***Exxon Valdez* Oil Spill Trustee Council**

Long-Term Research and Monitoring, Mariculture, Education and Outreach

Annual Project Reporting Form

Project Number: 25120114-C

Project Title: Monitoring long-term changes in forage fish distribution, relative abundance, and body condition in Prince William Sound and the Northern Gulf of Alaska

Principal Investigator(s): Mayumi Arimitsu, Ocean Bight LLC

Reporting Period: February 1, 2025 – January 31, 2026

Submission Date: March 16, 2026

Project Website: https://gulfwatchalaska.org/

Please check all the boxes that apply to the current reporting period.

☐ **Project progress is on schedule.**

☒ **Project progress is delayed.**

The lead principal investigator (Arimitsu) left her position with U. S. Geological Survey (USGS) Ecosystems Mission Area in April 2025 due to restructuring of the workforce and shifting priorities in the federal government. By summer 2025, three additional USGS employees plus an Alaska Sea Grant Fellow working on the Gulf Watch Alaska Long-Term Research and Monitoring forage fish project had also moved on to new jobs. Although contractual work was accomplished, and certain datasets were maintained (i.e., aerial survey, summer forage fish collections, and Middleton Island seabird diet sampling), the USGS no longer had capacity to conduct the Integrated Predator Prey survey acoustic-trawl forage fish surveys planned during September 2025. Moving forward this project will be administered along with other non-Trustee institutions through the Prince William Sound Science Center.

☐ **Budget reallocation request.**

Because of the transition of the principal investigator to a non-Trustee organization, a budget reallocation request will be forthcoming.

☐ **Personnel changes.**

1. Summary of Work Performed:

Project milestones and tasks by fiscal year and quarter, beginning February 1, 2022.
FY Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.
C = completed, X = planned or not completed, D = delayed.

Milestone/Task	FY22				FY23				FY24				FY25				FY26			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone 1: admin and logistics																				
Contracting	C	C		C	C	C		C	C	C		C	C	C		C	X	X		X
Permitting			C				C				C				C				X	
Equipment Calibration		C								C				X				X		
Milestone 2: data acquisition																				
Middleton Island Seabird Diets	C	C	C		C	C	C		C	C	C		C	C	C		X	X	X	
Aerial Survey Validation		C				C				C				C				X		
Summer Forage Fish Sampling		C				C				C				C				X		
Integrated Predator Prey Survey			C				C				C				X				X	
Milestone 3: data management																				
Data processing, lab analyses, QAQC	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	X	X	X	X
Metadata	C				C				C				C				X			
Reporting																				
Annual reports					C				C				C				X			
Deliverables																				
Peer reviewed paper										C										
Data posted online				C				C				C				C				X

The Gulf Watch Alaska-Long Term Research and Monitoring (GWA-LTRM) program Forage Fish project has three main components including: 1) continuation of the longest time series on forage fish availability to seabirds in the Gulf of Alaska (GOA), i.e., a study that tracks the diets of adult and nestling seabirds at Middleton Island and is conducted in collaboration with Scott Hatch (Institute for Seabird Research and Conservation [ISRC]), 2) ship-based surveys including the Integrated Predator Prey (IPP) survey in Prince William Sound (PWS) conducted in collaboration with the humpback whale study (project 24120114-O, John Moran, National Oceanographic and Atmospheric Administration [NOAA], and Lauren Wild, University of

Alaska Southeast [UAS]) project, and 3) summer forage fish sampling - including aerial survey validation, forage fish sampling for condition in PWS, and juvenile salmon (*Oncorhynchus* spp.) otolith analysis (Fig. 1). In this report we describe work conducted in 2025.

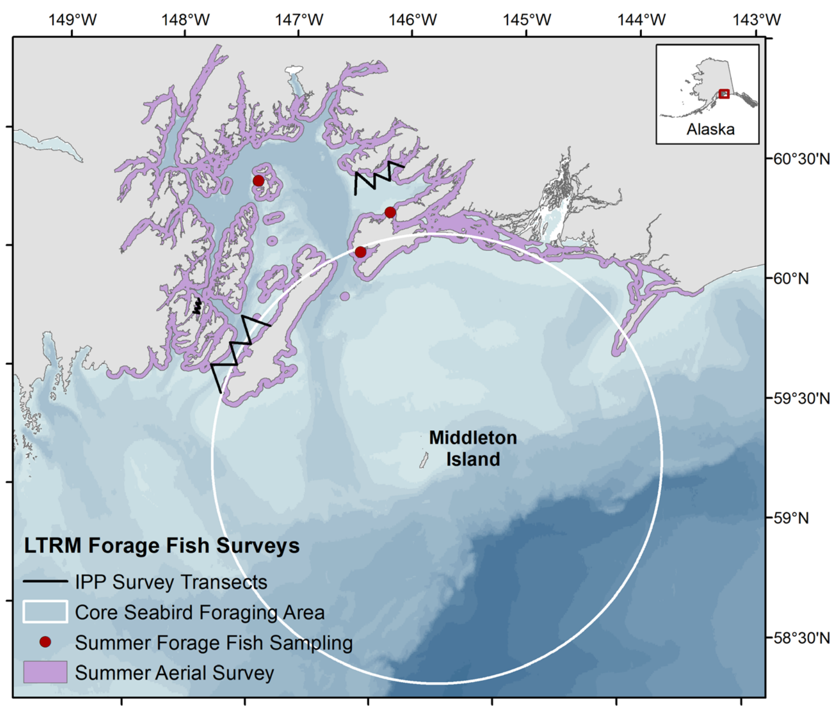

Figure 1. Distribution of Gulf Watch Alaska Long-Term Research and Monitoring (LTRM) seasonal forage fish survey effort in Prince William Sound and Middleton Island. Bathymetry is shown in blue with darker shades indicating deeper seafloor depth; IPP is the Integrated Predator Prey survey.

<u>*Seabird Diets*</u>

During 2025 the Middleton Island seabird diet sampling was conducted by the ISRC scientific team according to schedule. Working with partners at the U. S. Fish and Wildlife Service (USFWS) Alaska Maritime National Wildlife Refuge (AMNWR) and the National Marine Fisheries Service (NMFS), we prepared seabird diet datasets for reporting as part of NOAA's 2025 Gulf of Alaska Ecosystem Status Report (Whelan et al. 2025) to provide local- to basin-scale inference from seabird diet monitoring efforts at Middleton, St. Lazaria (eastern GOA), Chowiet and Suklik (western GOA), and Aiktak (western GOA or eastern Aleutians) islands.

This work aims to provide context for the Middleton samples, as requested by the North Pacific Fisheries Management Council's Science and Statistical Committee for decision making. We updated the Middleton Island Seabird Diet Data U. S. Geological Survey (USGS) data release according to schedule (Arimitsu et al. 2017 ver. 5 update May 2025). We provide a brief background and summary of 2025 seabird diet results below.

Seabird diet information from Middleton Island integrates forage fish species composition and availability over broad areas of the Northern GOA, i.e., across coastal, shelf, and slope regions (Hatch 2013, Arimitsu et al. 2021). An in-depth analysis of rhinoceros auklet (*Cerorhinca monocerata*) diets, supplemented with data from global positioning system (GPS) tags attached to foraging birds, showed that the seabirds can detect prey species in foraging areas where other survey types have found the prey to be sparse or absent (Cunningham et al. 2018). Seabird diets, including those from Middleton Island, are useful indicators of spatial and interannual variability in forage species in Alaska (Sydeman et al. 2017, 2021; Piatt et al. 2018; Thompson et al. 2019).

Seabird diet samples at Middleton Island were collected from April to August 2025. This included a total of 1169 diet samples from black-legged kittiwakes (*Rissa tridactyla*) and 365 diet samples from rhinoceros auklets.

Spring and summer kittiwake diets were composed mainly of capelin (Fig. 2). Additionally, capelin indices increased in rhinoceros auklet chick diets during 2024 and 2025 (Fig. 3), which, along with increasing trends in capelin in seabird diets at other colonies around the GOA (Arimitsu et al. 2024) and acoustic surveys in their core area around Kodiak (McGowan et al. 2024), suggest that capelin continue to recover in the region following population collapse during the Pacific marine heatwave of 2014-2016 (Arimitsu et al. 2021, McGowan et al. 2024).

In contrast, seabird diets at Middleton Island suggest that Pacific sand lance (*Ammodytes personatus*) indices peaked in the late-1990s and early 2000s, then declined around 2010 through the marine heatwave (Figs. 2 and 3). Following the heatwave, sand lance experienced a short-lived recovery, albeit to a lower level than in the 1990s, owing to a strong cohort in 2016 but have since declined again by 2024 and 2025 (Figs. 2 and 3). Coherent trends in sand lance are apparent in spring and summer kittiwake diets, summer rhinoceros auklet diets at Middleton.

Alternate prey species Hexagrammid species (i.e., kelp [*Hexagrammos decagrammus*] and rock greenlings [*H. lagocephalus*], lingcod [*Ophiodon elongatus*], and Atka mackerel [*Pleurogrammus monopterygius*]) continue to be well represented in both the auklet and kittiwake diets (Fig. 3). During 2025, Pacific herring (*Clupea pallasii*) increased and juvenile salmon indices decreased in rhinoceros auklet diets compared to 2024 (Fig. 3).

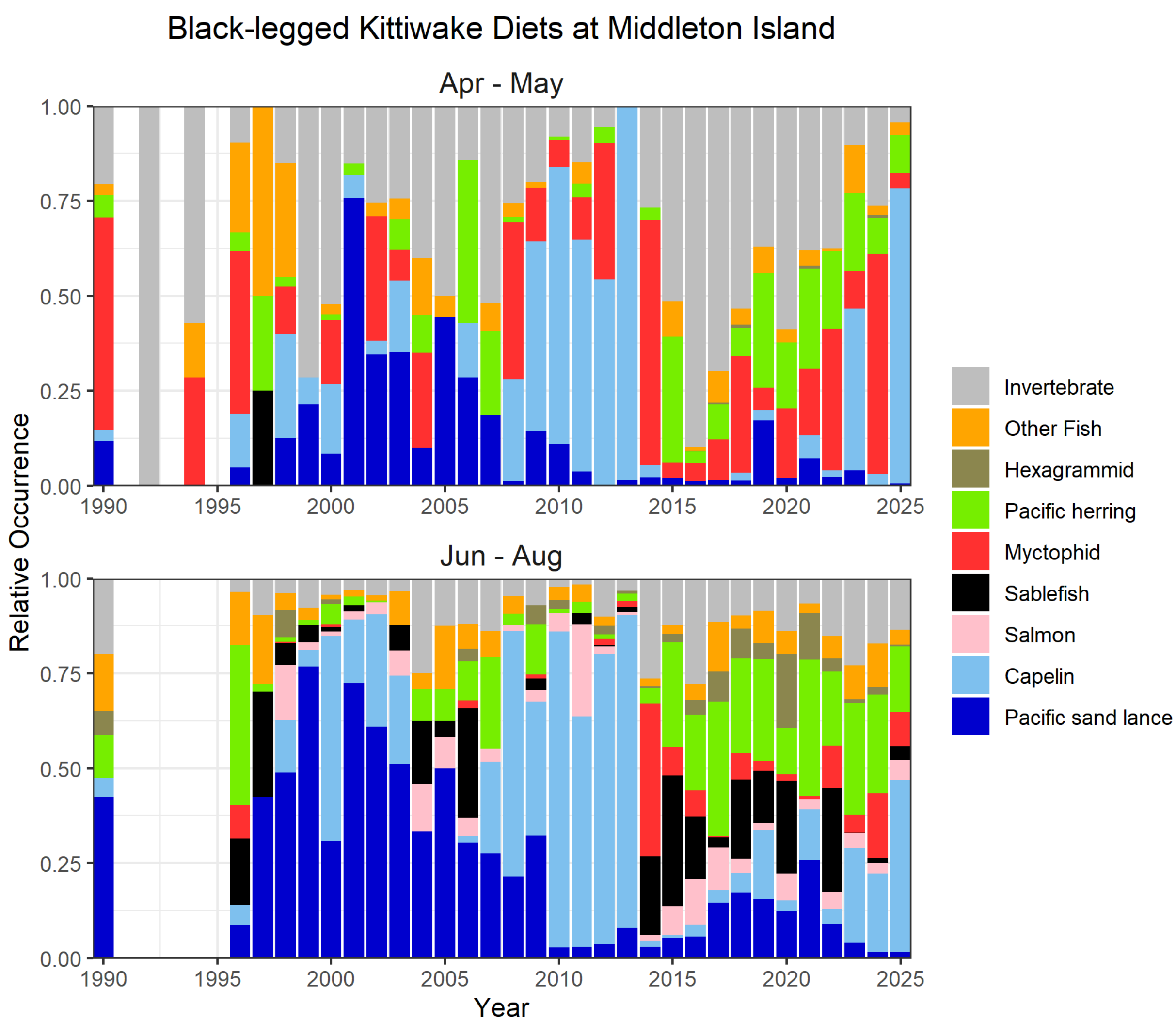

Figure 2. Interannual variation in diet composition of black-legged kittiwakes during spring (top) and summer (bottom) on Middleton Island.

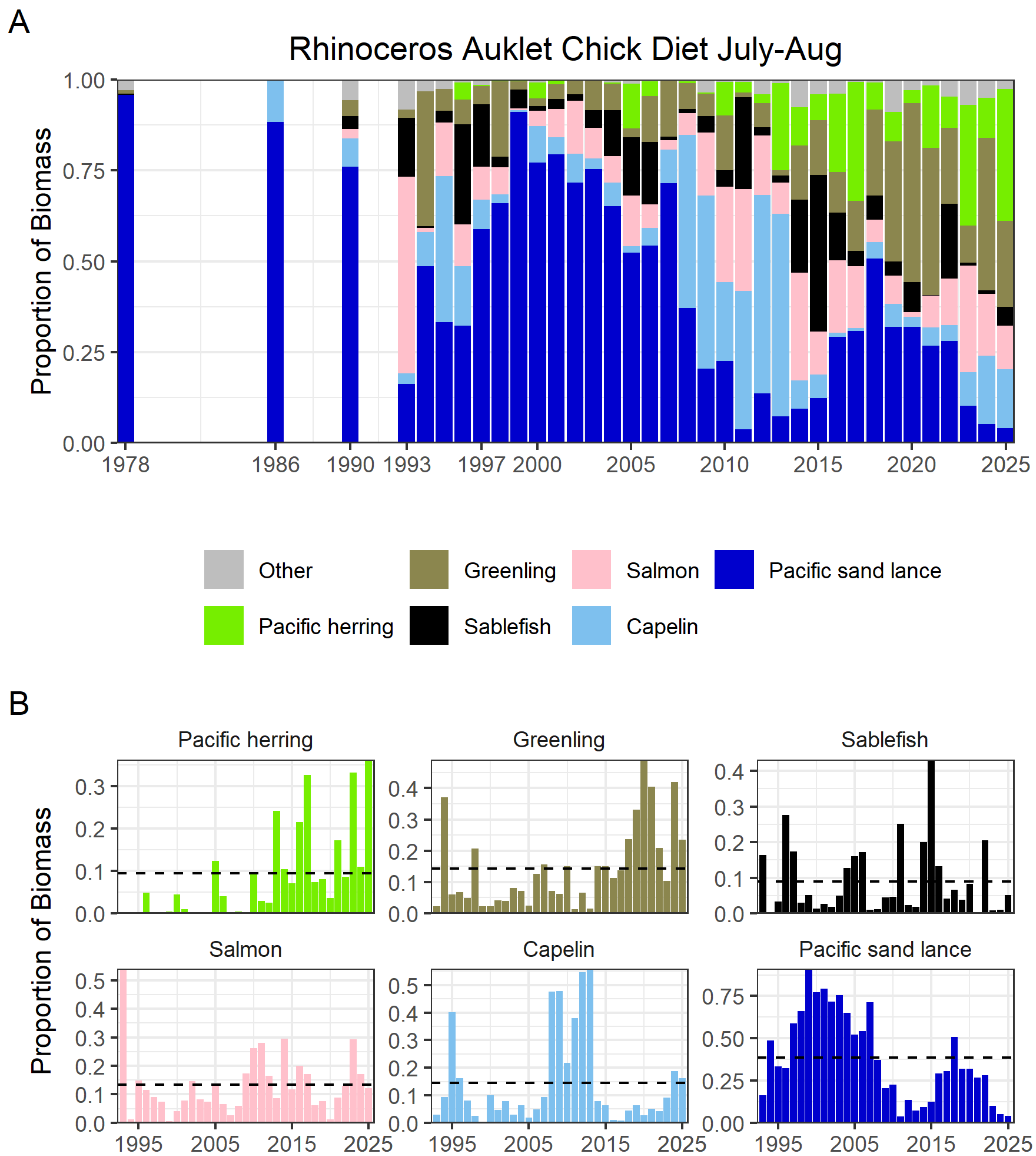

Figure 3. Interannual variation in rhinoceros auklet chick diets by species (color) at Middleton Island. (A) Stacked bars show relative proportions and importance of different prey types, and (B) Species-specific bar plots over time, note y-axis scale differences across panels.

Middle-Trophic Community Analysis

We used non-metric multi-dimensional analysis (NMDS) followed by ANOSIM and SIMPER (Anderson et al. 2008) to better understand differences between rhinoceros auklet forage communities at Middleton Island compared to USFWS refuge colonies in the western GOA (WGOA, Chowiet and Suklik) and eastern GOA (EGOA, St. Lazaria). We used Bray-Curtis distances on frequency of occurrence of dominant species (see Fig. 3). ANOSIM analysis indicated differences between colonies were significant ($p < 0.01$), and that the WGOA colonies were most different from Middleton (R stat = 0.663) and from EGOA (R stat = 0.681), whereas Middleton was relatively more similar to the EGOA colony (R stat = 0.388). SIMPER analysis showed highest diet variability in the EGOA (avg similarity = 68.01) with dominant prey species sand lance, herring, capelin, and greenling. Diet variability at Middleton was intermediate (avg similarity = 72.79) with dominant prey species sand lance, greenling, salmon, and sablefish. Diet variability was lowest at the WGOA sites (avg similarity = 75.31) with dominant prey species sand lance and greenling. The dominant feature of the 2025 Middleton forage community was aligned mainly with NMDS plot x-axis and generally correlated with low sand lance and high herring occurrence (Fig. 4). Analyses were conducted with Primer v7 by Mariela Brooks (NOAA NMFS).

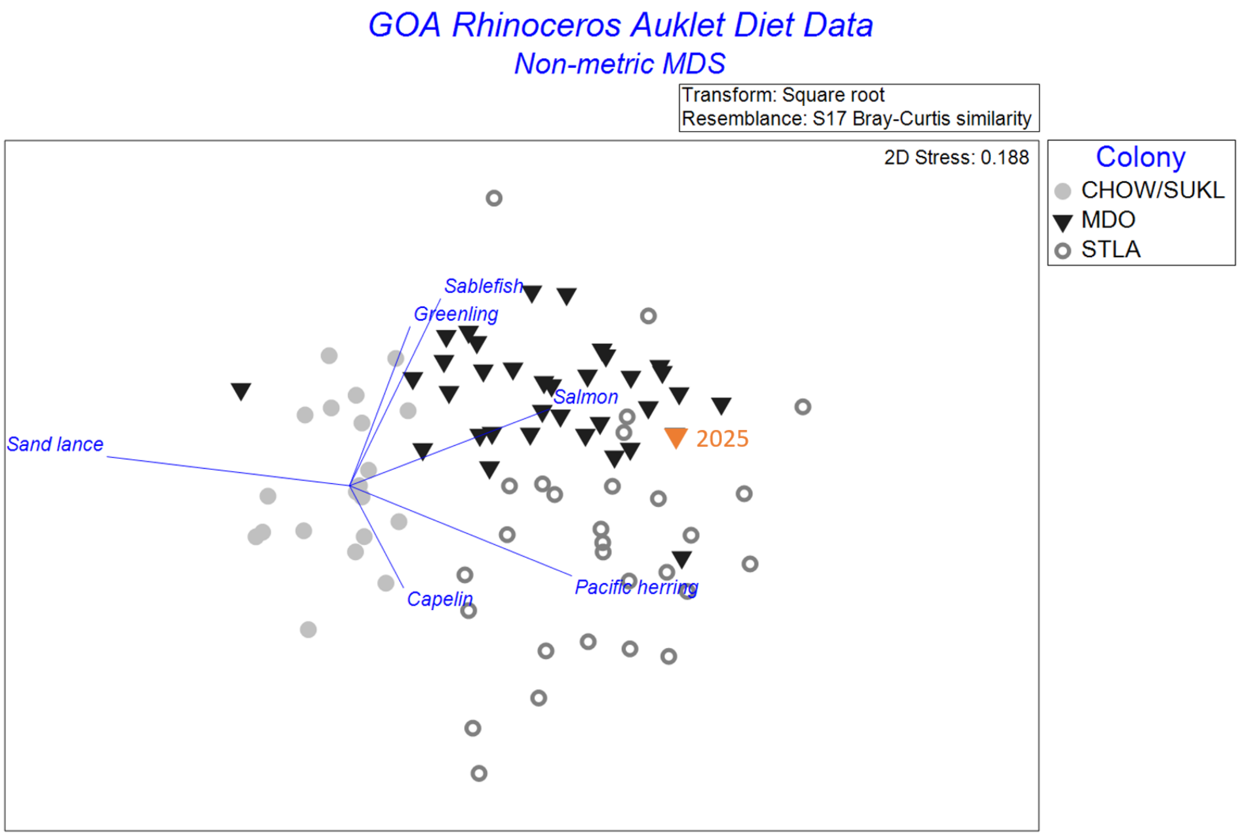

Figure 4. Forage community analysis based on rhinoceros auklet diets at Middleton Island (MDO) compared to U. S. Fish and Wildlife Service refuge colonies in the western Gulf of Alaska (GOA) (Chowiet and Suklik, CHOW/SUKL) and eastern GOA (St. Lazaria, STLA). Fish species loadings are shown as blue vectors, indicating the strength and direction of correlations with each axis. Although a 3D non-metric multi-dimensional analysis (MDS) decreases stress to 0.128, due mainly to capelin which do not fit as well within the 2D scheme, we present the 2D plot for visualization purposes. Graphic credit: Mariela Brooks (National Oceanic and Atmospheric Administration National Marine Fisheries Service Auke Bay Lab).

<u>Age-0 Sablefish Indices</u>

NOAA Alaska Fishery Science Center has determined that age-0 sablefish (*Anoplopoma fimbria*) growth information from seabird diets at Middleton Island may be relevant for understanding drivers of sablefish recruitment (Shotwell and Dame 2024). NOAA has requested annual updates on these sablefish data for use in the Ecosystem and Socioeconomic Profiles evaluated as part of the sablefish stock assessment process each fall. From samples of age-0 sablefish collected in diets over the chick rearing period, growth rate is calculated using the relationship between mean fish length and Julian date for each year, except in 1994 when data were omitted because of low sample size and effort conducted over only a short period of time (Arimitsu and Hatch 2023). From this relationship we predict length for each year on the median sampling date (July 24).

The 2025 indices are based on measurements of 147 fish sampled between June 28 and August 12, 2025. A total of 365 bill load samples were collected in 2025. The interaction between Julian Day and year explains the majority of variability in age-0 sablefish length through 2025 (ordinary least squares: $F = 29.55$, $p < 0.001$, $R^2 = 0.87$). During 2025 the age-0 sablefish predicted length (95 mm) was slightly below average (-5 mm) on the median sampling date (Jul 24). In 2025 age-0 sablefish growth (2.0 mm/day) and the growth index anomaly (0.12 mm/day) was near the long-term average (Fig. 5).

Age-0 sablefish are not well sampled by other survey methods, so time series of age-0 sablefish growth derived from seabird diet monitoring at Middleton Island are among the longest available from any Alaska location. Growth (or size) of age-0 sablefish may provide an early indication of recruitment because these indices may be related to survival of the cohort. Size of age-0 sablefish at the end of July is important because frequency of occurrence of age-0 sablefish in seabird diets is positively related to predicted fish length ($p < 0.001$). Seabirds may avoid age-0 sablefish that are too small, either because they can't sense them as easily or because they prefer higher energy food, resulting in lower provisioning rates than would be if the fish were larger in size during the chick rearing stage.

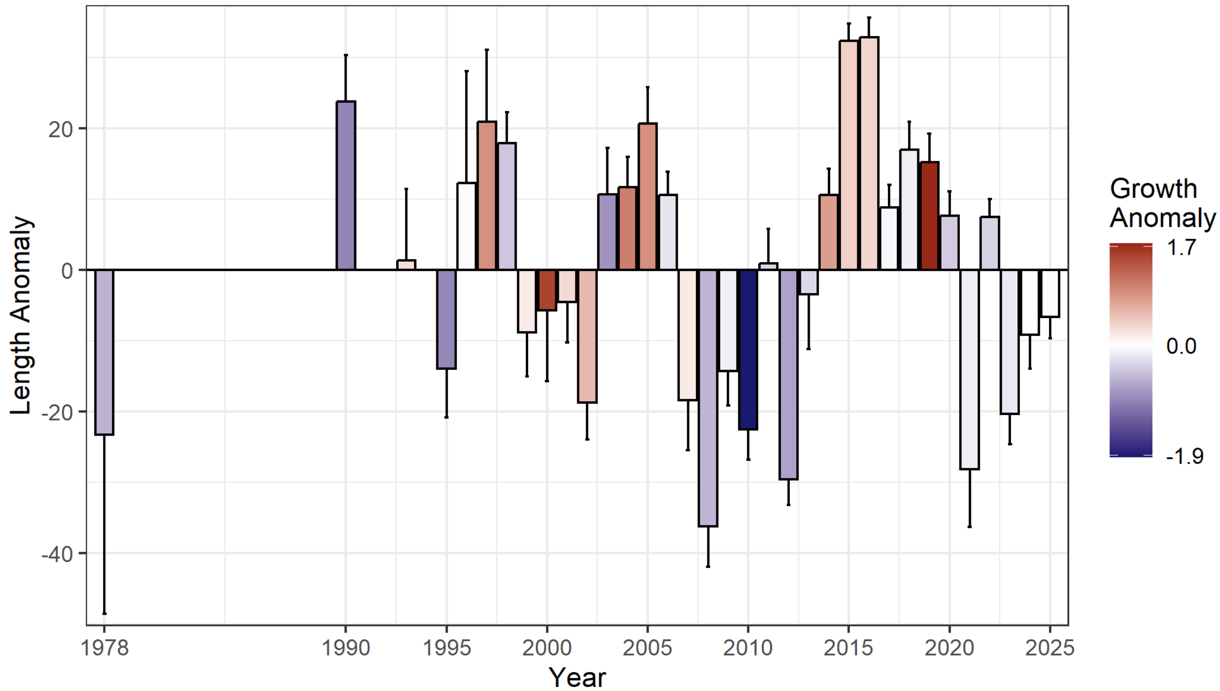

Figure 5. Interannual variability in predicted length anomaly (y-axis) and growth anomaly (color) for age-0 sablefish in seabird diets at Middleton Island, Alaska.

Preyscape Mapping

Middleton seabird diets are the focus of a student master's thesis by Katelyn Depot (McGill University, Montreal Quebec Canada, advisor: Kyle Elliot) that investigates the spatial distribution of prey by pairing kittiwake diets with foraging behavior from GPS tagging data. This work used Residence in Space and Time (RST) models to identify foraging behavior and location from tag data then match this information with corresponding prey data from regurgitation samples or fecal DNA during 2013-2024. For example, capelin and herring were obtained over a wide area of the shelf to the north of the colony, including the continental shelf and coastal areas around Hinchinbrook Island, the Copper River Delta, and Kayak Island (Fig. 6). Age-1+ and age-0 sand lance were sampled by the birds farther to the west near Montague Island. Eulachon (*Thaleichthys pacificus*) were obtained exclusively at the Copper River Delta outflow, juvenile salmon were obtained over the shelf, and age-0 herring were obtained very close to the colony (Fig. 6). In contrast, mesopelagic species like myctophids and squid (at night), as well as age-0 sablefish (near surface during the day) were obtained over the continental shelf slope to the south of the colony. These findings are broadly relevant to understanding spatial context of Middleton Island seabird diet samples spanning nearly five decades.

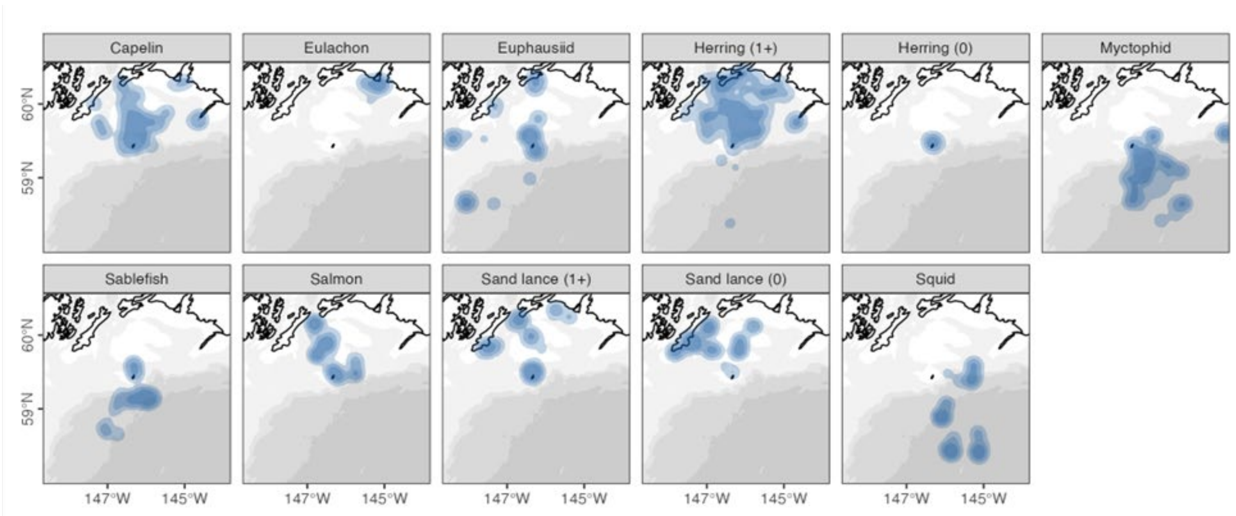

Figure 6. Foraging areas of GPS-tracked black-legged kittiwakes, by dominant prey taxa in associated regurgitates during 2013, 2017-2019, and 2021-2024. Dark, medium, and light blue polygons represent the 50th, 80th, and 95th percentiles of utilization distributions of foraging points in the 9 h preceding sample collection. Herring and sand lance were classified as age 0 or age 1+ based on length. Ocean bottom depth is shown by gray shading at 100, 300, 1000, and 3000 m contours. Graphic credit: Katelyn Depot (McGill University).

<u>Recruitment Forecasting</u>

Middleton seabird diets provide the longest running time series for middle trophic communities for southern PWS and adjacent coastal to outer shelf habitat (Hatch et al. 2023 ver. 3 update February 2025). With nearly 30 years of continuous data, we are better able to integrate these data into more sophisticated analyses intended to inform ecosystem-based management (e.g., Ferris et al. 2025) and better understand how seabird diets reflect ecosystem integration of climate forcing (Cushing et al. in prep). Additionally, we are currently developing a Bayesian state-space forage fish forecasting model that estimates sand lance and herring recruitment and climate-driven survival informed by age-0 and age-1 fish in diets of surface-feeding kittiwakes (frequency of occurrence) and diving rhinoceros auklets (fish counts in bill loads). For each forage fish species, age-0 recruitment is modeled with species-specific intercepts, and cohort tracking is accomplished with age-1 estimates from spring and summer the following year. Apparent overwinter survival is modeled as a function of the previous year's fall sea surface temperature for each fish species. These parameter estimates provide the basis for a climate conditional forecasting framework for spring age-1 herring and sand lance abundance indices the following year (Fig. 7).

Preliminary model results using seabird diet data at Middleton Island identify the emergence of a potential even-odd year pattern in age-1 herring after 2013, which is examined in more detail in Dan Cushing's PhD thesis work. Although there was no regular attempt to measure spawning activity at Kayak Island over the years (McGowan et al. 2021), some evidence suggests greater use of the Kayak Island spawning grounds since around 2020 (Scott Pegau, personal communication) which may be related to increasing herring occurrence in seabird diets during recent years (Figs. 2 and 3). We found a generally positive relationship between age-0 herring overwinter survival indices and fall sea surface temperature. In contrast, modeled sand lance recruitment and age-1 indices were generally higher during the late-1990s and 2000s, and, although previous work found a positive relationship between sand lance indices and thermal conditions (using data through 2012, Sydeman et al. 2017), the extended time series analysis found a significant negative relationship between age-1 sand lance abundance in diets and last year's average fall (Oct-Dec) sea surface temperatures.

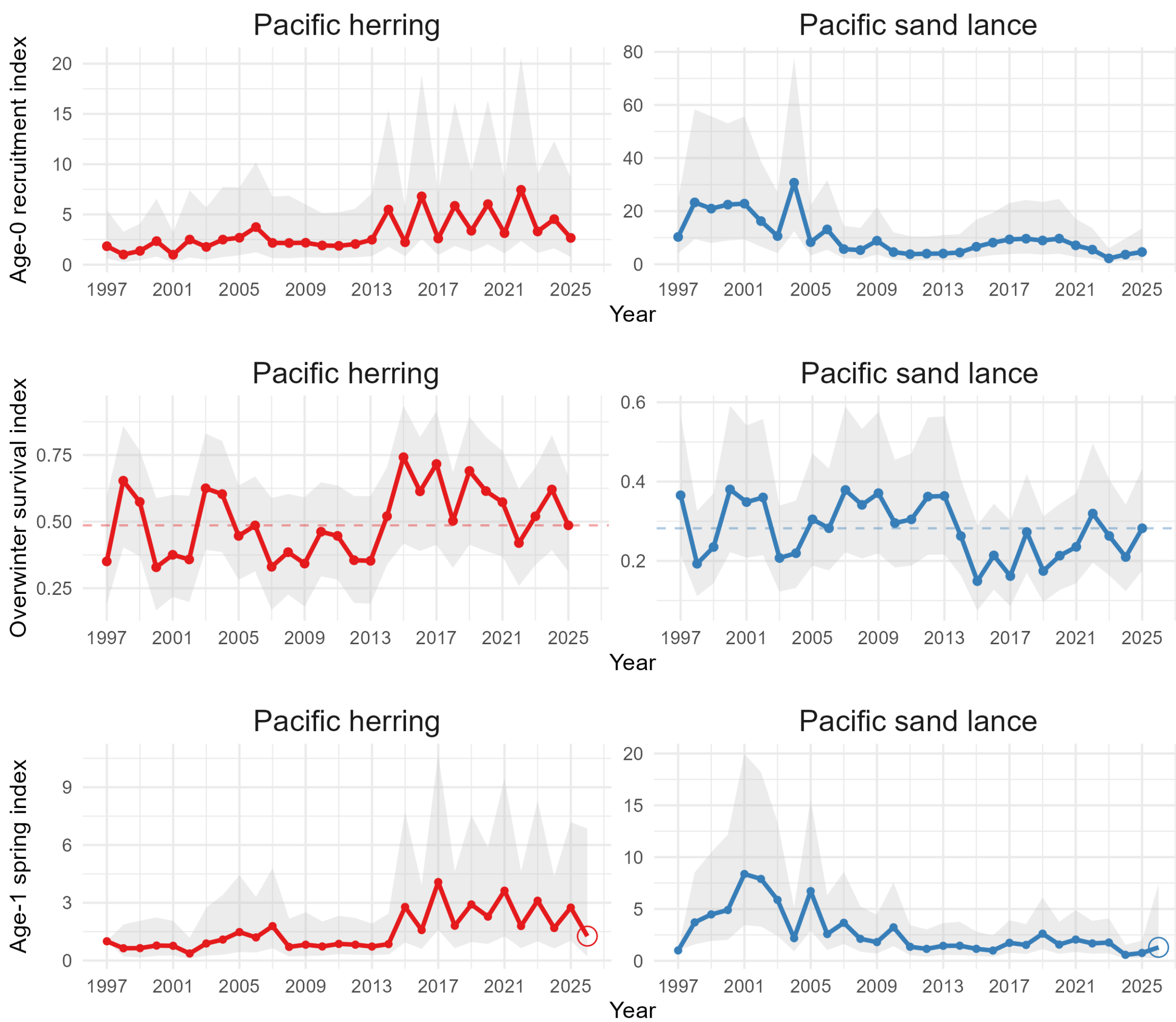

Figure 7. Preliminary results from a Bayesian state space forage fish recruitment and survival forecasting model using Pacific herring and Pacific sand lance in black-legged kittiwake and rhinoceros auklet diets at Middleton Island (1997-2025). Using the time series of age-0 recruitment index (top panels) and an index of overwinter survival (middle panels), the age-1 spring forecast (lower panels, open circle) is a function of survival and fall sea surface temperatures for each species.

Juvenile Salmon Otoliths

Rhinoceros auklets at Middleton regularly sample juvenile pink *(O. gorbuscha*) and chum (*O. keta*) salmon (size range = 56 – 190 mm) within their core foraging range (Fig. 1). These fish are from a mix of hatchery and wild origin that have recently out-migrated from streams in the region as smolt and were intercepted by the seabirds as they exited PWS through ocean passages at Hinchinbrook and Montague.

Juvenile salmon samples from 2025 could not be processed due to staffing issues, but samples were frozen separately in the field and were shipped directly to Pete Rand (PWSSC) in Cordova by ISRC in September 2025 so that plans for processing the otoliths and other potential sample analyses could be coordinated with the GWA-LTRM herring-salmon interactions project (25220111-I). The 2010-2024 juvenile salmon dataset (as described below) with Federal Geographic Data Committee compliant metadata was prepared, reviewed, and published (Donnelly et al. 2026).

Juvenile salmon were removed from archived frozen rhinoceros auklet bill load samples collected at Middleton Island between 2010 and 2024 (Fig. 8). Otoliths were recovered from individual pink and chum salmon from bill loads, although not all otoliths were recovered because some were missing, damaged, or otherwise unreadable. Preparation and reading of otoliths by Dan Donnelly at USGS closely followed procedures described in the Alaska Department of Fish and Game's Cordova otolith lab procedure manual (Fernandez and Moffitt 2016). The average (standard deviation) proportion of hatchery origin chum and pink salmon in seabird diets was 0.61 (0.31) and 0.53 (0.27), respectively. We applied hatchery vs. wild origin proportions to Middleton Island seabird diet indices (proportion of biomass) for pink and chum salmon over time (Fig. 8). For years between 2019 and 2023, a subset of samples from which otoliths could be recovered (n=100) were randomly selected for analysis of energy density. Whole fish were freeze-dried, then homogenized before being processed for energy density using a Parr 6725 semimicro bomb calorimeter. Mean energy density was not significantly different between hatchery and wild origin salmon (two-tailed *t* test $p = 0.9152$).

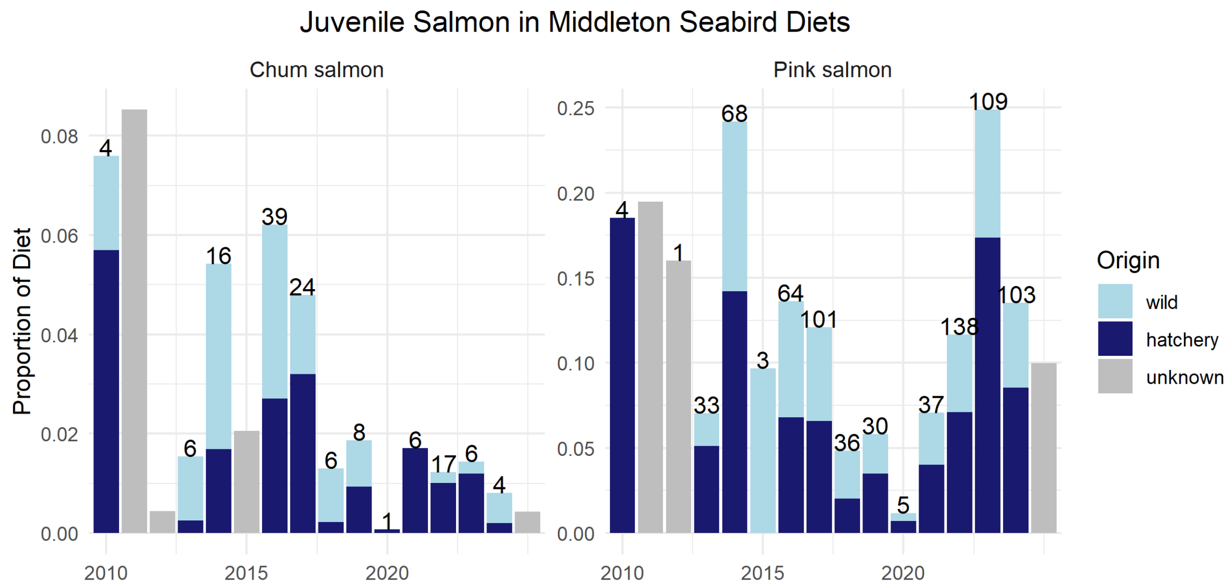

Figure 8. Interannual variation of juvenile salmon indices (proportion of biomass) in rhinoceros auklet diets at Middleton Island during July–August. Bars are colored by the proportion of recovered otoliths that were determined to be wild vs. hatchery origin, and otolith sample sizes are provided above each bar. Grey bars indicate years in which origin could not be determined, or 2025 otoliths, which are planned for processing during 2026.

Fall Integrated Predator Prey Surveys

The 2025 IPP survey was canceled, due to staffing issues, and progress on analyses were delayed for much of the year. To the extent possible we worked with Anne Schaeffer and Mary Anne Bishop (PWSSC) and John Moran (NOAA) and Lauren Wild (UAS) to advance the project. Staffing issues also hampered progress on an analysis of humpback whale foraging behavior paired with acoustic surveys of prey when an Alaska Sea Grant Fellow working on this aspect of the project had to take another job. We anticipate, however, that IPP survey analyses and writing projects will get back on track during 2026.

From 2017 to 2024 we conducted acoustic transects, trawls, marine bird surveys and habitat sampling in Bainbridge Passage, Montague Strait, and Port Gravina as planned. Acoustic indices of capelin on transects in Montague and Port Gravina increased during 2024 compared to previous years, and in Port Gravina juvenile walleye pollock acoustic indices were higher than usual (Fig. 9). However, acoustic backscatter of euphausiids was lower in 2024 in all regions compared to 2023, juvenile and adult herring biomass indices were lower than previous years. We did not encounter sand lance on surveys in any region during IPP surveys in 2024 (Fig. 9).

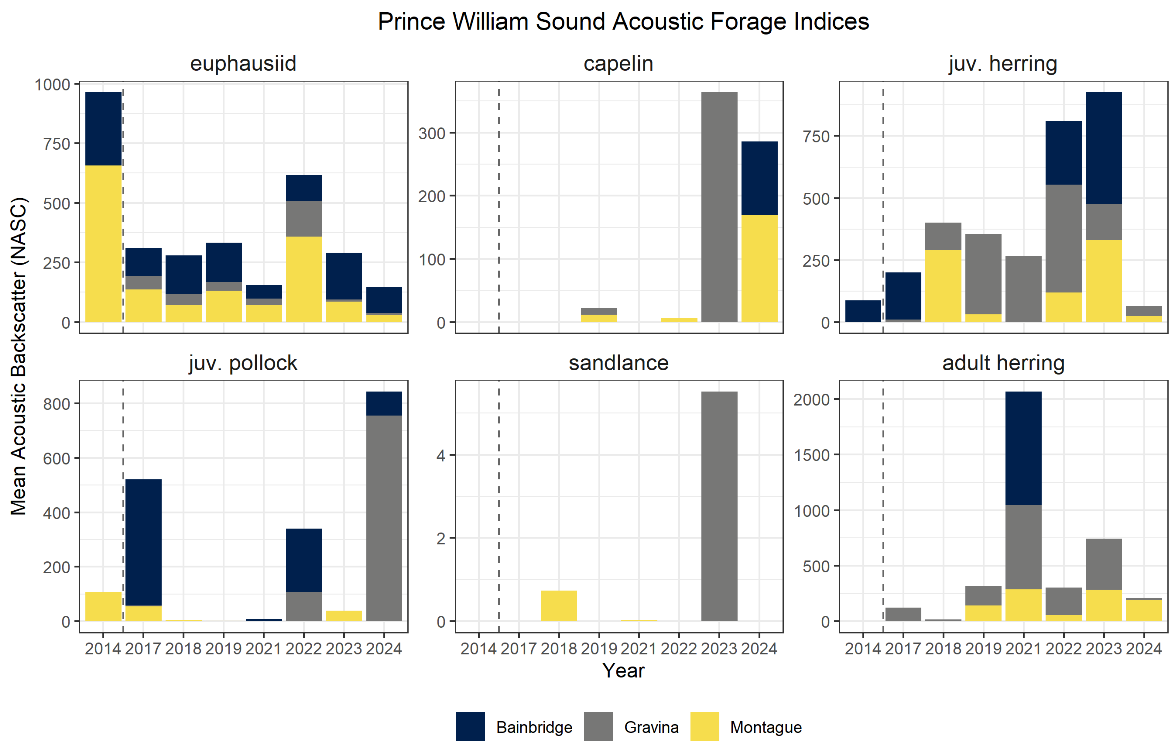

Figure 9. Interannual variability of acoustic backscatter indices by forage species (panels). Acoustic indices derived from Integrated Predator-Prey surveys in three regions (color) within Prince William Sound through 2024. In 2014 pilot surveys were conducted over a reduced area in Bainbridge and Montague (see Arimitsu et al. 2021 for details).

Summer Forage Fish Sampling

Aerial surveys were conducted on eight days in June 2025 by Scott Pegau (PWSSC) and Mike Collins (spotter pilot). On July 11, 2025, validation surveys were conducted by Rob Campbell from Cordova, Alaska, in support of the continuing GWA-LTRM aerial forage fish surveys during aerial surveys in Sheep Bay and Gravina. Normally this process involves coordination between a boat-based team departs from Cordova to the general area identified by aerial observers. When both the aerial spotter plane and boat-based crew arrive in the area, the spotter plane locates a school of forage fish, make a visual identification of that school, and then guides the boat-based crew to the school communicating via marine VHF radio. Once the skiff reaches the school, the boat crew identifies the fish either by catching fish with jigs, dipnets, or castnets, or by visual confirmation of fish at the surface or below the surface with a drop camera. Overall, the validation efforts between 2014 and 2025 (104 validated schools) indicate a high level of correct species identification (96% for herring, 74% for sand lance) by the aerial observers. In 2025, relative density of forage fish schools during the June aerial surveys had increased compared to 2024 and were composed mainly of juvenile herring (Fig. 10).

Spatial and temporal variation of forage school densities in PWS since 2010 were driven by juvenile herring, which tend to be concentrated in the eastern Sound, and in Knight Island Passage (Donnelly et al. 2024). Sand lance were more restricted to core areas around Middle Ground Shoal, Naked Island, and Perry Island, but school densities in these regions declined after 2010. Sand lance declines on aerial surveys are consistent with findings from seabird diets at Middleton Island (Figs. 2 and 3) and other seabirds colonies around the GOA (Arimitsu et al. 2024).

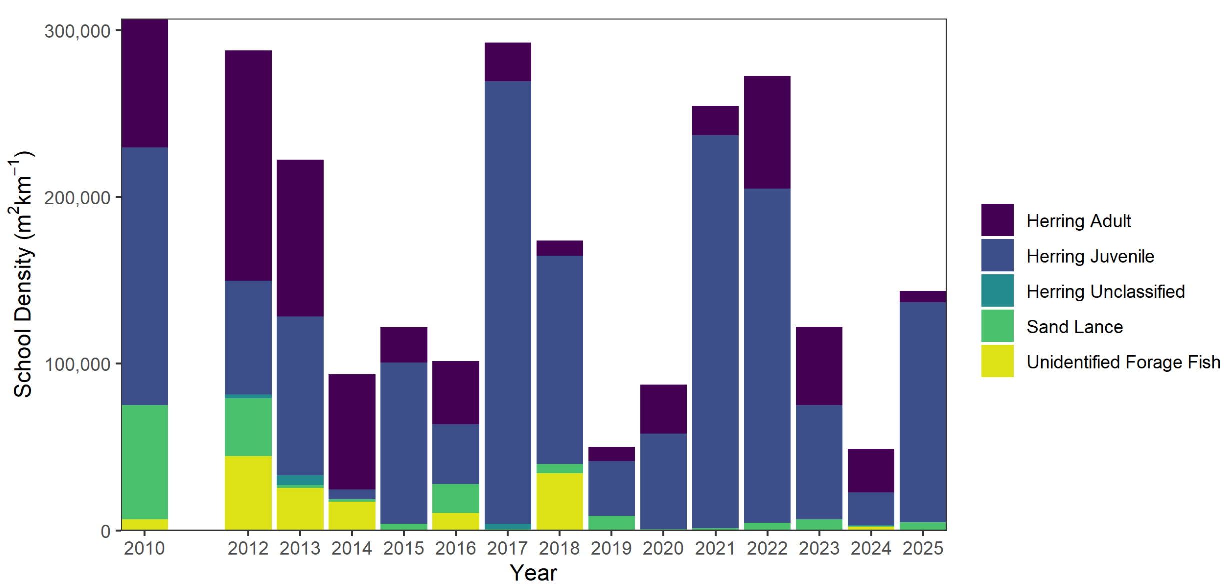

Figure 10. Forage fish school density (median surface area per shoreline km surveyed, m^2km^{-1}) observed June aerial surveys during 2010 to 2025. Species and age (for herring) classifications are shown in color.

Summer Forage Fish Condition

With the help of Rob Campbell (PWSSC), summer forage fish collections were conducted in PWS during July 2025. Pacific sand lance samples were collected at Naked Island for size, age, and energy measurements. Although we visited Port Etches and looked for spawning capelin over several tidal cycles in July, we did not encounter any spawning capelin activity in the area during summer 2025. We also worked with John Johnson who runs the Nuuciq Spirit Camp, and Rob Campbell (PWSSC) to search for spawning capelin in Port Etches in July but none were observed that summer. We worked closely with otolith aging experts in Newfoundland to ensure that our methods for aging capelin correspond with those developed for Atlantic populations and are developing an aging key for Pacific capelin. We continue to have success with a citizen science project to collect information about spawning capelin around Alaska (https://www.usgs.gov/media/images/capelin-flyer, accessed 1/31/2026), with samples obtained from other spill-affected regions such as Kodiak and Cook Inlet, for comparison with other regions in Alaska such as the Beaufort Sea and southeast Alaska.

From capelin samples collected during beach spawning events and aged by their otoliths, we found that the age structure of summer spawners in PWS shifted from primarily age-2 fish in 2013 (pre-heatwave) to primarily age-1 fish during and following heatwaves (2016, 2019, 2020) (Fig. 11, Arimitsu et al. 2021). In contrast, we found that spawning aggregations in the greater GOA region (2020, 2022, 2023) were composed of primarily age-2 and age-3 fish during spring (Kodiak, Cook Inlet, Glacier Bay) and a mix of age-1 to age-3 fish during fall (Sitka) (Fig. 11). Older age compositions, especially during spring in the core capelin areas correspond with a recovering capelin population in the GOA (Figs. 2-3, Arimitsu et al. 2024, McGowan et al. 2024). Spawning capelin age composition data provide important context for understanding plasticity in maturation rates in response to marine heatwave conditions. Preliminary work suggests that plasticity in spawn timing (spring vs summer vs fall) appears to be key to understanding size and energy content (Fig. 12, Marsteller et al. *in prep*). We are currently working with Claudine Hauri and Remi Pages (University of Alaska Fairbanks [UAF], GWA-LTRM Environmental Drivers component projects) to better understand basin-scale circulation as a potential mechanism underlying demographic collapse and recovery of capelin in the GOA.

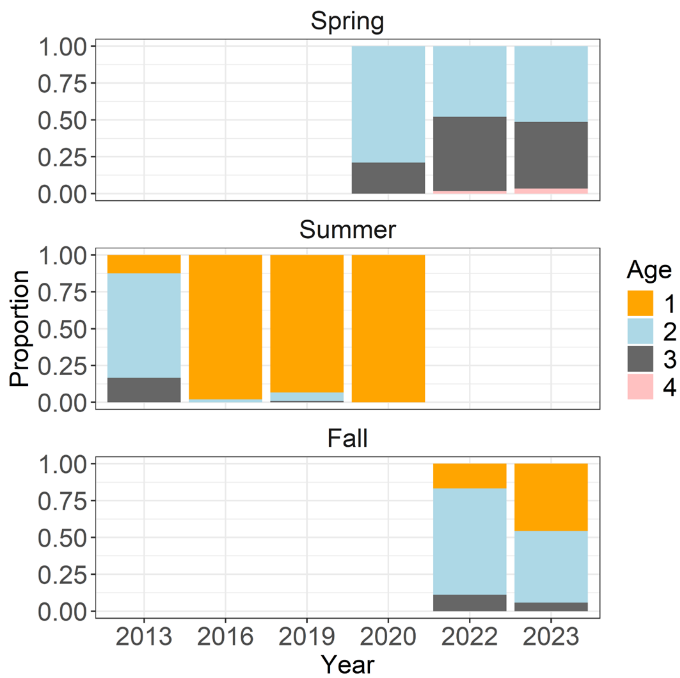

Figure 11. Spawning male capelin age proportions (color) by year and season. Spring sampling events occurred in Kodiak, Cook Inlet, and Glacier Bay, summer sampling events occurred in Prince William Sound, and fall sampling events occurred in Sitka. Graphic credit: Caitlin Marsteller (U. S. Geological Survey, current affiliation: Alaska Pacific University).

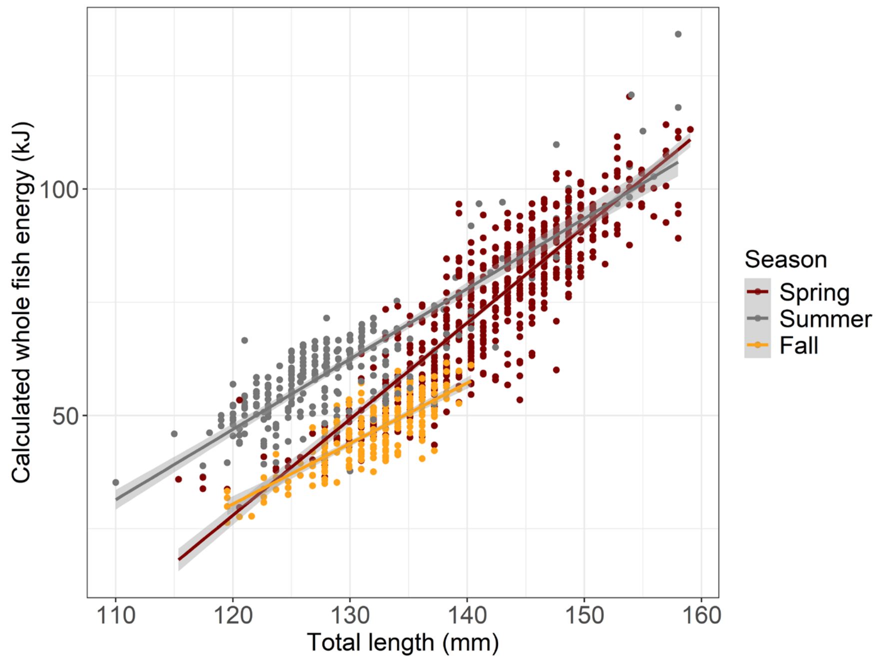

Figure 12. Seasonal variability of spawning Pacific capelin whole fish energy (y-axis) in relation to length (x-axis). Graphic credit: Caitlin Marsteller (U. S. Geological Survey, current affiliation: Alaska Pacific University).

Acknowledgements

We thank John Piatt (USGS, emeritus), Sarah Schoen (USGS), Scott Hatch (ISRC), Shannon Whelan (ISRC), the Middleton Island 2025 field team, Dan Donnelly (USGS, current affiliation Alaska Department of Fish and Game [ADFG]), Caitlin Marsteller (USGS, current affiliation Alaska Pacific University [APU]), Scott Pegau (PWSSC), Mike Collins, John Moran (NOAA), Anne Schaefer (PWSSC), Katelyn Depot (McGill University), and Mariela Brooks (NOAA) for their dedicated work in the field and/or for key contributions to this report including data collection, data management, graphics, and project summaries. We are grateful for the efforts of the captains of the R/V *Alaskan Gyre*, Paul Tate, Rand Seaton, and Ben Couturier and for help in the field from Jenna Schlener (Alaska Sea Grant Fellow), Sam Stark (USGS), and Bree Witteveen (UAF). We appreciate efforts by Eric Munk (Kodiak), Craig Murdoch (National Park Service [NPS], Glacier Bay), Jamie Womble (NPS), Heather Coletti (NPS), Karen Johnson

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2. Products:

Peer-reviewed publications:

Ferris, B., M. Hunsicker, E. Ward, M. Litzow, L. Rogers, M. Callahan, W. Cheng, S. Danielson, B. Drummond, E. Fergusson, C. Gabriele, K. Hebert, R. Hopcroft, J. Nielsen, K. Spallinger, W. Stockhausen, W. Strasburger, S. Whelan. 2025. Identifying common trends and ecosystem states to inform Gulf of Alaska ecosystem-based fisheries management. PLoS One 20(6):e0324154 https://doi.org/10.1371/journal.pone.0324154.

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Reports:

Ciafro, C. 2025. From Burrow to Sea: Tufted puffins (*Fratercula cirrhata*) as indicators of forage fish populations in the Gulf of Alaska. Thesis, McGill University, Montreal, Canada.

Solmon, P. 2025. Effects of environmental conditions on life-history traits of rhinoceros auklets *(Cerorhinca monocerata)* during the breeding season over two decades. Thesis, University of Burgundy, Dijon, France.

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Popular articles:

Clynes, T., and M. Heim. 2025. Extreme birding at the edge of the world. August 2025 issue of National Geographic.

Ferlazzo, M. 2025. Seabirds as Sentinels: Bucknell Researchers Make 'National Geographic'. Bucknell University. Bucknell University, July 10. https://www.bucknell.edu/news/seabirds-sentinels-bucknell-researchers-make-national-geographic

Conferences and workshops:

Cushing, D., M. Arimitsu, S. Danielson, R. Kaler, E. Labunski, S. Whelen, and R. Suryan. 2026. Seabird distributions and diets reflect ecosystem integration of climate forcing. Oral presentation, Alaska Marine Science Symposium, Anchorage, Alaska, January.

Marsteller, C., C. Reo, M. Arimitsu, L. Bien, K. McNett, S. Schoen, K. Gravenus, and C. Conant. 2026. Making science murre accessible: A collaborative approach to science communication. Poster presentation, Alaska Marine Science Symposium, Anchorage, Alaska, January.

Public presentations:

Arimitsu. M. 2025. Seabirds and forage fish as ocean sentinels; Overview of USGS research to understand mechanisms underlying seabird die-offs and forage fish response to marine heatwaves in the Gulf of Alaska. Invited community-oriented lecture, Mendenhall Glacier Visitor Center Fireside Lecture Series, Juneau, Alaska, March.

Whelan, S. 2025. Black-legged kittiwake diets. Invited presentation, Alaska Fisheries Science Center Preview of Ecosystem and Economic Conditions (PEEC) virtual workshop, May.

Data and/or information products developed during the reporting period:

None to report.

Data sets and associated metadata:

Arimitsu, M. L., J. F. Piatt, B. M. Heflin, and C. E. Marsteller. 2017. Gulf Watch Alaska - Pelagic Ecosystems Forage Fish Component - data from Prince William Sound: distribution, abundance, and morphology of fish, zooplankton, and predators and oceanographic conditions (ver 5, May 2025): U. S. Geological Survey data release, https://doi.org/10.5066/F74J0C9Z.

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Donnelly, D. S., M. L. Arimitsu, S. Whelan, S. A. Hatch, and S. K. Schoen. 2026. Natal origin of juvenile salmon collected on Middleton Island, Alaska, 2010-2024: U. S. Geological Survey data release, https://doi.org/10.5066/P1C48YQZ.

Hatch, S., M. Arimitsu, J. Piatt, S. Whelan, and C. E. Marsteller. 2023. Seabird diet data collected on Middleton Island, Gulf of Alaska (ver 3.0, February 2025): U.S. Geological Survey data release, https://doi.org/10.5066/P93I0P67.

Additional Products not listed above:

None to report.

3. Coordination and Collaboration:

The Alaska SeaLife Center or Prince William Sound Science Center

We work closely with PWSSC scientists on several aspects of our work, e.g., with Scott Pegau on validation of aerial surveys, Mary Anne Bishop and Anne Schaefer on the IPP survey and other marine bird surveys, and Pete Rand on juvenile salmon samples, otolith protocols, and opportunities for sharing information and resources across projects. We shared juvenile salmon data (2010-2024), including length-weight, origin, and energy density with Pete Rand and others. We are currently discussing ways we may coordinate sample collection and future collaborations on the juvenile salmon project. We are also working closely with Rob Campbell on summer forage fish sample collections and aerial survey validations as we have for several years.

EVOSTC Long-Term Research and Monitoring Projects

Mayumi Arimitsu is on the GWA-LTRM science coordinating committee, serving as lead for the GWA-LTRM pelagic component, which includes monitoring projects including marine birds, humpback whales, and forage fish. Her duties in this role have included leading science synthesis activities, coordinating pelagic program science products and information transfer, leading presentations at conferences and principal investigators meetings, and facilitating communications between the program management team and the pelagic component project leaders. Arimitsu is also working closely with GWA Environmental Drivers researchers Claudine Hauri and Remi Pages to better understand potential drivers of capelin boom and bust population variability. Mayumi Arimitsu is on the PhD advisory committee of Dan Cushing, who is working on his dissertation entitled "Predator responses to variability in prey-field characteristics across contrasting oceanographic settings in the northern Gulf of Alaska", and who has a science synthesis manuscript in prep to identify environmental and ecological drivers of seabird distributions and middle trophic response in the northern GOA since the late-1990s.

EVOSTC Mariculture Projects

We engaged with *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) mariculture projects group at the GWA-LTRM principal investigator (PI) meetings and look forward to working with the mariculture team as our sampling goals and geographic regions are complimentary.

EVOSTC Education and Outreach Projects

In FY25 we worked with the Community Organized Restoration and Learning (CORaL) Network to provide content for educational kiosks planned in spill-affected communities. In 2025, we worked closely with Cristina Reo and Lauren Bien (PWSSC) to develop outreach materials with education specialists at CORaL network, U. S. Fish and Wildlife Service Alaska Maritime National Wildlife Refuge, the Pratt Museum in Homer, and the Chugach Regional Resources Commission. This work features artwork by Kim McNett intended to help educate the public about changes in predator-prey dynamics at common murre colonies following a massive die-off associated with the 2014-2016 marine heatwave.

Individual EVOSTC Projects

The forage fish project works with the Data Management program to ensure data collected are properly reviewed, have current metadata, and are posted to the Gulf of Alaska data portal within required timeframes.

Trustee or Management Agencies

Data and fish samples gathered as part of the GWA-LTRM forage fish study are used by NOAA NMFS annual stock assessment process (e.g., Bridget Ferriss Gulf of Alaska Ecosystems Status Report and Kalei Shotwell et al. Sablefish Ecosystem and Socioeconomic Profile to the North Pacific Fisheries Management Council), and these data are also being summarized along with seabird diets at USFWS AMNWR refuge sites in the Gulf of Alaska. The GWA-LTRM forage fish work is also complimentary to a related USGS outer Continental Shelf and Bureau of Ocean Energy Management funded study of forage fish and seabird trends in areas of oil and gas development in Cook Inlet. This continued coordination and collaboration with GWA-LTRM PIs and other researchers (Liz Labunski and Robb Kaler, USFWS; Kris Holderied and Martin Renner, NOAA) in Cook Inlet and Kachemak Bay increases the scope of ecosystem monitoring in the Northern Gulf of Alaska.

Native and Local Communities

We continue to work with John Johnson (Chugach Alaska Corporation) regarding information and sample collection and spawning capelin observations in Port Etches. We also continue to foster relationships with members of the Chugach Regional Resources Commission, and we are seeking ways to share information in the future.

4. Response to EVOSTC Review, Recommendations and Comments:

No review, recommendations, or comments were provided in 2025. This project responded to comments in the FY24 annual report.

5. Budget:

Differences between proposed and actual spending are due to shifting priorities and spending challenges in the federal government during 2025. This included the initiative to reduce the federal workforce, which hampered general project management. In addition to losing the PI, there was a federal hiring freeze, which led to the termination of two biologists whose term appointments expired, and a third biologist that needed to find another job. There were also travel and purchasing restrictions beginning around February 2025 that persisted through the year. The vessel contract for the IPP survey was canceled because USGS no longer has the capacity to conduct these surveys. Therefore, spending in the personnel, travel, and commodities categories was lower than proposed. Contractual costs were higher than proposed through 2025 because they include a January 30, 2026, contract award to ISRC intended for 2026 field work at Middleton. Typically, this cooperative agreement is awarded annually during the EVOSTC fiscal year in which field work is to be performed. It was awarded early, two days before FY26 began, due to uncertainty regarding a potential government shut down on February 1, 2026. Moving forward this project will be administered through PWSSC, along with other non-Trustee institutions.

***Exxon Valdez* Oil Spill Trustee Council**

Long-Term Research and Monitoring, Mariculture, Education and Outreach

Annual Project Reporting Form

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROJECT BUDGET PROPOSAL AND REPORTING FORM

Budget Category:	Proposed FY 22	Proposed FY 23	Proposed FY 24	Proposed FY 25	Proposed FY 26	5- YR TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$155,284	$96,905	$132,135	$137,923	$144,000	$666,247	$343,495
Travel	$14,492	$24,161	$15,226	$15,606	$15,996	$85,482	$59,573
Contractual	$106,800	$109,470	$112,207	$115,012	$117,887	$561,376	$538,935
Commodities	$32,000	$32,000	$32,000	$32,000	$32,000	$160,000	$96,422
Equipment	$10,650	$31,326	$11,189	$11,469	$11,756	$76,390	$72,874
Indirect Costs Rate = 0%	$0	$0	$0	$0	$0	$0	$0
SUBTOTAL	$319,226	$293,863	$302,757	$312,010	$321,639	$1,549,494	$1,111,299
General Administration (9% of subtotal)	$28,730	$26,448	$27,248	$28,081	$28,947	$139,455	N/A
PROJECT TOTAL	$347,956	$320,311	$330,005	$340,091	$350,586	$1,688,949	
Other Resources (In-Kind Funds)	$482,500	$482,500	$482,500	$482,500		$1,930,000	

COMMENTS:
Differences between proposed and actual spending are due to challenges and shifting priorities in the federal government and USGS during 2025. This included the initiative to reduce the federal workforce, which hampered project management in general. In addition to losing the PI, there was a federal hiring freeze, which led to the termination of two biologists whose term appointments expired, and a third biologist that found another job. There were also travel and purchasing restrictions beginning around Feb 2025 that persisted through the year. The vessel contract for the Integrated Predator Prey survey was canceled because USGS no longer has the capacity to conduct these surveys. Therefore spending in the personnel, travel, and commodities categories was lower than proposed. Contractual costs were higher than proposed through 2025 because they include the 1/30/2026 contract award intended for 2026 field work at Middleton. This coop agreement was awarded two days before the EVOSTC FY26 began, as it was initiated slightly early due of uncertainty about a potential government shut down on Feb 1.

FY22-26

Project Number: 25120114-C
Project Title: Forage Fish Monitoring
Primary Investigator: Arimitsu (Ocean Bight LLC)

NON-TRUSTEE AGENCY SUMMARY PAGE