Eastern Bering Sea Ecosystem Status Report

BSAI
Groundfish Plan Team
November 14, 2022

Elizabeth Siddon

ESRs
(through 2021)

2022 Eastern Bering Sea Ecosystem Status Report

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Outline

- BLUF (risk table scores, ecosystem summary)
- Response to SSC comments (Dec. 2021)
- Review of the recent warm stanza
- Current conditions: 2022

2022 Ecosystem Status Report – Eastern Bering Sea

Risk Table Environmental/Ecosystem Considerations

Level 1
(No apparent environmental/ ecosystem concerns)

- EBS pollock
- EBS P. cod
- Yellowfin sole
- Sablefish (statewide)
- Northern rock sole
- Arrowtooth flounder
- Kamchatka flounder
- Greenland turbot
- Sharks (statewide)

Noteworthy

- Factors affecting 2022 Western AK Chinook runs
- Climate change projections for the EBS

Ecosystem Assessment

- Return to more average thermal conditions for the EBS shelf
  - MHWs infrequent and brief compared to recent years
  - Rapid sea ice growth in November; rapid ice loss in April
  - 2022 cold pool near historical average

- Primary productivity variable over the shelf; spring bloom peak timing average
- Zooplankton trends mixed
  - Spring: more small copepods, fewer large copepods and euphausiids
  - Late-summer: (SEBS) average small copepods, fewer large copepods, more euphausiids; (NBS) fewer small copepods, more large copepods and euphausiids
- Seabird reproductive success indicates sufficient prey over the southern shelf, but suggests limited forage fish availability over the northern shelf

- Fish condition improved from 2021 to 2022 over the southern shelf (except adult pollock); trends were more variable over the northern shelf
- Groundfish community shifted north through 2019, south in 2021, and into slightly deeper waters in 2022

Response to SSC comments (Dec. 2021)

"The SSC supports a holistic review of how economic and social science information is communicated and applied to Council decision-informing analytic products…"

Economic and social science contributions will focus on other products to inform Council (Economic SAFE, ACEPO reports, AKFIN's Human Dimensions of Fisheries Data Explorer, ESPs) but will not be in the ESRs.

"The SSC suggests including a flow chart/infographic in the ``Purpose of the Ecosystem Status Reports'' section of the ESR to visualize the process."

A flow diagram has been added to the ESR (next slide).

"`In Briefs': The SSC is supportive of these continued efforts to disseminate ESR information to stakeholders and communities"

ESR editors, with AFSC Comms Program, will be producing In Briefs for 2022 ESRs (available for December Council meeting).

"The SSC concurs with the BSAI GPT recommendation for a forage species workshop…"

The ESR editors, the Forage Report editor, and others at NOAA's Alaska Fisheries Science Center convened a virtual ``Forage Congress'' in March-April 2022 with four main objectives. The workshop helped to develop an understanding of AFSC's internal engagement in forage research and monitoring, to be able to better engage in the broader discussions described by the SSC in their request.

**ESRs will have a CIE review in 2023

COUNCIL

Ecosystem-Based Fisheries Management (**EBFM**)

Annual harvest specification process

LME-based

Ecosystem Status Report **(ESR)**

Stock-based

Stock Assessment

Risk Table

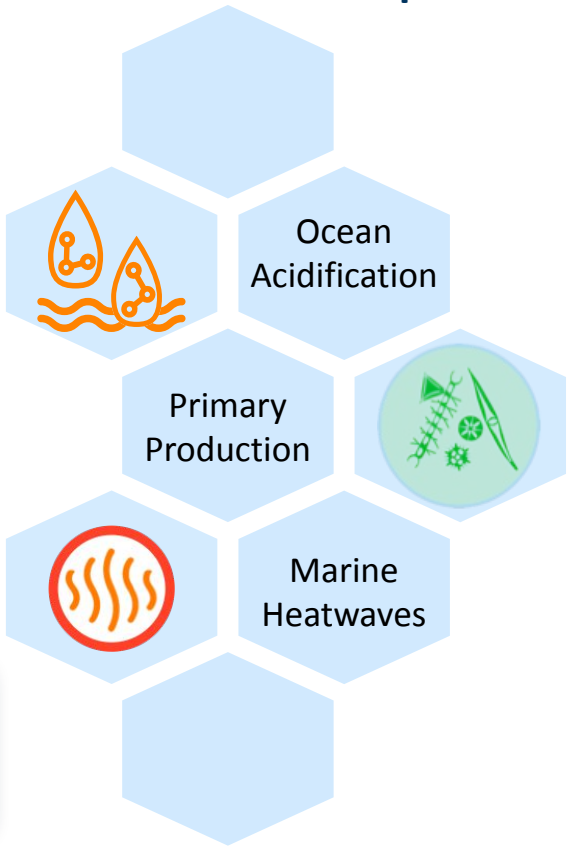
table

Ecosystem and Socio-economic Profile **(ESP)**

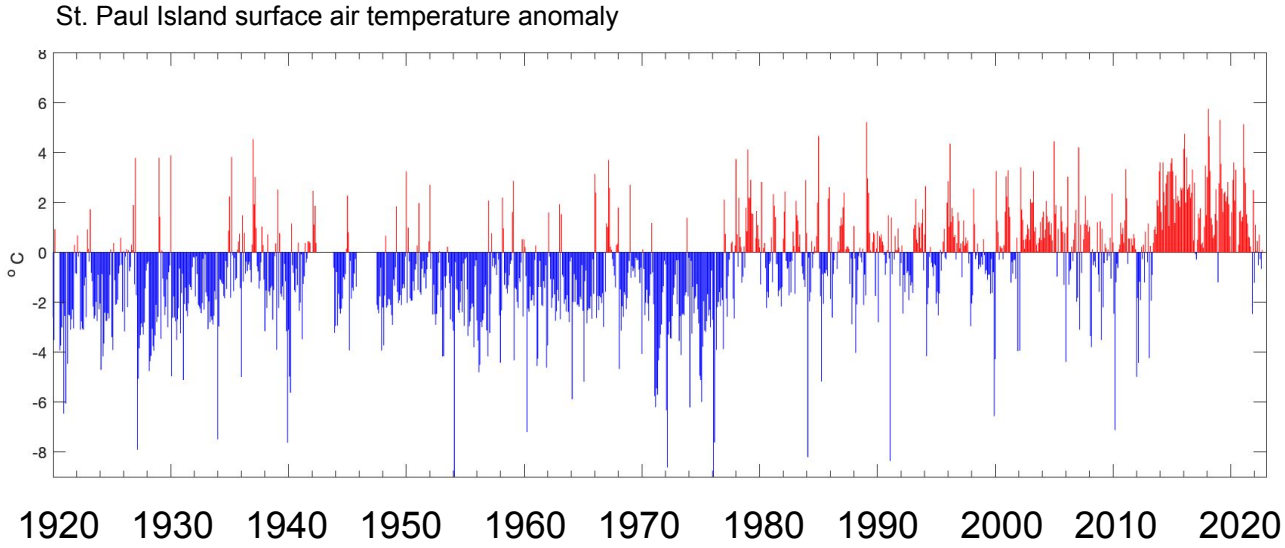
Profile **(ESP)**

Profile **(ESP)**

Process Research & Indicator Development

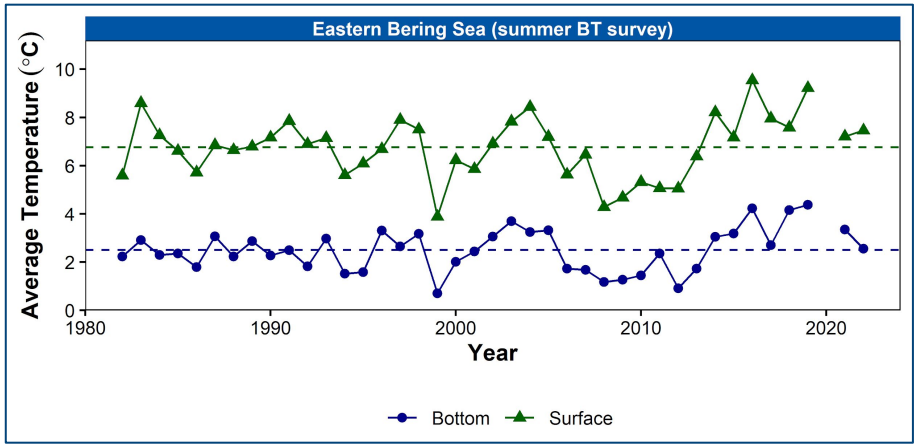


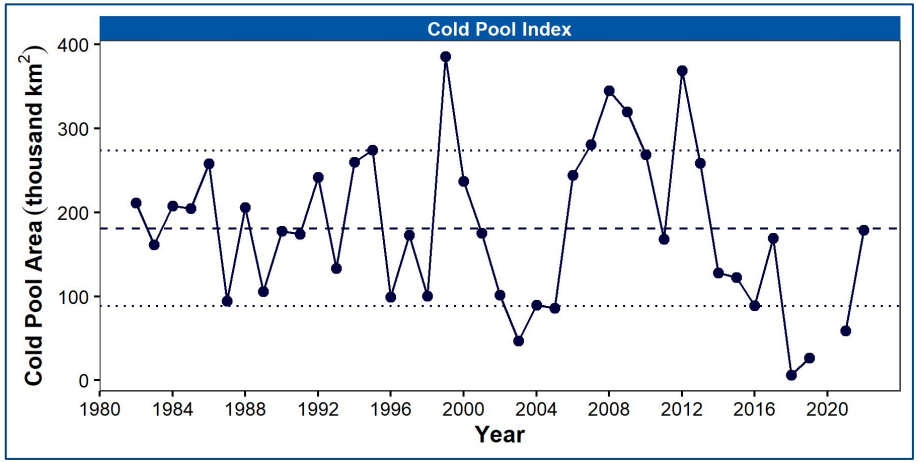
Review of the recent warm stanza



- In ~2014, the EBS entered a warm phase of unprecedented duration
- Ecosystem responses can be:
  - Immediate
  - Lagged
  - Cumulative
- Impacts of the recent warm stanza to groundfish and crab stocks
- The past year has seen a relaxation to more average thermal conditions

Oceanographic response



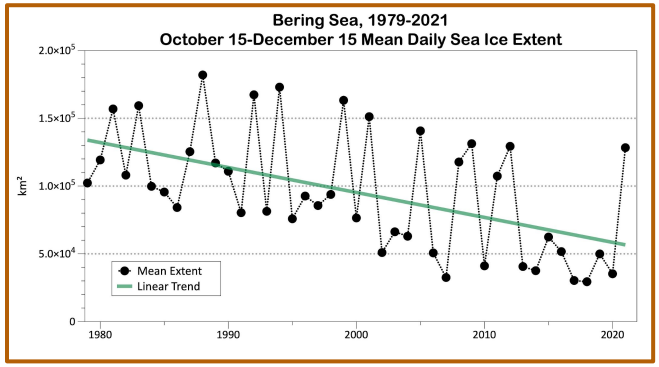


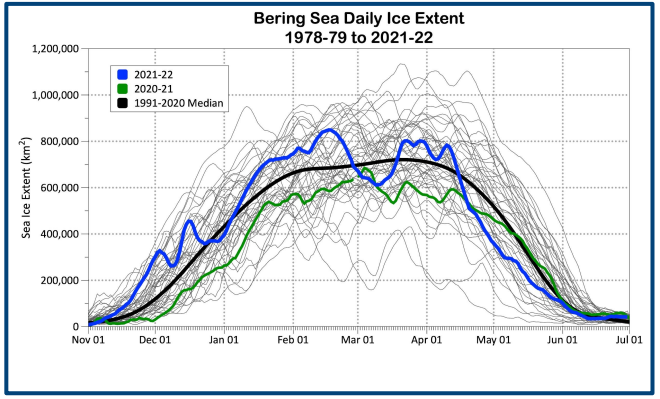
Immediate ecosystem responses

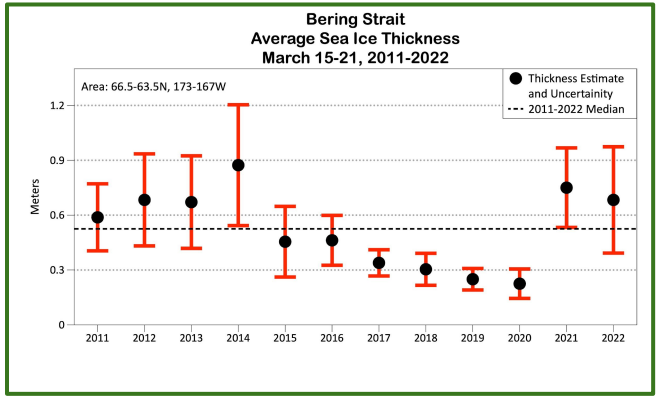
- Surface and bottom temperatures from the bottom trawl survey

- The cold pool extent
  - below the time series average beginning in 2014
  - 2018, 2019, and 2021 were the lowest cold pool extents in the time series

Oceanographic response

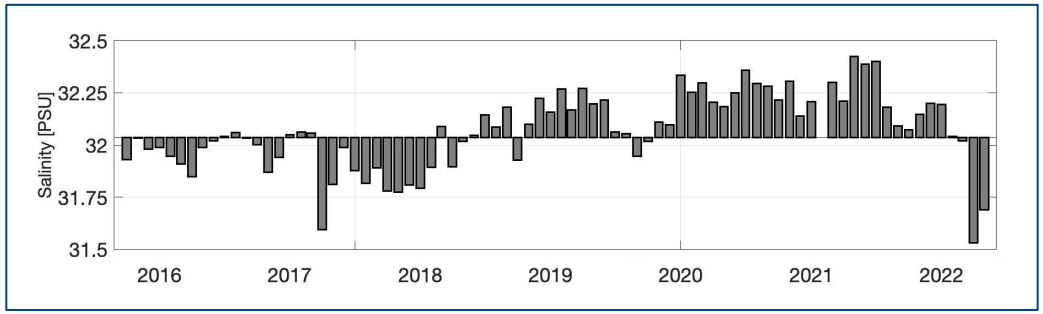






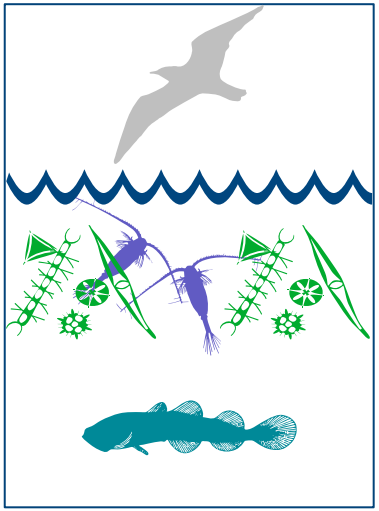
Cumulative ecosystem responses

- Residual warmth resulted in delayed sea-ice formation
- Delayed freeze-up led to shortened ice seasons that in turn had impacts on ice thickness
- Thinner sea ice resulted in earlier ice retreat, further truncating the ice season and perpetuating the residual warmth into the following year



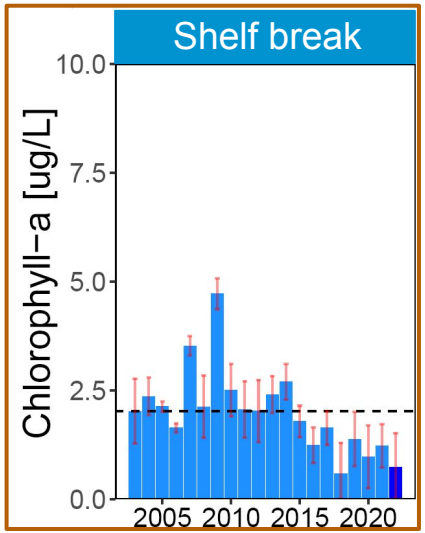
Sea-ice growth
- Salt is extruded
- Increased salinity

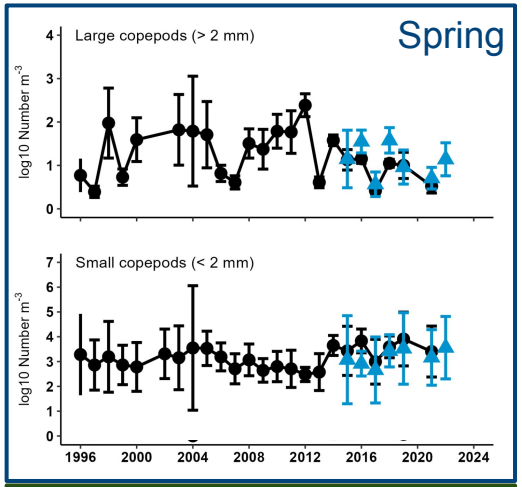
Sea-ice melts
- Freshwater
- Decreased salinity

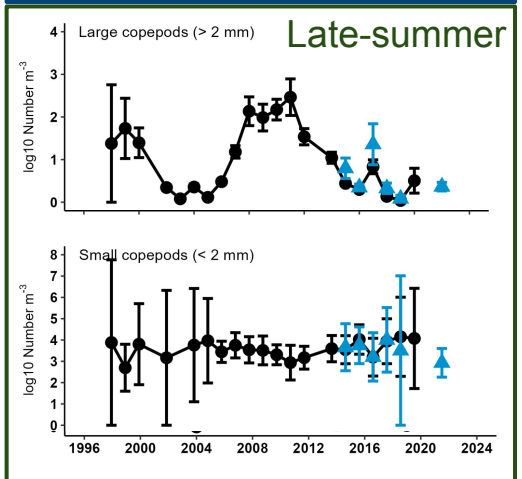


Impacts to groundfish and crab

- Loss of sea ice may have contributed to an increase in salinity at the Pribilof Islands.
- Sea ice “conveyor belt”
- Changes in the salinity structure can impact the vertical stratification and vertical mixing of primary and secondary productivity.

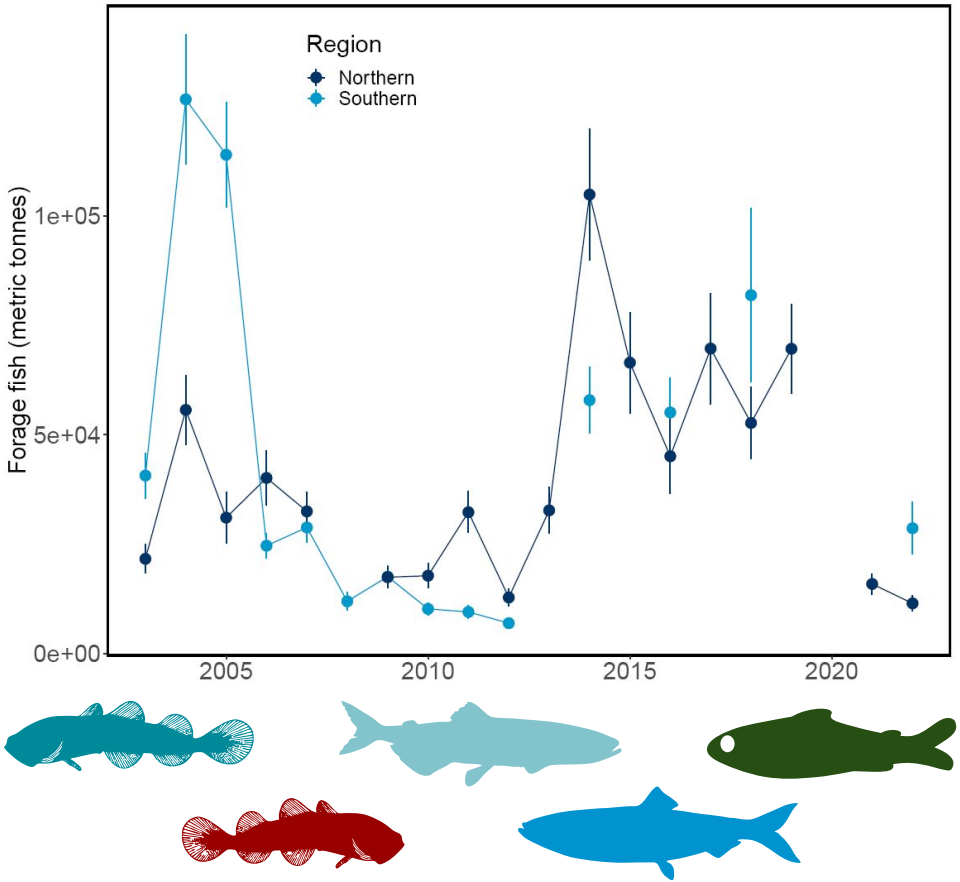






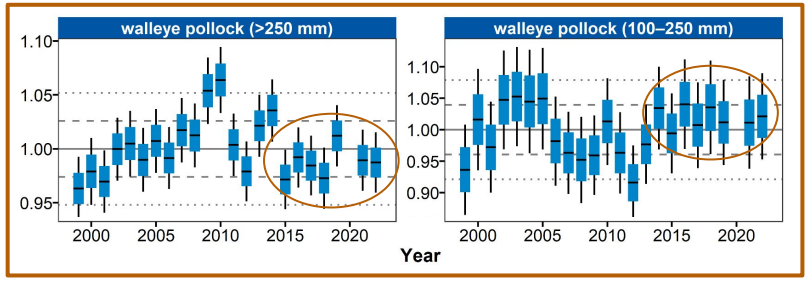
Primary and secondary productivity

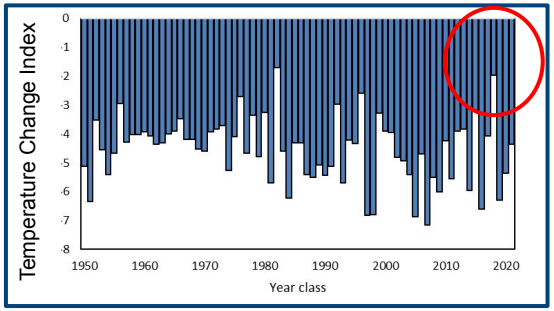
- Chlorophyll-*a* at the shelf break has been decreasing since 2014
  - Suggests potential limitations at the base of the food web
- Spring zooplankton: decrease in large copepods; increase in small copepods
  - Suggests favorable prey conditions for early life stages of pollock
- Late-summer zooplankton: marked shift to lower large copepods; no trend in small copepods
  - Suggests large, lipid-rich copepods may have been limiting for age-0 pollock, other forage fish, and seabirds

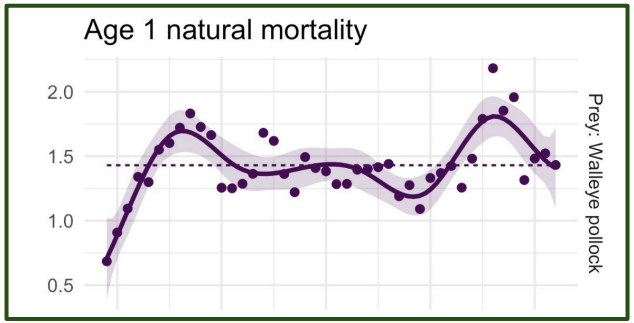


Forage Fish

- Aggregate index from the BASIS surface trawl survey
  - Age-0 pollock, age-0 cod, capelin, herring, juvenile salmonids
- Increased forage fish biomass during the warm stanza compared to the preceding cooler stanza; biomass low again in 2021-2022
- Trends are driven by pollock, especially during warm years, as pollock are closer to the surface during warm years
  - Suggests improved summer foraging conditions during the recent warm stanza, especially for surface-feeding organisms like piscivorous seabirds

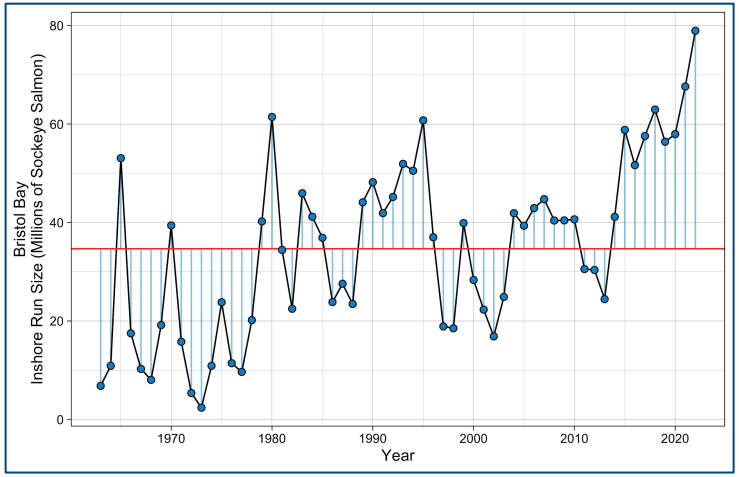


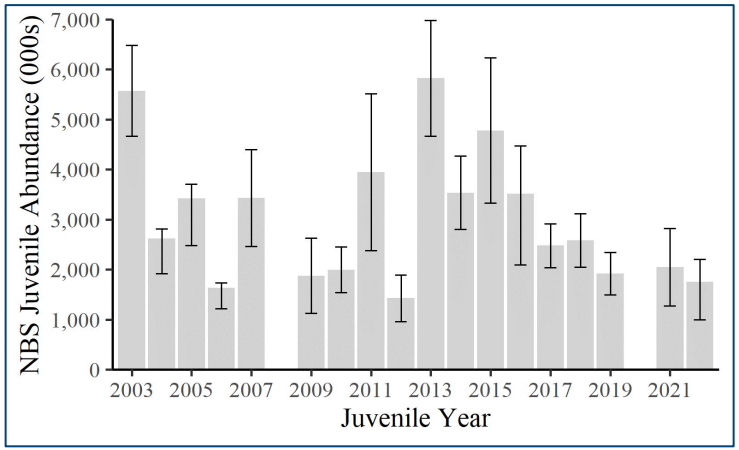




The 2018 year class of pollock

- Fish condition indicates prey availability, growth, general health, and habitat.
  - Below-average condition of adult pollock
  - Above-average condition of juvenile pollock
- Bottom-up drivers of recruitment success
  - Cool summer SSTs in 2018 (age-0); warmer spring SSTs in 2019 (age-1)
  - Age-0 diets in 2018 had a large proportion of euphausiids, mitigate lower large copepod abundances
- Top-down drivers of predation pressure
  - CEATTLE model shows declines in predation mortality due to declines in total predator biomass
  - Reduced cold pool extent, adult pollock moved into the NBS, reduced predation pressure on the 2018 year class

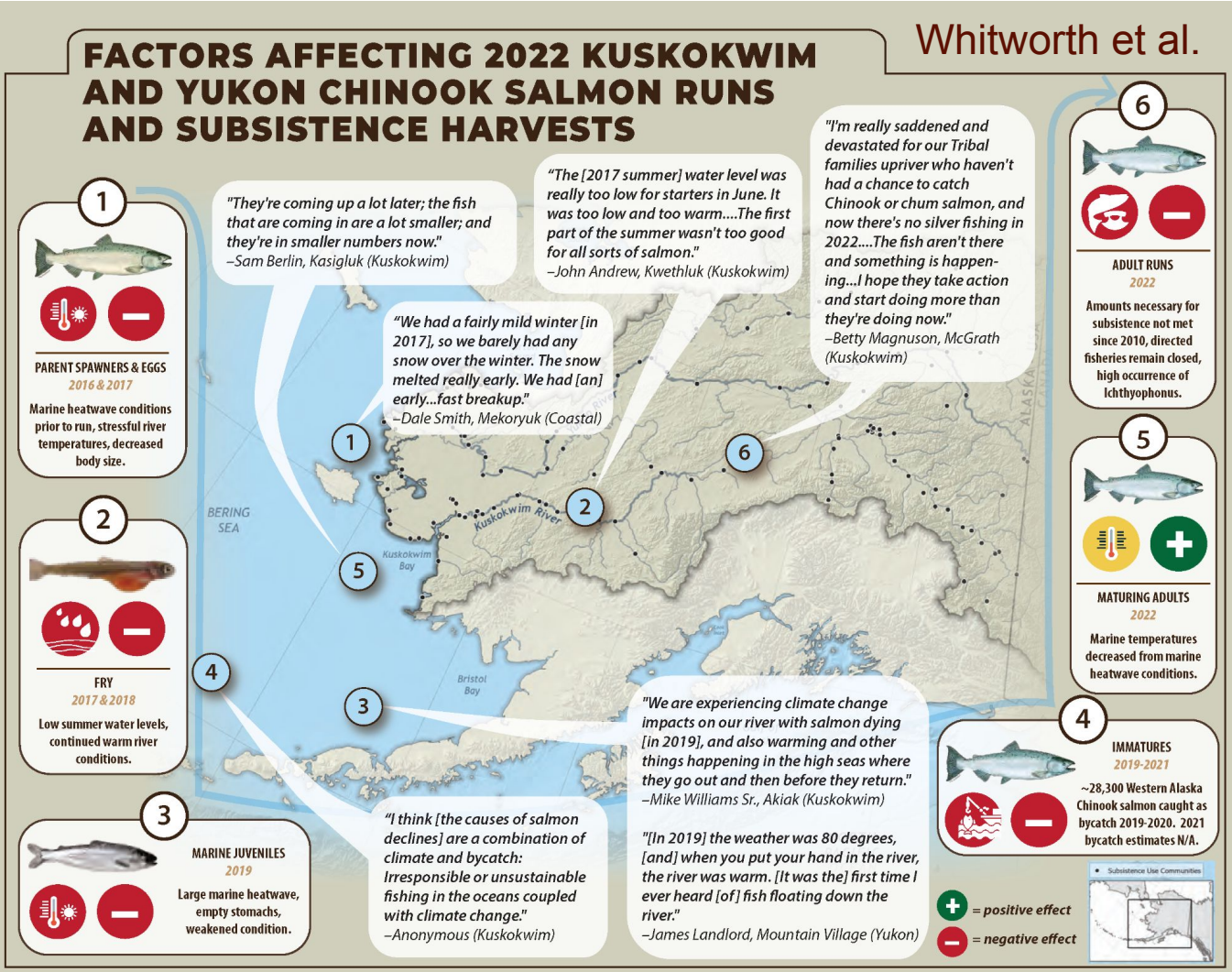




Contrasting salmon responses

- Bristol Bay sockeye salmon returns showed a large increase during the recent warm stanza
  - 2015-2022 returns all >50 million salmon
  - 2022 run was the largest since 1963
  - *Suggests favorable ocean conditions for juveniles since summers of 2012 & 2013 and winters 2012/2013 and 2013/2014*

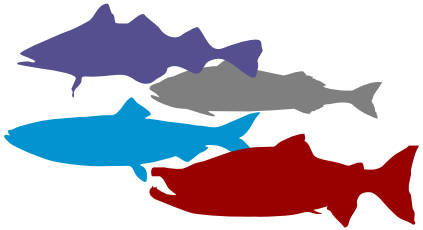
- Juvenile Chinook salmon in the northern Bering Sea have shown declines since ~2013
- Adult runs (e.g., Chinook, chum, and coho) throughout the AYK region have experienced unprecedented failures in recent years
  - *Suggests the dynamic life histories within salmon species are impacted by freshwater and marine habitat conditions*



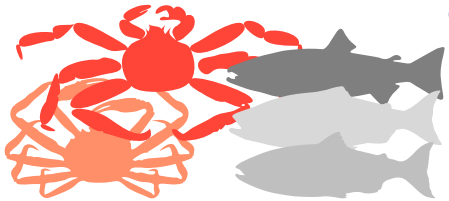
[2022 Kuskokwim River Salmon Situation Report]

Summary of the recent warm stanza

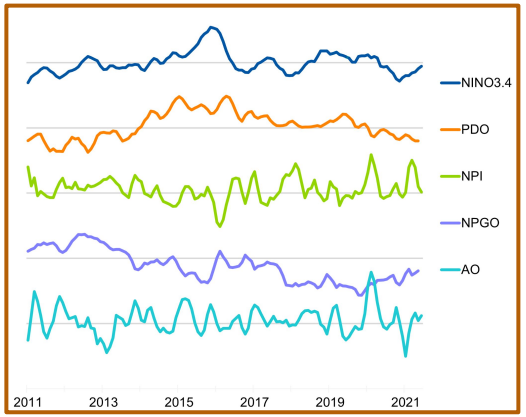
- The warm stanza contained a pulse event of near-absence of sea ice, and subsequent absence of cold pool, in the winters of 2017/2018 and 2018/2019
- Shifts in the distribution of groundfish and crab stocks have been documented
- Examples of stocks that are “winners” and “losers”, although the exact mechanisms are not fully understood at this time

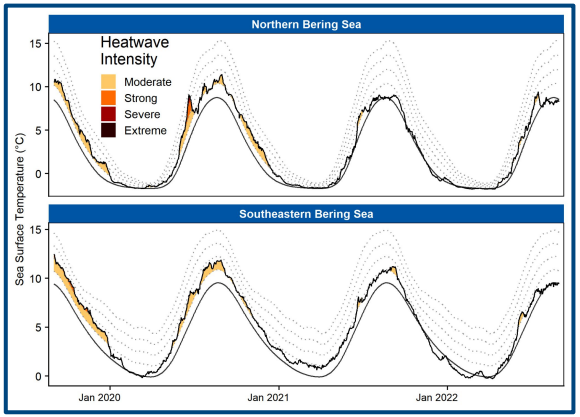


- “Winners”
  - 2018 year class of pollock
  - 2014-2019 year classes of sablefish
  - 2017 year class of Togiak herring
  - Bristol Bay sockeye salmon returns since 2015



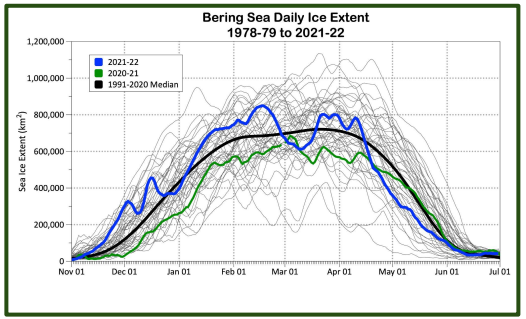
- “Losers”
  - Several crab stocks (notably snow crab and Bristol Bay red king crab)
  - Multiple Western Alaska Chinook, chum, and coho salmon runs.

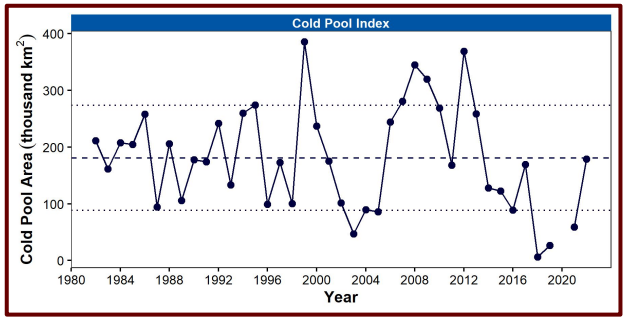


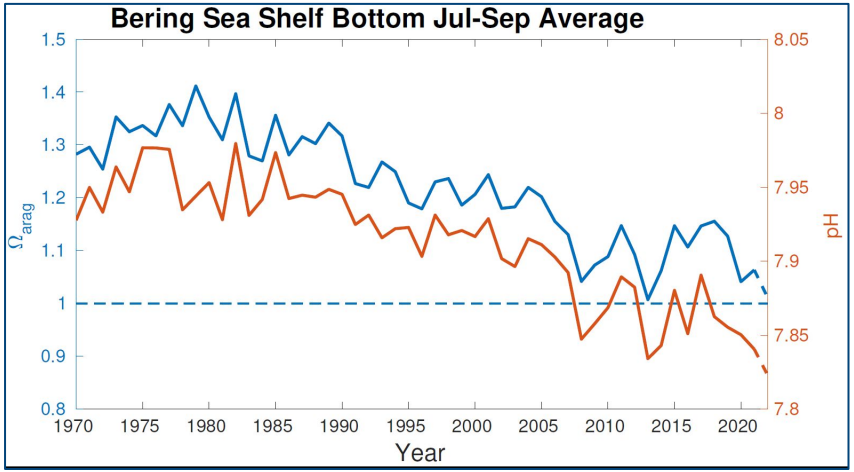


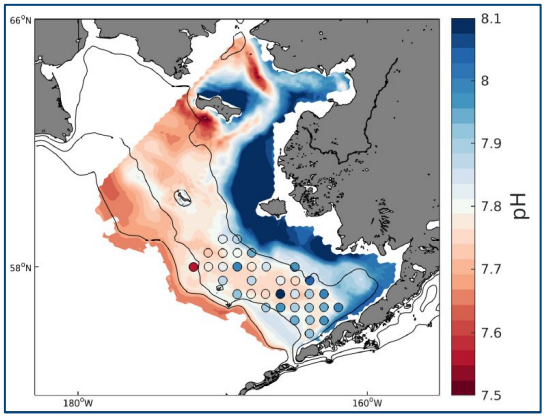
Oceanographic conditions

- Indications that the warm phase has ended:
  - The combined states of 3 climate indices (NPI, AO, La Niña)
  - Marine heatwaves have been infrequent and brief
  - Sea-ice extent was generally above average during winter 2021-2022
  - 2022 cold pool was near average



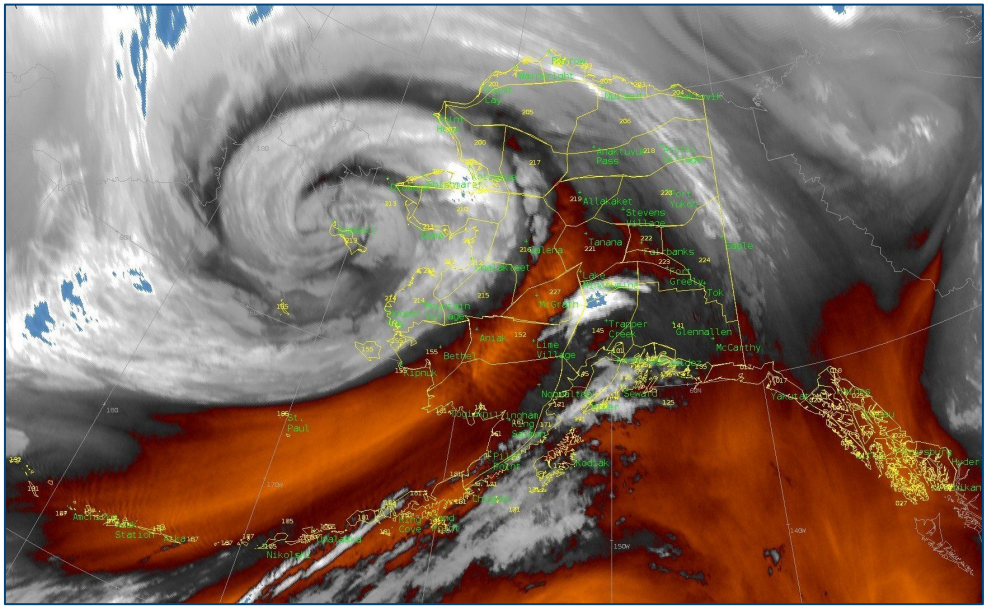






Ocean acidification (OA)

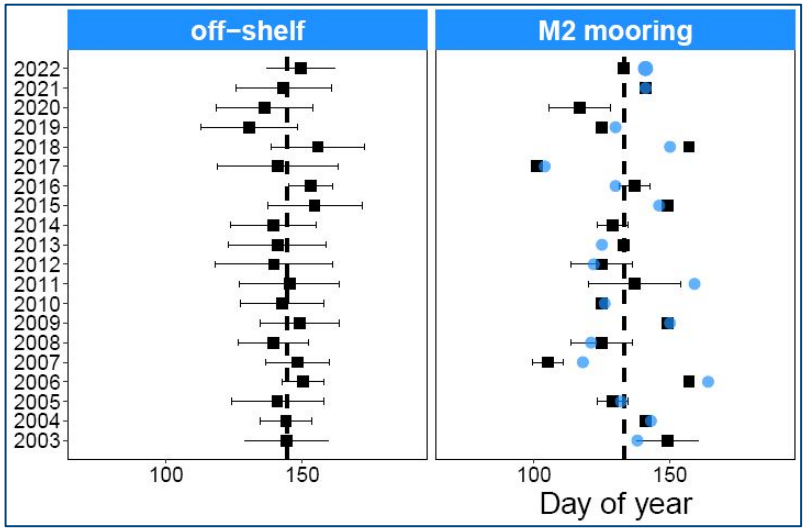
- Modeling research shows an expansion of bottom water conditions experimentally shown to negatively impact pteropods and red king crab
- In 2022, relatively lower pH was predicted for most of the outer and middle shelves and near Bering Strait
- At this time, there is no evidence that OA can be linked to recent declines in surveyed snow crab and red king crab populations

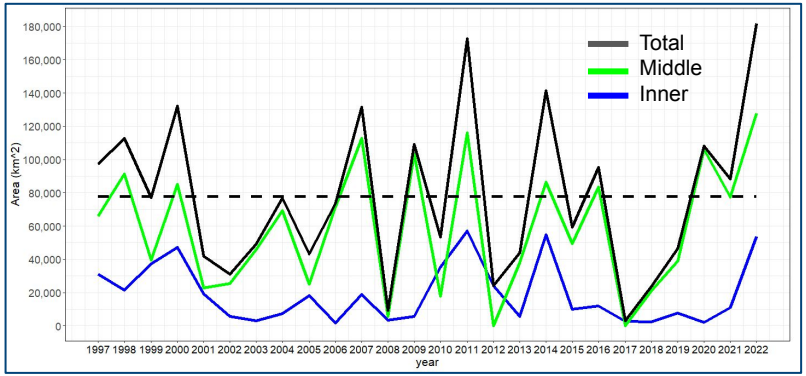


Article by Rick Thoman here

Typhoon Merbok
September 17, 2022

- Timing (i.e., early) and intensity fueled by warm ocean waters
- Immediate impacts included
  - damage to infrastructure
  - disruption of the fall subsistence harvest season
- Longer-term impacts of storm surges and coastal and river flooding may include
  - disturbance of HAB cyst beds
  - disturbance of salmon eggs





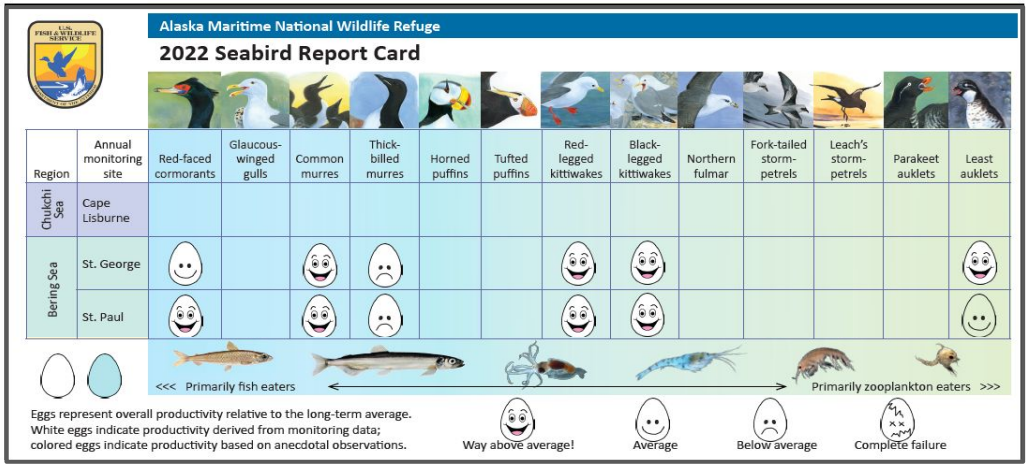
Primary and secondary productivity

- 2022 spring bloom peak timing was similar to the long-term average
- 2022 coccolithophore index was among the highest ever observed
- Spring zooplankton composition similar to warm years: fewer large copepods, more small copepods
- Late summer zooplankton: low abundance of both large and small copepods; increased abundance of euphausiids

- Euphausiids were also in higher abundances over the NBS, suggesting widespread abundance

Integrated Seabird Information

Biological response

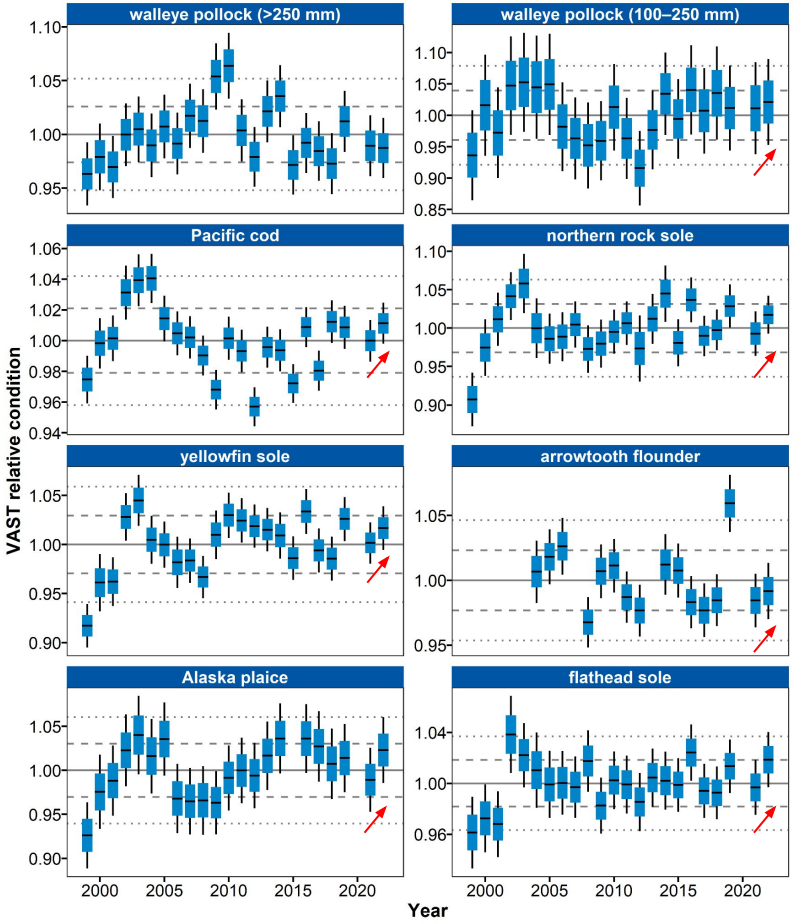


"Less **puffins, murres/murrelets, and seabirds** than expected generally"

- Skipper Science contributor

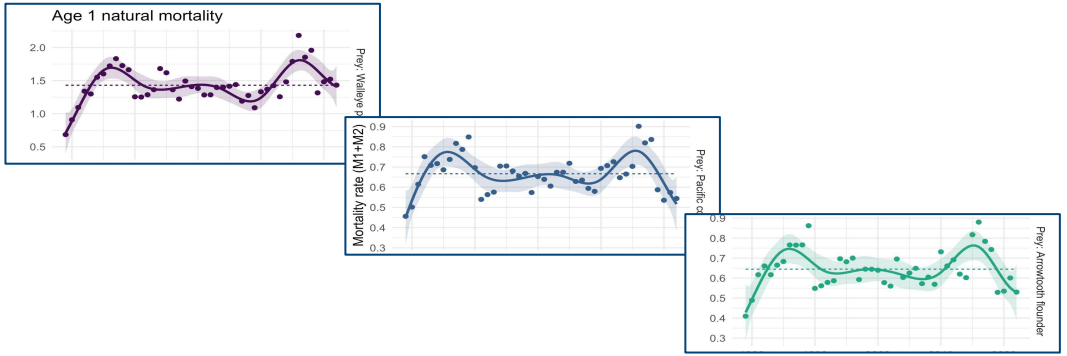
Seabirds

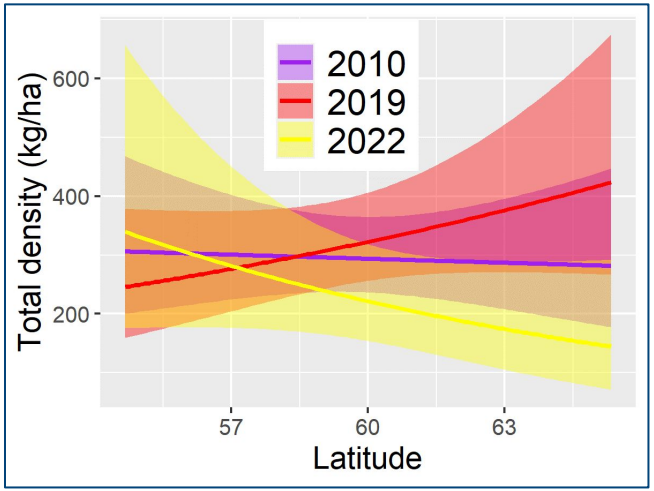
- Seabird reproductive success tracks prey availability
- Pribilof Islands
  - Reproductive success was high (except thick-billed murres)
  - Abundance was low
- St. Lawrence Island
  - Planktivorous seabirds did well
  - Piscivorous seabird species had reproductive failures
- No indications of a major die-off event (COASST)

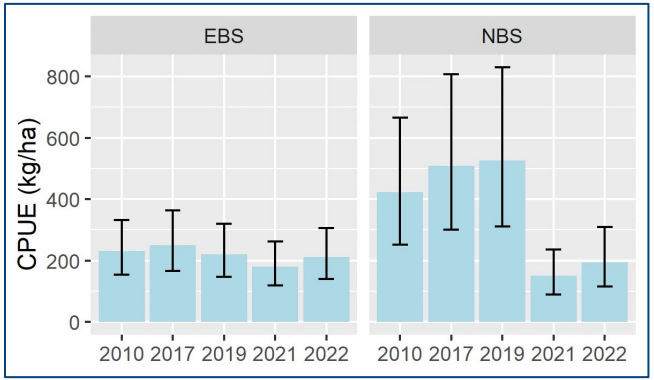


Groundfish Condition

- Cooler conditions should coincide with better groundfish condition, based on metabolic demands
- Groundfish condition improved from 2021 to 2022 for fish over the southern shelf (except adult pollock); trends were more variable over the northern shelf
- CEATTLE multispecies model indicates improved conditions for juvenile groundfish survival through 2022 via predation release

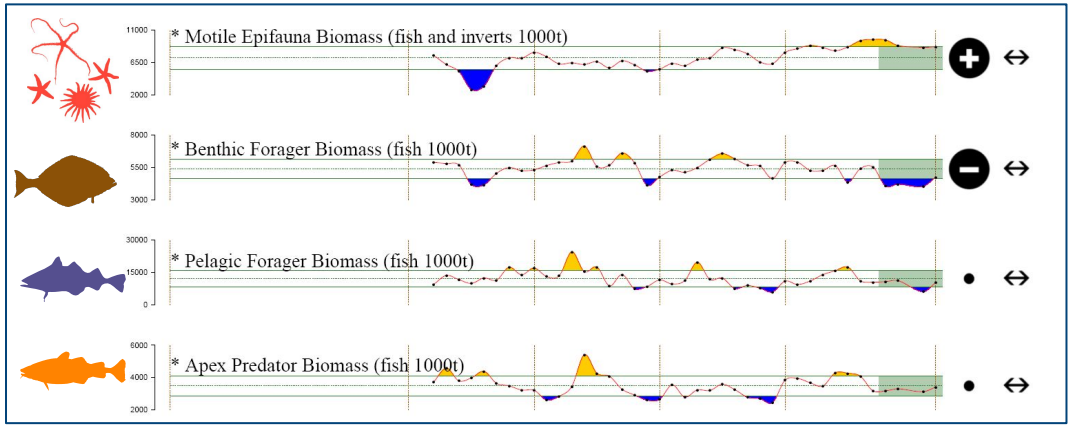


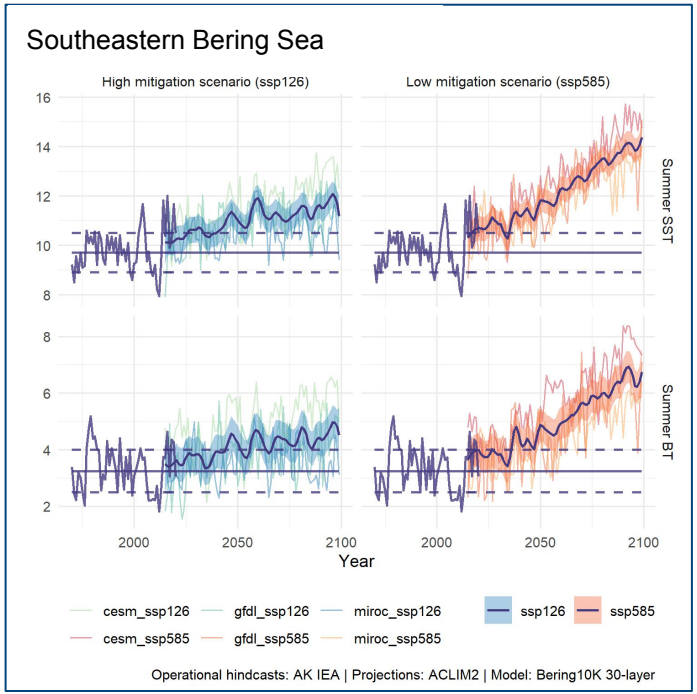




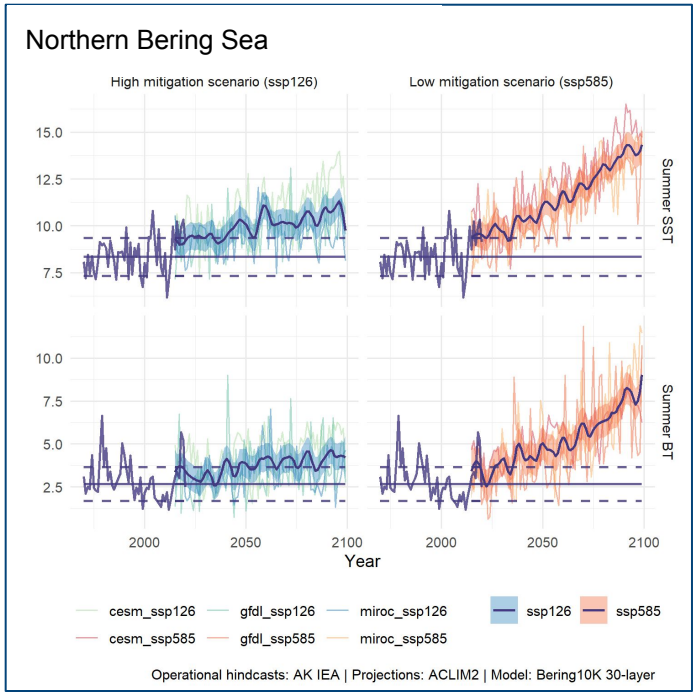
Groundfish community responses

- Groundfish community shifted north during the warm stanza through 2019, shifted south in 2021 as conditions cooled
- Groundfish community shifted into slightly deeper waters in 2022
- Drop in CPUE in the NBS in 2021 and 2022 may indicate
  - Migration out of the survey area
  - Carrying capacity exceeded during the very warm years





ACLIM SST and BT projections



- “High mitigation scenarios” predict a future Bering Sea that is slightly warmer but relatively similar to contemporary conditions
- “Low mitigation scenarios” predict warming that drives the modeled Bering Sea system to conditions well beyond those observed to date

2022 Summary and *implications*

Sea-ice extent was above average during winter 2021-2022; the 2022 cold pool extent was near average

Indicates a return to more average thermal conditions and potential end of the extended warm phase

Monitoring of emerging stressors: Ocean Acidification (OA), Harmful Algal Blooms (HABs)

Impacts to groundfish and crab are active areas of research

Primary productivity average; large coccolithophore bloom; in late-summer, lower abundance of small and large copepods, but relatively higher abundance of euphausiids

Spatial and temporal trends in bottom-up trophic pathways varied over the shelf

Seabird reproductive success was exceptional at the Pribilof Islands, but was mixed at St. Lawrence Island

Indicates local availability of zooplankton and forage fish over the southern shelf, but limited forage fish availability in the northern Bering Sea

Groundfish condition improved from 2021 to 2022 (except adult pollock); CEATTLE multispecies model indicates improved conditions for juvenile groundfish survival through 2022 via predation release

Indicates sufficient prey availability under cooler thermal conditions (i.e., reduced metabolic demands)

Groundfish community indicators (e.g., guilds) based on data collected from the standard bottom trawl survey

Individual stock dynamics continue to fluctuate between the southern and northern shelves (i.e., Pacific cod)