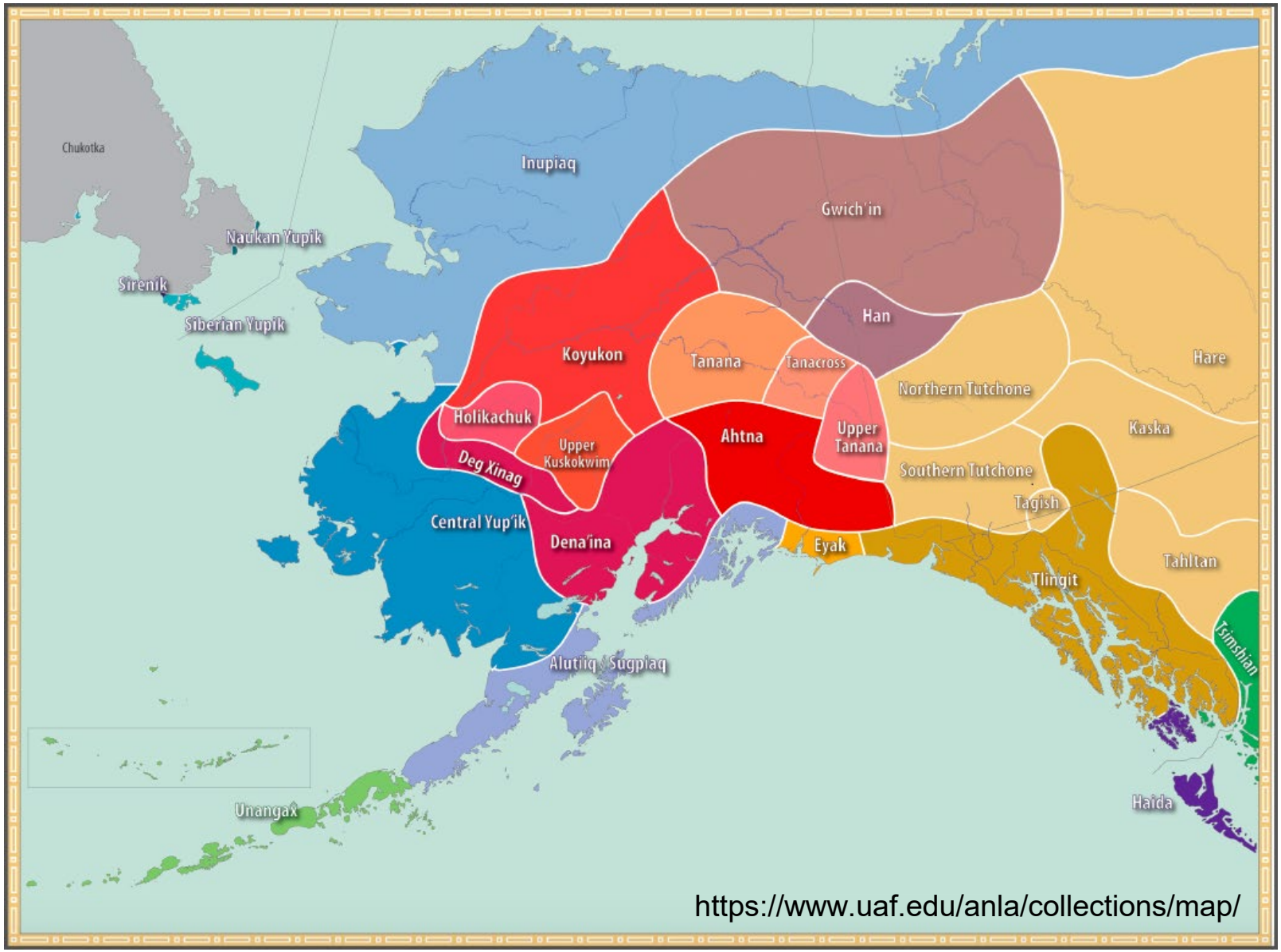
Eastern Bering Sea Ecosystem Status Report

NPFMC
Scientific & Statistical Committee
December 3, 2021

Elizabeth Siddon

Land Acknowledgement



2021 Contributors

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Thank you!

Response to SSC Comments

The SSC commends and greatly appreciates these efforts and supports development of similar activities that incorporate local and traditional knowledge (LK/TK) and collaborations where possible.

The SSC recommends that the ESR authors pursue the systematic and consistent incorporation of LK and TK as relevant to ecosystem status reports.
The ESR editors are equally appreciative to the efforts of partners who have, and continue to, provide local and traditional knowledge (LK/TK) that better our understanding of ecosystem dynamics in the region. We continue to explore and invite partners to contribute to the ESRs while also awaiting advice on the systematic and consistent incorporation of LK and TK through the Bering Sea LK/TK/S Task Force.

The combined climate section and the combined seabird section were both excellent and much easier to digest. The SSC greatly appreciates these efforts to streamline the ESR without losing important information.
In 2021, we again present synthesized sections for the Physical Environment and Integrated Seabird Information.

The SSC suggests that the use of the ROMS model for predicting specific indices in 2020, such as the extent of the cold pool or measures of mean bottom temperatures, continue to be validated with appropriate comparisons of hindcasts with data available from the bottom trawl surveys.
In 2021, we include a “Noteworthy” contribution focused on ROMS bottom temperature output, including information and references on model skill and validation.

Editorial Comments (n=13)
See ESR Appendix for specific responses.

Outline

1. Summary of BSAI risk tables
2. 2021 Ecosystem Status
3. Update on topics from 2019 and 2020
4. SST forecasts for 2022
5. Summary and Implications

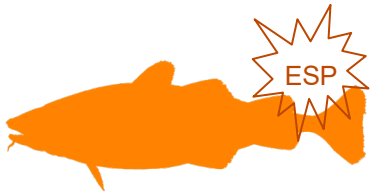
1. 2021 BSAI Risk Tables

7 full assessments for BSAI (+ Alaska-wide Sablefish):

- 4 recommended an ecosystem risk level of 1.
- 4 recommended an ecosystem risk level 2 (details below).

EBS Pollock

Prolonged warm phase, lack of cold pool, and carrying capacity concerns in the NBS

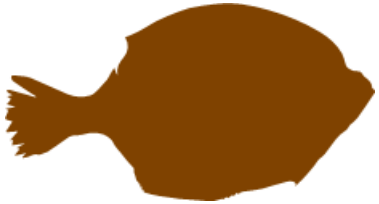


EBS Pacific cod

Prolonged warm phase, reduced prey availability and increased metabolic demands, and carrying capacity concerns in the NBS

AI Pacific cod

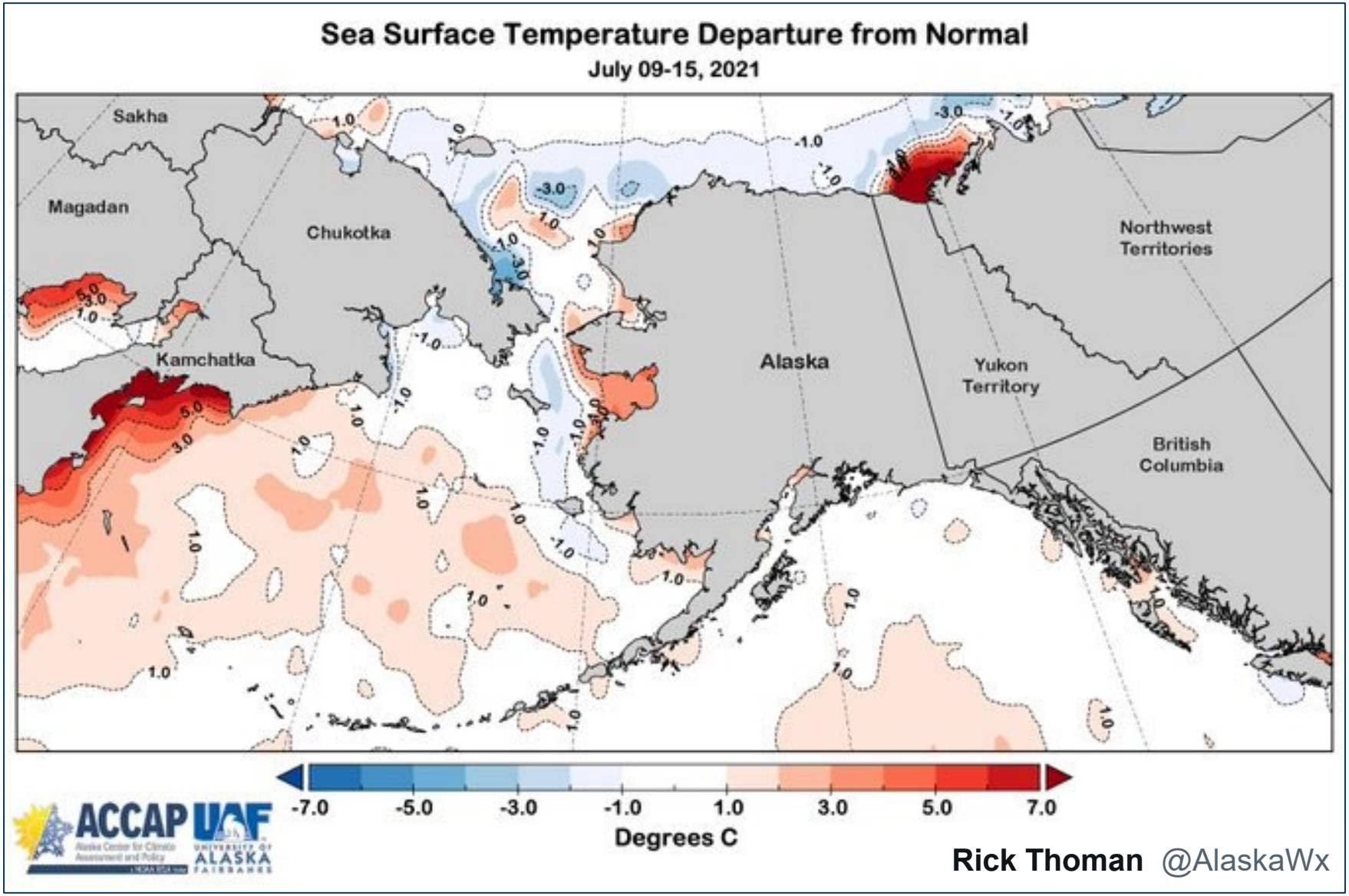
Persistent warm conditions and lower prey quality resulting in reduced fish condition



Yellowfin sole

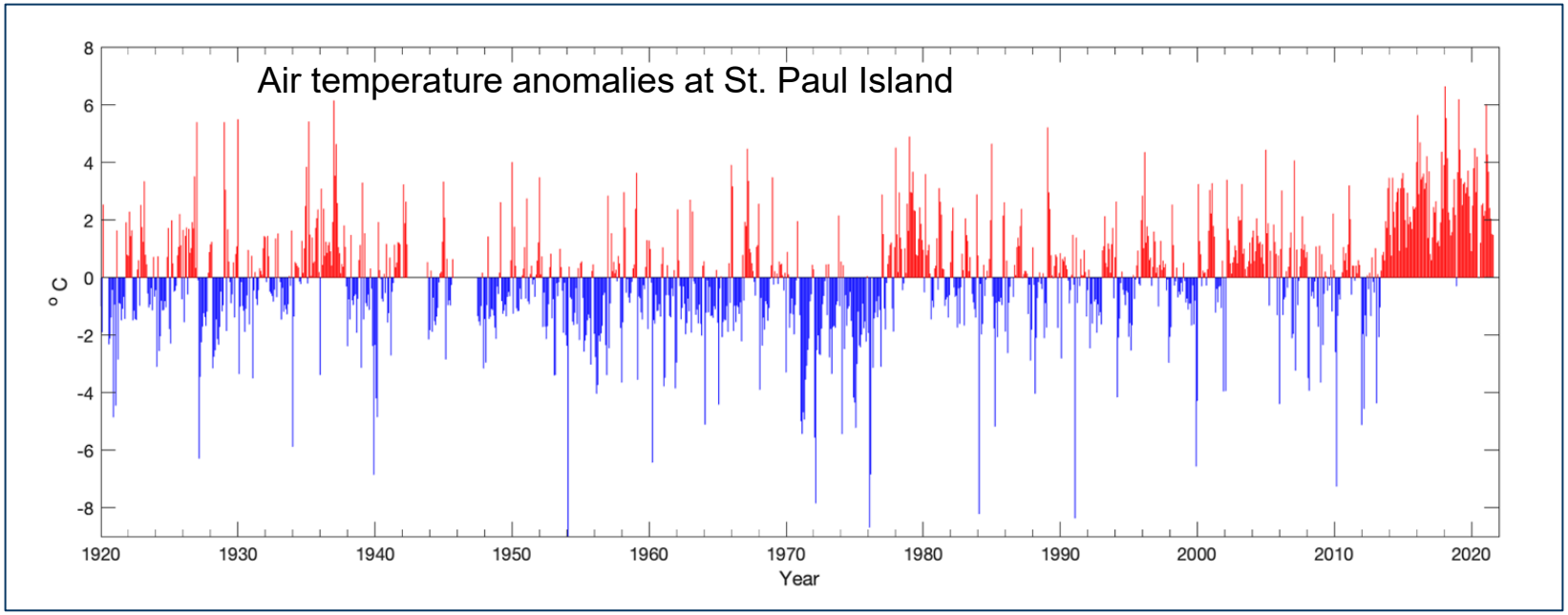
Bottom temps may exceed thermal tolerance, carrying capacity concerns in the NBS, declines in fish condition from 2019

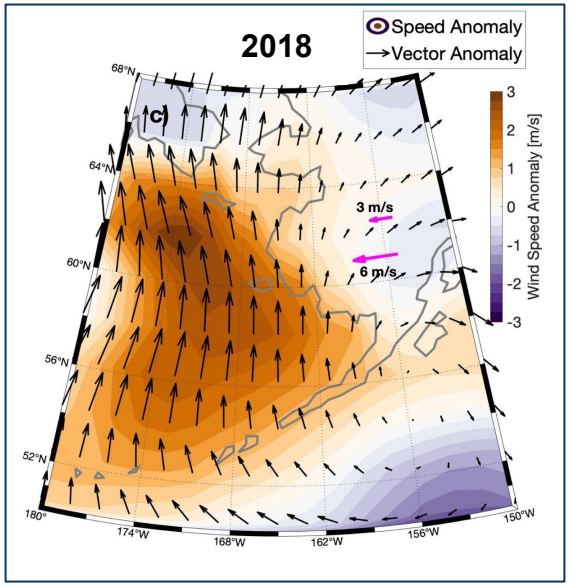
2. 2021 Ecosystem Status

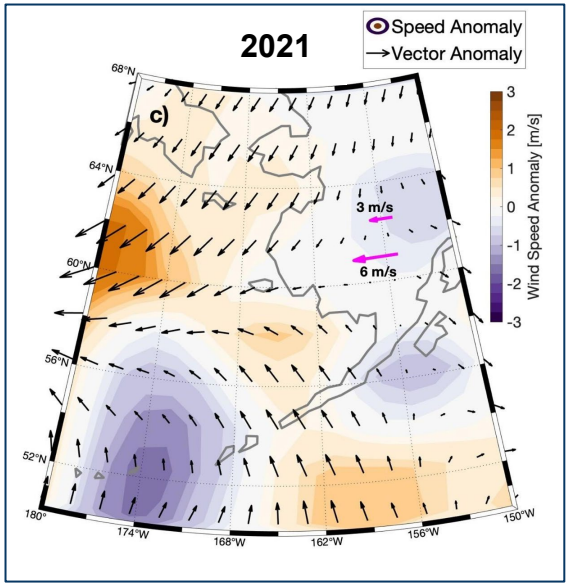


Sea ice dynamics

Overland & Wang, Hennon



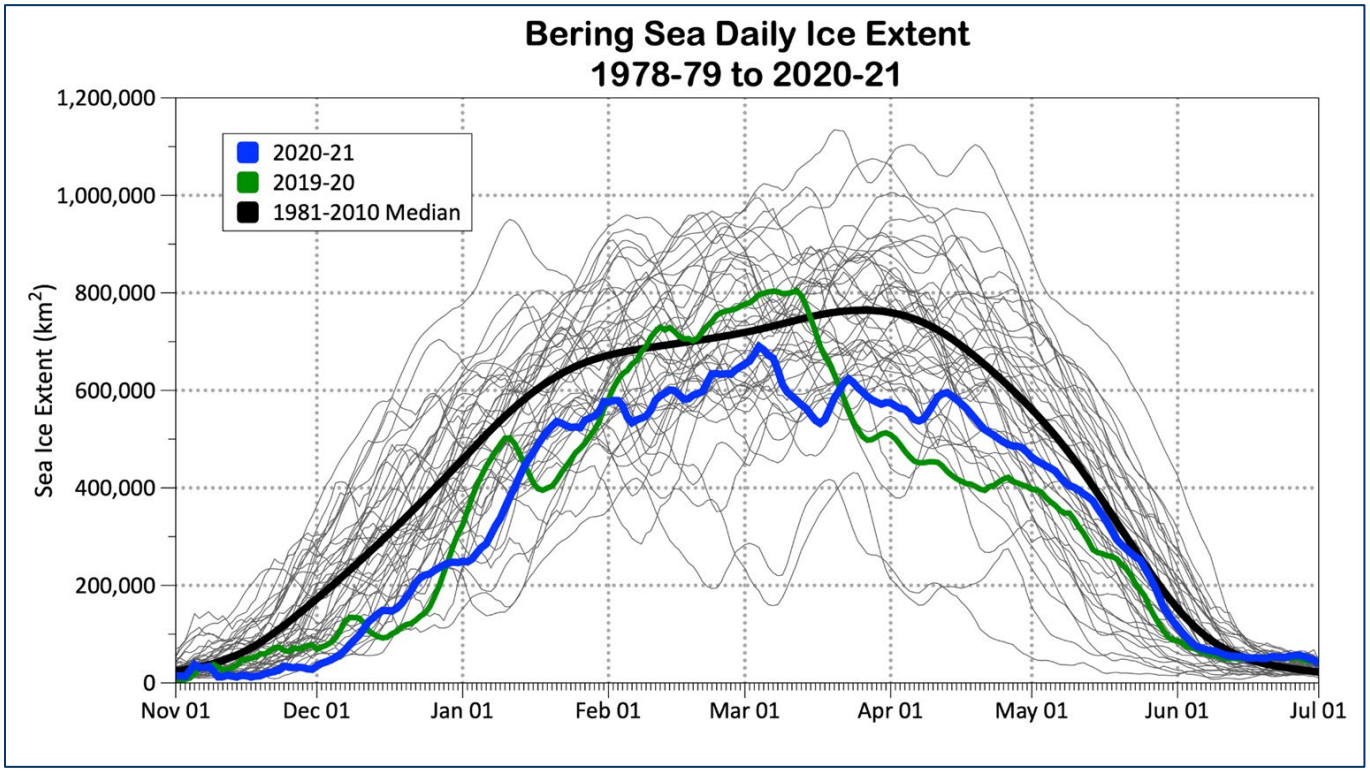




- Persistent warm phase since 2014
- Winds in Feb 2018 and 2019 were from the south
- Winds in Feb 2021 were from north in NBS and from the south in SEBS

Sea ice

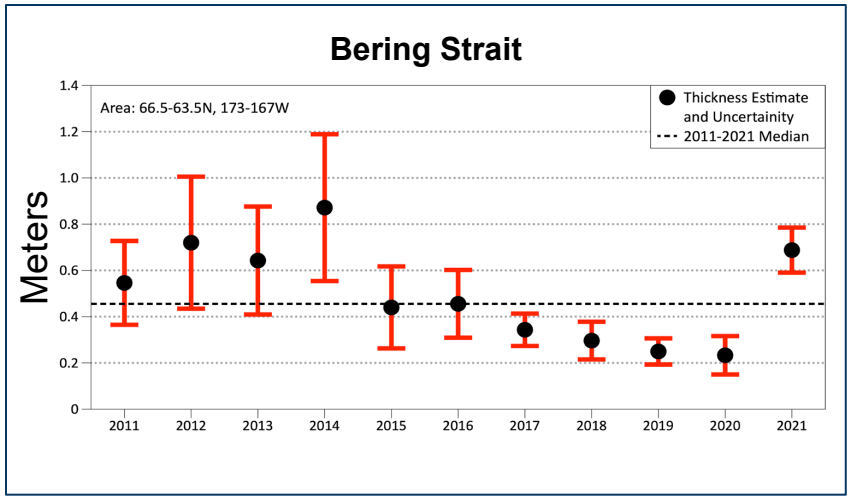
Thoman

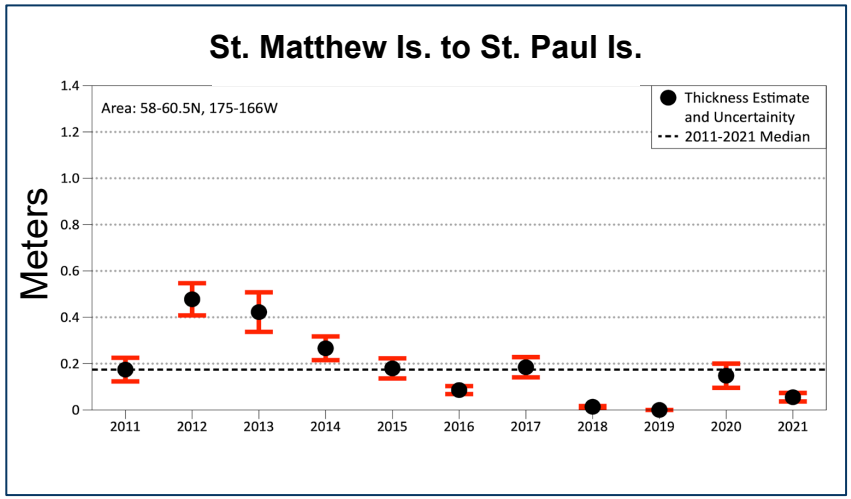


- Delayed freeze-up (‘new normal’)
- Ice advance stalled at end of January
- Ice was steady February through early April
- Wind pattern in Jan-Mar resulted in decoupled ice dynamics between the NBS and SEBS

Sea Ice Thickness

Thoman



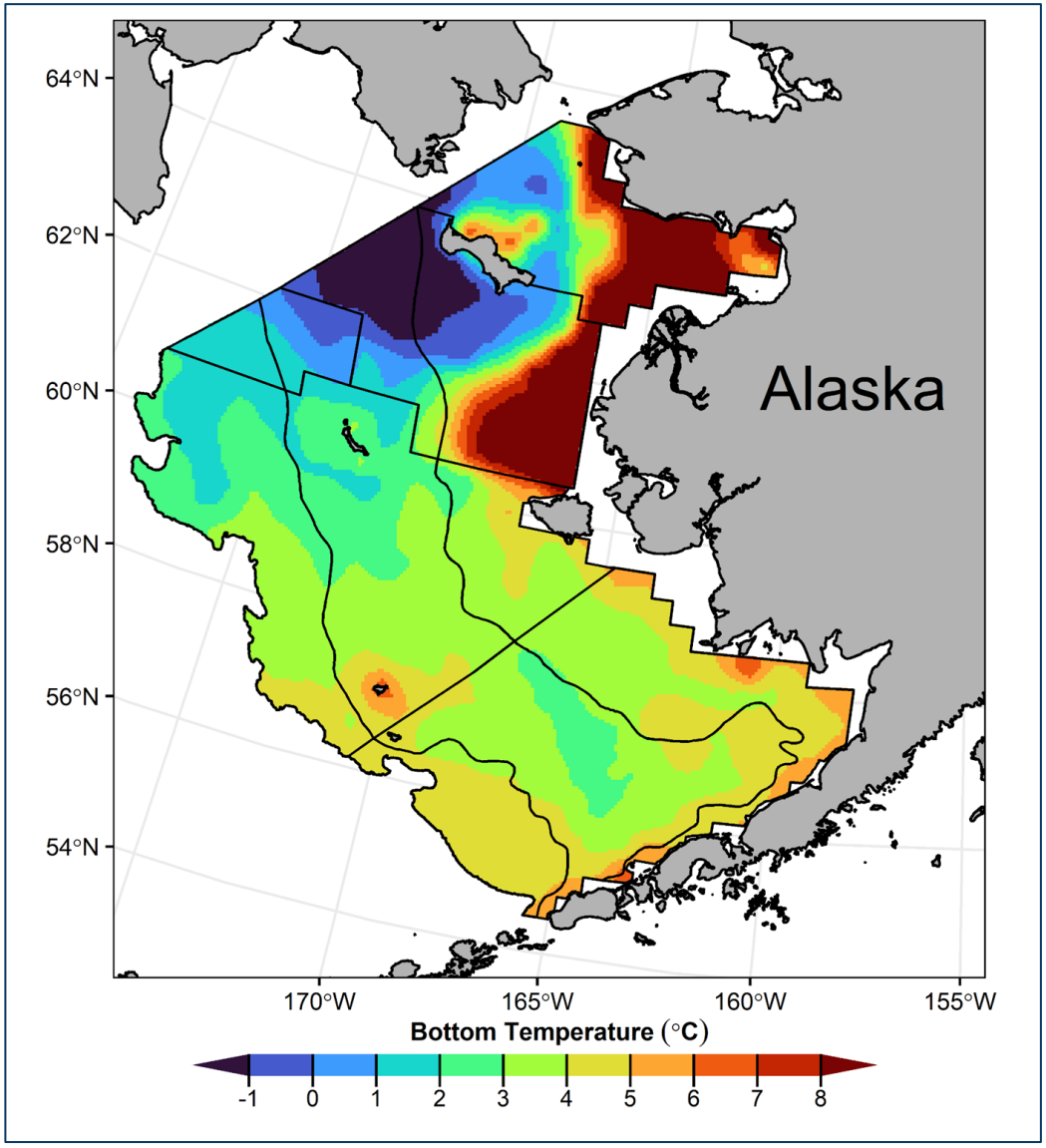


- 3rd week of March
- Ice thickness is related to duration of ice over the shelf
- *Implications* for:
  - ice-associated algae
  - stratification
  - cold pool extent

- Northern and western areas had ***increased*** ice thickness in 2021.
- South of St. Matthew Is. continued to have ***decreased*** ice thickness in 2021.

2021 bottom temperatures

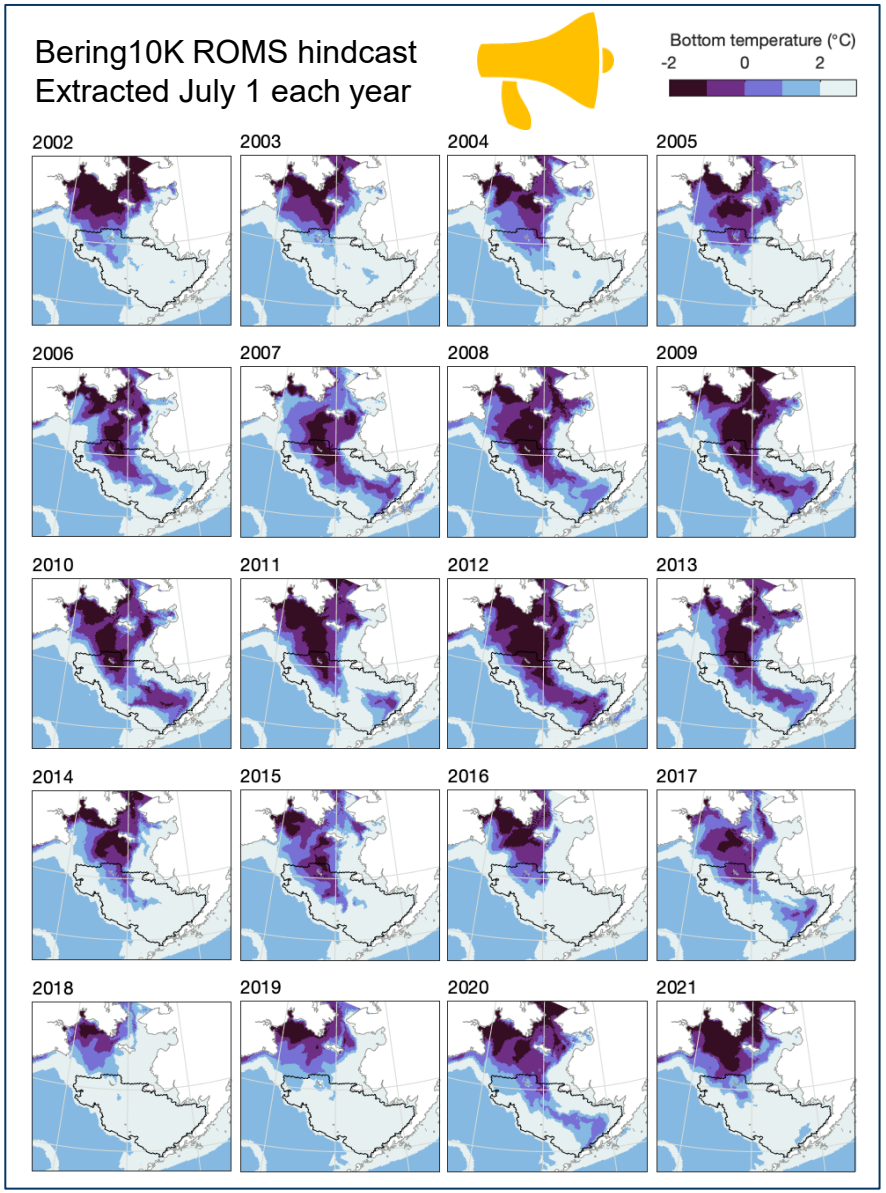
Rohan & Barnett

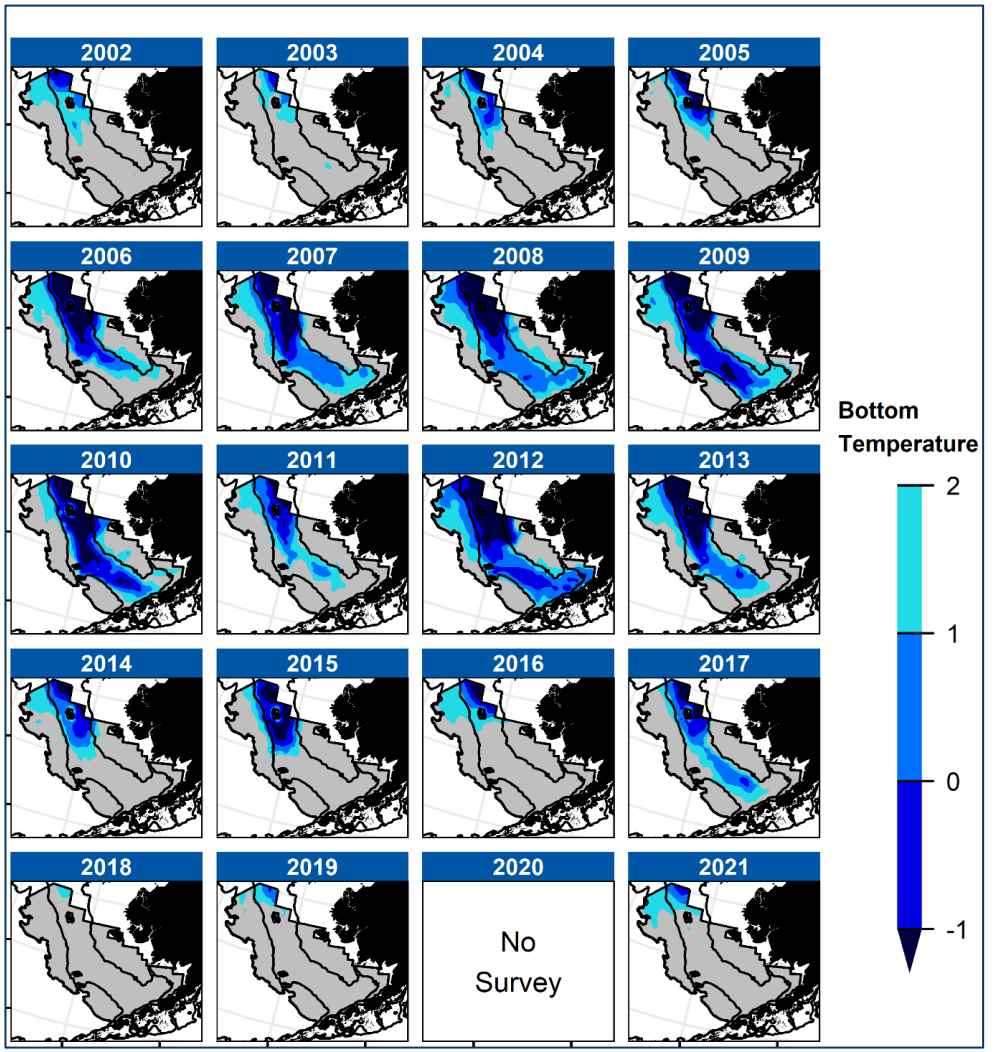


- Cold pool restricted to northwest of survey area
  - May have imposed some barrier to migration
- Extremely warm bottom waters on the northern inner shelf
  - Partially due to survey timing

2021 cold pool

Kearney, Rohan & Barnett



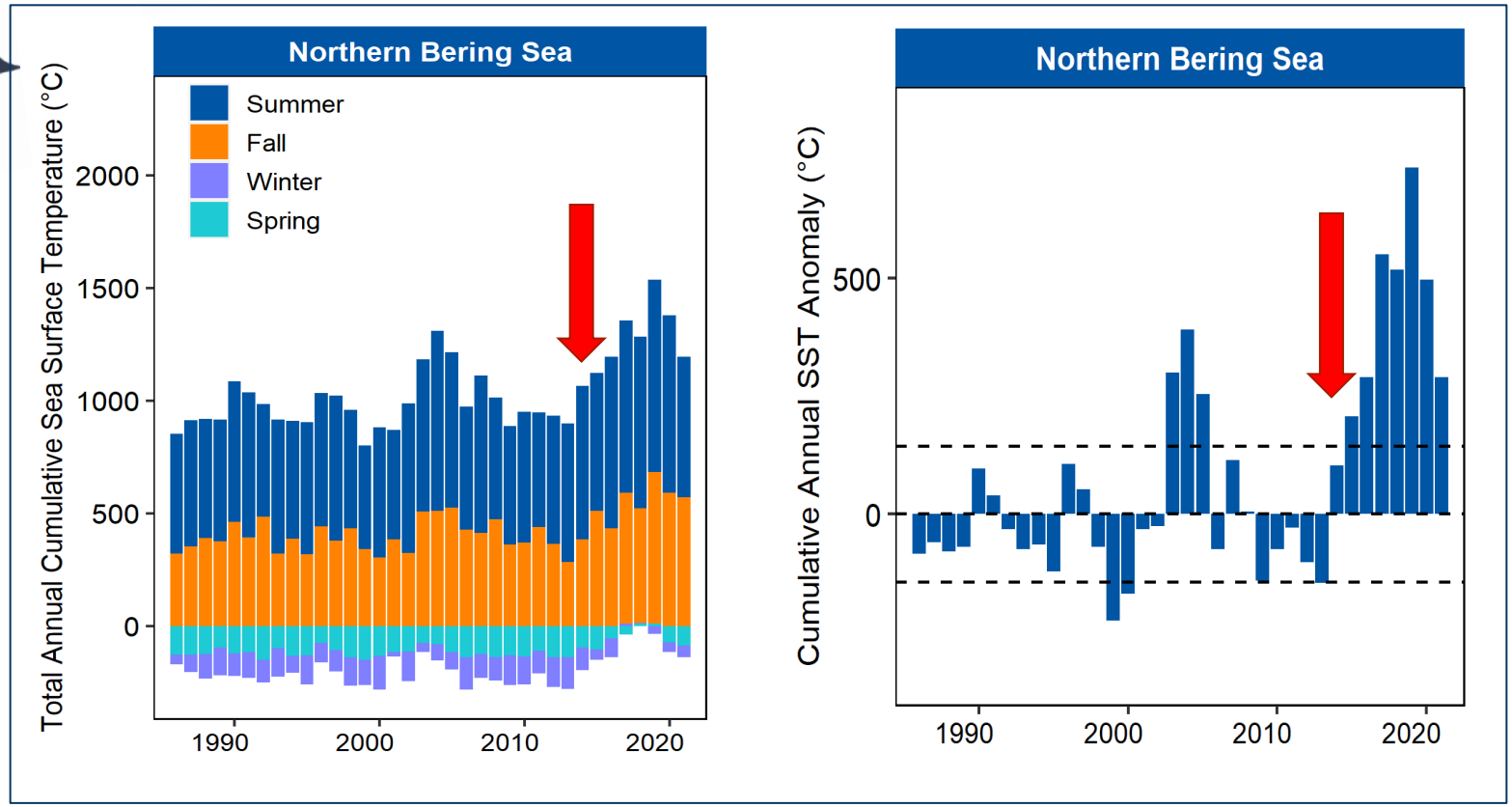


- 2021 resembles 1982 and 2004
- Warmer than average, but not extreme

- 2021 cold pool was 4th lowest on record
- >1SD below the time series mean

NBS: cumulative impacts

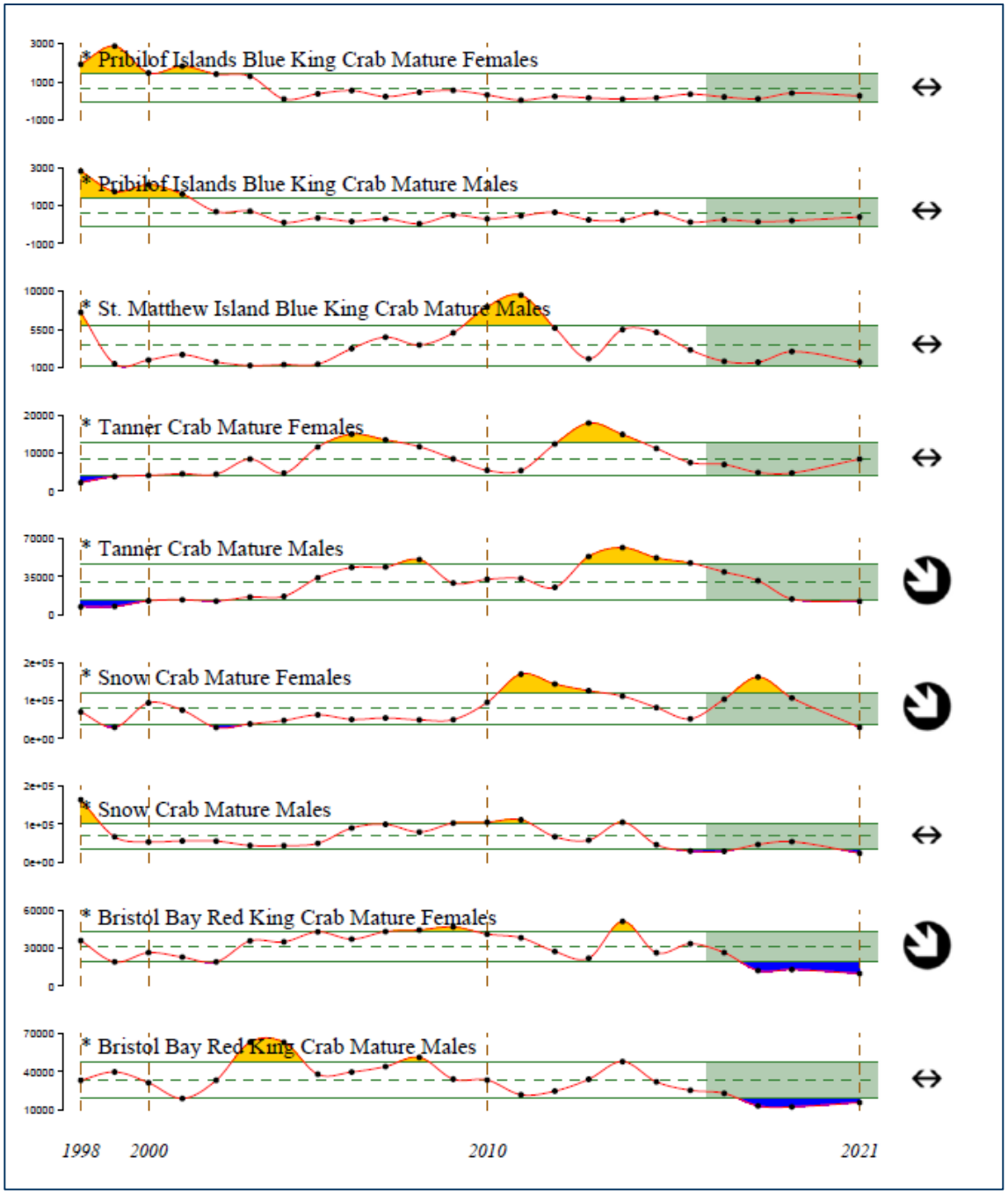
Watson & Callahan



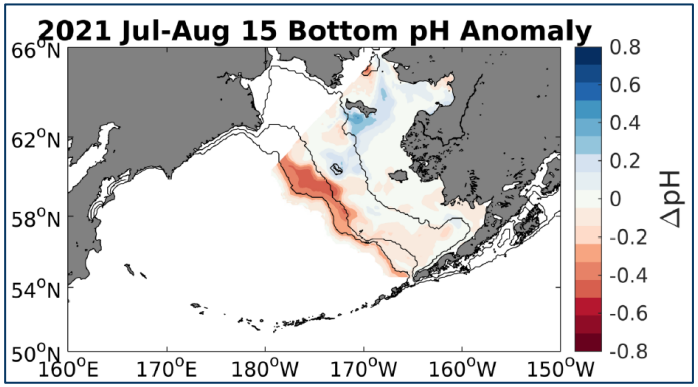
- Cumulative impacts of protracted warm phase
- Ecosystem ‘shock’ of lack of sea ice in 2017/2018 and 2018/2019
- Food web dynamics and carrying capacity concerns
  - Northward shift of fish distributions
  - Shearwater die-offs
  - Gray whale UME

NBS: crab declines

Richar, Pilcher et al.

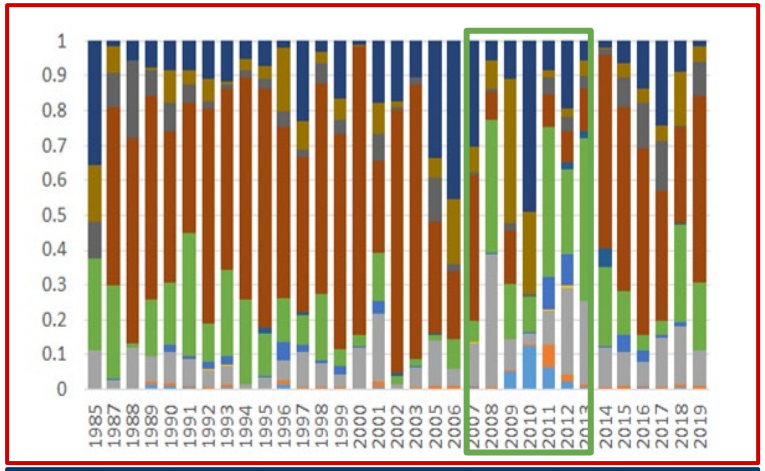


- Ecosystem explanations:
  - Predation
  - Disease
  - Temperature effects
- Persistent lower pH on outer shelf is result of changes in circulation, not OA
- At this time, no evidence that crab declines are linked to OA

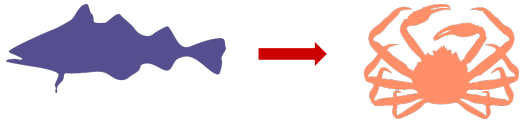


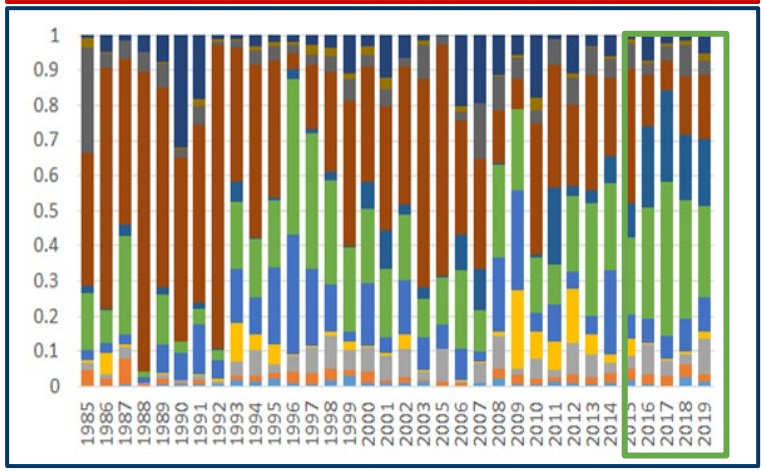
Adult Pacific Cod Food Habits

Aydin

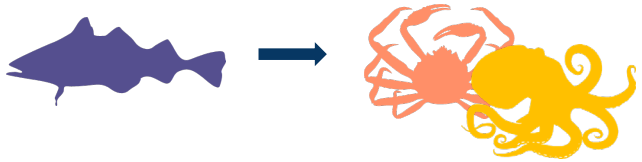


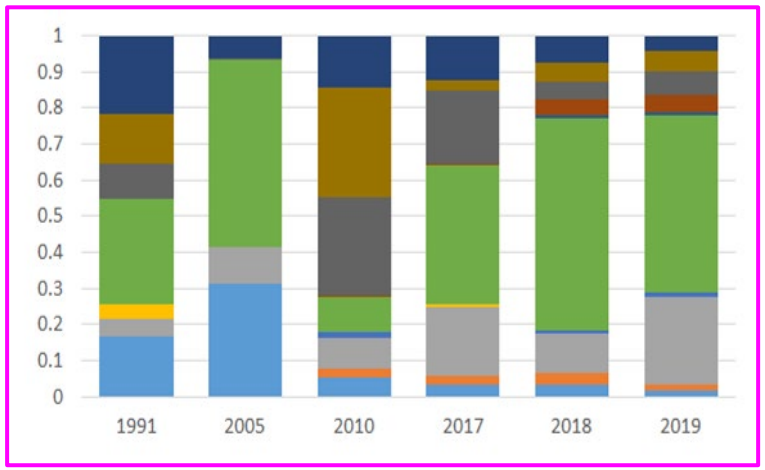
- Southeast middle: pollock are dominant, except in 2008-2012 when replaced by *Chionoecetes.*





- Northwest outer: pollock are dominant, but in 2016-2019 *Chionoecetes* and octopus increased.

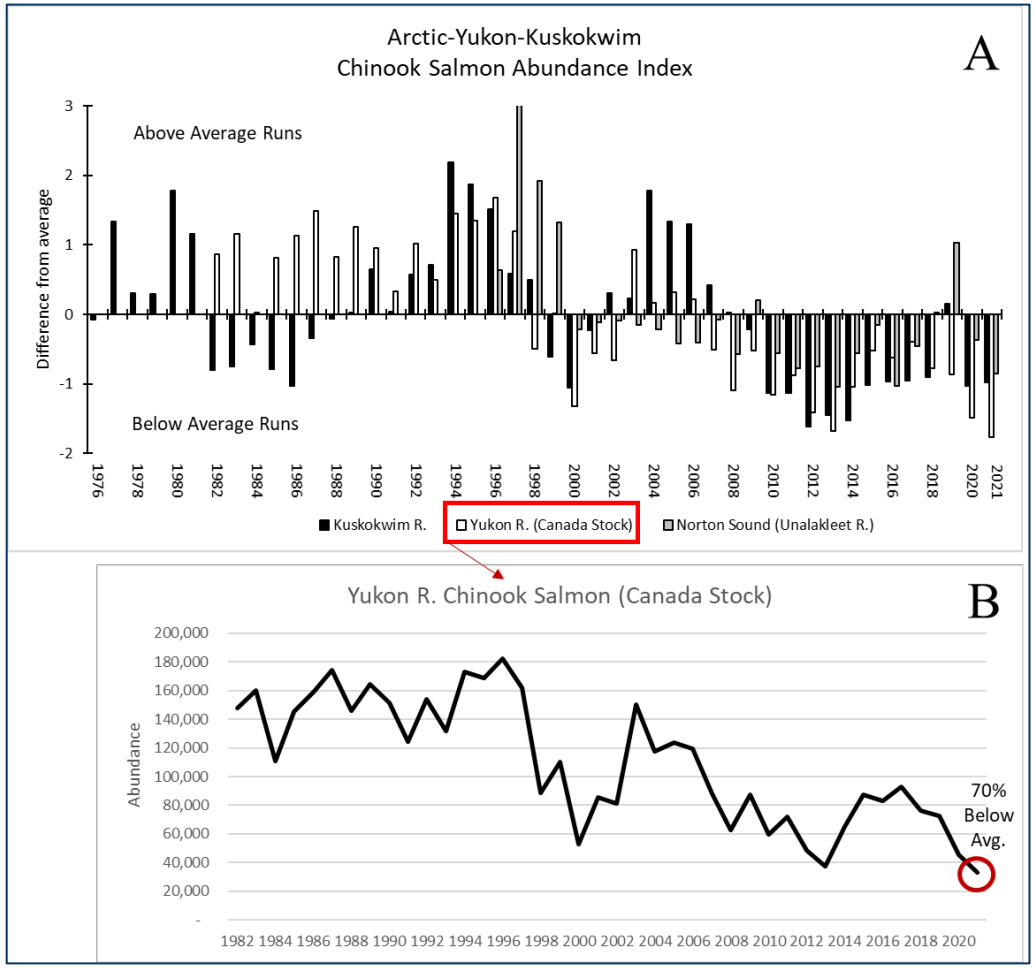




- NBS: For most years, *Chionoecetes* (primarily ID'd as snow crab) are dominant.

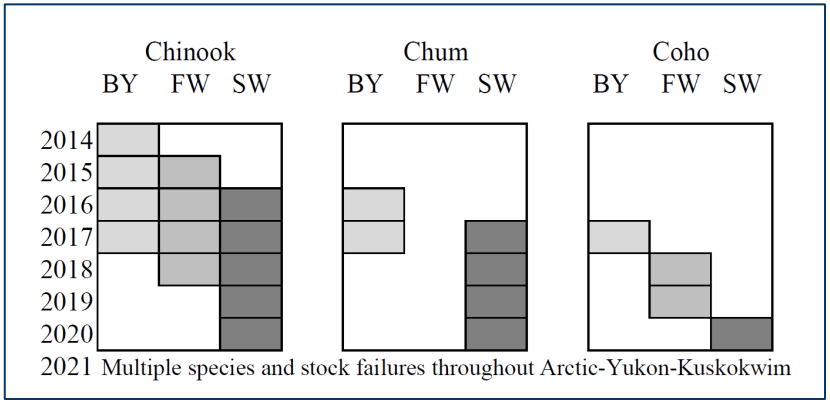
NBS: salmon run failures

Liller



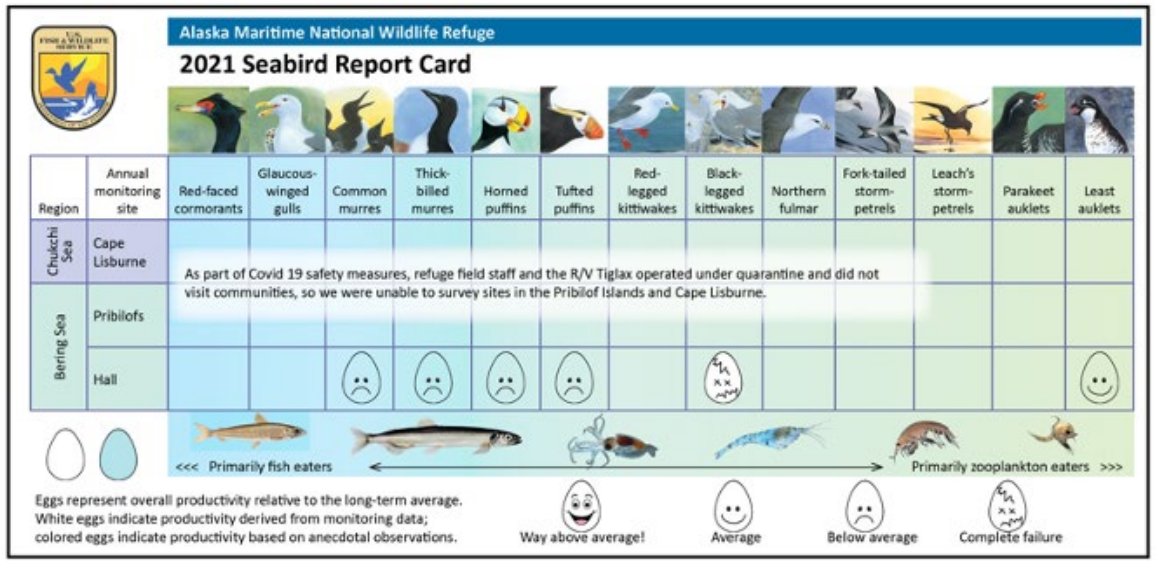
- Chinook, chum, and coho salmon
- Yukon River
  - All directed gillnet fisheries were closed in 2021
- AYK chum run failures portend continued low chum abundance in coming years

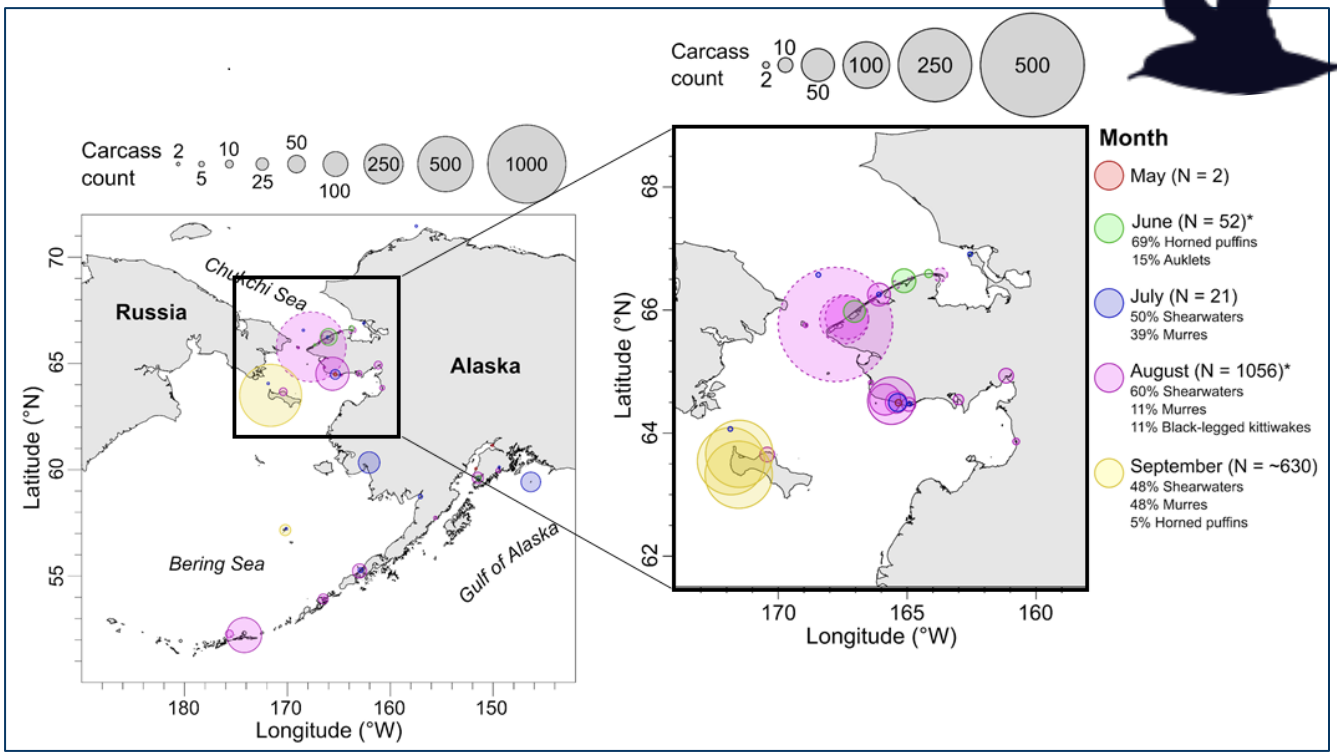
- Reflect poor conditions in the marine environment since 2016
- ADF&G addressing through wide range of research initiatives



NBS: Seabirds

Integrated Seabird Information



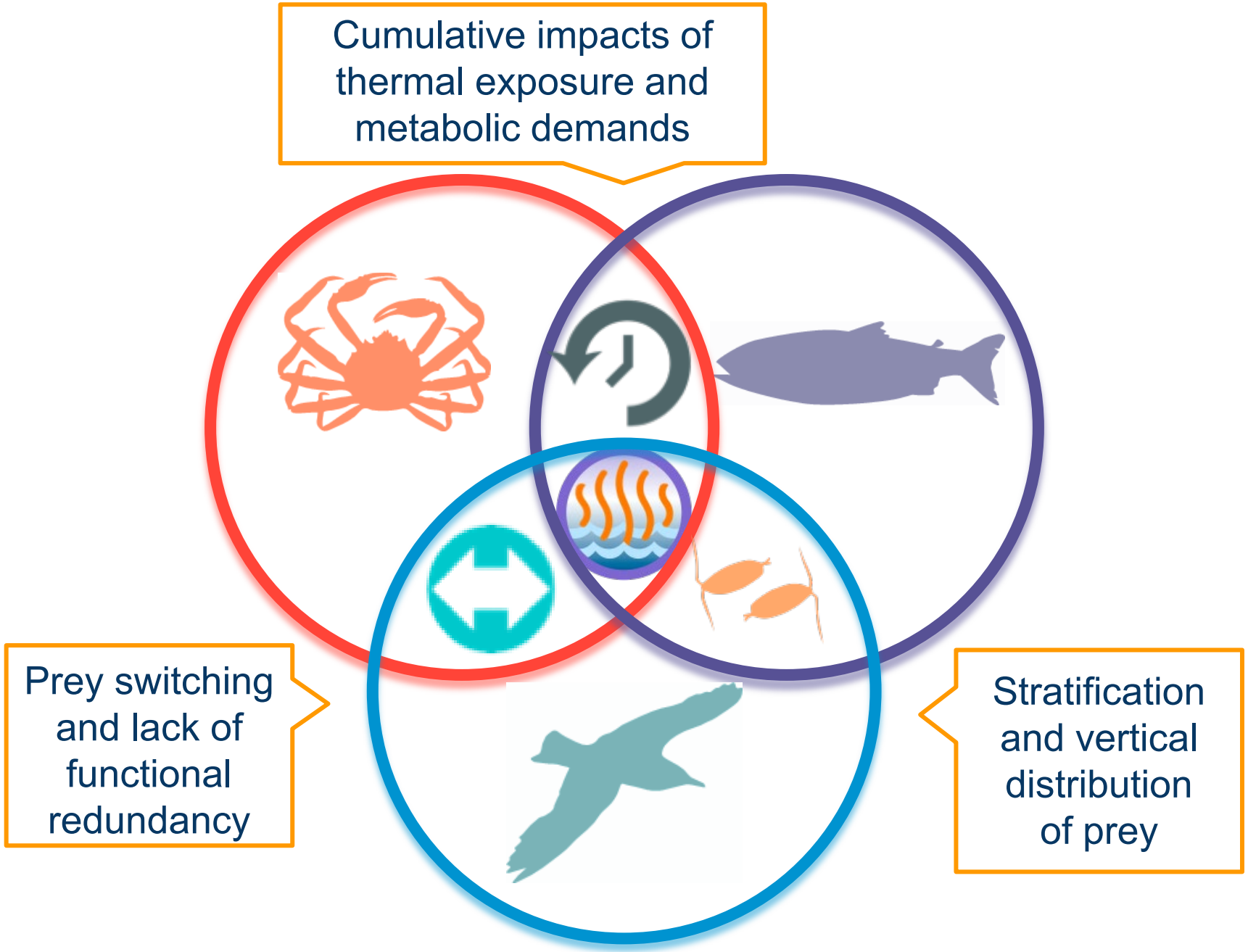


- Seabird die-offs highest in the NBS
- Zooplankton-eaters
  - Shearwaters (migrant)
  - Kittiwakes
- Fish-eaters
  - Murres
  - Puffins

- Reproductive failures for most species

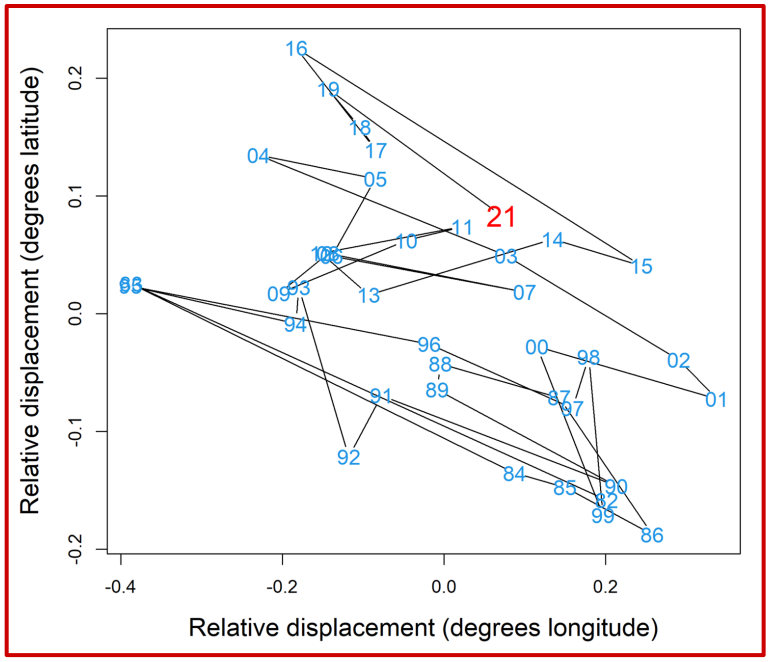
- Least auklets hatched and fledged chicks

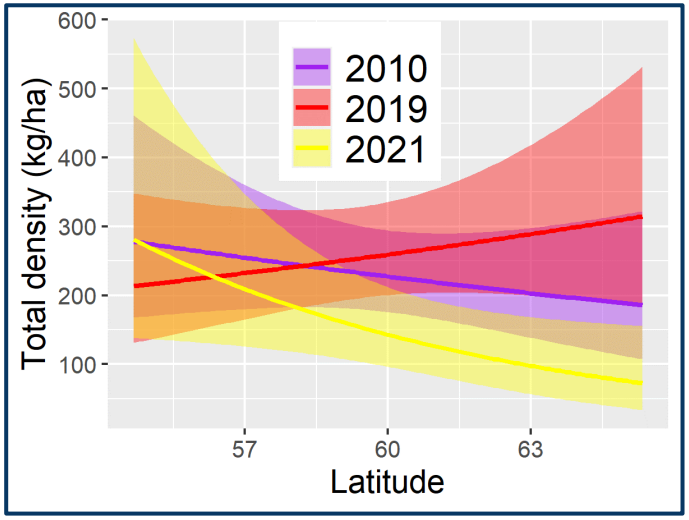
Are there common threads?

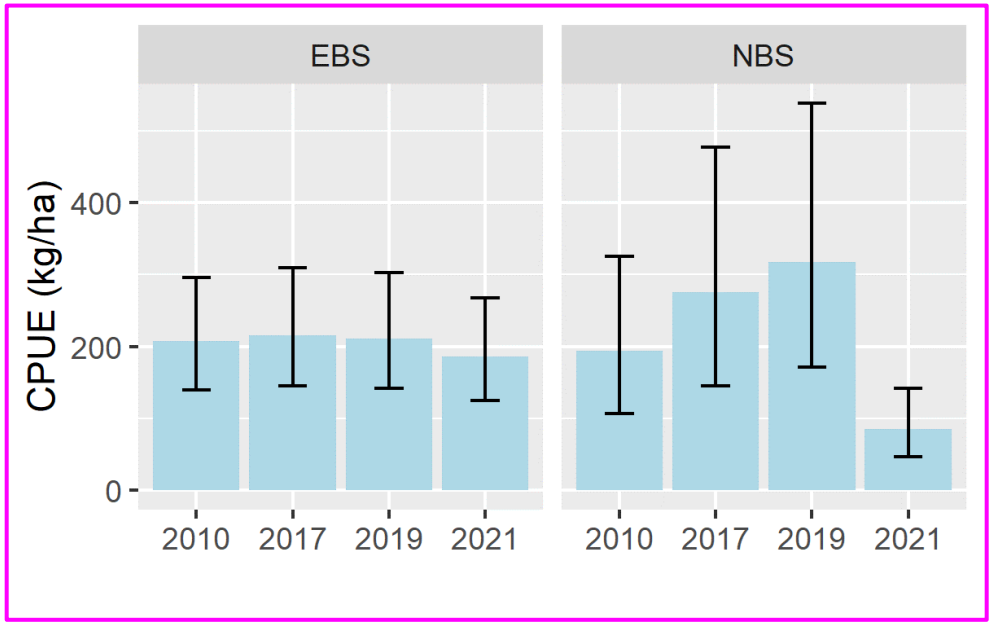


Shifts in fish and invertebrate distribution

Mueter & Britt



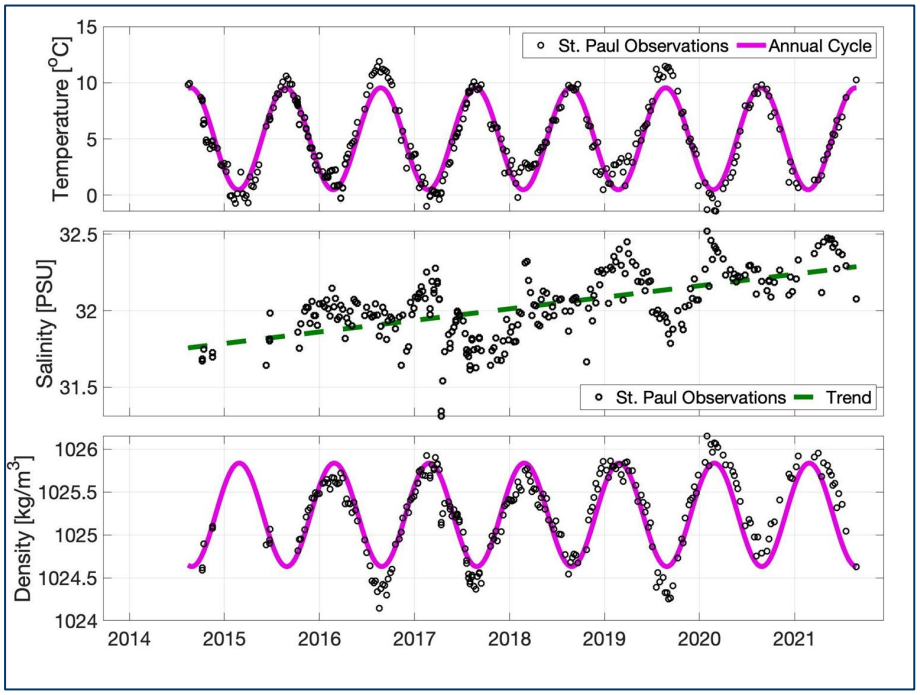


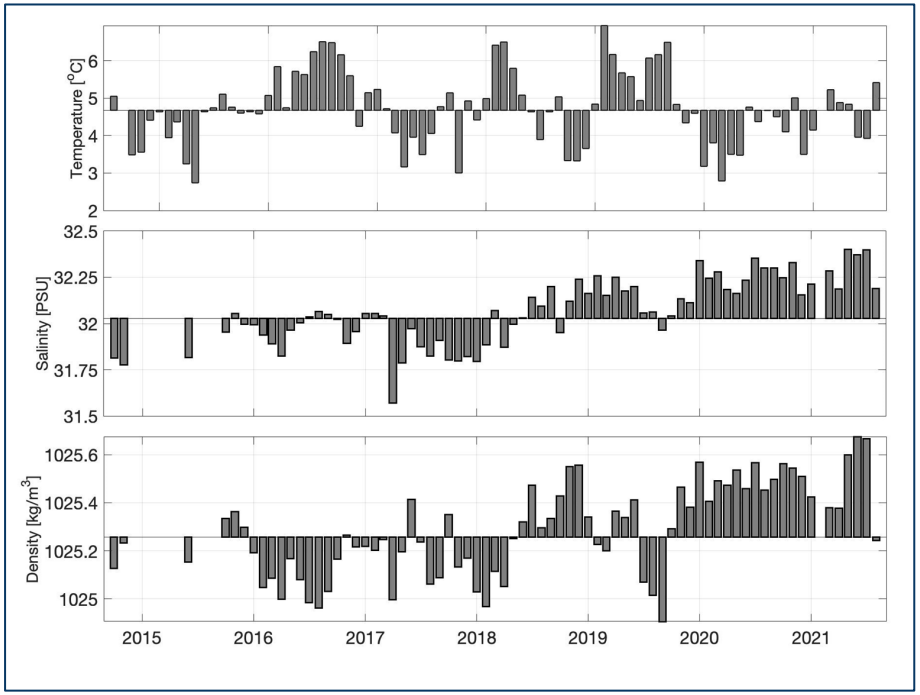


- The distribution of species shifted back to the southeast from 2019 to 2021
- Latitudinal trend had shifted northward, but this reversed in 2021
- Total CPUE in the NBS increased between 2010 and 2019, then decreased substantially between 2019 and 2021

SEBS: physical variables

Danielson & Divine et al.

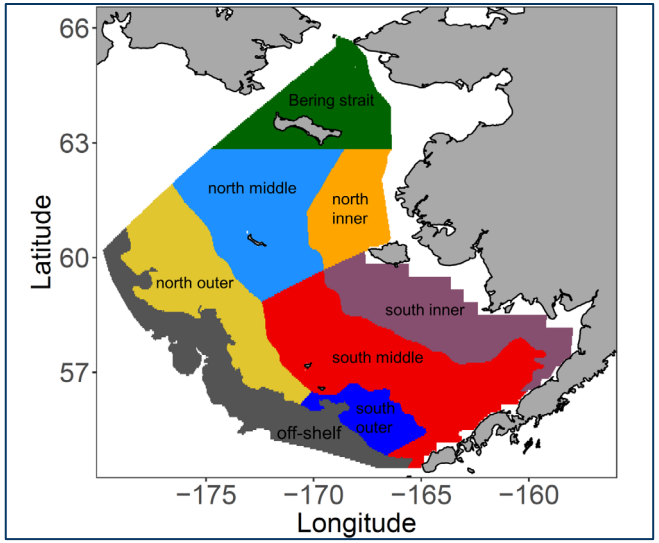


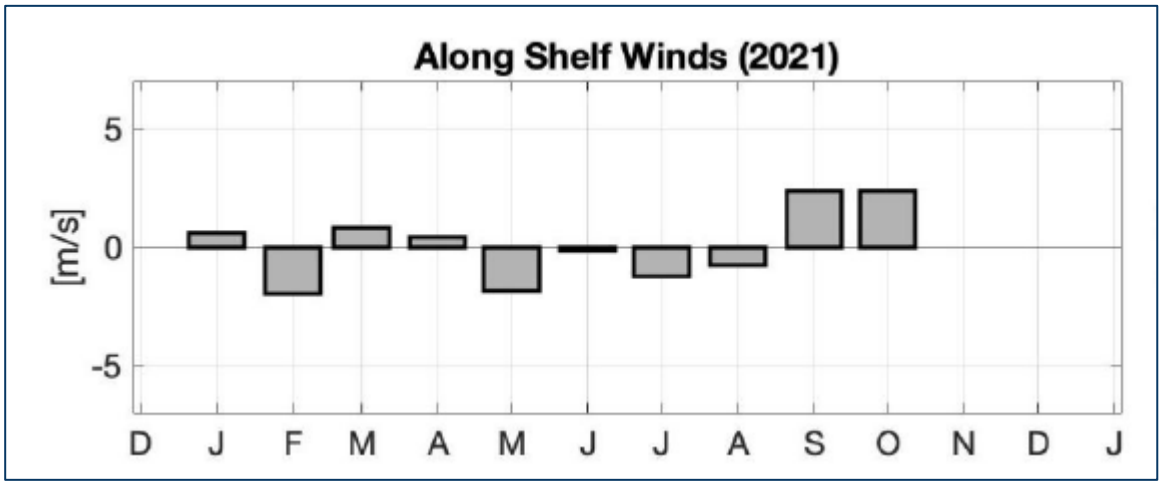


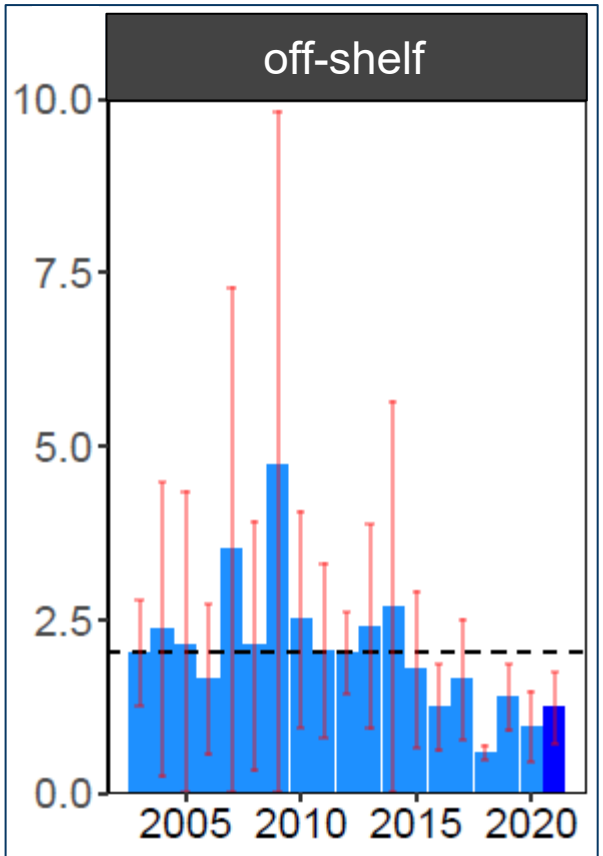
- Community-led monitoring at St. Paul Island since 2014, start of current protracted warm period
- Salinity shows an increasing trend over the time period, in part due to lack of ice melt
- The long-term increase in density at St. Paul Island is driven by the increase in salinity
- *Implications* for water column stratification and vertical mixing

SEBS: lower trophic dynamics

Nielsen et al., Hennon, Kimmel et al.





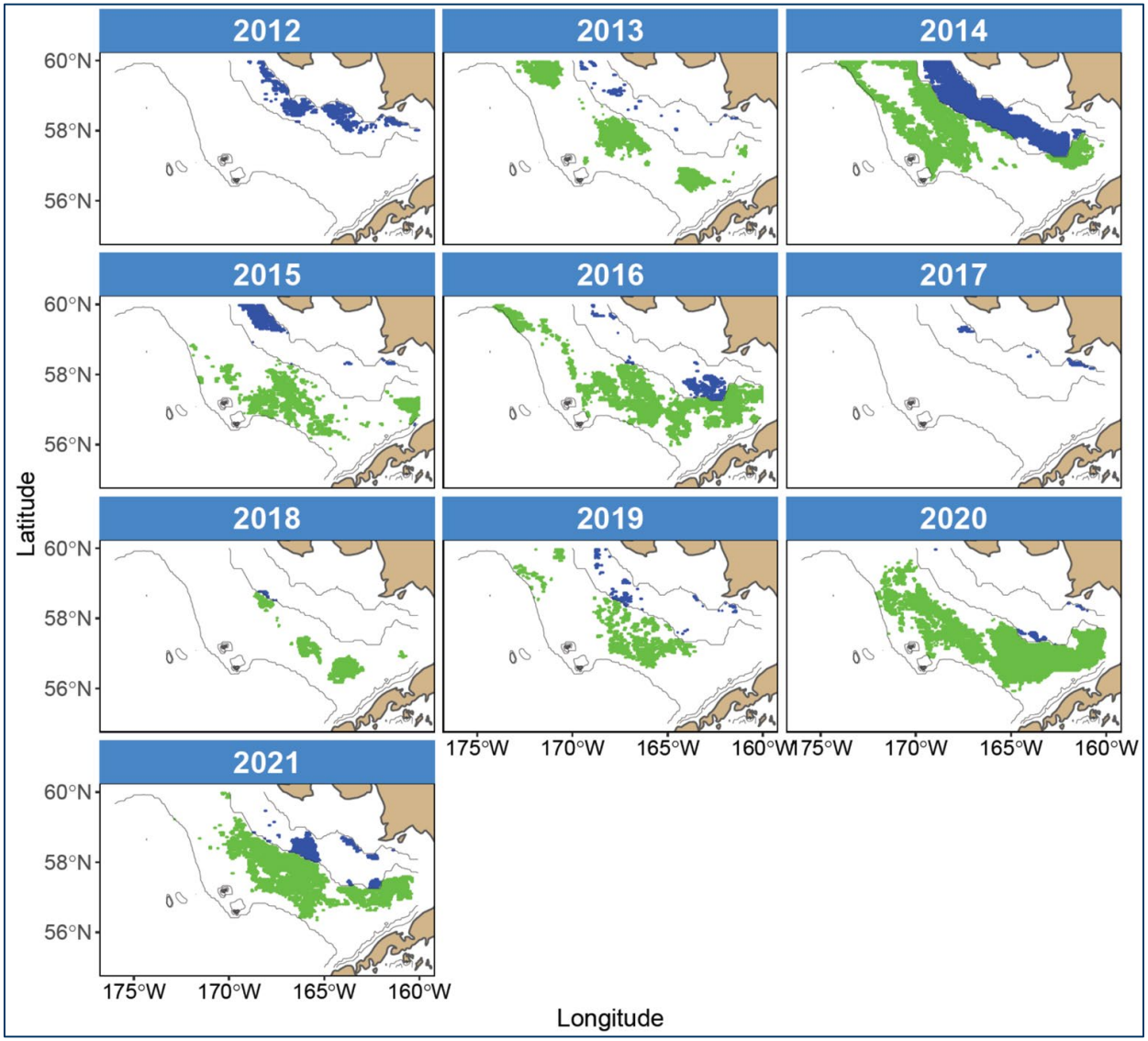


- Southern shelf had below-average chlorophyll-a biomass
- The off-shelf region had below average values, continuing a trend since 2014
- Along-shelf winds through 2021 were variable (i.e., not consistently upwelling or downwelling favorable conditions)

- *Calanus* spp. appeared to be developing more slowly due to the relative colder temperatures
- May have resulted in higher availability later in the year

SEBS: lower trophic dynamics

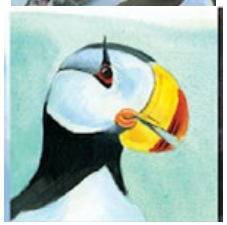
Nielsen et al.



- Coccolithophore bloom index was low in 2018 and 2019, but higher in 2020 and 2021
- Stratification determines bloom strength
- Higher during years with very low **or** very high stratification
- *Implications:* coccolithophores result in longer trophic chains, may be a less desirable food source, and can reduce foraging success for visual predators

SEBS: Seabirds

Integrated Seabird Information

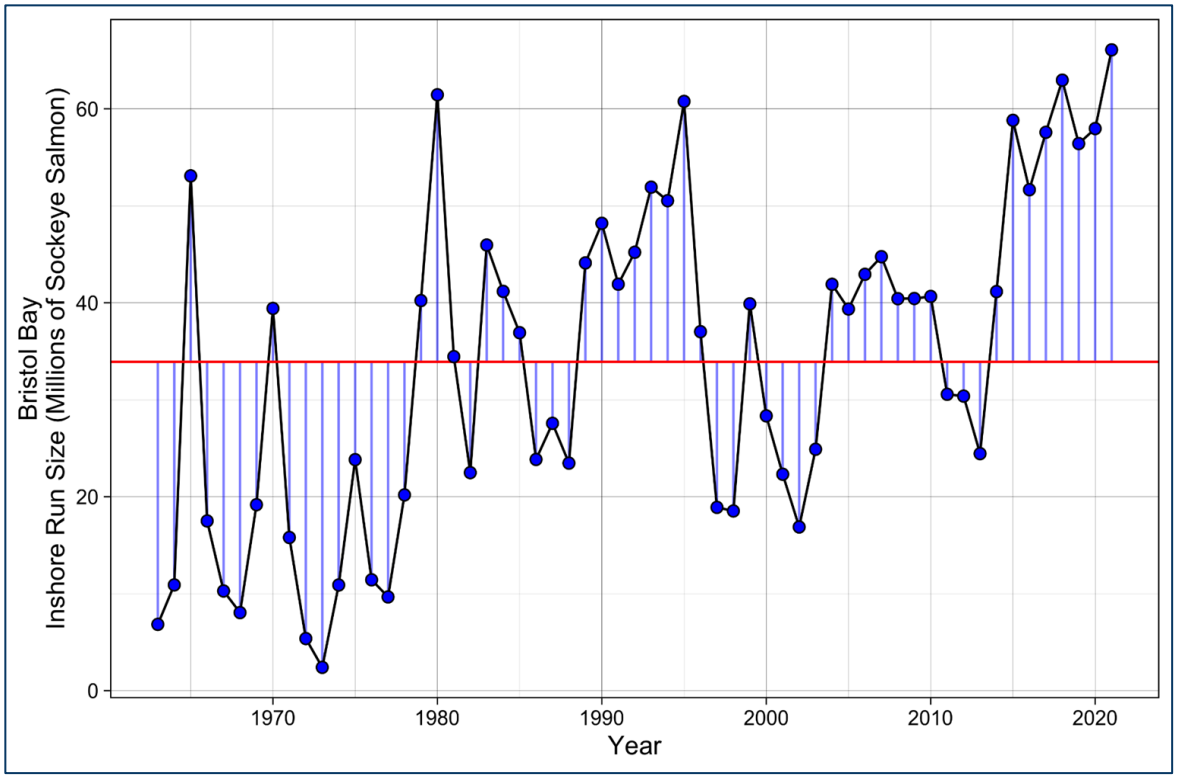


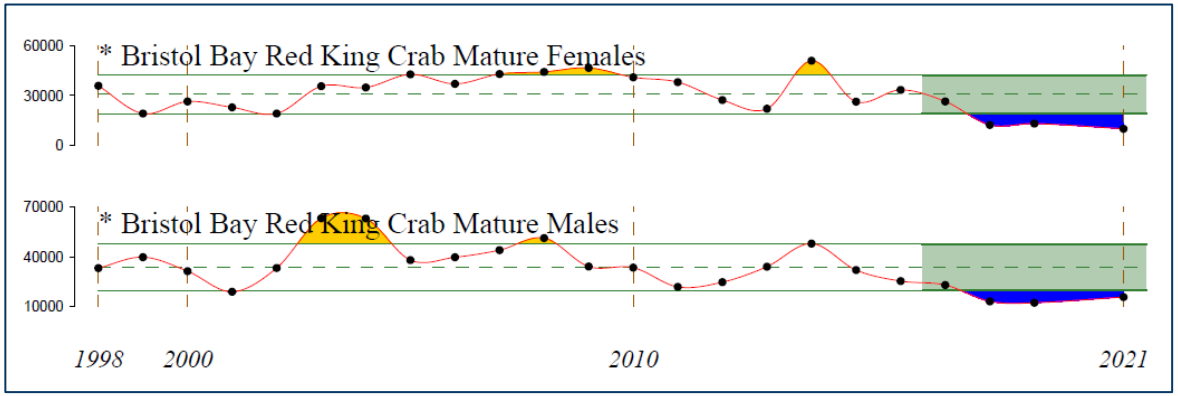
- On St. Paul Island, the timing of breeding and abundance of fish-eating birds (e.g., murres, puffins) appeared average
- Abundance of plankton-eating birds (e.g., least auklets) was lower than average
- Parakeet auklets have been declining; none were observed in 2020, but some were observed in 2021
- Ship-based surveys by USFWS in 2021 indicated average or slightly above average seabird densities across the SEBS
- Low-to-average encounter rate of carcasses (i.e., die-offs) at the Pribilof Islands in 2021

SEBS: Bristol Bay sockeye salmon

Cunningham, Richar

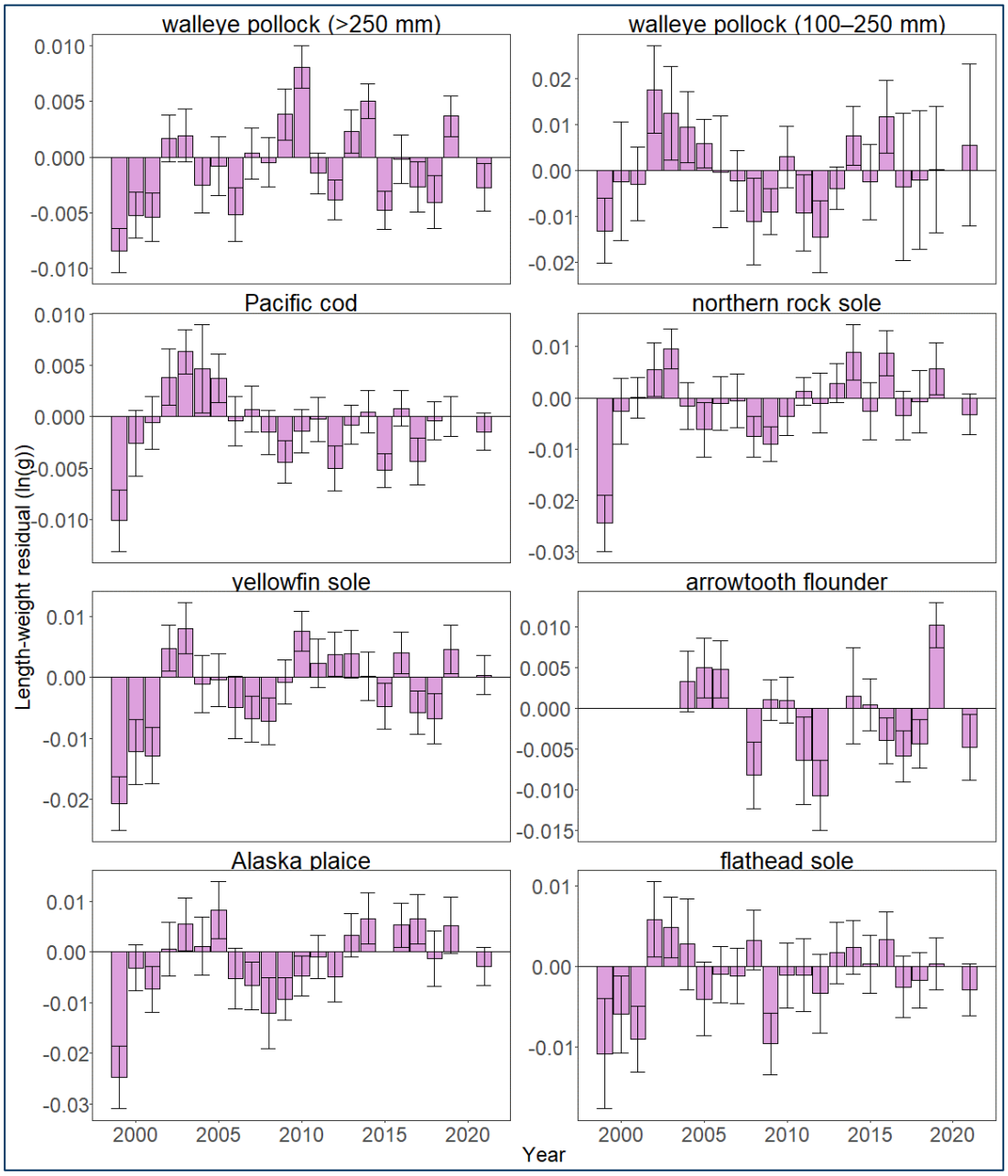
- 2021 is the largest inshore run on record.
- Juvenile sockeye feed on zooplankton and age-0 pollock in warm years; adults feed on zooplankton and krill.
- Are there system-wide impacts?





SEBS: fish condition

Rohan & Prohaska

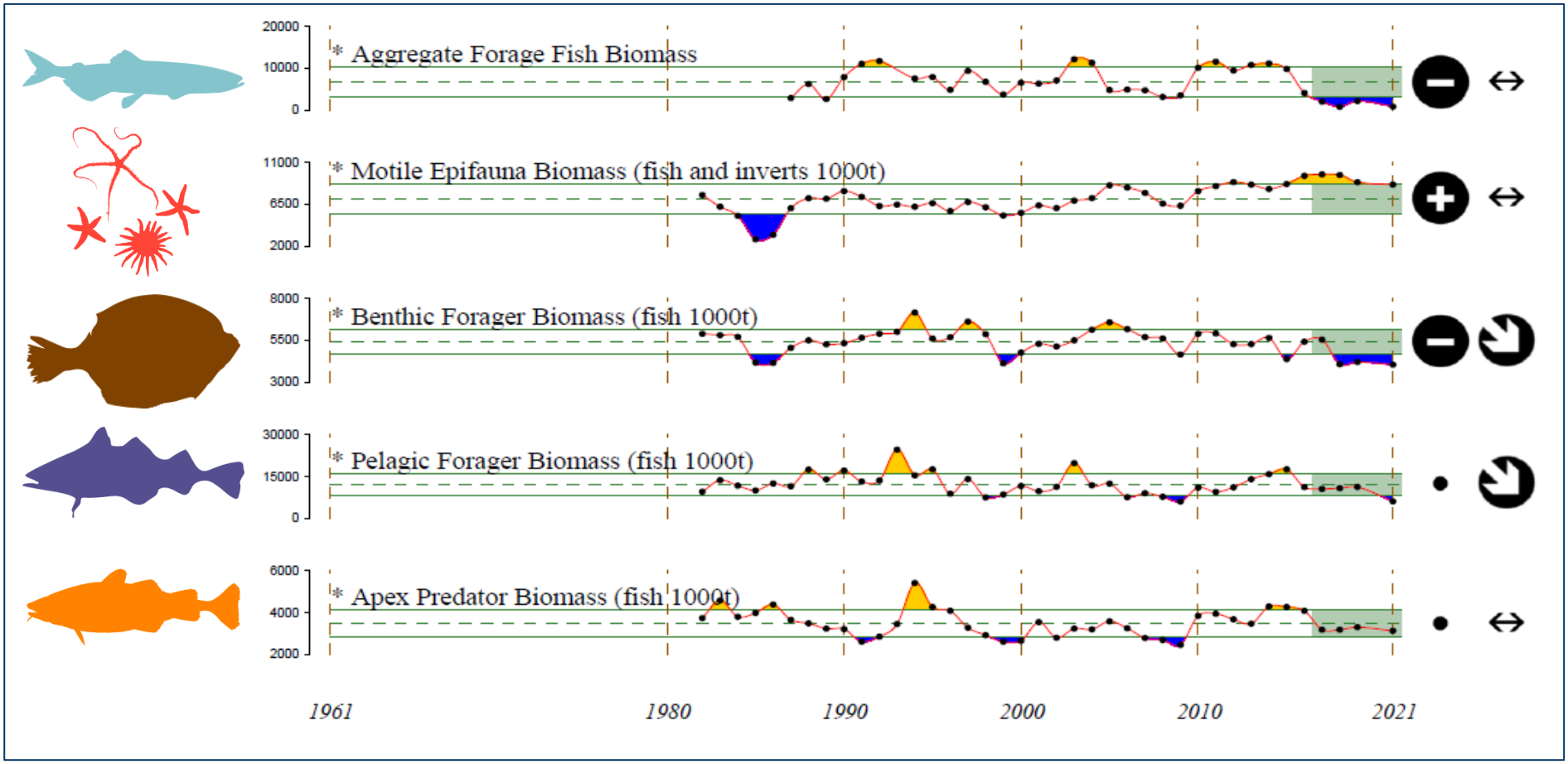


- In 2019, an upward trend in condition was observed for most species relative to 2017-2018

- In 2021, negative residuals were observed for most species, neutral for Yellowfin sole, and positive residuals for small pollock

SEBS: functional guilds

Ormseth, Whitehouse

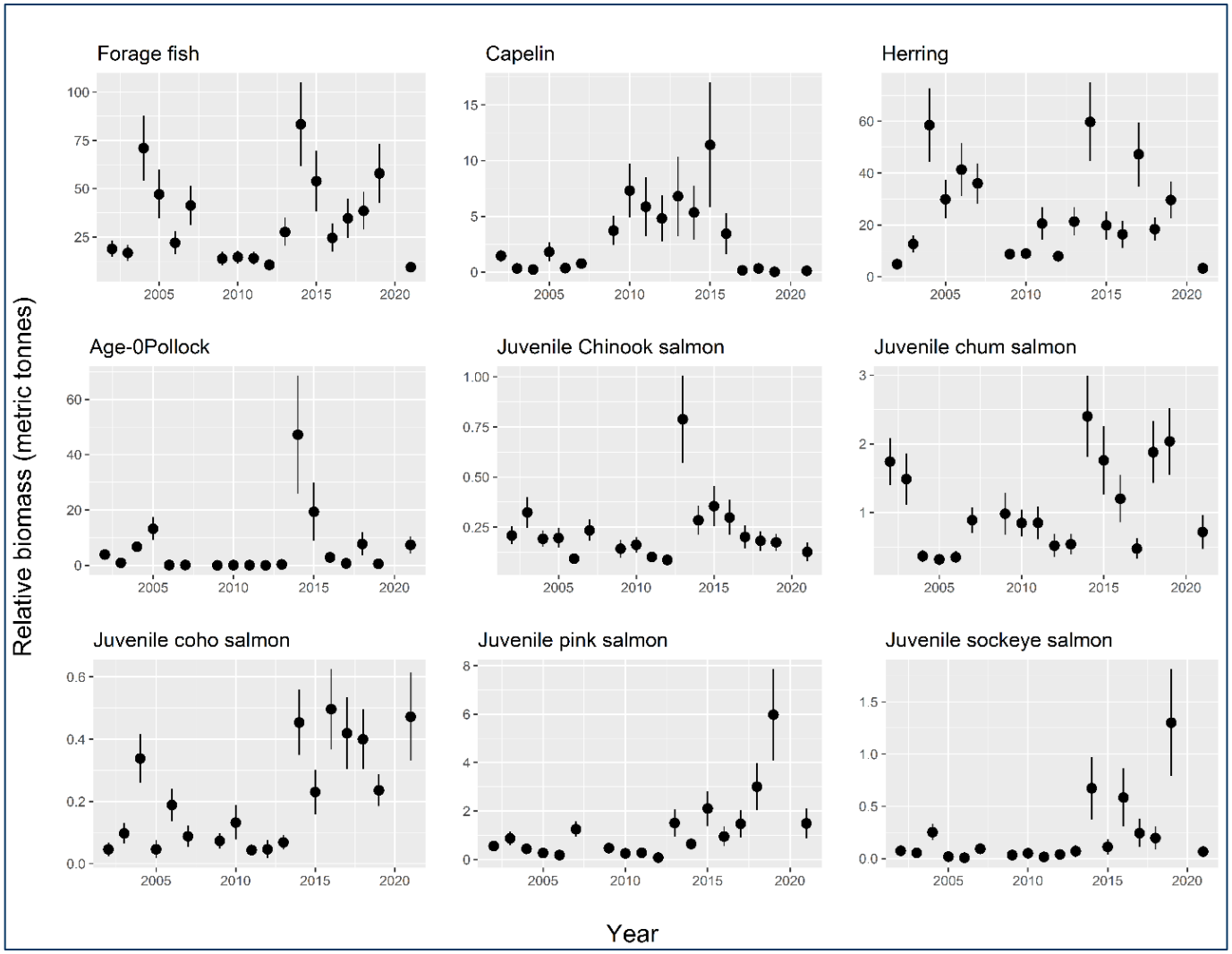


- Forage fish declined steeply between 2015-2017 and remain below their long term mean
- Motile epifauna peaked in 2017 and remain above their long term mean
- Benthic foragers are at lowest level over the time series
- Pelagic foragers dropped in 2021 to their second lowest value (driven by pollock)
- Apex predators was within normal limits in 2021

Forage Fish Report

NBS Surface Trawl Survey

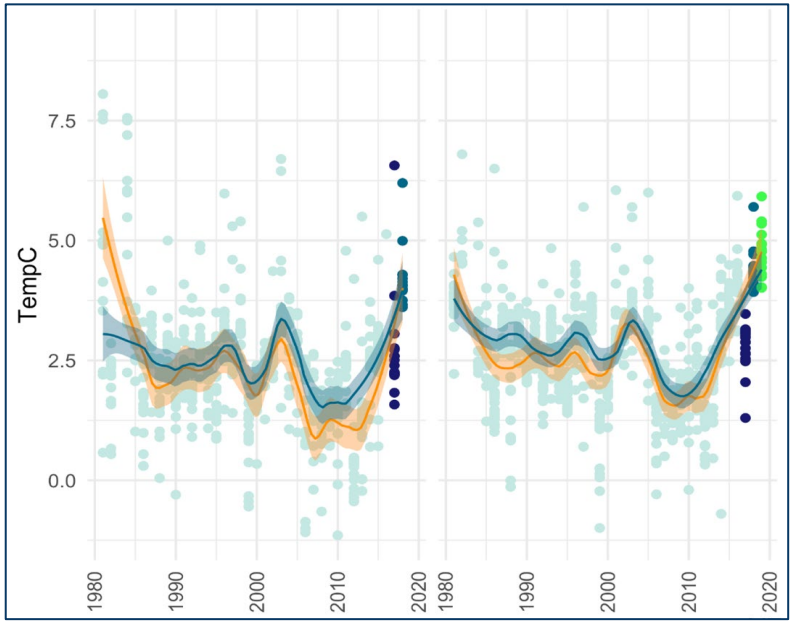
Ormseth

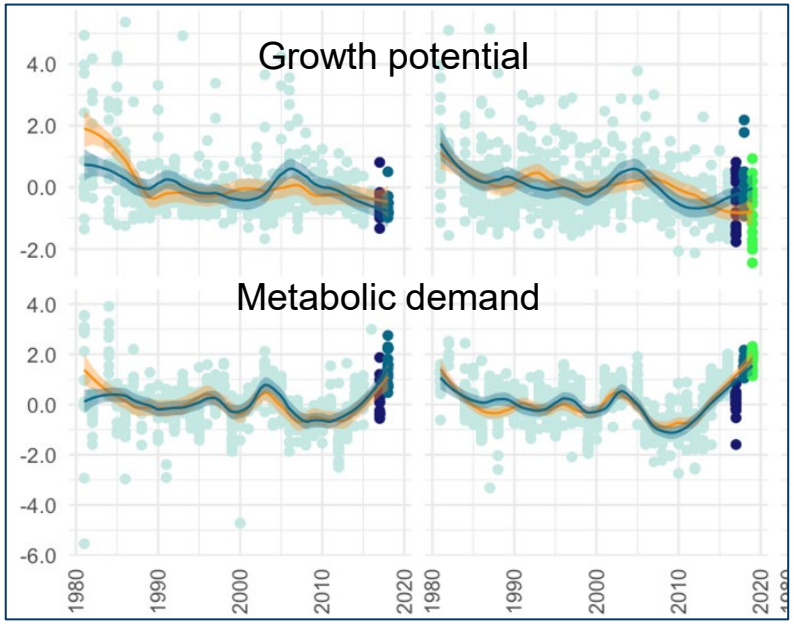


- Forage availability has declined, except possibly for herring (based on ADF&G survey)
- Declines have coincided with warmer temperatures and reduced sea ice extent
- Decline in forage availability may have contributed to other substantial changes in the Bering Sea

SEBS: bioenergetics

Holsman et al.

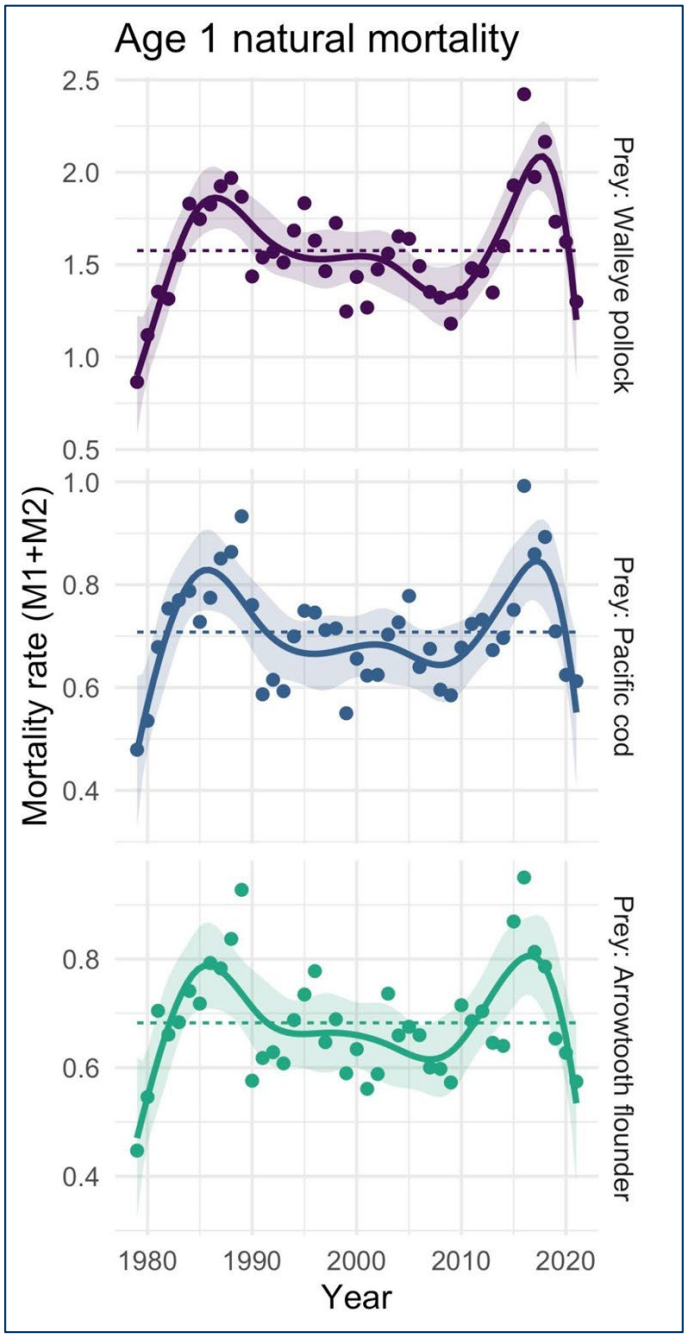




- The thermal experience has increased in recent years, especially for Pacific cod
- Metabolic demand has increased while foraging rates and prey energy have decreased
- *Implication:* combined, this has led to a decline in growth potential, especially for juvenile and adult pollock and juvenile Pacific cod

Southeastern Bering Sea

Holsman et al.



- Estimates of age-1 natural mortality continue to decline from the peak in 2016, and remain below the long-term mean
- Warm temperatures lead to high metabolic demand of predators
- But declines in total predator biomass result reduced predation relative to 2016
- *Implication:* improved top-down conditions for juvenile groundfish survival in 2020

3. Topics from 2019 and 2020

- Ice seal Unusual Mortality Event (Mahoney et al.)
  - Increased mortality in 2018-2019 coincided with reduction in sea ice habitat and potential competition for prey

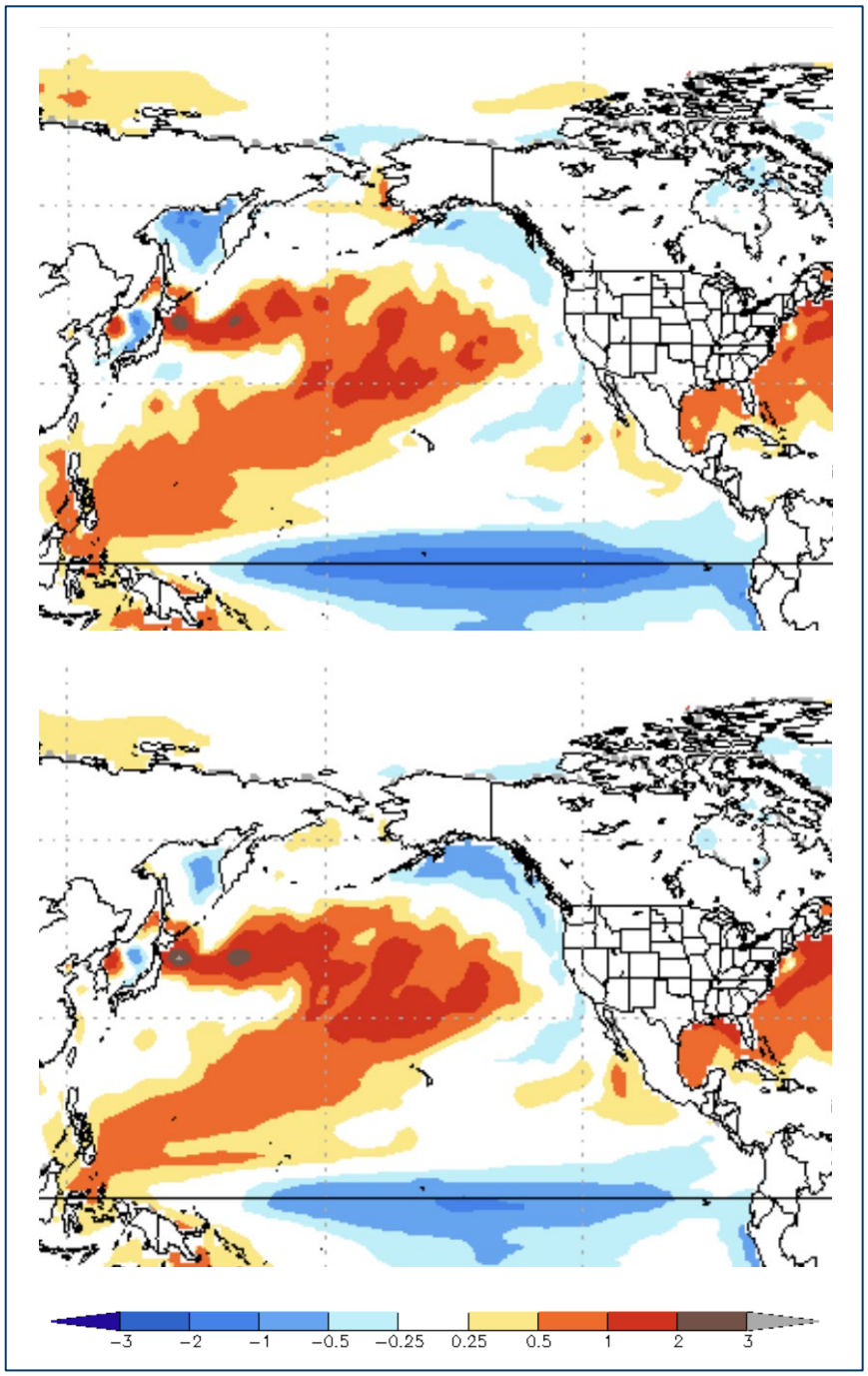
- Gray Whale Unusual Mortality Event (Keogh & Savage)
  - Gray whales strandings dropped ~50% in 2021
  - Closure of the UME has been discussed; will reassess in early summer 2022

- Herring bycatch and PSC limit (Buck et al.)
  - The 2016 year class is estimated to be the largest since 1982
  - The 2020 pollock A season may have encountered these age-4 Togiak fish, partially explaining the increase in incidental catch

- Seabird bycatch (Krieger & Eich)
  - Bycatch decreased 52% from 2019 to 2020, but…
    - COVID-19 reduced fishing days
    - Shift from hook-and-line to pot gear
  - Spectacled and Steller's eiders takes
    - Result of species' shifts in response to warming waters?

4. SST projections for 2022

Bond



December 2021 - February 2022

High SLP over western Bering Sea resulting in decreased warmth over SEBS; consistent with La Niña winters.

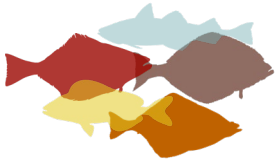
February - April 2022

Near-normal temperatures in the Bering Sea and Aleutian Islands with neutral La Niña conditions.

5. Summary and Implications

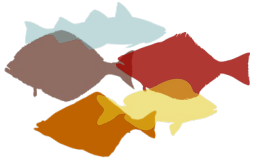
The eastern Bering Sea has been in a persistent warm phase since 2014; 2021 sea ice extent was near-normal, with thicker ice in the NBS and thinner/less ice in the SEBS; cold pool extent was 4th lowest of the time series.
Implications: Cumulative impacts of continued warm conditions over the shelf

Crab population declines, salmon run failures, and seabird die-offs & reproductive failures all connected to the NBS marine environment.
Implications: Concerns about carrying capacity of the NBS



Groundfish shifted to the southeast between 2019 and 2021, with the latitudinal trend reversing to the south in 2021. Total CPUE in the NBS decreased substantially between 2019 and 2021.
Implications: Changes in fish distributions may result in biomass outside the shelf ecosystem and may indicate limitations of productivity in the NBS

Lack of sea ice over the southern shelf contributed to salinization with *impacts to stratification and vertical mixing.* Reduced chl-a biomass and weak upwelling conditions may limit productivity and combined with an above-average coccolithophore bloom in 2021 *suggests poor bottom-up trophic pathways to support juvenile and forage fishes.* Indications that *Calanus* spp. were developing slowly *indicating lipid-rich prey may have been available in late summer*



Groundfish condition was negative for many species, although positive for small pollock; guilds for forage fish, benthic foragers, and pelagic foragers all below their long term means; thermal experience has increased resulting in increased metabolic demands.
Implications: cumulative impacts of continued warmth evident across indicators; fish will need to eat more prey, use energetic reserves, or move to energetically favorable foraging grounds.