

# 2023 Aleutian Islands Ecosystem Status Report:

## IN BRIEF

### Current Conditions

- Relatively stormy during the winter of 2022-23 and summer of 2023.
- Warmest winter sea surface temperatures since 1900
- Cooler (but still above average) spring-summer conditions.
- The upper mixed layer extended deeper than during 2022, which potentially impacted the vertical distribution and availability of prey throughout the water column.
- Wind patterns and low eddy kinetic energy suggest that there was lower transport of heat and nutrients through the passes.
- Seabird reproductive success in the eastern Aleutian Islands was at or above average, indicating wide availability of zooplankton and fish prey. Seabird reproductive success was mixed in the western Aleutian Islands.
- Eastern Kamchatka pink salmon abundance was the third highest on record.
- Paralytic shellfish toxins in blue mussels sampled in June were 47 times above the legal limit.

### Multi-year Patterns observed across the Aleutian Islands continued in 2023:

**Persistent warm conditions since 2013 14.** Water column temperatures have been above-average for the last decade, consistent with warmer mean annual sea surface temperatures across the North Pacific as a whole. These warm conditions suggest that there has been lower productivity across the ecosystem. Spring phytoplankton abundance was below the 1998-2022 average in 2023, which appears to fit a declining trend in abundance over time. In many cases, warmer temperatures lead to increased fish metabolism, faster growth rates for zooplankton and larvae, and shorter incubation periods for fish eggs

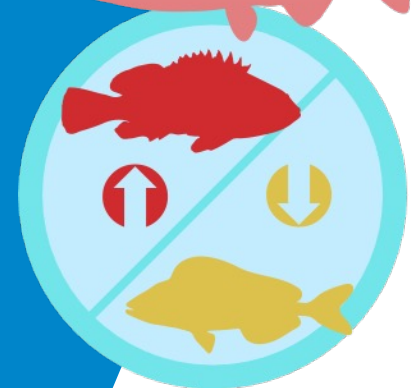
#### Increased abundance of Eastern Kamchatka pink salmon in odd numbered years.

Their abundance during even-numbered years has also increased, although numbers remain much lower compared to the odd-numbered years. Several other ecosystem indicators show a biennial pattern. For example, satellite chl-a is lower in even years, and tufted puffin chick hatching dates are earlier in odd years, although tufted puffin reproductive success does not vary by year the same way.

#### Rockfish continue to be the most abundant pelagic foragers.

Stock assessment estimates show that rockfish, which include Pacific Ocean perch and northern rockfish, are the dominant groundfish pelagic foragers. This is a change from the early 1990s, when Atka mackerel and pollock were dominant. Longer-lived species such as rockfish help to increase the stability of the food web because their numbers don't vary with environmental conditions as much as shorter-lived species. However, this also means there is a lower availability of Atka mackerel and pollock which are common prey for predators in the region. Rockfish in the Aleutians are not a common prey in the region. Analysis of Pacific cod diets in this region reflects these trends.

See Noteworthy for Pacific cod diets.



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## Regional Highlights

**The western Aleutians** were under a moderate heat wave throughout winter before cooling in spring and summer. Heatwave conditions have largely persisted since August. **Eddy kinetic energy was below average**, suggesting that there was **lower transport of heat and nutrients through the passes**. There was **lower phytoplankton biomass across the chain**.

The reproductive success of least, whiskered and crested auklets, planktivorous seabirds at Buldir Island was average, but was below average for parakeet auklets. This suggests that **overall zooplankton availability** was sufficient to support seabird reproductive success in 2023 and potentially other plankton-eating commercial groundfish species. However, conditions were not as good as in 2022 when reproductive success was average to above the long-term average for all seabirds.

Reproductive success of fish-eating seabirds was mixed for both

divers and surface-foragers. Tufted and horned puffins had above-average and average reproductive success respectively in 2023, signaling **potentially favorable conditions for fish foragers**. They fed chicks mostly **squid** (63% by weight) and Pacific saury (18%), while horned puffins fed chicks mostly Atka mackerel (43%) and **squid** (30%). In contrast, the reproductive success of fork-tailed storm-petrels, kittiwakes, and thick-billed murres was below average.

**The central Aleutians** were also under a moderate marine heat wave throughout winter. These conditions resumed in fall. **Eddy kinetic energy during 2023 was generally below the 1993-2022 average**. This indicates a **potentially below-average flux of nutrients and heat across the passes** from the Pacific Ocean to the Bering Sea. Phytoplankton biomass, as represented by chl-a concentration, was also generally below the long-term average.

**School enrollment continued a decreasing trend in the 2022-2023** school year. This trend was driven by decreased enrollment in Adak, where school enrollment decreased from 13 to 5 students. Alaska schools need at least 10 students minimum for schools to qualify for state funding. Amid rising operating costs and flat funding in general, small schools like those at Adak and Atka are at increasing risk of closure. Thus, decreasing enrollment impacts family stability in those communities.

**In the eastern Aleutians** as in past years, sea surface temperatures during 2023 were not as high during winter as in the western and central Aleutians. **Winds suppressing northward flow** and **eddy kinetic energy was below average**, suggesting that there was **lower transport of heat and nutrients through Unimak Pass**. Fish-eating seabirds, such as murres, puffins and gulls, had above-average reproductive success. **Capelin comprised 86% (by weight)**

**of the forage fish in tufted puffin check meals**. Storm-petrels, which feed on a mix of invertebrates and zooplankton, had average to above-average reproductive success. **The continued overall seabird reproductive success** suggests that there was **enough fish and invertebrate prey** to support seabird chick-rearing, which may indicate that there were favorable foraging conditions for some species of groundfish.

**Paralytic shellfish toxins in blue mussels** sampled in June at Sand Point, Unalaska, False Point and Akutan **were 47 times above the regulatory limit**. **School enrollment fell for the third year in a row** to the lowest point in the time series. Enrollment at Unalaska Elementary school peaked in 2019-2020 at 238 students but currently has 176 students. As is the case in the central Aleutians, decreasing enrollment impacts family stability in those communities.



### Changes in large scale sea surface temperature patterns

There was a thermal regime shift in North Pacific annual mean sea surface temperature in 2013/2014, when temperatures increased abruptly, similar to what occurred in 1977. The thermal regime shift in 2013-2014 aligns with the increased regional satellite SST temperatures for the Aleutian Islands and is reflected in the increased number of days under marine heatwave conditions. Mean bottom temperatures observed during the AFSC Aleutian Islands bottom trawl survey as well as midwater temperatures from the longline survey also increased beginning in 2014. These changes can make indices like the Pacific Decadal Oscillation (PDO), which have provided good insights into spatial patterns in the past, less reliable for capturing current spatial patterns. As a result, indicators like the PDO may not be as useful in the future as their relationships with physical and ecological processes may vary as the climate continues to change.

### Key temperature ranges for commercial species in the Aleutian Islands

Vulnerability to persistent warm conditions in the Aleutian Islands is likely to differ among groundfish species. Pacific cod eggs may be the most vulnerable as they have a narrow optimal temperature range for hatching success above 20% (3–6°C); spawning occurs in January to May. The second most vulnerable species is Atka mackerel, as their nests in the Aleutians which have been observed at a wide temperature range (3.9–10.7 °C), but as shallow as 34 m depth, shallower than the bottom trawl survey boats can go. Atka mackerel spawn from July to October and temperatures above 15 °C can be lethal to eggs or unfavorable for embryonic development. Pollock eggs have above 20% hatching success within a wide temperature range of temperatures (-1–12°C), and they spawn from March to June. Long-lived marine species such as Pacific ocean perch may be relatively more resilient to environmental variability because they are capable of adapting to and surviving varying environmental conditions during their first year of life. Thus, they are able to maintain a wide genetic variability suitable for many different environmental conditions. Marine heat waves are defined by temperatures at the sea surface, and bottom temperature data, closer to where groundfish spawn, are not readily available year round, so it is hard to assess how groundfish spawning is impacted during marine heatwaves. The maximum summer bottom temperature recorded to date is 6.6°C, and in certain locations, winter and summer temperatures can be very similar.

### Changes in Pacific cod diet

The Alaska Fisheries Science Center Trophic Interactions Lab routinely analyzes stomach samples collected during the biennial bottom trawl survey for the Aleutian Islands. A preliminary analysis of Pacific cod diets (for fish between 30–85 cm, from 1991–2022) shows invertebrates such as shrimp are now more prevalent in their diets than fish, which were more prevalent in the past. The trend may be partially influenced by the decline in the Atka mackerel stock. However the trend could also reflect changes in the availability of all prey, as there is an overall decline in prey consumed as a proportion of predator weight. The change in the ratio of fish to invertebrates in cod diets over time is seen across the Aleutians west of Samalga Pass but is not evident to the east. It is unclear whether other groundfish predators or marine mammals have experienced similar changes in their diets over the same time period. However, several of these species, like halibut, have been decreasing in abundance in past years, which could indicate less favorable foraging conditions for them.

### Management Uses

Ecosystem information was formally considered in seven full assessments for Bering Sea/Aleutian Islands stocks plus the Alaska-wide sablefish stock in 2023. In the Aleutian Islands, ecosystem dynamics remained at a risk level 2 (out of 3 levels) for Pacific cod, noting concerns based on multiple indicators that showed consistent adverse signals for the stock such as a less fish in their diets, lower overall quality of prey, and warm winter temperatures? coinciding with their spawning season. The stock assessment authors had recommended an 8% reduction from the maximum acceptable biological catch (max ABC). However, due to concerning environmental conditions, the SSC recommended a reduction of 10% from the max ABC.

In the Bering Sea, ecosystem dynamics for both walleye pollock and yellowfin sole were also categorized at level 2, (see EBS In Brief for details). Several additional BSAI stocks that did not have full assessments in 2023 had recommended reductions from max ABC for 2024 based on concerns noted in 2022. Northern rocksole, black-spotted/rougeye rockfish, and sharks were reduced from max ABC, but concerns were not related to ecosystem dynamics.

For the remaining four stocks, no ecosystem-related reductions from max ABC were recommended for 2024. Precautionary measures already incorporated into setting catch levels were considered sufficient to address uncertainty about ecosystem impacts on stocks.

**Reference:** Ortiz, I. and Zador, S., 2023. Ecosystem Status Report 2023: Aleutian Islands, Stock Assessment and Fishery Evaluation Report. North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, AK 99501.

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*More information on these and other topics can be found on the Ecosystem Status Report website.*

Links to full reports from Large Marine Ecosystems are available here: <https://www.fisheries.noaa.gov/alaska/ecosystems/ecosystem-statusreports-gulf-alaska-bering-sea-and-aleutian-islands>



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