

The Northern Bering Sea: An Ecosystem in Change

- Bering Strait region shallow (<100 m); a sentinel indicator of global change effects
- Bering Sea shifting towards an earlier spring transition between ice-covered and ice-free conditions
- Surface sea temperature increase in the 1990s vs the 1980s, tied to the Arctic Oscillation further to the north (Stabeno and Overland 2001)
- Time series benthic studies indicate changes in both carbon deposition and benthic biomass since the late 1980's



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Bering Strait Environmental Observatory Project

(Cooper, Grebmeier, Codispoti and Sheffield)

(<http://arctic.bio.utk.edu>)

Objectives

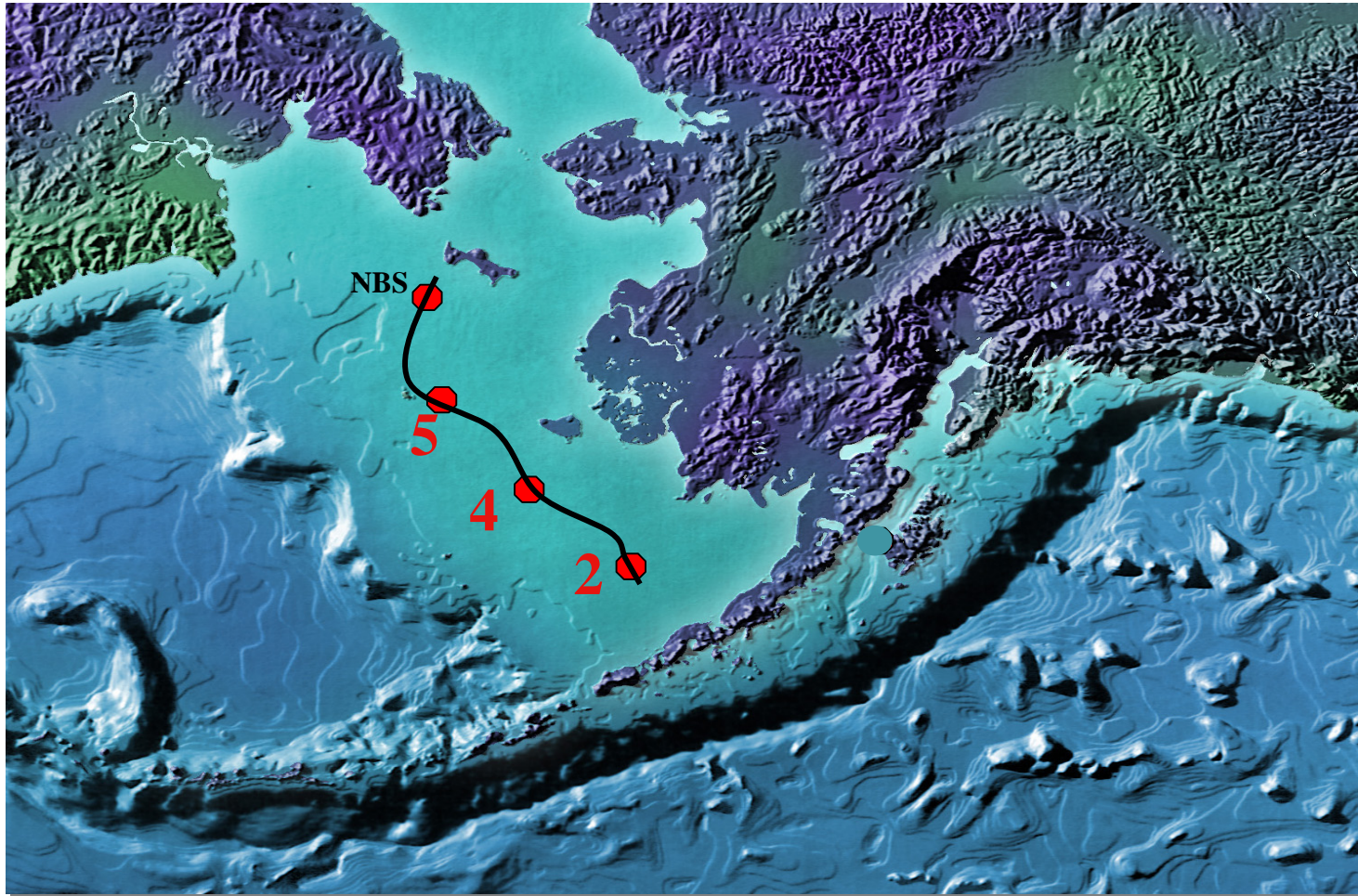
- 1) land-based marine sampling on Little Diomedede Island in Bering Strait
- 2) annual July time series oceanographic cruises in collaboration with IOS/DFO Canada (Eddy Carmack); mooring in A-SLIP (PMEL-Jim Overland and UAF-Terry Whitledge)
- 3) Marine mammal collection program

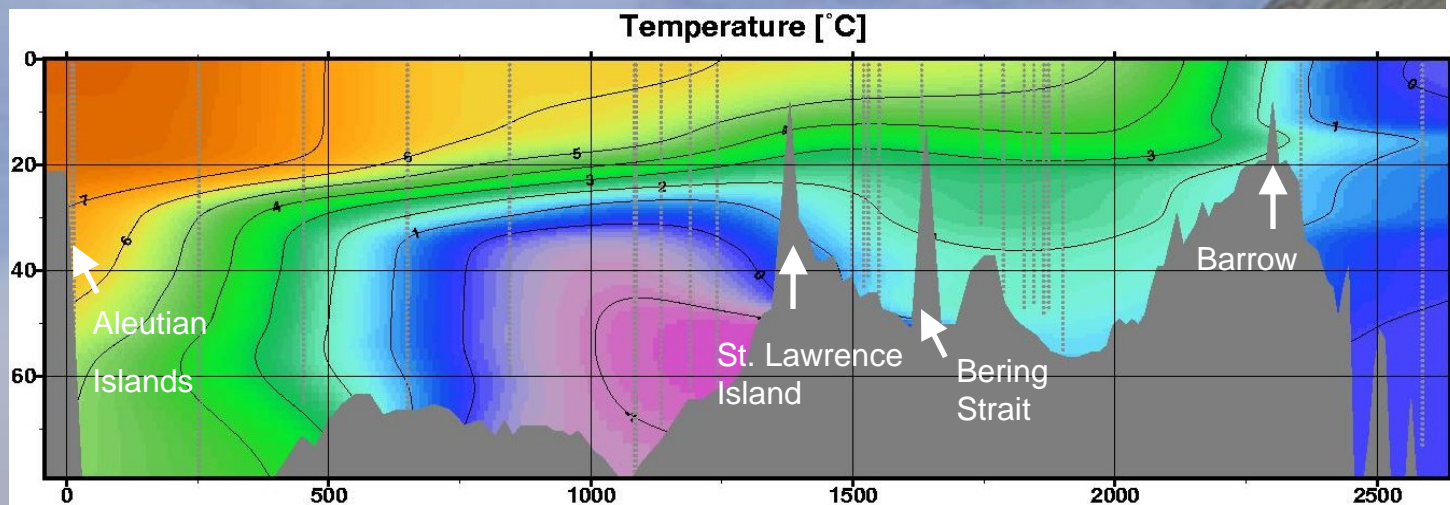
[NSF and NOAA support]



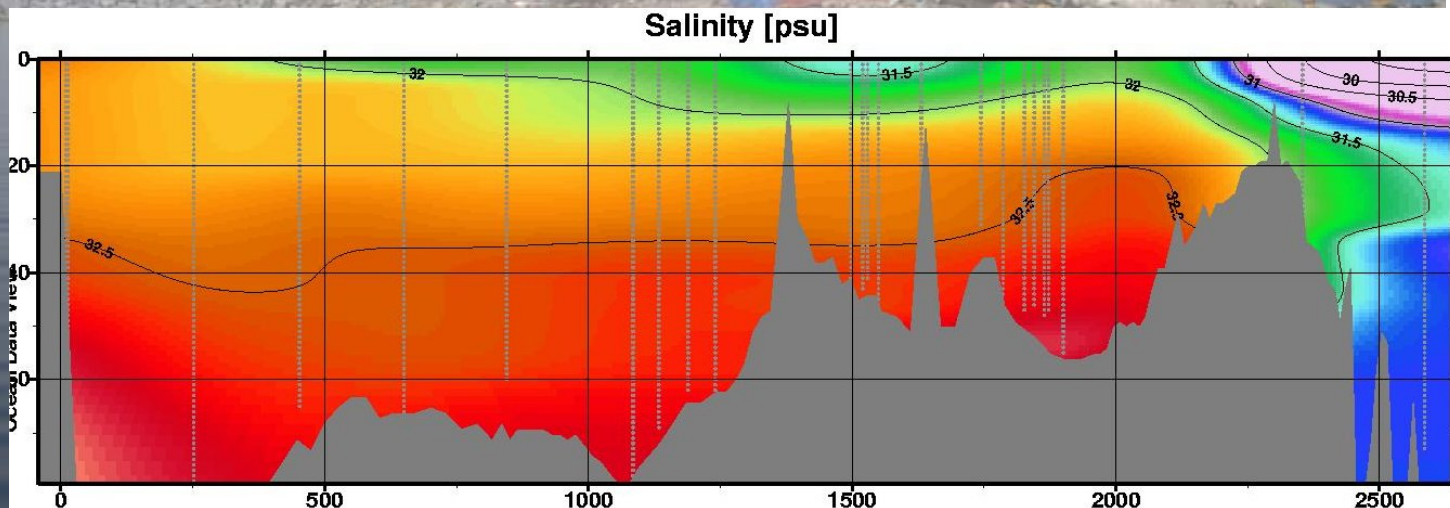
Mooring Sites

NBS=Northern Bering Sea mooring (NOAA)

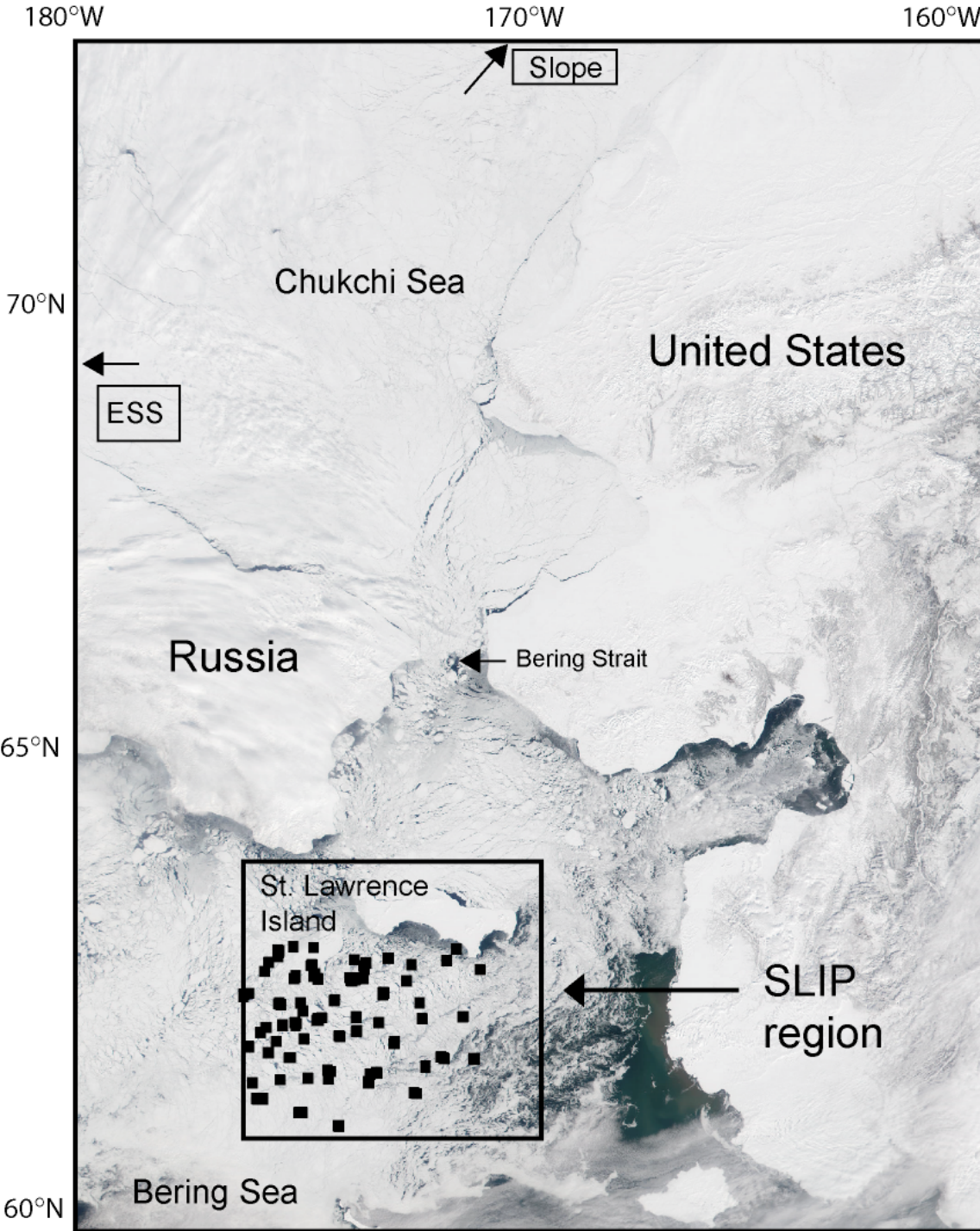




Preliminary
Results

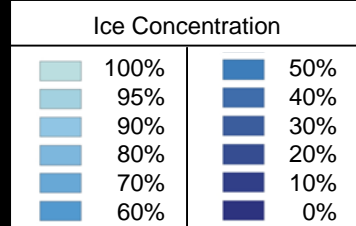


Bering/Chukchi Sea transect, Sir Wilfrid Laurier July 2004 [courtesy Bon von Hardenburg 2004]

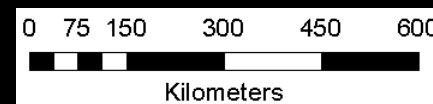


MODIS ice cover image of the St. Lawrence Island polynya (SLIP) region on April 22, 2002, showing nearshore opening of SLIP south of St. Lawrence Island. Station locations for cruises from 1988-2002 are contained in the black box, with another black box to the NW in the East Siberian Sea (ESS) and NW Chukchi Sea slope area (Slope) also indicating the location of stations used in the carbon export analysis. The SLIP expands during the spring, producing an ice-free northern Bering Sea in late spring/summer. Image courtesy of NASA/Visible Earth (<http://visibleearth.nasa.gov/>).

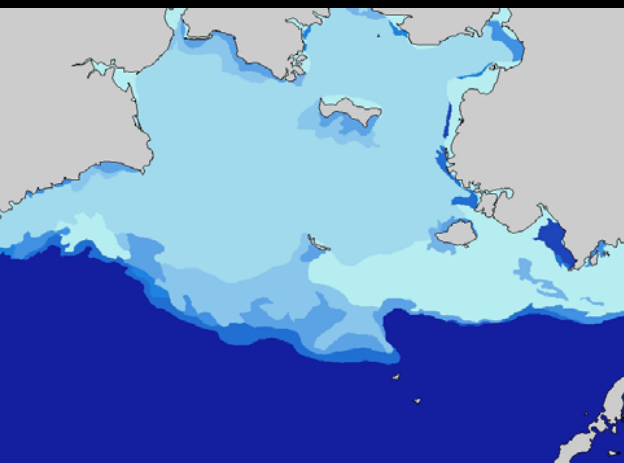
[Grebmeier and Barry 2005, in press]



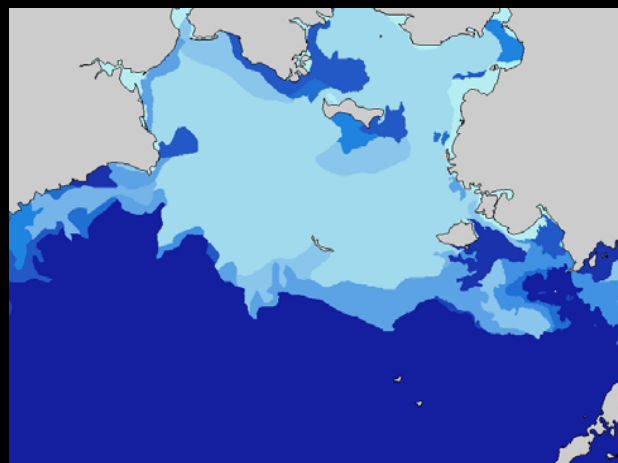
Sea Ice Melt



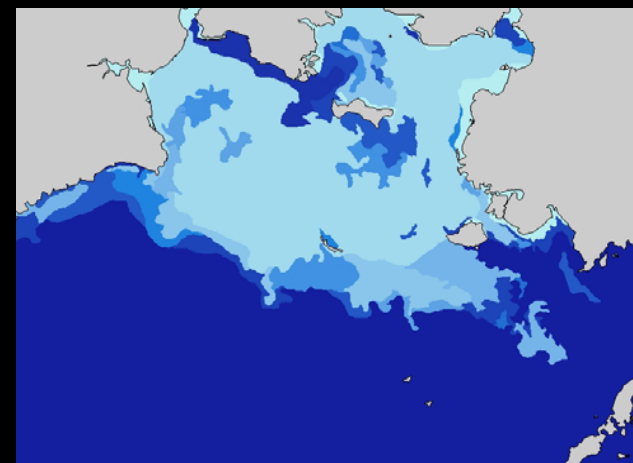
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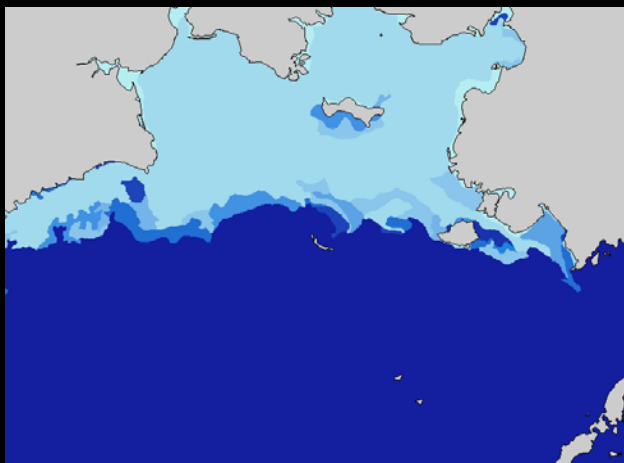
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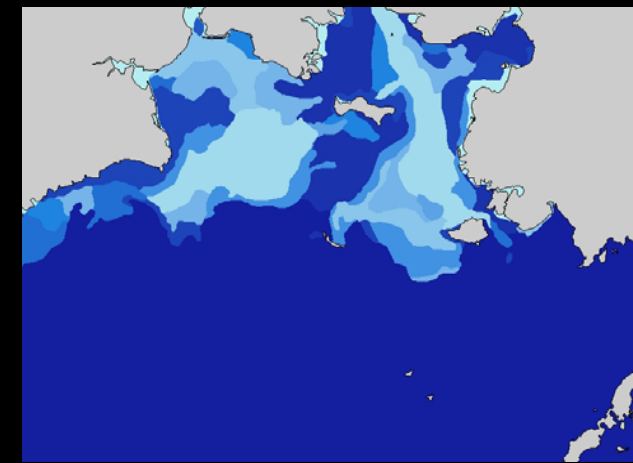
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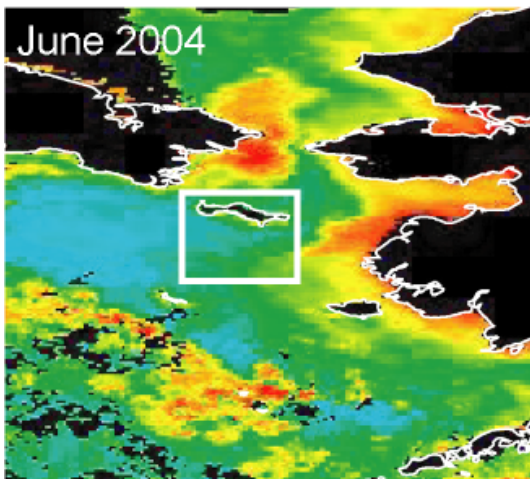
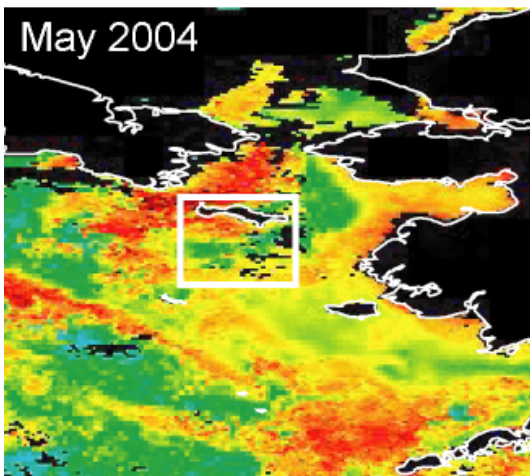
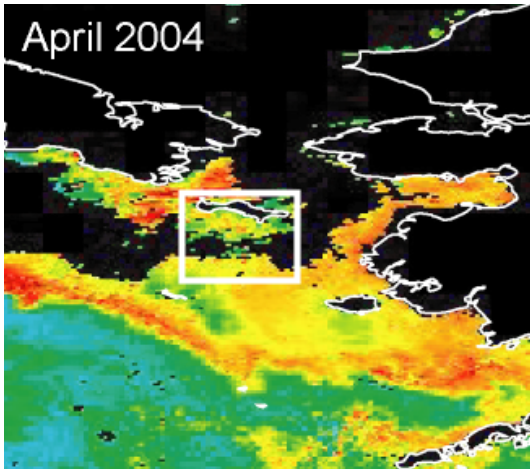


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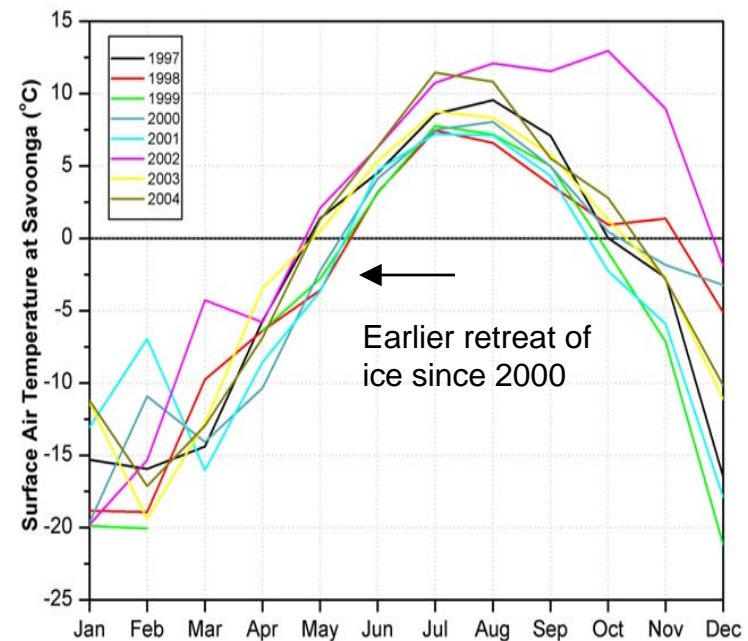
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Chlorophyll-a concentrations (mg/m^3), as measured by the MODIS and SeaWIFS platforms in April, May, and June 2004. Black areas represent land areas, sea ice cover, or cloud cover. Note after the breakup of sea ice in April, chlorophyll-a concentrations peak in May and again subside in June. Data are from NASA and are available at <http://oceancolor.gsfc.nasa.gov>. (Grebmeier and Barry in press)

Monthly averaged surface air temperature measured at Savoonga (63.68°N, 170.5°W) on St. Lawrence Island over years 1997–2004, the current availability period of SeaWIFS and Aqua-MODIS chlorophyll-a data. Note the interannual variability in the timing of melt onset (~3 weeks). Data are from the National Climatic Data Center.



(Grebmeier et al. in prep.)

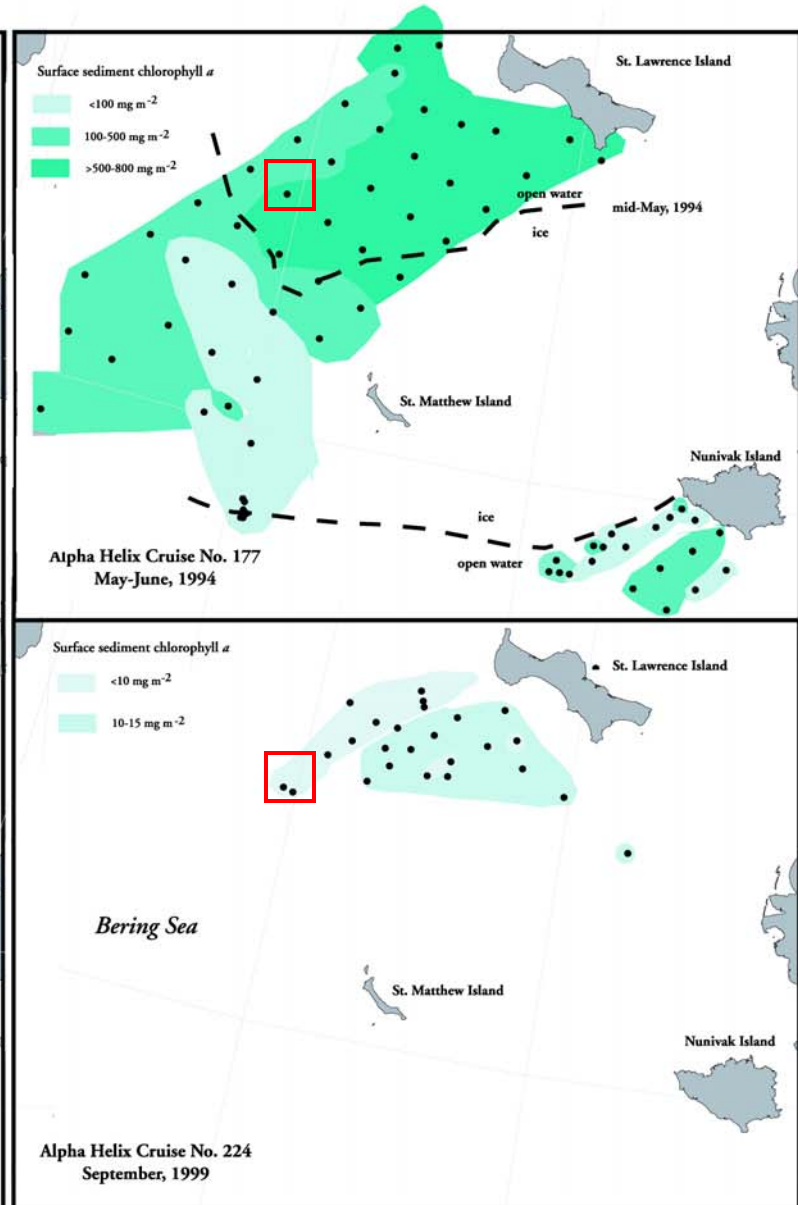
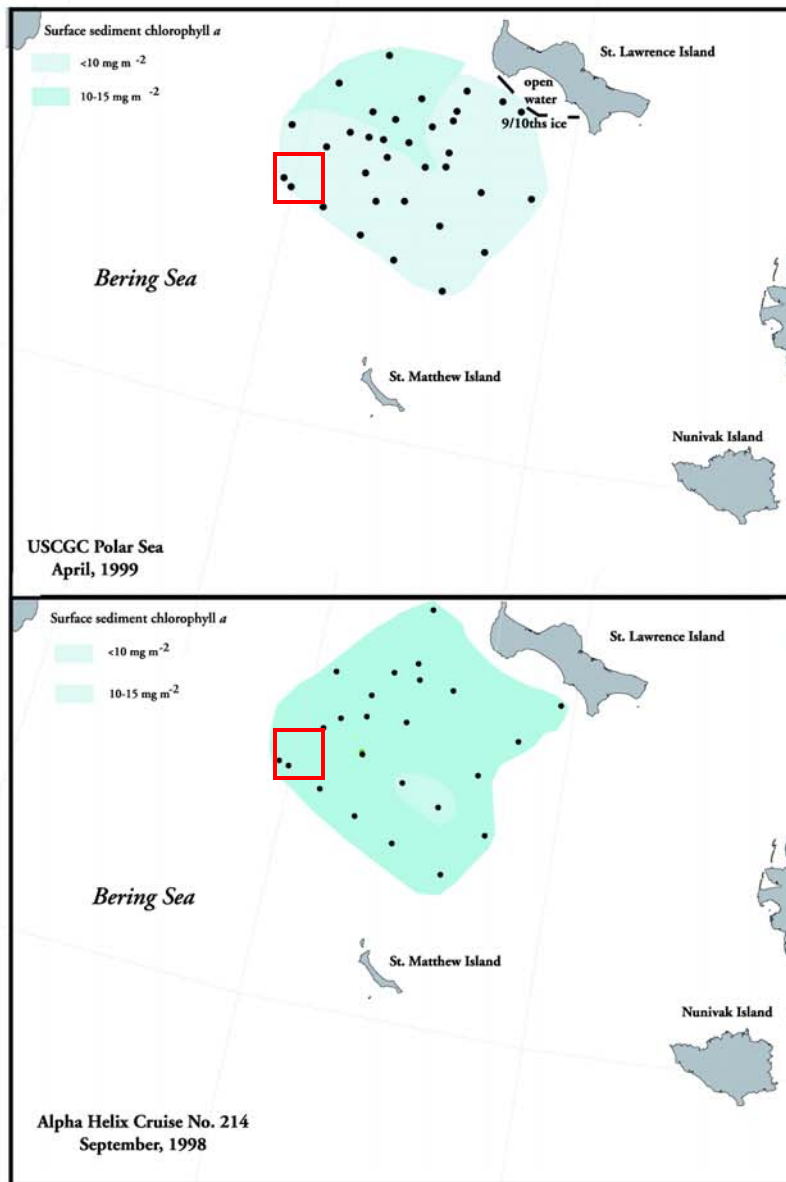


[photos by J. Lovvorn]

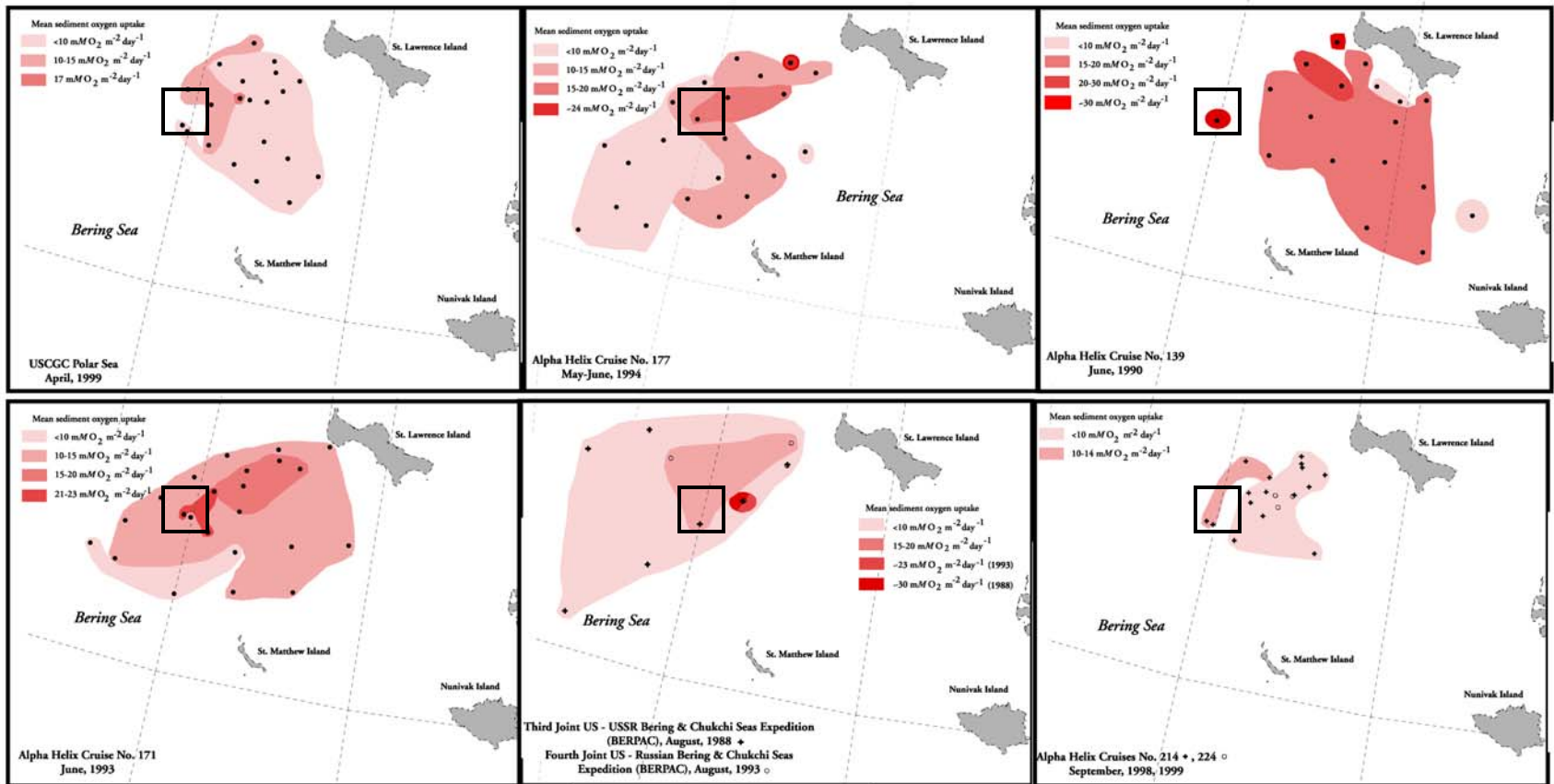


Spectacled Eider and
benthic food supply
(dominated by
bivalves: *Nuculana
radiata*, *Nucula belloti*,
Macoma calcaria)

Sediment chlorophyll (mg m^{-2})

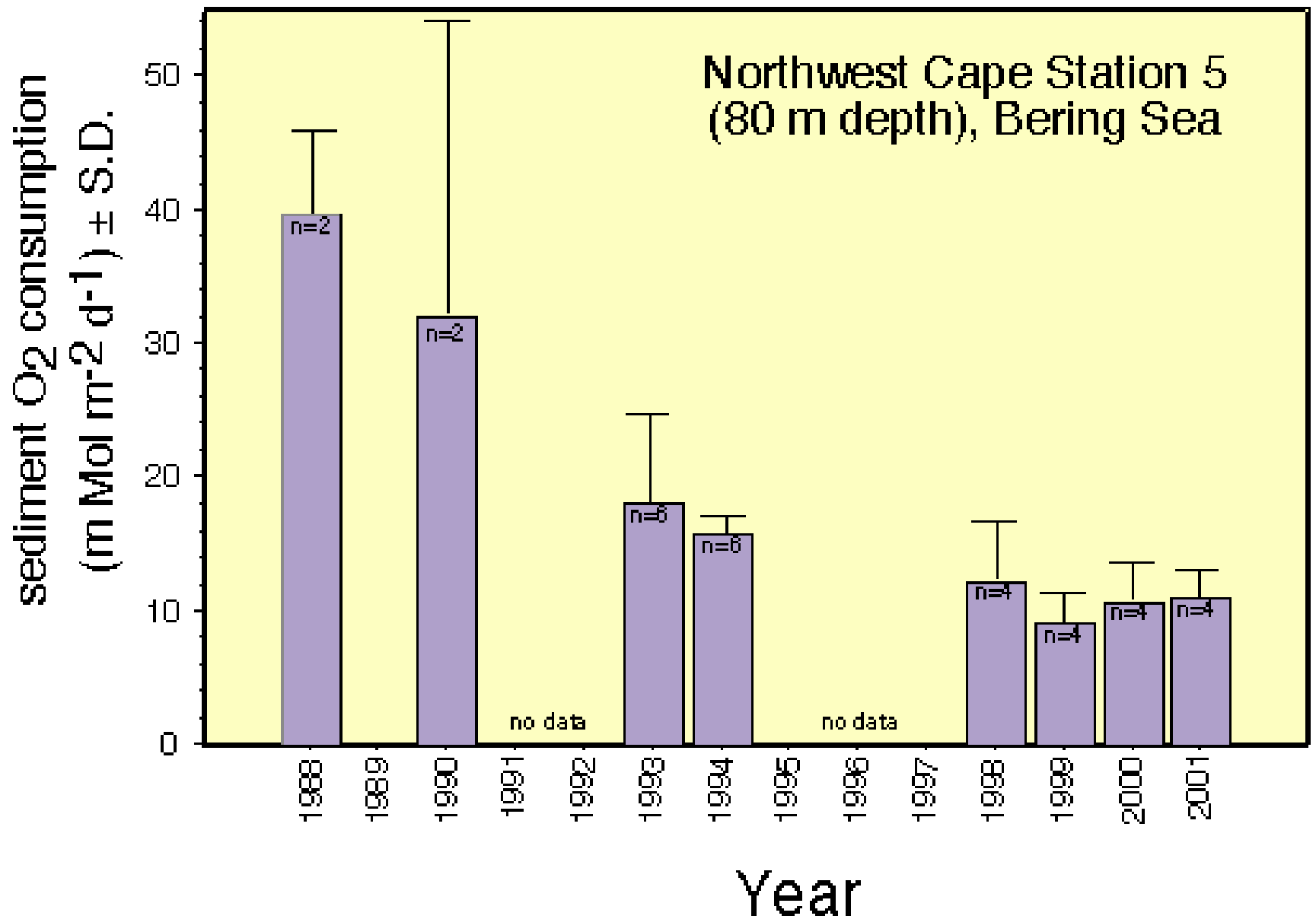


Sediment oxygen uptake($\text{mmol O}_2 \text{ m}^{-2} \text{ d}^{-1}$)



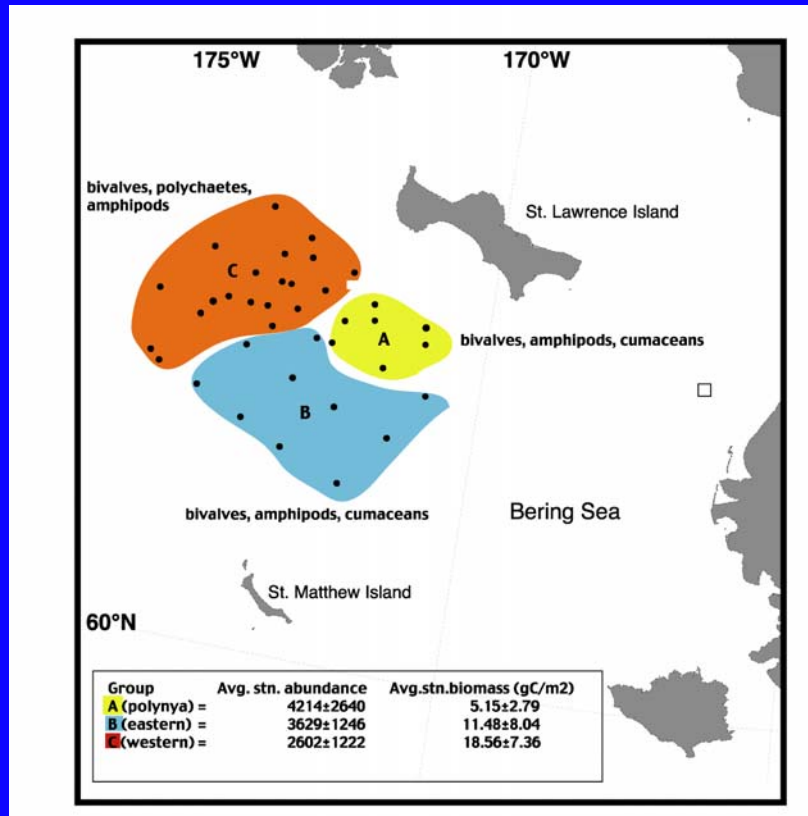
[Cooper et al. 2002]

Seasonal carbon supply to benthos



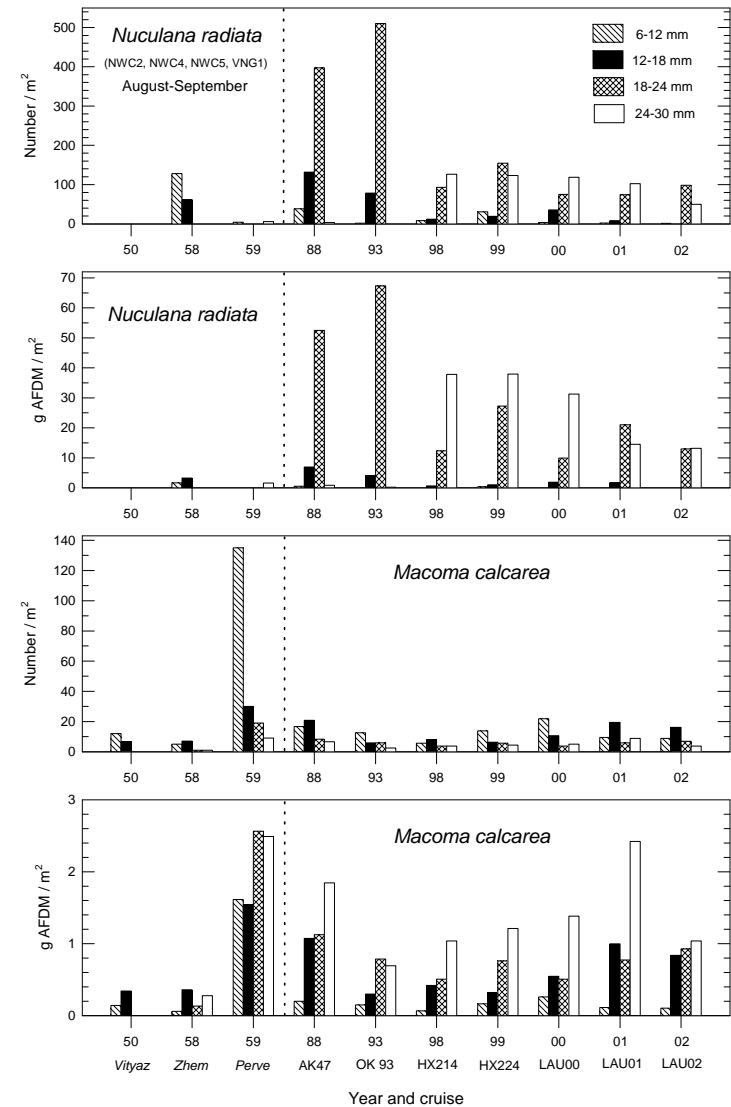
Time series site indicates reduction carbon supply to benthos (orange region in Cluster Group C (Grebmeier et al. in prep.)

BSEO-S sites embedded in Group C, orange



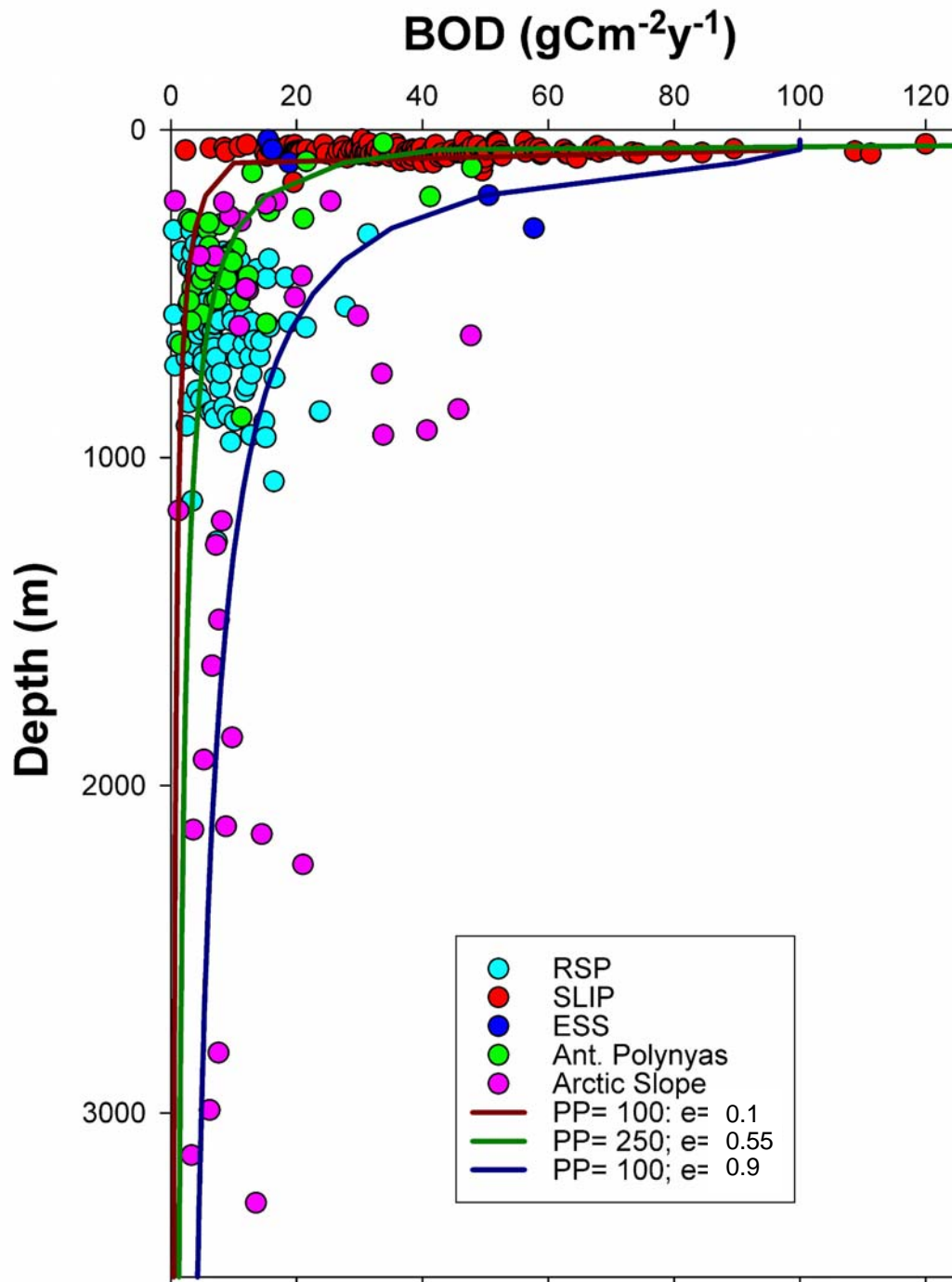
[Simpkins et al., Polar Biology, 2003]

- retrospective study indicates changes in dominant bivalve from *Macoma calcarea* to *Nuculana radiata*, results in lower bivalve prey caloric content



[Grebmeier, Lovvorn, Sirenko and Cooper, in prep.]

Benthic oxygen demand (BOD) versus depth for Arctic and Antarctic polynyas



Green dots indicate estimated BOD for 37 coastal polynyas

Light blue dots indicate BOD for 58 stations in the Ross Sea polynya (RSP) during 1996-1998

BOD in the St. Lawrence Island polynya (SLIP, **red dots**) and under sea ice in the East Siberian Sea (ESS, **dark blue dots**) illustrate the higher BOD of the shallower arctic shelves (1984-2004)

Purple dots indicate the Arctic Continental slope, where high BOD was observed in and near Barrow Canyon.

Curves indicate estimates of carbon flux, based on a modified Martin et al (1987) function.

The export fraction (e) in the Martin curve is adjusted to 0.55 in the green line, which matches the mean estimated production of Antarctic polynyas. High retention of primary production (**red line**) or high export (**green line**).

Summary

- **Pacific-influenced shelf regions experiencing earlier spring transition between ice-covered and ice-free conditions, extensive ice retreat, indications of increased freshwater flux and summer seawater temperatures**
- **changes in the timing of productivity over shelf will rapidly impact trophic structure and carbon export to the benthos**
- **observed time series changes in both carbon deposition and benthic biomass since the late 1980s in the northern Bering Sea**
- **long-term, time series studies in focused regions critical for analysis of climate change impacts from natural variability in the system**