NOAA Technical Memorandum NMFS-AFSC-363
doi:10.7289/V5/TM-AFSC-363

Results from the Eastern Gulf of Alaska Ecosystem Assessment, July through August 2016

W. W. Strasburger, J. H. Moss, K. A. Siwicke, and E. M. Yasumiishi

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

January 2018

NOAA Technical Memorandum NMFS

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

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

This document should be cited as follows:

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.

Document available: https://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-363.pdf

NOAA Technical Memorandum NMFS-AFSC-363
doi:10.7289/V5/TM-AFSC-363

Results from the Eastern Gulf of Alaska Ecosystem Assessment, July through August 2016

by
W. W. Strasburger[1], J. H. Moss[1], K. A. Siwicke[2], and E. M. Yasumiishi[1]

[1]Auke Bay Laboratories
Alaska Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
17109 Pt. Lena Loop Rd.
Juneau, AK 99801

[2]Under contract to Auke Bay Laboratories

www.afsc.noaa.gov

U.S. DEPARTMENT OF COMMERCE
Wilbur L. Ross Jr., Secretary
National Oceanic and Atmospheric Administration
RDML Timothy Gallaudet (ret.), Acting Under Secretary and Administrator
National Marine Fisheries Service
Chris Oliver, Assistant Administrator for Fisheries

January 2018

This document is available to the public through:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

www.ntis.gov

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 GOA. 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. 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 (i.e., “The Blob”, and El Niño). In 2016, sampling for fish, plankton, and oceanography was completed at pre-determined 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 fluorescence, and photosynthetically available radiation (PAR).

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

Methods

There were a total of 31 designated sampling days on three separate cruises (NW1602, NW1604, and NW1605). Typically, four stations are expected to be occupied per day, resulting in a maximum of 124 stations potentially occupied. Due to weather and gear constraints, a total of 109 stations were occupied. The number of stations sampled per day decreased with added operations (e.g., gillnet and midwater trawls). The first leg began on the YBE (transect line naming convention follows Yakutat Bay, YB, or Southeast Alaska, SE) 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). Along the coast, transect lines were spaced 20 nautical miles (nmi) apart. Onshore-offshore spacing was variable. Over the shelf, stations were spaced 10 nmi apart, over the slope and basin, stations are 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 U.S. Exclusive Economic Zone (EEZ) for age-0 rockfishes and sablefish. Spacing of the additional stations followed the same conventions as the standard GOAIERP grid. Operations were typically completed between 0700 and 1900 h daily. The main survey stations (continuation of GOAIERP) within 100 nmi from shore were sampled during NW1602 (July). The stations sampled during the beginning of August (NW1604) were intended to sample live jellyfish and execute gear trials (Fig. 1). The additional offshore grid reaching the EEZ was sampled during survey leg NW1605 (Fig. 1).

Oceanography

Where possible, CTD casts occurred at each station on legs NW1602 and NW1605 (Tables 2, 4). No CTD casts were conducted during NW1604 (Table 3), as we had previously sampled this area. Instruments added to the Seabird Electronics 25 CTD included a 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). Water samples were taken at seven depths (0, 10, 20, 40, 75, 100 m, and "bottom"), nutrients were taken at all depths, and chlorophyll samples were taken at four depths (0, 20, 30, and 40 m). No water samples were collected during NW1604 and

NW1605. Salinity was sampled every other cast, alternating between the surface bottle and the deepest bottle (Table 2). 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 NW1602, when possible. No zooplankton sampling was conducted during NW1604 as we had previously sampled this area. Zooplankton was collected at approximately every third station to maximize spatial coverage during NW1605. The standard gear for plankton sampling was a 60-cm bongo net with a 505 and a 333-µm mesh net on each respective side of the frame paired with a 20-cm bongo with a 153-µm mesh net. A Seabird Electronics FastCat (49) or SeaCat (19) 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). Samples were preserved in a buffered 5% formaldehyde solution.

Fish

NW1602 - Surface trawling was conducted with a CanTrawl 400-601 rope trawl equipped with 7/8" TS2 Silver Spectra bridles and 4.5 m NETS alloy doors. Two 50-kg chain-link weights were added to the corners of the footrope as the trawl was deployed to assure fishing depth matched the mixed layer depth (~35 m). The codend was composed of a knotless liner with a mesh of 1.2 cm. To keep the trawl headrope fishing at the surface, two clusters of three A-5 Polyform buoys were clipped on to the opposing corner wingtips of the headrope prior to deployment. The vessel provided a Simrad FS-70 third wire net sounder for net mensuration. An average of four surface trawl stations were completed per day. Surface trawl duration was standardized to 30 minutes, beginning when the doors were fully deployed.

NW1604 - Surface trawling was conducted with a Nordic 264 rope trawl with 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 headrope to reduce the loss of fishes in the neuston. As with the CanTrawl, synthetic bridles and rigging, as well as polyform buoys (A-4) on the wingtips were used. The same chain weights used with the CanTrawl were used to open the Nordic Trawl vertically. Average vertical opening was ~19 m. The codend was composed of a knotless liner with a mesh of 0.8 cm. The same net sounding system was used for mensuration. Surface trawl duration was standardized to thirty minutes, beginning when the doors were fully deployed.

One goal of NW1604 was to evaluate sampling gear for age-0 sablefish. In addition to the Nordic Trawl, we also deployed a variable mesh gillnet. The gillnet was constructed with double-knotted nylon monofilament hung in a 2:1 ratio, dyed green, depth stretched and double selvaged on both sides. There were four panels (mesh sizes) including 19 mm, 25 mm, 31 mm, and 38 mm meshes. Total length was 200 m; depth was 3 m. Lead core line was used for the footrope; foam core line was used for the headrope and bridle. Three attempts were made to fish the gillnet and Nordic Trawl side-by-side, and two overnight attempts were made with the gillnet. Seas never dropped below approximately 5 ft the gillnet regularly fouled and did not fish well. Although a small number of fishes were captured, we do not believe they were representative and do not report on the handful of fishes sampled via gillnet.

At a small number of stations, 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. The purpose of the livebox was to collect large jellyfish in good condition, as they are normally damaged in the trawl.

NW1605 - Surface trawling was conducted with a Nordic 264 rope trawl with 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 headrope to reduce the loss of fishes in the neuston. As with the CanTrawl, synthetic bridles and rigging, as well as polyform buoys (A-4) on the wingtips were used. The same chain weights used with the CanTrawl were used to open the Nordic Trawl vertically Average vertical opening was ~19 m. The same livebox was deployed at a number of stations to capture live age-0 sablefish to return to the lab. The same net sounding system was used. Surface trawl duration was standardized to 30 minutes, beginning when the doors were fully deployed.

Midwater trawling was completed using the Nordic 264 rope trawl, minus the polyform buoy clusters on the wingtips. Midwater tows were standardized to 5 minutes.

Marine Fish and Salmon Collection -- Fifty individuals of all species were randomly selected to be measured and weighed at sea. Bulk weights were recorded when individual fish were too small to record an accurate weight (<8 g).

At Each Station -- Subsamples of whole age-0 walleye pollock (n = 5), Pacific cod (n = 5), sablefish (n = 50), and arrowtooth flounder (n = 5) were individually bagged and tagged and stored in the -40˚C freezer for energetic analysis. Up to n = 50 age-0 rockfish were subsampled for energetic and RNA/DNA analysis, individually bagged and tagged and stored at -40˚C. When catch size allowed for sampling above laboratory requests, diet analysis was performed on board for all above species during NW1602, as well as for age-0 sablefish during NW1604 and

NW1605. Note that age-0 rockfish could not be positively identified in the field; however, diet samples were nevertheless processed onboard at stations where rockfish were abundant.

Juvenile Chinook salmon were sub-sampled for energetic analysis (n = 5), onboard diet (n = 10), otoliths (n = all), and genetics (n = 10). Juvenile Chinook and coho salmon were scanned for the presence of coded wire tags, and all tagged fish were retained. Whole bodies of juvenile coho salmon (n = 2) were retained at each station for energetic analysis. Juvenile chum and pink salmon were subsampled for energetic analysis (n = 2) and genetics (n = 8). Whole individuals and tissue samples were stored in the ship's chest freezers at -18°C.

Data Analysis

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. 2, 3, and 4). This is a species-specific value, calculated as the number of individuals sampled during a standard 30 minute tow divided by area swept by the CanTrawl or the Nordic Trawl (distance of the tow (km) multiplied by the average horizontal spread of the net (km)). Trawl distance was estimated using the haversine formula for great circle distance. Length frequencies were generated for each of the focal species that were successfully sampled (Figs. 5 and 6). Abundance and distribution (center of gravity and effective area occupied) of fishes (NW1602 only, as other legs had only been sampled in 2016) were estimated using the VAST package for multispecies version 1.1.0 (Thorson et al. 2015; Thorson et al. 2016a, b, c) in

RStudio version 1.0.136 and R software version 3.3.0 (R Core Team 2016). The abundance index is a standardized geostatistical index developed by Thorson et al. (2015, 2016a) to estimate indices of abundance for stock assessments. This allows us to report abundance trends across all years of the survey. 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 nautical miles. Parameter estimates were within the upper and lower bounds and final gradients were less than 0.0005. Total counts for all fish were summed by survey (Tables 5, 6, and 7). Total weight of invertebrates from the trawl were summed by survey (Table 8, 9, 10). Frequency of occurrence for all species in the trawl was calculated across all stations occupied and survey legs (Table 11). Onboard diet analysis was added in 2015, and continued in 2016 (Figs. 7 and 8). The standard Tikhookeanskiy Nauchno-Issledovatelskiy Institut Rybnogo Khozyaystva I Okeanografiy (TINRO; Pacific Ocean Research Institute of Fisheries and Oceanography; Volkov et al. 2007, Chuchukalo and Volkov 1986) methodology was used, as described in Moss et al. (2009). Average surface temperature and salinity (top 10 m, Seabird Electronics FastCat 49 or SeaCat 19) data are presented in Tables 12, 13, and 14. Rough counts of broad taxonomic zooplankton categories were completed in the lab using a Folsom splitter and broad taxonomic categories are presented in numbers per cubic meter of water filtered (Table 15). Quantitative zooplankton abundance data were not available at the time of this report. Processed water sampling data (nutrients, chlorophyll, etc.) were also not available at the time this report was written.

Results and Discussion

The total sampling effort during 2016 included 109 occupied stations where fish sampling occurred. A total of 89 casts were made with a SeaBird Electronics 25 CTD. A total of 74 bongo tows were made using the standard bongo array. A total of 369 chlorophyll-a, 429 nutrient, and 30 salinity samples were collected, with the majority being collected during NW1602 (Tables 2, 3, and 4).

Ocean conditions

Average surface (top 10 m) temperatures ranged from 11.78° to 15.65°C. Average surface salinity ranged from 27.49 to 32.28 ppt (Tables 12, 13, and 14). Surface temperatures began to rise in 2014 and continued to be elevated through the 2016 survey season. Maximum temperatures observed during 2015 were above 16°C and were higher than the maximum temperatures observed in 2016.

Zooplankton

At the time of this report, quantitative zooplankton data was not available. Rough counts were produced from a subset of samples collected from the 60 cm bongo net (333-µm mesh) and preserved at sea (Table 15). Generally, zooplankton abundance was dominated by small copepods and the "Other" category. Small copepods were particularly abundant north of Cross Sound but were consistently present across all areas. The "Other" category, which included high numbers of doliolids and salps were more abundant south of Cross Sound. Large copepods were most abundant starting 40 nmi from shore on the YBA and SEQ transects. Chaetognaths were mostly concentrated offshore past the shelf break. Amphipod abundance peaked beyond the shelf break, while decapod abundance peaked over the shelf and south of Cross Sound. Shelled pteropods (thecosomes) were most abundant mid-shelf north of Cross Sound, and past the shelf break south of Cross Sound. The "Other" category was consistently present from the mid-shelf past the shelf break. Salps and gymnosomes that we observed offshore were also observed in inside waters of Icy and Chatham straits during the 2016 Southeast Coastal Monitoring Survey.

Fish

A0 Groundfish - Temporal trends in the estimated abundance of the focal groundfish species indicated above average abundance of arrowtooth flounder in 2012, above-average abundance of age-0 Pacific cod in 2014, above-average abundance of age-0 pollock during 2014, and an above-average abundance of age-0 rockfish in 2016 (Figs. 9-13, Table 16). Age-0 rockfish were the most abundant age-0 groundfish species in 2016 followed by pollock (Figs. 9-13, Table 16).

Distribution of groundfish in pelagic waters varied among species and years (Figs. 10-13). Age-0 Pacific cod were commonly distributed over the shelf (50-200 m bottom depth) and within 20 nmi from shore. Although no age-0 Pacific cod were sampled in 2016, the VAST package requires a minimum value to calculate the probability of presence (see Methods). The abundance and center of gravity analyses for fishes with n = 0 in the catch should be treated accordingly. Age-0 walleye pollock were more widely distributed, occupying shelf, slope, and basin domains (50-2,000 m bottom depth). Age-0 rockfish were the most widely distributed species in the eastern GOA, occupying shelf, slope, and basin domains up to 100 nmi from shore. Arrowtooth flounder were typically found offshore, with the exception of 2012.

Center of gravity indicated that age-0 Pacific cod were distributed farther north during recent warm years (2014-2016), whereas age-0 walleye pollock, age-0 arrowtooth flounder, and age-0 rockfish were not (Fig. 14). Range expansion and contraction occurred for all species (Fig. 15).

Arrowtooth flounder expanded their range in the survey area during odd-numbered years, while the age-0 Pacific cod occupied a larger area during even-numbered years (Fig. 15). Age-0 walleye pollock occupied a larger area during 2015. Age-0 rockfish occupied a larger area during cold years (2011-13) and smaller area during warm years (2014-16) (Fig. 15).

Lower abundances of age-0 groundfish in pelagic waters during 2011 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 (e.g., Pacific Pomfret; *Brama japonica*) not common to the eastern GOA were present in the area during 2014 and 2015, presumably in response to the unprecedented warming in the eastern Pacific Ocean commonly referred to as “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 abundances of all four of the age-0 groundfish species in surface waters during 2011 may have indicated a change in productivity in pelagic waters. Warm conditions during 2014 and 2015 coincided with higher than average abundances of age-0 walleye pollock and Pacific cod (2014), but not arrowtooth flounder or rockfish.

Juvenile Salmon - Temporal trends in the estimated abundance of juvenile salmon indicated a recent increase in the productivity of pink, chum, and sockeye, a slight increase in coho, and no change in Chinook (Fig. 16, Table 17). Juvenile pink salmon were the most abundant species followed by chum, coho, sockeye and Chinook salmon (Figs. 16-20, Table 17). Both juvenile pink and chum salmon had an alternating year pattern with higher abundances in even-numbered years. Juvenile salmon were generally less abundant during atypically warm years (2013-15), except for in 2016 (Fig. 16). Juvenile salmon were distributed nearshore in waters above the continental shelf (Figs. 17-20). Some species of juvenile salmon exhibited synchronous latitudinal and longitudinal tendencies; for example pink, chum, and sockeye salmon in 2013 and 2015 (Fig. 21), likely due to similarities in prey fields. Juvenile coho salmon were distributed farther north during even-numbered years (Fig. 21). During the 2015 "Blob" year, juvenile salmon distribution contracted relative to the other years (Fig. 22).

Higher abundances of juvenile salmon during 2016 were likely due to a combination of higher odd-year-brood pink salmon production and the dissipation of the warm water caused by "The Blob".

Recent increases in the abundance of juvenile salmon in the eastern GOA survey area during later summer may imply improved 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 the survey area during July. Juvenile indices may be an early indication for the numbers of returning adults to their region of origin.

Forage Fish - Pacific herring were most abundant in 2011 but have remained at low abundances in the GOA since 2012 (Fig. 23, Table 18). Wolf eel (*Anarrhicthys ocellatus*) abundance was relatively low between 2011 and 2014, increased to the highest level observed in 2015, and then moderated to an intermediate level in 2016 (Fig. 23; Table 18). Squid has steadily increased since 2011 with the exception of a large spike in abundance in 2014 (Fig. 23; Table 18).

Distribution of these species varied by species and year. Pacific herring were distributed in the nearshore (Fig. 24), wolf eel were distributed offshore (Fig. 25), and squid were distributed more evenly across the shelf (Fig. 26). During the 2014-16 warm years, squid were distributed farther north (Fig. 27) and over a larger area (Fig. 28). Pacific herring and wolf eel did not show a distinct warm and cold year difference in their distributions.

Low abundance of herring and high abundance of wolf eel in pelagic waters during 2015 may be a response to atypically warm conditions. Pacific herring were most abundant during 2011 when conditions were anomalously cool, despite poor primary production (Strom et al. 2016) and during an increased abundance of salps (Li et al. 2016), which further reduced the amount of plankton available to transfer energy to upper trophic levels. Squid abundance was lowest during 2011. Piscivorous predators not common to the eastern GOA 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 Blob’ (Bond et al. 2015). Additional predation pressure by these warm-water predators may have reduced the amount of forage fish that would have otherwise been present. Lower abundances of herring in 2016 may have caused seabirds, marine mammals, and adult salmon to prey more heavily upon squid or other alternative prey during 2016.

Acknowledgments

We extend our gratitude to B&N Fisheries, as well as the captain and crew of the FV *Northwest Explorer*. Their expertise, suggestions, and willingness to help us accomplish our goals has been a great help over the years. We thank the contracting officers and their representatives responsible for ensuring that we have the necessary personnel, supplies, equipment, and platforms to complete this work. We thank those that provided helpful suggestions for the revision of this report.

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)

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.

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 Jo. 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/.

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

Station	Longitude	Latitude	Continued	Station	Longitude	Latitude.
SEE10	-136.039	56.997	-	SEM180	-141.81	56.771
SEE20	-136.308	56.918	-	SEM200	-142.342	56.611
SEE30	-136.576	56.839	-	SEO110	-140.548	57.548
SEG0	-136.058	57.368	-	SEO130	-141.091	57.387
SEG10	-136.329	57.289	-	SEO150	-141.632	57.227
SEG20	-136.6	57.21	-	SEO170	-142.17	57.067
SEG30	-136.869	57.13	-	SEO190	-142.707	56.907
SEI0	-136.351	57.66	-	SEQ0	-138.293	58.925
SEI10	-136.624	57.581	-	SEQ10	-138.479	58.79
SEI20	-136.896	57.501	-	SEQ20	-138.664	58.654
SEI30	-137.167	57.421	-	SEQ30	-138.848	58.518
SEI40	-137.437	57.34	-	SEQ40	-139.03	58.382
SEI60	-137.972	57.176	-	SEQ50	-139.21	58.246
SEI80	-138.503	57.011	-	SEQ70	-139.567	57.973
SEI100	-139.028	56.842	-	SEQ90	-139.918	57.698
SEI120	-139.561	56.682	-	SER0	-138.822	59.116
SEI140	-140.092	56.522	-	SER10	-139.007	58.98
SEI160	-140.621	56.362	-	SER20	-139.191	58.844
SEI180	-141.147	56.202	-	SER30	-139.373	58.707
SEI200	-141.593	56.066	-	SER40	-139.554	58.57
SEK0	-136.649	57.952	-	SER50	-139.734	58.433
SEK10	-136.924	57.872	-	SER70	-140.088	58.159
SEK20	-137.197	57.791	-	SER90	-140.438	57.883
SEK30	-137.47	57.711	-	YBA0	-139.357	59.305
SEK40	-137.741	57.629	-	YBA10	-139.541	59.168
SEK60	-138.279	57.464	-	YBA20	-139.724	59.031
SEK80	-138.813	57.297	-	YBA30	-139.905	58.894
SEK100	-139.341	57.128	-	YBA40	-140.085	58.756
SEK120	-139.878	56.967	-	YBA50	-140.263	58.619
SEK140	-140.413	56.807	-	YBA70	-140.615	58.342
SEK160	-140.946	56.647	-	YBA90	-140.962	58.065
SEK180	-141.476	56.487	-	YBC0	-139.898	59.491

Table 1. -- Continued.

SEK200	-141.978	56.335	-	YBC10	-140.081	59.354
SEM0	-136.952	58.242	-	YBC20	-140.262	59.216
SEM10	-137.228	58.162	-	YBC30	-140.442	59.078
SEM20	-137.504	58.081	-	YBC40	-140.621	58.94
SEM30	-137.777	57.999	-	YBC50	-140.798	58.802
SEM40	-138.05	57.917	-	YBC70	-141.148	58.524
SEM60	-138.591	57.751	-	YBC90	-141.492	58.245
SEM80	-139.128	57.583	-	YBE0	-140.479	59.652
SEM100	-139.659	57.412	-	YBE10	-140.626	59.537
SEM120	-140.2	57.252	-	YBE20	-140.807	59.399
SEM140	-140.739	57.092	-	YBE30	-140.985	59.26
SEM160	-141.276	56.931	-	YBE40	-141.163	59.121

Table 2. -- NW1602 completed operations for each station.

Date	Station	Trawl	CTD	SeaCat	Bongo	Chl-a	Nutrients	Salinity
5-Jul	YBE40	1	1	1	1	6	7	-
5-Jul	YBE30	1	1	1	1	6	7	1
5-Jul	YBE20	1	1	1	1	6	7	-
6-Jul	YBE10	1	1	1	1	6	7	1
6-Jul	YBC0	1	1	1	1	5	7	-
6-Jul	YBC10	1	1	1	1	6	7	1
7-Jul	YBC20	1	1	1	1	6	7	-
7-Jul	YBC30	1	1	1	1	6	7	1
7-Jul	YBC40	1	1	1	1	6	7	-
7-Jul	YBC50	1	1	1	1	6	7	1
8-Jul	YBC70	1	1	1	1	6	7	-
8-Jul	YBC90	1	1	1	1	6	7	1
8-Jul	YBA90	1	1	1	1	6	7	-
8-Jul	YBA70	1	1	1	1	6	7	1
9-Jul	YBA50	1	1	1	1	6	7	-
9-Jul	YBA40	1	1	1	1	6	7	1
9-Jul	YBA30	1	1	1	1	6	7	-
10-Jul	YBA20	1	1	1	1	6	7	1
10-Jul	YBA10	1	1	1	1	6	7	-
10-Jul	YBA0	1	1	1	1	5	5	1
10-Jul	SER0	1	1	1	1	5	5	-
10-Jul	SER10	1	1	1	1	6	7	1
11-Jul	SER20	1	1	1	1	6	7	-
11-Jul	SER30	1	1	1	1	6	7	1
11-Jul	SER40	1	1	1	1	6	7	-
11-Jul	SER50	1	1	1	1	6	7	1
12-Jul	SER70	1	1	1	1	6	7	-
12-Jul	SER90	1	1	1	1	6	7	1
12-Jul	SEQ90	1	1	1	1	6	7	-
12-Jul	SEQ70	1	1	1	1	6	7	1
13-Jul	SEQ50	1	1	1	1	6	7	-
13-Jul	SEQ40	1	1	1	1	6	7	1
13-Jul	SEQ30	1	1	1	1	6	7	-
13-Jul	SEQ20	1	1	1	1	6	7	1
14-Jul	SEQ10	1	1	1	1	6	7	-

Table 2. – Continued.

14-Jul	SEQ0	1	1	1	1	6	6	1
16-Jul	SEE10	1	1	1	1	6	7	-
16-Jul	SEE20	1	1	1	1	6	7	1
16-Jul	SEE30	1	1	1	1	6	7	-
17-Jul	SEG30	1	1	1	1	6	7	1
17-Jul	SEG20	1	1	1	1	6	7	-
17-Jul	SEG10	1	1	1	1	6	7	-
18-Jul	SEG0	1	1	1	1	6	7	1
18-Jul	SEI0	1	1	1	1	6	7	-
18-Jul	SEI10	1	1	1	1	6	7	1
18-Jul	SEI20	1	1	1	1	6	7	-
18-Jul	SEI30	1	1	1	1	6	7	1
19-Jul	SEI40	1	1	1	1	6	7	-
19-Jul	SEI60	1	1	1	1	6	7	1
19-Jul	SEI80	1	1	1	1	6	7	-
20-Jul	SEK80	1	1	1	1	6	7	1
20-Jul	SEK60	1	1	1	1	6	7	-
21-Jul	SEK40	1	1	1	1	6	7	1
21-Jul	SEK30	1	1	1	1	6	7	-
21-Jul	SEK20	1	1	1	1	6	7	1
21-Jul	SEK10	1	1	1	1	6	7	-
22-Jul	SEK0	1	1	1	1	6	7	1
22-Jul	SEM80	1	1	1	1	6	7	-
22-Jul	SEM60	1	1	1	1	6	7	1
22-Jul	SEM40	1	1	1	1	6	7	-
23-Jul	SEM30	1	1	1	1	6	7	-
23-Jul	SEM20	1	-	-	-	-	-	-
23-Jul	SEM10	1	-	-	-	-	-	-
23-Jul	SEM0	1	1	1	1	6	7	1

Table 3. -- NW1604 completed operations for each station.

Date	Station	Trawl	Live Box	Gillnet	Seacat	Bongo
8/5/2016	SEK0	1	1	-	1	-
8/5/2016	SEI20	1	1	-	1	1
8/6/2016	SEI40	1	1	-	1	-
8/6/2016	SEH20	1	1	-	1	-
8/6/2016	SEG60	1	1	-	1	-
8/6/2016	SEG40	1	1	-	1	-
8/7/2016	SEG20	1	1	-	1	1
8/7/2016	SEG00	1	1	-	1	-
8/7/2016	SEG15	1	1	-	1	-
8/7/2016	SEG05	1	1	-	1	-
8/8/2016	SEF20	1	-	-	1	-
8/8/2016	SEE20	1	-	-	1	-
8/9/2016	SED20	1	-	-	1	1
8/9/2016	SEF20	1	-	1	1	-
8/9/2016	SEG20	1	-	1	1	-
8/10/2016	SEG20	-	-	1	-	-
8/10/2016	SEG15	1	-	-	1	-
8/10/2016	SEG10	1	-	-	-	-

Table 4. -- NW1605 completed operations for each station.

Date	Station	Trawl	Midwater	Live Box	CTD	Bongo
8/12/2016	SEI40	1	-	-	1	1
8/12/2016	SEI60	1	-	-	1	-
8/12/2016	SEI80	1	-	-	1	-
8/13/2016	SEI100	1	-	-	-	-
8/13/2016	SEI120	1	-	-	1	1
8/13/2016	SEI140	1	-	-	1	-
8/13/2016	SEI160	1	-	-	1	1
8/14/2016	SEI180	1	1	-	1	-
8/14/2016	SEI200	1	-	-	1	-
8/14/2016	SEK200	1	1	-	1	1
8/14/2016	SEK180	1	-	-	1	-
8/15/2016	SEK160	1	-	-	1	-
8/15/2016	SEK140	1	1	-	1	1
8/15/2016	SEK120	1	-	-	1	-
8/15/2016	SEM120	1	-	-	1	-
8/16/2016	SEM140	1	-	-	1	-
8/16/2016	SEM160	1	-	-	1	1
8/16/2016	SEM180	1	-	-	1	-
8/16/2016	SEM200	1	-	-	1	-
8/17/2016	SEO190	1	1	-	1	1
8/17/2016	SEO170	1	-	-	1	-
8/17/2016	SEO150	1	-	-	1	-
8/17/2016	SEO130	1	-	-	1	-
8/18/2016	SEO110	1	1	-	1	1
8/18/2016	SEM100	1	-	-	1	-
8/18/2016	SEM80	1	-	-	1	-
8/18/2016	SEM60	1	-	-	1	1
8/19/2016	SEM40	2	-	2	1	-

Table 5. -- Fish catch summary for NW1602.Common name is followed by a life history designator. A0 is age-0, IM is immature/maturing, J is juvenile or first ocean year Pacific salmon, U is unspecified, A1+ is all age classes above A0. Surface trawls were completed with a CanTrawl 400-601 rope trawl.

Common name	Scientific name	Count
Arrowtooth flounder A0	*Atheresthes stomias*	67
Chinook salmon IM	*Oncorhynchus tshawytscha*	26
Chinook salmon J	*Oncorhynchus tshawytscha*	89
Chum salmon IM	*Oncorhynchus keta*	182
Chum salmon J	*Oncorhynchus keta*	2,366
Coho salmon IM	*Oncorhynchus kisutch*	56
Coho salmon J	*Oncorhynchus kisutch*	1,077
Dover sole U	*Microstomus pacificus*	4
Dusky Rockfish U	*Sebastes ciliatus*	2
Flatfish, unident. U	*Pleuronectiformes*	159
Hippoglossoides, genus U	*Hippoglossoides*	1
King-of-the-salmon U	*Trachipterus altivelis*	1
Lanternfish, unident. U	*Myctophidae*	1
Pacific herring U	*Clupea pallasii*	7,962
Pacific pomfret U	*Brama japonica*	41
Pink salmon IM	*Oncorhynchus gorbuscha*	164
Pink salmon J	*Oncorhynchus gorbuscha*	9,858
Pipefish sp. U	Syngnathidae	1
Pleuronichthys sp. U	*Pleuronichthys* sp.	3
Pollock A0	*Gadus chalcogrammus*	933
Pollock A1+	*Gadus chalcogrammus*	5
Prickleback, unident. U	Stichaeidae	3
Prowfish U	*Zaprora silenus*	28
Ragfish U	*Icosteus aenigmaticus*	1
Rex sole U	*Glyptocephalus zachirus*	67
Rockfish, unident. A0	*Sebastes* spp.	35,163
Ronquil, unident. U	Bathymasteridae	7
Sablefish A0	*Anoplopoma fimbria*	2
Sablefish A1+	*Anoplopoma fimbria*	13
Smooth lumpsucker U	*Aptocyclus ventricosus*	4
Sockeye salmon IM	*Oncorhynchus nerka*	38
Sockeye salmon J	*Oncorhynchus nerka*	4,876

Table 5. – Continued.

Spiny dogfish U	*Squalus suckleyi*	1,719
Starry flounder U	*Platichthys stellatus*	1
Steelhead U	*Oncorhynchus mykiss*	1
Wolf eel U	*Anarrhichthys ocellatus*	46

Table 6. -- Fish catch summary for NW1604. Common name is followed by a life history designator. A0 is age-0, IM is immature/maturing, J is juvenile or first ocean year Pacific salmon, U is unspecified, A1+ is 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*	3
Chinook salmon J	*Oncorhynchus tshawytscha*	11
Chum salmon J	*Oncorhynchus keta*	91
Coho salmon IM	*Oncorhynchus kisutch*	1
Coho salmon J	*Oncorhynchus kisutch*	15
Pacific herring U	*Clupea pallasii*	611
Pacific sandfish U	*Trichodon trichodon*	1
Pacific saury U	*Cololabis saira*	13
Pink salmon IM	*Oncorhynchus gorbuscha*	1
Pink salmon J	*Oncorhynchus gorbuscha*	177
Prowfish U	*Zaprora silenus*	2
Rockfish, unident. A0	*Sebastes* spp.	7,224
Sablefish A0	*Anoplopoma fimbria*	3,735
Salmon shark U	*Lamna ditropis*	1
Sockeye salmon J	*Oncorhynchus nerka*	34
Sockeye salmon U	*Oncorhynchus nerka*	8
Wolf eel U	*Anarrhichthys ocellatus*	6

Table 7. -- Fish catch summary for NW1605. Common name is followed by a life history designator. A0 is age-0, IM is immature/maturing, J is juvenile or first ocean year Pacific salmon, U is unspecified, A1+ is all age classes above A0. Surface and midwater trawls were completed with a Nordic 264 rope trawl.

Common name	Scientific name	Count
Blue shark U	*Prionace glauca*	2
Chum salmon IM	*Oncorhynchus keta*	1
Pacific saury U	*Cololabis saira*	5,147
Pollock A0	*Gadus chalcogrammus*	2
Prowfish U	*Zaprora silenus*	2
Ragfish U	*Icosteus aenigmaticus*	2
Rex sole U	*Glyptocephalus zachirus*	8
Rockfish, unident. A0	*Sebastes* spp.	6,017
Sablefish A0	*Anoplopoma fimbria*	7,090
Salmon shark U	*Lamna ditropis*	1
Wolf eel U	*Anarrhichthys ocellatus*	5

Table 8. -- Invertebrate catch summary for NW1602. Life history classes are not recorded for invertebrate catch.

Common name	Scientific name	Weight (kg)
Aequorea sp. U	*Aequorea* sp.	427.97
Moon jelly U	*Aurelia labiata*	18.10
Northern sea nettle U	*Chrysaora melanaster*	123.23
Corolla spectabilis U	*Corolla spectabilis*	323.61
Lion’s mane U	*Cyanea capillata*	27.32
Gonatus sp. U	*Gonatus* sp.	22.92
*Hormiphor*a sp. U	*Hormiphora* sp.	33.07
Japetella diaphana U	*Japetella diaphana*	0.05
Fried egg jelly U	*Phacellophora camtschatica*	334.91

Table 9. -- Invertebrate catch summary for NW1604. Life history classes are not recorded for invertebrate catch.

Common name	Scientific name	Weight (kg)
Aequorea sp. U	*Aequorea* sp.	NA
Moon jelly U	*Aurelia labiata*	NA
Carinaria japonica U	*Carinaria japonica*	NA
Northern sea nettle U	*Chrysaora melanaster*	2.09
Corolla spectabilis U	*Corolla spectabilis*	NA
Ctenophore, unident. U	Thaliacea.	NA
Lion's mane U	*Cyanea capillata*	2.18
Gonatus sp. U	*Gonatus* sp.	NA
Hormiphora sp. U	*Hormiphora* sp.	NA
Fried egg jelly U	*Phacellophora camtschatica*	12.03

Table 10. -- Invertebrate catch summary for NW1605. Life history classes are not recorded for invertebrate catch.

Common Name	Scientific Name	Weight (kg)
Aequorea sp. U	*Aequorea* sp.	200.66
Moon jelly U	*Aurelia labiata*	1.15
Northern sea nettle U	*Chrysaora melanaster*	363.37
Corolla spectabilis U	*Corolla spectabilis*	6.30
Lion's mane U	*Cyanea capillata*	2.64
Gonatus sp. U	*Gonatus* sp.	6.41
Hormiphora sp. U	*Hormiphora* sp.	1.10
Fried egg jelly U	*Phacellophora camtschatica*	32.74

Table 11. -- Number of stations with positive catch and frequency of occurrence for each taxon across all survey legs. N = 109 total surface trawl stations.

Common name	Scientific name	Num. Stn	Percent
Aequorea sp. U	*Aequorea* sp.	103	94.5
Arrowtooth flounder A0	*Atheresthes stomias*	5	4.6
Moon jelly U	*Aurelia labiata*	21	19.3
Blue shark U	*Prionace glauca*	5	4.6
Carinaria japonica U	*Carinaria japonica*	10	9.2
Chinook salmon IM	*Oncorhynchus tshawytscha*	17	15.6
Chinook salmon J	*Oncorhynchus tshawytscha*	24	22.0
Northern sea nettle U	*Chrysaora melanaster*	32	29.4
Chum salmon IM	*Oncorhynchus keta*	41	37.6
Chum salmon J	*Oncorhynchus keta*	45	41.3
Coho salmon IM	*Oncorhynchus kisutch*	23	21.1
Coho salmon J	*Oncorhynchus kisutch*	43	39.4
Corolla spectabilis U	*Corolla spectabilis*	82	75.2
Ctenophore, unident. U	*Ctenophore*, unident.	6	5.5
Lion's mane U	*Cyanea capillata*	23	21.1
Dover sole U	*Microstomus pacificus*	2	1.8
Dusky rockfish U	*Sebastes ciliatus*	2	1.8
Flatfish, unident. U	Pleuronectiformes	31	28.4
Gonatus sp. U	*Gonatus* sp.	65	59.6
Hippoglossoides, genus U	*Hippoglossoides* sp.	1	0.9
Hormiphora sp. U	*Hormiphora* sp.	75	68.8
Japetella diaphana U	*Japetella diaphana*	1	0.9
King-of-the-salmon U	*Trachipterus altivelis*	1	0.9
Lanternfish, unident. U	Myctophidae	1	0.9
Pacific herring U	*Clupea pallasii*	31	28.4
Pacific pomfret U	*Brama japonica*	5	4.6
Pacific sandfish U	*Trichodon trichodon*	1	0.9
Pacific saury U	*Cololabis saira*	21	19.3
Fried egg jelly U	*Phacellophora camtschatica*	51	46.8
Pink salmon IM	*Oncorhynchus gorbuscha*	38	34.9
Pink salmon J	*Oncorhynchus gorbuscha*	49	45.0
Pipefish U	Syngnathidae	1	0.9
Pleuronichthys sp. U	*Pleuronichthys* sp.	2	1.8
Pollock A0	*Gadus chalcogrammus*	30	27.5

Table 11. – Continued.

Pollock A1+	*Gadus chalcogrammus*	3	2.8
Prickleback, unident. U	Stichaeidae	3	2.8
Prowfish U	*Zaprora silenus*	21	19.3
Ragfish U	*Icosteus aenigmaticus*	2	1.8
Rex sole U	*Glyptocephalus zachirus*	20	18.3
Rockfish, unident. A0	*Sebastes* spp.	69	63.3
Ronquil, unident. U	Bathymasteridae	3	2.8
Sablefish A0	*Anoplopoma fimbria*	27	24.8
Sablefish A1+	*Anoplopoma fimbria*	1	0.9
Salmon shark U	*Lamna ditropis*	2	1.8
Smooth lumpsucker U	*Aptocyclus ventricosus*	3	2.8
Sockeye salmon IM	*Oncorhynchus nerka*	18	16.5
Sockeye salmon J	*Oncorhynchus nerka*	43	39.4
Sockeye salmon U	*Oncorhynchus nerka*	1	0.9
Spiny dogfish U	*Squalus suckleyi*	24	22.0
Starry flounder U	*Platichthys stellatus*	1	0.9
Steelhead U	*Oncorhynchus mykiss*	1	0.9
Wolf eel U	Anarrhichthys ocellatus	31	28.4

Table 12. -- NW1602 Average temperature (^{0}C) and salinity (ppt) for top 10 m.

Station	Temperature	Salinity
YBE40	14.61	31.76
YBE30	14.43	31.67
YBE20	14.23	31.18
YBE10	14.1	31.35
YBC0	13.46	27.61
YBC10	14.36	31.57
YBC20	14.94	31.62
YBC30	14.99	31.64
YBC40	14.96	31.77
YBC50	14.62	31.86
YBC70	14.76	31.85
YBC90	14.34	31.82
YBA90	14.41	31.74
YBA70	14.22	32.15
YBA50	15.29	31.71
YBA40	15.09	31.74
YBA30	15.54	30.3
YBA20	14.69	30.82
YBA10	14.61	30.23
YBA0	13.38	31.38
SER0	13.53	27.49
SER10	14.8	31.41
SER20	14.89	31.03
SER30	15.25	29.99
SER40	14.58	32.03
SER50	14.7	31.77
SER70	14.58	32.27
SER90	15.18	31.82
SEQ90	14.67	32.28
SEQ70	14.8	32.26
SEQ50	14.8	31.53
SEQ40	13.65	31.56
SEQ30	14.67	31.91
SEQ20	15.08	31.69
SEQ10	15.65	30.68

Table 12. – Continued.

SEQ0	14.35	31.38
SEE10	15.07	31.61
SEE20	15.16	32.06
SEE30	14.53	32
SEG30	14.41	32.2
SEG20	15.08	32.22
SEG10	15.42	31.86
SEG0	13.14	31.57
SEI0	11.78	31.6
SEI10	15.24	31.87
SEI20	15.26	32.21
SEI30	14.45	32.15
SEI40	14.83	31.92
SEI60	15.09	31.85
SEK80	14.29	32.2
SEK60	14.46	32.24
SEK40	14.2	32.28
SEK30	14.88	32.25
SEK20	15.51	32.21
SEK10	15.4	31.92
SEK0	14.45	31.66
SEM80	15.28	32.24
SEM60	15.09	32.23
SEM40	15.44	32.21
SEM30	14.5	32.11
SEM0	13.56	31.53

Table 13. -- NW1604 Average temperature (^{0}C) and salinity (ppt) for top 10 m.

Station	Temperature	Salinity
SEK0	15.21	31.24
SEI20	15.04	32.18
SEI40	15.16	32.09
SEH20	15.22	32.17
SEG60	15.42	31.8
SEG40	15.08	32.07
SEG00	14.94	31.69
SEG-15	11.84	31.04
SEG-05	11.97	31.49
SEF20	15.29	32.11
SEE20	15.37	32.1
SED20	15.47	31.75

Table 14. -- NW1605 Average temperature (^{0}C) and salinity (ppt) for top 10 m.

Station	Temperature	Salinity
SEI40	15.51	32.1
SEI120	15.38	32.1
SEI160	15.38	32.06
SEK200	13.94	31.82
SEK200	13.94	31.82
SEK140	14.99	31.55
SEK140	14.99	31.55
SEM160	14.85	31.78
SEO190	14.67	32.25
SEO190	14.67	32.25
SEO110	15.36	32.12
SEO110	15.36	32.12
SEM60	15.32	32.17

Table 15. -- NW1602 Zooplankton rough counts, number per cubic meter from 60 cm bongo, 333 µm mesh.

Station	Eupausiid (Lg)	Euphausiid (Sm)	Copepoda (Lg)	Copepoda (Sm)	Gymnosome	Thecosome	Chaetognath	Amphipod	Decapod	Other
YBE40	1.6	1.5	5.1	94.5	0	0	4	1.5	0	5.1
YBE20	0.2	0	4.8	36.8	0	0.4	0.7	0	0	5.9
YBA70	0	0	52.4	57	0	2.3	10.3	1.7	1.1	2.3
YBA40	0.2	0	45.5	152.6	0	0	1.2	0	0	9.8
YBA20	0.3	1.8	19.6	236.8	0	21.4	0	1.8	1.8	138.9
SEQ70	0.1	0.3	14.9	35.7	0	5.2	3.7	0.9	0	69.5
SEQ40	0.2	0	44.1	96.5	0	2.8	1.4	2.8	0.7	6.2
SEQ20	0	0	6.8	348	0	111.5	0	2.3	0	66
SEQ0	0	0	4	2.6	1.9	0	0	0.5	0.7	21.6
SEE20	0.1	0	6.5	12.1	0.5	1.4	2.3	4.7	0	43.8
SEI0	0.2	0.3	5.8	35.1	0	7.5	1.4	0.7	17	55.9
SEI20	0	0	1.3	1.3	0	0	0.9	0.9	0	85.4
SEI40	0.1	1.4	9.3	27.7	1.9	12.8	8.8	4.4	0.2	13
SEI80	0.1	0	12.6	35.1	0.7	19.8	2	11.9	1.3	16.5
SEM80	0.1	0	14.7	11.6	0	1.3	2.7	0.4	0	9.8
SEM40	0.1	0	4.6	11.4	0	0.3	4.3	1.8	0	12.4
SEM0	4.7	1.8	32.6	54.2	0	6.9	1.8	0	1.8	17.9

Table 16. -- Index of biomass (estimated metric tonnes) ± 1 standard error (SE) for age-0 groundfish in pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

Species	Year	Tonnes	SE
Arrowtooth flounder	2011	0.133288	0.091551
Arrowtooth flounder	2012	1.407965	0.374294
Arrowtooth flounder	2013	0.131508	0.058734
Arrowtooth flounder	2014	0.066856	0.029269
Arrowtooth flounder	2015	0.147957	0.084153
Arrowtooth flounder	2016	0.569463	0.394218
Pacific cod	2011	0.075669	0.091373
Pacific cod	2012	0.415345	0.255209
Pacific cod	2013	0.023238	0.031646
Pacific cod	2014	1.297332	0.247807
Pacific cod	2015	0.271385	0.160566
Pacific cod	2016	0.244119	0.362970
Pollock	2011	0.091556	0.153961
Pollock	2012	9.549102	3.094399
Pollock	2013	35.83846	9.439356
Pollock	2014	93.13981	20.84864
Pollock	2015	7.290406	2.584512
Pollock	2016	13.53925	4.956674
Rockfish	2011	4.621313	3.351419
Rockfish	2012	4.6099	2.074678
Rockfish	2013	8.309468	4.901025
Rockfish	2014	37.79021	7.778197
Rockfish	2015	18.11566	7.017681
Rockfish	2016	278.8128	78.18626

Table 17. -- Index of biomass (estimated metric tonnes) ± 1 standard error (SE) for Pacific salmon in the eastern Gulf of Alaska during summer, 2011-16.

Year	Chinook	Chum	Pink	Sockeye
2011	307 (112)	102 (36)	69 (29)	229 (71)
2012	736 (188)	538 (207)	659 (301)	1,231 (490)
2013	568 (138)	242 (108)	67 (45)	309 (123)
2014	249 (51)	369 (88)	1,561 (388)	304 (73)
2015	261 (70)	240 (73)	324 (156)	319 (104)
2016	235 (62)	705 (160)	1,887 (472)	1,053 (262)

Table 18. -- Index of biomass (estimated metric tonnes) ± 1 standard error (SE) for forage fish in the eastern Gulf of Alaska during summer, 2011-16.

Year	Pacific herring	Squid	Wolf eel
2011	9740 (13,147)	23 (20)	13 (8)
2012	614 (1211)	49 (16)	8 (4)
2013	2827(3449)	81 (22)	11 (4)
2014	2503 (2224)	529 (81)	9 (3)
2015	31 (49)	89 (30)	108 (25)
2016	751 (444)	164 (45)	28 (7)

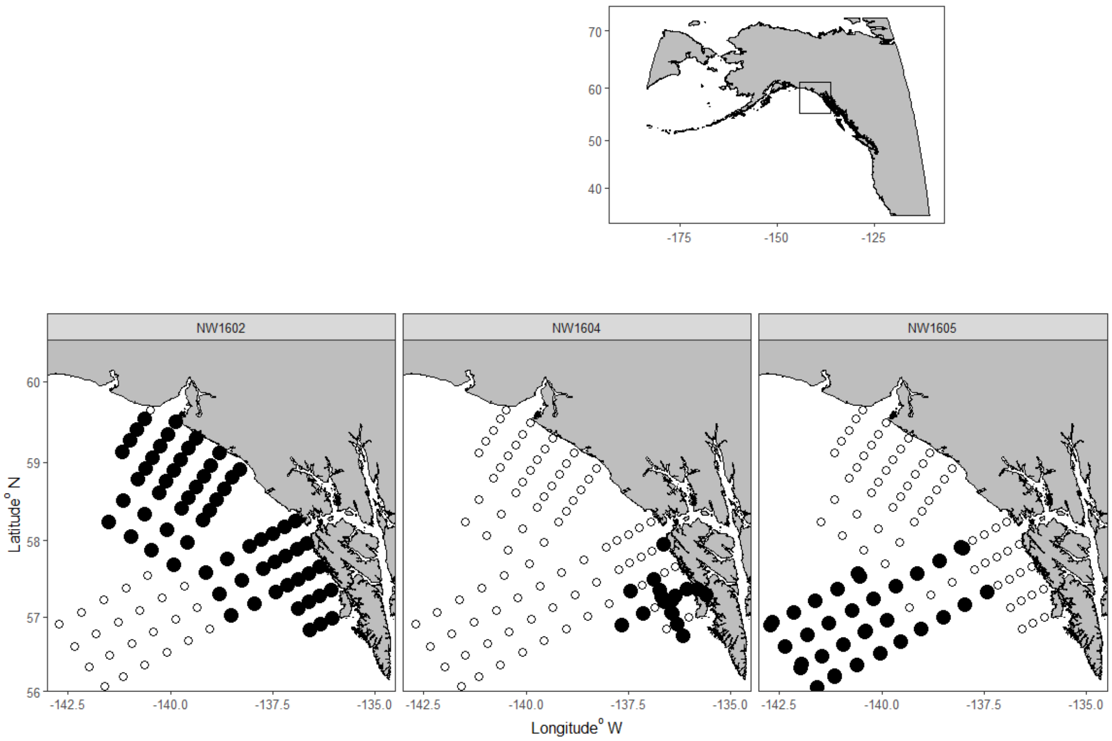

Figure 1. -- Stations occupied by survey leg NW1602, NW1604, and NW1605 are filled. The entire grid is represented in each panel.

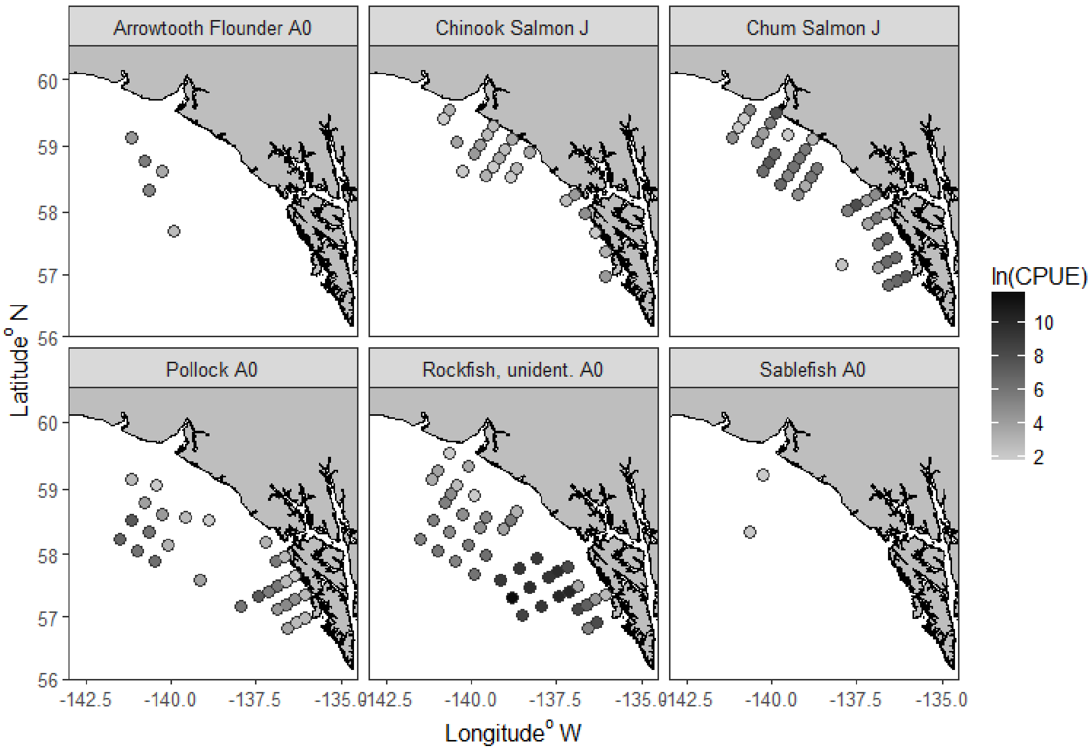

Figure 2. -- Surface trawl CPUE sampled with the CanTrawl during NW1602.

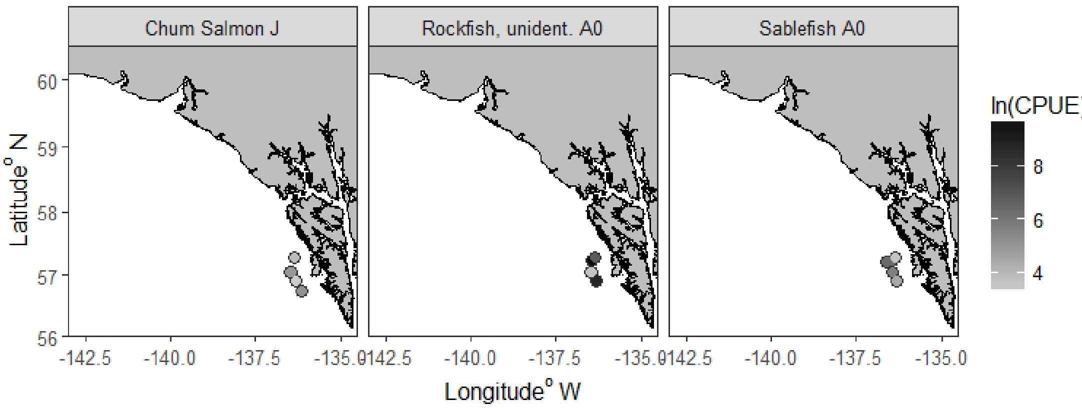

Figure 3. -- Surface trawl CPUE sampled with the Nordic Trawl during NW1604.

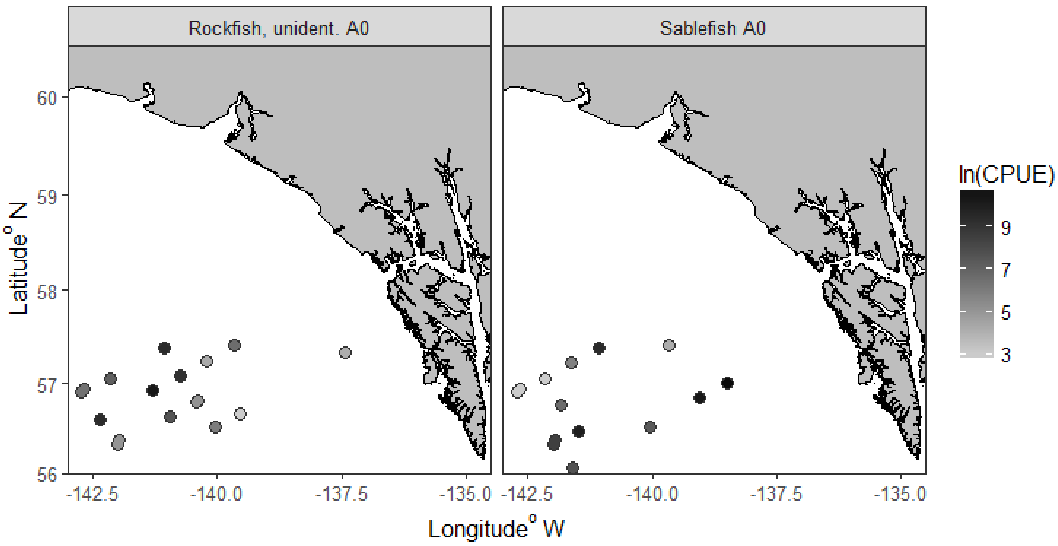

Figure 4. -- Surface trawl CPUE sampled with the Nordic Trawl during NW1605.

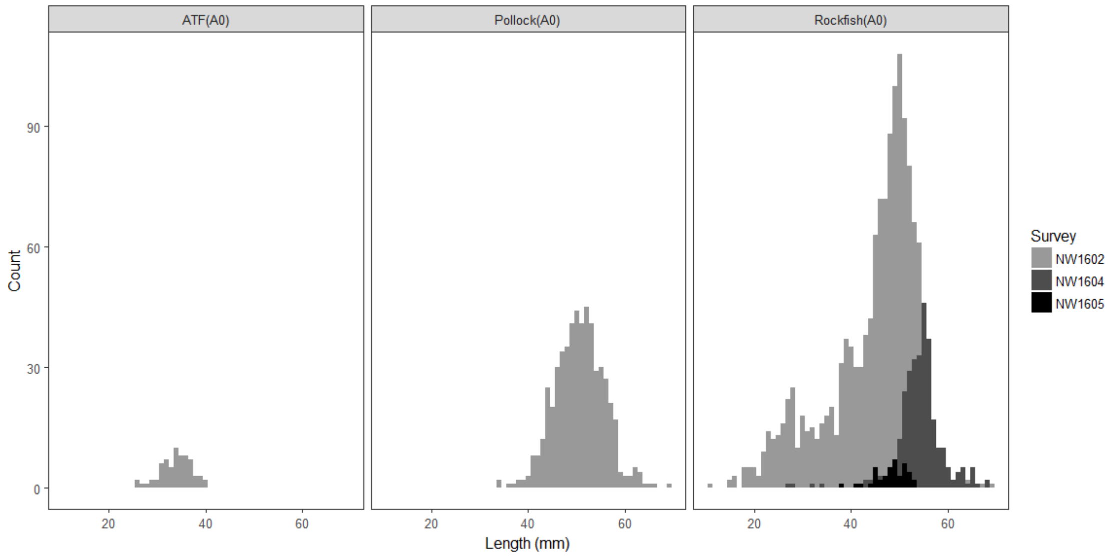

Figure 5. -- Age-0 focal groundfish length frequency (standard length) by survey.

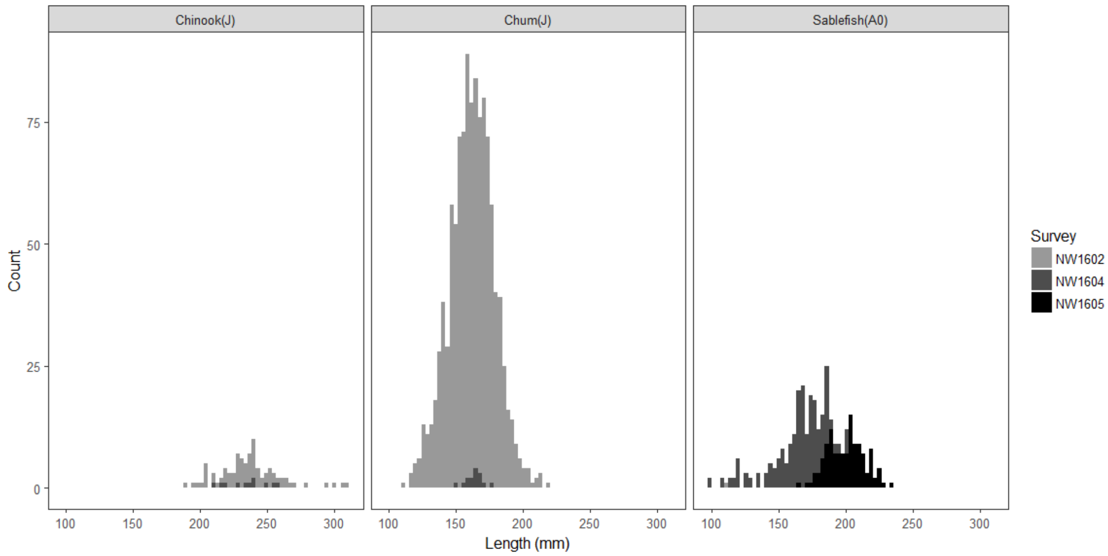

Figure 6. -- Juvenile Chinook and chum salmon, and age-0 sablefish length frequency (fork length) by survey.

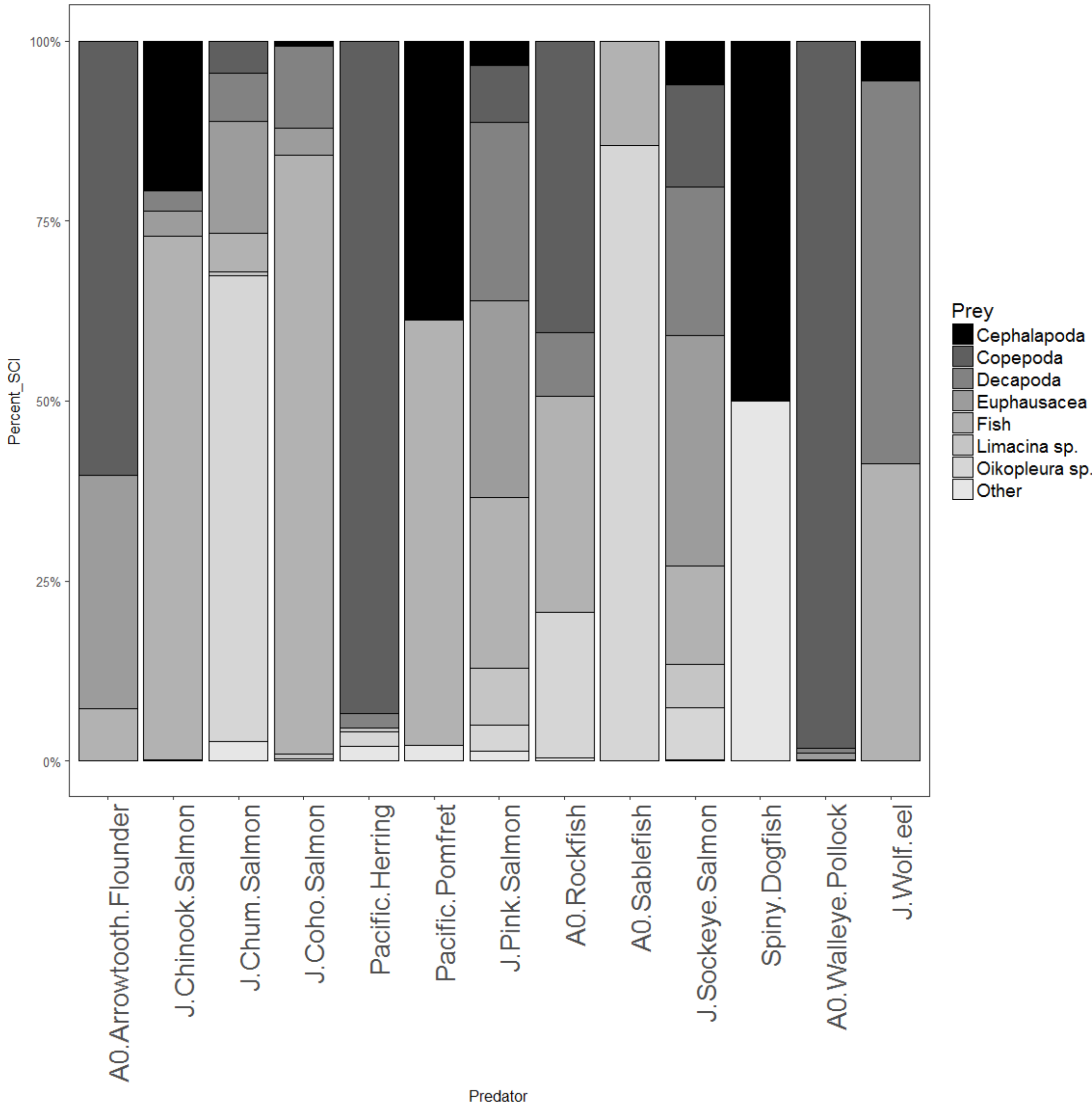

Figure 7. -- Onboard diets from NW1602, represented as percent stomach content index (TINRO method).

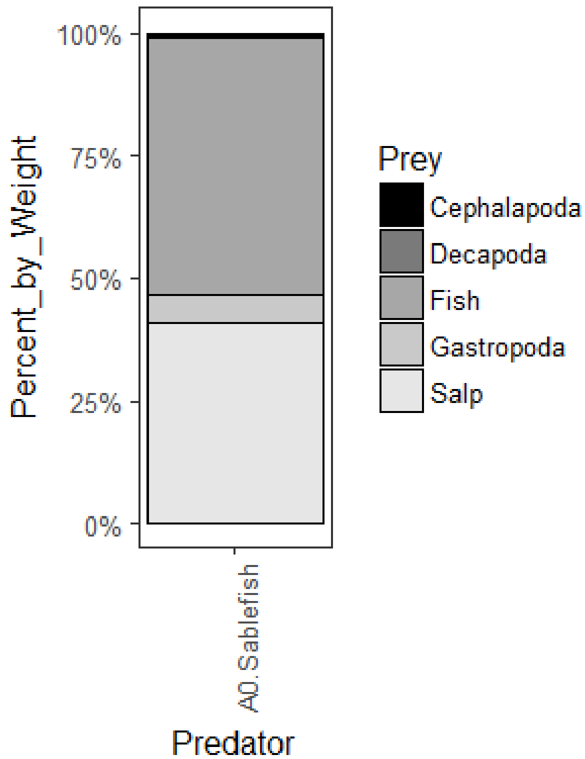

Figure 8. -- Sablefish diets from 50 stomachs sampled from 5 shelf stations and 70 stomachs sampled from 7 stations on offshore; total of 10 empty stomachs all at a single station (SEI 200).

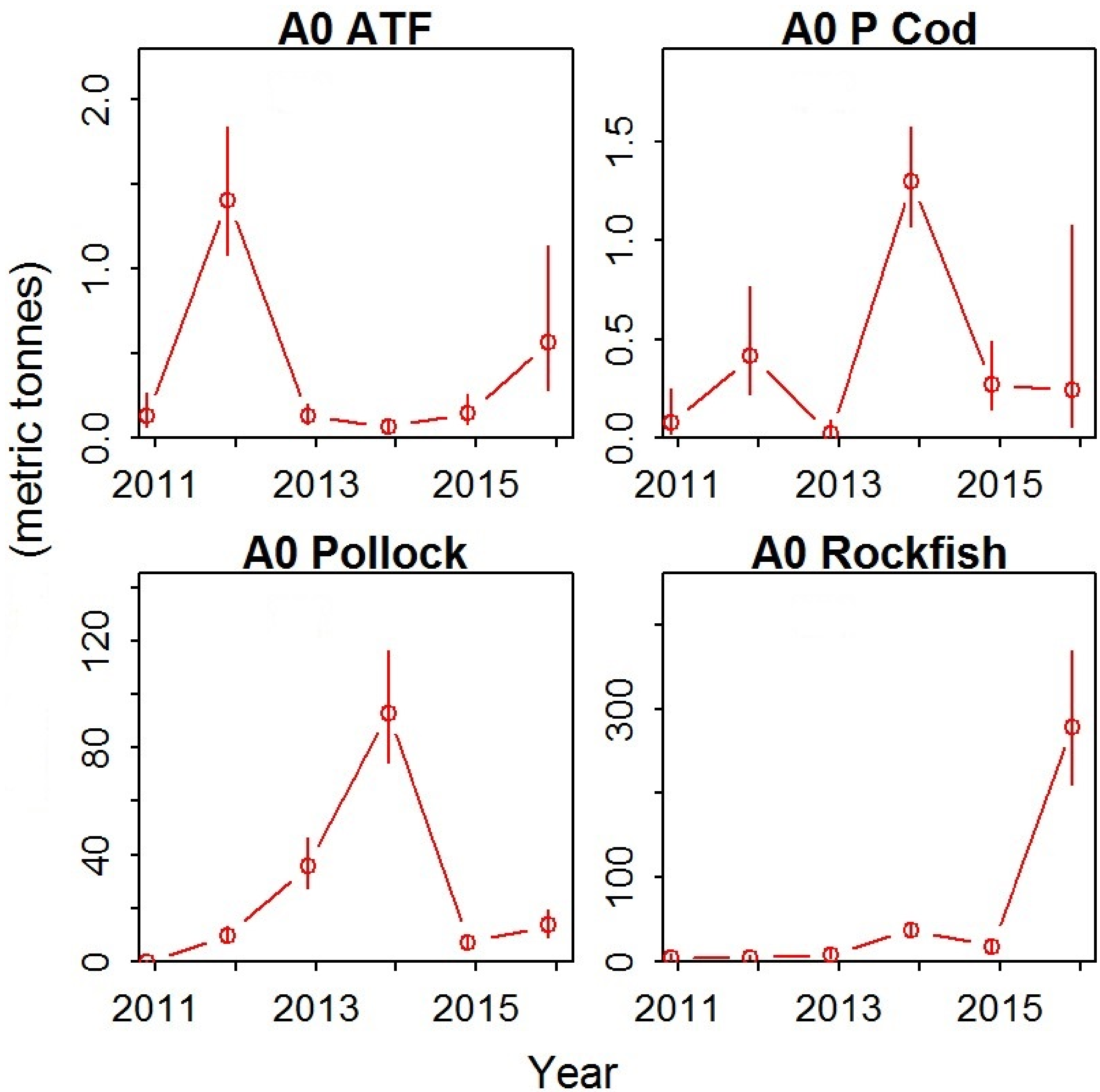

Figure 9. -- Index of biomass (estimated metric tonnes) ± 1 standard error for groundfish species in pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

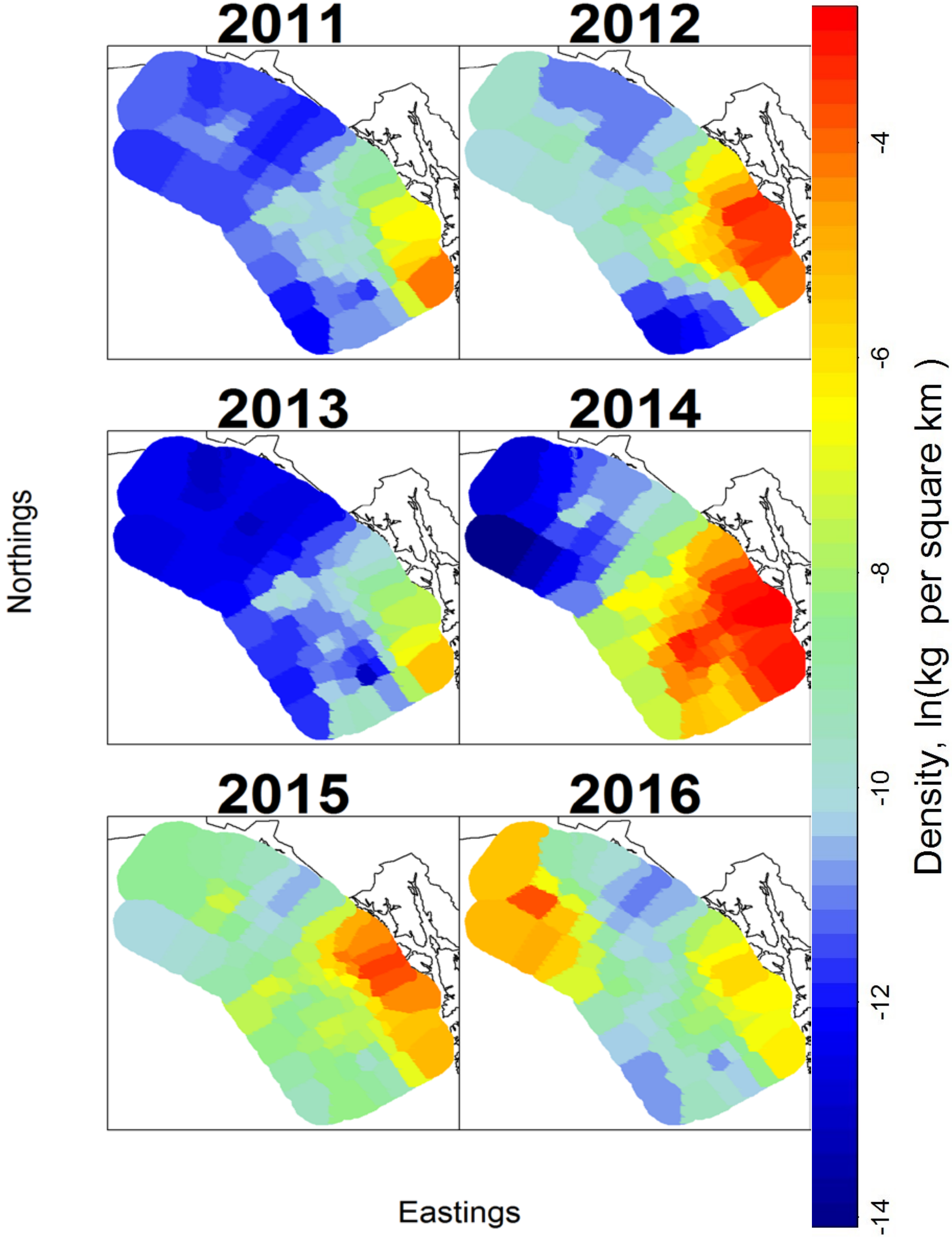

Figure 10. -- Predicted field densities of age-0 Pacific cod in pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

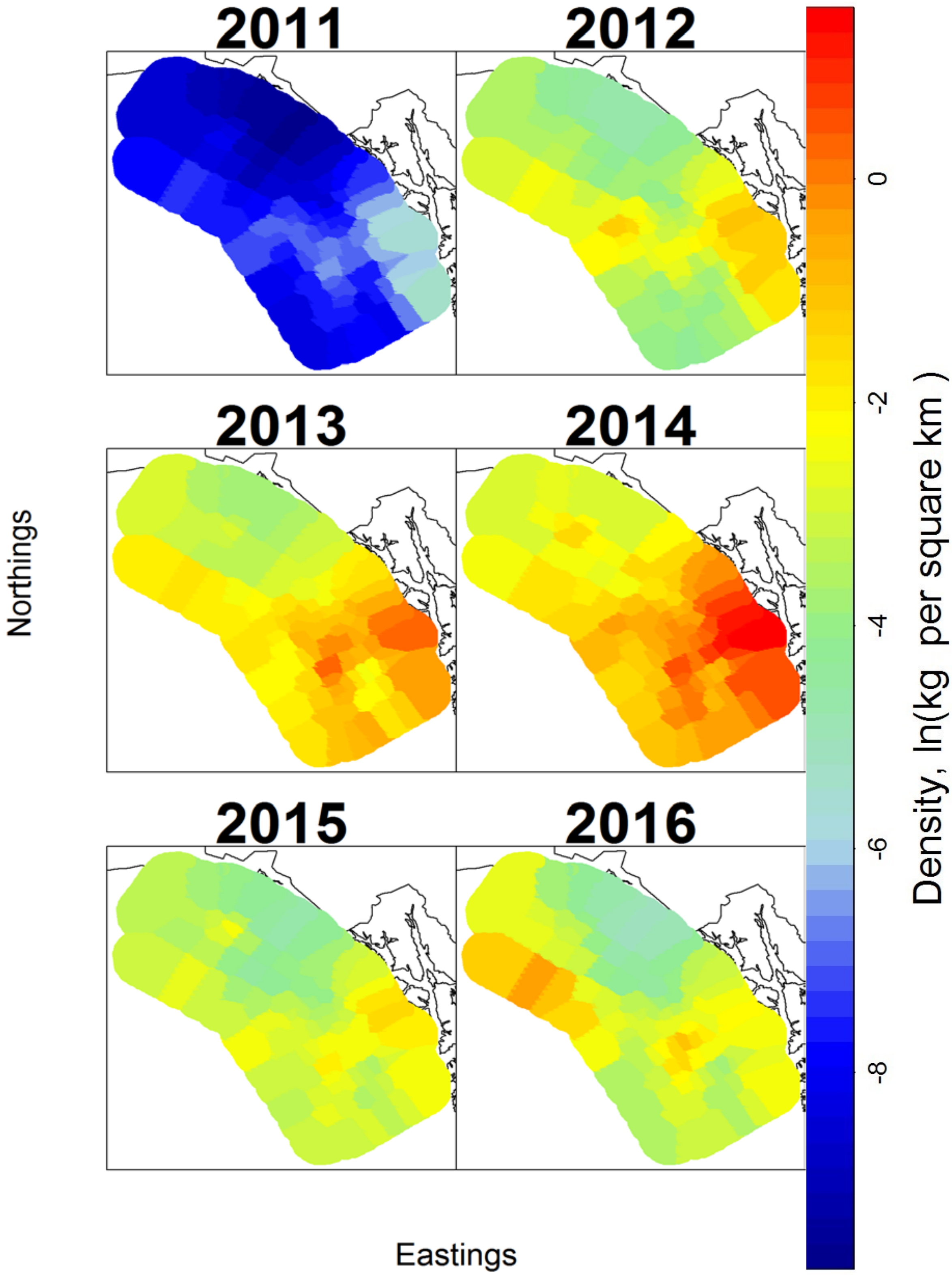

Figure 11. -- Predicted field densities of age-0 pollock in pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

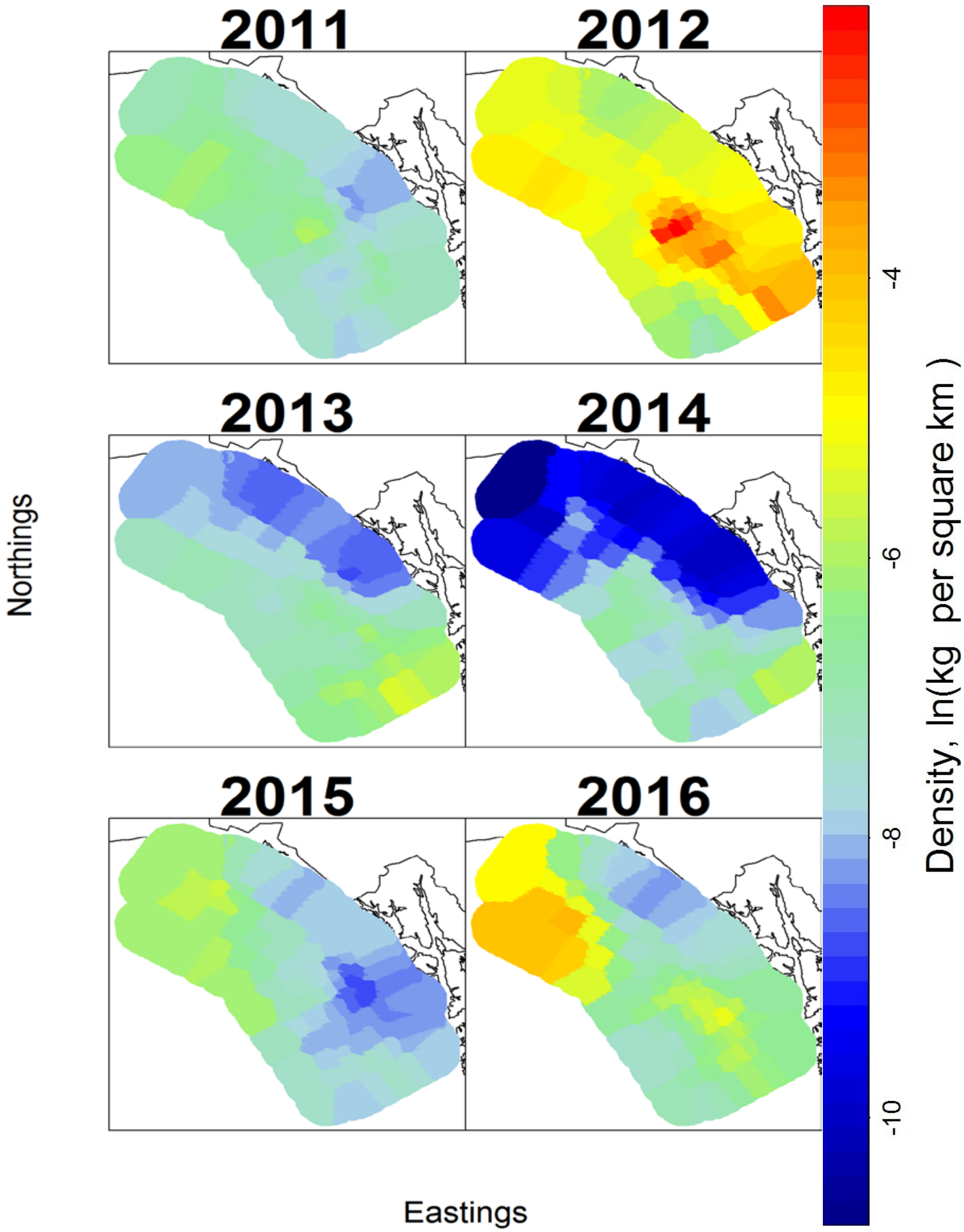

Figure 12. -- Predicted field densities of age-0 arrowtooth flounder in pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

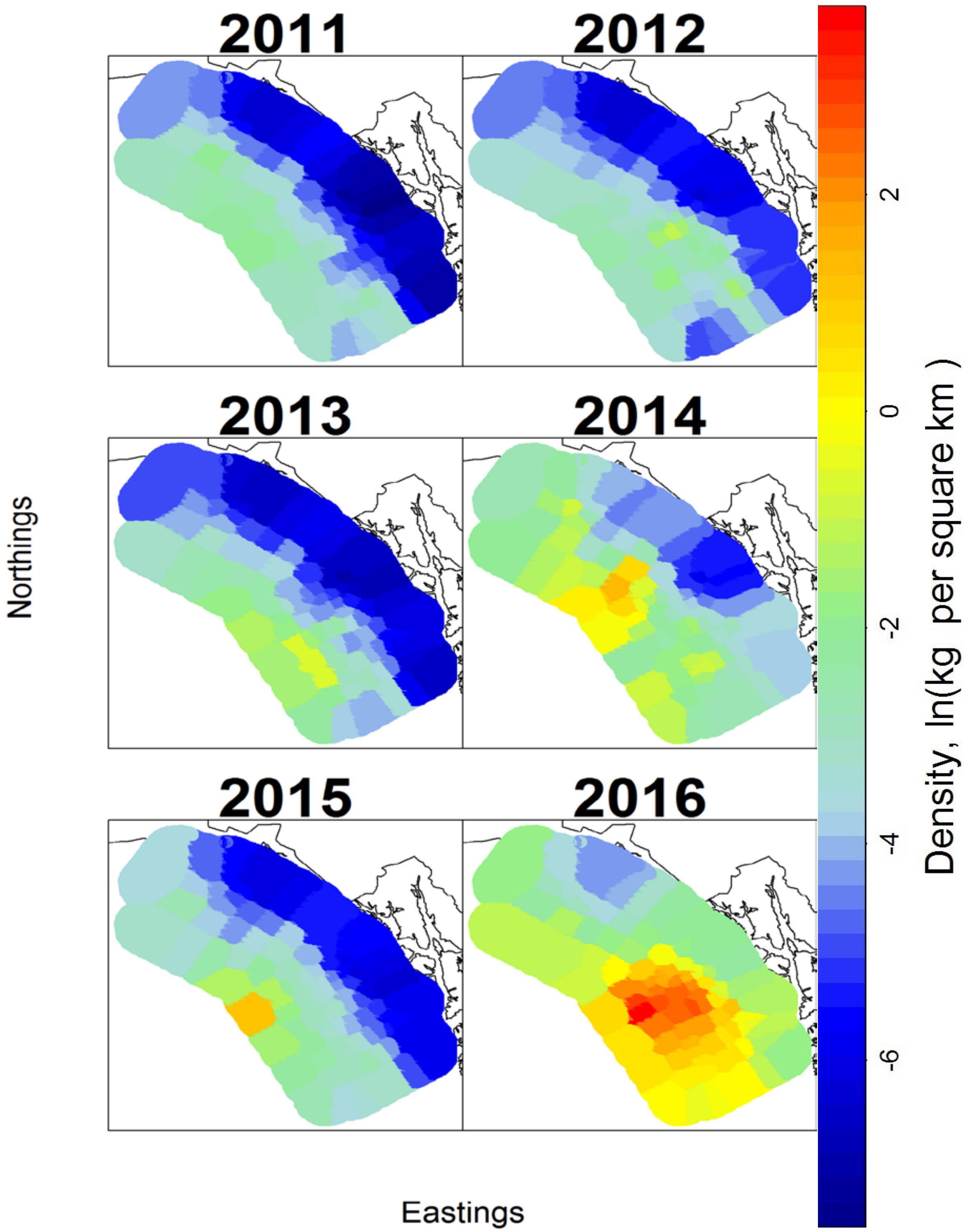

Figure 13. -- Predicted field densities of age-0 rockfish pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

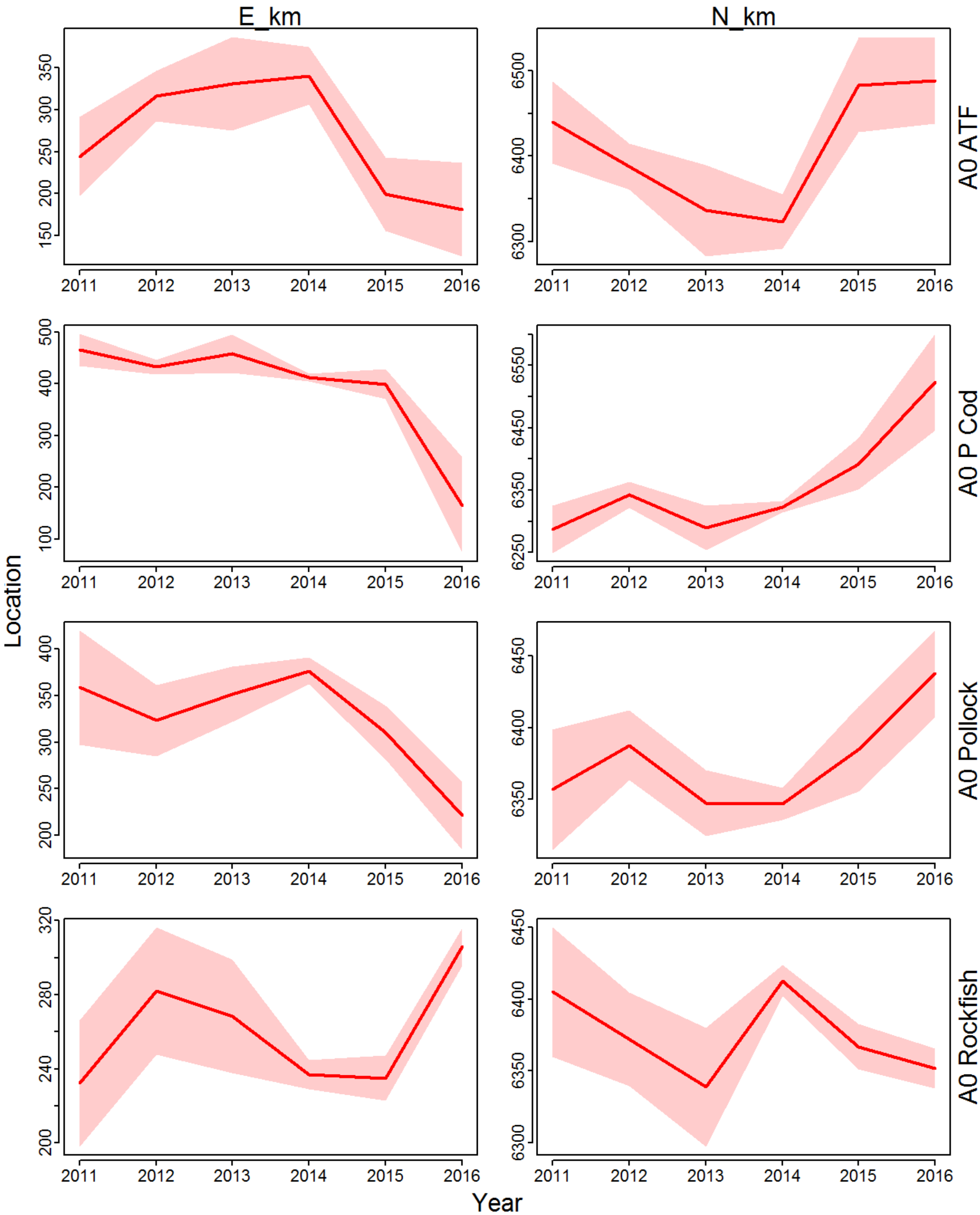

Figure 14. -- Center of gravity indicating temporal shifts in the mean east-to-west and north-to-south distribution ± 1 standard error in UTM (km) for age-0 groundfish in pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

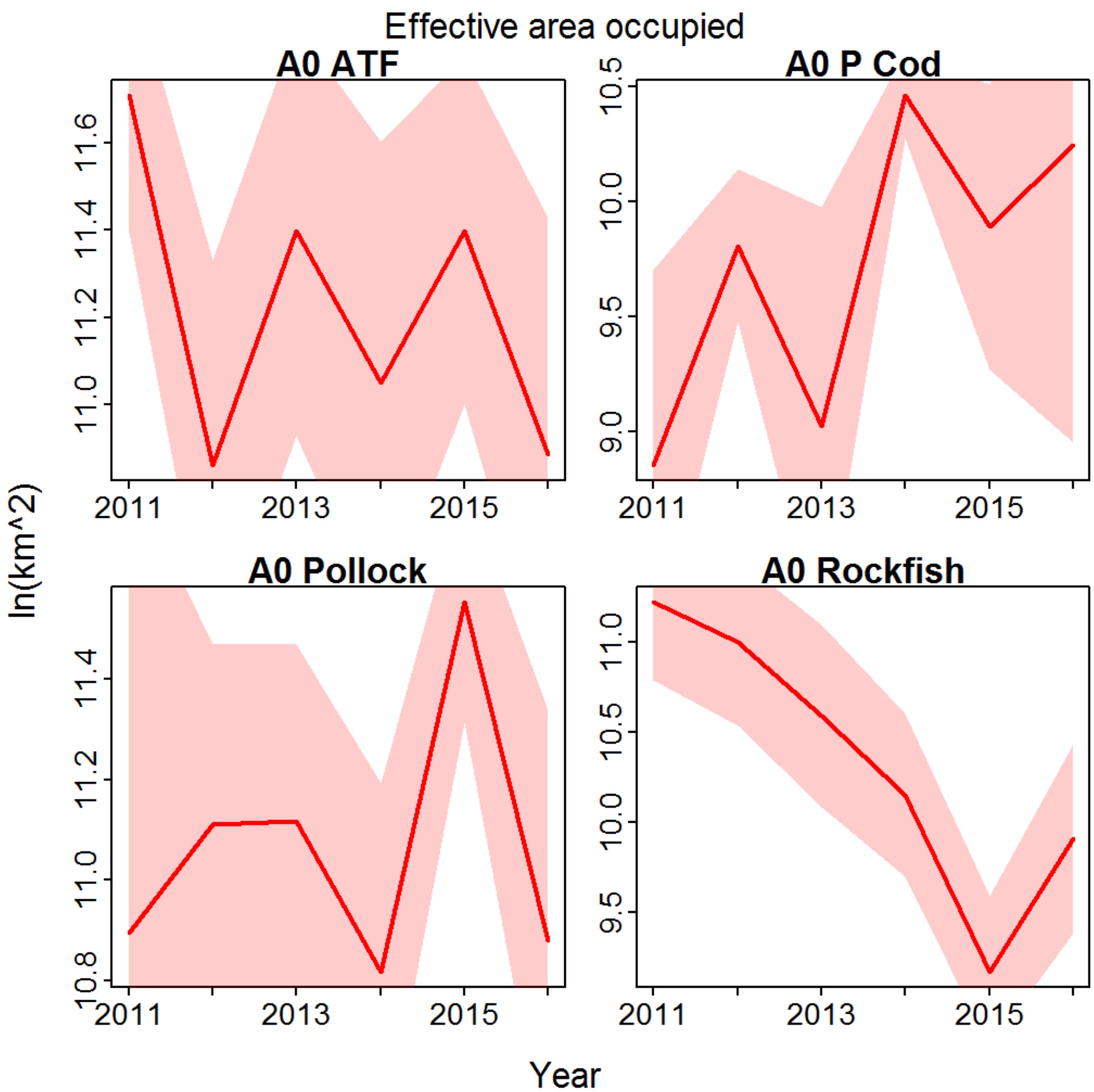

Figure 15. -- Effective area occupied (ln(km^2)) indicating range expansion/contraction ± 1 standard error for age-0 groundfish in pelagic waters of the eastern Gulf of Alaska during summer, 2011-16.

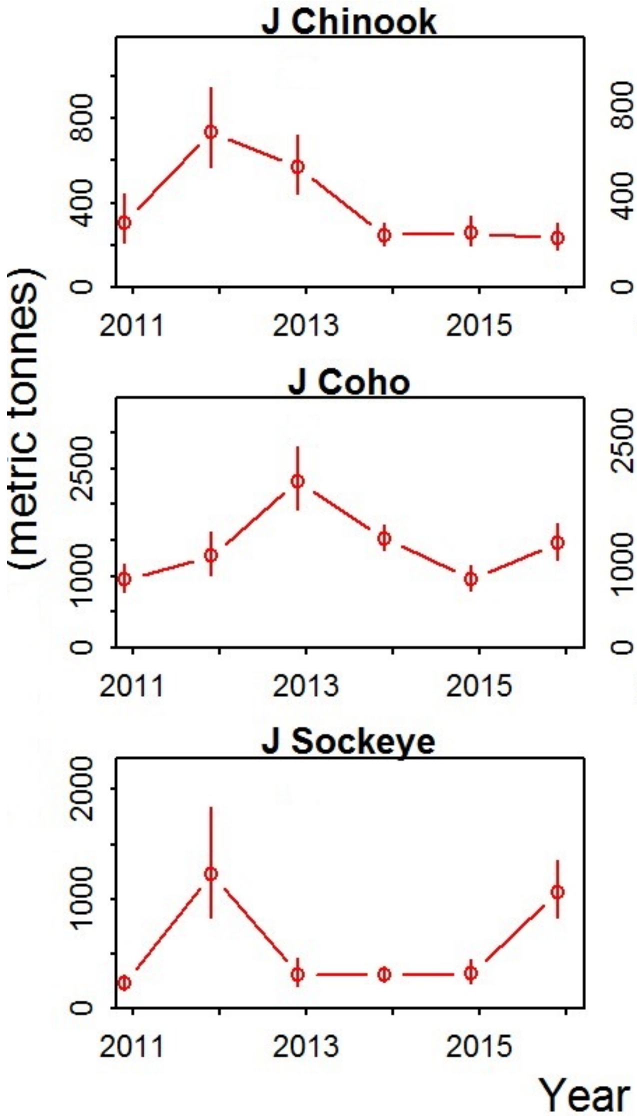

Figure 16. -- Index of biomass (estimated metric tonnes) ± 1 standard error for juvenile Pacific salmon in the eastern Gulf of Alaska during late summer, 2011-16.

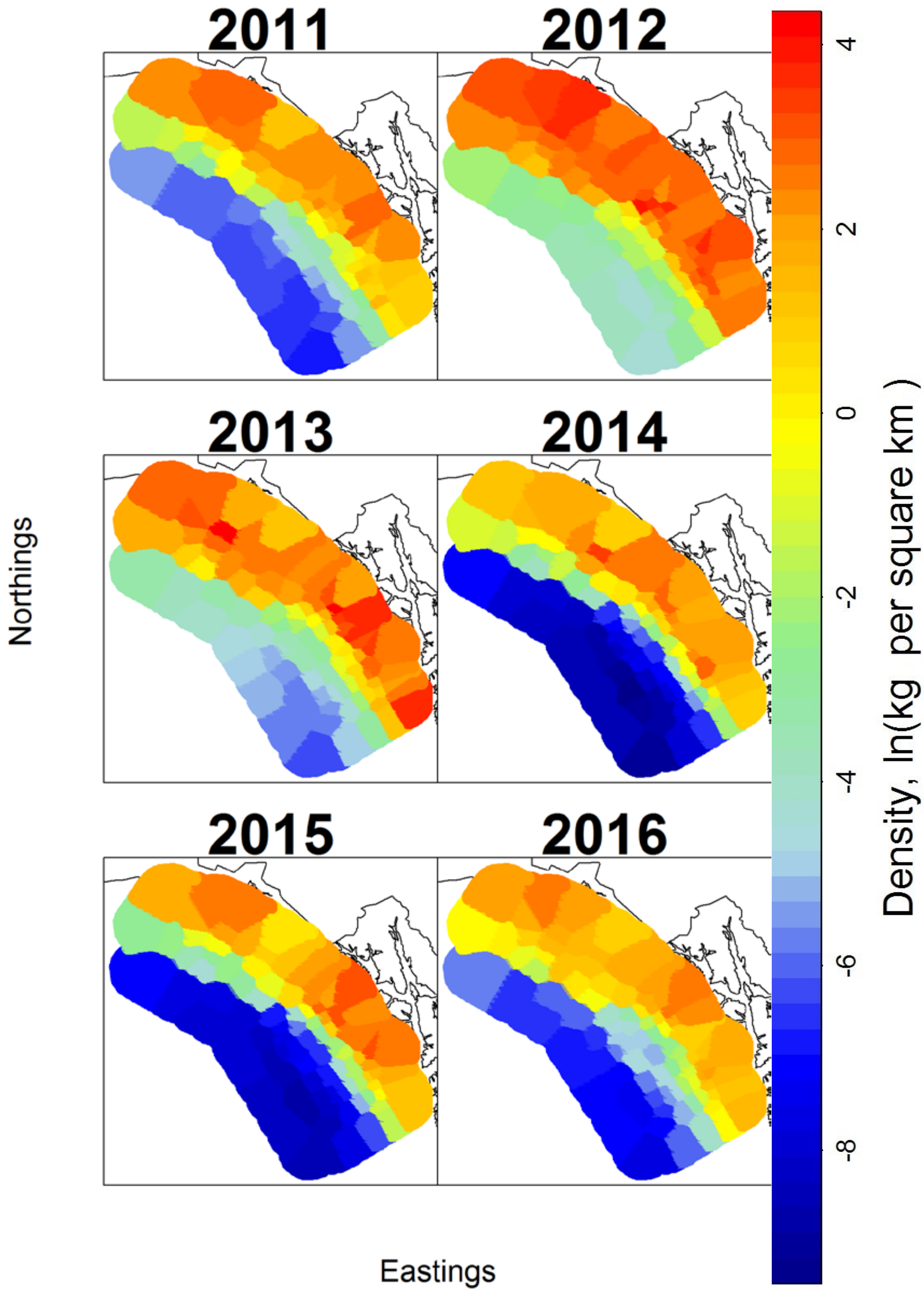

Figure 17. -- Predicted field densities of juvenile Chinook salmon in the eastern Gulf of Alaska during summer, 2011-16.

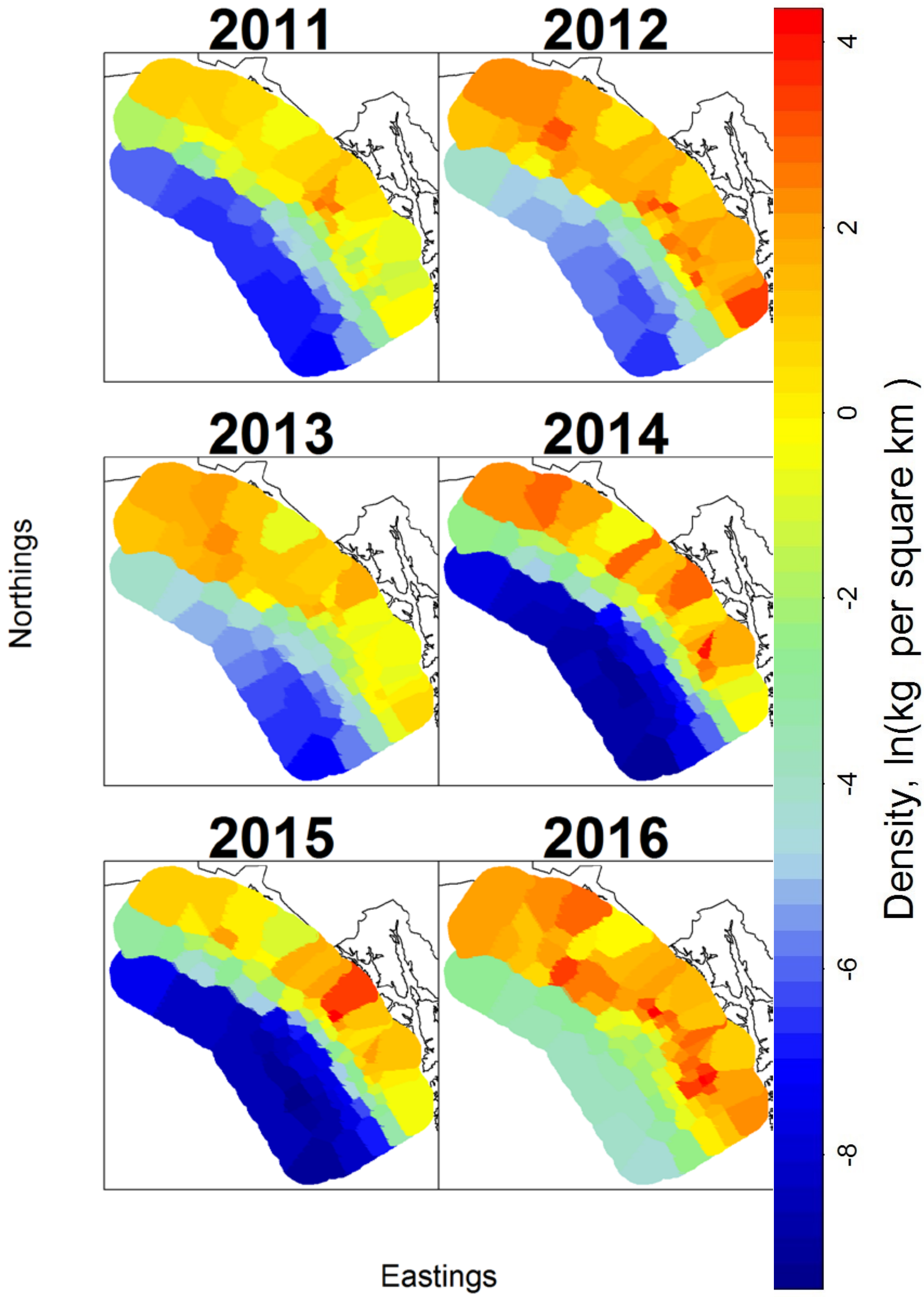

Figure 18. -- Predicted field densities of juvenile chum salmon in the eastern Gulf of Alaska during summer, 2011-16.

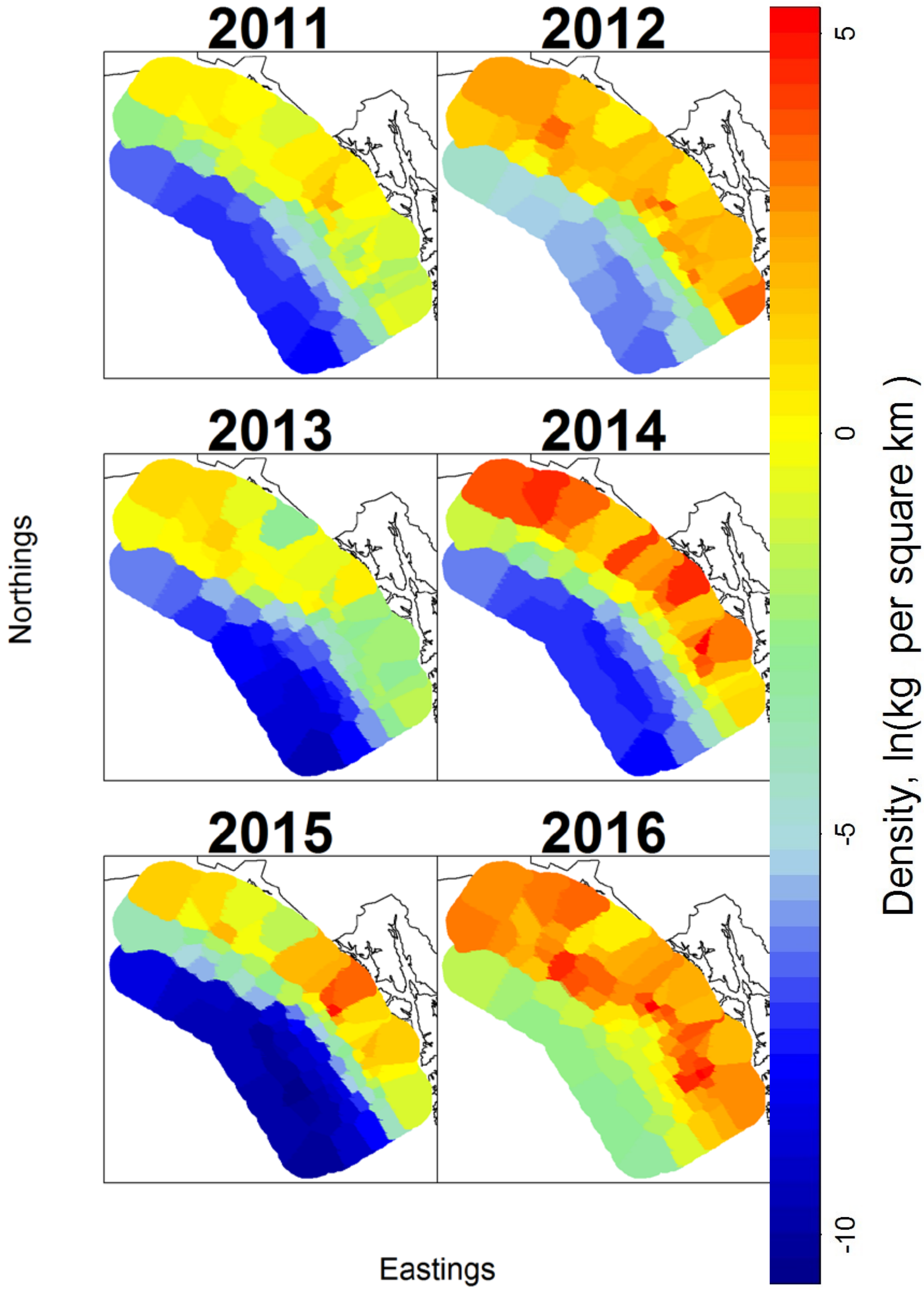

Figure 19. -- Predicted field densities of juvenile pink salmon in the eastern Gulf of Alaska during summer, 2011-16.

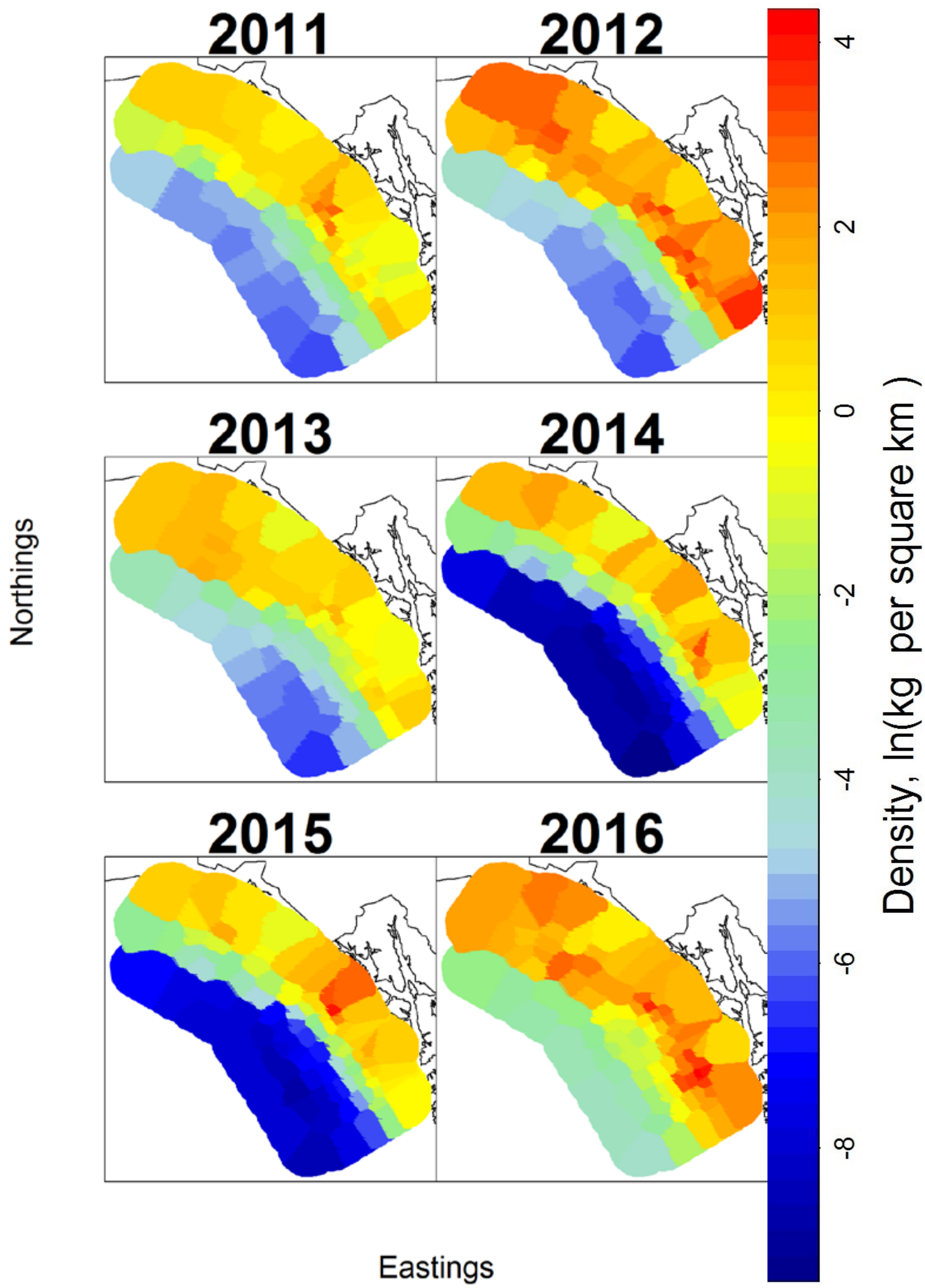

Figure 20. -- Predicted field densities of juvenile sockeye salmon in the eastern Gulf of Alaska during summer, 2011-16.

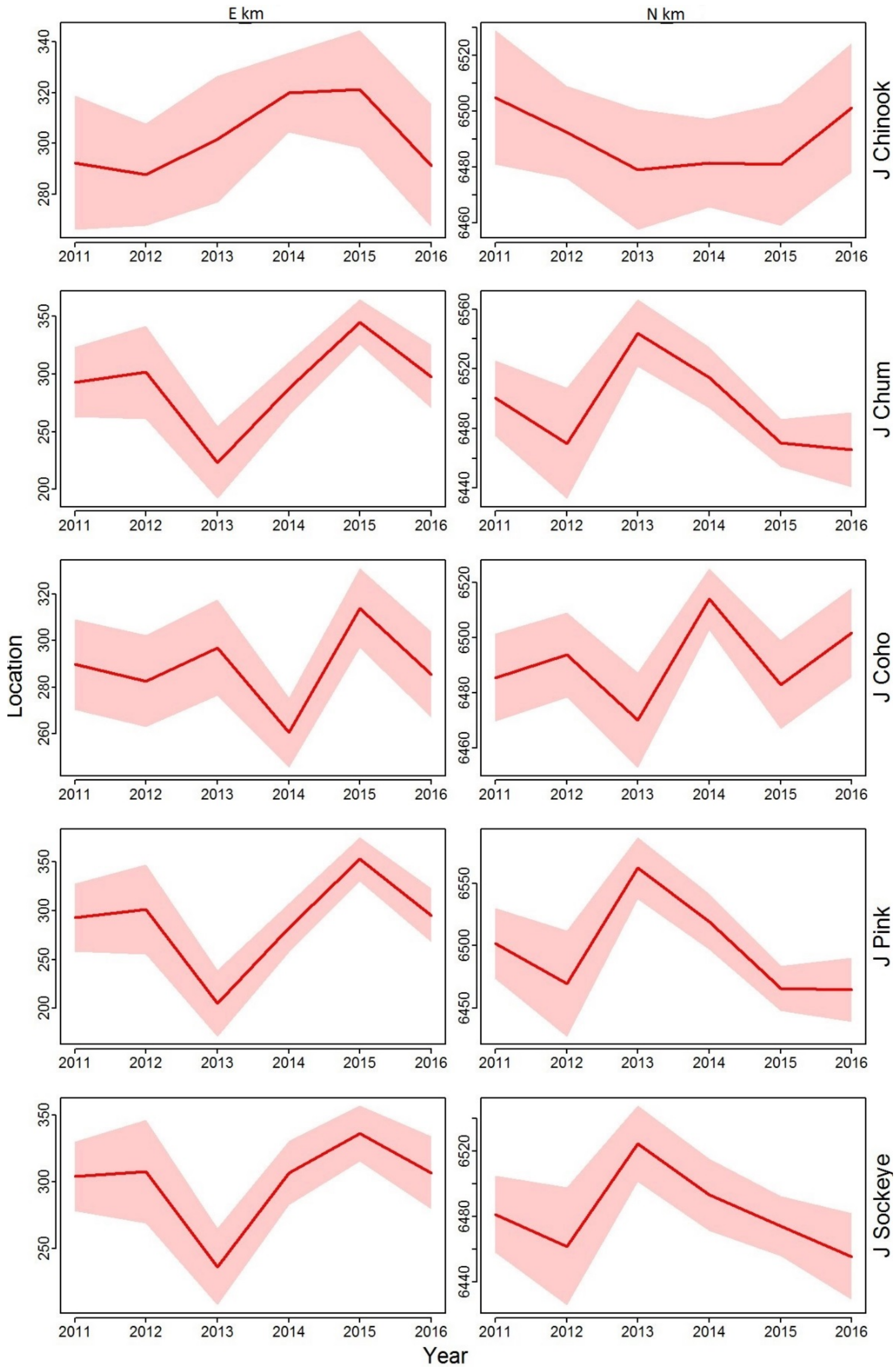

Figure 21. -- Center of gravity indicating temporal shifts in the mean east-to-west and north-to-south distribution ± 1 standard error in UTM (km) for juvenile Pacific salmon in the eastern Gulf of Alaska during summer, 2011-16.

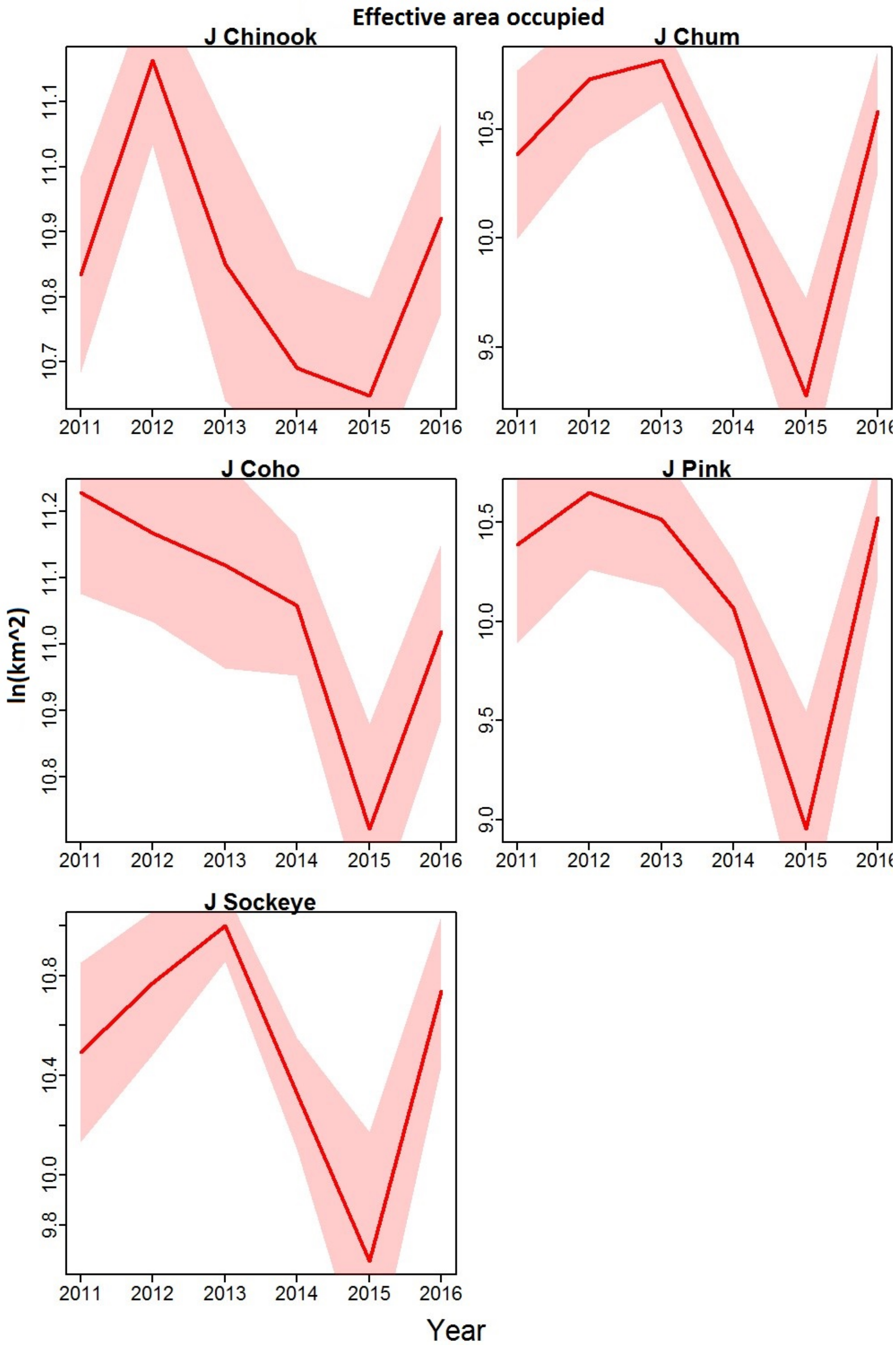

Figure 22. -- Effective area occupied ($\ln(km^2)$) indicating range expansion/contraction ± 1 standard error for juvenile Pacific salmon in the eastern Gulf of Alaska during summer, 2011-16.

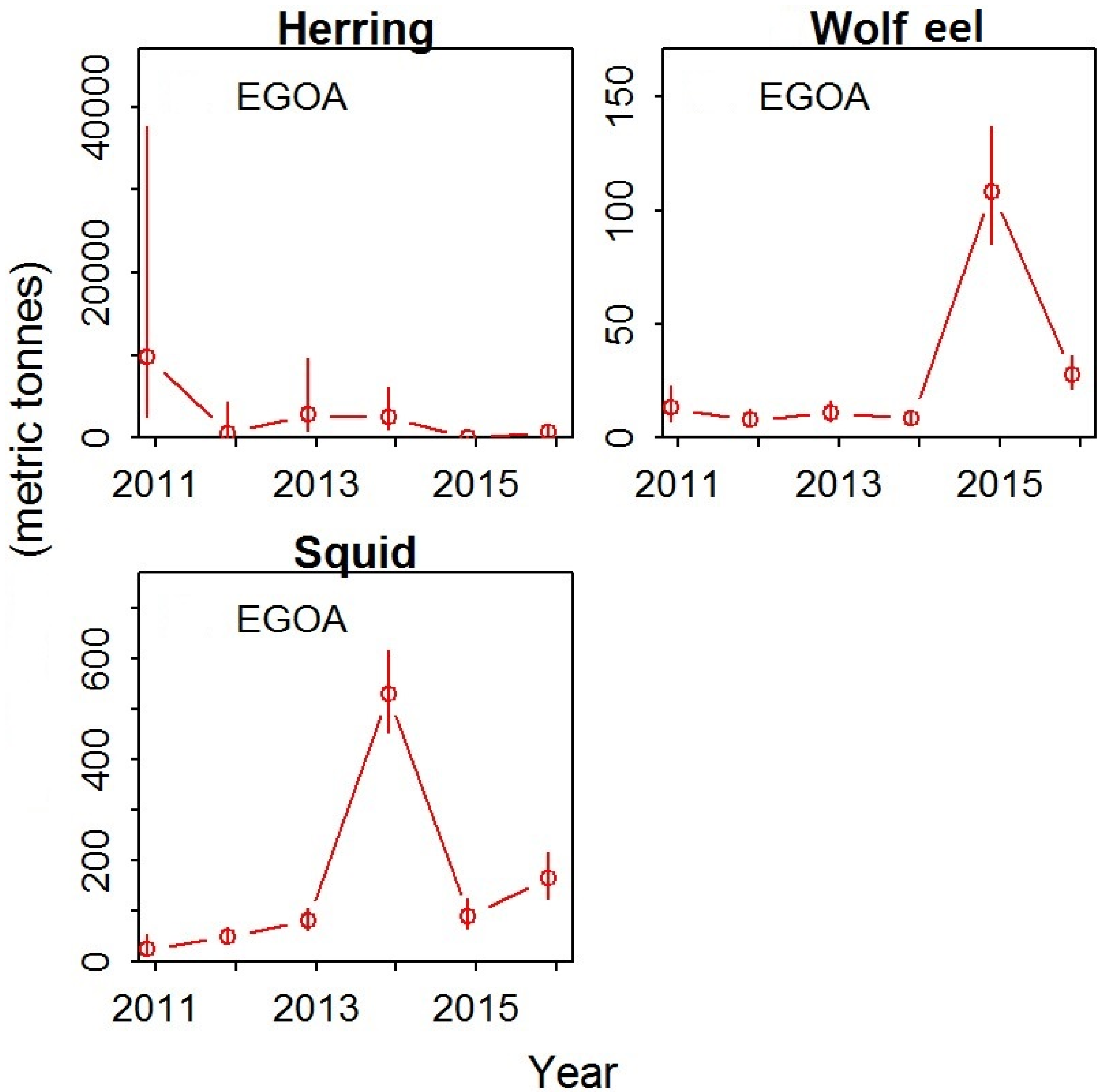

Figure 23. -- Index of biomass (estimated metric tonnes) ± 1 standard error for forage fish in the eastern Gulf of Alaska during late summer, 2011-16.

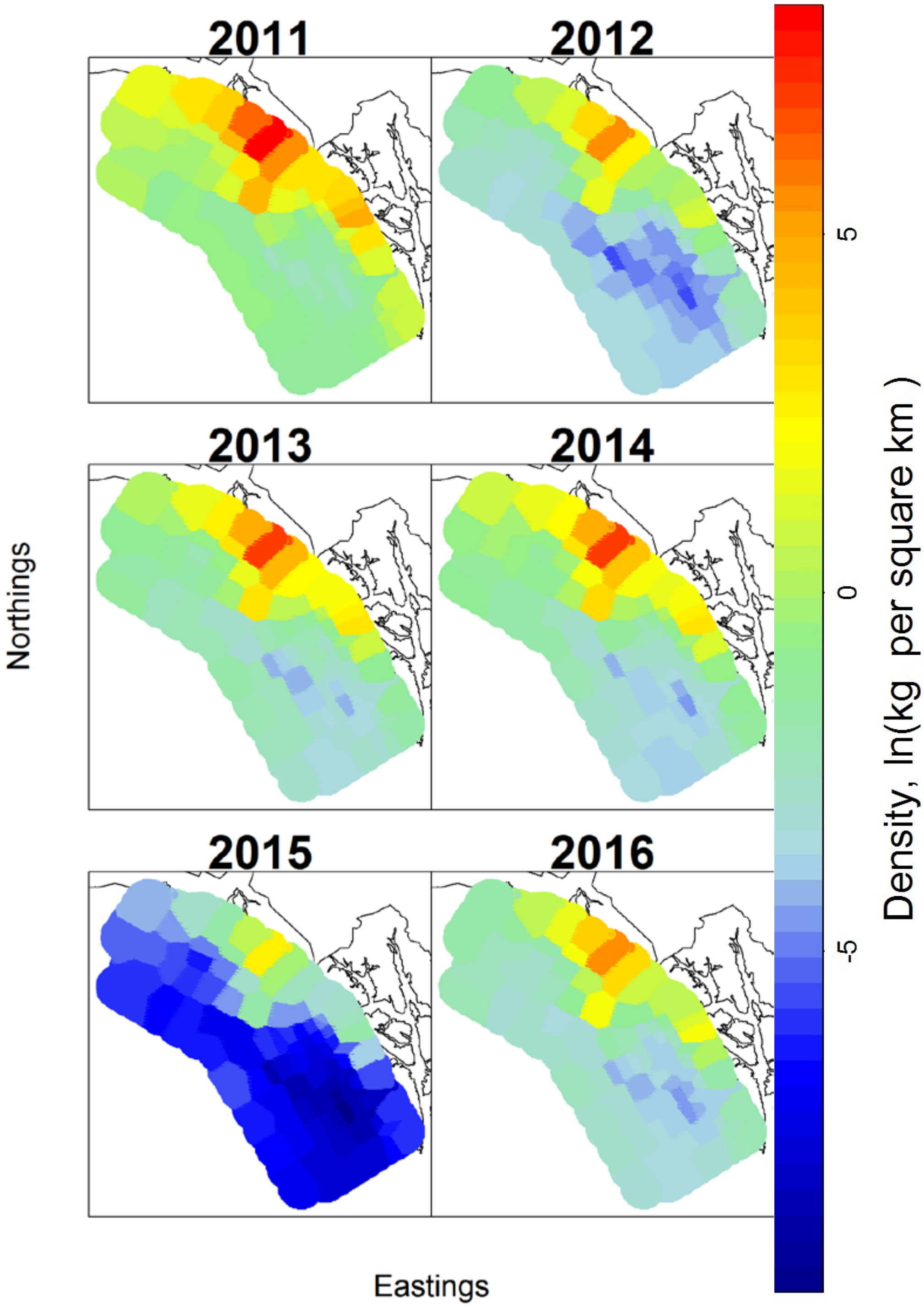

Figure 24. -- Predicted field densities of Pacific herring in the eastern Gulf of Alaska during summer, 2011-16.

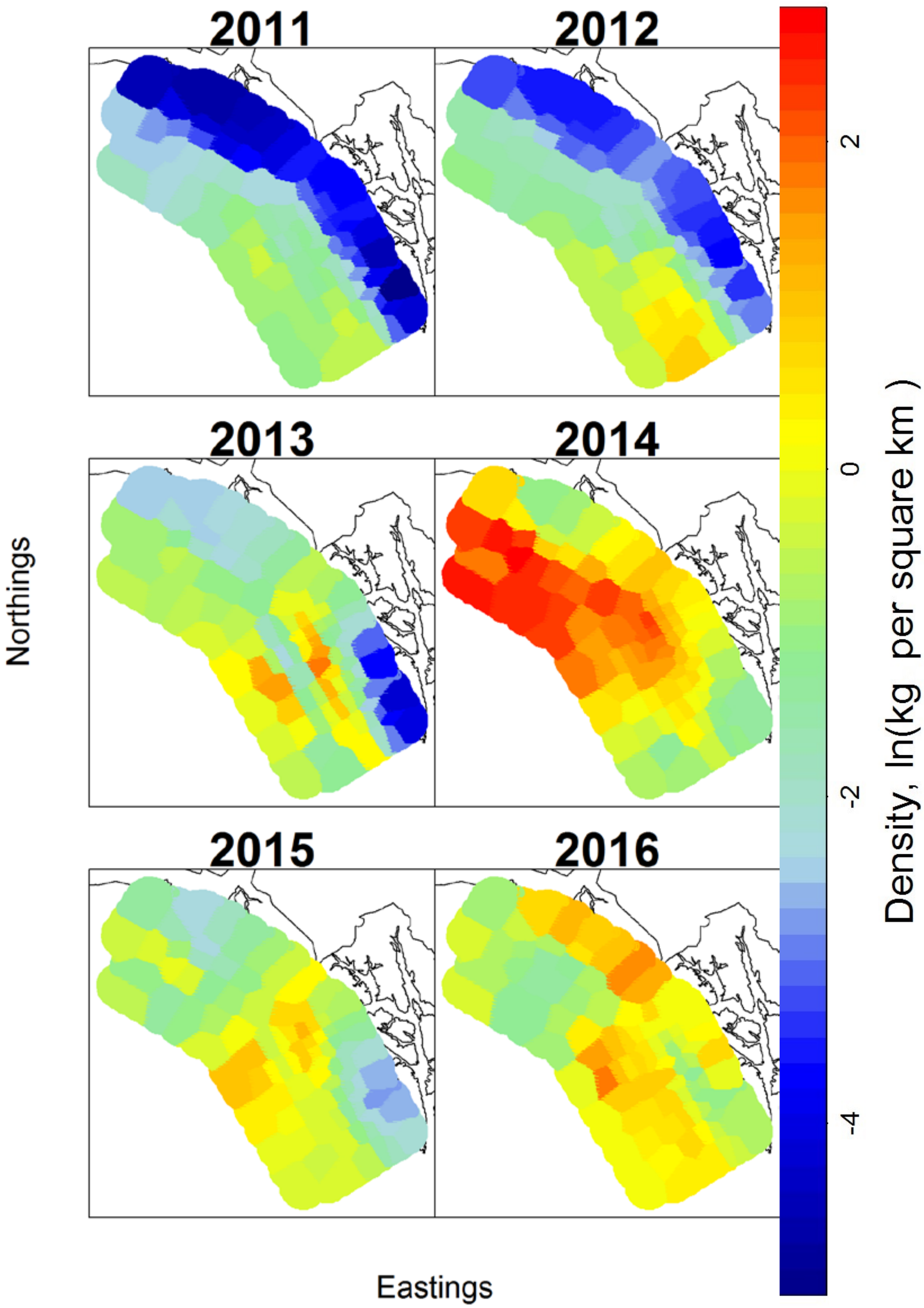

Figure 25. -- Predicted field densities of squid in the eastern Gulf of Alaska during summer, 2011-16.

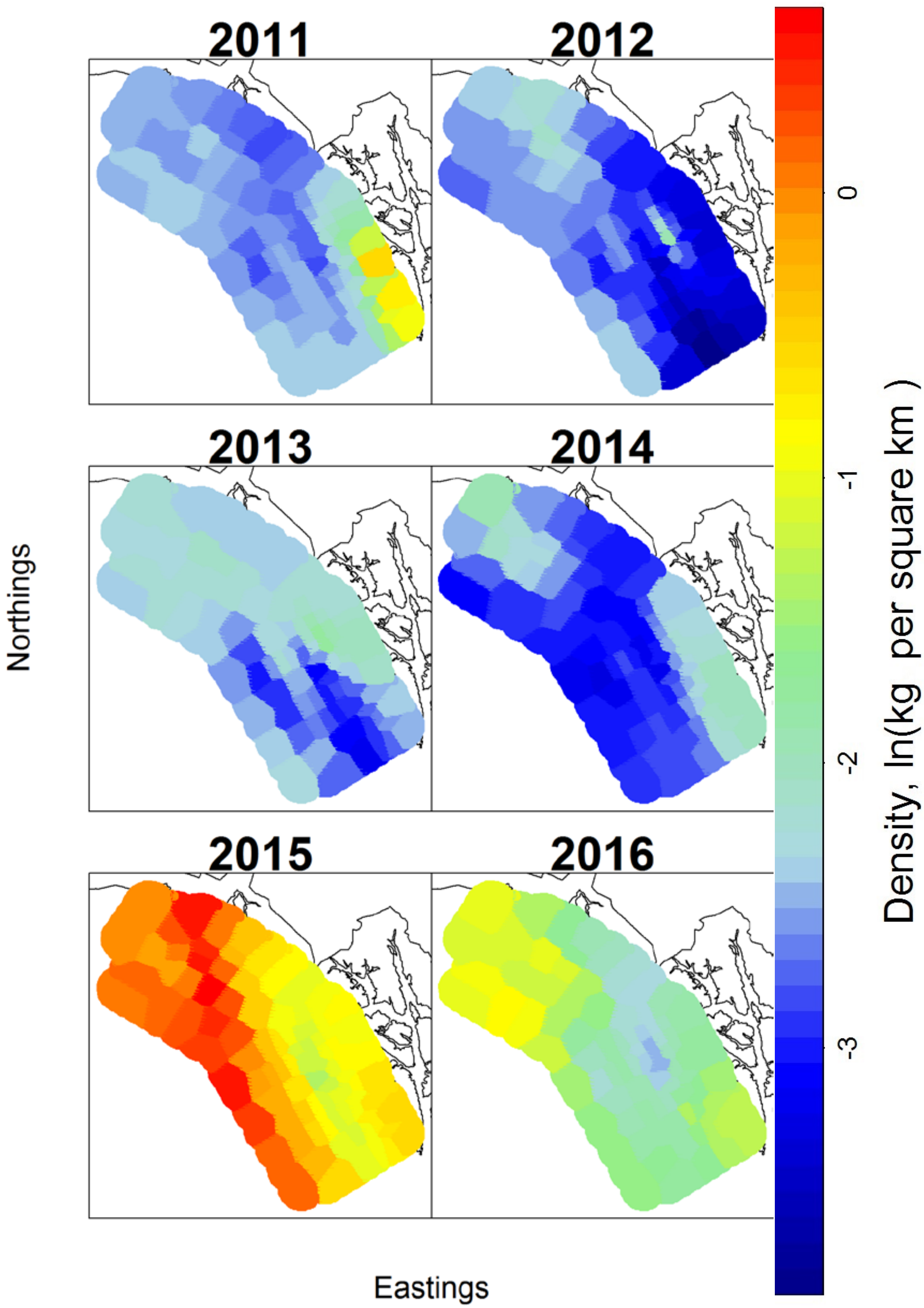

Figure 26. -- Predicted field densities of wolf eel in the eastern Gulf of Alaska during summer, 2011-16.

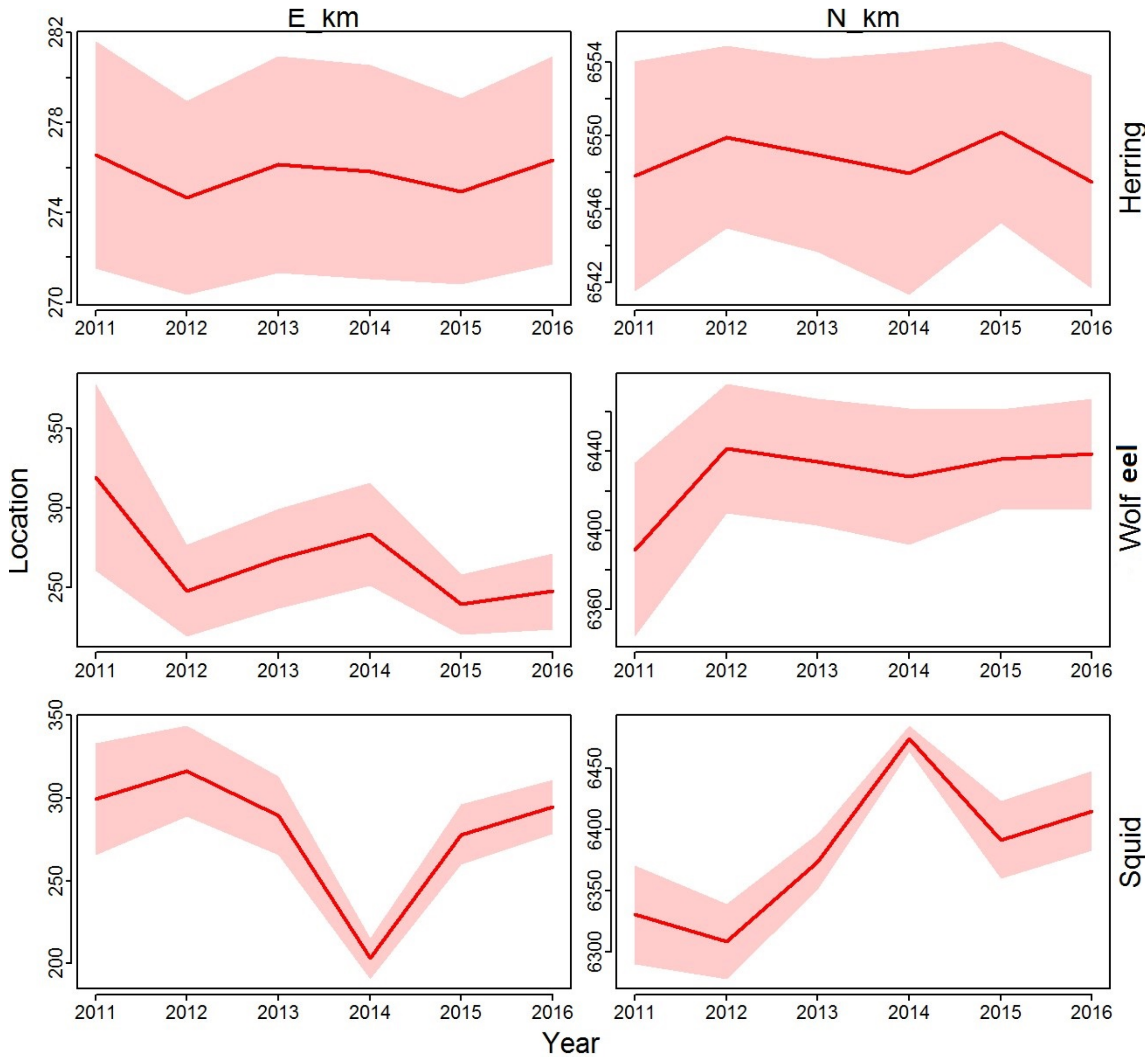

Figure 27. -- Center of gravity indicating temporal shifts in the mean east-to-west and north-to-south distribution ± 1 standard error in UTM (km) for forage fish in the eastern Gulf of Alaska during summer, 2011-16.

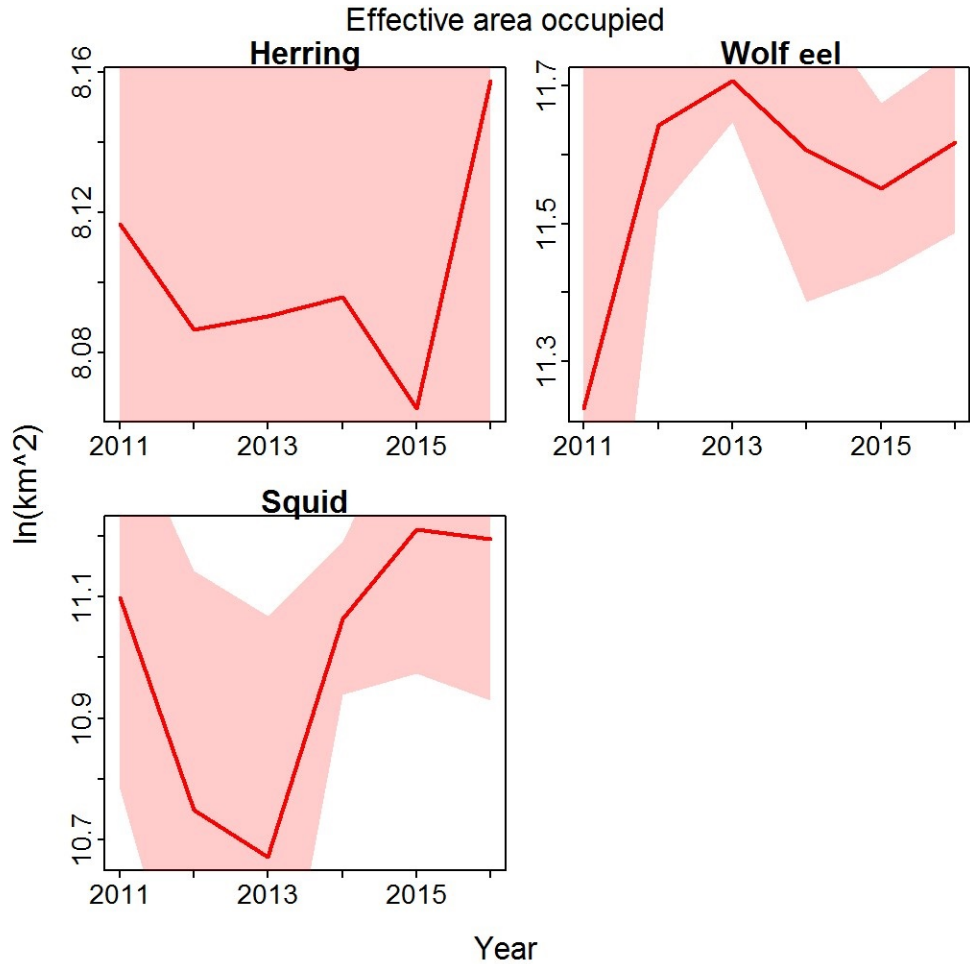

Figure 28. -- Effective area occupied ($\ln(km^2)$) indicating range expansion/contraction ± 1 standard error for forage fish in the eastern Gulf of Alaska during summer, 2011-16.

Appendix I. Itinerary

Date	Location/Activity
NW1602, Leg 1a	
July 2	GOA-Embark scientists and load gear at subport, Juneau, AK
July 3	Depart Juneau in the evening, transit to offshore grid via Cross Sound
July 4	Arrival and proceed to sample with grid stations
July 15	Port call Sitka, AK, supplies and shipping
NW1602, Leg 1b	
July 15	GOA-Depart Sitka in the evening, transit to offshore grid
July 16	Arrival and proceed to sample with grid stations
July 24	Port call Juneau, unload
NW1604	
August 3	GOA-Embark scientists and load gear at subport, Juneau, AK
August 4	Depart Juneau in the evening, transit to offshore grid via Cross Sound
August 5	Arrival and proceed to sample with grid stations, Live Box and Gillnet
August 11	Port call Sitka, AK, supplies and shipping
NW1605	
August 11	GOA-Depart Sitka in the evening, transit to offshore grid
August 12	Arrival and sampling, extended age-0 rockfish grid 100+ miles offshore
August 20	Port call Juneau, unload

Appendix II. Scientific Personnel

FV *Northwest Explorer* **EGOA**

Leg	**Name**	**Affiliation**
NW1602, 1a	Wesley Strasburger[1]	AFSC/ABL
	Alex Andrews	AFSC/ABL
	Kevin Siwicke	AFSC/ABL
	Dave Nicolls	AFSC/ABL
	Andrew Diamond	AFSC/ABL
	Jared Weems	UAF
NW1602, 1b	Wesley Strasburger[1]	AFSC/ABL
	James Murphy	AFSC/ABL
	Kevin Siwicke	AFSC/ABL
	Jamal Moss	AFSC/ABL
	Brian Beckman	NWFSC
	Jared Weems	UAF
NW1604	Wesley Strasburger[1]	AFSC/ABL
	Jamal Moss	AFSC/ABL
	Kristin Cieciel	AFSC/ABL
NW1605	Wesley Strasburger[1]	AFSC/ABL
	James Murphy	AFSC/ABL
	Kevin Siwicke	AFSC/ABL
	Dave Nicolls	AFSC/ABL

1 -- Chief Scientist

AFSC -- Alaska Fisheries Science Center

ABL -- Auke Bay Laboratories

NWFSC -- Northwest Fisheries Science Center

UAF -- University of Alaska Fairbanks

Appendix III. Sample Requests

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: 2016 Gulf Survey - Fish Energetics

Principle Investigator (PI)/Point of Contact: Ron Heintz

AFSC Point of Contact: Ron Heintz

Affiliation: AFSC/RECA

Address: 17109 Pt Lena Loop Rd

Email: Ron.Heintz@noaa.gov

Phone: 907-789-6058

General Description and Objectives:

Obtain energy density estimates for age-0 Walleye Pollock, Pacific Cod, Arrowtooth Flounder, Sablefish, Saffron Cod, juvenile Chinook and Chum Salmon, Capelin, and Herring.

The below table lists the trawl types that samples are requested from:

Species	Surface	Gillnet
Age-0 Walleye Pollock	X	X
Age-0 Pacific Cod	X	X
Arrowtooth Flounder	X	
Sablefish	X	X
Juvenile Chinook	X	X
Juvenile Chum	X	X
Age-0 Sebastes	X	X

Collection Protocol:

Collection procedures:

Collect up to 5 fish (12 rockfish) of each species 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.

Select fish close to the overall mean length (for each species) observed at that station.

Data request:

Sample collection information: station location (Latitude, Longitude), gear type (surface,

trawl, gillnet), collection date, species, length (mm; SL), and catch.

List of supplies:

Bags and labels. CLAMS barcodes will be assigned on-board.

Hazardous materials: N/A

Shipping:

Ron Heintz

NOAA Fisheries / Auke Bay Laboratories

17109 Pt. Lena Loop Rd.

Juneau, AK 99801

Permits (if applicable): NA

Project Title: Using stable isotopes to analyze diet of depredating male sperm whales in the Gulf of Alaska.

Principle Investigator: Jan Straley; PhD student 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 large marine mammals can be determined using stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope ratios from skin samples, providing insight into their diet. 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. Since 2003, the Southeast Alaska Sperm Whale Avoidance Project (SEASWAP) has been opportunistically collecting tissue sample biopsies (n=25) of male sperm whales involved in depredation in the eastern Gulf of Alaska. Additional samples will be collected in 2016 by SEASWAP. PhD student Lauren Wild (UAF SFOS) will be analyzing these samples for variation in diet between individuals and among seasons. Additionally, we hope to use stable isotope mixing models (SIAR package in R) to assess contribution of sablefish and other potential prey items to their diet. Potential prey items will be collected both from commercial longline fishermen, and the AFSC annual Sablefish Survey in the GOA in 2016, including sablefish, squid, grenadier, rockfish, and halibut. Primary consumers for baseline ratios are needed 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) Determine if some sperm whales preferentially target sablefish and 3) Identify if seasonal variations exist in sperm whale diets related to the commercial longline fishing season. These objectives will be met through a combination of collection of tissue samples of whales 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 will proceed with the GOA Assessment Survey in 2016 and 2017.

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

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

Collaborators:

PI Jan Straley, University of Alaska Southeast (UAS)

Co-PI Russ Andrews, University of Alaska Fairbanks (UAF) and the Alaska SeaLife Center.

Co-Investigator Brianna Witteveen, UAF

UAF PhD student 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 would like samples collected at stations corresponding to continental slope waters, including:

E, G, and I: 0, 10, and 20;

K: 10, 20, 30;

L: 20, 30;

M: 30;

Q R A C: 40, 50;

E F G: 40

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 calenoid copepods to subsample for stable isotopes.

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. 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

Address shipment to:

Jan Straley & Lauren Wild

University of Alaska Southeast Sitka Campus

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

<u>For all trawl catches:</u>

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: Juvenile salmon prey field investigation

Principle Investigator (PI)/Point of Contact: Emily Fergusson

AFSC Point of Contact: Emily Fergusson

Affiliation: NOAA / ABL / RECA

Address: 17109 Pt Lena Loop Road

Email: emily.fergusson@noaa.gov

Phone: 789-6613

General Description and Objectives:

Collect & preserve (5% formalin-seawater solution) 333µm sample from bongo tow. Collect and freeze (-80 freezer) individual zooplankton for lipid analysis.

Collection Protocol:

Preserved plankton samples:

1. Collection procedures: Save in 500 or 1000 ml plastic Nalgene bottles, label with station name and collection date.

Data request: Station Data

List of supplies: N/A

Hazardous materials: N/A

<u>Frozen plankton samples:</u>

1. Collection procedures: We are requesting zooplankton samples for lipid analysis. We would like individual samples sorted by species if possible. If time/technician limited, we would like composite samples collected following the above protocol. For individual samples, we are providing you with prepared vials. These vials contain a foil well that is unique to each vial and should not be intermixed (they are pre-weighed).

Below is a list of the desired taxa. Each vial will contain a unique taxa (including stage/sex or size fraction), the number of individuals per vial is noted below. We would like 3 replicate vials for each taxa.

Place indicated number of samples in well in labeled vial.

Note species on provided datasheet, if possible not stage.

Carefully dab sample with kim-wipe to remove excess water.

Immediately place vials in provided, labeled vial box in -80.

Complete station information section of datasheet.

Desired taxa:

Large copepod:

Calanus marshallae CV (5 per vial)

Calanus marshallae CVI female (5 per vial)

Neocalanus cristatus CV (5 per vial)

Neocalanus cristatus CVI female (5 per vial)

Small copepod:

Pseudocalanus sp. CV (10 per vial)

Pseudocalanus sp. CVI female (10 per vial)

Euphausiid:

Furcilia (10 per vial)

E. pacifica 10-15 mm (2 per vial)

E. pacifica 15-20 mm (1 per vial)

Thysanoessa raschii 10-15 mm (2 per vial)

Thysanoessa raschii 15-20 mm (1 per vial)

Chaetognath:

Sagitta sp. 5-20mm (10 per vial) (please make sure they don't have any visible copepods in their gut.

Pteropods:

Clione limacina (3 per vial)

Limacina helicina 2-5 mm diameter (3-5 per vial)

Data request: Station Data

List of supplies:

labeled vials with pre-weighed aluminum well

vial box for sample storage in freezer

datasheets for zooplankton lipid samples

Hazardous materials: N/A

Shipping: N/A

Permits (if applicable): Covered under AFSC & ADF&G collection permits.

Appendix IV. Survey Protocols

EGOA Trawl Sampling Protocol 2016

This guide is for all fish caught in the Trawl

Separate entire catch by species

All fish bio-data is recorded in CLAMS or on one of three deck sheets

-Focal Fish

-Juvenile Salmon

-Trawl Catch

Focal species (Age-0): Collection n=

Arrowtooth flounder	5
Pacific cod	5
Sablefish	5
Sebastes spp. (POP type)	50
Walleye pollock	5
Pacific herring	≤50

On Focal Fish sheet:

Record station #, station name (bag ID), date, species, length and weight and assign barcode

If individual weight is unattainable, record bulk weight

Bag each fish individually with a barcode

Bag all fish by species and place within one bag labeled with station #, species, PI, and station name

Store in -40 freezer as space permits, else -20

On Trawl Catch Sheet:

Record weight and lengths for a total n=50 for each species

Count all remaining fish of each species and collect bulk weight

If catch is large and mixed, sub-sampling is acceptable

Juvenile Salmon:

In CLAMS or on Juvenile Salmon sheet:

First 2 individuals of each species are “Bombers” and are bagged individually with salmon barcodes

Place bombers in one bag with station # and station name. Store in species “Bomber” bag in chest freezer

Diets of next 10 fish will be done onboard

Store in species bulk bag in chest freezer

Record weight and lengths remaining fish until total n=50 for each species

Count all remaining fish of each species and collect bulk weight

Chinook Salmon: Wand all for cwt, caudal fin clip all place into pre-labeled vials with ethanol, barcode all juvenile Chinook, retain 5 additional salmon, individually bagged with #’s

Coho Salmon: Wand all for cwt, retain 5 additional salmon, individually bagged with #s

Sockeye Salmon: Retain 18 paired heads and tails individually bagged with #s. keep an additional 2 fish whole individually bagged with #’s

Chum and Pink Salmon: keep 2 individuals individually bagged with #s

Trawl Catch:

Record lengths and weights of the first 50 individuals of all species of fish caught in the trawl.

Count all remaining fish of each species and collect bulk weight.

Immature/Mature Salmon:

Remove stomachs from up 10 adult salmon.

Bag by species, label with station # and station name.

Store in chest freezer by species

Chinook

Keep snouts of any clipped fish, individually bagged with #’s

2016 Oceanography sampling summary F/V Northwest Explorer

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

CTD Operations

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

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

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).

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).

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

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

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	GFF/ >10 Duplicates 1/day
0	X		X			
10	X	X	X	X (OR) ↓	X OR ↓	
20	X		X		X OR ↑	
30	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)				** for Phyto preservation and Lipid collection, collect at depth nearest Chl max		

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!

Salinity (Every other day, alternate surface then deep)

Write salinity bottle number in oceanography log 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.)

Parafilm top

Place back in wooden box, upright.

Chlorophyll (Every Station, 0-60m)

Collect chlorophyll samples (filled to overflowing) according to detailed protocol,l in 250ml brown bottles.

Filter samples through appropriate filter sizes (GFF or >10)

Label cryovials accordingly with depth, survey, filter, etc..

Freeze vials in a labeled cryovial box (label top with starting and ending stations) in supercold freezer.

**No chlorophyll samples collected below 60m!

Replicates 1/day

Blanks every other day

Nutrients (Every Station)

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)

Fill to shoulder, leaving some air space at the top to prevent breaking during freezing.

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)

Store upright in supercold in boxes, or metal racks.

Phytoplankton Preservation

At designated stations (see protocol) collect phytoplankton ID sample at the depth closest to the chlorophyll a maximum.

For Phytoplankton, fill jar ~ 2/3 full with water, and fix with 5 ml of buffer and 12.5 ml of formalin.

Lipid Collection

At designated stations collect 2 L of water (filtered through 153uM mesh) and filter again through a large diameter (47mm) GF/F filter. Label cryovial with haul or station #, cruise and depth, then place filter in vial, and then in the appropriate cryo box, and freeze in -80 freezer.

RECENT TECHNICAL MEMORANDUMS

Copies of this and other NOAA Technical Memorandums are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22167 (web site: *www.ntis.gov)*. Paper and electronic (.pdf) copies vary in price.

AFSC-

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*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-362, 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. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-361, 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. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-358, 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.

355 M. M. MUTO, V. T. HELKER, R. P. ANGLISS, B. A. ALLEN, P. L. BOVENG, J. M. BREIWICK, M. F. CAMERON, P. J. CLAPHAM, S. P. DAHLE, M. E. DAHLHEIM, B. S. FADELY, M. C. FERGISON, L. W. FRITZ, R. C. HOBBS, Y. V. IVASHCHENKO, A. S. KENNEDY, J. M. LONDON, S. A. MIZROCH, R. R. REAM, E. L. RICHMOND, K. E. W. SHELDEN, R. G. TOWELL, P. R. WADE, J. M. WAITE, and A. N. ZERBINI. 2017. Alaska marine mammal stock assessments, 2016, 366 p. NTIS No. PB2017-102381

354 HELKER, V. T., M. M. MUTO, K. SAVAGE, S. TEERLINK, L. A. JEMISON, K. WILKINSON,and J. JANNOTT. 2017. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2011-2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-354,112 p. NTIS No. PB2016102765.

353 CONNER, J., D. G. NICHOL, and R. R. LAUTH. 2017. Results of the 2015 eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate resources, 154 p. NTIS No. PB2017-102385.