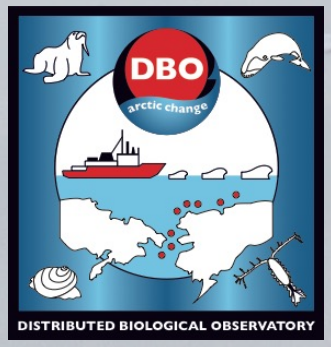
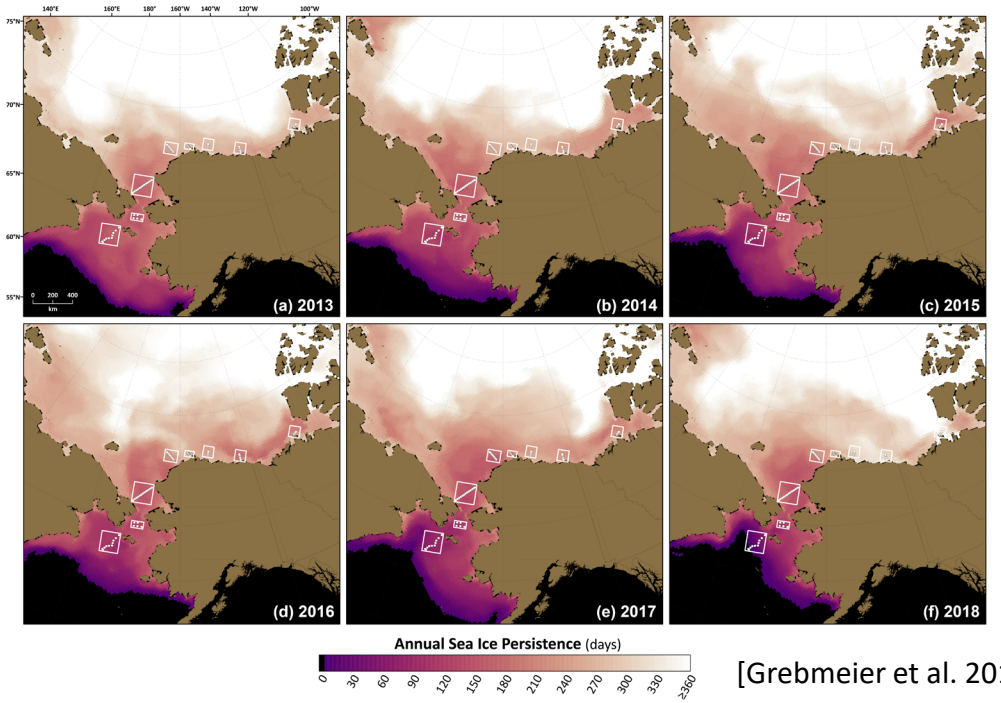
Time series benthic biomass and composition in the DBO regions

Jacqueline Grebmeier
Chesapeake Biological Laboratory
University of Maryland Center for Environmental Science
Solomons, Maryland, USA

NOAA Pacific Marine Environmental Laboratory
Seattle, WA
January 22, 2020

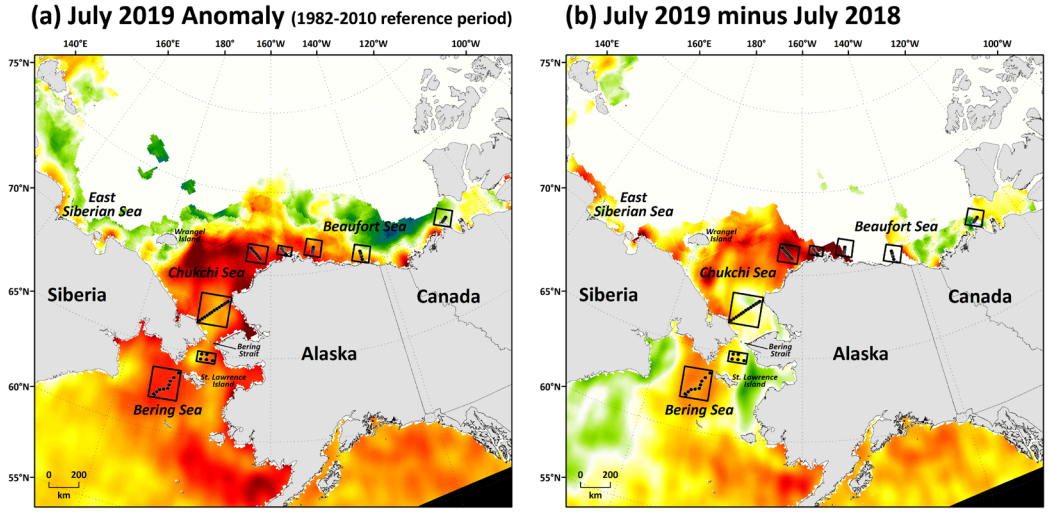


Annual sea ice persistence and sea surface temperature anomalies



[Grebmeier et al. 2019]

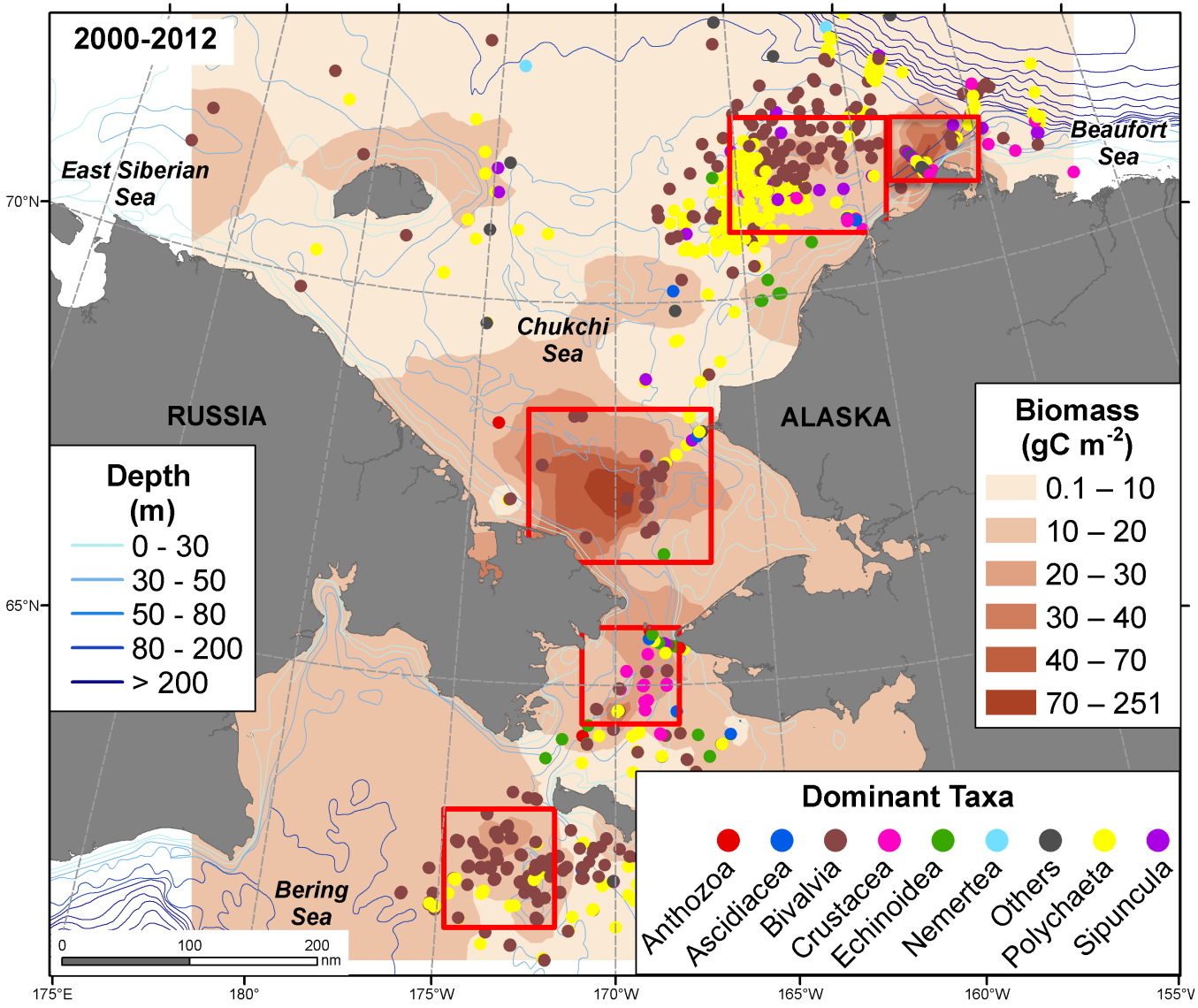
- Annual sea ice persistence (# of days/year of sea ice presence) across the DBO1–8 regions in the Pacific Arctic from 2013–2018
  - Decreasing sea ice cover over time
  - Lowest level sea ice persistence in northern Bering Sea



[courtesy Karen Frey, Clark University]

- **Sea Surface Temperature Anomalies July 2018-2019**
  - >5°C in Bering and Chukchi Sea surface waters
  - Difference 2019-2018 highlights the warm water in DBO1 and DBO4-5

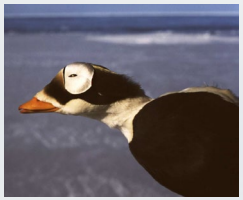
Rich benthic communities on the western side of the Bering/Chukchi Sea system 2000-2012



[modified from Grebmeier et al. 2015, Prog. Oceangr.]

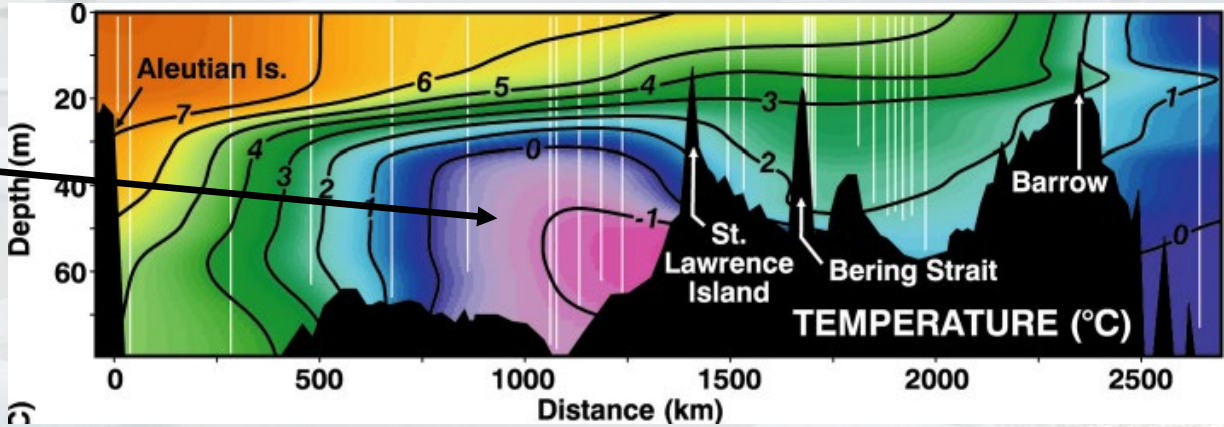
- **"foot prints"** of high benthic biomass reflect pelagic-benthic coupling and export of carbon to sediments
- macrofauna dominated by amphipods, bivalves, polychaetes, and sipunculids

DBO1: Threatened spectacled eiders keyed to sea ice and specific bivalves



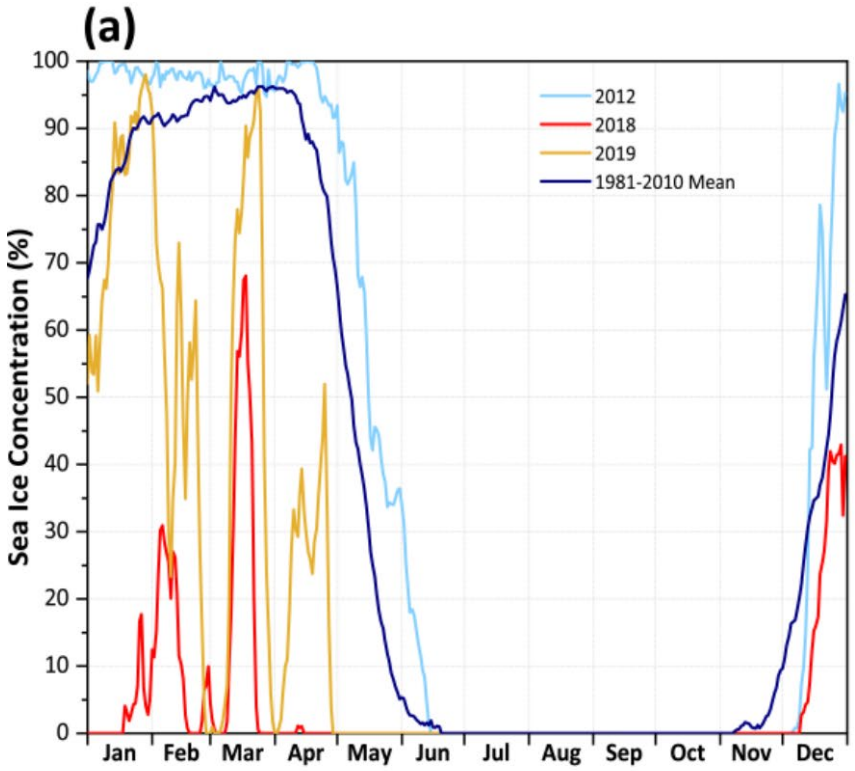
[Matt Sexson, USGS]

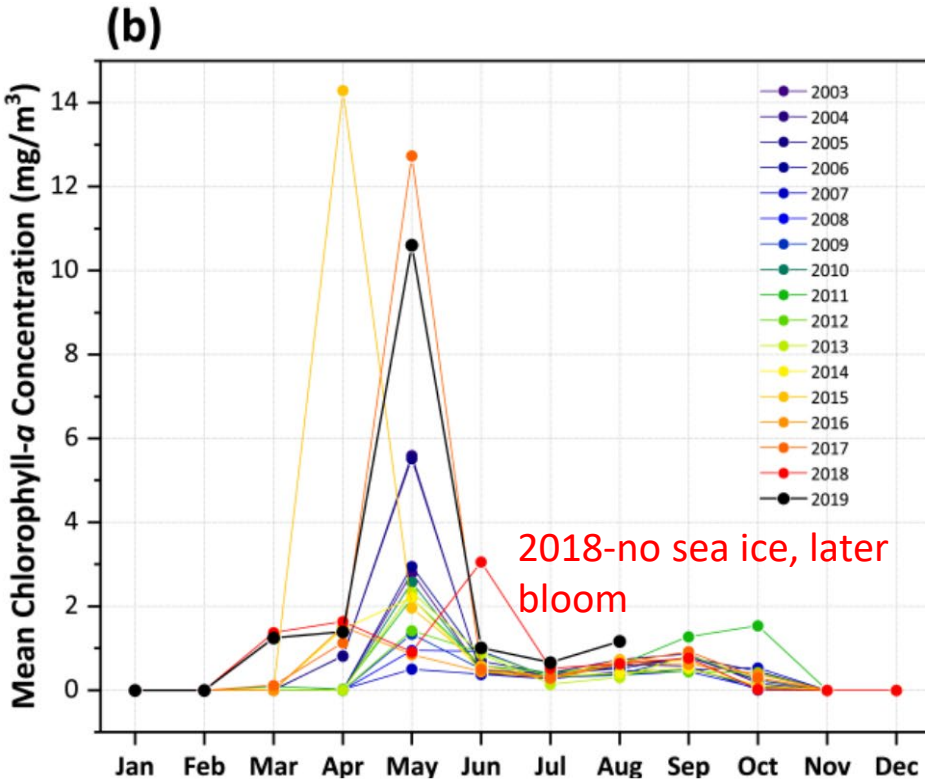
- feed on 3 species of bivalves
- shallow shelf system, high cascade potential lower to higher trophic levels
- ocean acidification potential dissolve bivalve shells
- extent & duration cold pool (<0°C) critical to benthic infauna by exclusion of benthic fish and epibenthic predators



[Grebmeier et al. 2006, Science 311]

Sea Ice Extent and Chlorophyll-a Concentration in the DBO SLIP region





(Frey et al. 2019)

(a) Daily time series of sea ice concentrations at the DBO1/SLIP region

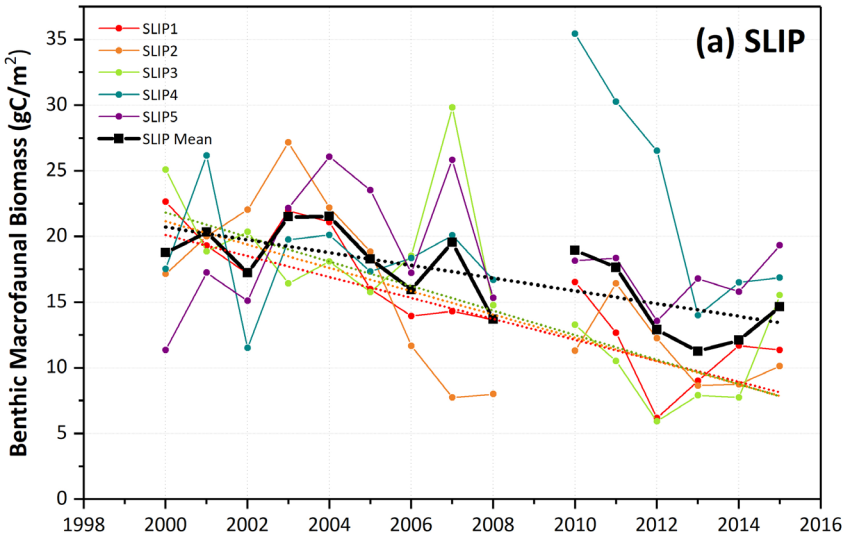
- highlighting the 1981-2010 mean, with 2012 (one of highest ice year covers on record) and 2018/2019 (lowest ice years on record)

(b) Mean chlorophyll-*a* concentrations for the DBO1/SLIP region from 2003–2019

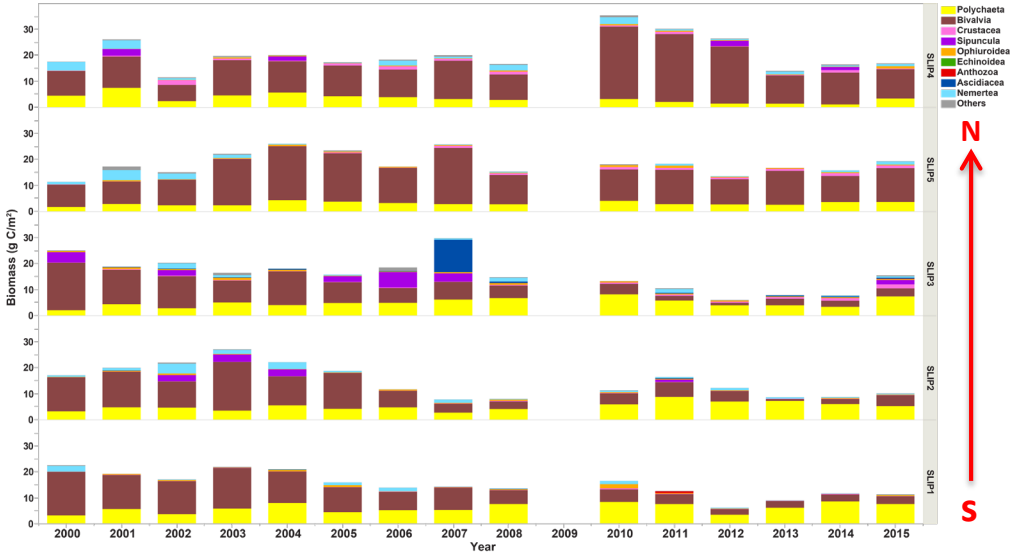
- higher chl-a values and earlier when ice present (May)
- lower chl-a values and later with low sea ice cover, although early Mar chl

Macrofaunal biomass and composition at time series stations (DBO1: SLIP1-5) south of St. Lawrence Island, 2000-2015

Time series benthic biomass in the DBO1



Macrofaunal composition for SLIP time series sites in DBO1

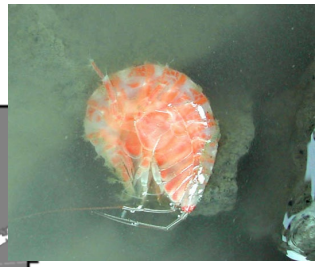


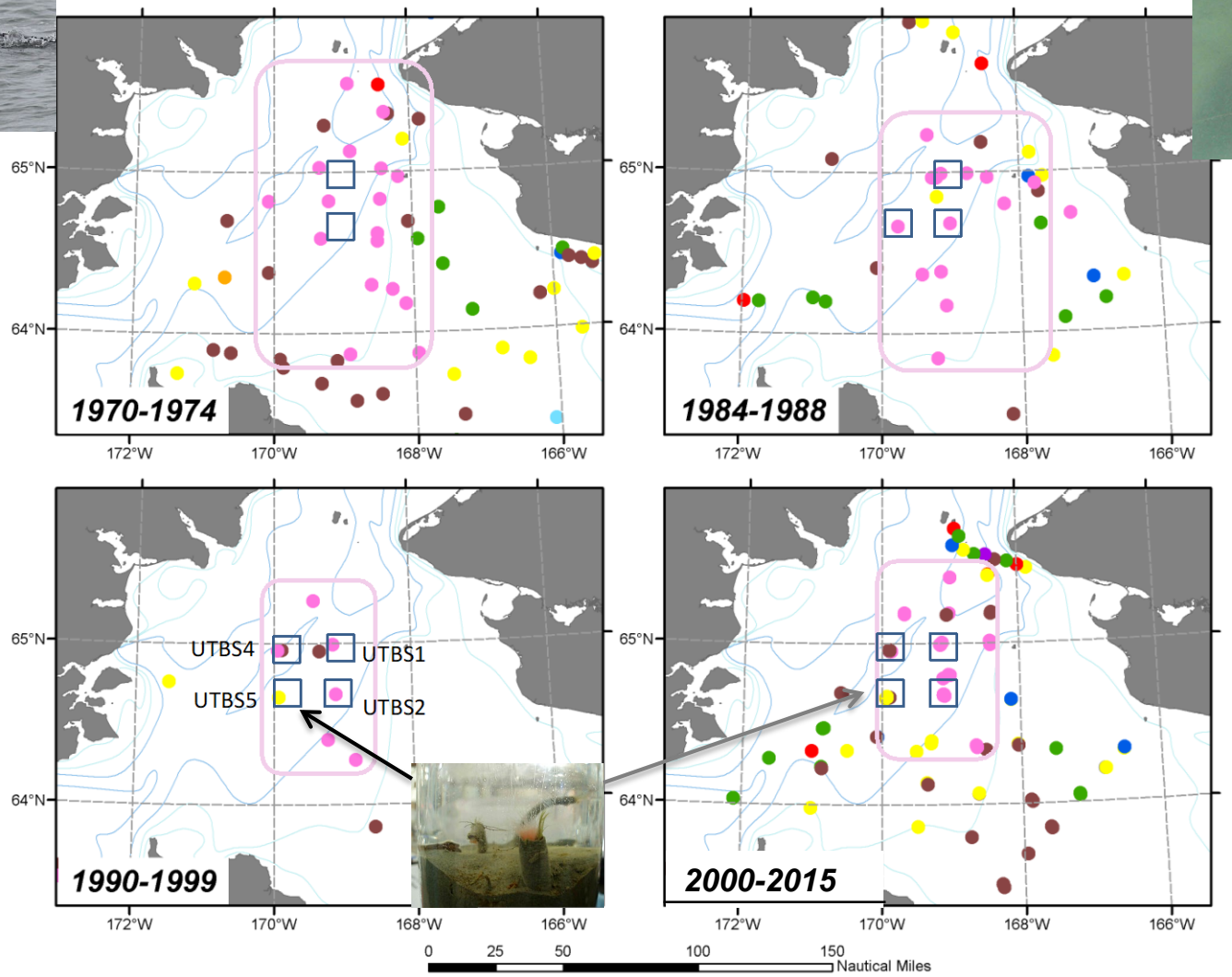
- Significant declining trend in southern SLIP1-3 stations and average values using Mann-Kendall (Kendall's tau) trend analysis ($p<0.0001$)

- Stations stacked from southern site (SLIP1) to northern site (SLIP4)
- Change in dominance from bivalve (brown) to polychaete (yellow) fauna in 2008 in southern sites

[Grebmeier et al., Oceanography, 2018]

DBO 2: Chirikov Basin ampeliscid amphipod prey hotspot contracting spatially northward

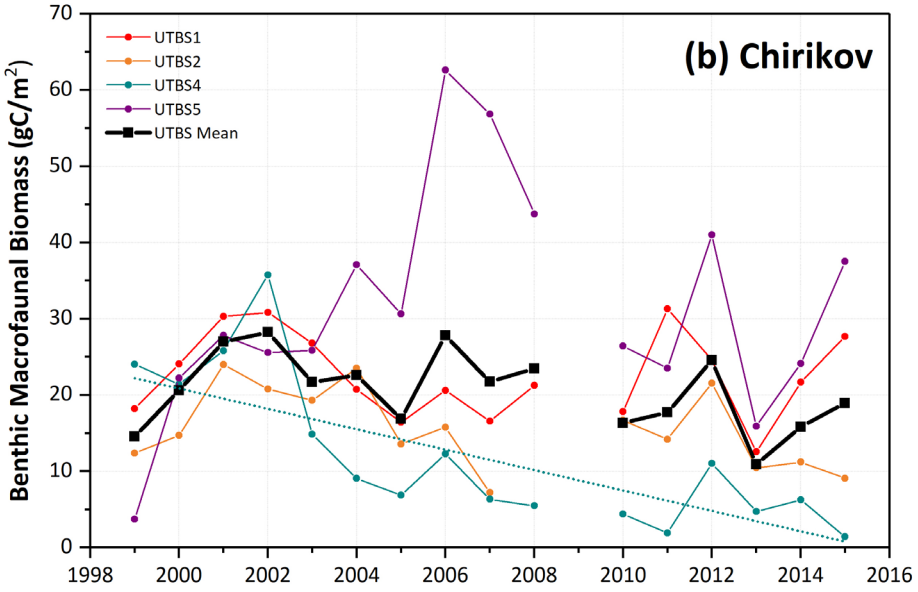




- Northward direction of core benthic biomass of amphipods in hotspot
- Polychaetes and bivalves replacing amphipods in the SW and NW, respectively

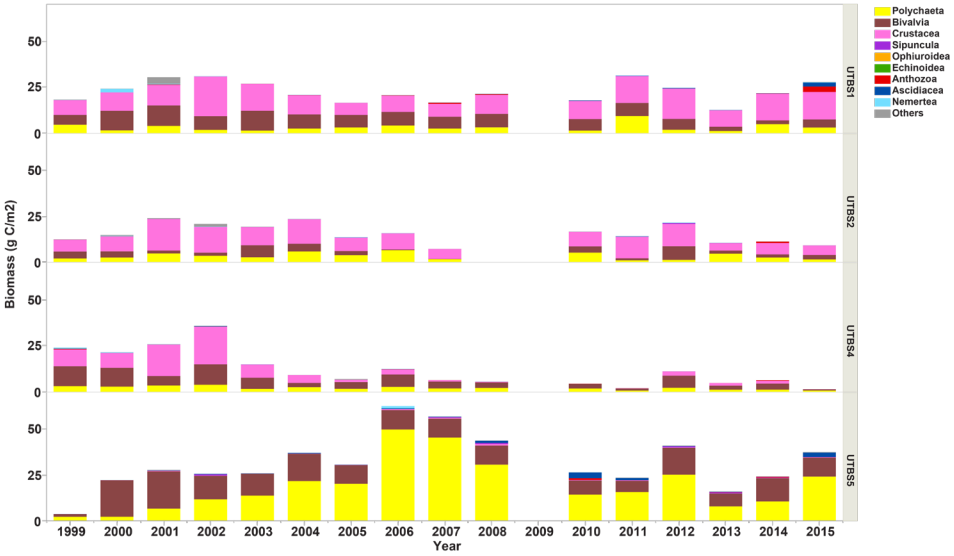
Macrofaunal biomass and composition at time series stations (DBO2: UTBS stations) north of St. Lawrence Island, 2000-2015

Time series benthic biomass in the DBO2



- Recent years variability in biomass trends at Chirikov DBO2 stations, with only one significant trend at northwest time series station UTBS4 using Mann-Kendall (Kendall's tau) trend analysis ($p<0.0001$)

Macrofaunal composition for UTBS time series sites in DBO2

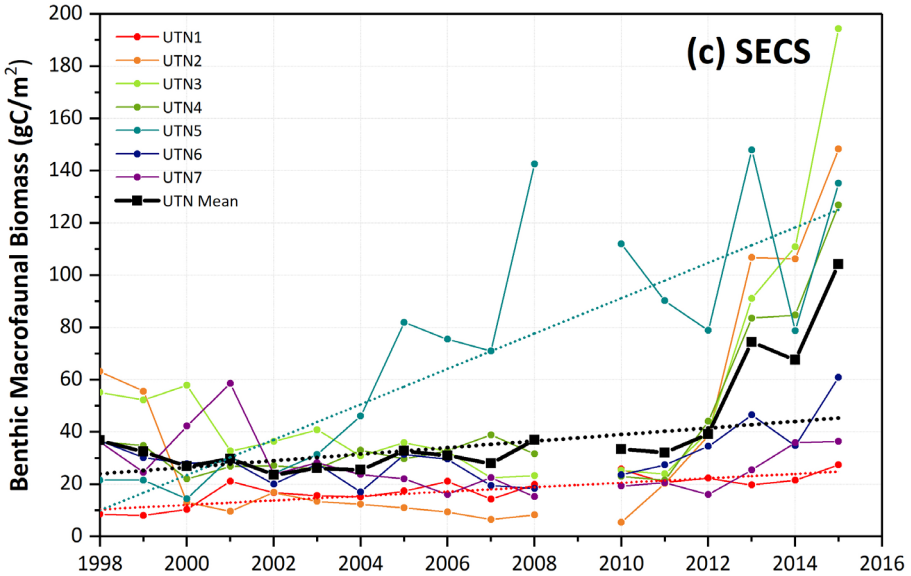


- Station stacked spatially from UTBS5 (SW) and UTBS4 (NW) and UTBS2 (SE) and UTBS1 (NE)
- UTBS5 (lower graph) dominated by ampeliscid amphipods in the 1980s, but changed to bivalves in the early 2000s and became dominated by polychaetes from 2003

[Grebmeier et al., Oceanography, 2018]

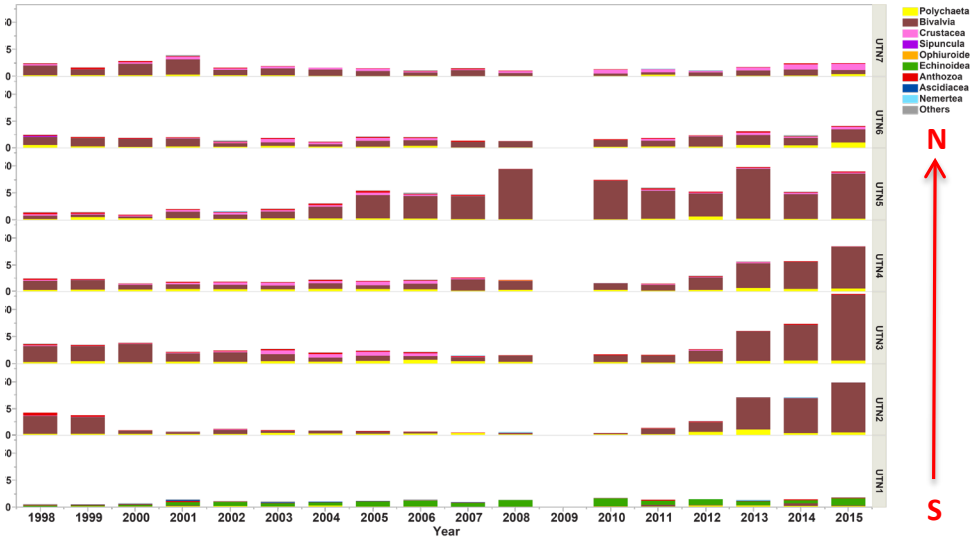
DBO3 Macrofaunal biomass and composition at time series stations (UTN1-7) in SE Chukchi Sea, 2000-2015

Time series benthic biomass in the DBO3



- Significant increasing trend at UTN1 in south and UTN5 in the north, as well as average values
- Expanding high biomass region spatially since 2012

Macrofaunal composition for UTN time series sites in DBO3

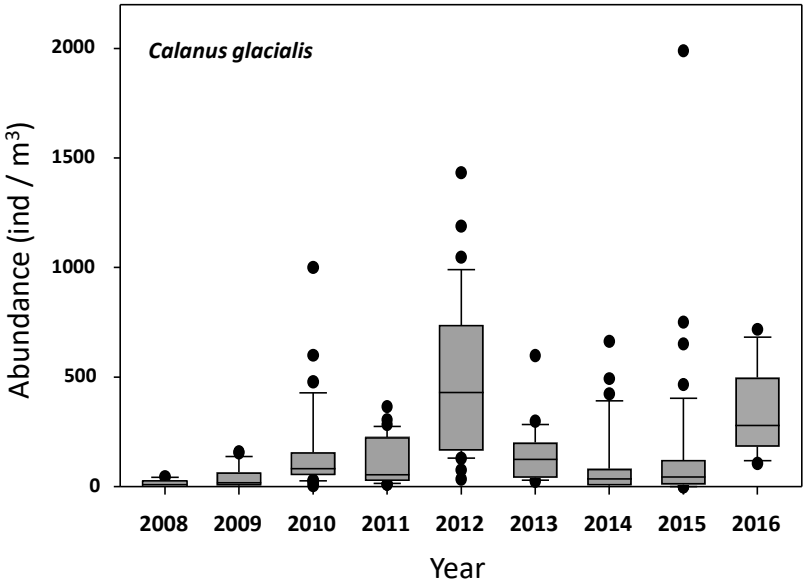


- Station stacked latitudinally from UTN1 in the south to UTN7 in the north
- Large bivalve (brown) biomass expansion southward from UTN5 to UTN2 since 2012 coincident with observations of increased primary production in SECS (Arrigo and van Dijken 2015)

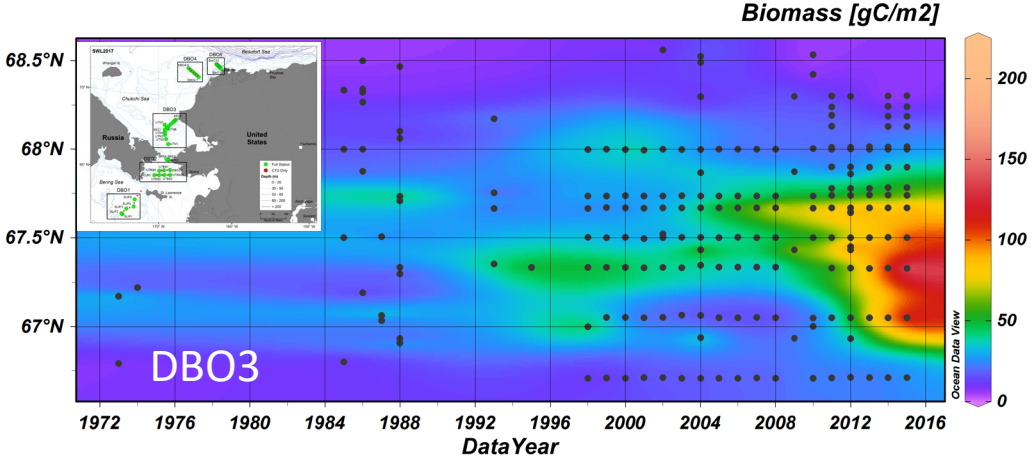
[Grebmeier et al., Oceanography, 2018]

DBO3-Adding to long-term time series

Zooplankton



Macrofaunal Biomass



[Grebmeier unpubl. data]

Relate copepod abundance to hydrographic conditions

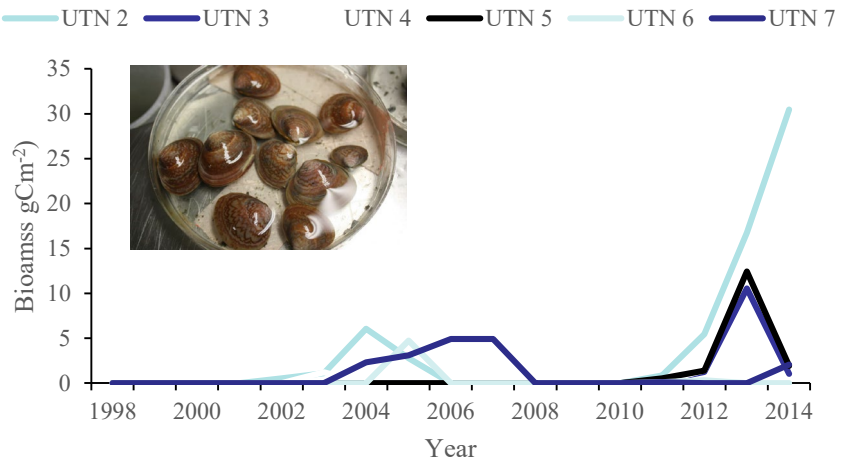
= warm years dominated by small *Pseudocalanus*

= lipid-rich *Calanus* more abundant in cold years

[R. Hopcroft]

Example Data

Biomass of *Serripes groenlandicus* in DBO 3



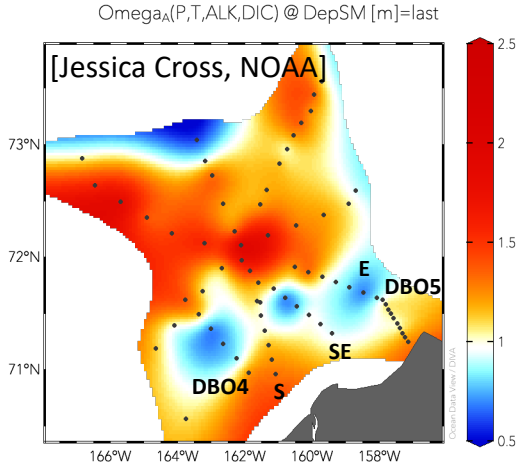
[Goethel unpubl. data]

Examples of environmental stressors occurring in the Pacific Arctic

- Ocean acidification could impact ecosystem services in the Arctic region

Implications of ocean acidification in the Pacific Arctic: Experimental responses of three Arctic bivalves to decreased pH and food availability

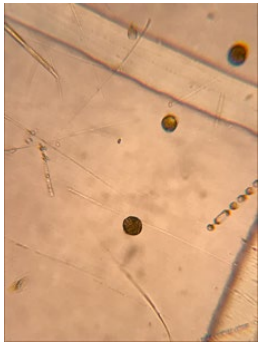
Christina L. Goethel, Jacqueline M. Grebmeier, Lee W. Cooper, Thomas J. Miller

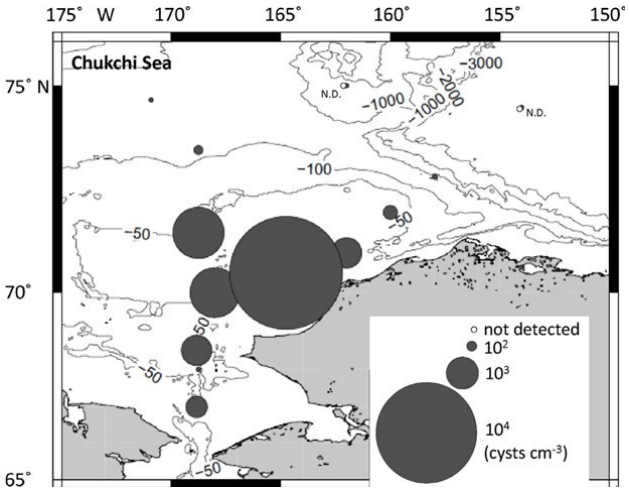


- Corrosive waters (blue) prevalent on SE side of Hanna Shoal, area of focused carbon deposition and high bivalve biomass

Harmful Algal Blooms (HABs) are increasing in Pacific Arctic with declining sea ice, more sunlight and warmer seas

- Blooms of *Alexandrium* sp. that are dinoflagellates that cause paralytic shellfish poisoning.
- Don Anderson (WHOI) has found overwintering cysts in the mud and hotspot of seasonal blooms (DBO-NCIS cruises 2018-2019)



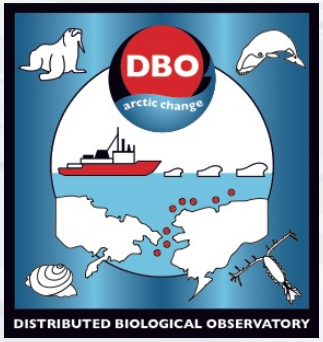


(Anderson et al. 2018, figure modified from Natsuike et al. (2013)

Thank you for your attention.

Questions and comments?

Thank you for the invitation to present the Arctic research undertaken in our research program. I also thank all DBO collaborators, field and laboratory technicians over the years for the time series efforts. We thank the Captain and crew of the USCGC Healy and CCGS Sir Wilfrid Laurier for support for the DBO program. Financial support for the science provided by the US NSF, NOAA, BOEM, NASA, and ongoing international science partners in the Pacific Arctic Group.



http://www.arctic.noaa.gov/dbo/

http://arctic.cbl.umces.edu

BOEM
Bureau of Ocean Energy Management

NASA

NSF

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

PAG
Pacific Arctic Group