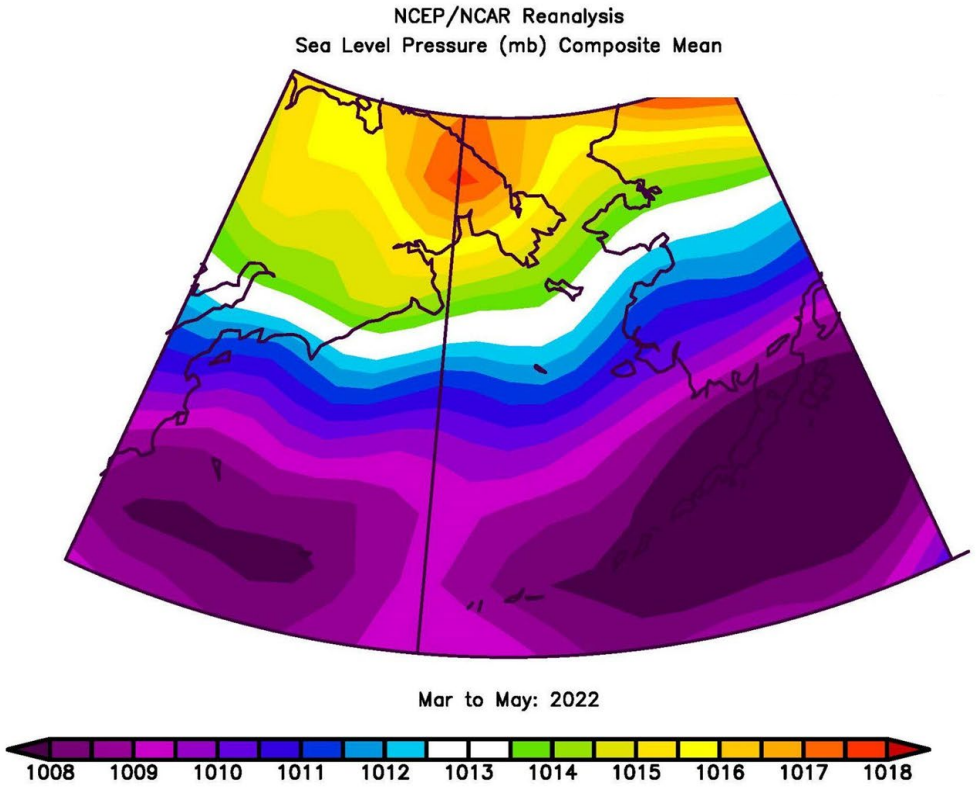
ECOSYSTEM STATUS REPORT

NPFMC Crab Plan Team
September 12, 2022

Elizabeth Siddon

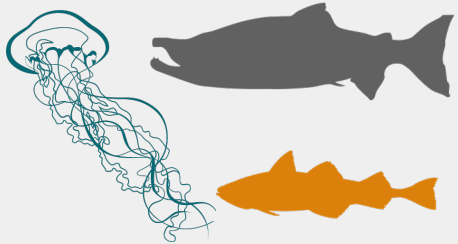


Crab-relevant ecosystem information

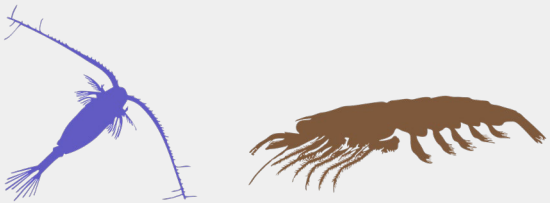
- Pelagic and benthic stages
- Environmental processes, prey, competitors, predators
- 2022 (where available) in context

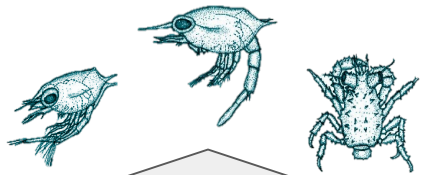
pelagic larval indicators

PREDATORS

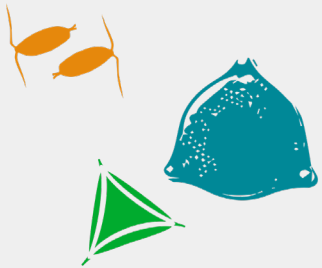


COMPETITORS





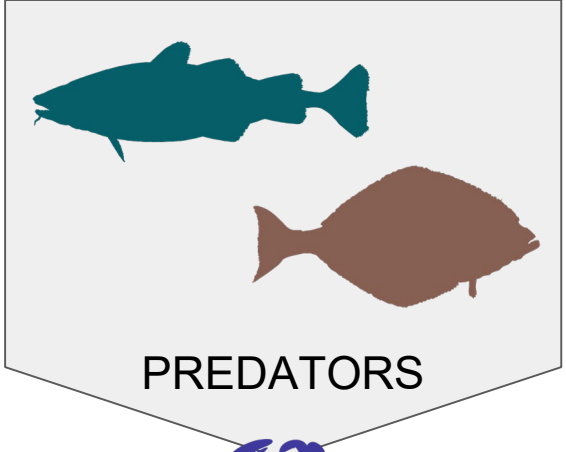
PREY

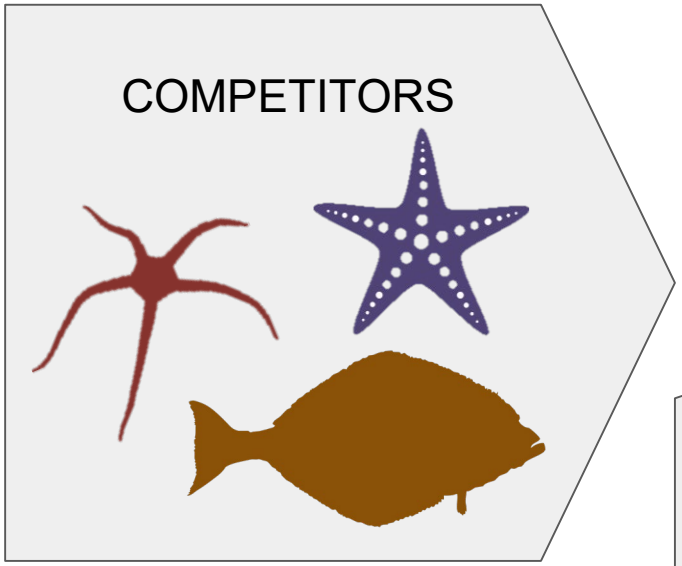


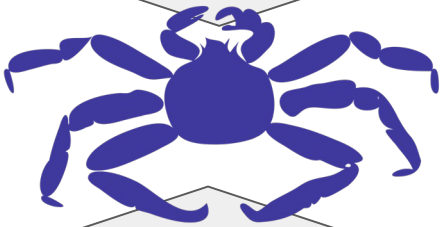
H

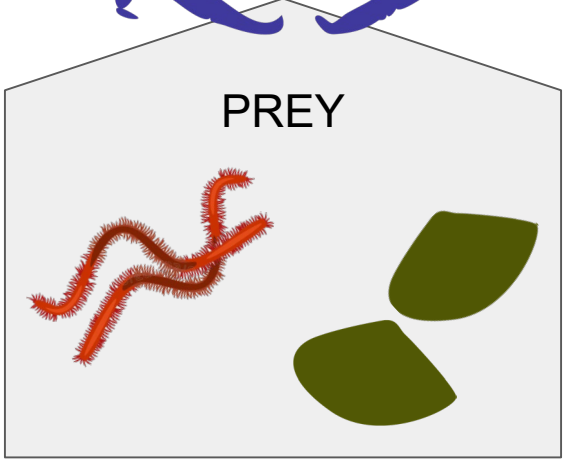
ENVIRONMENTAL PROCESSES

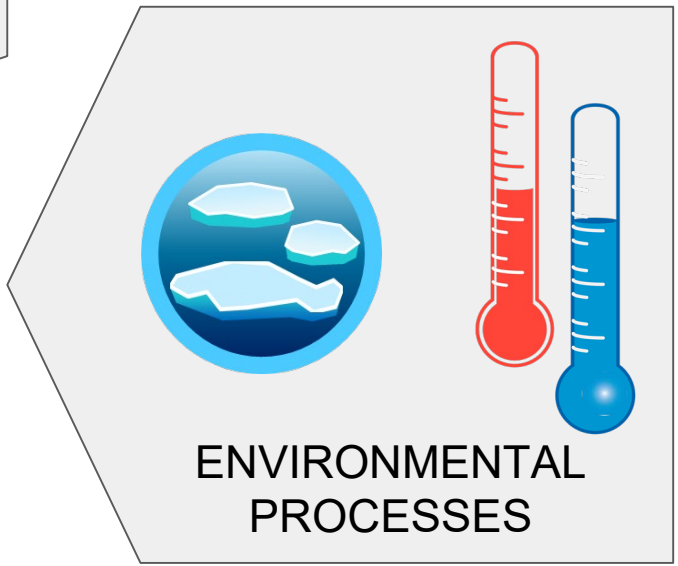
benthic juvenile/adult indicators

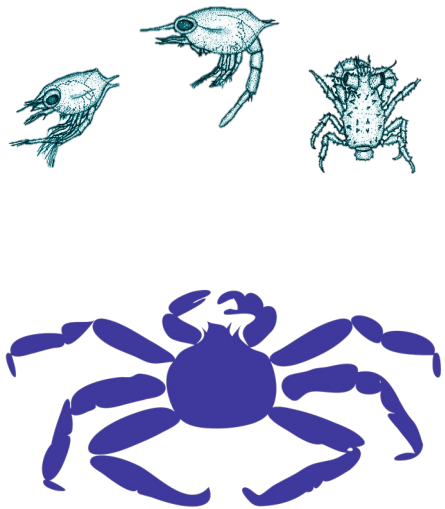


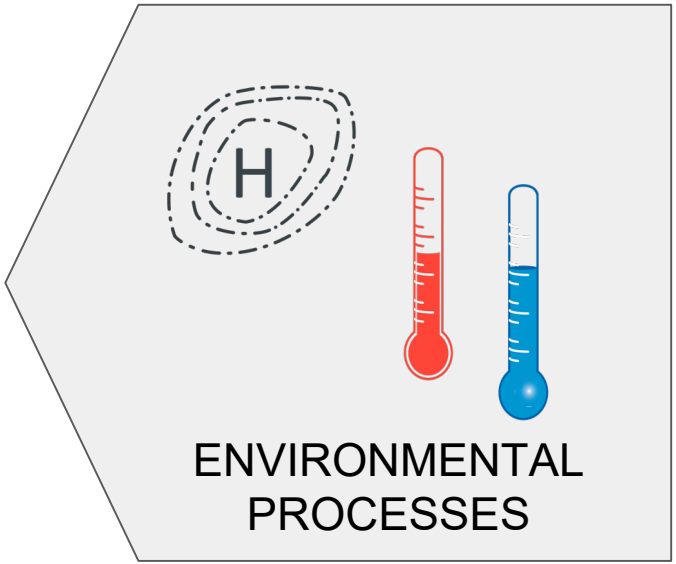






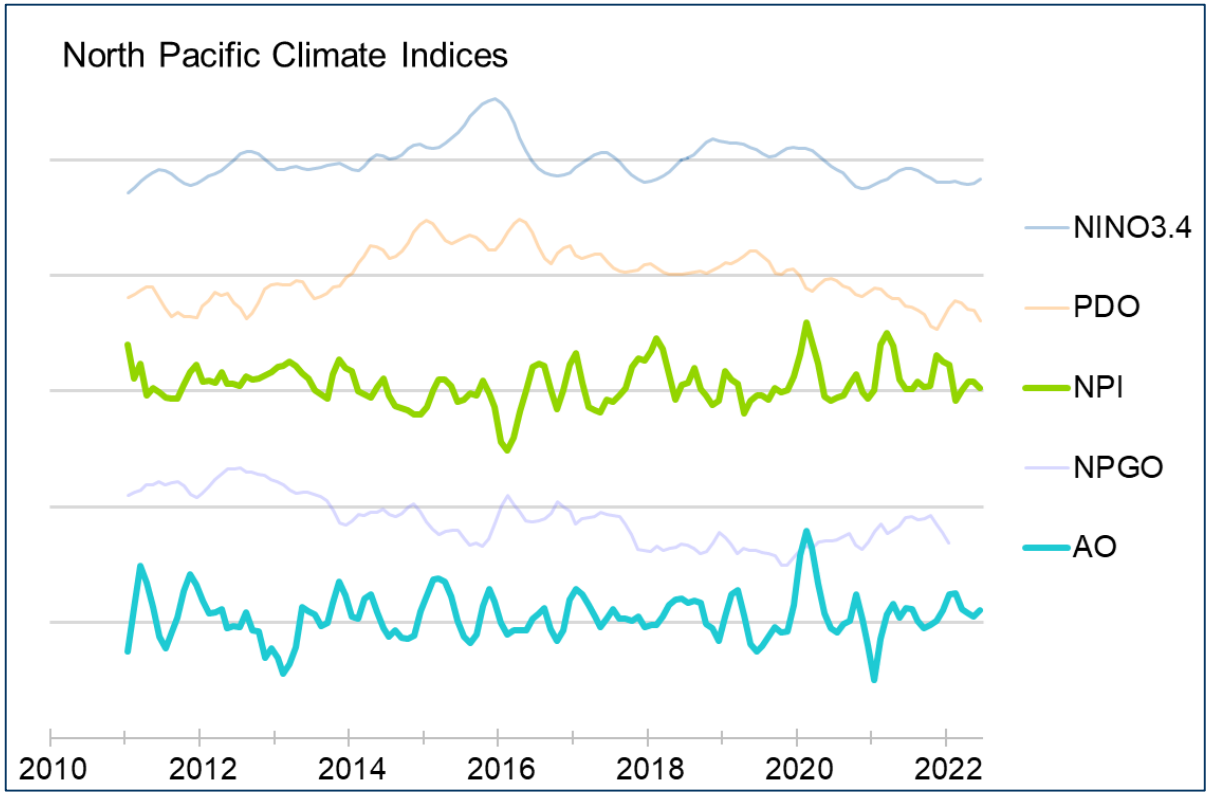





H
ENVIRONMENTAL
PROCESSES

Climate Indices

Bond

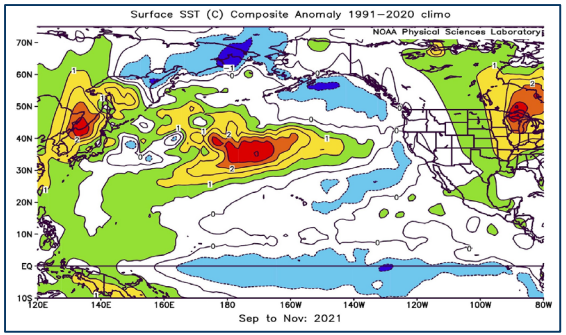


- NPI reflects the ALPS; Positive values mean weak ALPS and calmer conditions.
- NPI has been positive for 5 of last 6 winters.
- The AO measures the polar vortex; mostly positive since the spring of 2021.
- Positive AO in winter usually means cold temps, but 2021-2022 had near-normal temps.

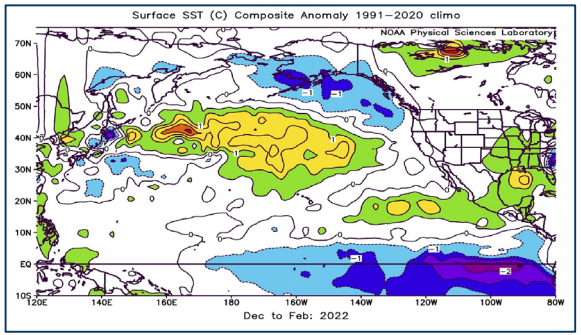
Sea Surface Temperature Anomalies

Bond

Cool conditions over the middle domain; average for the inner/outer domains.



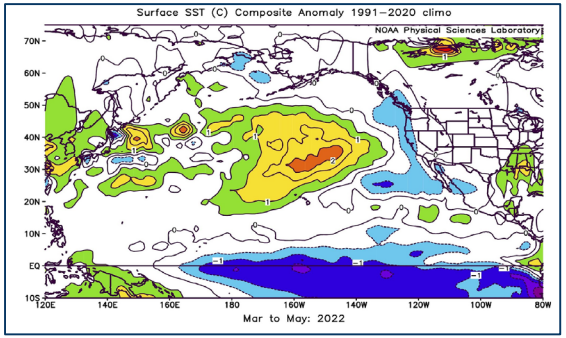
Fall 2021



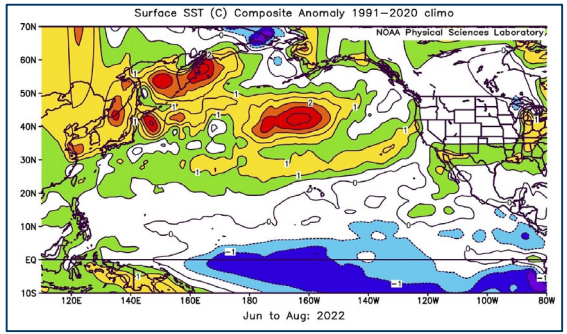
Winter 2021/2022

Quite cold SSTs in SEBS (inner shelf >2°C below normal).

Less cool conditions over the EBS shelf.

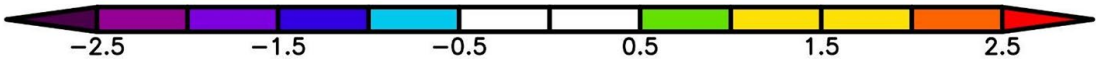


Spring 2022



Summer 2022

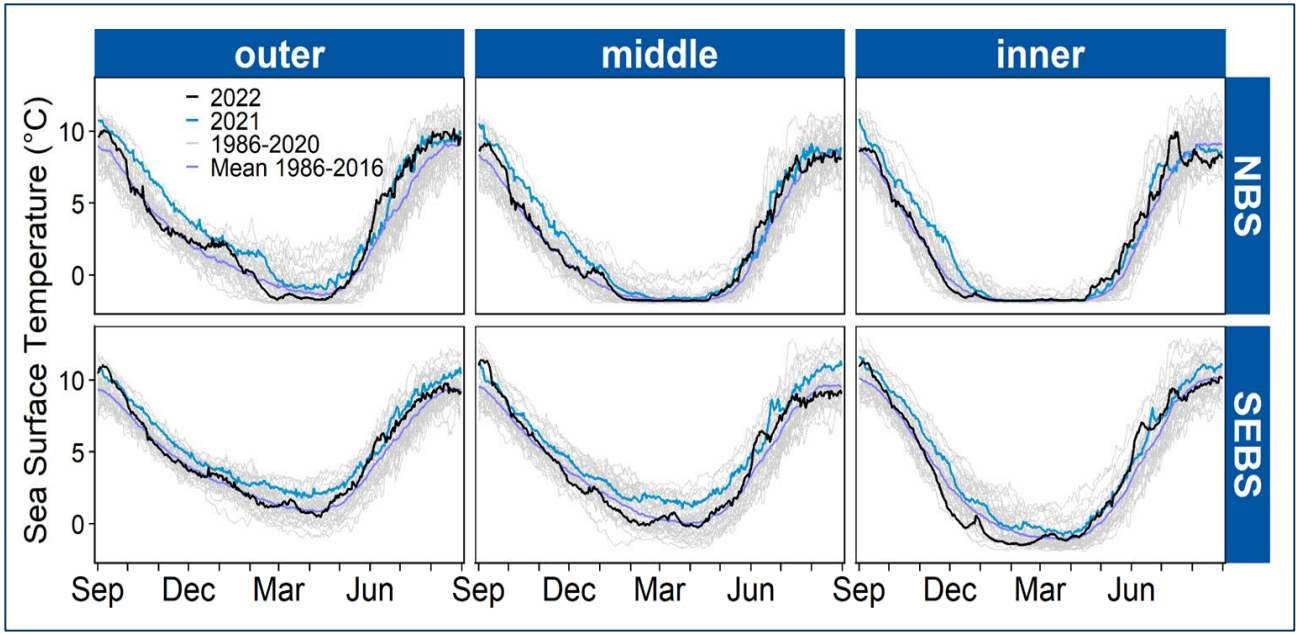
Modest warming driven by warm air temperatures in coastal Alaska.



From NOAA's Optimum Interpolation SST analysis

Sea Surface Temperature

Lemagie & Callahan

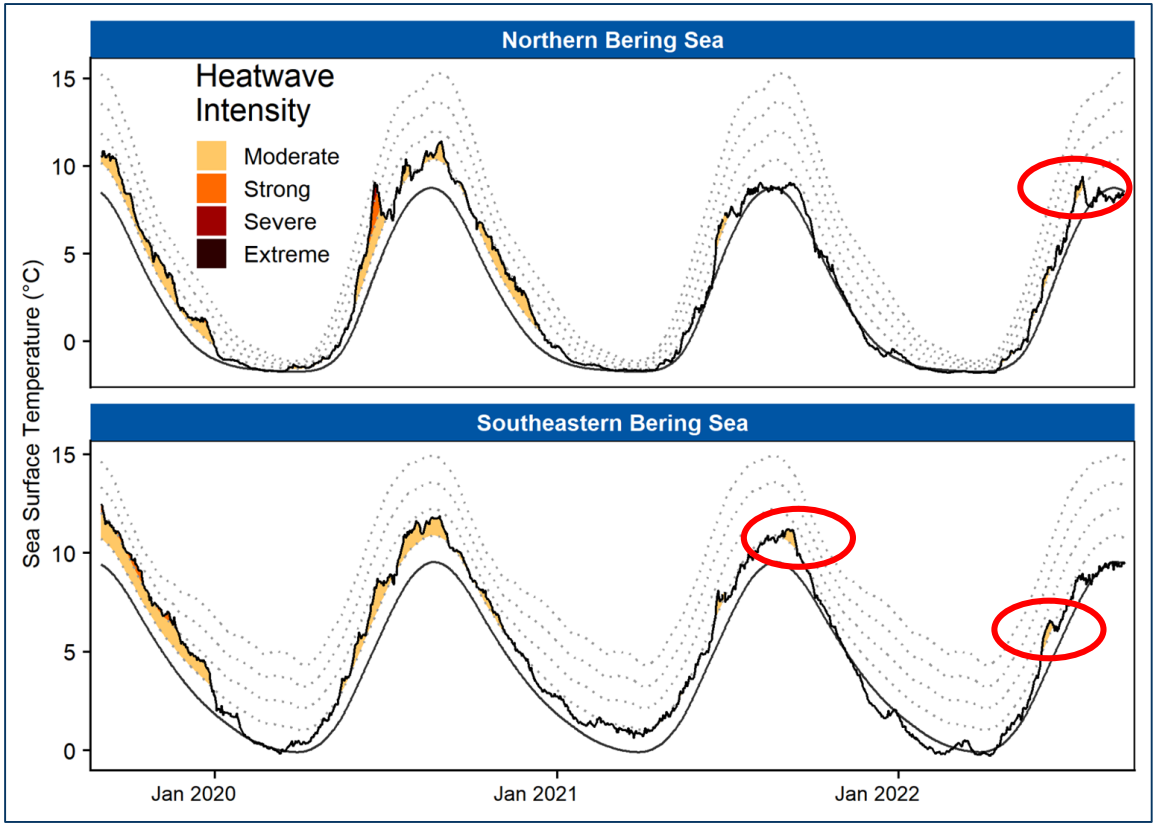


- SSTs largely similar to (and in some cases below) the long-term mean in fall, winter, and spring.
- SSTs were slightly above average in summer.

Marine Heatwave Index

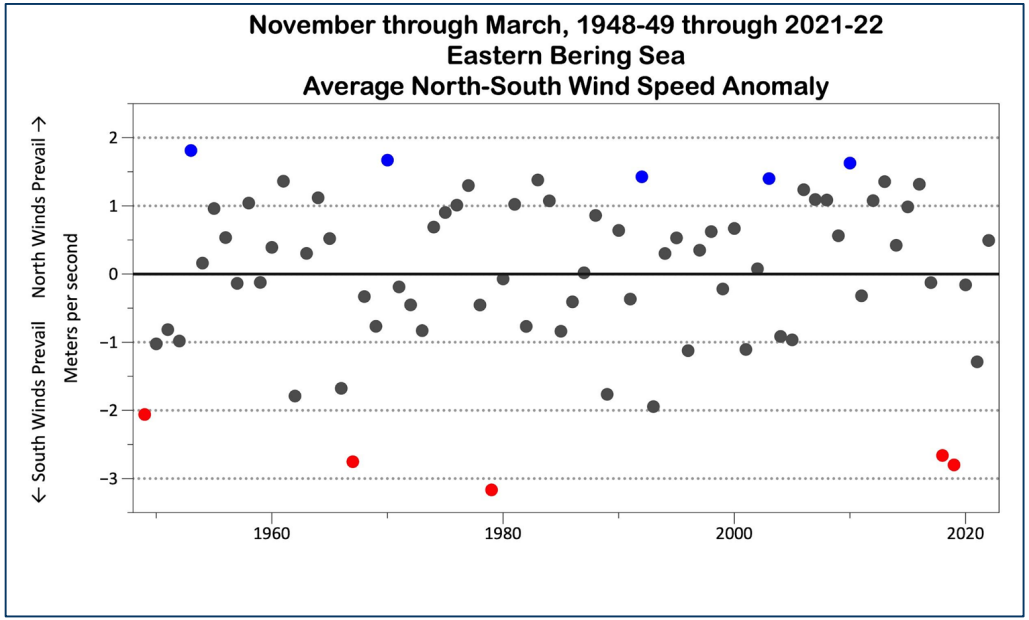
Lemagie & Callahan

- MHWs in 2022 have been infrequent and brief compared to recent years.
- No MHWs occurred between early fall 2021 and mid-spring 2022.



Winter Winds

Thoman

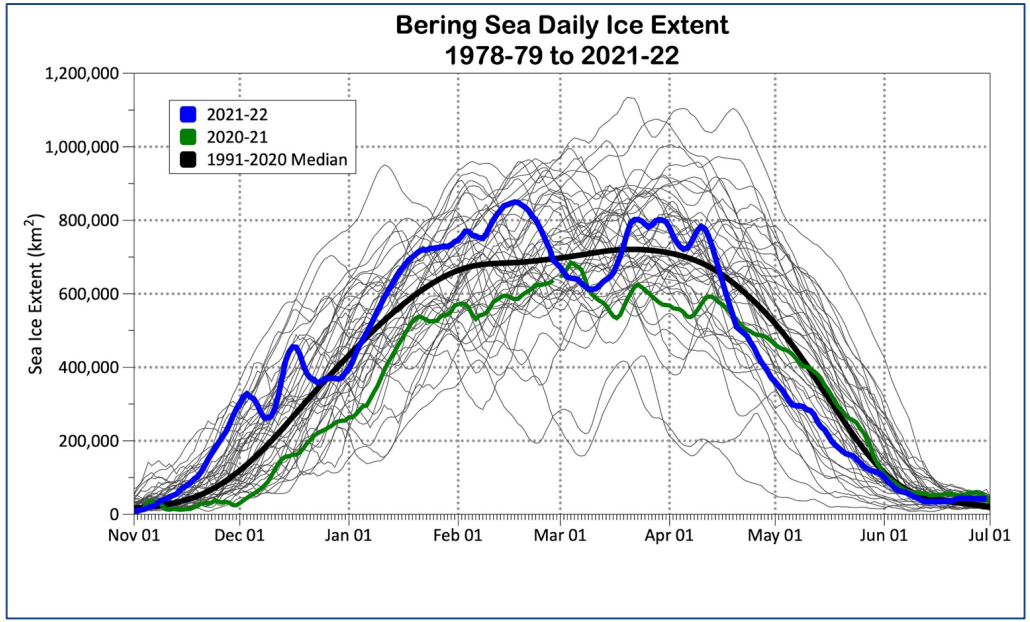


- Winters ending in 2018 and 2019 were among 5 years with the strongest south winds, which contributed to low sea ice extent in those years.

- Winter 2020 had winds near the long-term average.
- Winter 2021 had winds that prevailed from the south.
- Winter 2022 had winds that were more northerly than the long-term average (first winter since 2017).

2022 Sea Ice

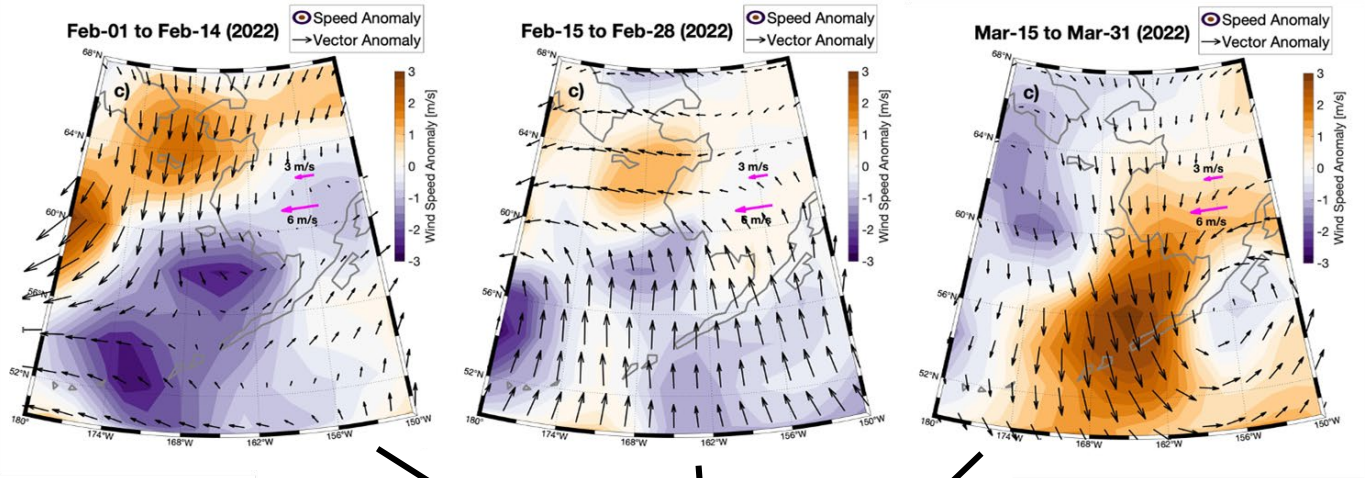
Thoman

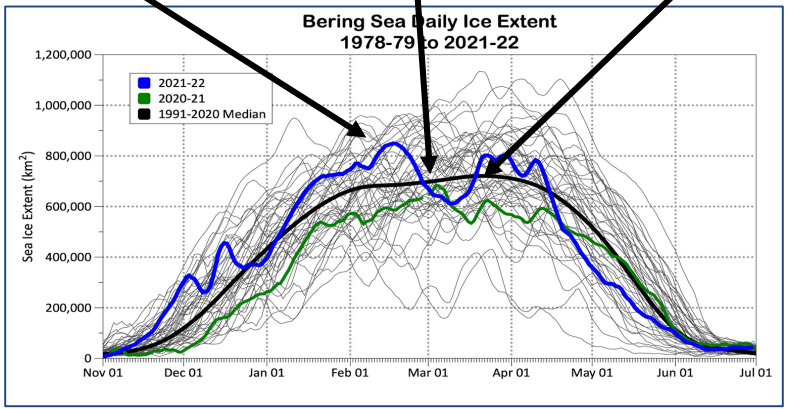


- Rapid sea ice growth in November:
  - Cold temps over western Alaska
  - Less open water in the Chukchi; ice able to form/move south of the Bering Strait
- Dramatic ice loss in April:
  - Thin ice (plots coming next)
  - Storminess
- Maximum ice extent occurred February 17, almost a month earlier than the median.

Winds & Sea Ice

Hennon, Thoman

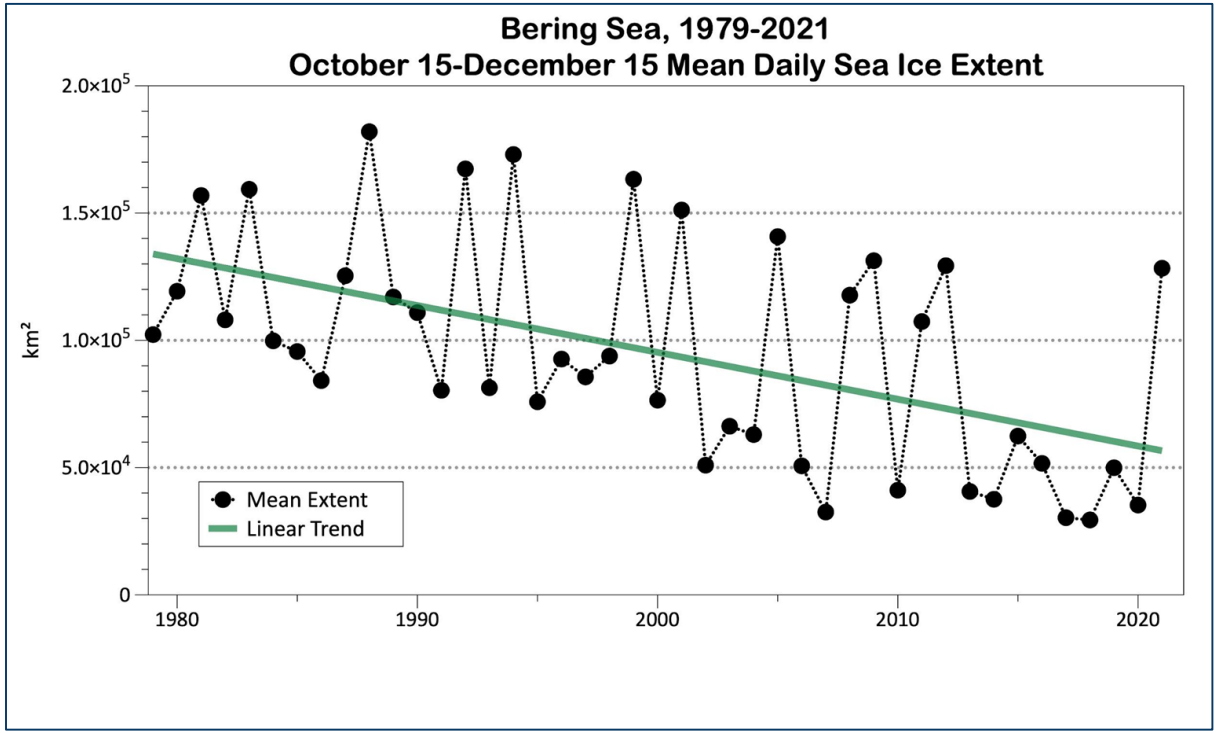




Wind anomalies correlate with sudden shifts in sea ice extent.

Early Season Ice Extent

Thoman

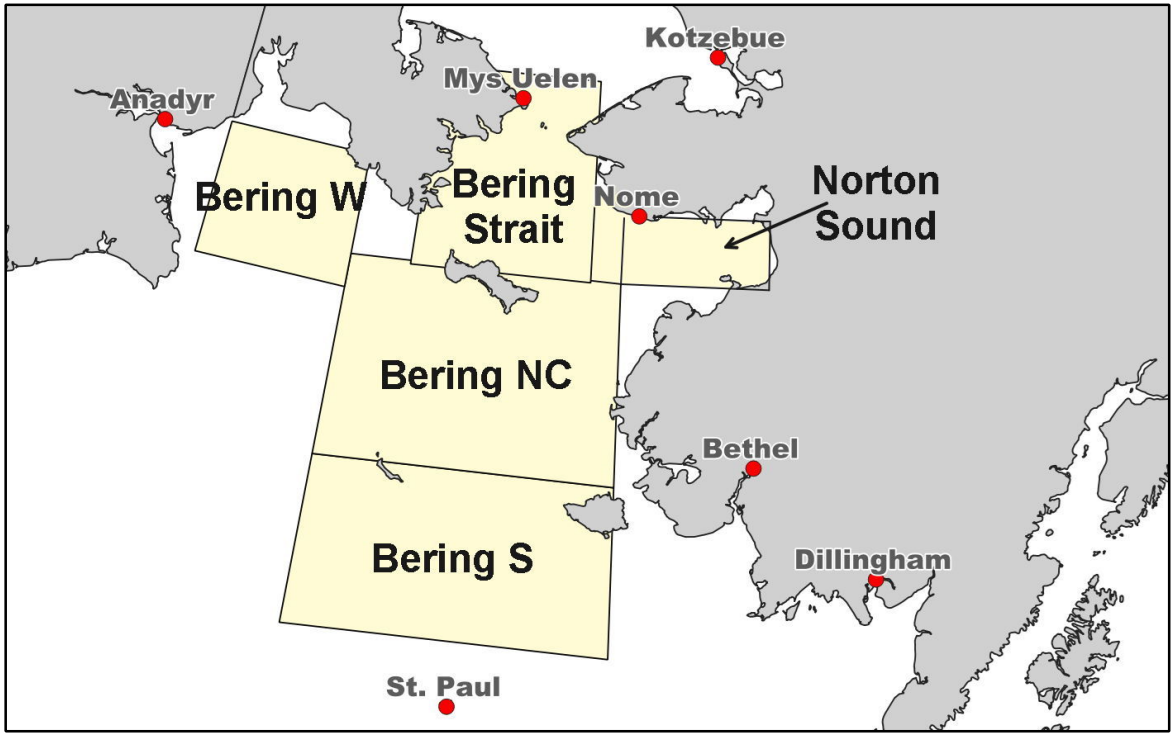


- One of the coldest Novembers on record produced rapid sea ice growth.
- Early season ice extent was the highest since 2012.

Source: Alfred Wegener Institute, https://www.meereisportal.de/en/

Bering Sea Ice Thickness

Thoman

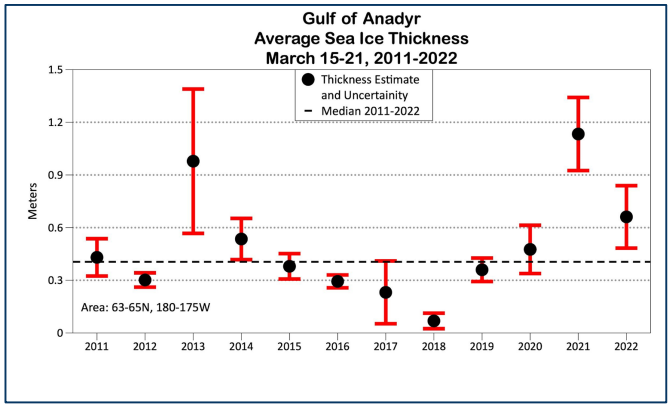


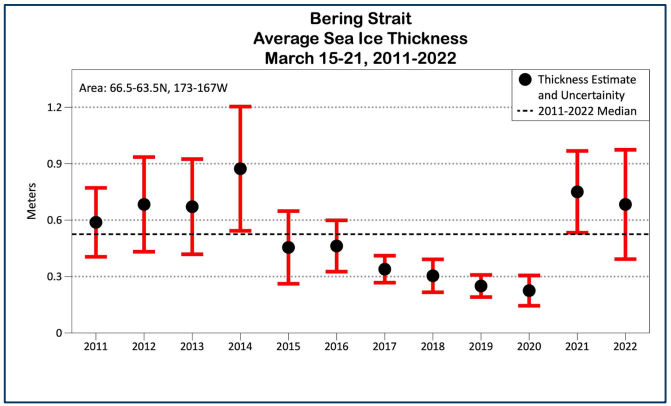
- 3rd week of March.
- Ice thickness is related to duration or residency of ice over the shelf.
- Abundance of ice-associated algae correlated to ice duration?

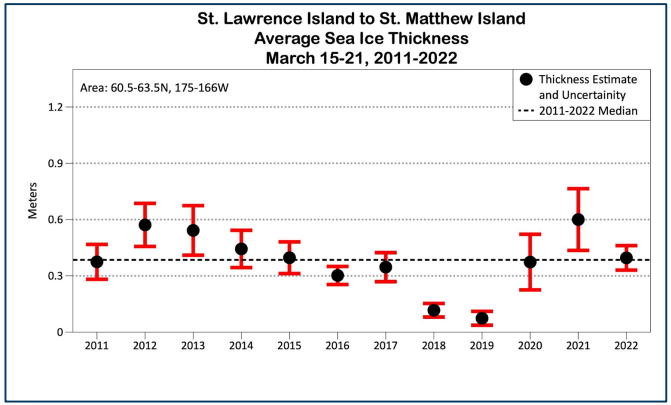
Source: Alfred Wegener Institute, https://www.meereisportal.de/en/

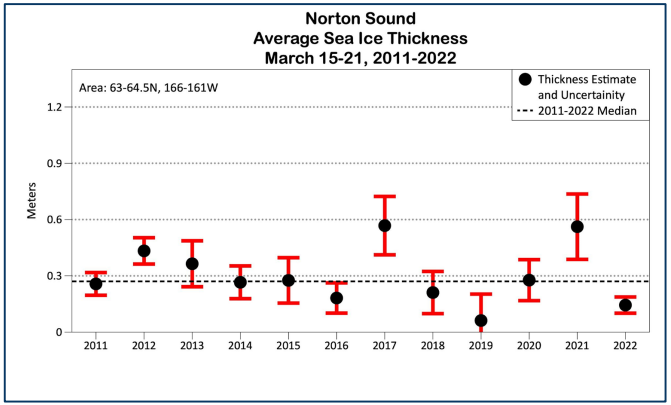
Bering Sea Ice Thickness

Thoman







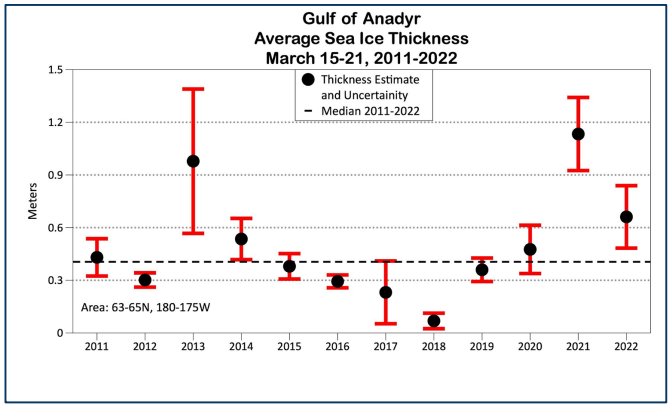


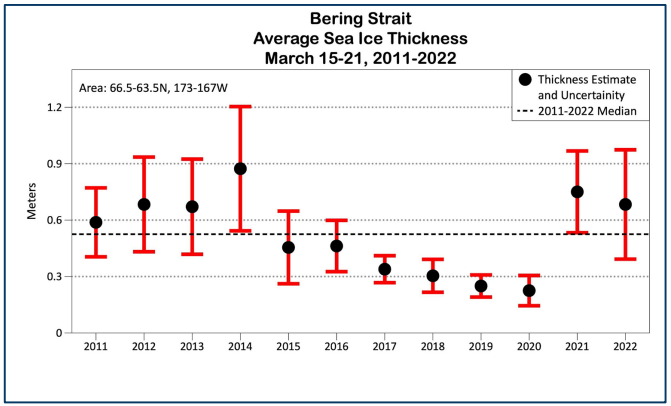
- Ice ***extent*** was higher than recent years.
- Ice ***thickness*** was lower than 2021 in all NBS areas.
- Norton Sound ice thickness was 2nd lowest of record.

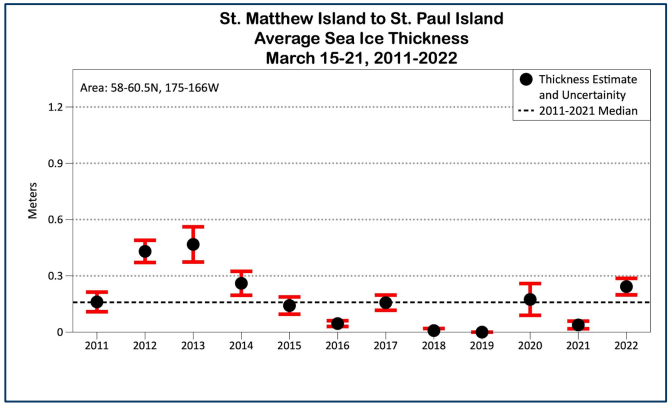
Source: Alfred Wegener Institute, https://www.meereisportal.de/en/

Bering Sea Ice Thickness

Thoman





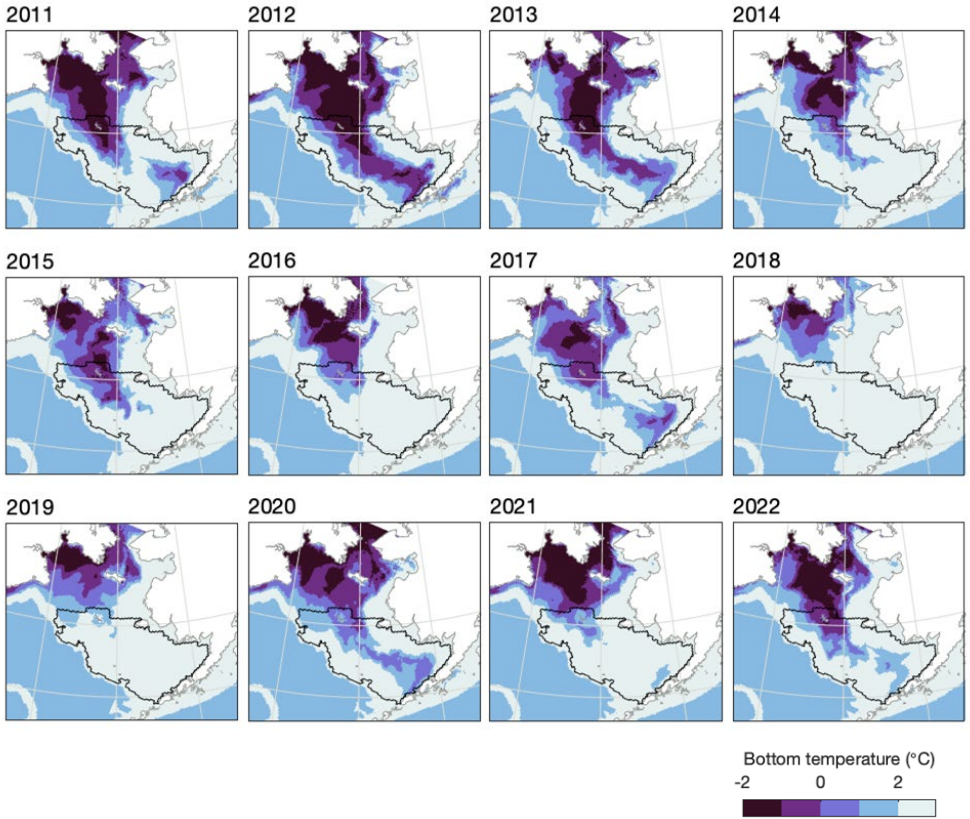


- Ice ***extent*** was higher than recent years.
- Ice ***thickness*** was lower than 2021 in all NBS areas.
- Norton Sound ice thickness was 2nd lowest of record.
- Only thicker ice in 2022 was St. Matthew to St. Paul, which had near-zero in 2021.

Source: Alfred Wegener Institute, https://www.meereisportal.de/en/

Cold Pool

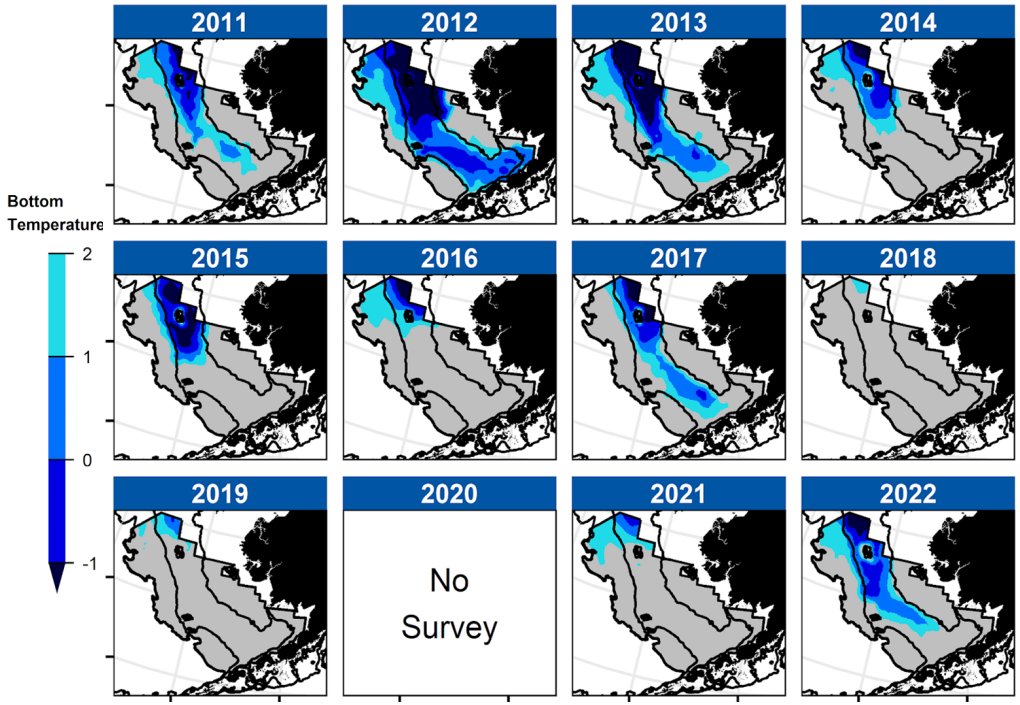
Kearney



- Bering 10K ROMS hindcast of bottom water temperature, extracted for July 1 of each year.
- 2022 very near the historical average based on the amount of 2°C and 0°C water.
- 2022 resembles other average-to-cool years, most similar to 2017.

Cold Pool

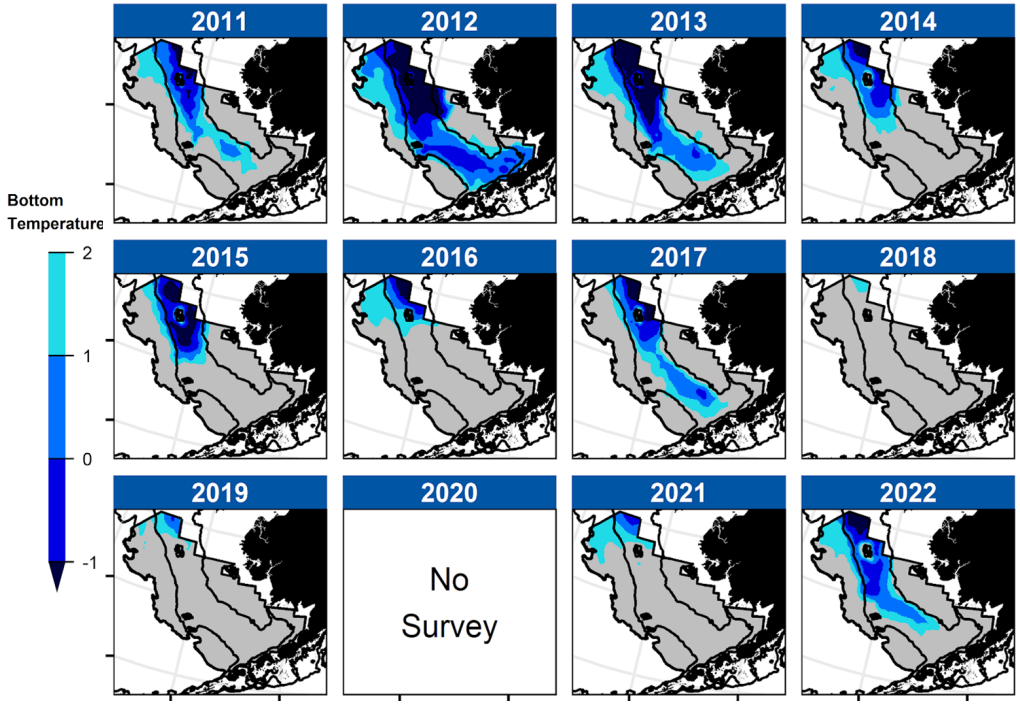
Rohan & Barnett

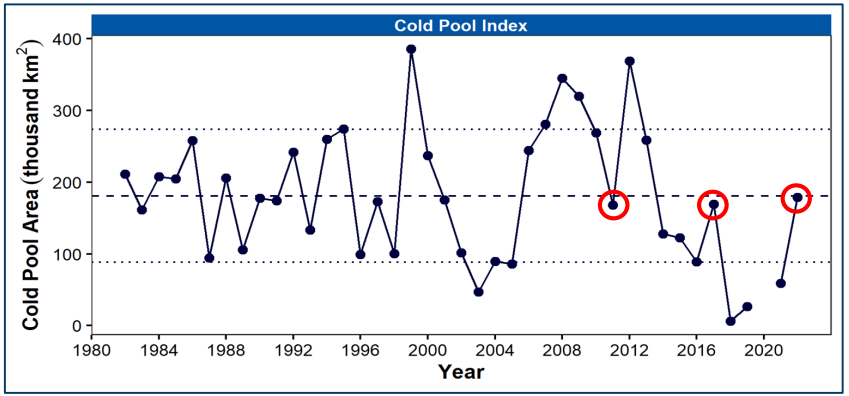


- Cold pool extent was approximately equal to the time series mean.
- Cold pool covered most of the middle shelf north of 57°N.
- Cold pool was similar to 2011 and 2017.

Cold Pool

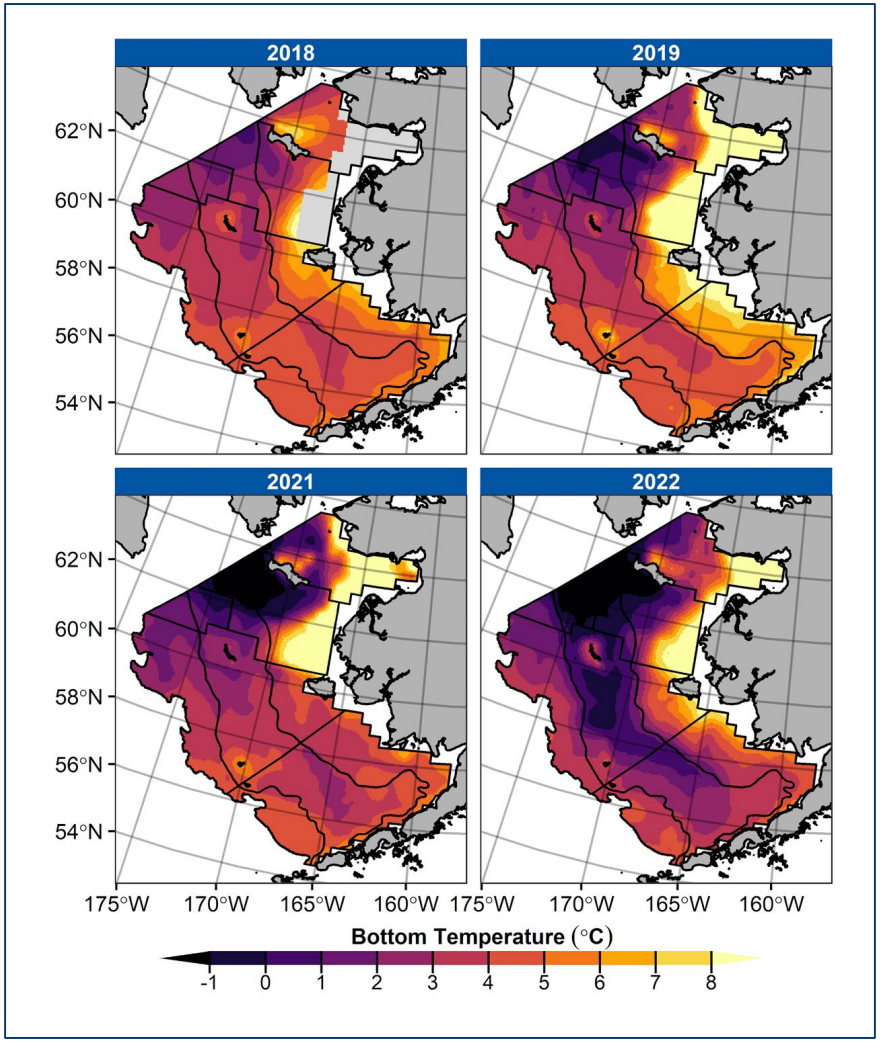
Rohan & Barnett





Cold Pool

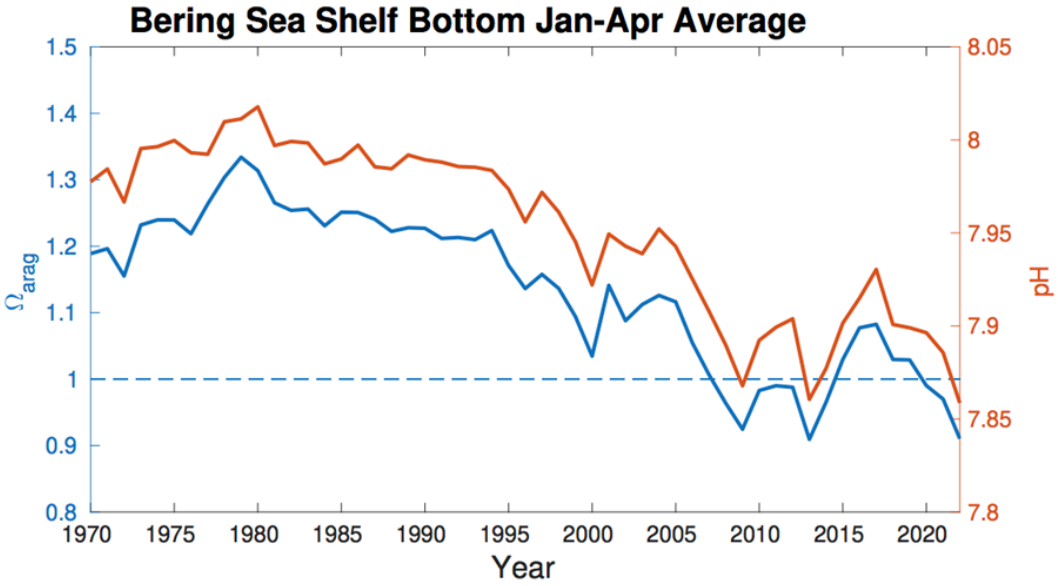
Rohan & Barnett

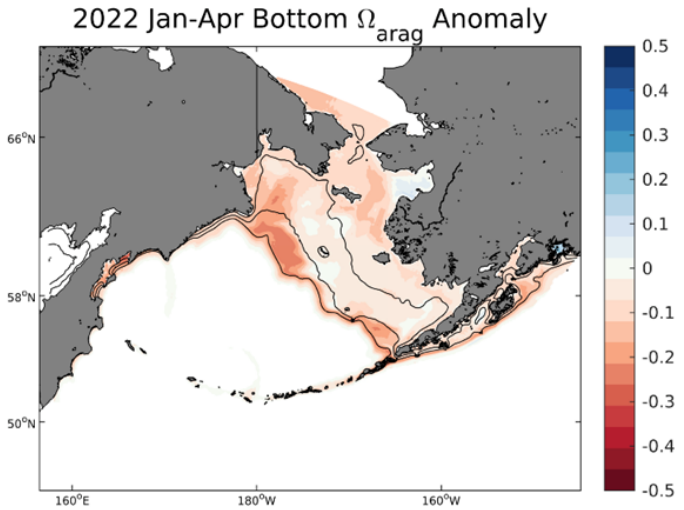


- Bottom temperatures over EBS and NBS survey areas.
- 2019 had extremely warm inner domain waters.
- 2022 cold pool extended over middle domain of EBS and NBS shelves.

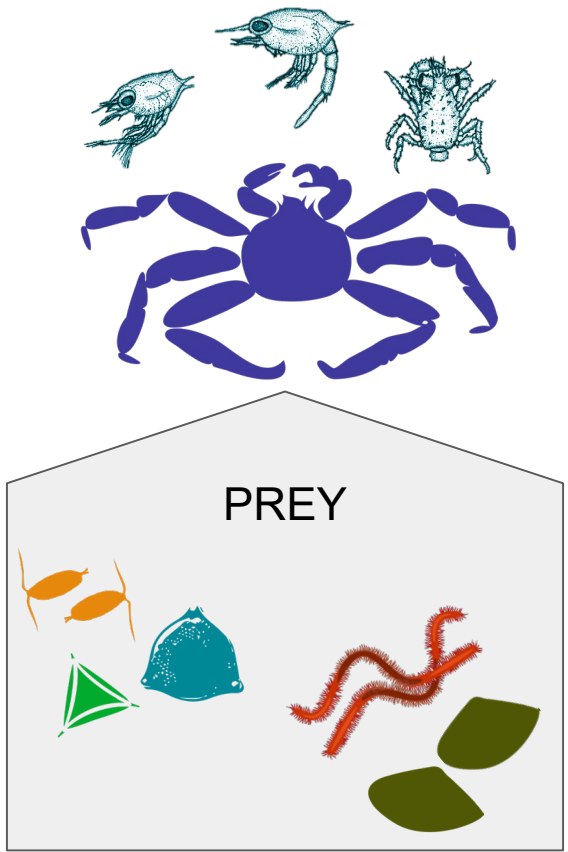
EBS Ocean Acidification

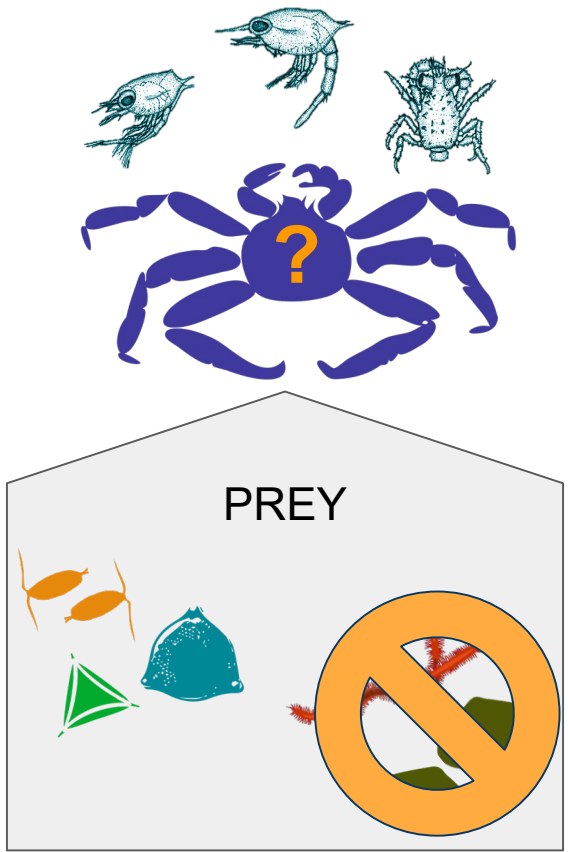
Pilcher & Cross

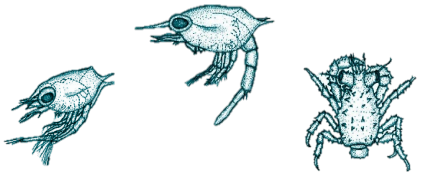




- Through April 2022, Ω_{arag} is 2nd lowest over hindcast and pH is the lowest.
- Low anomalies throughout most of shelf, but particularly strong on outer shelf.

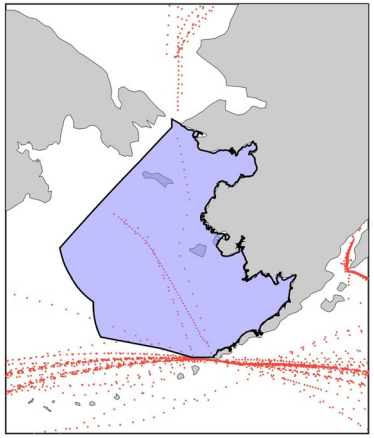

PREY

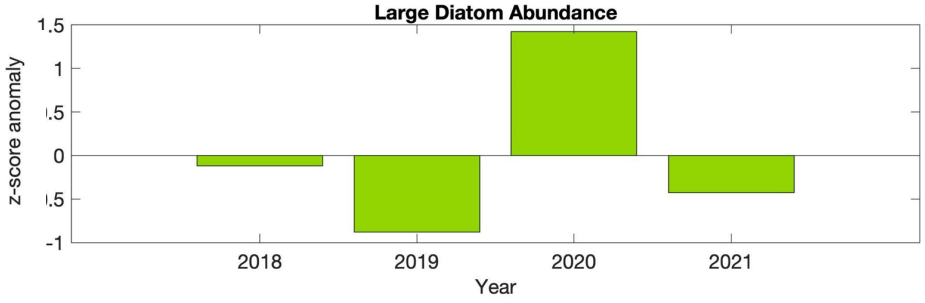

?
PREY

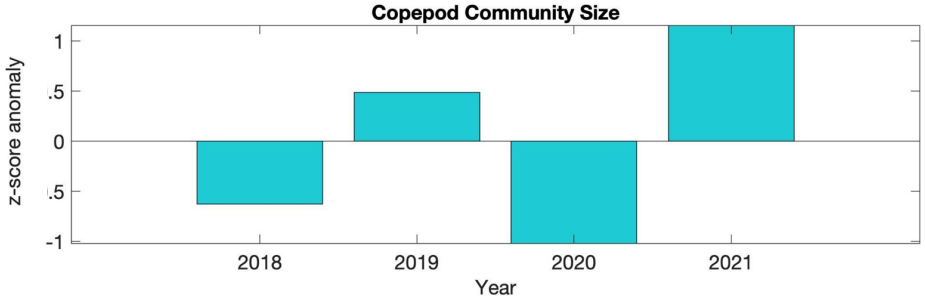


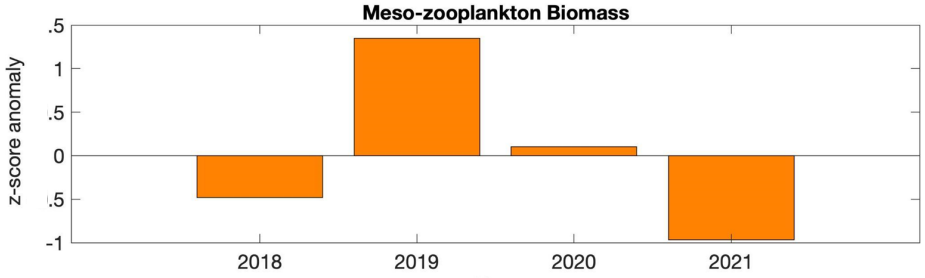
2021 Continuous Plankton Recorder

Ostle & Batten

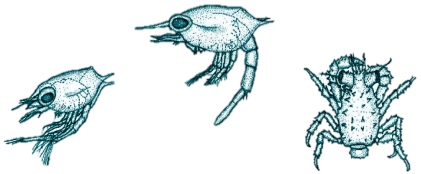


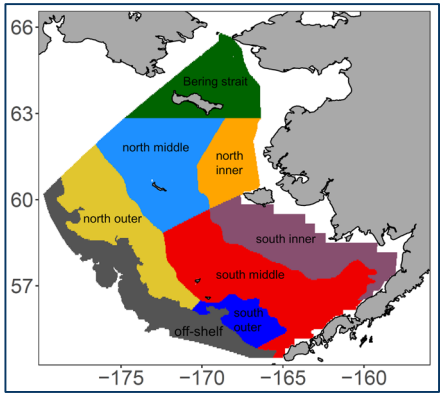






- The mean diatom abundance was negative in 2021.
- Copepod community size was positive in 2021, where it had been negative in 2020.
- Mesozooplankton biomass was negative in 2021, where it had been positive in 2020.

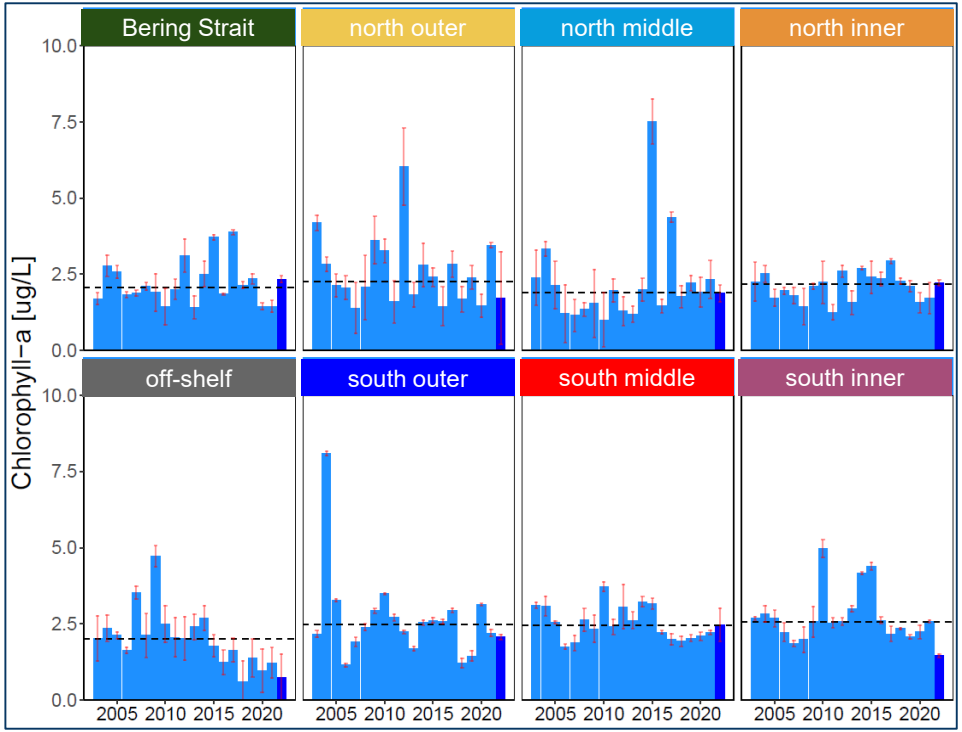


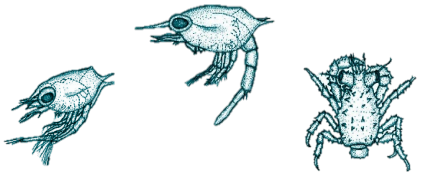


2022 Spring Bloom

Nielsen

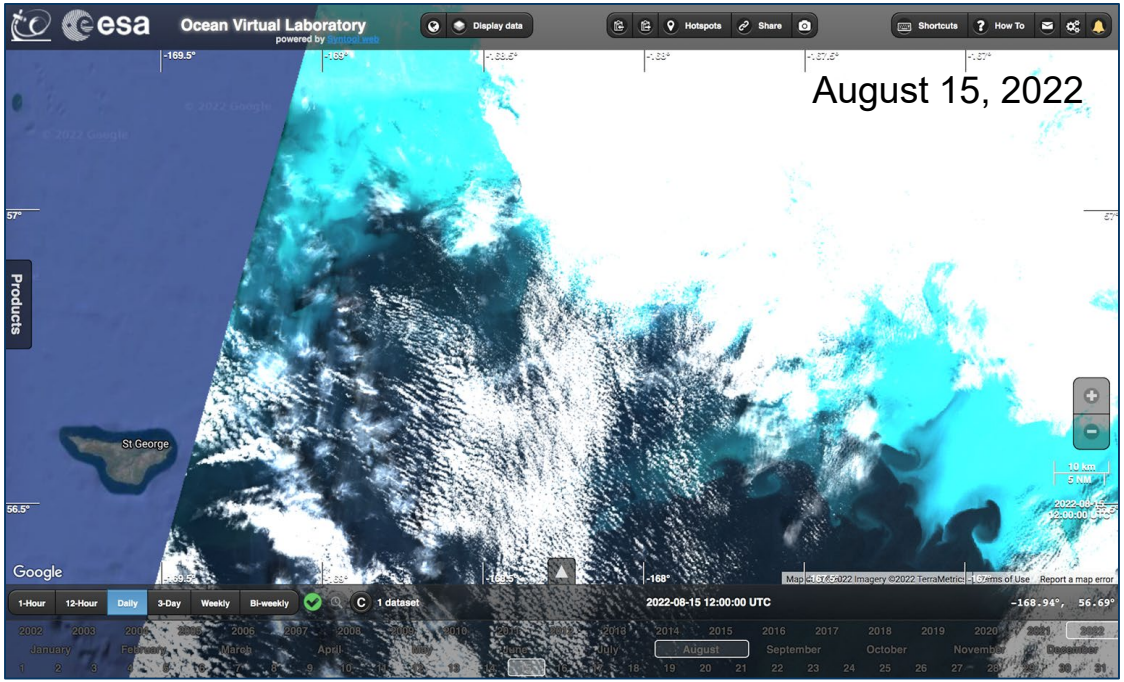
- *Preliminary interpretation:*
- Chl-*a* biomass trends are close to the long term average.
- Exceptions are the south inner, south outer, and the off-shelf (which continues a low trend).
- Bloom timing (*figure not shown*) appears average.



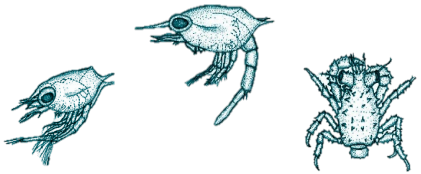


2022 Coccolithophores

Gann & Lange

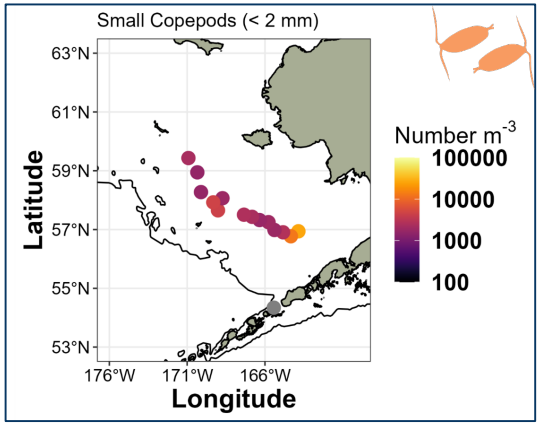


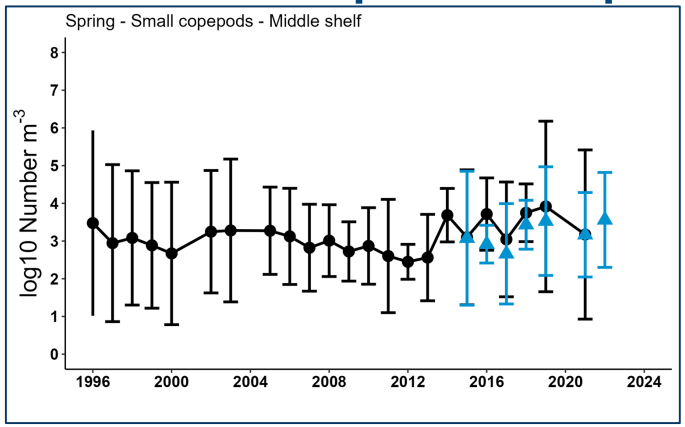
- Coccolithophore bloom index was low in 2018 and 2019, but higher in 2020 and 2021.
- 2022: a noticeable coccolithophore bloom (full index available in October).
- *Implications:* coccolithophores result in longer trophic chains, may be a less desirable food source, and can reduce foraging success for visual predators.

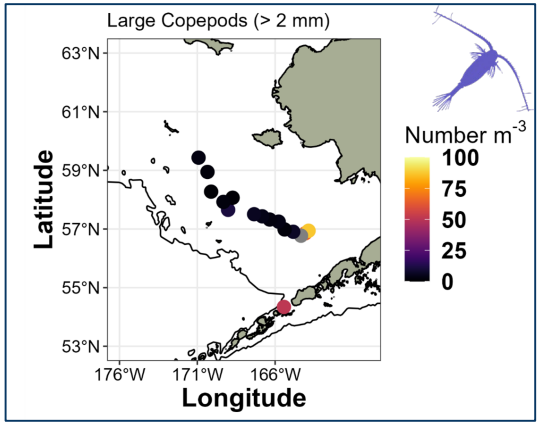


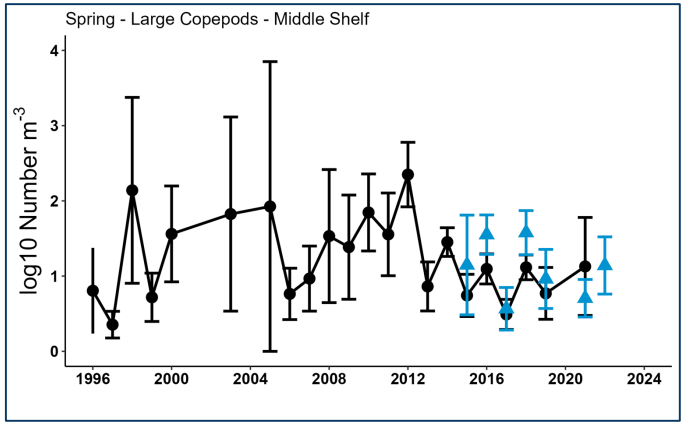
Spring 2022 Rapid Zooplankton Assessment

Kimmel



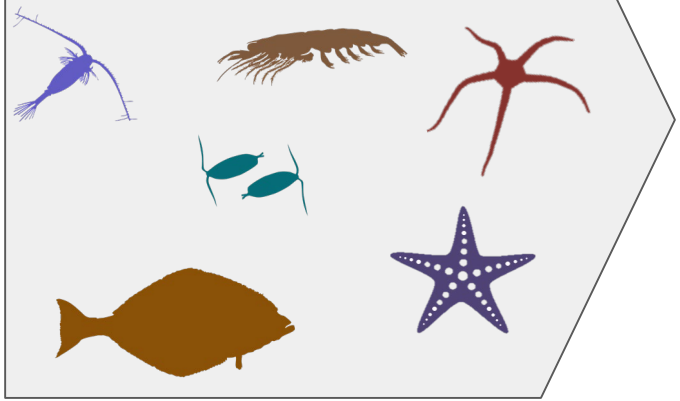


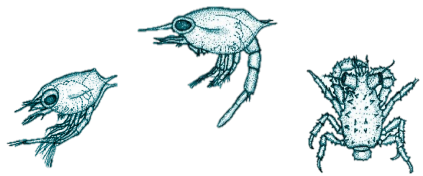


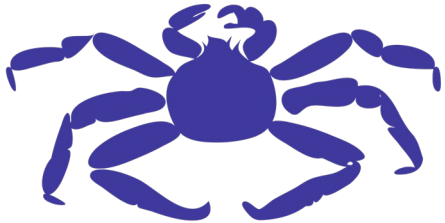


- Copepods were more abundant than 2021, particularly small copepods.
- *Calanus* (a large copepod) were low in lipid.

COMPETITORS



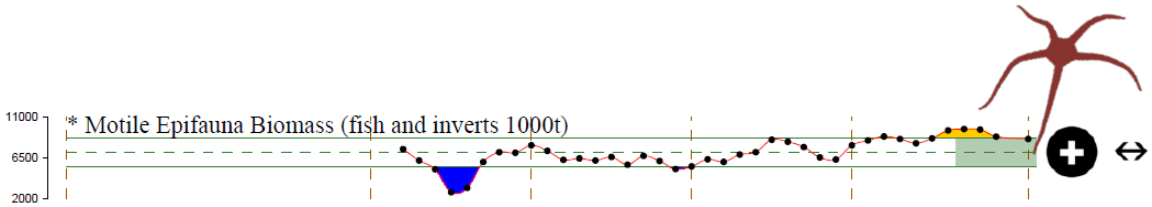




2021 Motile Epifauna and Benthic Foragers

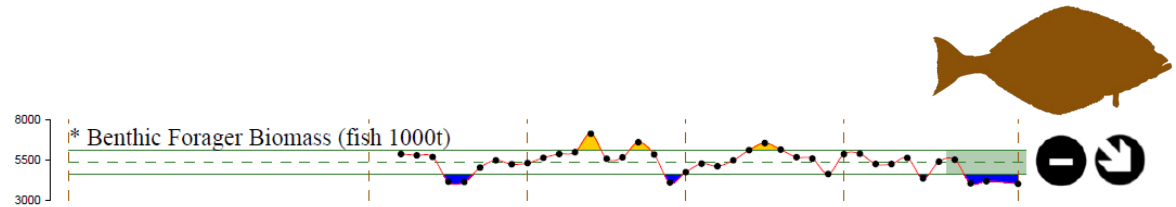
Whitehouse

Motile epifauna and benthic foragers are competitors with benthic crab for prey and space.



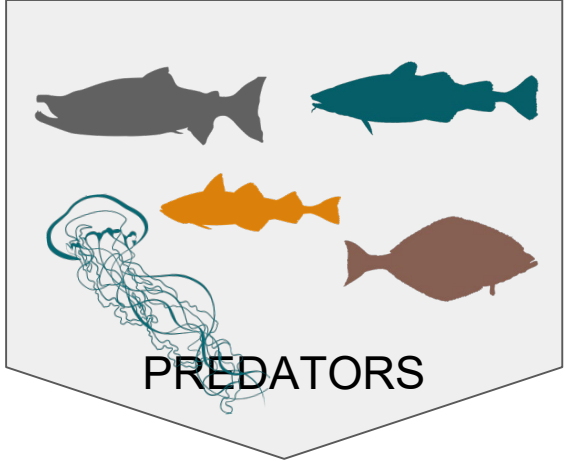
Indicates benthic productivity

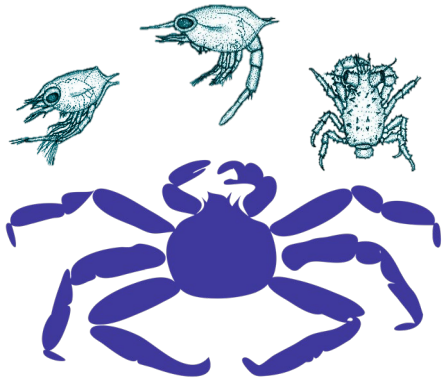
- Motile epifauna biomass peaked in 2017 and remained above the long-term mean in 2021.



Indirect indicator of infauna

- Benthic foragers biomass was at the **lowest level in the time series** in 2021.

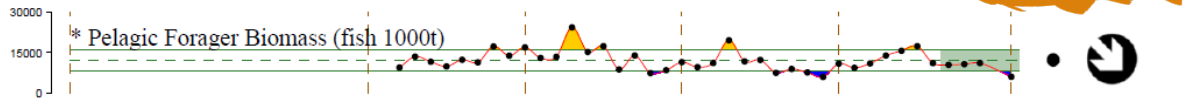

PREDATORS

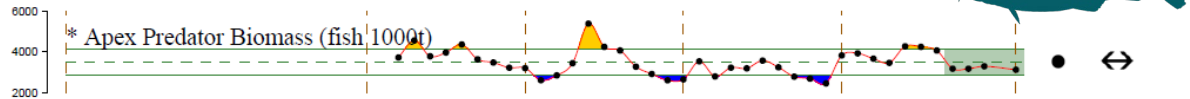


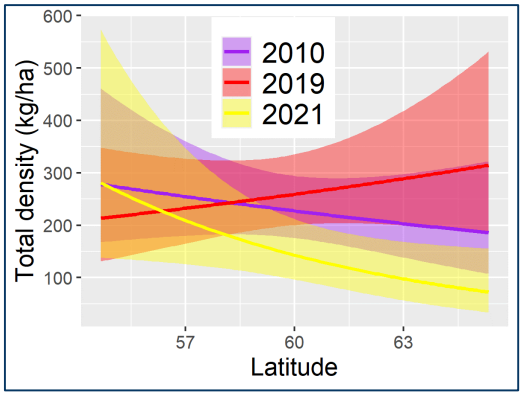
2021 Pelagic Foragers and Apex Predators

Whitehouse

Pelagic foragers are predators of larvae while apex predators consume small benthic crab stages.



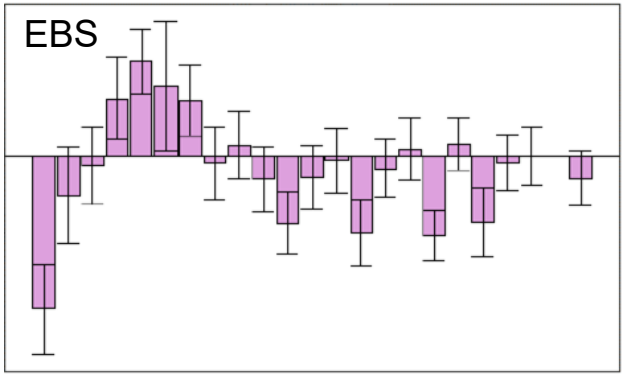


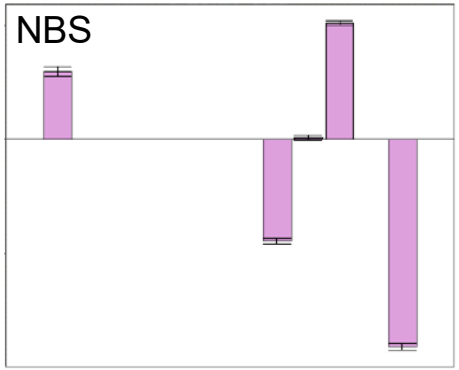


- Pelagic foragers (pollock and jellyfish) dropped to 2nd lowest in time series in 2021.
- Apex predators (P. cod and ATF) were within 1SD in 2021.
- Northward shift of the fish community reversed in 2021; CPUE in NBS decreased from 2019 to 2021.

2021 Adult Pacific Cod Condition

Rohan & Prohaska, Holsman

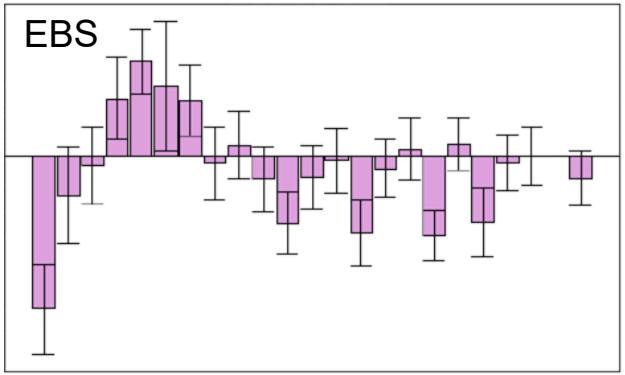


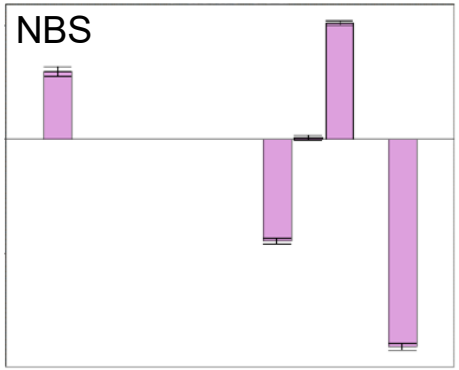


- EBS: PCod condition was negative (95%CI incl. mean) and across all strata
- NBS: PCod condition was negative.

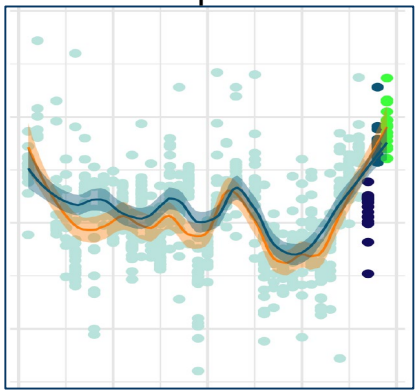
2021 Adult Pacific Cod Condition

Rohan & Prohaska, Holsman

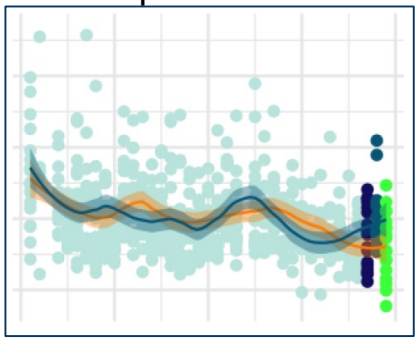




Thermal experience



Growth potential

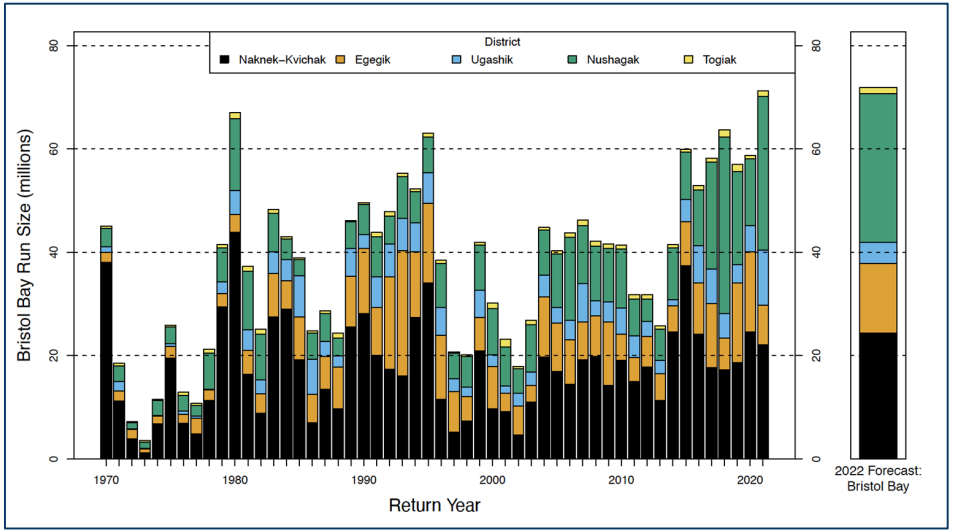


- EBS: PCod condition was negative (95%CI incl. mean) and across all strata.
- NBS: PCod condition was negative.
- Bioenergetics through 2019 indicate increased temperature led to increased metabolic demand while foraging rates and prey energy decreased.
- This resulted in a decline in growth potential

2022 Bristol Bay Sockeye Salmon

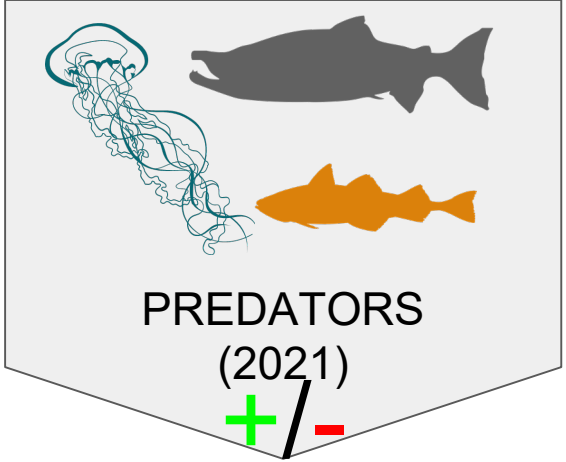
Cunningham

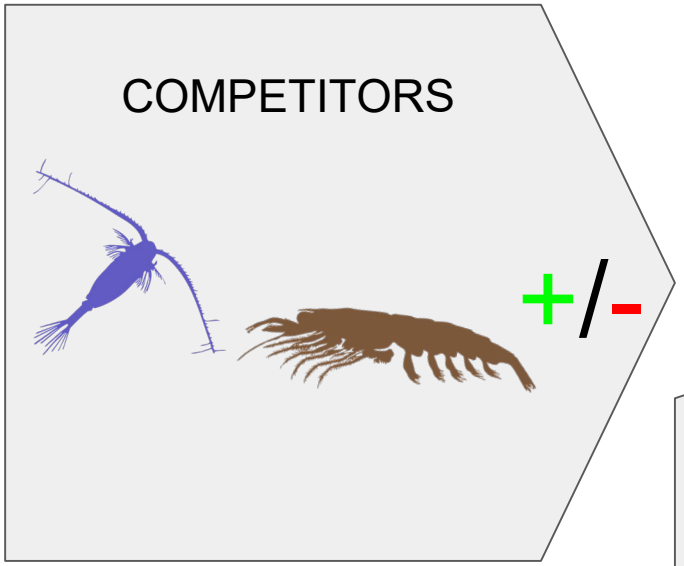
- 2022 was largest run on record (>78 mil).
- Small size at age (density-dependent growth).
- Higher than expected proportion of 1.3 fish.
- Juvenile sockeye feed on zooplankton and age-0 pollock in warm years; adults feed on zooplankton and krill.
- Are there system-wide impacts?

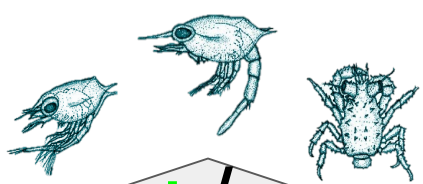


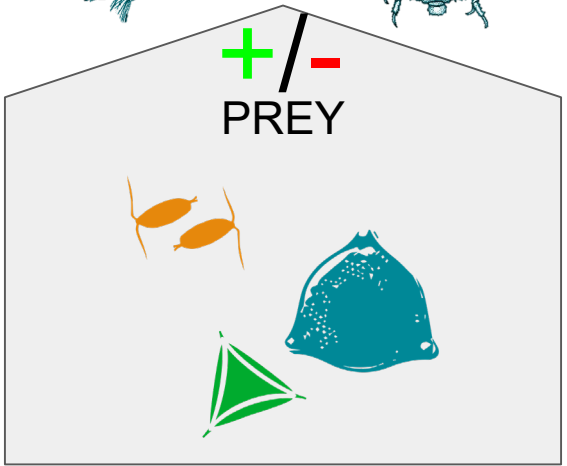
2022 Summary

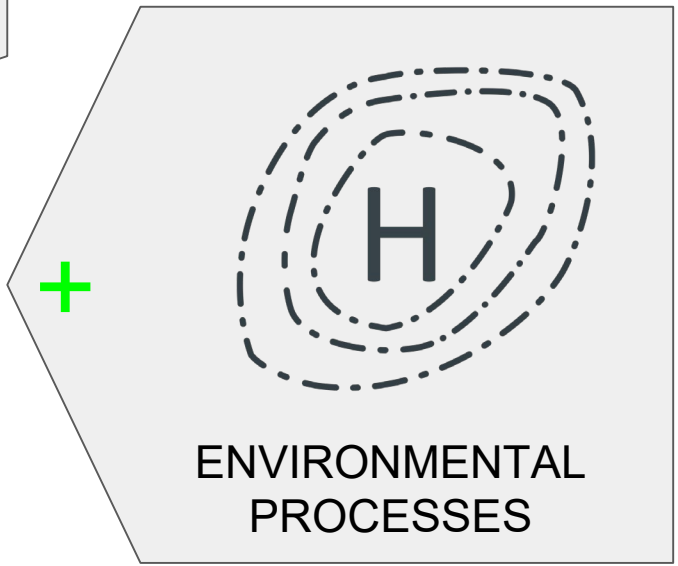
& Larval Implications











2022 Summary

& Adult Implications

PREDATORS
(2021)

=

COMPETITORS
(2021)

-

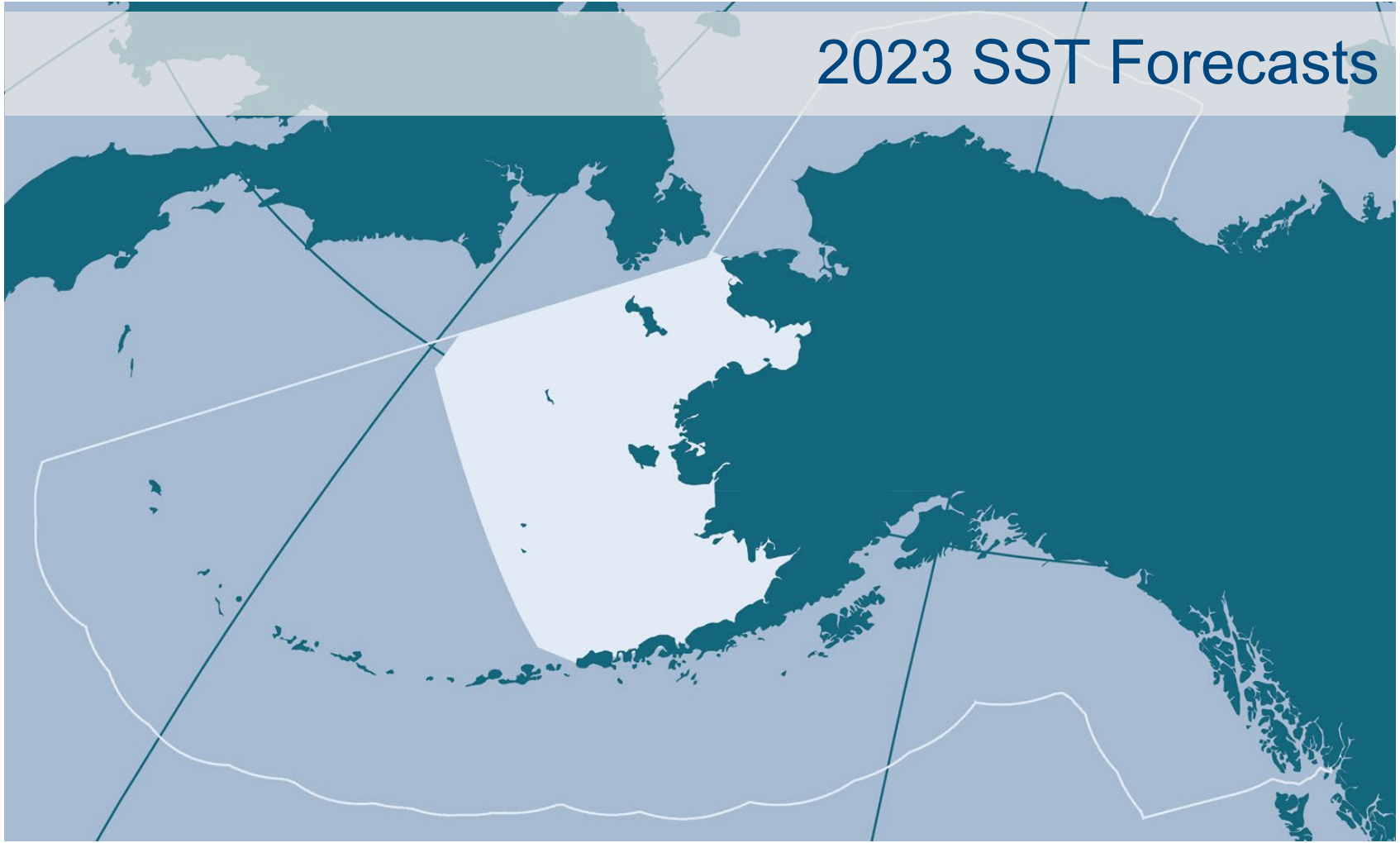
?

PREY

+

ENVIRONMENTAL
PROCESSES

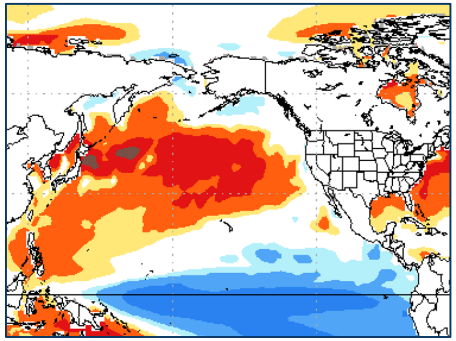
2023 SST Forecasts



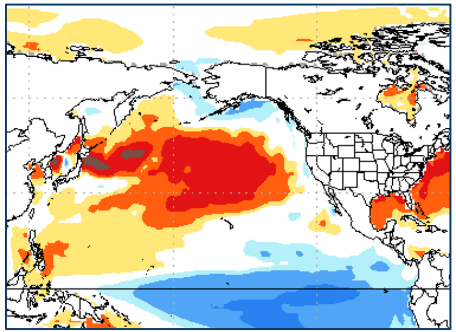
SST Projections from the National Multi-Model Ensemble

Bond

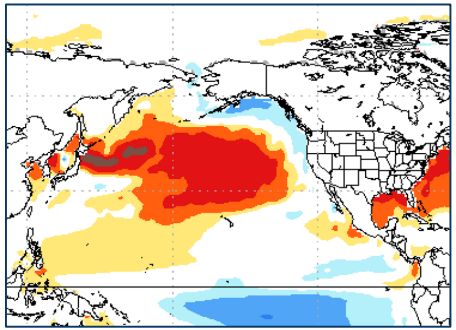
Oct - Dec 2022



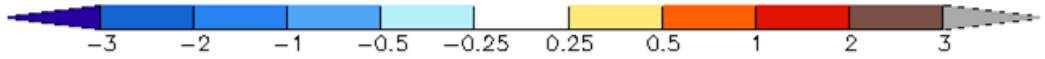
Dec 22 - Feb 23

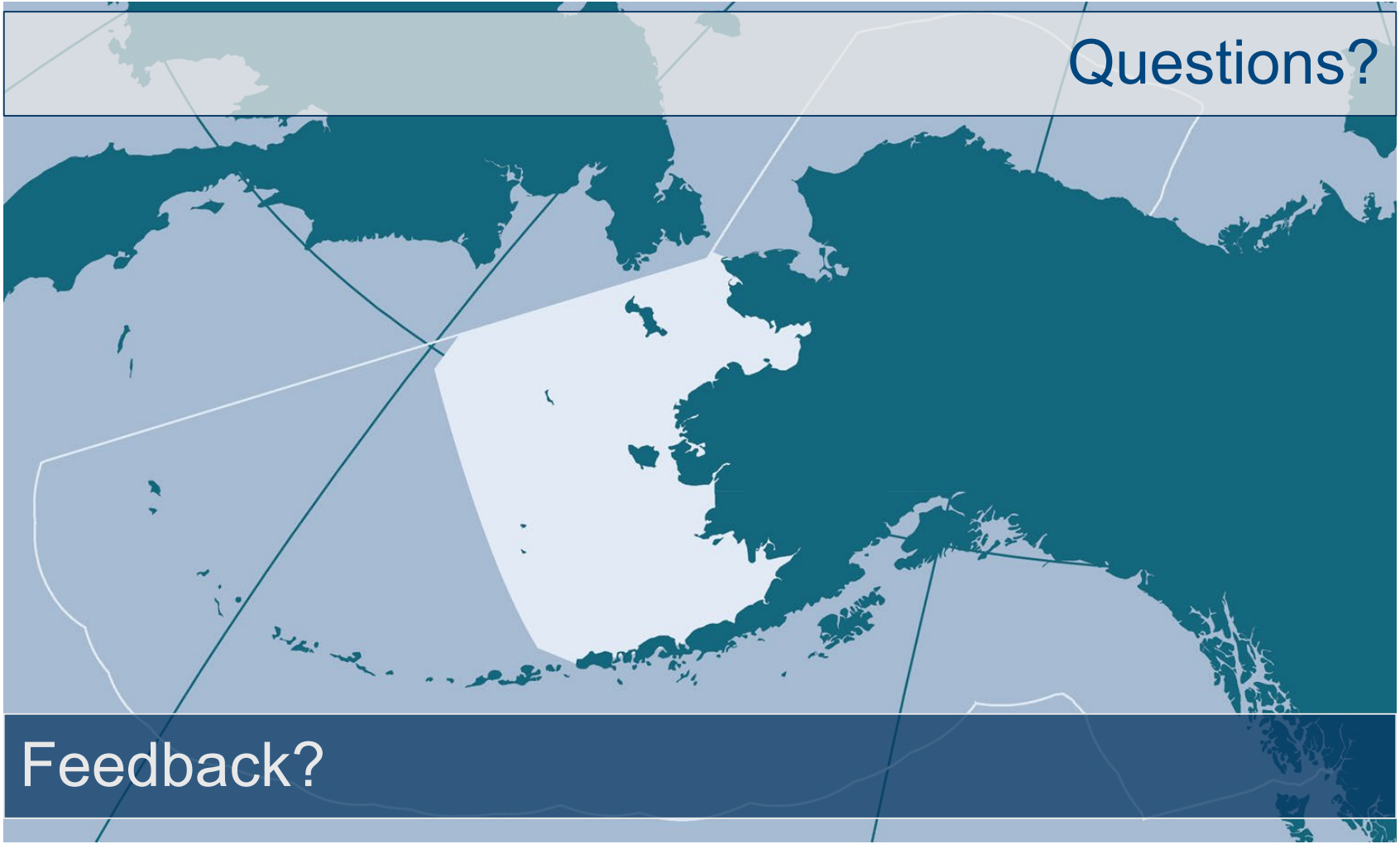


Feb - April 2023



- **TOP**: Near-normal temperatures are predicted for Alaskan waters (except WAI has positive anomalies).
- **MIDDLE**: Similar to previous period. A weak-moderate La Niña is projected.
- **BOTTOM**: Forecasts for the EBS shelf range from moderately below to moderately above normal temperatures. Most of the models suggest reasonably normal conditions that would result in ice extending south of 60˚N and as far south as Bristol Bay.




Questions?
Feedback?