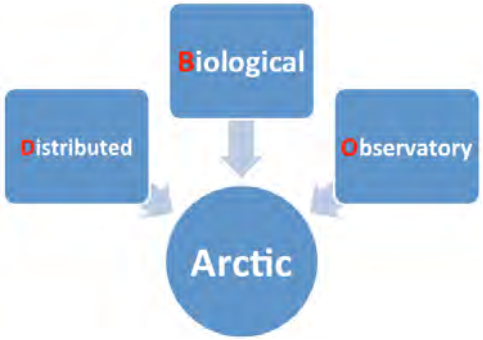

The Distributed Biological Observatory (DBO): A change detection array in the Pacific Arctic region

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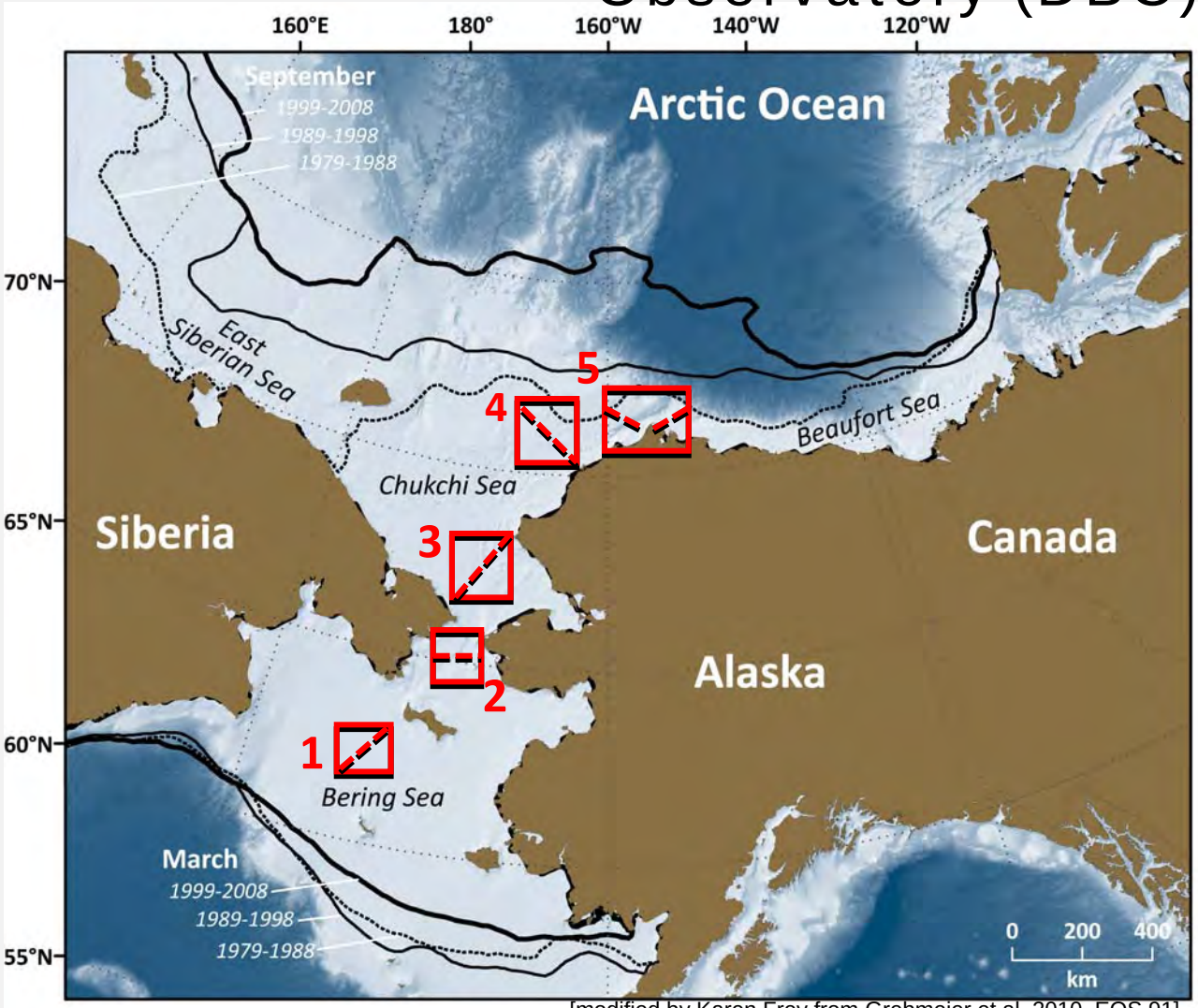
Observed Changes in the Pacific Arctic Region - a few examples

- Pacific zooplankton in Beaufort Sea and benthic species in the Chukchi Sea
- Commercially fished ‘Bering species’ & snow crab in the western Beaufort Sea
- Seabird declines with drop in clam biomass [eiders] & access to ice-associated cod [guillemots]
- Gray whale feeding-focus shift from N. Bering to Chukchi
- Walrus hauling out on land in unprecedented numbers
- Polar bears reported drowned at sea, scavenging & denning on land

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**

Rationale of the DBO

- Biological response and shifts in ecosystems are ecologically significant, requiring multidisciplinary field collections in time and space

- Many developing observation systems in the Arctic are focused on physical sensors, but biological sampling at different scales are required to detect biological changes in response to environmental forcing

- Coordinated ship-based observations on a regular basis, coincident with satellite and moorings could provide an early detection system for biological systems in the Arctic

Distributed Biological Observatory: Linking Physics to Biology

Core standardized ship-based sampling:

- CTD
- Chlorophyll
- Nutrients
- Ice algae/Phytoplankton (size, biomass and composition)
- Zooplankton (size, biomass and composition)
- Benthos (size, biomass and composition)
- Seabird (standard transects, no additional shiptime)
- Marine mammal observations (no additional ship time)

“Change detection array” – same measurements every year, process information in near real time <6 mos; detect regime shifts in rapid changes

Second tier ship-based sampling:

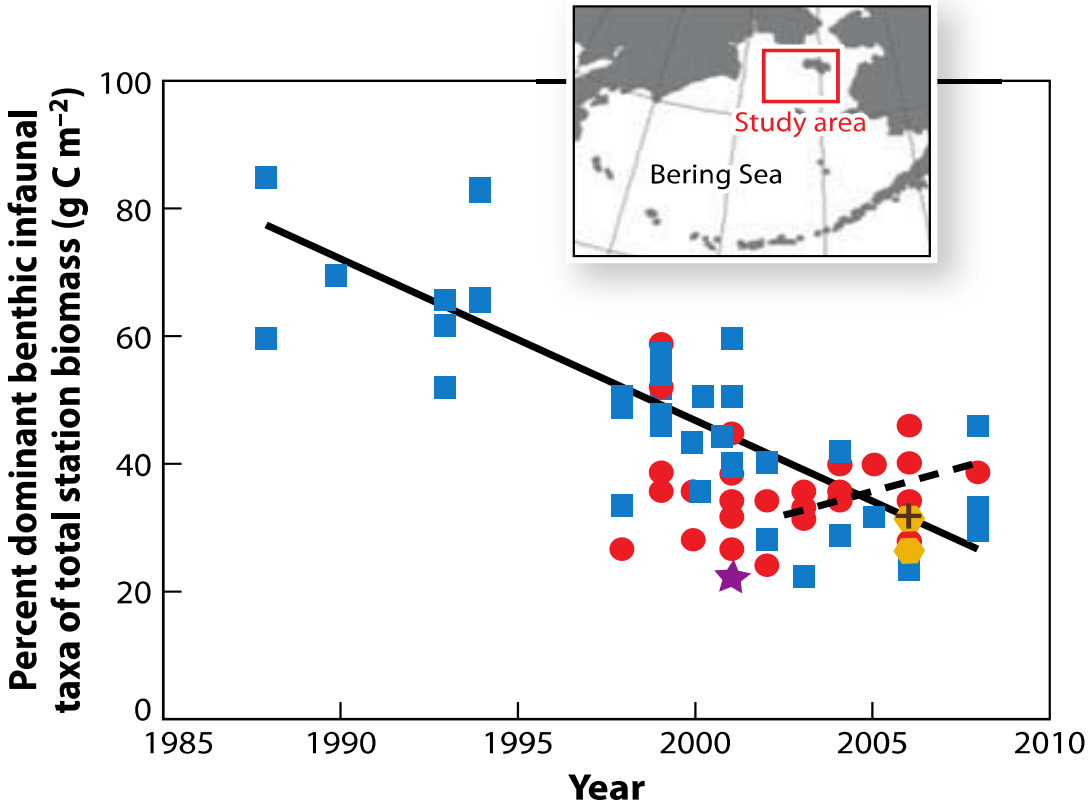
- Fishery acoustics (less effort than standardized bottom trawling)
- Bottom trawling (every 3-5 years)

DBO occupations by national and international science programs

DBO1: 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

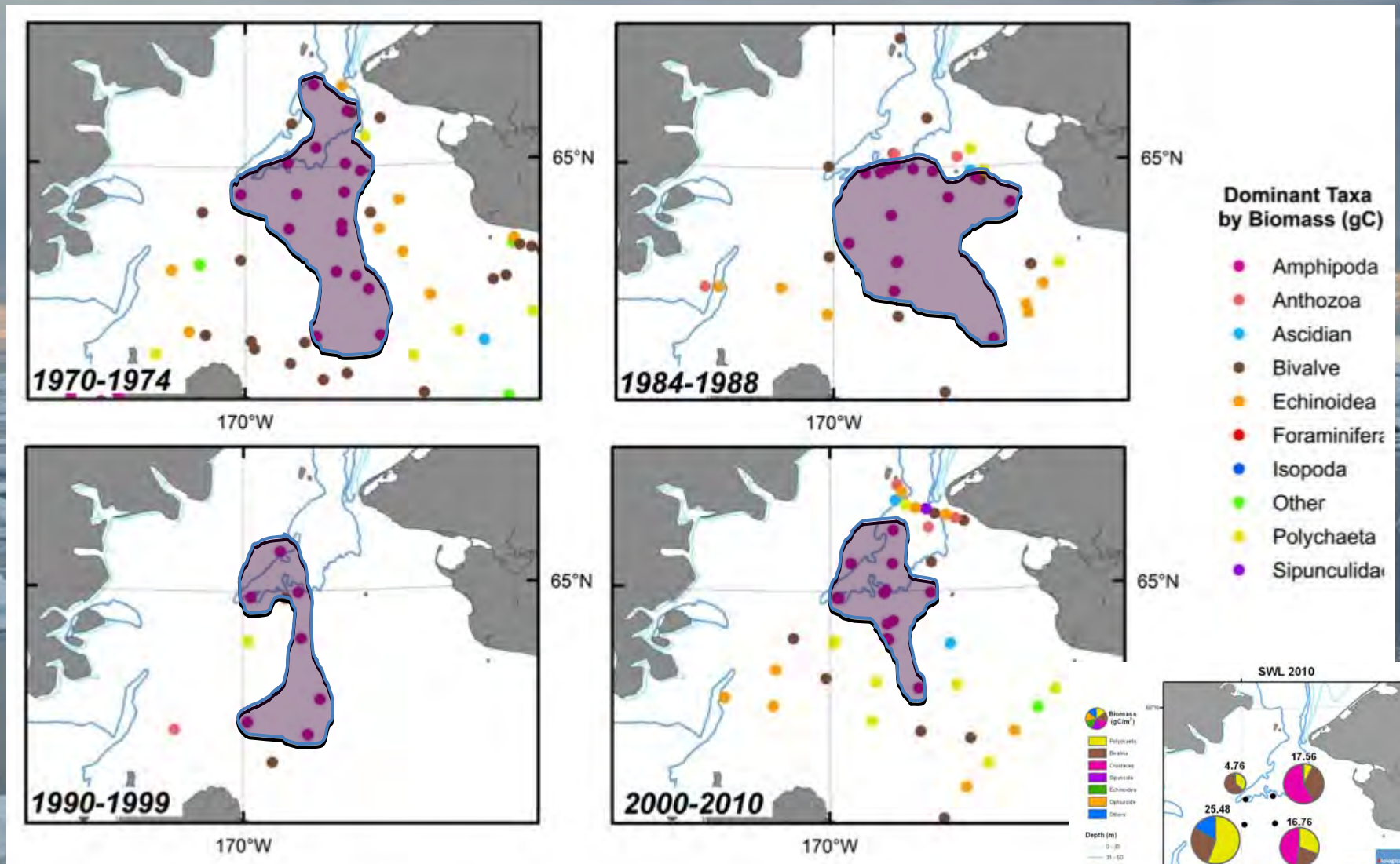


Nuculanidae (*Nuculana radiata*)*
Nuculidae (*Ennucula tenuis*)
Tellinidae (*Macoma calcarea*)
Maldanidae
Sipunculidae

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

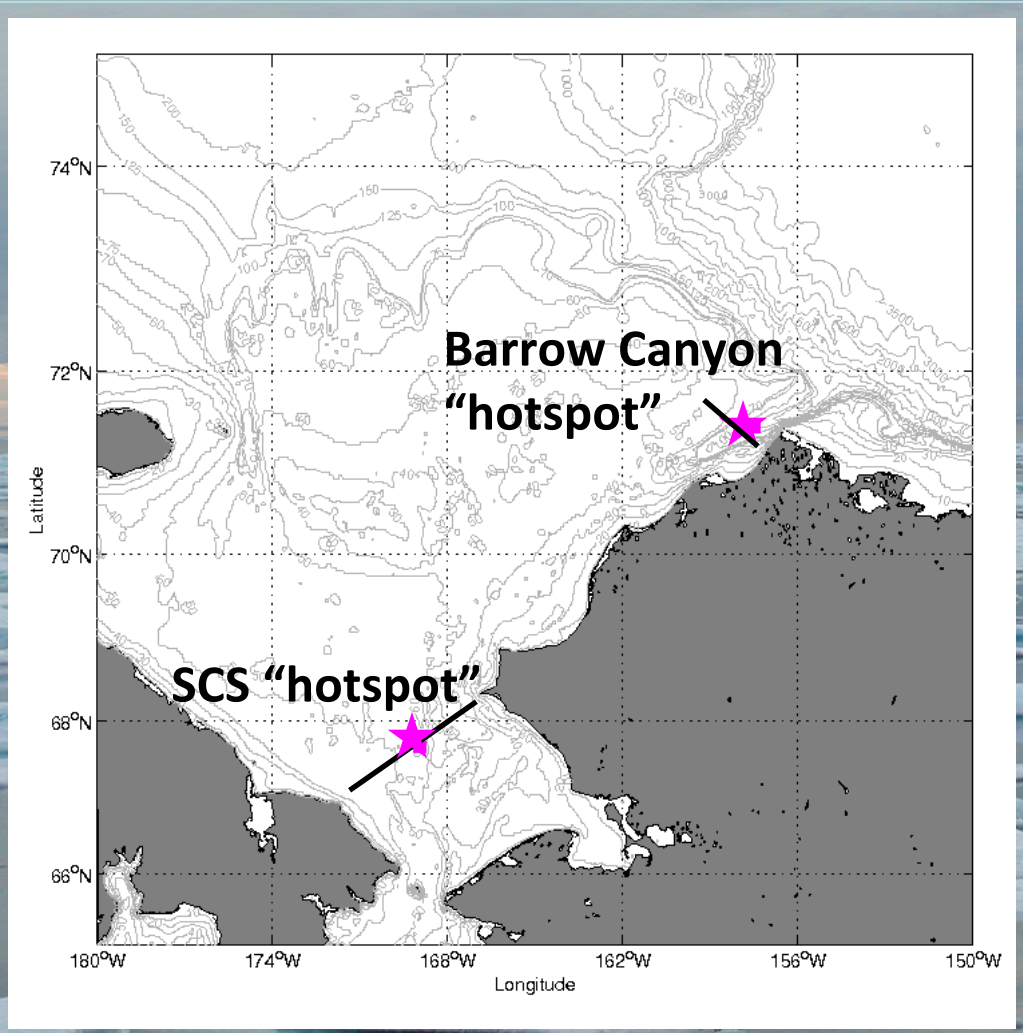
[Grebmeier Ann. Rev. Mar. Sci. 4, 2012]

DBO 2: “Footprint” of ampeliscid amphipod prey contracting spatially



[J. Grebmeier]

DBO 2010 and 2011 "Pilot" Season: International cruises to Pacific Arctic (**both years)

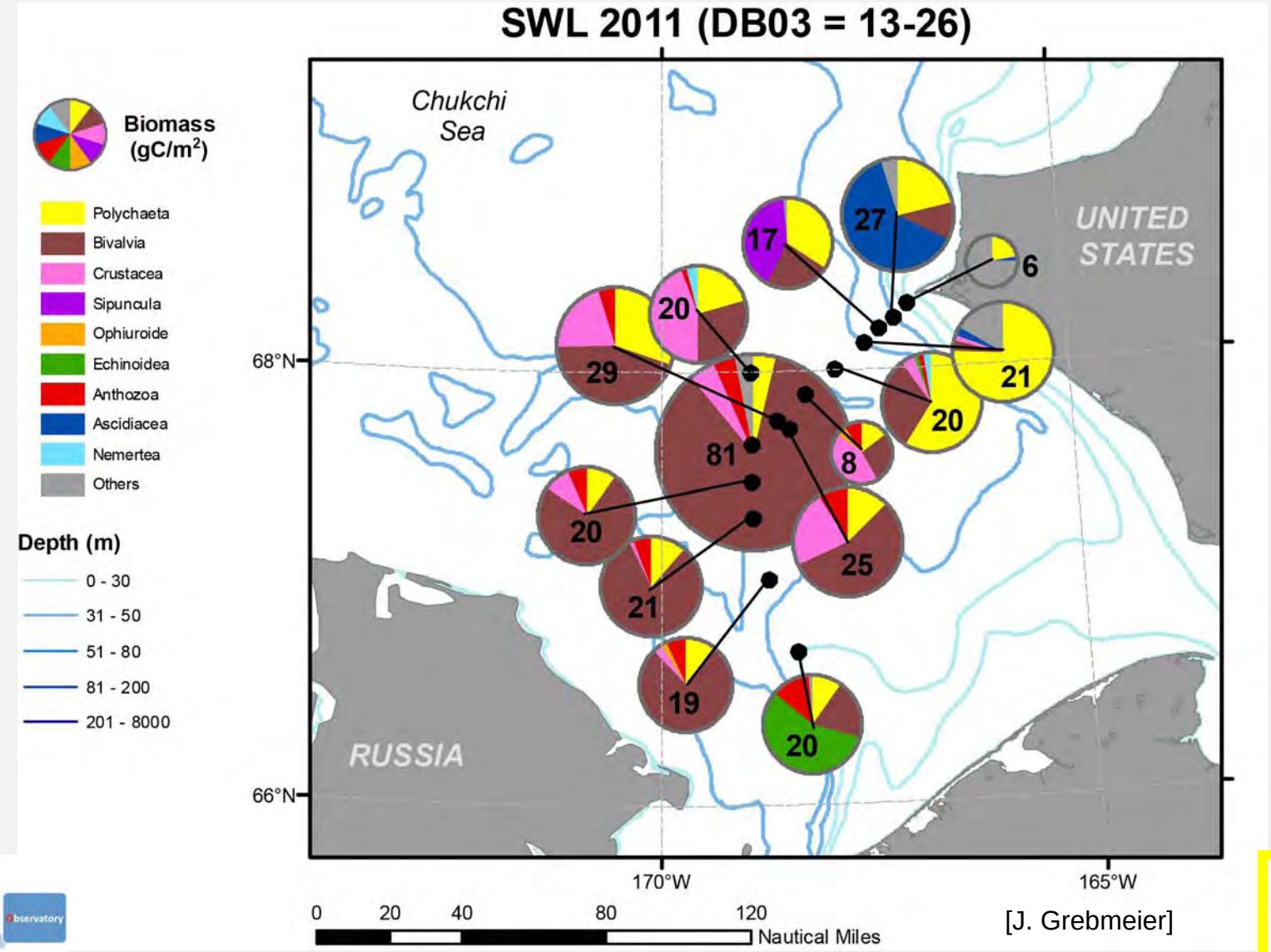


Vessel	Country	PI
Moana Wave	USA	Grebmeier
Healy (**)	USA	Arrigo
Xue Long	China	He
Mirai	Japan	Itoh
Laurier (**)	Canada	Vagle
Araon	Korea	Chung
Khromov (**)	Russia and USA	Woodgate
Alaskan Enterprise	USA	Napp
Annika Marie (**)	USA	Ashjian
Healy (**)	USA	Pickart
Westward Wind	USA	Day

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

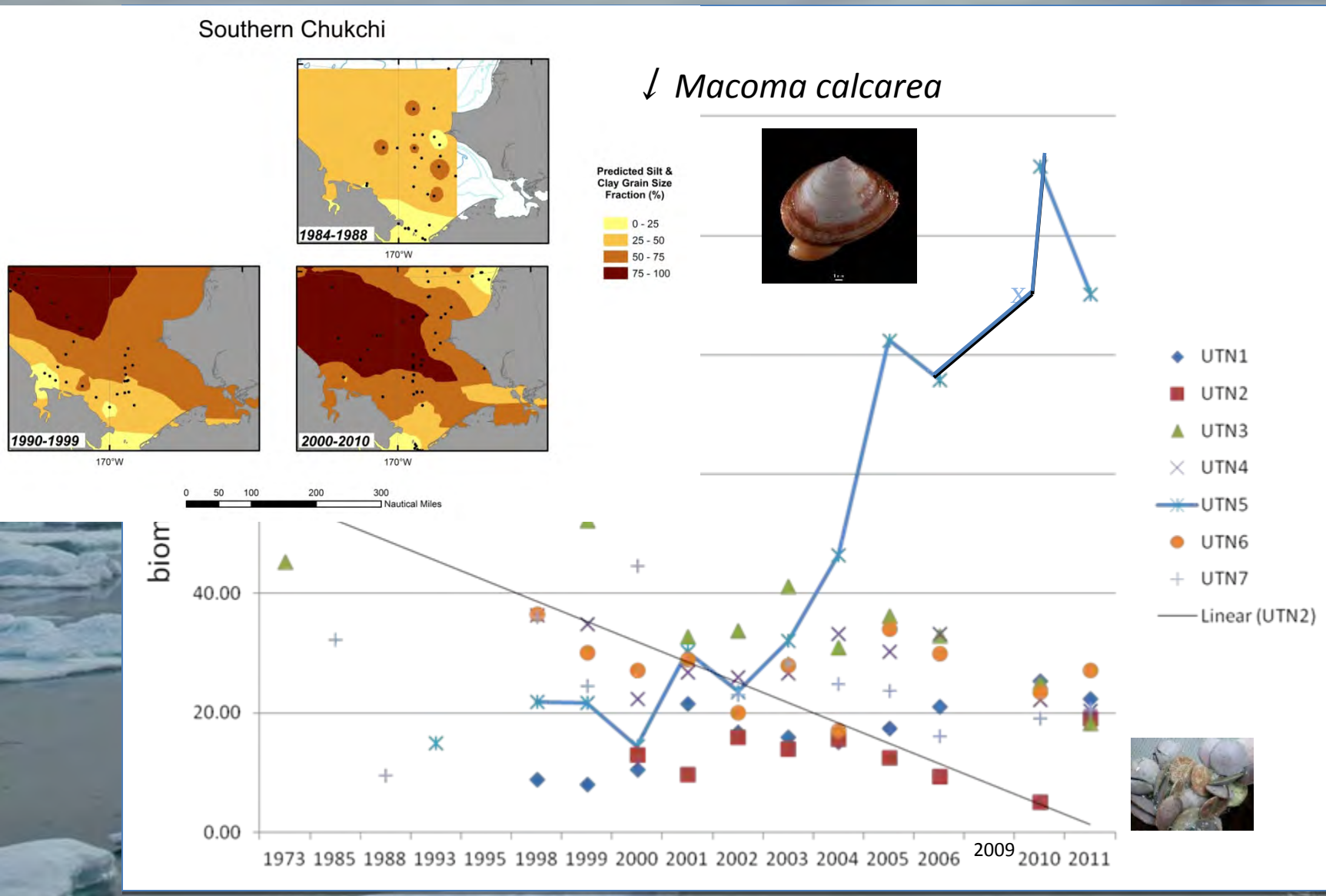
http://pag.arcticportal.org

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



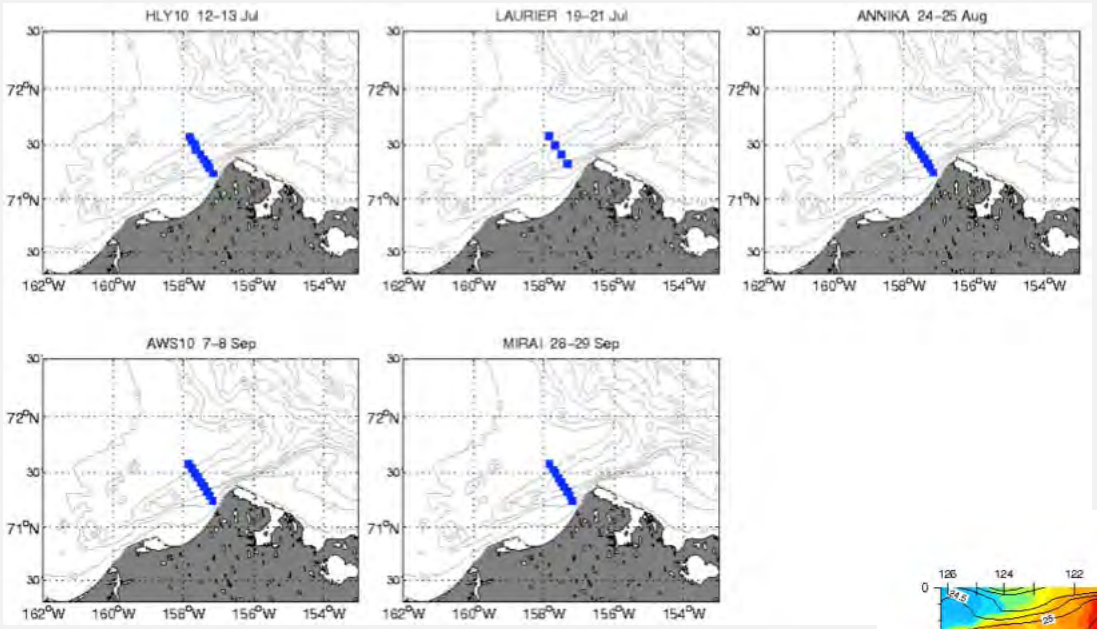
[J. Grebmeier]

DBO3-Southern and southeastern Chukchi Sea



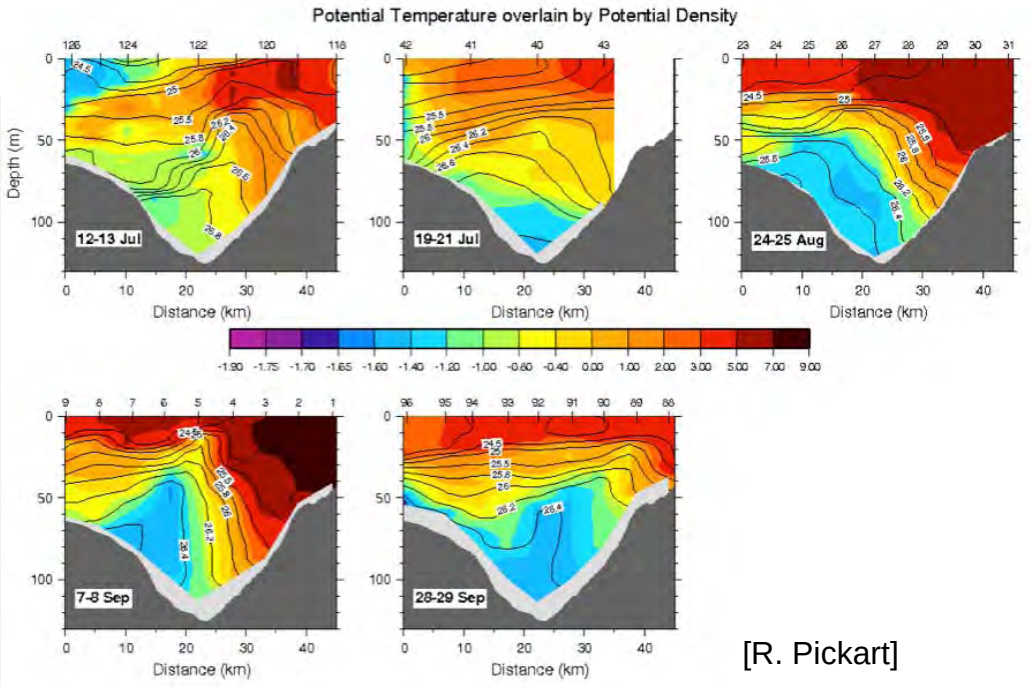
[Updated and modified from Grebmeier et al. 2006; Grebmeier unpublished data]

DBO 5: Barrow Canyon Section



-5 reoccupation of sections by international partners from June-October 2010

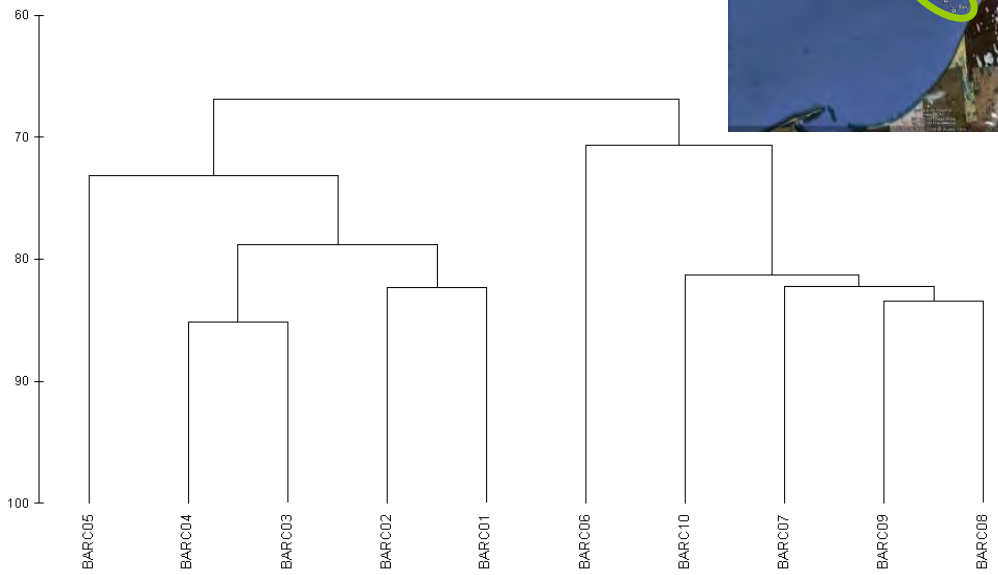
-observed seasonal warming of Alaska Coastal Water



[R. Pickart]

Cluster analysis of zooplankton communities on DBO BC line-July 2011

2011 DBO- results

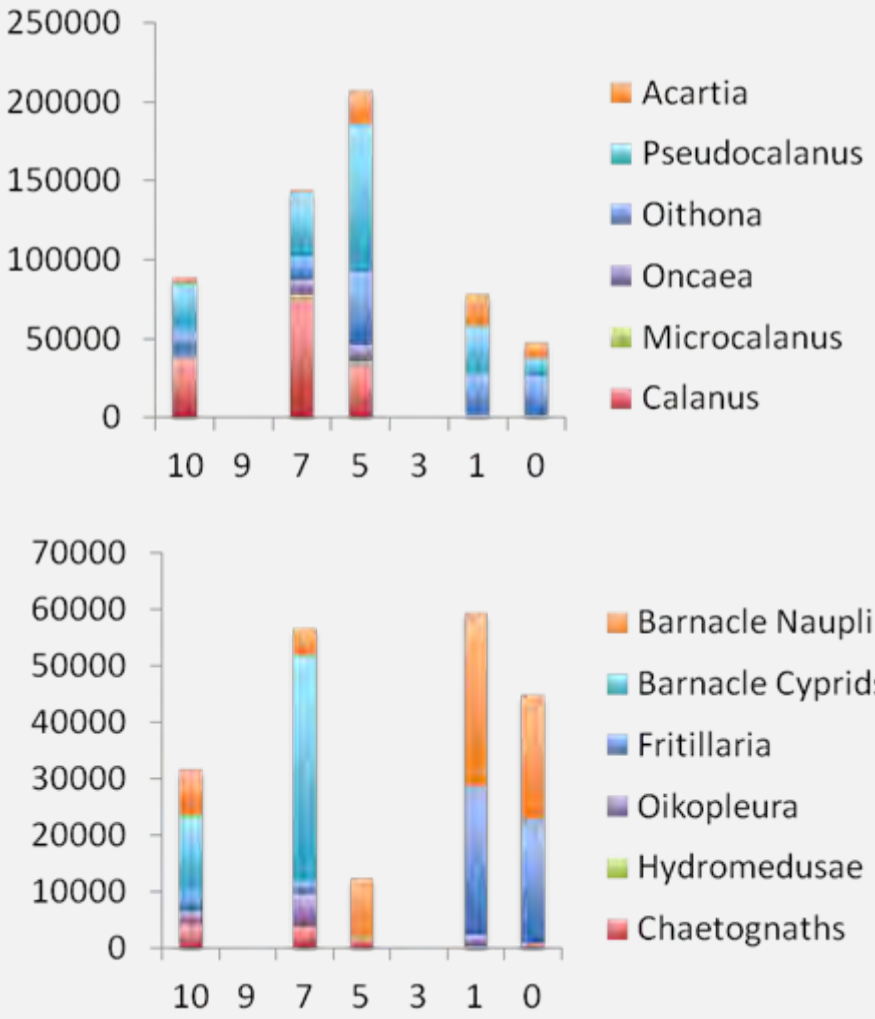


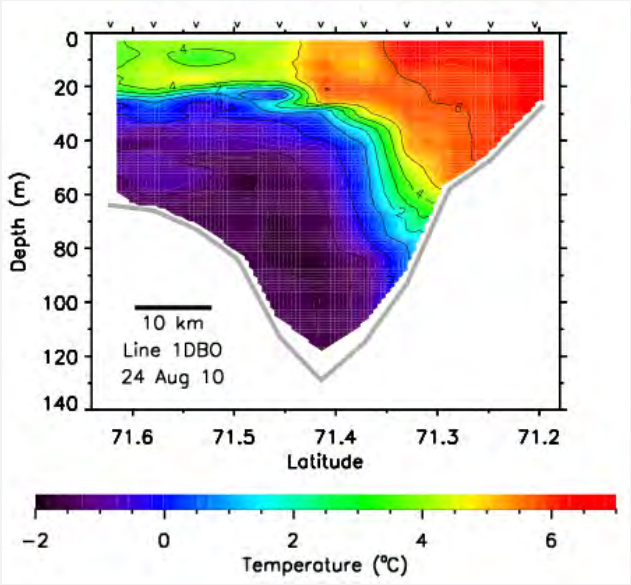
– 4th root transformed Bray-Curtis similarity based on abundance

[John Nelson]

Heavy colored bars indicate stations characterized by copepods *Neocalanus sp* (Pacific) and *Calanus hyperboreous* (Arctic). Inset shows this species distribution overlaid on a chart of the stations

2010 Taxonomic Composition-DBO BC-Aug/Sept

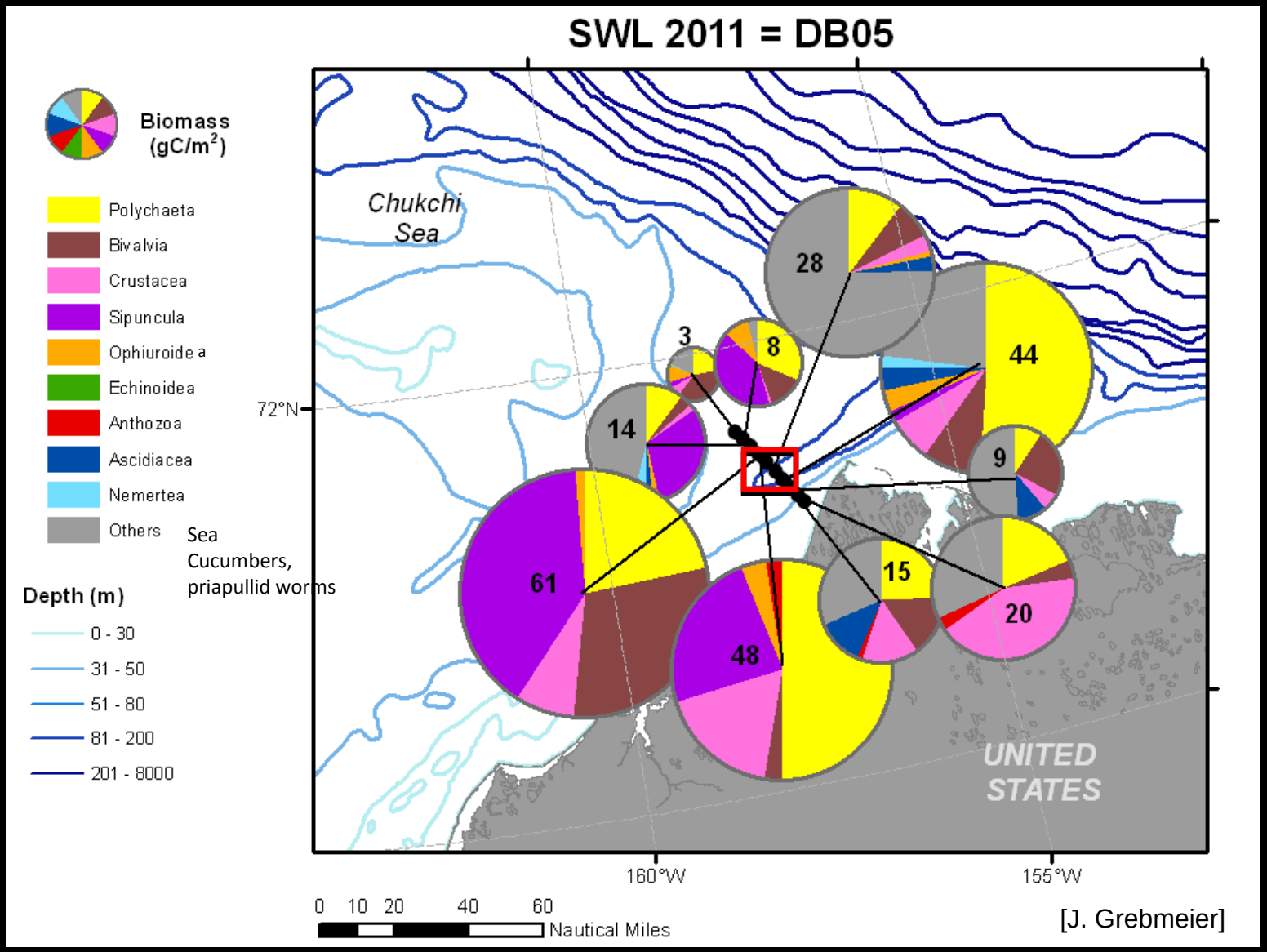




- *Calanus* abundant on western end, in or above cold Winter Water
- Barnacle nauplii and fritillaria abundant on eastern end in ACC water
- Barnacle cyprids abundant on western end

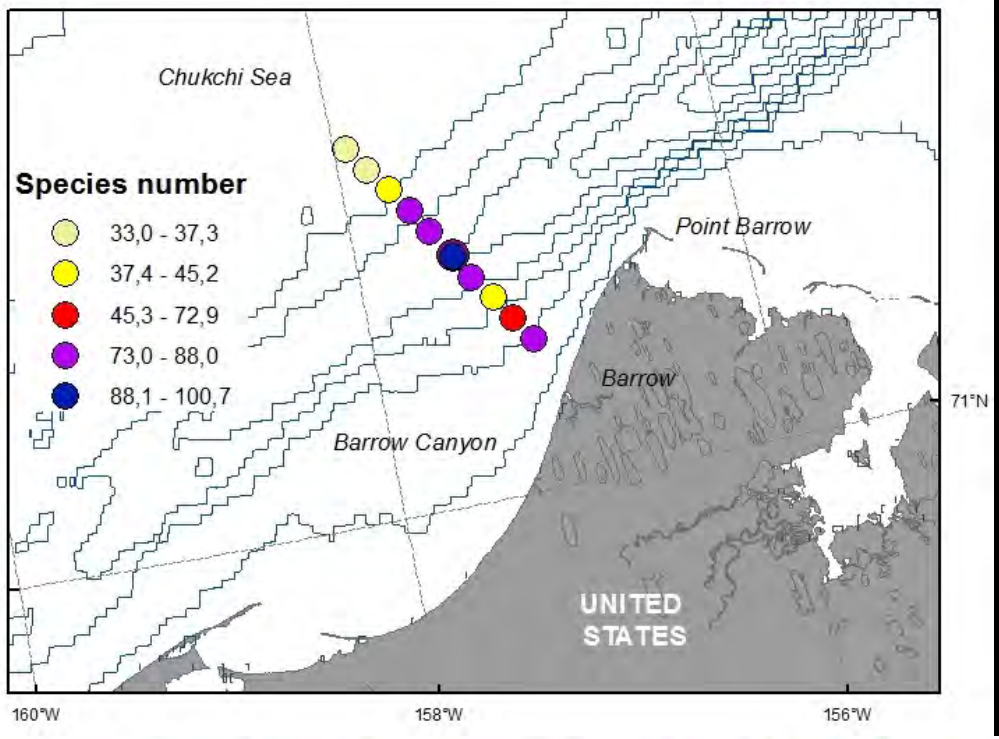
[Carin Ashjian]

DBO 5-Barrow Canyon benthic macroinfaunal biomass-July 2011



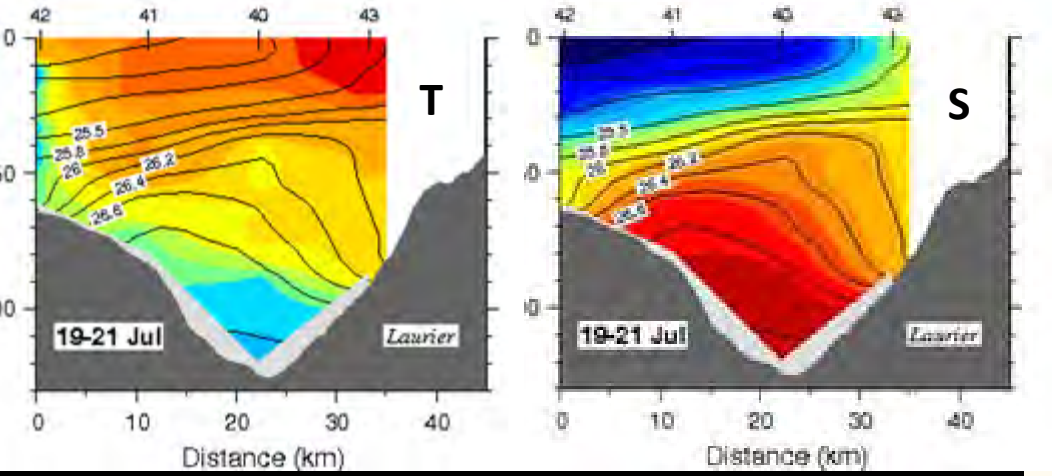
[J. Grebmeier]

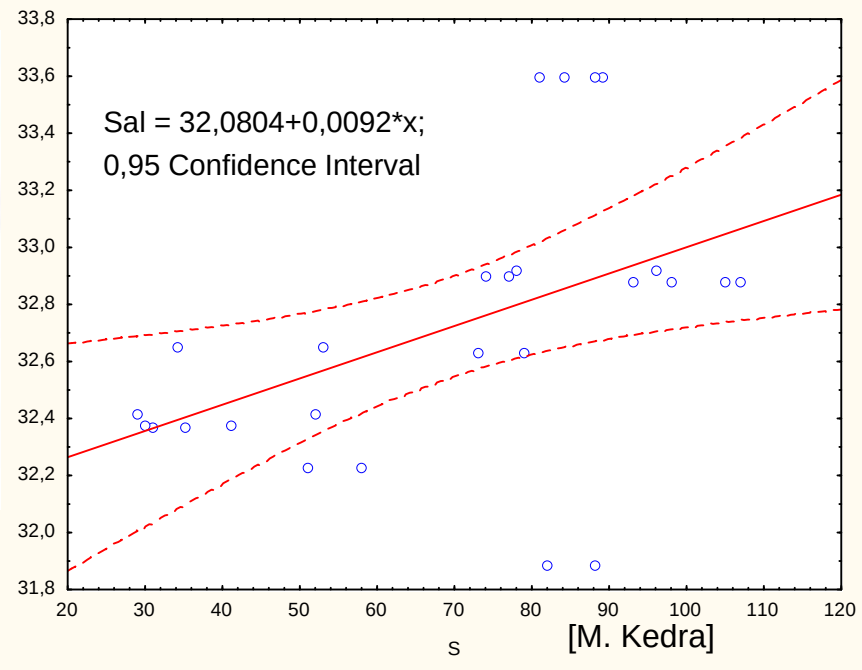
Barrow Canyon



Spearman correlations:
Species richness & bot. sal.: 0.55*
Species richness & chl a: 0.59*
Species richness & TOC : 0.4*

Similar correlations found
for abundance and biomass





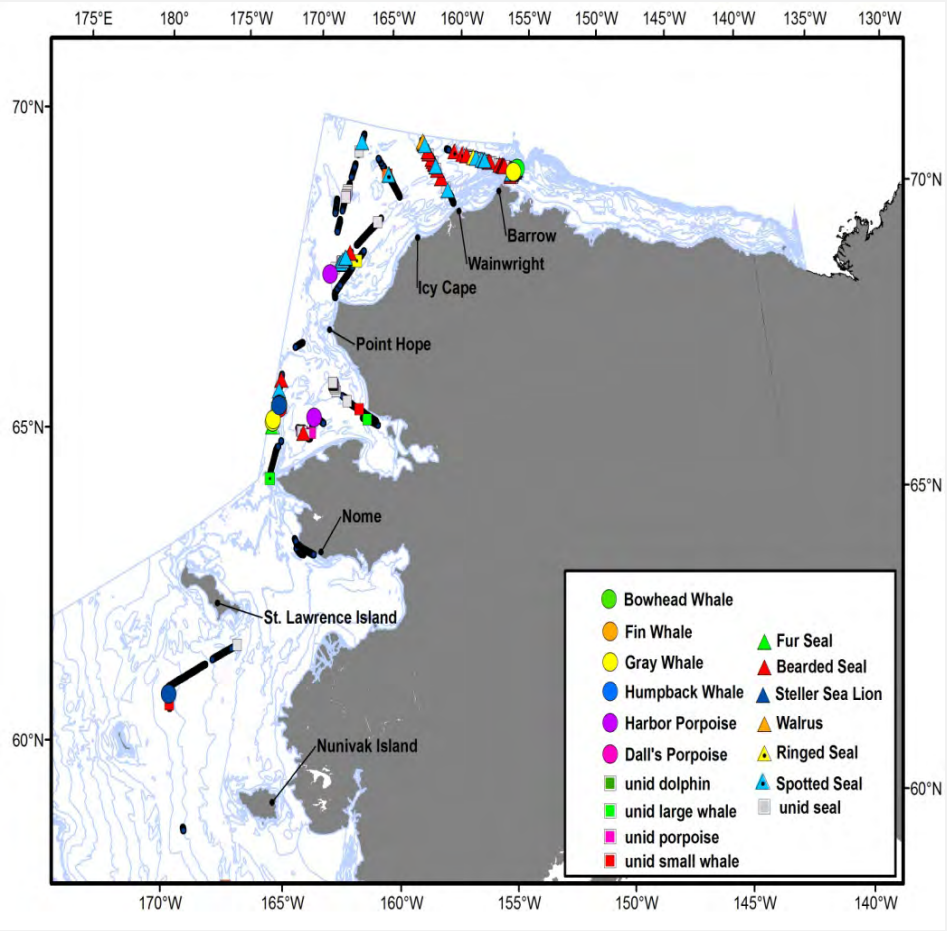
[M. Kedra]

http://www.arctic.noaa.gov/dbo
cruise_data_2010_pilot_study.html C30)

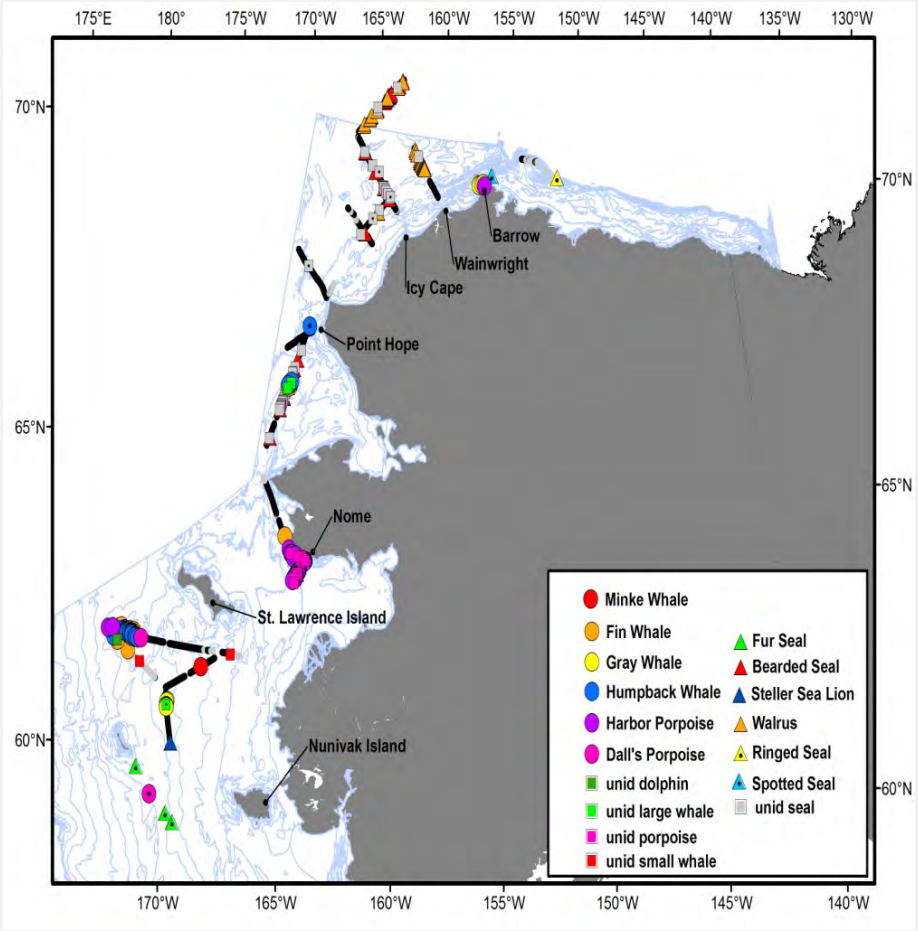
Marine Mammal Sightings (CHAOZ)

Standard Survey Protocol

2010 – DBO Region 3 – 'hotspot'



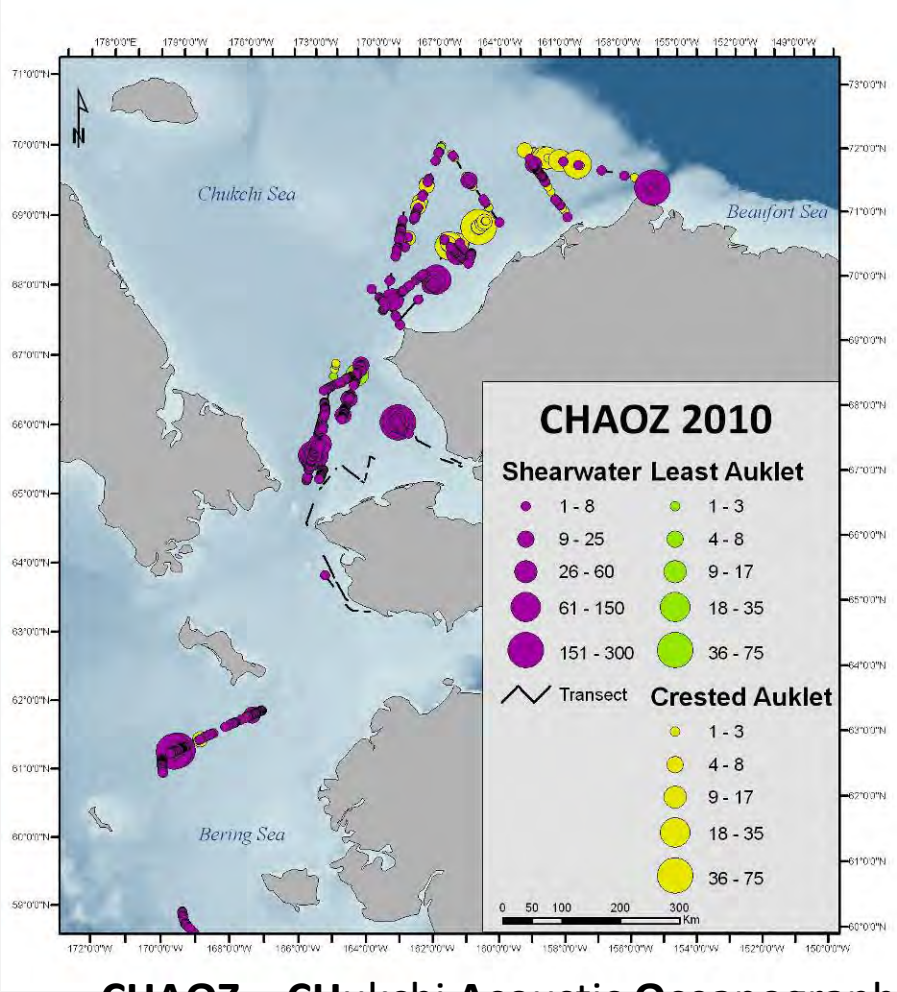
2011: DBO Region 1 – 'hotspot'



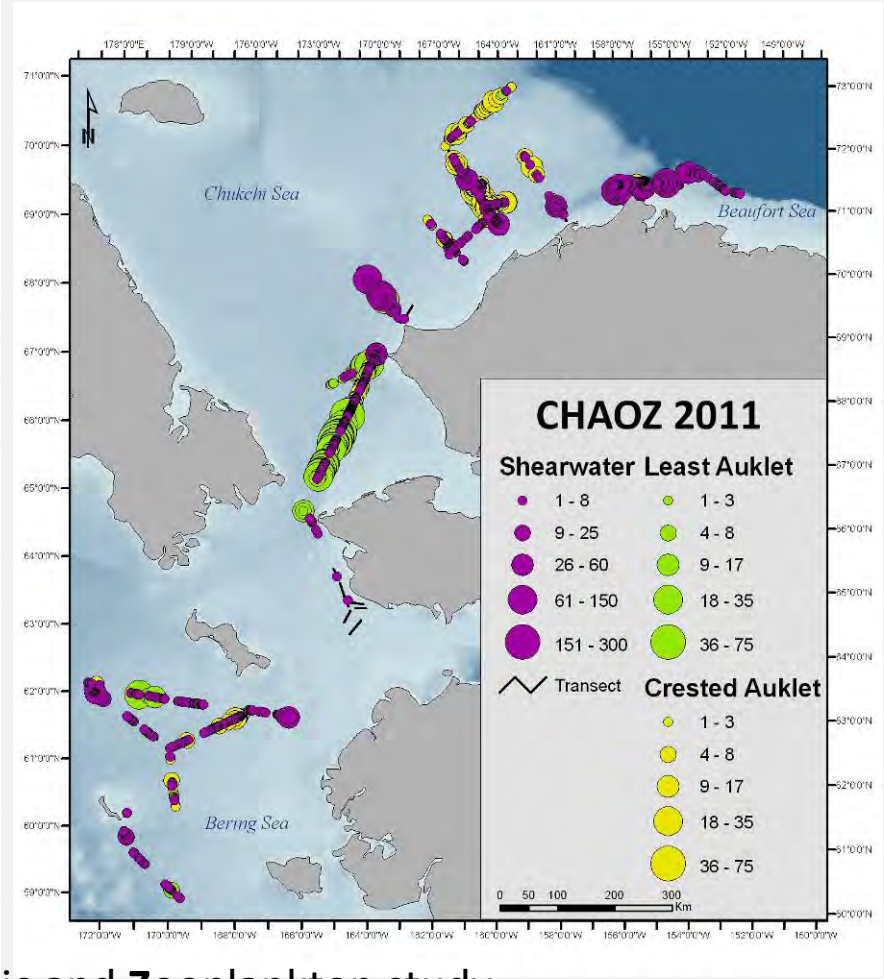
[Sue Moore]

Seabird Sightings from CHAOZ Cruises (USFWS Survey Protocol)

2010 – DBO Region 3 – 'hotspot'



2011: DBO Region 1& 3 – 'hotspot'



CHAOZ = **CH**ukchi **A**coustic **O**ceanographic and **Z**ooplankton study

[Sue Moore]

Connection to People

- **Higher-Trophic (HT) species reflect ecosystem 'hotspots' & organization**
- **People *CARE* about HT species – they provide a link to local communities and to public education & outreach**
- HT species reflect ecosystem shifts in their bodies and by their behavior
- The **DBO** will be informed through <u>research partnerships</u> focused on HT species
- Examples: over **30 years of collaborative studies** on seabirds & marine mammals

[courtesy Sue Moore]

DBO Data Management Considerations-working with Jim Moore-UCAR/EOL

>Develop an International DBO data policy and exchange protocol (including priority measurements) to facilitate:

- •Dataset exchange and access
- •Preparation of datasets for data integration, intercomparison and modeling studies

>Encourage broad access to data and metadata beyond national restrictions through scientific collaboration/cooperation

>Coordinate with other National and International Projects

>Consider data format and documentation guidelines to enhance international data exchange and analysis

>Document and standardize (if possible) data collection protocols (time, sensors, processing, parameters, units)

Summary

•Data indicates freshening and warming as Pacific seawater transits northward over the spring to fall season, with potential impacts on both plankton and benthic prey bases for larger marine mammals and seabirds

•Observations of changes in benthic dominant macrofauna and biomass at benthic hotspots in the region

•Spatially explicit DBOs as a latitudinal “change detection array” to track biological response to sea ice retreat and environmental change being organized through the Pacific Arctic Group (PAG), endorsed by the International Arctic Science Committee (IASC)

•Repeat collections of hydrography, plankton, benthic and higher trophic level parameters over the seasons through international coordination

•Ongoing effort to develop coordinated data management, access, and publications

Thank you for your attention.

Questions and comments?

Financial support from the international science partners in the Pacific Arctic Group (PAG), the US National Oceanic and Atmospheric Administration, and the National Science Foundation

Further information at http://www.arctic.noaa.gov/dbo/ and http://pag.articportal.org