

Eastern Bering Sea Ecosystem Status Report

**North Pacific Fishery
Management Council**
SSC presentation
November 30, 2020



Elizabeth Siddon



Response to SSC Comments from December 2019*

“...the SSC recommends that there be a single, short, but comprehensive (integrated) contribution on sea temperatures in each region.”

A new Physical Environment Synthesis provides an overview of the physical oceanographic conditions in the region. The synthesis includes: Climate, Regional Highlights, Sea Ice, Winds, SST, and Bottom Temperature.

“...there are several Ecosystem or Community Indicators. The SSC suggests calculating these indices with and without the dominant species.”

Indicators for Mean Lifespan, Mean Length, and the Stability of Groundfish Biomass have been recalculated through 2019 with and without pollock.

“The SSC supports continued exploration of the use of VAST models as an update of the large copepod index. However, we caution that the 2008 estimate should be carefully examined.”

“Reduced observations in the outer shelf and biological variation of large copepods could lead to increased variance. Model-based estimate different than sample-based: (1) model-based accounts for spatial correlation and (2) inclusion of unsampled areas in the extrapolation grid.” (see Appendix for full response)

“Integrated Seabird Section: The SSC commends the authors and editors in assembling this section.”

The 2020 EBS ESR continued with the Integrated Seabird Information section which also contains a Summary section.

*Detailed responses to all SSC comments from Dec 2019 are provided in the Appendix of the 2020 EBS ESR.

Thank You

2020 Ecosystem Status Report Contributors

Don Anderson, Kerim Aydin, Shaun W. Bell, Nick Bond, Lyle Britt, Caroline Brown, Greg Buck, Dan Cooper, Jessica Cross, Deana Crouser, Curry J. Cunningham, Seth Danielson, Lauren Divine, Elizabeth Dobbins, Sherri Dressel, Darcy Dugan, Ginny Eckert, Serafima Edelen, Anne Marie Eich, Lisa Eisner, Benjamin Fissel, Sarah Gaichas, Jeanette C. Gann, Colleen Harpold, Jordan Head, Kris Holderied, Kirstin Holsman, Jim Ianelli, Tim Jones, Robb Kaler, Stephen Kasperski, Kelly Kearney, Esther Kennedy, David Kimmel, Alexander Kitaysky, Joseph Krieger, Kathy Kuletz, Elizabeth Labunski, Carol Ladd, Ned Laman, Geoffrey M. Lang, Kari Lanphier, Jean Lee, Kathi Lefebvre, Dennis Lekanof, Aaron Lestenkof, Jackie Lindsey, Christopher Long, Rosie Masui, Paul Melovidov, Sara Miller, Calvin W. Mordy, Franz Mueter, Peter Murphy, Jens M. Nielsen, Elena Oaks, Jim Overland, Darren Pilcher, Chandra Poe, Melissa Rhodes-Reese, Sean Rohan, Marc Romano, Kate Savage, Gay Sheffield, Punguk Shoogukwruk, Kalei Shotwell, Elizabeth Siddon, Kim Sparks, Ingrid Spies, Phyllis Stabeno, Richard L. Thoman, Grant Thompson, Stacy Vega, Andie Wall, Muyin Wang, Jordan T. Watson, George A. Whitehouse, Tom Wilderbuer, Alexis Will, Sarah Wise, and Ellen Yasumiishi

2020 Ecosystem Status Reports

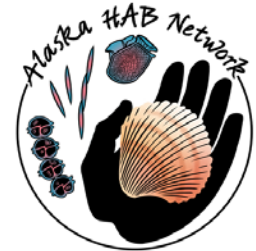
Contributing Partners



PRINCE WILLIAM SOUND
SCIENCE CENTER










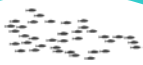



COASST



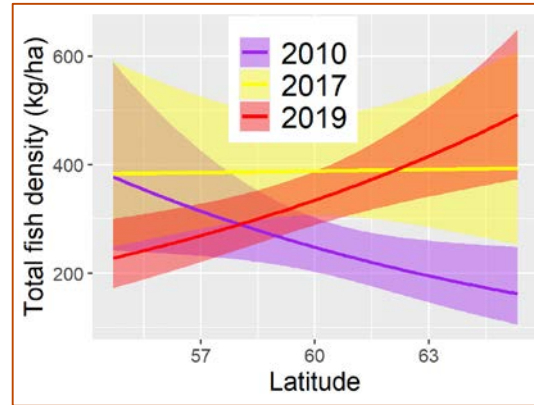
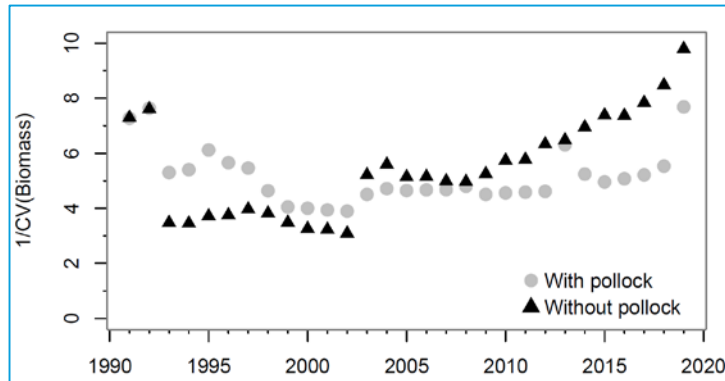
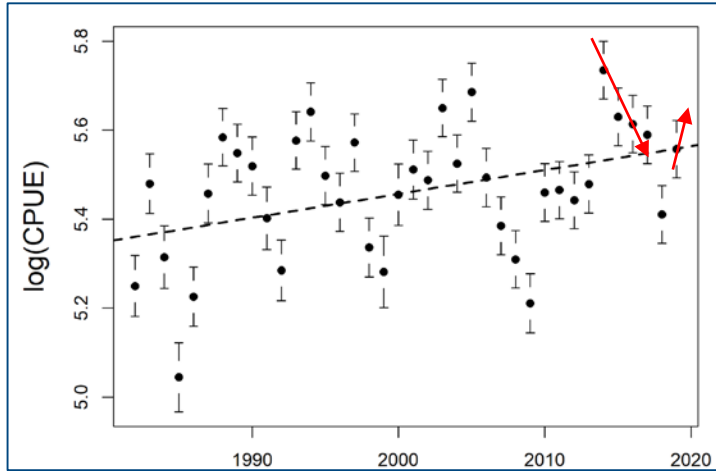
2019 Review

For the complete summary of 2019 ecosystem conditions, please see the Assessment in the 2020 EBS Ecosystem Status Report.

Indicator Category	2019	2020
Physical Oceanography		
Primary Producers		
Zooplankton		
Forage Fish		
Salmon		
Herring		
Groundfish		
Seabirds		
Marine Mammals		
Ecosystem Indicators		
Fishing and Human Dimensions		

2019 Ecosystem or Community Indicators

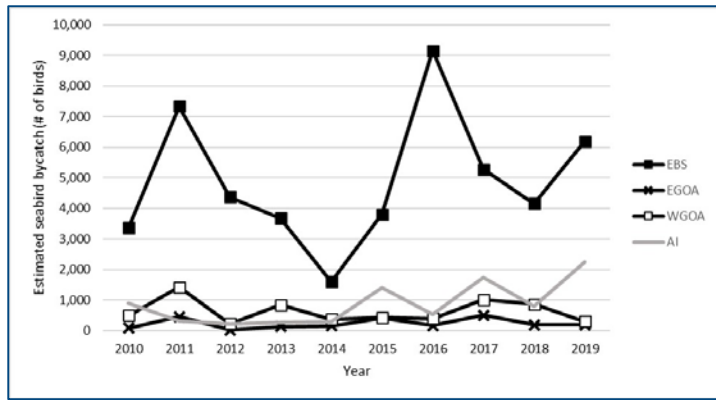
Mueter & Britt, Whitehouse



- Total CPUE declined 2014-2018, but increased in 2019; likely reflects 75% increase in pollock biomass.
- Strong directional trend of fish community to the north.
- The stability of the groundfish community - its resiliency to perturbations - increased in 2019.

















2019 Fishing & Human Dimensions Indicators

Krieger & Eich, Fissel et al., Rhodes-Reese, Sparks & Wise




















- Estimated seabird bycatch increased in 2019 in the EBS; largely due to shearwater mortality event.
- Landings stable through 2019; driven by pollock. Pacific cod landings dropped, but off-set by flatfish and rockfish.
- SEBS unemployment decreased in 2019; overall population increased, but 47% communities saw declines; school enrollment stabilized after 2017.
- NBS unemployment decreased, but above State and national rates; overall population increased and 75% communities saw increases; school enrollment stable, but graduation rates below state average.



















2020 Overview

Indicator Category	2019	2020
Physical Oceanography		
Primary Producers		
Zooplankton		
Forage Fish		
Salmon		
Herring		
Groundfish		
Seabirds		
Marine Mammals		
Ecosystem Indicators		
Fishing and Human Dimensions		


























2020 Overview

Indicator Category	2019	2020
Physical Oceanography		
Primary Producers		
Zooplankton		
Forage Fish		
Salmon		
Herring		
Groundfish		
Seabirds		
Marine Mammals		
Ecosystem Indicators		
Fishing and Human Dimensions		

2020 Overview

Indicator Category	2019	2020
Physical Oceanography		
Primary Producers		
Zooplankton		
Forage Fish		
Salmon		
Herring		
Groundfish		
Seabirds		
Marine Mammals		
Ecosystem Indicators		
Fishing and Human Dimensions		

2020 Overview

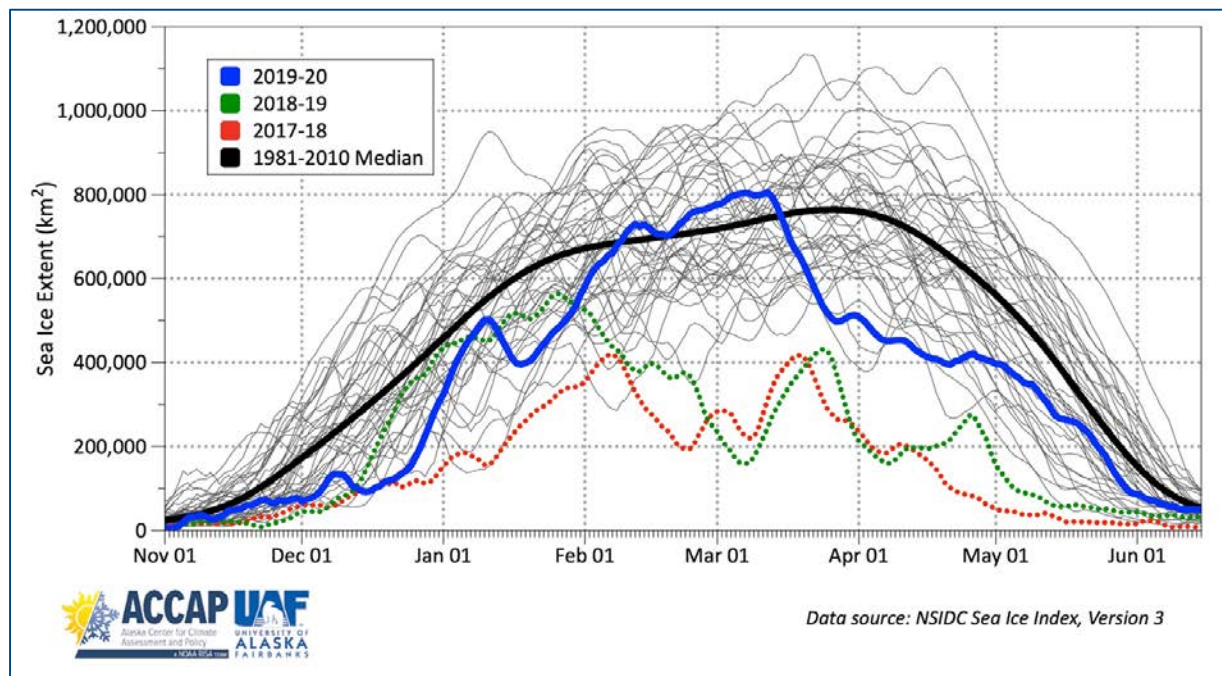
Indicator Category	2019	2020
Physical Oceanography		 
Primary Producers		
Zooplankton		  
Forage Fish		 
Salmon		
Herring		 
Groundfish		
Seabirds		
Marine Mammals		
Ecosystem Indicators		
Fishing and Human Dimensions		 

 Noteworthy



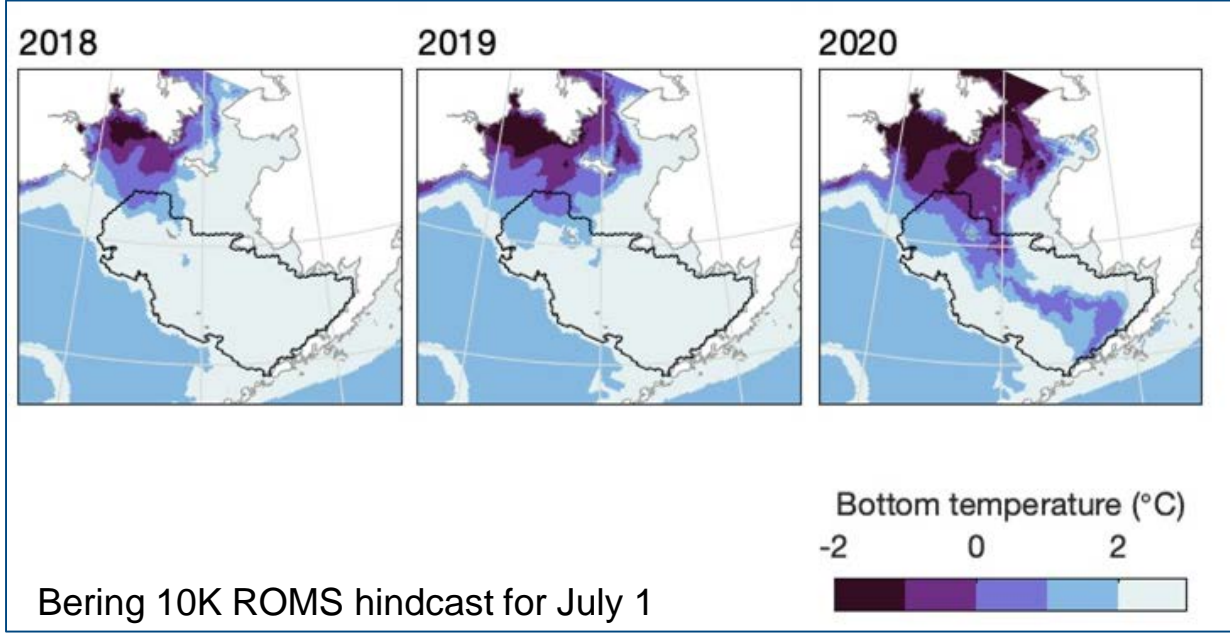
Sea Ice

Thoman



- Winters 2017/2018 and 2018/2019 had minimal sea ice.
- 2019/2020 had average ice extent, but ice was thin.
- Exceeded median in February/March.
- Southerly (warm) winds in spring lead to rapid ice retreat.

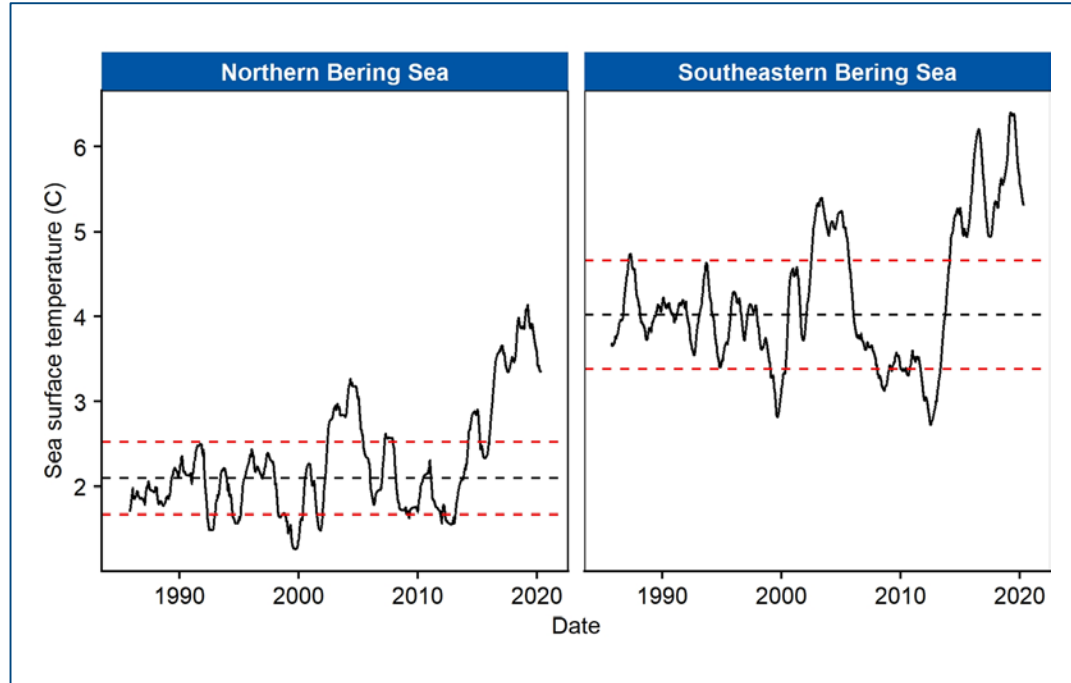
Cold pool Kearney



2020 was an 'average' year in terms of $<2^{\circ}\text{C}$ and $<0^{\circ}\text{C}$ waters in the standard bottom trawl survey area.

Sea Surface Temperatures

Watson



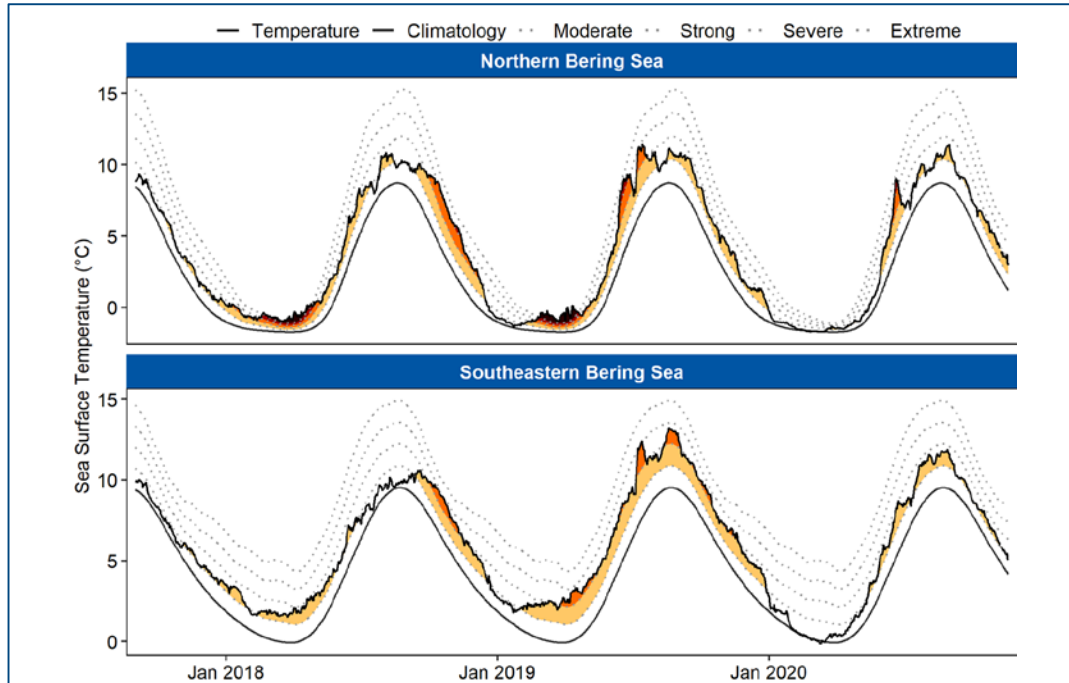
- Removed seasonality and noise from the time series.
- Trends are compared to the mean (± 1 SD) from baseline (1986-2015).
- Both regions are in a persistent warm stanza that is greater in magnitude and duration than the early 2000s.

Implications: Sea ice had minimal mitigating effect on warmth of the upper water column, even though the cold pool extent was average. Vertical stratification (i.e., warm surface and cooler bottom) is more typical of shelf conditions and impacts predator/prey dynamics.



★ Marine Heatwave

Watson



- Marine Heatwave status (Sept 2017 to current).
- Heatwaves occur when daily SSTs exceed the 90th percentile of normal for 5 consecutive days.
- Darker colors indicate more intense heatwave conditions.

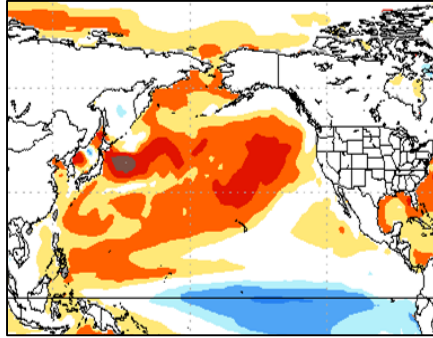
Note: there are a variety of SST and MHW metrics in the Noteworthy contribution.



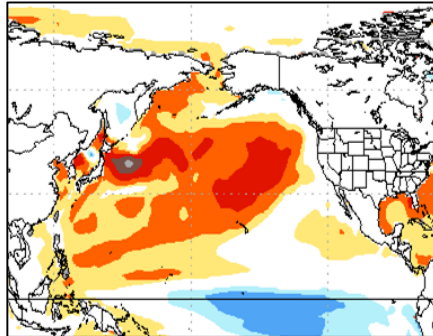
SST Projections from the National Multi-Model Ensemble

Bond

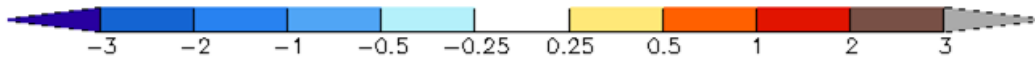
Dec 20 -
Feb 21



Feb -
April
2021



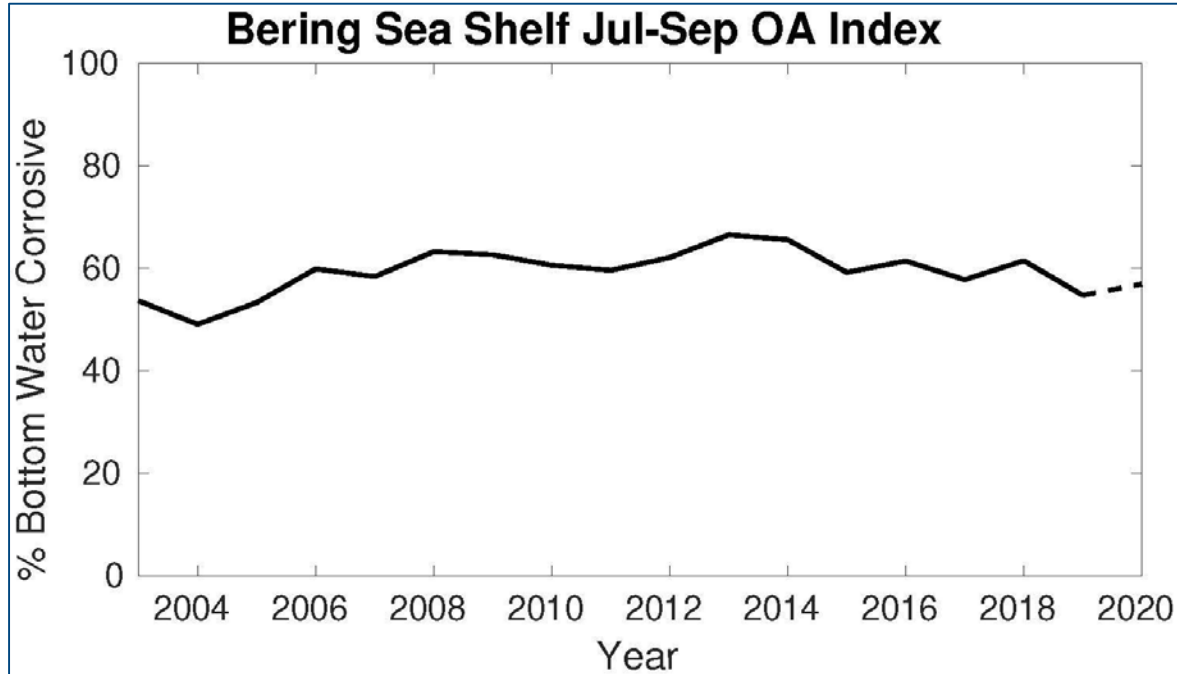
- Warm conditions are projected across the Bering Sea and north of Bering Strait.
- Peak temperatures in the Chukchi Sea are expected to delay sea ice formation.
- Modestly warm conditions over the shelf are predicted to result in a light sea ice year.
- SST projections in the tropical Pacific indicate a weak to moderate La Niña that is predicted to bring some cooling to the EBS shelf into spring 2021.





★ Ocean Acidification

Pilcher et al.

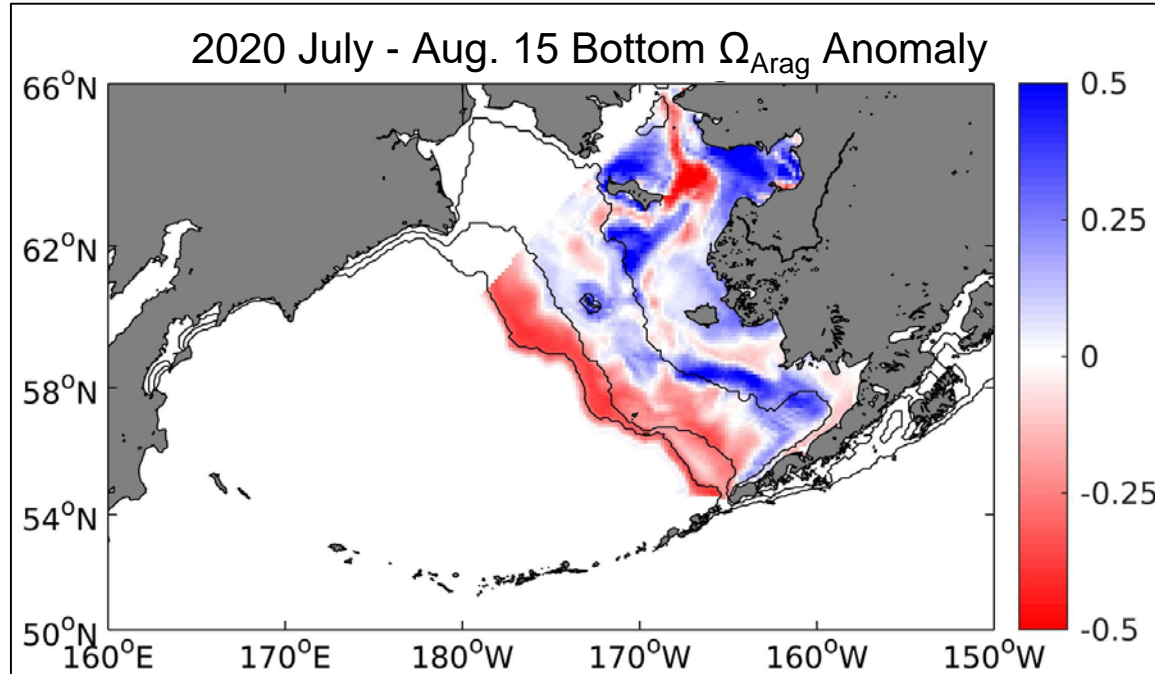


- ROMS output tailored to red king crab.
- The spatial extent of bottom waters with an Ω_{arag} value < 1 .
- $\Omega_{\text{arag}} < 1 \approx \text{pH} 7.8$ considered corrosive.
- July-Sept when larvae are in the water column.



★ Ocean Acidification

Pilcher et al.

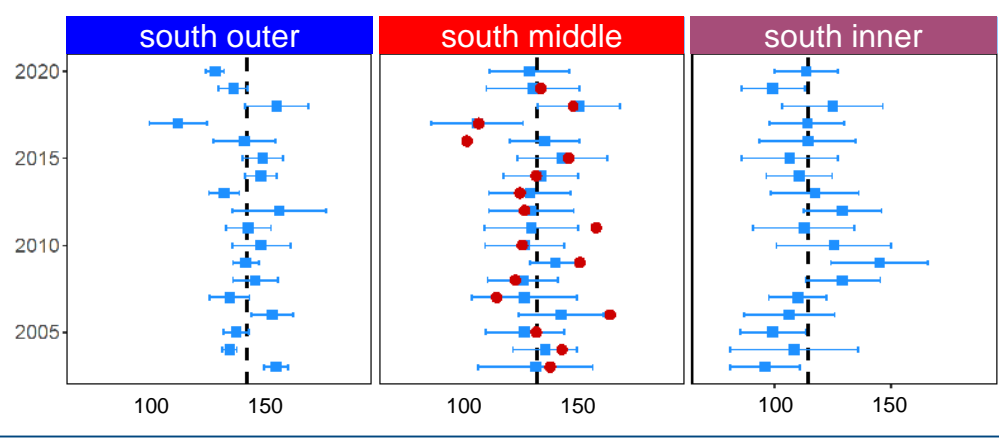
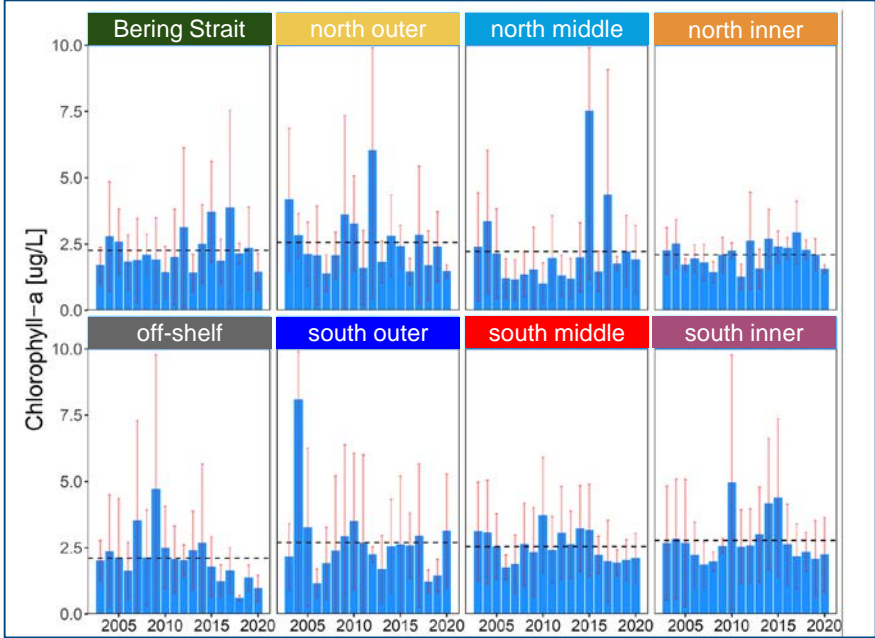
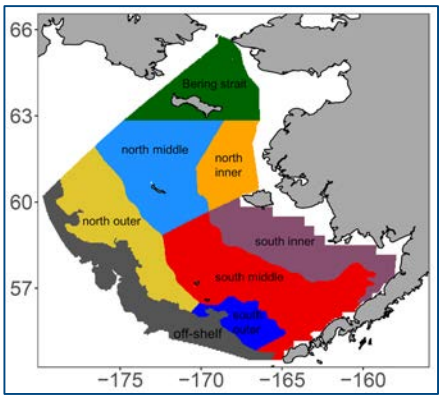


- Anomaly plot shows 2020 compared to the 2003-2019 mean.
- Blue is better; red is worse.

Note: Additional OA outputs (e.g., pH, calcite saturation) are available as spatially and temporally explicit stock-specific metrics.

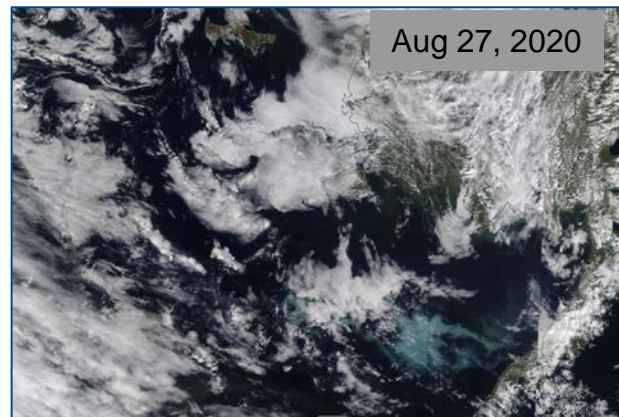
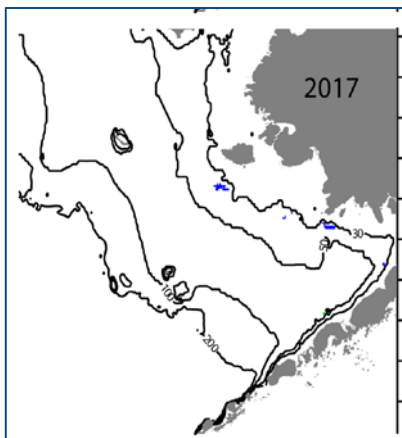
Spring Bloom

Nielsen et al.



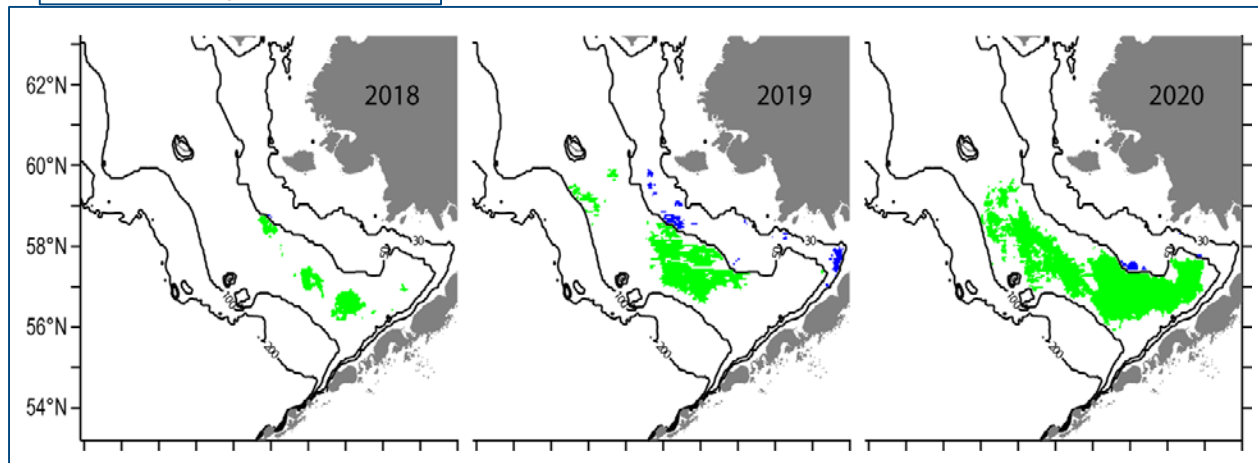
- 2020 spring bloom peak timing earlier than average;
- 2019 about a week earlier;
- 2018 among the latest;
- 2017 among the earliest in most regions.

- Chl-a biomass; dotted line is 2003-2020 average.
- North: 2019 at average; 2020 below average.
- South: below average since at least 2016, except outer domain above-average.



Coccolithophores

Ladd and Eisner



- 2017 was lowest index on record.
- Bloom index below average in 2018 and 2019.
- Increased, particularly on the middle shelf, in 2020.

Implications: coccolithophores result in longer trophic chains, may be a less desirable food source, and can reduce foraging success for visual predators.

★ Gray Whale UME

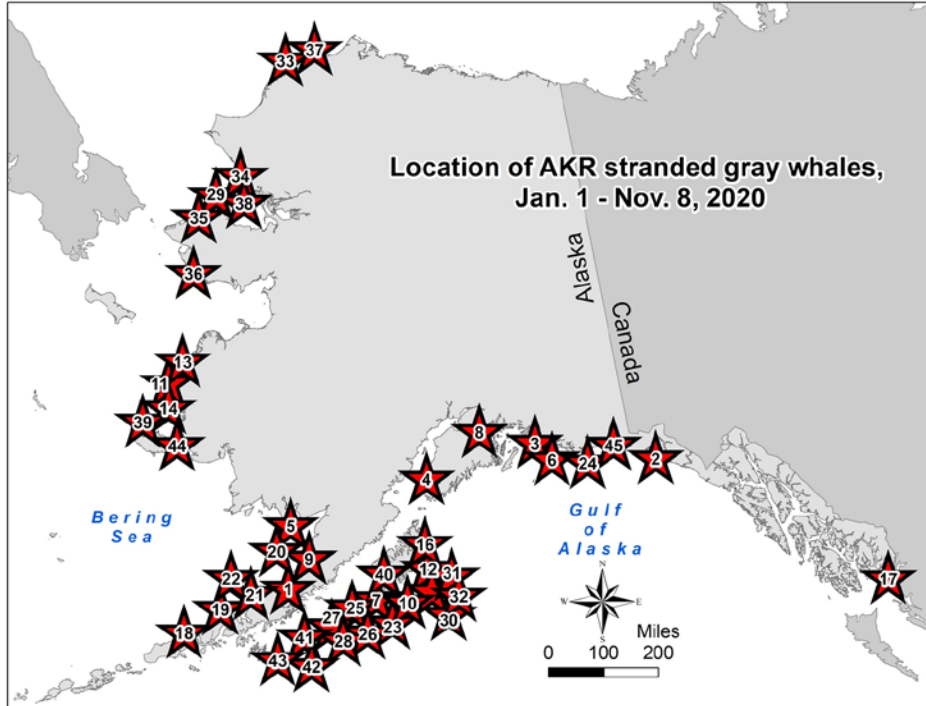
Savage

Unusual Mortality Event continued into 2020.



Location	2019	2020
Canada	10	5
US Total	122	78
Alaska	48	45
Washington	34	12
Oregon	6	3
California	34	18
Mexico	81	87
TOTAL	213	170

★ Gray Whale UME Savage



- Whales feed in the northern Bering and Chukchi seas.
- Typically benthic feeders (e.g., amphipods, crab larvae).
- In warm conditions, may shift to zooplankton in the water column.
- Potential explanations include: nutritional stress, contaminants, biotoxins, disease and parasites, direct anthropogenic factors, and reaching carrying capacity.

Implications: may reflect cumulative impacts of changes in food web structure and carrying capacity of the northern Bering Sea.

Integrated Seabird Information

This integration is in response to ongoing collaborative efforts within the seabird community and contains contributions from (in alphabetical order):

Lauren Divine (Ecosystem Conservation Office at Aleut Community of St. Paul Island)

Serafima Edelen (Community member, St. Paul Island)

Tim Jones (University of Washington, Coastal Observation and Seabird Survey Team (COASST), Seattle, WA)

Robb Kaler (U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK)

Alexander Kitaysky (University of Alaska Fairbanks, Institute of Arctic Biology, Fairbanks, AK)

Kathy Kuletz (U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK)

Elizabeth Labunski (U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK)

Dennis Lekanof (Community member, Island Sentinel, St. George Island)

Aaron Lestenkof (Community member, Island Sentinel, St. Paul Island)

Jackie Lindsey (University of Washington, Coastal Observation and Seabird Survey Team (COASST), Seattle, WA)

Paul Melovidov (Community member, Island Sentinel, St. Paul Island)

Elena Oaks (Community member, Hooper Bay)

Marc Romano (U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, Homer, AK)

Gay Sheffield (University of Alaska Fairbanks, Alaska Sea Grant, Nome, AK)

Punguk Shoogukwruk (Community member, Savoonga, AK)

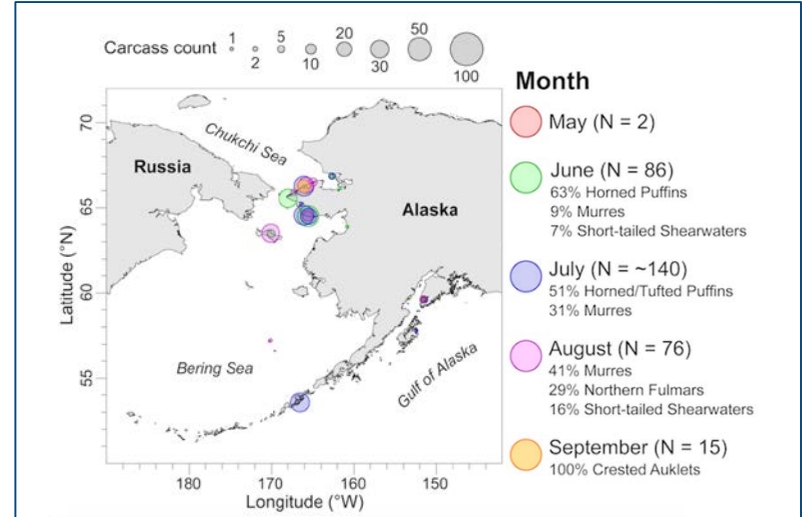
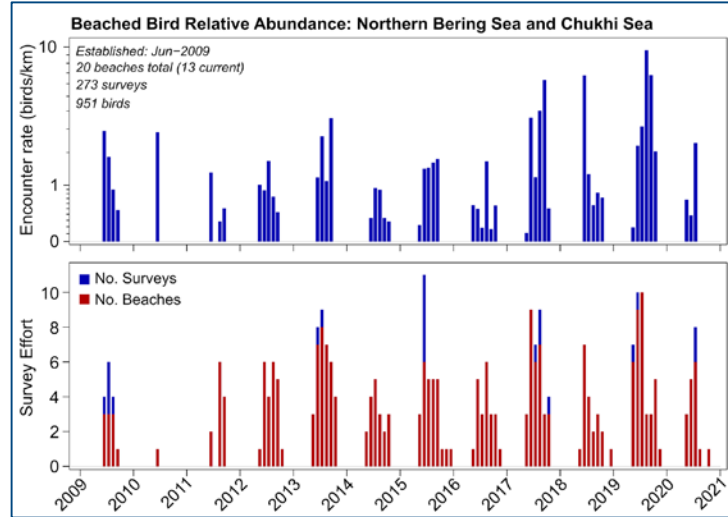
Alexis Will (University of Alaska Fairbanks, Institute of Arctic Biology, Fairbanks, AK)



Integrated Seabird Information

Summary Statement

During 2020, the U.S. Fish and Wildlife Service was unable to conduct field research in the eastern and northern Bering Sea due to COVID-19 travel restrictions. Coastal community members, tribal governments, and state/university partners provided information on seabird dynamics; the U.S. Fish and Wildlife Service biologists helped to synthesize this information.



Over 330 seabird carcasses were reported from the Bering Sea, with most reported from the Bering Strait region. *Implications:* most were fish-eating species, but plankton-eating birds were also affected, suggesting some impact across trophic levels.

Integrated Seabird Information

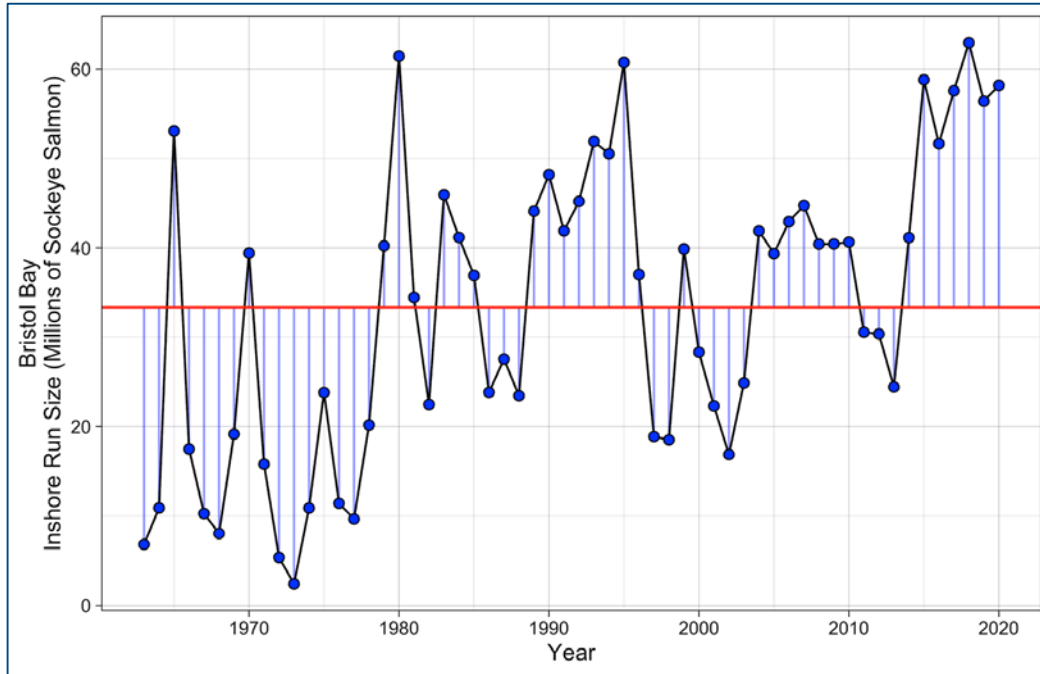


- At the Pribilof Islands, it was an average, to slightly below average, year for most fish-eating seabird species (e.g., black-legged kittiwakes, common murre).
- Plankton-eating species (e.g., least auklets) continued to decline.
- Complete lack of parakeet auklets (plankton-eating known for eating jellyfish) from St. Paul Island, which had been the most abundant auklet species since monitoring began in the late 1970s.

Implications: Fish-eating species were able to find moderate/sufficient food; plankton-eating species were not.

Bristol Bay Sockeye Salmon

Cunningham et al.



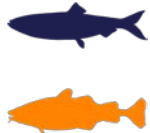
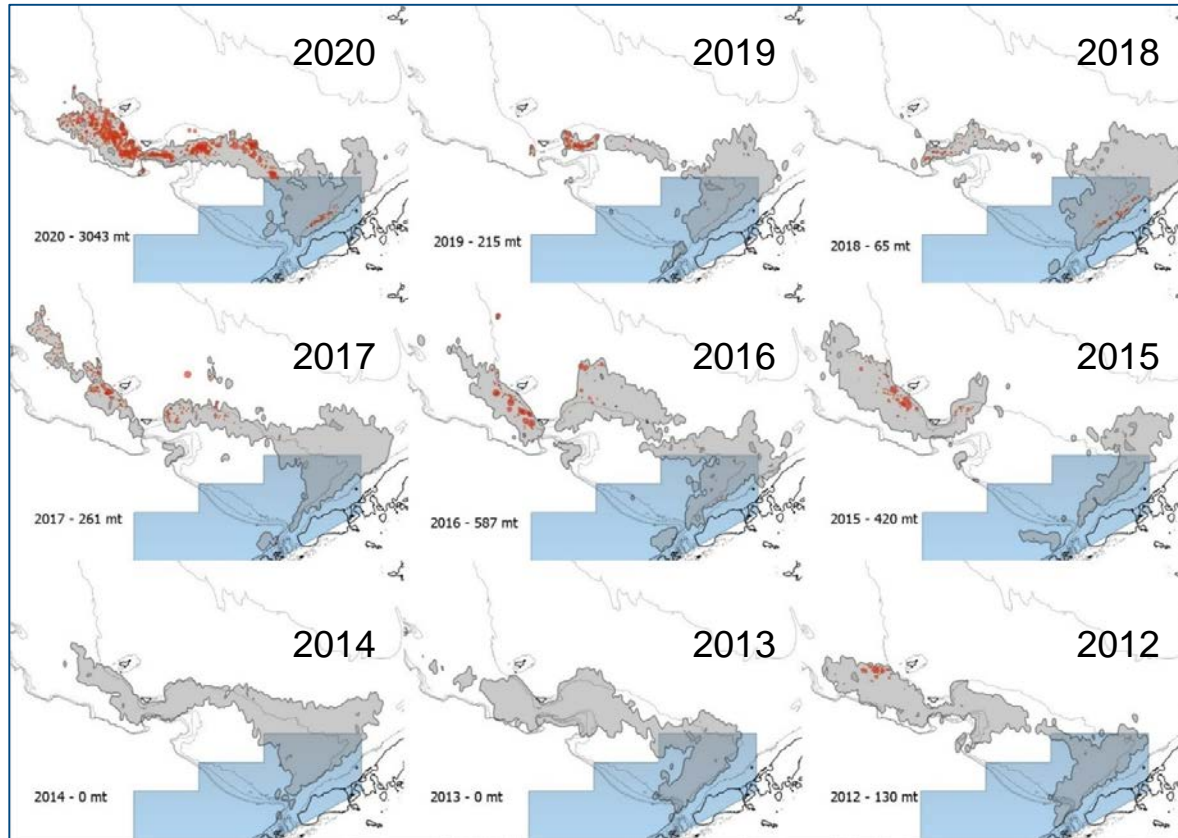
- 2020 was the 5th largest run on record since 1963.
- Inshore runs in 2015-2020 all exceeded 50 million.
- Positive ocean conditions in summers of 2017 and 2018, and winters 2017/2018 and 2018/2019.

Implications: Juvenile sockeye feed on zooplankton and age-0 pollock in warm years; adults feed on zooplankton and krill.

★ Incidental Catch of Herring in 2020

Siddon et al.

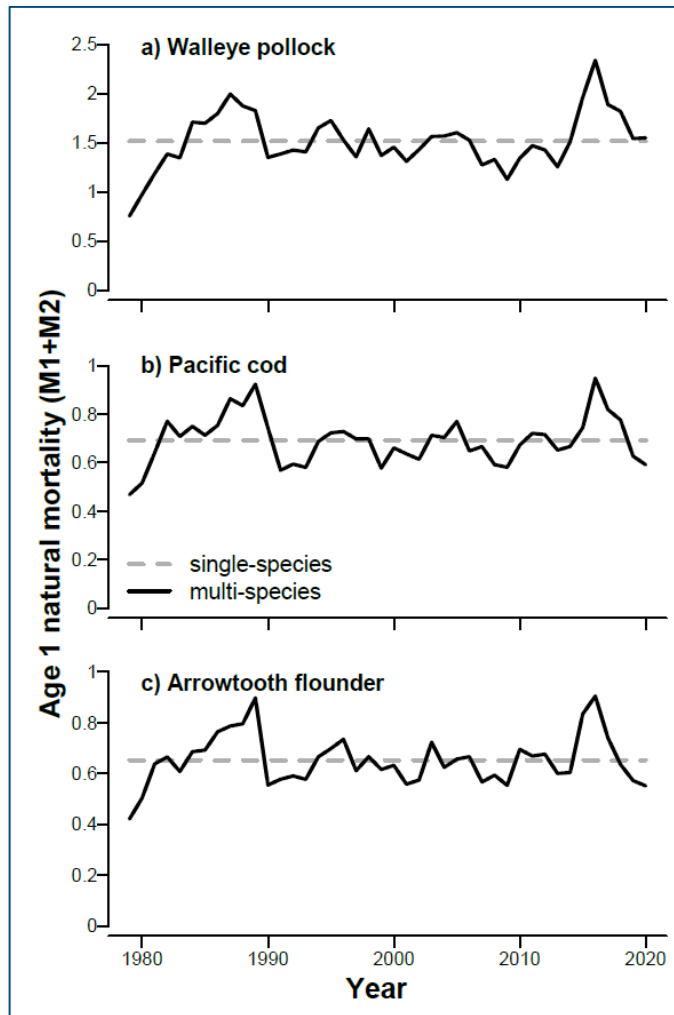
Figure provided by SeaState, Inc.



- Contribution explores hypotheses that may explain the increased herring catch.
- Provides areas of research to help inform the hypotheses.
- Gray: Pollock A season footprint.
- Red: Herring bycatch.

Groundfish

Holsman et al.



- CEATTLE model estimates of age-1 predation mortality continued to decline from peak in 2016.
- Age-1 predation mortality for pollock is at the long-term mean.
- Age-1 Pacific cod and Arrowtooth flounder remain below their long-term means.

Implications: declines in predator biomass mean an overall decline in age-1 mortality.

★ Marine Debris

Murphy and Sheffield



- Marine debris reported in Bering Strait communities from July through October 2020.
- Predominantly foreign in manufacture, with identifiable Russian and Korean writing.
- Adds to existing concerns in the region regarding food security and economic impacts with an increase in commercial fishing/processing activities and other industrial vessel traffic.



2020 Summary and Implications



Sea ice extent was near-normal, but ice was thin/weak. Average cold pool extent. SSTs above average and NBS in “heatwave” status. *Implications: EBS is in a persistent warm stanza; the vertical stratification in 2020 is more typical of shelf conditions and affects predator/prey dynamics.*



Chl-a biomass was below average and peak bloom timing was earlier than average in most regions. *Implications: Low chl-a biomass could indicate reduced production and/or increased grazing by zooplankton.* Coccolithophores increased. *Implications: longer trophic chains, less desirable food source, and reduced foraging success for visual predators.*



Gray whale UME continued. *Implications: cumulative impacts of changes in food web structure and carrying capacity of the NBS.*



Seabird die-offs in the NBS were mostly fish-eating species, but plankton-eating birds were also affected. Colony attendance at the Pribilofs indicated fish-eating species were able to find sufficient food, but plankton-eating species were not. *Implications: fish-eating birds were able to find sufficient food in the south while plankton-eating birds indicated poor prey availability in both regions.*



Sockeye salmon returns indicate favorable ocean conditions in summers 2017 and 2018, and winters 2017/2018 and 2018/2019. *Implications: Juveniles feed on zooplankton and age-0 pollock in warm years; adults feed on zooplankton, including krill.*













CEATTLE model shows declines in age-1 predation mortality for Pollock, PCod, and ATF. *Implications: indicates potential declines in predator biomass.*

2020 BSAI Risk Tables

21 full assessments (BSAI plus Alaska-wide Sablefish).

- 16 recommended an ecosystem risk level of 1.
- 5 recommended an ecosystem risk level >1.

	Sablefish		A mixture of positive (early juv.) and negative (juv./adult) indicators; fish condition has declined.
	EBS Pollock		EBS in a warm stanza; concerns about prey quality/quantity; fish condition at or near average.
	EBS Pacific cod		Shift in distribution northward; fish condition in NBS above average; concerns of carrying capacity exist.
	AI Pacific cod		Concerns about adult prey availability and fish condition.
	Greenland turbot		Competitors are abundant and/or increasing.