# Biological Change in the Pacific Arctic Ecosystem

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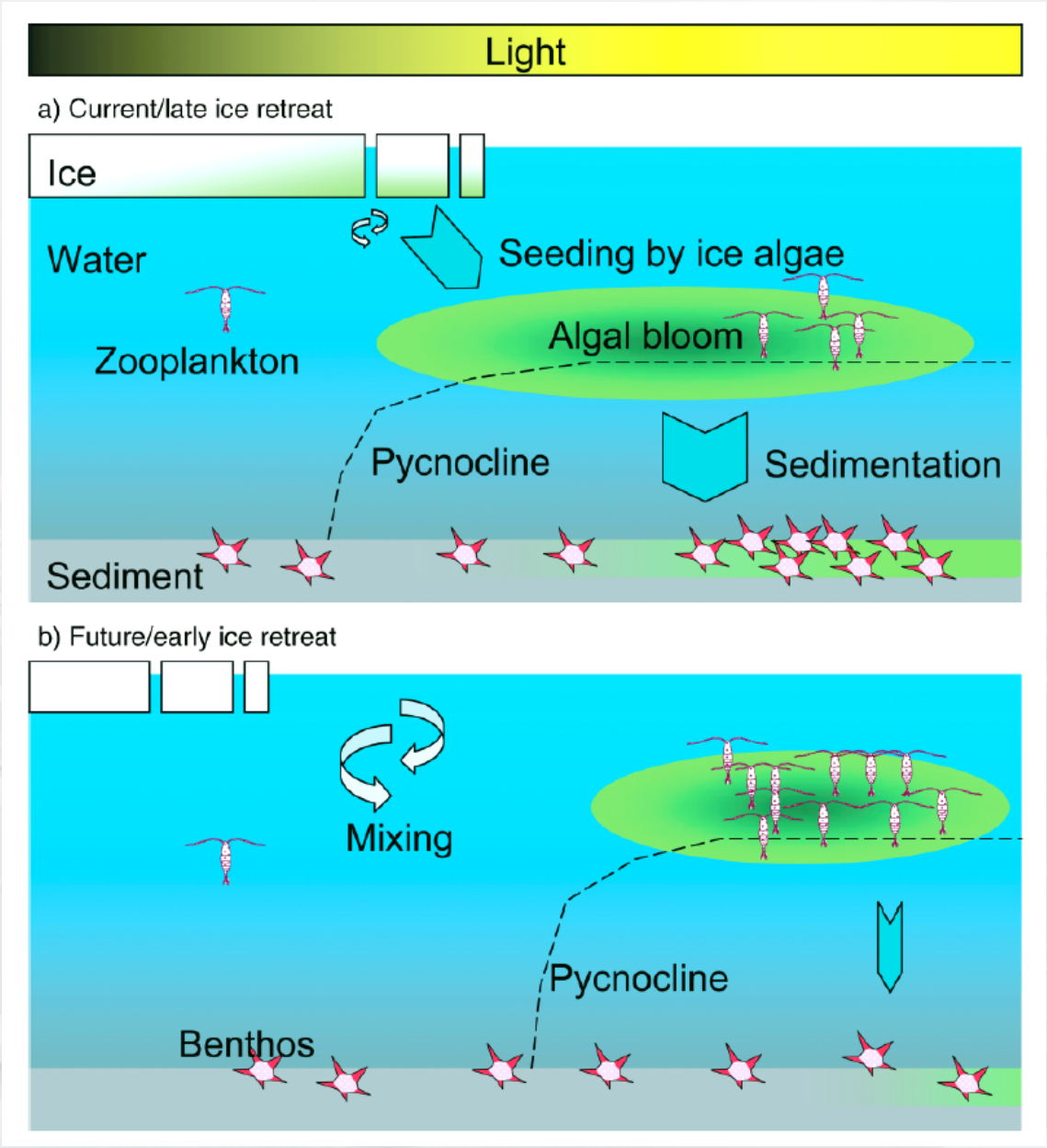
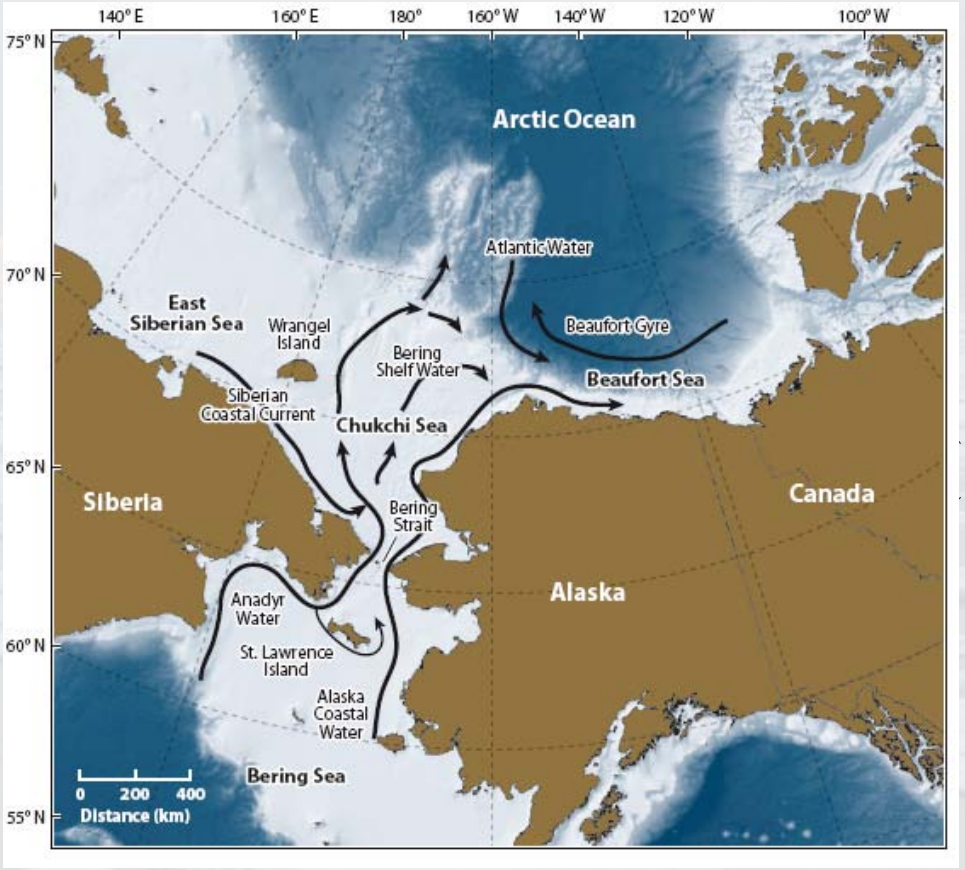
# Seasonal cycle of marine production: now to beyond

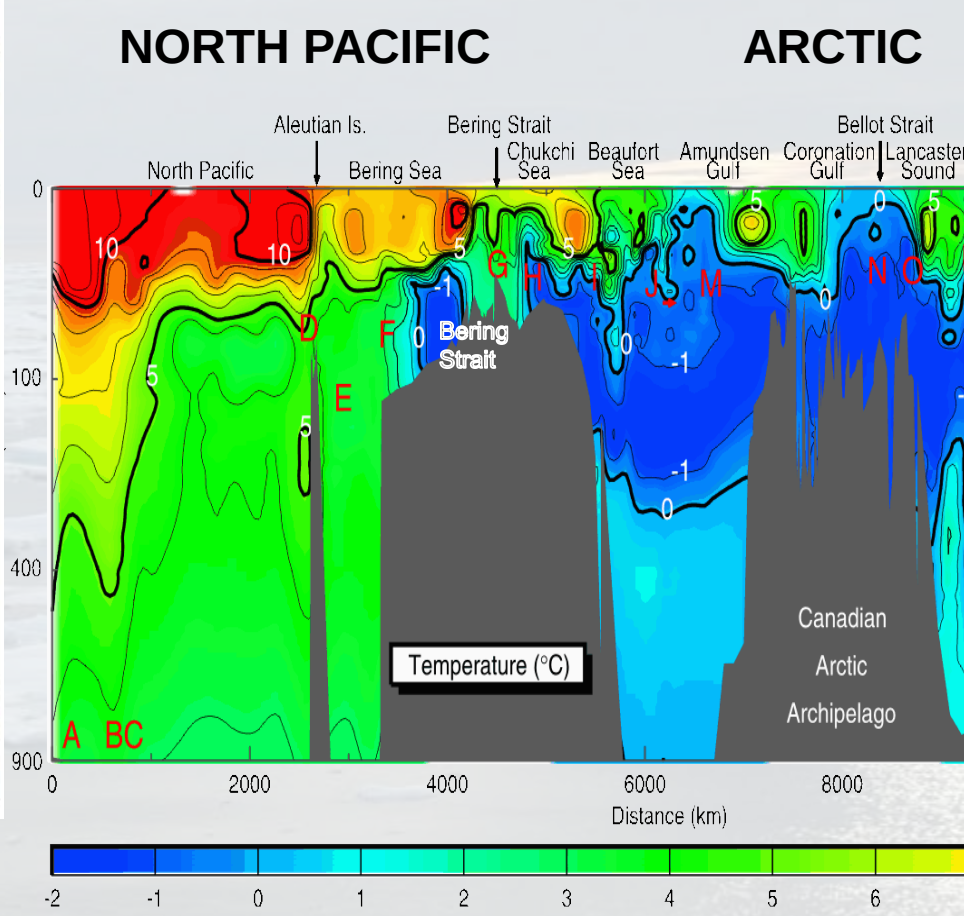



Bluhm and Gradinger 2008, Ecological Applications 18(2): S77-S96

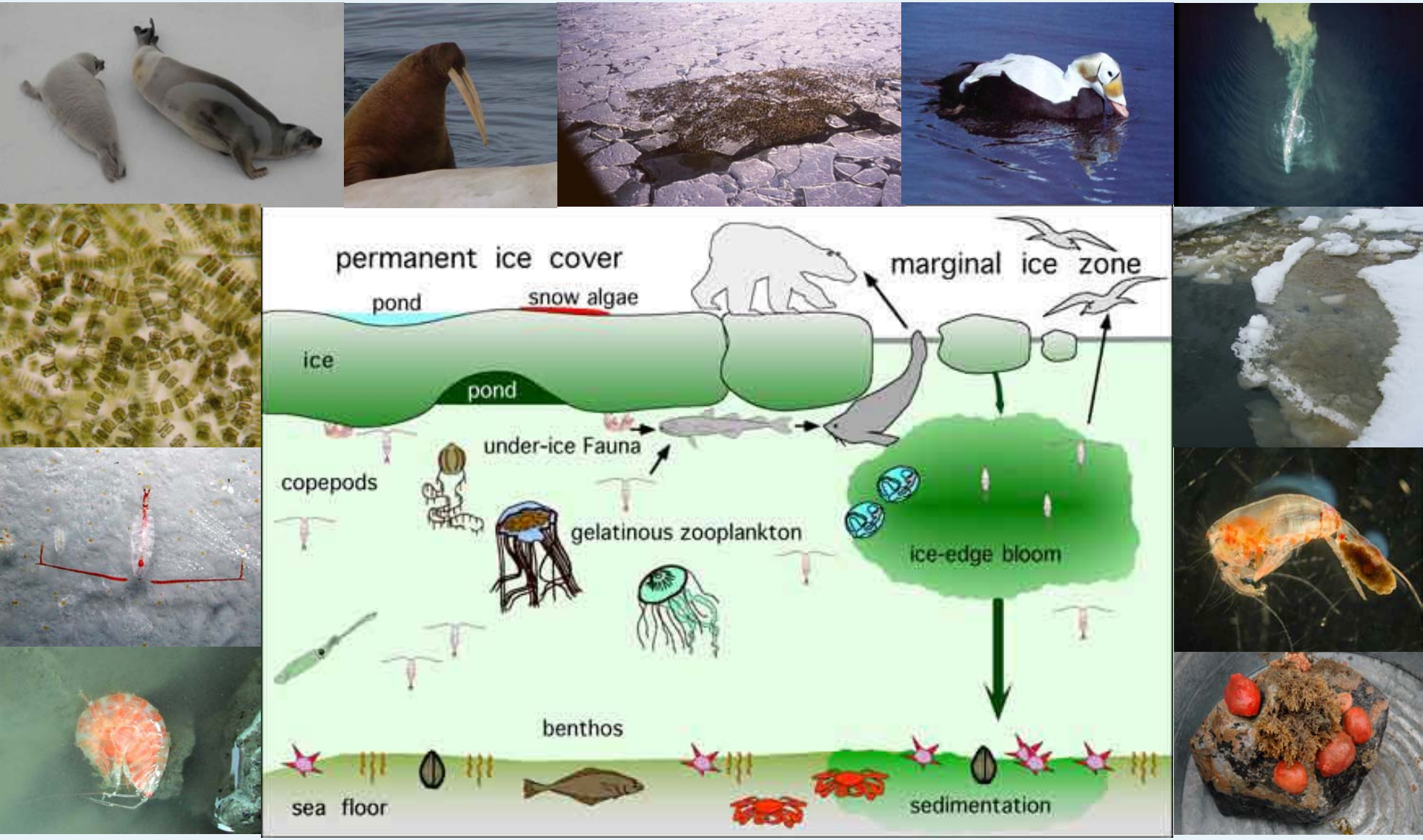
# Seasonal water mass structure in the Pacific sector




## C3O Seawater Temperature "Slice" in July 2008

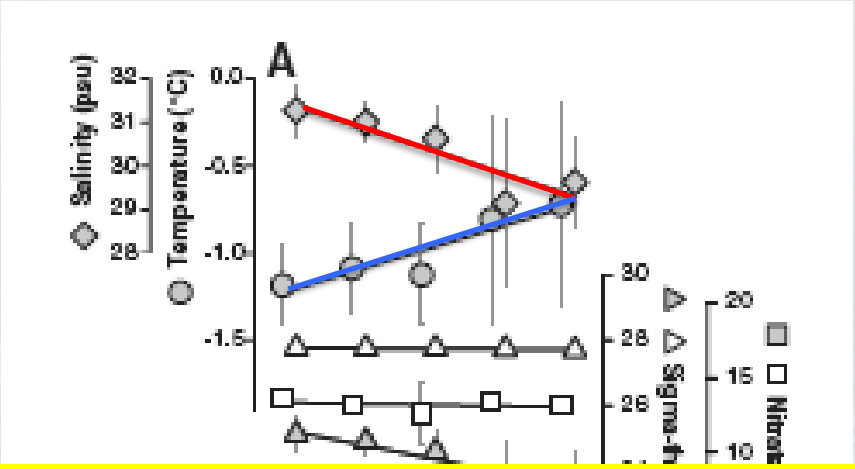


# Arctic Marine Food Web

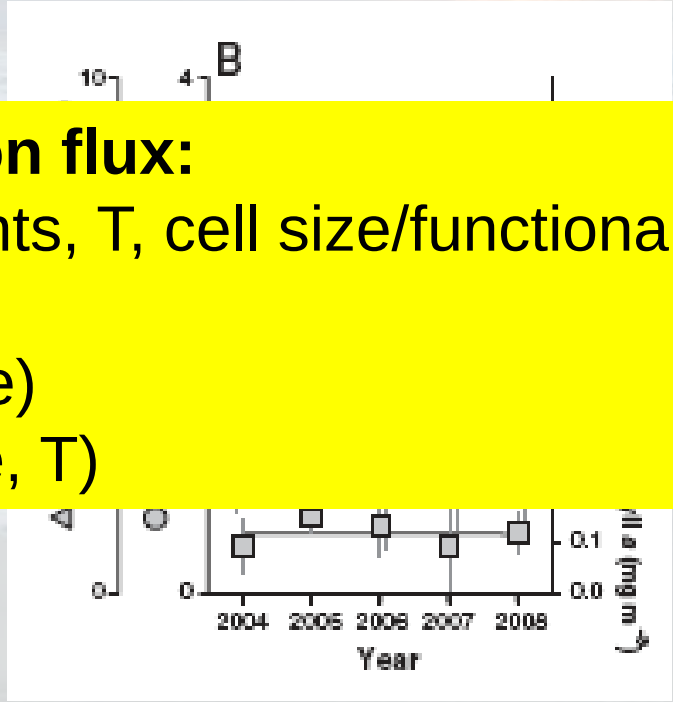



[figure from http://www.arcodiv.org/]

# Climate tendencies in Canadian Arctic Ocean surface waters



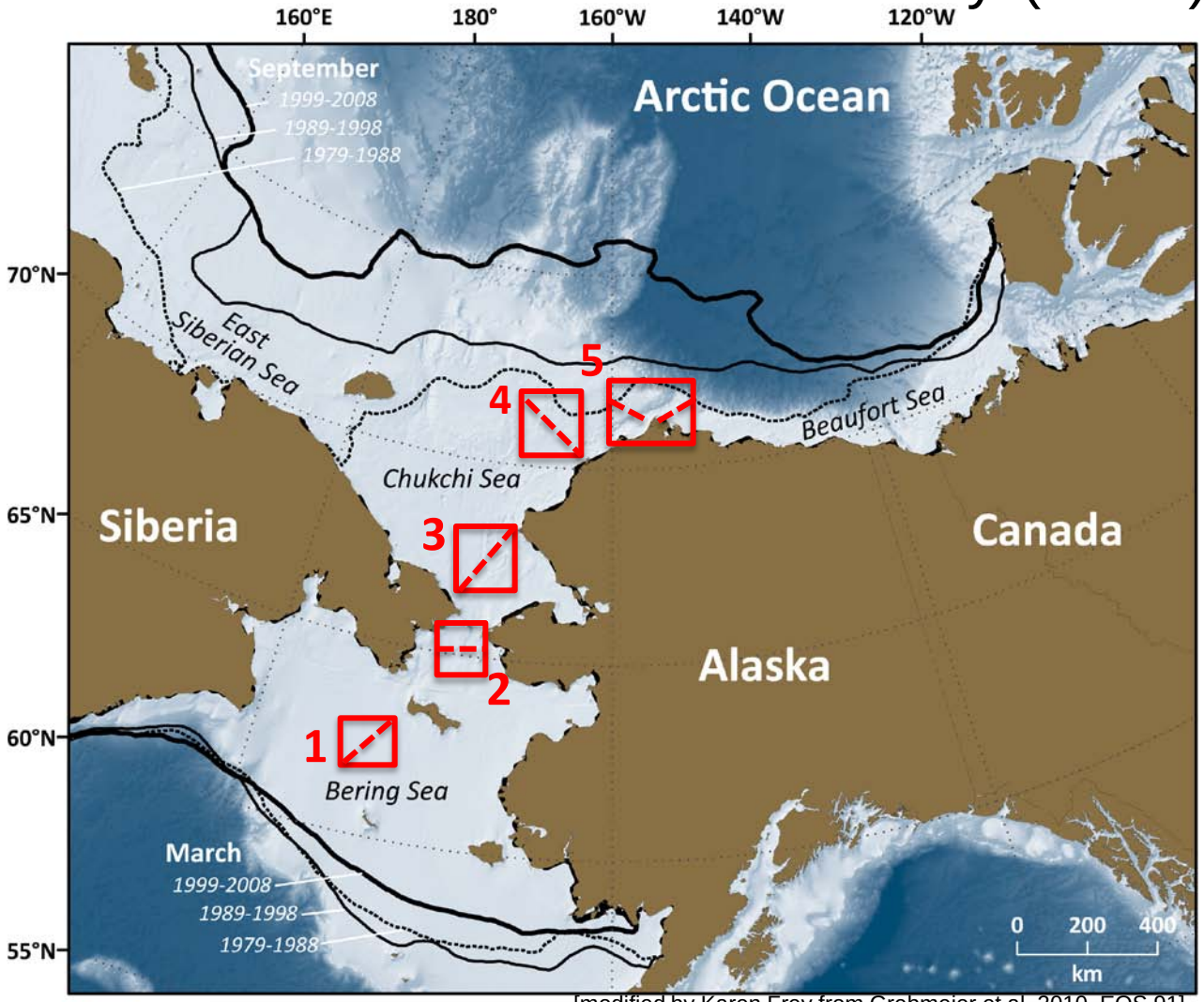

Decreased salinity
Increased temperature
Decreased nitrate
Increased picoplankton
Decreased nanoplankton




**Changes do matter for carbon flux:**
Net primary production (nutrients, T, cell size/functional group)
Grazers (size, T),
Vertical export (nitrate, cell size)
carbon turnover rates (cell size, T)

Li et al. (2009)

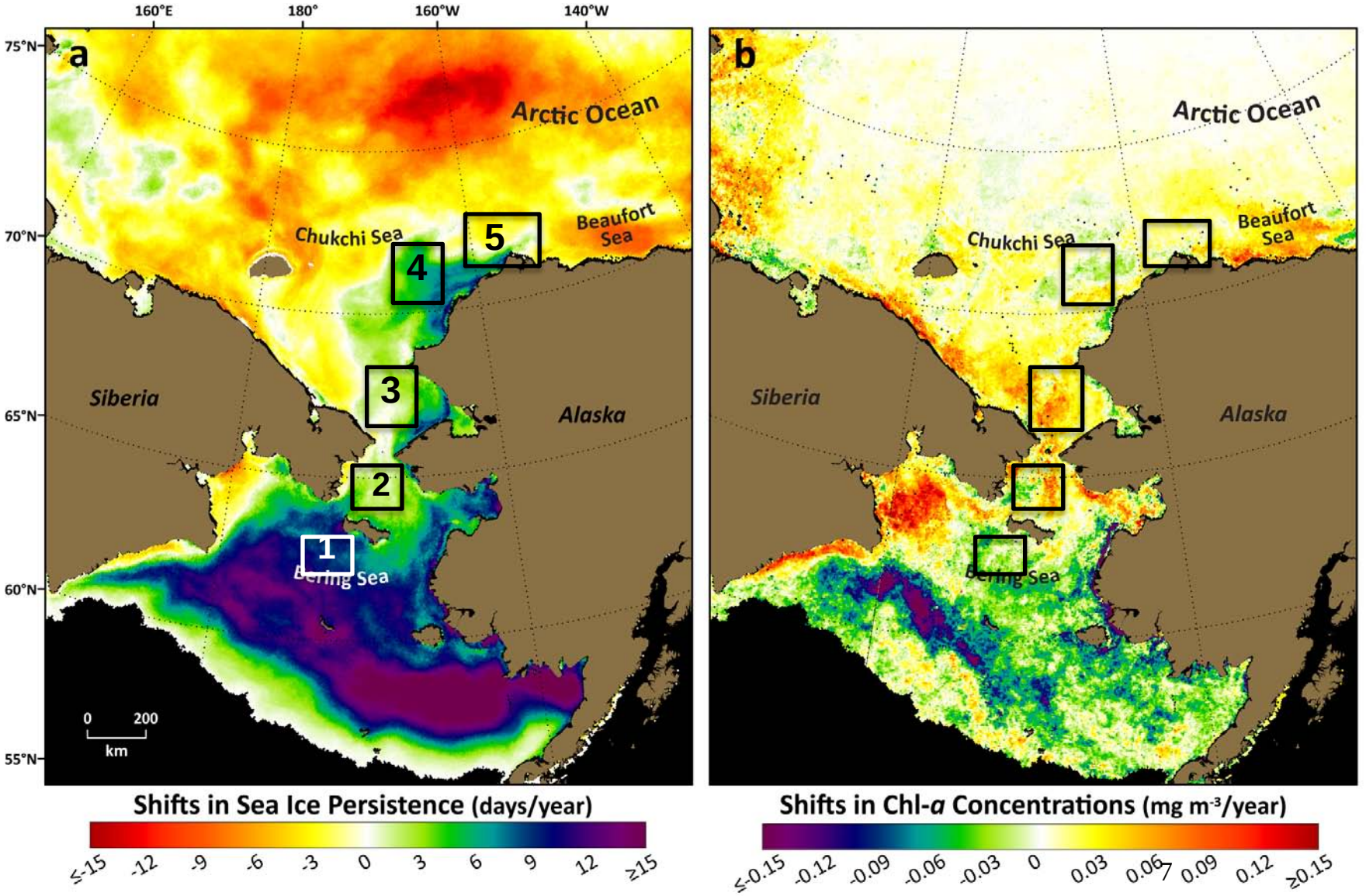
# Linking Physics to Biology: the Distributed Biological Observatory (DBO)




[modified by Karen Frey from Grebmeier et al. 2010, EOS 91]

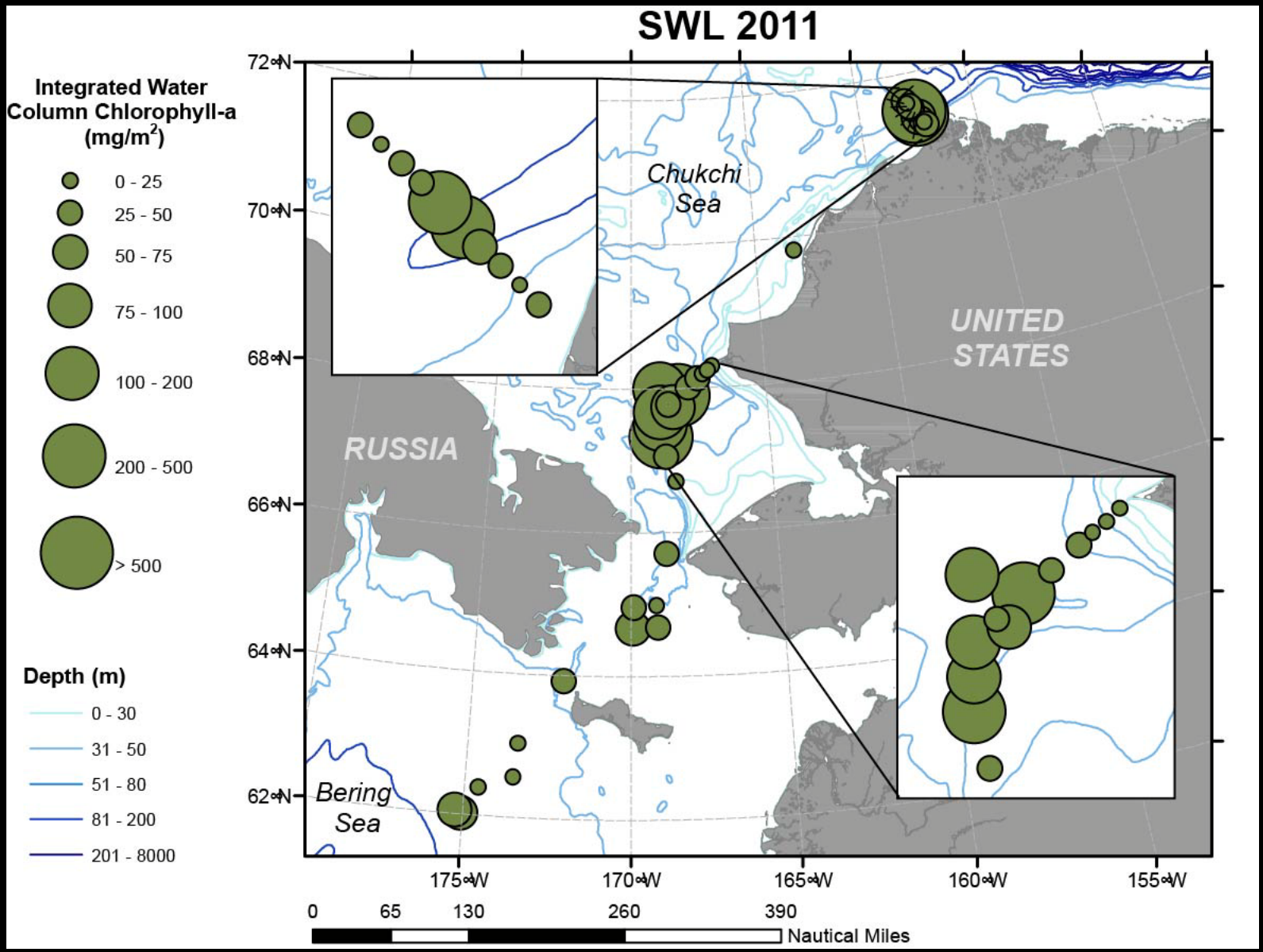
- **DBO sites (red boxes) are regional "hotspot" transect lines and stations located along a latitudinal gradient**
- **DBO sites are considered to exhibit high productivity, biodiversity, and overall rates of change**
- **DBO sites will serve as a change detection array for the identification and consistent monitoring of biophysical responses**
- **Sites occuppied by national and international entities with shared data plan**

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



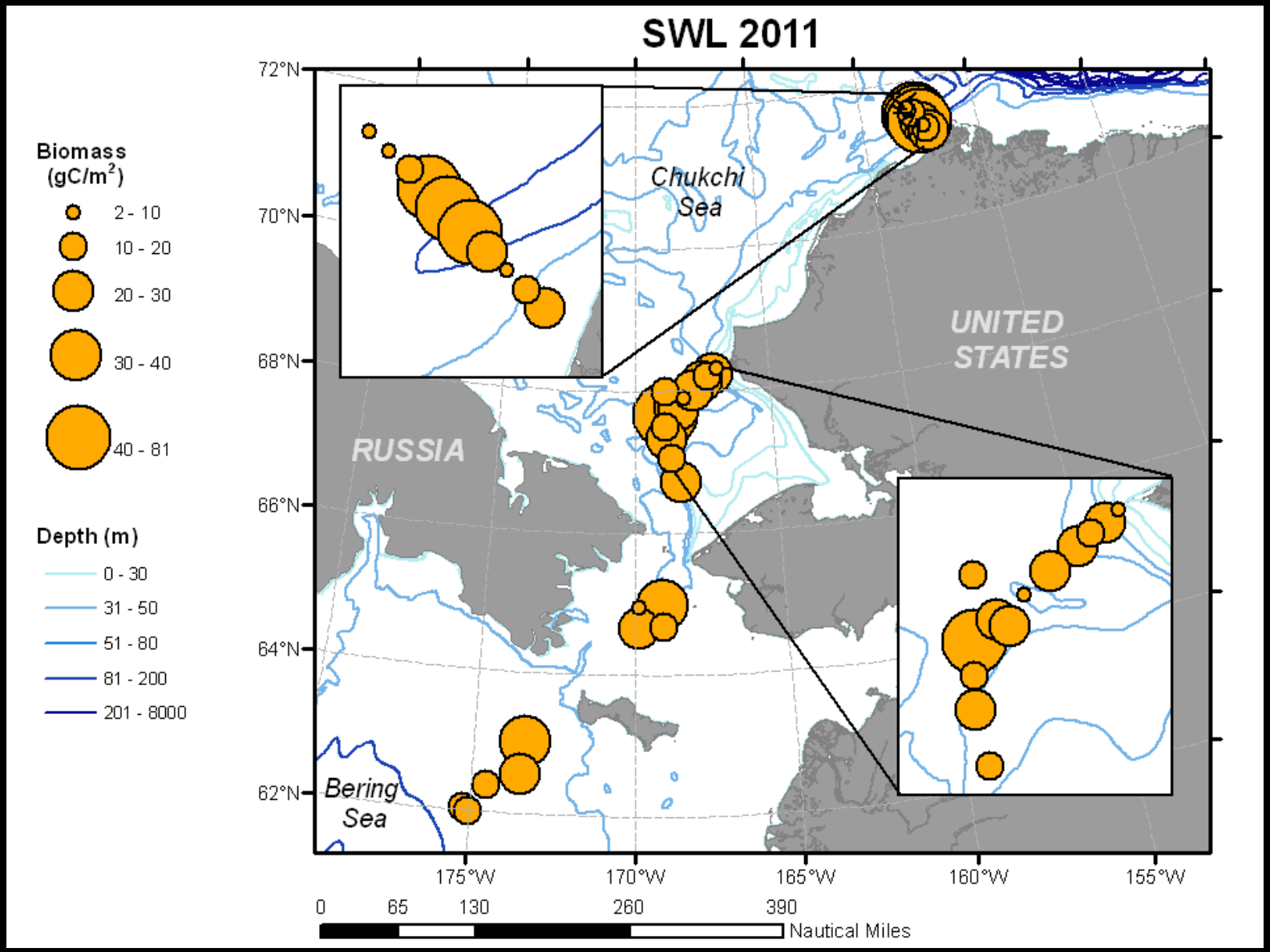

*Based on SSM/I Sea Ice Concentrations and the GlobColour (SeaWiFS, MODIS, MERIS) satellite time series, courtesy Karen Frey*

# SWL 2011 Integrated Chl (mg/m2)



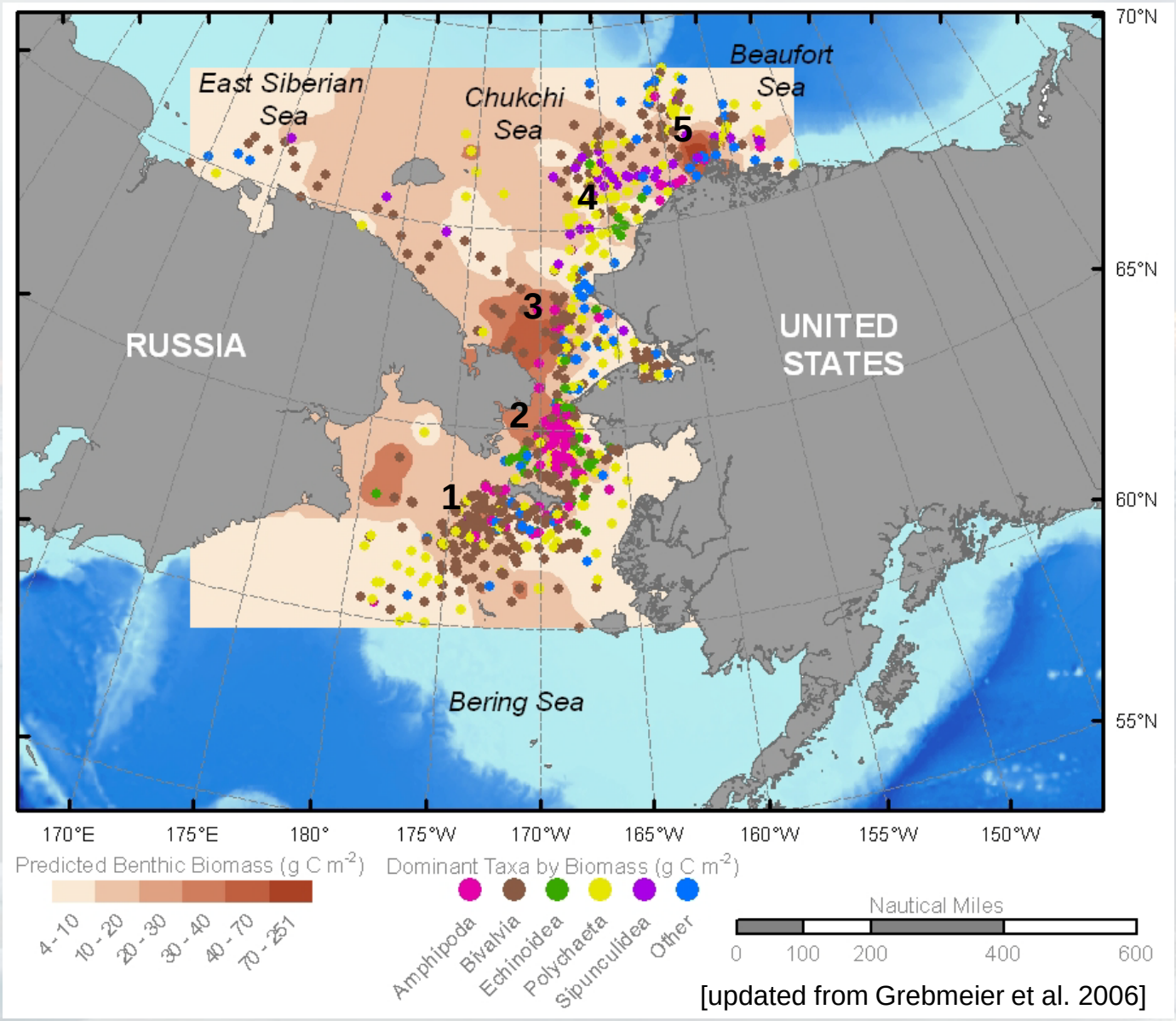

[Canada's Three Oceans (C30)/DBO Program-Grebmeier/Cooper]

# SWL 2011 Benthic Biomass (gC/m2)



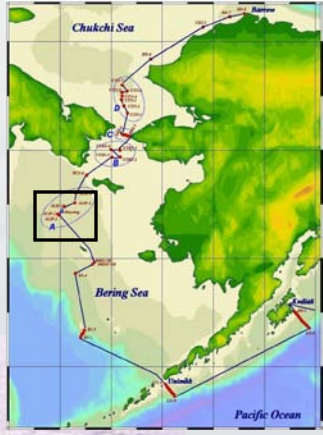

[Canada's Three Oceans (C30)/DBO Program-Grebmeier/Cooper]

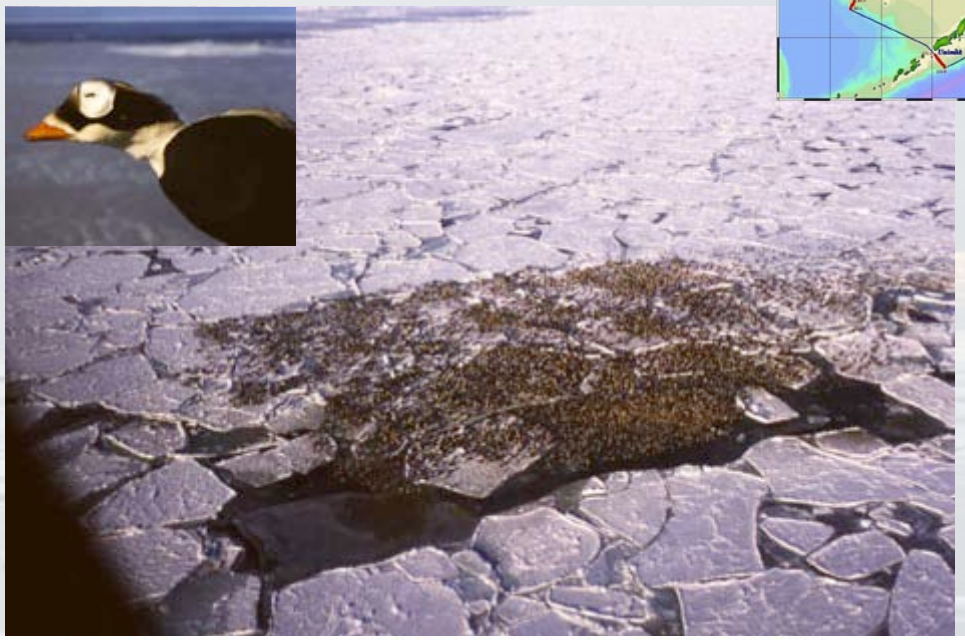
# Rich benthic communities on the western side of the Bering/Chukchi Sea system 1970-2010




[updated from Grebmeier et al. 2006]

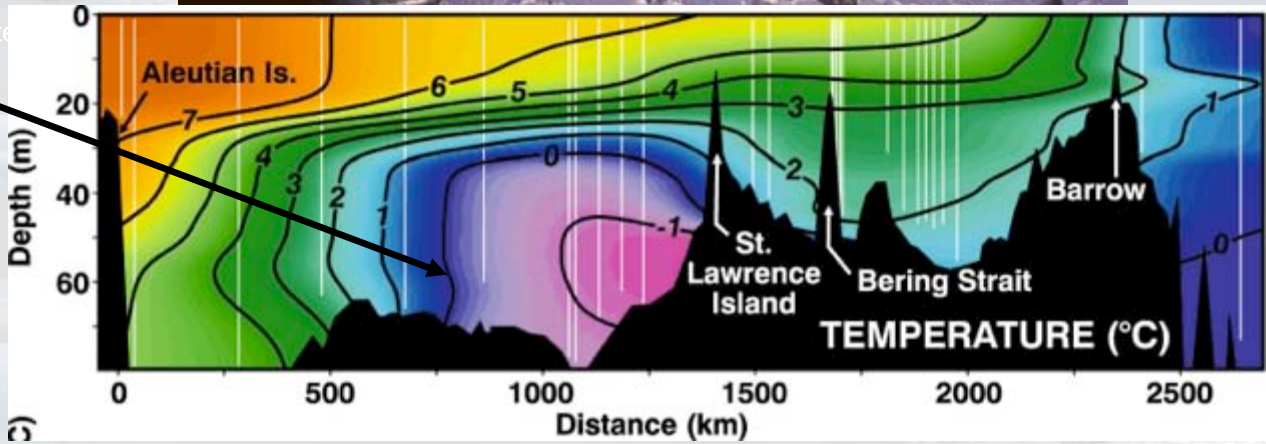
# DBO1-Threatened spectacled eiders keyed to sea ice and specific bivalves



- 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

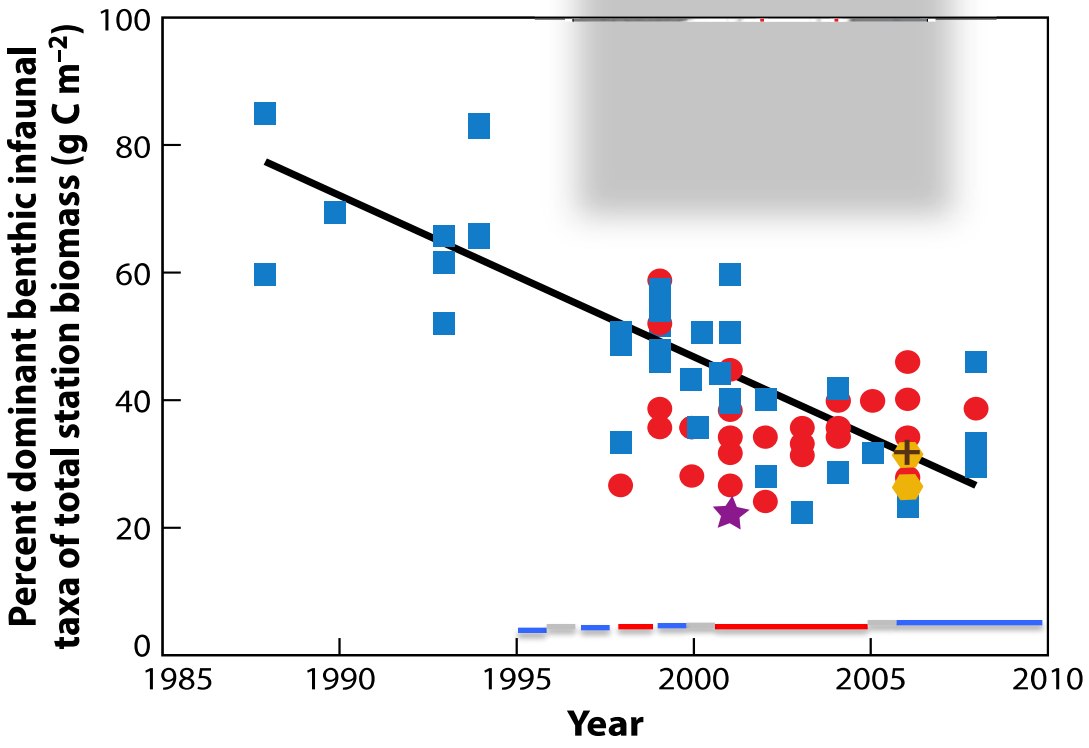
[Andrew Trite




[Grebmeier et al. 2006, Science 311]

# Regional decline in dominant bivalve (*N. radiata*), with potential shift to smaller bivalve (*E. tenuis*)

- **Coincident decline in sediment community oxygen consumption indicative of reduced carbon supply to the benthos**
- **Impact on declining spectacled eider (diving seaduck) populations**




Nuculanidae (*Nuculana radiata*)*
Nuculidae (*Ennucula tenuis*)
Tellinidae (*Macoma calcarea*)
Maldanidae
Sipunculidae

* Linear regression:
$y = -2.5359x + 5{,}118.8$
$r^2 = 0.64509$; $p < 0.0001$

**Temperature regimes (P. Stabeno)**
**cold (1995, 1997, 1999, 2007-2010)**
average (1996, 2000, 2006)
**warm (1998, 2001 - 2005)**

[Grebmeier Ann. Rev. Mar. Sci. 4, 2012]

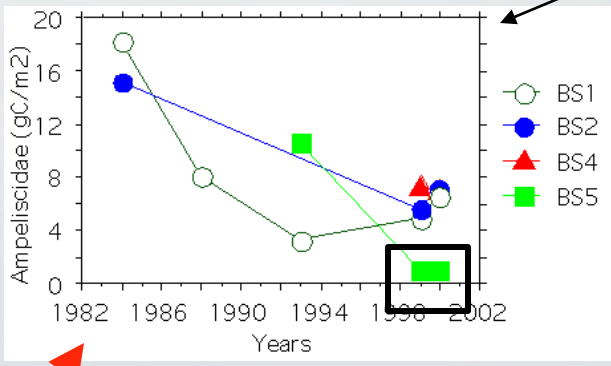
# DBO 2: Chirikov Basin: Drop in Benthic Productivity 1980s to 1990s

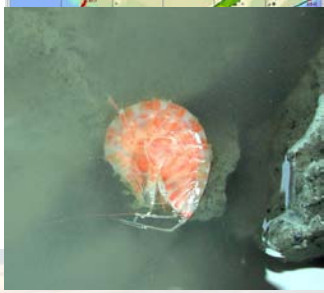
- Highsmith and Coyle (1992) evidence of 30% benthic amphipod production downturn from 1986-88 (gray whale food)

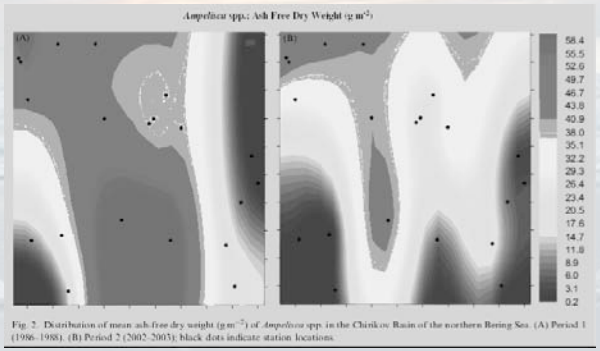
- decline of ampeliscid amphipod biomass at 4 time series stations (Moore et al. 2003); supported at more stations in the region (Coyle et al. 2007)

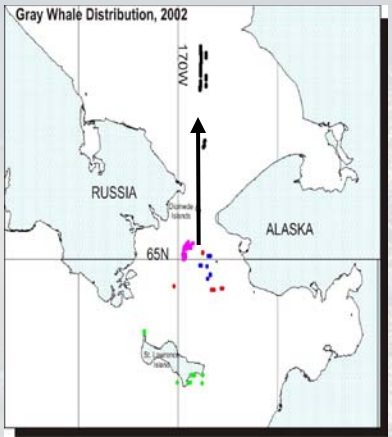
- Shift gray whales north of Bering Strait; prefer feeding in ice-free areas


Time-series sites

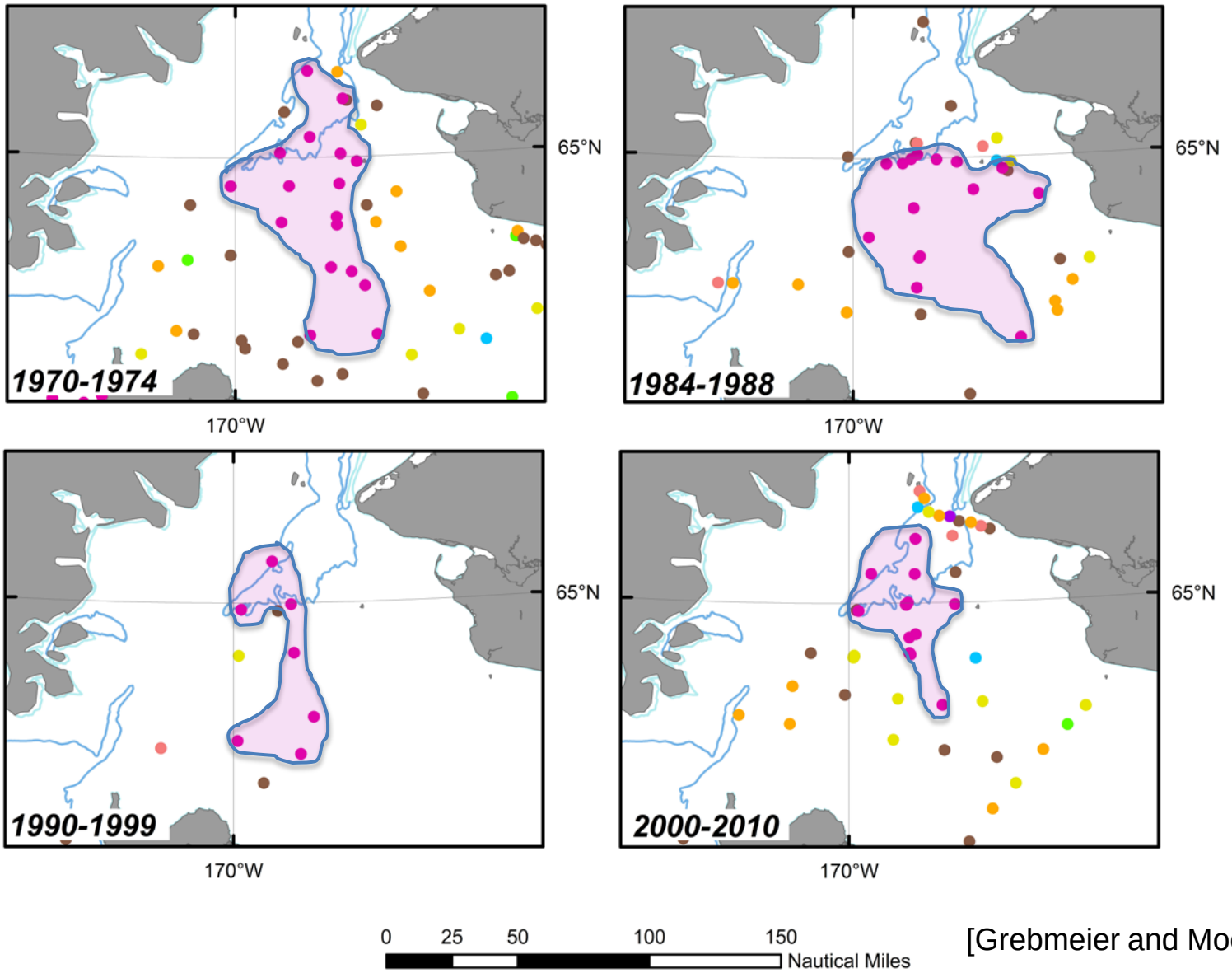




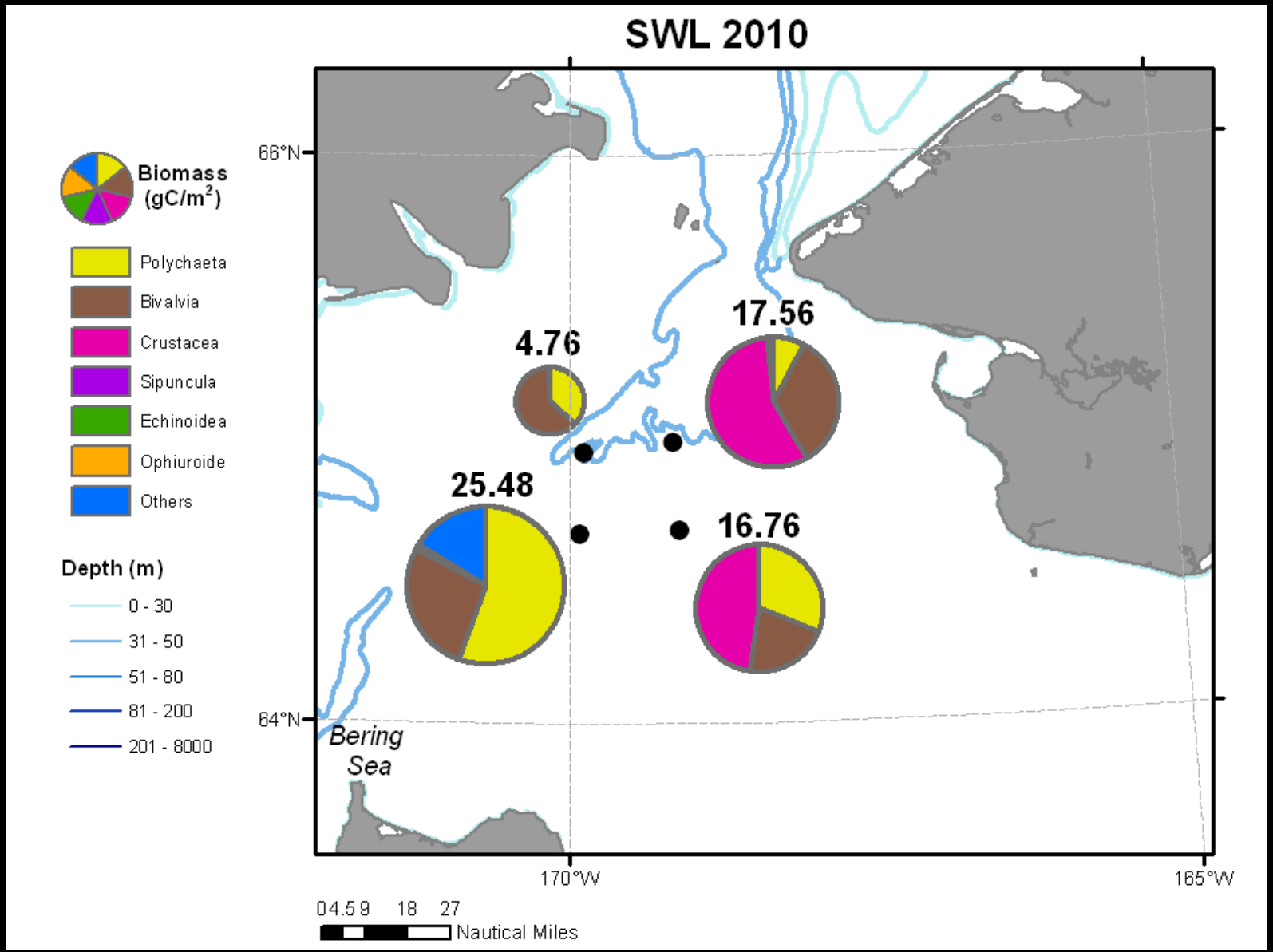


# “Footprint” of ampeliscid amphipod prey contracting spatially



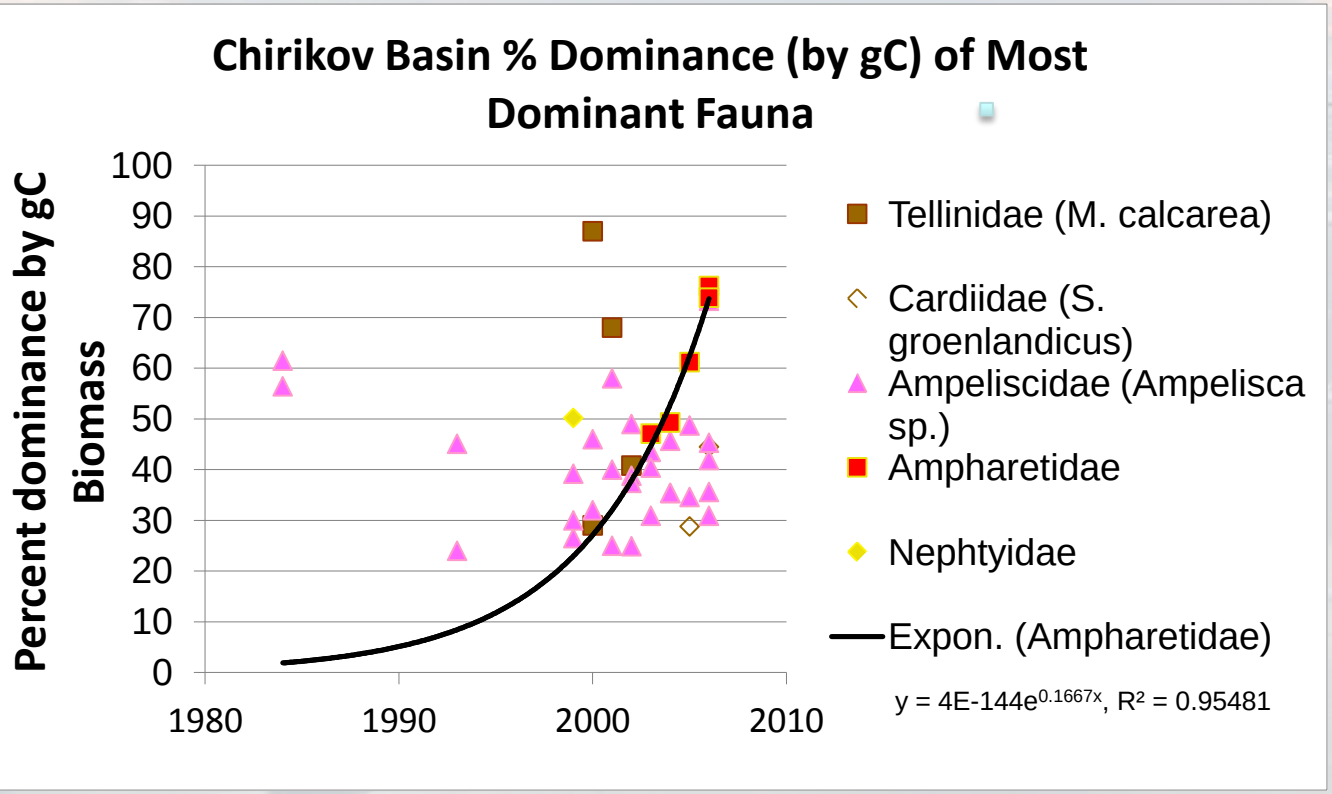

[Grebmeier and Moore in prep.]

# DBO2: Infaunal biomass amphipods highest in east time series sites, gone from the western side



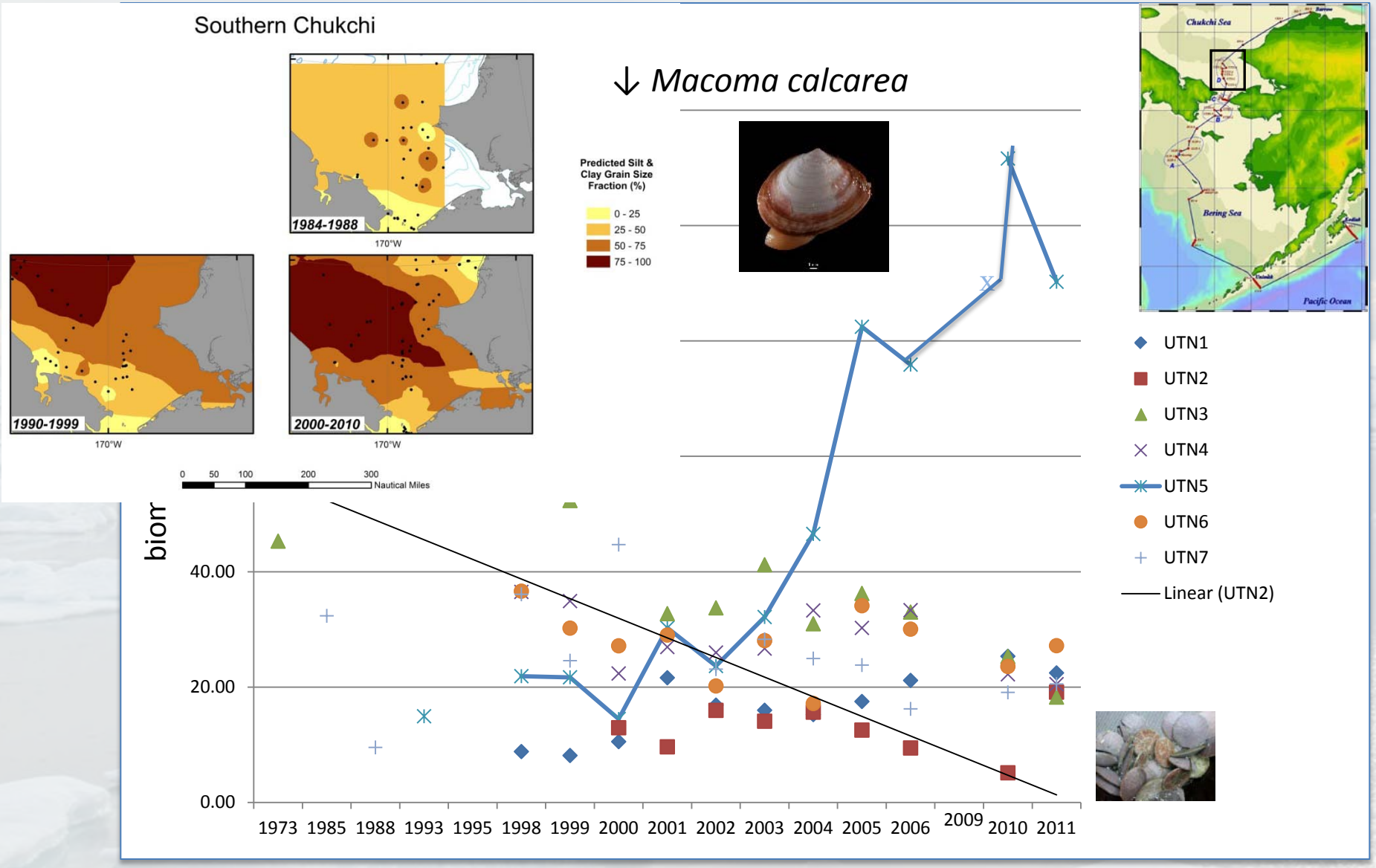
# Northern Bering Sea (DBO2)-one station shifted from amphipods to polychaetes in 2003



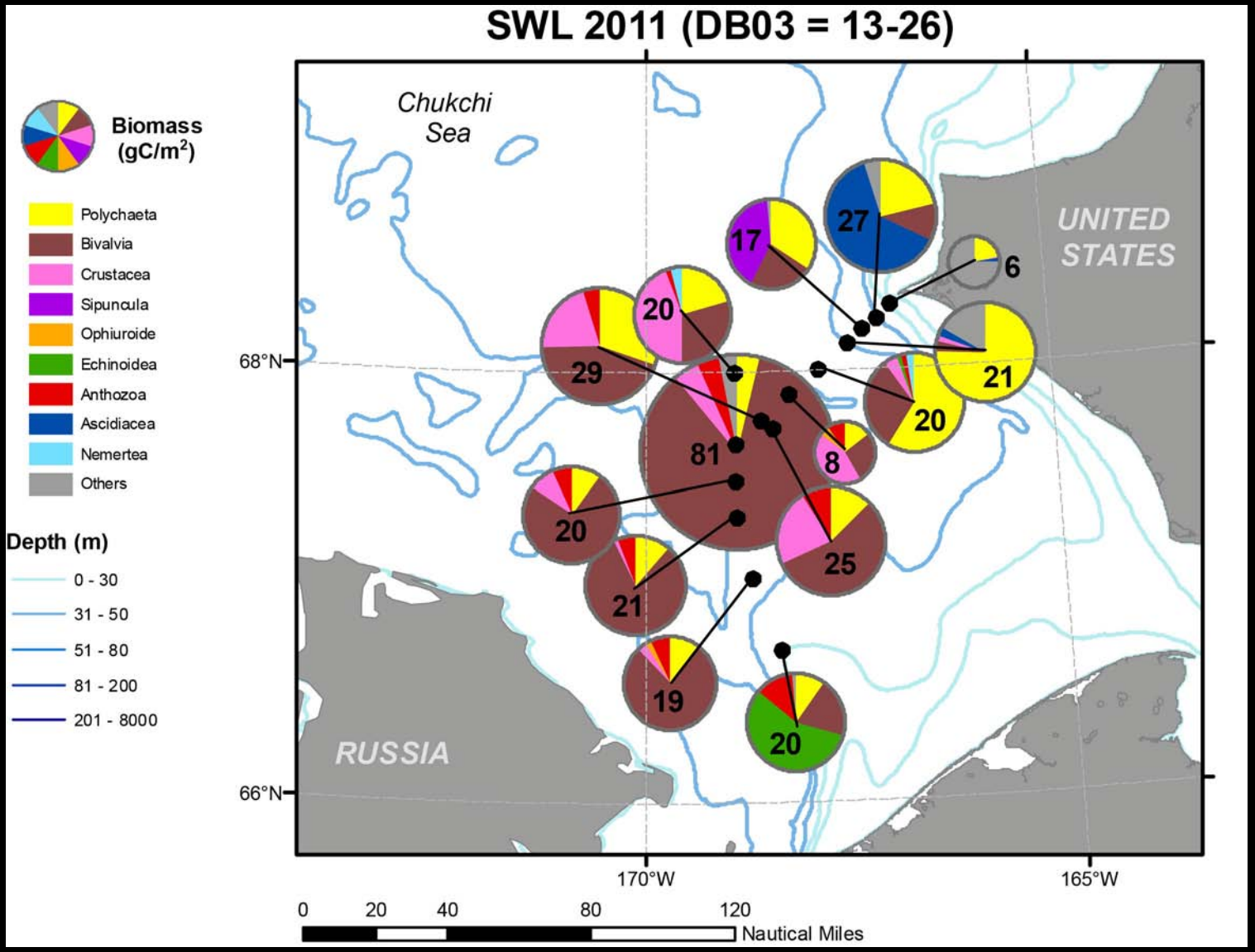

- shift in dominance at SW Chirikov site in 2000s from ampeliscid amphipods (gray whale food) to ampharetid polychaetes (sculpin food)
- change to ampharetid polychaetes coincident with increase in silt and clay content of sediments

# DBO3 (Southern Chukchi Sea)-decline in benthic infaunal biomass, except upper Herald Valley

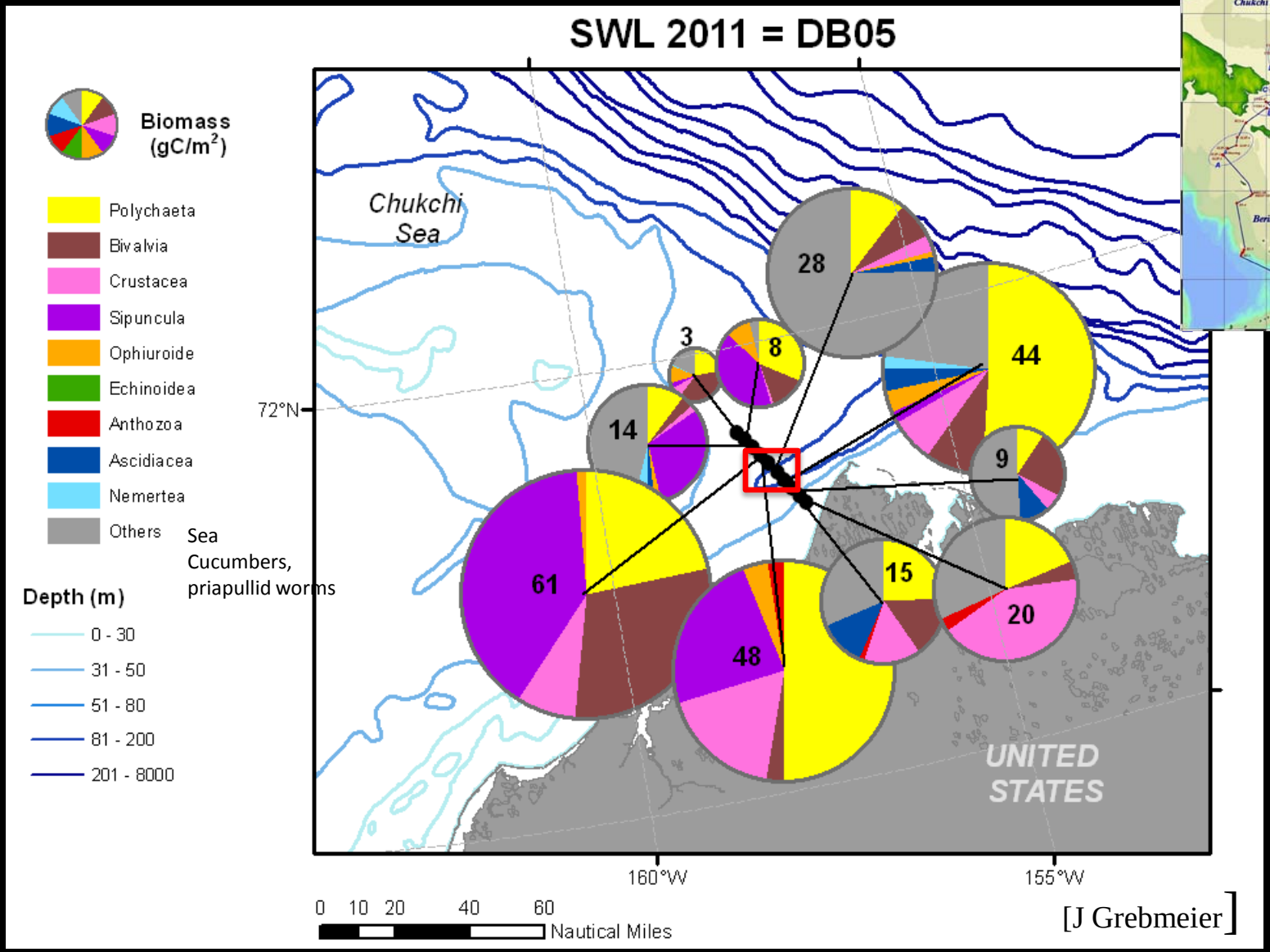



[Updated and modified from Grebmeier et al. 2006; Grebmeier unpublished data]

# DBO 3-So Chukchi Sea Benthic macroinfaunal biomass-July 2011



# DBO 5-Barrow Canyon benthic macroinfaunal biomass-July 2011




[J Grebmeier]

# How might changes in benthic prey biodiversity impact higher trophic level food supply?

- Influence extent northward migrations and/or time in feeding areas of marine mammals and seabird
- Expand species distribution ranges / community composition; issue of changing competition and predation impacts on trophic dynamics
- Change growth rates / population dynamics
- Change in benthic biomass influences available food supply
- Climate change stressors may cause shifts species richness, composition with changing temperature, freshwater content, change pH (ocean acidification impacts)

# Thank you. Any questions?

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[photo courtesy Karen Frey]