Benthic Carbon Cycling and Population Dynamics within the RUSALCA Program

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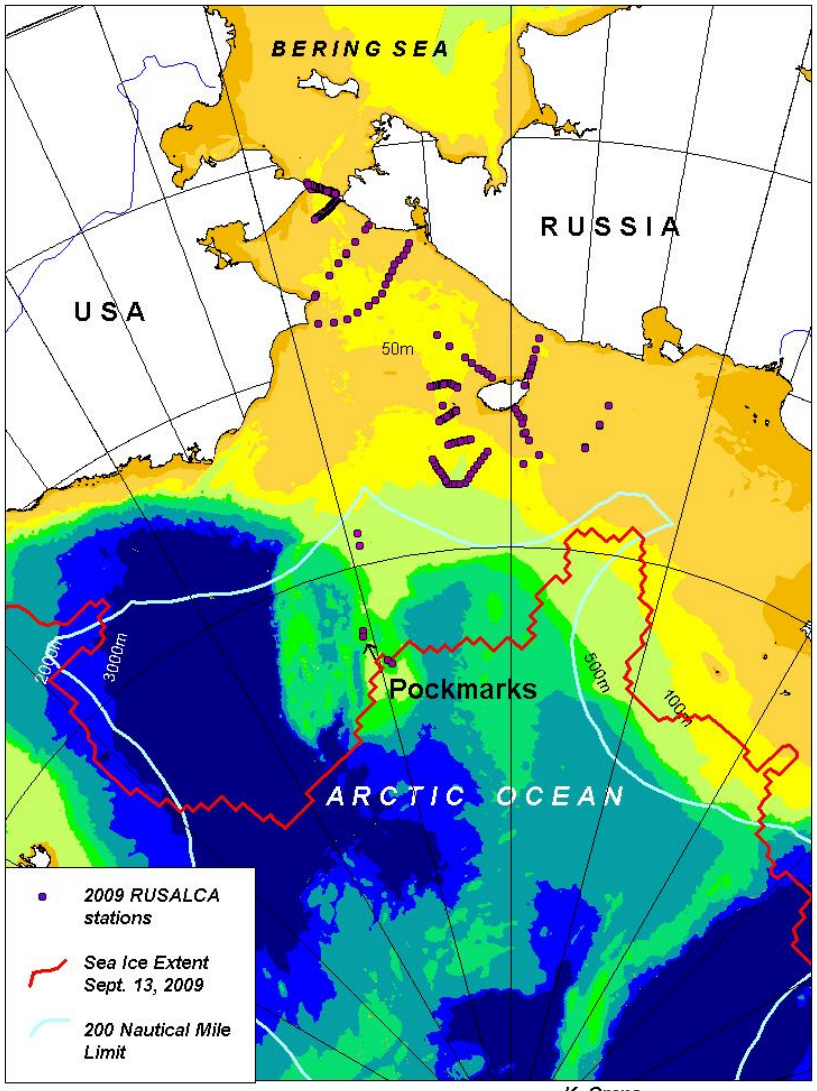
Benthic Carbon Cycling and Ecosystem Structure in the Pacific Arctic Region as part of RUSALCA

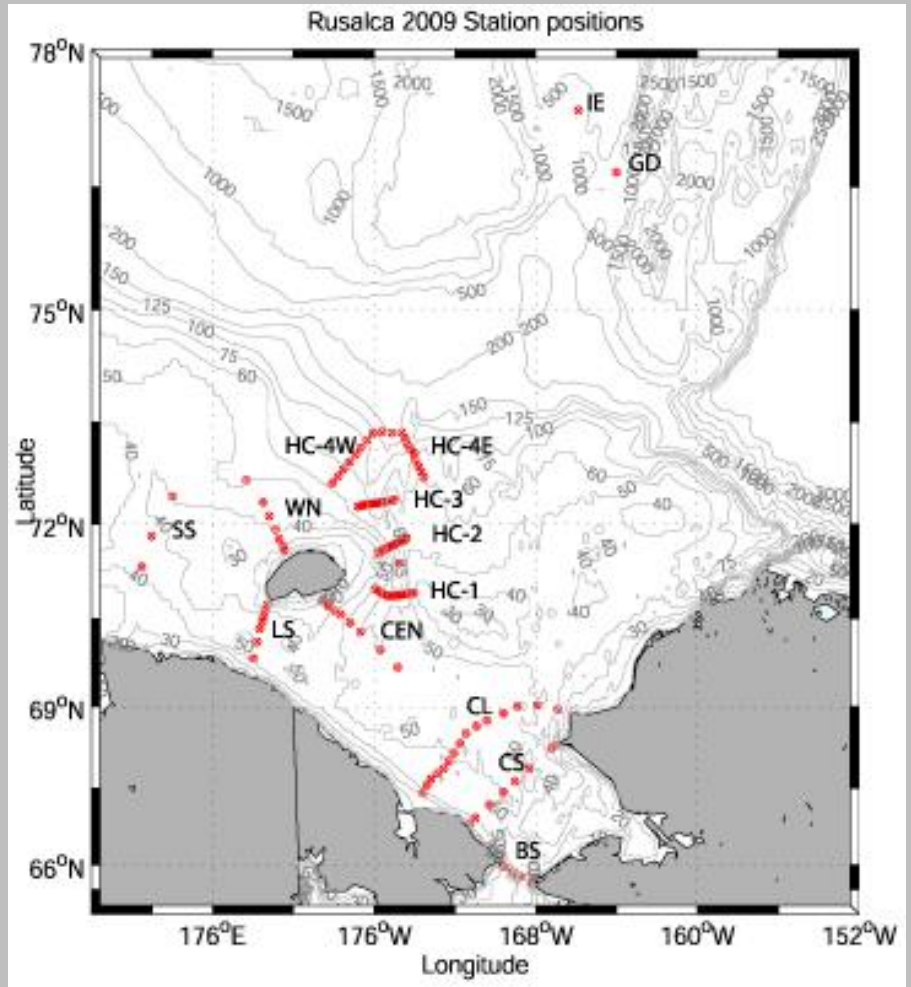
Objectives

- evaluate carbon export to benthos via sediment oxygen uptake and nutrient exchange studies (HAPS corer)
- sediment indicators (TOC, chl a, grain size)
- benthic infaunal population structure and biomass (133 cm^2 cores and 0.1 m^2 van Veen grabs)
- stable and radioisotope analyses

PIs: Jackie Grebmeier and Lee Cooper, UMCES/CBL

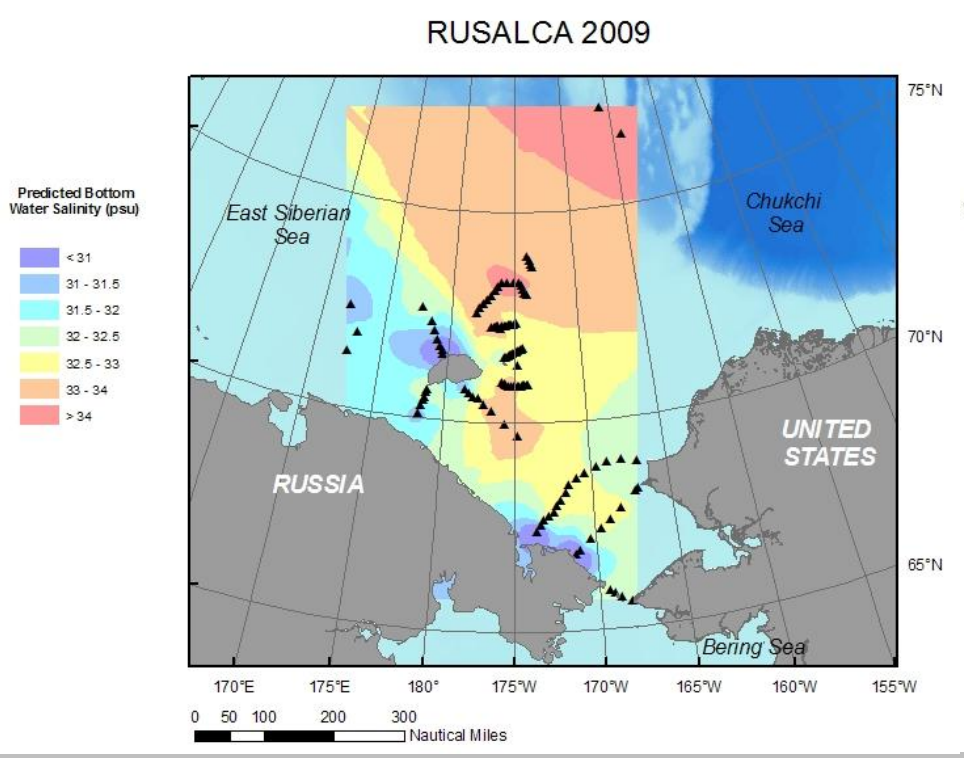
RUSALCA 2009 Cruise Effort

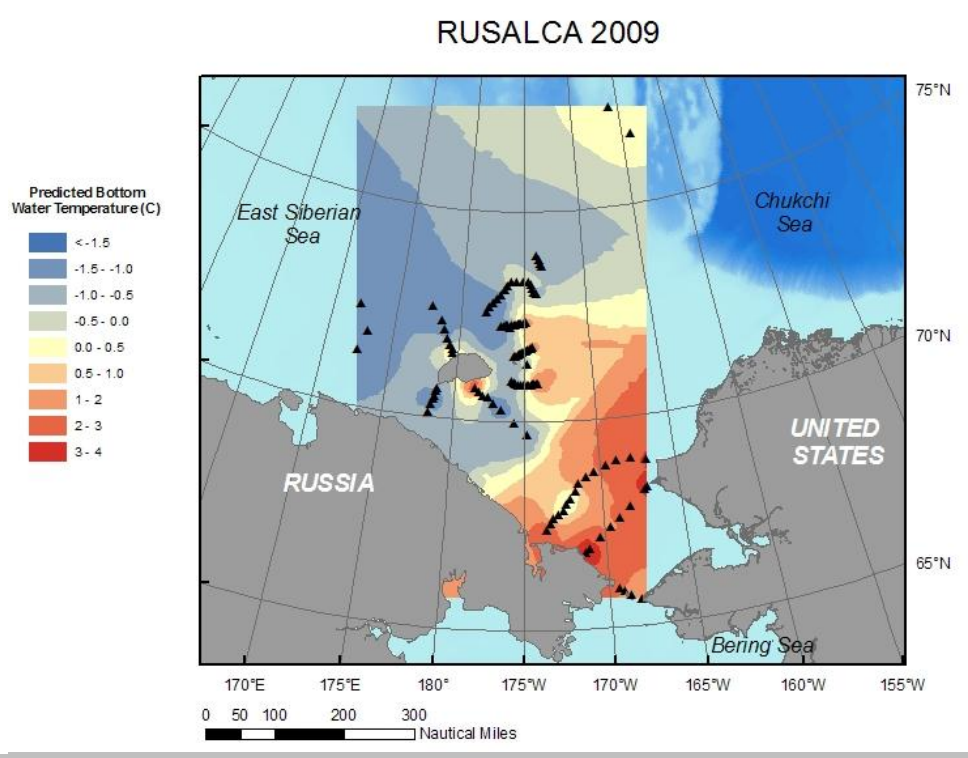




Bering Strait	(BS)	Ice Edge	(IE)
Cape Lisburne	(CL)	Long Strait	(LS)
Central	(CEN)	Siberian Shelf	(SS)
Chukchi South	(CS)	Wrangel North	(WN)
Herald Canyon	(HC)	Geologic Dredge	(GD)

Bottom water temperature and salinity during the RUSALCA09 cruise

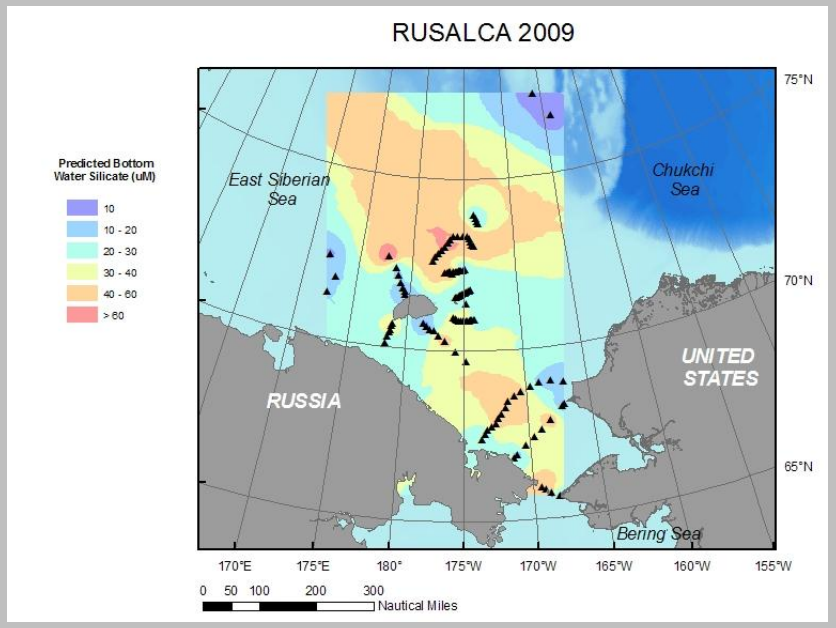


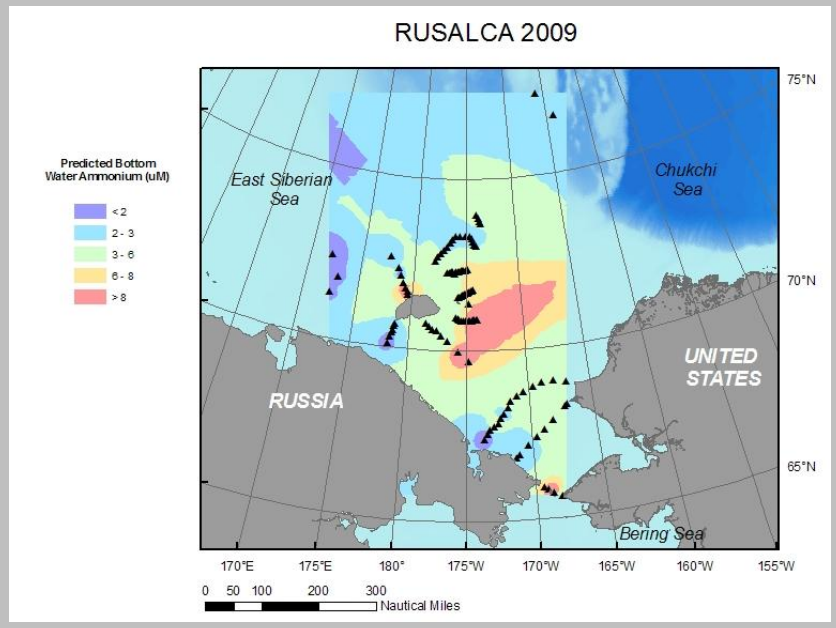


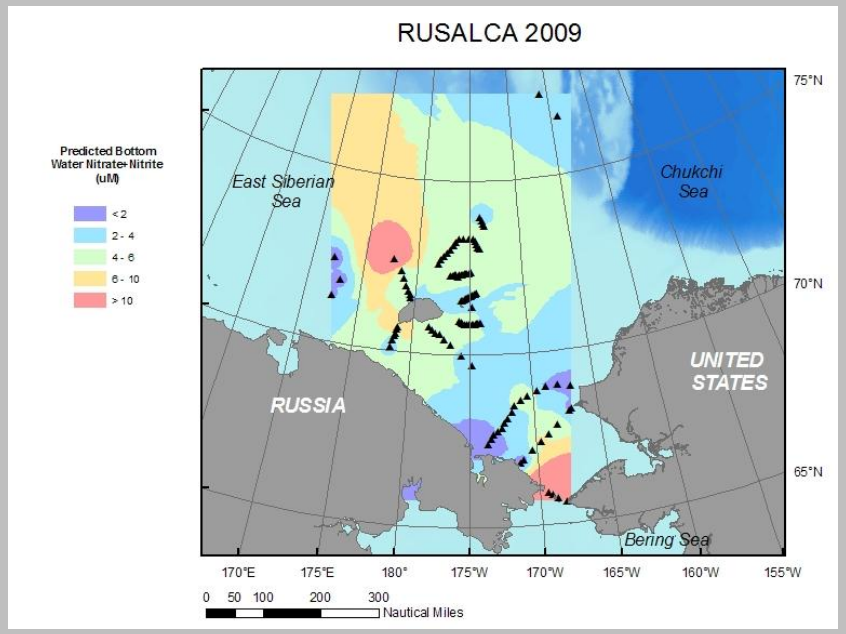
[courtesy Bob Pickart-CTD team]

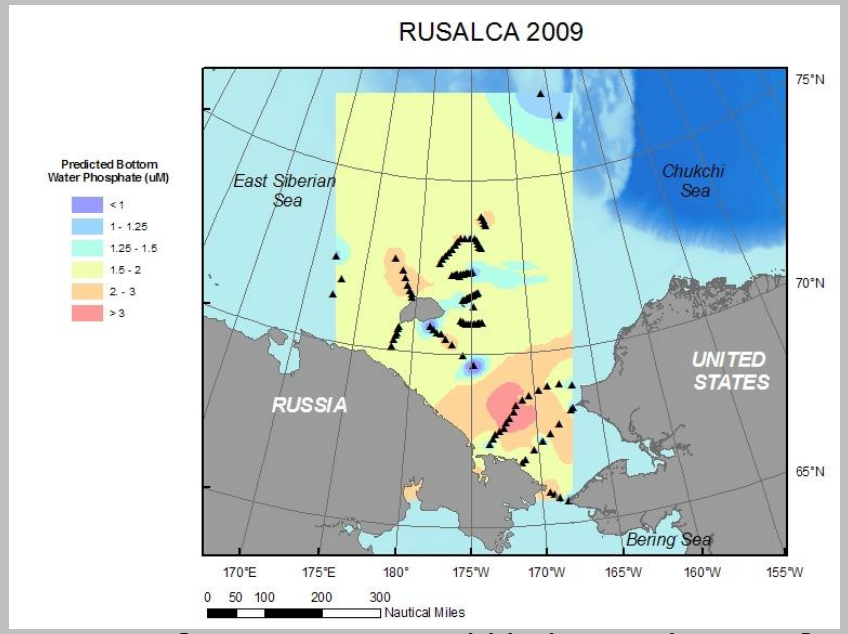
- increasing BW salinity SE to NW highest
- highest BW temperatures in the SW Chukchi Sea and eastern side of Herald Canyon
- low BW temps western side of system and in East Siberian Sea

Bottom water hydrography



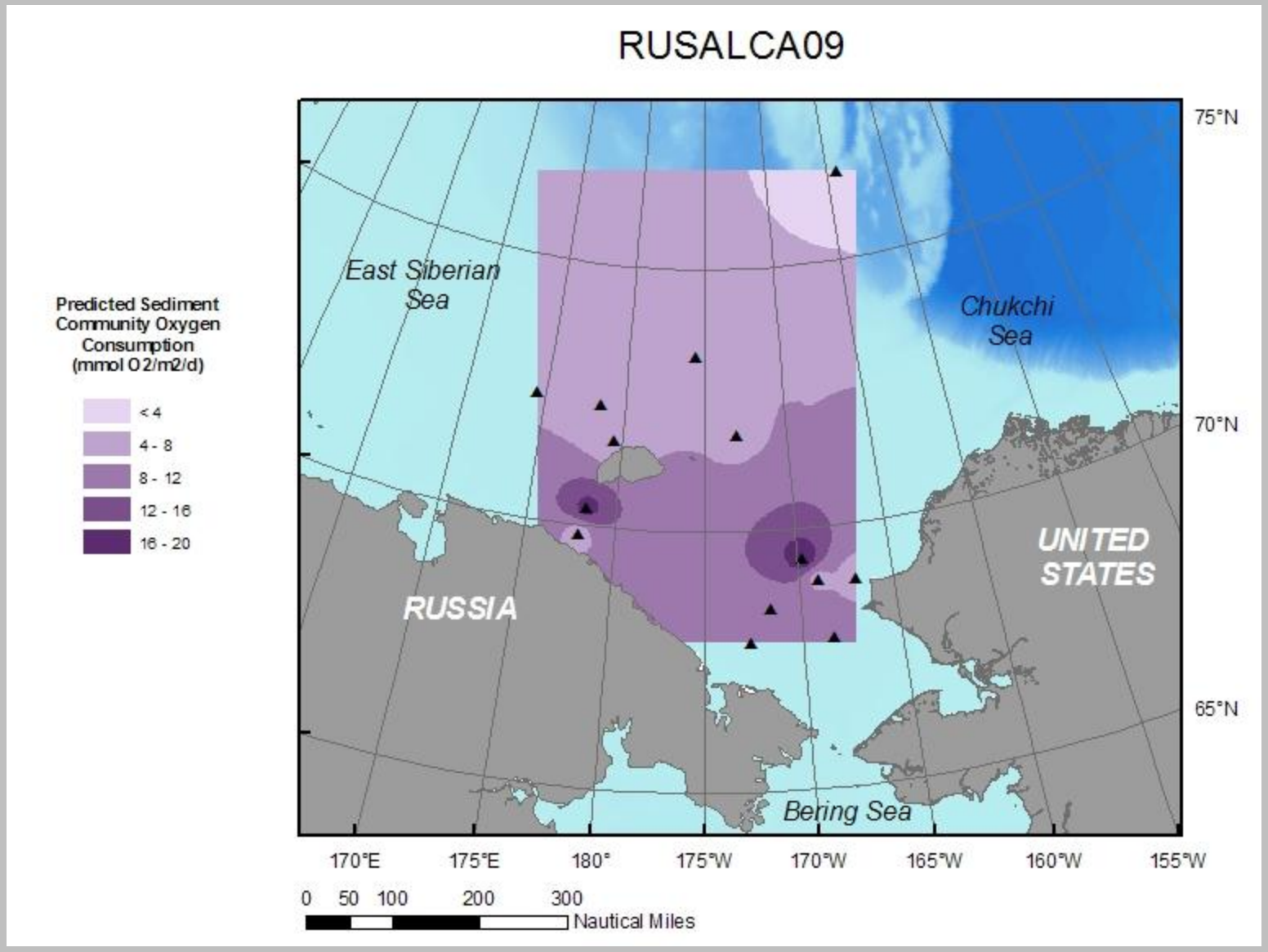




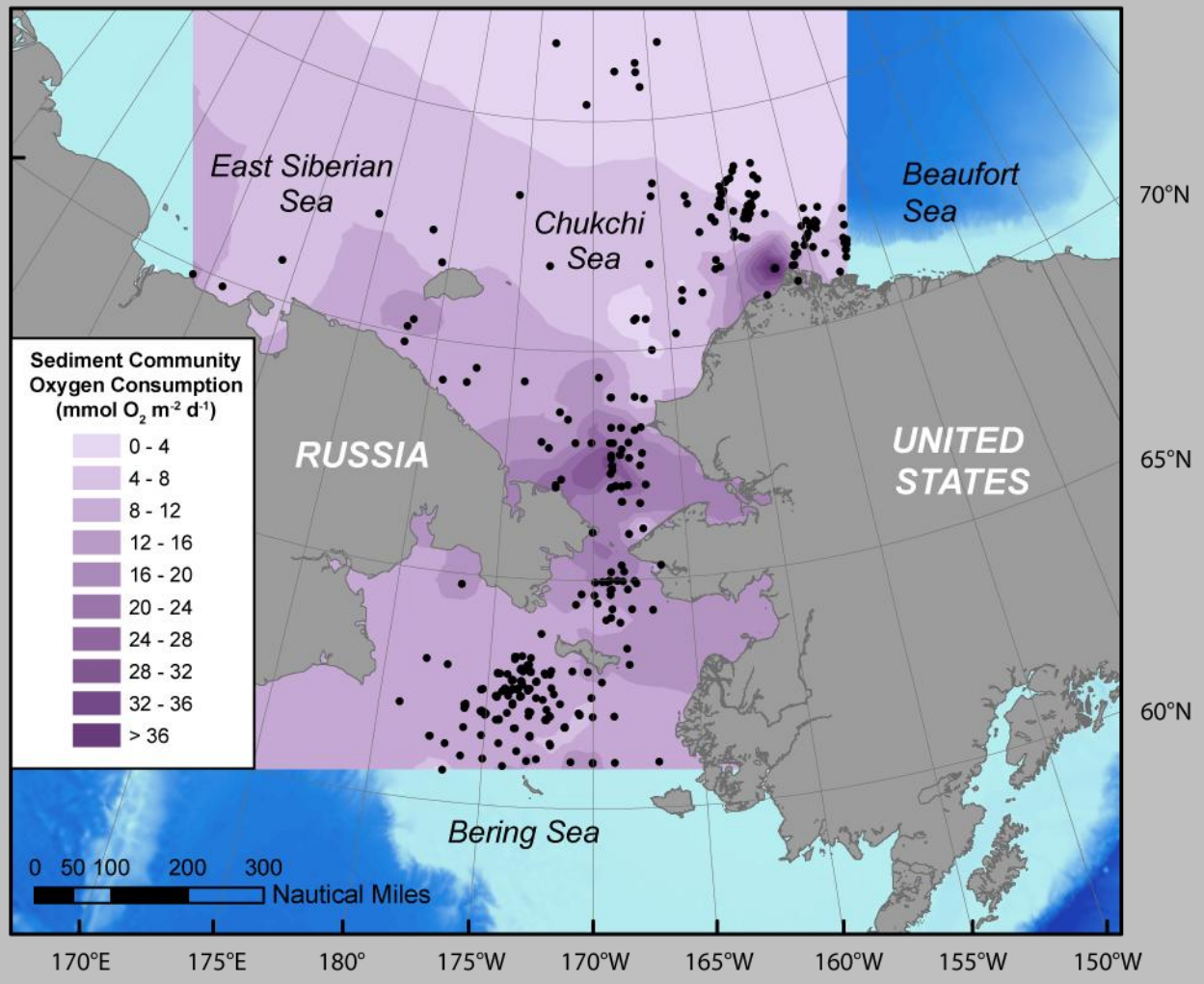


[courtesy Terry Whitledge-Hydro team]

Sediment Community Oxygen Consumption-RUSALCA 2009



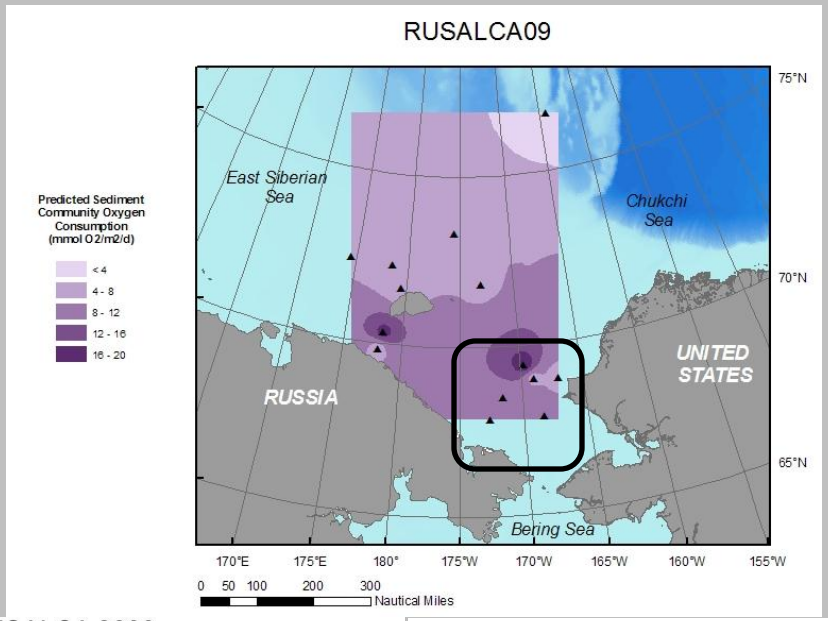
Sediment community oxygen consumption 1984-2010

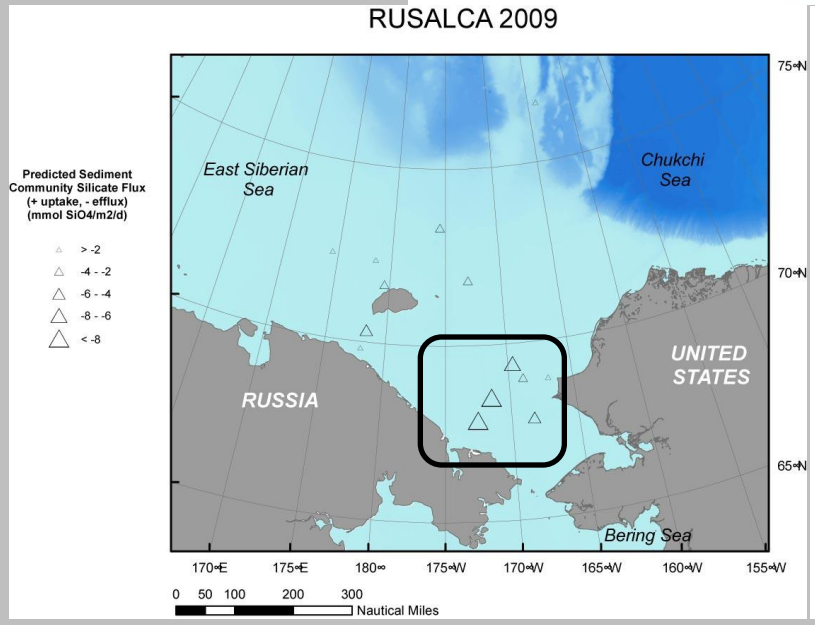


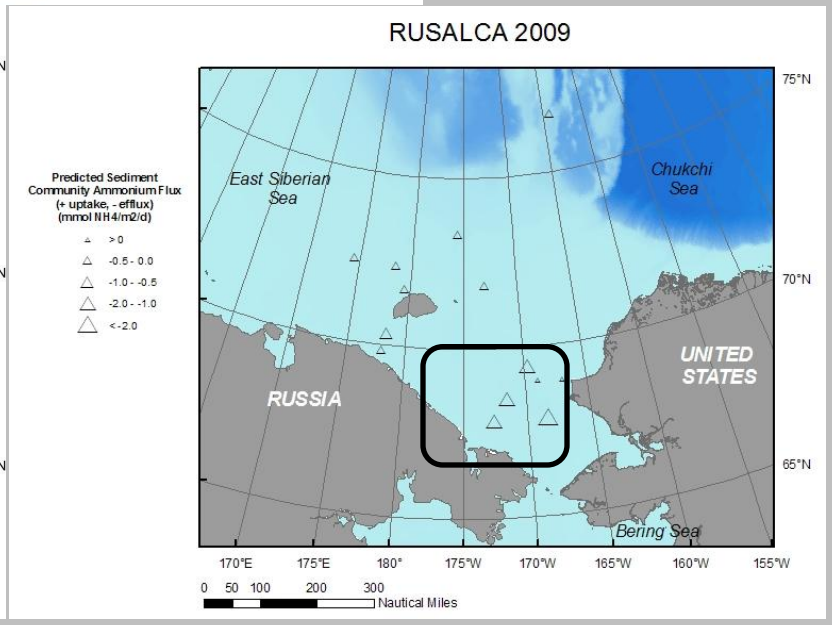
- spatial patterns indicative of the amount of carbon reaching the sediments

[updated from Grebmeier et al. 2006, unpubl. data]

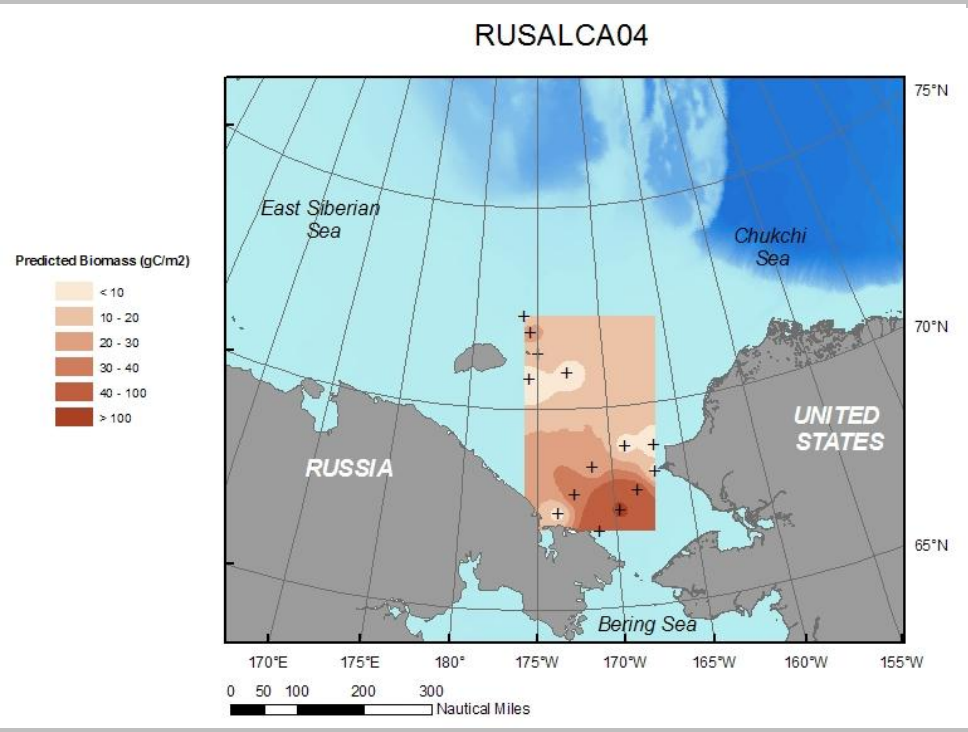
High nutrient efflux from sediments in regions of high organic carbon deposition during RUSALCA 2009

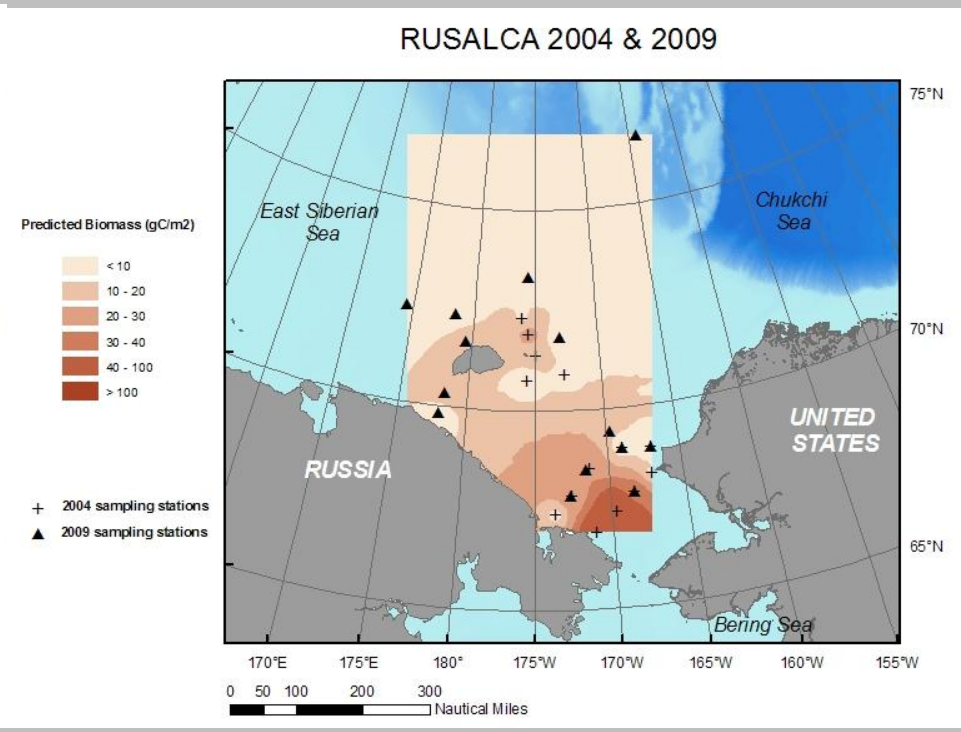






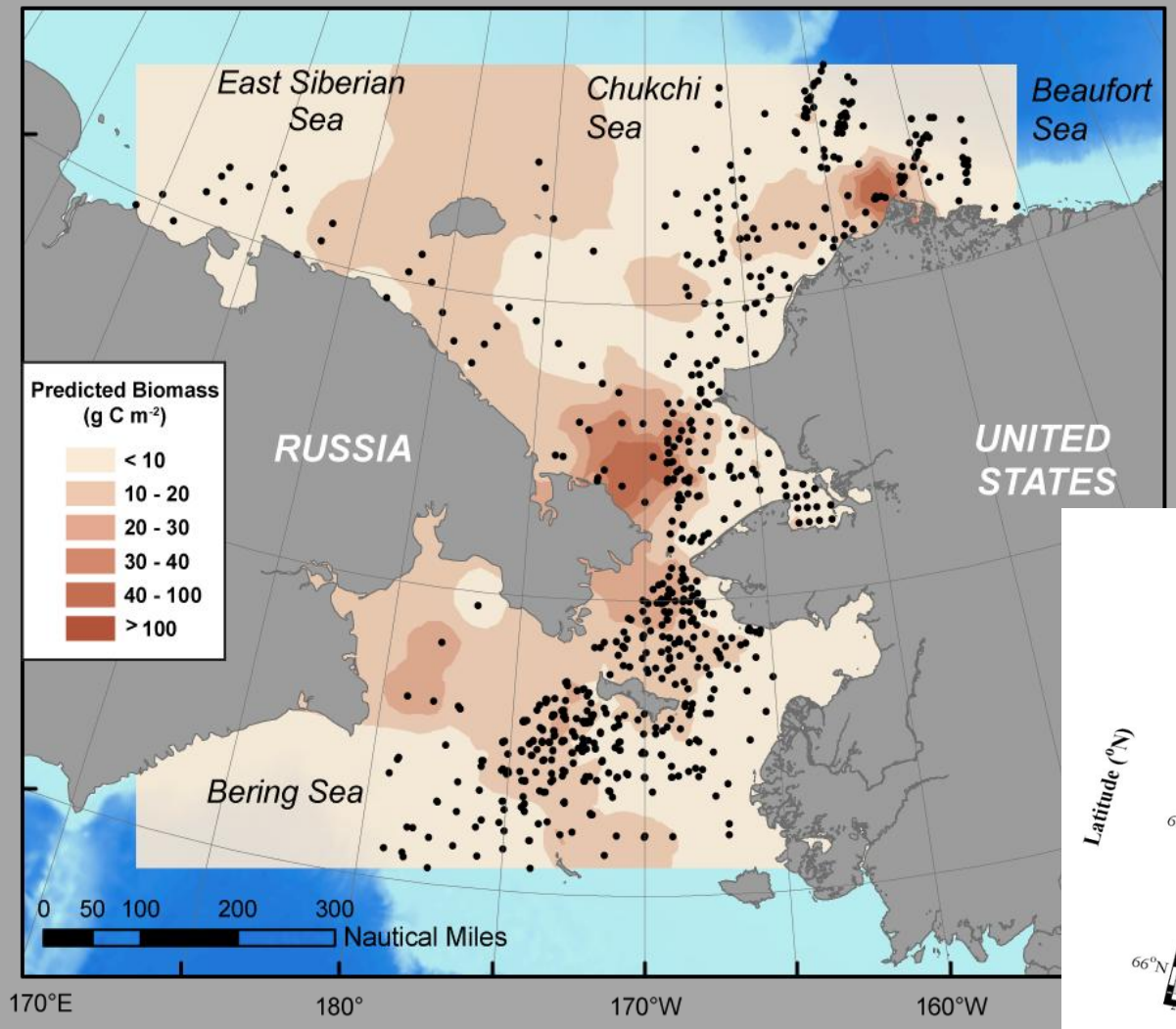
Macrobenthic biomass (gC/m^2) during RUSALCA 2009





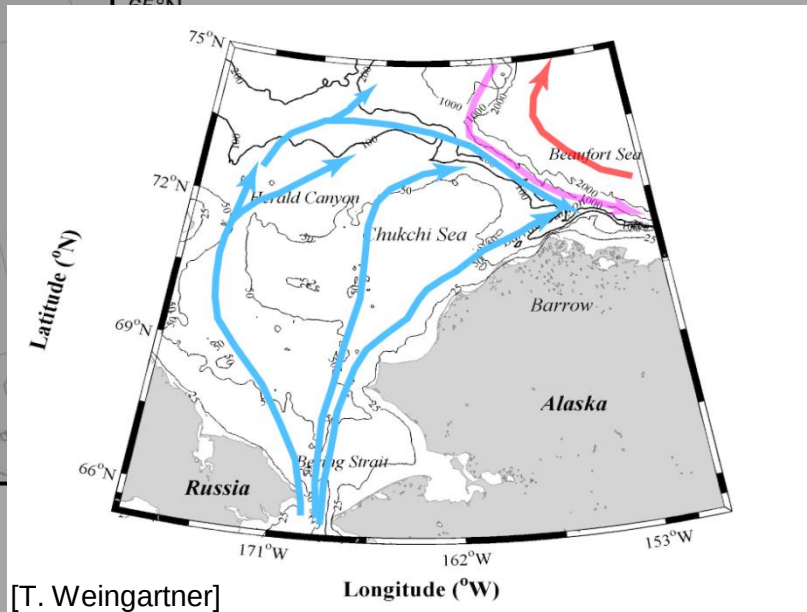
- high benthic biomass head Herald Valley, decrease moving northward down the valley to Herald Canyon; lowest benthic biomass moving further north offshore
- main contributors are bivalves and polychaetes

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



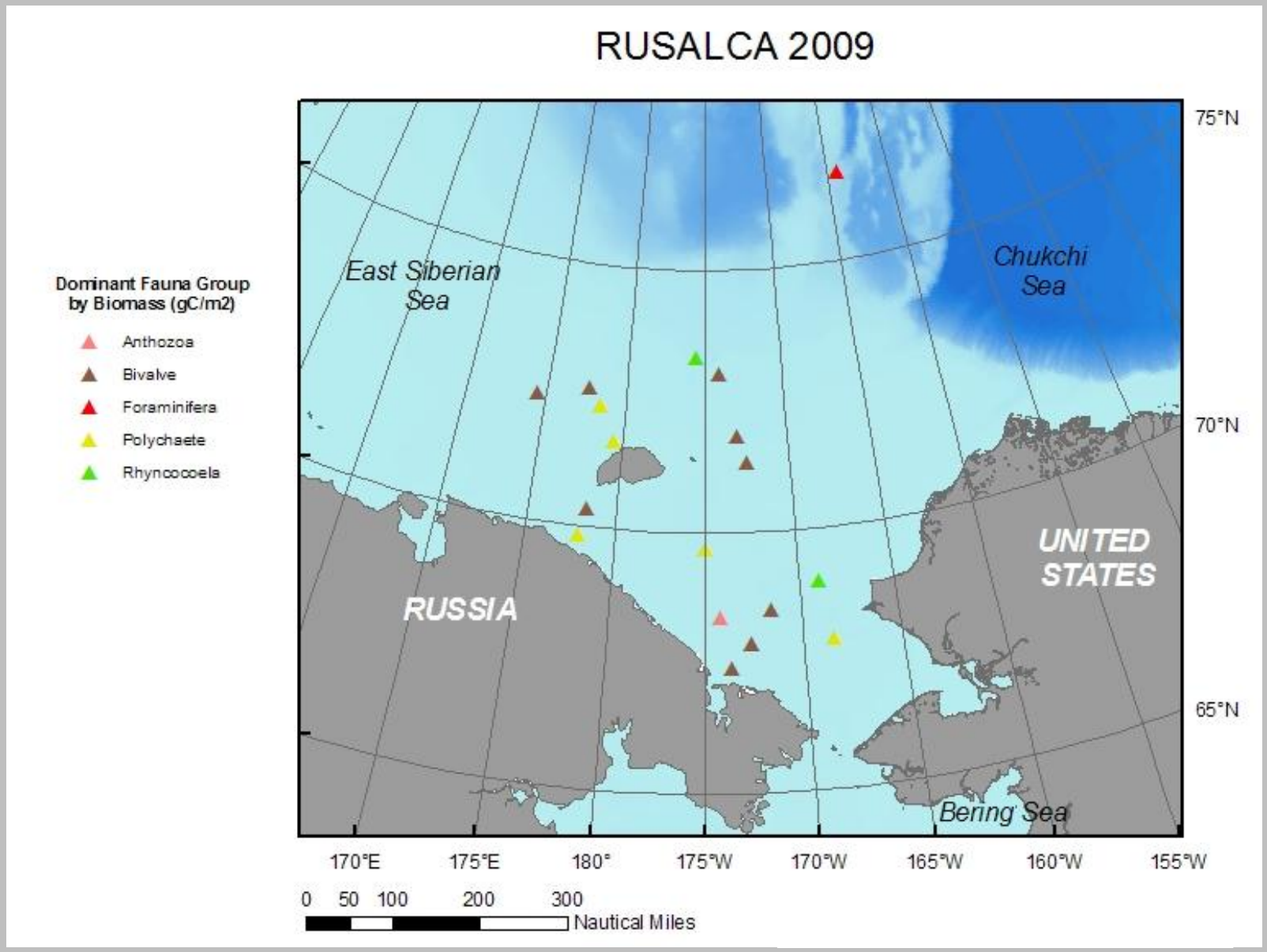
[updated from Grebmeier et al. 2006a]

- **"footprints"** of high benthic biomass reflect pelagic-benthic coupling and export of carbon to sediments
- advection of organic carbon also influences biomass patterns

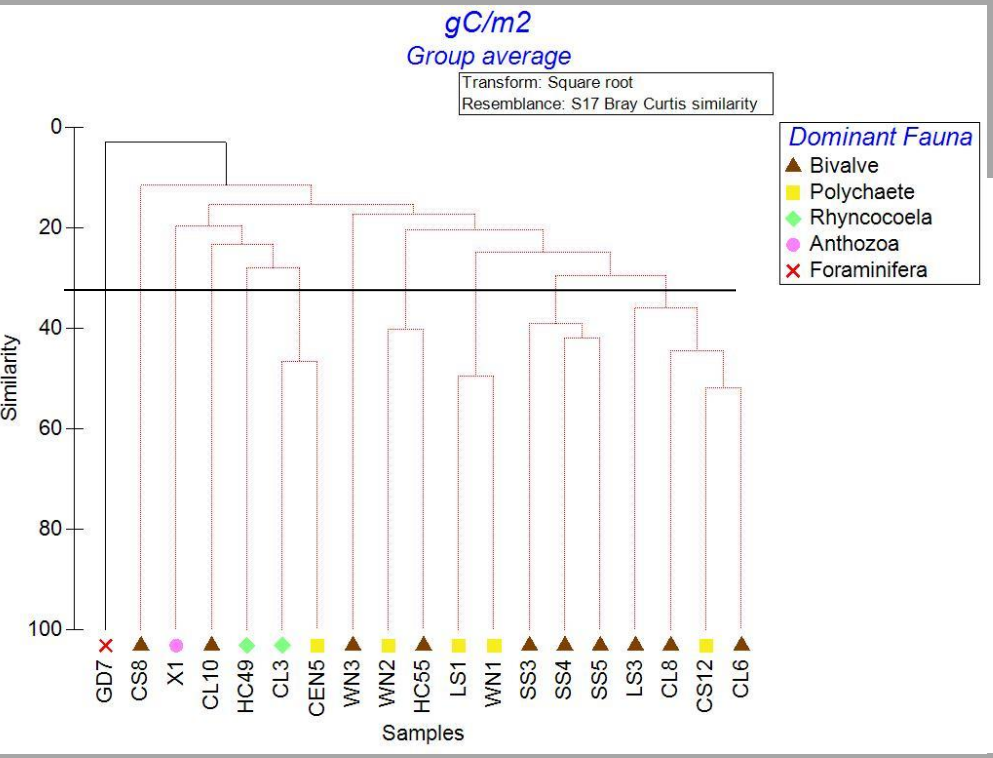


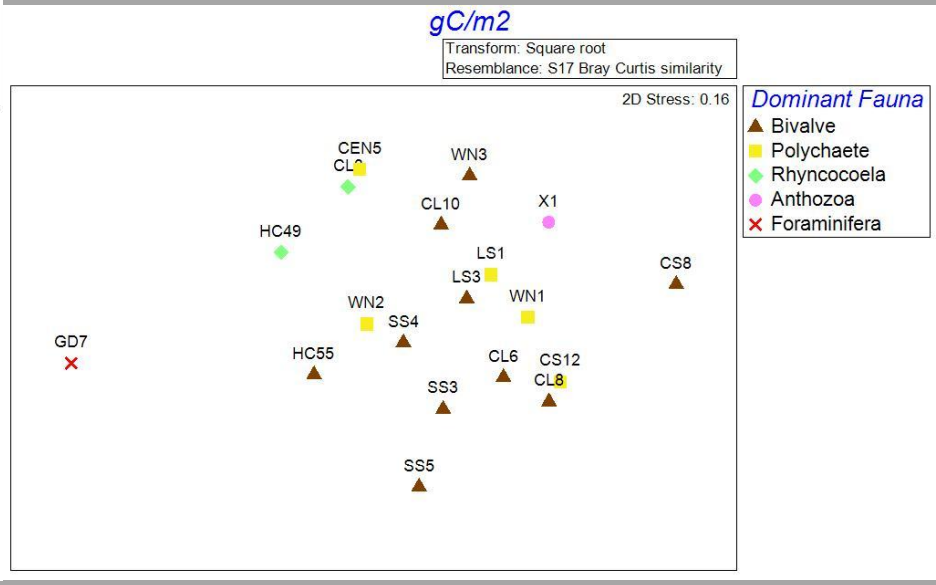
[T. Weingartner]

Dominant benthic fauna by gC biomass



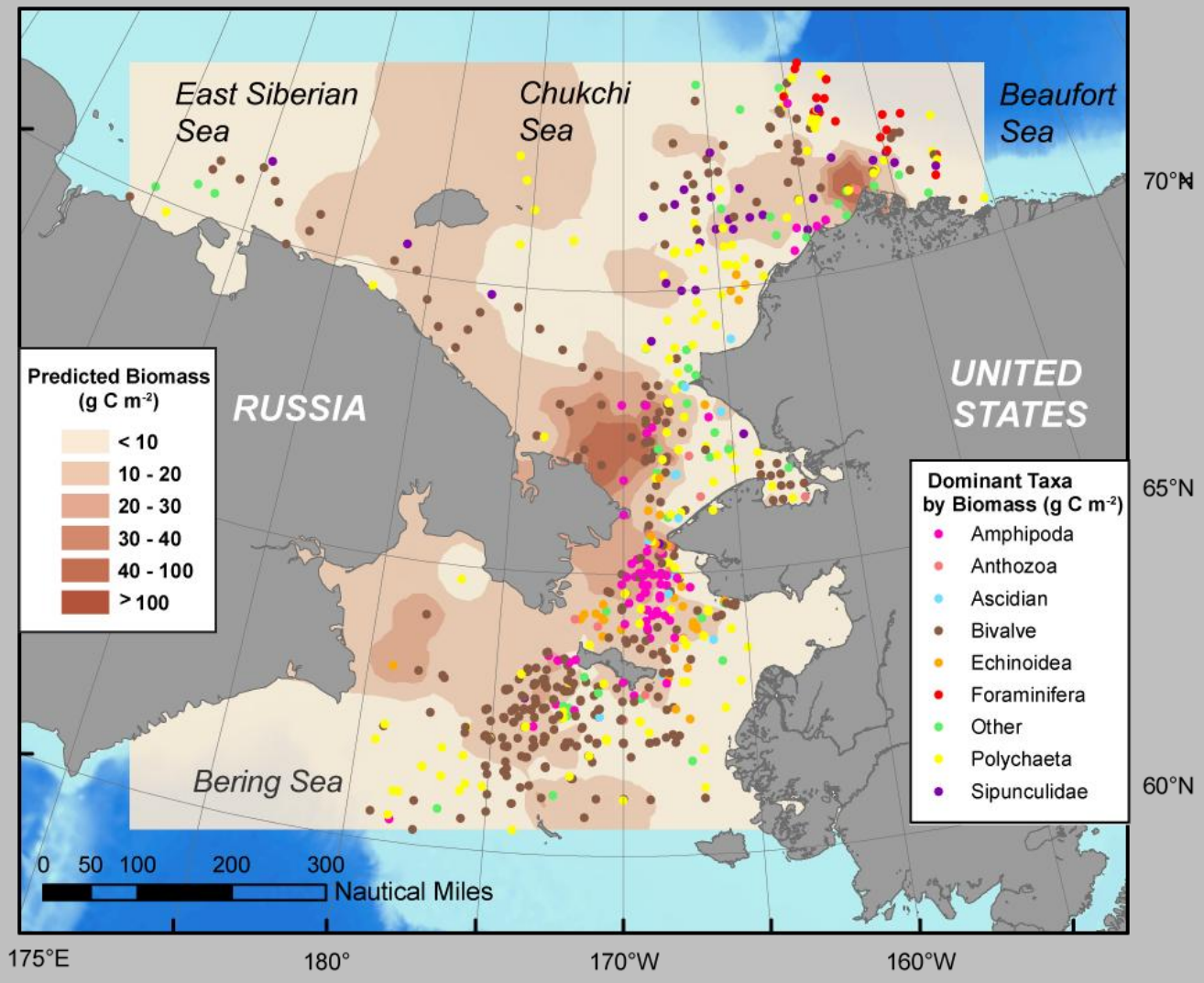
Similarity of infauna in the RUSALCA stations 2009





-5 groups dominated by bivalves, polychaetes, flatworms (Rhynchocoela) and sea anenomes (anthozoa)

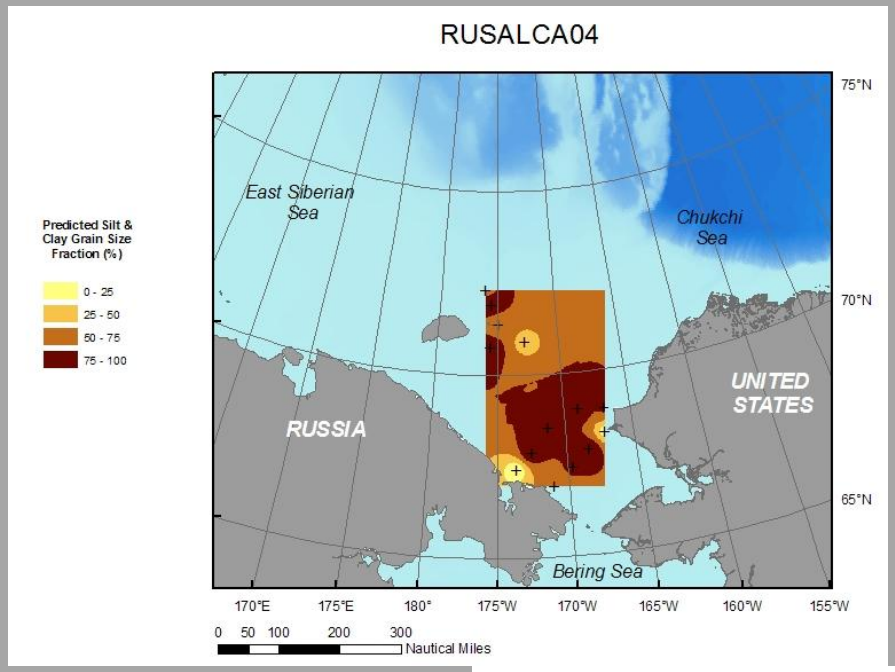
Rich benthic communities on the western side of the Bering/Chukchi Sea system

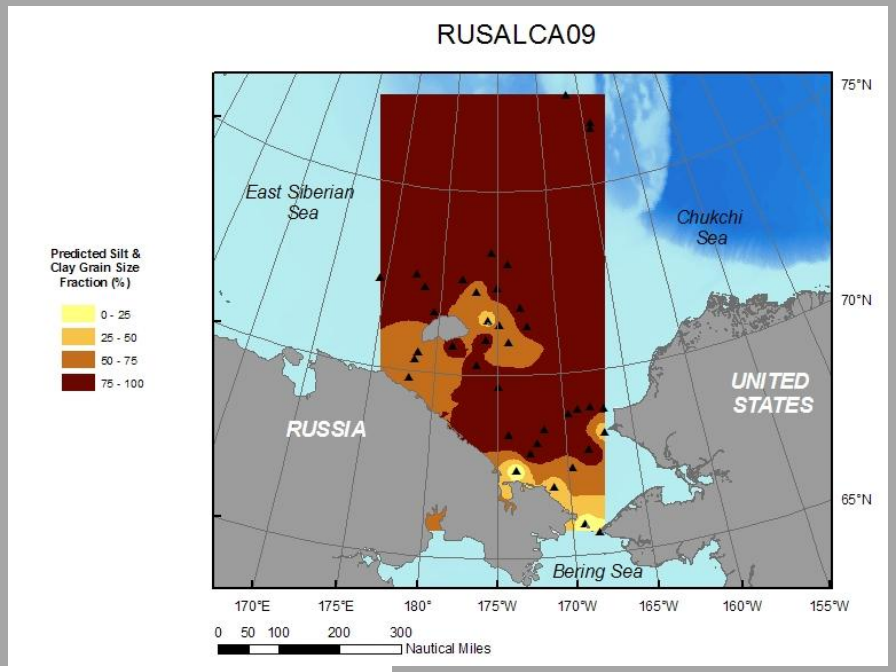


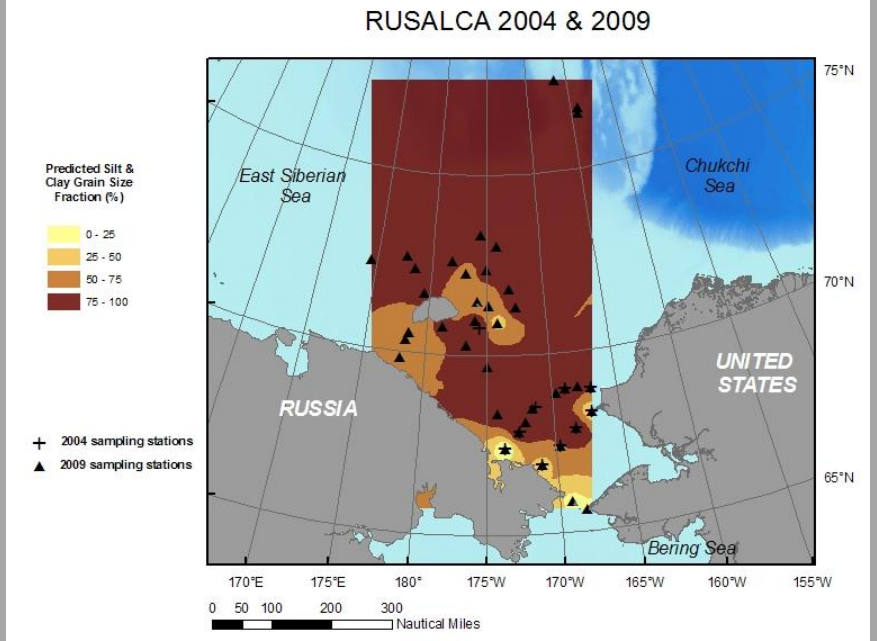
- macroinfaunal biomass dominated by bivalves, polychaetes, amphipods and sipunculids

[Grebmeier et al. in prep.]

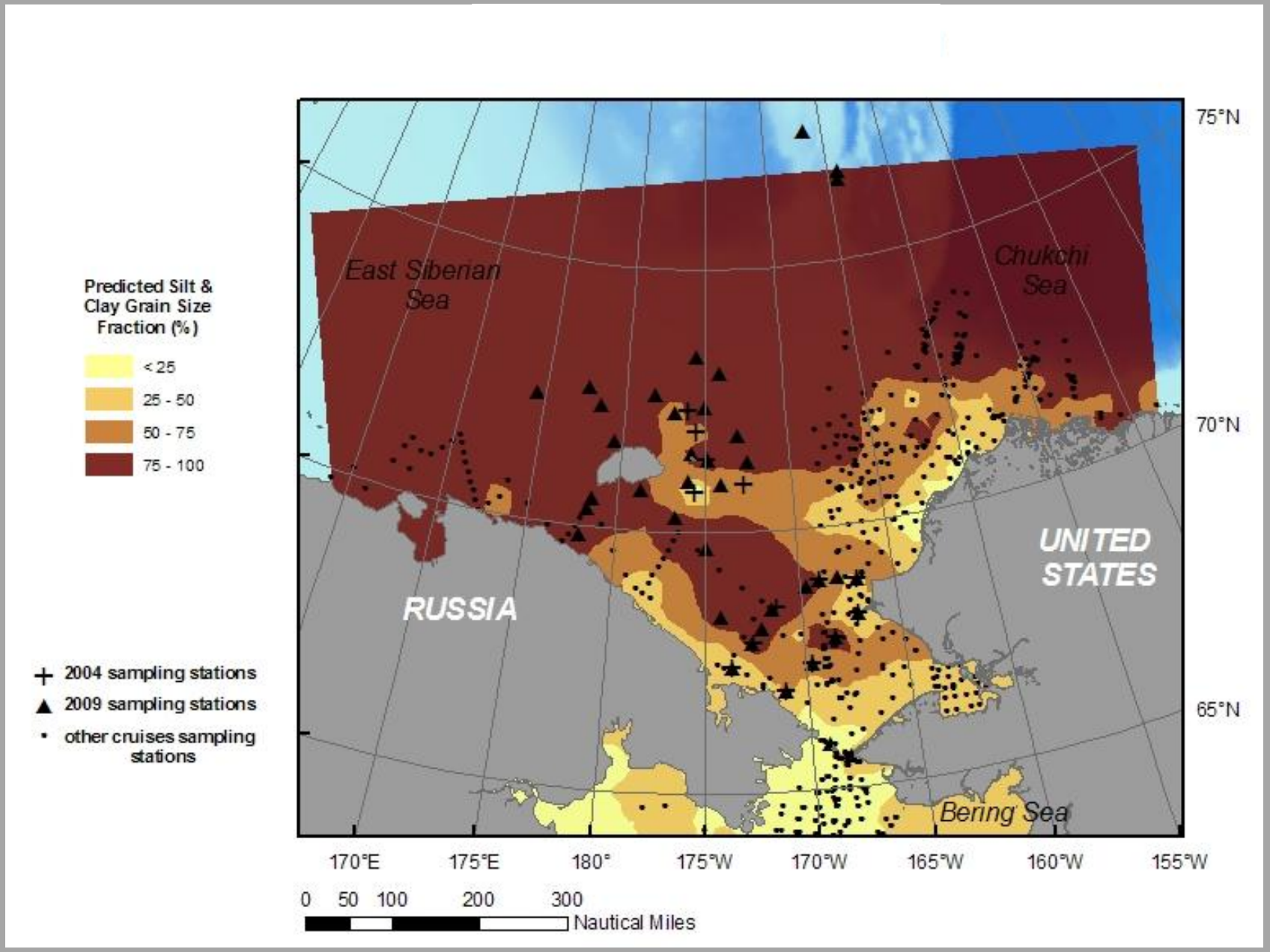
% Silt and clay content-indicator of deposition zones



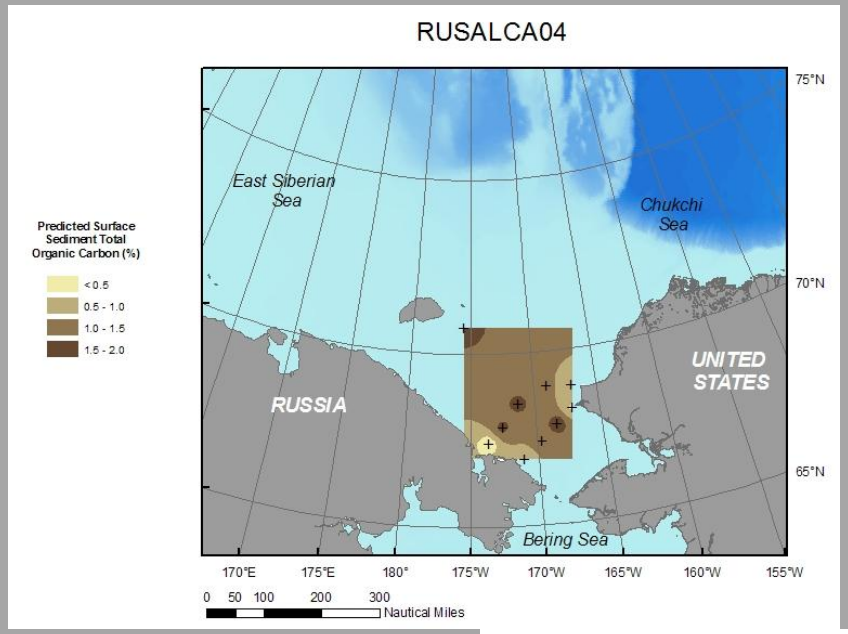


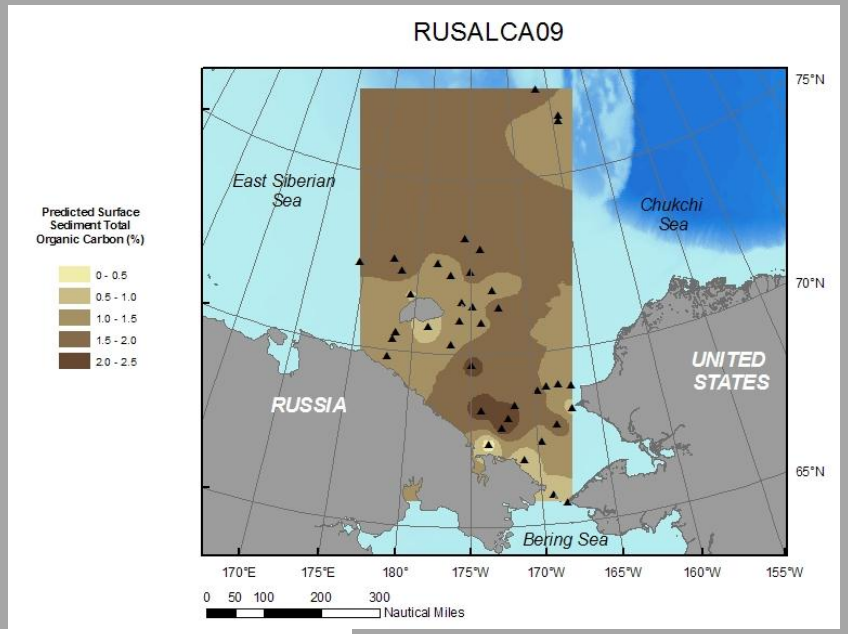


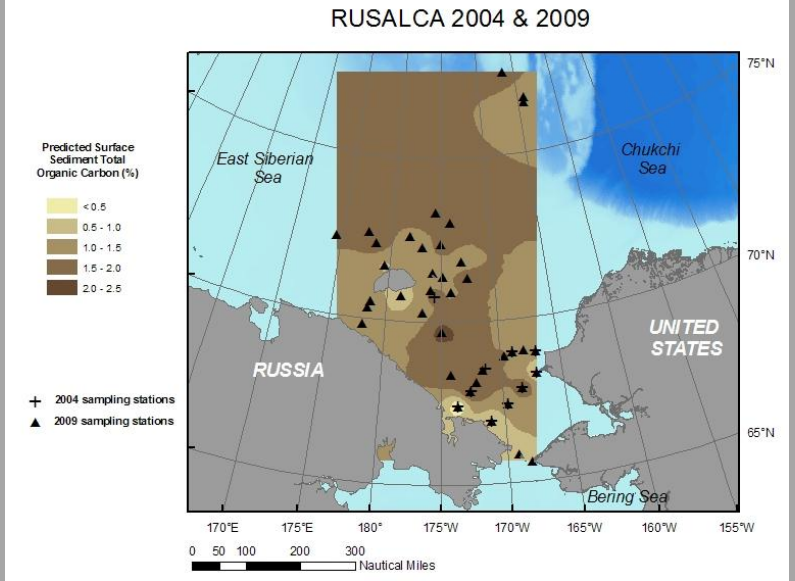
% Silt & Clay Content: RUSALCA 2004, 2009 and All Station data



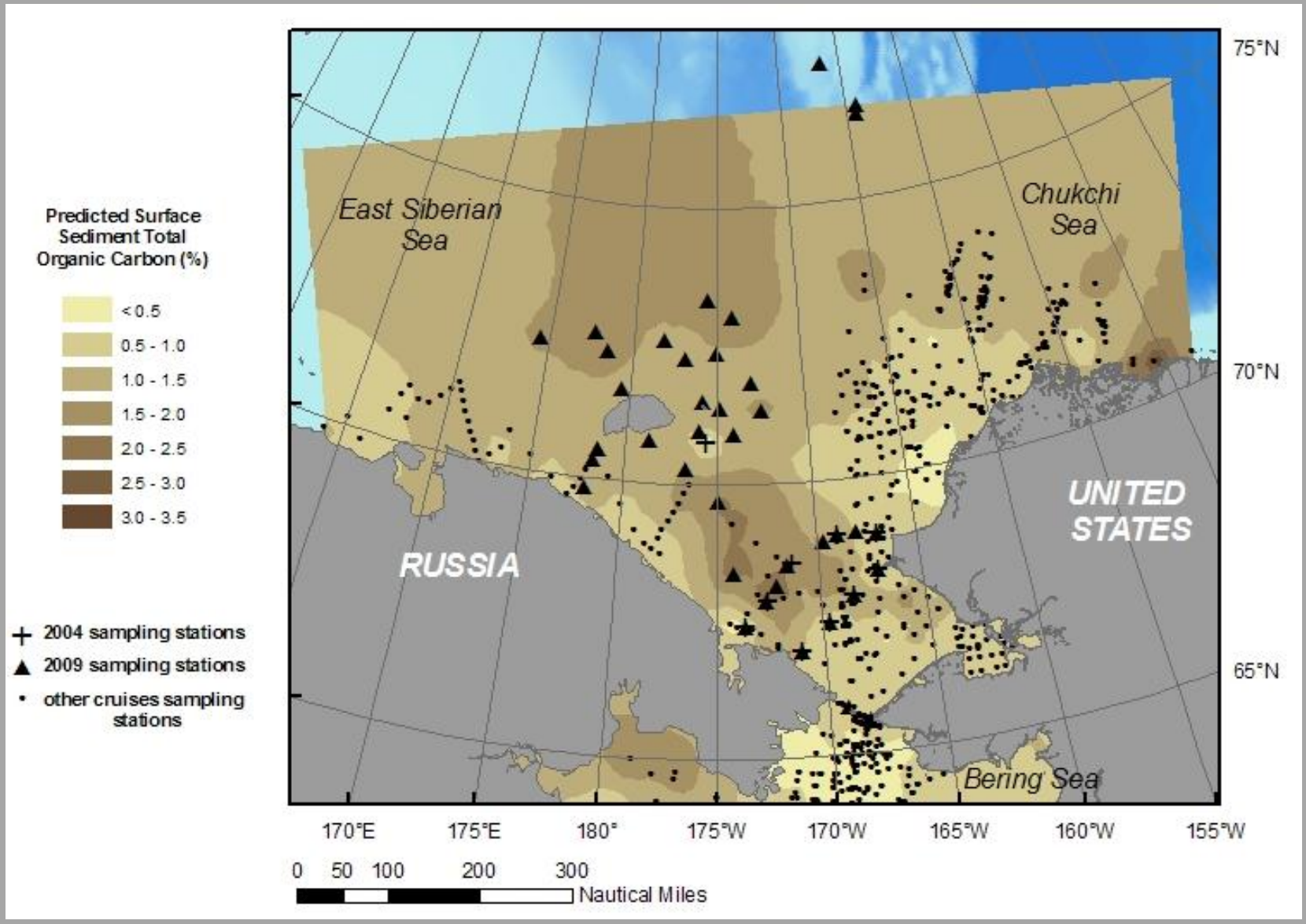
Total organic carbon content in surface sediments-indicator current speed and material deposition zones





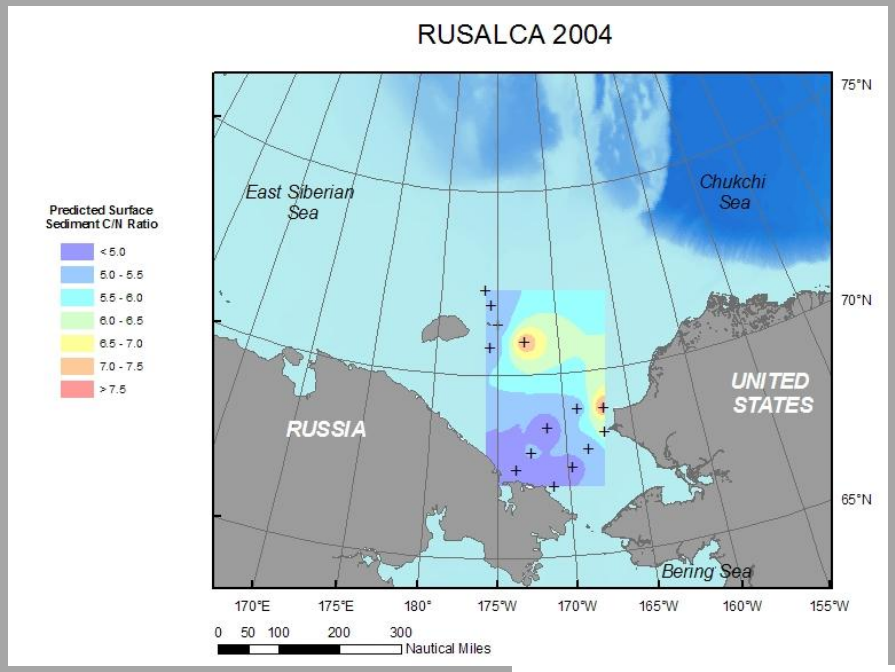


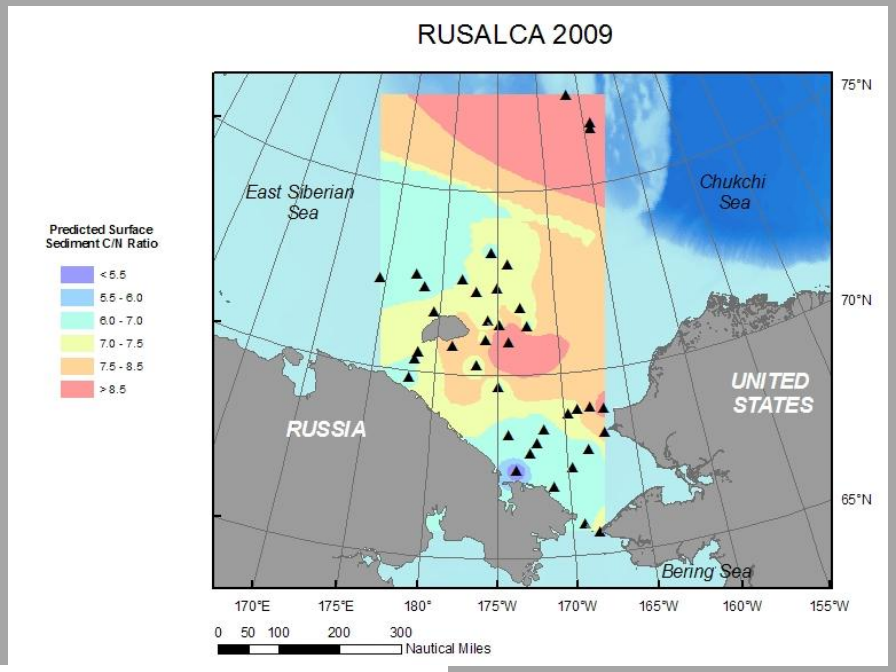
TOC Content: RUSALCA 2004, 2009 and All Station data

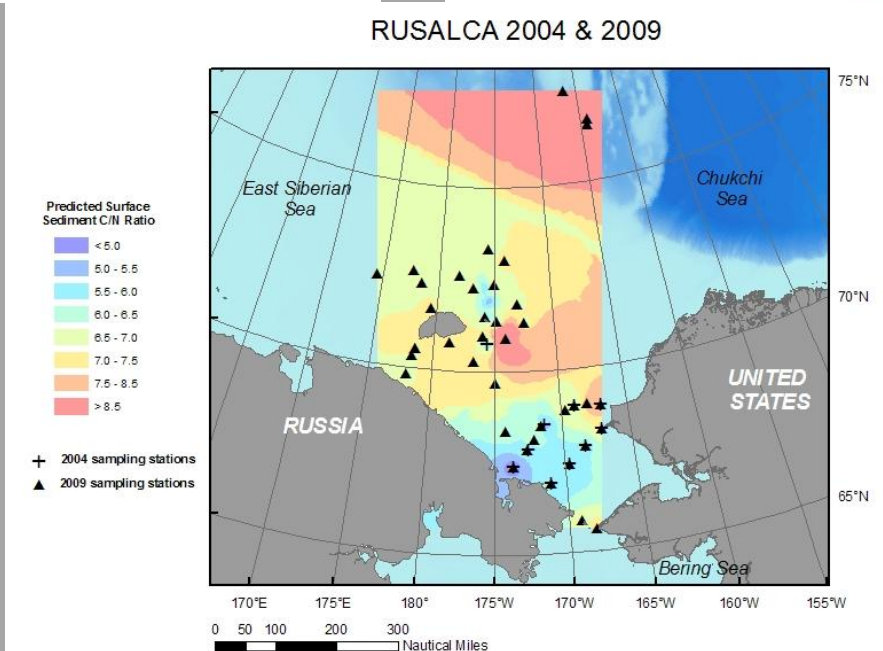


[update of Grebmeier et al. 2006, Prog. Oceanogr., 71: 331-361]

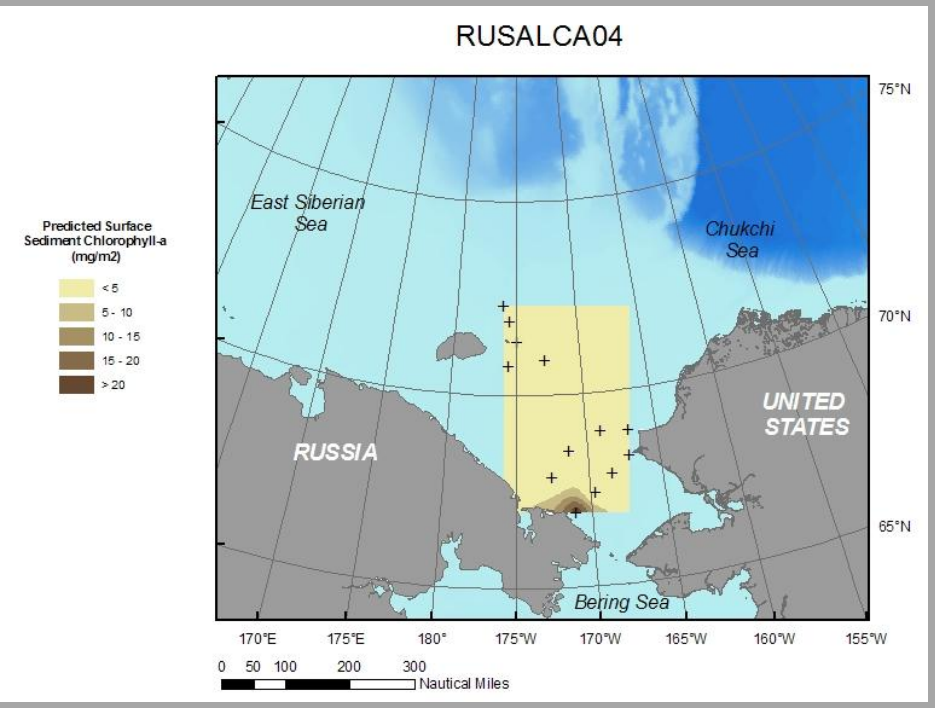
C/N surface sediments-indicator of quality food supply

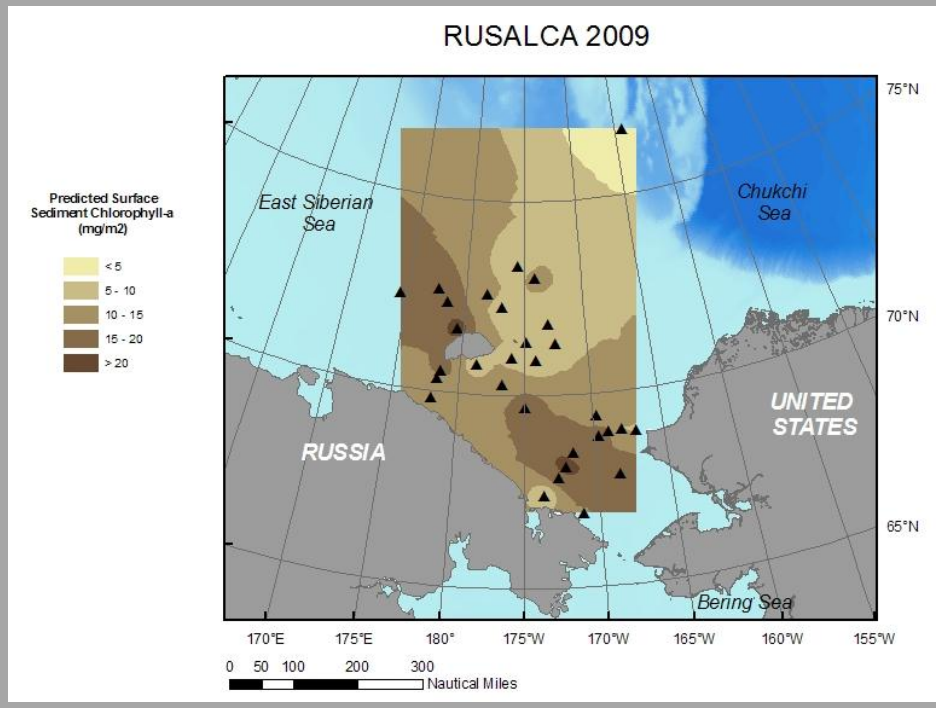






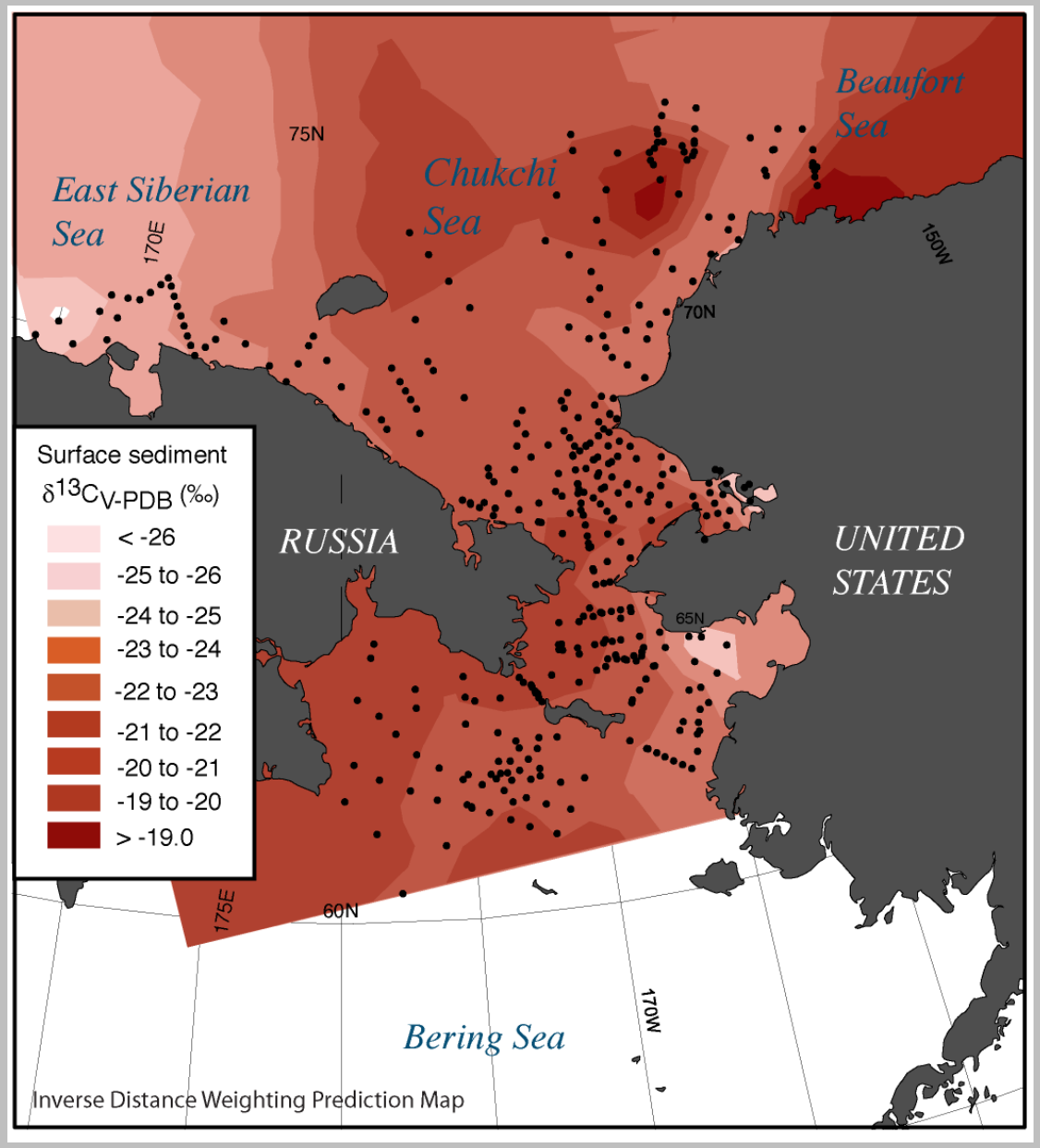
Sediment Chlorophyll a (mg/m2)-short-term indicator of carbon supply to benthos





- Depends on overlying water column production seasonally

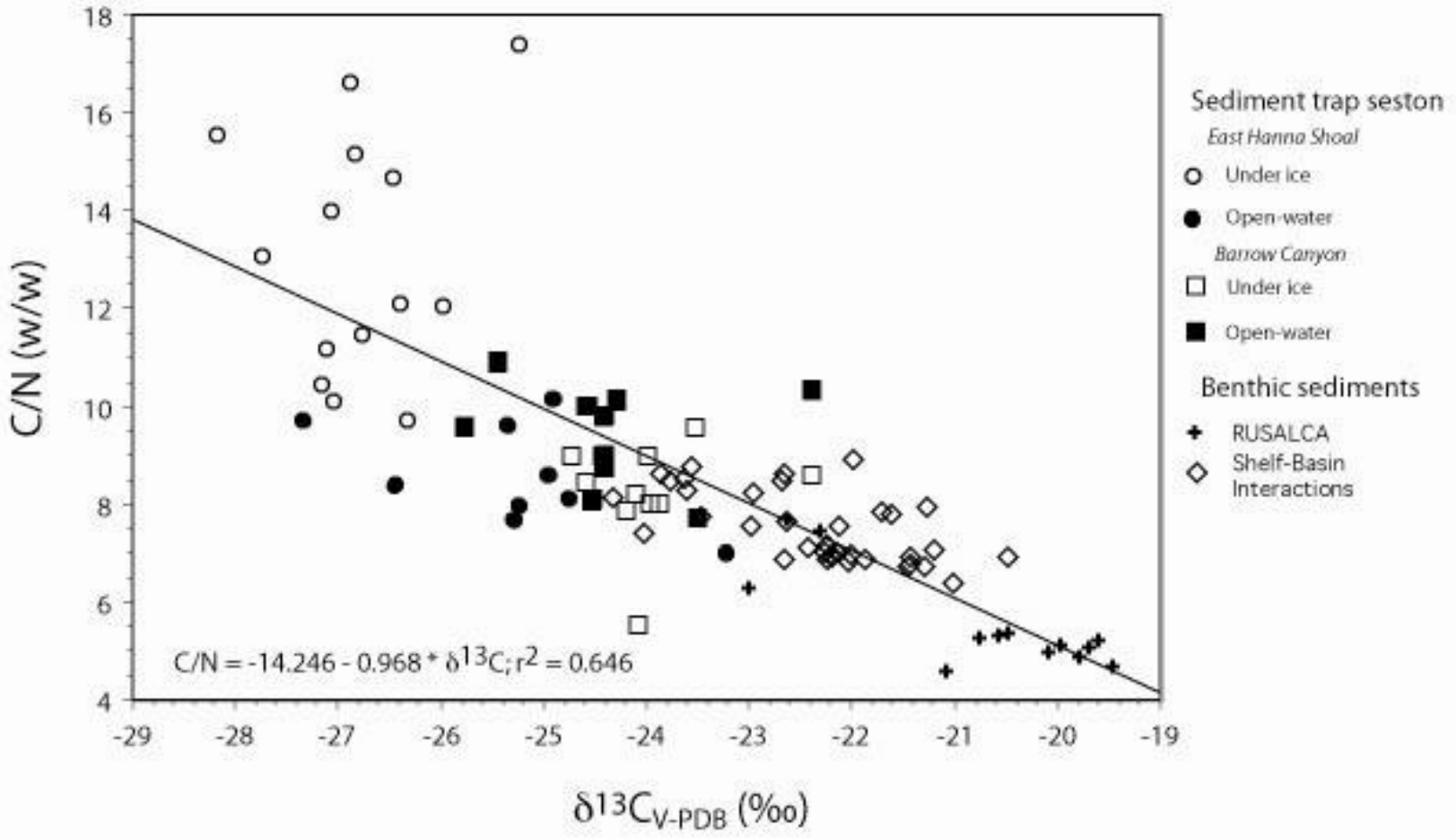
Surface sediment $\delta^{13}C$ values



[Grebmeier et al. 2006, Prog. Oceanogr., 71: 331-361]

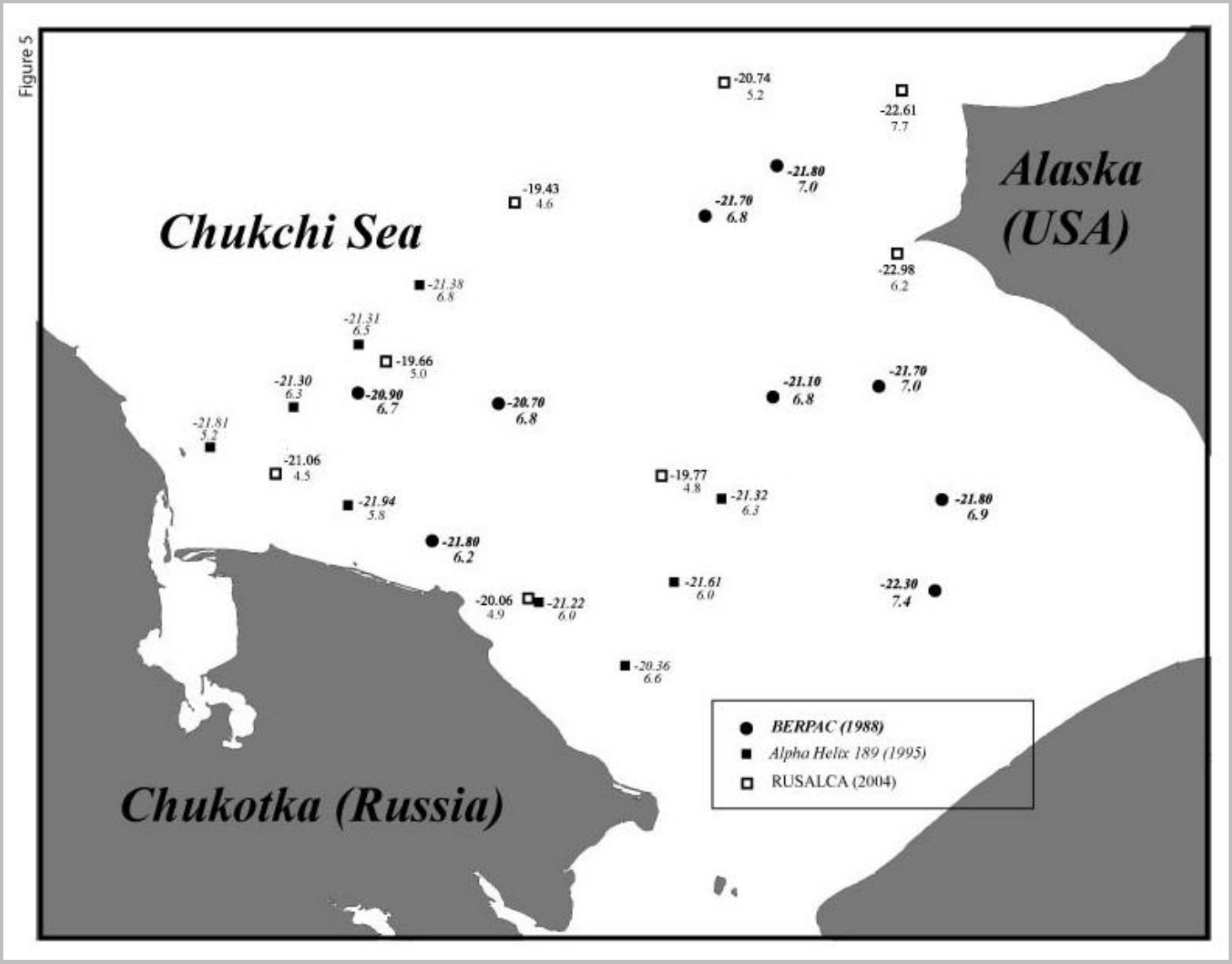
Figure 4

C/N versus C-13 carbon isotope relationship



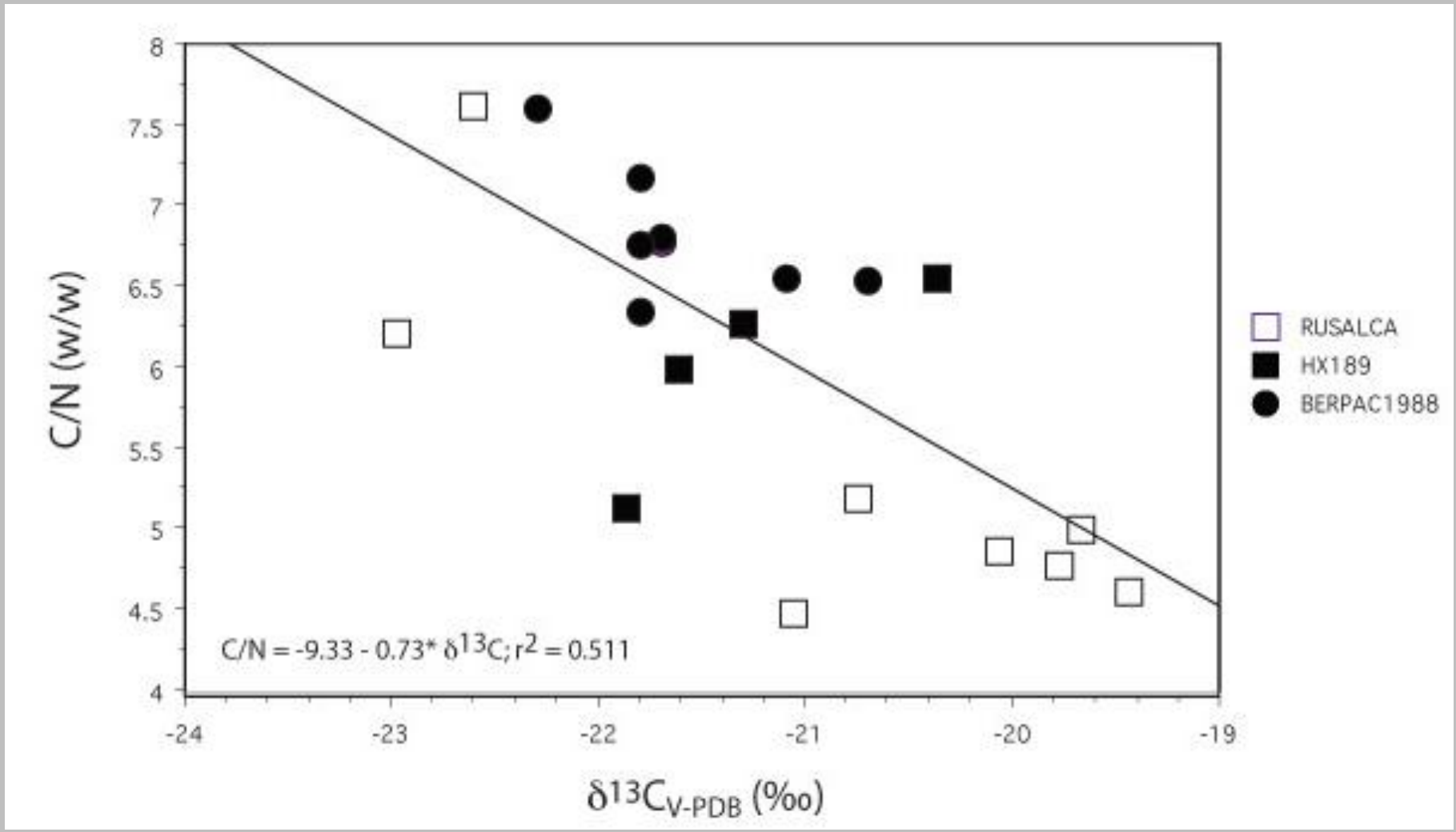
Cooper et al. 2009, Deep-Sea Research

Comparison $\delta^{13}C$ values over time series (1993, 1995, 2004) in the Chukchi Sea



Cooper et al. 2009, Deep-Sea Research

C/N versus stable carbon isotope values for time series cruises in the Chukchi Sea: 1988-2004



Cooper et al. 2009, Deep-Sea Research

SUMMARY

1. Highest observed infaunal benthic biomass was observed at the head of Herald Valley in the southeast Chukchi Sea in the known “hotspot” of *Macoma* bivalves the extends from across the US-Russian boundary. This high biomass region results for the high productivity of the Anadyr Water and tight pelagic-benthic coupling between the upper water column production zone and underlying benthos during annual primary production.

2. Sediment community oxygen consumption (SCOC) and surface sediment chlorophyll (sed chl a) was highest under the Anadyr water in the SE Chukchi Sea and in portions of the East Siberian Sea and Long Strait, indicative of efficient carbon export to the benthos.

3. Areas of highest carbon export to the benthos (SCOC, sed chl a) coincident with highest areas of infaunal biomass (gC/m^2) which are important prey to walrus gray whales, and bearded seals.
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4. Lowest observed infaunal biomass occurred in the furthest northern station at about 600 m at the “pockmark” sites. Very fine sediments were observed at this site.

Thank you. Any questions?

Acknowledgements: Many thanks to Betty Carvellas for assistance at sea as well as preparation of an outreach web journal posted at http://arctic.cbl.umces.edu. Stanislav Denisenko and Petr Strelkov (Zoological Institute, St. Petersburg, Russia) and Alexander Bosin and Alexander Kolesnik of the Pacific Oceanology Institute in Vladivostok, Russia) for assistance with deck operations on stations. Many thanks to Regan Simpson, Lisa Wilt, Kathryn Osborne and Linton Beaven at CBL/UMCES for assistance in the sorting lab as well as Marisa Guarinello for sediment analyses and GIS data interpolations and graphics. Funding was provide by the Arctic Program (Climate Dynamics Office) of the US National Oceanic and Atmospheric Administration.

[photo courtesy Karen Frey]