

Ecosystem Status Report: Eastern Bering Sea 2023

Elizabeth Siddon



North Pacific Fishery Management Council
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Outline

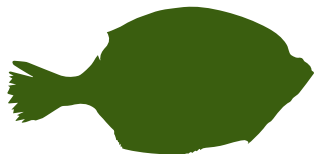
- Risk table scores
- Noteworthy Topic
- Ecosystem assessment
 - Southeastern Bering Sea
 - Northern Bering Sea

Ecosystem Considerations for Risk Tables



Pollock
Level 2

Multiple indicators of primary and secondary productivity show adverse signals borne out in continued declining trends in juvenile and adult fish condition.



Yellowfin sole
Level 2

Multiple indicators across the same trophic level are present in the consistent declines in fish condition for flatfishes. In addition, there are bottom-up concerns for prey availability.



Pacific cod
+ESP
Level 1

ESR + ESP indicators together suggest no increased concern for the stock at this time.



Sablefish
+ESP
Level 1

ESR + ESP indicators together suggest no increased concern for the stock at this time. *Note:* impact of juvenile sablefish in the EBS ecosystem remains unknown.



Skates
Level 1

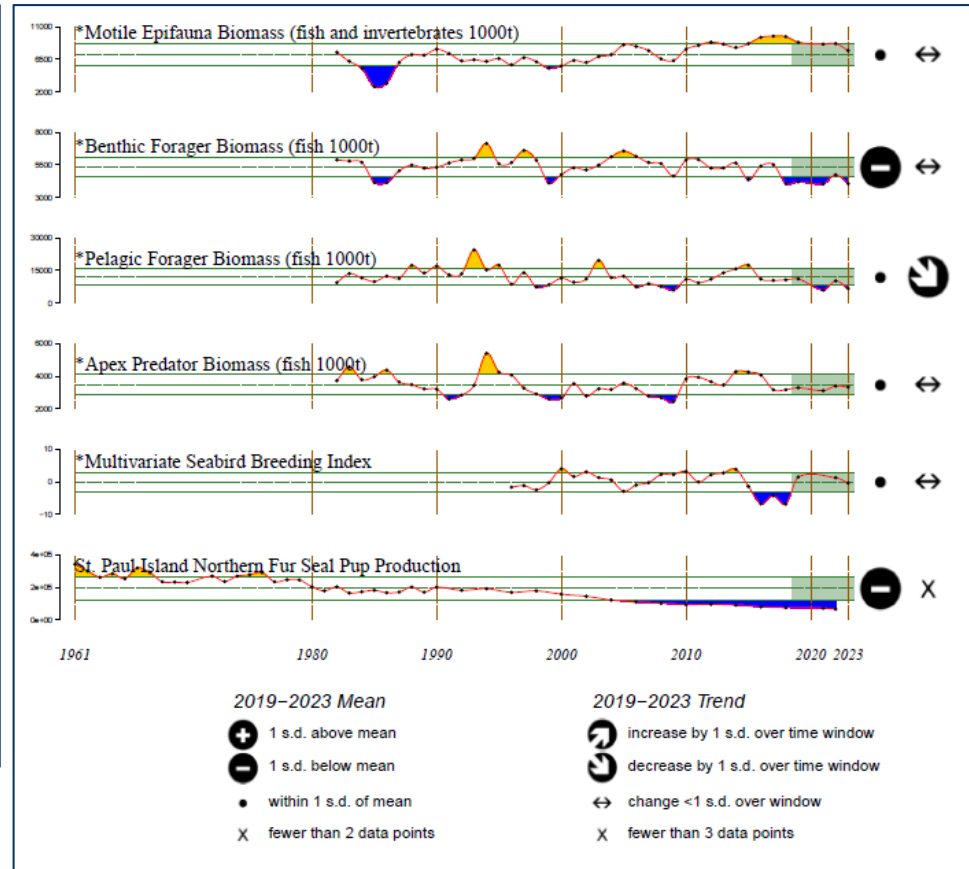
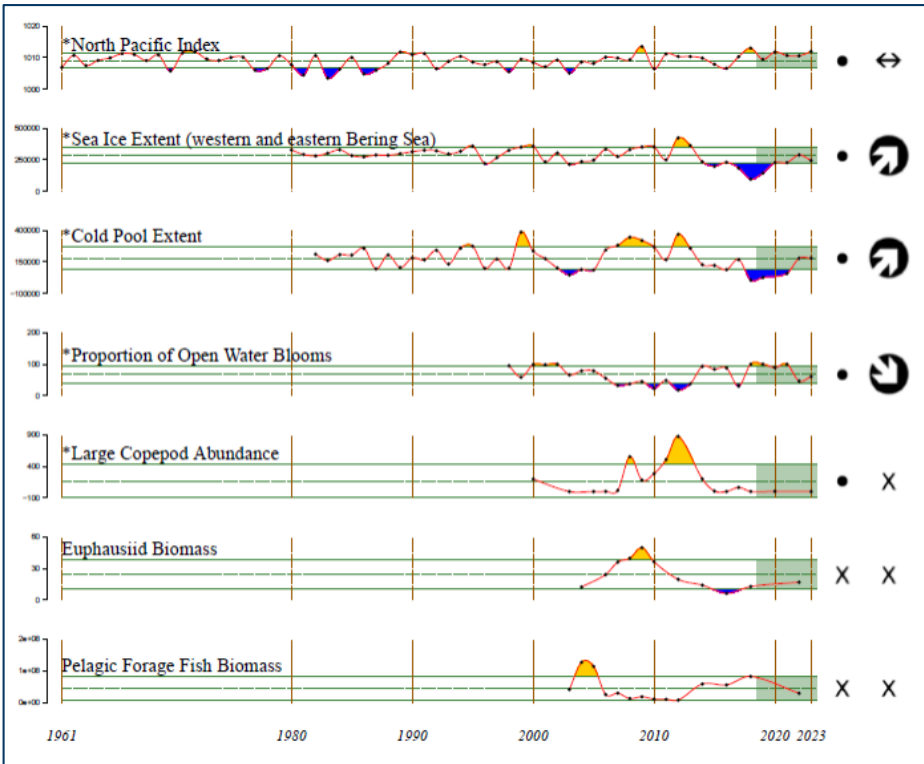
Proper evaluation of risk is difficult for a data-limited stock. However, available data suggests no increased concern for the stock at this time.



Octopus
Level 1

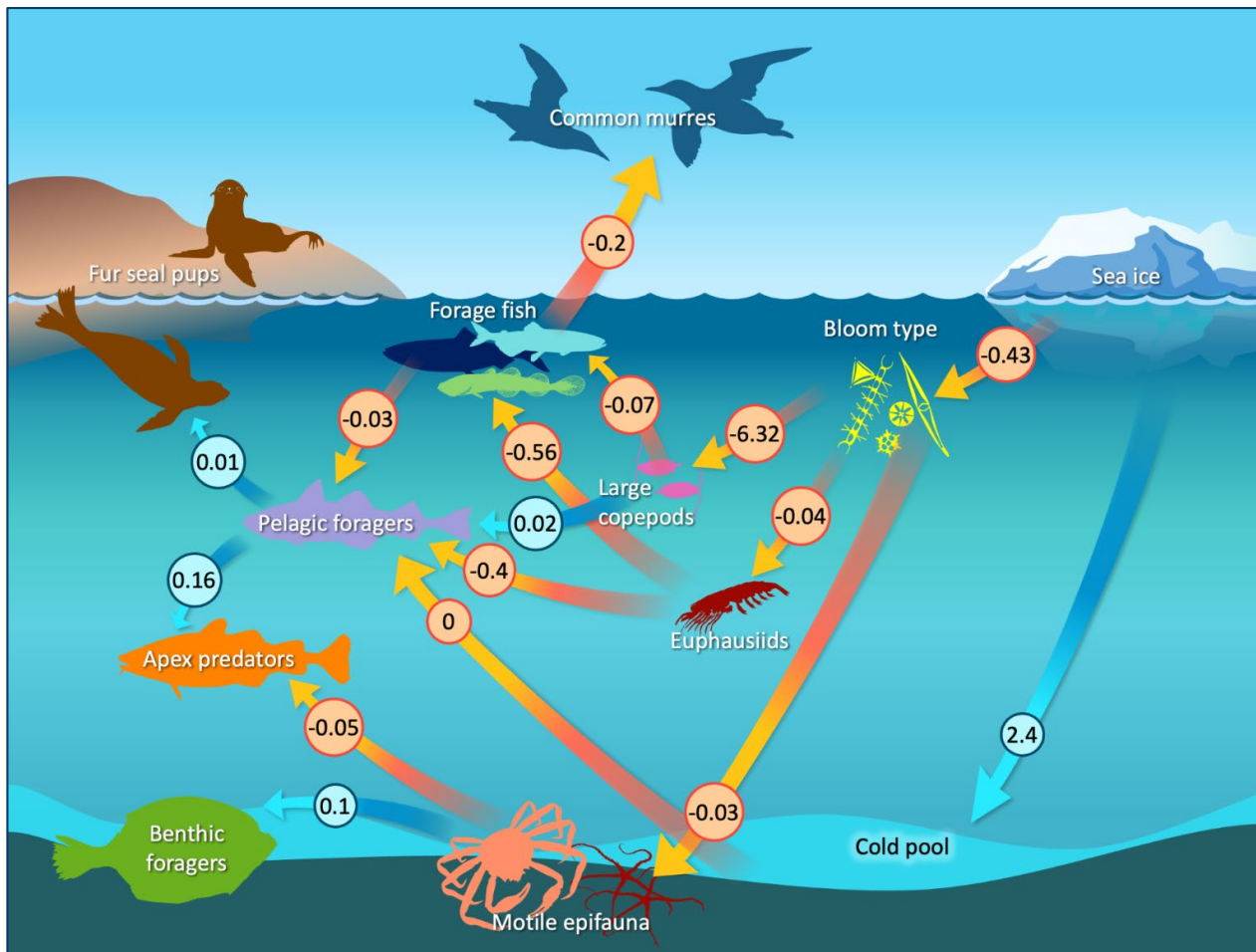
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Quantifying Linkages Among Report Card Indicators

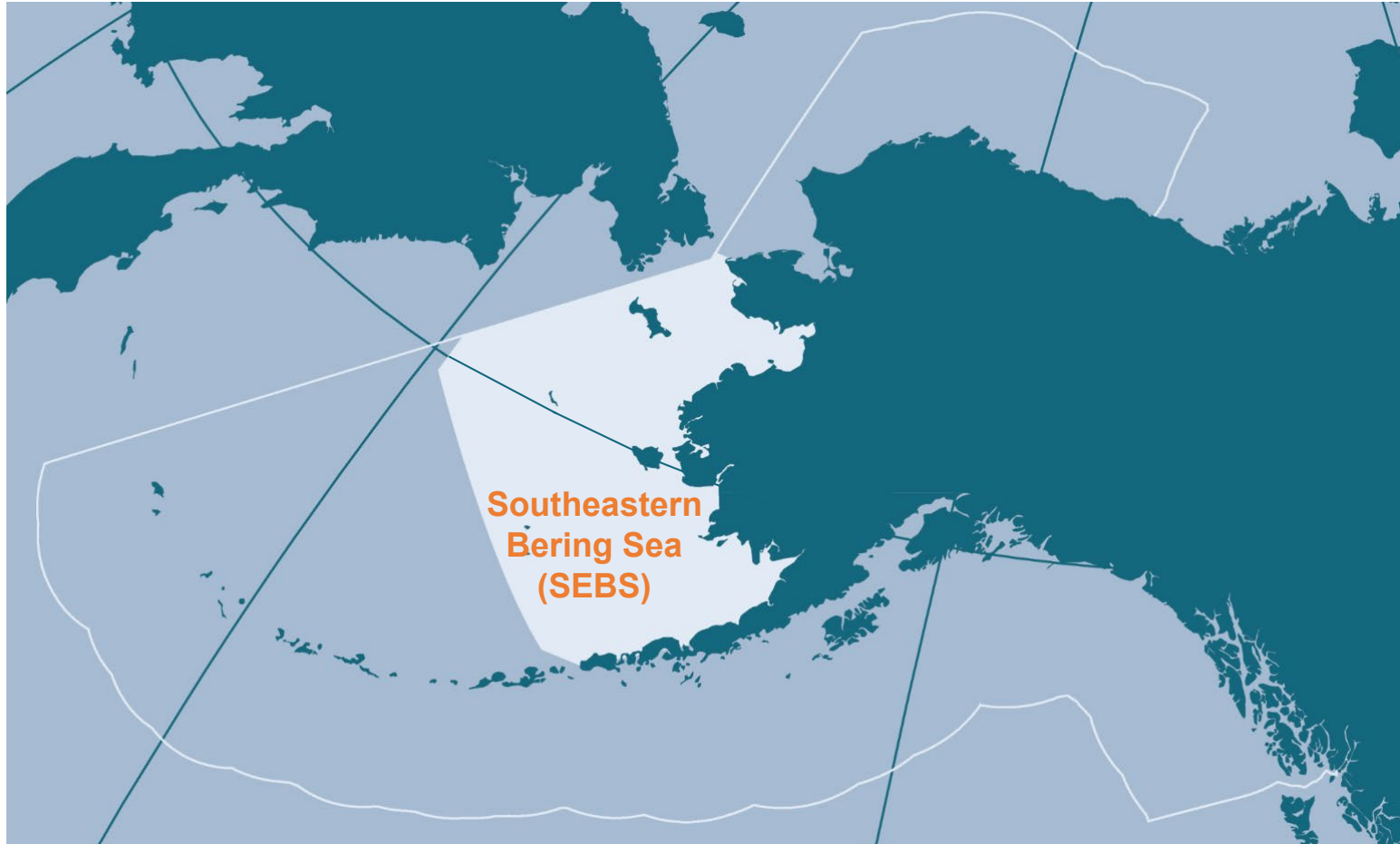


Thorson & Siddon with contributions from Barnett, Kimmel, Nielsen, Ressler, Rohan, Rustand, Thoman, Towell, Whitehouse, and Yasumiishi and methods development with Andrews and Large

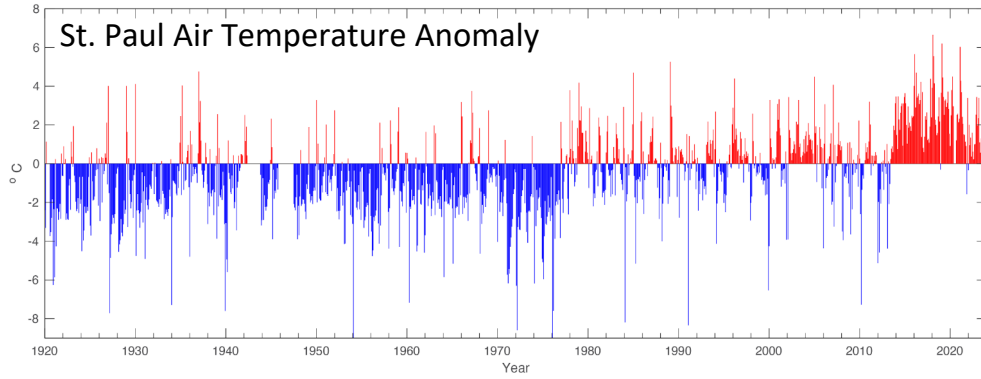
Quantifying Linkages Among Report Card Indicators



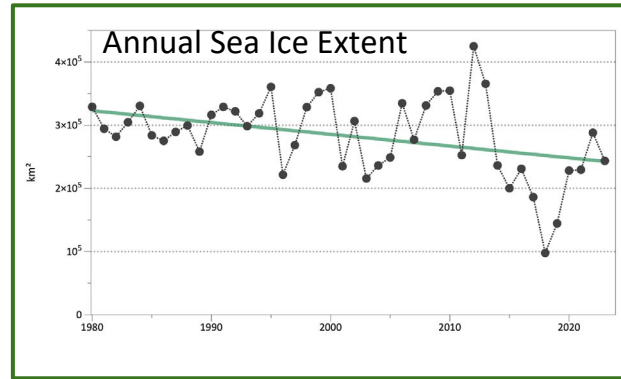
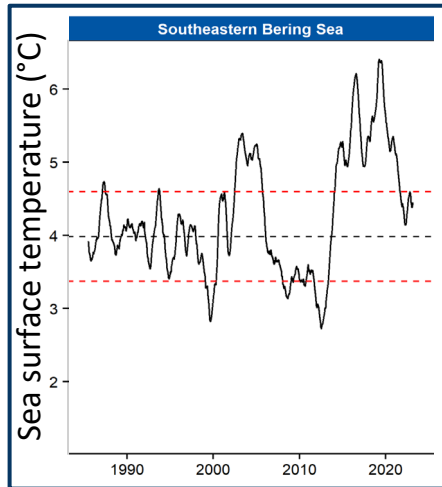
Ecosystem Assessment



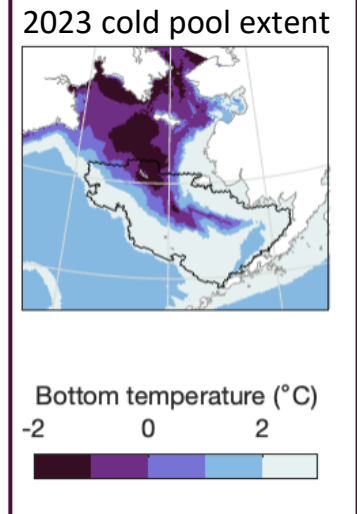
The Bering Sea has *cooled* relative to the recent warm stanza (2014-2021),
but largely *remains warmer* than average



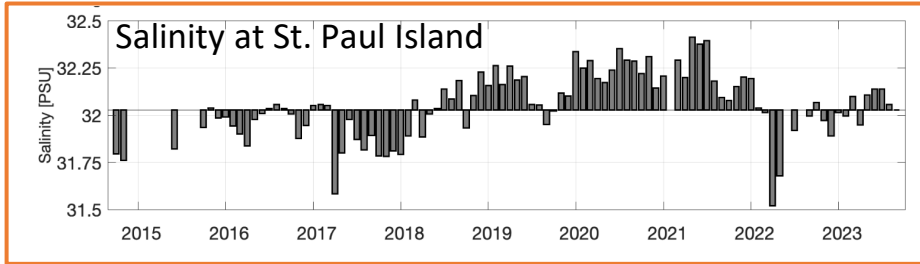
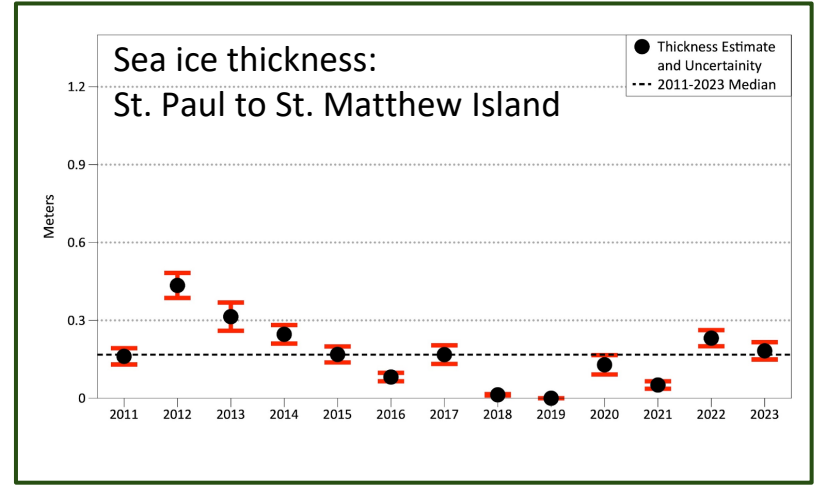
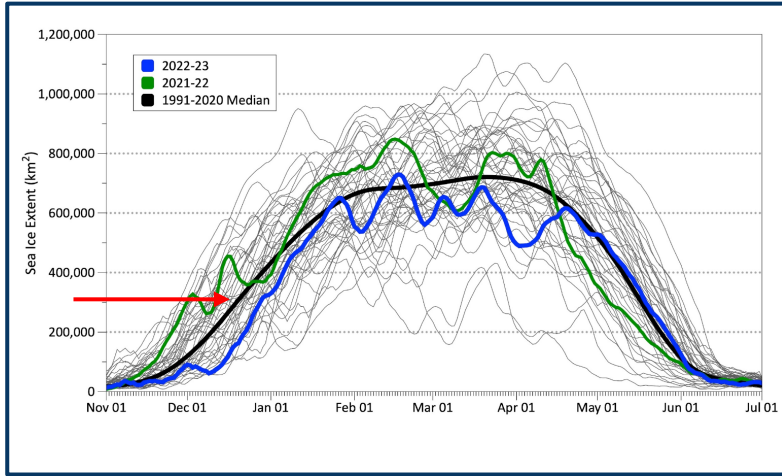
- Sea surface temperatures are **within 1SD** of the 30-year mean (1985-2014).
- Annual sea ice extent increased, but similar low ice years prior to 2010.
- Cold pool extent was **average**.



Overland & Wang, Lemagie & Callahan, Thoman, Kearney

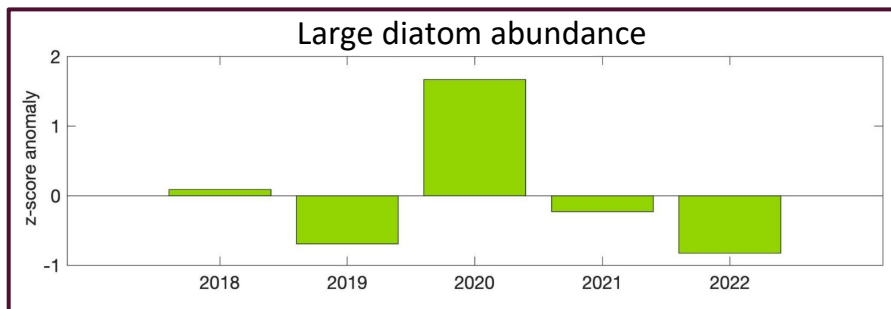
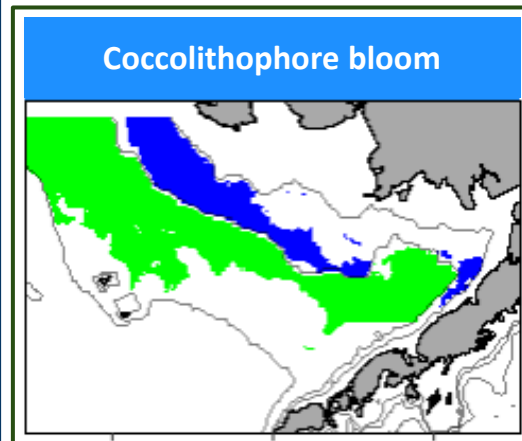
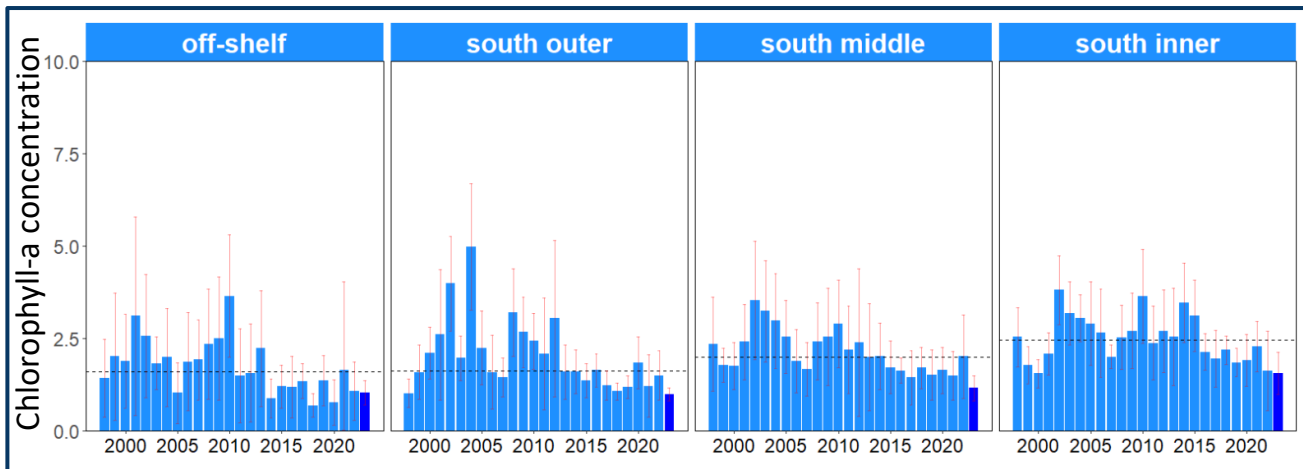


Sea ice dynamics impact the vertical stratification of the water column, which impacts biological dynamics



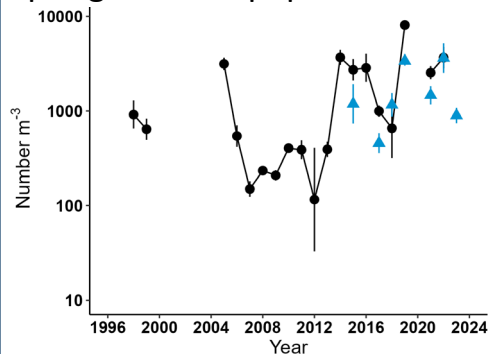
- Delayed freeze-up due to warm SSTs.
 - Sea ice thickness at time series median (2011-2023).
 - Salinity increased during the warm stanza (lack of freshwater input from sea ice melt), but that trend slowed since 2022.
- * Stratification index planned for 2024.

Metrics indicate poor primary productivity over the southern shelf



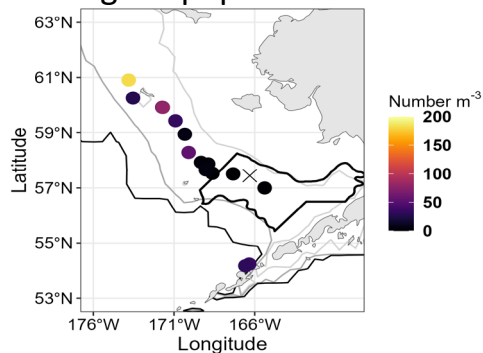
- Chlorophyll-a concentrations were among the **lowest** across sub-regions.
- Cocolithophore bloom was **highest** in the time series (1997–2023).
- Large diatoms from the continuous plankton recorder (CPR) show a **declining trend** 2020–2022.

Spring: small copepod abundance

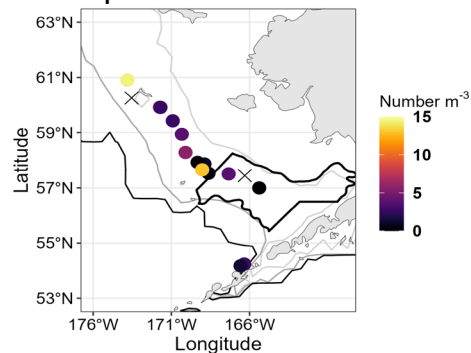


- Spring: **moderate** abundance of small copepods; **low** abundance and **low** lipid content of large copepods and euphausiids.
- Fall: **moderate** abundance of small copepods continued; abundance of large copepods and euphausiids **low, but increased** south to north.
- Jellyfish abundance was **average**; competitors with plankton-feeders.

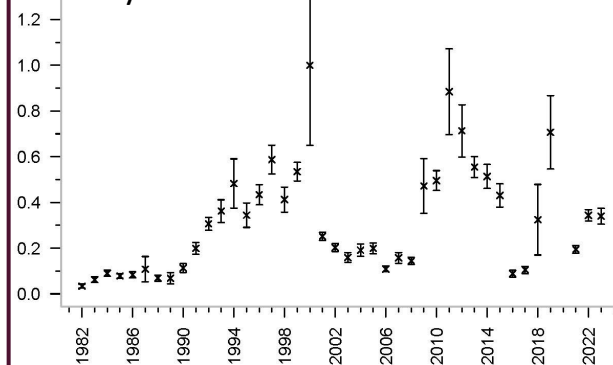
Fall: large copepod abundance



Fall: euphausiid abundance

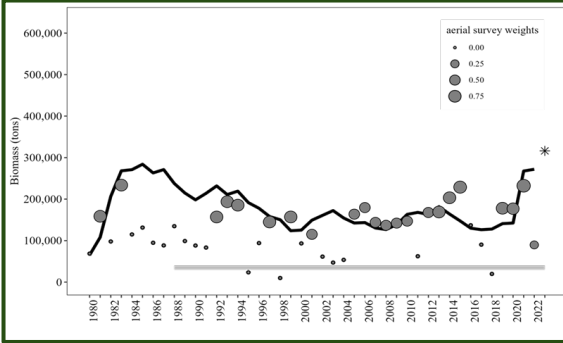
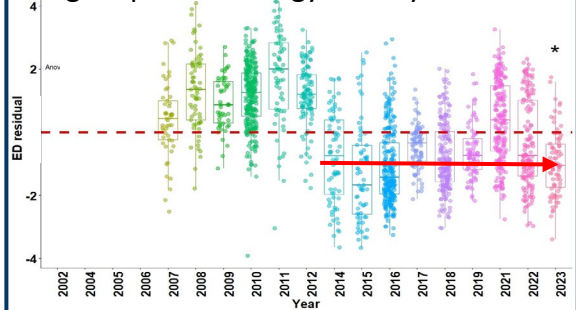


Jellyfishes

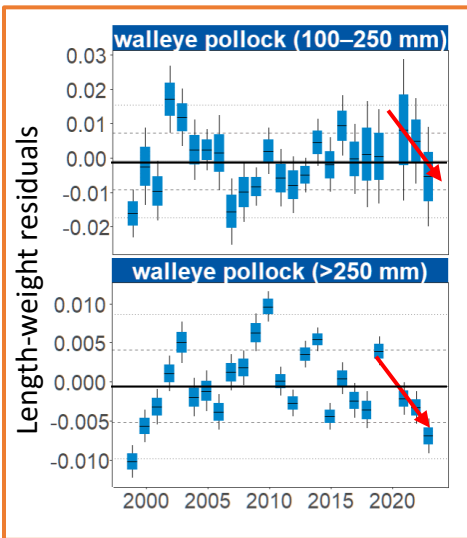
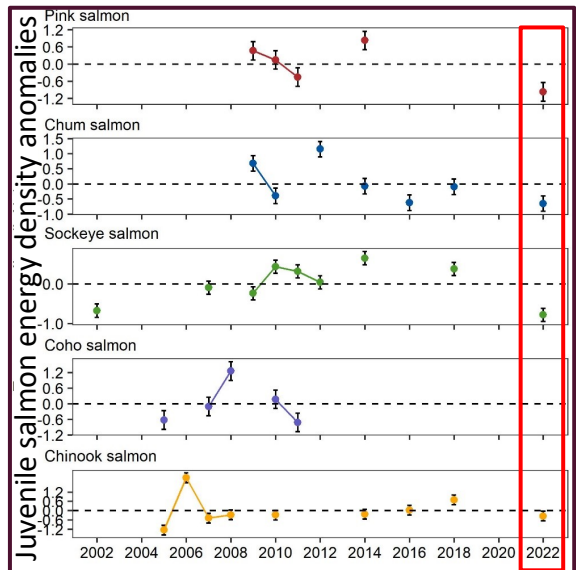


Integrated measures of pelagic productivity were mixed

Age-0 pollock energy density anomalies



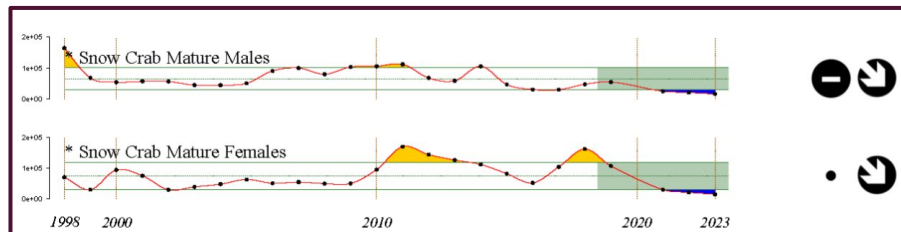
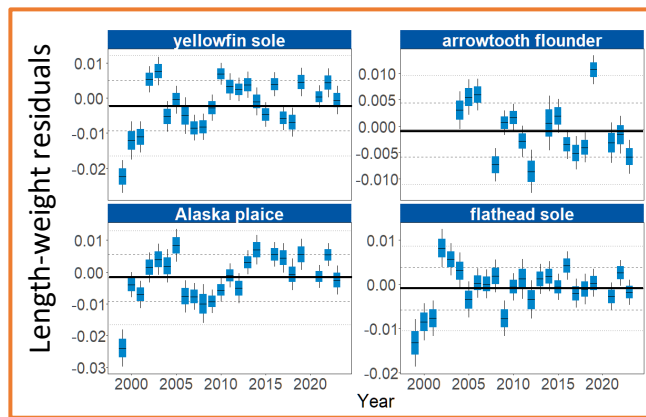
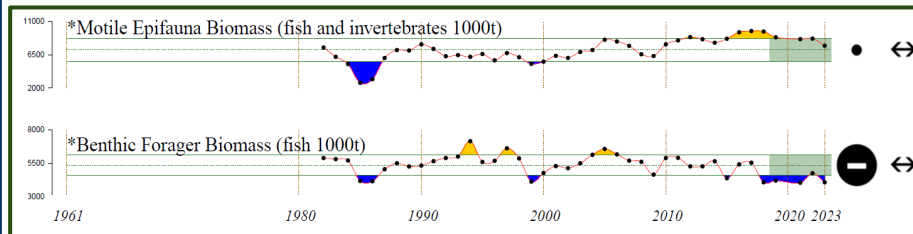
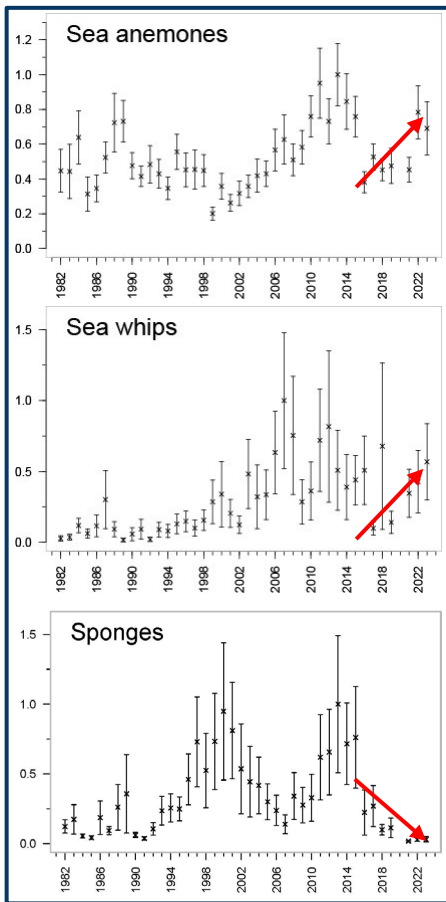
- Age-0 pollock condition remained **low**.
- 2022 juvenile salmon condition was **low**.
- Juvenile and adult pollock condition **continued to decline**.
- Togiak herring biomass **high** (strong 2016 & 2017 year classes).
- Bristol Bay sockeye biomass **high** since 2015 (not shown).
- Seabird reproductive success was **mixed**; higher on St. George Island than on St. Paul Island.



Alaska Maritime National Wildlife Refuge
2023 Seabird Report Card

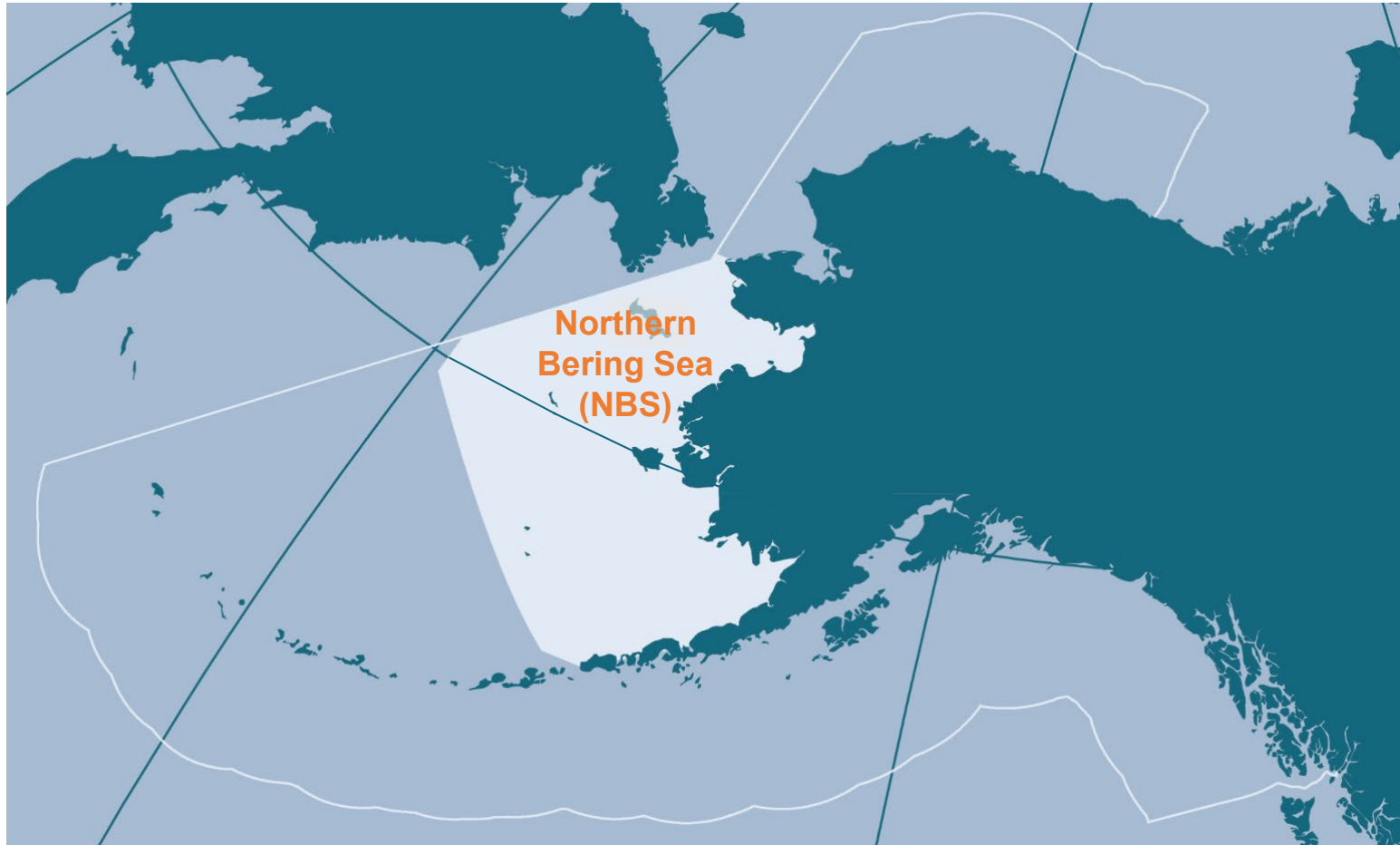
Refugia	Annual monitoring site	Red-faced cormorants	Glaucous-winged gulls	Common murres	Thick-billed murres	Horned puffins	Tufted puffins	Red-legged kittiwakes	Black-legged kittiwakes	Northern fulmar	Fork-tailed storm-petrels	Leach's storm-petrels	Parakeet auauers	Least auauers
Bering Sea	St. George	😊		😊	😊			😊	😊					😊
	St. Paul	😊		😊	😊			😊	😊					😊

Direct and indirect measures of benthic productivity were mixed, but largely showed declines

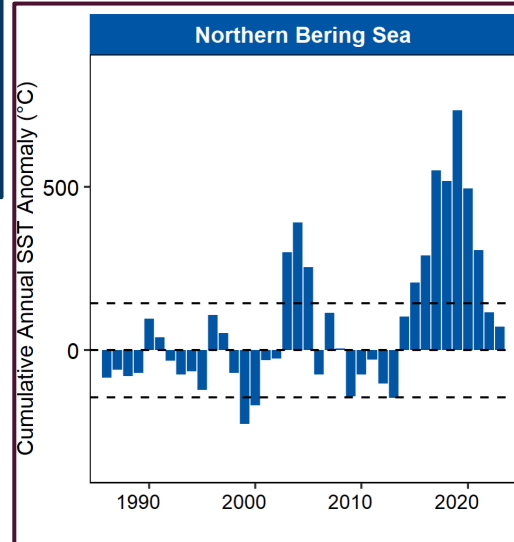
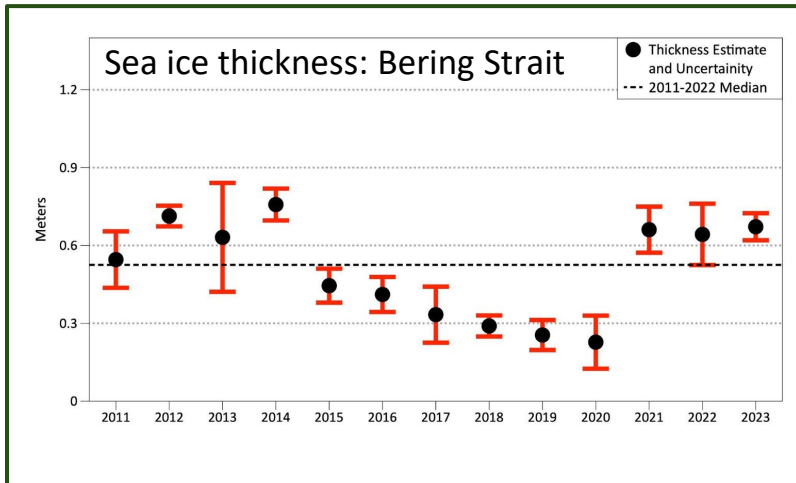
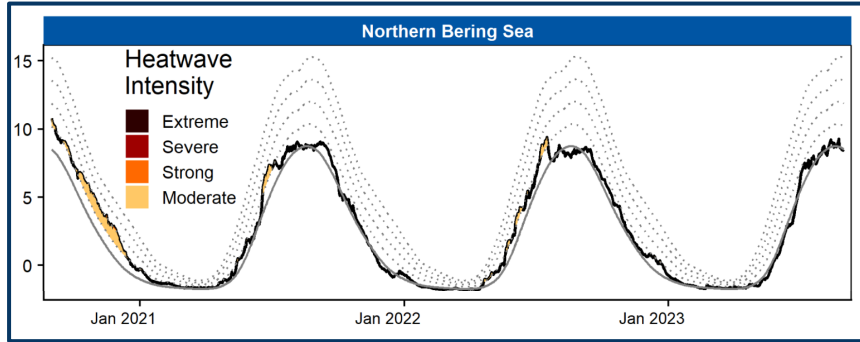


- Structural epifauna trends were **mixed**.
- Motile epifauna **declined** since 2017, **but above time series mean (1982–2023)**.
- Echinoderms have **increased**, crabs have **decreased**.
- Benthic foragers remain **below** the mean.
- Flatfishes may be experiencing **prey limitations**.
- Several crab stocks showed biomass **declines** in 2023.

Ecosystem Assessment

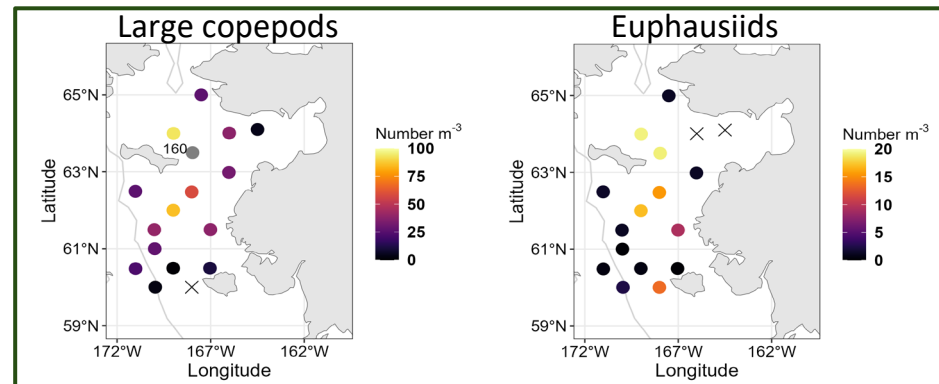
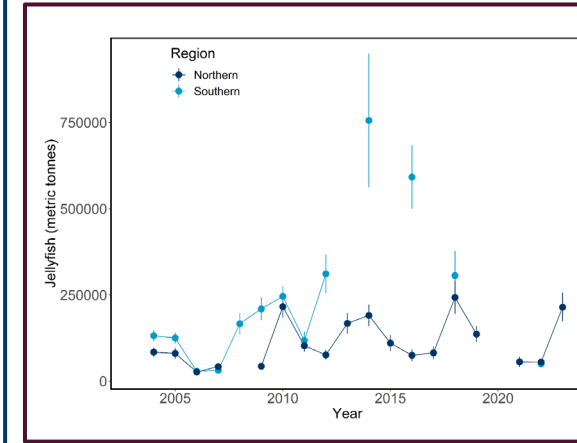
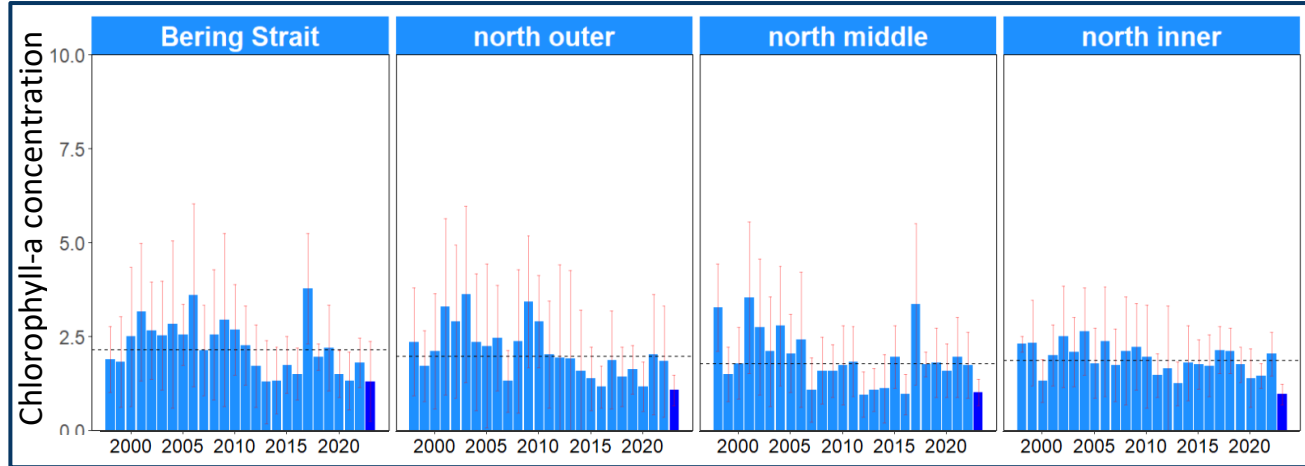


*Northern Bering Sea also transitioned to more average physical conditions since 2021;
Biological response has differed from the southeastern shelf ecosystem*



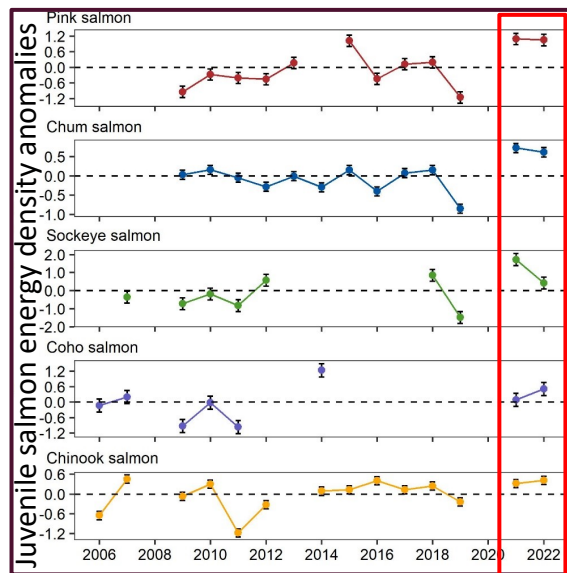
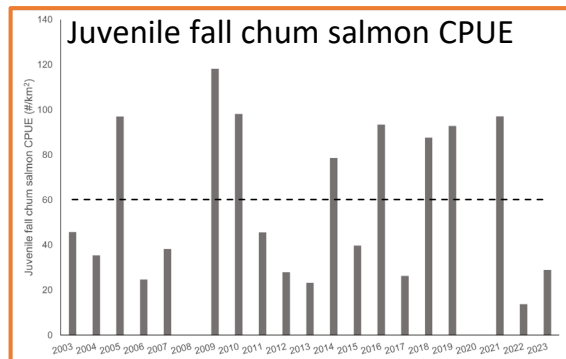
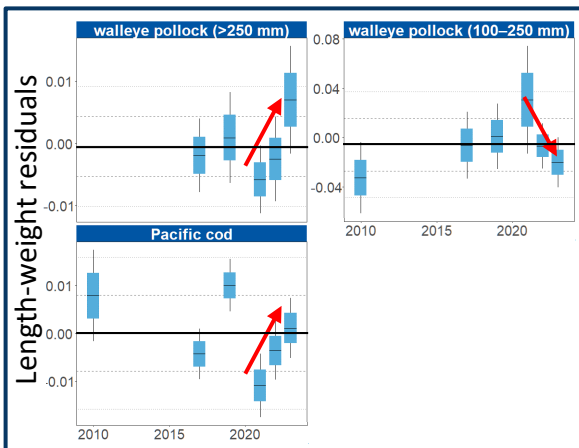
- No prolonged marine heatwaves since January 2021.
- Sea ice thickness **above** time series median (2011-2023) since 2021.
- SSTs **within 1SD**; organisms experienced reduced cumulative thermal exposure and metabolic demands.

*Primary productivity was low;
Zooplankton abundance was higher, especially for euphausiids*



- Chlorophyll-a concentrations among the **lowest** across sub-regions.
- **Hot spots** of large copepods and euphausiids observed around St. Lawrence Island.
- Jellyfish, potential competitors for zooplankton prey, **increased** over the NBS shelf.

Integrated measures of pelagic productivity were mixed



- Adult pollock condition **highest** in time series; juvenile pollock **decreased** since 2021.
- Pacific cod condition **increased** to average in 2023.
- Qualitative observations from St. Lawrence Island indicated that **seabirds did well** in 2023.
- In 2022, juvenile salmon condition was **positive** for all species in the NBS.
- **Slight increases** were observed in juvenile Chinook and chum salmon indices in 2023.

FACTORS AFFECTING 2023 YUKON & KUSKOKWIM CHUM SALMON RUNS AND SUBSISTENCE HARVESTS

SALMON LIFECYCLE



PARENT SPAWNERS & EGGS 2018-2019

2019 poor forage conditions during MHW; 2019 returning parents also experienced premature mortality associated with low water levels and warm river temperatures.



MARINE JUVENILES Summer EBS and winter GOA 2019-2021

2019 empty stomachs and poor juvenile salmon condition in EBS associated with MHW; GOA winter MHW 2019; 2020-2021 temperatures return to more average conditions in the GOA and EBS.



IMMATURES AND MATURING ADULTS EBS|GOA | 2021-2022

Total bycatch of 107,235 Western Alaska and Yukon chum in the EBS 2021 and 2022; Harvest of 1105,320 Coastal Western Alaska and Upper Yukon chum salmon in the South Peninsula Area M fishery in 2022; Competition for food likely occurring.



MATURING ADULTS AND ADULTS EBS | 2023

River temperatures variable for 2023 returning adults; WAK chum returns remain well below long-term average and most escapement goals still not being met; food security, culture, and ecosystem health impacted.



OBSERVED IMPACTS TO SUBSISTENCE HARVESTS*



"There's the climate change part, there's bycatch and things like that. And then not only the ocean life, but also what's happening in our spawning rivers. The health of those because of climate change; too much snow, not enough snow; too cold, too warm. How different everything is changing. I think there's a lot of things that come into play."

"2019 was a very bad year. We were finding a lot of dead fish because the water was getting very warm, and there was a lot of bacteria in the water. That's really unusual."

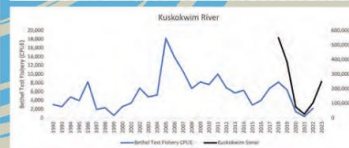
"There were more chums in the river [in 2023] and people were catching more; but when compared to the past 40 years and even just 10 years ago, there were far less chums in the river running and being caught by the people now. We should not pretend that this season's slight increase means the chum run has significantly improved."

"When the chum returns were good, it was just stink, and fish were everywhere. I don't think people realize the importance they have to the ecosystem. The river's health, the plants. I think of all the bears, and if they have no fish, they're eating berries; but that's not going to hold them off, so they have to eat more baby moose; and then we get back to where we are still: trying to conserve moose up here."

"This used to be a chum river. In the old days, [their] uses were multifold. We ate them and our dogs ate them. And I still think of what the old people say: You use them, they will come back in numbers."

*Observations are kept anonymous

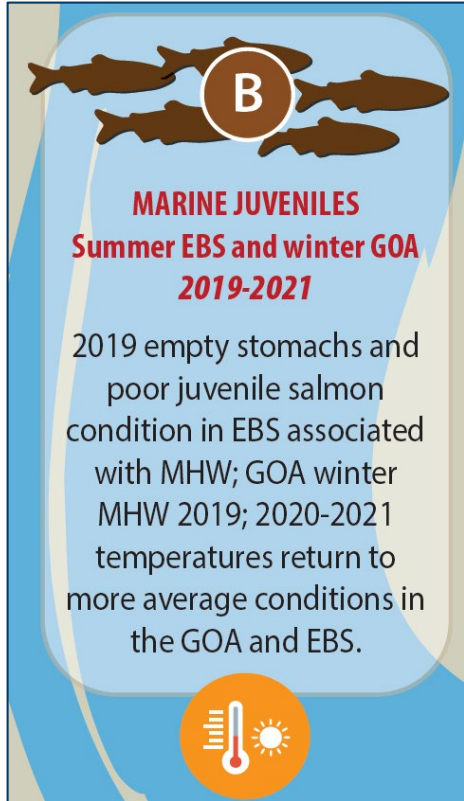
INDICES OF CHUM SALMON RUN SIZE OVER TIME



Contributors:

Whitworth, Vicente, Magel, Howard, von Biela, Williams, and Chambers


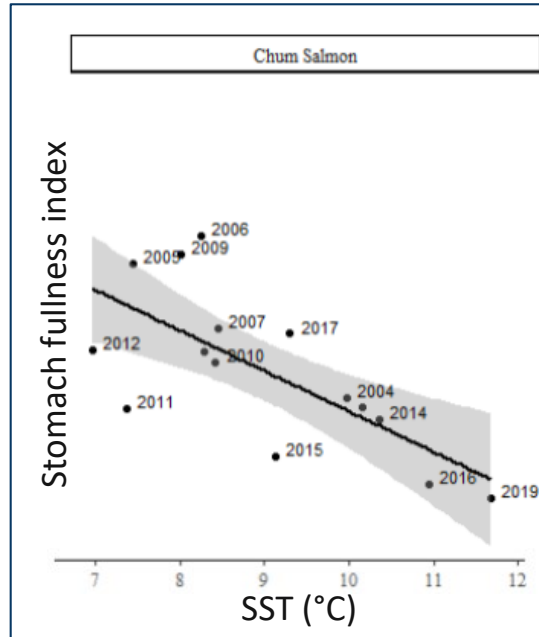
Juvenile chum salmon consume zooplankton and fish and are prey for upper trophic levels



B

MARINE JUVENILES
Summer EBS and winter GOA
2019-2021

2019 empty stomachs and poor juvenile salmon condition in EBS associated with MHW; GOA winter MHW 2019; 2020-2021 temperatures return to more average conditions in the GOA and EBS.

Siddon, 2022; Ferriss and Zador, 2022;
 Murphy et al., 2021; Burril et al., 2018

“There’s the climate change part, there’s bycatch and things like that. And then not only the ocean life, but also what’s happening in our spawning rivers. The health of those because of climate change; too much snow, not enough snow; too cold, too warm. How different everything is changing. I think there’s a lot of things that come into play.”

Kuskokwim River Inter-Tribal
 Fish Commission, 2023

Adult chum salmon integrate marine conditions in the Bering Sea and Gulf of Alaska



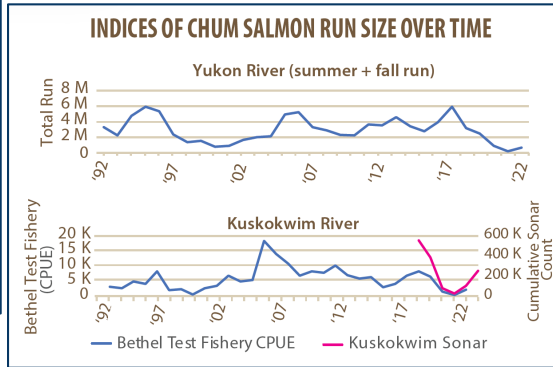
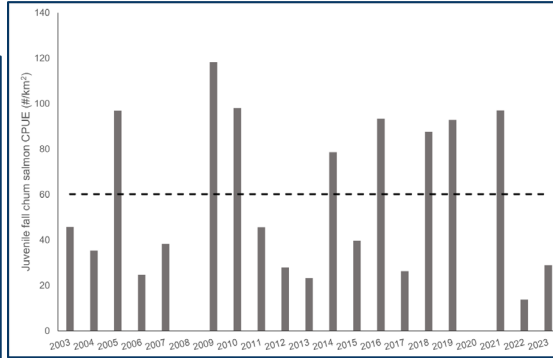
MATURING ADULTS AND ADULTS

EBS | 2023

River temperatures variable for 2023 returning adults; WAK chum returns remain well below long-term average and most escapement goals still not being met; food security, culture, and ecosystem health impacted.



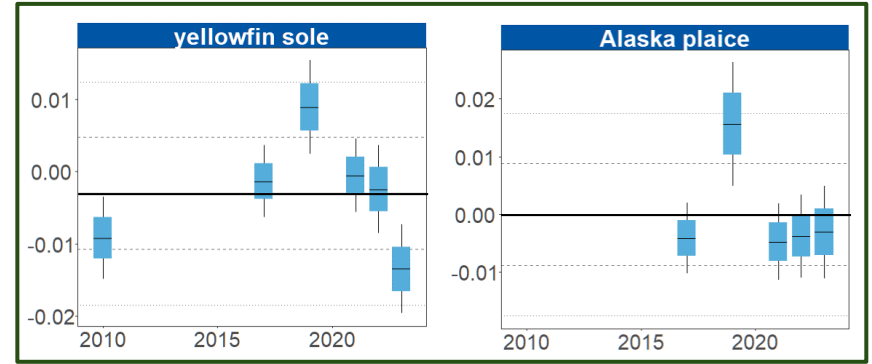
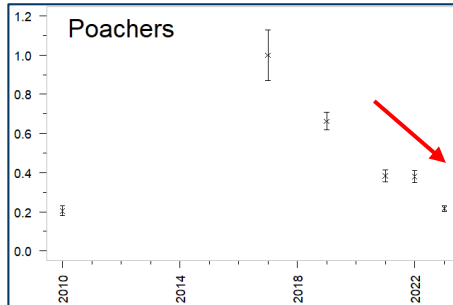
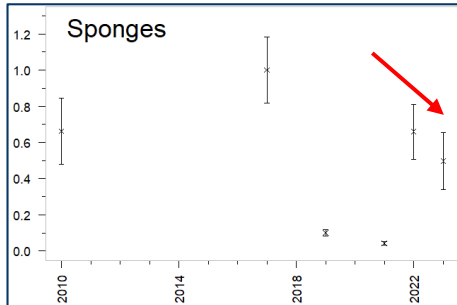
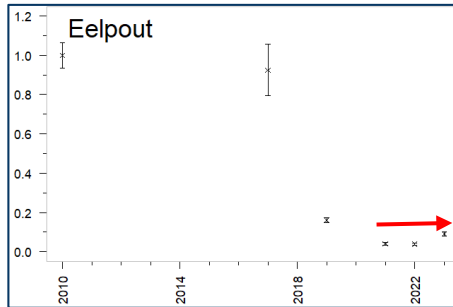
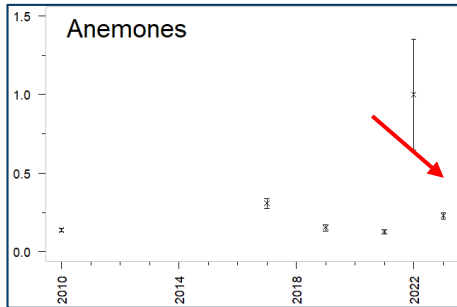
Murphy et al., 2023



“There were more chums in the river [in 2023] and people were catching more; but when compared to the past 40 years and even just 10 years ago, there were far less chums in the river running and being caught by the people now. We should not pretend that this season's slight increase means the chum run has significantly improved.”

Kuskokwim River Inter-Tribal Fish Commission, 2023

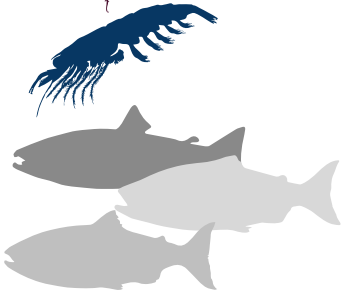
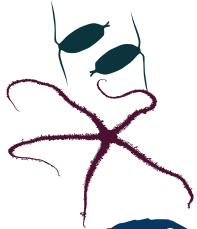
Direct and indirect measures of benthic productivity were mixed, but largely showed declines



- Anemone biomass **low** in 2023.
- Sponges more variable; biomass **moderate** in 2023.
- Continued **low** biomass of eelpouts in 2023.
- Continued **declining** trend in poachers since 2017.
- Yellowfin sole condition **decreased** to time series low in 2023.
- Alaska plaice condition remained just **below** the time series average.

2023 Summary and *implications*

The Bering Sea has cooled relative to the recent warm stanza (2014-2021), but largely remains warmer than average
Cumulative thermal stress is lower; species distributions and predator/prey interactions are impacted by cold pool extent



SOUTHEASTERN BERING SEA: AN ECOSYSTEM IN TRANSITION

Metrics indicate poor primary productivity while secondary productivity was moderate to low

Potential bottom-up limitations throughout the food web

Integrated measures of pelagic productivity were mixed

*Cumulative impacts of thermal exposure & prey limitations during extended warm phase;
Potential competitive pressure from large year classes (i.e., Togiak herring, Bristol Bay sockeye salmon)*

Metrics of benthic productivity were mixed, but largely showed declines

Echinoderms (i.e., brittle stars) continue to do well; multiple crab stocks continue to show declines

NORTHERN BERING SEA: SOME SIGNS OF RECOVERY IN THE PELAGIC SYSTEM

Biological response has differed from the southeastern shelf ecosystem

Faster ecological response to cooler conditions

Primary productivity was low; secondary productivity was higher, especially for euphausiids

Improved bottom-up conditions relative to the southern shelf

Integrated measures of pelagic productivity were mixed

Some signs of recovery, though several salmon stocks still well below average

Measures of benthic productivity were mixed, but largely showed declines

Understanding drivers and impacts of changes in benthic community in the NBS remains limited