

The Impact of Changing Sea Ice and Hydrographic Conditions on Biological Communities in the Northern Bering and Chukchi Seas

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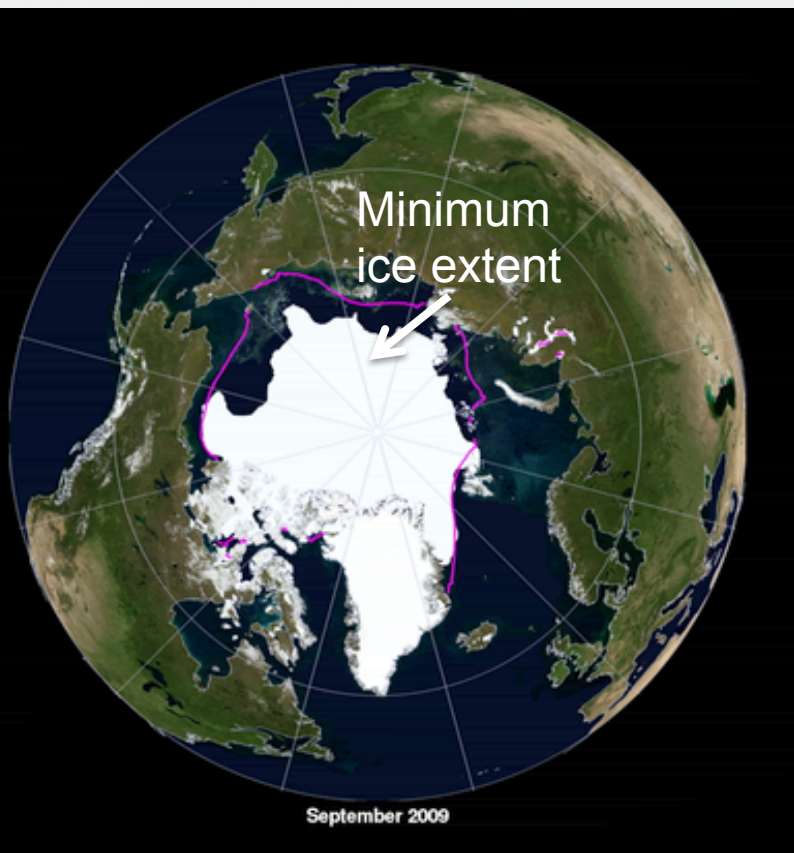
INTRODUCTION

- Arctic Pacific sector is experiencing changes in seasonal sea ice extent and retreat and increased ocean temperatures and freshwater content
- Emerging observations indicate these changes are driving shifts in marine species composition and carbon cycling that may signal ecosystem reorganization
- Biological observations include changing composition and range extensions of benthic fauna as prey coincident with more northern migration of marine mammals into Pacific Arctic



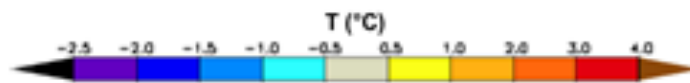
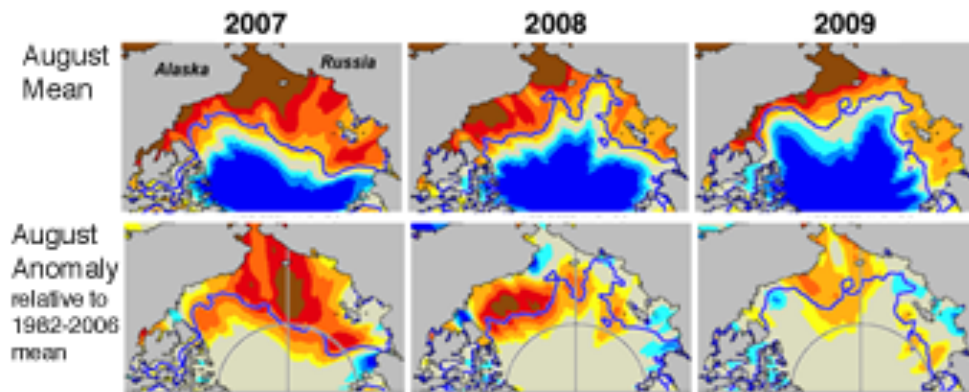
Sea ice extent (2009) and surface sea water temperatures (2007-2009) in Pacific region

National Snow and Ice Data Center / NASA Earth Observatory

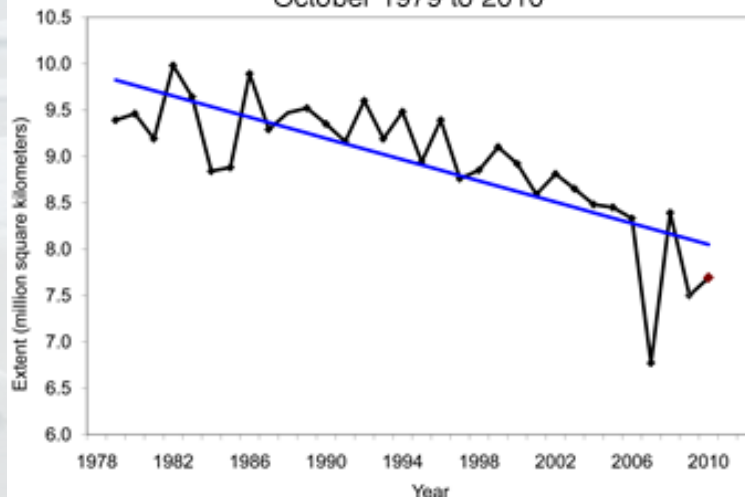


- 2010 3rd lowest sea ice extent on record

Arctic Sea Surface Temperatures August 2007 to 2009



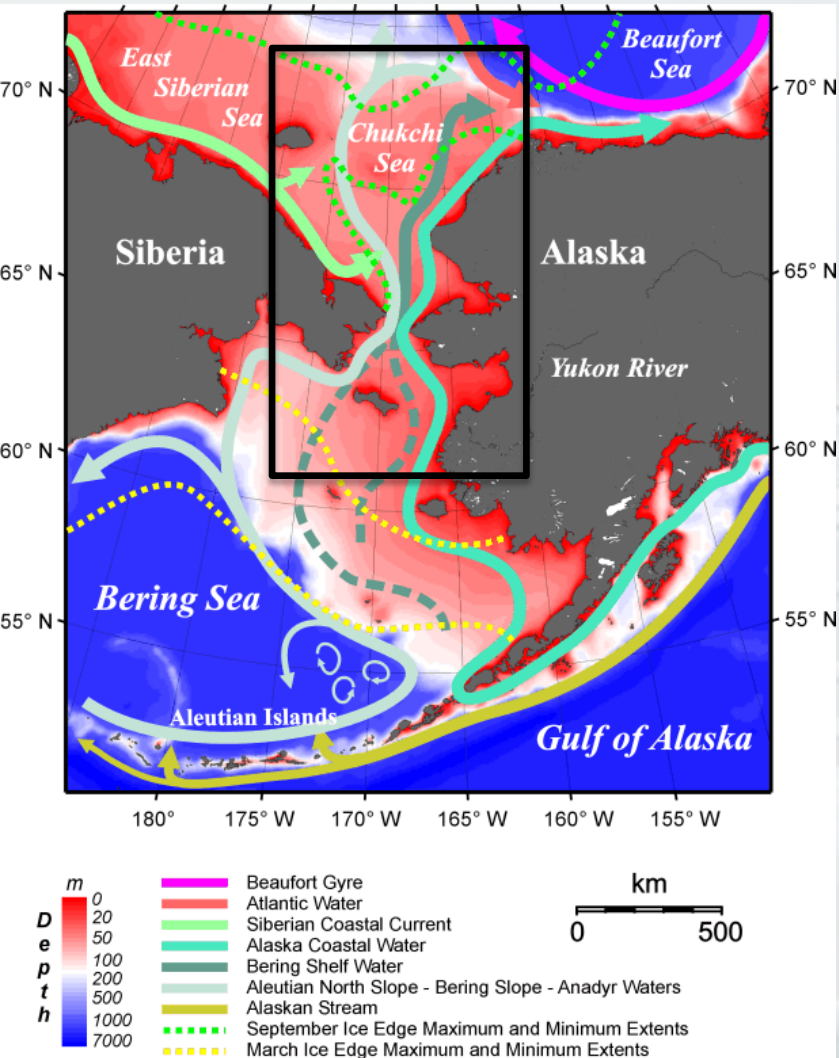
Average Monthly Arctic Sea Ice Extent October 1979 to 2010



National Snow and Ice Data Center

NSIDC courtesy Milva Steele, University of Washington

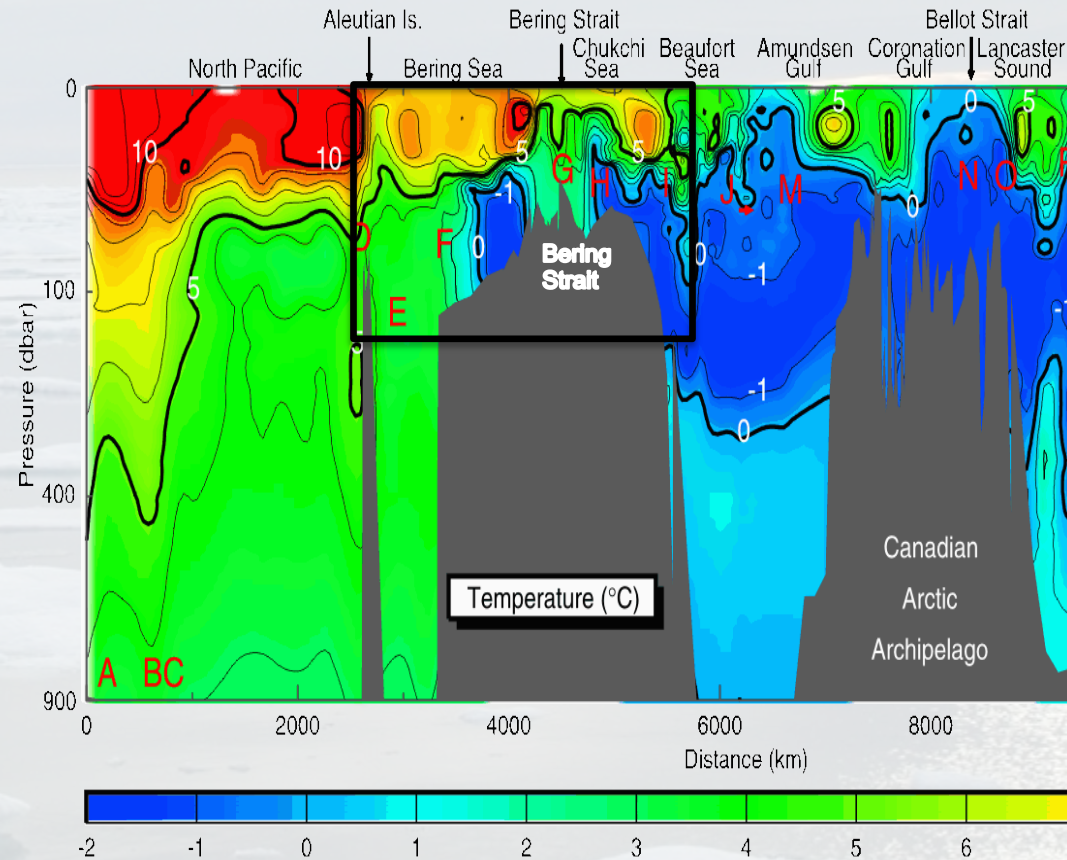
Seasonal water mass structure in the Pacific sector



C30 Seawater Temperature "Slice" in July 2008

NORTH PACIFIC

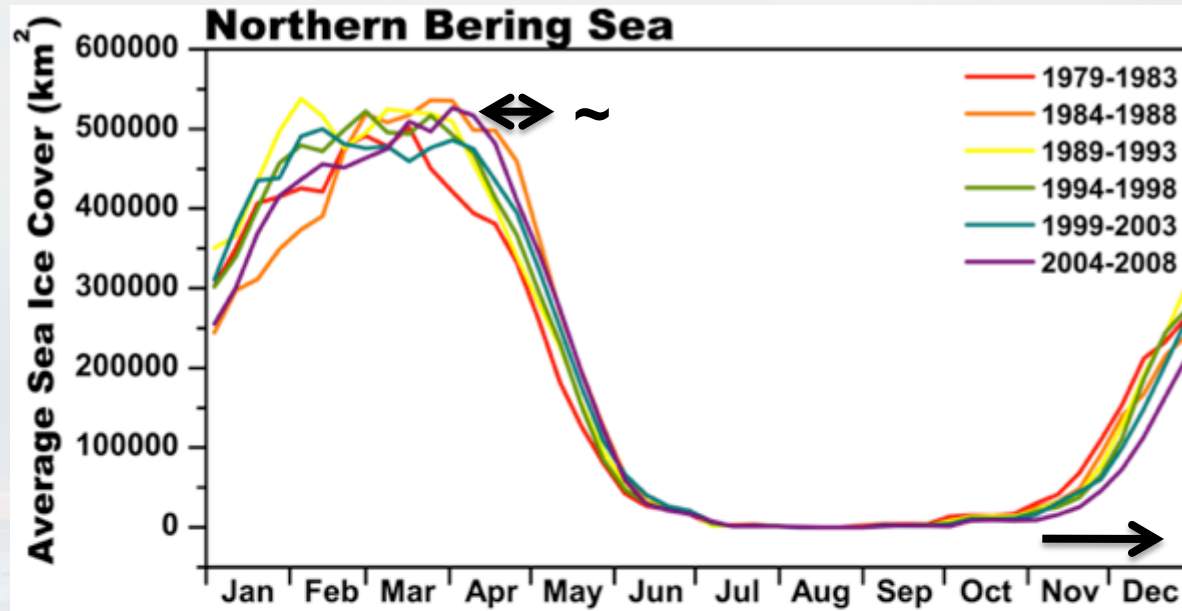
ARCTIC



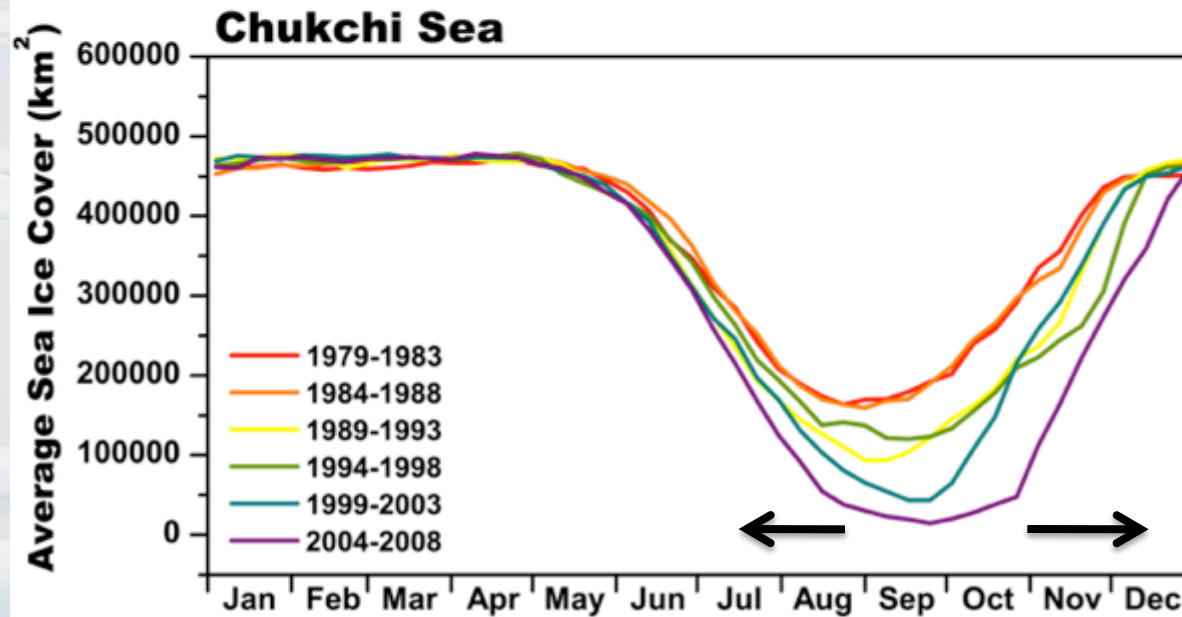
[Tom Weingartner and Seth Danielson]

[Eddy Carmack/IOS]

Earlier spring sea ice retreat, later fall ice formation

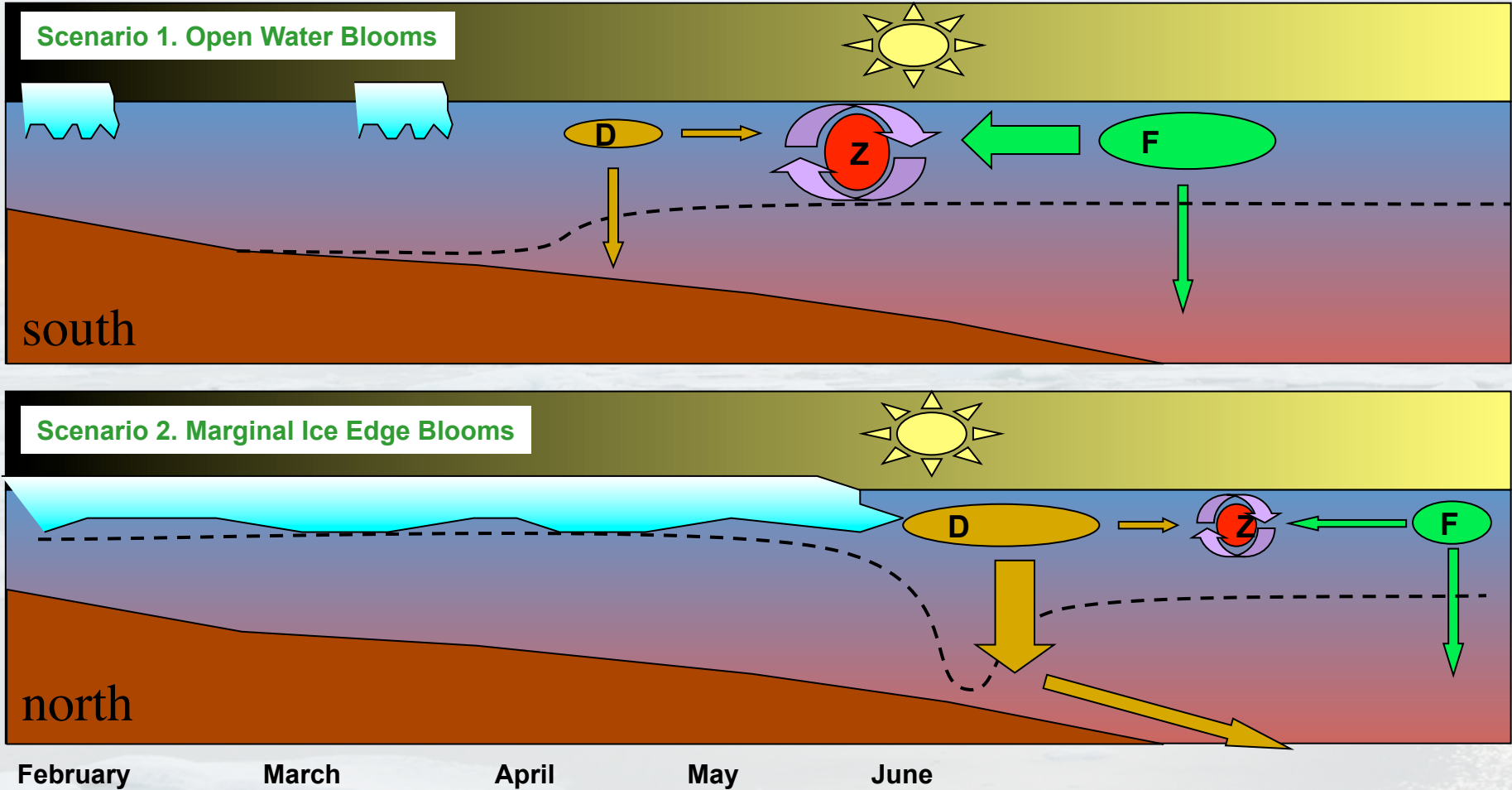


2000s vs.
1980s
and
1990s



2000s vs.
1980s and
1990s

South to north pelagic to benthic ecosystem transition in the Bering Sea



Key - Diatoms, Zooplankton, Flagellates

[Graphic courtesy of Brad Moran and Mike Lomas-BEST program]

Arctic, Subarctic and Bering Sea: dominant copepods

All sketches drawn at same magnification; all scale bars represent 1mm



Arctic Copepods

Calanus hyperboreus
C. glacialis
Metridia longa



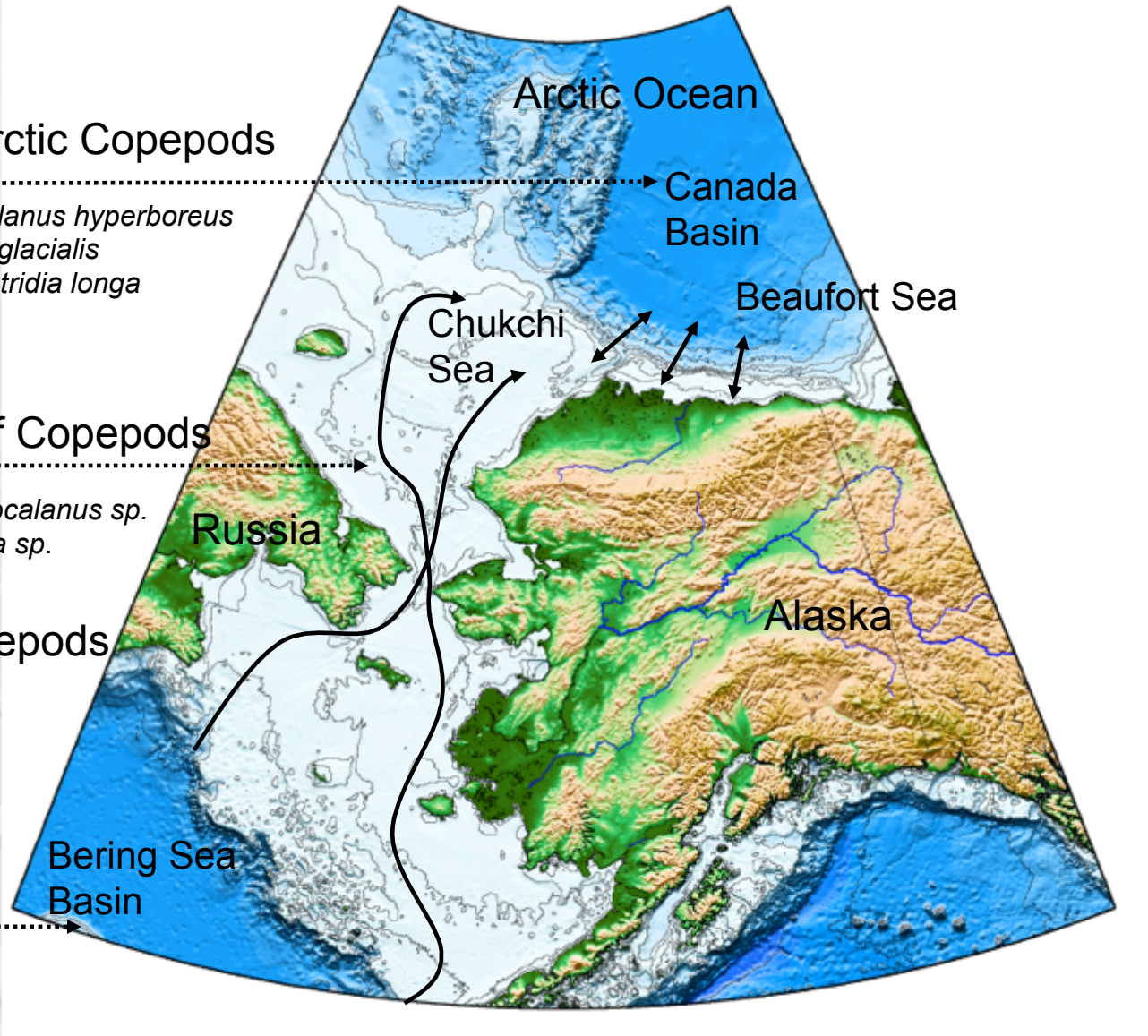
Shelf Copepods

Pseudocalanus sp.
Oithona sp.

Bering Sea Copepods

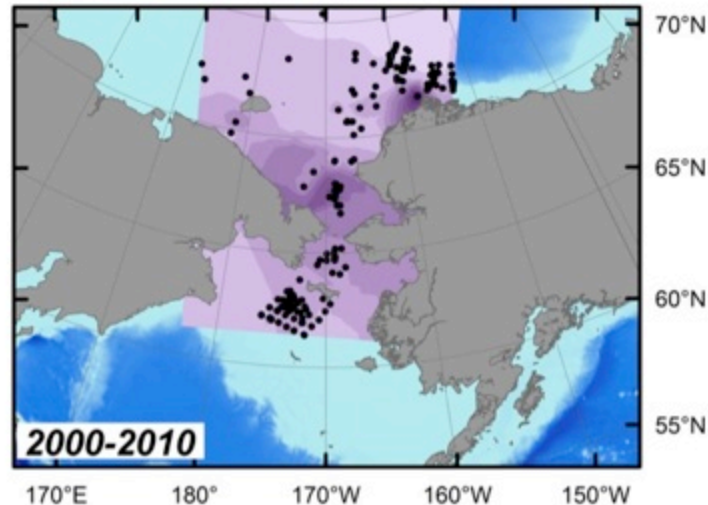
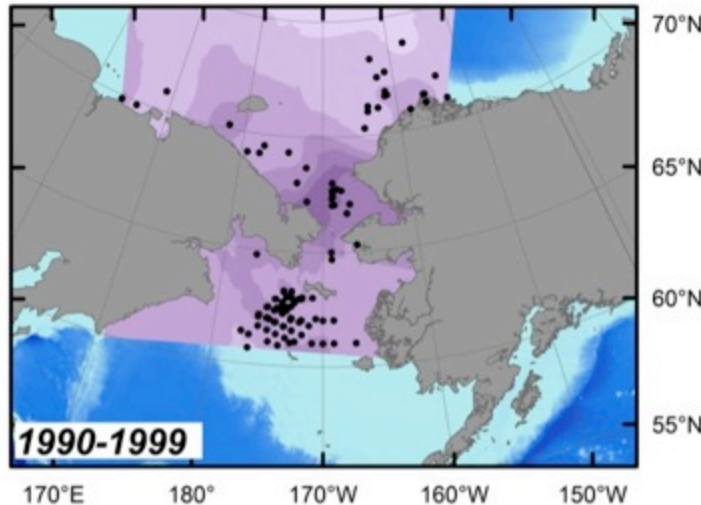
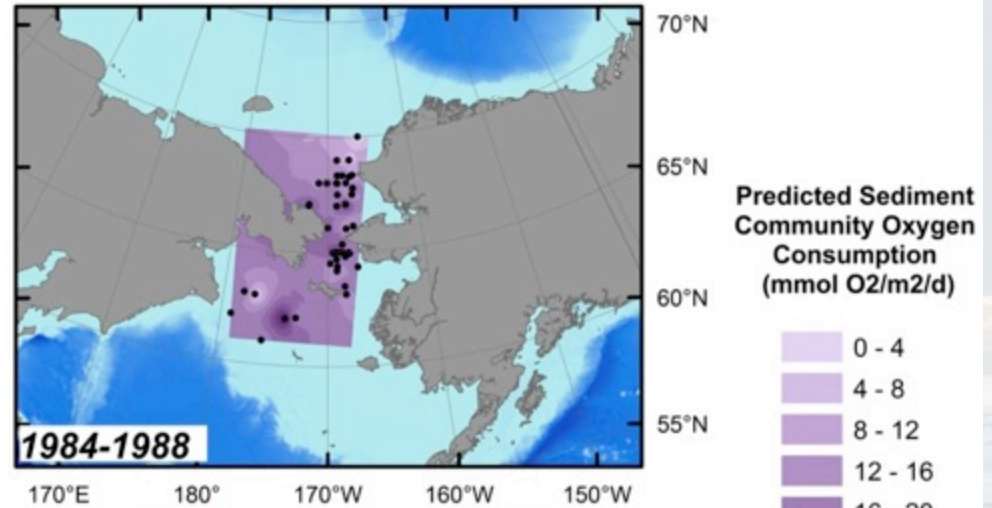


Neocalanus cristatus
N. flemingeri
Calanus marshallae



[courtesy Sharon Smith]

Decadal sediment community oxygen consumption indicate spatial patterns of organic carbon deposition to the sediments

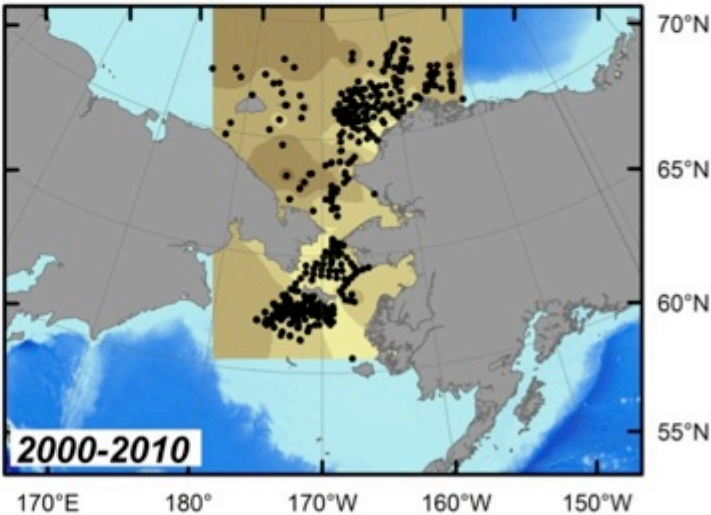
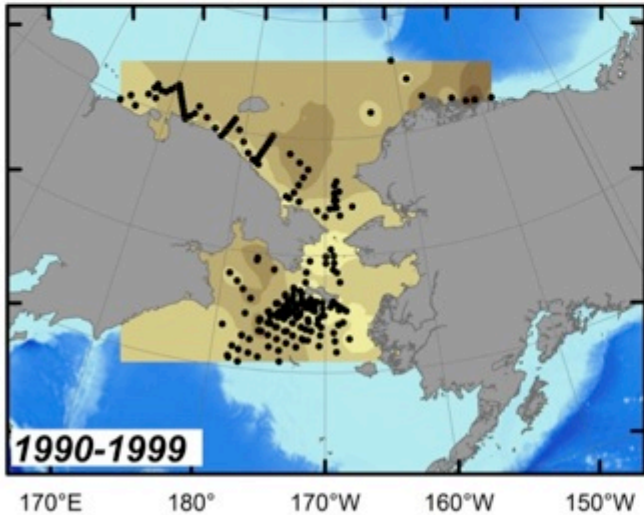
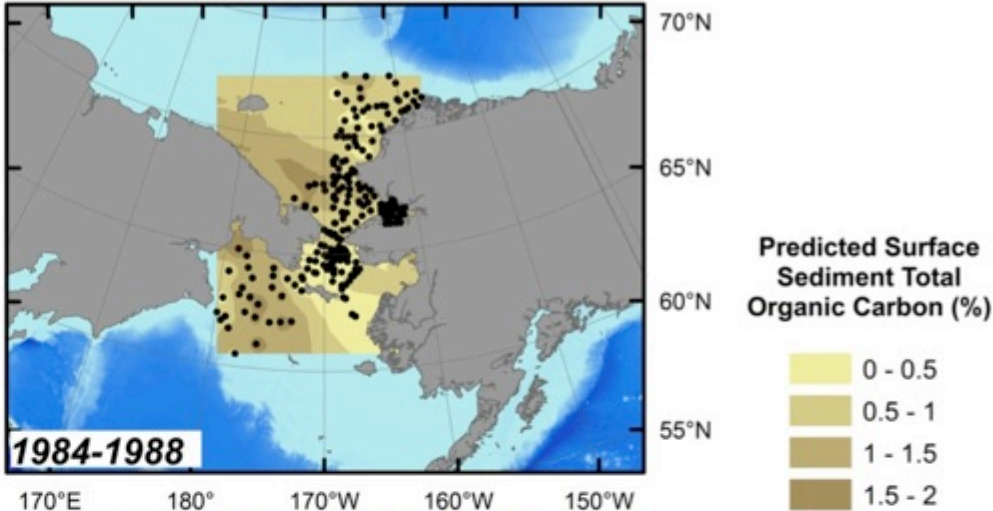


0 200 400 800 1,200
Nautical Miles

[Grebmeier in prep. ARMS 2011]

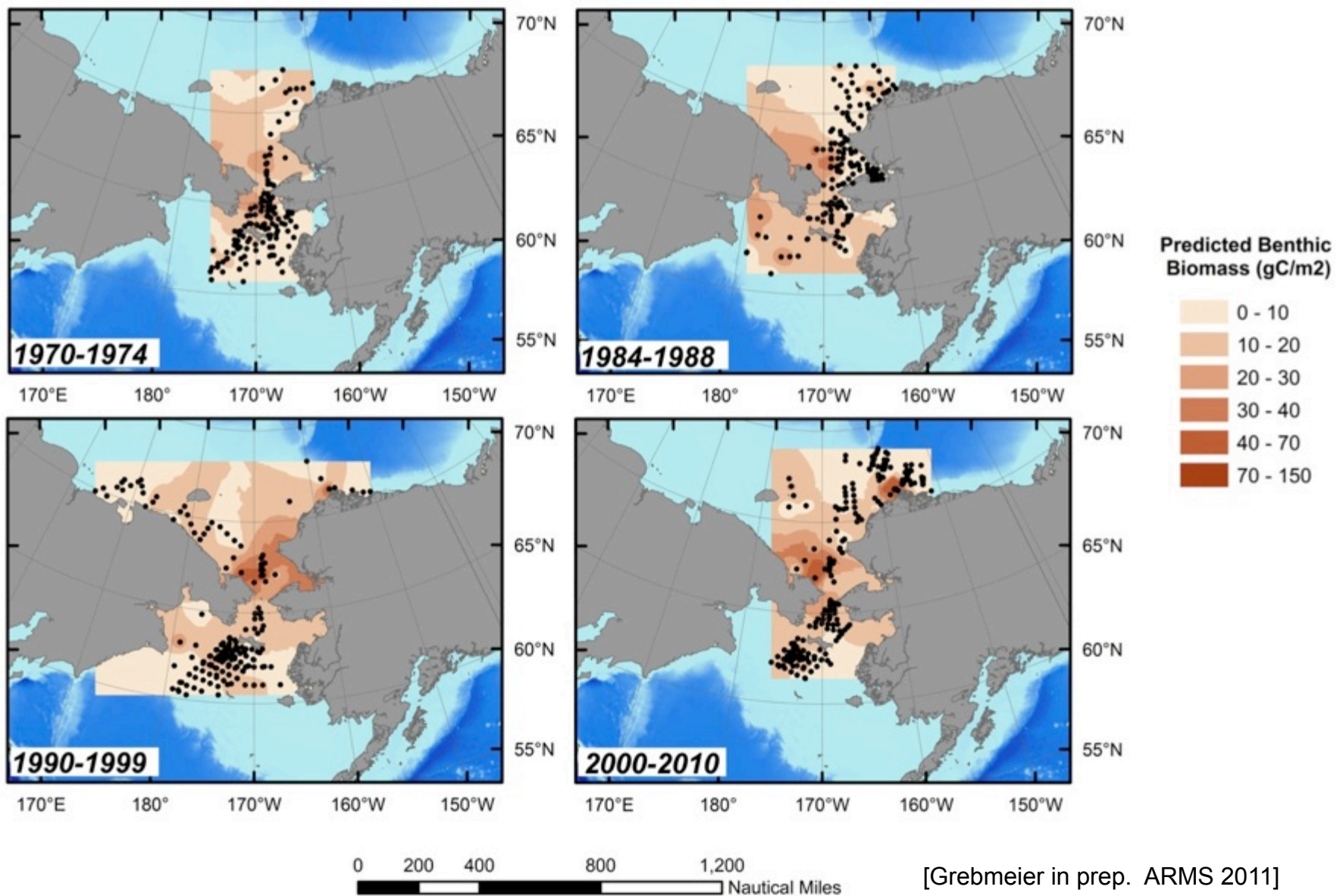
Decadal distribution of Total Organic Carbon content as indicator current speed and deposition zones

- higher TOC associated with silt & clay content, indicative of sediment deposition zones, slower currents



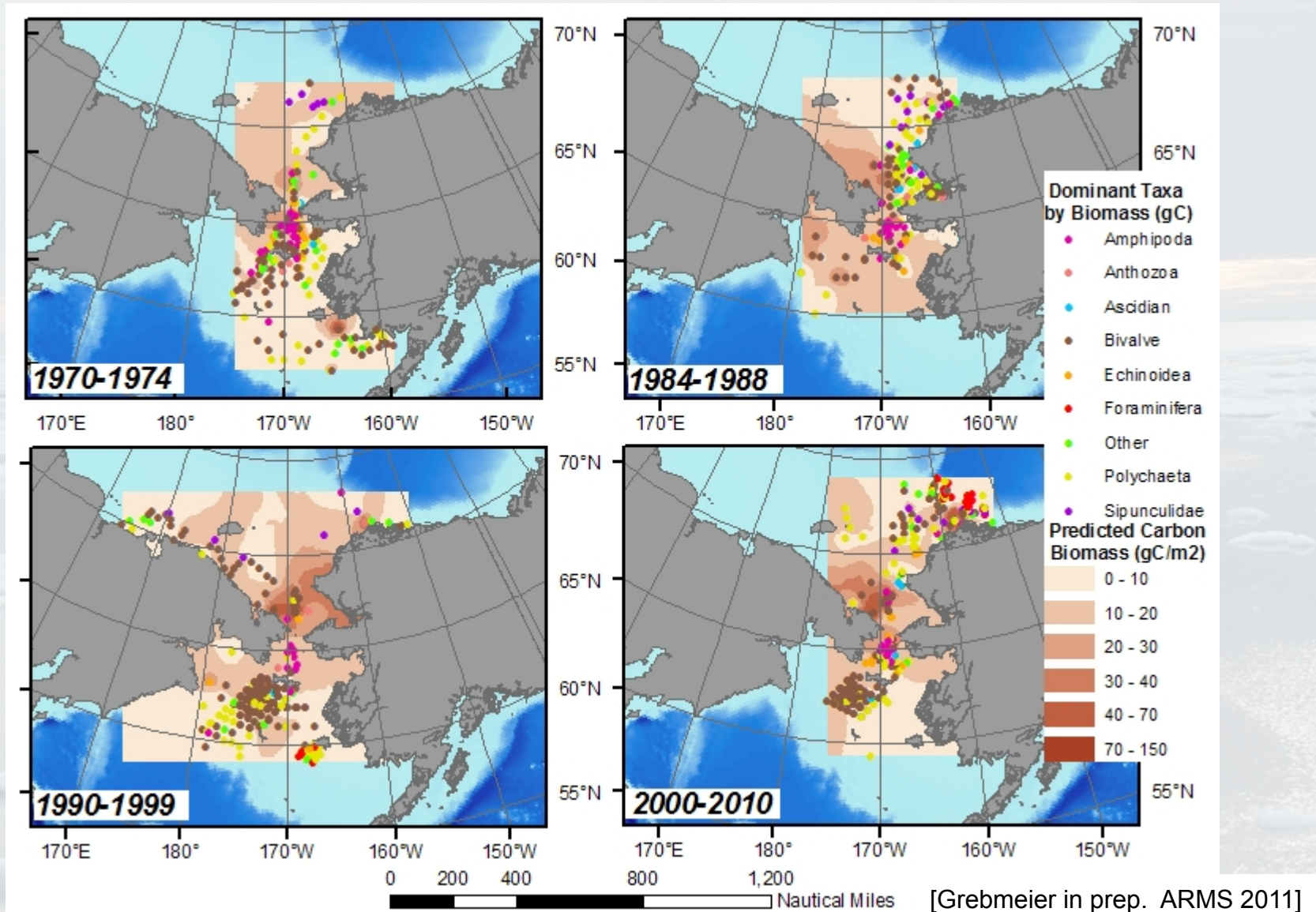
[Grebmeier in prep. AMS 2011]

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

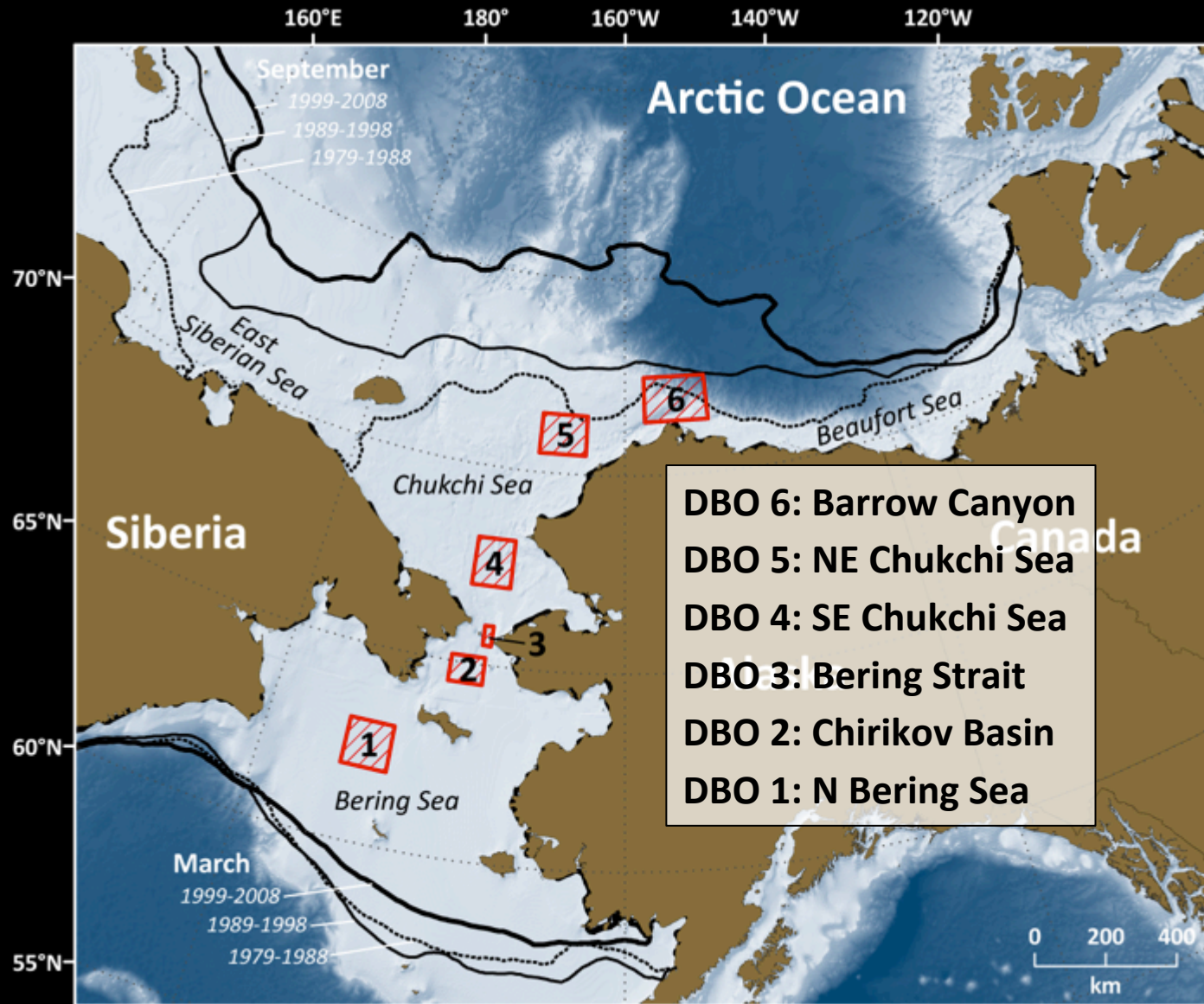


[Grebmeier in prep. ARMS 2011]

Dominant infaunal taxa includes bivalves, amphipods, polychaetes and sipunculids



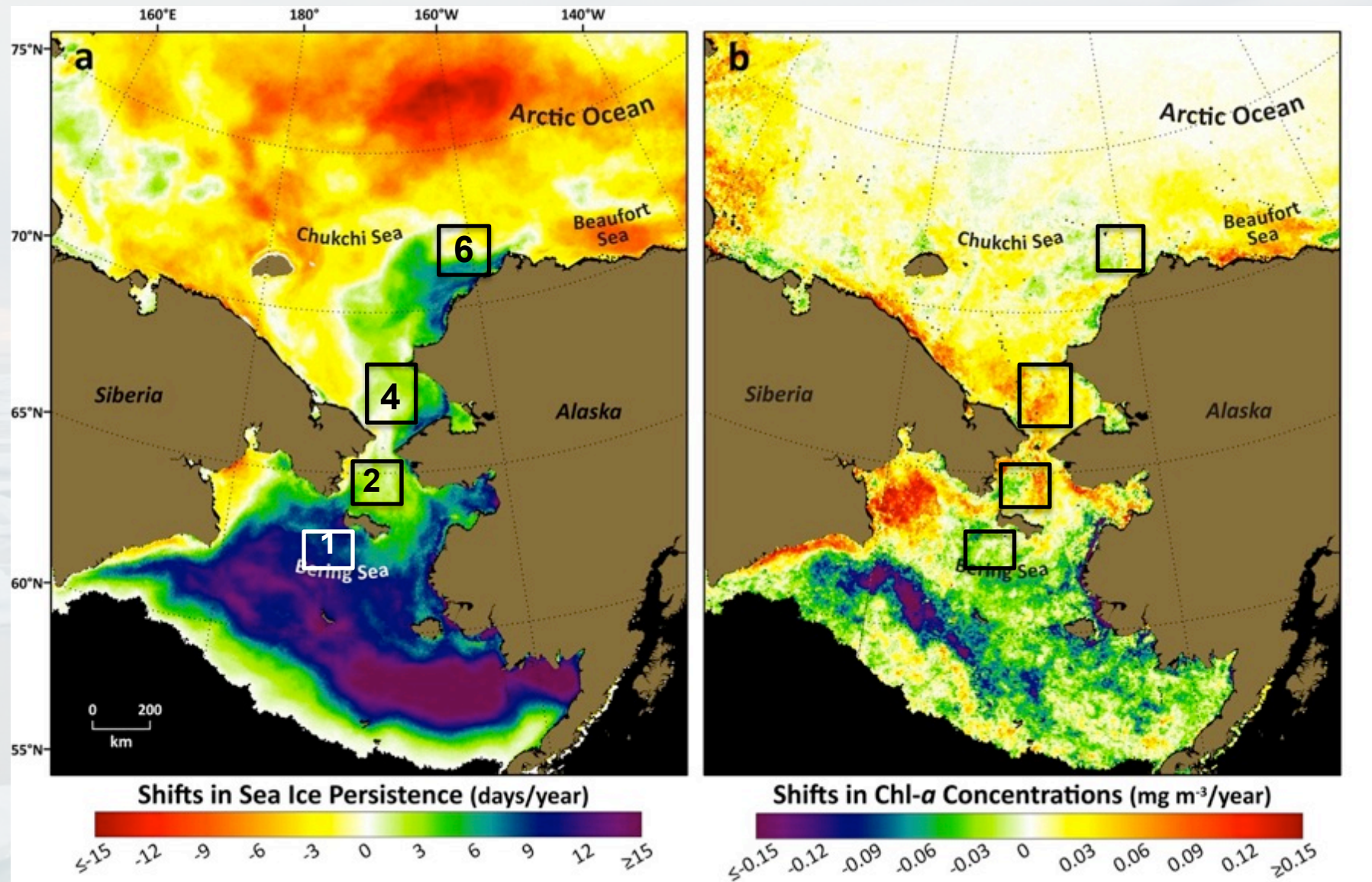
Distributed Biological Observatory (DBO) Sites



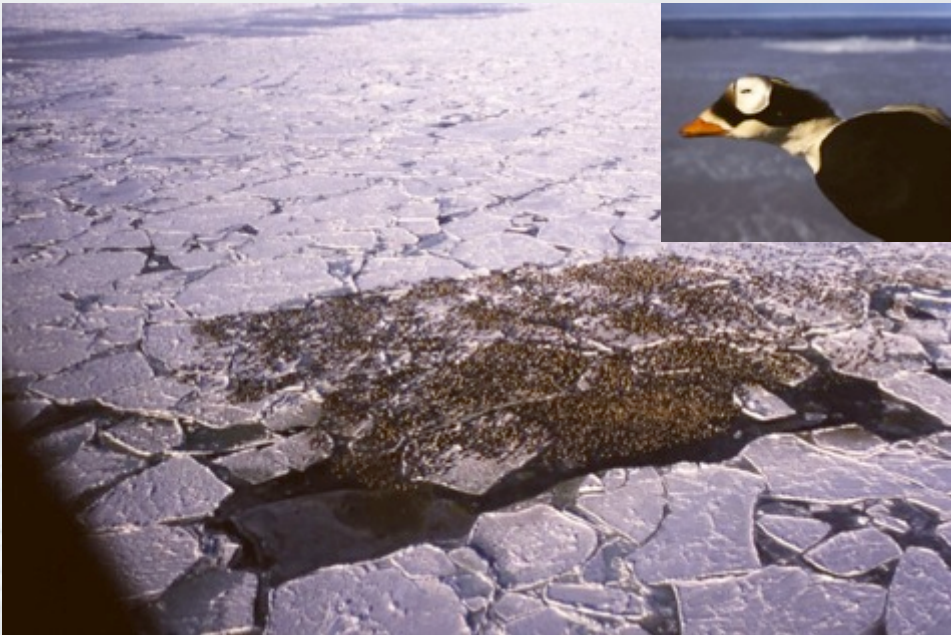
- Regional “hotspot” locations along a latitudinal gradient will comprise the DBO sites
- DBO sites are considered to exhibit high productivity, biodiversity, and overall rates of change
- DBO sites will serve as a change detection array for the identification and consistent monitoring of biophysical responses

[modified from Grebmeier et al. 2010, EOS]

Shifts in sea ice persistence and Chl-a concentration from 2003-2009

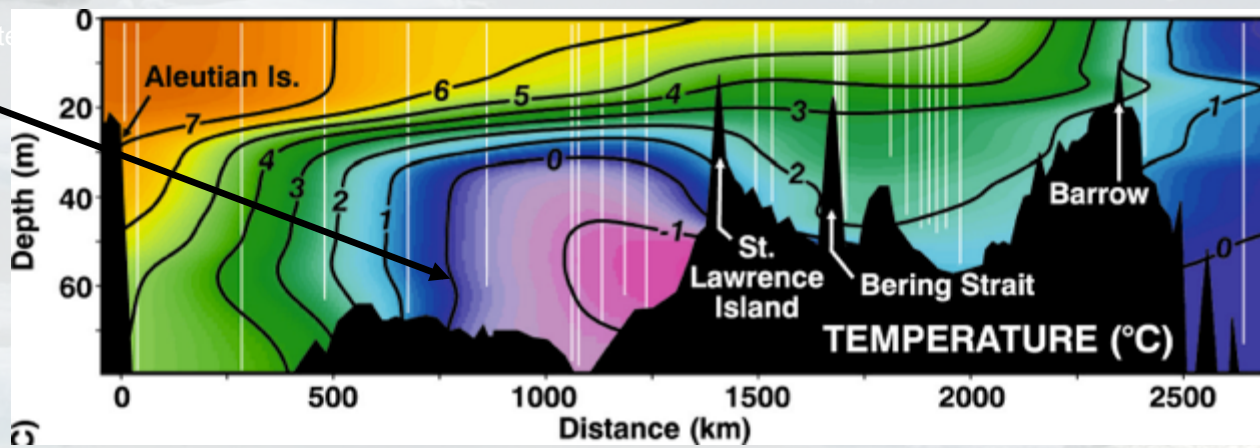


Threatened spectacled eiders keyed to sea ice and specific bivalves (DBO1)

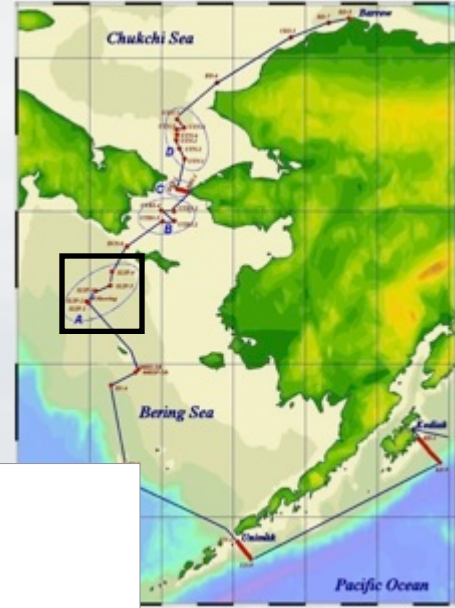


- feed on 3 species of bivalves
- shallow shelf system, high cascade potential lower to higher trophic levels
- ocean acidification potential dissolve bivalve shells
- extent & duration cold pool (<math><0^{\circ}\text{C}</math>) critical to benthic infauna by exclusion of benthic fish and epibenthic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

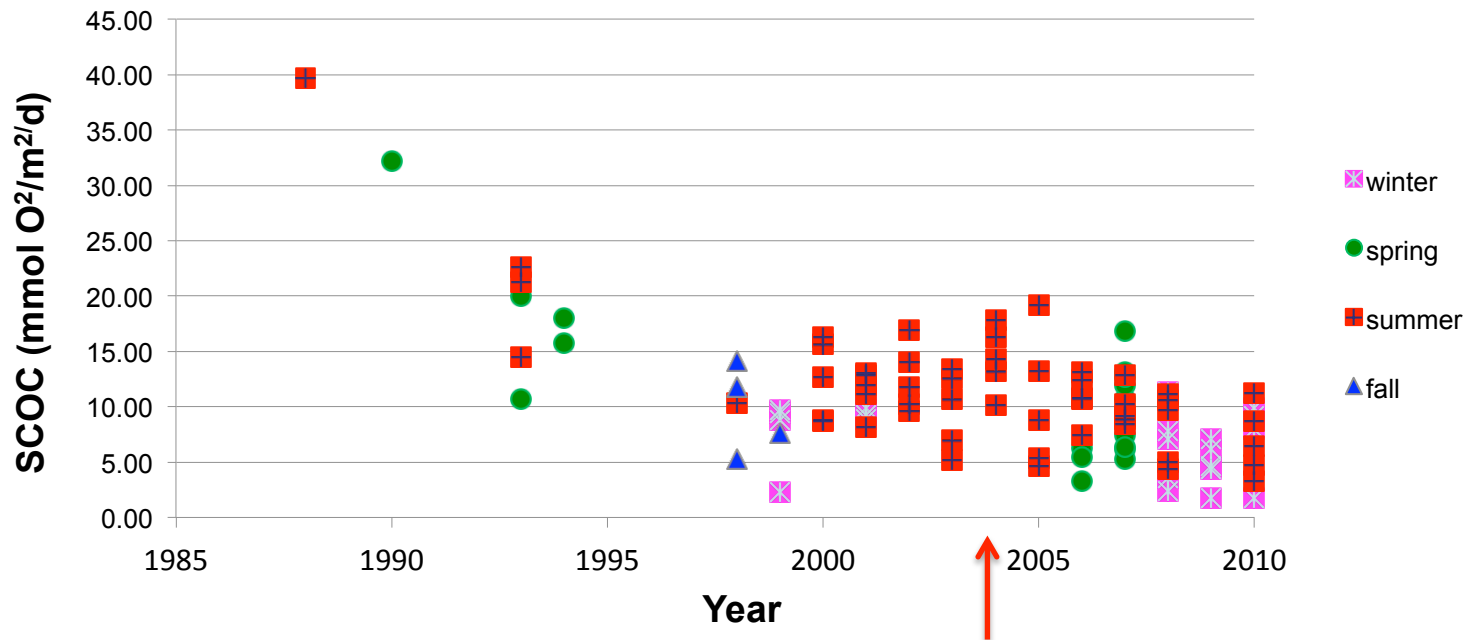
[Andrew Triton]



Decline in sediment community oxygen consumption indicative of reduced carbon supply to the benthos SW St. Lawrence Island



Sediment Community Oxygen Consumption (SCOC)
($\text{mM O}_2 \text{ m}^{-2} \text{ d}^{-1}$)



[update from Grebmeier et al. Science 2006]