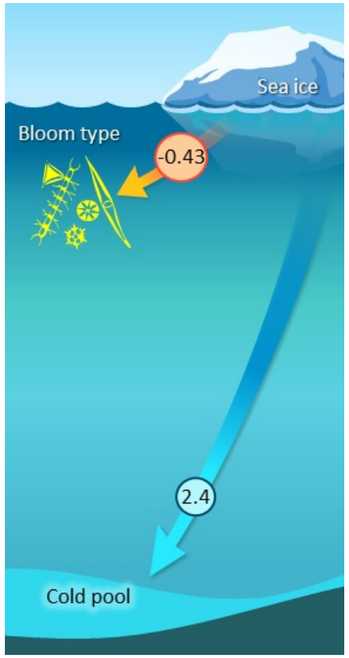
Noteworthy Topic

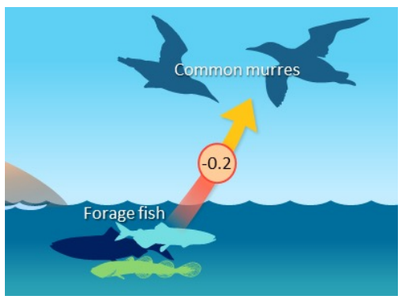
Quantifying Linkages Among Report Card Indicators

Exploring linkages among Report Card indicators illustrates how changes in one variable might affect another. A new approach called a dynamic structural equation model (DSEM) was applied to the Report Card indicators.

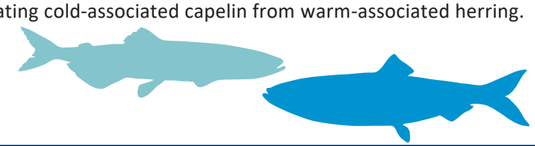


This model allows us to better understand connections between different indicators and the factors that may be affecting increases and decreases in their abundance. The model also allows us to estimate missing information, lags in indicator responses to ecosystem changes and strengths in the connections between indicators. The model also can project next year values and could be used as a tool alongside the Spring PEEC (Preview of Ecosystem and Economic Conditions) meeting to identify emergent trends and potential noteworthy topics to track through summer surveys and research efforts.

The DSEM fitted to the Report Card time-series data resulted in some linkages that are in-line with prior expectations. For example, increased sea ice drives an increase in cold pool extent and a decrease in the proportion of open water blooms. On the other hand, some linkages were not consistent with prior expectations. For example, increased forage fish is estimated to decrease the reproductive success of fish-eating seabirds.



DSEM provides an avenue to combine a conceptual model for ecosystem function with time-series indicators that are compiled in the ESRs, while compensating for (and interpolating) missing data. Future research during 2024 could address some estimated linkages that are currently inconsistent with widely understood relationships. For example, separating cold-associated capelin from warm-associated herring.



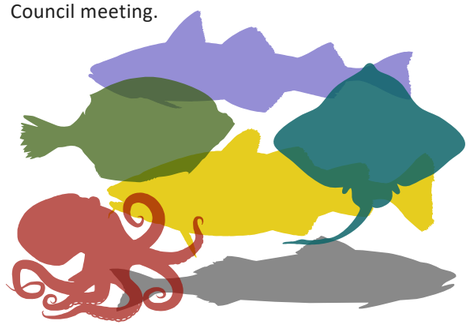
Future Projections

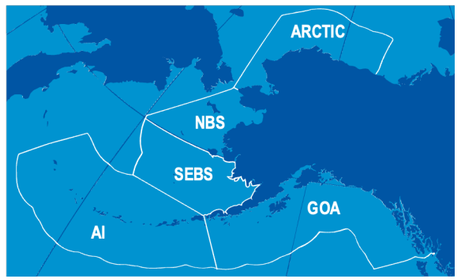
Broad-scale climate indices in 2023 reflected a transition from La Niña conditions to developing El Niño conditions in the tropical Pacific. The National Multi-Model Ensemble (NMME) projections of sea surface temperature over the eastern Bering Sea shelf show temperatures to be slightly elevated (anomalies of <+1°C) in 2024.

Management Uses

In 2023, ecosystem information was formally considered in five stock assessments for Bering Sea/Aleutian Islands groundfish stocks as well as the Alaska-wide sablefish stock assessment.

This section will be completed following the December 2023 North Pacific Fishery Management Council meeting.





Reference: Siddon, E. 2023. Ecosystem Status Report 2023: Eastern Bering Sea, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West 3rd Ave., Suite 400, Anchorage, Alaska 99501.

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

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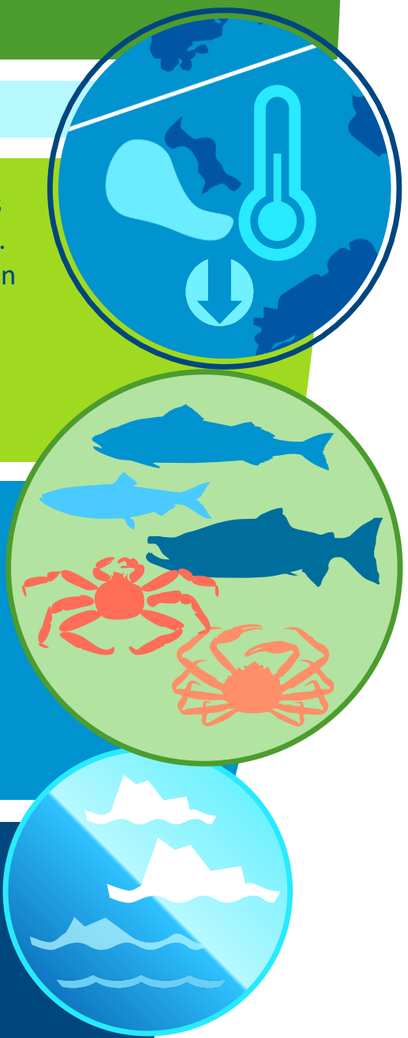
2023 Eastern Bering Sea Ecosystem Status Report:

IN BRIEF

Current Conditions

The eastern Bering Sea has experienced multi-year periods of warm or cold conditions of varying durations since 2000. The recent warm stanza (2014–2021) was unprecedented in magnitude and duration with the near-absence of sea ice during two winters (2017/18 and 2018/19). The following summers (2018 and 2019) had dramatically reduced cold pool extent (areas of cold bottom waters).



Groundfish and crab stocks shifted their distribution in response to changes in sea ice and cold pool extent. Some stocks experienced increased recruitment during the warm stanza: sablefish, Togiak herring, and Bristol Bay sockeye salmon. Conversely, some stocks experienced declines: snow crab and Bristol Bay red king crab, and multiple Western Alaska salmon runs.

Since 2021 conditions have cooled. Ocean temperatures and cold pool extent were near historical average in 2023, though the cold pool was significantly smaller than the large extents that were common prior to 2010. More broadly, the North Pacific is also undergoing a transition from three consecutive years of La Niña conditions to predicted El Niño conditions by early 2024. Marine life, like zooplankton and fish, have lagged in their expected response to these cooler conditions. Ecologically, the eastern Bering Sea remained in a transitional state in 2023.

NOAA FISHERIES
Alaska Fisheries Science Center

Ecosystem Impacts

The southeastern and northern Bering Sea (divided at 60°N) have different oceanographic and zoogeographic characteristics. An assessment of the ecosystem response to the recent transitional state (since 2021) and current 2023 status in the ecoregions is provided.

Southeastern Bering Sea

Winter 2022/2023 was on the warmer side while summer 2023 was cooler. Sea-ice advance in the winter was delayed due to warmer conditions, but spring ice melt-out occurred near the historical date. **Sea ice** did eventually reach as far south as St. Paul Island in 2023, providing a source of freshwater as ice melted at the ice edge, reversing a trend of **increasing salinity** during the recent warm stanza.

Chlorophyll-a, the base of the food chain, has generally been decreasing and 2023 was among the lowest levels across the shelf. Meanwhile, **coccolithophore blooms** (generally not considered a positive sign of ecosystem productivity) have been more prominent since 2017 with 2023 being the largest bloom. In spring 2023, a moderate amount of **small copepods** were available, but **large copepods and euphausiids** were scarce. In fall, the moderate abundance of small copepods continued, and the abundance of large copepods and euphausiids remained low, but increased from south to north. The abundance of **jellyfish** - potential competitors for zooplankton prey - was average in 2023, representing no significant change in competitive pressure.

The effects of water temperature and prey availability are evident in the indicators of pelagic fish condition, which were mixed in 2023. **Age-0 pollock**, the numerically dominant forage fish, as well as juvenile and adult pollock showed continued declines in fish condition in 2023. Togiak herring and Bristol Bay sockeye salmon biomass remained high. **Seabird reproductive success** was mixed with birds on St. George Island having higher success than birds on St. Paul Island.

The benthic habitat showed mixed responses following the recent warm stanza. There were continued declines in habitat disturbance by fishing gear. The biomass of some epifauna (e.g., anemones and sea whips) increased in 2022 and 2023 yet sponges have shown a steady decline since 2015. **Sea stars and brittle stars** continued to have high abundance and biomass while several **crab stocks** showed declines in 2023. Flatfish, like yellowfin sole and flathead sole, that feed on benthic infauna have continued to decrease in abundance, suggesting potential prey limitations. In fact, fish condition declined from 2022 to 2023 for **several flatfish species**: arrowtooth flounder, northern rock sole, yellowfin sole, flathead sole, and Alaska plaice.

Northern Bering Sea

Ecosystem-wide impacts of the loss of sea ice have been observed in the northern Bering Sea (NBS). Northward shifts in the distribution of groundfish species and concerns about the food web dynamics and carrying capacity have existed since 2018. However, since 2021, the NBS ecosystem has also been transitioning to more average conditions. Sea surface temperatures have cooled. Marine life has experienced lower metabolic stress.

Chlorophyll-a has been decreasing over the northern shelf, and 2023 was among the lowest levels. In fall, small copepods were present and increased in abundance from south to north. Hot spots of large copepods and **euphausiids** were observed around St. Lawrence Island. The abundance of **jellyfish** increased over the NBS shelf.

Integrated indicators of the pelagic environment were mixed for the NBS in 2023. Adult pollock condition was the highest observed during the bottom trawl survey since 2017, yet juvenile pollock condition has decreased since 2021. Observations from St. Lawrence Island indicated that seabirds, like **crested auklets,** did well in 2023. Western Alaska **salmon** runs have experienced precipitous declines in recent years. This is largely attributed to ecosystem conditions experienced in both the freshwater and marine residency phases. However, slight increases were observed in juvenile Chinook and chum salmon indices in 2023.

Fewer metrics of benthic habitat condition are currently available for the NBS. Those available for 2023 were mixed, but largely showed declines. Trends in anemones show low biomass in 2023. Sponges are more variable and biomass was moderate in 2023. Indirect measures of benthic productivity show continued low biomass of eelpouts in 2023 and continued declining trend in poachers since 2017. The condition of **yellowfin sole** decreased to its lowest level and Alaska plaice condition remained just below the time series average in 2023.

The prevalence of **harmful algal blooms** (HABs) in marine food webs of the NBS are important indicators of ecosystem health and of potential threats to wildlife and human health. Recent oceanographic changes have made conditions more favorable for HAB species. Dedicated research has documented HABs in the Bering Strait and this trend will continue to be monitored.

What do the indicators tell us this year?