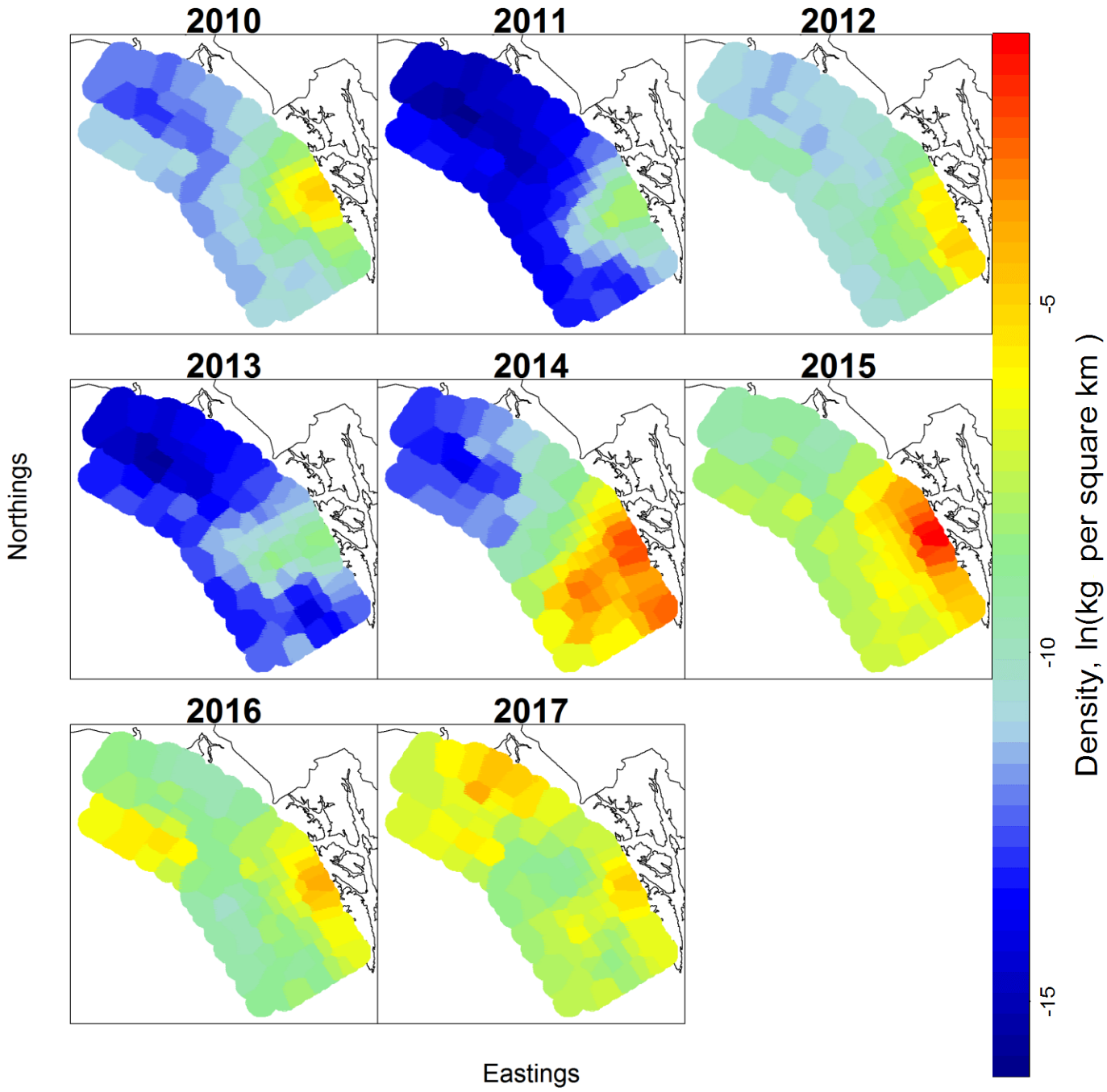


Figure 14. -- Predicted field densities of age-0 Pacific cod in pelagic waters of the eastern Gulf of Alaska during summer, 2010-17. No age-0 Pacific cod were caught in 2016, see methods.

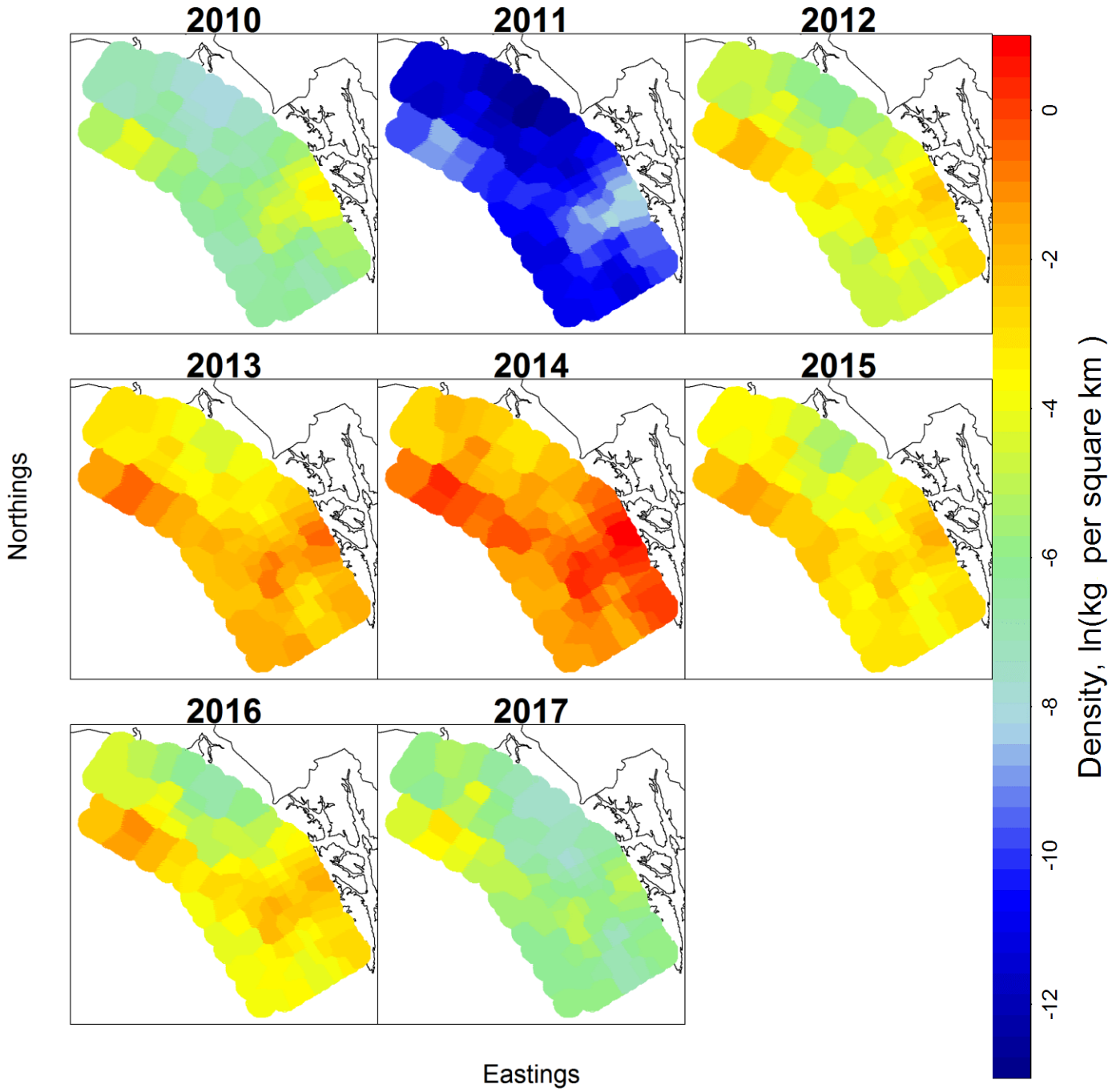


Figure 15. -- Predicted field densities of age-0 walleye pollock in pelagic waters of the eastern Gulf of Alaska during summer, 2010-17.

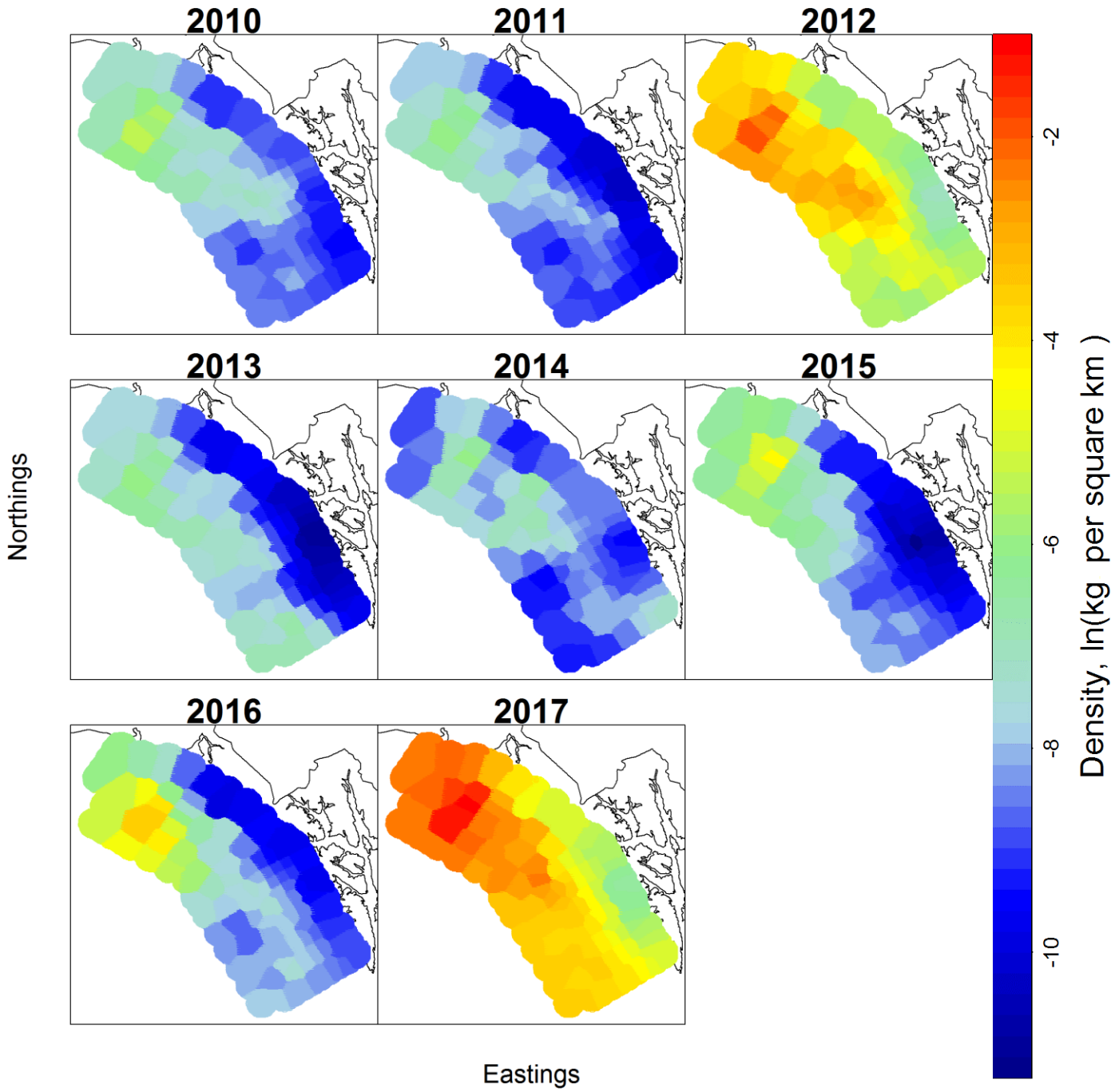


Figure 16. -- Predicted field densities of age-0 arrowtooth flounder in pelagic waters of the eastern Gulf of Alaska during summer, 2010-17.

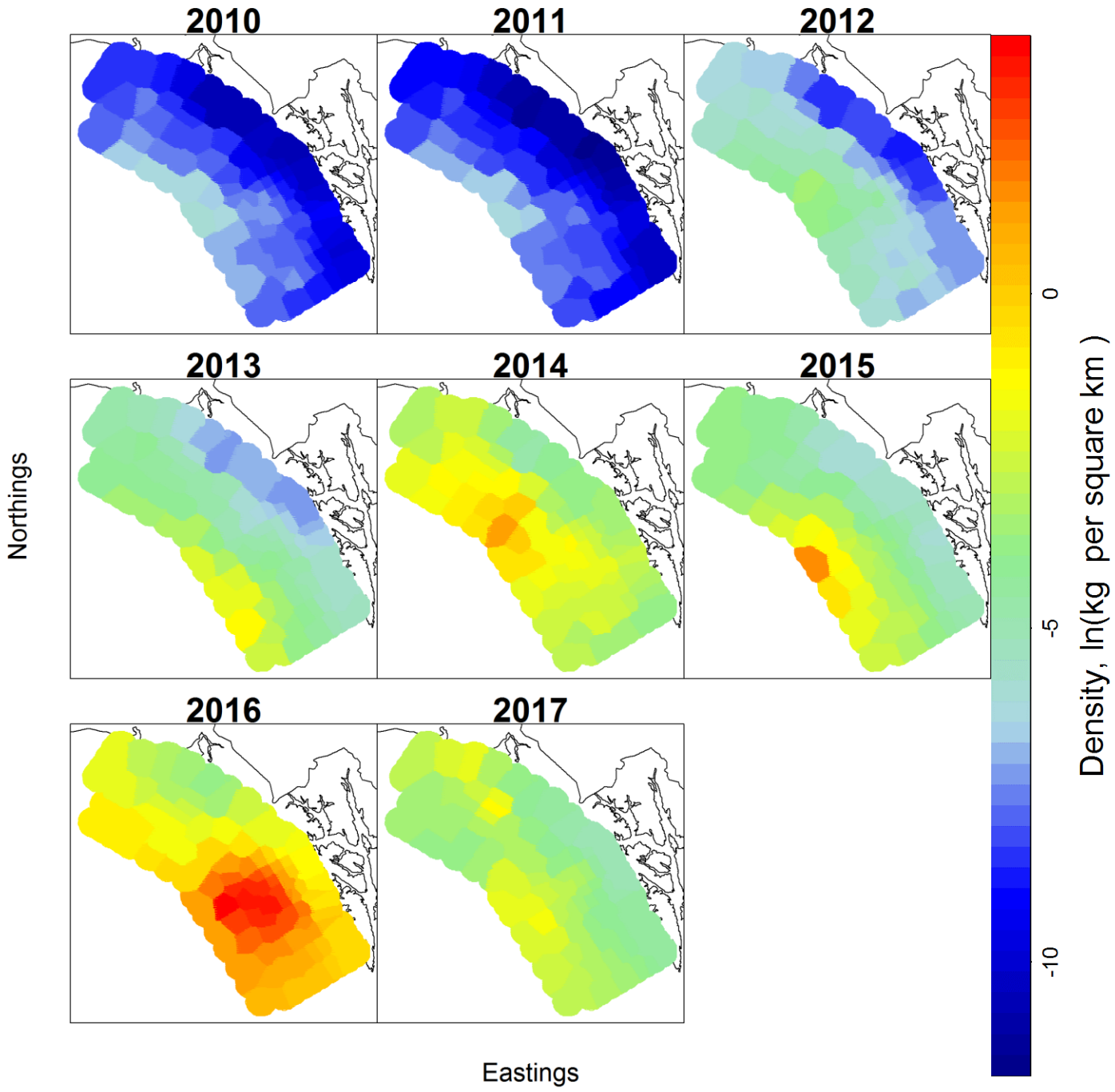


Figure 17. -- Predicted field densities of age-0 rockfish pelagic waters of the eastern Gulf of Alaska during summer, 2010-17.

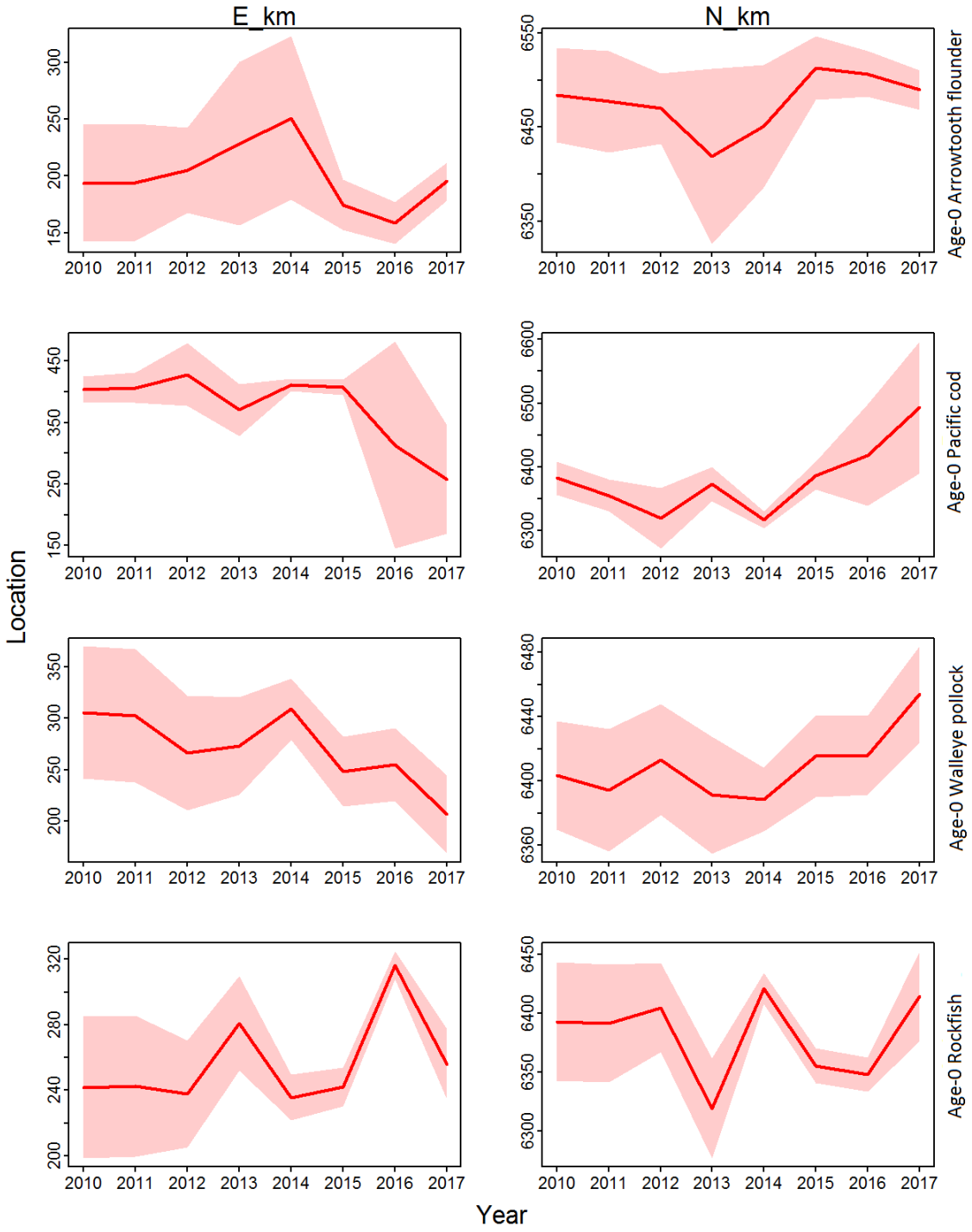


Figure 18. -- Center of gravity indicating temporal shifts in the mean east-to-west and north-to-south distribution ±1 standard error in UTM (km) for age-0 groundfish in pelagic waters of the eastern Gulf of Alaska during summer, 2010-17. No Pacific cod were caught in 2016, see methods.

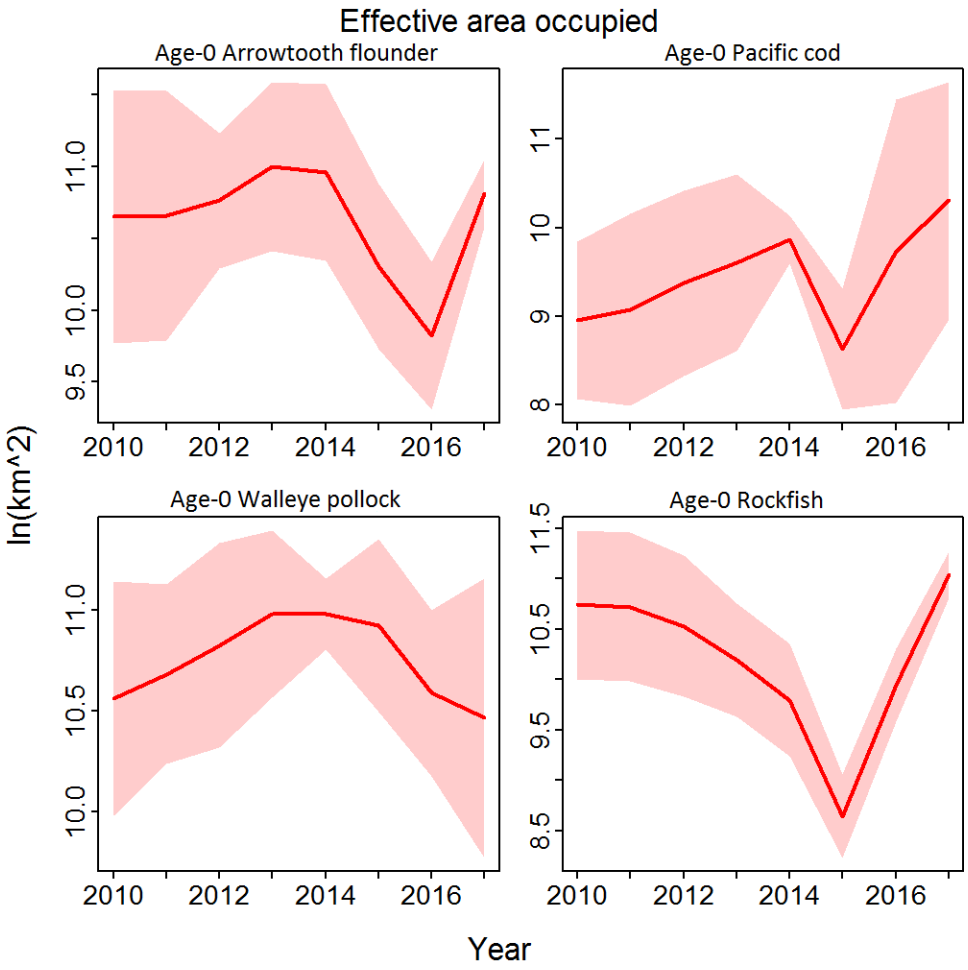


Figure 19. -- Effective area occupied (ln(km^2)) indicating range expansion/contraction ±1 standard error for age-0 groundfish in pelagic waters of the eastern Gulf of Alaska during summer, 2010-17. No Pacific cod were caught in 2016, see methods.

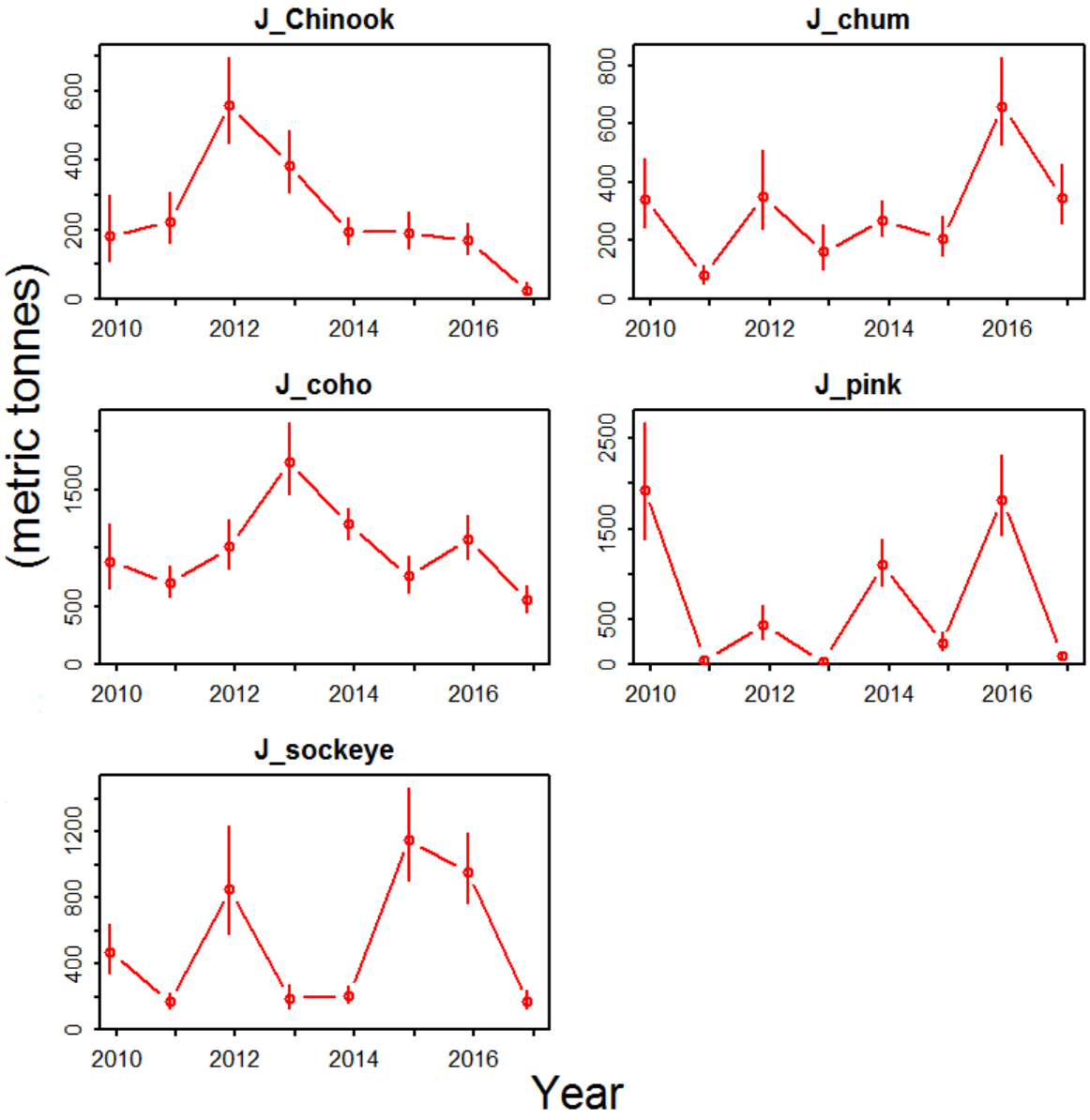


Figure 20. -- Index of biomass (estimated metric tonnes) ±1 standard error for juvenile Pacific salmon in the eastern Gulf of Alaska during summer, 2010-17.

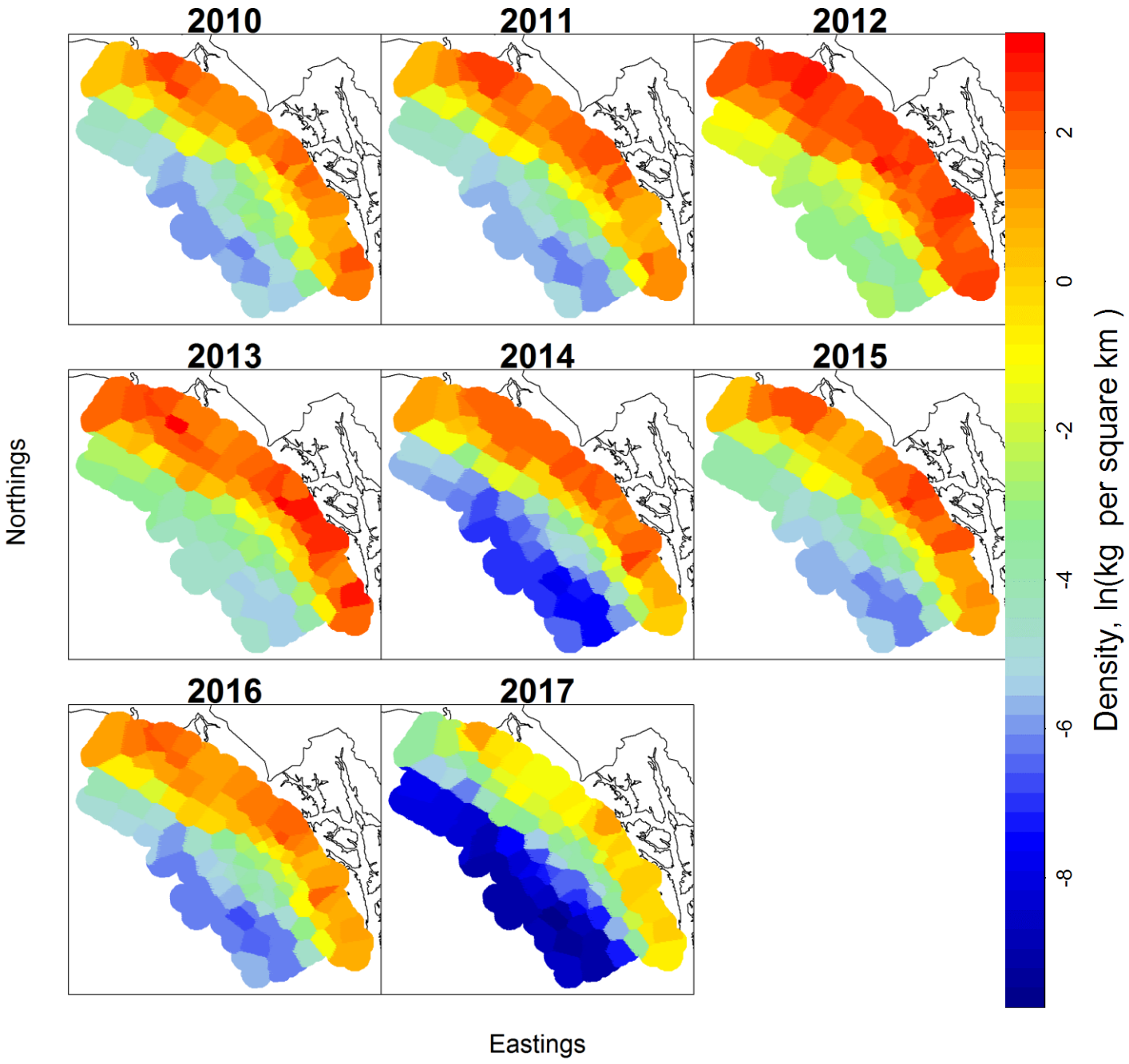


Figure 21. -- Predicted field densities of juvenile Chinook salmon in the eastern Gulf of Alaska during summer, 2010-17.

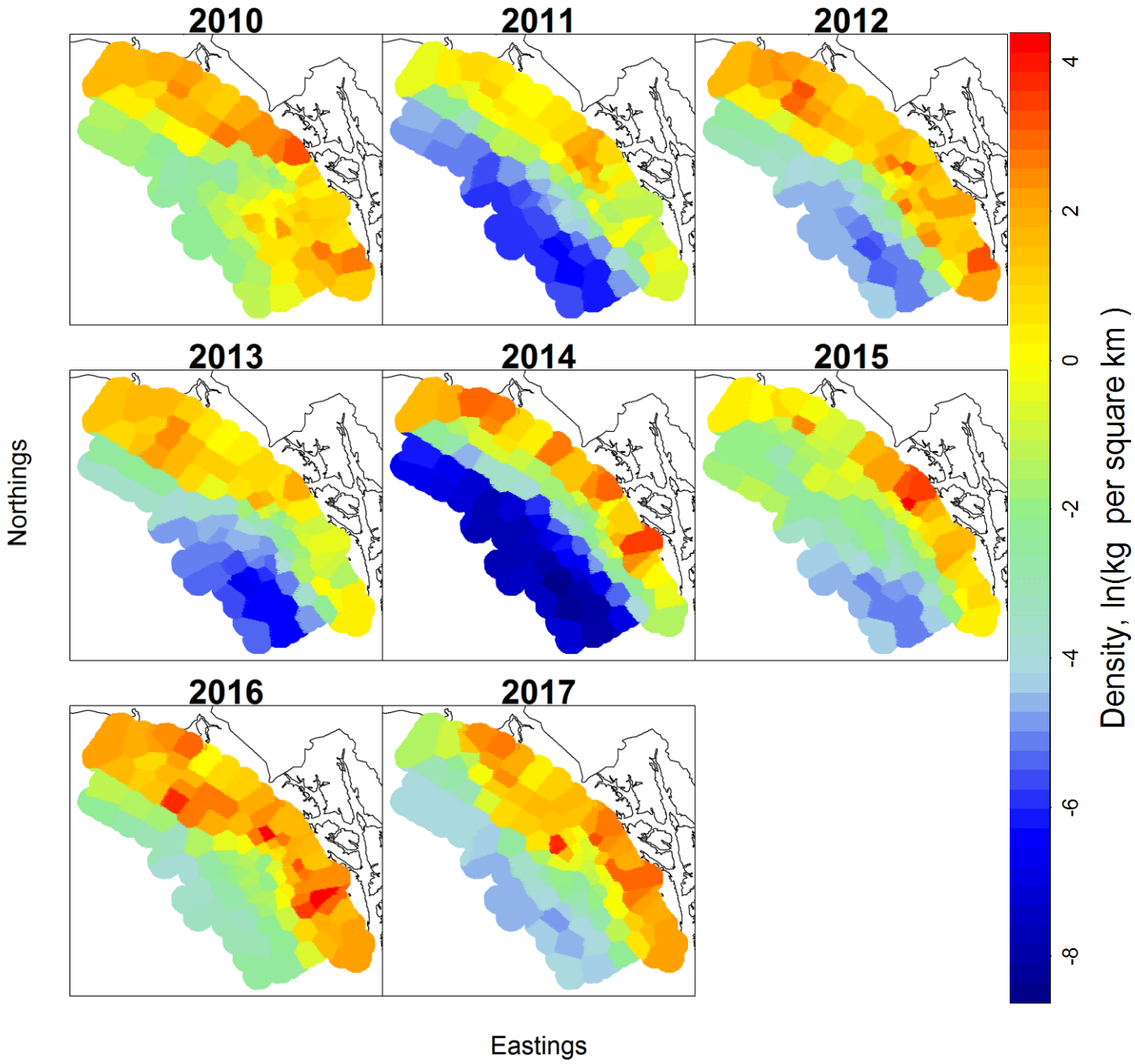


Figure 22. -- Predicted field densities of juvenile chum salmon in the eastern Gulf of Alaska during summer, 2010-17.

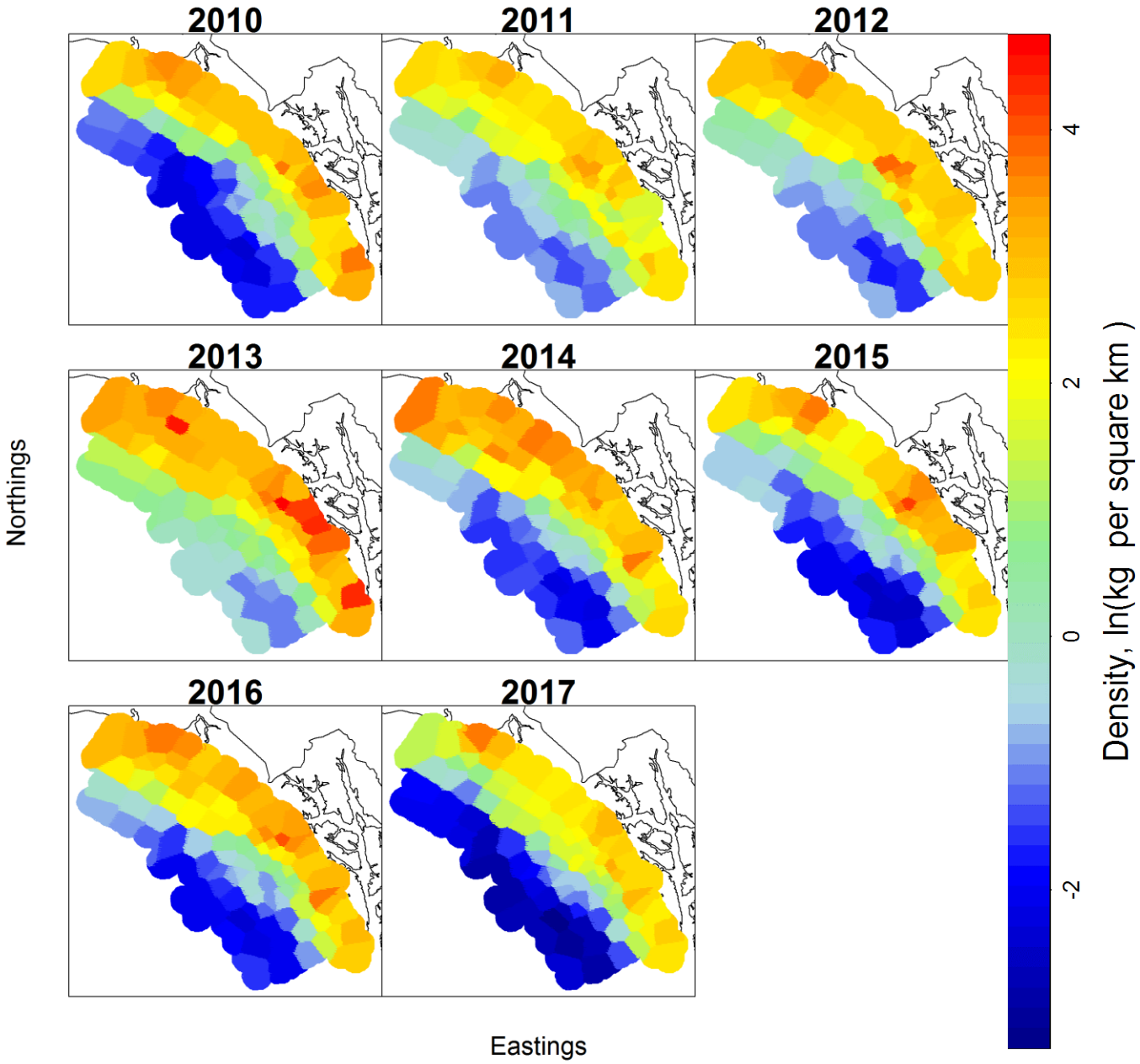


Figure 23. -- Predicted field densities of juvenile coho salmon in the eastern Gulf of Alaska during summer, 2010-17.

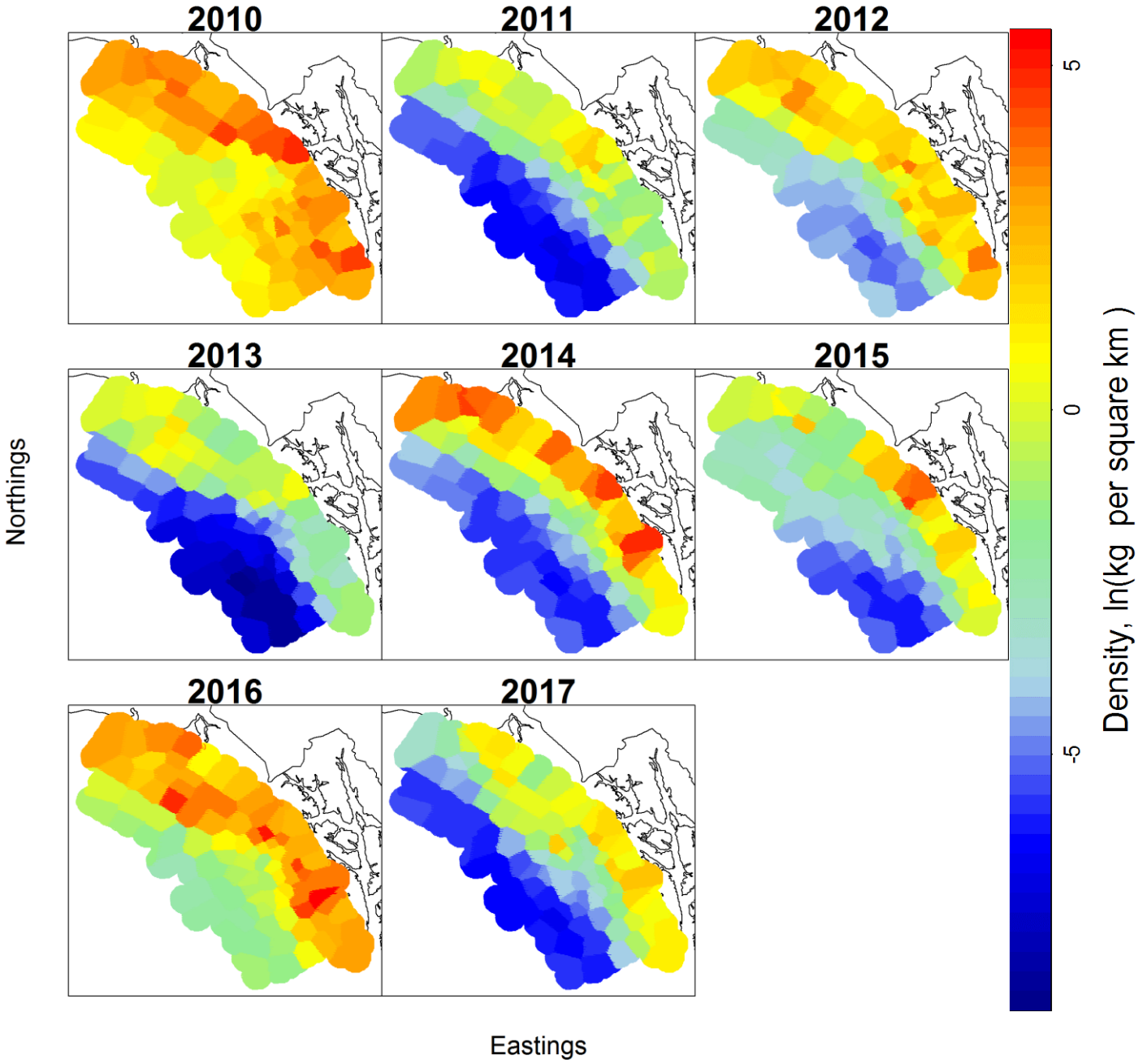


Figure 24. -- Predicted field densities of juvenile pink salmon in the eastern Gulf of Alaska during summer, 2010-17.

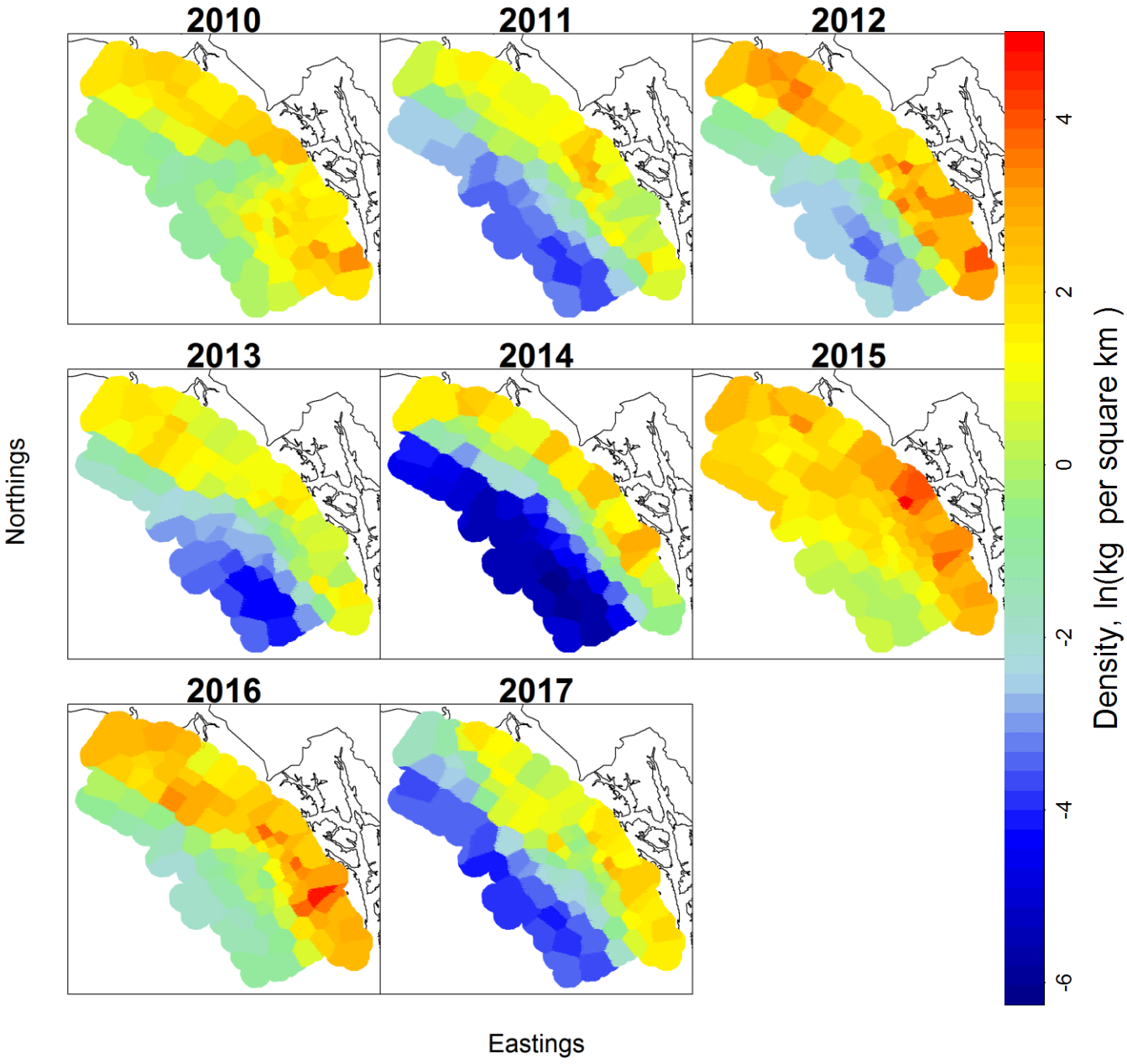


Figure 25. -- Predicted field densities of juvenile sockeye salmon in the eastern Gulf of Alaska during summer, 2010-17.

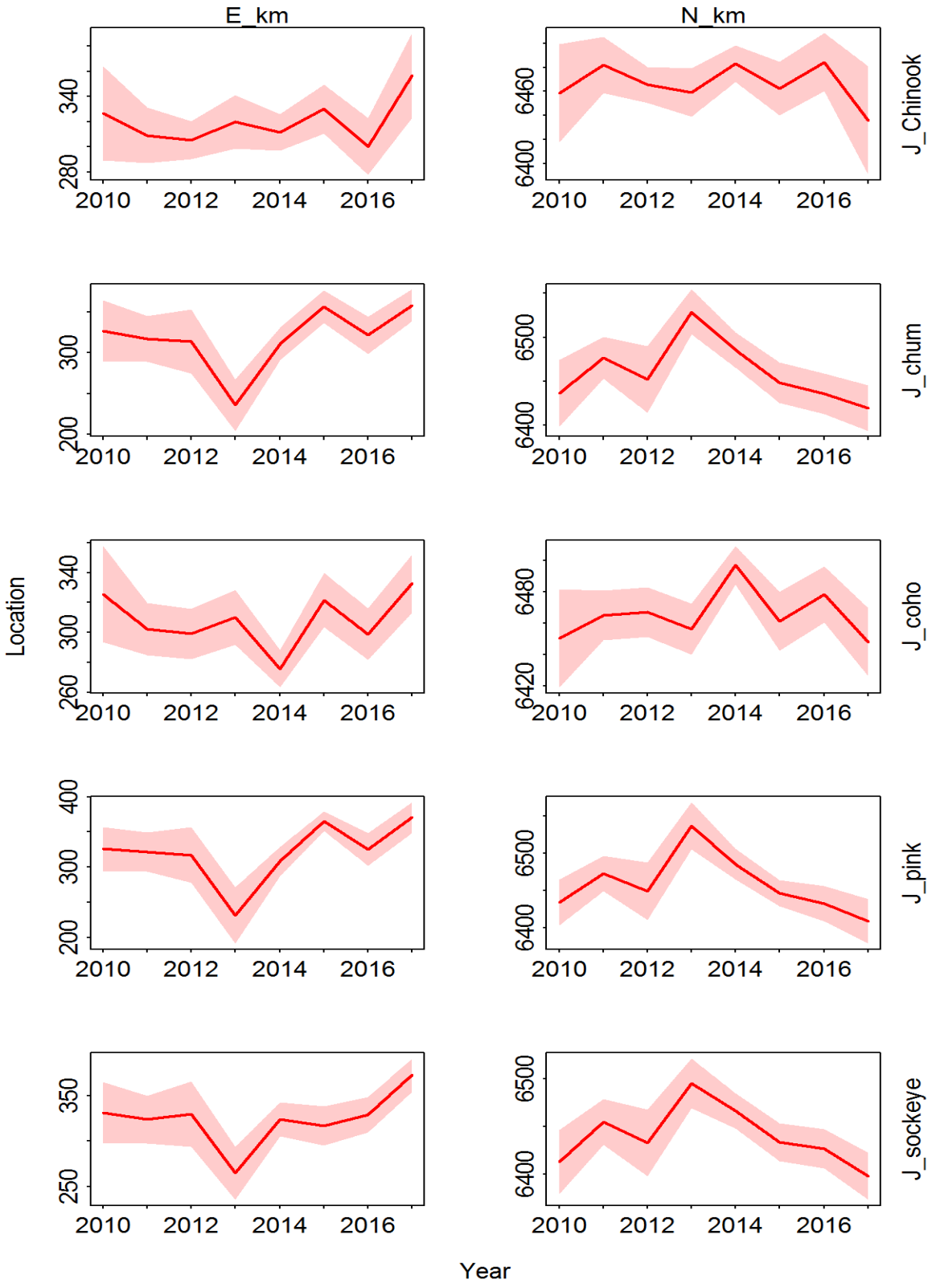


Figure 26. -- Center of gravity indicating temporal shifts in the mean east-to-west and north-to-south distribution ±1 standard error in UTM (km) for juvenile Pacific salmon on the eastern Gulf of Alaska during late summer, 2010-17.

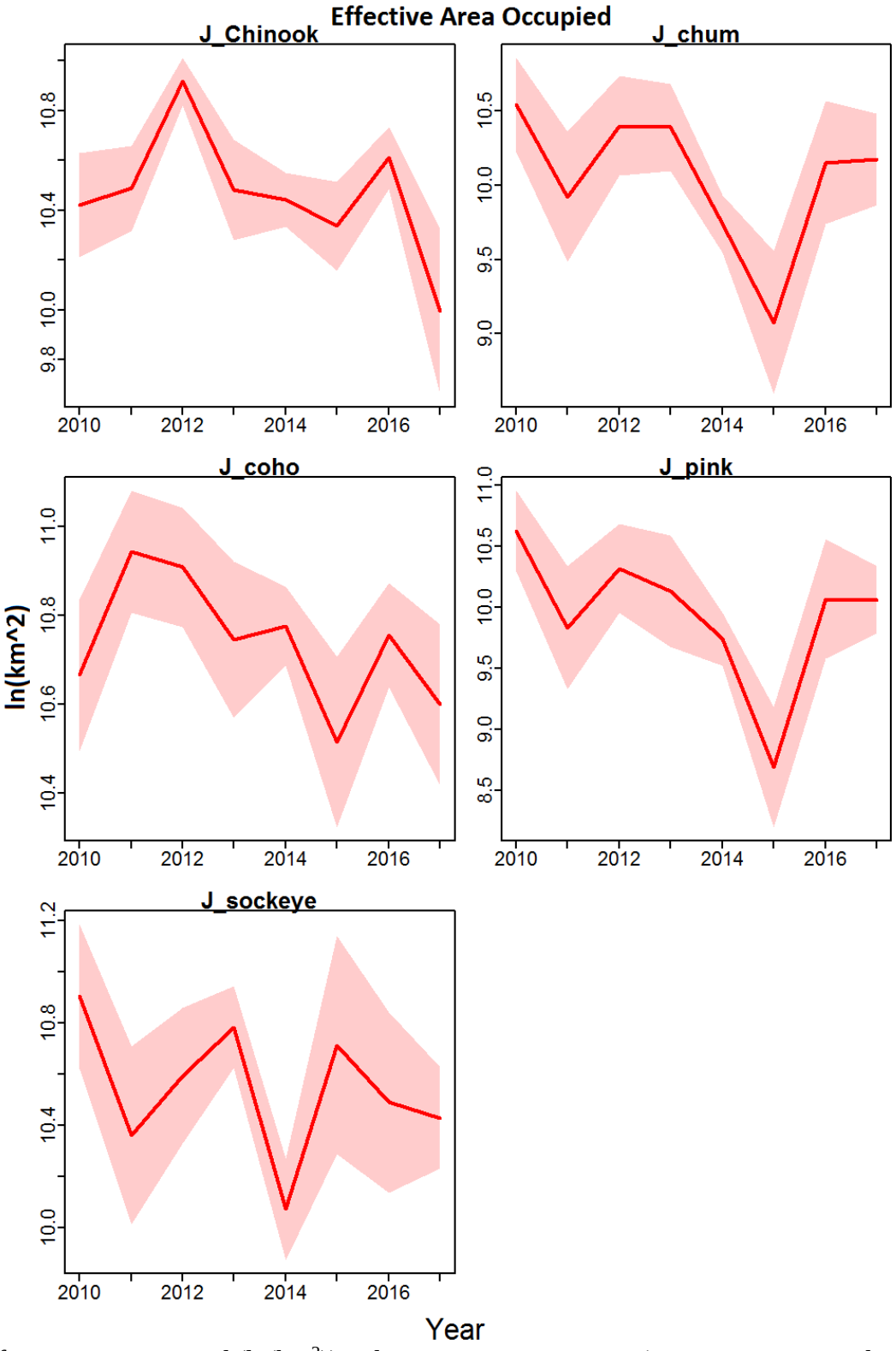


Figure 27. -- Effective area occupied (ln(km^2)) indicating range expansion/contraction ±1 standard error for juvenile Pacific salmon on the eastern Gulf of Alaska during summer, 2010-17.

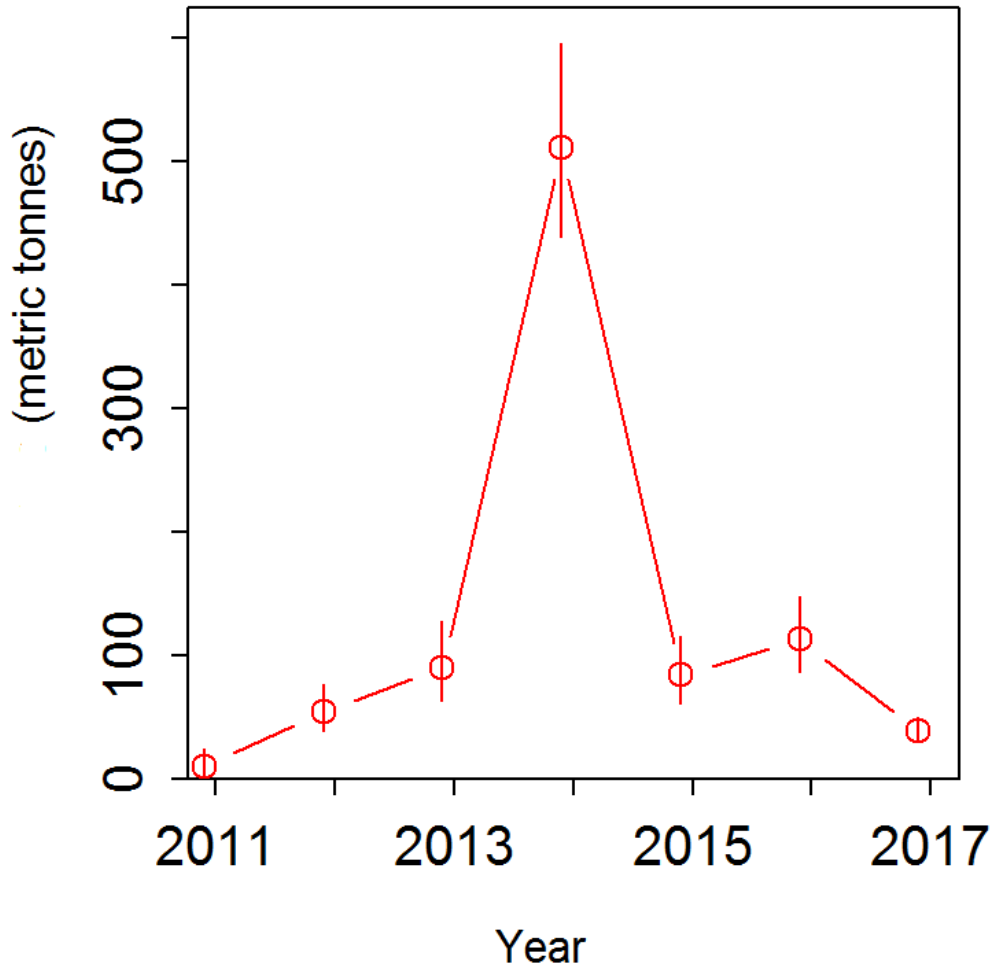


Figure 28. -- Index of biomass (estimated metric tonnes) ±1 standard error for squid in the eastern Gulf of Alaska during summer, 2010-17.

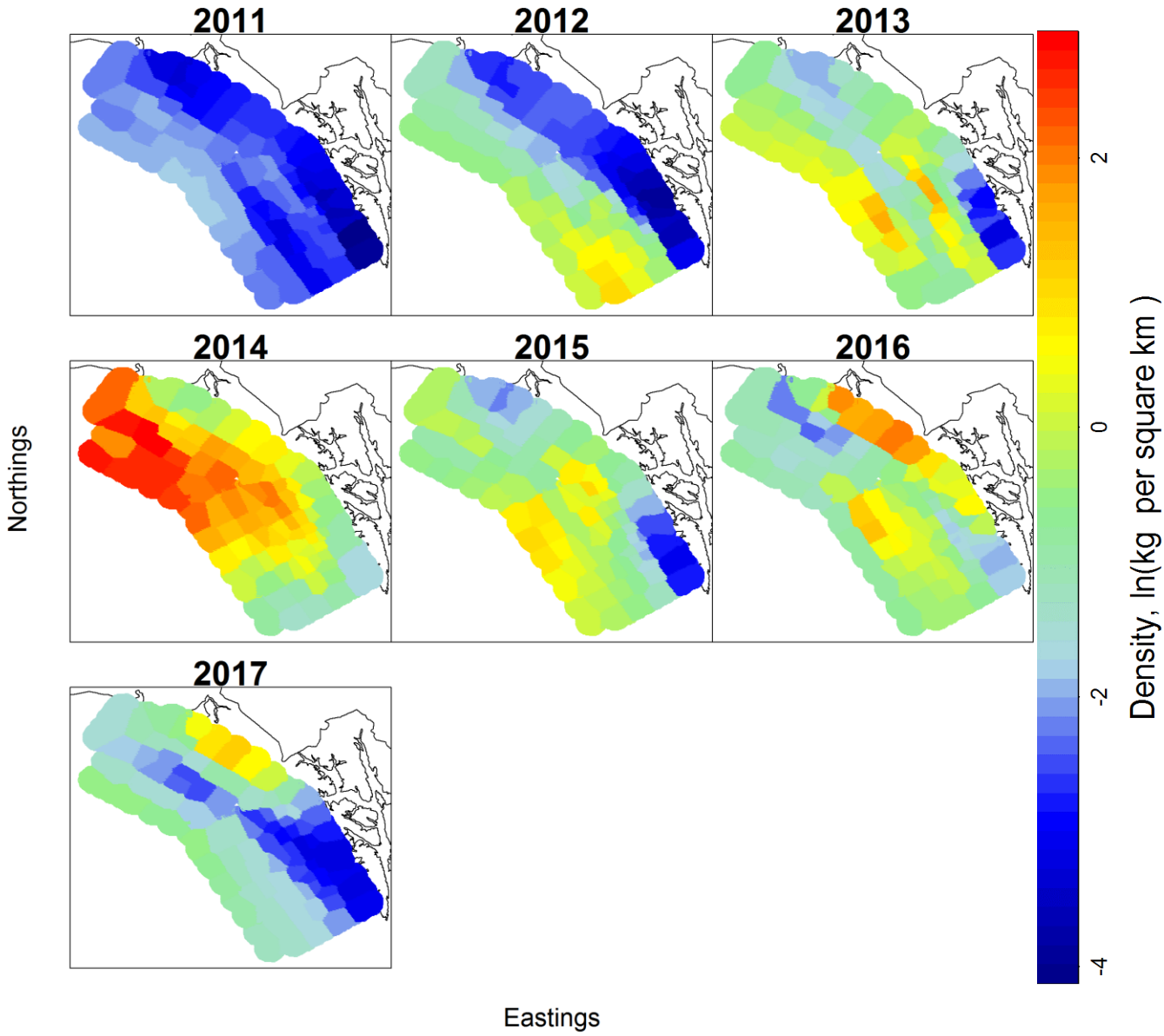


Figure 29. -- Predicted field densities of squid in the eastern Gulf of Alaska during summer, 2011-17.

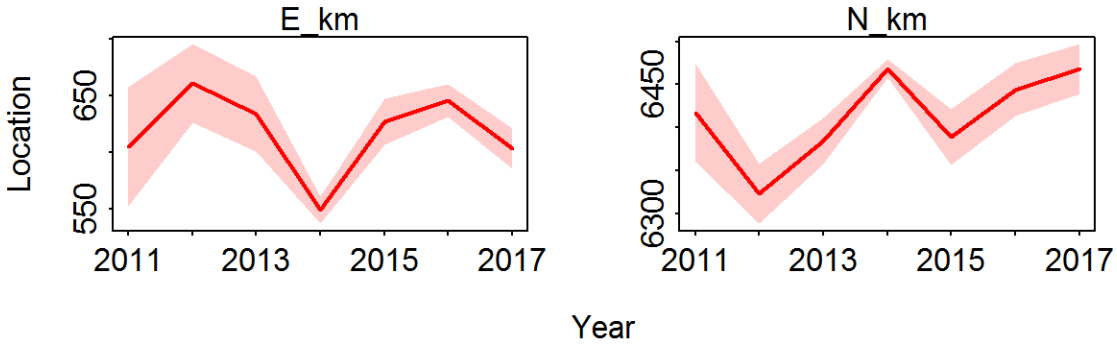


Figure 30. -- Center of gravity indicating temporal shifts in the mean east-to-west and north-to-south distribution ±1 standard error in UTM (km) for squid in the eastern Gulf of Alaska during summer, 2011-17.

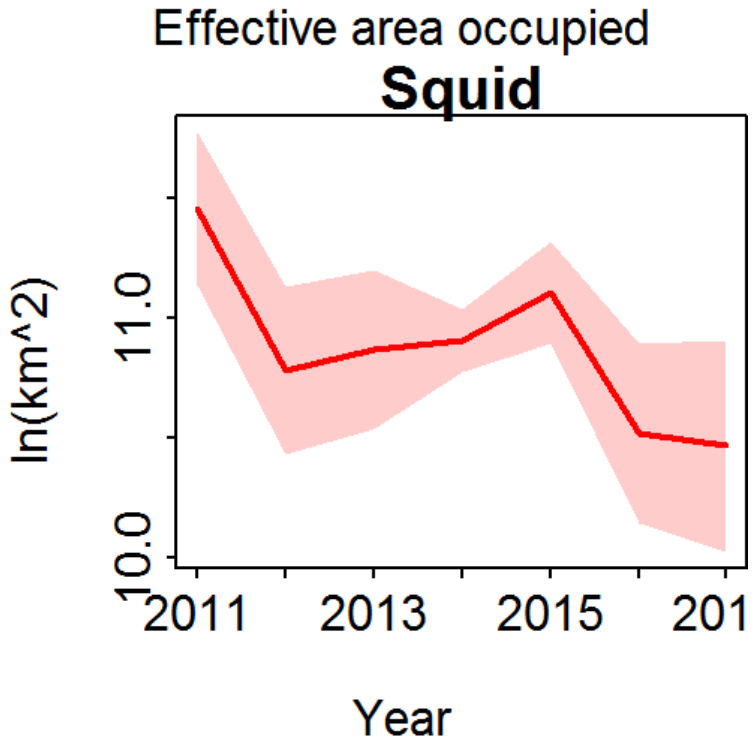


Figure 31. -- Effective area occupies (ln(km^2)) indicating range expansion/contraction ±1 standard error for squid in the eastern Gulf of Alaska during summer, 2011-17.

Appendix I. Cruise Itinerary

Cruise itinerary for the FV *Northwest Explorer* pelagic trawl survey in the coastal and offshore waters of northern southeast Alaska and offshore waters of the eastern Gulf of Alaska, 3 July through 28 July; 2 August through 18 August, 2017. Dates are in AKDT.

Date	Location/Activity
NW1702a	
3 July	Transit to northern grid (YB Stations)
4 July	Arrival and proceed to sample stations to the south
16 July	Port call Sitka, AK crew change
NW1702b	
16 July	Depart Sitka, AK, in the evening, transit to southern grid (SE Stations)
18 July	Arrival and proceed to sample stations to the north
28 July	Transit to Icy Strait
NW1704	
2 August	Depart Juneau, AK, in the evening, transit to offshore grid (EEZ)
3 August	Arrival and proceed to sample offshore stations
8 August	Complete planned grid, opportunistic stations begin
18 August	Port call Juneau, unload

Appendix II. Scientific Personnel

Leg	Name	Affiliation
NW1702a	Wesley Strasburger[1]	AFSC/ABL
	Alex Andrews	AFSC/ABL
	Melanie Paquin	AFSC/RACE
	Harmony Wayner	AFSC/ABL
	Kevin Siwicke	AFSC/ABL
	Andrew Diamond	AFSC/ABL
NW1702b	Jamal Moss[1]	AFSC/ABL
	James Murphy	AFSC/ABL
	Heidi Mendoza-Islas	UAF
	Kevin Siwicke	AFSC/ABL
	Dave Nicolls	AFSC/ABL
	Lauren Wild	UAF
NW1704	Wesley Strasburger[1]	AFSC/ABL
	Jeanette Gann	AFSC/ABL
	Kari Fenske	AFSC/ABL
	Dave Nicolls	AFSC/ABL

1 -- Chief Scientist
AFSC -- Alaska Fisheries Science Center
ABL -- Auke Bay Laboratories Division
RACE -- Resource Assessment and Conservation Engineering
UAF -- University of Alaska Fairbanks

Appendix III. Sample Requests

Project Title: Phytoplankton ID

Principle Investigator (PI)/Point of Contact: Jeanette Gann
Affiliation: AFSC Auke Bay Labs
Address: 17109 Pt Lena Loop Road, Juneau, AK 99801
Email: Jeanette.gann@noaa.gov
Phone: 907-789-6445

General Description and Objectives:

Preserved phytoplankton samples are to be collected for ID and enumeration. These data will be used to compare onshore-offshore differences in phytoplankton taxa as well as to compare eastern and western GOA phytoplankton community differences, for the GOA survey. For the NBS survey, the samples will be used to compare with southeastern Bering Sea phytoplankton communities and to look at differences between Norton Sound and other areas in the Bering Sea.

Collection Protocol:

Collection procedures:
Please collect samples at every other station, where the full CTD w/rosette is deployed. 3 Samples at each station should be collected as follows:
surface
closest to Chl a maximum (or 10 meters if there is no chl a max)
closest to the pycnocline (30m if there is no pyc)

To make 500 mls of buffered formalin:
250 mls Distilled water/ filtered seawater
250 mls Formalin (~37- 40%)
Add 4 teaspoons of Borax to the container and swirl until the Borax is dissolved.
Label the jar with "Gann", and " 20% Buffered Formalin".

Volume of above buffered formalin solution to be added to each sample:

C1*V1 = C2*V2
(20%)*(x) = (1%)*(~200mls)
20x = 200 => **10 mls**

Sample collection:

Rinse jar 3 times with a small amount (~10 ml) of sample water. Fill 250 ml jar to approximately 4/5ths full (or ~200 mls. Add 10 ml of buffered formalin using a syringe (syringe can be reused if it doesn't become contaminated by the water sample). After capping tightly, invert the sample bottle gently a couple times to mix. Wrap Parafilm around lip of bottle and lid to keep out air (and keep formalin vapors from escaping). Store in original box that jars came in. Store in cool place but do not freeze. End concentration of formalin is < 1%.

Data request:

N/A

List of supplies:
Sample jars will be provided along with a pre-made ~20% buffered formalin solution and a separate syringe to be used only for these phytoplankton samples. If you run out of buffered formalin solution, directions can be found above.

Hazardous materials:
Buffered formalin

Shipping: N/A

Permits (if applicable):
N/A

Project Title: Southeast Coastal Monitoring Project

Principle Investigator (PI)/Point of Contact: Emily Fergusson
Affiliation: AFSC Auke Bay Labs
Address: 17109 Pt Lena Loop Road, Juneau, AK 99801
Email: emily.fergusson@noaa.gov
Phone: 789-6613

General Description and Objectives: We are requesting zooplankton samples for lipid analysis to maintain our time series of prey quality measures in SEAK.

Collection Protocol:

Collection procedures: Collections include vials of composites of zooplankton taxa as outlined in the table below.

Samples will be sorted from the extra 505-µm cod end collected as time allows.

Collect taxa according to the table below. Place each taxa into a snap cap vial, one taxa per vial.

Record station/haul number, collection date, vial number, and contents (including # of taxa) in the logbook.

Freeze the samples at -80 C as soon as possible.

If it is not possible to collection the minimum number of specimens requested, then do not collect those taxa.

If possible for the Large Euphausiids, separate species into different vials.

Taxa	Size range	Minimum # desired per vial
Pseudocalanus spp.	CV & CVI females	10
Neocalanus spp. (not cristatus)	CV & CVI females	3-5
C. marshallae	CV & CVI females	3-5
Small Euphausiids (furcillia)	<10mm	10
Large Euphausiids	10-20mm	1-2
Themisto libellula	10-15 mm	2-3
Themisto pacifica	>10 mm	3-5
Limacina helicina	2-5mm diameter	7
Clione limacine		2-3
Small Chaetognath	5-20mm	3-5
Large Chaetognath	>20mm	2
Brachyuran zoea		5
Brachyuran megalope		3-5

Data request: Station information including location, date, species, and number collected.

List of supplies: Microscope, plastic box, snap cap vials (labeled), Kim wipes, soft forceps, sample logbook.
Hazardous materials: None

1. Project Title: Using stable isotopes to analyze diet of depredating male sperm whales and trophic food webs in the Gulf of Alaska.

Principle Investigator: Jan Straley; PhD candidate Lauren Wild
Affiliation: University of Alaska Southeast & University of Alaska Fairbanks
Email: jstraley@uas.alaska.edu; lawild@alaska.edu
Phone: (907) 747-7779; (907) 738-5315

2. General Description and Justification: The demersal longline fishery is an important way of life for coastal communities in Alaska. Since the federally-managed sablefish fishery season lengthened in the mid-90s, sperm whales have increasingly associated with this fishery in the Gulf of Alaska (GOA). Removal of sablefish, or depredation, by whales occurs as the gear is hauled to the vessel.

The trophic position for marine food webs can be determined using stable carbon $\delta^{13}C$ and nitrogen $\delta^{15}N$ isotope ratios from skin samples, providing insight into diet and trophic connections. Diet studies are essential in understanding a top predator's role in the ecosystem and the impacts they have upon their environment. In lower latitude warm-water regions, sperm whales are known to have a diet of primarily cephalopods. However, diet in the high latitude foraging grounds is largely unknown, likely comprised of both cephalopods and a variety deep water fishes. Some of these fishes, such as sablefish and rockfish, have commercial importance Since 2003, the Southeast Alaska Sperm Whale Avoidance Project (SEASWAP) has been opportunistically collecting tissue sample biopsies (n =35) of male sperm whales involved in depredation in the eastern Gulf of Alaska. Additional samples will be collected in 2017 by SEASWAP, as well as on the NMFS AFSC Longline Survey. Fishermen have been donating large squid caught on commercial longline gear in the GOA between 2014 and 2017. Additonal squid samples have been requested from the AFSC GOA Bottom Trawl Survey, summer 2017. Finally, five species of groundfish (sablefish, rockfish, grenadier, skates, and dogfish) known to be both prevalent and common prey of sperm whales have been collected from the GOA Longline survey in 2016 and are requested for 2017. Primary consumers, such as calanoid copepods are commonly used in isotope studies to provide a baseline for the ecosystem, and were collected at 4 stations (10, 15, 26, 31) by the AFSC GOA Ecosystem Assessment cruise in 2016. University of Alaska Fairbanks (UAF) PhD candidate Lauren Wild is currently analyzing all samples collected through 2016 as a food web analysis in the GOA with a focus on diet of sperm whales. Additionally, we hope to use stable isotope mixing models (SIAR package in R) to assess contribution of sablefish and other potential prey items to sperm whale diet diet. Primary consumers for baseline ratios are needed for the second and final year of this data collection for diet analysis and comparison.

3. Scope of Work: Our project goal is to discern diet inferred through trophic level of whales associating with vessels. The objectives are to: 1) Use stable isotope analysis to assess the contribution of sablefish to sperm whales' diets; 2) Identify trophic connections of groundfish, squid, and predators in the offshore ecosystem of the eastern GOA. These objectives will be met through a combination of collection of tissue samples of whales, groundfish, and squid, and with the assistance from NOAA's GOA assessment survey to collect baseline primary consumer items (large calanoid copepods).

Timeline: Data collection of primary producers and potential prey items initially proceeded with the GOA Assessment Survey in 2016, and will continue in 2017.

Funding sources: PhD student Wild is funded through UAF's Biomedical Learning & Student Training (BLaST).

Products: This project will result in at least two thesis chapters for UAF PhD candidate Lauren Wild's dissertation, as well as a peer-reviewed publication.

Collaborators:
PI Jan Straley, University of Alaska Southeast (UAS)
Co-Investigator Dr. Franz Mueter, UAF
Co-Investigator Dr. Brianna Witteveen, UAF

UAF PhD candidate Lauren Wild
Alaska Longline Fishermen's Association (ALFA)
NOAA AFSC Ted Stevens Marine Research Institute (TSMRI), Juneau.

4. Collection Protocol:
Detailed collection procedures: Our samples can be collected as part of the routine bongo tows (200m) conducted by NOAA's GOA Assessment cruise (formerly GOA-IERP). We had samples collected (n=4) during the 2016 cruise, and would like samples collected at the same sampling stations this year, corresponding to continental slope waters.
The stations collected in 2016 were:
YBC 50, St 10
YBA 50, St 15
SER 50, St 26
SEQ 50, St 31

These stations would be a priority to re-sample 2017.
Additional priority stations are:
EGI: 10; K:20; LM: 30; QRAC: 50; and EFG: 40.

We would like samples from deep-water bongo tows (505 mesh size ideal, 333 is fine) at these stations if available. We will be looking for large calanoid copepods to subsample for stable isotopes. 200m depth tows are ideal.
Subsamples of specimens from the tows are to be sieved and stored dry in a plastic Nalgene sample jar (~200ml) and labeled for each station. Samples should NOT be stored in formalin or ethanol, but rather frozen at -80°F or -40. Each jar should be labeled with the haul number, survey vessel name, date, depth of tow, and location.

5. List of supplies: Wide-mouth plastic Nalgene sample jars (200 or 250ml), quantity = 25-30.
Please print the haul number, cruise, depth, location, and date on the sample bottle.
Samples should be frozen at -80°F

6. Shipping:
Deliver samples to Alaska Air Cargo, use Known Shipper Number: 35214, Jan Straley
Alternatively, could drop off at UAS Sitka when the cruise is in port here.

Address shipment to:
Jan Straley & Lauren Wild
University of Alaska Southeast
1332 Seward Ave.
Sitka, AK 99835
(907) 738-5315

Project Title: Jellyfish Dynamics
Principle Investigator: Kristin Cieciel
Affiliation: Alaska Fisheries Science Center, Auke Bay Labs
Email: kristin.cieciel@noaa.gov
Phone: (907) 789-6089

For all trawl catches:

- Separate jellyfish on sorting table by genus/species into baskets, being careful not to further damage the bodies, and for each species sort into "whole" jellyfish versus pieces (broken jellyfish) baskets.

For each of the following genus/species-Chrysaora, Cyanea, Aequorea, and Aurelia-only

- Prior to bell measuring, orient jellies with mouth down (convex side facing upwards and the opening is facing the table).
- Measure the first 50 jellyfish for 'True Bell' diameter in centimeters (a noticeable line around the bell-see photo), and take individual weights in kilograms of each measured jellyfish.
- Count one basket of "whole" jellyfish (by species) and weigh. Combine remaining whole jellyfish for a total weight. Combine all pieces for a total weight. Record on jellyfish data sheet (all data) and non-salmon data form (total weight by species only).
- If subsampling a catch make several notes and show all calculations, be very clear as to how the subsampling occurred. Be sure to record data on fish data sheet.

If really short on time, meaning the net is coming in for the next station.

- Measure bell diameters for 25 individuals of each species and take individual weights. Weigh remaining pieces and combine remaining "whole" jellyfish by species for total weight.

If super short on time and spirit is crushed (this should not happen for every tow)

- Measure bell diameter for 25 individuals of each species and take total weights of remaining sorted jellyfish.

Dipnetting (For *Chrysaora, Cyanea, Aequorea and Aurelia*):

- Collection will be done prior to net operations during oceanography, vessel must be stopped. Best time for collections seem to be at dawn and dusk, sampling must be on a station associated with fishing and oceanography.
- Up to 200 *Chrysaora melanaster* will be dip-netted during 15-20 minute increments prior to zooplankton operations using 14ft dip nets. Up to three nets are permitted in the water.
- All jellyfish captured will be bathed in ~10% formalin and sealed in an appropriate sized container. Each container will be labeled with the station, sample number, cruise ID, and placed in a box.
- Live tanks will be used on the OSCAR DYSON to attempt to run digestion experiments with dip net caught specimens. Sea water will need to run continuously during those 8 hours.

LIVEBOX (For *Chrysaora, Cyanea, Aequorea and Aurelia*):

- The live box will be used for up to 5 hauls to run digestive experiments, which will require two live tanks aboard and last for up to 8 hours. Sea water will need to run continuously during those 8 hours.
- These experiments will only occur in the EGOA and NBS.

Project Title: Species Identification of Squid

Principle Investigator (PI)/Point of Contact: Jim Murphy

General Description and Objectives:

Squid are an important component of the diet of salmon in offshore waters of the Gulf of Alaska and Bering Sea and therefore are an integral component of the growth, maturation, and survival of salmon on the highseas. Methods for identifying squid species varies significantly with life stage and we currently do not have a method for clearly identifying the squid species at the life stages captured during surface trawl sampling. The overall goal of this project will be to examine odd and even year abundance patterns of squid species in the Gulf of Alaska from surface trawl catches. We will use the CO1 gene in mitochondrial DNA to validate squid species ID and to establish protocols for assigning species ID in the field.

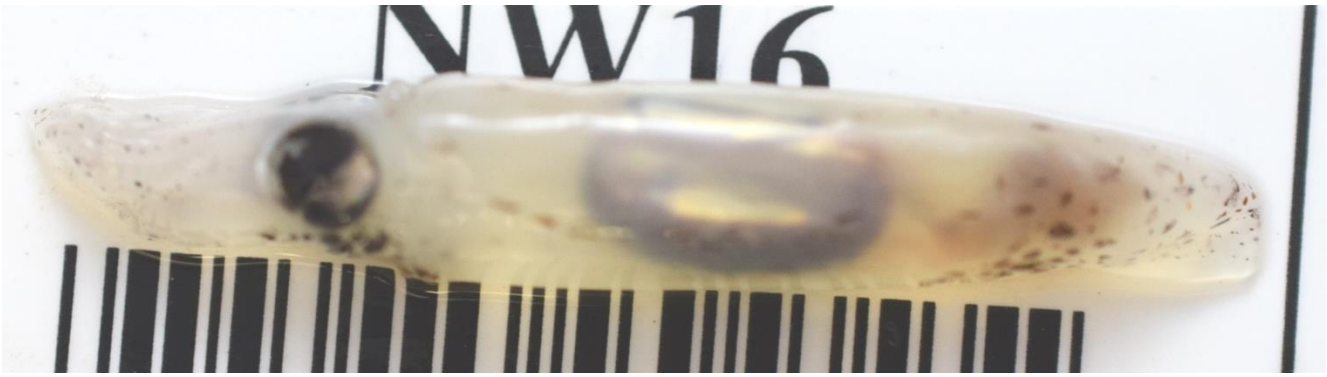
Collection Protocol:

1. **Collection procedures:**

Sort squid into the four species groups listed below and measure up to 25 mantel lengths for each group (99% of the time it will be the small gonatid squid species).

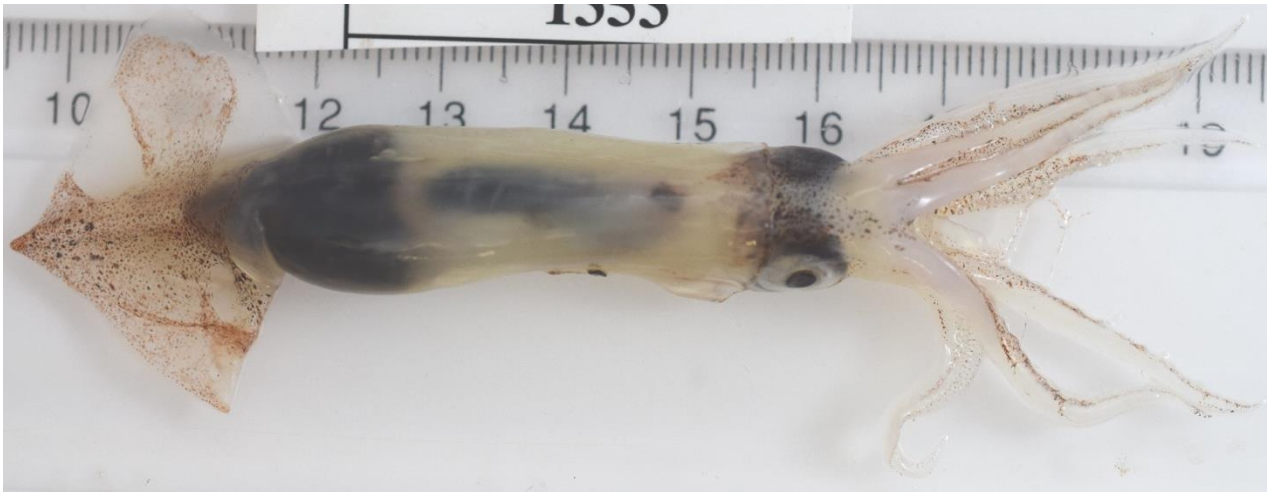
1.) Berryteuthis anonychus (species group)

The primary catch is expected to be small squid (< ~50mm mantel length) and a key objective of this analysis will be to identify the species composition of this group. Measure mantel lengths and preserve 25 squid specimens within this species group in a small Nalgene bottle of ethanol at each station. Although we are anticipating the dominate species to be *Berryteuthis anonychus*, there will most likely be other squid species present within this group. Do not mix squid that can be visually separated from this group of small squid (body shape, pigment, etc.). If a visually distinct species is encountered that is not in the four groups listed here, photograph specimens, and preserve in ethanol. .



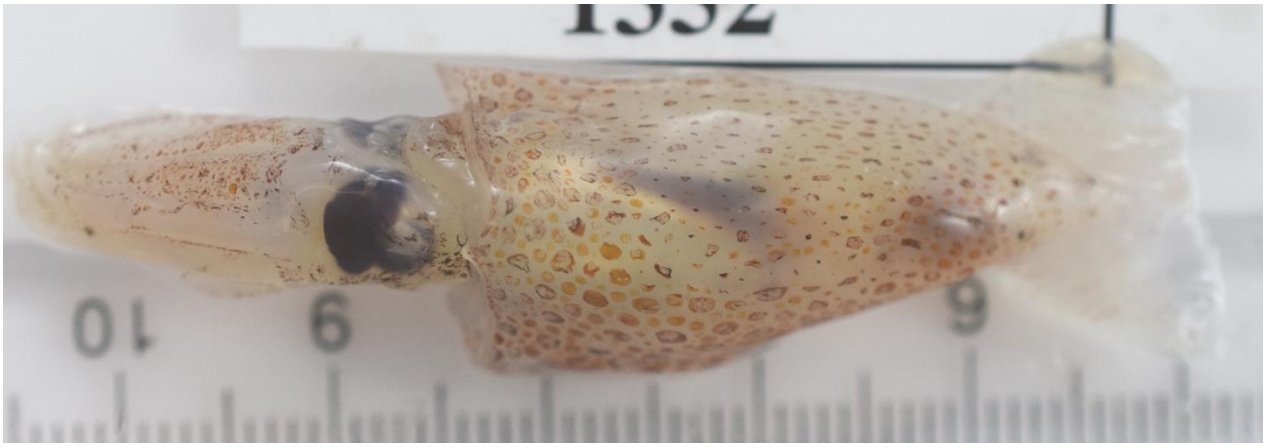
2.) *Gonatus kamtschaticus*

This species is regularly encountered but typically only a few individuals are present at a station and therefore is less abundant than the *Gonatid sp.* group above. It typically loses its epidermis during capture similar to the *Berrytheuthis anonychus (species group)* and therefore is generally only separable from this group based on mantel length (typically > ~50mm). Do*ryteuthis opalescens* will also be a larger squid species encountered during the survey but only occur in the nearshore stations. *G. kamtschaticus* is generally encountered further offshore and its mantel is much thinner and flaccid, and it has a wider tail fin relative to mantel size. Preserve specimens in ethanol, and photograph high quality specimens with length reference.



3.) *Gonatid Squid sp.*

There is another species of squid that is occasionally encountered, its mantel shape is rounder, flaccid, and tends to retain its outer epidermis with pigment more readily than the above species. Until we have determined the ID of this species assign this species as *Gonatid squid sp.* Preserve all specimens of this type in ethanol. Once we have identified the species with genetics and will update catch records in CLAMS.



4.) California Market Squid (*Doryteuthis opalescens)*:

Doryteuthis opalescens is generally only present in nearshore habitats. These species are easily recognizable due to their size, shape, and pigmentation. Genetic ID is not needed for this species.

Project Title: 2017EGOA Fish Energetics

Principle Investigator (PI)/Point of Contact: Ron Heintz
AFSC Point of Contact: Jacek Maselko
Affiliation: AFSC/RECA
Address: 17109 Pt Lena Loop Rd
Email: Jacek.Maselko@noaa.gov
Phone: 907-789-6067

General Description and Objectives:

Obtain energy density estimates for age-0 Walleye Pollock, Pacific Cod, Arrowtooth Flounder, Sablefish, Rockfish, Herring, Capelin and Saffron Cod.
The below table lists the trawl types that samples are requested from:

Species	Surface	Midwater	Oblique
Walleye Pollock	X		
Pacific Cod	X		
Arrowtooth Flounder	X		
Sablefish	X		
Rockfish	X (5&45)		
Herring	X		
Capelin	X		
Saffron Cod	X		
Chum Salmon	X (2)		
Chinook Salmon	X (2)		

Collection Protocol:

1. **Collection procedures:**
   Select fish at random (for each species) observed at that station.
   a) Collect up to 5 fish of each species (unless otherwise noted above) from each station/trawl as specified above; bag the fish individually with a barcode and combine the individual bags into a single Station/Trawl bag; label the Station/Trawl bag with collection information (Station #, Event #, Haul #, Trawl Type) and freeze at –20° C.
   b) If unable per (a) above, combine and bag 5 fish per species per haul with collection information (Station #, Event #, Haul #, Trawl Type) and freeze at –20° C.

2. **Data request:**
   Sample collection information: station location (Latitude, Longitude), trawl type (surface, midwater, oblique), collection date, species, length (mm; SL), and catch.
3. **List of supplies:**
   Bags and labels. CLAMS barcodes will be assigned on-board.
4. **Hazardous materials: N/A**

Shipping: Jacek Maselko, NOAA Fisheries / Auke Bay Laboratories, 17109 Pt. Lena Loop Rd. Juneau, AK 99801

PROJECT OVERVIEW
Project Title: Gulf of Alaska Assessment
Principle Investigator (PI)/Point of Contact: brian.beckman@noaa.gov, jamal.moss@noaa.gov, Don.VanDoornik@noaa.gov
Division: Auke Bay Laboratories
Email: brian.beckman@noaa.gov
Phone: (206)-860-3461

General Description: The overall goal of our proposed research focuses on identifying and quantifying the proportional contribution of Chinook salmon stocks in the GOA.

Collection Protocol: Detailed collection procedures: Collect a fin clip from the fin from all juvenile Chinook salmon captured during trawling operations. Fin clips are to be placed in pre-labeled vials filled with 99% genetics grade ethanol. Please store vials at room temperature in a vial rack in numerical order..

List of supplies: sample vials, vial boxes, ethanol, 2 permanent markers

Data: Please provide metadata at the end of the cruise linking each specimen with the haul number, survey vessel name, and date.

Hazardous materials: ethanol

Personnel available to help with project and overall survey mission: Jamal Moss (ABL), jamal.moss@noaa.gov, 907-789-6609.

Estimated time and resource expense: 5-10 minutes per station where samples are collected

Shipping: 24/7 contact: Jamal Moss (907)-957-0275
Detailed shipping instructions: Mail to NWFSC. Address shipment to:

Brian Beckman
2725 Montlake Blvd East
Seattle, WA 98112-2097
(206) 860-3461

Project Title: Eastern Gulf of Alaska Assessment

Principle Investigator (PI)/Point of Contact: Strasburger
Affiliation: AFSC Auke Bay Labs
Address: 17109 Pt Lena Loop Road, Juneau, AK 99801
Email: wes.strasburger@noaa.gov
Phone: 789-6009

General Description and Objectives: I am requesting juvenile sablefish <40cm sampled during EGOA cruises in 2017. The purpose of these samples will be to investigate, feeding ecology, growth, and size prior to their 1st winter.

Collection procedures: Juvenile sablefish: sample in 10cm length bins.

Freeze (-20) the first 10 juvenile sablefish of each 10cm length bin at each station. Length, weight, barcode, and bag each fish individually. Flag TSMRI in CLAMS. Label station level bags as:

Strasburger

Cruise ID

Station Name/Number

Species

Shipping: Samples will be offloaded at Juneau Subport at the end of the season.

Appendix IV. Sampling Protocols

***General overview of operations, check protocols for specifics on sample procedures!**

CTD Operations

1. Before station arrival, fill out labels for chla and nutrients (station numbers, year, ship and depth). Cock Niskin bottles and take syringe off CTD

2. **AFTER** carousel is plugged in at wet end, hit power button to the CTD deck unit, confirm deck unit is communicating with instrument.

3. Start a new file in Seasave with ship, year, survey, and **station** number (NW1601c01for NWX station 1, **SECM= NW1601, GOA = NW1602**). (Write CTD file name on Oceanography log).

4. Deploy CTD to 10m, keep submerged for 2 minutes (for pump)**, bring to surface** then deploy to depth (~ 3-5 meters above bottom, depending on seas).

5. During downcast, record lat, long, date and other info for log sheets, i.e. lat long, weather, seas, GMT data/time, etc…

6. Check the downcast profile for out of the ordinary data and log if unusual or spiky…

7. Collect samples on up-cast, hold at each sample depth **for 30 seconds**, then fire bottle at pre-determined depths detailed below.

Depth	**GFF** **Every station**	**>10 Large Diameter** **Every Station**	**Nut** **Every station**	**Salinity** **(Every other station alternate surface/deep)**	**Phyto preservation Collection** **Every Other Station**	**GFF/ >10 Duplicates** **1/day**
0	**X**		**X**		**X**	
10	**X**	**X**	**X**	**X (OR) ↓**	***X**	
20	**X**		**X**			
30	**X**	**X**	**X**		****X**	
40	**X**	**X 1/day (more if time)**	**X**			
50 (OR)	**X**		**x**			
60			**X OR ↓**			
75						
100				**X (OR) ↑**		
200			**X OR↑**			
X (OR) ↑ (Sample either here or at shallower depth depending on criteria) **X (OR) ↓** (sample either here or at deepest depth available)				*** Phyto preservation, collect 2nd depth nearest Chl max or at 10m if no max.** **** Phyto, collect 3rd depth nearest pycnocline, or at 30m if no pycnocline.**		

8. When CTD is on deck, hit stop acquire in Seasave, turn off deck unit, **wait 2 min**. then signal crew to unplug pigtail and plug into Seacat, and replace Syringe. Remove plug from 25_36+ deck unit and re-plug into Seacat deck unit, and start a new file for seacat on seacat laptop.

CTD Water Sampling

****Rinse all bottles 3X with small amount of sample water before filling, and check protocols for in-depth instructions!**

1. ***Salinity (Every other station, alternate surface then deep)***
    a. Write salinity bottle number in oceanography log, rinse bottle 3x and fill ~2/3 of bottle, then cap. (**Note: salinity bottles that have not been used will be stored upside down with some fresh water inside**.)
    b. Parafilm top
    c. Place back in wooden box, upright.
2. ***Chlorophyll (Every Other Station, 0-60m)***
    a. Collect chlorophyll samples (filled to overflowing) according to detailed protocol, in 250ml brown bottles.
    b. Filter samples through appropriate filter sizes (GFF or >10)
    c. Label cryovials accordingly with depth, survey, filter, etc..
    d. Freeze vials in a labeled cryovial box (label top with starting and ending stations) in supercold freezer.
    e. ****No chlorophyll samples collected below 60m!**
    f. Replicates 1/day
    g. Blanks every other day
3. ***Nutrients (Every Station)***
    a. Filter through syringe into 60ml nutrient bottles, being careful not to bust the filter (**Hint: if it's really easy to push the syringe plunger, then you need to re-apply the filter and start again**)
    b. Fill to shoulder, leaving some air space at the top to prevent breaking during freezing .
    c. Dry-off bottle and affix filled out sample label to the dry bottle (if you put the label on before filling bottle, it will often get wet and tear)
    d. Store **upright** in supercold in boxes, or metal racks.
4. Phytoplankton Preservation
    a. At every other station (see protocol) collect phytoplankton ID sample at the depth closest to the chlorophyll a maximum.
    b. For Phytoplankton, fill jar ~ 2/3 full with water, and fix with 5 ml of buffer and 12.5 ml of formalin.
5. Lipid Collection
    a. At designated stations collect 2 L of water (filtered through 153uM mesh) and filter again through a large diameter (47mm) GF/F filter. Label cryo vial with haul or station #, cruise and depth, then place filter in vial, and then in the appropriate cryo box, and freeze in -80 freezer.

Chlorophyll a sampling protocol:

Choosing volume:
Use 250 ml, brown HDPE bottles filled to overflowing. **Record volume (250) for every sample on log sheet.**

Water sample collection:
Rinse sample containers 3 times with a small volume (~10 ml) of sample water. Fill 250 ml, brown HDPE Nalgene bottles to overflowing.

Filtration:
Use forceps to place all chlorophyll a filters (textured side up for GF/F filters), on the fret of the filter funnel, seal cup (Luer Lok screws shut). Pour directly from the bottle into the filter funnel. To remove cells stuck to the sides of the sample bottle rinse with filtered seawater (5-10 ml) and pour rinse water into filter funnel. Turn on vacuum pump (5-10 psi, 7-10 psi is about right). Open valves to each funnel. Just before filter is sucked dry, rinse cup with a small amount (~5 ml) of filtered seawater to remove cells stuck to the sides of the cup. As soon as last amount of water goes through filter, turn off value (cells can be damaged when vacuum is applied to a dry filter).

Remove filter cup. If the filter is hard to remove, after vacuum is shut off, open and then close value to release the air seal on the filter. Use forceps to grab filter at edge (where there is no pigment). Fold filter in thirds like a burrito lengthwise, and slide into labeled cryovials. **(When placing in cryovial, please do not 'ball' up the filter, as it makes post-processing much more difficult and may impede sample quality).** Place cryovials in a cryobox (order samples by haul number), and *immediately* put in the -80°C freezer. **Do not thaw until analysis.**

Filtered seawater:
The easiest way to make filter seawater (for rinsing filter cups and cylinders) is to hook up the 1L filter flask to the vacuum pump tubing Make sure a protective filter is inserted in line between flask and pump. Put one of the filter funnels into a stopper that fits on the filter flask. Filter spare sample water (deep water is best since it typically has less particles) through a GF/F filter and save the filtrate. You may need to go through a couple filters as they start to get clogged. Store filtered seawater in a squirt bottle.

Duplicates/Replicates:
Collect Blanks for 1 GFF every other day
Collect replicates for 1 GFF at 1 station per day

Blanks:
Once per day, filter a blank after filtering a set of samples (post-blank). This is just like filtering a sample, but with no sample water. Put a GF/F (or >10um) filter on the filter funnel and filter ~10-15 ml of filtered seawater through the cup. Fold filter in half and store in the same way as the sample filters.

Additional hints:

- **Don't forget to dump the trap containing waste filtrate before it overflows. An inline filter to prevent moisture from reaching the pump can be used as a safeguard.**

- To keep cups clean, rinse filter cups with DI (or fresh tap water if that's all you have) and wipe with a Kimwipe between sample sets (stations).

SECM/GOAA Zooplankton Sampling Protocol 2017

All zooplankton collection data is recorded in MasterCod and on paper catch sheets. Sampling will proceed as in the FOCI Field Guide (available on the vessel). Preferentially preserve net 1 from both the 60 and 20 cm bongo frames. During SECM, the 60 cm frame will be fitted with a 333 for net 2. This will also be quantitatively preserved and stored in the PI provided Nalgene bottles. Complete the RZA at predetermined stations as per separate provided protocols.

SECM focal species:

	Collection n=
• **Pseudocalanus spp. CV&CVI Females**	**10 (Fergusson/Fugate)**
• **Acartia spp. CV&CVI Females**	**3-5 (Fergusson/Fugate)**
• **C. marshallae CV&CVI Females**	**3-5 (Fergusson/Fugate)**
• **Euphausiids <10 mm**	**10 (Fergusson/Fugate)**
• **Euphausiids >10 mm**	**1-2 (Fergusson/Fugate)**
• **Themisto pacifica <10 mm**	**7 (Fergusson/Fugate)**
• **Themisto pacifica >10 mm**	**3-5 (Fergusson/Fugate)**
• **Limacina helicina 2-5 mm diameter**	**7 (Fergusson/Fugate)**
• **Clione limacina**	**2-3 (Fergusson/Fugate)**
• **Small Chaetognath 5-20 mm**	**3-5 (Fergusson/Fugate)**
• **Large Chaetognath >20mm**	**2 (Fergusson/Fugate)**
• **Brachyuran zoea**	**5 (Fergusson/Fugate)**
• **Brachyuran megalope**	**3-5 (Fergusson/Fugate)**

Each of these will be sorted from net 2 (333) from a second bongo tow as time allows. Place each taxa into a snap cap vial, one taxa per vial. Record station data, vial number, and contents (# and taxa) in logbook provided. Freeze in -40. If minimum # cannot be achieved, do not collect. If possible, separate large euphausiids by species. Complete 1 0r 2 collections per taxa total.

Gulf focal species:

	Collection n=
• **Pseudocalanus spp. CV&CVI Females**	**10 (Fergusson/Fugate)**
• **Neocalanus plumchrus/flem. CV&CVI Females**	**3-5 (Fergusson/Fugate)**
• **C. marshallae CV&CVI Females**	**3-5 (Fergusson/Fugate)**
• **Euphausiids <10 mm**	**10 (Fergusson/Fugate)**
• **Euphausiids >10 mm**	**1-2 (Fergusson/Fugate)**
• **Themisto libellula 10-15 mm**	**2-3 (Fergusson/Fugate)**
• **Themisto pacifica >10 mm**	**3-5 (Fergusson/Fugate)**
• **Limacina helicina 2-5 mm diameter**	**7 (Fergusson/Fugate)**
• **Clione limacina**	**2-3 (Fergusson/Fugate)**
• **Small Chaetognath 5-20 mm**	**3-5 (Fergusson/Fugate)**
• **Large Chaetognath >20mm**	**2 (Fergusson/Fugate)**
• **Brachyuran zoea**	**5 (Fergusson/Fugate)**
• **Brachyuran megalope**	**3-5 (Fergusson/Fugate)**

Each of these will be sorted from net 2 (spare 505) as time allows. Sampling will proceed as above.

Gulf Bulk Samples: Straley & Wild

Samples will be taken from net 2 (spare 505) After other protocols have been fulfilled, a bulk subsample of total zooplankton are to be sieved and stored dry in a plastic Nalgene sample jar (~200ml) and labeled for each station**. Samples should NOT be stored in formalin or ethanol**, but rather frozen at -80°C or -40. Each jar should be labeled with the haul number, survey vessel name, date, depth of tow, and location.

Requested Stations:

YBC 50

YBA 50

SER 50

SEQ 50

SEE 10

SEG 10

SEI10

SEK 20

SEL 30

SEM 30

SEE 40

SEF 40

SEG 40

GOAA Trawl Sampling Protocol 2017

This guide is for all fish caught in the Trawl

Separate entire catch by species and LHS
All fish bio-data is recorded in CLAMS or on paper catch sheets.

Record weight and lengths of remaining fish until total n=50 for each species.
Collect bulk weight on remainder of sorted catch. If remaining number is small (<100), count and bulk weigh.

Focal species (Age-0): Collection n=

- **Arrowtooth flounder** **5 (Heintz)**
- **Pacific cod** **5 (Heintz)**
- **Sablefish** **15 (5 for Heintz, 10 for Strasburger)**
- ***Sebastes* spp. (POP type)** **5 (&45) (Heintz)**
- **Walleye pollock** **5 (Heintz)**
- **Saffron cod** **5 (Heintz)**
- **Herring** **5 (Heintz)**
- **Capelin** **5 (Heintz)**

Barcode individuals, flag Heintz in CLAMS (TSMRI for Strasburger samples), place in labeled station level bags. Store in -20 freezer. For rockfish, select 5 POP type and individually bag and barcode, burrito up to an additional 45 after measuring length (no barcodes).

Juvenile Salmon:

In CLAMS or on Juvenile Salmon sheet:

General

First 2 individuals of each species are "Bombers" and are bagged individually with barcode
Place bombers in one bag with station # and station name. Store in species "Bomber" bag in chest freezer.
Store in species bulk bag in chest freezer -20C.

Stomachs of next 10 fish will be pulled and placed into soil bags and into labeled 5 gallon buckets with a 10% Formalin solution. Flag each fish as "stomach" in CLAMS and label soil bag with species and station information on a paper tag inside and outside (if soil bag has exterior tag).

Record weight and lengths of remaining fish until total n=50 for each species.
Collect bulk weight on remainder of sorted catch. If remaining number is small (<100), count and bulk weigh.

Juvenile Salmon Detail:

Chinook: All juvenile chinook will be fin clipped and stored in pre-labeled vials with ethanol for genetics. Scan all fish for CWT (if tagged insert high seas cwt card into bag). Two fish for Heintz whole, 10 stomachs as above. If less than 12 fish, pull stomach contents from bomb fish and place in labeled ziplock bag (station, species, barcode range) replace stomach lining to each respective fish and freeze.

Coho: Scan all for CWT (if tagged insert high seas cwt card into bag). Two fish for Heintz whole, 10 stomachs as above.

Sockeye: Two fish whole Heintz, 10 stomachs as above, 18 heads for otoliths barcoded.

Chum and Pink: Two fish whole Heintz, 10 stomachs as above.

Immature/Mature Salmon:
Remove stomachs from up 10 adult salmon per station/species.
Place in soil bags by species, label with station # and station name flag stomach in CLAMS.

Chinook
Scan snouts of adipose clipped fish, if cwt present cut snout and individually bag with barcode and high seas cwt card.

RECENT TECHNICAL MEMORANDUMS

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AFSC-

366 WHITTLE, J. A., C. M. KONDZELA, HV. T. NGUYEN, K. HAUCH, D. CUADRA, and J. R. GUYON. 2018. Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2016 Bering Sea walleye pollock trawl fishery and Gulf of Alaska groundfish fisheries, 56 p. NTIS number pending.

365 GUTHRIE, C. M. III, HV. T. NGUYEN, A. E. THOMSON, K. HAUCH, and J. R. GUYON. 2018. Genetic stock composition analysis of the Chinook salmon (*Oncorhynchus tshawytscha*) bycatch from the 2016 Bering Sea walleye pollock (*Gadus chalcogrammus*) trawl fishery, 32 p. NTIS No. PB2018-100476.

364 SULLIVAN, J., and C. FAUNCE. 2018. Alternative sampling designs for the 2018 Annual Deployment Plan of the North Pacific Observer Program, 30 p. NTIS No. PB2018-100475.

363 STRASBURGER, W. W., J. H. MOSS, K. A. SIWICKE, and E. M. YASUMIISHI. 2018. Results from the eastern Gulf of Alaska ecosystem assessment, July through August 2016, 90 p. NTIS No. PB2018-100430.

362 ORR, A. J., J. D. HARRIS, K. A. HIRSCHBERGER, R. L. DELONG, G. S. SANDERS, and J. L. LAAKE 2017. Qualitative and quantitative assessment of use of offshore oil and gas platforms by the California sea lion (*Zalophus californianus*), 72 p. NTIS No. PB2018-100078.

361 MCCONNAUGHEY, R. A., K. E. BLACKHART, M. P. EAGELTON, and J. MARSH. 2017. Habitat assessment prioritization for Alaska stocks: Report of the Alaska Regional Habitat Assessment Prioritization Coordination Team, 102 p. NTIS No. PB2018-100160.

360 TURNER, K., C. N. ROOPER, E. A. LAMAN, S. C. ROONEY, D. W. COOPER, and M. ZIMMERMANN. 2017. Model-based essential fish habitat definitions for Aleutian Island groundfish species, 239 p. NTIS No. PB2017-102717.

359 RODGVELLER, C. J., P. W. MALECHA, and C. R. LUNSFORD. 2017. Long-term survival and observable healing of two deepwater rockfishes, *Sebastes*, after barotrauma and subsequent recompression in pressure tanks, 37 p. NTIS No. PB2017-102716.

358 FAUNCE, C., J. SULLIVAN, S. BARBEAUX, J. CAHALAN, J. GASPER, S. LOWE, and R. WEBSTER. 2017. Deployment performance review of the 2016 North Pacific Groundfish and Halibut Observer Program, 75 p. NTIS No. PB2017-102715.

357 LAMAN, E. A., C. N. ROOPER, S. C. ROONEY, K. A. TURNER, D. W. COOPER, and M. ZIMMERMANN. 2017. Model-based essential fish habitat definitions for Bering Sea groundfish species, 75 p. NTIS No. PB2017-102512.

356 CSEPP, D. J., D. C. HONEYFIELD, J. J. VOLLENWEIDER, and J. WOMBLE. 2017. Estuarine distribution, nutritional and thiaminase content of eulachon (*Thaleichthys pacificus*) in Southeast Alaska, with implications for Steller sea lions, 56 p. NTIS No. No. PB2017-102383.