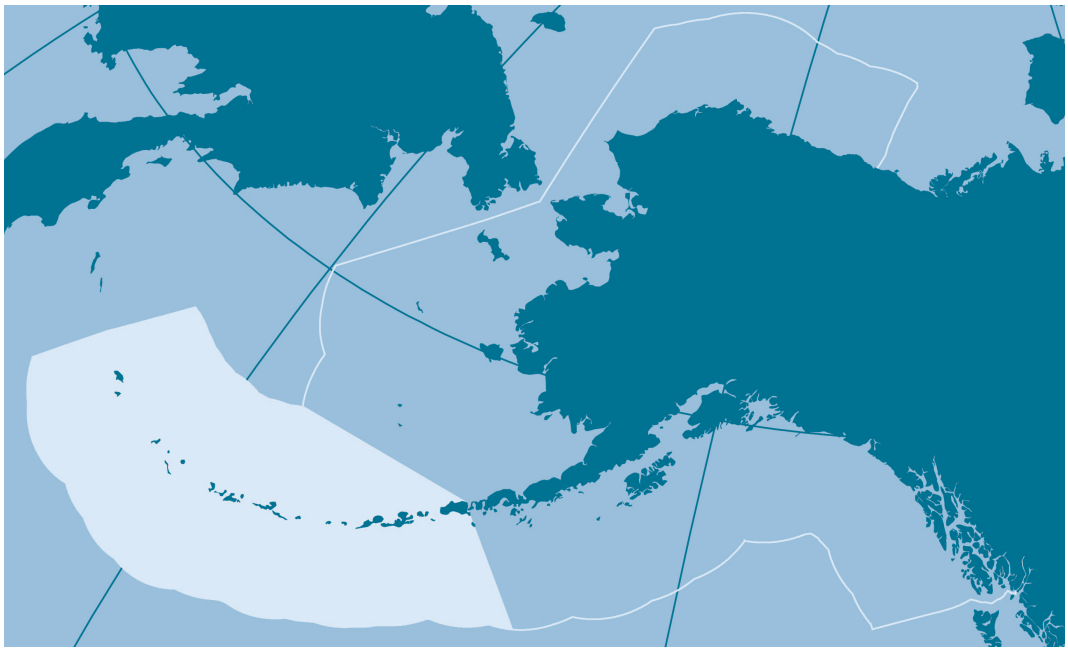
# Ecosystem Status Report 2026

# ALEUTIAN ISLANDS



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# Contributing Partners


















































# Purpose of the Ecosystem Status Reports

This document is intended to provide the North Pacific Fishery Management Council (NPFMC), including its Scientific and Statistical Committee (SSC) and Advisory Panel (AP), with information on ecosystem status and trends. It follows the same annual schedule and review process as groundfish stock assessments, and is made available to the Council at the annual December meeting when Alaska's federal groundfish harvest recommendations are finalized.

Ecosystem Status Reports (ESRs) include indicators developed and contributed by scientists and fishery managers at NOAA, other U.S. federal and state agencies, academic institutions, tribes, nonprofits, and other sources. The ecosystem information in this report will be presented to the Groundfish and Crab plan teams in their annual September and November meetings, presentations to the Council in their annual October and December meetings, and submission of the final report to the Council in December (see Figure 1).

The SSC is the primary audience for this report, as final acceptable biological catch (ABCs) is determined by the SSC, based on biological and environmental scientific information through the stock assessment and Tier process[1],[2]. Total allowable catch (TAC) may be set lower than the ABCs due to biological and socioeconomic information. Thus, the ESRs are also presented to the AP and Council to provide ecosystem context to inform TAC as well as other Council decisions. Additional background can be found in the Appendix (p. 132). Outside the annual harvest specification cycle, the Alaska Region and NPFMC use ESRs to support National Environmental Policy Act assessments for regulatory and plan amendments, discussion papers, protected species analyses, responses to constituency inquiries, and policy write-ups.

ESRs and Ecosystem and Socioeconomic Profiles (ESPs) are complementary documents that allow for incorporating ecosystem information into stock-specific Risk Tables (Dorn and Zador (2020)) and thereby directly considering ecosystem dynamics in management decisions (i.e., EBFM). Both documents inform the SSC's ABC and overfishing limit (OFL) recommendations, as well as for the Council's final TAC determination for groundfish and crab. ESRs provide ecosystem status and trends annually for three Large Marine Ecosystems: the Eastern Bering Sea, Aleutian Islands, and the Gulf of Alaska. ESRs include assessments that reflect ecosystem components ranging from physical oceanography up through the food-web. ESPs are both a process and a product and serve as a proving ground to identify key ecosystem and socioeconomic indicators within the stock assessment model and are presented as appendices in high priority stock assessments (see current list of available ESPs in Figure 1.

[1] https://www.npfmc.org/wp-content/PDFdocuments/fmp/GOA/GOAfmp.pdf
[2] https://www.npfmc.org/wp-content/PDFdocuments/fmp/BSAI/BSAIfmp.pdf

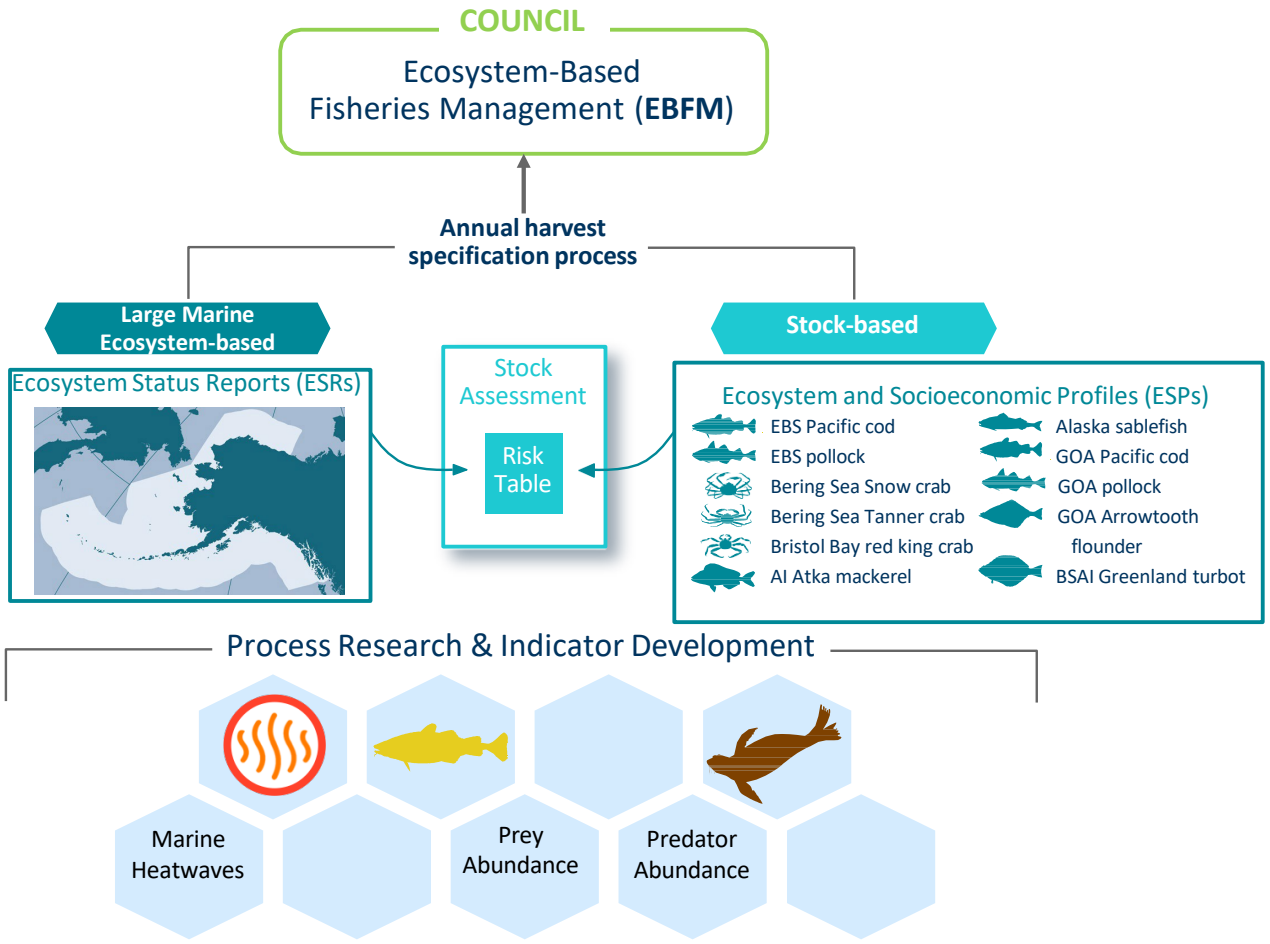



Figure 1: Ecosystem information mapping to support Ecosystem-Based Fisheries Management through Alaska's annual harvest specification process. The 'honeycomb' on the left shows examples of ecosystem indicators that are provided to Ecosystem Status Reports (ESRs) at the Large Marine Ecosystem (LME) scale and/or to Ecosystem and Socioeconomic Profiles (ESPs) at the stock-based level.

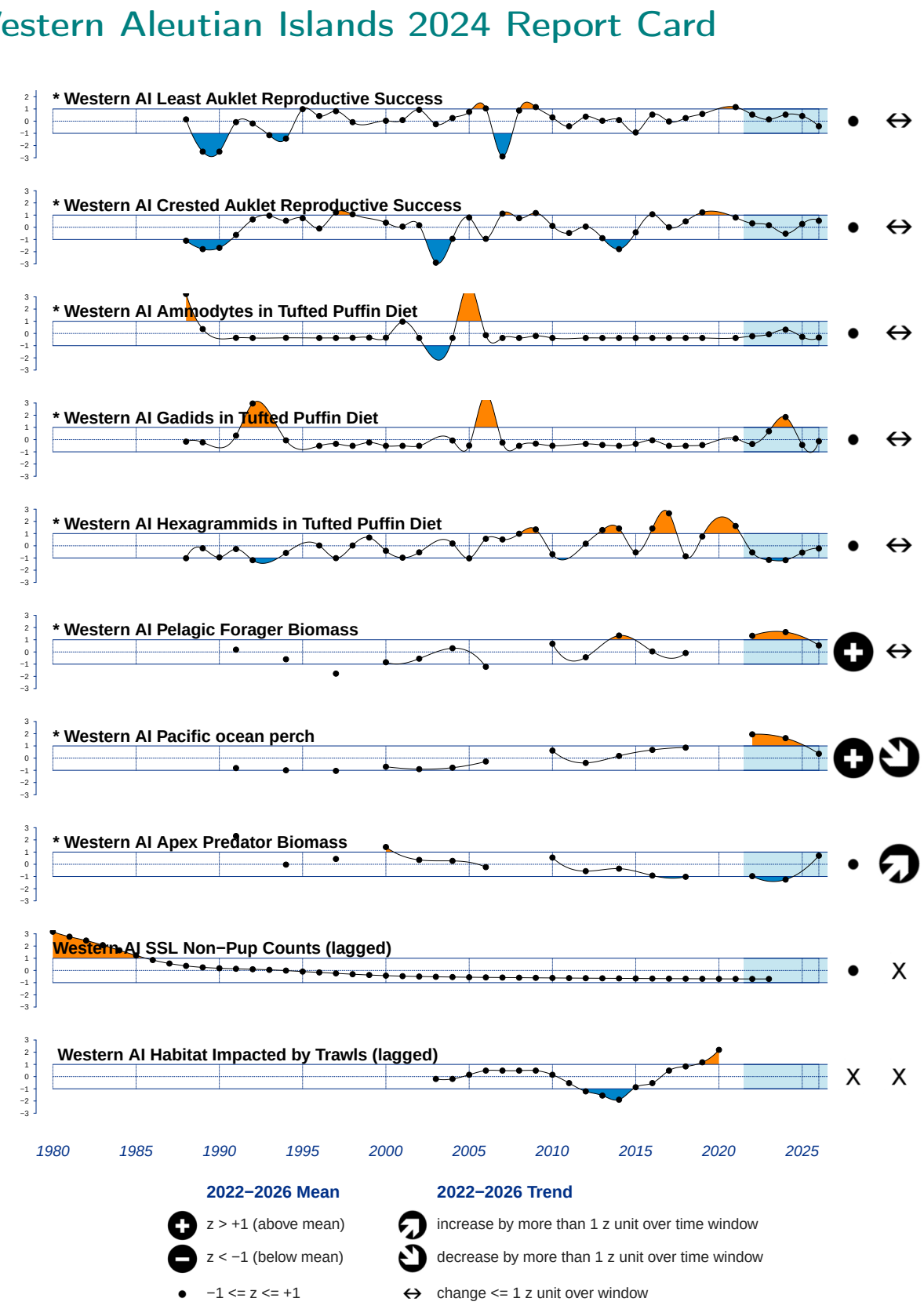



Figure 2: Region-wide and Western Aleutian Islands indicators. *indicates time series updated with 2026 data

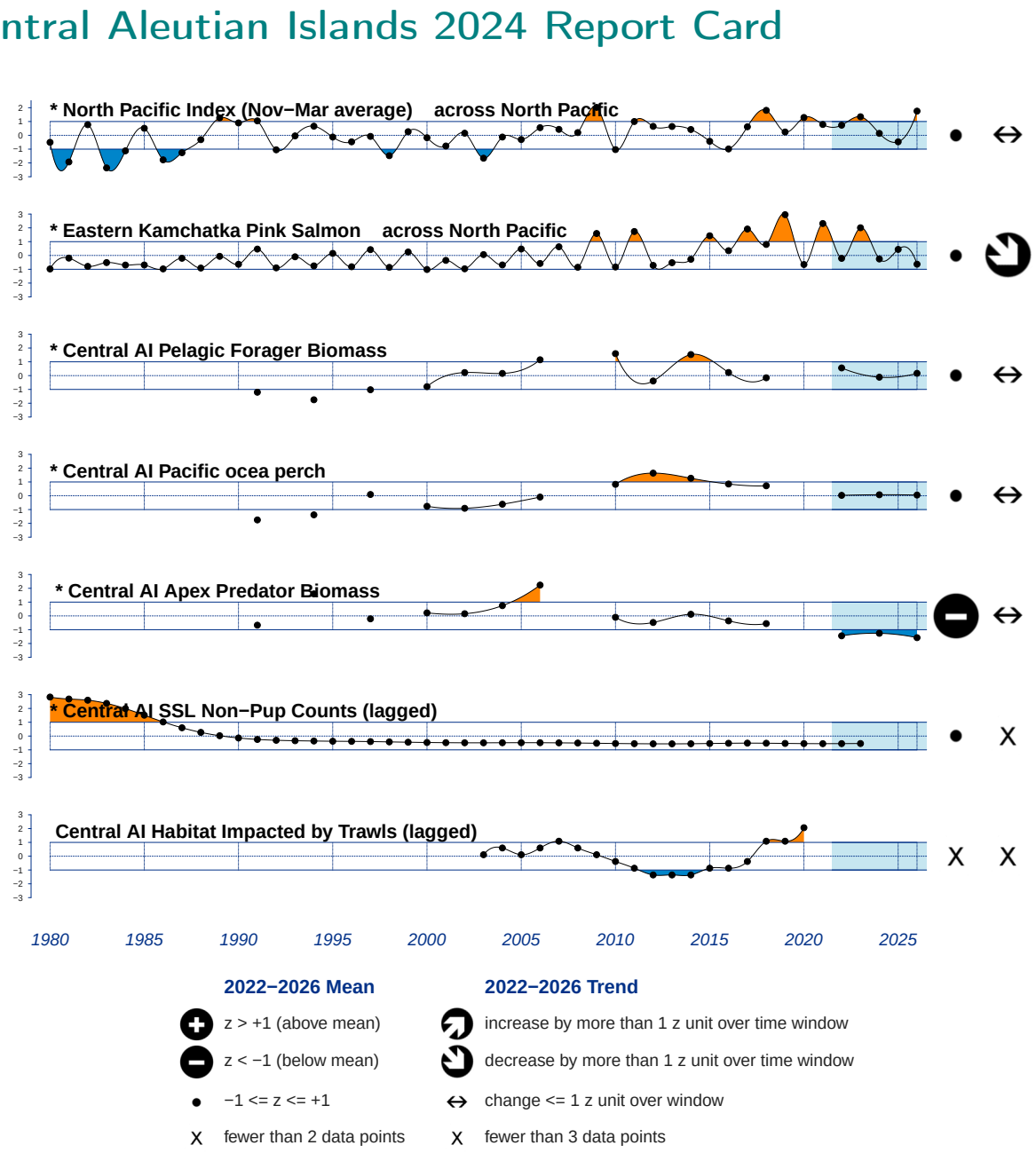



Figure 3: Central Aleutian Islands indicators. * indicates time series updated with 2026 data

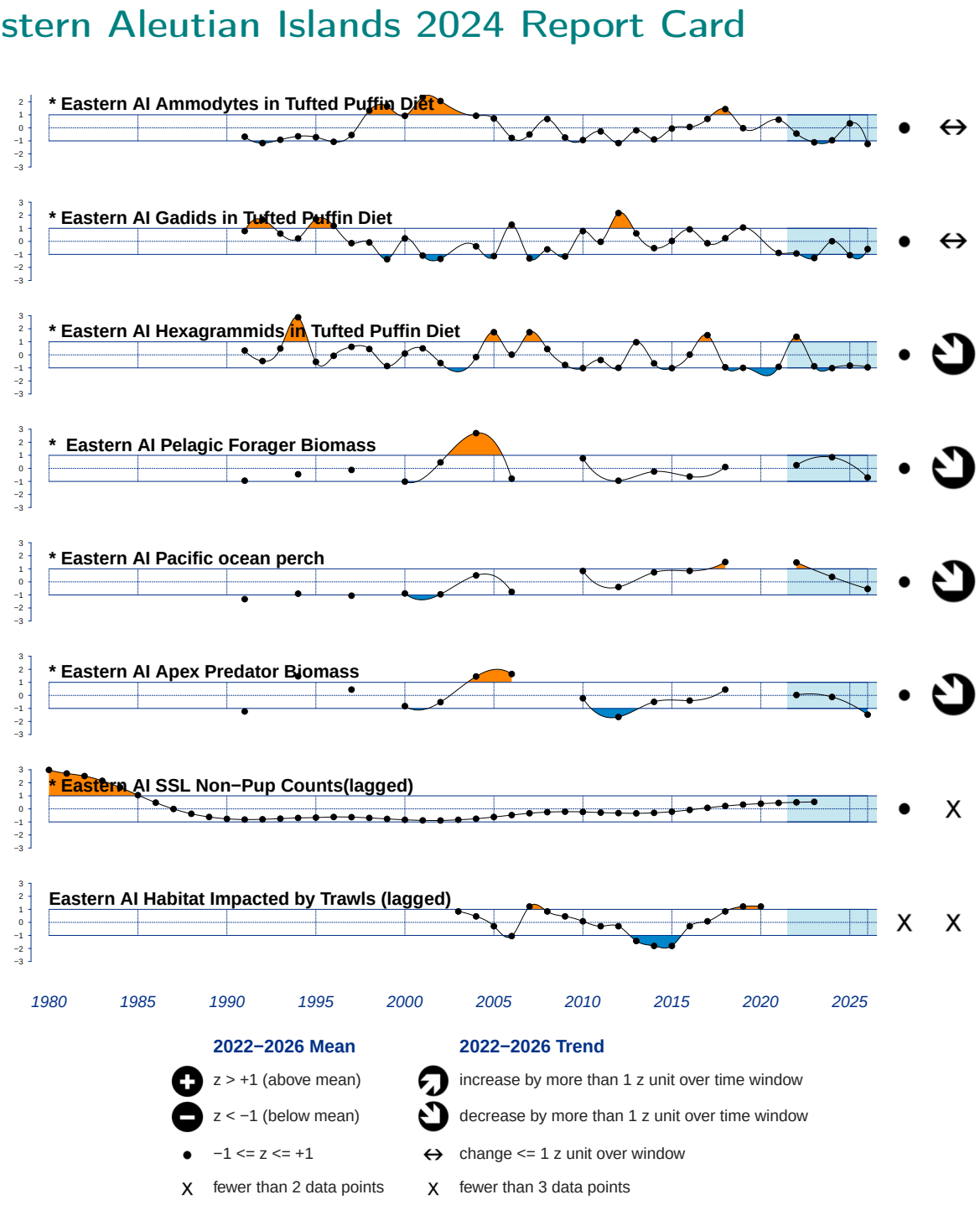



Figure 4: Eastern Aleutian Islands indicators. * indicates time series updated with 2026 data

For more information on individual Report Card Indicators, please see Description of Report Card indicators (p. 136). For more information on the methods for plotting the Report Card indicators, please see "Methods Description for Report Card Indicators" (p. 140).
* indicates Report Card information updated with 2026 data

To highlight the spatial dynamics and east to west gradients characterizing the Aleutian Islands, we divide the ecosystem into three ecoregions: the Western, Central and Eastern Aleutian Islands (p.11).

## Western Aleutian Islands

- ***Reproductive success of least auklets and crested auklets**: Reproductive success was generally good for auklets (planktivores) at Buldir Island. Three of the species (crested, parakeet and whiskered auklets) had average to above average breeding success, while only least auklets had below average reproductive success, suggesting prey availability was low for their preferred prey items but other prey were largely available. The overall good reproductive suggests that there was **average to good availability of zooplankton** to support seabird reproductive success and potentially other plankton-eating commercial groundfish species.

- ***Ammodytes, Gadids and Hexagrammids in tufted puffin chick's diet**: Forage fish trends, as indicated by their percent in the composition in tufted puffin chick meals, have varied over time, with episodic peaks lasting 1–2 years, but their frequency tends to be low at Buldir, as the primary prey in the region is squid. In 2026, *Ammodytes* (sand lance) were close to the time series average, as were those of age-0 gadids. Hexagrammids (primarily Atka mackerel) were also close to average from their diet. The primary prey has been squid the last two years (>60% by weight). Note puffin reproductive success was low, which suggests that they prey they brought back to their chicks was not optimal. This suggests **mixed availability of forage fish** and potentially mixed availability of prey for groundfish feeding on fish.

- ***Pelagic fish forager guild and Pacific ocean perch biomass**: The pelagic fish foraging guild includes Pacific ocean perch, northern rockfish, Atka mackerel, and pollock, with Pacific ocean perch and Atka mackerel having the highest biomass among commercial groundfish in the ecosystem. In the early 1990s Atka mackerel biomass was higher than that of Pacific ocean perch, until 2012 when the later surpassed Atka mackerel and has stayed the same since. Atka mackerel mackerel and pollock are widely consumed prey by fish, seabird and marine mammal predators, while rockfish are rarely preyed upon. The pelagic fish foraging guild biomass **decreased but stayed above the time series mean**, with the **decrease in 2026 driven by Pacific ocean perch and offset by northern rockfish**.

- ***Fish apex predators** biomass **increased driven largely by Pacific cod** and modest increases of Pacific halibut and arrowtooth flounder. The reduced thermal stress, particularly in 2024, may have favored an increase in the availability of fish prey, compared to past years.

- Steller sea lion numbers non-pups declined 5.7% between 2008-2023. The Steller sea lion count of non-pups was not updated this year.

- Habitat impacted by trawls: The amount of area trawled was not updated this year.

## Central Aleutian Islands

Region wide indicators are included here as this area has the highest extent and highest groundfish biomass. However, they influnce dynamics across the entire ecosystem.

- *Region wide: The **North Pacific Index (NPI)**: effectively represents the state of the Aleutian Low Pressure System. Above average (below average) winter (Nov-Mar) NPI values imply a weak (strong) Aleutian Low and generally calmer (stormier) conditions. Contrast to the previous two winters (2024, 2025) which had near normal conditions, the **2026 winter NPI had a large positive anomaly** at 3.76 hPa, an indication of a weak Aleutian Low in the region (Figure 10). This may have partially contributed to the highly variable ice edge during January and February 2026, and the exceptional southward expansion of sea ice extent in March and April that, combined with winds, cooled temperatures the Aleutians Islands.

- *Region wide: **Eastern Kamchatka pink salmon** is an exceptionally abundant population of wild pink salmon, especially in odd-numbered years. No hatchery production of pink salmon occurs in this region. Odd year runs began to increase over time. Biomass in odd years is high, low in even years. The largest run on record occurred in 2019, followed by a very small run in 2020, and alternated between very high biomass and small runs subsequently, until 2025 when biomass decreased substantially compared to previous odd years. Biomass **decreased in 2026 to levels similar to 2020**, among the lowest in recent even years. This biennial pattern was also apparent in other species, but appears to have been disrupted in later years.

- ***Pelagic fish forager guild biomass**: The pelagic fish foraging guild was close to the time series mean. While the **overall biomass stayed stable, pollock biomass decreased 80%, largely offset by northern rockfish**. This may decrease the prey availability for piscivorous predators in the area.

- ***Pacific ocean perch biomass**: In the early 1990s Atka mackerel biomass was higher than that of Pacific ocean perch, until 2012 when the later surpassed Atka mackerel and has stayed the same since. The biomass of Pacific ocean perch **was stable in 2026**.

- *The **Fish apex predator guild biomass** had a **slight increase** overall where large flatfish and other fish decreased and Pacific cod increased. The overall biomass is **still more than 1 SD below the time series average**.

- Steller sea lion non-pup counts. Within the central Aleutians, non-pup counts declined from 2008 to 2023 in the three westernmost rookery complex areas and increased slihtly in the one furthest east. Steller sea lion non-pup counts wer not updated this year.

- Habitat impacted by trawls.The amount of area trawled was not updated this year.

## Eastern Aleutian Islands

- ***Ammodytes, Gadids and Hexagrammids in tufted puffin chick's diet**: Forage fish trends, as indicated by their percent in the composition in tufted puffin chick meals, have varied over time, with episodic peaks lasting 1–2 years, but their frequency tends to be higher at Aiktak Is. In 2026, *Ammodytes* (sand lance) **were below the time series average**, as capelin comprised 72% of their diet. All seabirds at Aiktak Is. had average or above average reproductive success, suggesting seabirds were able to provide enough food to their chicks. This suggests **average to high prey availability of alternative forage fish** and potentially avergae to high availability of prey for groundfish feeding on fish.

- ***Pelagic fish forager guild and Pacific ocean perch biomass**: The overall **biomass of the pelagic foragers guild decreased to 30% compared to 2024**. The biomass of all species in this group decreased in the area, primarily Atka mackerel (~80% decrease); Pacific ocean perch decreased ~50%. Swings in Atka mackerel biomass are common in the area, but the decrease in both pollock and Atka mackerel helps explain their absence in tufted puffin chick's diets.

- The **fish apex predator foraging guild biomass decreased 50%**, driven by Pacific cod and arrowtooth flounder. This is the only area where Pacific cod decreased. The guild biomass had been consistently increasing from its lowest point in 2012 through 2018 and decreasing since since then.

- In contrast to the other regions in the Aleutian Islands, Steller sea lions non-pup counts show increases of 2.1% and 1.5% from 2008 to 2023. Increasing counts in this area offset declines observed in the other regions of the Aleutian Islands. In most regions, and population wide, stability in non-pup counts was preceded by stable pup counts.

- Habitat impacted by trawls: The amount of area trawled was not updated this year.

# Introduction

## The Aleutian Islands ecoregions

The Aleutian Islands ecosystem assessment and Report Card are presented by three ecoregions. The ecoregions were defined based upon evidence of significant ecosystem distinction from the adjacent ecoregions by a team of ecosystem experts in 2011. The team also concluded that developing an assessment of the ecosystem at this regional level would emphasize the variability inherent in this large area, which stretches 1900 km from the Alaska Peninsula in the east to the Commander Islands in the west. For the purposes of this assessment, however, the western boundary is considered the U.S.–Russia maritime boundary at 170°E.

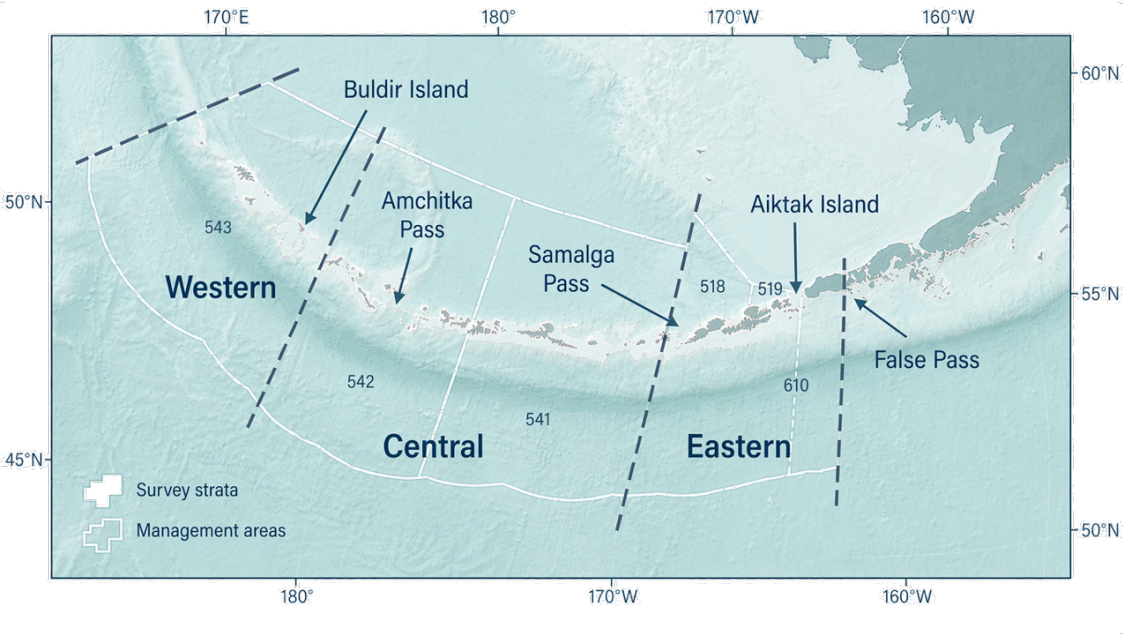



Figure 5: The three Aleutian Islands assessment ecoregions.

The three Aleutian Islands ecoregions are defined from west to east as follows (Figure 5). The western Aleutian Islands ecoregion spans 170° to 177°E. These are the same boundaries as the National Marine Fisheries Service area 543. This ecoregion was considered to be distinct from the neighboring region to the east by primarily northward flow of the Alaska Stream through wide and deep passes (Ladd, pers. comm.), with fewer islands relative to the other ecoregions.

The central Aleutian Islands ecoregion spans 177°E to 170°W. This area encompasses the National Marine Fisheries Service areas 542 and 541. There was consensus among the team that the eastern boundary of this ecoregion occurs at Samalga Pass, which is at 169.5°W, but for easier translation to fishery management areas, it was agreed that 170°W was a close approximation. The geometry of the passes between islands differs to the east and west of Samalga Pass (at least until Amchitka Pass). In the central ecoregion the passes are wide, deep and short. The Alaska Stream, a shelf-break current, is the predominant source of water (Figure 6). There is more vertical mixing as well as bidirectional flow in the passes. This delineation also aligns with studies suggesting there is a biological boundary at this point based on differences in chlorophyll, zooplankton, fish, seabirds, and marine mammals (Hunt and Stabeno, 2005).

The eastern Aleutian Islands ecoregion spans 170°W to False Pass at 164°W. The passes in this ecoregion are characteristically narrow, shallow and long, with lateral mixing of water and northward flow. The prominent source is from the Alaska Coastal Current, with a strong freshwater component. This area encompasses the NMFS areas

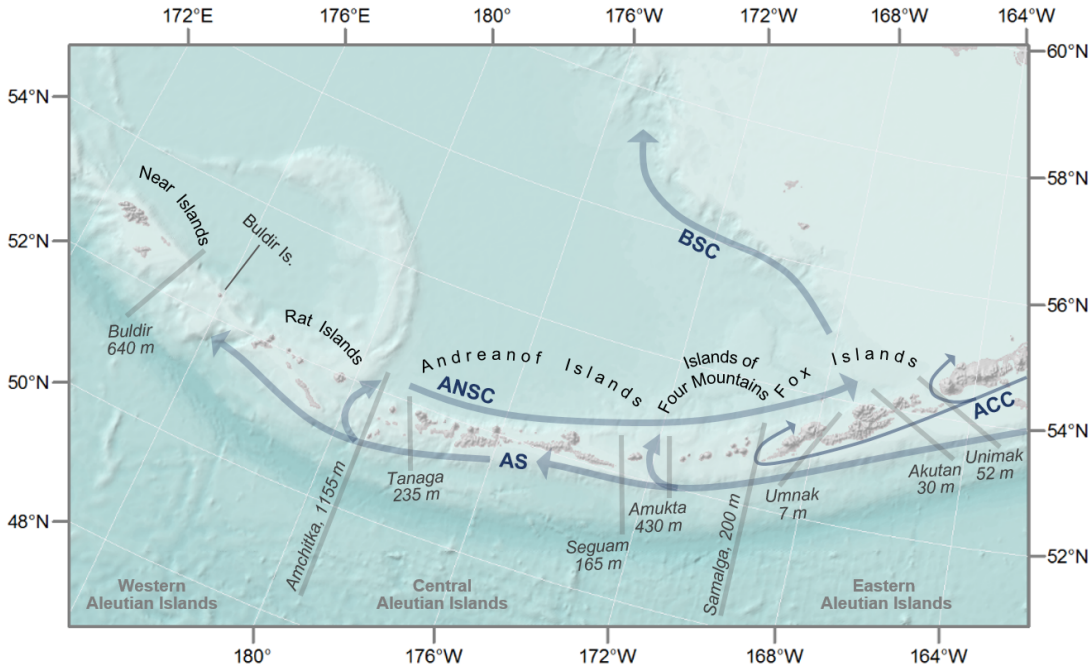



Figure 6: Ocean water circulation in the Aleutians. Currents are indicated with black lines. Currents are indicated by grey arrows. Selected passes are indicated by straight light grey lines

518, 519 (EBS) and the western half of 610 (GOA).

As the Aleutian Islands are situated between the Bering Sea and the Pacific Ocean, they are influenced by different ocean currents, eddies, and geographic constraints. Given these challenges, there are large gaps in knowledge about the local physical processes. The use of technology to address these challenges can be limited. For example, persistent cloudiness can preclude obtaining comprehensive satellite-derived data, and strong currents preclude the use of various unmanned underwater vehicles. The long distances involved in surveying the island chain make comparing west–east trends in indicators difficult due to time lags during oceanographic surveys across the region. The archipelago is also influenced by different processes in the eastern than in the western Aleutian Islands. Differences in survey timing and longitudinal gradients may also affect detection of biological patterns, as gradients are seldom monotonic in any direction. Integrative biological indicators such as fish or marine mammal abundances may be responding to physical indicators such as temperature, but are less sensitive to timing of when they are surveyed compared with direct measurements of temperature. Also, the extensive nearshore component of the ecosystem is a long, narrow shelf relative to the entire ecosystem, and strong oceanographic inputs mean that some metrics commonly used as ecosystem indicators in other systems may not be as informative in the Aleutian Islands. Therefore, our synthesis of ecosystem indicators by necessity includes speculation

# Ecosystem Assessment

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**Last updated: November 2026**

## Current Conditions 2026

*Climate and Oceanography: Partial relief, uneven conditions*. 2026 brought partial relief from prolonged warmth, but conditions remained uneven across the Aleutians—cooler and more productive in the east, warmer and more heat-retentive in the west. Winter sea surface temperature was still among the ten warmest on record (Fig XX), as higher sea surface temperatures and subsurface warming have persisted since 2020 over the central North Pacific Ocean. Strong spring winds from the west and south drove cooling across the Gulf of Alaska, Aleutian Islands, and Bering Sea, while anomalous warmth persisted in the central and western North Pacific and western Bering Sea.These conditions coincided with an earlier-than-usual spring bloom in April that declined by mid-May and resulted in widespread areas with below average phytoplankton biomass. Marine heatwave conditions were infrequent during spring and summer, particularly in the eastern Aleutians. Summer bottom and surface temperatures have generally decreased since the peak in 2016 but both show higher heat retention between 2016 and 2026 towards the west. Strong eddies increased flows during 2026. Both winds and eddies suggest enhanced upper-ocean mixing, which may have impacted the vertical distribution and availability of prey throughout the water column.

*Biological conditions in 2026: Moderate improvement of conditions across the ecosystem*. The overall relaxation of the multi-year warm conditions across the ecosystem seems to have supported the improvement condition for several fish such as southern rock sole, Pacific cod and Atka mackerel, although their condition indices remained below the long-term average. Small pollock and southern rock sole were the only species with above average condition, same as in 2024. The biomass of the fish apex predators, Pacific cod and Pacific halibut, increased in 2026 relative to survey indices in 2024. The biomass of several prey groups, such as shrimp, eelpouts and poachers, also increased. The overall biomass of both calcifying and non-calcifying structural epifauna has been increasing after lower abundances in 2016-2018. Both sea pens (calcifying soft corals) and sea anemones (which are non-calcifying and have been shown to thrive in lower-pH conditions elsewhere, Suggett et al, 2012) increased, whereas corals biomass declined. Both calcifying and non-calcifying structural epifauna provide important habitat complexity, foraging areas and nursery grounds.

*Multi-year biological trends: A persistent west–east productivity gradient*. While the west to east gradient from planktivorous to piscivorous food-webs is well documented for the Aleutians (Hunt and Stabeno 2005, Jahncke et al 2005, Aydin, 2007), indicators suggest a continued productivity gradient for piscivorous predators, with lower productivity in the western Aleutians and higher productivity towards the east, past Samalga Pass. This pattern is supported by declining west-to-east trend in piscivorous seabird reproductive success from 2021 to 2026 (Fig ??), fish apex predator biomass from 1991-2026 (Fig ??), and the most recent available Steller sea lion non-pup counts from 2024 (Fig ?? Ortiz and Zador, 2024). One contributing factor may be the switch in biomass dominance between Atka mackerel and Pacific ocean perch. Through the early 1990s to 2012 Atka mackerel was the dominant groundfish biomass; past 2012 Pacific ocean perch has dominated while Atka has had lower and variable biomass. Rockfish have remained stable and a relatively large proportion of the fish community in the west, while their proportion decreases towards the east where the proportion of roundfish tends to increase. Although rockfish are consumed by some predators, Atka mackerel and pollock are generally common and preferred prey. The decrease of Atka mackerel coincides with an increase of squid in the diets of Pacific cod and sablefish. Rockfish are also long-lived, locking down energy and resulting in slower energy transfer than the shorter, cycling flows of energy

cascading throughout the system associated with shorter-lived roundfish. This ecosystem structure may limit energy transfer to higher trophic levels while bringing stability to the ecosystem.

*Eastern Kamchatka (EK) pink salmon: Disruption of the biennial cycle*. Several papers link the pink salmon biennial pattern of abundance (high in odd years, low in even years) to trophic cascades, showing impacts on fish growth (Atka mackerel, Matta 2020), food availability for seabirds (Zador et al., 2013; Springer and van Vliet, 2014; Springer et al., 2018), salmon populations, and Pacific ocean perch recruitment (Ruggerone et al. 2023). Biomass of odd year runs began to increase over time, with step increases in 2009, and 2019. These step increases tend to be followed and decreases in biomass both during even and odd years. These extreme high/ low abundances may be followed by disruptions in the biennial pattern observed in other species (e.g. tufted puffins hatch dates, large diatoms, this Report). The low abundance in 2025 and 2026 suggest larger scale processes influencing productivity in the region.

*Looking ahead: Cooler winter temperatures in the eastern Aleutians and warmer towards the west may reinforce west-east productivity gradient*. The National Multi-Model Ensemble; (NMME; baseline 1991-2020) forecasts indicate sea surface anomalies of up to 1°C are likely to persist over the western Aleutians from January through March, and to extend to the central and eastern Aleutian Islands in March to May. The warm winter sea surface temperatures are consistent with ongoing long-term warming trends and may be expected independently of a lagged response to El Niño. Forecast confidence is high towards the eastern Aleutians but lower in the western Aleutians (Fig.?). The recently updated MOM6 NEP10k forecast (baseline 1994-2023) included in this Report projects bottom temperatures with a similar trend. Both forecasts have similar predictability: intermediate between for the Gulf of Alaska and eastern Bering Sea, deteriorating towards the west. Increased temperatures in the west could represent a return to the warmer temperatures observed in previous years, when fish condition declined as did the biomass of several taxa. The opposite is true for the eastern Aleutians, hence the observed west-east productivity gradient could be reinforced in the early part of the year. Temperatures are expected to increase later in the year, with biological responses varying depending on the magnitude and duration of the temperature increase.

## Western Aleutians

*Persistent warmth and strong eddy activity support mixed conditions with increased Pacific cod biomass but mixed foraging conditions*. Sustained high sea surface temperatures during winter resulted in a moderate marine heat wave in the western Aleutians (Figure ??) that lasted from January to June with temperatures close to the 1985-2014 average from July to August. Strong eddies are moving along the area, since July 2026 suggesting higher fluxes of nutrients, heat, and salt through the passes in the western Aleutians (Figure ??). Low to moderate phytoplankton biomass was observed south of the islands in April but declined by mid May. Warm sea surface temperatures over the western Aleutians have been the dominant trend for the last decade, which aligns with an increase observed since 2013 throughout Alaskan waters (Xiao and Ren 2023). The western Aleutians have shown the highest heat retention and sustained warm bottom temperatures, relative to the central and eastern Aleutians.

The 2026 NOAA bottom trawl survey observed a decrease in pelagic forager biomass and an increase in apex predator biomass compared to the last survey in 2024. The increase in apex predator biomass was largely due to an increase in Pacific cod. The relative proportion of rockfish to overall survey biomass estimates of pelagic foragers has remained $\tilde{7}5\%$ with northern rockfish increasing when Pacific ocean perch decreases and vice versa, with little change in the proportion of non-rockfish pelagic forager biomass. Small pollock condition index stayed above the long term mean. Overall pollock did not increase in this area, and they were not present in puffin chick diets. Both horned (nearshore) and tufted (offshore) puffins fed their chicks squid and Atka mackerel, but had below average reproductive success, as did least auklets (surface feeder). Overall, nine out of twelve monitored species had average to above average reproductive success which combined with the phytoplankton information suggest patchy prey availability and mixed foraging conditions both in the nearshore and offshore areas and throughout the water column.

## Central Aleutians

*Transitional conditions with near-average summer temperatures, mixed conditions for groundfish.* Similar to the Western Aleutians, the central Aleutians experienced a moderate but short marine heatwave in winter, with close to average sea surface temperatures from June to August. Bottom temperatures remained above average with some warmer spots in Petrel Bank. Eddy kinetic energy is typically lower overall in this region, and 2026 was characterized by average flows, indicating potentially below-average to average fluxes of nutrients and heat across the passes. There was moderate to high phytoplankton biomass, south of the central islands in April and within the Alaska Stream region in May then low in June.

The bottom trawl survey indices estimated pelagic forager biomass to have increased slightly with increases of rockfish driven by northern rockfish that offset a steep decline in pollock biomass. In contrast, the overall biomass of apex predators decreased because of the decline in large flatfish but Pacific cod biomass increased relative to the last survey in 2024. Generally, large flatfish biomass tends to increase in this area when cod biomass decreases and vice versa. As in the western Aleutians, the condition of most groundfish remained below average, with some increases in condition seen at the eastern portion of the region. Shrimp and eelpout biomass increased notably, particularly in the eastern portion of the region, potentially indicating an improving prey base for benthic foragers (Fig. ??). Sea pens have notably increased in the area during the last three surveys, potentially indicating improvements in the quality of foraging grounds and nursery areas for rockfish and other fish. In contrast to the western Aleutians, the relative proportion of rockfish biomass in the survey time series is not stable, but the absolute biomass is and trends in roundfish are more variable.

## Eastern Aleutians

*Cooling temperatures, a strong early spring bloom and forage fish availability.* This region encompasses the islands east of Samalga Pass to False Pass. This is the area with the widest temperature variability, both at surface and bottom. The marine heatwave over the winter was the shortest relative to the regions to the west, with average sea surface temperatures extending from April through August. Bottom temperatures were cooler than previous years, staying close to the 1991-2012 mean. Eddy kinetic energy was the highest on record in 2025, peaking in March and again as of October. The early phytoplankton bloom was most notable in this area, with high phytoplankton biomass north and south of the islands in April and sustained moderate to high biomass southeast of the islands in May. Mesoscale eddies are known to be a major physical forcing mechanism for localized high chlorophyll in this region.

Similar to the rest of the Aleutians, the condition of most groundfish continued to be below average with the exception of southern rock sole. There is no information for small pollock in this area. Pelagic forager biomass decreased but the relative proportion of roundfish has been increasing mostly due to the decline of rockfish in this area. Shrimps and sea anemones increased the most in this area (Fig. ??). Continued above average reproductive success of seabirds at Aiktak Island since 2019 (no surveys in 2020) suggests uniformly high prey availability for both nearshore and offshore foragers throughout the water column down to 100 m (Fig. ??). Late hatch dates might have resulted from strong winds and storms in the area. Capelin and pollock comprised most of the tufted puffin chick diet (offshore), while horned puffin chick diets (nearshore) were mostly Atka mackerel, sand lance and capelin, by weight. This indicates the high quality of forage fish available that contrasts to that of the western Aleutians.

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# Ecosystem Indicators

## Noteworthy Topics

We include information here that is deemed of relevance to ecosystem considerations of fisheries managers, but does not fit our typical indicator format. Information included here is often new, a one-time event, qualitative, some other type of non-standard ecosystem indicator, or a deeper discussion on a topic of interest. There are noteworthy topics for the Aleutian Islands this year.

# Ecosystem Status Indicators

Indicators presented in this section are intended to provide detailed information and updates on the status and trends of ecosystem components. Older contributions that have not been updated are excluded from this edition of the report. Please see archived versions available online[3].

## Biophysical Synthesis

This section provides an overview of physical oceanographic variables, with contributions from (in alphabetical order):

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**Last updated: November 2026**

***Synthesis*** *(Ivonne Ortiz)*

*Fall 2025 - Surface temperatures were 1–2°C above average across the Bering Sea basin and eastern Bering Sea shelf. Southward winds through the Bering Strait cooled the northern shelf and advected sea ice southward from November through February. A six-week period of unusually strong southward winds in March and April then drove a rapid late-season expansion of sea ice across the eastern Bering shelf, producing the greatest maximum sea ice extent in the Bering Sea since 2013 and the greatest local coverage at the M2 mooring since 2017. Although the ice retreated rapidly in mid-April, it persisted long enough to cool the southeastern shelf, where temperatures remained more than 2°C below average through summer. Strong winds from the west and south also cooled the Gulf of Alaska and Aleutian Islands during spring and summer, while persistent subsurface and surface warmth remained in the central and western North Pacific and western Bering Sea.*

[3] https://www.fisheries.noaa.gov/alaska/ecosystems/ecosystem-status-reports-gulf-alaska-bering-sea-and-aleutian-islands

*The North Pacific transitioned rapidly from La Niña to El Niño conditions during the reporting period. El Niño conditions emerged in June 2026 and strengthened through late summer. Strong-to-very strong El Niño conditions are expected through winter 2026–27, with warm anomalies projected to strengthen in the Gulf of Alaska and western North Pacific. The Aleutian Islands continued to experience a long-term warming trend, although conditions varied substantially among regions and seasons. Marine heatwave activity was limited during spring and summer 2026, particularly in the eastern Aleutians, where less than 25% of the region experienced moderate or strong conditions. This represented a break from the frequent marine heatwaves of the preceding winter. Marine heatwave conditions reemerged by late summer as subsurface warmth mixed upward.*

*Forecasts: NMME - Warm anomalies of at least 1°C are expected to persist over the central and western North Pacific and western Bering Sea, while temperatures in the Gulf of Alaska are projected to increase through spring 2027, with the greatest warming along the coast. These projections are consistent with a lagged response to the ongoing strong El Niño. Forecast confidence is high over the western and central North Pacific and Gulf of Alaska, while the eastern Bering Sea shelf forecast remains sensitive to seasonal sea ice coverage. Bottom temperature available from the MOM6 NEP10k seasonal forecast are similar to the NMME surface temperatures in that they are warmer for the WAI and cooler for the EAI*. The model has similar predictability as the NMME ensemble: intermediate between the Gulf of Alaska and the eastern Bering sea in the EAI and it deteriorates towards the west.

*The 2026 bottom trawl survey showed mean bottom temperatures more than one standard deviation above the 1994–2012 reference period in the western and central Aleutians, while temperatures in the eastern Aleutians were near average. Warm bottom anomalies covered most of the western and central survey area, in contrast to 2024, when warm anomalies were limited to smaller locations. Mean surface temperatures were near average throughout the Aleutian Islands and were spatially variable, increasing from east to west. These bottom-temperature patterns may affect habitat use, prey consumption, growth, and recruitment of commercially important species.*

*The pilot Modular Ocean Model version 6 Northeast Pacific model provides year-round estimates of bottom temperature across Alaskan waters. Simulated Aleutian bottom temperatures showed relatively low spatially averaged variability, with conditions near the upper end of the observed range and anomalies of approximately 0.3°C in winter increasing to about 0.4°C above the 1993–2022 climatological mean by mid-summer. Stronger warm anomalies reappeared in late July and August across the Aleutian Islands, western Gulf of Alaska, and southern Bering Sea. The Aleutian region has not yet been fully validated, and the model may underestimate transport through the passes; nevertheless, it provides a useful year-round framework for evaluating the risk of temperatures outside optimal ranges during different life stages of commercially important species.*

*Local transports of heat, salt, and nutrients through the Aleutian passes were likely elevated during 2025 and the first half of 2026. Eddy kinetic energy in the western Aleutians remained above climatology through mid-2026, associated with a large anticyclonic eddy that began moving out of the region in July. South of Amukta Pass, 2025 had the highest eddy kinetic energy in the record, associated with a strong southwestward-propagating anticyclonic eddy, and strong eddy activity continued into part of 2026. These conditions are consistent with enhanced Alaska Stream influence and potentially greater transport from the North Pacific into the Bering Sea, although the relationship between eddy activity, mean flow, and transport remains uncertain.*

*Above-average chlorophyll-a (chl-a) concentrations in early spring 2026 suggested an earlier-than-usual bloom, with strong positive anomalies in the Alaska Stream region, the southeastern Aleutian Basin, and a mesoscale feature south of the Alaska Stream. Bloom conditions weakened in mid-May, and negative anomalies became widespread by June. Fall 2025 chl-a concentrations were average to above average but spatially variable. High chl-a centered near $188°W$, $51°N$ in May and June 2026 formed a ring-like pattern consistent with a mesoscale eddy near the Alaska Stream, supporting the role of eddies in redistributing nutrients and mixing shelf, slope, and offshore waters. No trend was evident in spring seasonal mean or maximum chl-a, while fall seasonal mean chl-a showed a modest positive trend. A modest correlation between fall chl-a and the following spring, together with*

*intermittent biennial patterns, suggests combined effects of ocean climate, mesoscale variability, and pink salmon grazing.*

*The CPR data, which only retains large, hard-shelled phytoplankton(i.e. diatoms) has revealed a general alternating (and opposing) pattern of high and low abundance of diatoms and large copepods between 2000 and 2012, believed to be the result of a trophic cascade caused by maturing Pink Salmon. The region sampled about 4 times a year from spring to fall. For 2025, large diatom biomass was above the time series average, while copepod community size was below than average, coinciding with what would be expected in a high abundance pink salmon year, but further investigation is needed. The meso-zooplankton (medium-sized zooplankton of 0.2 to 20 millimeters in size) biomass continues what appears to be a decreasing trend, though it is unclear what may be driving the potential decrease.*

We provide an overview of the physical oceanographic conditions impacting the Aleutian Islands, describe conditions observed from fall 2024 through summer 2025, and place 2025 in the context of recent years. The physical environment impacts ecosystem dynamics and productivity important to fisheries within the system and their management. The information has been merged across sources, from broad-scale to local-scale, and is presented following the outline below:

Outline:

1. Regional Highlights
2. State of the North Pacific
3. Seasonal Projections of SST from the National Multi-Model Ensemble (NMME)
4. Long Term Sea Surface Temperatures
5. Regional Sea Surface Temperatures
6. Survey Surface and Bottom Temperatures 7. Simulated Bottom Temperatures, MOM6
8. Ocean Transport: Eddies in the Aleutian Islands
9. Satellite Chlorophyll-a 10. Zooplankton: Continuous Plankton Recorder data

## 1. Regional Highlights

*Contributed by Emilie Lemagie and Shawn Bell*

Sea surface temperatures (SST) and sea ice data from the NOAA High-resolution Blended Analysis of Daily SST and Ice (OI SST V2[4]), along with 10-m wind data from the ERA5 Reanalysis[5] from September 2025 – August 2026 are described across four regions of the North Pacific Ocean and U.S. Arctic: 8, 3, 7 and 2 (Figure 7).Note the transition this year to the ERA5 Reanalysis from the National Centers for Environmental Prediction (NCEP) due to data availability; the conclusions in this report are not impacted by the change.

The North Pacific underwent a rapid transition from La Niña to El Niño conditions this last year (Fig. 10). Notably, strong winds from the north drove rapid cooling and sea ice expansion across the Bering Sea in March and April. This late season burst resulted in the most sea ice coverage at the southern Bering Sea shelf M2 ecosystem mooring than observed since 2017. Through summer, cool surface temperature anomalies extended across the Bering Sea and Gulf of Alaska. However, warm anomalies that have been present since 2020 persisted in the western and central North Pacific from south of the Aleutian Islands and into the Bering Sea deep basin. By late summer, as the El Niño in the tropical Pacific gained strength, the Gulf of Alaska has rapidly transitioned back to above average surface temperatures, with anomalies projected to increase through the coming winter.

[4] https://psl.noaa.gov/data
[5] https://cds.climate.copernicus.eu/datasets/reanalysis-era5-land

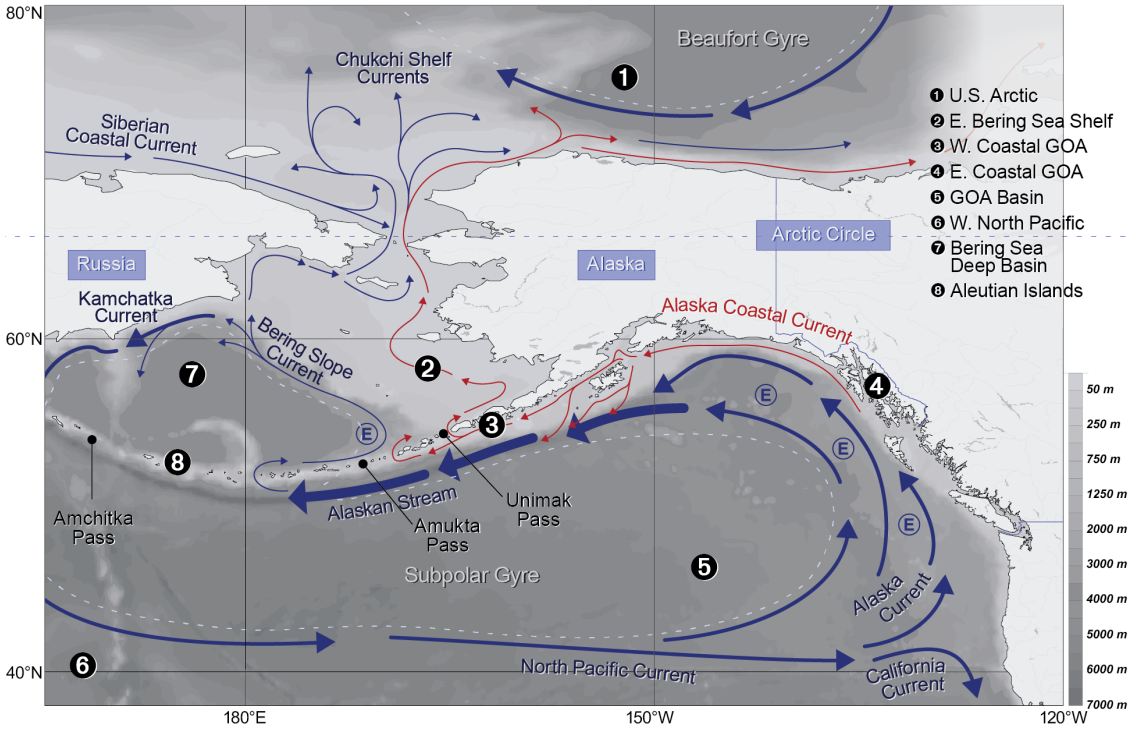



Figure 7: Geographic regions of interest, ocean bathymetry, and mean currents across the North Pacific and U.S. Arctic. Figure courtesy of Sarah Battle, PMEL.

*Aleutian Islands:* Since 2020, strong SST anomalies and subsurface warming has persisted over the central North Pacific Ocean, as indicated by ocean indices such as the PDO and marine heatwave statistics Figure 10 and MHW section). Weaker, but largely persistent warm anomalies have also spanned much of the Aleutian Islands–particularly in the west–and Bering Sea basin. Anomalous spring and summer winds disrupted typical atmospheric and oceanic heat transport, driving cooler ocean temperatures eastward across the archipelago. Sea surface temperatures dropped below the marine heatwave threshold in mid-summer across the western and central Aleutians. However, moving into fall, marine heatwave conditions have reemerged as subsurface warmth mixes to the surface.

*Western Coastal Gulf of Alaska:* Coastal temperatures in the western Gulf of Alaska were warmer than average from the summer of 2025 through the end of the year (Figure 8)Driven by a weak winter Aleutian Low, southerly warm air advection remained minimal (Figure 9). Strong spring winds from the west then brought cool air into the region, deepening the mixed layer and delaying stratification. As a result, western coastal Gulf of Alaska temperatures have tracked near or below average since spring 2026. Warm anomalies have already reemerged in late summer, and are likely to remain through the strong winter El Niño that is projected as the warm coastal anomalies that are already impacting the U.S. west coast propagate around the coastal Gulf of Alaska.

*Bering Sea Deep:* Above average surface temperature anomalies ĩ-2°C persisted across the Bering Sea basin since autumn 2025, similar to the conditions since autumn 2024 (Figure 8). Through much of the last year, winds were weaker than average over the basin. In particular, due to the extremely weak Aleutian Low pressure over winter, there was less advection of cool air from northern latitudes (Figure 9). Transport of heat from lower latitudes via the Alaska Stream that feeds the Bering Slope and Kamchatka current (e.g., Figure 7) and from warm air temperature anomalies over the region likely contributed to the above average basin surface temperatures. The slightly below-average sea ice extent this winter near Cape Navarin–where the Bering Slope current becomes the Kamchatka current–was likely due to the warm current melting the ice along the leading edge.

*Eastern Bering Sea Shelf:* In autumn 2025, the eastern Bering shelf surface temperatures were 1-2°C above average (Figure 8). In November, southward winds through the Bering Strait began to cool the northern Bering sea shelf and advect sea ice southward. The sea ice extent as it advanced over the shelf from November through February was near-average, varying in association with the prevailing winds. In March and April, a six week period of anomalous southward winds drove a rapid expansion of sea ice southward–passing the long-term M2 mooring site, and extending into Bristol Bay and to the Aleutian Islands. This resulted in the greatest local sea ice coverage at M2 since 2017, and the greatest maximum sea ice extent across the Bering Sea since 2013. This rapid late-season expansion was followed by a rapid retreat in mid-April. However, the sea ice was present long enough to cool the waters of the southeastern Bering Sea shelf, and temperatures cooler than 2°C below average have persisted through the summer.

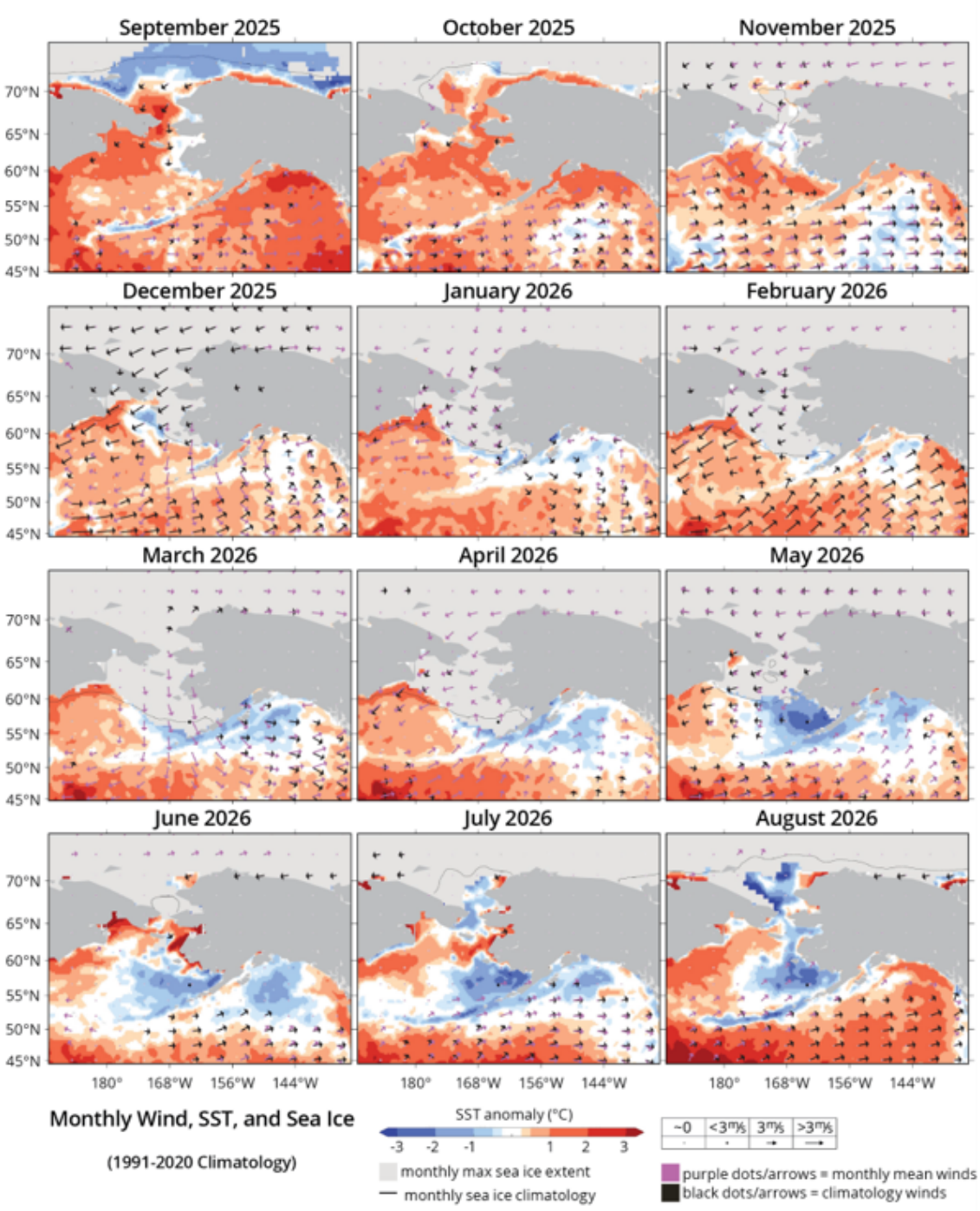



Figure 8: Monthly mean maps of sea surface temperature (SST) anomalies and surface winds. Monthly climatological winds (black) are compared to monthly mean winds (purple). The climatological period is from 1991–2020. SST data are from the NOAA High-resolution Blended Analysis of Daily SST and Ice (OISST) available from NOAA's Physical Sciences Laboratory1, and 10-m wind data are from the ERA5 Reanalysis available from the Copernicus Climate Change Service3. Figure design courtesy of Sarah Battle, PMEL.

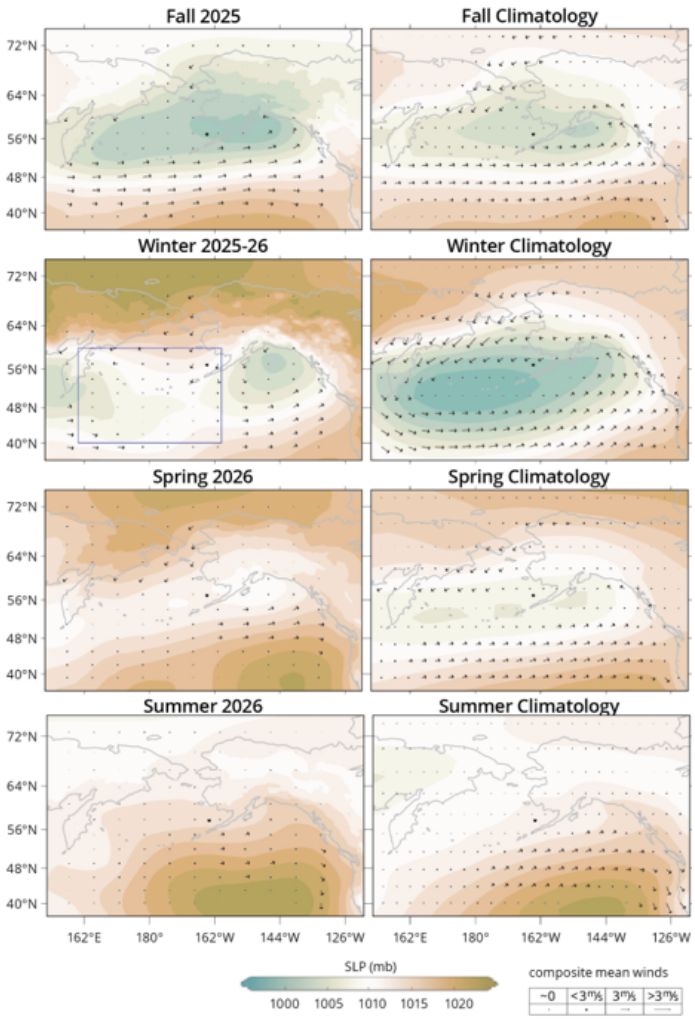



Figure 9: On the left, Seasonal SLP and mean winds for autumn (Sep–Nov 2025), winter (Dec 2025–Feb 2026), spring (Mar–May 2026), and summer (Jun–Aug 2026). On the right, climatologies of seasonal mean SLP and wind calculated from 1991–2020. The blue box over the winter panel corresponds with the region over which the AL climate index is calculated (Figure 11). Data are from ERA5 Reanalysis available from the Copernicus Climate Change Service.

## 2. State of the North Pacific Ocean

*Contributed by Emily Lemagie and Muyin Wang*

Strong positive SST anomalies have dominated the mid-latitudes of the global oceans this summer. As these anomalies increase in the eastern equatorial Pacific, El Niño conditions have strengthened (Figure 10). The latest update from the NOAA Climate Program Center is for a 90% chance of a very strong El Niño this coming autumn through winter. Though weaker in magnitude, positive SST anomalies have also dominated in the North Pacific and Bering Sea basins (Figure 8. In contrast, along the Gulf of Alaska and Bering sea shelves–especially above $50°$–surface ocean temperatures were below average in spring and summer 2026. In winter, as El Niño reaches peak strength and the impacts expand northward, warm anomalies are expected to strengthen in the Gulf of Alaska, where ocean forecasts from the NOAA Physical Sciences Laboratory projects 50% chance of reaching marine heatwave threshold by winter.

The mean atmospheric circulation over the North Pacific during the winter of 2024-2025 featured relatively modest anomalies, as has generally been the case during the previous 5 years. The mean winter sea level pressure over the North Pacific did include a moderately strong Aleutian Low, whether integrated from November through March, or only in January and February when the pressure system is most consistently developed (e.g. NPI and AL

indices, Figure 11). The center of the mean Aleutian low pressure was located south of $51°$N, so its longitude was not registered by the ALlon index this past winter. In the spring, the development of a strong North Pacific high pressure and a mean low pressure centered around Kodiak Island resulted in unseasonably strong winds over the Gulf of Alaska and Bering Sea (Figure 9). Through the summer, the persistence of the mean high pressure over the North Pacific was also associated with anomalous eastward winds over the North Pacific between 40-$50°$N and towards the northeast over the southern Bering Sea.

The Aleutian Low is the dominant feature of the atmospheric pressure system in the North Pacific during winter (Dec-Mar). In general, the intensity and position of the Aleutian Low can significantly impact storm tracks, ocean circulation, and weather across the North Pacific. A stronger Aleutian Low means the Bering Sea tends to be warm, stormy, and have less ice. This past winter, the Aleutian Low was extremely weak (Figures 9, 11). This reduced the poleward advection of warm air masses over the eastern North Pacific and the southward advection of Arctic air masses over the Bering Sea. Winter air temperature anomalies were cool over much of Alaska, except along the northern coast, while warm air temperature anomalies spanned the Russian continent and most of the North Pacific west of the dateline. This contrast marks a departure from the previous three winters, when above-average temperatures were anchored over Alaska and neighboring regions experienced far greater variability. In spring, the steep pressure gradient between the high pressure to the north and low pressure systems moving across the Aleutian Islands and Gulf of Alaska drove strong southward winds, bringing cold air and sea ice across the Bering Sea and rapid cooling into the North Pacific. (Figure 8, 11).

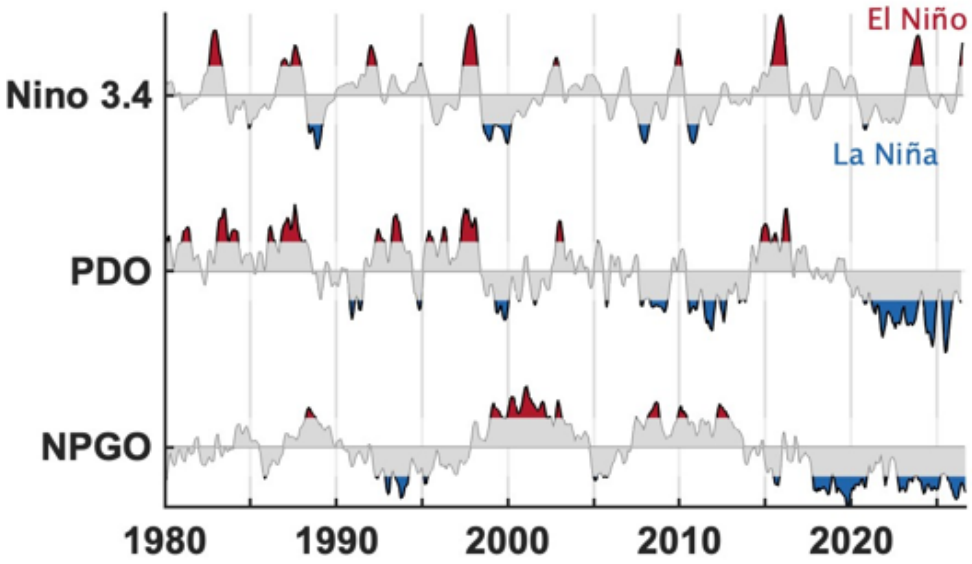



Figure 10: Time series of three commonly used indices for relating patterns across the Alaska marine ecosystem, including the NINO3.4 index for the state of the El Nino/Southern Oscillation, the Pacific Decadal Oscillation (PDO) index, and the North Pacific Gyre Oscillation (NPGO) index, from 1980 to present. Each monthly index is normalized using a 30-year climatology from 1991–2020 and smoothed using a 3-month running mean. Red and blue shading indicates positive and negative values outside of one standard deviation, respectively. Lighter shaded areas are within one standard deviation of the 30-year climatology. Additional information on these indices can be found on the NOAA Physical Sciences Laboratory website.

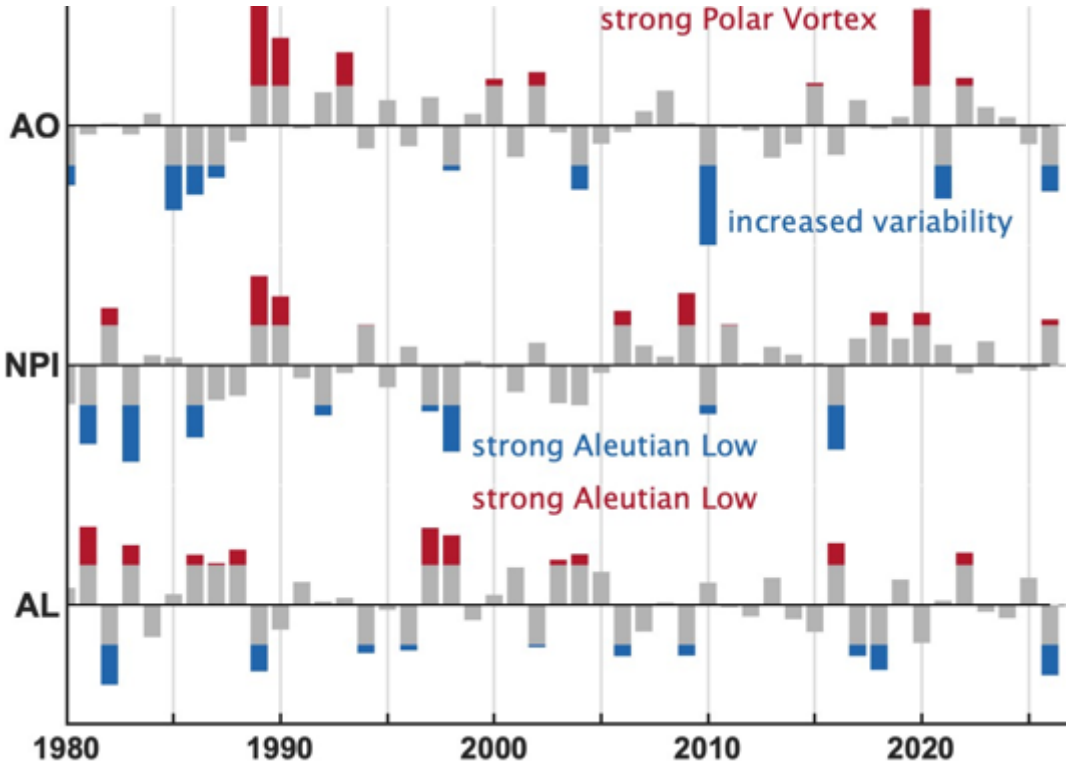



Figure 11: Time series of four indices for relating atmospheric patterns across the Alaska marine ecosystem, including the Arctic Oscillation (AO), North Pacific Index (NPI), Aleutian Low index (AL), The AO and NPI indices are averaged over the winter period from November to March, while the two Aleutian Low indices are calculated as averaged over the months of January and February. The NPI and AL are normalized using a 30-year climatology from 1991–2020. Red and blue shading indicates positive and negative values, respectively, outside of a threshold value (AO = $\pm 1$) or of one standard deviation from the mean (NPI and AL). Additional information on these indices can be found on the NOAA Physical Sciences Laboratory website.

## 3. Seasonal Projections of SST from the National Multi-Model Ensemble (NMME) and MOM6 NEP10k

*Contributed by Emily Lemagie, Kelly Kearney, and Ivonne Ortiz*

The climate prediction center/ NCEP provides monthly statements on the recent evolution, status and prediction of El Niño Southern Oscillation (ENSO)[6].El Niño conditions emerged in June 2026, are currently present and continue to strengthen, with a strong-to-very strong El Niño likely through January-March 2027 (83% for October-December, and 70% for November-January)[7] El Niño warming is in addition to the warming of the North Pacific. It turns out that the North Pacific is warming at a greater rate than most of the rest of world's mid-latitude regions; the mechanisms and implications of these changes, including a negative state of the PDO, are attracting the attention of the climate community (e.g.,Klavans et al. 2025).

Seasonal predictions of SST anomalies from the National Multi-Model Ensemble (NMME) are shown in Figure 12. An ensemble approach incorporating different models is particularly appropriate for seasonal and interannual predictions. The NMME represents the average of eight climate models. The uncertainties and errors in the predictions from any single climate model can be substantial. More detail on the NMME, and predictions of

[6] https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf
[7] https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.shtml

other variables, are available at the NCEP website[8]. A description of the probability forecasts can be found on the NOAA NMME website. This probability forecast combines predictions from 79 model ensembles and divides the outcomes into three equal groups: Above normal, Below normal, and Near normal. Map contours highlight a specific category whenever a clear consensus emerges: Above (A) or Below (B) is shown if at least 38% of models favor that outcome while fewer than 33% favor the opposite. If Near Normal is also high (over 33%), the Above or Below forecast still takes priority. Near Normal (N) is shown only when more than 38% of models predict average conditions and both Above and Below remain under 33%. White areas indicate uncertainty where no single category dominates—either because model votes are split evenly across all three outcomes, or because models are conflicting heavily between Above and Below.

Surface temperatures are projected to be below—but within $0.5^{\circ}$C—of the historical mean temperature over the eastern Bering Sea shelf. However, the winter and spring forecasts are highly dependent on seasonal sea ice coverage. Warm surface ocean temperatures $\geq 1^{\circ}$C above typical are likely to persist over the central and western North Pacific and the western Bering Sea. Gulf of Alaska temperature anomalies are projected to increase over time, with greater warmth along the coast, particularly in the eastern coastal Gulf of Alaska, through spring 2026. This pattern is consistent with a lagged response to the ongoing El Niño in the tropical Pacific. In the eastern north Pacific basin, south of the Gulf of Alaska, near-normal or slightly below average surface temperatures are forecast. There is high model agreement across the ensemble member forecasts, particularly in the western and central North Pacific and in the Gulf of Alaska.

MOM6-NEP10k - Forecasted Bottom temperatures are similar to the NMME surface temperatures in that they are warmer for the WAI and cooler for the EAI (not shown). Temperature estimates for Jan to March 2027 (3-4 months lead for Jan, 4-5 for February, forecast), with the forecast initiated in October are projected cooler than in 2026, between $3.8^{\circ}$C and $4^{\circ}$C. The Aleutian Islands region was not evaluated. However, when visually evaluated (based on figures 2-4, Jacox et al in review), predictability is similar to that of the NMME ensemble: intermediate between that for the Gulf of Alaska and the EBS in the eastern Aleutians, and it deteriorates toward the western Aleutians.

[8] `https://www.cpc.ncep.noaa.gov/products/NMME/seasanom.shtml`

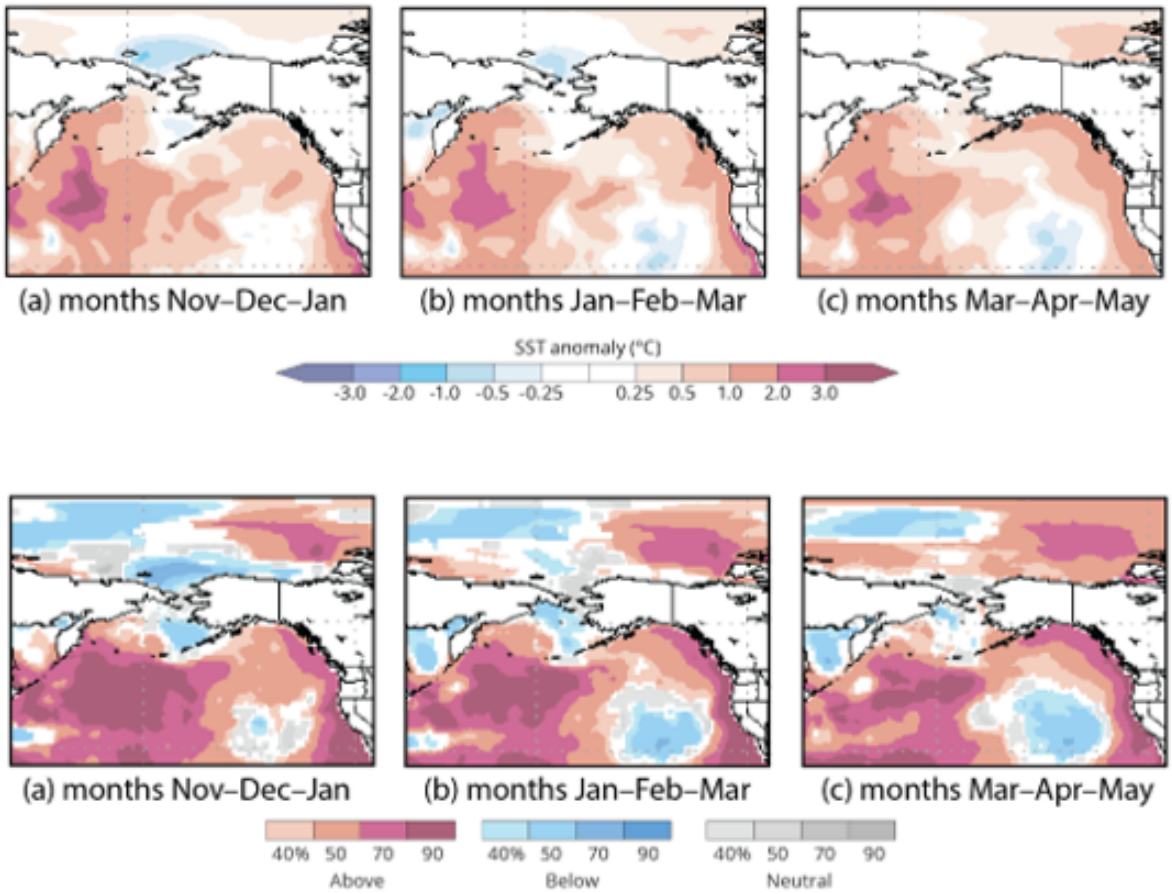



Figure 12: Predicted SST anomalies from the NMME model for Nov–Dec–Jan (1-month lead) for the 2025–2026 season, Jan–Feb–Mar (3-month lead), and Mar–Apr–May (5-month lead) 2026

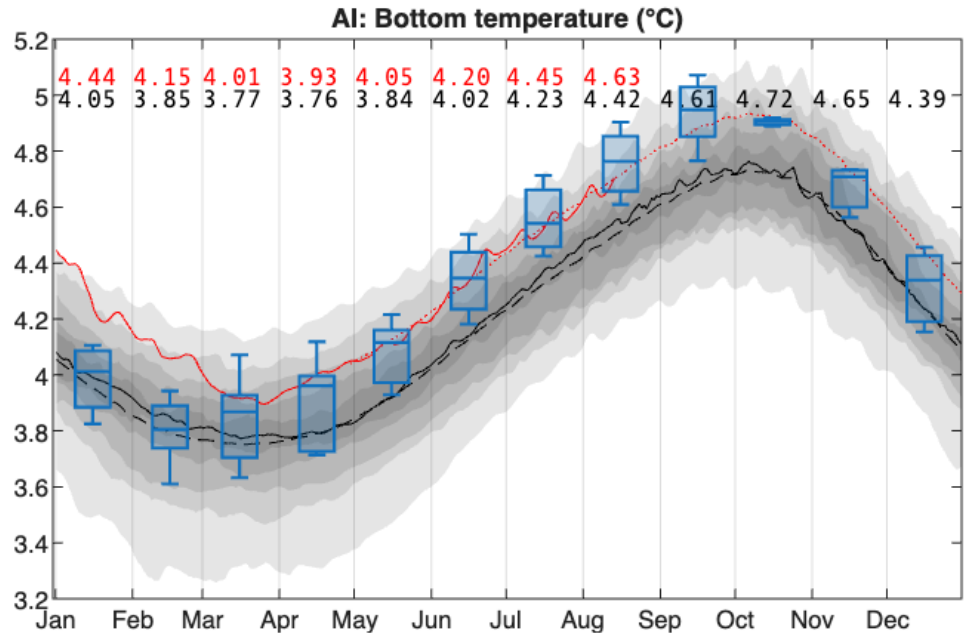



Figure 13: Time series of Jan-Dec forecast calculated across the AI survey area. Red line = 2026, red dotted line = spring-initiated persistence forecast, black solid line = median across 1993–2026, black dashed line = climatological (1993–2022) mean, shaded gray = 1993–2026 percentiles (lightest = 0-10% and 90-100%, darkest = 40-60%). Numbers indicate the values on the first of the month in the climatological mean (bottom, black) and in 2026 (red, top). Blue boxplots depict the October-initiated dynamic seasonal forecast, running from Oct 2026 through Sep 2027, with boxes indicating the spread across the 10-member ensemble.

## 4. Regional Long-term Sea Surface Temperature

*Contributed by Rick Thoman*

Long-term sea surface temperatures in the Aleutian Islands can be calculated using NOAA's Extended Reconstructed SST V6 data[9]. ERSST is a global monthly sea surface temperature dataset produced at 2 x 2 resolution starting in 1854. Statistical processes are used to infill data sparse/missing areas and standardize the many ways that ocean surface temperatures have been collected and reported over the decades. However, known problems remain, especially pre-1900 and in the WW2 era and in general in Arctic and Southern Oceans. Constrained B-Spline regression used here is a form of nonparametric quantile regression using quadratic splines. This approach allows for conditional estimates of any quantile of interest. Initial analyses examined eastern, central and western AI separately, but regions were combined due to reduced subregional sample sizes and similar trends across the three ecoregions.

[9] https://climatedataguide.ucar.edu/climate-data/sst-data-noaa-extended-reconstruction-ssts-version-6-ersstv6

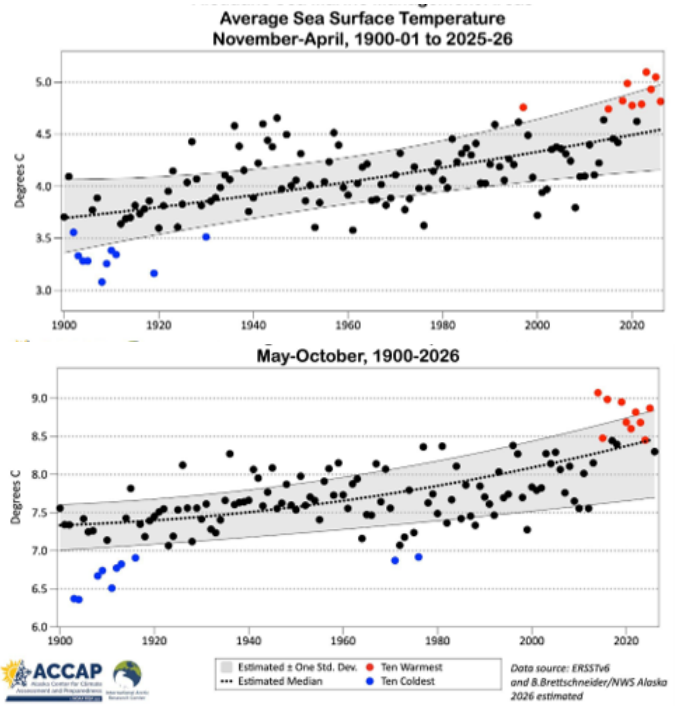



Figure 14: Sea surface temperatures for the Aleutian Islands from 1900–2026 for (a) winter (Nov–Apr). and b) summer (May–Oct, preliminary -through early September only). Presented here are the quantiles representing ±1 standard deviation of a Gaussian distribution and for completeness the median calculated using constrained B-Spline regression.

**Status and Trends**: The surface waters in the Aleutian Islands have been warming since 1900. This analysis provides context for the short-term sea surface temperature time-series presented in the next section. The seasonal difference in warming trends is not determined but could be due to changes in stratification, precipitation and freshwater runoff, cloud cover, circulation or other oceanographic and atmospheric drivers.

Winter (Nov–Apr, Figure 14, top) sea surface temperatures show a significant trend over the past 124 years, with this past winter being the second warmest on record. Temperatures show an increased warming from the 1970s onwards consistent with the recent analysis of Ge et al.(2026), and substantial warming in the late 1990s and again in recent years. Likewise, summer (May–Oct, Figure 14, bottom) sea surface temperatures over the Aleutian Islands show an initial extended period of little long-term trend, with most of the warmest summers recorded in the last few years.

'Above' or 'below' average surface temperatures, as reported in shorter-term time series in this report, may have different meanings if considered relative to the longer-term time series presented here. The thermal responses of species in the Aleutian Islands marine ecosystem must be considered in terms of these longer-term shifts in temperature. Research on species-specific thermal ranges at different life stages can also help interpret potential implications of continued warming in the ecosystem.

May to October: similar pattern as that of winter, with accelerated warming in the 1970s and again in the late 1990s and recent years. SST temperatures cooled this year and are closer to the mean, however note that Figure 14 only has partial data and is missing part of Sep-Oct, when temperatures increased again.

## 5.Subregional Sea Surface Temperature and Marine Heatwaves

*Contributed by Emily Lemagie and Matt Callahan*

Sea surface temperature is a foundational characteristic of the marine environment and temperature dynamics can impact many biological processes. Changes in temperatures can influence physiological processes of fish (e.g., metabolic rates and growth rates), fish distribution (e.g., (Yang et al., 2019), trophic interactions, availability of spawning habitat (e.g., Laurel and Rogers, 2020 ), and energetic value of prey (von Biela V. R. et al., 2019). At shorter timescales of days-to-weeks, changes in water temperature can also influence predator-prey interactions (Sydeman et al., 2006), feeding rates (Sanford, 2002; Clements et al., 2020), and food web composition (Barth et al., 2007). Extended periods of elevated SST for greater than 5 consecutive days are defined as marine heat waves (MHWs), which can drastically influence ecosystem dynamics (Bond et al., 2015; Hobday et al., 2016). Here, trends in SST and MHWs throughout the Aleutian Islands ecosystem regions are presented (Figure 15). Note that high SST can be indicative of a shallow surface layer (high surface temperature, even if a relatively moderate or low overall heat content integrated over the full water depth), and/or high temperatures throughout the water column.

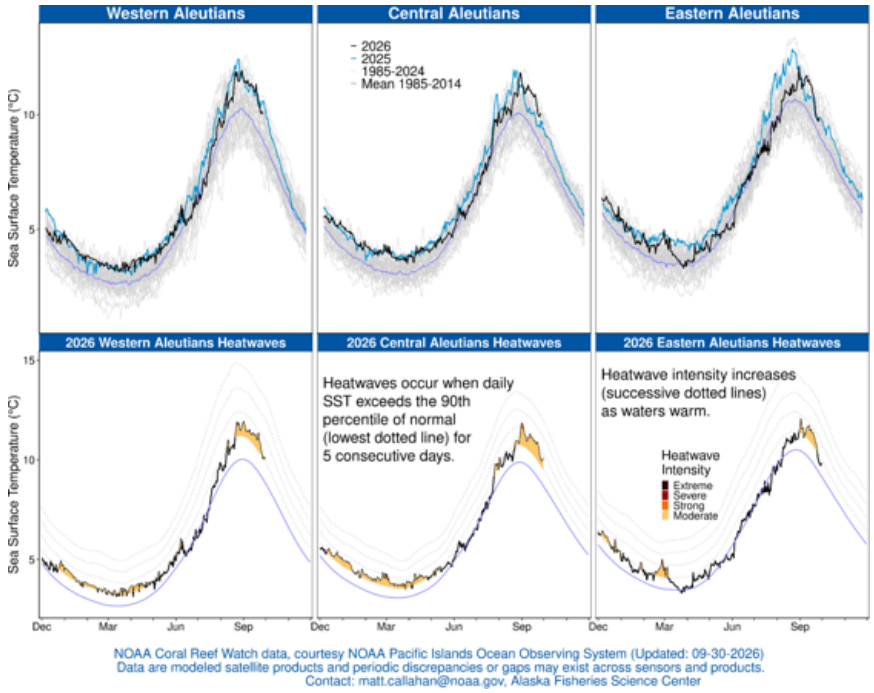



Figure 15: Annual sea surface temperatures and 2026 marine heatwave status for Aleutian Islands ecosystem regions. Data extends through September 30, 2026.

Satellite SST data and MHW status were accessed via Alaska Fisheries Information Network (AKFIN) database for January 1, 1985 – September 30, 2026. Daily SST data were averaged within the western (west of 177°W), central (170–177°W), and eastern (165–170°W) Aleutian Islands.

A MHW is defined as when SST exceeds the 90th percentile of temperatures for a particular day of the year based on a 30-year baseline for five or more days (Hobday et al., 2016) The intensity of a MHW can be further characterized by examining the difference between the 90th percentile threshold for a given day and the baseline ("normal") temperature for that day. When the threshold is exceeded, the event is considered moderate, strong (2 times the difference between the threshold and normal), severe (3 times the difference), or extreme (4 times the difference; Hobday et al. 2018). The earliest complete 30-year time series (January 1, 1985 – December 31,

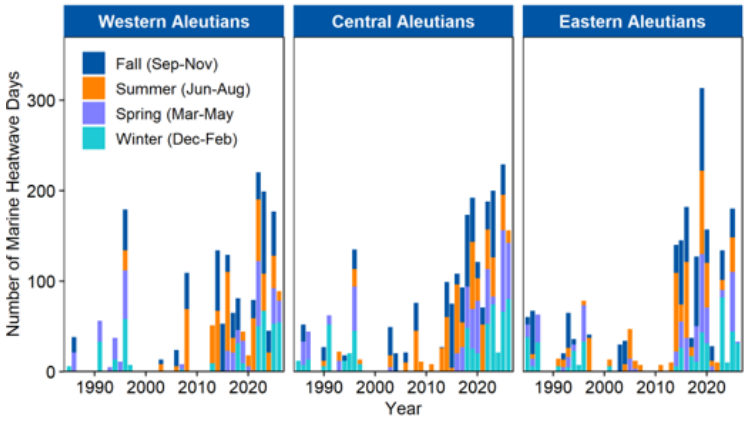



Figure 17: Number of days during which marine heatwave conditions persisted in a given year. Seasons are summer (Jun–Aug), fall (Sept – Nov), winter (Dec – Feb), spring (Mar – May). Years are shifted to include complete seasons so December of a calendar year is grouped with the following year to aggregate winter data (e.g., Dec 2020 occurs with winter of 2021). Data extends through August 2026.

2014) was used as the baseline period for mean and standard deviation comparisons. Annual SST time series are apportioned from December of the previous year through November so that the winter season (Dec–Feb) for each year can be consistently aggregated.

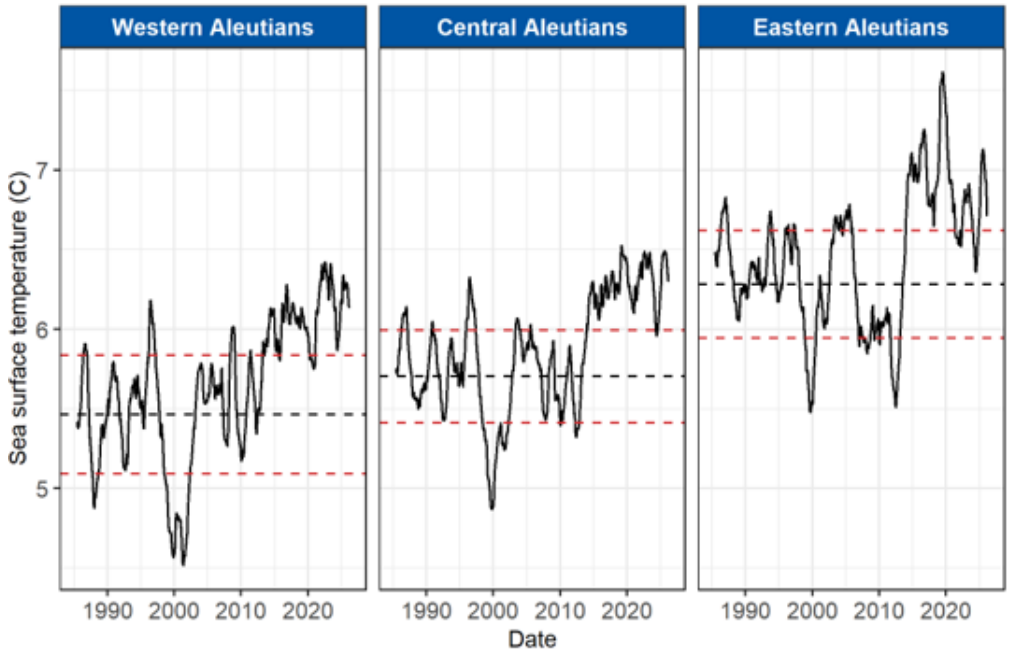



Figure 16: Time series trend (i.e. seasonality and noise removed) of sea surface temperatures. Horizontal dashed lines represent the mean (black) and standard deviation from the mean (red) during the earliest complete 30-yr baseline period (1985-2014).

**Status and Trends**:Across the Aleutian Islands, there were few marine heatwaves in summer 2026, a break from the frequent marine heatwaves the previous winter, and that developed again by late summer (Figure 15). The number of days in MHW status by season in the western and central Aleutian Islands has been similar in 2026 to recent years (Figure 17).However, there were few MHW days in spring and summer 2026 in the eastern Aleutian Islands; over this period <25% of the region experienced moderate or strong MHW conditions, this was not enough to register in the spatial mean.

**Implications**: Barbeaux et al. (2020) demonstrated that marine heatwaves impact Pacific cod populations and during recent warm years, the Gulf of Alaska has seen record low returns for several salmon stocks. Meanwhile, growing evidence supports the notion of temperature driven northward range shifts. While we do not connect SST to fish production here, continued warm periods may well have significant impacts on food webs, and ultimately are concerning from fish populations and recruitment perspectives.

## 6. Bottom and Surface Temperatures from Survey

*Contributed by Sean Rohan and Rebecca Howard*

This section provides estimated mean bottom temperature, maps of bottom temperature, and maps of bottom temperature anomalies based on summer (May to August) Aleutian Islands trawl surveys from 1994 to 2026 that were conducted by the NOAA Alaska Fisheries Science Center's Groundfish Assessment Program. Bottom temperature data have been routinely collected during Aleutian Islands bottom trawl survey hauls since 1994. Bottom temperature measurements were obtained using temperature-depth recorders attached 0.5-1 m behind the headrope of the trawls. A Brancker XL200 temperature-depth recorder (Richard Brancker Research, Ltd., Kanata, Ontario, Canada) was used from 1994 to 2002 and a SeaBird SBE-39 temperature-depth recorder (TDR; Sea-Bird Scientific, Bellevue, Washington, USA) was used from 2004 to 2026. Sea surface temperature (SST) was measured using thermometer-in-bucket measurements from surface samples (1994 to 2006) and at 1-m depth using an SBE-39 TDR (2010 to 2026).

Annual surface and bottom temperature grids were generated for the AI bottom trawl survey area (nominal depth range: nearshore at ĩ0 m to 500 m) using spatial linear models that were fitted to bottom temperature data from individual hauls. For each year, a Gaussian spatial linear model was fitted to bottom temperature (response variable) with a spatial random effect (Matérn covariance with geometric anisotropy) and a fixed effect of log-transformed (bottom temperature) and quadratic (surface temperature) effect of bottom depth as predictors using the R package spmodel (Dumelle et al., 2023). Bottom temperatures were predicted throughout the AI bottom trawl survey area at 1 x 1 km resolution using a bathymetry grid derived from 100 x 100 m resolution AI bathymetry (Zimmermann and Prescott, 2021). Annual mean bottom temperatures for western (WAI), central (CAI), and eastern (EAI) Aleutian Islands ESR ecoregions were calculated for each year as the means of all 1 x 1 km grid cells whose centers were within the ecoregions. Bottom temperature anomaly (Z-score) maps were calculated as cell-wise anomalies relative to the 1994 to 2012 reference period, i.e.,

$$Z_{y,i} = \frac{\widehat{T_{y,i}} - \overline{T_{r,i}}}{\sigma_{r,i}},$$

where $Z_{y,i}$ is the anomaly for grid cell textiti in year $y$, ?? is predicted bottom temperature, ?? is the cell-specific mean for the 1994 to 2012 reference period, and $\sigma_{r,i}$ is cell-specific standard deviation. Annual subregion anomalies were calculated relative to subregion grand means from 1994 to 2012. For both cell-wise and subregion anomalies, positive values indicate that temperatures were higher than the reference period mean and negative values indicate that temperatures were lower than the mean. Interpolated temperature rasters and mean temperature time series are publicly available in the coldpool R package version 3.6-1 (Rohan and Barnett, 2026).

**Methodological changes**: Bottom trawl survey temperature indicators were included in past AI ESRs, but the estimation method for this contribution is new for 2026. Bottom trawl survey temperatures were reported in the AI ESR for the surface (1 m) and bottom layers based on mean of temperature observations from within each bottom trawl survey area subregion. Temperatures had been calculated for specific subregions because mean temperature and the magnitude of temperature variability differ among depths, spatially, and over the months of survey sampling, meaning simple averages across the survey can obscure temperature variation. The spatial

linear model approach in this contribution accounts for this variation by explicitly modelling spatial covariance and depth-dependent variation to estimate bottom temperatures at 1 x 1 km resolution. Boundaries used for calculating subregion temperatures were changed to align with ESR ecoregion boundaries for the WAI, CAI, and EAI as specified by areas 541, 542, and 541.

In 2026, mean bottom temperatures in the WAI and CAI were above average (> 1 SD [standard deviation]) compared to the 1994 to 2012 reference period mean (Figure 18). Aside from 2022, bottom temperatures in the WAI and CAI have been above average every year since 2014. Mean bottom temperature in the EAI was near average in 2026 and has been decreasing since the time series maximum in 2016. These recent subregional temperature patterns are reflected in bottom temperature maps comparing the 1994 to 2012 reference period mean to results from the last three surveys in 2022, 2024, and 2026 (Figure 19).

Mean SST was near average in all three AI ecoregions and has been steadily decreasing since the time series maximum in 2016 (Figure 18 and **??**). SST shows an increasing pattern from east to west in each year that reflects, in part, seasonal warming caused by solar heating during the survey (Figure 20).

Bottom temperature anomaly maps (Figure 21) show that 2026 bottom temperatures were > 1 SD warmer than the reference period mean across most of the WAI and CAI, but within 1 SD in the EAI, consistent with mean temperature trends. This contrasts with 2024, when warm bottom temperature anomalies were confined to small areas, such as the north side of Amchitka Pass near Semisopochnoi Island ($179.5°$E) and south of Seguam Pass ($172.5°$W). Above and below average SST anomalies were confined to small areas in both 2024 and 2026 (Figure 22). This contrasts with 2014 to 2022, in which warm anomalies were widely distributed across entire subregions within the survey area.

Temperature variation can have substantial impacts on the structure and function of marine ecosystems, although impacts in the Aleutian Islands are poorly understood compared to the eastern Bering Sea and Gulf of Alaska regions. Warmer temperatures are linked to reduced prey consumption for Aleutian Islands region Pacific cod and walleye pollock (Holsman  Aydin, 2015) and lower productivity for Gulf of Alaska cod and pollock (Laurel et al., 2023; Rogers et al., 2021). Embryo incubation time for Atka mackerel is known to decrease as temperatures increase, similar to many fish species, possibly affecting recruitment (Lauth et al., 2007). Water temperature has also been shown to influence Aleutian Islands groundfish habitat occupation (Harris et al., 2022) and body condition (O'Leary et al., 2026)

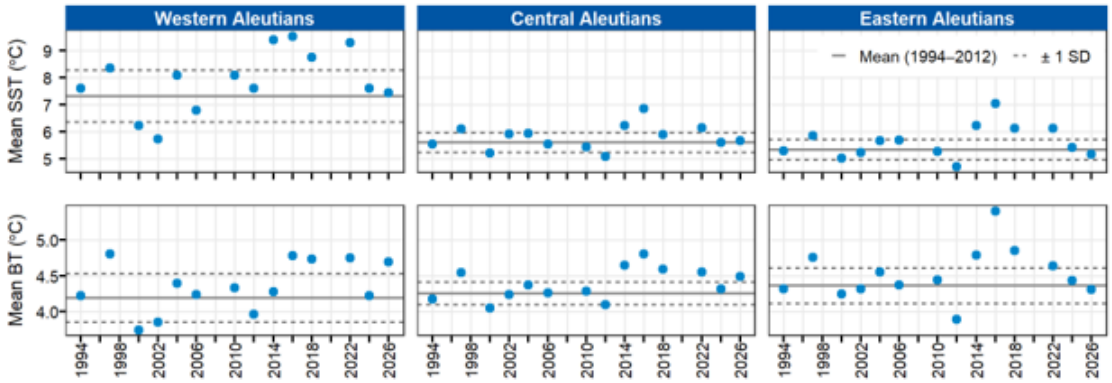



Figure 18: Mean summer bottom (BT) and sea surface temperatures (SST) in Ecosystem Status Report western, central, and eastern Aleutian Islands subregions from 1994 to 2026 estimated from NOAA/AFSC Groundfish Assessment Program bottom trawl survey data. Circles denote annual mean temperatures calculated from gridded bottom temperature estimates. Solid and dashed horizontal lines respectively denote the 1994–2012 time series mean plus/minus one standard deviation.

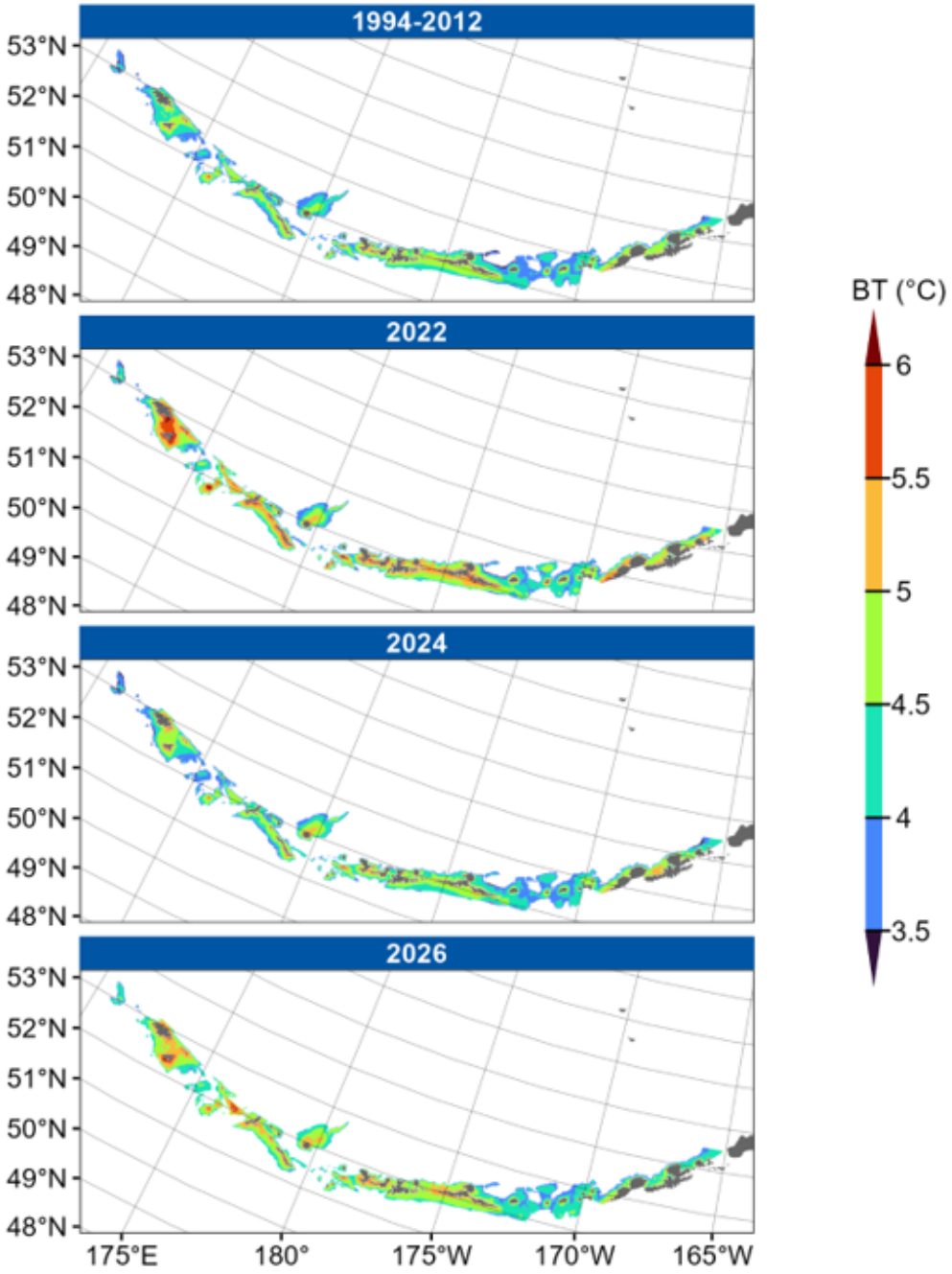



Figure 19: Maps of summer bottom temperatures in the NOAA/AFSC Aleutian Islands bottom trawl survey area estimated from NOAA/AFSC Groundfish Assessment Program bottom trawl survey data. Panels show mean bottom temperature for the 1994 to 2012 reference period and for the last three surveys (2022, 2024, and 2026).

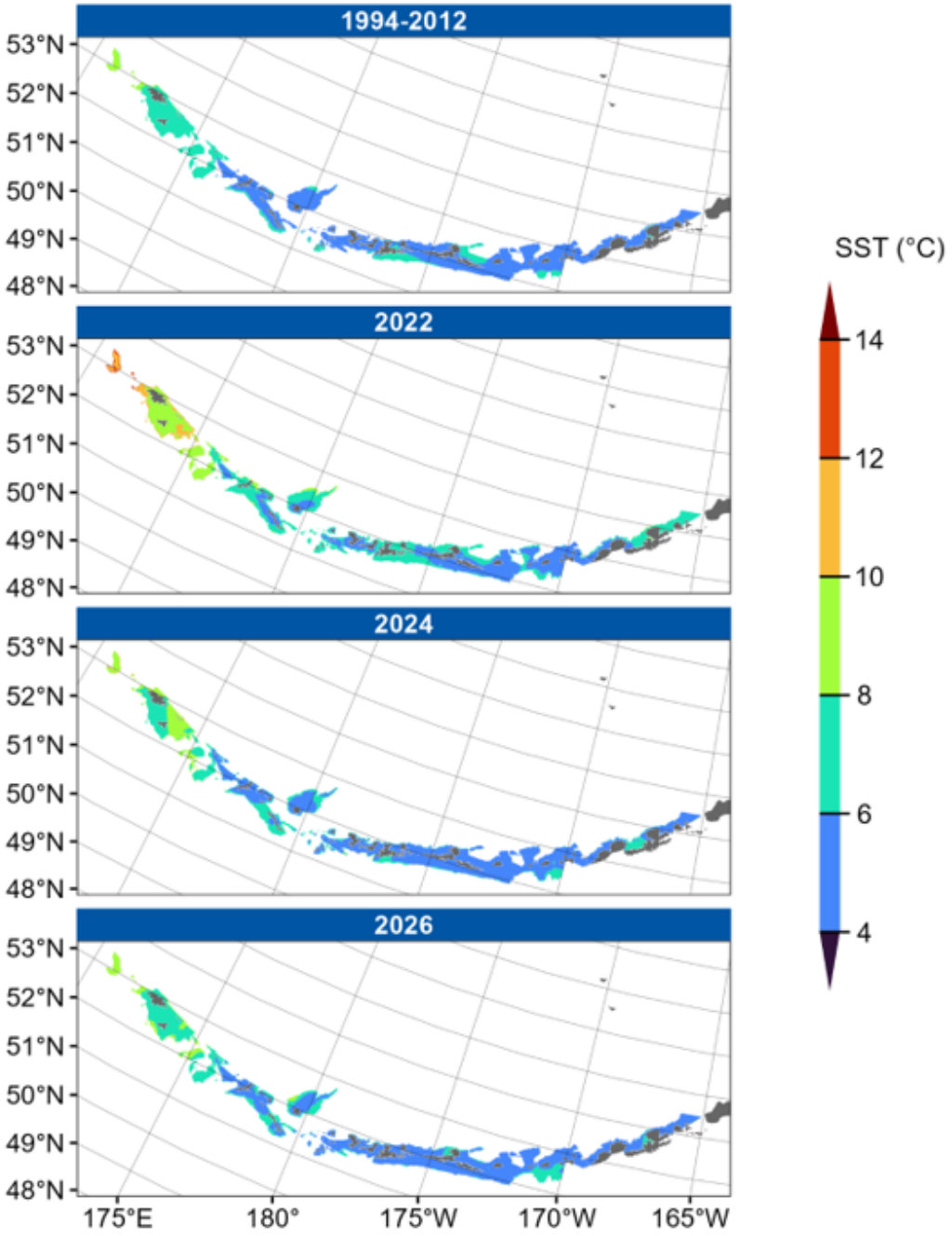



Figure 20: Maps of summer surface temperatures in the NOAA/AFSC Aleutian Islands bottom trawl survey area estimated from NOAA/AFSC Groundfish Assessment Program bottom trawl survey data. Panels show mean bottom temperature for the 1994 to 2012 reference period and for the last three surveys (2022, 2024, and 2026).

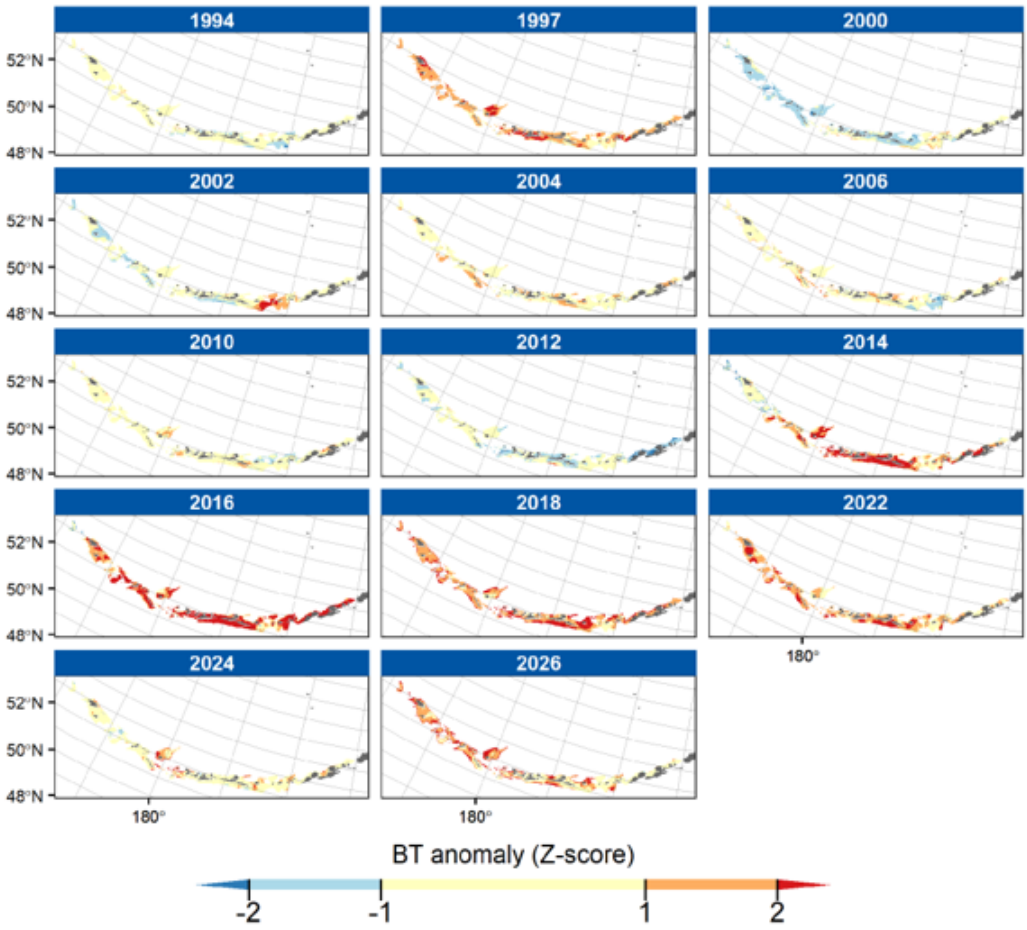



Figure 21: Maps of summer bottom temperature (BT) anomalies (Z-scores) relative to the 1994 to 2012 reference period in the NOAA/AFSC Aleutian Islands bottom trawl survey area as estimated from NOAA/AFSC Groundfish Assessment Program bottom trawl survey data. Negative values indicate colder than average temperatures and positive values indicate warmer than average temperatures.

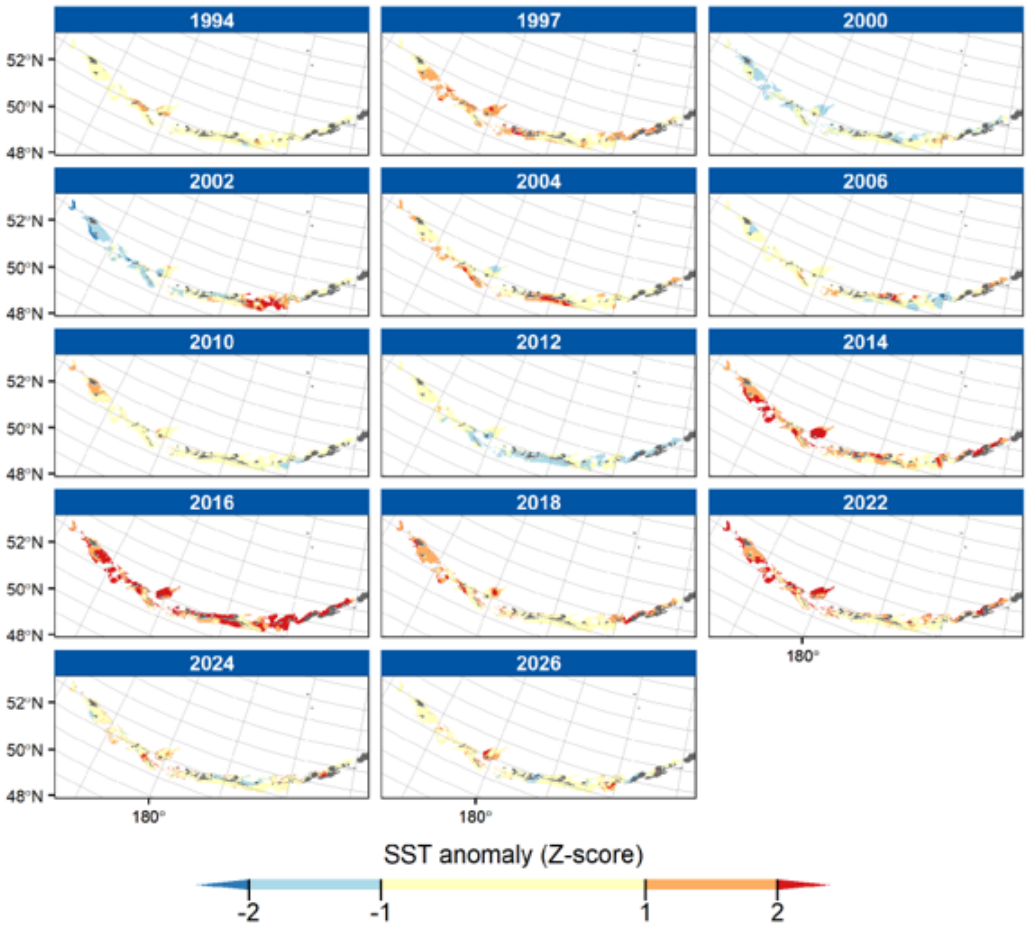



Figure 22: Maps of summer sea surface temperature (SST) anomalies (Z-scores) relative to the 1994 to 2012 reference period in the NOAA/AFSC Aleutian Islands bottom trawl survey area as estimated from NOAA/AFSC Groundfish Assessment Program bottom trawl survey data. Negative values indicate colder than average temperatures and positive values indicate warmer than average temperatures.

## *7. Bottom Temperatures from MOM6 NeP10k (pilot contribution)*

*Contributed by Kelly Kearny and Liz Drenkard*

**MODEL OVERVIEW** The new Modular Ocean Model version 6 Northeast Pacific (MOM6-COBALT-NEP10k) model (Drenkard et al., 2025), resolves bathymetry along the shelf break better than previous models. The NEP10k domain also encompasses the Bering Sea, Gulf of Alaska, and Aleutian Islands, which allows the output for all three regions from one source. Initial comparison between the previous Regional Ocean Modeling System Bering10K and MOM6-COBALT-NEP10k suggests that the latter model is performing similarly or better with respect to the temperature metrics in the Bering Sea region. A more complete comparison between these two models will be forthcoming.

For this contribution, we extended the hindcast running through the end of 2024 to August 22, 2025 to cover the end date of the last 2025 AFSC groundfish survey. This required the use of a few intermediate forcing datasets to extend the simulation beyond the end of those used in the Drenkard et al (2025) standard configuration (Figure 23, **??**).

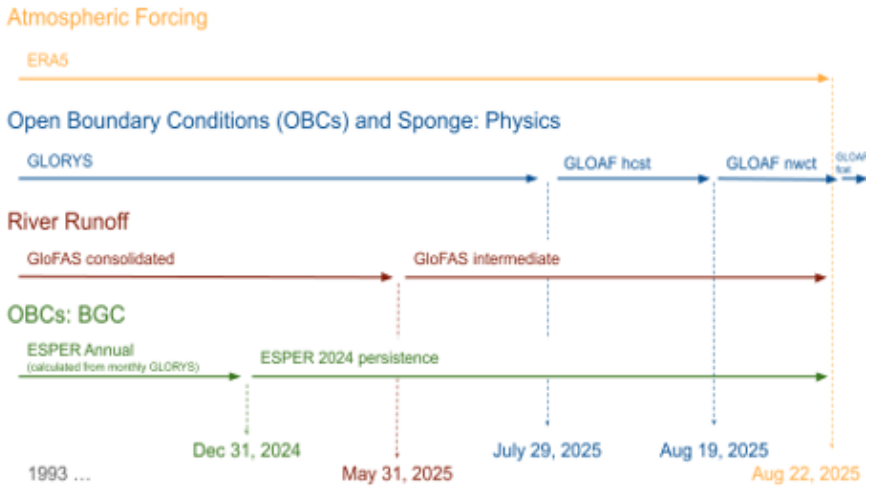



Figure 23: Schematic of external forcing used for the MOM6-COBALT-NEP10k near-real-time hindcast extension. (Figure courtesy of Liz Drenkard).

| Table 1. Detailed description of the external forcing datasets referred to in this description. | | |
|---|---|---|
| Abbreviation | Full Name | References |
| ERA5 | European Centre for Medium-Range Weather Forecasts Reanalysis 5 | Hersbach et al., 2020 |
| GLORYS | 1/12° Global Ocean Physics Reanalysis | Lellouche et al., 2021 |
| GLOAF | 1/12° Global Ocean Physics Analysis and Forecast | |
| GloFAS | Global Flood Awareness System, version 4.0 | Harrigan et al., 2020; Grimaldi et al., 2022 |
| ESPER | Empirical Seawater Property Estimation Routines Locally Interpolated Regressions | Carter et al., 2021Table 1 |

**Summary simulated temperatures**: Aleutian Island bottom temperatures across the survey area have low variability over the simulation period. Conditions in 2025 were near the upper end of the observed range, with

anomalies of $\tilde{0}.3°$C in the winter and increasing to $0.4°$C above the climatological (1993 – 2022) mean by mid-summer (Figure 24). The temperatures are spatially averaged and do not show differences between the western, central and eastern Aleutians. Stronger warm anomalies reappeared in late July through August, extending across the Aleutian Islands, western Gulf of Alaska, and southern Bering Sea. Cluster analysis suggested 2025 conditions in the Aleutian Islands were similar to 2017, 1996, 2021, and 2022 (Figure 25). The AI region has not had much concerted validation yet. The Drenkard et al., 2025 paper noted possible underestimation of flows through Aleutian Passes, but didn't look too closely at this region. Skill assessment based on AI surveys will be done in the near future. Importantly this output will provide year-round bottom temperature estimates which will improve risk evaluation of temperatures outside the optimal thermal range across different life stages for key commercial species.

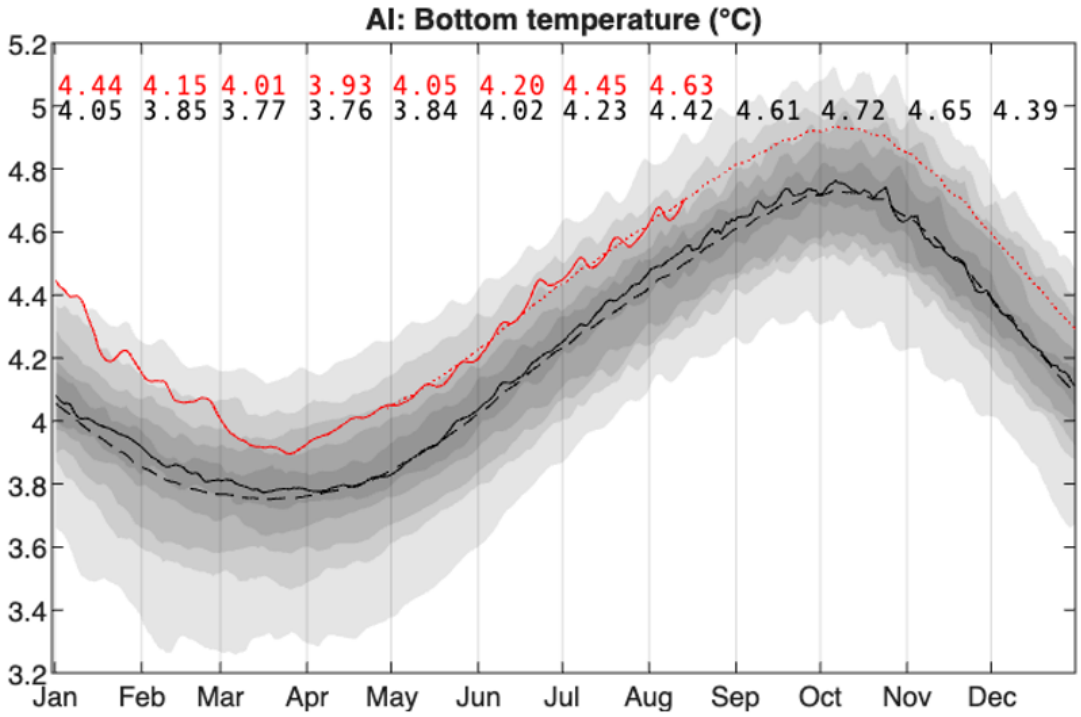



Figure 24: MOM6 NEP10k Time series of bottom temperature, averaged across the AI survey area. Red line = 2026, red dotted line = spring-initiated persistence forecast, black solid line = median across 1993–2026, black dashed line = climatological (1993–2022) mean, shaded gray = 1993–2026 percentiles (lightest = 0-10% and 90-100%, darkest = 40-60%). Numbers indicate the values on the first of the month in the climatological mean (bottom, black) and in 2026 (red, top).

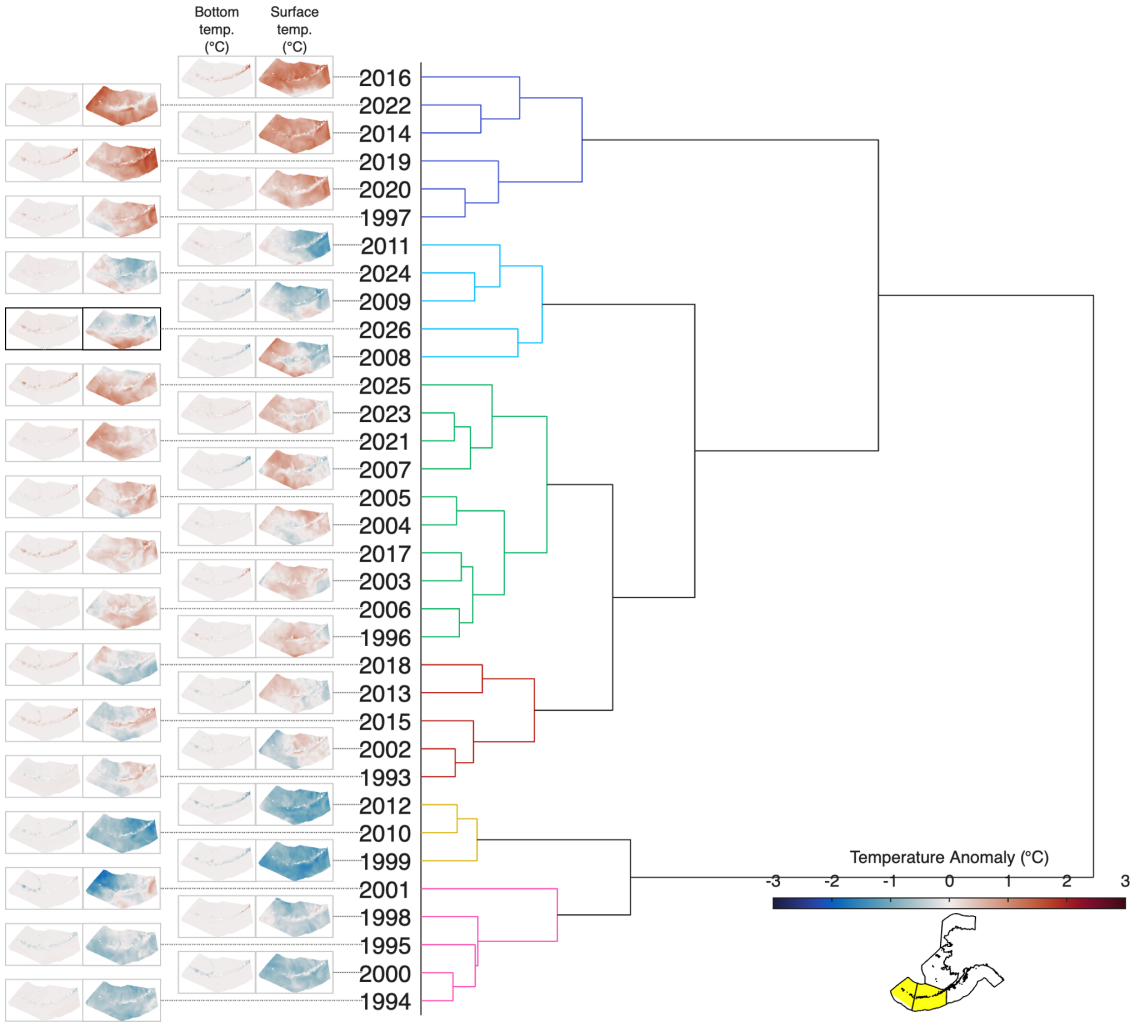



Figure 25: Jun- August (temporally-averaged across the period of 2026/06/11–2026/08/22) hierarchical clustering of surface and bottom temperatures anomalies (0- 500m depth, and relative to the 1993-2022 climatology) based on output for MOM6 NEP10k

## 8. Ocean Transport: Eddies in the Aleutian Islands

*Contributed by Wei Cheng*

**Description of indicator:** Eddy kinetic energy can be used as an index of strength and frequency of eddies. Three regions of high eddy kinetic energy are highlighted in Figure 26. Eddies in the Alaskan Stream south of the Aleutian Islands and east of $\sim 180^{\circ}$ (easternmost box in map figure) have been shown to influence flow into the Bering Sea through the Aleutian Passes (Okkonen, 1996; Stabeno and Hristova, 2014). Numerical models have suggested that eddies passing near Amukta Pass may result in increased flow from the Pacific to the Bering Sea (Maslowski et al., 2008). By influencing flow through the passes, eddies can impact flow in the Aleutian North Slope Current (Stabeno et al., 2009) and Bering Slope Current (Ladd, 2014) as well as influence the transports of heat, salt and nutrients (Mordy et al., 2005; Stabeno et al., 2005) into the Bering Sea. Eddies north of the Aleutian Islands (middle box in map, Figure 26) typically form in the Bering Slope Current near Pribilof Canyon and propagate southwestward toward Amchitka Pass (Ladd et al., 2012). They are typically weaker than those in the Alaskan Stream but may play a role in modulating flow through Amchitka Pass. Eddies formed west of 180° are called Aleutian Eddies (westernmost box in Figure 26). They typically form near the Aleutian Islands and then move southwestward away from the Aleutians (Saito et al., 2016) potentially influencing the distribution of phytoplankton and zooplankton (Saito et al., 2013) during their propagation.

Since 1992, a suite of satellite altimetry system has been monitoring sea surface height. Eddy kinetic energy (EKE) can be calculated from gridded altimetry data (Ducet et al., 2000). Average EKE in the three regions WAI, CAI, and EAI provides indices of eddy energy likely to influence flow through the passes as well as phytoplankton and zooplankton distributions. The Ssalto/Duacs altimeter products were produced and distributed by the Copernicus Marine and Environment Monitoring Service (CMEMS)[10].

The most recent data were downloaded on September 3, 2026 so we have daily time series from 1/1/1993 to 9/03/2026 on a $0.25^{\circ}$ longitude x $0.25^{\circ}$ latitude grid. Original data is global but we subset it to $150^{\circ}$E-$125^{\circ}$W and $40^{\circ}$N-$72^{\circ}$N during download. Data from 1993 to 2020 is from the delayed/re-processed product whereas data from 2021 onward is from the "NRT" (near real time) products. Horizontal map (Figure 26) and monthly climatology (Figure 27) shown below are averaged over 1993-2025 (period with full year coverage).

**Status and trends:** In the western Aleutian Islands, (Figure 27, top panel), EKE in 2025 through mid–2026 has values above its long-term climatology, and these high EKE values are associated with an anticyclonic eddy that wobbled around the area and began to transit out in July, 2026. Over the decadal time period (from 1993 to the present day), EKE was low from 1993 to 2006 when it abruptly increased and remained relatively high until 2011. This region experienced another period of high EKE in 2015–2016. Since 2020, EKE in this region has slightly elevated values in the spring of 2020 and 2024, followed by much higher EKE in the most recent period from 2025 through mid-2026, with EKE magnitudes on par with high values in 2006-2012 and 2015-2016. EKE north of the Aleutian Islands near Amchitka Pass (Figure 27, middle panel) has generally been above its long-term average in 2016, 2022-2023.Since late 2023, EKE in this region has been fluctuating around its mean state with moderate values. Presently, it is below its long-term mean. Note this area is north of the AI chain and generally has lower EKE than the eastern and western boxes.

Particularly strong eddies were observed south of Amukta Pass (Figure XX9, bottom panel) in 1997, 1999, 2004, 2006/2007, 2009/2010, 2012, 2021/2022, 2025, and part of 2026; 2025 has the highest EKE on record for the region. This high value in 2025 is associated with a strong anticyclonic eddy traveling southwestward. This eddy is detectable in November 2024 and possibly even earlier. Similarly, the high EKE in this area from mid-2021 to early-2022 is associated with a transit eddy.

Eddies in the eastern AI are related to the strength of the Alaska Stream (AS) which in turn is forced by large scale atmospheric forcing and the North Pacific gyre. Local wind can push the AS against or away from the coast

[10] `http://www.marine.copernicus.eu`

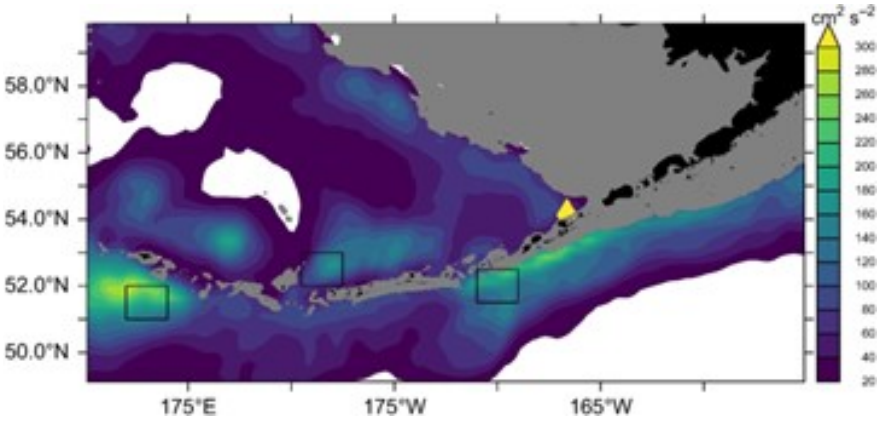



Figure 26: Eddy Kinetic Energy computed from satellite sea surface height (SSH) averaged over January 1st, 1993 – December 31st, 2023. Squares denote regions over which EKE was averaged for Figure 27.

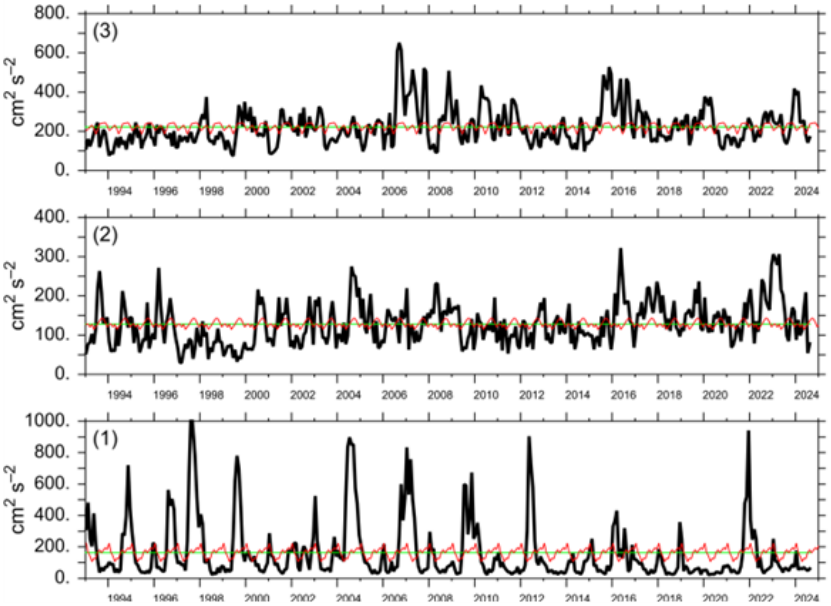



Figure 27: Eddy kinetic energy ($cm^2$ $s^{-2}$) averaged over boxes shown in Figure 26 (panels from the top to the bottom correspond to west to east boxes). Plotted are monthly EKE time series (black), monthly climatology of EKE (red) and the long-term (1993-2023) average of EKE (green straight line).

and change transport in Unimak Pass. Transport and eddies in the western AI passes are less studied/measured. Presumably transport in the western region is highly correlated with the AS. Causes of variability in EKE in this region are currently unclear and a subject of ongoing research. For example, it is unclear whether changes in the time series reflect a long-term trend in the large-scale forcing (e.g., wind, NPGO, the latter shows a declining trend since 2011), and it is unknown whether the relationship between mean flow and eddy strength reinforce or counteract each other.

These trends indicate that higher than average volume, heat, salt, and nutrient fluxes to the Bering Sea through Amukta Pass may have occurred in 1997/1998, 1999, 2004, 2006/2007, 2009, summer 2012, 2021/2022, and 2025.

## 9. Staellite chla from the Aleutian Islands and southern Bering Sea

*Contributed by Noel Pelland and Matt Callahan*

**Description of indicator:** Surface chlorophyll ("chl-a") concentrations are used as a proxy of phytoplankton biomass or abundance. These provide a first-order indicator of variations in biomass at the lowest levels of the oceanic food chain. In adjacent ecosystems, biomass indicators or related quantities have predictive relationships with fisheries yields (Ware and Thomson, 2005) or recruitment (Ladd and Stabeno, 2012). In the AI, there is a need to better understand chl-a variability, its relationship to physical forcing, and significance to higher trophic level organisms. This indicator addresses the first of these, providing a large-scale characterization of chl-a in the AI, using blended satellite data. We focus on months encompassing the spring and fall blooms, which are times when peak chl-a values are observed, and where cloud cover and solar angle allow reasonable data availability.

Surface chl-a in the AI was analyzed using 8-day composites at a 4km x 4km resolution from OC-CCI v6.0 (Sathyendranath et al. 2019, 2023). These cover 1998-2026 for spring (April-June), and 1998-2025 for fall (August-October). Concentrations were averaged in Alaska Department of Fish and Game Groundfish/Shellfish Statistical Areas ("stat-areas"), nominally $1^\circ$ longitude by $0.5^\circ$ latitude. Only stat-areas >2500 km2 were used to maintain data availability. This excludes smaller stat-areas in shelf and near-coastal zones; chl-a metrics are therefore oriented towards slope, basin, and deep pass habitats. In each stat-area, a seasonal cycle and anomalies, normalized by the standard deviation for that stat-area, were estimated. The mean anomaly in each 8-day image was used to fill gaps (stat-areas obscured by clouds), when estimating whole-AI mean chl-a. Uncertainty due to data gaps was estimated by resampling from complete images using realistic cloud cover. These methods are described in more detail in Pelland and Callahan (2026).

**Status and trends:** Mean chl-a across the AI in spring 2026 was above-average in early spring, and below-average thereafter (Figure 28a, 28b). Above-average conditions were observed in April, suggestive of an earlier-than-usual bloom. Strong positive anomalies from typical seasonal conditions were observed in the Alaska Stream region, the southeastern Aleutian Basin, and in a mesoscale feature immediately south of the Alaska Stream (Figure 29a). A broad region of modest positive anomalies was also present west of the dateline and south of $51^\circ$N. Bloom conditions appeared to collapse in mid-May (Figure 28) and negative anomalies were widespread, aside from some persistence in the Alaska Stream region and adjacent mesoscale feature (Figure 29a). Increasing cloud cover in June resulted in more data gaps and fewer anomalies significantly different from zero, with mostly negative anomalies observed (Figure 29c). Conditions were average to above-average in fall 2025 (Figure 28d), but spatially inhomogeneous. Strong positive anomalies were observed throughout the southernmost portion of the AI, in addition to scattered portions of the Aleutian Basin, throughout August and September (Figure 29d-e). These were interspersed in August with negative anomalies in far western and northwestern areas as well as in the easternmost Alaska Stream and southeast Aleutian Basin zones.

No trends are evident in spring seasonal mean or maximum of ecosystem-average chl-a (Figure 30). There is evidence for a positive trend (0.07 mg m-3 per decade) in fall seasonal mean chl-a ($p = 0.0064$, not shown). P-values were estimated using a bootstrap that includes both finite sampling uncertainty, and uncertainty from data gaps (Pelland and Callahan, 2026).

**Factors affecting trends:** Light and nutrient availability, temperature, grazing pressure (e.g., Batten et al., 2018, see Section 10 below), turbulence intensity, and stratification are all significant factors that may affect phytoplankton growth, biomass, and chlorophyll concentrations. There is evidence for a modest correlation between seasonal mean chl-a in fall and the following spring (i.e., across the winter, $r = 0.435$ $p = 0.034$), but not spring to following fall (across the summer, $p = 0.276$). The pattern of consecutive anomalies of opposite sign in a series of years (i.e., anticorrelation at 1-year lag) is evident in spring AI chl-a in some periods, similar to results from large diatoms sampled in continuous plankton recorder (CPR) data noted in Section 10 below. This pattern is in a similar sense as the CPR data, that is, high in odd years. For spring, the signal is evident 2015-on,

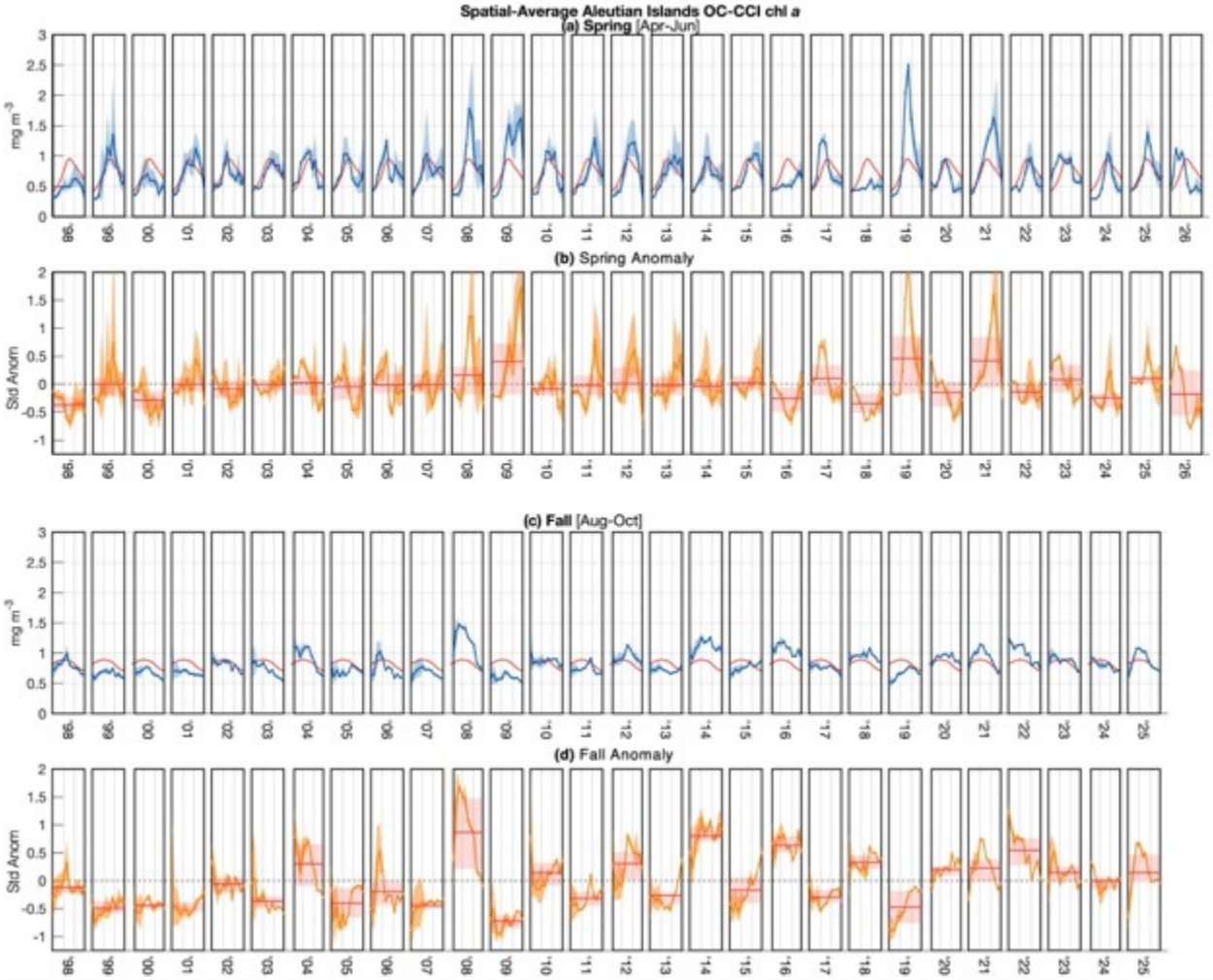



Figure 28: Time series of spatial-average Aleutian Islands chlorophyll a in ocean colour OC-CCI 8-day composites, for the months of (a)-(b) April to June, and (c)-(d) August to October. Panels (a) and (c) show the full time series, while (b) and (d) show ecosystem-average of anomalies normalized by the standard deviation ("Std Anom"). Red lines in (a)/(c) indicate the composite seasonal cycle. In (b) and (d), red line and shading respectively indicate the mean and interquartile range of anomalies in each year. Gray shading indicates 95% confidence bounds. Light gray lines delineate monthly boundaries.

as opposed to the time range in which the signal is most apparent for large diatoms (up to 2014 in the CPR data). For fall (not shown), the pattern is evident for a longer period, from 2002-2020, but in the opposite sense as CPR data (high in even years). Examining this relationship in more detail, potentially in smaller geographic regions, may yield additional information about the nature of this relationship and the possible role of top-down processes.

There is a modest negative correlation between May chl-a and increasing mixed layer depth, MLD, ($r = –0.478$, $p = 0.032$), with MLD from the Mercator GLORYS12 Ocean Reanalysis (https://doi.org/10.48670/moi-00021). This does not hold for April or June ($p > 0.05$). The May result does not reject the null hypothesis if a multiple comparisons test is used. No correlation was apparent between spring or fall chl-a and 3-month averages of NPGO – associated with salinity and nutrient availability in the North Pacific Ocean – at any lead time up to 18 months (NPGO leading chl-a). NPGO indices were obtained from https://www.o3d.org/npgo/data/NPGO.txt. Spring variability in the AI is mainly driven by May ($r2 = 0.79$ with seasonal chl-a) and June ($r2 = 0.55$). Climate processes affecting forcing of the mixed layer in these months may have particular importance for the AI spring bloom.

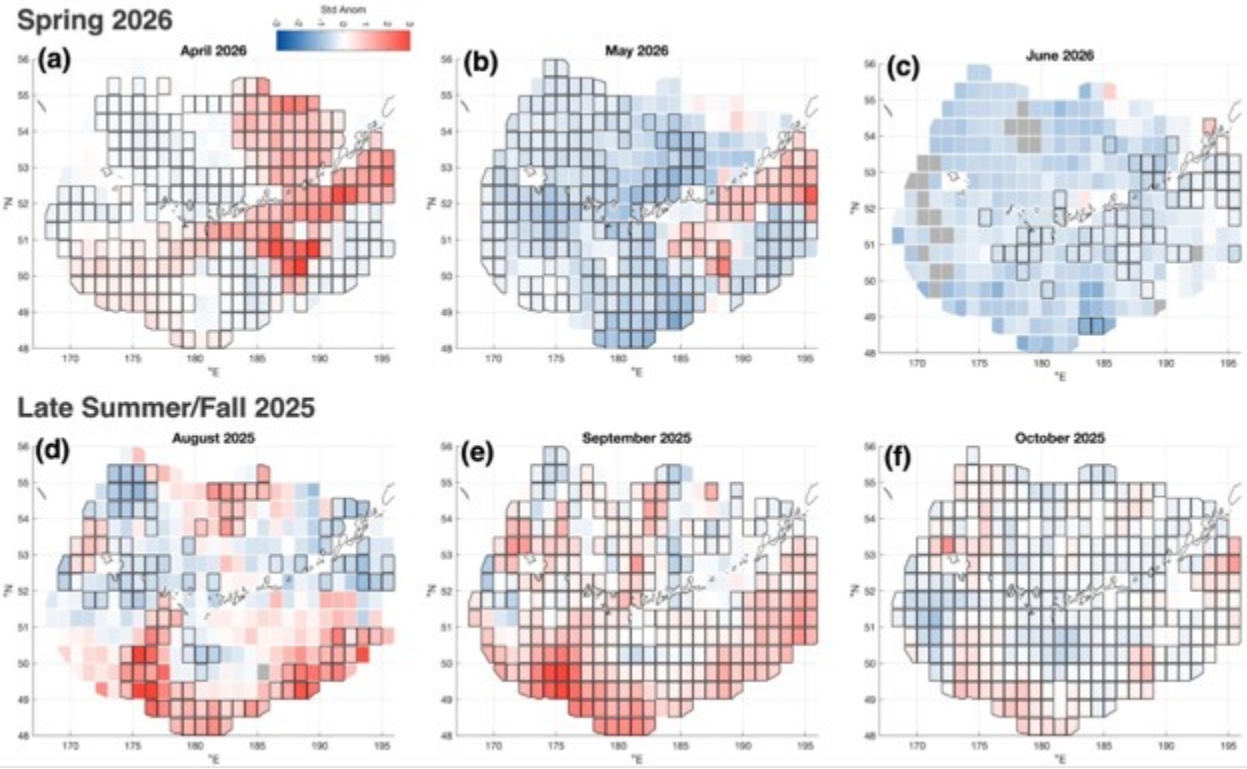



Figure 29: Spatial patterns in monthly-average anomalies from the seasonal cycle, April–June 2026 (top row) and August-October 2025 (bottom row). Anomalies are composed from data averaged with Alaska Department of Fish and Game Statistical Areas >2500 square kilometers and larger, and are normalized by the standard deviation in each area ("Std Anom"). Areas with a black boundary have a monthly anomaly exceeding the 95% confidence bounds. Gray shading indicates areas not sampled within a given month.

High chl-a values centered near $188°$W, $51°$N in May and June 2026 are arranged in a ring-like pattern suggestive of a mesoscale eddy on the periphery of the Alaska Stream. Examination of individual 8-day composites in April and early May supports this interpretation (not shown). Although high EKE values south of Amukta Pass were also observed in part of 2026 (section 8 above; Figure 27c), those occurred in June-July. However, record high EKE values in this same location in early 2025 were indeed associated with very high chl-a in images from that year (Figure 27c, chl-a not shown). Mesoscale eddies are known to be a major physical forcing mechanism for localized high chlorophyll in this region, through redistribution and lateral mixing of shelf/slope and offshore waters (Ueno et al., 2010; Prants et al., 2019).

**Implications:** There appears to be some top down influence by pink salmon. In addition to the biennial pattern typical of pink salmon populations, changes in the magnitude of chl-a concentration coincide with noticeable step increases in the biomass of eastern Kamchatka pink salmon in 2009 and 2019. Results from recent years imply large mesoscale eddies can generate positive chl-a anomalies of sufficient scale to influence a substantial portion of the AI ecosystem, in addition to their impact on exchange between the North Pacific Ocean and Aleutian Basin. Continued detailed examination of these stochastic, but influential physical events may yield further insight on predictive relationships in AI chl-a and importance for higher trophic levels.

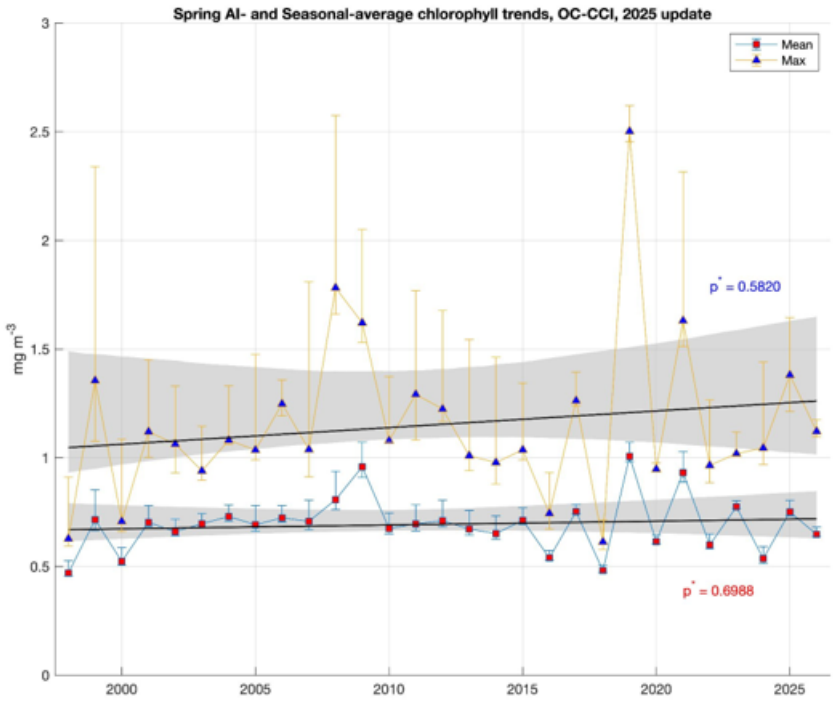



Figure 30: Trends in spring satellite chl-a 1998 to 2026 ocean colour OC-CCI, showing trend for spring maximum spatial- average AI chl-a and for spring average chl-a in the Aleutian Islands. "p*" notation indicates p-values for a trend different from zero, from a simple percentile of bootstrap iterations that take into account both sampling and chl-a uncertainty.

## 10. Zooplankton: Continuous Plankton Recorder Data from the Aleutian Islands and southern Bering Sea

*Contributed by Clare Ostle and Sonia Batten*

**Description of indicator:** Continuous Plankton Recorders (CPRs) have been deployed in the North Pacific routinely since 2000. Two transects are sampled seasonally, both originating in the Strait of Juan de Fuca, one sampled monthly (∼Apr–Sept) which terminates in Cook Inlet, the second sampled 3 times per year (in spring, summer and autumn) which follows a great circle route across the Pacific terminating in Asia. Several indicators are now routinely derived from the CPR data and updated annually. In this report we update three indices for the region around the Aleutian islands, including deep waters of the southern Bering Sea (Figure 31): large diatoms (the CPR only retains large, hard-shelled phytoplankton so while a large proportion of the community is not sampled, the data are internally consistent and may reveal trends), mesozooplankton biomass (estimated from taxon-specific weights and abundance data), and mean Copepod Community Size (see Richardson et al. 2006 for details but essentially the length of an adult female of each species is used to represent that species and an average length of all copepods sampled calculated) as an indicator of community composition. Anomaly time series of each index have been calculated as follows: A monthly mean value for each region is first calculated. Each sampled month's mean is then compared to the long-term mean of that month (calculated using the geometric mean) and an anomaly calculated (Log10). The mean anomaly of all sampled months in each year is calculated to give an annual anomaly. The Aleutian Island region, including the southern Bering Sea is sampled at most 4 times per year by the east-west transect. Note that in 2001, 2015, 2017 the region was only sampled in June, October and May respectively, owing to variability in the ship's transect.

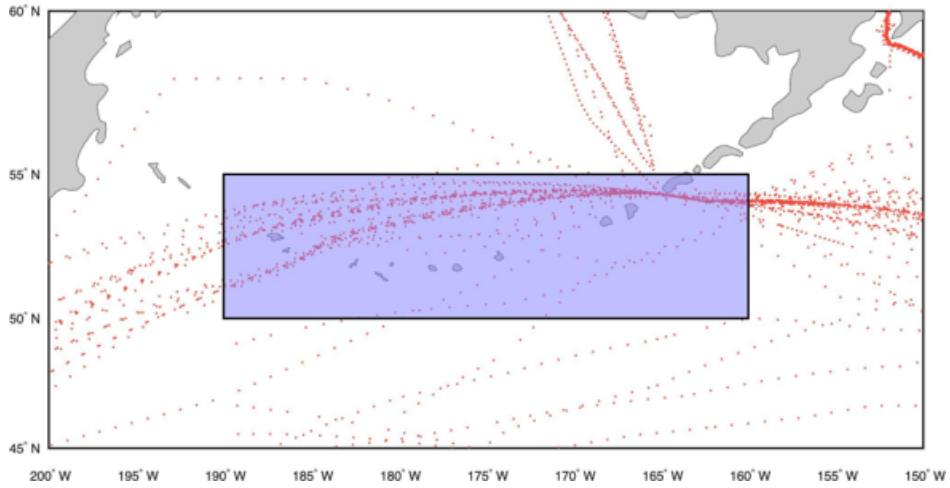



Figure 31: Location of the samples collected for the CPR analysis. Dots indicate actual sample positions and may overlay each other.

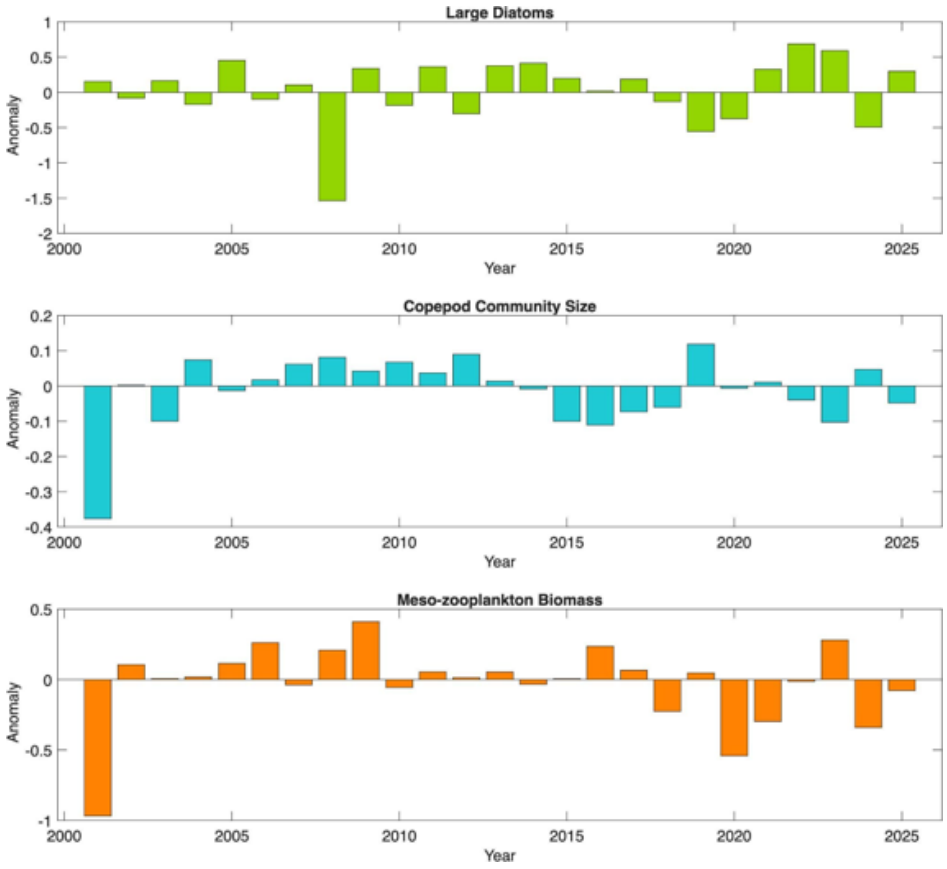



Figure 32: Annual anomalies of three indices of lower trophic levels (see text for description and derivation) for region shown in Figure 31.

**Status and trends:** Figure 32 shows that the large diatom abundance anomaly returned to a positive value in 2025, having been negative in 2024. The annual copepod community size anomaly switched back to a slightly negative value in 2025, after being positive in 2024. The mean meso-zooplankton biomass anomaly remained negative in 2025, though less strongly negative than in 2024.

**Factors influencing trend:** Analysis of summer CPR data in this region has revealed a general alternating (and opposing) pattern of high and low abundance of diatoms and large copepods between 2000 and 2012, believed to be the result of a trophic cascade caused by maturing Pink Salmon present in the region (Batten et al., 2018). Although the upper panel (diatoms) in Figure 32 contains data from spring and autumn, as well as summer, the alternating pattern is clear up until 2014. The zooplankton data in Figure 32 consist of more taxa than just large copepods but it is likely that there is some top-down influence of the Pink Salmon also present in these data. In 2013 the east Kamchatka Pink Salmon run was much lower than expected and in 2014 it was much higher. CPR data were not collected in this region in the summers of 2015 to 2017 so we are not certain if their influence on the plankton continues, nor how to tease out the simultaneous influence of ocean climate. However, the copepod community size anomaly has been negative in each season sampled since summer 2014 (apart from 2019 and in 2021) which suggests a real increase in the relative abundance of smaller species, potentially because of warmer than normal conditions.

**Implications:** This region appears to be subjected to top down influence by Pink Salmon as well as bottom up forcing by ocean climate, which is particularly challenging to interpret. Changes in community composition (e.g.

abundance and composition of large diatoms, prey size as indexed by mean copepod community size) may reflect changes in the nutritional quality of the organism to their predators. Changes in abundance or biomass, together with size, influences the availability of prey to predators.

**Acknowledgments**: The North Pacific CPR survey is supported by a consortium comprising the North Pacific Research Board, the Exxon Valdez Oil Spill Trustee Council through Gulf Watch Alaska, Fisheries and Oceans Canada, the North Pacific Marine Science Organisation and the Marine Biological Association, UK.

# Habitat

## *Structural Epifauna in the Aleutian Islands Ecosystem*

Contributed by Christina Conrath
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**Last updated: September 2026**

**Description of indicator:** This indicator tracks the abundance of structure forming invertebrates throughout the survey time period. The taxonomic groups that are included in this indicator include: sponges, corals (including fan-type coral taxa as well as hard or hydrocoral taxa, but not including sea pens), seapens (Pennatulaceans), and sea anemones. Sea pens are a superfamily of corals but are considered separately here because they are ecologically distinct as they do not require hard substrate and are found in sandy or soft substrates (**?**). Since 1991, the RACE Groundfish Assessment Program fishery-independent summer bottom trawl survey in the Aleutian Islands (AI) has deployed the same standardized trawl gear (footrope and trawl net) across the survey region. Therefore, biomass index trends are likely to reflect changes in the abundance of species and life history stages that are available to the survey, especially if trends are sustained over time. However, bottom trawl survey gear is inefficient at sampling these fauna groups and the survey does not sample in rough or rocky areas where some of these groups are likely to be more abundant (Rooper et al., 2016; **?**).

Regional and subarea (Southern Bering Sea [SBS], Eastern AI [EAI], Central AI [CAI], Western AI [WAI]) indices of abundance (biomass in kilotons) and confidence intervals were estimated for each taxonomic group by fitting a multivariate random effects model (REM) to subarea design-based index of abundance time series that were calculated from bottom trawl survey catch and effort data. Indices were calculated for the entire standardized survey time series (1991 to 2026). Design-based indices of abundance were calculated using the *gapindex* R package (Oyafuso, 2025) and REM were fitted to the time series using the *rema* R package (Sullivan et al., 2022; Sullivan and Balstad, 2022). Code and data used to produce these indicators are provided in the *esrindex* R package and repository (Rohan, 2025).

**Status and trends:** A few general patterns are clearly discernible (Figure 33). Sponges are abundant in the Aleutian Islands west of the southern Bering Sea. Sponge abundance began declining in the Aleutians west of the southern Bering Sea in 2010, but appears to have evened out in recent years (2016-2026) with a slight increase in the last two surveys. These declines are most notable in the WAI and EAI. Coral abundance has declined in all areas since about 1991–1993, but most substantially in the CAI and WAI. Sea anemones show no clear longterm trends in abundance in most areas. Abundance decreased from 2014 with a low in 2016 and an increase since 2022 to a biomass close to the long-term mean in 2026. Sea pens are encountered more frequently in the SBS and EAI than in areas farther west. Any large apparent increases in abundance, such as that seen in the EAI in 1997 are typically based on a single or a small number of large catches. The increase in the abundance index in 2024 and 2026 is driven by increases in abundance in the EAI and are due to a small number of large catches particularly near Amlia Island. The 2026 results suggest relatively little change in the abundance trends of corals and a slight increase in the abundance trends of sea anemones, and sponges.

**Factors influencing the observed trends:** The two major threats to populations of benthic invertebrates in the Aleutian Islands have been identified as impacts due to fishing activity and climate change (**?**Stone 2006; Stone and Lehnert 2011). Both of these processes are occurring in the Aleutian archipelago. Much of the benthic habitat in the Aleutians (∼50% of the shelf and slope to depths of 500 m) has been protected from mobile fishing gear since 2006; these closures effectively 'froze the footprint' of fisheries within this area. Fishing effects since 2006 are therefore limited to a proportion of the benthic habitat in the Aleutians outside of these closures, though it is documented to occur in locations that have been identified as coral and sponge gardens (**?**).Climate factors that may impact the abundance of these groups include changes in temperature, water chemistry, and changes in the

movement and speed of ocean currents. The 2026 bottom trawl survey temperatures trended higher than 2024 though still remained lower than the prior three surveys (2016, 2018, 2022). In 2026, bottom temperatures rose in the WAI and the CAI and decreased slightly in the EAI whereas surface temperatures in all sub areas were similar to 2024 (Rohan and Howard, p. 40). In addition, some of these species have carbonate skeletons that require the absorption of carbonate ions from the surrounding water and are likely to be negatively impacted by changing water chemistry. There is also some evidence of changes to the strength and variability of the Alaska Stream in recent years, which could result in changes to the strength of currents and transport of biological material through the oceanic passes of the Aleutian Islands Stabeno and Hristova (2014). These changes in currents will impact the food that is available to filter feeding organisms. Non-motile HAPC organisms are particularly sensitive to these changes in the benthic environment.

**Implications:** The association of many commercially important groundfish species with high relief habitat containing structure-forming invertebrates like coral and sponge is documented. Structurally complex habitat provides a refuge from strong currents, protection from predators, spawning habitat, and may act to increase prey resources (Carlson and Haight 1976; Carlson and Straty 1981; Lauth et al. 2008). In Alaska, the three most commercially important rockfishes, Pacific ocean perch (*Sebastes alutus*), northern rockfish (*S. polyspinis*), and dusky rockfish (S. variabilis) have all been documented to have strong associations with this habitat type (Carlson and Straty 1981; Rooper and Zimmerman 2007; Rooper and Martin 2011; Conrath et al. 2019). Atka mackerel nesting sites have also been documented to occur in rocky substrata in the Aleutian Islands (Lauth et al., 2008). While biomass trends for corals and sponges have increased slightly in recent surveys the recovery of these groups is likely to be time consuming given the slow rates of growth reported for deep-sea sponges and corals (**??**). The decline in biomass indices for sponges, anemones, and corals is concerning given these associations with commercially important fish species. Although, the unknown catchability and the grouping of many species into large taxonomic groups limit the amount of interpretation that is possible from these results, these surveys are conducted in a standardized manner and the trends in these large taxa groups are an indication of a decline in the habitat available to rockfishes and other species. It should be noted that another factor could impact these trends. Due to the difficulty in finding towable grounds in the high relief bottom habitat of the Aleutians Islands about 50% of the survey stations tend to be re-towed using the same towpath. This re-towing of the same area could potentially contribute to a decline in benthic invertebrates for the re-towed area that is not representative of the general trend in neighboring untowed areas. The amount of new ground surveyed compared to the total ground surveyed generally continues to decline since the 1990s; this decline was reversed after 2022. In light of these caveats, research aimed at achieving a more comprehensive understanding of these changes in the abundance of structure forming invertebrates in the annual bottom trawl surveys would be valuable.

**Research priorities:**The bottom trawl survey uses standardized survey protocols aimed at ensuring consistent sampling efficiency. However, additional research is needed to better characterize the catchability and selectivity of structural epifauna groups by the bottom trawl survey. Additional research is also needed to better understand how potential losses in habitat formed by structural epifauna will impact commercially important species.

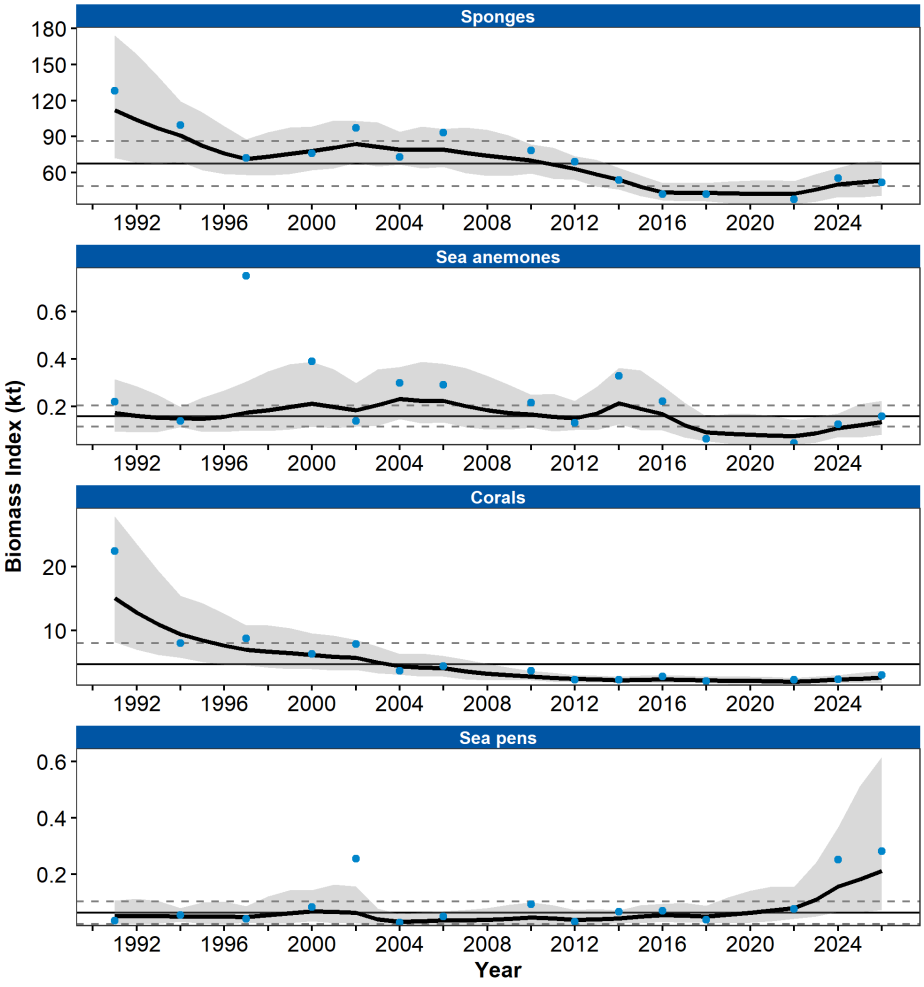



Figure 33: Biomass index of Structural Epifauna (sponges, sea anemones, corals, and sea pens) from RACE Groundfish Assessment Program summer bottom trawl surveys of the Aleutian Islands from 1991 to 2026. Panels show the observed survey biomass index mean (blue points), random effects model fitted mean (solid black line), 95% confidence interval (gray shading), overall time series mean (solid gray line), and horizontal dashed gray lines representing one standard deviation from the mean.

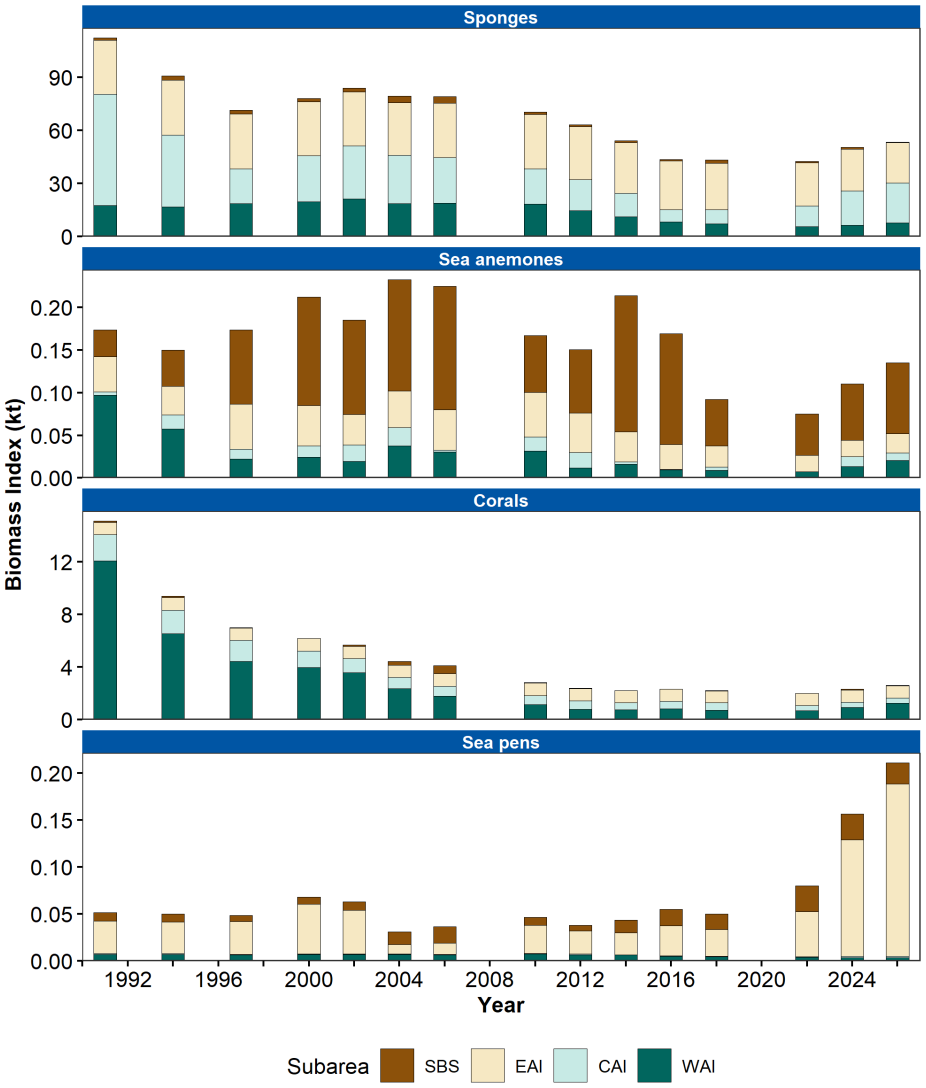



Figure 34: Biomass index (kilotons) of Structural Epifauna (sponges, sea anemones, corals, and sea pens) in Aleutian Islands subareas (Southern Bering Sea [SBS], Eastern Aleutian Islands [EAI], Central Aleutian Islands [CAI], and Western Aleutian Islands [WAI]) estimated from RACE Groundfish Assessment Program summer bottom trawl survey data from 1991 to 2026.

# Jellyfish

## *Jellyfish in the Aleutian Islands*

Contributed by Alexandra Dowlin
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**Last updated: September 2026**

**Description of indicator:** Jellyfish are an important component of plankton communities as both predators and competitors of fish, especially early life history stages (Purcell and Arai, 2001). Thus, fluctuations in jellyfish abundance may affect ecosystem dynamics and fish abundance through indirect (e.g., competition for prey) and direct (e.g., predation) competition with forage fishes and other commercially and ecologically important species.

Since 1991, the Resource Assessment and Conservation Engineering Division's Groundfish Assessment Program (RACE-GAP) at AFSC has employed standardized operating procedures in the Aleutian Islands (AI) to deploy the same gear (footrope and bottom trawl net) on triennial (1991-2000) and then biennial (2002-present) bottom trawl surveys. Therefore, biomass index trends are likely to reflect changes in the abundance of species and life history stages that are available to the survey, especially if trends are sustained over time and the relative abundance of jellies from these surveys may be informative of their population trends within the ecosystem (e.g.Decker et al. 2023).

Regional and subarea (Southern Bering Sea [SBS], Eastern AI [EAI], Central AI [CAI], Western AI [WAI]) indices of abundance (biomass in kilotons) and confidence intervals were estimated for each taxonomic group by fitting a multivariate random effects model (REM) to subarea design-based index of abundance time series that were calculated from RACE-GAP summer bottom trawl survey catch and effort data. Indices were calculated for the entire standardized survey time series (1991 to 2026). Design-based indices of abundance were produced using the gapindex R package (Oyafuso, 2025) and REM was fitted to the time series using the *rema* R package (Sullivan et al., 2022; Sullivan and Balstad, 2022). Code and data used to produce this indicator are provided in the *esrindex* R package and repository (Rohan, 2025).

**Status and trends:**Jellyfish biomass was above average ( 1 standard deviation higher than the time series mean) in the survey-record warm year of 2016, after declining from that peak, has fluctuated around the long term average (Figure 35). In 2026 Jellyfish biomass declined from 2024 and was estimated to be slightly below the long-term mean. Subareas contributing the most to jellyfish biomass varied over time (Figure 36). High biomass in 1991 was primarily attributed to the WAI while the peaks in 2004 and 2006 were attributed to the WAI, CAI, and EAI. In 2026, jellyfish were more abundant in the EAI than in the other three subareas.

**Factors influencing the observed trends:** Jellyfish populations in Alaska can vary widely in response to changing climate and prey availability (Decker et al., 2023). Brodeur et al. (2008) linked changes in jellyfish abundance to increasing sea surface temperature. However, Decker et al., (2023) found that higher sea temperature changes associated with climate change may not necessarily coincide with higher jellyfish biomass). Though RACE-GAP standardized bottom trawl surveys are a platform that can be used to assess relative abundance trends of jellyfishes in the Aleutian Islands, they do not provide the data necessary to address mechanisms responsible for their fluctuating biomass in this region of Alaska.

**Implications:** Jellyfish abundance can fluctuate widely over space and time as evidenced by their wide ranging biomass estimates across the RACE-GAP Aleutian Islands bottom trawl survey time series (Figure 35). Jellyfish abundance can fluctuate widely over space and time as evidenced by their wide ranging biomass estimates across the RACE-GAP Aleutian Islands bottom trawl survey time series (**?**) and as competitors for planktivorous fish prey (Purcell and Sturdevant, 2001).

**Research priorities:** The bottom trawl survey uses standardized survey protocols aimed at ensuring consistent sampling efficiency. However, additional research is needed to better characterize the catchability and selectivity of jellyfish by the bottom trawl survey.

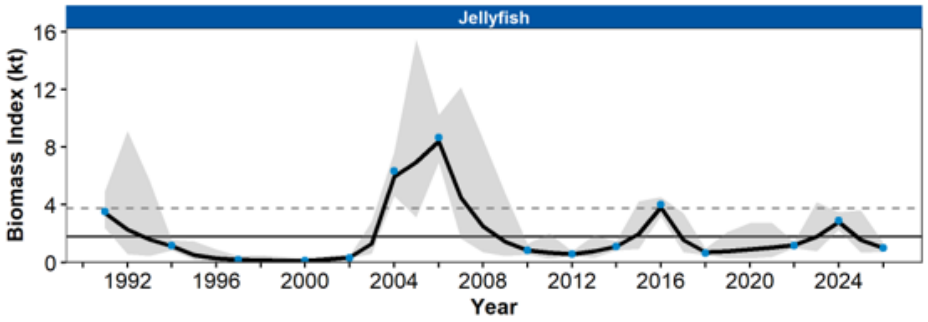



Figure 35: Biomass index (kilotons) of jellyfish from RACE Groundfish Assessment Program summer bottom trawl surveys of the Aleutian Islands from 1991 to 2026 showing the observed survey biomass index mean (blue points), random effects model fitted mean (solid black line), 95% confidence interval (gray shading), overall time series mean (solid gray line), and horizontal dashed gray lines representing one standard deviation from the mean.

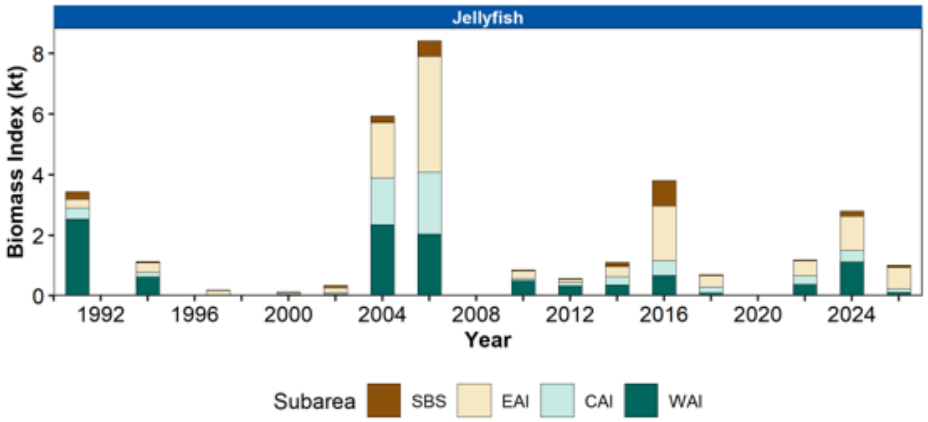



Figure 36: Biomass index (kilotons) of jellyfish in Aleutian Islands subareas (Southern Bering Sea [SBS], Eastern Aleutian Islands [EAI], Central Aleutian Islands [CAI], and Western Aleutian Islands [WAI]) estimated from RACE Groundfish Assessment Program summer bottom trawl survey data from 1991 to 2026.

# Salmon

## *The Increasing Abundance and Expanding Role of Eastern Kamchatka Pink Salmon in the Aleutian Islands Ecosystem*

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**Last updated: 5 October 2026**

**Description of indicator:** Eastern Kamchatka pink salmon (Russia) are the primary pink salmon population occupying the Aleutian Islands Ecosystem and adjacent areas, based on historical tag and recovery studies (Takagi et al., 1981). Other pink salmon populations from Russia, Japan, and Alaska may occur here to a lesser extent. However, stock-specific analyses of pink salmon in this region have not been conducted in several decades and it is unknown whether the increasing abundances of all pink salmon populations has led to a broader distribution at sea. In particular, the Western Kamchatka population of pink salmon increased substantially beginning in 2018 (350 million pink salmon) and became odd-year dominant in 2021. Eastern Kamchatka pink salmon emerge from spawning grounds in coastal rivers during early spring, migrate to sea with little rearing in freshwater, then migrate southward in epipelagic waters of the East Kamchatka Current and eastward with the Subarctic Current along the southern side of the Aleutian Islands up to about 150°W. Little sampling of age-0 pink salmon has occurred in the Aleutian Islands Ecosystem owing to their small size, but some have been captured in this region during August and September. Pink salmon spend only one winter at sea and are typically distributed farther south below the Aleutian Islands during winter compared with sockeye salmon (Ruggerone et al., 2005). During spring (primarily June and July), maturing pink salmon migrate north and west through the Aleutian Island passages (including the eastern area) and into the Bering Sea where they are exceptionally abundant in spring and summer of odd-numbered years prior to migrating back to their natal rivers in summer. Sampling at sea indicates abundance of pink salmon in odd years is approximately 40 times greater than that in even years (Batten et al., 2018), owing to their fixed two-year life history.

**Status and trends:** The eastern Kamchatka pink salmon is an exceptionally abundant population of wild pink salmon, especially in odd-numbered years (Figure 37). No hatchery production of pink salmon occurs in this region. Pink salmon abundance was relatively stable over time from 1952 through the mid-1970s, then odd year runs began to increase over time. Even year abundances began to increase in 2014, corresponding with the unexpected decline in the 2013 return (only ~33 million adults). From 2011 to 2023, abundance averaged 212 million salmon in odd-numbered years and 64 million salmon in even-numbered years. The largest run on record occurred in 2019 (~315 million adults), followed by the small run in 2020 (~28 million adult fish), a very large run in 2021 (273 million), and a small run in 2022 (53 million adult fish).In 2023, approximately 273 million pink salmon returned to Eastern Kamchatka, i.e., the second largest run on record along with that in 2021. Fish size was exceptionally small in 2023 and 2025 (~ 1.05 kg). During odd years (2015, 2017, 2019, 2021, 2023), Eastern Kamchatka pink salmon represented ~ 37% of total pink salmon returning from the North Pacific compared with 18% during even years (2016, 2018, 2020, 2022).

The 2026 commercial catch of pink salmon in Eastern Kamchatka was approximately 37% less than that during the previous three even years (2020, 2022, 2024) and 90% less than the previous three odd year runs (2021, 2023, 2025). This decline in abundance follows the relatively small odd-year run returning from the North Pacific in 2025, following the all-time record run in 2023. The 2024 harvest was much less than the preseason forecast. The preliminary 2026 run size of Easter Kamchatka pink is 29 million fish or approximately 36,000 mt (Figure 37).

As a species, pink salmon represent nearly 70% of all Pacific salmon (Ruggerone and Irvine, 2018). In 2018 and 2019, record numbers of Pacific salmon returned from the North Pacific (950 and 854 million, respectively, excluding Chinook and coho salmon that represent less than 4% of the total; Ruggerone et al. 2021). In 2021 and 2023, record high total abundances of Pacific salmon continued (~1 billion adults) with pink salmon representing

approximately 81% of the total in both years (~798 and 864 million fish, respectively; Ruggerone et al. 2023; Connors et al. 2024). Exceptionally small salmon body size has been reported throughout Alaska in 2024 (and other recent years), and evidence indicates the high abundances of pink salmon was a major factor. Abundance of non-native pink salmon in the Atlantic Ocean continues to increase every odd-numbered year, raising concerns for native species Lennox et al. (2023).

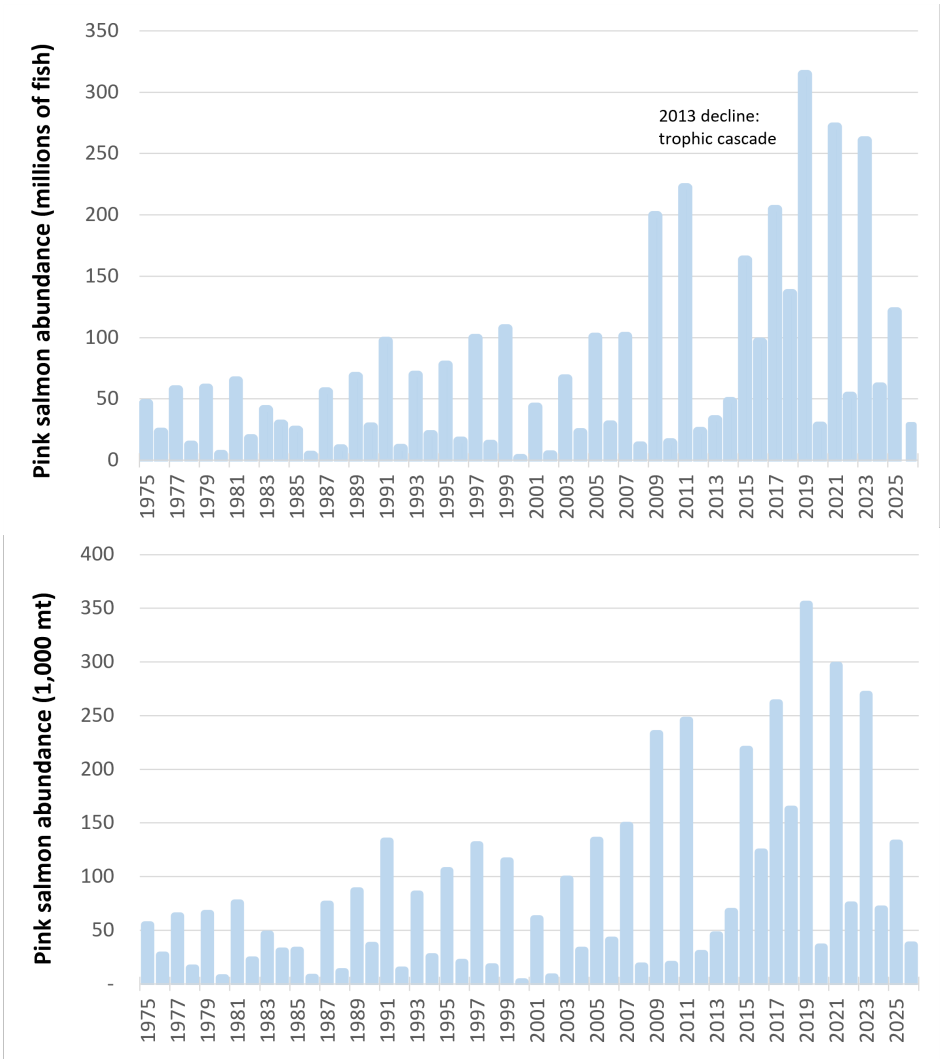



Figure 37: Time series of Eastern Kamchatka pink salmon abundance (numbers of fish and biomass), 1952-2024. Values include catch and spawner abundances. Recent values are preliminary. Sources: (Ruggerone and Irvine, 2018; Ruggerone et al., 2023). The 2024 value is based on preliminary harvest data.

**Factors influencing observed trends:** Abundances of pink salmon in Eastern Kamchatka and other regions increased after the 1977 ocean regime shift that was generally associated with warmer sea surface temperatures and greater zooplankton production (e.g., Brodeur and Ware 1992). Ocean heat content of the North Pacific Ocean explained 51% of the annual variability in pink salmon numbers returning from the North Pacific Ocean, 1952-2021, suggesting that climate change is benefiting pink salmon abundance and thus indirectly contributing to increased competition at sea for prey along with hatchery salmon (Ruggerone et al., 2023; Connors et al., 2024). In 2013 the abundance of Eastern Kamchatka pink salmon declined sharply (sampling suggested the decline occurred in marine waters), potentially supporting an increase in even-year abundances of pink salmon in

2014, 2016 and 2018, followed by exceptionally low abundance in 2020, then high abundance for an even-year in 2022 (Figure 37). Odd-year abundances quickly recovered after 2013 to exceptional numbers in 2019 and record numbers in 2021 and 2023. Pink salmon abundances in Asia and North America have declined considerably since these record-high pink salmon abundances. In 2026, salmon harvests were relatively low in both Russia and Alaska..

**Implications:** Pink salmon is the smallest (and youngest) species of Pacific salmon (as mature adults), but they grow exceptionally fast, consume many prey, and potentially affect growth and survival of many other species in the North Pacific Ocean and Bering Sea, including all species of Pacific salmon and steelhead trout, 11 seabird species, four forage fish species, and southern resident killer whales (Ruggerone et al., 2023; **?**). The unique biennial pattern of pink salmon in this region facilitates detection and evaluation of pink salmon competition with other species because physical oceanography studies have not been able to explain the biennial patterns. In the Aleutian Islands region, pink salmon give rise to a trophic cascade in which zooplankton declines and phytoplankton increases as pink salmon abundance increases (Batten et al., 2018). In 2013, when pink salmon abundance abruptly declined, the abundance of zooplankton rebounded to a high level, providing additional support for the trophic cascade hypothesis. Effects of this trophic cascade in the Aleutian Island region have been documented in the growth, survival, and abundance of Bristol Bay sockeye salmon (Ruggerone et al., 2003; Connors et al., 2020), seven sockeye populations originating from the Gulf of Alaska region (Rand and Ruggerone, 2024), Yukon/Kuskokwim/Nushagak Chinook salmon (Ruggerone et al., 2023), Columbia River steelhead (e.g., **?**), otolith growth of Atka mackerel (Matta et al., 2020), and reproduction of seabirds (Springer and van Vliet, 2014) that occupy the Aleutian Islands Ecosystem.

In 2020, the commercial harvest of all five salmon species, including salmon populations from most regions of the North Pacific, declined more than ever since comprehensive record keeping began in 1925 (Ruggerone et al., 2021). Chinook salmon experienced the greatest decline relative to the previous 10 years (54% decline). Investigators hypothesized that frequent marine heatwaves and unprecedented abundances of pink salmon in 2018 and 2019 contributed to the harvest decline. The high abundance of pink salmon in 2023 may have contributed to the unexpected decline of pink salmon in 2024, especially in Alaska. Pink salmon abundances have declined considerably in Asia and North America since 2023.

Bristol Bay sockeye salmon, which inhabit the Aleutian Islands Ecosystem, was a primary exception to the unprecedented decline of all salmon species in 2020. Abundances of Bristol Bay sockeye salmon set record highs in 2021 (66 million adults) and 2022 (78 million; www.adfg.alaska.gov). The exceptional abundance of both Eastern Kamchatka pink salmon and Bristol Bay sockeye salmon in recent years might seem counterintuitive because evidence indicates Kamchatka pink salmon adversely affect the growth, survival and abundance of Bristol Bay sockeye salmon (e.g., Ruggerone et al. 2003, 2016, 2023). However, competition for prey between these salmon populations does not begin until the second growing season at sea, based on scale growth analysis. Furthermore, studies of seasonal and annual growth of Bristol Bay sockeye salmon reported that the large increase in survival and abundance of Bristol Bay sockeye salmon after the 1976/1977 ocean regime shift was associated with greater growth during early marine life (Ruggerone et al., 2005, 2007). The recent consistently high abundance of Bristol Bay sockeye salmon is likely associated with favorable conditions in freshwater and greater early marine growth and survival in the warming Bering Sea, a benefit that overwhelms the adverse effect of pink salmon on sockeye growth and survival during later marine life (Ruggerone et al., 2023).

# Groundfish

## *Aleutian Islands Groundfish Condition*

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**Last updated: September 2026**

**Description of indicator:** Length-weight residuals represent how heavy a fish is per unit body length and are an indicator of somatic growth variability (Brodeur et al., 2004). Therefore, length-weight residuals can be considered indicators of prey availability, growth, general health, and habitat condition (Blackwell et al. 2000; Froese 2006). Positive length-weight residuals indicate better condition (i.e., heavier per unit length) and negative residuals indicate poorer condition (i.e., lighter per unit length) (Froese, 2006). Fish condition calculated in this way reflects realized outcomes of intrinsic and extrinsic processes that affect fish growth, which can have implications for biological productivity through direct effects on growth and indirect effects on demographic processes, such as reproduction and mortality (e.g., Rodgveller 2019; Barbeaux et al. 2020).

The groundfish morphometric condition indicator is calculated from paired fork lengths (mm) and weights (g) of individual fish that were collected during biennial bottom trawl surveys of the Aleutian Islands (AI), which were conducted by the Alaska Fisheries Science Center's Resource Assessment and Conservation Engineering (AFSC/RACE) Groundfish Assessment Program (GAP). Fish condition analyses were applied to walleye pollock (*Gadus chalcogrammus*), Pacific cod (*Gadus macrocephalus*), arrowtooth flounder (*Atheresthes stomias*), Atka mackerel (*Pleurogrammus monopterygius*), northern rockfish (*Sebastes polyspinis*), and Pacific ocean perch (*Sebastes alutus*). Southern rock sole (*Lepidopsetta bilineata*) was also analyzed in previous survey years but was not sampled in 2026. All species were collected in trawls with satisfactory performance at stratified random stations within the following subareas: southern Bering Sea, eastern Aleutians, central Aleutians, and western Aleutians (Figure 38).

To calculate indicators, length-weight relationships were estimated from linear regression models based on a log-transformation of the exponential growth relationship, $W = aL^b$, where $W$ is weight (g) and $L$ is fork length (mm) for all areas for the period 1991–2026 (Figure 38). Unique intercepts ($a$) and slopes ($b$) were estimated for each species, survey subarea, sex, and interaction between subarea and sex to account for sexual dimorphism, spatial-temporal variation in growth, and bottom trawl survey sampling. Length-weight relationships for 100–250 mm fork length walleye pollock (corresponding with ages 1–2 years) were calculated separately from adult walleye pollock (> 250 mm). Residuals for individual fish were obtained by subtracting observed weights from bias-corrected weights-at-length that were estimated from regression models. Length-weight residuals from each subarea were aggregated and weighted proportionally to total biomass in each subarea from area-swept expansion of mean bottom-trawl survey catch per unit effort (CPUE; i.e., design-based subarea biomass estimates). Variation in fish condition was evaluated by comparing average length-weight residuals among years. To minimize the influence of unrepresentative samples on indicator calculations, combinations of species, subarea, and year with a sample size <10 were used to fit length-weight regressions, but were excluded from calculating length-weight residuals. Morphometric condition indicator time series, code for calculating the indicators, and figures showing results for individual species are available through the *akfishcondition* R package and GitHub repository[11].

**Status and trends:** Body condition varied amongt years for all species considered (Figures **??**). Prior to 2010, the condition for most species cycled between positive and negative values through the years. Condition for most species has primarily been near-average (within 1 standard deviation [SD]) or below (> 1 SD) the time series mean since 2012. The exception to this was 100–250 mm walleye pollock in 2024, where the residual body condition was two standard deviations higher than the time series mean. Body condition for walleye pollock > 250 mm has

[11] `https://github.com/afsc-gap-products/akfishcondition`

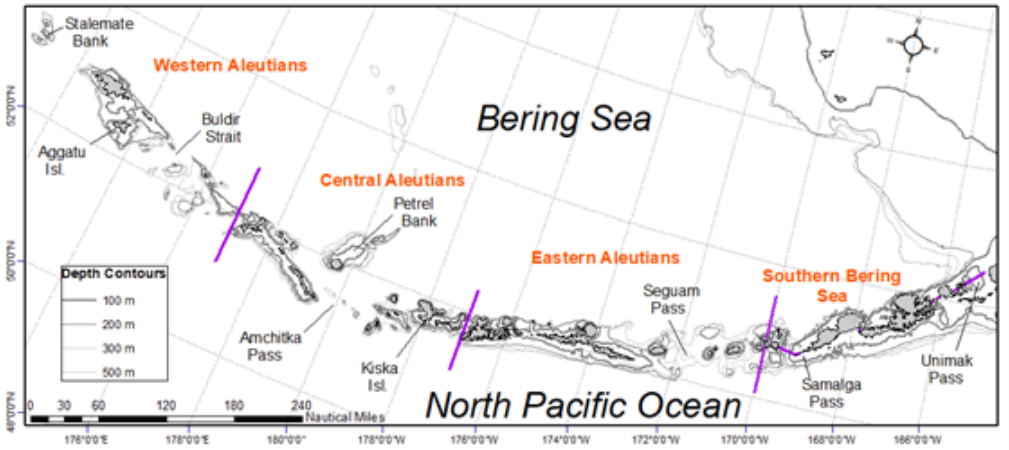



Figure 38: National Marine Fisheries Service (NMFS) Alaska Fisheries Science Center (AFSC) Resource Assessment and Conservation Engineering Groundfish Assessment Program (RACE-GAP) Aleutian Islands summer bottom trawl survey area with International North Pacific Fisheries Commission (INPFC) statistical fishing strata delineated by the purple lines.

been declining since 2022 and was below the time series mean in 2026, reaching the lowest condition since 2016. In contrast, 100-250 mm walleye pollock were in below average condition in 2022, reached the highest condition of the time series in 2024, and decreased in 2026 to slightly above the time series mean. Atka mackerel was above average in 2010 and has generally shown a decreasing trend since then, but was near-average in 2026. Southern rock sole body condition has been trending positive in the Aleutians since 2012, and was just above the time series mean in 2024. Southern rock sole individual length-weight measurements were not collected in 2026. Pacific cod and arrowtooth flounder were above average condition in 2010, but subsequently had declining condition through 2018 before increasing in 2022. Pacific cod and arrowtooth flounder remained below, but within one SD of the time series mean in 2026. Northern rockfish and Pacific ocean perch condition has shown a decreasing trend since 2010, with both species reaching their lowest values in the time series in 2026. Notably, residual body condition was below the time series mean for all species sampled in 2026 except 100-250 mm walleye pollock, and more than one standard deviation or more below the mean for walleye pollock > 250 mm, northern rockfish, and Pacific ocean perch.

In 2026, condition was negative in every subarea with an estimate for walleye pollock > 250 mm, Pacific cod, arrowtooth flounder, Atka mackerel, northern rockfish, and Pacific ocean perch (40). For Pacific cod, Atka mackerel, northern rockfish, and Pacific ocean perch, this included all four subareas (southern Bering Sea, eastern Aleutians, central Aleutians, and western Aleutians) in both 2024 and 2026. By comparison, Atka mackerel condition in 2022 was positive in the central and eastern Aleutians but negative in the western Aleutians and southern Bering Sea. Walleye pollock > 250 mm were negative in the western Aleutians, eastern Aleutians, and southern Bering Sea in 2024 and 2026, with the most negative values in the southern Bering Sea in 2026. In contrast, 100-250 mm walleye pollock were in positive condition in the western and eastern Aleutians in 2024 and 2026, the only two subarea with estimates in those years, and in 2022, the only estimate was for the central Aleutians, where condition was negative.

**Factors influencing observed trends:** Several factors could affect morphological condition, including water temperature. Since the Warm Blob in 2014 (Bond et al. 2015; Stabeno and Bell 2019, there has been a general

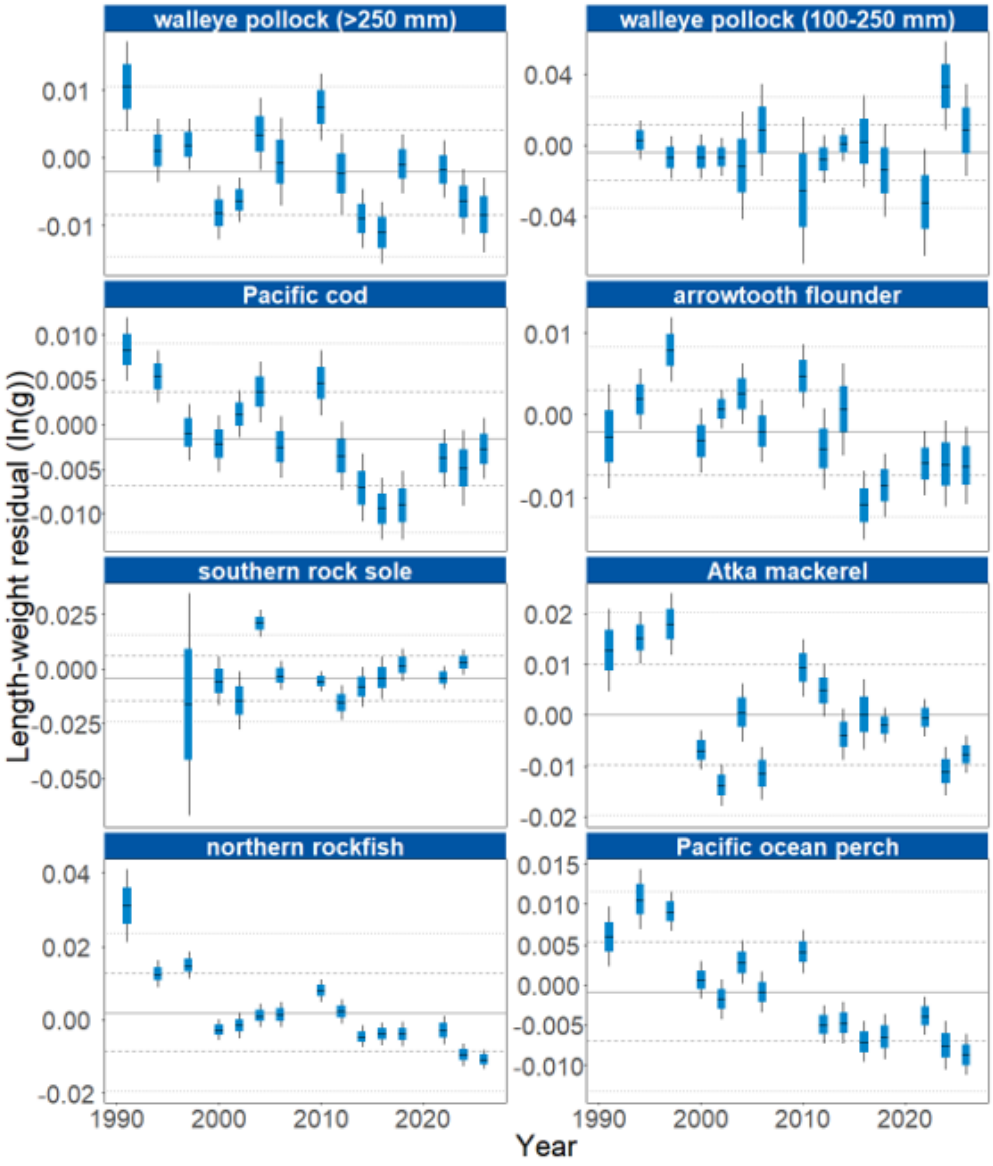



Figure 39: Morphometric condition of groundfish species collected during AFSC/RACE GAP standard summer bottom trawl surveys of the Aleutian Islands (1991 to 2026) based on residuals of length-weight regressions. The dash in the blue boxes denotes the mean for that year, the box denotes one standard error, and the lines on the boxes denote two standard errors. Lines on each plot represent the historical mean, dashed lines denote one standard deviation, and dotted lines denote two standard deviations.

trend of warming ocean temperatures in the survey area that could affect fish growth conditions. Summer sea surface temperatures in the Aleutian Islands hovered near the long-time mean in both 2024 and 2026 based on measurements recorded during the bottom trawl survey (Rohan and Howard, **??**). The influence of temperature on growth rates depends on the physiology of predator species, prey availability, and the adaptive capacity of predators to respond to environmental change through migration, changes in behavior, and acclimatization. For example, elevated temperatures during the 2014-2016 marine heatwave in the Gulf of Alaska led to lower growth rates and condition of Pacific cod and early life history stages of walleye pollock, likely because available prey resources did not make up for increased metabolic demand (Barbeaux et al. 2020; **?**). Density-dependent competition may also

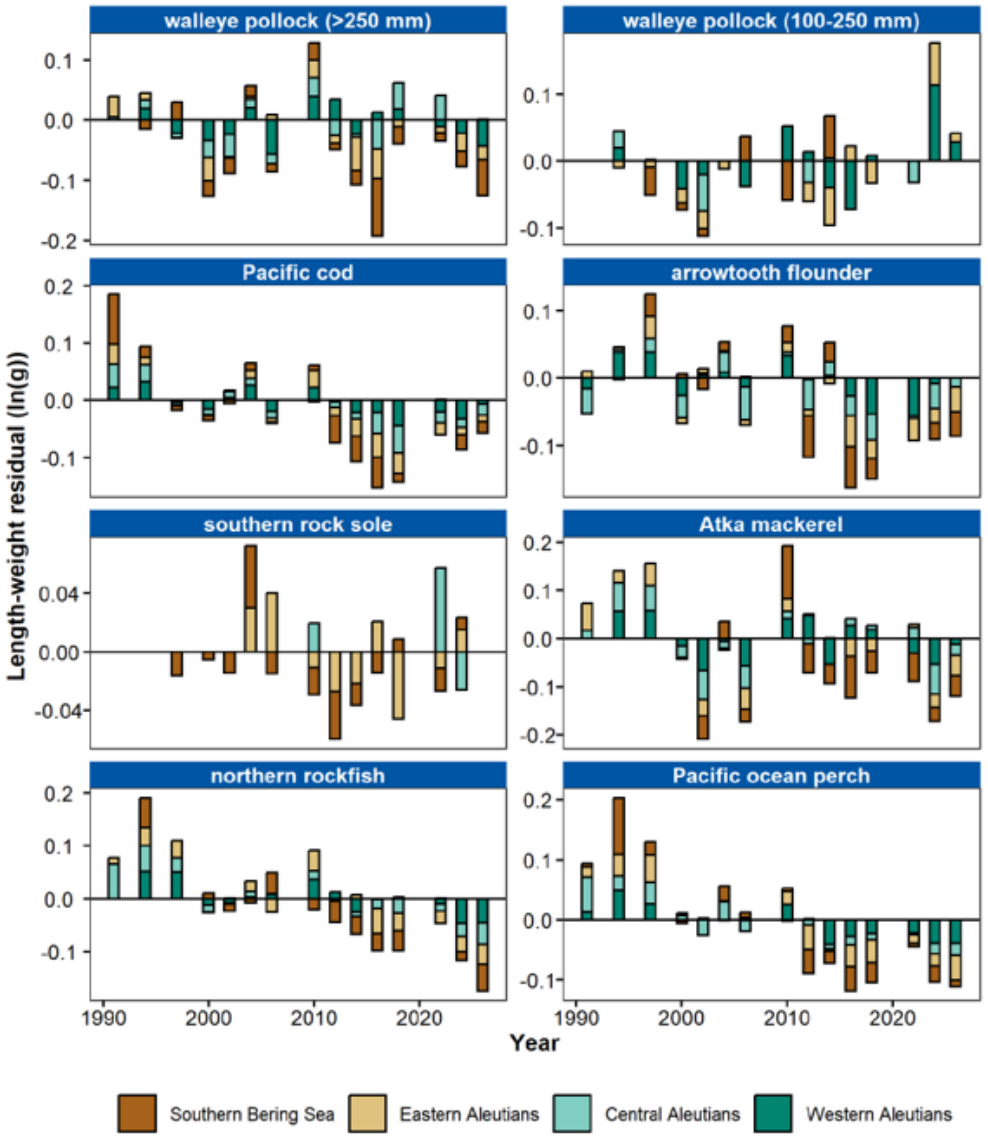



Figure 40: Length-weight residuals by survey subarea for seven Aleutian Islands groundfish species and age 1–2 walleye pollock (100–250 mm) sampled in the AFSC/RACE GAP standard summer bottom trawl survey, 1991-2026. Length-weight residuals are not weighted by subarea biomass.

influence condition, as morphometric condition is expected to be high when a stock is at low abundance and low when a stock is at high abundance (Haberle et al., 2023). Thus, the factors underpinning the negative or neutral condition remain unclear.

Other factors that could affect morphological condition include survey timing, stomach fullness, and fish movement patterns (Froese, 2006). Changing ocean conditions along with normal patterns of movement can cause the proportion of the population resident in the sampling area during the annual bottom trawl survey to vary. Effects of survey timing on body condition can be further compounded by seasonal fluctuations in reproductive status with the buildup and depletion of energy stores (Wuenschel et al., 2019). Another consideration is that fish weights sampled at sea include gut content weights, so variation in gut fullness may influence weight measurements since

feeding conditions, digestion, and gastric evacuation rates vary over space and time..

Spatial heterogeneity within the Aleutian Islands may also influence morphometric condition. Fish community composition changes abruptly at several of the major passes between islands, and growth rates of some fish species decline toward the west (Hunt and Stabeno, 2005) as has been documented for Atka mackerel (**?**). O'Leary et al. (2026) recently evaluated weight-at-length of six Aleutian groundfish species north and south of the Aleutian passes using survey data through 2022. Pacific ocean perch, northern rockfish, Pacific cod, and arrowtooth flounder were heavier for their length north of the passes, whereas Atka mackerel were heavier south of the passes, and walleye pollock showed no significant north-south difference; overall effect sizes were small. Because samples from both sides of the chain are combined to estimate subarea-specific regression parameters, north-south differences in weight-at-length are not accounted for in the current indicator and could contribute to variability in condition estimates, for example if the proportion of samples collected north versus south of the chain differs among years.

Finally, although condition indicators characterizes spatial and temporal variation in morphometric condition of groundfish species in the Aleutian Islands, it does not inform the mechanisms or processes behind the observed patterns.

**Implications:** Fish morphometric condition can be considered an indicator of ecosystem productivity with implications for fish survival, maturity, and reproduction. For example, in Prince William Sound, the pre-winter condition of herring may determine their overwinter survival (Paul and Paul, 1999), differences in feeding conditions have been linked to differences in morphometric condition of pink salmon in Prince William Sound (Boldt and Haldorson, 2004), variation in morphometric condition has been linked to variation in maturity of sablefish (Rodgveller, 2019), and lower morphometric condition of Pacific cod was associated with higher mortality and lower growth rates during the 2014–2016 marine heat wave in the Gulf of Alaska (Barbeaux et al., 2020). Condition can also be an indicator of stock status relative to carrying capacity because morphometric condition is expected to be high when the stock is at low abundance and low when the stock is at high abundance because of the effects of density-dependent competition (Haberle et al., 2023). Thus, the condition of Aleutian Islands groundfishes may provide insight into ecosystem productivity as well as fish survival, demographic status, and population health. However, survivorship is likely also affected by many factors not examined here.

Another important consideration is that fish condition was computed for all sizes of fishes combined, except in the case of walleye pollock. Examining condition of early juvenile stage fishes separately from the condition of adult fishes could provide further insight into the value of length-weight residuals as an indicator of individual health or survivorship (Froese, 2006), particularly since juvenile and adult walleye pollock exhibited opposite trends in condition in the Aleutian Islands this year..

The decreasing trend in body condition for many Aleutian Islands species suggests growth has decreased, which may have implications for stock assessment. The condition of northern rockfish and Pacific ocean perch, two long-lived and highly abundant planktivores, reached their lowest values in the time series in 2026. Downward trends in body condition could indicate poor overwinter survival or may reflect the influence of locally changing environmental conditions depressing fish growth, local production, or survivorship. Indications are that the 2014–2016 marine heatwave (Bond et al., 2015; Stabeno and Bell, 2019) has been followed by years with elevated water temperatures, which may be related to changes in fish condition in the species examined.

**Research priorities:** Research is underway at the AFSC to examine relationships among putatively similar indicators of fish condition (i.e., morphometric, bioenergetic, physiological). This includes an evaluation of hepatosomatic index, microwave energy meter (fatmeter) measurements, and Fourier-transform near-infrared (FT-NIR) spectroscopy as alternative condition indicators, compared against biochemical measurements of liver lipid content (Prohaska et al., in prep.). Depending on the outcome of this work and the feasibility of collecting the required measurements during surveys, these indicators may be incorporated into future Ecosystem Status Reports (ESRs).

## *Distribution of rockfish species along environmental gradients in Aleutian Islands bottom trawl surveys*

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**Last updated: September 2026**

**Description of indicator:** This indicator focuses on distribution shifts of commercial and ecologically important rockfish species in Alaska including Pacific ocean perch (*Sebastes alutus*), northern rockfish (*S. polyspinis*), dusky rockfish (*S. variabilis*), the rougheye/blackspotted rockfish complex (*S. aleutianus* and *S. melanostictus*), shortraker rockfish (*S. borealis*), and shortspine thornyhead (*Sebastolobus alascanus*). In a previous analysis of rockfish from 14 bottom trawl surveys in the Gulf of Alaska and Aleutian Islands (Rooper, 2008), five species assemblages were defined based on similarities in their distributions along geographic position, depth, and temperature gradients. Three distinct assemblages were found in the northern GOA and the AI with the 180 m and 275 m depth contours acting as major divisions between assemblages. The shelf assemblage (<180 m) includes juvenile Pacific ocean perch, northern rockfish, and dusky rockfish, the shelf break assemblage (180-275 m) includes juvenile rougheye rockfish and Pacific ocean perch, and the slope assemblage (>275 m) includes rougheye rockfish, shortraker rockfish, and shortspine thornyhead. Another noticeable division was between species centered in southeastern Alaska and those found in the northern GOA and AI.

Orr and Hawkins (2008) split the fish previously known as rougheye rockfish into two separate species: rougheye rockfish and blackspotted rockfish. However, due to a lack of species-specific data, current stock assessments continue to group them as a single complex and the complex will be used in this chapter.

In this time-series, the mean-weighted distributions of six rockfish taxa along the three environmental gradients (geographic position, depth and temperature) were calculated for the Aleutian Islands. These indices are also known as the center of gravity (COG) of population density with respect to a spatial or environmental variable. A weighted mean value for each environmental variable was computed for each survey year as:

$$x = \frac{\sum f_i x_i}{\sum f_i},$$

where $f_i$ is the catch-per-unit-effort (CPUE; kgkm$^{-2}$) of each rockfish species group in tow $i$ and $x_i$ is the value of the environmental variable at tow $i$. The weighted standard deviation ($SD$) was then computed as:

$$\text{SD} = \sqrt{\frac{\left(\sum_{i=1}^{N} f_i (x_i - \bar{x})\right)^2}{\frac{M-1}{M} \sum_{i=1}^{N} f_i}}$$

where $N$ is the number of tows, $M$ is the number of tows with positive catches and . $\bar{x}$ is the weighted mean CPUE. These indices monitor the distributions of major components of the rockfish fisheries along these environmental gradients to detect changes or trends in rockfish distribution.

Dusky rockfish were identified with low confidence prior to 1999, thus all years prior were excluded in the analyses for this species. Code used to produce indicator estimates and figures is available at: https://github.com/afsc-gap-products/rockfish-cog/tree/main.

**Methodological changes:** The fundamental approach for calculating Aleutian Islands rockfish distribution indicators has not changed in 2026; however, some aspects of the analysis and visualizations have been updated.

The indicators represent mean latitude, longitude, temperature, and depth, weighted by the design-based rockfish CPUE in units of biomass per area swept. In previous years, linear models were used to estimate trends in the weighted mean depth, temperature, and distance from Hinchenbrook Island over time. Now, these trends are reported as time series with uncertainty for visual evaluation of short- and long-term patterns, and weighted mean latitude and longitude are presented in 'sparkle plots' (bivariate scatterplots with error bars in both axis dimensions).

**Status and trends:** Several trends were observed with rockfishes along the three spatial and environmental gradients examined in the AI time series through 2026 (Figures 41, 42). Dusky, northern, and shortraker rockfish demonstrate higher variability in their COG than Pacific ocean perch, rougheye/blackspotted rockfish, and shortspine thornyhead (Figure 41).

Relative to 2024, the COG for northern, rougheye/blackspotted, and shortraker rockfish in 2026 was closer to the time-series average. For northern rockfish, this represents the continuation of an eastward trend from 2024, after a significant westward shift in 2022. Similarly for Pacific ocean perch, the 2026 COG is further west than in 2022 and 2024. For dusky rockfish, the COG in 2026 is further southwest than 2024, which was the most northeasterly point in the time-series. For shortspine thornyhead, the 2026 estimate is the furthest west, with little change on the north-south axis throughout the time series (Figures 41, 42).

Throughout the time series, the mean-weighted depth distributions became gradually shallower for rougheye/ blackspotted rockfish by 53 m (from 302 m to 249 m) and by 107 m for shortspine thornyhead (354 m to 247 m) (Figure 42). The other taxa examined remained relatively constant in their depth distribution.

Dusky and northern rockfish, which are shallower-dwelling species, have experienced the most variation in thermal conditions compared to the other taxa, with the exception of 2012, when all taxa experienced similar, cool conditions (Figure 42). In 2026, northern rockfish, Pacific ocean perch, and shortspine thornyhead occupied higher temperatures than in 2024 (an average increase of 0.39°C), whereas dusky rockfish experienced a 0.41°C decrease in temperature since 2024.

**Factors influencing the observed trends:** In the AI, most rockfish spatial and depth distributions appear to be relatively consistent while their thermal environment has changed to varying extents. Temperatures at greater depths along the slope tend to have less year-to-year variation than on the shelf. Anomalously warm temperatures were observed during the 2014 survey with continued warm conditions through 2022. Both surface and bottom temperatures in 2024 and 2026 returned to mean condition (Rohan and Howard, **??**). Although temperature is the primary candidate driver of distributional shifts for some groundfish species in the GOA (**?**Yang et al., 2019) and likely affects AI rockfish, the depth distributions have not changed substantially, indicating limited distributional responses to temperature variation. This may be due to rockfish life history and habitat requirements that may constrain their ability to respond to changing oceanographic conditions. Depth, position, slope and other covariates contribute more than bottom temperature to the final ensemble species distribution models defining Essential Fish Habitat for these rockfish taxa groups (Harris et al., 2022). Rockfish spatial distributions may not respond strongly to temperature changes due to several factors: limited movement, high generation times, long lifespans, affinity for fixed physical bottom structure, and location of predators and prey (**?**Rooper et al., 2019).

The geographic shifts and more subtle changes in depth distribution could also be explained by changing population abundance. Abundance, productivity, and competition may change differently over space to cause these patterns directly, or indirectly through expansion or contraction into marginal habitats. For example, Pacific ocean perch abundance in the Aleutian Islands has increased over the time series (**?**). Finally, age composition can influence distribution in species that have ontogenetic habitat shifts with older rockfishes typically occupying deeper depths (**?**Rooper, 2008; Yang et al., 2019).

**Implications:** The trends in the mean-weighted distributions of rockfishes should continue to be monitored, with a focus on how changes in these distributions may relate to oceanographic shifts and reflect the specific vulnerabilities of this species assemblage related to their unique life history characteristics. In general, rockfishes

are characterized by late maturity, viviparity, reduced genetic diversity, affinity for physical structure, and limited movement (**?**Rooper et al., 2019; **?**). This group of species may therefore have a more limited ability to change their distribution in response to changes in temperature or other oceanographic conditions. For example, reproductive success and the rate of skipped spawning in some of these rockfish species has been shown to be variable between years and this variability may be related to changing oceanographic conditions (Conrath et al., 2019; **?**).

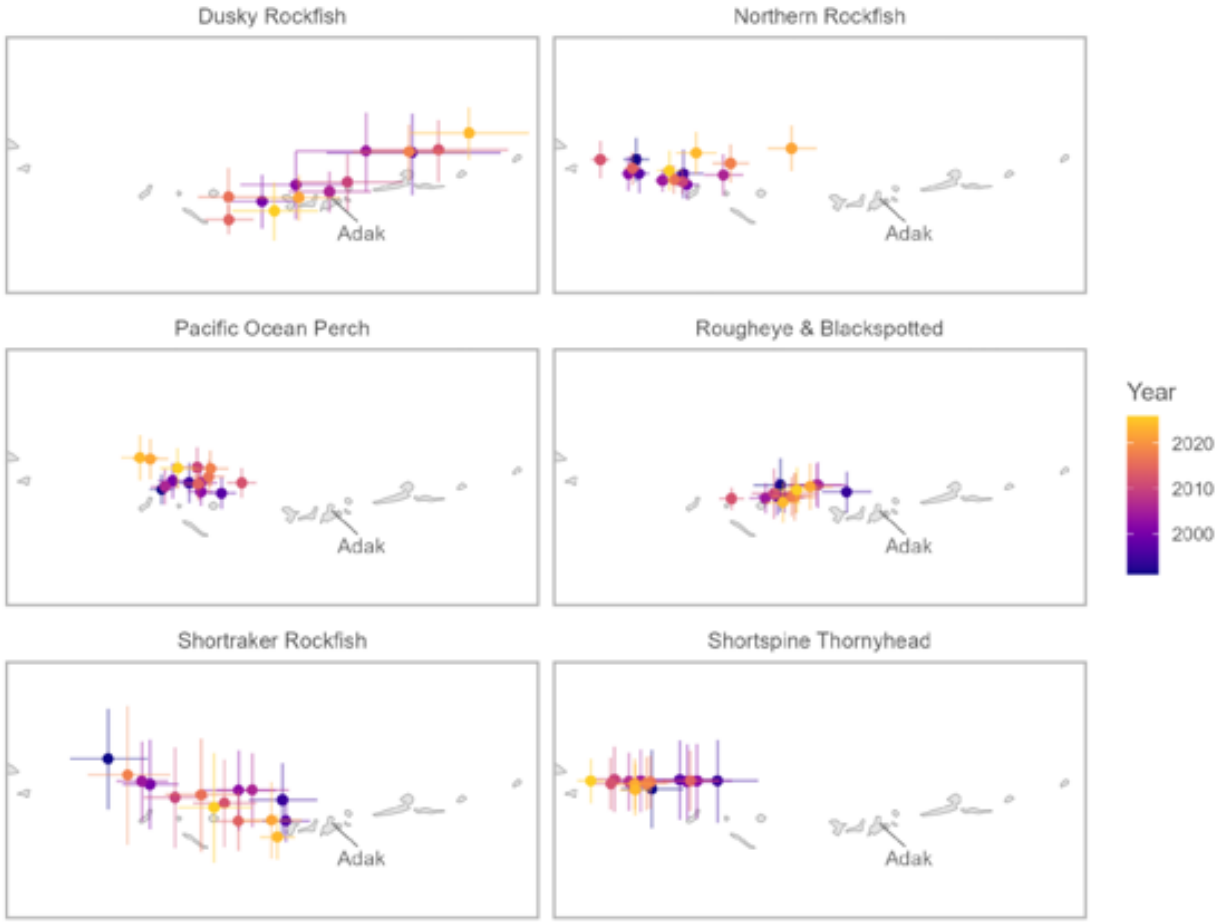



Figure 41: Sparkle plots of rockfish center of gravity over time. Points represent the mean and lines represent 1 standard deviation from the mean latitude and longitude.

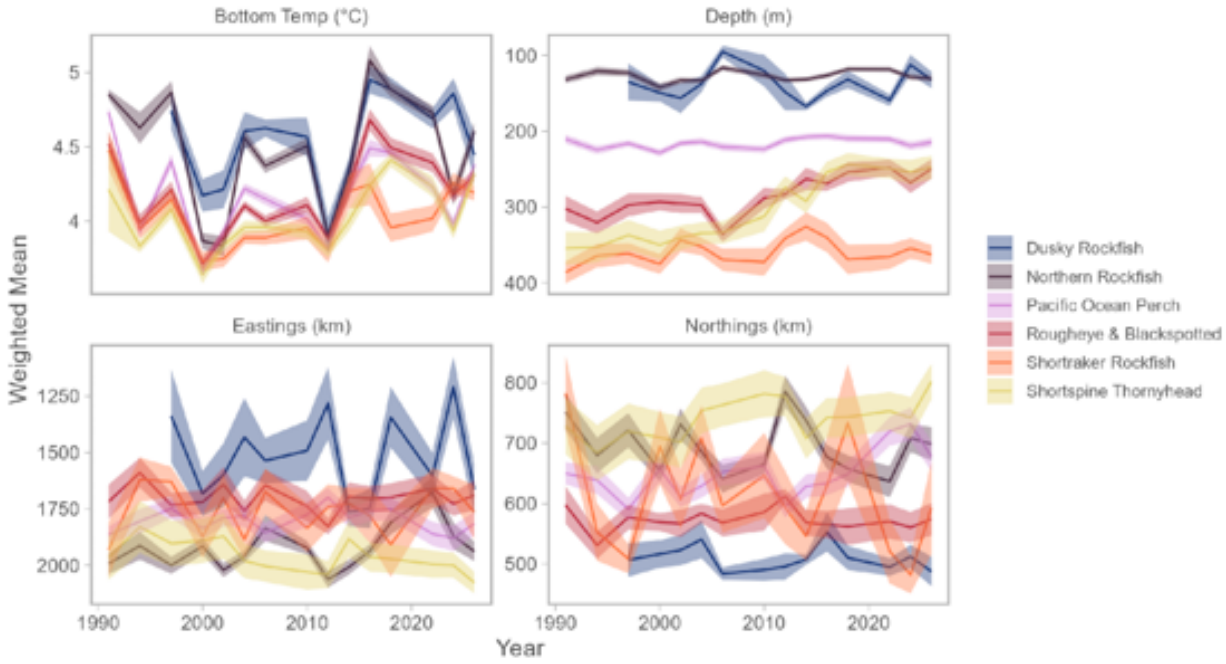



Figure 42: Time series of weighted mean spatial and environmental variables (bottom temperature, depth, eastings and northings) for each of the six rockfish species.

# Benthic Communities and Non-target Fish Species

## *Miscellaneous benthic fauna—Aleutian Islands*

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**Last updated: September 2026**

**Description of indicator:**Benthic species are often reliable ecosystem indicators due to their sensitivity to environmental fluctuations (Tampo et al., 2021) and their integral role in marine food webs (Griffiths et al., 2017). Consequently, shifts in their abundance serve as key sentinels for broader changes in environmental conditions and ecosystem functioning (**?**Salas et al., 2006). The benthic fauna presented here are categorized into four taxonomic groups: eelpouts (family Zoarcidae), poachers (family Agonidae), shrimps (infraorder Caridea), and sea stars (class Asteroidea). The three species comprising the bulk of the eelpout group are the ebony eelpout (*Lycodes concolor*), bicolor eelpout (*L. beringi*) and, to a lesser extent, the shortfin eelpout (*L. brevipes*). The biomass of poachers is dominated by sturgeon poachers (*Podothecus accipenserinus*) and sawback poachers (*Sarritor frenatus*). The biomass of shrimps is largely composed of Alaskan pink shrimp (*Pandalus eous*) and yellowleg pandalids (*P. tridens*), whereas the biomass of sea stars are primarily comprised of *Henricia* stars and the fragile sea star (*Cheiraster dawsoni*). These benthic fauna, when considered alongside formally assessed and commercially targeted species, can provide valuable context for the overall status of the Aleutian ecosystem. Since 1991, the biennial RACE Groundfish Assessment Program (GAP) fishery-independent summer bottom trawl survey in the Aleutian Islands (AI) has deployed the same standardized trawl gear (footrope and trawl net) across the survey region. Therefore, biomass index trends are likely to reflect changes in the abundance of species and life history stages that are available to the survey, particularly if trends are sustained over time.

Regional and subarea (Southern Bering Sea [SBS], Eastern AI [EAI], Central AI [CAI], Western AI [WAI]) indices of abundance (biomass in kilotons) and confidence intervals were estimated for each taxonomic group by fitting a multivariate random effects model (REM) to subarea design-based index of abundance time series that were calculated from RACE GAP summer bottom trawl survey catch and effort data. Indices were calculated for the entire standardized survey time series (1991 to 2026). Design-based indices of abundance were produced using the gapindex R package (Oyafuso, 2025) and REM were fitted to the time series using the rema R package (Sullivan et al., 2022; Sullivan and Balstad, 2022). Code and data used to produce these indicators are provided in the esrindex R package and repository (Rohan, 2025).

**Status and trends:** During the initial decade of the survey (1991–2000), sea star and shrimp biomass was relatively stable, despite minor annual fluctuations (Figure 43).Sea stars were concentrated primarily in the Eastern Aleutian Islands (EAI), whereas shrimps were centered in the Western Aleutian Islands (WAI). Over the past decade, both invertebrate groups experienced steady declines, driven largely by losses in the WAI. Although biomass for both taxa remained low and stable across the 2022 and 2024 surveys, the 2026 survey revealed substantial biomass increases toward the respective long term averages. Sea star distribution now resembles early-2000s patterns, with biomass concentrated primarily in the EAI and Central Aleutian Islands (CAI) (Figure 44). In contrast, shrimp biomass increased significantly in both the Southern Bering Sea and EAI relative to recent bottom trawl surveys.

Eelpouts and poachers historically maintained stable biomass as well, with eelpouts concentrated in the CAI and EAI, and poachers dominating the EAI and WAI. Mirroring the trends seen in invertebrates, both fish groups experienced major long-term declines from roughly 2006 to 2022. In 2026, eelpout biomass substantially increased, rebounding from recent years and driven primarily by gains in the EAI. Conversely, poacher biomass remained relatively stable with the previous survey and its subareal distribution remained similar to 2024.

**Factors influencing observed trends:** We hypothesize that persistent warm conditions and decreased ecosystem productivity in the Aleutian Islands since 2013 (Xiao and Ren, 2023) may have contributed to the steady biomass declines observed across all four taxonomic groups at that time. Many of these taxa are known to be sensitive to thermal stress (Anderson, 2000; Brodte et al., 2006), and sea stars in particular experienced severe sea star wasting disease outbreaks linked to elevated temperatures.

The substantial biomass increases observed in the 2026 survey for sea stars, shrimps, and eelpouts may reflect a positive response to cooler recent ocean conditions in the eastern Aleutian Islands region since 2016, where recent biomass gains for the taxa were largely concentrated. Conversely, the continued low biomass of poachers relative to historical levels may be related to elevated temperatures seen in the western Aleutians in recent years (Rohan and Howard in this report). However, other factors, such as changes in prey or predator dynamics, disturbance, or a combination of effects may also be contributing to these patterns. Continued monitoring and focused research on these non-target benthic taxa are essential to provide a more robust understanding of the mechanisms responsible for the biomass trends documented here.

**Implications:** These taxa are an important dietary component of many commercially important species, like Atka mackerel, Pacific cod, and king crab. Therefore, changes in biomass could substantially alter trophic dynamics and have ecosystem-wide ramifications.

**Research priorities:**The bottom trawl survey uses standardized survey protocols aimed at ensuring consistent sampling efficiency. However, additional research is needed to better characterize the catchability and selectivity of miscellaneous benthic fauna groups by the bottom trawl survey. In addition, the relationship between population dynamics and temperature is not well understood for these species. Research into the mechanisms driving population-level responses to ocean temperatures would help refine their use as indicators for tracking ecosystem changes.

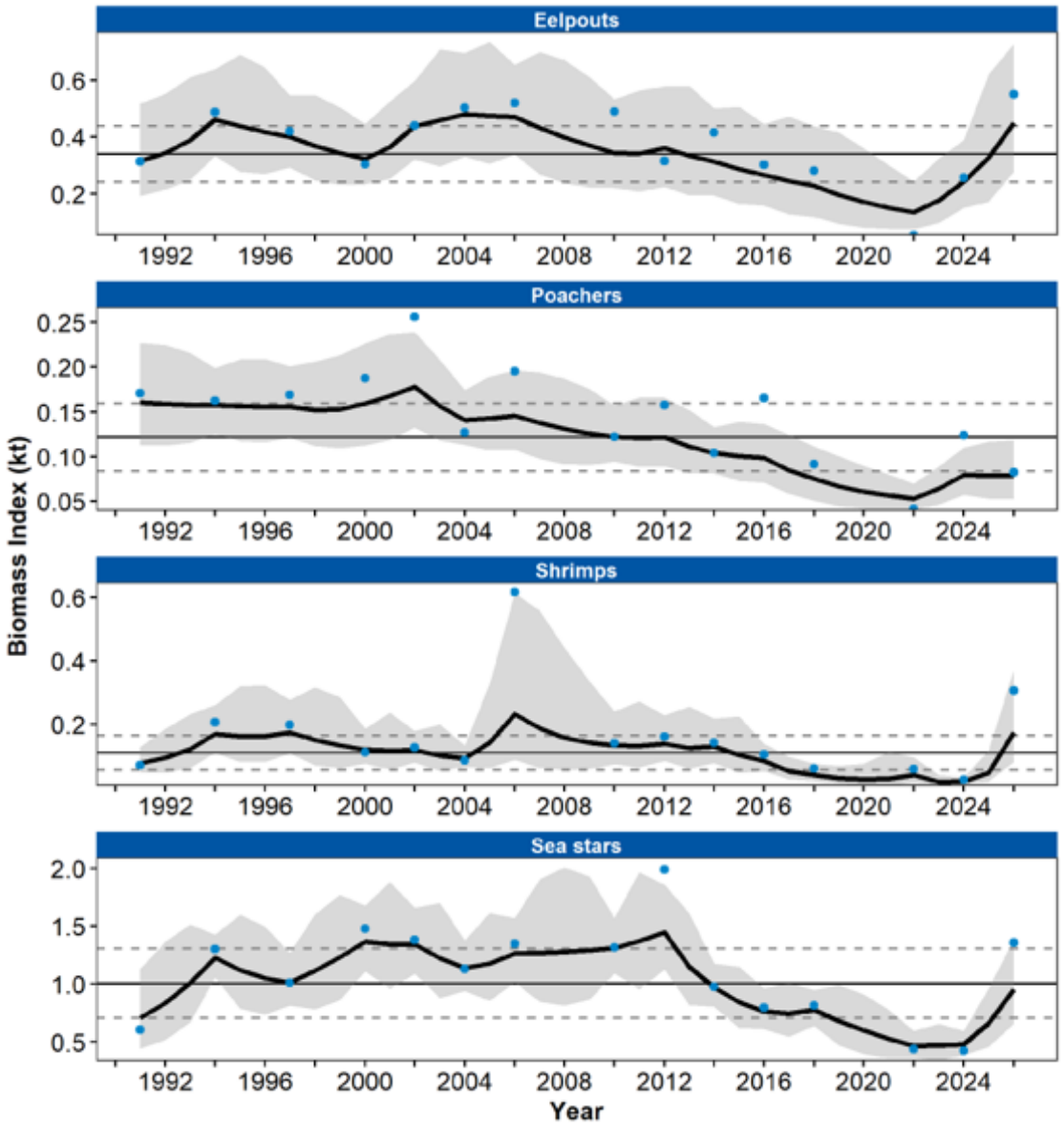



Figure 43: Biomass index (kilotons) of miscellaneous benthic fauna (eelpouts, poachers, sea stars, shrimps) from RACE Groundfish Assessment Program summer bottom trawl surveys of the Aleutian Islands from 1991 to 2026. Panels show the observed survey biomass index mean (blue points), random effects model fitted mean (solid black line), 95% confidence interval (gray shading), overall time series mean (solid gray line), and horizontal dashed gray lines representing one standard deviation from the mean.

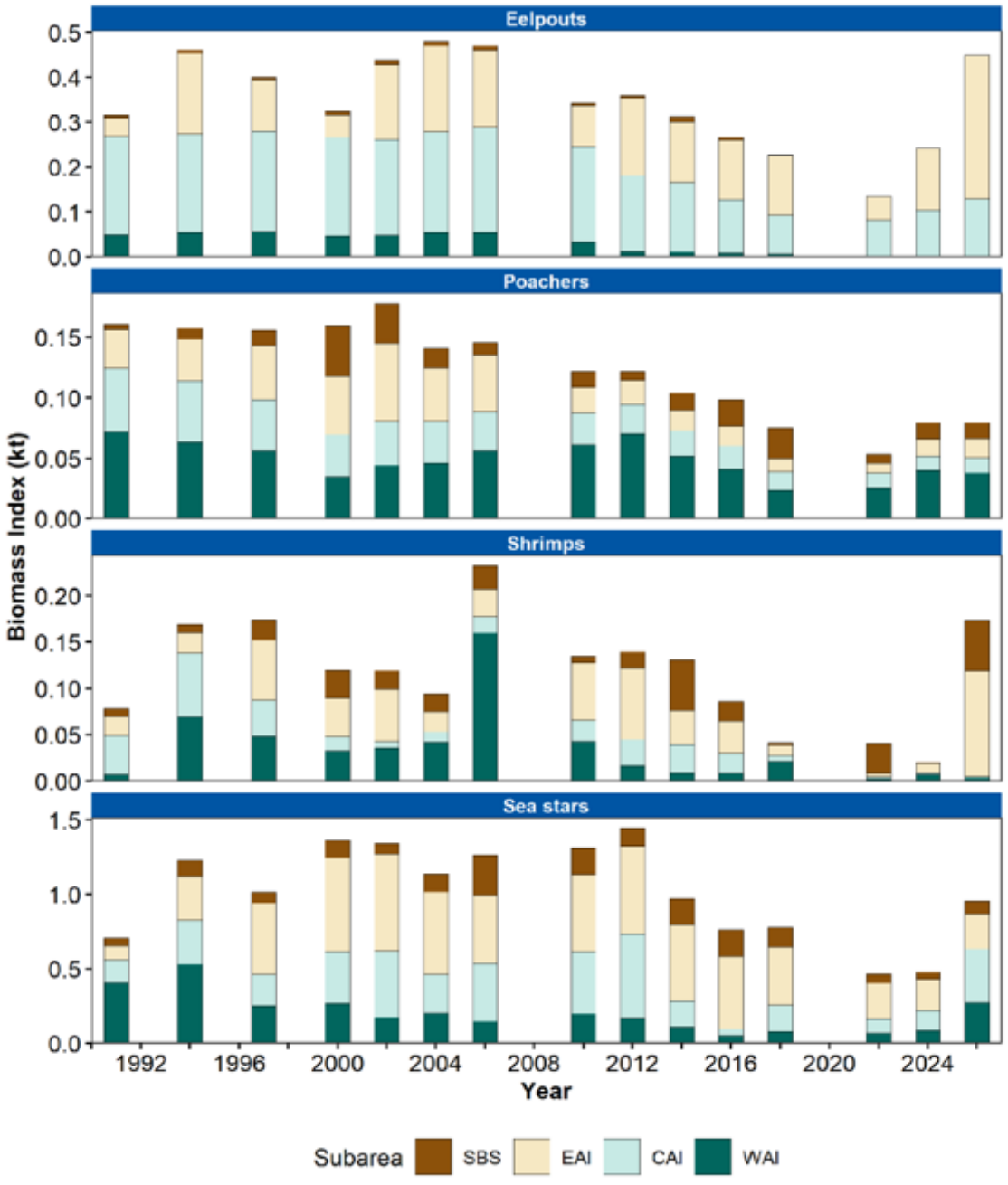



Figure 44: Biomass index (kilotons) of miscellaneous benthic fauna (eelpouts, poachers, sea stars, shrimps) in Aleutian Islands subareas (Southern Bering Sea [SBS], Eastern Aleutian Islands [EAI], Central Aleutian Islands [CAI], and Western Aleutian Islands [WAI]) estimated from RACE Groundfish Assessment Program summer bottom trawl survey data from 1991 to 2026.

## *Trends in Groundfish Biomass*

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**Description of indicator:** Examining trends in survey-estimated biomass of multiple groundfish species in the Aleutian Islands can identify broadscale changes in the marine ecosystem. Common trends across species within similar functional groups can indicate shared responses to environmental conditions, including changes in physical habitat suitability (e.g., temperature, dissolved oxygen) and prey availability. In addition, identifying trends in biomass within the groundfish community can inform food web dynamics with respect to predation pressure and energy flow.

The data are collected from the NOAA AFSC Aleutian Islands bottom trawl survey (Dowling et al., 2026). The survey has been conducted using the same randomized stratified design and season (late May to early August) every three years from 1990 – 1999 and then alternating years (even years) to 2026. There was no survey in 2020. Annual design-based estimates of population biomass estimates are provided by the AFSC groundfish assessment program[12] accessed from the AKFIN database29. Species selected for this contribution are listed below, and include those supporting federally managed commercial groundfish fisheries, in addition to Pacific halibut (*Hippoglossus stenolepis*). In some years species-specific estimates were not available due to low confidence in ability to consistently identify that species during earlier years.

- 1. Flatfish: arrowtooth flounder (*Atheresthes stomias*), Pacific halibut (*Hippoglossus stenolepis*), northern rock sole (*Lepidopsetta polyxystra*), southern rock sole (*Lepidopsetta bilineata*), Dover sole (*Microstomus pacificus*), rex sole (*Glyptocephalus zachirus*), and flathead sole (textitHippoglos-soides elassodon).
- 2. Rockfish: Pacific ocean perch (textitSebastes alutus), northern rockfish (*Sebastes polyspinis*), dark rockfish (*Sebastes ciliates*), dusky rockfish (*Sebastes variabilis*), rougheye rockfish (*Sebastes aleu-tianus*), blackspotted rockfish (*Sebastes melanostictus*), shortraker rockfish (*Sebastes borealis*), shortspine rockfish (*Sebastolobus alascanus*), and yelloweye rockfish (*Sebastes ruberrimus*).
- 3. Roundfish: w alleye pollock (*Gadus chalcogrammus*), Atka mackerel (*Pleurogrammus monopterygius*), Pacific cod (*Gadus macrocephalus*), sablefish (*Anoplopoma fimbria*). item 4. Skates: big skate (*Beringraja binoculata*) and longnose skate (*Beringraja rhina*).

**Status and trends:** The groundfish species with the highest biomass (mt) in the Gulf of Alaska bottom trawl survey in 2025 were (in descending order) arrowtooth flounder, walleye pollock, Pacific ocean perch, Pacific cod, Pacific halibut, flathead sole, and sablefish (Figure 79). Arrowtooth flounder returned to the top biomass in 2025, for the first time since 2017. Pacific ocean perch declined from highest biomass to third highest in 2025.

**Factors influencing observed trends:** The biomass estimates of groundfish species in the NOAA AFSC Aleutian Islands bottom trawl survey reflect changes in population size but can be influenced by changes in catchability. Specifically, spatial availability to the survey may be changing due to changes in species distributions. The roundfish species show a mixture of responses to the 2014 – 2016 marine heatwave, including a biomass decline (P. cod, Atka mackerel) and biomass increase (giant grenadier), But they also show some response to the decrease in temperature in 2012 durieng which Atka mackerel and Pacific cod decreased and the biomass of Pacific ocean perh seems to have stabilize since then. The biomass of some species respond more rapidly to large recruitment

[12]Design-Based Production Estimates generated by the gapindex R package (NOAA Fisheries Alaska Fisheries Science Center, Groundfish Assessment Program, 2024)

classes or environmental changes (e.g., walleye pollock) while other more long-lived species are typically less variable on the short-term (e.g., rockfish). A decreases in Pacific ocean perch coincides with increase of northern rockfish since 2022. The short-term variable survey biomass of rockfish (long-lived species) may be due to changes in catchability or distribution.

**Implications:** The increase in Pacific ocean perch, and decrease of Atka mackerel as two of the more abundant species in the bottom trawl catch, can indicate ecological implications for the AI marine food web. Both feed on plankton, however, Atka mackerel is a widespread common prey item for seabirds, marine mammals and fish predators. In contrast, Pacific ocean perch are planktivorous, infrequently preyed upon. Common trends across species with similar functional groups can indicate responses to environmental conditions including physical conditions (temperature, dissolved oxygen) and prey availability.

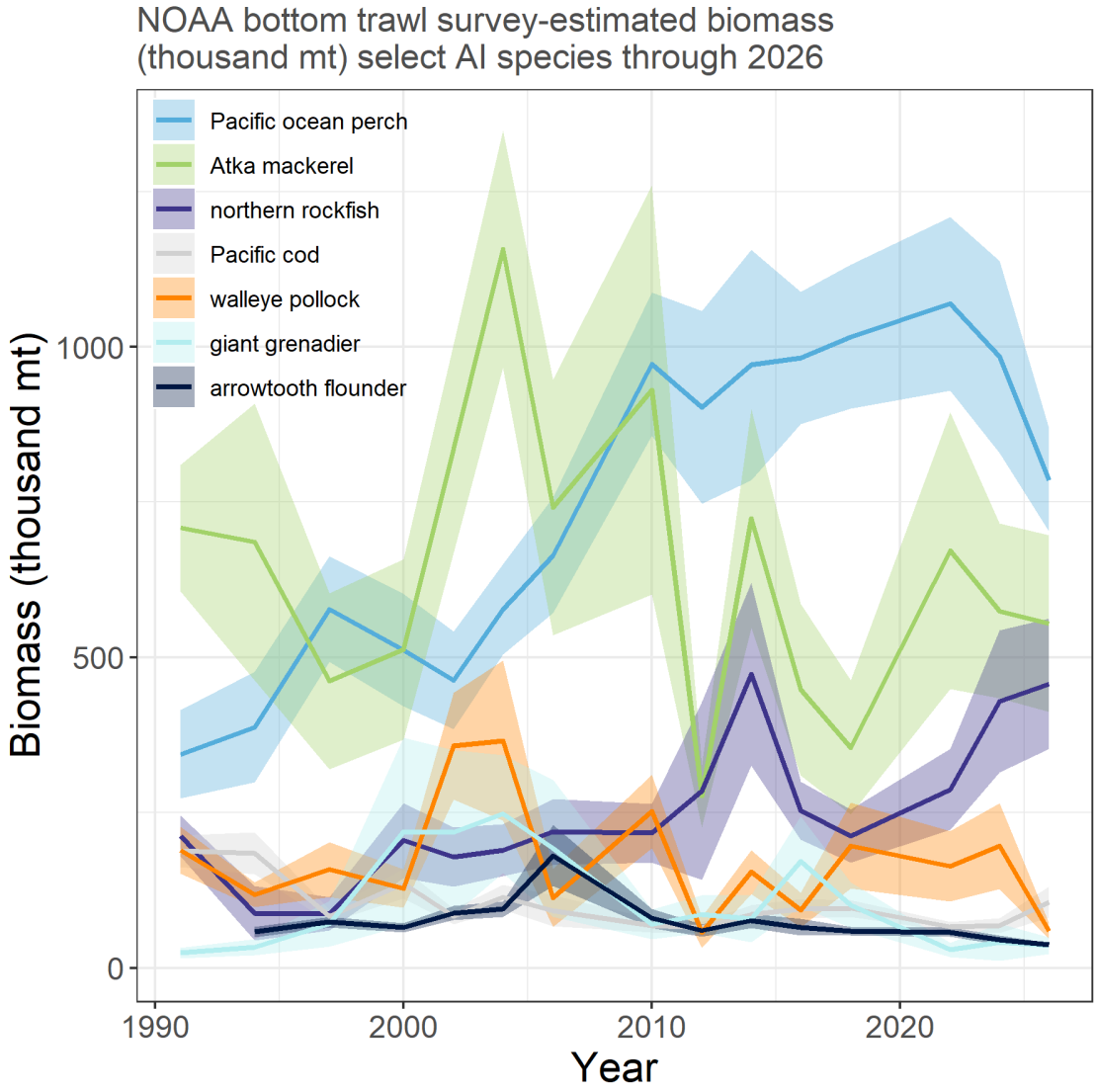



Figure 45: Design-based estimates of survey biomass (mt) of groundfish species with the highest biomass in the Aleutian Islands bottom trawl survey in 2025. Shaded area representes ± 1 standard deviation (not shown for groups > 1 stocks). The NOAA AFSC bottom trawl survey is conducted from May-August every three years from 1990 – 1999 and every 2 years 2001 – 2025.

## Apex predator and pelagic forager fish guild biomass

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**Description of indicator:** Foraging guilds are non-taxonomic groups of species with similar diet compositions (Root, 1967). We present temporal biomass trends of two foraging guilds in the western, central and eastern Aleutian Islands based on the aggregation of species by trophic role and habitat: pelagic foragers and apex predators. Pelagic foragers include: two roundfish, walleye pollock and Atka mackerel; and two rockfish, northern rockfish and Pacific ocean perch. Apex predators include six groups: Pacific cod, and three flatfish as individual species—Pacific halibut, arrowtooth flounder, Kamchatka flounde—and three aggregate groups: i) rougheye and blackspotted rockfish, ii) large sculpins (yellow Irish lord, butterfly sculpin, shorthorn or warty sculpin, great sculpin, plain sculpin and bigmouth sculpin), and iii) skates (big skate, Bering skate, longnose skate, mud skate, roughtail skate, Alaska skate, Aleutian skate, whiteblotched skate, whitebrow skate, cold-water skates, and unidentified skates). The guild excludes deep-water species such as sablefish and grenadiers, as most are found deeper than the trawl survey samples. The authors acknowledge that these species would ideally be included, but that the trawl survey does not sample them adequately.

Foraging guild biomass is based on a design-based index of abundance time series calculated from RACE-GAP biennial summer bottom trawl survey catch and effort data within 0 to 500 m depth. Indices were calculated for the entire standardized survey time series (1991 to 2026). Design-based indices of abundance were produced using the gapindex R package (Oyafuso, 2025), and were estimated for the survey strata within the western (NMFS statistical area 543 ), central (NMFS areas 542 and 541), and eastern Aleutian Islands (which includes only the northern shelf of the Islands east of Samalga Pass, NMFS areas 518 and 519). This is an update from past years which used to report guild biomasses for the eastern Aleutians as a composite of the Aleutian Islands survey north of the islands, and the Gulf of Alaska survey, which samples the southern portion.

Trends in total biomass over time for the pelagic forager and apex predator guilds across all subregions were modeled as linear regressions as a function of survey year (fig.46).

**Status and trends** Total biomass of pelagic foragers has a variable but overall increasing trend throughout the entire time series (1.5 million mt in 1991 to 1.8 million mt in 2026), peaking in 2010 at 2.4 million mt (fig.46A), with roundfish dominating at the beginning of the time series and switching to rockfish across all subregions by 2012 (fig.46C). Large changes in biomass are often driven by swings in Atka mackerel biomass and the increasing trend driven by Pacific ocean perch followed by northern rockfish (fig.46D). In contrast, the total biomass of apex fish predators has a variable but overall decreasing trend (300 thousand mt in 1991, down to 221 thousand mt in 2026), with lowest biomass in 2022. Overall, Pacific cod has the highest biomass, followed by aggregated flatfish of which arrowtooth flounder comprises the highest portion (fig.46E and F. Other apex predators have remained more or less stable since 2012. Over the years, the ratio of pelagic forager biomass to that of apex fish predators has varied significantly, starting between 4 and 3, increasing to a maximum ratio of 10 during 2022-2024 and currently at 8.

*In the western Aleutians*, Atka mackerel dominated the roundfish biomass and comprised 50% of the pelagic foragers biomass in the early 1990s, but since 2010 75% of biomass has been comprised by Pacific ocean perch, with northern rockfish increasing when Pacific ocean perch decreases. Among apex predators, Pacific cod declined through 2012 with the highest abundance in 2026 since 2004. Flatfish and other fish had the highest biomass through the 2000s and have subsequently decreased (fig.46 D and F).

*The central Aleutians* show a similar trend but with a lower change in the ratio of roundfish to rockfish and higher fluctuation in rockfish (mostly Pacific ocean perch at least 66%), but without northern rockfish increasing as

much when the latter decreases. Rockfish started  30% in the early 1990's, hovering around 50% since 2022, having peaked in 2012 at 79%. Roundfish have hovered around 35% since 2014, with pollock fluctuating between 2-18% of the pelagic foragers, (2% in 2026), and Atka mackerel starting ~50% in the early 1990's down to 30% in 2026 (an increase of 4% from 2024) (fig.46 C and D). Among the apex predators, large flatfish have decreased the most, with rougheye and blackspotted rockfish showing a relative increase in the later years, and Pacific cod slightly recovering in 2026 (fig.46 E and F).

*The eastern Aleutians* have the lowest biomass of pelagic foragers, as it is the subregion with the smallest area. This subregion is where the ratio of rockfish to roundfish has fluctuated the most, with roundfish comprising 96% of the pelagic foragers at the beginning of the time series driven by pollock, dropping to 10% in 2016, and increasing to 61% in 2026 but driven by Atka mackerel. Northern rockfish is typically below 5% of the rockfish, contributing above 20% of the rockfish only a few years throughout the time series (1991, 2006, 218-2024), currently down to 3%.

**Factors influencing observed trends**: Atka mackerel and walleye pollock are shorter lived species with maximum lifespans between 15 and 25 years, respectively (McDermott and Lowe, 1997; Williams et al., 2016), lay eggs and are common prey across a wide spectrum of predators including fish and marine mammals (Aydin et al., 2007; Zeppelin et al., 2004). Their populations have a larger annual variability. In contrast, the rockfish Pacific ocean perch and northern rockfish have a lifespan of 100 and 88 years, respectively (Beamish, 1979; Benson et al., 2024) and are live bearers, give birth to live, free-swimming larval fish and are only preyed upon occasionally. Rockfish tend to have stable populations with low interannual variability. Species in this group feed primarily on plankton, though they do supplement their diet with fish or other invertebrates, particularly pollock and Pacific ocean perch.

Historically, Pacific ocean perch were heavily fished in the 1960s, with a peak catch of 109,100 tons in 1965, and catches subsequently declining through the 1970s and reaching its lowest levels in the mid 1980s. Catches remained generally below 10,000 tons through 2005 and to over 30,000 tons in the eastern Bering and Aleutian combined. Catches in the Aleutian Islands vary between 20,000 and 25,000 tons. The population has increased from an estimated 205,200 tons in 1979 to a maximum of 978,910 tons in 2014 and has since remained >800,000 tons, the area occupied by the stock has also steadily increased (Spencer, 2024). The decrease of rockfish may have opened a niche opportunity for both Atka mackerel and pollock, which has been closing through the years as rockfish populations have increased back to historical levels.

Apex predators is a mixed group of generalist opportunistics predators, occasionally scavenging for food. They have a mixed diet of fish, squid, and benthic invertebrates. Both Atka mackerel and pollock are among their preferred fish prey, but they also feed on lanternfish, shrimp and crustaceans. In general, Atka mackerel has been decreasing in their diets (Aydin and Ortiz 2026 in Ortiz 2026).

**Implications:** As rockfish have increased, they have become the dominant consumers of plankton, far exceeding that of other fish (Aydin and Ortiz 2026 in Ortiz 2026). As rockfish are not a common prey, there is a lower transfer of energy to upper trophic levels. At the same time, the area expansion of rockfish may have displaced other fish. Warmer temperatures may also increase energetic demand, which would require fish to eat more prey. These combined factors suggest there may be a lower availability of prey in general to satisfy their needs. The shift in the composition of the pelagic foragers community may also have further reaching consequences, increasing predation on other fish species not only by fish but by seabirds and marine marine mammals. At the ecosystem level, the longer lifespans of rockfish may bring more stability, as they may be more resilient to environmental variability (Maselko et al. 2020).

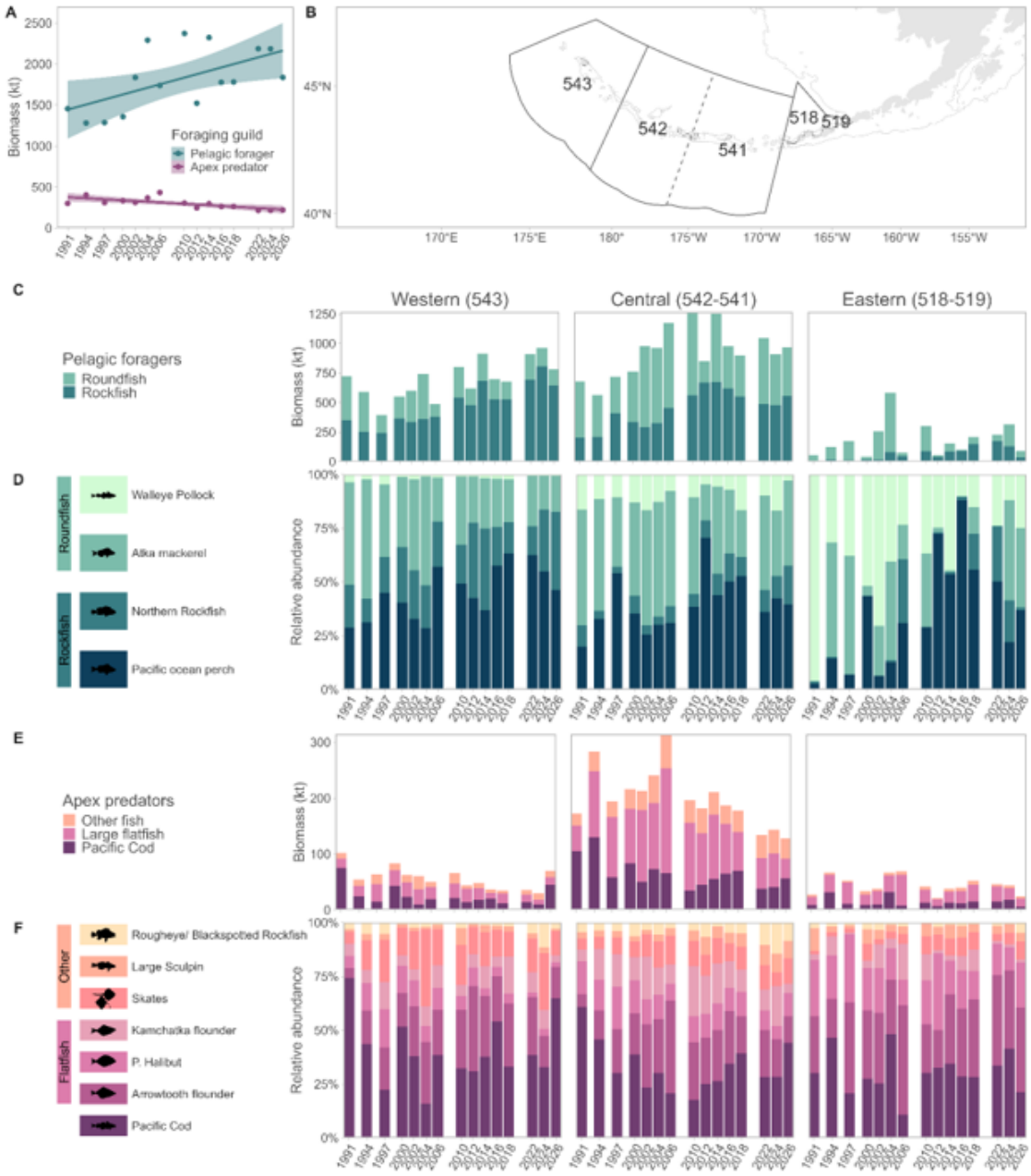



Figure 46: Biomass and composition of foraging guilds for pelagic foragers and apex predators. (A) Trends in total biomass over time for the pelagic forager (teal) and apex predator (purple) guilds across all Aleutian Islands subregions where the shaded area represents the 95% confidence interval. (B) Map of subregions and their corresponding NMFS (management) statistical areas. (C) Absolute biomass for pelagic foragers grouped by type, roundfish and rockfish, for each subregion with (D) composition by relative abundance of individual species. (E) Absolute biomass for apex predators grouped by type, Pacific cod, flatfish and other, for each subregion with (F) composition by relative abundance of individual species

## Summer Food Habits of groundfish in the Aleutian Islands

Contributed by Kerim Aydin[1] and Ivonne Ortiz[2]
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**Last updated: October 2026**

**Description of indicator:** Stomachs of walleye pollock (*Gadus chalcogrammus*), Pacific ocean perch (POP, *Sebastes alutus*), Pacific cod (*Gadus macrocephalus*), and sablefish (*Anoplopoma fimbria*), have been collected on the Alaska Fisheries Science Center's Aleutian Islands (AI) bottom-trawl shelf survey between 1990-2026 within NMFS statistical areas 541, 542 and 543). Samples were preserved in formalin and prey contents identified to the lowest resolvable taxonomic category and weighed. To estimate diet proportions for the population, samples are stratified by length and survey stratum and weighted by the survey biomass for each length class and stratum and estimated ration for each size class. Ration for each predator was estimated using bioenergetics models for each predator. Ration at length was assumed to be fixed and did not vary by year, temperature or stomach content weights for this analysis; further, these ration estimates do not account for differences between predator and prey caloric densities. These means consumption will vary mostly with predator biomass, but length structure and temperature can also influence the estimate. While these assumptions may obscure some consumption variability, these simplified common assumptions allow for summation of consumption across species. Collection, analysis, and stratification methods are described in Livingston et al. (2017) while ration estimation is described in Holsman and Aydin (2015). Species selected for this contribution represent groundfish species with high biomass (Rohan et al; p.X) based on design-based estimates of population biomass in the Aleutian Islands survey. These species support federally managed commercial groundfish fisheries in the Aleutian Islands (NPFMC, 2024).

**Status and Trends**:Total daily consumption by the four tracked species is shown in Figure 47. In 2024 two planktivorous fish, Pacific ocean perch and walleye pollock, consumed the greatest amount of food per day. The decrease in Pacific ocean perch consumption is due to its biomass decreasing in the last few years, but it is still the groundfish with the highest design-based population biomass estimate. In contrast, pollock biomass has varied more (planktivorous). Pacific cod and sablefish, both generalists, consumed a similar amount of food as pollock, but has a very different diet composition, as it is a generalist. Sablefish consumption, has been increasing and consumed a similar amount of food as Pacific cod and pollock. Temperature decreased in 2024 and that may have decreased consumption as well.

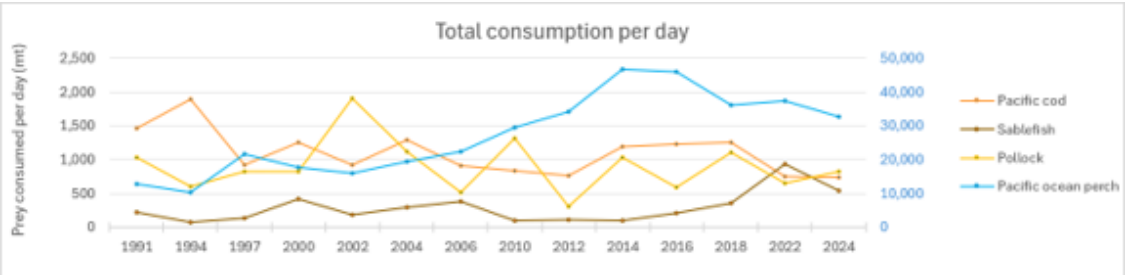



Figure 47: Total consumption per day by four major groundfish species in the Aleutian Islands, as calculated from bottom-trawl survey biomass- using a bottom trawl survey biomass for biomass, species-specific bioenergetics model parameters for ration, and diet proportion based on stomach content index. There was no survey in 2020

The diets (daily consumption by prey type) of the two planktivorous species is shown in Figure 48. Both species

have diets dominated by zooplankton, but pollock has a more diversified diet as it complements its diet with larger amounts of fish and benthos. In 2024, pollock noticeably consumed more fish. Diets for piscivorous fish are shown in Figure 49 and specific niche differences between Pacific cod and sablefish: sablefish consumes jellyfish but no shrimp a common component of cod diet. Sablefish also consumed more squid and within the benthos targets primarily brittle stars, worms and octopus.

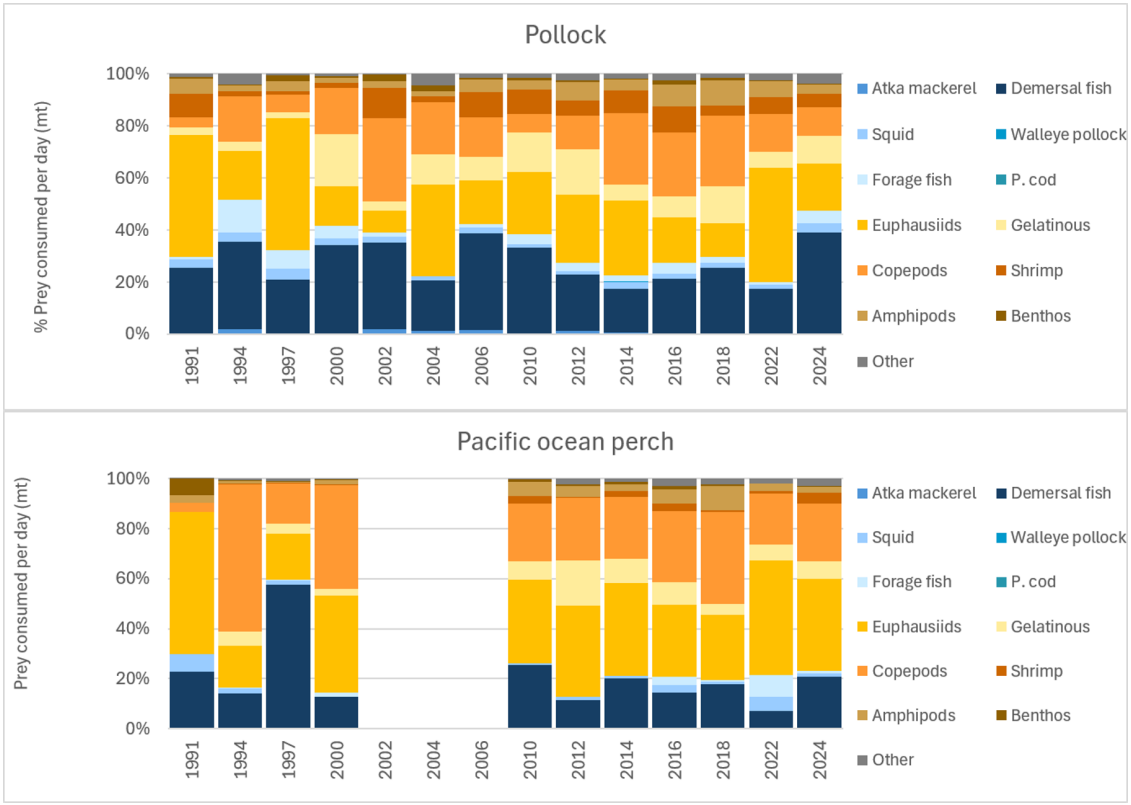



Figure 48: Percent of total consumed daily consumption (shown in fig. 47 above) by prey type of walleye pollock and Pacific Ocean perch in the Aleutian Islands. No Pacific ocean perch stomachs were collected in 2002, 2004 and 2006. There was no survey in 2020

**Factors influencing observed trends**: When viewing population-level consumption across the entire AI, shifts in diet composition for each predator may come from changes in prey populations within a single strata; however, the shifts may also be due to changes in predator distribution between strata or differences in the size composition of the predator population as age classes with differing feeding ontogeny move through the ecosystem.

**Implications**:Changes in diet composition of fish may be an indicator of fish health condition, growth, or later recruitment, and may also signal potential changes in productivity that would come with longer-term climate change. Groundfish diets also inform potential availability for other predators when considered in aggregate by diet type. In 2024, both walleye pollock and Pacific cod consumed more fish. diets were relatively consistent with long-term averages for Pacific ocean perch and walleye pollock. However both sablefish and Pacific cod show shifts in diet composition between 1991-2010 and 2012-2024. Sablefish consumes more squid as opposed to gelatinous prey. Likewise Pacific cod consumes more squid and less fish. 2012 onwards also coincides with the dominance of rockfish (POP and northern rockfish) over Atka mackerel and pollock within the pelagic foragers and increase of pelagic foragers as a whole. The co-occurrence of similar shifts in both generalists, cod and sablefish, exploiting slightly different niches, may be indicative of larger-scale shifts in prey availability.

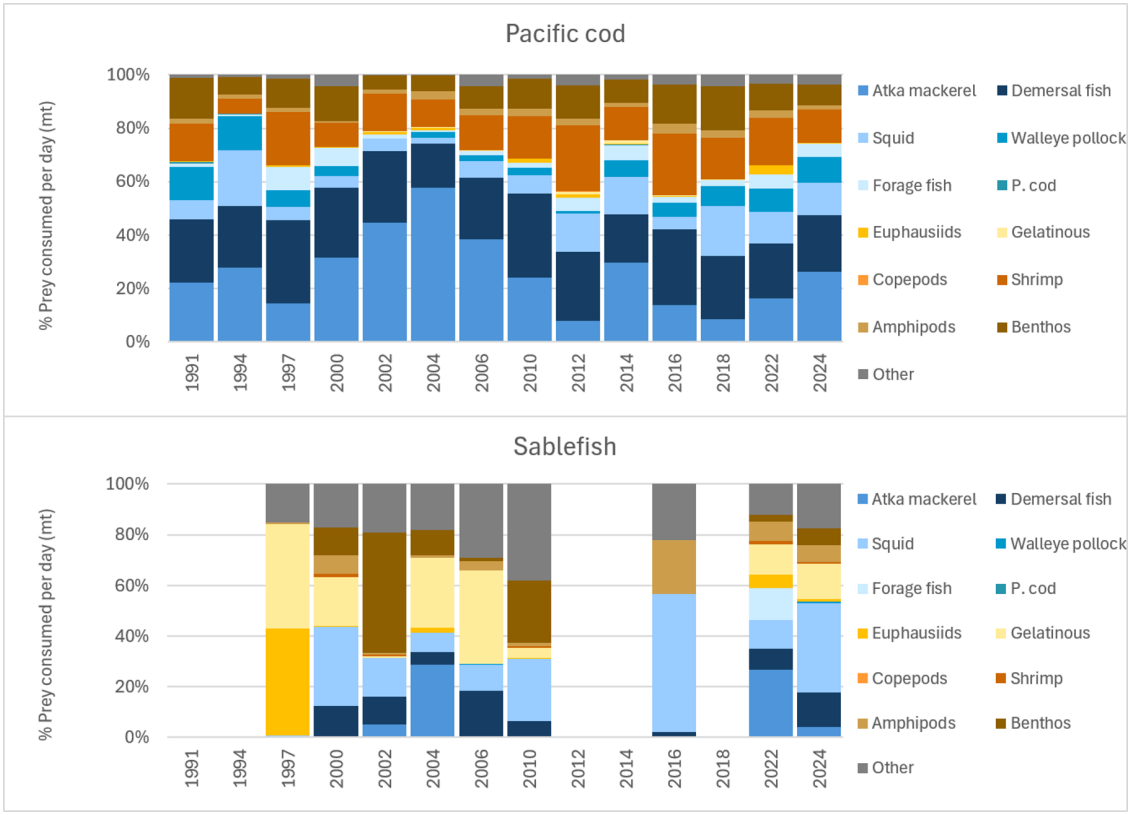



Figure 49: Percent of total consumed daily consumption (shown in fig. 47 above) by prey type of Pacific cod and sablefish. No stomachs were collected in 1991, 1994, 2012, 2014 and 2018. There was no survey in 2020

# Seabirds

## Integrated Seabird Information

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**Last updated: November 2026**

*Synthesis: This synthesis references oceanographic conditions included in the Biophysical Synthesis (p.X) and the Seabird Bycatch (p.X) sections. Most seabirds in the Aleutians feed offshore, and so population and reproductive trends at breeding colonies can reflect conditions in the pelagic ocean environment. At Buldir Island in the western Aleutians in 2026, hatch dates were average for the majority of seabird species (7 out 12), including both fish and planktivorous feeders. Reproductive success at Buldir was below average for some of the piscivorous seabird species, and average or above average for all other seabirds regardless of prey and/or feeding strategy except for least auklets. The below-average reproductive success for puffins (diving fish- and squid-eaters) and least auklets (diving plankton-eaters) at Buldir suggests possibly unfavorable foraging conditions for fish prey for some seabird species, or other factors. These could be the combined effect of an early bloom and eddies in the area. An earlier-than-average bloom around the eastern Aleutians in April was present in the western Aleutians but at low to average phytoplankton biomasses, followed by widespread areas of below average phytoplankton biomass in May and June. High eddy kinetic energy (EKE; above average) in the western Aleutians prevailed from October 2025 through June 2026, enhancing upper mixing and potentially decreasing the availability of prey throughout the water column. That may have affected the puffin's and the least auklet's ability to successfully breed this year. Puffin's diet sampling showed over 85% of tufted puffins predominately fed chicks squids followed by Atka mackerel (by weight), while the inverse was true for the horned puffins. Some of the Atka mackerel were large, with a mass of 15-18 g. which may be too large for the chicks to consume. Given their poor reproductive success, we can assume that the number and/or quality of fish and squid prey items were not sufficient to fledge chicks at average or above average levels*

*At Aiktak Island in the eastern Aleutians, hatch timing was early or average for most seabirds with mostly above-average reproductive season at Aiktak in 2026. Common murres were the only species that showed average –as opposed to above average– reproductive success. The exceptional year for seabirds suggests high prey availability for both nearshore and offshore foragers, including surface feeders and divers. Capelin was particularly abundant in tufted puffin chick diets at Aiktak, followed by age-0 pollock. In contrast, horned puffins fed their chicks mostly small Atka mackerel, sand lance and capelin. Reproductive success has been average or above-average since 2019 (no data for 2020) for most seabirds breeding at Aiktak*

*No large or unusual seabird die-offs were documented via standardized beach-based surveys in 2026. Opportunistic reports of beached birds included low numbers of seabirds that have nesting colonies in the Aleutians. In 2025, there was a higher than average encounter rate of beached birds of all species at Buldir. The influence of pink salmon abundance on seabirds that breed in Alaska can be observed in the reproductive timing of some species*

*(and possibly bycatch trends), but they do not seem to drive die-offs. This contrasts with seasonally resident shearwaters that breed in Australia during the austral summer/northern winter. High pink salmon abundance has been found to correlate to occasional mortality events and low abundance of short-tailed shearwaters. Abundance of East Kamchatka pink salmon was low for an even year (typically with low abundance), and later hatch dates were observed for tufted puffin. The biennial pattern on hatch dates was disrupted in 2018-2019 but seems to have been reestablished since 2021.*

**Description of indicator:** : Seabirds are considered to be useful ecosystem indicators, as their breeding performance and diet composition reflect conditions in the marine environment. Here we provide an overview of environmental impacts to seabirds and what those may indicate for ecosystem productivity as it pertains to fisheries management. We synthesize data and field observations collected by government, university, and non-profit partners to assess the status of seabirds in the Aleutian Islands during 2026.

We present information in four main sections as indicators of processes at different spatio-temporal scales:

1. Timing of breeding, which reflects ecosystem conditions prior to breeding,
2. Reproductive success, which reflects feeding conditions during the breeding season,
3. Puffin chick diet composition, which reflects preferred available prey, and
4. Population information, including mortality, which encompasses environmental and ecosystem effects during spring/summer.

Seabirds at Buldir Island and Aiktak Island were monitored by the Alaska Maritime National Wildlife Refuge (AMNWR). Each type of indicator is presented for seabirds based on their feeding strategy and main prey: surface or diving seabirds feeding on fish or plankton (see Figure 50). Seabirds discussed here feed offshore, as well as nearshore (3 km from land, Byrd et al. 2005). Since nearshore feeders generally forage in shallow water, their prey is less likely to be affected by currents and fronts Byrd et al. (2005)

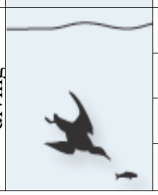
| strategy | | prey | habitat | common name |
|---|---|---|---|---|
| surface |  | plankton | offshore | fork-tailed and Leach's storm-petrels |
| | | fish | nearshore | glaucous-winged gull |
| | | fish | offshore | red/black-legged kittiwakes and northern fulmars |
| diving |  | plankton | nearshore | parakeet auklets, whiskered auklet |
| | | plankton | offshore | ancient murrelets, least auklets, crested auklet |
| | | fish | nearshore | red-faced cormorant, horned puffin |
| | | fish | offshore | common murre, thick-billed murre, tufted puffin |

Figure 50: Feeding strategy, prey and habitat of the main seabird species monitored annually by AMNWR in the Aleutian Islands, based on Byrd et al. (2005)

## WESTERN ALEUTIANS — BULDIR ISLAND

The western Aleutians are numerically dominated by breeding seabird species that are primarily planktivorous. The influence of the cold and nutrient-rich Alaskan Stream and its ability to transport more oceanic zooplankton

taxa closer to seabird colonies likely influences the prevalence of planktivorous seabird species in this ecoregion, as does advection around shallow passes that concentrate zooplankton closer to the surface (Renner et al. 2008)

*Timing of Breeding*

The long-term average hatch dates for seabirds at Buldir fall between mid-June to early August (Dragoo et al., 2019), along with average hatching periods of 30 to 42 days. At Buldir, 2 of the 12 species monitored were later than average in 2026; Leach's storm petrel (surface mixed foragers eating fish and invertebrates) and the planktivorous parakeet auklet. Other fish-eaters (tufted puffin, kittiwakes) and plankton eaters (auklets) had average hatch timing. Three species were early this year: glaucous winged gulls, fork-tailed storm-petrels and whiskered auklets, spanning across prey types and surface/diving feeding (Figure 51).

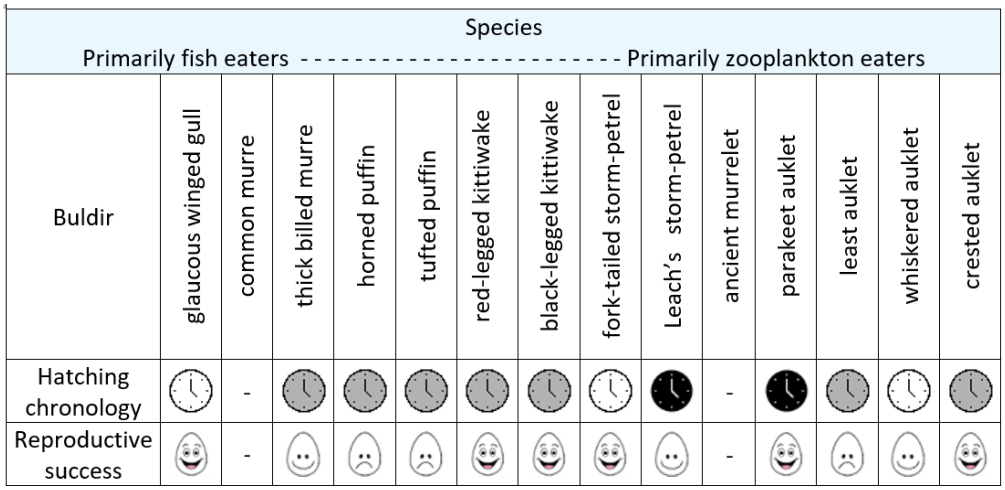



Figure 51: Seabird relative breeding chronology in 2026 compared to long-term averages for past years at Buldir islands. White clock indicates hatching chronology was >3 days earlier than average. Gray clock within 3 days of average. Black clock <3 days later than average. Dashes indicate species not monitored at a site or for which sample size too small for comparison.

The hatch timing of tufted puffins nesting at Buldir has been shown to vary between odd and even years, matching the pattern of high/low biennial runs of Eastern Kamchatka pink salmon (Springer and van Vliet, 2014)where high pink salmon numbers (odd years) correlated with later tufted puffin hatch dates. The pattern could not be discerned in some of the recent years: in 2017-2018, which were two consecutive years of poor reproductive success with little or no hatch data, and in 2020, when no data were collected. The biennial pattern that correlates with pink salmon was observed again in 2021-2026, although the correlation was weak in 2024, when tufted puffin mean hatch date was one day earlier than the long-term mean (Figure 52). The abundance of Eastern Kamchatka pink salmon this year was low, even for a low abundance year (Figure 37)), but abundance has been decreasing in both odd and even years since the historical peak in 2019. Abundance levels in 2025-2026 were similar to that of even and odd years before the population started increasing in 2009.

*Reproductive Success*

Reproductive success at Buldir in 2026 was below average for puffins and least auklets, and average for thick-billed murres, Leach's storm-petrels and whiskered auklets. Half of the monitored species – glaucous winged gull, kittiwakes, and parakeet and crested auklets had above average reproductive success. Horned puffins had the lowest recorded reproductive success for all year monitored at Buldir. Hatch chronology did not correspond with reproductive success. (Figures 51 and 53).

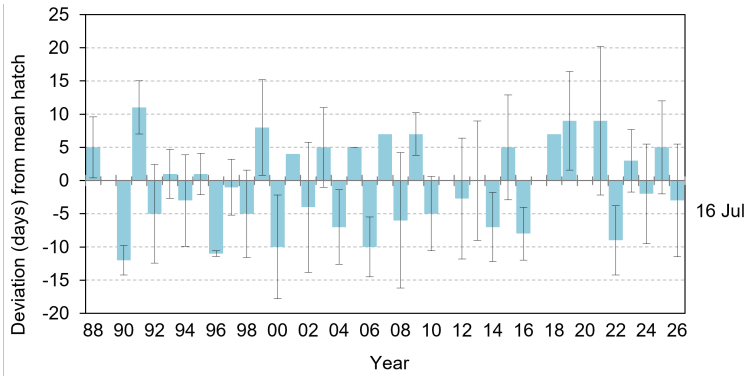



Figure 52: Yearly hatch date deviation (from the 1988–2026 average of 15 July) for tufted puffins at Buldir Island, Alaska. Negative values indicate earlier than mean hatch date, positive values indicate later than mean hatch date. Error bars represent standard deviation around each year's mean hatch date (years without error bars have sample size of one). No data were collected in 2020; no hatch dates were recorded with the appropriate egg to chick interval ($\leq$7 days) in 1989 or 2017 and no eggs hatched in plots in 2011.

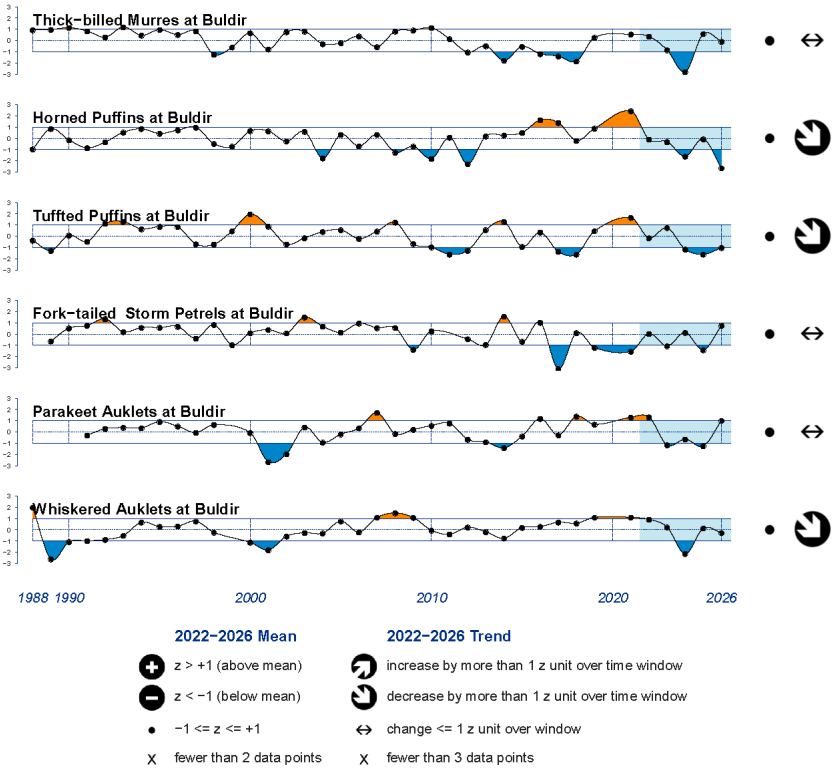



Figure 53: Seabird reproductive success in 2026 compared to long-term means for past years at Buldir island. Big smiley face indicates reproductive success >1 SD above the long term mean, smiley indicates within 1 SD of long term mean, frowny face indicates >1 SD below long term mean. Dashes indicate species not present or monitored at a site or for which sample size is too small for comparison.

## EASTERN ALEUTIANS — AIKTAK ISLAND

In contrast to Buldir and seabird colonies in the western Aleutians, eastern Aleutian colonies (including Aiktak) are numerically dominated by piscivorous seabird species. Colonies in this region may be more influenced by the proximity to Unimak and Samalga passes, and the neritic Alaska Coastal Current (Renner et al., 2008). Piscivorous species may also benefit from being closer to groundfish hotspots in the western GOA region (e.g., walleye pollock).

*Timing of Breeding*

Hatch dates were mixed at Aiktak in 2026, with earlier than average hatch dates for tufted puffins and fork-tailed storm-petrels, later hatch dates for thick-billed murres and average hatch dates for the remaining species. Hatch chronology did not correspond to reproductive success.

*Reproductive Success*

Seabird reproductive success at Aiktak in 2026 was above average of the long-term mean for all species monitored except for that in common murres, which was average. This is the seventh year since 2019 (not including 2020 when no data were collected) that breeding by most seabirds at Aiktak was average or above average. This includes diving, fish-eating seabirds (common and thick-billed murres, tufted and horned puffins), mixed foragers (storm-petrels, which consume a mix of fish and invertebrate), and predominately planktivores (ancient murrelets). Leach'sstorm-petrels had the highest ever recorded reproductive success at Aiktak (Figures 54 and 55.

| Species<br>Primarily fish eaters ---------- Primarily zooplankton eaters | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aiktak | glaucous winged gull | common murre | thick billed murre | horned puffin | tufted puffin | red-legged kittiwake | black-legged kittiwake | fork-tailed storm-petrel | Leach's storm-petrel | ancient murrelet | parakeet auklet | least auklet | whiskered auklet | crested auklet |
| Hatching chronology | | | | | | | | | | | - | - | - | - |
| Reproductive success | | | | | | - | - | | | | - | - | - | - |

Figure 54: Seabird reproductive success in 2026 compared to long-term means for past years at Aiktak Island. Big smiley face indicates reproductive success >1 SD above the long term mean, smiley indicates within 1 SD of long term mean, frowny face indicates >1 SD below long term mean. Dashes indicate species not present or monitored at a site or for which sample size is too small for comparison.

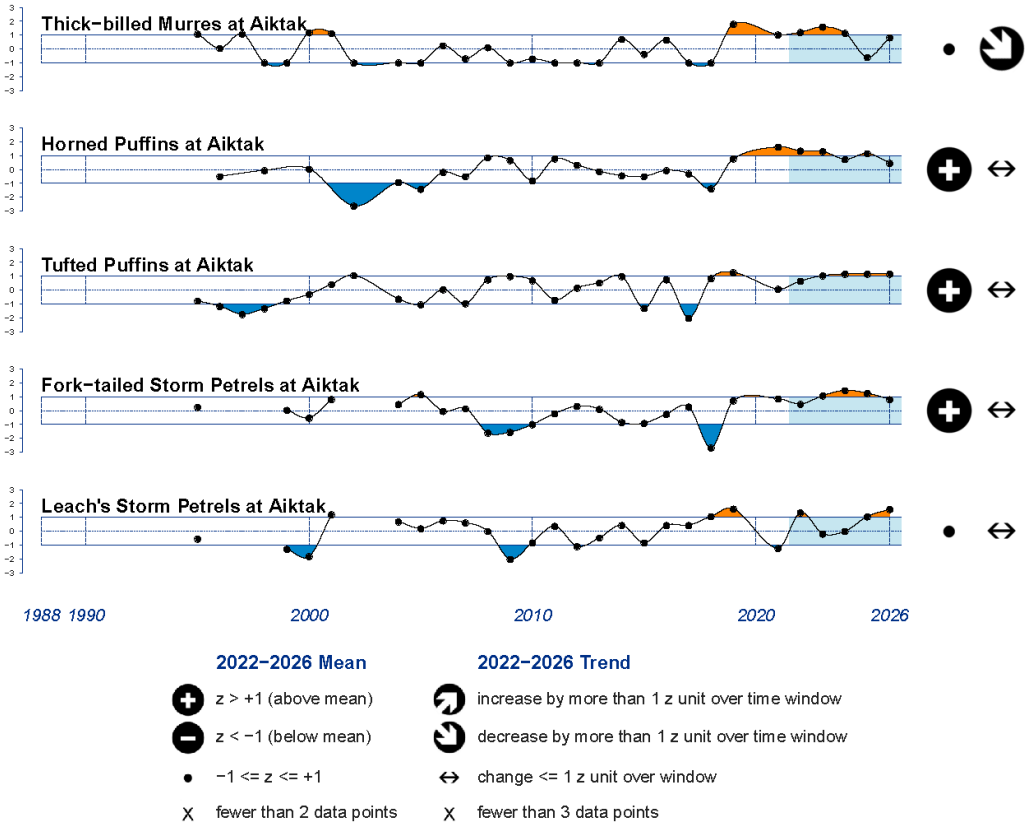



Figure 55: Time series of seabird reproductive success through 2024 at Buldir and Aiktak Islands

## SEABIRD PUFFIN CHICK DIET AT BULDIR AND AIKTAK

Seabird diet data span 48 years in the Aleutian Islands. Puffins (tufted puffins and horned puffins, hereafter "puffins") are medium-sized seabirds that nest in varying densities throughout the Aleutians. AMNWR samples puffin chick diets annually at Buldir and Aiktak Islands, and less frequently at puffin colonies on other Aleutian Islands. Puffins feed their chicks primarily small pelagic schooling fish, juvenile groundfish, and mesopelagic species (Sydeman et al., 2017; Piatt et al., 2018) by carrying multiple prey items in their bills when they return to their colonies to feed their chicks. Energy-rich and densely schooling small pelagic species, especially Pacific sand lance (*Ammodytes personatus*), Pacific capelin (*Mallotus catervarius*) (in the eastern Aleutians only), greenlings (Hexagrammidae) including juvenile Atka mackerel (*Pleurogrammus monopterygius*), juvenile gadids (Gadidae) including walleye pollock (*Gadus chalcogrammus*), and squid are preferred prey for puffins provisioning chicks in the Aleutians. Collectively, puffin chick diets provide information on prey communities across large marine ecosystems and context for multidecadal changes in upper trophic-level biology and ecology in Alaska. In the absence of direct measures of forage fish abundance, the diet composition in puffin chick meals may be used as indicators of forage fish abundance and system-wide productivity. Seabirds will select preferred prey species by size, availability, and nutritional content, but patterns in puffin diets in the eastern Aleutians have been corroborated by fisheries surveys and diets of piscivorous fish, indicating that these datasets do reflect local forage fish abundances (Piatt et al., 2018).

*Buldir* In 2026, tufted puffin chick diets (offshore) by percent biomass at Buldir were largely composed of squids (59%), similar to 2025 (56%), however diets had more Atka (25% vs 16% in 2025) and less prowfish (3% vs 26% in 2025). In contrast to 2025, there was almost no sand lance (<1%) and no pollock. Instead there was a higher

diversity of other species including lanternfish (Myctophidae), and sculpins (Cottidae). In contrast to 2025, the squid identified down to species were shortarm gonate squid (*Gonatus kamtschaticus*) instead of smallfin gonate squid (*Berryteuthis anonychus*). Shortarm gonate squids are generally larger (300 mm vs 100-150mm) and their mean individual prey mass was higher than that of smallfin gonate squids in 2025 (1.4 – 12 grams, mean mass 3.4 grams). Atka mackerel prey were also larger fish between 6 and 20 grams. (Figure 56).

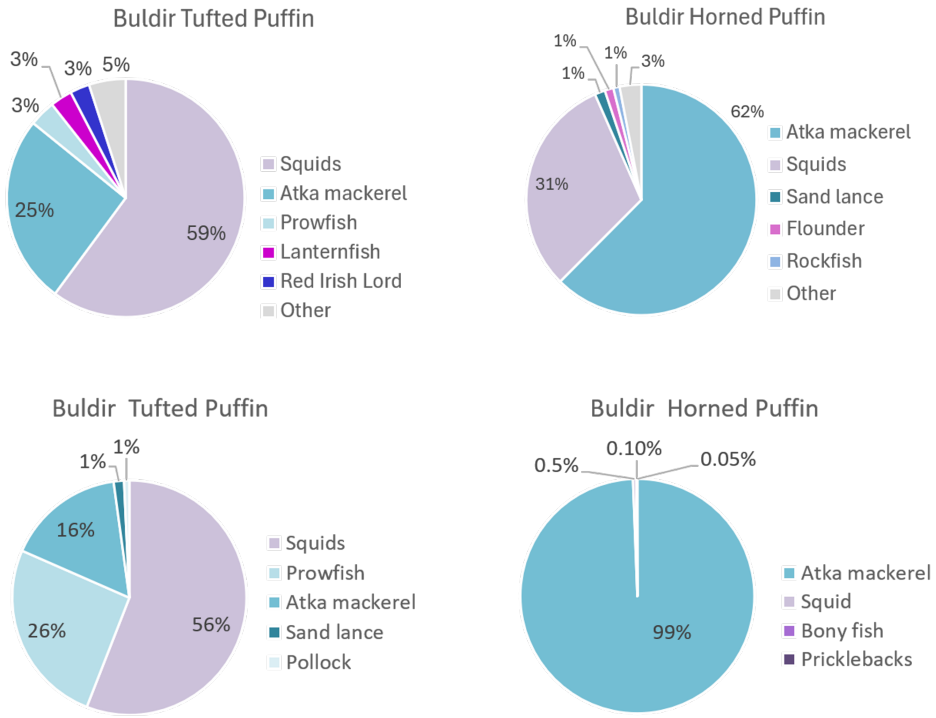



Figure 56: Diet composition by percent weight, based on samples collected in 2024 for tufted puffin and horned puffin at Buldir (western Aleutians).

Horned puffins (nearshore feeders) fed chicks Atka mackerel (62%) and squids (32%) by weight in 2026. In 2025, their diet was almost exclusively Atka mackerel (99%). Individual prey mass increased from 17 grams in 2025 to 6.8 grams in 2026 (but were either <3 or >10 grams).[jn7.1][IF7.2][jn7.3] In some cases, such as for Atka mackerel, mean mass was very large, which also can be problematic if the fish are too large for chicks to ingest. The bimodal distribution of prey mass at Buldir (either very small, <1g, or very large, >5g) suggests that chick-provisioning, piscivore parents had difficulty finding suitable prey in 2026 (Figure 56).

*Aiktak*: 2026: Diets of tufted puffin chicks (offshore feeding) on Aiktak were again primarily composed of capelin and pollock (89% combined by weight vs 84% in 2025). In contrast, horned puffin's diets (nearshore) were mostly composed of Atka mackerel and sand lance (Figure 57). Both species consumed some cod (5-6%).

## POPULATION INFORMATION—MORTALITY

Monitoring by the Coastal Observation and Seabird Survey Team (COASST) and regional partners provides a standardized measure of relative beached bird abundance. Carcass identifications are verified using collected measurements and photographs. Basic data (carcass count, identity and condition information) are used to create a baseline (long-term normal) against which unusual events can be compared. Surveys began in the Aleutian Islands in 2006, and since that time, 766 surveys have taken place across 20 beaches. In 2026, 30 surveys took

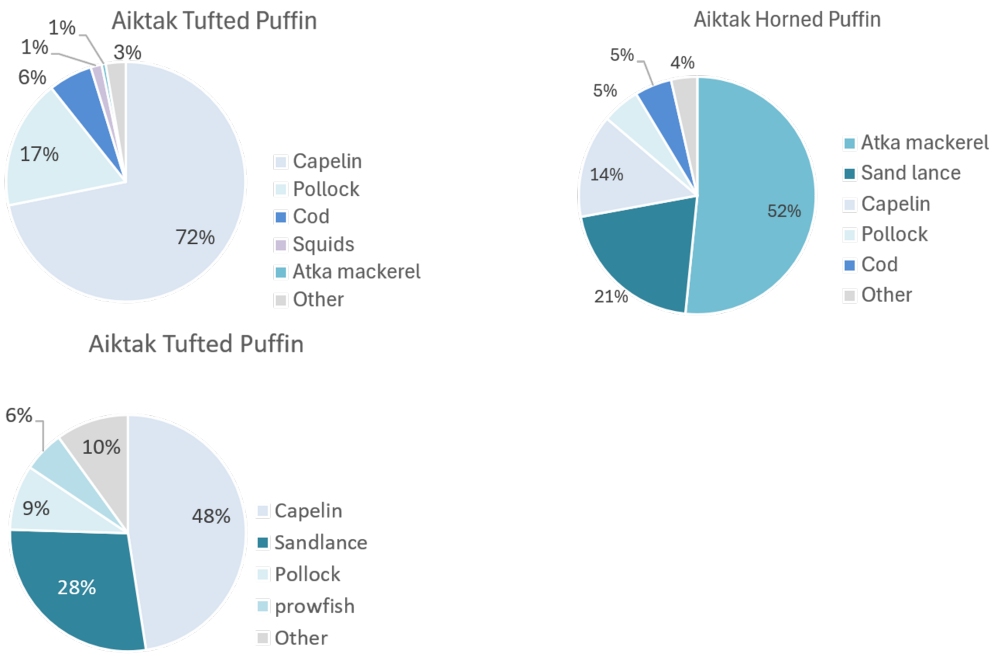



Figure 57: Diet composition by percent weight, based on samples collected in 2024 for tufted puffin and horned puffin at Buldir (wester Aleutians) and tufted puffin at Aiktak, (eastern Aleutians)

place across 9 beaches, and 31 surveys took place across 9 beaches in 2025.[IF8.1] Between May and September, most reports of carcasses in the Aleutian Islands are from AMNWR seasonal surveys (using COASST protocols) at Buldir, Adak, and Aiktak. Additional reports from Unalaska Island are conducted by trained citizen scientists. Detailed methods for beach bird surveys can be found in (Jones et al., 2019).

No large or unusual seabird die-offs were documented via standardized beach-based surveys in the Aleutian Islands in 2026.

In August 2025, a die-off event, which is generally defined as 5x the baseline encounter rate, occurred on Buldir Island. During the event, the average carcass encounter rate on Buldir was 71.5 carcasses per kilometer, 8 times higher than the historical August average of 8.5 +/- 1.9 carcasses per kilometer on Buldir (mean, SE, N = 17 years). Affected Sspecies included: glaucous-winged gulls, auklets and small alcid species, and storm petrels. The event was only documented on Buldir, but was large enough to skew the monthly average. No other large-scale mortality events were recorded by beached bird surveys in 2025. Interpretation of mortality trends in the Aleutians is complicated by the paucity of baseline data across the spatial extent of the chain. USFWS colony monitoring teams noted that they did not observe corresponding mortality trends within the Buldir colonies in 2025.

The biennial pattern previously observed in seabird bycatch and correlating with pink salmon abundanace is not evident in the relative abundance of beached birds which are primarily gulls and small alcids. The species composition of seabird bycatch estimates differs from that of beached birds. One possible explanation could be that the competitive effects of pink salmon abundance on seabird prey might increase how aggressively seabirds go after bait, but not enough to drive mortality or beached bird numbers. Pink salmon abundance has been linked to kittiwake reproductive success on the Pribilof Islands, with lower reproductive success in odd-numbered years (Zador et al., 2013). Similarly, short-tailed shearwater reproductive success at breeding colonies in Southeastern Australia is negatively correlated with high runs (odd years) of Eastern Kamchatka pink salmon in the preceding austral winter (Springer et al., 2018).

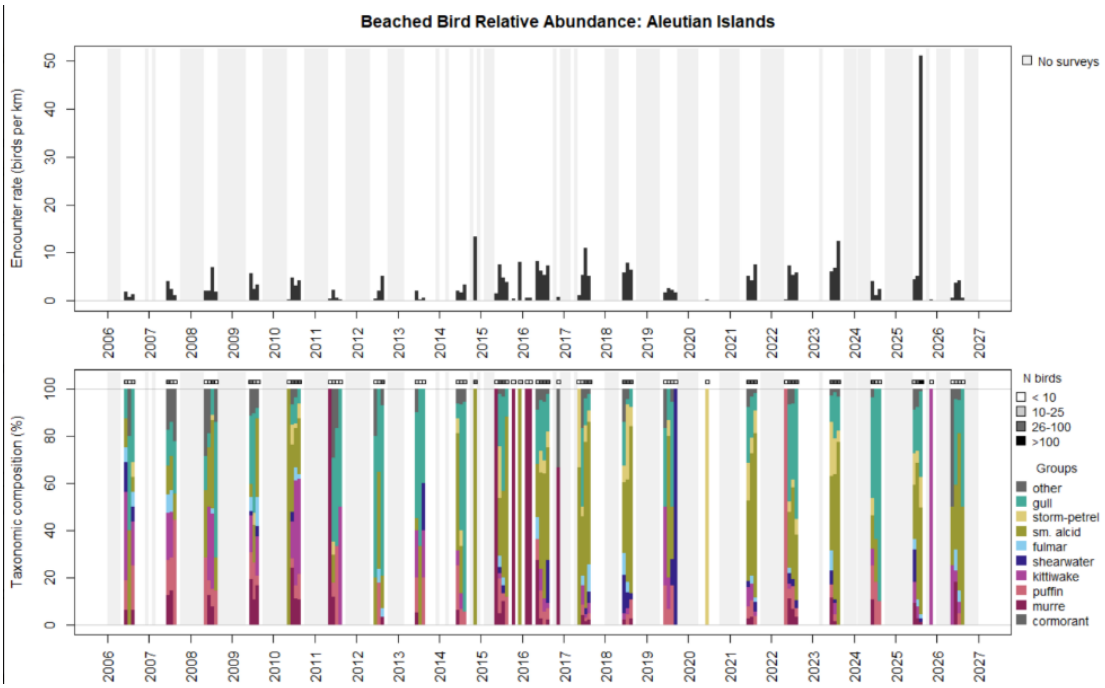



Figure 58: Encounter rate (top panel) and month-averaged beached bird abundance (bottom), standardized per km of survey effort, for the Aleutian Islands. Species groups (gull, storm-petrel, small alcid, fulmar, shearwater, kittiwake, puffin, murre) are depicted with different colors within each bar, with gray bars indicating months where no survey was conducted. Credit: COASST

**Factors influencing observed trends:** In 2026, we observed mixed reproductive success for seabird species in the western Aleutians. In the eastern Aleutians, both piscivores and planktivores had good reproductive success, indicating positive conditions for prey species. In the western Aleutian Islands, poor forage fish conditions for some seabirds, as indicated by low reproductive success and the lack of mid-sized prey in their diet, could be due to the combined effect of an early phytoplankton bloom and eddies in the area (Figure X and X). April phytoplankton blooms in the western Aleutians disappeared by May and June leading to below average biomasses of phytoplankton in the area. However, several species did well, thus timing of prey availability or other factors contributed to reproductive success outcomes. In contrast, phytoplankton blooms persisted longer in the eastern Aleutians, possibly leading to positive foraging conditions for seabird prey species. In the western Aleutians, another possible factor contributing to poor forage fish conditions may be the above average Eddy Kinetic Energy (EKE) that prevailed from October 2025 through June 2026, which could have enhanced upper mixing and decreased the availability of prey throughout the water column. Forage fish conditions in the nearshore appeared to be worse than in offshore seabird foraging areas, as indicated by more reproductively successful murres and kittiwakes in comparison to horned puffins.

**Implications:** Reproductive activity of central-place foraging seabirds can reflect ecosystem conditions at multiple spatial and temporal scales. This year all monitored species in Aiktak had average to above average breeding success compared to the long-term means. This suggests that foraging conditions for both plankton and fish-eating commercial groundfish may have been favorable in the eastern Aleutians. The presence of capelin, considered a high-quality forage fish, supports this assessment. In the western Aleutians at Buldir, 3 out of 12 nine seabirds had below average reproductive success across feeding strategies and 9 had average or above average reproductive success suggesting it was the preferred prey types of puffins and least auklets that had limited availability, lower quality prey, or were affected by other factors, such as a temporally constrained phytoplankton bloom and above average EKE.

**Methods**

1. AMNWR: The Alaska Maritime National Wildlife Refuge (AMNWR) has monitored seabirds at colonies around Alaska in most years since the early- to mid-1970's. Monitored colonies in the Aleutians include Buldir Island in the western Aleutians and Aiktak Island in the eastern Aleutians. The Refuge monitors breeding chronology, productivity and/or population parameters for indicator species representing four major feeding guilds: 1) diving fish-feeders (e.g., common and thick-billed murres, horned and tufted puffins), 2) surface fish- feeders (e.g., black and red-legged kittiwakes), 3) diving plankton feeders (e.g., parakeet and least auklets), and 4) surface plankton feeders (e.g., Leach's and fork-tailed storm-petrels).

   The timing of breeding is based on mean hatch date at a site. The deviation of the current year mean hatch dates from the mean of all prior years is used to determine whether the timing in the current season is earlier, average, or later than the long-term mean. For this summary, early hatch is defined as >3 days earlier than mean hatch, average as within 3 days of the mean, and late as >3 days later than the mean. Reproductive success is defined as the proportion of nest sites with eggs (or just eggs for murres, which do not build nests) that fledged a chick. For the summary presented in Figure **??** of seabird productivity at these sites, success categories (depicted with egg icons) were determined using parametric SD estimates for most species, and nonparametric bootstrap SD estimates (based on 1000 resamples) for those species with the possibility of more than one egg/chick. For each species and location, using all previous years' data, success was delineated as follows:

   (a) Way above average: current year's values above the quantity (mean + 1 SD) received big smiley faces;

   (b) current year's values between (mean - 1 SD) and (mean + 1 SD) received smiley faces; III.

   (c) Below average: current year's values below (mean - 1 SD) received frowny faces;

   (d) Complete failure: current year's values at or near zero received cracked frowny faces.

2. Seabird Reproductive time series: Based on data from AMNWR above, shown with respect to the average of the entire time series. (AMNWR uses the mean of previous years only; the current year is not included).

3. Puffin chick diet time series: Based on seabird diet data from AMNWR; samples consist of bill loads from adult puffins returning to the colony to feed chicks. Time series were based on frequency of occurrence (percentage of food samples in which each prey item was present), whereas the year specific diet composition is based on relative biomass of major prey items (numbers represent the percentage of the mass of combined food samples comprised by each prey item). Prey are identified to the lowest taxon possible.

4. COASST: The Coastal Observation and Seabird Survey Team (COASST) provided a standardized measure of relative beached bird abundance collected by citizen scientists for the Aleutian Islands from 2006 to present. Time-series of month-averaged beached bird abundance show several of the recent mortality events that have affected the Bering Sea. Time- series of month-averaged beached bird abundance for the Aleutian Islands show several of the recent mortality events that have affected this area.

# Marine Mammals

## *Harbor Seal Abundance, Trends, and Ecosystem Indicators in the Aleutian Islands*

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**Last updated: September 2026**

**Description of indicator:** Pacific harbor seals (*Phoca vitulina richardii*) are an important protected species in Alaska and a valuable cultural resource for Alaska Native communities. Throughout the Aleutian Islands, harbor seals are also key upper-trophic predators and nearshore ecosystem sentinels. Occupying intertidal shorelines, reefs, and rocky islets, harbor seals integrate oceanographic and trophic processes across nearshore marine habitats. They serve as general indicators for coastal and pelagic fish populations, ecosystem productivity, and coastal health and ocean warming.

In 2010, the National Marine Fisheries Service formally recognized 12 demographically independent Alaska harbor seal management stocks (fig. 59). The Aleutian Islands stock spans the Aleutian archipelago.

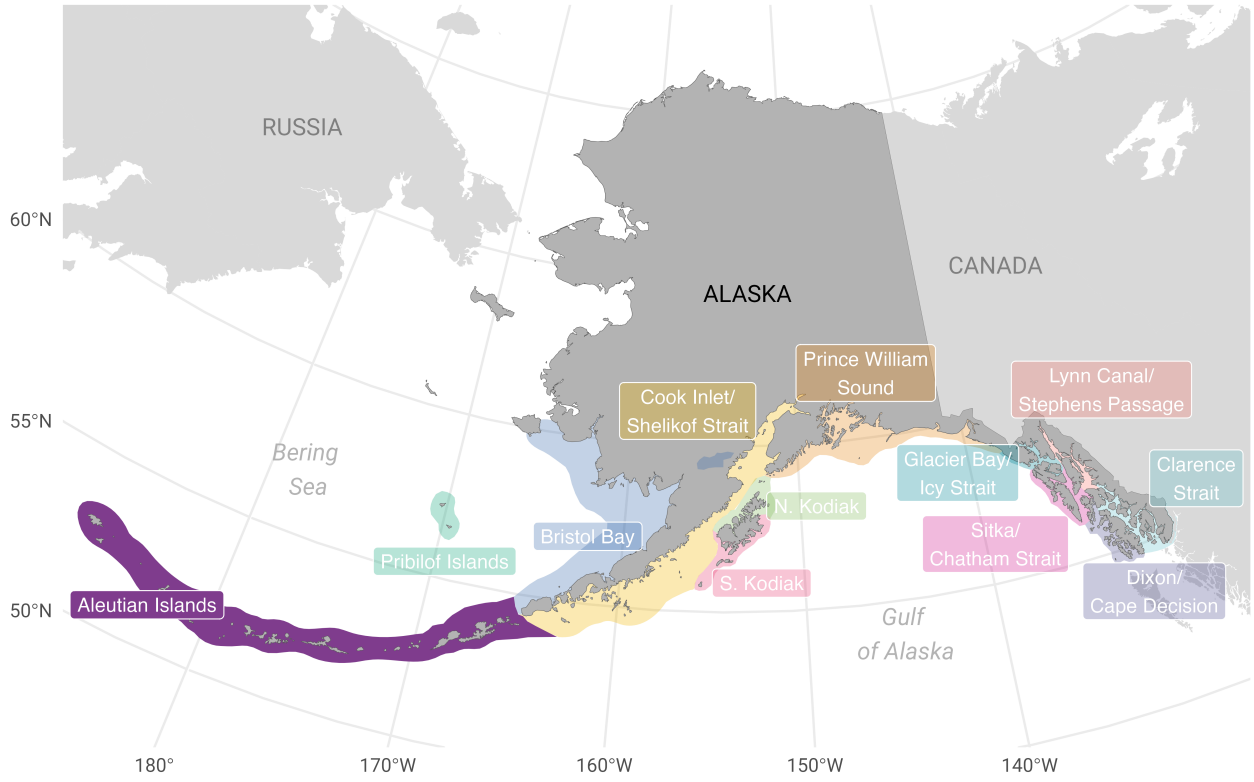



Figure 59: Geographic range and stock boundaries of harbor seal stocks in Alaska. This map represents the approximate extent of harbor seals in Alaskan waters with shaded colors indicating the 12 different managed stocks. Stock delineations are based on genetic information, movement ecology, and traditional knowledge of local communities. The Aleutian Islands stock is highlighted and other Alaska stocks are shown with partial transparency. Adapted from Boveng et al. (2026)

Harbor seals are likely influenced by shifts in the abundance and composition of the fish community within coastal marine ecosystems of Alaska. There are limited dietary studies for harbor seals in the Aleutian Islands region,

and those that do exist are decades old or of limited sample size. Nevertheless, these studies can provide insights into the prominent prey consumed by harbor seals in the Aleutian Islands. Kenyon 1965 noted the presence of octopus and Atka mackerel in the stomachs of harbor seals collected from Amchitka Island in 1959 and 1962. **?** reported walleye pollock, Pacific sandfish, and octopus as the three most prominent prey items found in stomachs collected along the Alaska peninsula from 1973 through 1978. The Alaska peninsula borders the Aleutian Islands stock to the east.

Between 2014 and 2016, the Alaska Fisheries Science Center's (AFSC) Marine Mammal Laboratory collected scats (n=21) from harbor seal haul-out locations through the Aleutian Islands. Two statistics are used here to quantify prey remains in scats. Percent frequency of occurrence (FO) represents the percentage of scats that a prey taxa was present. Because more than one prey taxa are found within a scat, percent FO results will not typically sum to 100 percent. Split-sample frequency of occurrence (SSFO) calculates the occurrence of prey taxa such that the results represent a true proportion. Both statistics are important with FO indicating common prey taxa and SSFO more meaningful when comparing diet proportions and estimating biomass consumption.

Results (60) from the identification of prey remains in those scats indicate Atka mackerel (Pleurogrammus monopterygius), likely arrowtooth flounder (Atheresthes sp.), rockfish (Sebastes sp.), sole (Lepidopsetta sp.), and walleye pollock (Gadus macrocephalus) were the five most prominent taxa. Additional scats were collected in summer 2026 but have not yet been processed. We hope to prioritize more regular collections of harbor seal scats from the region in coming years.

| | | Harbor seal n=21 | |
|---|---|---|---|
| Class/Family | Prey Taxa | % FO | % SSFO |
| ***Teleostei (Fish)*** | | | |
| Cottidae | *Gymnocanthus* **sp.** | 4.8 | 1.0 |
| Gadidae | *Gadus chalcogrammus* | 9.5 | 2.1 |
| | ***Gadus macrocephalus*** | **14.3** | **3.7** |
| Gasterosteidae | unidentified | 9.5 | 3.6 |
| Hexagrammidae | ***Pleurogrammus monopterygius*** | **47.6** | **18.3** |
| | unidentified | 4.8 | 1.2 |
| Liparidae | unidentified | 4.8 | 0.7 |
| Pleuronectidae | ***Atheresthes* sp.** | **28.6** | **13.4** |
| | *Glyptocephalus zachirus* | 4.8 | 1.2 |
| | *Hippoglossoides elassodon* | 9.5 | 1.9 |
| | ***Lepidopsetta* sp.** | **14.3** | **6.2** |
| Salmonidae | *Oncorhynchus* **sp.** | 9.5 | 3.6 |
| Scorpaenidae | ***Sebastes* sp.** | **23.8** | **8.4** |
| Trichodontidae | *Trichodon trichodon* | 14.3 | 3.1 |
| Zoarcidae | *Lycodes* **sp.** | 4.8 | 1.2 |
| Teleostei | unidentified | 19.0 | 7.4 |
| ***Cephalopoda (Squid and octopus)*** | | | |
| Decapodiformes | unidentified | 4.8 | 0.8 |
| ***Polychaeta (Polychaete worms)*** | | | |
| Polynoidae | *Eunoe* **sp.** | 4.8 | 2.4 |

Figure 60: Harbor seal diet presented as frequency of occurrence from scats (n=22) collected at haul-out locations in the Aleutian Islands between 2014-2016. All identifiable prey hard parts found in the scat were used to determine species presence (NOAA, unpublished data).

Between 2014 and 2016, the Alaska Fisheries Science Center deployed satellite telemetry devices on 80 harbor seals at 11 locations distributed throughout the Aleutian Islands archipelago (Dahle et al. *in prep.*; NOAA AFSC, unpublished data). Analysis of telemetry data showed that most seals remained within about 25 kilometers of the haul-out site where they were captured, and many made use of a small network of nearby haul-out sites. A few seals, mostly sub-adults, undertook longer trips off the Aleutian shelf or to haul-out locations 50 or more kilometers away from their release site. Dive behavior records indicate harbor seals are targeting the bottom of the water column as their dive depths often match the shelf bathymetry.

Given the common prey items found in harbor seal scats and the spatial overlap with commercial fisheries, the abundance, trend, and foraging ecology of harbor seals in the Aleutian Islands are important ecosystem indicators for sustainable groundfish fishery management. That said, harbor seals are not just indicators of the fisheries ecosystem. The non-migratory behavior and coastal site fidelity of harbor seals makes them valuable for monitoring the coastal marine ecosystem for anthroprogenic impacts, persistent pollutants and heavy metals, and harmful algal blooms (HABs) exacerbated by warming events.

**Status and trends:** A partial estimate of harbor seal abundance in the Aleutian Islands was determined from skiff-based surveys conducted at 106 islands from 1977 to 1982 (Small et al., 2008). When researchers compared

this estimate (8,601 seals) to counts at the same islands from aerial surveys conducted in 1999 (2,859 seals), the number of harbor seals had declined by 67 percent. Regionally, the strongest declines occurred in the western Aleutians (Near Islands, 86%) with progressively lower declines in the central (Rat and Andreanof Islands, -66%) and eastern (Fox Islands, -45%) Aleutians. The magnitude and geographic pattern of the harbor seal declines was similar to that of Steller sea lions in the Aleutian Islands from 1985 to 2000 (Small et al., 2008). The factors responsible for these declines remain unknown.

The Aleutian stock covers the largest geographic range of any harbor seal stock in Alaska (over 1,600 km long) and is challenging to adequately survey due to frequent and extensive fog cover, turbulent winds, and access to only three viable airports (located on the islands of Unalaska, Adak, and Shemya). Limited funds and availability of suitable aircraft have also prevented greater survey coverage. Aerial surveys are conducted from fixed-wing aircraft flown at a target altitude of 750 feet. High-resolution photographs (taken with handheld DSLR cameras) and GPS coordinates are recorded at each location that harbor seals are spotted hauled out along the shoreline. Seals are later counted from survey photos.

Stock abundance and trend estimates are derived from a multi-decadal (1996–2023) monitoring effort based on aerial photographic surveys conducted by the AFSC's Marine Mammal Laboratory and analyzed using a two-stage Bayesian hierarchical model (Boveng et al. 2026; Ver Hoef et al. 2025). The framework integrates survey counts with haul-out timelines from satellite bio-loggers to correct for availability (seals in the water during surveys) and survey covariates (tide, solar hour, date). The modeling approach, importantly, enables annual estimates of abundance and trend with uncertainty, even in years with limited or no survey effort.

In 2023, statewide harbor seal abundance in Alaska was estimated at 201,122 seals (95% CI: 194,459–208,174; CV = 0.018). The statewide population trajectory showed general growth from 1996-2009, reaching a peak of approximately 225,000 seals in 2015. This growth likely reflects continued recovery after implementation of protections within the Marine Mammal Protection Act of 1973. Statewide growth, however, does not fully reflect regional variability. Notably, the Aleutian Islands stock remained relatively stable with only a slight increase during the 1996-2009 period (61), likely reflecting a leveling off of the steep declines described by Small et al. (2008). Regional declines and variability in population dynamics expanded to include a number of stocks in the later period from 2010-2023 but the Aleutian Islands stock has remained relatively stable in recent years – albeit at historically low abundance levels.

**Factors influencing observed trends:** *Forage fish availability and Marine Heatwaves.* The overall paucity of data regarding abundance, trend, genetic structure, and ecology of harbor seals in the Aleutian Islands limits our ability to evaluate ecosystem factors that could be influencing the observed trends. That harbor seals appear to share similar patterns in trend with Steller sea lions (dramatic decline followed by limited recovery; larger declines in the western portion of the stock) and that they overlap in their spatial range and diet suggests many of the factors influencing Steller sea lions are also influencing harbor seals. Atka mackerel, arrowtooth flounder, and walleye pollock are all commercially harvested prey species and are likely to exhibit differences in spatial distributions, altered demographics, and lower overall abundance in fished versus unfished regions. (Hsieh et al., 2006; Barbeaux et al., 2013; Fritz et al., 2019).

During the severe 2014–2016 and 2019–2021 Pacific marine heatwaves, warm ocean anomalies disrupted forage fish abundance, energy density, and recruitment (Suryan et al. 2021). A study of changes in harbor seal body condition within the Aleutian Islands (Bov, 2020) showed an annual decline in body condition of 45g body mass per centimeter of body length from 2014-2016. This decline in body condition was likely an acute response to short-term environmental variation and may reflect a lag response to the 2014-2016 warm period.

**Implications**: *Top-down trophic dynamics and fishery interactions.*Harbor seal predation likely represents an important source of natural mortality for important fish species such as Atka mackerel, rockfish, arrowtooth flounder, walleye pollock, and salmon. The lack of recent and consistent food habits data for seals in the region, though, severely limits our understanding of the trophic impact. With improved data on food habits and continued population monitoring, trophic linkages between harbor seals and commercial fisheries could be quantified and, potentially, included in future multi-species fisheries management models. Harbor seals also serve as a pri-

mary prey for transient killer whales and killer whale predation provides some level of top-down population control.

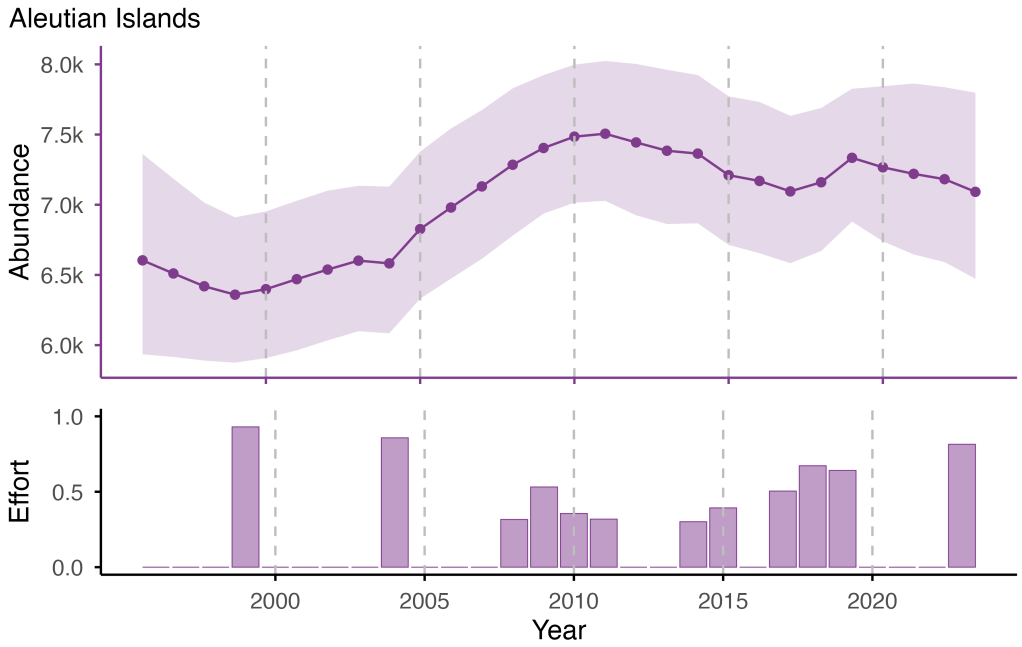



Figure 61: Abundance and survey effort for the Aleutian Islands stock of harbor seals (adapted from Boveng et al. (2026). Estimated abundances by year displayed as solid circles. Ninety-five percent credible intervals are displayed as shaded regions in the upper panel. In the lower panel, bars depict an index of survey effort, calculated as the sum of the estimated abundance for those SSUs that were surveyed at least once in that year, divided by that year's estimated abundance for the entire stock.

## *Marine Mammal Strandings*

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**Last updated: September 2026**

**Description of indicator:**: Since 1985, members of the NMFS Alaska Marine Mammal Stranding Network (AMMSN) have collected and compiled reports on marine mammal strandings throughout the state. These reports are indices of events witnessed by members of the stranding network, the scientific community, and the general public, with varying degrees of knowledge regarding marine mammal biology and ecology. A marine mammal is considered "stranded" if it meets one of the following criteria: 1) dead, whether found on the beach, ice, or floating in the water; 2) alive on a beach (or ice) but unable to return to the water; 3) alive on a beach (or ice) and in need of apparent medical attention; or 4) alive in the water and unable to return to its natural habitat without assistance. The causes of marine mammal strandings are often unknown but some causes include disease, exposure to contaminants or harmful algal blooms, vessel strikes, and entanglement in or ingestion of human-made gear or debris.

When a stranded marine mammal is reported, information is collected including species, location, age class or size. In some cases, the initial photos and observations reported to AMMSN may be the only opportunity to collect information on the event. When possible trained and authorized AMMSN members respond and collect life history data and samples as part of a postmortem examination. Photos and carcasses are evaluated for potential human

interactions such as entanglements or vessel strikes. These responses are conducted under the Marine Mammal Protection Act authorization either under a 112 (c) agreement issued by NMFS to AMMSN members through a Stranding Agreement or under 109 (h) authority exercised by local, state, federal or tribal entities. All responses involving ESA-listed species and some enhanced responses (e.g. remote sedation) are authorized under the NOAA Permit No. 24359.

**Status and trends:** The number of confirmed strandings in Alaska has increased over time. Stranding data was not included in the 2025 Ecosystem Status Report; the current report includes complete 2024 and 2025 stranding data (January 1 - December 31; Table 1), in addition to data from January 1, 2026 through September 30, 2026. Thus far in 2026, 215 confirmed stranded marine mammals were reported within Alaska; 7 occurred in the Aleutian Islands (Table 1). These numbers do not include entangled pinnipeds with no response or live, entangled baleen whales. Reported strandings in the Aleutian Islands since 2022 varied between years without an overall pattern or consistent increase in reports (Table 1).The data from January 1, 2026 through September 30, 2026 are preliminary and the details may change as we review reports and receive additional information.

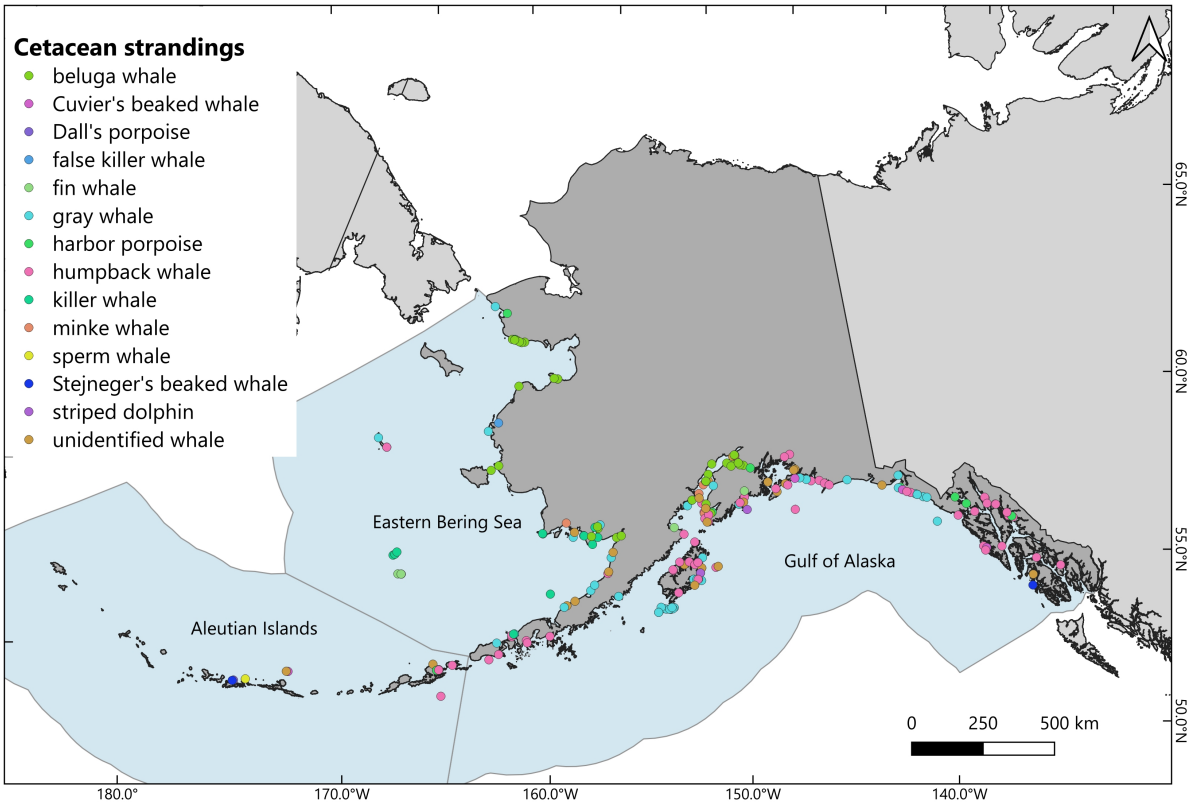



Figure 62: Reported cetacean strandings from Sept 1, 2024 through Sept 30, 2026 in Alaska.

**Factors influencing observed trends:**: It is important to recognize that stranding reports represent effort that has varied substantially over time and location and overall has increased over time and within areas with higher human population densities. There have been relatively few reported stranded marine mammals in the Aleutian Islands (Table 1) likely due to the remoteness of the area and the low and sporadic human population throughout the area (Figure 62 and 63). The number of stranded marine mammals are likely grossly underestimated as observations are opportunistic and without consistent effort.

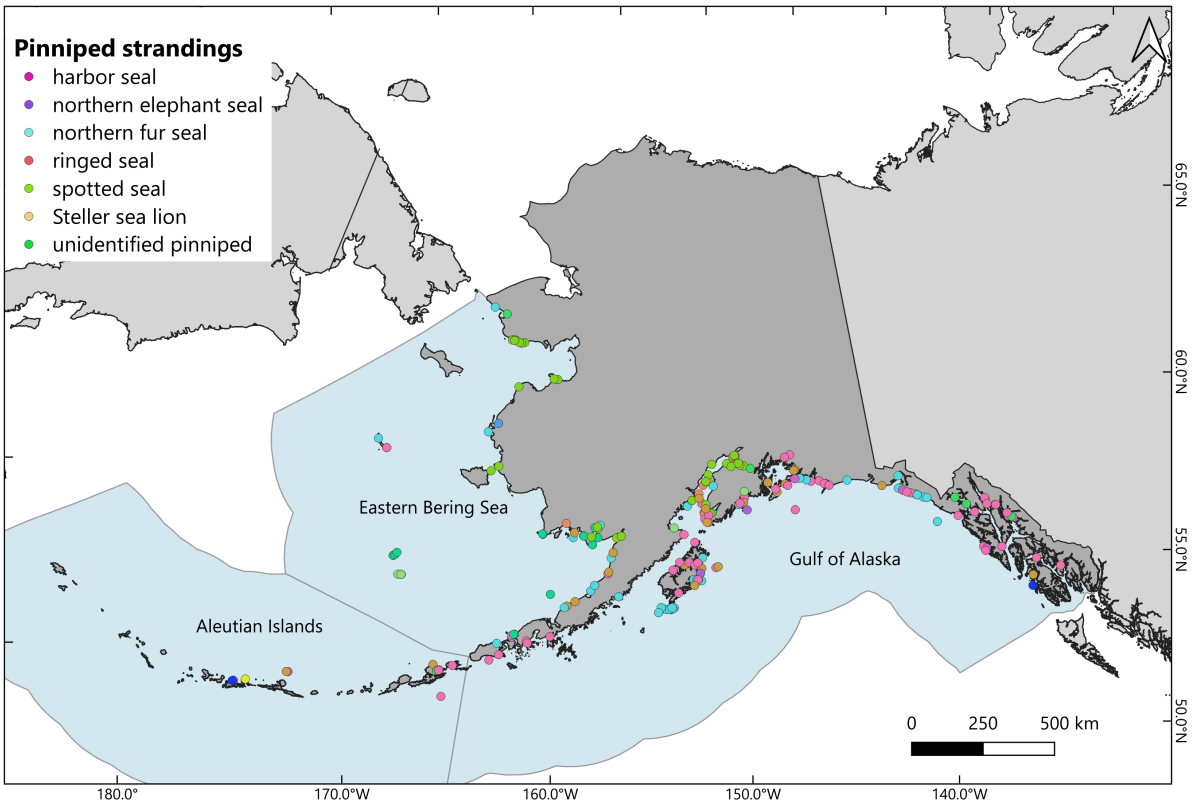



Figure 63: Reported cetacean strandings from Sept 1, 2024 through Sept 30, 2026 in Alaska.

**Implications:** Across Alaska, reported marine mammal strandings have been increasing in more recent years which may signal changes in the environment or human interactions (e.g. vessel strike, entanglement). It is important to track and have a sense of the regular number of strandings in an area to provide a context to mass strandings or Unusual Mortality Events. Marine mammal stranding data can be paired with other datasets and may give clues to ecosystem-wide changes or other stressors.

Table 1: .
Reported NMFS marine mammal strandings from 2022 - 2026[13] in the Aleutian Island Region by species. The numbers represent combined dead and live strandings.

| | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|
| Baird's beaked whale | 1 | | | | |
| Cuvier's beaked whales | | | 1 | | |
| Dall's porpoise | | | 1 | | |
| Harbor porpoise | | | | | 1 |
| Humpback whale | | 2 | 1 | 4 | 1 |
| Killer whale | 1 | | | | |
| Sperm whale | | 1 | 1 | | 1 |
| Stejneger's beaked whale | | | | 1 | |
| unidentified beaked whale | | | | | 2 |
| unidentified cetacean | | | | 1 | |
| **Total Cetaceans** | 2 | 3 | 4 | 6 | 5 |
| | | | | | |
| Harbor seal | | | | 1 | 1 |
| Northern fur seal | | | | | 1 |
| Steller sea lion | | | 3 | 4 | |
| **Total Pinnipeds** | 0 | 0 | 3 | 4 | 2 |
| | | | | | |
| **Total Animals** | 2 | 3 | 7 | 2 | 5 |

# Ecosystem or Community Indicators

## *Stability of Groundfish Biomass*

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**Last updated: September 2026**

**Description of indicator:** The stability of the groundfish community total biomass is measured with the inverse biomass coefficient of variation (1 divided by the coefficient of variation of total groundfish biomass (1/CV[B]). This indicator provides a measure of the stability of the ecosystem and its resistance to perturbations. The variability of total community biomass is thought to be sensitive to fishing and is expected to increase with increasing fishing pressure (Blanchard and Boucher, 2001). This metric is calculated following the methods in Shin et al. (2010). The CV is the standard deviation of the groundfish biomass index over the previous 10 years divided by the mean over the same time period. This metric is presented as an inverse, so as the CV increases the value of this indicator decreases, and if the CV decreases the value of this indicator increases.

The biomass index for groundfish species was calculated from the catch of the NMFS/AFSC biennial summer bottom-trawl survey of the Aleutian Islands. The Aleutian Islands survey time series began in 1980 and was conducted on a triennial basis until 2000 when it switched to a biennial schedule. The surveys prior to 1991 were conducted jointly with Japan and preceded the establishment of standardized survey methodology for the Aleutian Islands (von Szalay et al., 2023) Thus, this indicator begins with the 1991 survey. The 2008 and 2020 surveys did not occur leaving 4 year gaps. Since 10 years of data are required to calculate this metric, the indicator values start in 2014, the tenth time the Aleutian Islands were surveyed over the time series examined (1991-2026).

Since 2022, rockfish are included in this indicator, including dusky rockfish, northern rockfish, Pacific Ocean perch, rougheye rockfish, shortraker rockfish, shortspine thornyhead, and other Sebastes. Rockfishes are abundant in the Aleutian Islands and variations in their population could drive the value of this indicator. Therefore, the mean lifespan of groundfish is presented as two series, one with rockfish included and one without.

**Status and trends:** : The stability of groundfish biomass with rockfish included is 6.9 in 2026, down from a time series high of 8.0 in 2024. Without rockfish, the stability of groundfish biomass has gradually decreased from a high of 4.0 in 2014 to 3.4 in 2026.

**Factors influencing observed trends:** Fishing is expected to influence this metric as fisheries can selectively target and remove larger, long-lived species effecting population age structure (Berkeley et al., 2004; Hsieh et al., 2006). Larger, longer-lived species can become less abundant and be replaced by smaller shorter-lived species (Pauly et al., 1998). Larger, longer-lived individuals help populations to endure prolonged periods of unfavorable environmental conditions and can take advantage of favorable conditions when they return (Berkeley et al., 2004). A truncated age-structure could lead to higher population variability (CV) due to increased sensitivity to environmental dynamics (Hsieh et al., 2006). Interannual variation in this metric could also be influenced by interannual variation in species abundance in the trawl survey catch, and patchy spatial distribution for some species. This metric, as calculated here with trawl-survey data, reflects the stability of the groundfish community that is represented in the catch of the Aleutian Islands summer bottom-trawl survey. In general, as total biomass decreases species spatial distribution may contract or have increasingly isolated patches, both of which may lead to increased CV (Shin et al., 2010).

The biomass of Pacific Ocean perch increased over the time series to a peak in 2014 and has trended downwards in the years since. In particular, the biomass index of Pacific Ocean perch dropped 25% from 2024 to 2026. This change in biomass by a biomass dominant species has increased variability in total groundfish biomass, thus contributing to the reduced groundfish stability indicator in 2026.

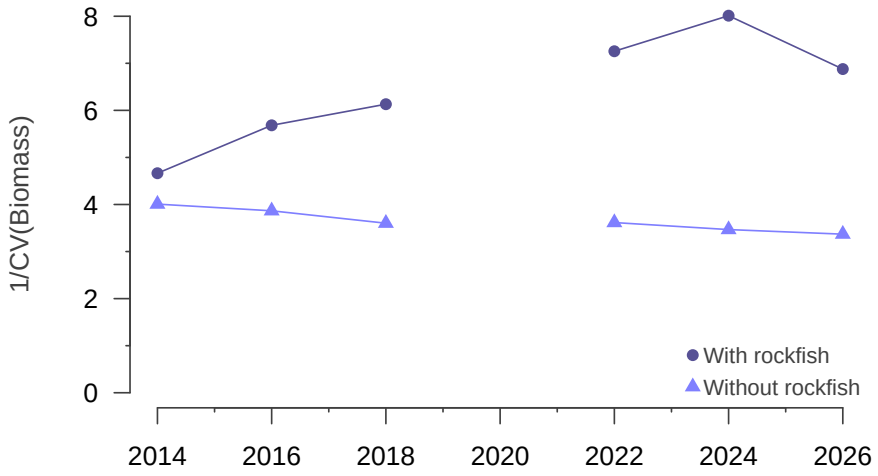



Figure 64: The stability of groundfish in the Aleutian Islands, represented by the inverse biomass coefficient of variation (1 divided by the coefficient of variation of total groundfish biomass (1/CV[B]). Ten years of data are required to calculate this metric, so the indicator begins in 2014 after the tenth occurrence of the NMFS/AFSC summer bottom-trawl survey over the time period examined (1991-2026).

In the series with rockfish excluded, walleye pollock and Atka mackerel are two of the biomass dominant species in the catch of the Aleutian Islands bottom trawl survey. Atka mackerel has had the highest biomass index in all years of the survey examined here and exhibits considerable variability between survey years. The biomass index for walleye pollock has similarly exhibited high variability between survey years. Collectively, this heightened variability has led to lower groundfish stability for the series without rockfish.

**Implications:** : The total biomass of the groundfish community in the Aleutian Islands has exhibited interannual variability over the survey time series. However, the presence of long-lived rockfishes has had a stabilizing effect on total groundfish biomass. The recent decrease in biomass index of Pacific Ocean perch has increased variability, but status and trends indicate the overall groundfish community remains stable.

## *Mean Length of the Fish Community*

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**Last updated: September 2026**

**Description of indicator:**: The mean length of the groundfish community tracks fluctuations in the size of groundfish over time. This size-based indicator is sensitive to the effects of commercial fisheries because larger predatory fish are often targeted by fisheries and their selective removal would reduce mean size (Shin et al., 2005). This indicator is also sensitive to shifting community composition of species with different mean sizes. Fish lengths are routinely recorded during the biennial NMFS bottom trawl survey of the Aleutians Islands. The survey time series began in 1980 and was conducted on a triennial basis until 2000 when it switched to a biennial schedule. The surveys prior to 1991 were conducted jointly with Japan and preceded the establishment of standardized survey methodology for the Aleutian Islands (von Szalay et al., 2023). Thus, this indicator begins with the 1991

survey. The 2008 and 2020 surveys did not occur leaving 4 year gaps. Previous year's contributions included the 1983 and 1986 surveys.

Species-specific mean lengths are calculated for groundfish species from the length measurements collected during the trawl survey. The mean length for the groundfish community is calculated with the species-specific mean lengths, weighted by biomass indices (Shin et al., 2010) calculated from the bottom-trawl survey catch data. The survey biomass index is weighted by strata area (km2). This indicator specifically applies to the portion of the demersal groundfish community efficiently sampled with the trawling gear used by NMFS during the summer bottom-trawl survey of the Aleutian Islands and have their lengths regularly sampled (for complete survey details see von Szalay et al. 2023). This includes species of skates, flatfishes, and roundfishes (e.g., cods, sculpins, eelpouts). Species that are predominately found in the pelagic environment (e.g., capelin, pelagic smelts), are infrequently encountered (e.g., sharks, grenadiers, myctophids), or not efficiently caught by the bottom-trawling gear are excluded from this indicator.

Since 2022, rockfish are included in this indicator, including dusky rockfish, northern rockfish, Pacific Ocean perch, rougheye rockfish, shortraker rockfish, shortspine thornyhead, and other *Sebastes*. Rockfishes are abundant in the Aleutian Islands and variations in their population could drive the value of this indicator. Therefore, groundfish mean length is presented as two series, one with rockfish included and one without.

**Status and Trends:** *With rockfish*—The mean length of the Aleutian Islands groundfish community in 2026 is 36.8 cm, just below the long term mean of 37.2 cm (Figure 65). This indicator has shown a small amount of year to year variation and has generally stayed close to the long term mean

*Without rockfish*—The mean length of the groundfish community in 2026, excluding rockfish, is 39.3 cm, down from 39.9 cm in 2024 and just below the long-term mean of 39.5 cm. The trends in this indicator without rockfish approximately mirrors that of the indicator with rockfish, however it is shifted up about 1–3 cm.

**Factors influencing observed trends:** : This indicator is specific to the fishes that are routinely caught and sampled during the NMFS summer bottom-trawl survey. The estimated mean length can be biased if specific species-size classes are sampled more or less than others, and is sensitive to spatial variation in the size distribution of species. Changes in fisheries management or fishing effort could also affect the mean length of the groundfish community. Modifications to fishing gear, fishing effort, and targeted species could affect the mean length of the groundfish community if different size classes and species are subject to changing levels of fishing mortality. The mean length of groundfish could also be influenced by fluctuations in recruitment, where a large cohort of small forage species could reduce the mean length of the community. Environmental factors could also influence fish growth and mean length by affecting the availability and quality of food, or by direct temperature effects on growth rate.

Pacific Ocean perch and northern rockfish are the biomass dominant species of rockfish included in this indicator. Their mean lengths are generally less than the mean length for Atka mackerel and are less than the mean lengths for walleye pollock and Pacific cod, which are the biomass dominant species among non-rockfish species. This leads to the groundfish community mean length being greater when rockfish are excluded.

**Implications:** The mean length of the groundfish community in the Aleutian Islands has been stable over the bottom-trawl time series (1991-2026) with some interannual variation. There is no evidence at this time of a trend in mean size or other indication that external pressures such as climate or fishing are affecting the mean length of groundfish.

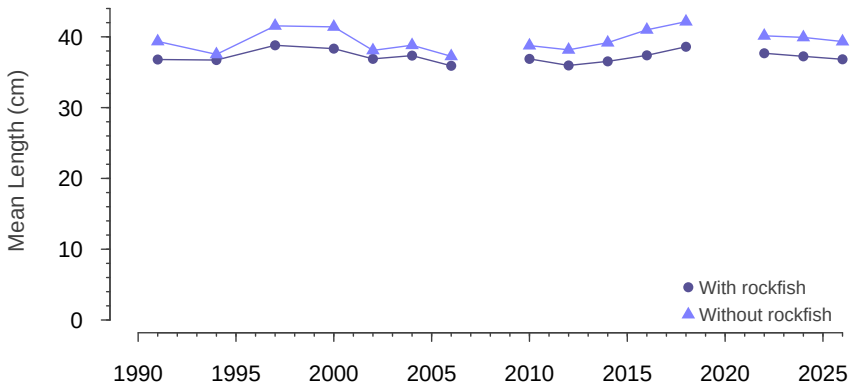



Figure 65: Mean length of the groundfish community sampled during the NMFS/AFSC summer bottom-trawl survey of the Aleutian Islands (1991-2026). The groundfish community mean length is weighted by the relative biomass of the sampled species.

## *Mean Lifespan of the Fish Community*

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**Last updated: September 2026**

**Description of indicator**: The mean lifespan of the community is a proxy for the turnover rate of species and communities and reflects the resistance of the community to perturbations (Shin et al., 2010). Lifespan estimates of groundfish species regularly encountered during the NMFS/AFSC biennial summer bottom-trawl survey of the Aleutian Islands were retrieved from the AFSC Age and Growth Program Database[14]. The groundfish community mean lifespan is weighted by biomass indices calculated from the bottom-trawl survey catch data (Shin et al., 2010).

This indicator specifically applies to the portion of the demersal groundfish community that is efficiently sampled by the trawling gear used by NMFS during this survey (for complete survey details see von Szalay et al. 2023). This includes species of skates, flatfishes, and roundfishes (e.g., cods, sculpins, eelpouts). Species that are predominately found in the pelagic environment (e.g., capelin, pelagic smelts), are infrequently encountered (e.g., sharks, grenadiers, myctophids), or not efficiently caught by the bottom-trawling gear are excluded from this indicator. The Aleutian Islands survey time series began in 1980 and was conducted on a triennial basis until 2000 when it switched to a biennial schedule. The surveys prior to 1991 were conducted jointly with Japan and preceded the establishment of standardized survey methodology for the Aleutian Islands (von Szalay et al., 2023). The 2008 and 2020 surveys did not occur leaving 4 year gaps.

Since 2022, rockfish are included in this indicator, including dusky rockfish, northern rockfish, Pacific Ocean perch, rougheye rockfish, shortraker rockfish, shortspine thornyhead, and other Sebastes. Rockfishes are abundant in the Aleutian Islands and variations in their population could drive the value of this indicator. Therefore, the mean lifespan of groundfish is presented as two series, one with rockfish included and one without.

**Status and Trends:** *With rockfish*— The mean lifespan of the Aleutian Islands demersal fish community in 2026 is 62.2, down from 63.8 in 2024 but above the long term mean of 54.4 over the years 1991–2026. This indicator

[14]Short, J.A., and D. M. Anderl. 2012. The Age and Growth Program Database. Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, Seattle WA 98115

generally trended upward from a low of 33.1 in 1994 to a peak of 68.5 in 2012 and has been relatively stable since 2014 (Figure 65).

*Without rockfish*—The mean lifespan of the groundfish community, excluding rockfish, is 20.4 in 2026, which is equal to the long-term mean but down slightly from 21.2 in 2024. This indicator with rockfish excluded has shown little year-to-year variation and no apparent trend.

**Factors Causing Trends**: Fishing can affect the mean lifespan of the groundfish community by preferentially targeting larger, older fishes, leading to decreased abundance of longer-lived species and increased abundance of shorter-lived species (Pauly et al., 1998). Interannual variation in mean lifespan can be influenced by the spatial distribution of species and the differential selectivity of species and age classes to the trawling gear used in the survey. Strong recruitment events or periods of weak recruitment could also influence the mean community lifespan by altering the relative abundance of age classes and species.

Lower values of this indicator in the early part of the time series (e.g., 1994) when rockfish are included, reflect relatively lower abundances of biomass dominant long-lived rockfish species, such as Pacific Ocean perch and northern rockfish, and relatively higher abundances of shorter-lived species, in particular Atka mackerel and walleye pollock. Higher values of this indicator since 2012 reflect greater abundances of Pacific Ocean perch and northern rockfish.

**Implications:** The groundfish mean lifespan with rockfish included has generally trended upward over the time series indicating an increasing prevalence of longer-lived species. The mean lifespan when rockfish are excluded has been stable over the time series, showing no signs of an increasing or decreasing trend. Species that are short-lived are generally smaller and more sensitive to environmental variation than larger, longer-lived species (Winemiller, 2005). Longer-lived species help to dampen the effects of environmental variability, allowing populations to persist through periods of unfavorable conditions and to take advantage when favorable conditions return (Berkeley et al., 2004; Hsieh et al., 2006).

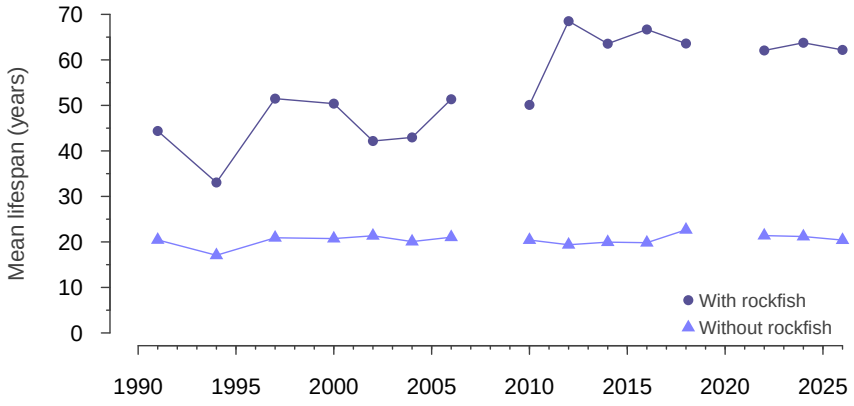



Figure 66: The mean lifespan of the Aleutian Islands groundfish community, weighted by biomass indices calculated from the NMFS/AFSC summer bottom-trawl survey (1991-2026).

# Disease Ecology Indicators

## *Harmful Algal Blooms in the Aleutian Islands*

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**Last updated: October 2026**

**Description of indicator:** Alaska's most well-known and toxic harmful algal blooms (HABs) are caused by phytoplankton in the genera of *Alexandrium* and *Pseudo-nitzschia*. textitAlexandrium produces paralytic shellfish toxins (PST) which can cause paralytic shellfish poisoning (PSP) and has been responsible for five deaths and over 100 cases of PSP in Alaska since 1993 (State of Alaska, 2022). Analyses of paralytic shellfish toxins are commonly reported as µg of toxin/100 g of tissue, where the FDA regulatory limit is 80µg/100g. Toxin levels between 80µg - 1000µg/100 g are considered to potentially cause non-fatal symptoms, whereas levels above 1000µg/100g (1̃2x regulatory limit) are considered potentially fatal. Testing for PSTs is done for all commercial species by regulation, whereas for marine subsistence food items, testing is done as funding allows.

Another harmful algal species, *Pseudo-nitzschia* produces domoic acid which can cause amnesic shellfish poisoning and inflict permanent brain damage. *Pseudo-nitzschia* has been detected in 13 marine mammal species and has the potential to impact the health of marine mammals and birds in Alaska. No human health impacts of domoic acid have been reported in Alaska, although both acute and chronic amnesic shellfish poisoning has been reported in several states, including Washington and Oregon.

Another organism, *Dinophysis* spp., produces okadaic acid which can lead to diarrhetic shellfish poisoning. This primarily impacts the gastrointestinal system and is not usually life-threatening but can lead to nausea, vomiting, abdominal cramping, and diarrhea. Although there have not been recorded cases of diarrhetic shellfish poisoning in Alaska, *Dinophysis* has been detected throughout Alaska, and okadaic acid is at times detected in shellfish.

As a way of detecting these harmful species in Alaska and using them as an ecosystem status indicator, we have started to develop a monitoring program using Imaging FlowCytoBots (IFCBs). IFCBs are connected to the flow-through seawater system of research vessels and sample 5mL approximately every 20 minutes. These samples are run through a flow cell and images are taken of individual particles up to 150 m in size. To learn more about IFCBs in Alaska, refer to Gann et al. 2026. In 2026, the Alaska Ocean Observing System (AOOS) deployed three IFCBs on research vessels that transited through Alaskan waters between Seattle, Prince William Sound and the Chukchi Sea (68). When a bloom of a potentially toxic species is detected by the IFCBs, a HAB advisory is drafted and sent to nearby communities to alert them of the situation.

The State of Alaska tests all commercial shellfish harvest, however there is no state-run shellfish testing program for recreational and subsistence shellfish harvest. Regional programs, run by Tribal, agency, and university entities, have expanded over the past five years to provide test results to inform harvesters and researchers and reduce human health risk. All of these entities are partners in the Alaska Harmful Algal Bloom Network which was formed in 2017 to provide a statewide approach to HAB awareness, research, monitoring, and response in Alaska. More information can be found on the Alaska HAB Network website[15] or through the sampling partners listed above. For a summary of HAB events and testing results once they are available, visit the HAB Alerts page [16].

[15]https://aoos.org/alaska-hab-network/
[16]https://ahab.aoos.org/hab-alerts/

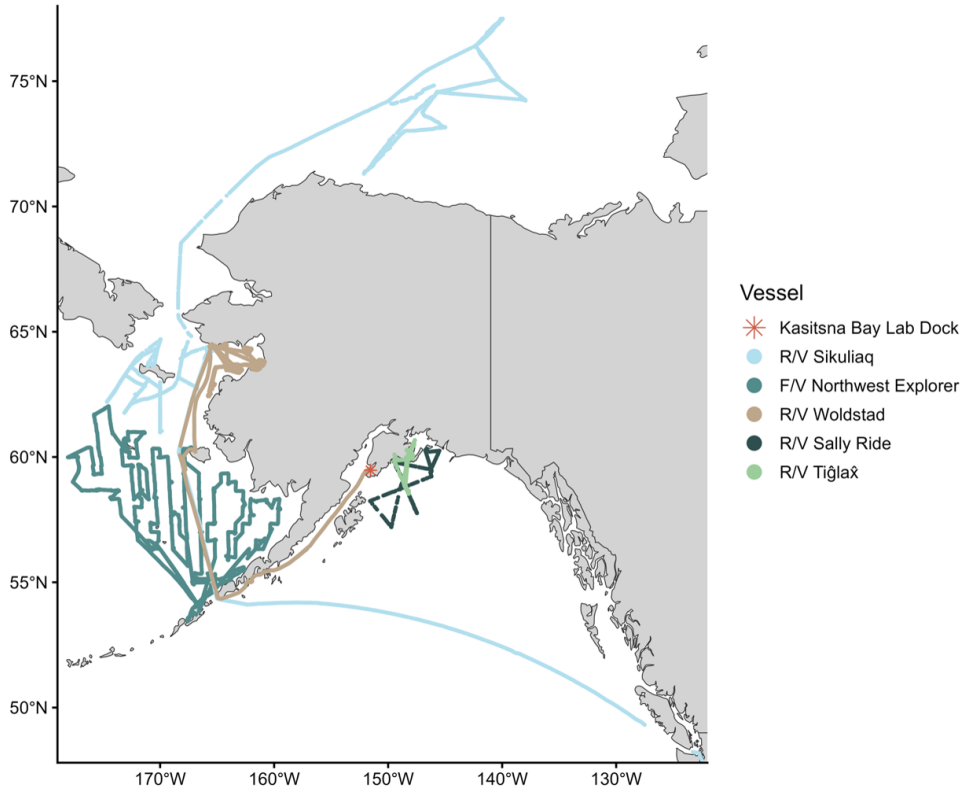



Figure 67: Tracks of the three IFCBs deployed on research vessels at on shore during May-October 2026. Colors represent different deployments (see text for details and links to the data dashboards for each deployment).

**Status and trends: Alaska Region:**:
Three IFCBs sampled for over 270 days in Alaska waters (fig.**??**) and results from the IFCB monitoring in 2026 showed a generally similar picture of phytoplankton from 2025 and 2024. However, detection of HAB species seemed to have been slightly lower, especially in the Gulf of Alaska.

The only bloom of a harmful algal species detected by IFCBs this summer happened in the Bering Sea, where an *Alexandrium* bloom seemed to have started at low levels at the end of June east of the Pribilof Islands, and by the end of August there was a widespread and fairly dense bloom covering much of the southeast Bering Sea. This is now the third year in a row that this *Alexandrium* bloom is detected in this general area, suggesting that this may be a perennial feature of the southeast Bering Sea. Unlike 2024 and 2025, no mortalities of northern fur seals were linked to paralytic shellfish toxins in 2026.

Although low levels of *Pseudo-nitzschia* and *Dinophysis* were also detected throughout the season, and showed occasional slight upticks, nothing that would be categorized as a bloom was detected. 2026 seemed to have been an overall cooler year in terms of sea surface temperatures, and this likely accounted for the slight decrease in bloom events. Over the last few years, the dinoflagellate *Dinophysis* has become more common and abundant in water samples, and 2026 continued that trend. We are also seeing a geographic expansion of areas that are sampling for phytoplankton species.

**Aleutian Islands**: The Aleutian Islands were primarily sampled by IFCBs as vessels were transiting through Unimak Pass. The F/V Northwest Explorer also made several trips in and out of Dutch Harbor, providing a lot of nearshore data around Unalaska (fig. 68) Overall, the phytoplankton community was abundant and diverse, with periods of very high phytoplankton abundance. However, no HABs were detected by the IFCBs around the Aleutian Islands in 2026.

Details about each deployment, as well as images taking by the IFCBs and maps of sampled locations can be accessed through the following Woods Hole Oceanographic Institution (WHOI) dashboards (dates indicate the date range for which the IFCB collected data around the Aleutian Islands):

- F/V Northwest Explorer (May 31 – August 14) [17].
- R/V Woldstad (June 21 and August 26)[18]
- R/V Sikuliaq (August 27 – 28)[19]

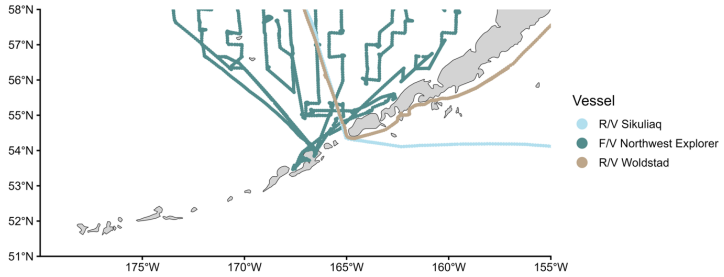



Figure 68: Tracks of IFCB deployments along the Aleutian Islands. Colors represent different deployments (see text for details and links to the data dashboards for each deployment).

**Factors influencing observed trends:** HABs are likely to increase in intensity and geographic distribution in Alaska waters with warming water temperatures. Observations in Southeast and Southcentral Alaska suggest *Alexandrium* blooms occur at temperatures above 10°C and salinities above 20 (Vandersea et al., 2018; Tobin et al., 2019; Harley et al., 2020). As waters warm throughout Alaska, blooms may increase in frequency and geographic extent.

**Implications:** HABs pose a risk to human health when present in wildlife species that people consume, including shellfish, birds and marine mammals. Research across the state is attempting to better understand the presence and circulation of HABs in the food web. HAB toxins have been detected in stranded and harvested marine mammals from all regions of Alaska in past years (Lefebvre et al., 2016). A multi-disciplinary statewide study funded by NOAA's ECOHAB program is underway and encompasses ship-based sediment samples, water samples, zooplankton samples which include krill and copepods, multiple species of fish, bivalves, and the continuation of sampling subsistence-harvested and dead stranded marine mammals.

The Alaska Department of Health, Section of Epidemiology (SOE) continues to partner with the AHAB network. Nurse consultants join in on the monthly meetings and collaborate with stakeholders so they can be made aware of reportable illness such as Paralytic shellfish Poisoning (PSP). SOE published an Epidemiology Bulletin describing cases of PSP from 1993-2021[20]. More information about PSP and other shellfish poisoning can be found on the SOE website[21].

[17] https://habon-ifcb.whoi.edu/timeline?dataset=NWexplorer2026
[18] https://habon-ifcb.whoi.edu/timeline?dataset=Woldstad2026
[19] https://habon-ifcb.whoi.edu/timeline?dataset=Sikuliaq2026
[20] https://epi.alaska.gov/bulletins/docs/b2022_05.pdf
[21] https://health.alaska.gov/dph/Epi/id/Pages/dod/psp/default.aspx

# Fishing and Human Dimensions Indicators

## Discards and Non-Target Catch

### *Time Trends in Groundfish Discards*

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**Description of indicator:**Estimates of groundfish discards for 1993-2002 are sourced from NMFS Alaska Region's blend data, while estimates for 2003 and later come from the Alaska Region's Catch Accounting System. These sources, which are based on observer data in combination with industry landing and production reports, provide the best available estimates of groundfish discards in the North Pacific. Discard rates as shown in figure 69 below are calculated as the weight of groundfish discards divided by the total (i.e., retained and discarded) catch weight for the relevant area-gear-target sector. Where rates are described below for species or species groups, they represent the total discarded weight of the species/species group divided by the total catch weight of the species/species group for the relevant area-gear-target sector. These estimates include only catch of FMP-managed groundfish species within the FMP groundfish fisheries. Discards of groundfish in the halibut fishery and discards of forage fish and species managed under prohibited species catch limits, such as halibut, are not included.

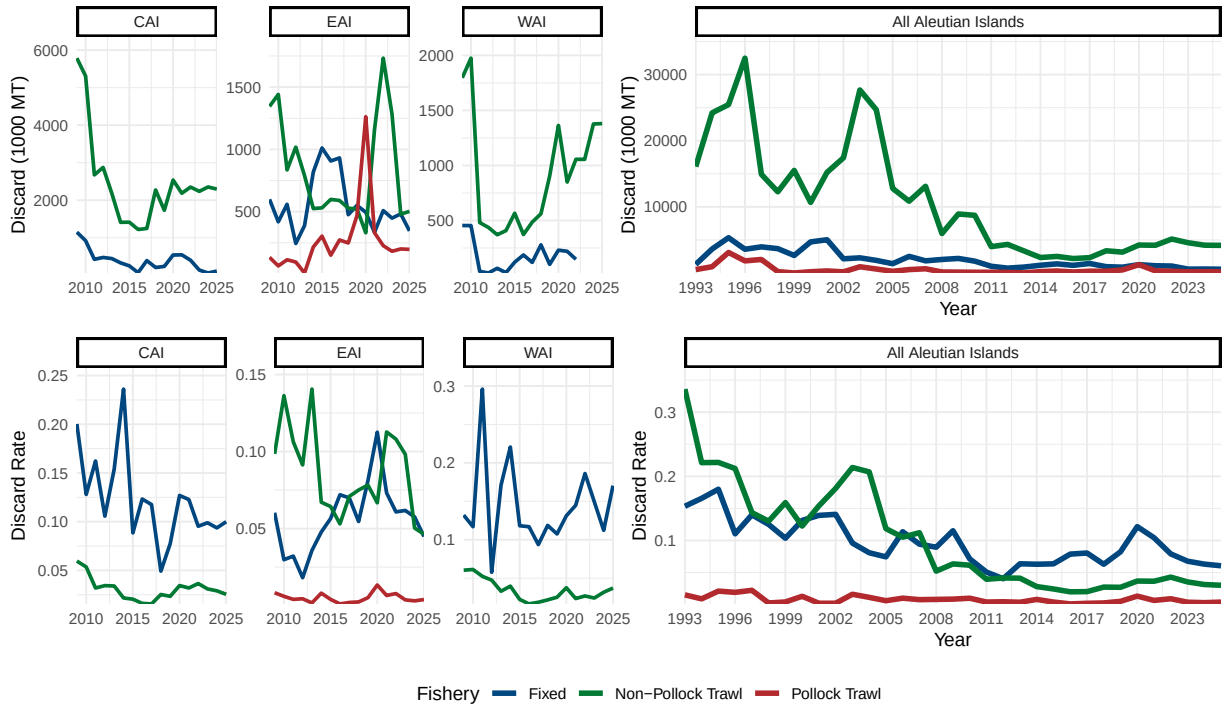



Figure 69: Total biomass and percent of total catch biomass of FMP groundfish discarded in the fixed gear, pollock trawl, and non-pollock trawl sectors for the Aleutian Islands region, 1993-2025; and for central (CAI), eastern (EAI), and western (WAI) subregions, 2009-2025. Discard rates are calculated as total discard weight of FMP groundfish divided by total retained and discarded weight of FMP groundfish for the sector (includes only catch counted against federal TACs)

.

**Status and trends:** Since 1993 discards and discard rates of groundfish in federally-managed Alaskan groundfish fisheries have generally declined in the trawl pollock and non-pollock trawl sectors in the Aleutian Islands (AI), (see Figure 70). Discard biomass in the trawl pollock sector was highest from 1995 to 1997, averaging 2,330 mT annually during this period, before falling in 1998 to 215 mT and averaging 320 mT annually from 1998 to 2020. The 2020 discard biomass in this sector (1265 mT) was the highest since 2007, but decreased once again to 197 mT in 2026. The non-pollock trawl sector has seen the steepest declines in discard biomass and rates since 1993. Discards in this sector peaked at 32500mT in 1996 (21% discard rate); annual discard biomass and rates averaged 15,300 mT and 15% annually from 1997 to 2007 and 4,315 mT and 4% annually from 2008 to 2025.

In fixed-gear sector, the discard volume and discard rate have also declined across the AI area in general since 1993. Over the most recent 5-year period (2021–2025), the annual discard biomass and discard rate in the AI fixed gear sector have averaged 785 mT and 8%, respectively, compared to 2,102 mT and 10% averaged over the longer 1993–2020 period. When disaggregated by subarea, fixed gear discard rates in the Western (WAI) and Central AI (CAI) subareas show large interannual variation over the 10 most recent years. Discard rates in non-pollock trawl sectors in the CAI and WAI steadily declined until a slight 2021 increase, while the EAI rate fluctuated, spiking in 2021 before dipping once again to 5%. To date in 2026, discard biomass through week 42 is lower in all three sectors relative to the preceding 5-year (2021–2025) period (Figure 70).

**Factors influencing observed trends:** Improved-retention regulations implemented in 1998 prohibiting discards of pollock and Pacific cod help account for the sharp declines in discard rates in the GOA and BSAI trawl pollock fisheries after 1997. Discard rates in the BSAI non-pollock trawl sector had a similar decline in 2008 following implementation of a groundfish retention standard for the trawl head-and-gut fleet. Improved observer coverage on vessels less than 60' long and on vessels targeting IFQ halibut may account for the apparent increase in the volume of discards in the GOA fixed gear sector in 2013.

Additionally, the regulations 50 CFR 679.20(j) and 50 CFR 679.7(a)(5) primarily require operators of catcher vessels using hook-and-line, pot, for jig gear (fixed gear) to fully retain rockfish landings in the BSAI or GOA. These regulations, which also restricts the amount of rockfish that can enter into the market, were implemented back in March 2020 with the overall purpose of limiting total catch of rockfish.

In April 2025, the North Pacific Fishery Management Council (NPFMC) recommended allowing economically undesirable small sablefish to be discarded (NPFMC, 2025a). While this is still pending NMFS rulemaking, the Advisory Panel is urging implementation in time for the 2027 season (NPFMC Advisory Panel, 2026). Later, in October 2025, the Council recommended updating the Maximum Retainable Amounts (MRA) for groundfish in the BSAI and GOA. This change could reduce regulatory discards without increasing overall harvest limits, though it is also currently pending rulemaking (NPFMC, 2025b).

**Implications:** Fishery discards adds to the total human impact on biomass without providing a benefit to the Nation and as such is perceived as "contrary to responsible stewardship and sustainable utilization of marine resources" (Kelleher, 2005). Discards may constrain the utilization of target species and increases the uncertainty around total fishing-related mortality, making it more difficult to assess stocks, define overfishing levels, and monitor fisheries for overfishing (Alverson 1994, NMFS2011, Clucas 1997). Although ecosystem effects of discards are not fully understood, discards of whole fish and offal have the potential to alter energy flow within ecosystems and have been observed to result in changes to habitat (e.g., oxygen depletion in the benthic environment) and community structure (e.g., increases in scavenger populations) (Queirolo 1995, Alverson 1994, Catchpole 2006, Zador et al. 2008). Monitoring discards and discard rates provides a means of assessing the efficacy of measures intended to reduce discards and increase groundfish retention and utilization.

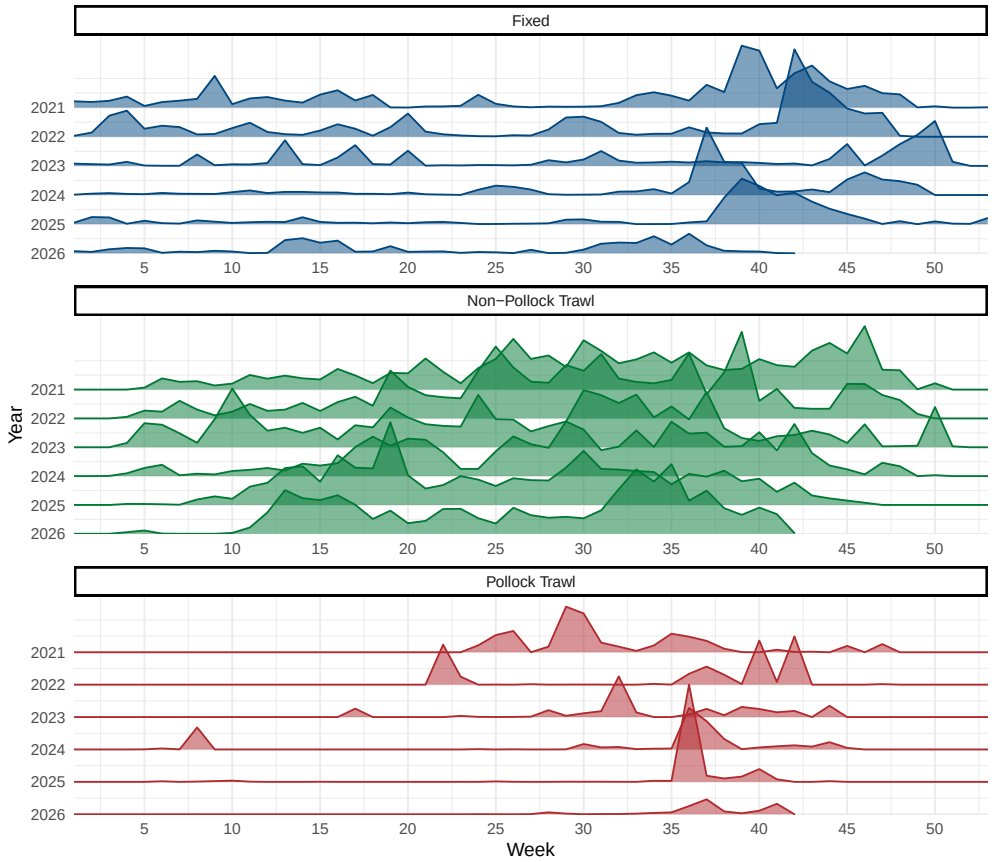



Figure 70: Total biomass (MT) of FMP groundfish discarded in the Aleutian Islands region by sector and week, 2018 - 2023 (data for 2023 is shown through week 37). Plotted heights are not comparable across sectors.

## *Time Trends in Non-Target Species Catch*

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**Last updated: August 2026**

**Description of indicator:** This indicator reports the catch of non-target species in groundfish fisheries in the Aleutian Islands (AI). Catch since 2003 has been estimated using the Alaska Region's Catch Accounting System (Cahalan et al., 2014). This sampling and estimation process does result in uncertainty in catches, which is greater when observer coverage is lower and for species encountered rarely in the catch. Since 2013, the three categories of non-target species tracked here are::

1. Scyphozoan jellyfish
2. Structural epifauna (seapens/whips, sponges, anemones, corals, tunicates)
3. Assorted invertebrates (bivalves, brittle stars, hermit crabs, miscellaneous crabs, sea stars, marine worms, snails, sea urchins, sand dollars, sea cucumbers, and other miscellaneous invertebrates).

The catch of non-target species/groups from the AI includes the reporting areas 518, 519, 541, 542, 543, and 610 [22]. Within reporting area 610, the GOA and Aleutian Islands (AI) Large Marine Ecosystems (LMEs) are divided at 164°W. Non-target species caught east of 164°W are within the GOA LME and the catch west of 164°W is within the AI LME.

**Status and trends:** The catch of Scyphozoan jellies in the AI increased from 2015 to 2020, with peaks in 2017 and 2020, then declined to its second lowest value over this time series in 2022 (fig. 71). The catch of scyphozoan jellies increased from 2022 to 2024 but sharply dropped to its lowest value since 2022. Scyphozoan jellies are primarily caught in the pollock fishery. The catch of structural epifauna in the AI has been variable from 2011-2025, with a peak catch in 2015 and a low catch in 2022. Sponge comprise the majority of the structural epifauna catch, followed by corals and bryozoans. These species are primarily caught in the Atka mackerel and rockfish fisheries. The catch of assorted invertebrates in the AI has been variable from 2011 to 2025, with a peak in 2013 and lows in 2011, 2014, and 2020 and 2024. Sea stars dominate the catch of assorted invertebrates and are primarily caught in the Pacific cod and halibut fisheries.

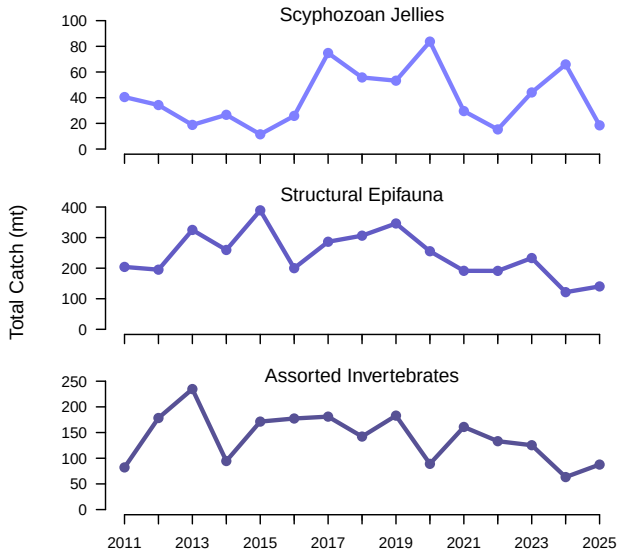



Figure 71: Total catch of non-target species (tons) in AI groundfish fisheries (2011-20254). Please note the different y-axis scales.

**Factors causing trends:** The catch of non-target species may change if fisheries change, if ecosystems change, or both. Because non-target species catch is unregulated and unintended, if there have been no large-scale changes in fishery management in a particular ecosystem, then large-scale signals in the non-target catch may indicate ecosystem changes. Alternatively, changes in allowable catch for target species, external market forces, fishing effort, or fishing gear restrictions can affect the catch of non-target species. Catch trends may be driven by changes in biomass or changes in distribution (overlap with the fishery) or both. Fluctuations in the abundance of jellyfish are influenced by a suite of biophysical factors affecting the survival, reproduction, and growth of jellies including temperature, wind-mixing, ocean currents, and prey abundance ((Purcell, 2005; Brodeur et al., 2008; Decker et al., 2023).

**Implications:** The catches of structural epifauna species and assorted invertebrates are very low compared with

[22] https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-figures-maps-boundaries-regulatory-areas-and-zones

the catches of target species. The higher catches of scyphozoan jellies in 2017–2020 may reflect interannual variation in jellyfish biomass or changes in the overlap with fisheries. Abundant jellyfish may have a negative impact on fishes as they compete with planktivorous fishes for prey resources (Purcell and Sturdevant, 2001), and additionally, jellyfish may prey upon the early life history stages (eggs and larvae) of fishes (Purcell and Arai, 2001; Robinson et al., 2014).Additionally, jellyfish may be an important prey resource for predators, including commercially important groundfishes (Brodeur et al. 2021)

## Maintaining and Restoring Fish Habitats

There are no updates in this year's report. See the contribution archive for previous indicators at: `https://www.fisheries.noaa.gov/alaska/ecosystems/ecosystem-status-reports-gulf-alaska-bering-sea-and-aleutian-islands`.

## Seabird Bycatch Estimates for Groundfish and Halibut Fisheries in the Aleutian Islands, 2016–2025

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**Last updated: September 2026**

**Description of indicator:** This report provides estimates of the numbers of seabirds caught as bycatch in commercial groundfish and halibut fisheries operating in waters off Alaska in the Aleutian Islands for 2016 through 2025. Estimates of seabird bycatch from earlier years using different methods are not included here, nor are estimates prior to the start of data collection in the Pacific halibut longline fishery (see previous Ecosystem Status Reports for these estimates). Fishing gear types included are demersal longline, pot, pelagic trawl, and non-pelagic trawl. These numbers do not apply to jig, gillnet, seine, or troll fisheries[23]

The NOAA Fisheries Alaska Regional Office Catch Accounting System (CAS) produces estimates (Cahalan et al., 2014, 2010) and provides near real-time delivery of accurate groundfish and prohibited species catch and bycatch information for inseason management decisions. These estimates are based on three sources of information: (1) data provided by NMFS-certified fishery observers deployed to vessels and floating or shoreside processing plants, (2) video review of electronically monitored (EM) fixed gear vessels, and (3) industry reports of catch and production. CAS also estimates non-target species (such as invertebrates) and seabird bycatch in the groundfish and halibut fisheries. The three data sets used by CAS are subject to change over time. Each year, an Annual Deployment Plan (ADP) describes the science driven method for deployment of observers and EM on vessels in the partial coverage component of the North Pacific Observer Program (50 CFR 679.51(a))

The ADP specifies the scientific deployment design for the partial coverage fisheries and the selection rate—the portion of trips that are sampled by observers and EM. Deployment rates can differ by gear type, location, or other factors. In the full coverage category of the North Pacific Observer Program every trip is monitored by 1 or 2 observers. In 2025, 61.6% of the demersal longline fishing trips were in the partial coverage category in the BSAI and 38.4% were in full coverage (Table 4-1; Alaska Fisheries Science Center and Alaska Regional Office 2026).

In previous versions of the Aleutian Islands ESR, estimates of seabird bycatch were summarized across the entire Aleutian Islands area (reporting areas 610 (west of 164°W), 518, 519, 541, 542, and 543)[24]. In this update, the estimates are summarized separately for the Western Aleutian Islands (part of reporting area 530 and the entirety of 543), Central Aleutian Islands (reporting areas 541 and 542 and parts of 523 and 530), and Eastern Aleutian Islands (reporting areas 518, 519, and reporting area 610 (west of 164°W)). The areas have been updated to more accurately reflect the AI ecosystem and its ecoregions and the seabird bycatch estimates are provided for each ecoregion to provide more granularity to the information.

**Status and trends:** The number of seabirds estimated to be caught incidentally in the western Aleutian Islands in 2025 (741 birds) increased 128% compared to the 2016-2024 average (325 birds, Table 2). This is due largely to increased takes of shearwater species, which increased 172% from the 2016-2024 average (272 birds).

In the central Aleutian Islands, an estimated 71 seabirds were taken as bycatch, down 87% from the 2016-2024 average (584 birds, Table 3). In 2025, reduced takes of shearwater species and Northern Fulmars (both down

[23]This report does not include estimates of seabird bycatch in fisheries using jig, gillnet, seine, or troll gear because NOAA Fisheries does not have independent observer data from these fisheries. These estimates also do not apply to State of Alaska-managed salmon, herring, shellfish (including crab), or dive fisheries.

[24]https://www.fisheries.noaa.gov/alaska/commercial-fishing/alaska-fisheries-figures-maps-boundaries-regulatory-areas-and-zones

Table 2: Estimated seabird bycatch in Western Aleutian Islands groundfish and halibut fisheries for all gear types, 2016 through 2025. Note that these numbers represent extrapolations from observed bycatch, not direct observations. See text for estimation methods.

| Species Group | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| Unidentified Albatrosses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Short-tailed Albatross | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Laysan Albatross | 11 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Black-footed Albatross | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Norther Fulmar | 55 | 12 | 20 | 75 | 109 | 2 | 0 | 0 | 46 | 0 |
| Shearwaters | 0 | 218 | 0 | 1,588 | 1 | 357 | 30 | 48 | 205 | 741 |
| Storm Petrels | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 18 | 0 | 0 |
| Gulls | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 14 | 0 |
| Kittiwakes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Murres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Puffin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Auklets | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Alcid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cormorants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified | 0 | 1 | 2 | 0 | 0 | 13 | 1 | 0 | 0 | 0 |
| Grand Total | 67 | 232 | 74 | 1,664 | 110 | 375 | 71 | 66 | 266 | 741 |

100% from the 2016-2024 averages) helped drive the lower annual estimates in this region. However, 66 storm petrels were caught in the region in 2025, an increase of 214% from the 2016-2024 average (21 birds). There were also 24 Laysan Albatross takes in the central Aleutians in 2024, which was a 73% increase over the 2014-2023 average of 13 birds. The 2024 increase in Laysan Albatross was not observed in 2025.

In the eastern Aleutian Islands, overall takes were down 63% (59 birds, 4) from the 2016-2024 average (162 birds). The reduced number of bycatch takes were largely due to low numbers of shearwater species and Northern Fulmar takes in the eastern Aleutian Islands region.

**Factors influencing observed trends:** There are many factors that may influence annual variation in bycatch rates, including seabird distribution, population trends, prey supply, and fisheries activities.

*Increase in shearwater takes*

Shearwater takes in the Aleutian Islands regions are predominantly made of up Short-tailed Shearwaters (*Puffinus tenuirostris*), a trans-Pacific species that breeds in southern Australia and migrates to the Sea of Okhotsk, Aleutian Islands, and the Chukchi Sea during their non-breeding seasons. Short-tailed Shearwaters feed on forage fishes, squid, and pelagic crustaceans, and compete for these resources with other marine predators. Short-tailed Shearwaters will also scavenge behind fishing vessels for bait and offal.

Short-tailed Shearwaters frequently return to the same regions over their lifetime to feed, but time spent foraging in those areas varies in response to local prey availability (Bool et al., 2024). Additionally, Short-tailed Shearwaters have high foraging plasticity, and can alter feeding strategies in response to prey availability, e.g. switching from natural prey to fisheries offal in areas with low abundances of natural prey. This may be especially evident in years with large runs of pink salmon (*Oncorhynchus gorbuscha*), which can induce top-down trophic cascades in the southeastern Bering Sea and Aleutian Islands (Batten et al., 2018). Past bycatch estimates have linked low bycatch of Short-tailed Shearwaters in Alaska waters - particularly in the Aleutian Islands regions - with "even" years corresponding to low pink salmon abundance, and high bycatch in "odd" years with high pink salmon abundance (Ortiz and Zador, 2021). Shearwater take increases in the Western Aleutian Islands in 2025 follow this pattern, but more analysis into other potential fleet-related and ecological factors is needed to fully understand factors behind the bycatch increase.

Table 3: Estimated seabird bycatch in Central Aleutian Islands groundfish and halibut fisheries for all gear types, 2016 through 2025. Note that these numbers represent extrapolations from observed bycatch, not direct observations. See text for estimation methods.

| Species Group | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| Unidentified Albatrosses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 |
| Short-tailed Albatross | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Laysan Albatross | 41 | 13 | 57 | 0 | 0 | 0 | 0 | 0 | 24 | 0 |
| Black-footed Albatross | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Northern Fulmar | 18 | 208 | 194 | 29 | 139 | 15 | 153 | 176 | 379 | 0 |
| Shearwaters | 184 | 838 | 132 | 329 | 1 | 1,156 | 125 | 498 | 158 | 0 |
| Storm Petrels | 0 | 0 | 0 | 177 | 0 | 0 | 8 | 5 | 0 | 66 |
| Gulls | 4 | 0 | 0 | 4 | 5 | 33 | 11 | 14 | 0 | 5 |
| Kittiwakes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Murres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Puffin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Auklets | 0 | 0 | 2 | 52 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Alcid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cormorants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| Unidentified | 0 | 1 | 2 | 0 | 0 | 13 | 1 | 0 | 0 | 0 |
| Grand Total | 246 | 1,069 | 615 | 362 | 144 | 1,230 | 314 | 708 | 570 | 71 |

Table 4: Estimated seabird bycatch in Eastern Aleutian Islands groundfish and halibut fisheries for all gear types, 2016 through 2025. Note that these numbers represent extrapolations from observed bycatch, not direct observations. See text for estimation methods.

| Species Group | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| Unidentified Albatrosses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Short-tailed Albatross | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Laysan Albatross | 6 | 5 | 16 | 0 | 0 | 0 | 0 | 3 | 1 | 1 |
| Black-footed Albatross | 25 | 38 | 1 | 3 | 0 | 3 | 2 | 2 | 14 | 0 |
| Northern Fulmar | 113 | 352 | 79 | 58 | 102 | 4 | 78 | 38 | 12 | 11 |
| Shearwaters | 8 | 20 | 8 | 152 | 5 | 3 | 1 | 0 | 30 | 29 |
| Storm Petrels | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 0 | 0 |
| Gulls | 16 | 8 | 9 | 2 | 2 | 22 | 10 | 49 | 4 | 3 |
| Kittiwakes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Murres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Puffin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Auklets | 28 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 |
| Other Alcid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cormorants | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 0 | 0 |
| Unidentified | 1 | 4 | 0 | 2 | 3 | 7 | 0 | 23 | 6 | 15 |
| Grand Total | 246 | 1,069 | 615 | 218 | 113 | 68 | 112 | 118 | 78 | 59 |

*Increase in storm petrel takes*

Storm petrel species, usually Leach's (*Hydrobates leucorhous*) or Fork-tailed Storm Petrels (*H. furcatus*), are occasionally caught as bycatch in Alaska groundfish fisheries. These species are planktivorous and also scavenge offal behind fishing vessels. While storm petrels can congregate in large groups, it is unusual to have large temporally and/or spatially condensed storm petrel bycatch events as bycatch interactions are usually due to gear entanglements (rather than storm petrel individuals attacking gear like Northern Fulmars or albatross spp.).

In the case of the 2025 storm petrel increase in the Central Aleutians, bycatch estimate data was extrapolated from a single Leach's storm petrel specimen that was recorded in a trawl sample. This particular event is an example of the challenges of extrapolating certain uncommon bycatch events in a highly complex fisheries management region.

**ESA species:**There were no takes of ESA-listed seabirds in the Aleutian Islands in 2024 or 2025 in federally-managed groundfish and halibut fisheries. Observers are trained to retain any specimens that they suspect could be ESA-listed species, even if they cannot positively identify the specimen to species in the field[25]

**Implications:** In 2025, estimated seabird bycatch in Alaska groundfish fisheries operating across all the Aleutian Island regions decreased compared to the 2016-2024 average.

It is difficult to determine how seabird bycatch estimates and trends are linked to changes in ecosystem components. Many seabirds caught in groundfish and halibut fisheries in Alaska are wide-ranging and can fly hundreds of miles per day, resulting in less restricted foraging areas. Of the species caught as bycatch in the Aleutian Islands in 2025, only Northern Fulmars, gull, and storm petrel species breed in the region. Changes in fleet dynamics also affect seabird bycatch estimates, further complicating direct links with ecosystem components.

Fisheries bycatch can also affect seabird populations directly. In Alaska, bycatch of ESA-listed species is tightly regulated, and NOAA works in conjunction with outside agencies and partners to assess and manage the risk of bycatch to unlisted seabird species, including requiring seabird bycatch mitigation tools in hook-and-line groundfish and halibut fisheries[26].

[25] urlhttps://www.fisheries.noaa.gov/resource/document/north-pacific-observer-sampling-manual
[26] https://www.fisheries.noaa.gov/alaska/bycatch/seabird-avoidance-gear-and-methods

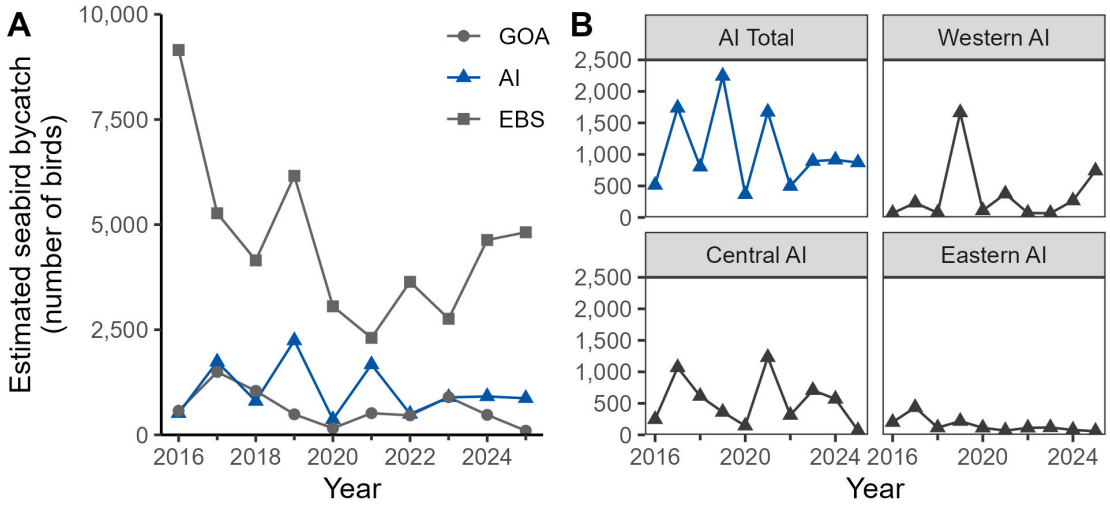



Figure 72: Total estimated seabird bycatch in Gulf of Alaska (GOA), Aleutian Islands (AI), and eastern Bering Sea (EBS) groundfish and halibut fisheries, all gear types combined, 2016 through 2025. (B) Total estimated seabird bycatch in the Aleutian Islands (AI Total), Western AI, Central AI, and Eastern AI groundfish and halibut fisheries, all gear types combined, 2016 through 2025.

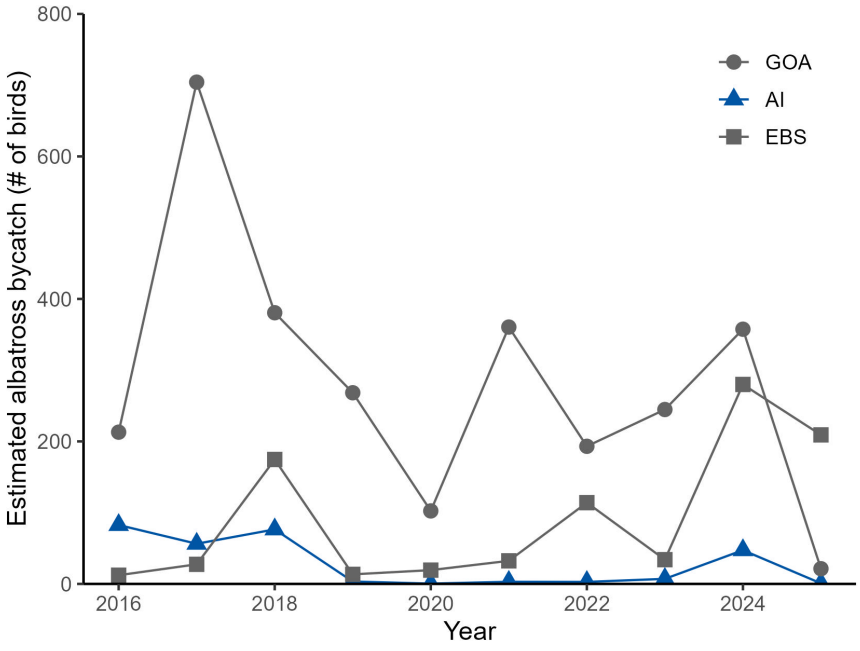



Figure 73: Total estimated albatross bycatch in Gulf of Alaska (GOA), Aleutian Islands (AI), and eastern Bering Sea (EBS) groundfish and halibut fisheries, all gear types combined, 2016 through 2025.

# Sustainability (for consumptive and non-consumptive uses)

## *Fish Stock Sustainability Index – Bering Sea/ Aleutian Islands*

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**Description of indicator:** The Fish Stock Sustainability Index (FSSI) is a performance measure for the sustainability of fish stocks selected for their importance to commercial and recreational fisheries[27]. The FSSI will increase as overfishing is ended and stocks rebuild to the level that provides maximum sustainable yield. The FSSI is calculated by awarding points for each stock based on the following rules:

1. Stock has known status determinations:
   (a) overfishing level is defined = 0.5
   (b) overfished biomass level is defined = 0.5
2. Fishing mortality rate is below the "overfishing" level defined for the stock = 1.0
3. Biomass is above the "overfished" level defined for the stock = 1.0
4. Biomass is at or above 80% of the biomass that produces maximum sustainable yield ($B_{MSY}$) = 1.0 (this point is in addition to the point awarded for being above the "overfished" level)

The maximum score for each stock is 4.

In the Alaska Region, there are 35 FSSI stocks and an overall FSSI of 140 would be achieved if every stock scored the maximum value, 4. Over time, the number of stocks included in the FSSI has changed as stocks have been added and removed from Fishery Management Plans (FMPs). To keep FSSI scores for Alaska comparable across years we report the FSSI as a percentage of the maximum possible score.

Additionally, there are 33 non-FSSI stocks in Alaska, three ecosystem component species complexes, and Pacific halibut which are managed under an international agreement. Two of the non-FSSI crab stocks are overfished but are not subject to overfishing. The Pribilof Islands blue king crab stock is in year twelve of a rebuilding plan, and the Saint Matthews Island blue king crab stock is in year six of a 26-year rebuilding plan. None of the other non-FSSI stocks are known to be subject to overfishing, are overfished, or known to be approaching an overfished condition. For more information on non-FSSI stocks see the Status of U.S. Fisheries webpage[1].

**Status and trends:** The statewide Alaska FSSI generally trended upwards from 80% in 2006 to a high of 94% in 2018, then trended downward to 88.2% in 2022. It increased incrementally to 89% in 2023 and 90.3% in 2024 and 2025. The statewide Alaska FSSI has decreased slightly to 90.0% in 2026 (Figure 74).

As of June 30, 2026, no BSAI groundfish stock or stock complex is subject to overfishing, is known to be overfished, or known to be approaching an overfished condition (Table 5). The BSAI groundfish FSSI score is 60.5 out of a maximum possible 64. The Aleutian Islands Pacific cod stock FSSI increased from 1.5 to 3 due to establishing that the stock is not overfished, is not approaching an overfished condition, and for the stock biomass being above the overfished level. The Bogoslof walleye pollock stock FSSI score is of 1.5 due to not having known overfished status or known biomass relative to their overfished levels or to BMSY. All other BSAI groundfish FSSI stocks received the maximum possible score of four points.

[27] https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates

The BSAI king and tanner crab FSSI is 17 out of a possible 20. Two points were deducted for the Bering Sea snow crab being overfished and for the stock's biomass being below 80% of $B_{MSY}$. Another point was lost for the biomass of Aleutian Islands golden king crab being less than 80% of $B_{MSY}$.

The overall BSAI FSSI score is 77.5 out of a maximum possible score of 84 (Table 5). The BSAI FSSI trended upward from 74% in 2006 to a peak of 95.5% in 2019. It dropped to 92.9% in 2020 and has generally been stable since then (Figure 75).

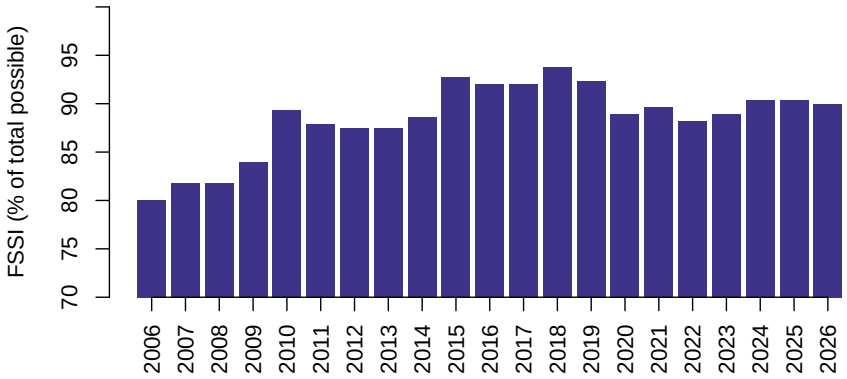



Figure 74: The trend in Alaska statewide FSSI from 2006 through 2026, as a percentage of the maximum possible FSSI. The maximum possible FSSI was 140 from 2006 to 2014, 144 from 2015 to 2019, and 140 since 2020. All scores are reported through the second quarter (June) of each year and are retrieved from the Status of U.S. Fisheries website: `https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates`.

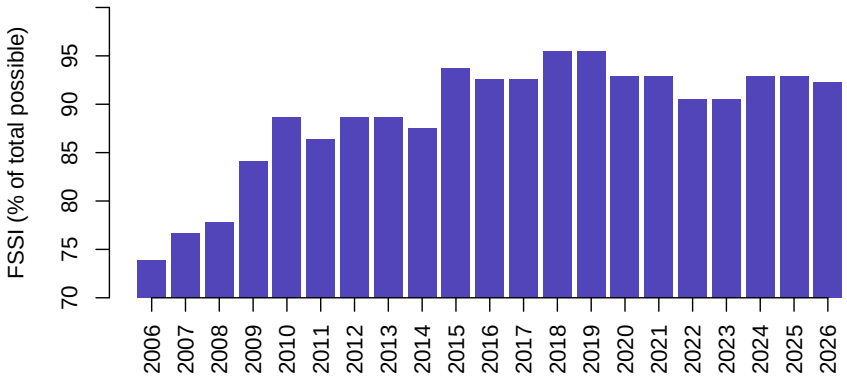



Figure 75: The trend in BSAI FSSI from 2006 through 2026 as a percentage of the maximum possible FSSI. All scores are reported through the second quarter (June) of each year and are retrieved from the Status of U.S. Fisheries website: `https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates`.

**Factors influencing observed trends:** The overall trends in the Alaska statewide FSSI and the BSAI FSSI were positive between 2006–2015, and both have remained generally flat from 2016–2026. There was a net loss of 0.5 points in the Alaska statewide FSSI due to one point each lost for Aleutian Islands golden king crab and Bering Sea snow crab and a 1.5 point gain for Aleutian Islands Pacific cod.

**Implications:** The majority of Alaska groundfish and crab fisheries appear to be sustainably managed. Bering Sea snow crab is the only FSSI groundfish or crab stock in the BSAI known to be overfished and is presently in year 3 of a 6 year rebuilding plan.

Table 5: BSAI FSSI stocks under NPFMC jurisdiction updated through June 2026 adapted from the NOAA Fishery Stock Status Updates webpage: `https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates`. *See FSSI and Non-FSSI Stock Status Table on the Fishery Stock Status Updates webpage for definition of stocks, stock complexes, and notes on rebuilding.

| Stock | Overfishing | Overfished | Approaching | Progress | B/Bmsy | FSSI Score |
|---|---|---|---|---|---|---|
| Golden king crab - Aleutian Islands* | No | No | No | NA | 1.094, 0.788 | 3 |
| Red king crab - Bristol Bay | No | No | No | NA | 1.066 | 4 |
| Red king crab - Norton Sound | No | No | No | NA | 1.097 | 4 |
| Snow crab - Bering Sea* | No | Yes | No | Year 3 of 6 year plan | 0.421 | 2 |
| Southern Tanner crab - Bering Sea | No | No | No | NA | 2.302 | 4 |
| BSAI Alaska plaice | No | No | No | NA | 1.578 | 4 |
| BSAI Atka mackerel | No | No | No | NA | 1.164 | 4 |
| BSAI Arrowtooth Flounder | No | No | No | NA | 2.583 | 4 |
| BSAI Kamchatka flounder | No | No | No | NA | 1.504 | 4 |
| BSAI Flathead Sole Complex* | No | No | No | NA | 2.077 | 4 |
| BSAI Rock Sole Complex* | No | No | No | NA | 1.612 | 4 |
| BSAI Skate Complex* | No | No | No | NA | 2.065 | 4 |
| BSAI Greenland halibut | No | No | No | NA | 1.489 | 4 |
| BSAI Northern rockfish | No | No | No | NA | 2.095 | 4 |
| BS Pacific cod | No | No | No | NA | 1.075 | 4 |
| AI Pacific cod | No | No | No | NA | 0.704 | 3 |
| BSAI Pacific Ocean perch | No | No | No | NA | 1.600 | 4 |
| Walleye pollock - Aleutian Islands | No | No | No | NA | 1.309 | 4 |
| Walleye pollock - Bogoslof | No | Unknown | Unknown | NA | not estimated | 1.5 |
| Walleye pollock - Eastern Bering Sea | No | No | No | NA | 1.373 | 4 |
| BSAI Yellowfin sole | No | No | No | NA | 1.699 | 4 |

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# Appendices

## Appendix I. History of the ESRs

Since 1995, staff at the Alaska Fisheries Science Center have prepared a separate Ecosystem Status (formerly Considerations) Report within the annual Stock Assessment and Fishery Evaluation (SAFE) report. Each new Ecosystem Status Report provides updates and new information to supplement the original report. The original 1995 report presented a compendium of general information on the Gulf of Alaska, Bering Sea, and Aleutian Island ecosystems as well as a general discussion of ecosystem-based management. The 1996 edition provided additional information on biological features of the North Pacific, and highlighted the effects of bycatch and discards on the ecosystem. The 1997 edition provided a review of ecosystem-based management literature and ongoing ecosystem research, and provided supplemental information on seabirds and marine mammals. The 1998 edition provided information on the precautionary approach, essential fish habitat, effects of fishing gear on habitat, El Niño, local knowledge, and other ecosystem information. The 1999 edition again gave updates on new trends in ecosystem-based management, essential fish habitat, research on effects of fishing gear on seafloor habitat, marine protected areas, seabirds and marine mammals, oceanographic changes in 1997/98, and local knowledge.

In 1999, a proposal came forward to enhance the Ecosystem Status Report by including more information on indicators of ecosystem status and trends and more ecosystem-based management performance measures. The purpose of this enhancement was to accomplish several goals:

1. Track ecosystem-based management efforts and their efficacy
2. Track changes in the ecosystem that are not easily incorporated into single-species assessments
3. Bring results from ecosystem research efforts to the attention of stock assessment scientists and fishery managers
4. Provide a stronger link between ecosystem research and fishery management
5. Provide an assessment of the past, present, and future role of climate and humans in influencing ecosystem status and trends

Each year since 1999, the Ecosystem Status Reports have included some new contributions and will continue to evolve as new information becomes available. Evaluation of the meaning of observed changes should be in the context of how each indicator relates to a particular ecosystem component. For example, particular oceanographic conditions, such as bottom temperature increases, might be favorable to some species but not for others. Evaluations should follow an analysis framework such as that provided in the draft Programmatic Groundfish Fishery Environmental Impact Statement that links indicators to particular effects on ecosystem components.

In 2002, stock assessment scientists began using indicators contained in this report to systematically assess ecosystem factors such as climate, predators, prey, and habitat that might affect a particular stock. Information regarding a particular fishery's catch, bycatch, and temporal/spatial distribution can be used to assess possible impacts of that fishery on the ecosystem. Indicators of concern can be highlighted within each assessment and can be used by the Groundfish Plan Teams and the Council to justify modification of allowable biological catch (ABC) recommendations or time/space allocations of catch.

We initiated a regional approach to the ESR in 2010 and presented a new ecosystem assessment for the eastern Bering Sea. In 2011, we followed the same approach and presented a new assessment for the Aleutian Islands based on a similar format to that of the eastern Bering Sea but with regional report cards for the western, central, and eastern Aleutian Islands. In 2012, we provided a preliminary ecosystem assessment on the Arctic. Our intent was to provide an overview of general Arctic ecosystem information that may form the basis for more comprehensive future Arctic ecosystem assessments. In 2015, we presented a new Gulf of Alaska report card and

assessment, which was further divided into Western and Eastern Gulf of Alaska report cards beginning in 2016. This was also the year that the previous Alaska-wide ESR was split into four separate reports, one for the Gulf of Alaska, Aleutian Islands, eastern Bering Sea, and the Arctic[28].

The eastern Bering Sea and Aleutian Islands ecosystem assessments were based on additional refinements contributed by Ecosystem Synthesis Teams. For these assessments, the teams focused on a subset of broad, community-level indicators to determine the current state and likely future trends of ecosystem productivity in the EBS and ecosystem variability in the Aleutian Islands. The teams also selected indicators that reflect trends in non-fishery apex predators and maintaining a sustainable species mix in the harvest as well as changes to catch diversity and variability. Indicators for the Gulf of Alaska report card and assessment were also selected by a team of experts, via an online survey first, then refined in an in-person workshop.

Originally, contributors to the Ecosystem Status Reports were asked to provide a description of their contributed indicator, summarize the historical trends and current status of the indicator, and identify potential factors causing those trends. Beginning in 2009, contributors were also asked to describe why the indicator is important to groundfish fishery management and implications of indicator trends. In particular, contributors were asked to briefly address implications or impacts of the observed trends on the ecosystem or ecosystem components, what the trends mean and why are they important, and how the information can be used to inform groundfish management decisions. Answers to these types of questions will help provide a "heads-up" for developing management responses and research priorities.

In 2018, a risk table framework was developed for individual stock assessments as a means of documenting concerns external to the stock assessment model, but relevant to setting the Acceptable Biological Catch (ABC) value for the current year. These concerns could be categorized as those reflecting the assessment model, the population dynamics of the stock, and environmental and ecosystem concerns—including those based on information from Ecosystem Status Reports. In the past, concerns used to justify an ABC below the maximum estimated by the assessment model were documented in an ad-hoc manner in the stock assessment report or in the minutes of the Groundfish Plan Teams or Scientific and Statistical Committee (SSC) reviews. With the risk table, formal consideration of concerns—including ecosystem—are documented and ranked, and the stock assessment author presents a recommendation for the maximum ABC as specified by the stock assessment model or a lower value. The recommended ABC (whether at maximum or lower) from the lead stock assessment author is subsequently reviewed and adjusted or accepted by the Groundfish Plan Team and the Scientific and Statistical Committee. Five risk tables were completed in 2018 as a test case. After review, the Council requested risk tables to be included in all full stock assessments in 2019. The SSC also requested a fourth category of concern to be added to the risk tables. The fishery performance category serves to represent any concerns related to the recommended ABC that can be inferred from commercial fisheries performance. Importantly, these concerns refer to indications of stock status, not economic performance.

*In Briefs* were started in 2018 for the Eastern Bering Sea, 2019 for the Gulf of Alaska, and 2020 for the Aleutian Islands. These more public-friendly succinct versions of the full ESRs have since been produced annually in tandem with the ESRs.

In 2019, risk tables were completed for all full assessments. Ecosystem scientists collaborated with stock assessment scientists to use the Ecosystem Status Reports to help inform the ecosystem concerns in the risk tables. Some ecosystem information can also be used to inform concerns related to the population dynamics of the stock. Initially, there were 4 levels of concern from no concern to extreme. In 2023 (and revised in 2024), based on a recommendation from the SSC, the levels of risk were reduced to 3: Level 1 (Normal), Level 2 (Increased concern), and Level 3 (Extreme concern). For stock assessments which include an Ecosystem and Socioeconomic Profile (ESP), the ESP is also used to inform the ecosystem risk column as well as the population dynamics and fisheries performance columns.

ESPs were initiated in 2017 (sablefish) and ESR editors began working closely with ESP teams in 2019 (starting with GOA walleye pollock). These complimentary annual status reports inform groundfish management and alignment in research that feeds these reports increases efficiency and collaboration between ecosystem and stock

[28]The Arctic Report has not been regularly produced.

assessment scientists.

Full ESRs were not produced in 2025 due to the lapse in government appropriations in the fall 2025.

This report represents much of the first three steps in Alaska's IEA: defining ecosystem goals, developing indicators, and assessing the ecosystems (Figure 76). The primary stakeholders in this case are the North Pacific Fishery Management Council. Research and development of risk analyses and management strategies is ongoing and will be referenced or included as possible.

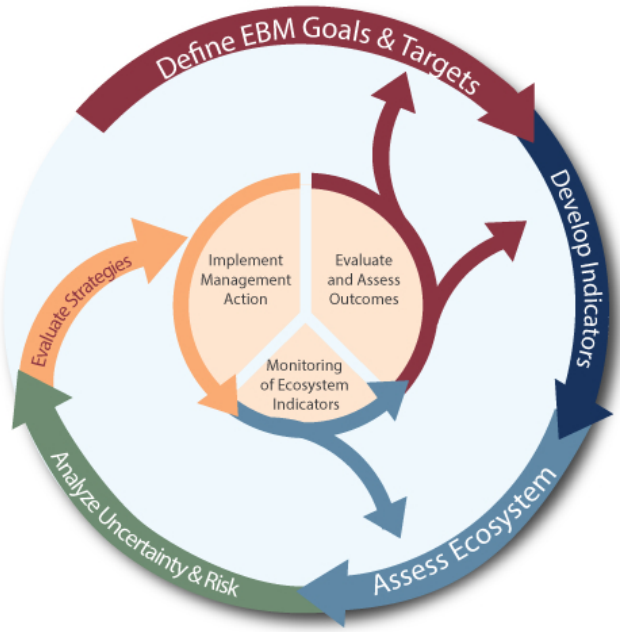



Figure 76: The IEA (integrated ecosystem assessment) process.

It was requested that contributors to the Ecosystem Status Reports provide actual time series data or make them available electronically. The Ecosystem Status Reports and data for many of the time series presented within are available online at: `https://alaskaesr.psmfc.org`. These reports and data are also available through the NOAA-wide IEA website at: `https://www.integratedecosystemassessment.noaa.gov/regions/alaska`.

Past reports and all groundfish stock assessments are available at: `https://www.fisheries.noaa.gov/alaska/population-assessments/north-pacific-groundfish-stock-assessments-and-fishery-evaluation`.

# Appendix II. Responses to Comments from the Scientific and Statistical Committee (SSC)

## December 2024-2026 and Crab Plan team 2025- 2026 meetings

**December 2024 SSC Final Report to the NPFMC**

**C-3 BSAI and C-4 GOA Ecosystem Status Reports, General Comments applicable to all three ESRs**

*The SSC thanks the authors for their responses to SSC comments, in particular the development of integrated metrics to track changes in ecosystem state, modeling approaches to help discern linkages among indices affecting individual species, and references to how conditions will affect different groundfish species depending on spawn timing, larval ecology, and varying responses to temperature changes. The SSC encourages continued efforts along these lines.*

The ESR team appreciates this line of encouragement. Examples in the 2026 ESRs include updated Ecosystem State metrics in Ferris et al. (2026), updated DSEM analyses connecting ecosystem conditions to groundfish population dynamics (Siddon et al. 2026; Domke et al. 2026).

*The SSC looks forward to the continued consideration of socioeconomic metrics that could be included in ESRs.*

The ESR team continues to engage with NOAA's Alaska Fisheries Science Center to advance the development of socioeconomic metrics that could be used in ESRs

*The SSC requests that for report cards, contributors not connect time series points in figures if there is a gap greater than the standard survey interval to avoid indicating a trend between missing years.*

Starting in 2026, ESR Report Cards no longer connect time series points when there is a gap greater than the standard survey interval. ESR editors have also requested a similar approach from contributors and will continue to update figures in future ESR editions.

*The SSC notes the value of continuing dynamic structural equation modeling (DSEM) modeling efforts, but recommends including the full model for comparison with the final most parsimonious model to clearly identify which hypothesized links were not supported by the data. The SSC appreciates the five-month lead climate forecasts.*

The 2026 EBS ESR includes two applications of DSEM modeling: "Forage Fish Dynamics in the Eastern Bering Sea" (Domke et al. 2026) and "Eastern Bering Sea Walleye Pollock Early Survival Pathways" (Siddon et al. 2026). Regarding climate forecasts, the ESRs will continue including NMME forecasts. This years the GOA ESR and AI ESR also include forecasts from MOM6 NEP10k

# Appendix III. Report Card Indicator Descriptions

The suite of indicators that form the basis for the Aleutian Islands Report Cards was selected to provide a comprehensive view of the Aleutian Island ecosystem reflecting across trophic levels from the physical environment to top predators and humans, as well as both the nearshore and offshore environments. Ideally, they would be regularly updated across all ecoregions (Western, Central and Eastern), thereby characterizing a global attribute with local conditions. Although a single suite of indicators was chosen for the entire ecosystem, not all are available or applicable in each of the three ecoregions. The final selection reflected the limitations of available data sets for the Aleutian Islands ecosystem.

1. North Pacific Index Nov-Mar mean
2. Reproductive anomalies of planktivorous least auklet and crested auklets as indicators of zooplankton productivity
3. Proportions of Ammodytes, gadids, and hexagrammids in tufted puffin chick diets
4. Apex predator and pelagic forager fish biomass indices
5. Steller sea lion non pup counts (juveniles and adults)
6. Percent of shelf <500m deep trawled
7. K-12 enrollment in Aleutian Islands schools

## *North Pacific Index (NPI) winter average (Nov-Mar):*

The North Pacific Index (Trenberth and Hurrell, 1994), the area weighted mean sea level pressure over the region was selected as the single most appropriate index for characterizing the climate forcing of the Bering Sea. The NPI is a measure of the strength of the Aleutian Low, specifically the area-weighted sea level pressure (SLP) for the region of 30° - 65°N, 160°E - 140°W. Above (below) average winter (November - March) NPI values imply a weak (strong) Aleutian Low and generally calmer (stormier) conditions.

The advantage of the NPI include its systematic relationship to the primary causes of climate variability in the Northern Hemisphere, especially the El Ni no-Southern Oscillation (ENSO) phenomenon, and to a lesser extent the Arctic Oscillation (AO). It may also respond to North Pacific SST and high-latitude snow and ice cover anomalies, but it is difficult to separate cause and effect.

The NPI also has some drawbacks: (1) it is relevant mostly to the atmospheric forcing in winter, (2) it relates mainly to the strength of the Aleutian Low rather than its position, which has also been shown to be important to the seasonal weather of the Bering Sea (Rodionov et al., 2007), and (3) it is more appropriate for the North Pacific basin as a whole than for a specific region (i.e., Bering Sea shelf).

Implications: For the Bering Sea, the strength of the Aleutian Low relates to wintertime temperatures, with a deeper low (negative SLP anomalies) associated with a greater preponderance of maritime air masses and hence warmer conditions. It has been suggested that correlations between a strong Aleutian Low and decreased seabird productivity in the Aleutian Islands may be due to decreased prey (zooplankton) availability (Bond et al., 2011). Also, stormier conditions may make seabird foraging more difficult for both surface-feeding and pursuit-diving seabird species. The winter index is the average NPI from November through March (year of January), and the anomalies are normalized by the mean (8.65) and standard deviation (2.23) for 1961-2000. Data is updated every month, indicator is updated annually.

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## Reproductive anomalies of planktivorous least auklet and crested auklets

Least auklets (*Aethia pusilla*) and crested auklets (*A. cristatella*) are small, abundant seabirds that nest in the Aleutian Islands. The USFWS stations field biologists to monitor auklet chick diets and reproductive success annually at Buldir Island and less frequently at other islands on which they occur. Both species are planktivorous and dive to capture their prey. Least auklet chick diets are mainly composed of *Neocalanus cristatus*, *N. plumchrus*, and *N. flemingeri*. Crested auklet chick diets consist of mainly Euphausiacea and *N. cristatus*. Due to the lack of time series of direct measurements of zooplankton in the Aleutian Islands, the team selected reproductive anomalies of least and crested auklets as indicators of copepod and euphausiid abundance, respectively. Reproductive anomalies were selected as the metric of interest instead of chick diets because reproductive success is an integrative indicator of ecosystem productivity and forage for planktivorous commercially-fished species. Surveys are conducted on an annual basis.

Reproductive success is defined as the ratio of number of nest sites with a fledged chick to the number of nest sites with eggs. In the Western ecoregion, reproductive success of least and crested auklets have been recorded annually at Buldir Island with the exception of 1989, 1999 and 2020. In the Central ecoregion, reproductive success was monitored annually at Kasatochi Island from 1996-2007. In 2008 a volcanic eruption covered the monitored colony in ash, disrupting breeding. This indicator was dropped in 2020 as it is unknown when auklets will nest there again and if so, whether observations will continue. Data were provided by the Alaska Maritime National Wildlife Refuge.

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## Proportions of hexagrammids, gadids, and Ammodytes in tufted puffin chick diets

Tufted puffins (*Fratercula cirrhata*) are medium-sized seabirds that nest in varying densities throughout the Aleutians. The USFWS stations field biologists to monitor puffin chick diets annually at Buldir and Aiktak Islands (Figure 5) and less frequently at other Aleutian islands on which they occur. Puffins carry multiple prey items in their bills when they return to their colonies to feed their chicks. Forage fish and squid comprise most of puffin chick diets. In the absence of direct measures of forage fish abundance, time series of percent biomass of hexagrammids, gadids, and *Ammodytes* in puffin chick meals were selected as indicators of forage fish recruitment and system-wide productivity. Surveys are conducted on an annual basis.

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## Apex predator and pelagic forager fish biomass indices

We present two foraging guilds to indicate the status and trends for fish in the Aleutian Islands: apex predators and pelagic foragers. Each is described in detail below. This guild analysis was based on the time series available as part of the NOAA summer bottom trawl survey for the Aleutian Islands (Western and Central ecoregions) and the Aleutian Islands and Gulf of Alaska combined (Eastern ecoregion). These two guilds are based on the aggregation of Aleutian species by trophic role, habitat and physiological status. The species included in each guild are listed in Table 6, see p.X for details.

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Table 6: Species included in foraging guild-based fish biomass indices for the Aleutian Islands

| Fish Apex Predators | Pelagic Fish Foragers |
|---|---|
| Pacific cod | Atka mackerel |
| Pacific halibut | Northern Rockfish |
| Arrowtooth flounder | Pacific ocean perch |
| Kamchatka flounder | Walleye pollock |
| Rougheye rockfish | |
| Blackspotted rockfish | |
| Large sculpins | |
| Skates | |

## *Steller sea lion non pup counts*

Counts of adult and juvenile Steller sea lions (*Eumetopias jubatus*) are used in the Aleutian Island ecosystem assessment to represent the status of an apex piscivorous predator whose diet consists primarily of commercially-fished species. The Steller sea lion inhabits coastal regions of the North Pacific Ocean, breeding in summer on terrestrial rookeries located from California north throughout the Gulf of Alaska, the eastern Bering Sea, the Aleutian Islands, Kamchatka Peninsula, Sea of Okhotsk, and the Kuril Islands (NMFS, 2010). The Steller sea lion is the world's largest member of the Otariidae family of pinnipeds. On average, Steller sea lions consume 6-10% of their body weight per day, but during lactation, energy intake by adult females may increase by as much as 3-fold (Keyes, 1968; Winship et al., 2002; Williams, 2005). Steller sea lions are generalist predators and consume a wide variety of fish and cephalopods in habitats ranging from nearshore demersal to offshore epi-pelagic, with local diets reflecting the species composition of the local fish community (Pitcher and Fay, 1982; Riemer and Brown, 1997; Sinclair and Zeppelin, 2002; Waite and Burkanov, 2006; Trites et al., 2007; McKenzie and Wynne, 2008; Fritz and Stinchcomb, 2005). In the Aleutian Islands, the diet consists largely of Atka mackerel, followed by salmon, cephalopods, Pacific cod, sculpins and walleye pollock (Sinclair and Zeppelin, 2002). Unlike phocid pinnipeds, otariids do not have large blubber (energy) stores, and as a consequence, require reliable access to predictable, local prey aggregations to thrive (Williams, 2005; Sigler et al., 2009).

Status and trend of Steller sea lion populations in Alaska are assessed using aerial photographic surveys of a series of 'trend' terrestrial haul-outs and rookeries that have been consistently surveyed each summer breeding season, when the proportion of animals hauled out is the highest during the year (Sease and York, 2003). Since 2004, NMFS has used high-resolution vertical photography (computer-controlled camera mounted in the belly of the plane) in its sea lion surveys in Alaska. This replaced the oblique, hand-held photographic techniques used from the first surveys in the 1960s and 1970s through 2002. Counts from vertical high resolution photographs were found to be 3.6% higher than those from oblique photos, necessitating the use of a correction factor to correctly compare recent counts with the rest of the time series (Fritz and Stinchcomb, 2005). Trend sites include the vast majority (>90%) of animals observed in each survey. Adults and juvenile (non-pup) numbers used for population trend assessment are sums of counts at trend sites within sub-areas or across the range of the western DPS in Alaska (NMFS, 2010). Replicate surveys conducted in the summers of 1992 and 1994 indicated that sub-area trend site counts of non-pups are stable within each breeding season (coefficients of variation of ∼5%; NMFS, unpublished data).

In our Aleutian Island ecosystem assessment, estimated counts of adult and juvenile Steller sea lions at trend sites are used to indicate the 'health' of apex piscivores whose diet consists primarily of commercially-fished species. The estimated counts are updated annually. The survey sites used in the assessment are:

- Western (172-177°E; 10 sites in the Near Island group and Buldir west of Kiska),
- Central (177°E to ∼170°W; 62 sites in the Rat, Delarof, and Andreanof Island groups, plus the Islands of Four Mountains), and

- Eastern ecoregions (163-170°W; 30 sites in the Fox and Krenitzin Islands, on Unimak Island, and on and near Amak Island in the southeastern Bering Sea)

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## *Habitat disturbance from trawls*

This indicator uses output from the Fishing Effects (FE) model to estimate the habitat reduction of geological and biological features over the Bering Sea domain, utilizing spatially-explicit VMS data. The effects are cumulative, incorporating both estimated recovery time and disturbance. The time series for this indicator has been available since 2003, when widespread VMS data became available. The monthly value in December is used as an annual indicator, which is updated annually.

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## *K-12 enrollment in Aleutian Islands schools*

The number of children enrolled in schools was selected as an indicator of vibrant, sustainable communities in the Aleutian Islands ecosystem. Community residents are closely tied to the ecosystem through sense of place and daily experience and activity. Enrollment statistics for kindergarten through twelfth (K-12) grades by school and region were compiled for the years 1996 through 2014 (`http://www.eed.state.ak.us/stats/`). School enrollment numbers fluctuate widely and serve to highlight the difficulties in maintaining sustainable communities within the Aleutian Islands ecosystem. Enrollment statistics are updated annually. This indicator is no longer included as of 2026.

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# Appendix IV. Methods for the Report Card Indicators

For each plot, the mean (green dashed line) and ±1 standard deviation (SD; green solid lines) are shown as calculated for the entire time series. Time periods for which the time series was outside of this ±1 SD range are shown in yellow (for high values) and blue (for low values).

The shaded green window shows the most recent 5 years prior to the date of the current report. The symbols on the right side of the graph are all calculated from data inside this 5-year moving window (maximum of 5 data points). The first symbol represents the "2015–2019 Mean" as follows: '+ or -' if the recent mean is outside of the ±1 SD long-term range, '.' if the recent mean is within this long-term range, or 'x' if there are fewer than 2 data points in the moving window. The symbol choice does not take into account statistical significance of the difference between the recent mean and long-term range. The second symbol represents the "2015–2019 Trend" as follows: if the magnitude of the linear slope of the recent trend is greater than 1 SD/time window (a linear trend of >1 SD in 5 years), then a directional arrow is shown in the direction of the trend (up or down), if the change is <1 SD in 5 years, then a double horizontal arrow is shown, or 'x' if there are fewer than 3 data points in the moving window. Again, the statistical significance of the recent trend is not taken into account in the plotting.

The intention of the figures is to flag ecosystem features and the magnitude of fluctuations within a generalized "fisheries management" time frame (i.e., trends that, if continued linearly, would go from the mean to ±1 SD from the mean within 5 years or less) for further consideration, rather than serving as a full statistical analysis of recent patterns.