

# Distributed Biological Observatory (DBO)

*Linking Physics & Biology in the Arctic*

## The Distributed Biological Observatory (DBO): 3<sup>rd</sup> DBO Data Meeting and Data Updates

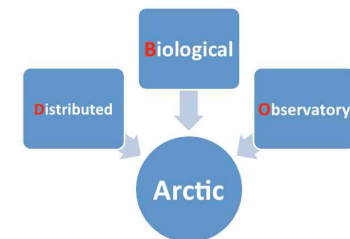
Jacqueline M. Grebmeier

Chesapeake Biological Laboratory  
University of Maryland Center for Environmental Science, Solomons, MD, USA

Pacific Arctic Group Fall Meeting  
March 13, 2016  
Fairbanks, Alaska, USA



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



# 3rd DBO WORKSHOP: Data Synthesis and 10-year Implementation plan

Jackie Grebmeier, CBL/UMCES

March 9–10, 2016

PMEL/NOAA, Bldg. 3, Oceanographer Room  
7600 Sand Point Way NE, Seattle, Washington, USA



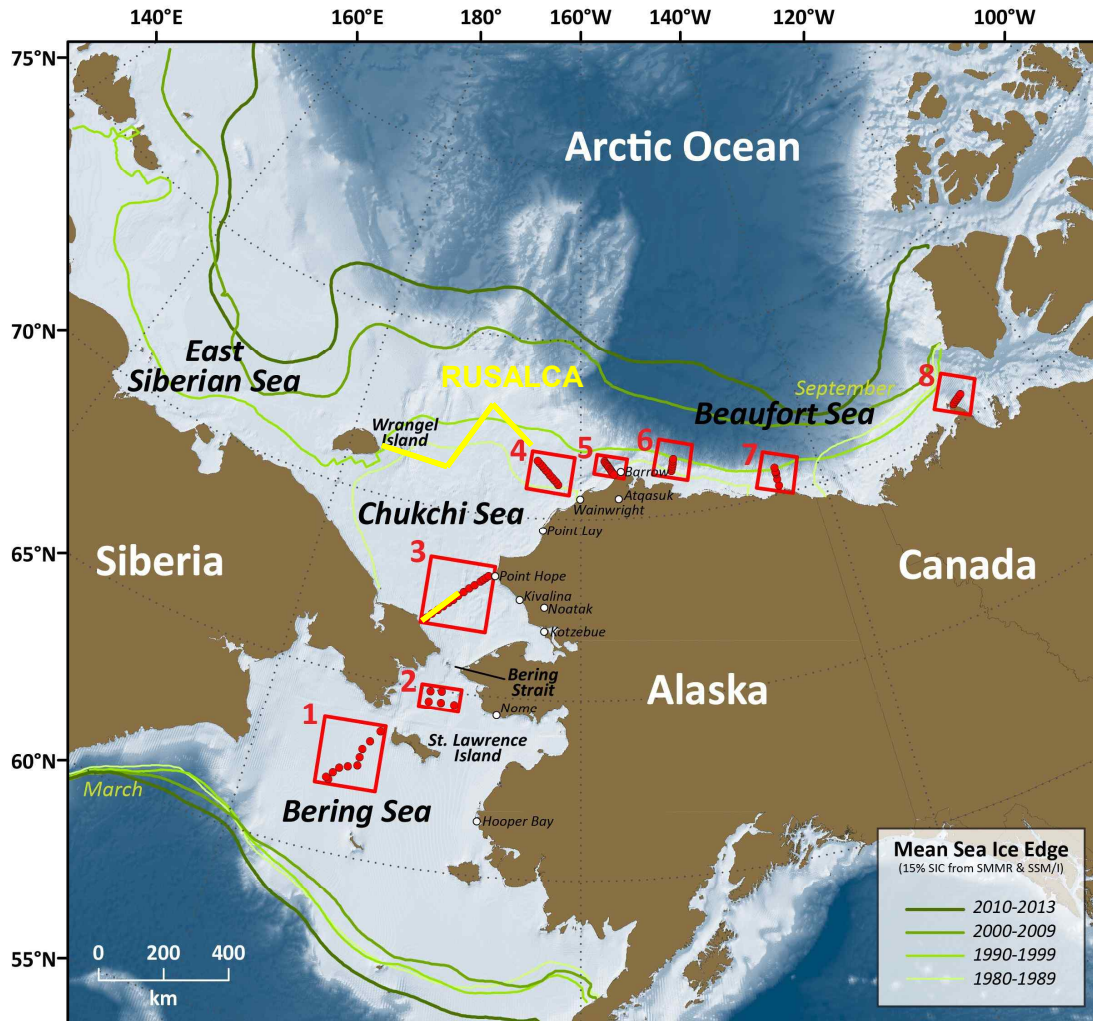
# Workshop Overview

**46 participants, 5 countries, all career levels of scientists**

## 3 objectives for this workshop

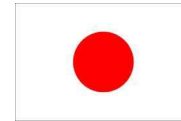
- Present results from the 2010–2015 DBO field program and commit to multidisciplinary papers to showcase results of the DBO international effort
- Evaluate the DBO data submission effort through the EOL DBO Metadata site and linkage to other national archives
- Overview of US–IARPC Draft DBO Implementation Plan + International 10–year future efforts

# 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 (DBO1-5) and longitudinally (DBO6-8)
- DBO sites exhibit high productivity, biodiversity, and/or overall rates of change
- DBO sites serve as a change detection array for consistent monitoring of biophysical responses
- Sites occupied by national and international entities with shared data plan



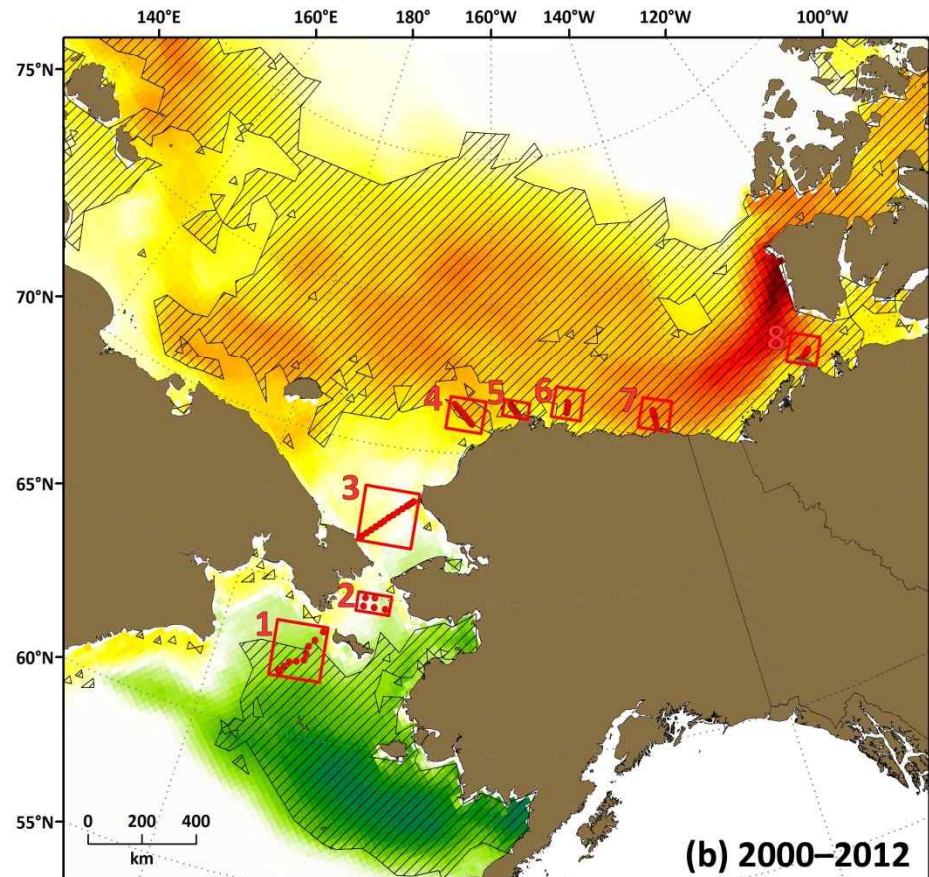
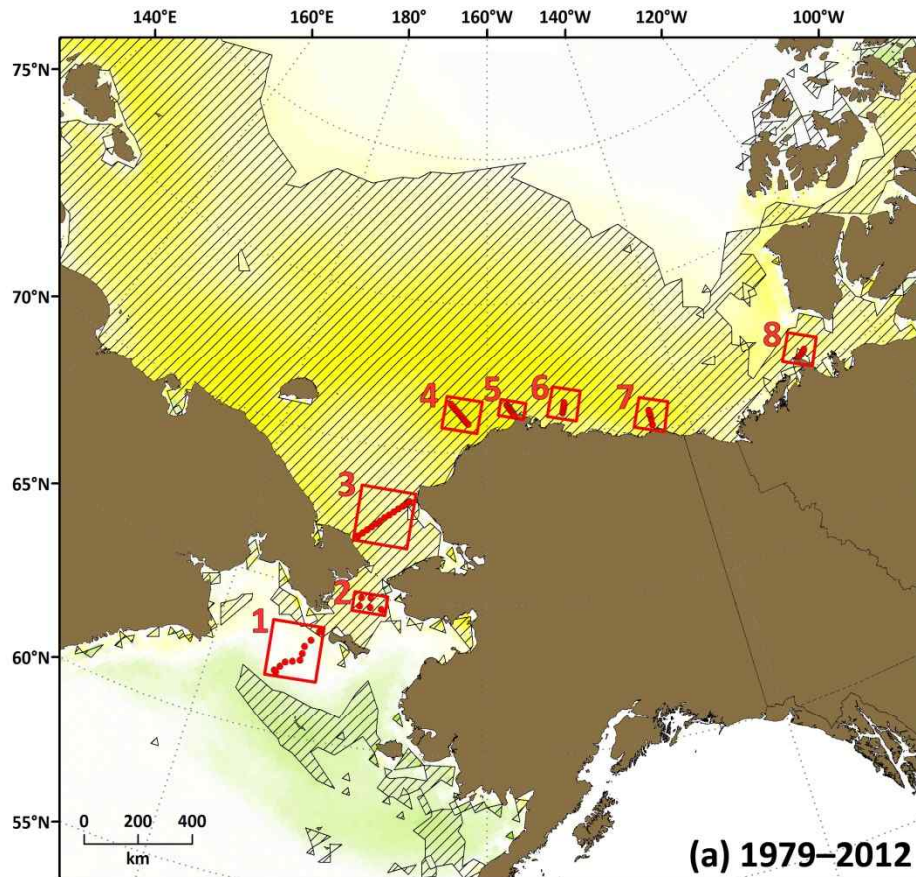
## Suite of selected DBO data types and parameters

- Conductivity, Temperature, Depth (CTD), Acoustic Doppler Current Profiler (ADCP) data
- bottle data for chlorophyll and nutrients
- abundance, biomass and composition of Ice algae, phytoplankton, zooplankton, benthic fauna (both infauna and epifauna), and fish
- sediment parameters (grain size, organic carbon content, chlorophyll *a* content)
- seabird and marine mammal surveys
- mooring data (temperature (T), salinity (S), Currents, fluorescence, nutrients, sediment trap)
- satellite data (data presented are weekly averages of most recent data on: (1) chlorophyll pigment concentration; (2) sea surface temperature (SST); (3) sea ice concentration; (4) cloud fraction, and (5) winds and sea level pressure)
- Other (a text entry): model output, other parameters being collected on DBO lines, but not a core DBO measurement listed above.

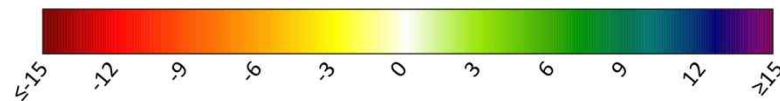
# Trends in Annual Sea Ice Persistence (DBO 1–8)

*Hatching indicates statistically significant trends (Mann-Kendall  $p < 0.1$ )*

*Trends in annual sea ice persistence have accelerated since 2000*



Trends in Annual Sea Ice Persistence (days/year)

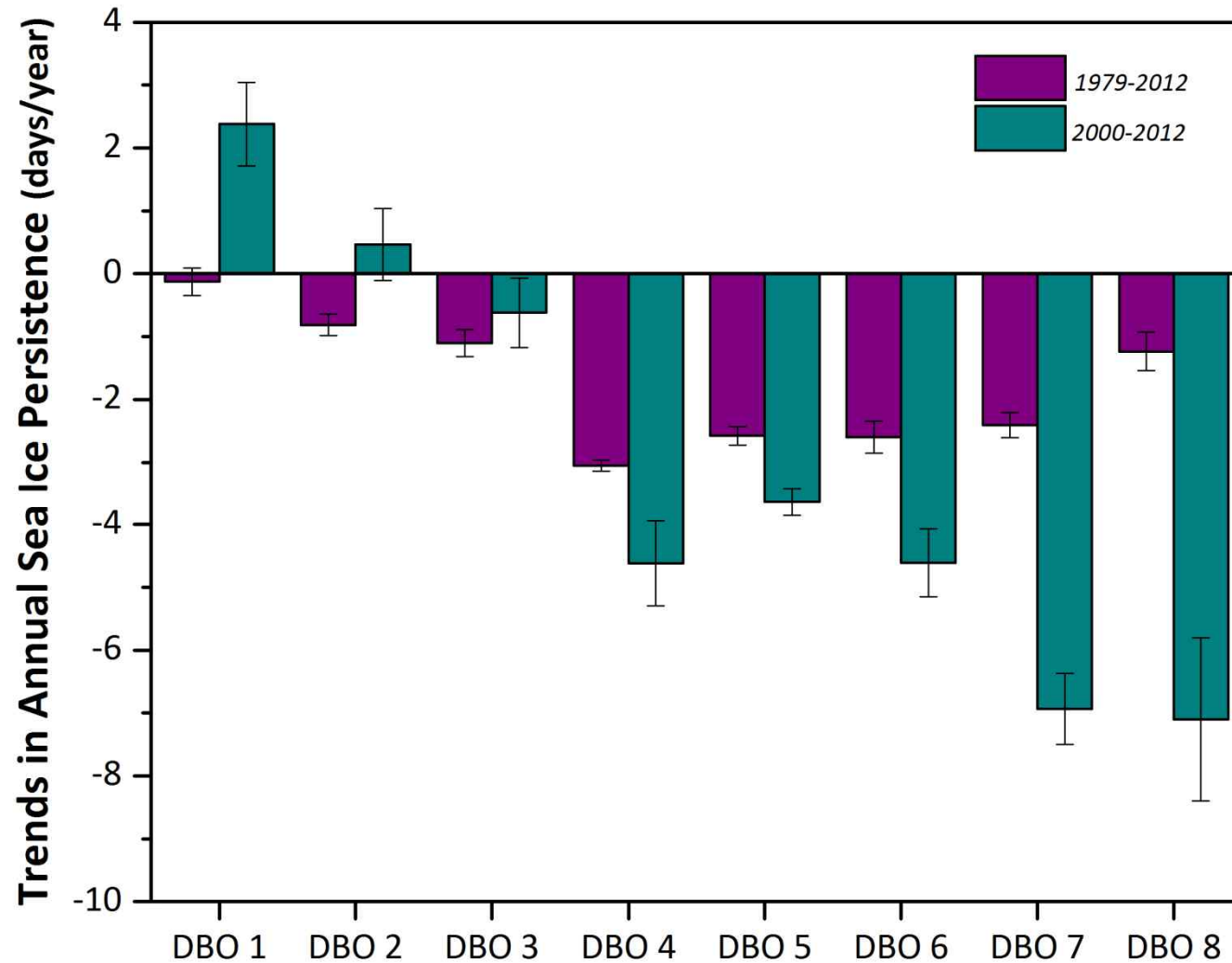


[Karen Frey]

# Trends in Annual Sea Ice Persistence (DBO 1–8)

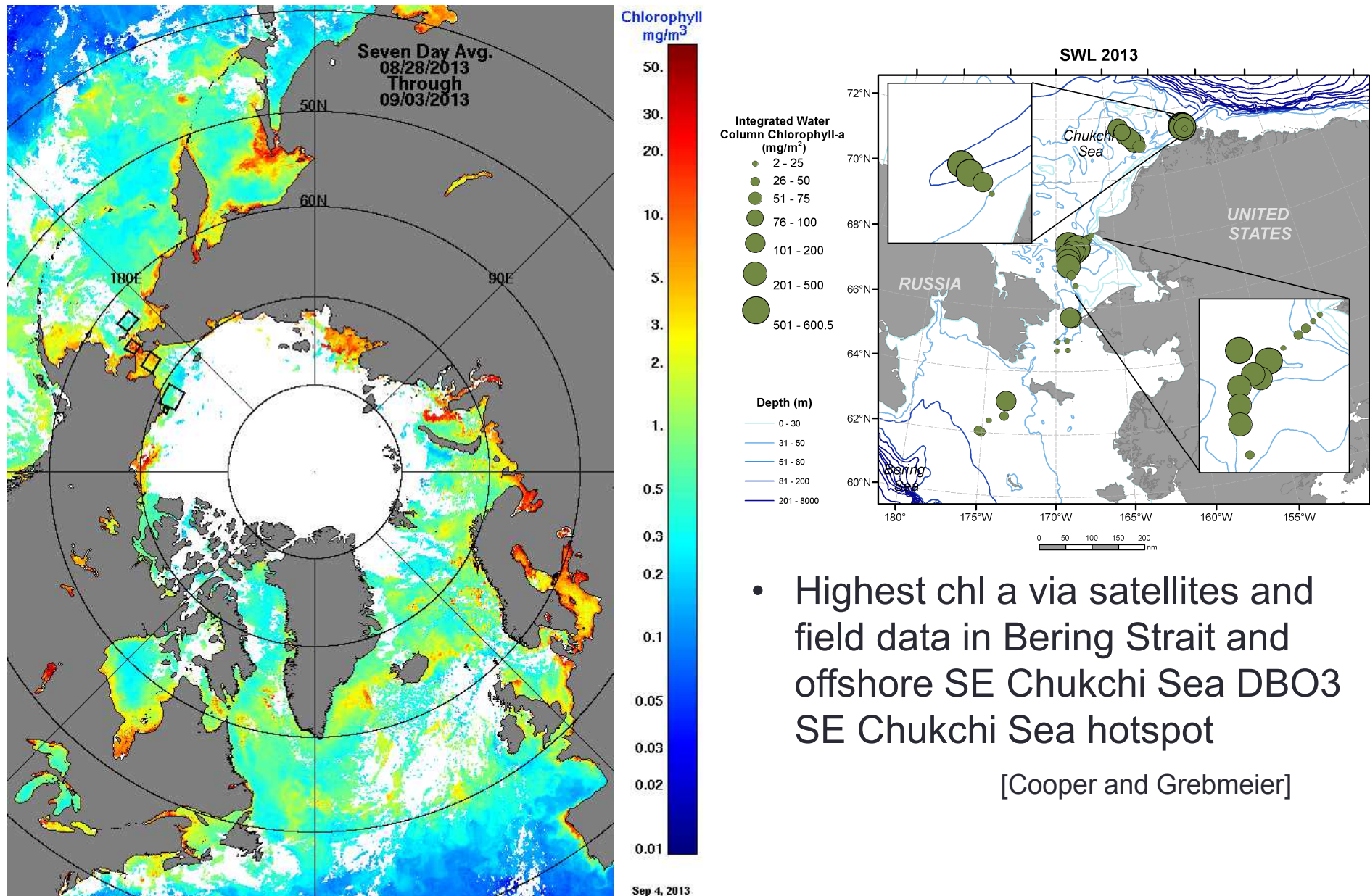
*Trends in annual sea ice persistence have accelerated since 2000*

*Recent gains in annual sea ice persistence in the south (DBO 1–2) transition to losses in the north (DBO 3–8)*



[Karen Frey]

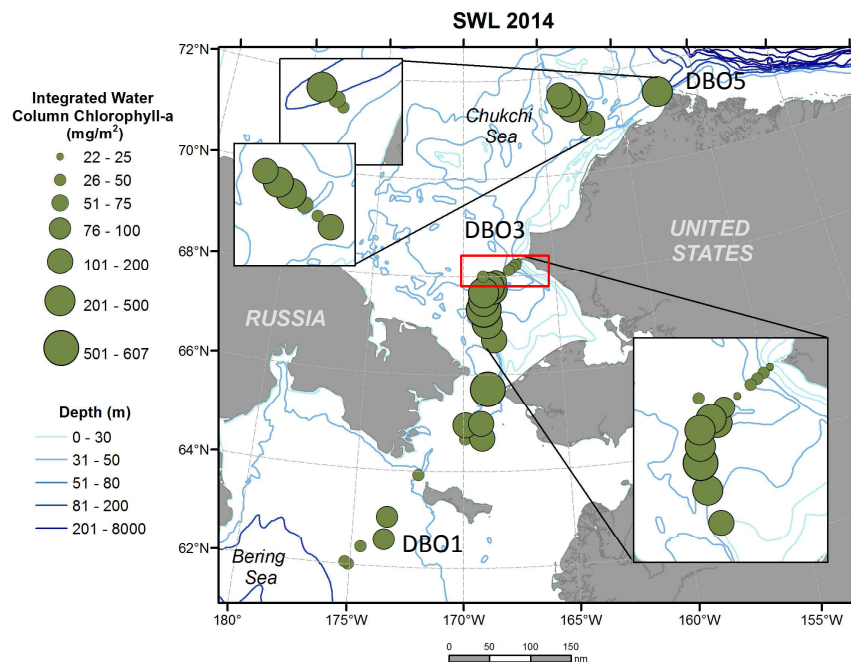
# NASA DBO-surface chlorophyll and field collected integrated values



<http://neptune.gsfc.nasa.gov/csb/index.php?section=270> (courtesy Joey Comiso)



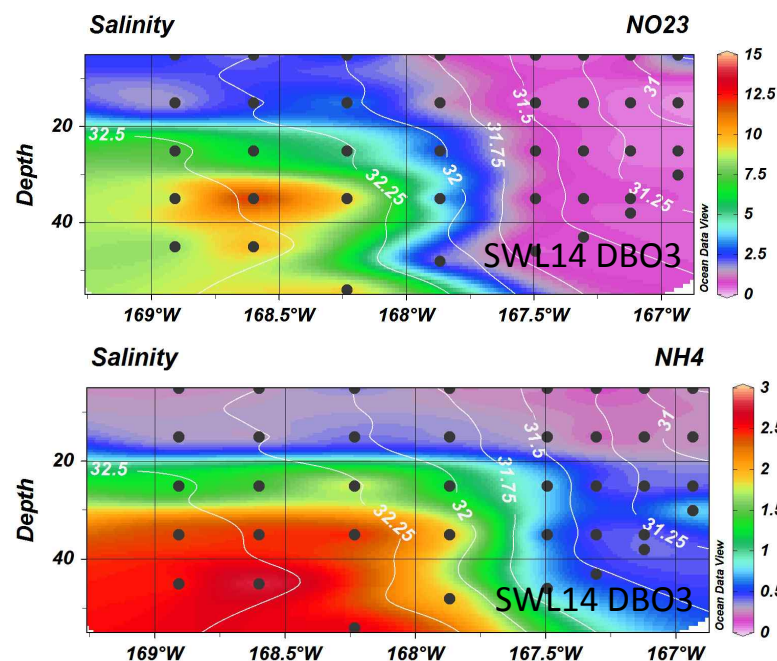
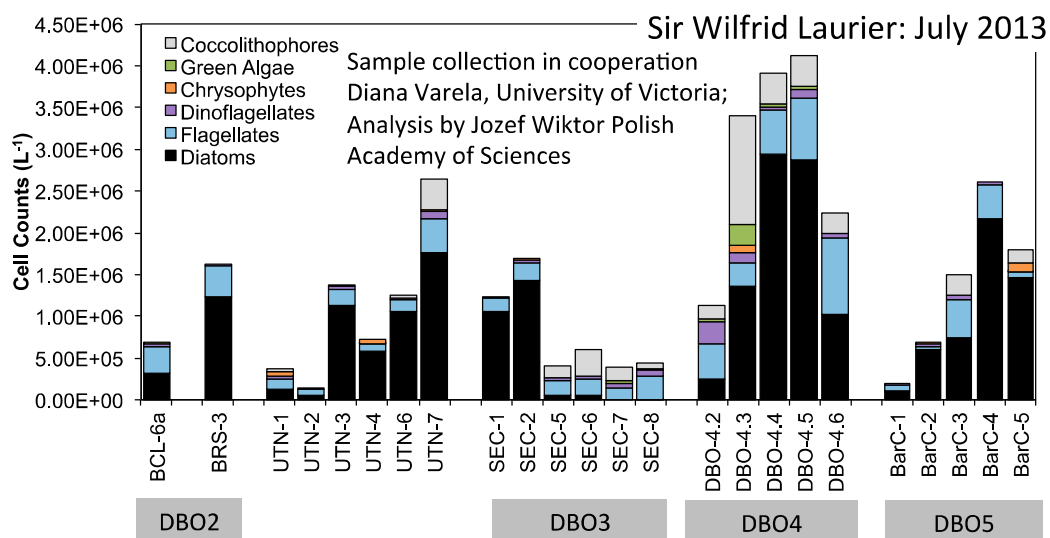
# Plankton and DBO Data Product



**Top Left:** Integrated Chlorophyll *a* during annual DBO cruise [Cooper]

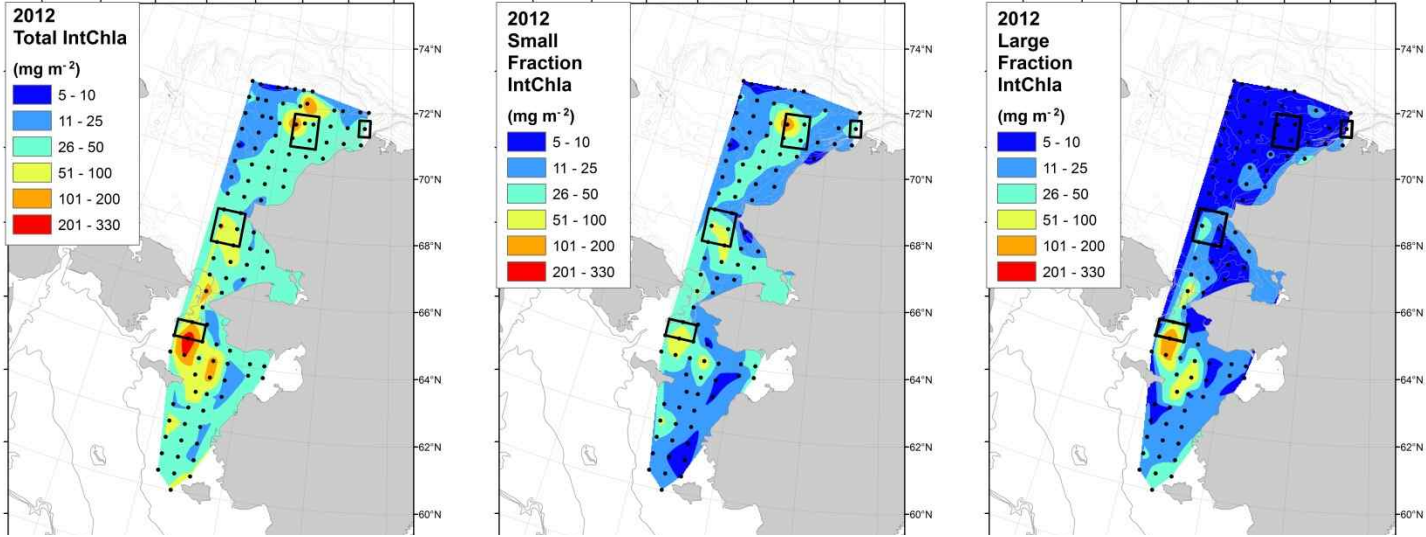
**Bottom left:** Phytoplankton taxonomy, with dominance by diatoms in western side maintained by nutrient rich Anadyr and Bering Shelf waters [Varela and Grebmeier]

**Bottom right:** nitrate/nitrite (top panel) and ammonium (bottom panel) ( $\mu\text{M}$ ) [Cooper]

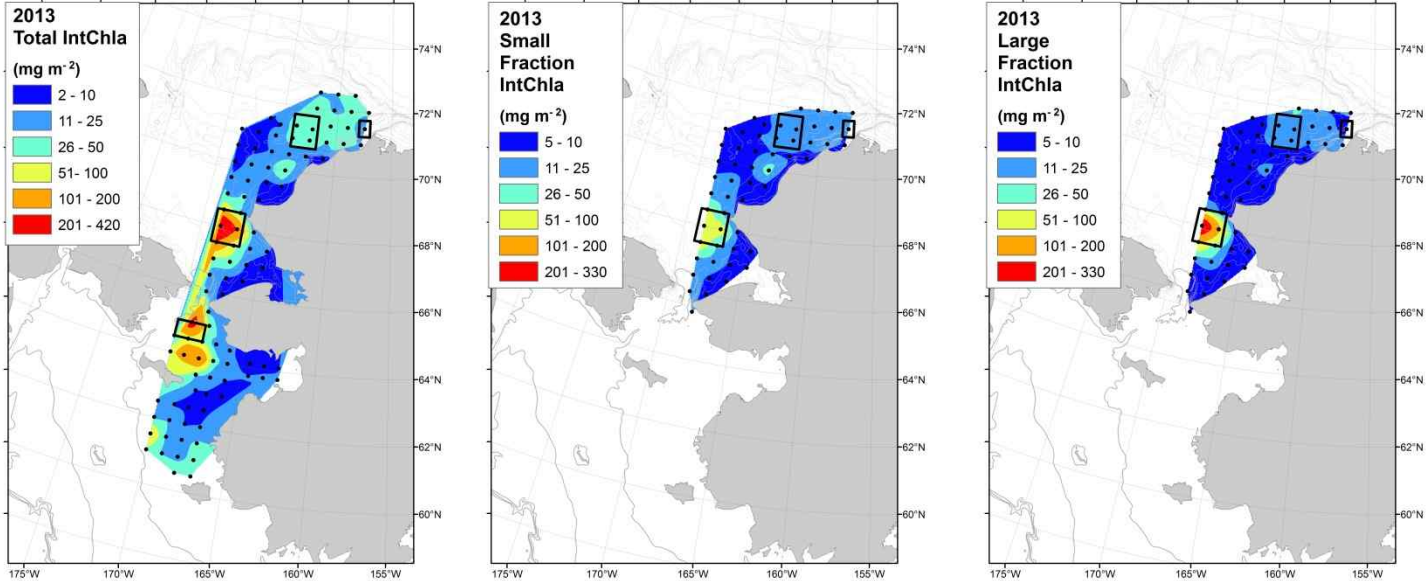


# Arctic Eis Integrated Chla: total, small (< 10µm) and large (> 10µm) size fraction

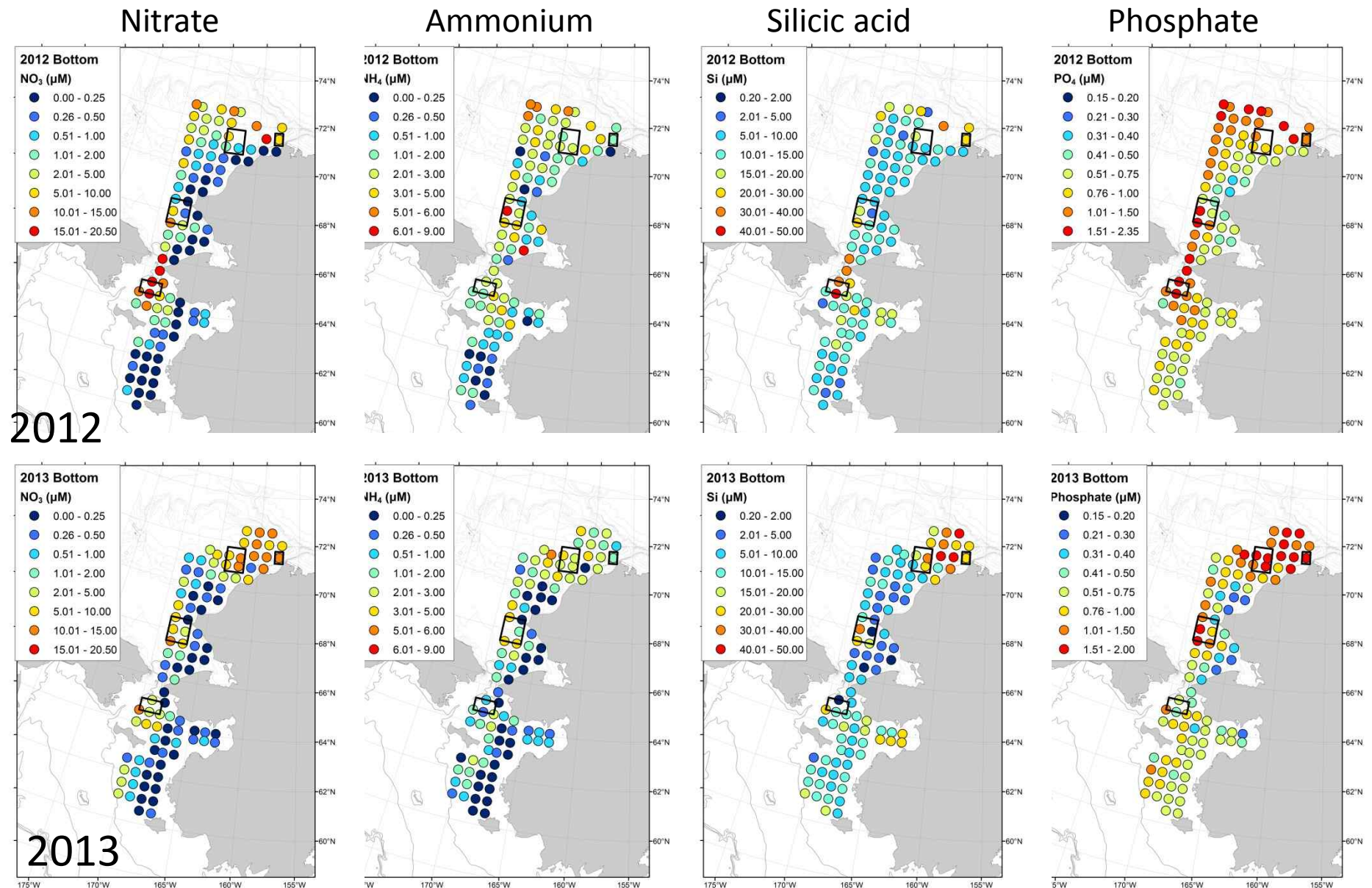
2012



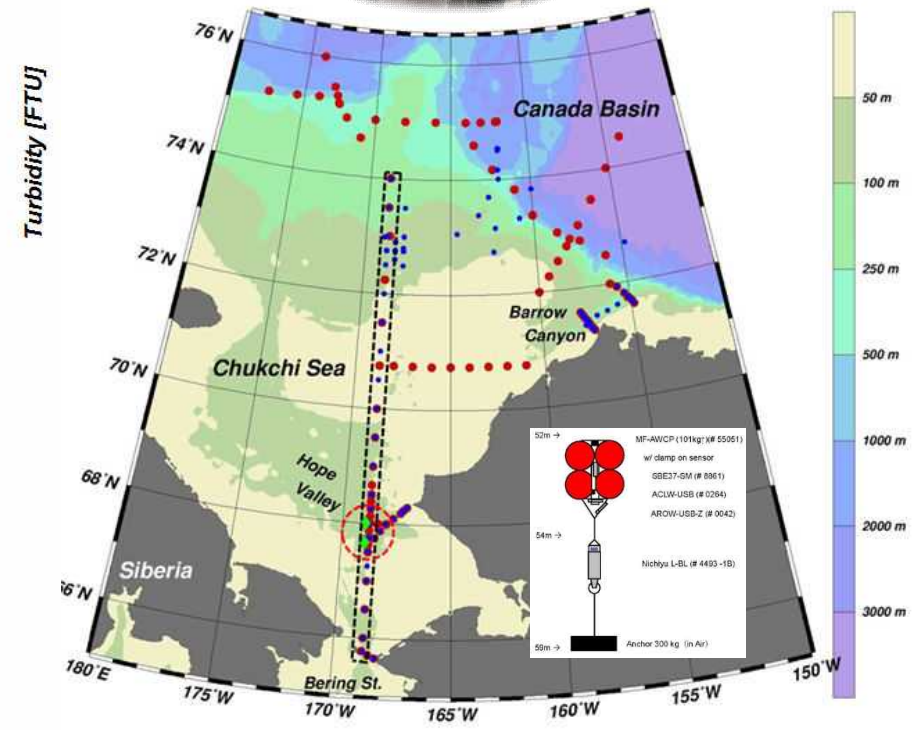
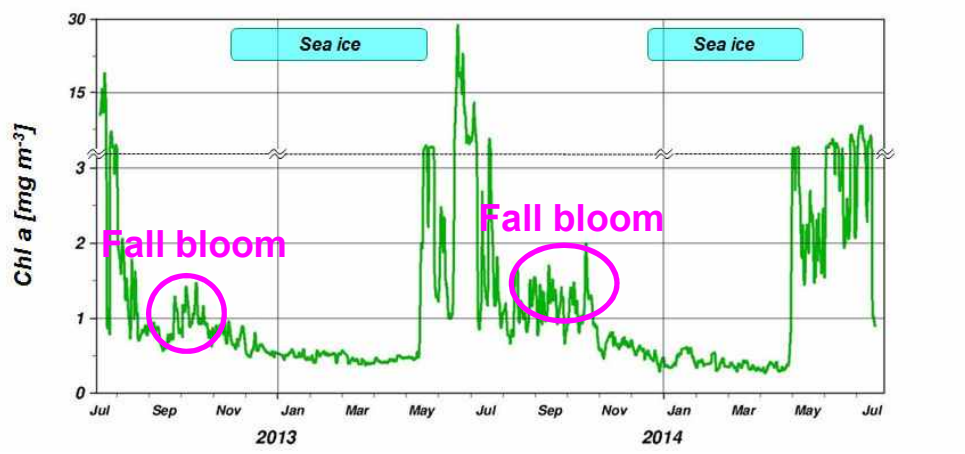
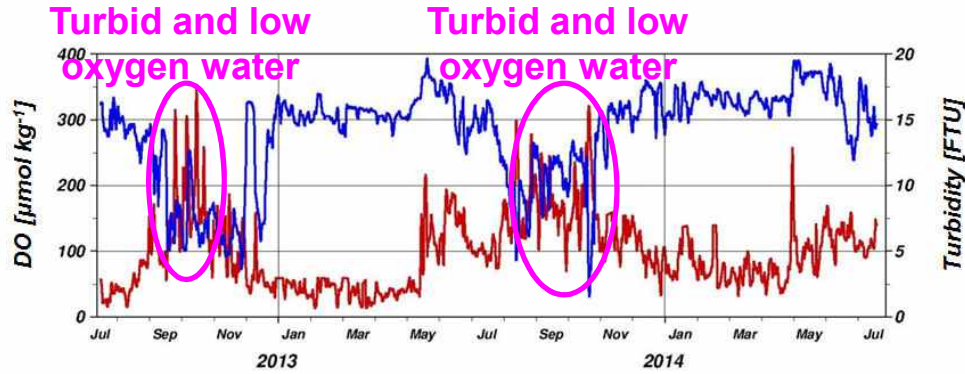
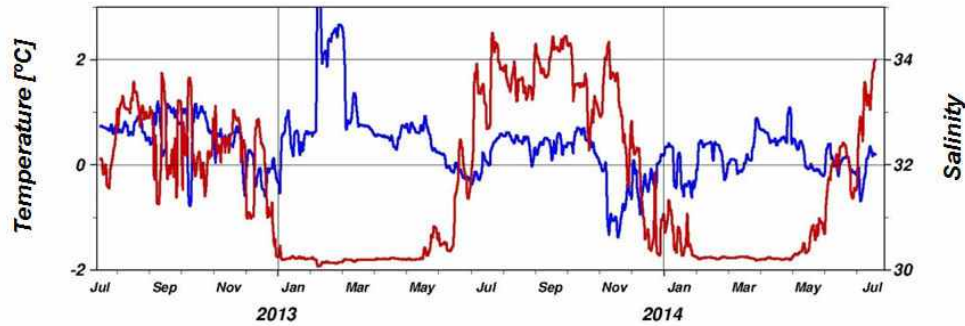
2013



# Arctic Eis (7Aug-24 Sep): near bottom nutrients



# DBO3 moorings during July 2012 to July 2014



[Nishino et al., 2015b]

# Mooring observations at DBO-5

● Publication

Itoh et al. (2015, DS



Water properties, heat and volume  
 Canyon during summer 2010

Motoyo Itoh <sup>a,\*</sup>, Robert S. Pickart <sup>b</sup>, Takashi Kikuchi <sup>c</sup>,  
 Daisuke Simizu <sup>c,d</sup>, Kevin R. Arrigo <sup>e</sup>, Svein Va  
 Jeremy T. Mathis <sup>h</sup>, Shigeto Nishino <sup>a</sup>, Carolina

<sup>a</sup> Japan Agency for Marine-Earth Science and Technology, Yokosuka, Kanagawa  
<sup>b</sup> Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA  
<sup>c</sup> Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan  
<sup>d</sup> National Institute of Polar Research, Tachikawa, Japan  
<sup>e</sup> Department of Environmental Earth System Science, Stanford University, Sta  
<sup>f</sup> Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, British Col  
<sup>g</sup> Polar Research Institute of China, Shanghai, China  
<sup>h</sup> NOAA Pacific Marine Laboratory, Seattle, WA 98115, USA

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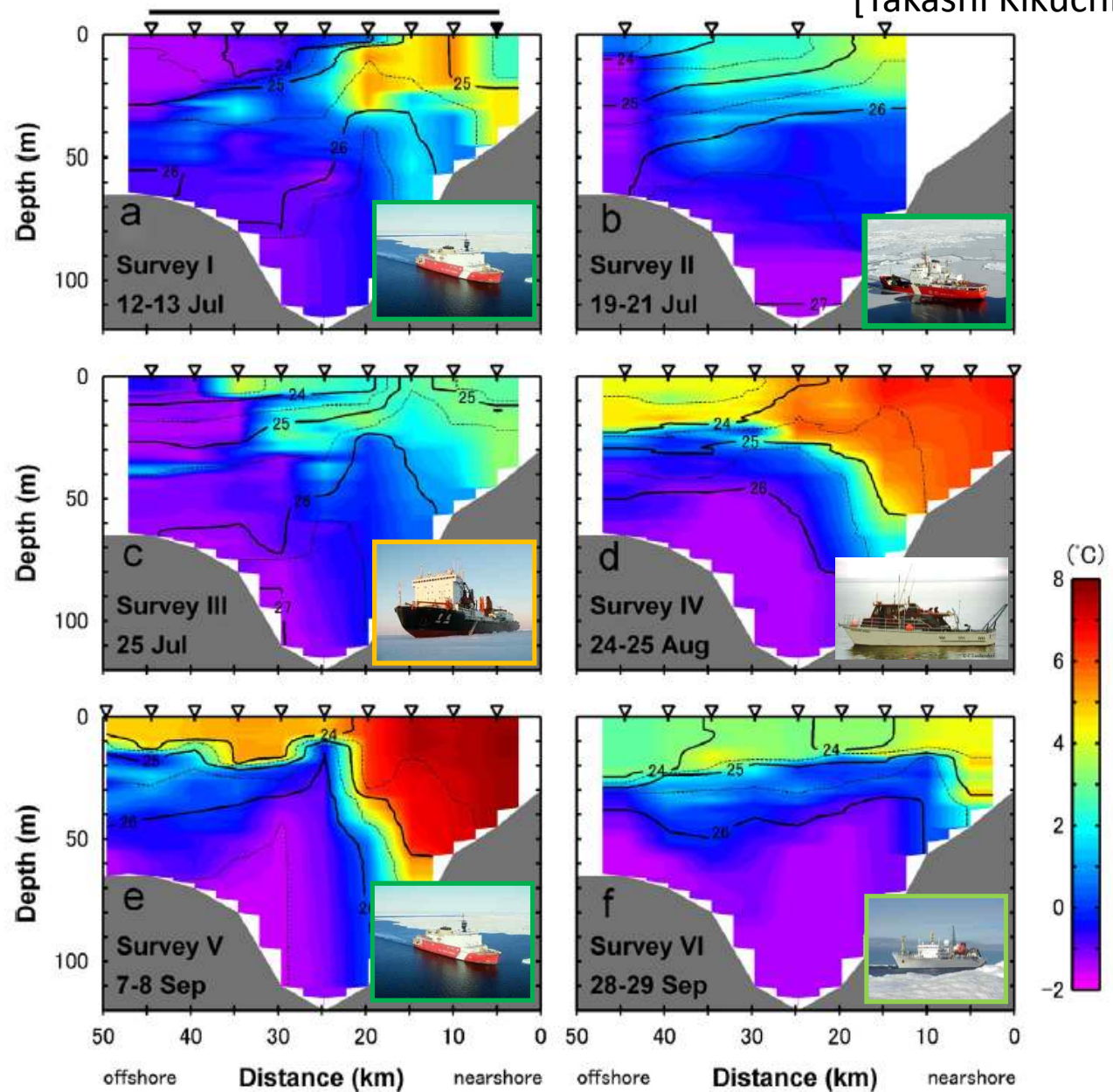
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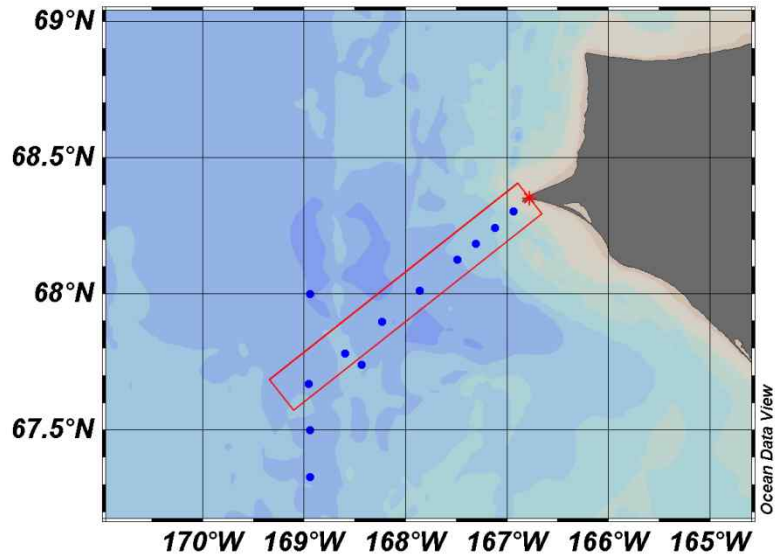
Keywords:  
 Polar oceanography  
 Arctic Ocean  
 Chukchi Sea  
 Heat fluxes  
 Volume transports  
 Water properties

ABSTRACT

Over the past few  
 Arctic basin, likely  
 Strait. Barrow Cany  
 water enters the  
 hydrographic/velo  
 water masses feed  
 Pacific winter wat  
 through the canyo  
 water (ACW and B  
 from 8.56 TW to 2  
 supplemental moo  
 weather station, w  
 period, which is w  
 2010 was estimat  
 amount of heat cr  
 summer sea ice re  
 © 2015 The Auth

[Takashi Kikuchi]

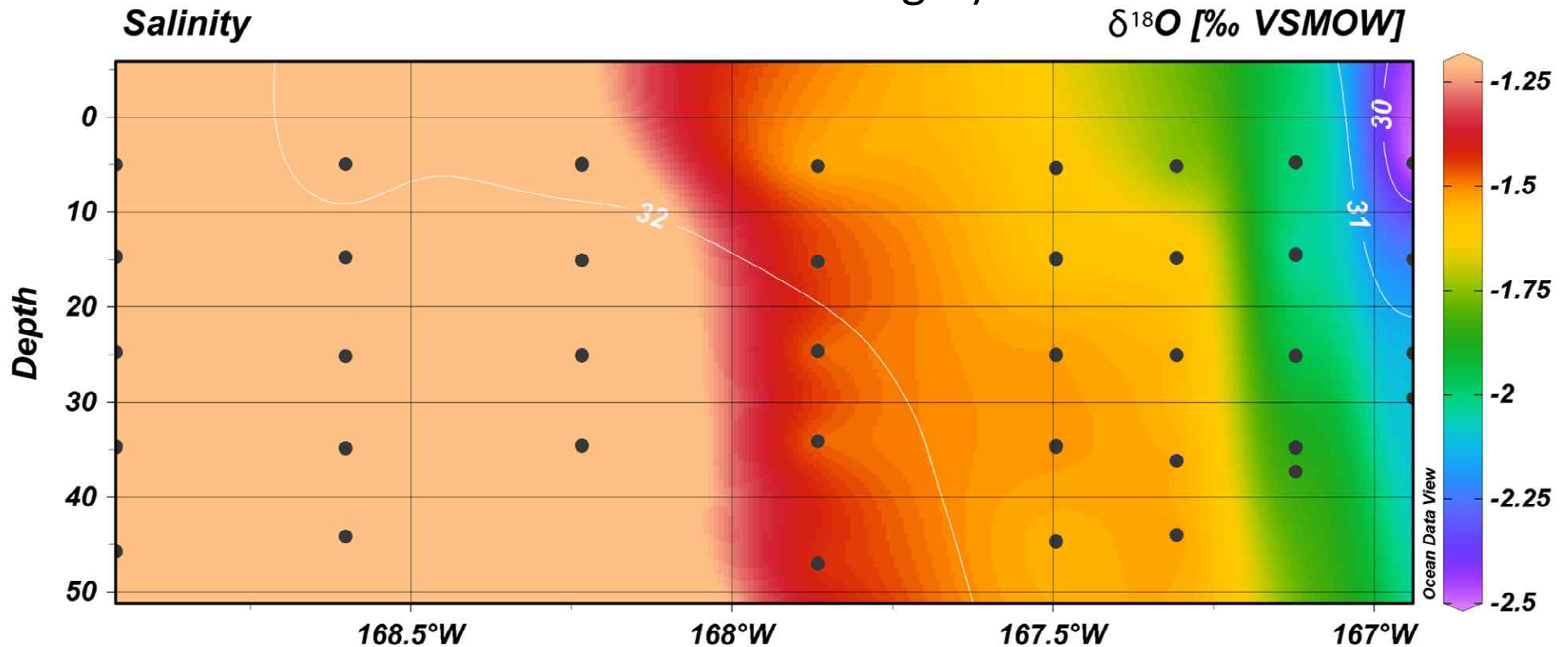


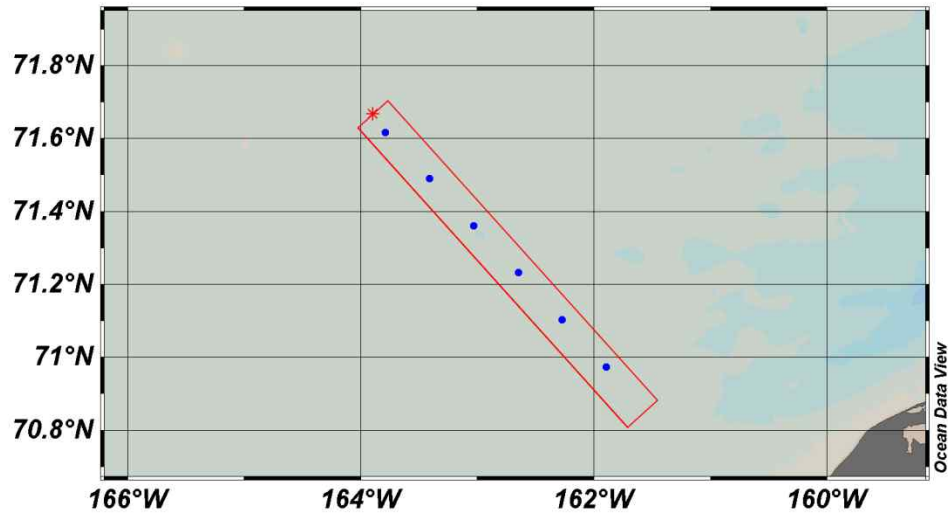


## SWL15 DBO 3

[Lee Cooper]

Interpretation: No sea ice melt, water mass gradient. Anadyr to Bering Shelf Water to Alaska Coastal Water (left to right)



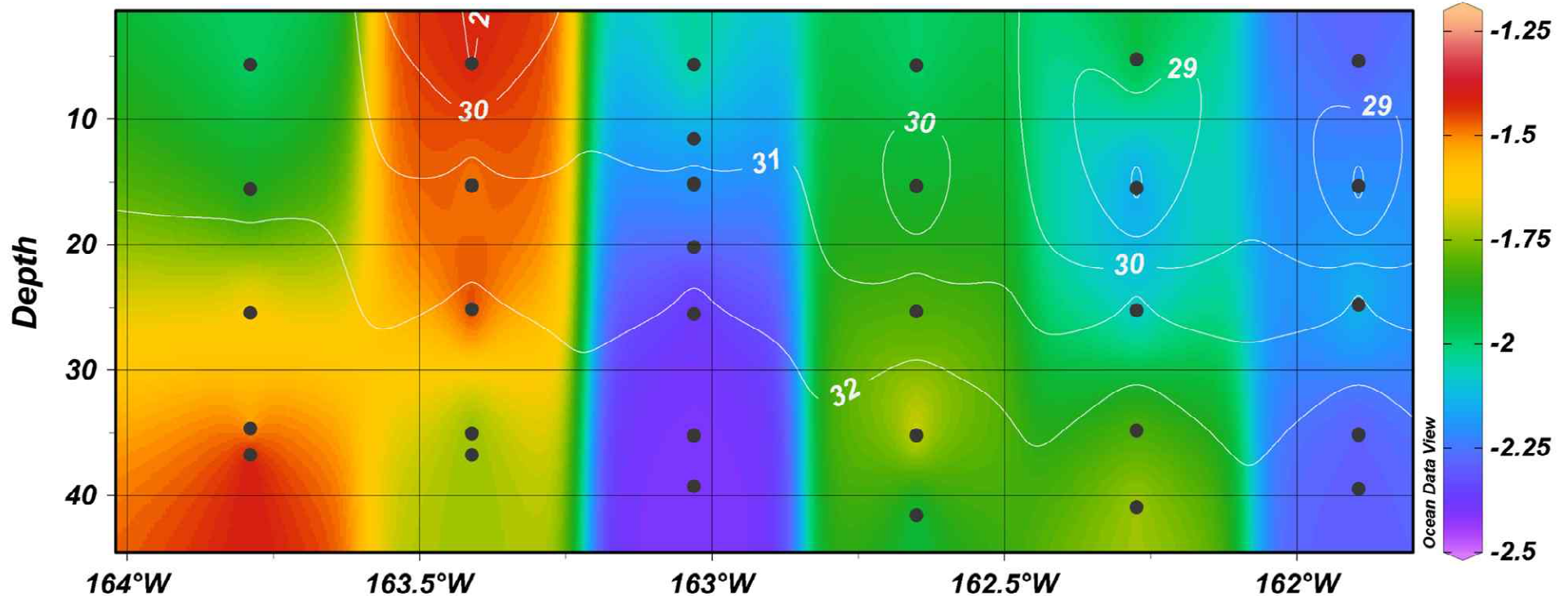


## SWL15 DBO 4

[Lee Cooper]

Interpretation: Sea ice melt present (particularly orange colors at surface), Alaska Coastal Water to the right the right  $\delta^{18}\text{O}$  [‰ VSMOW]

### Salinity

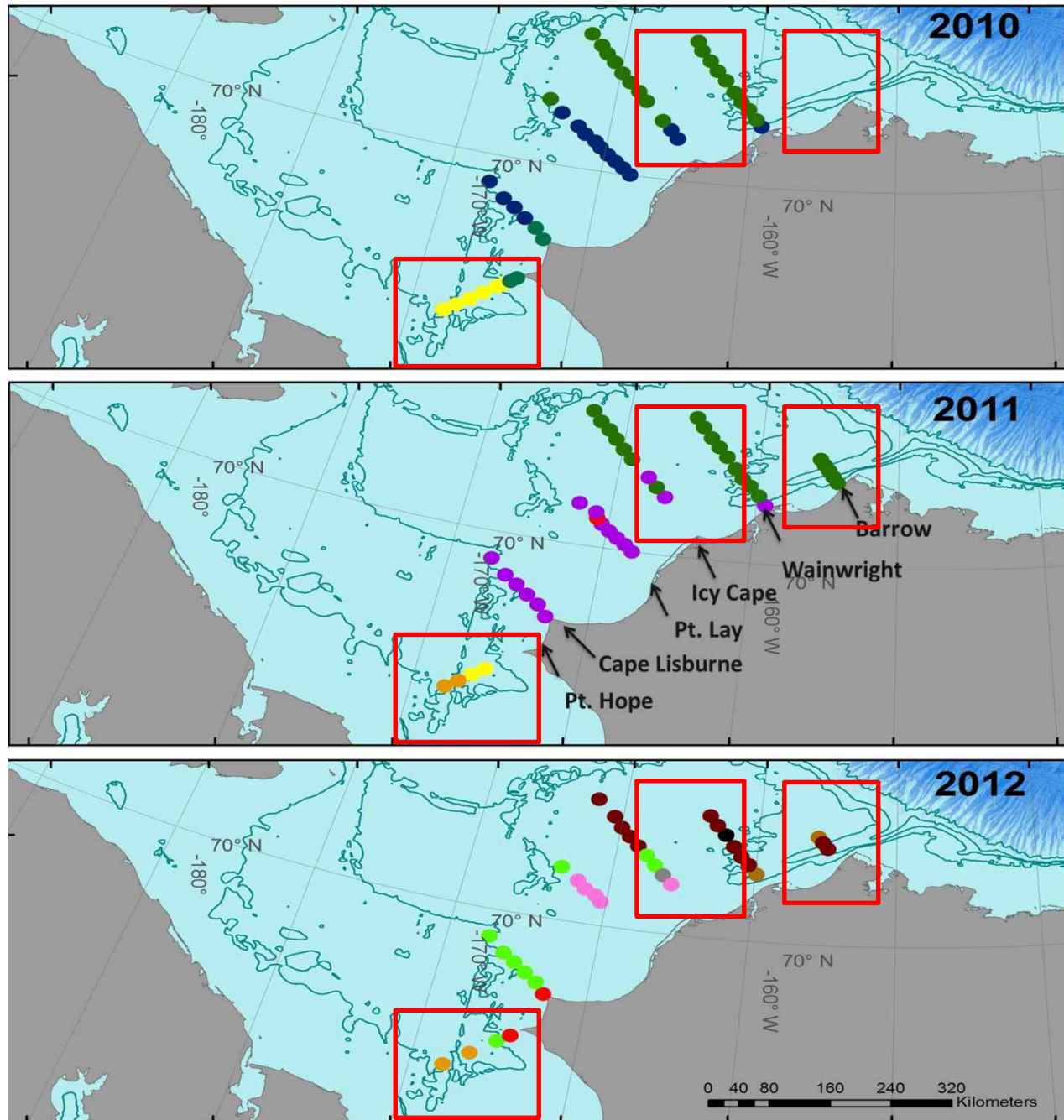


# CHAOZ data: Zooplankton community cluster analysis

Dark green:  
larvaceans  
cnidarians  
cirripedia  
*Pseudocalanus spp.*  
*Oithona spp.*

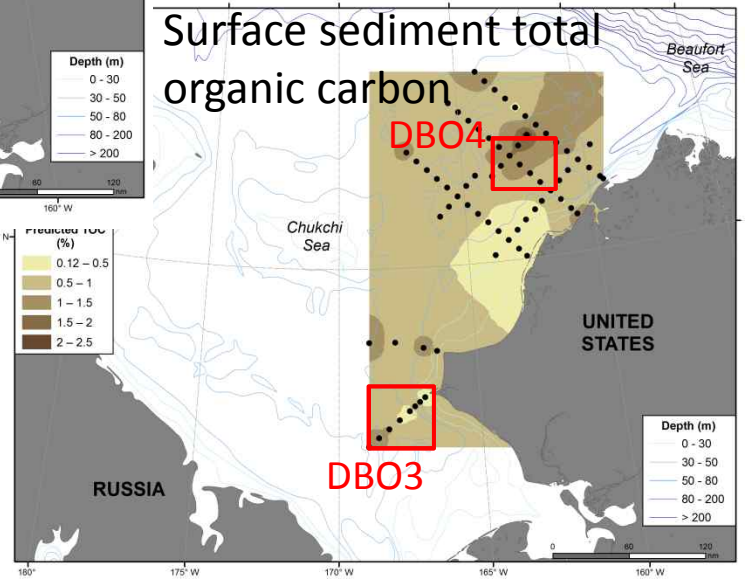
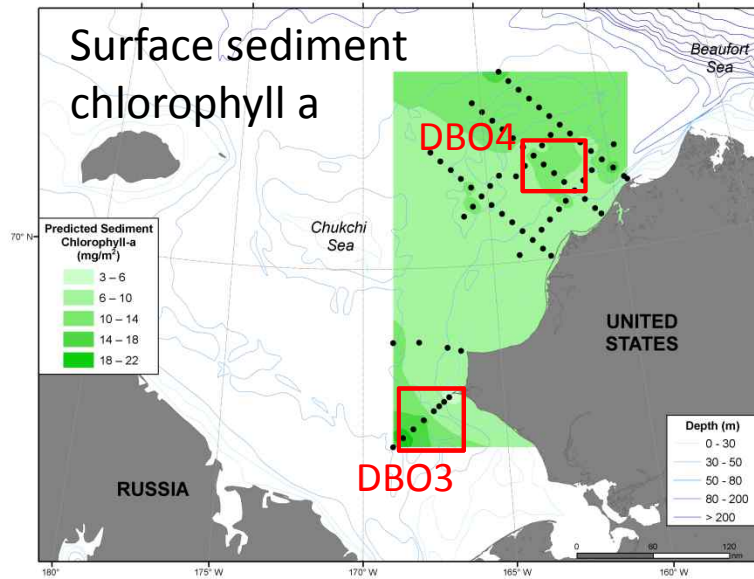
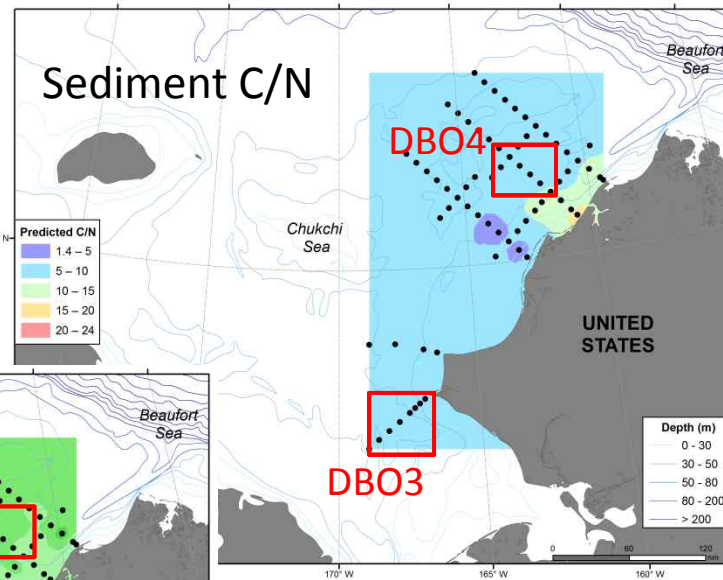
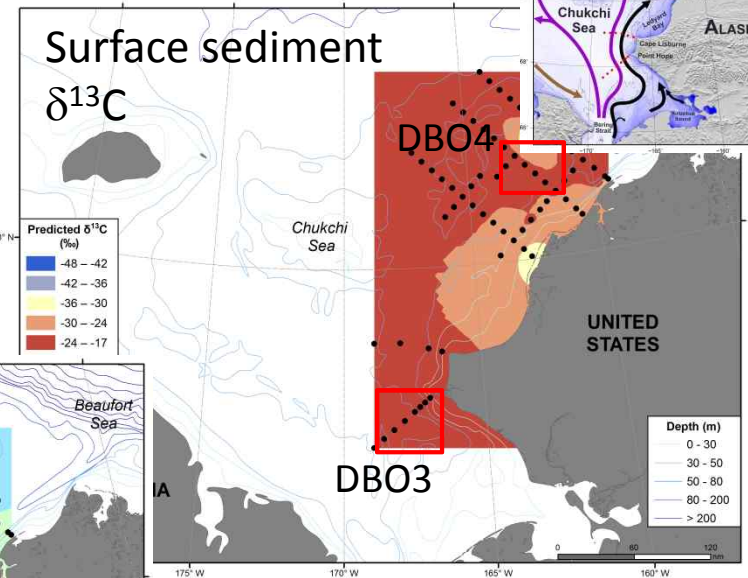
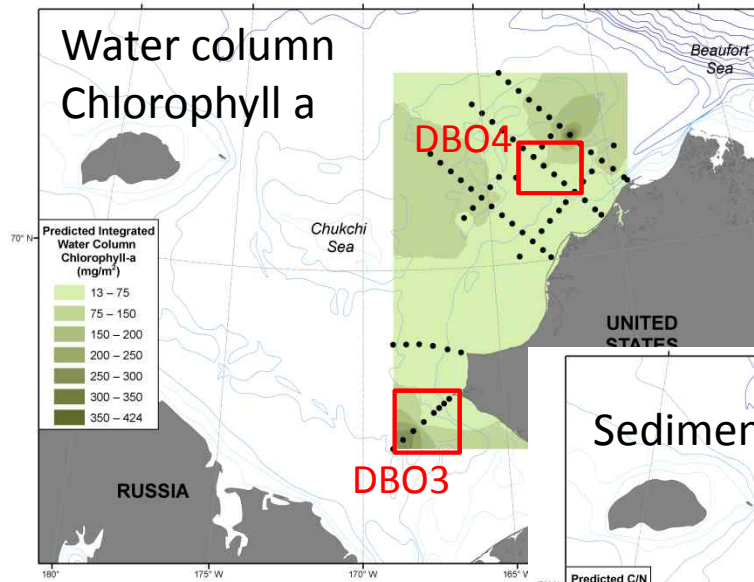
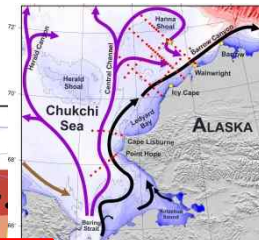
Dark red:  
*Calanus glacialis*

Dark Blue:  
cladocerans  
thecosomata





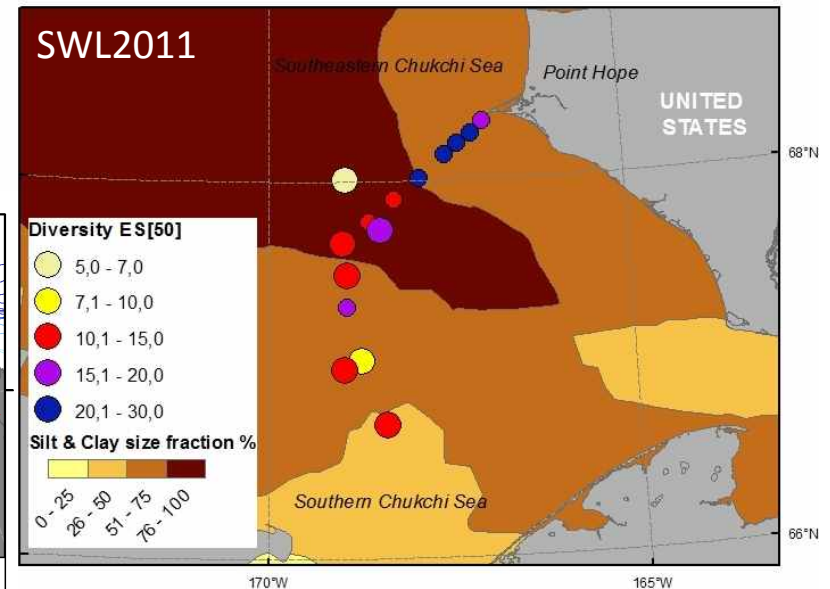
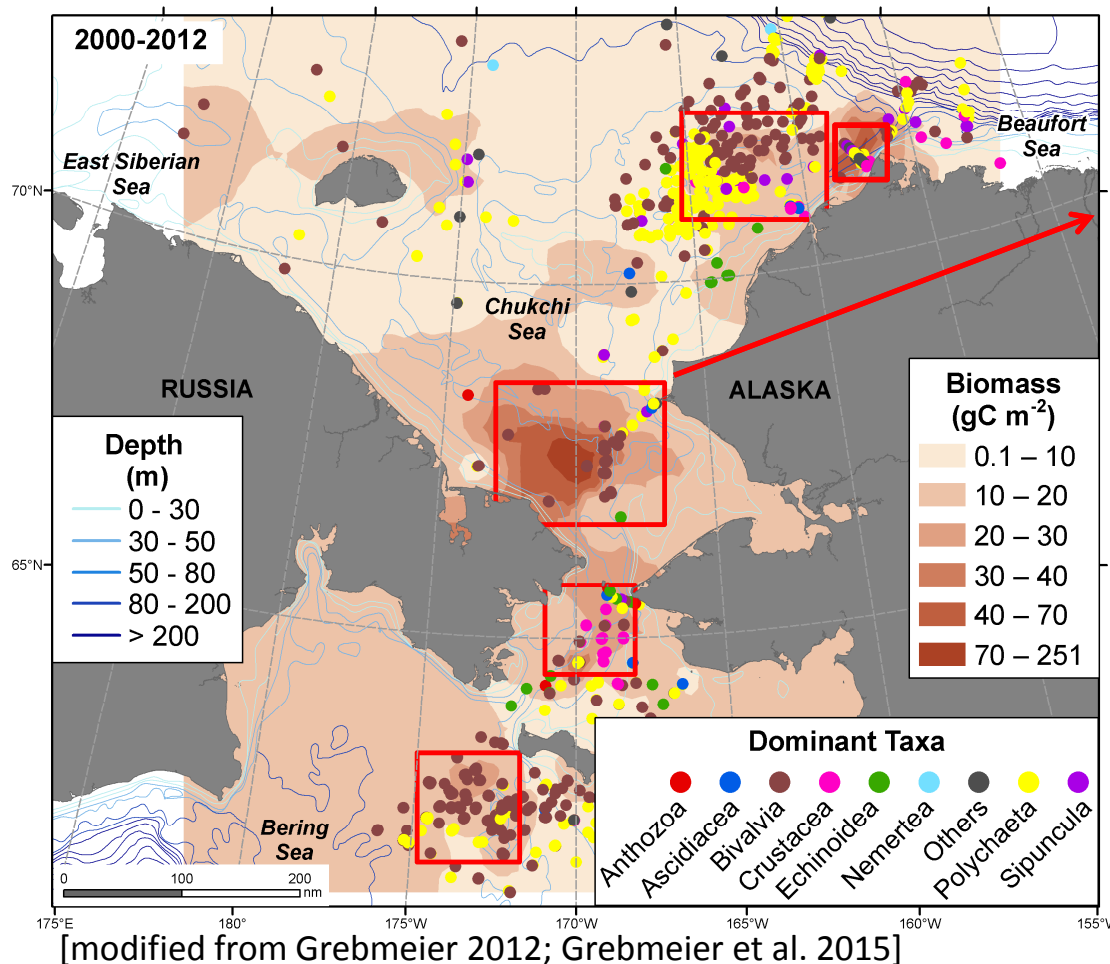
# Arctic Marine Biodiversity Observing Network (AMBON) Aug-Sept 2015



[data from Grebmeier and Cooper]

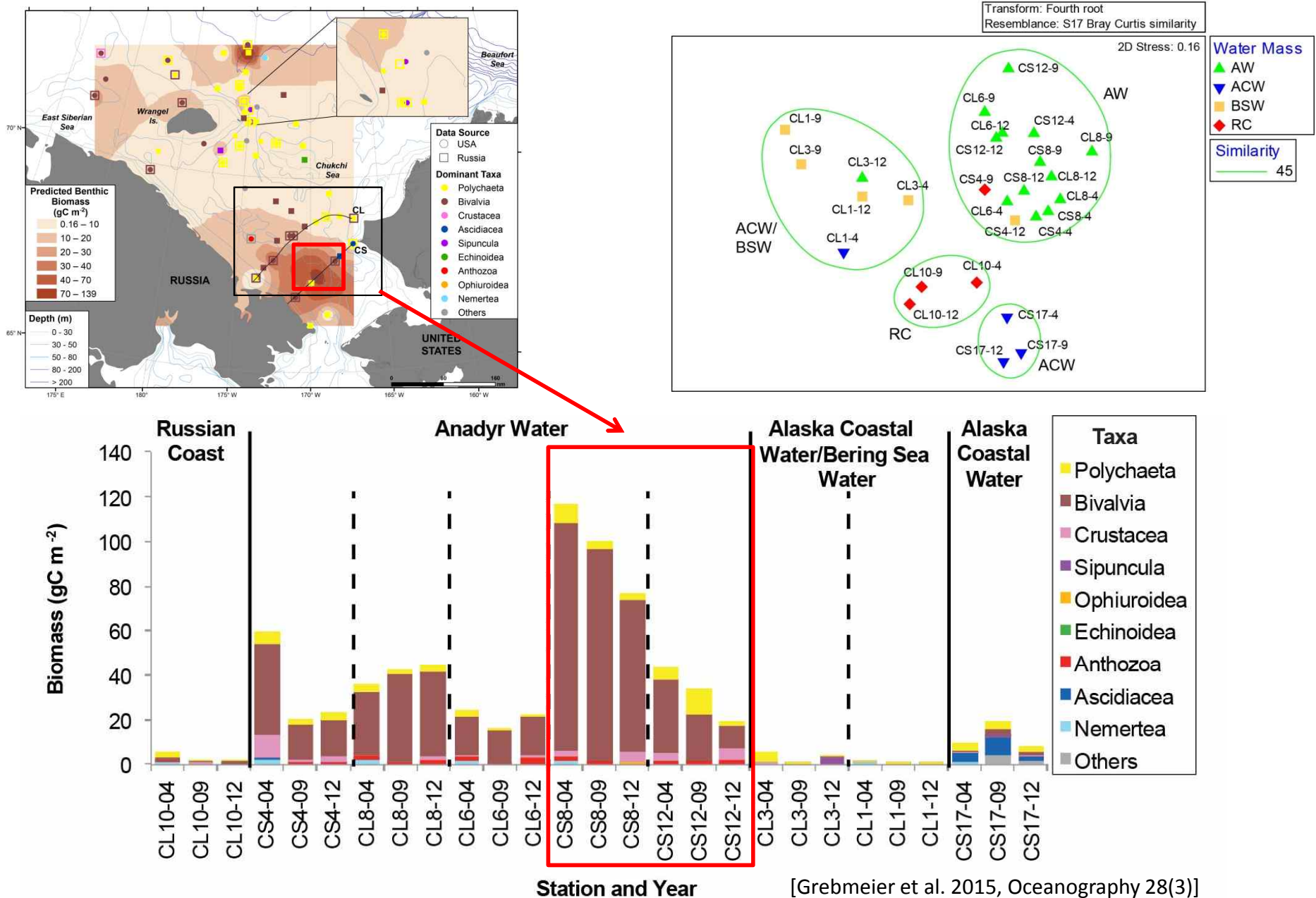
# Benthic biomass and dominant taxa in the Northern Bering and Chukchi Seas, with diversity on DBO 3

**Below:** Distribution of benthic biomass and dominant fauna, with DBO bounding boxes

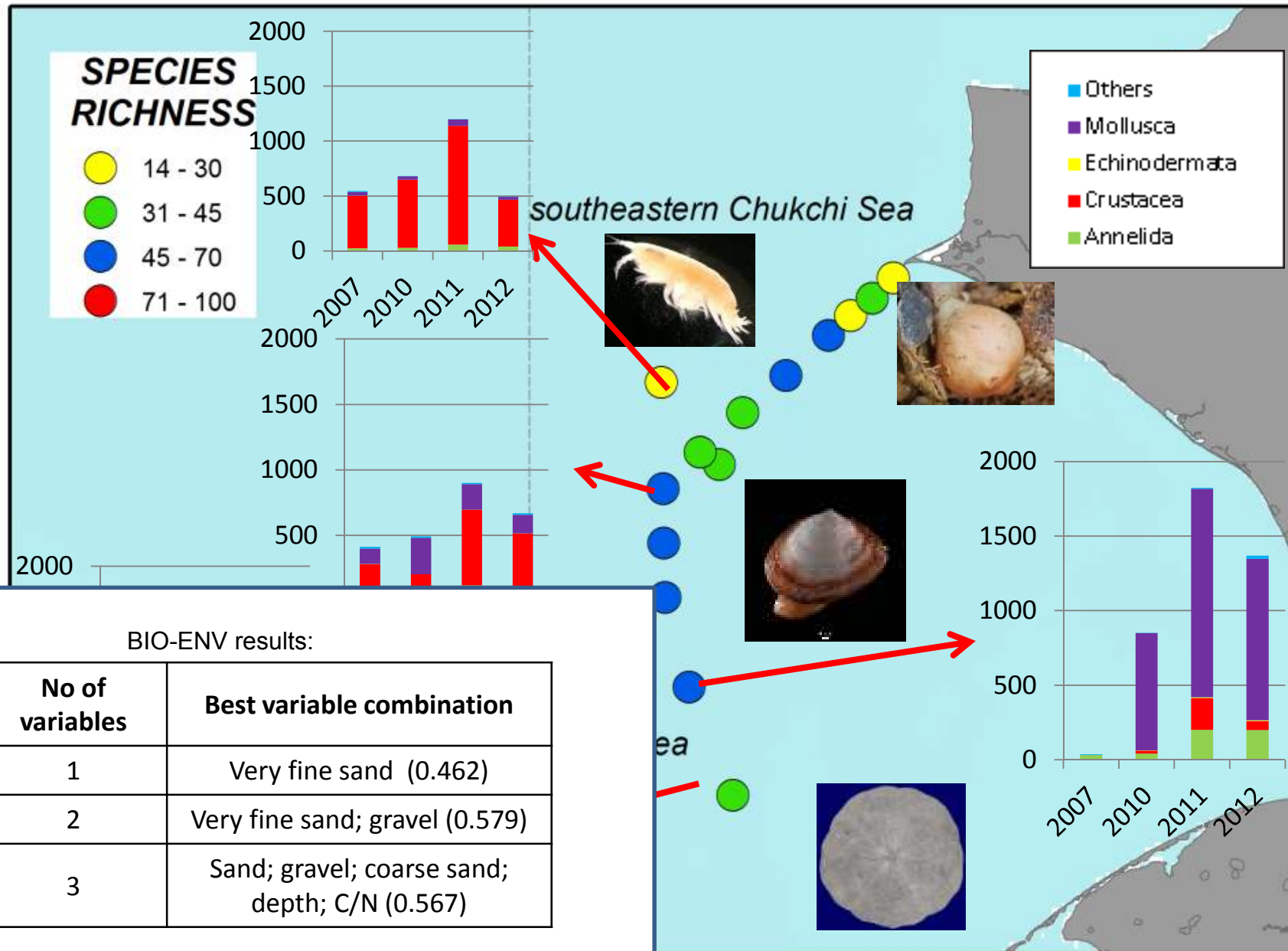


**Above:** Diversity values highest in coarse, nearshore sediments, with lower values in finer, silt and clay sediment  
 [courtesy Monika Kedra, Institute of Oceanology Polish Academy of Sciences]

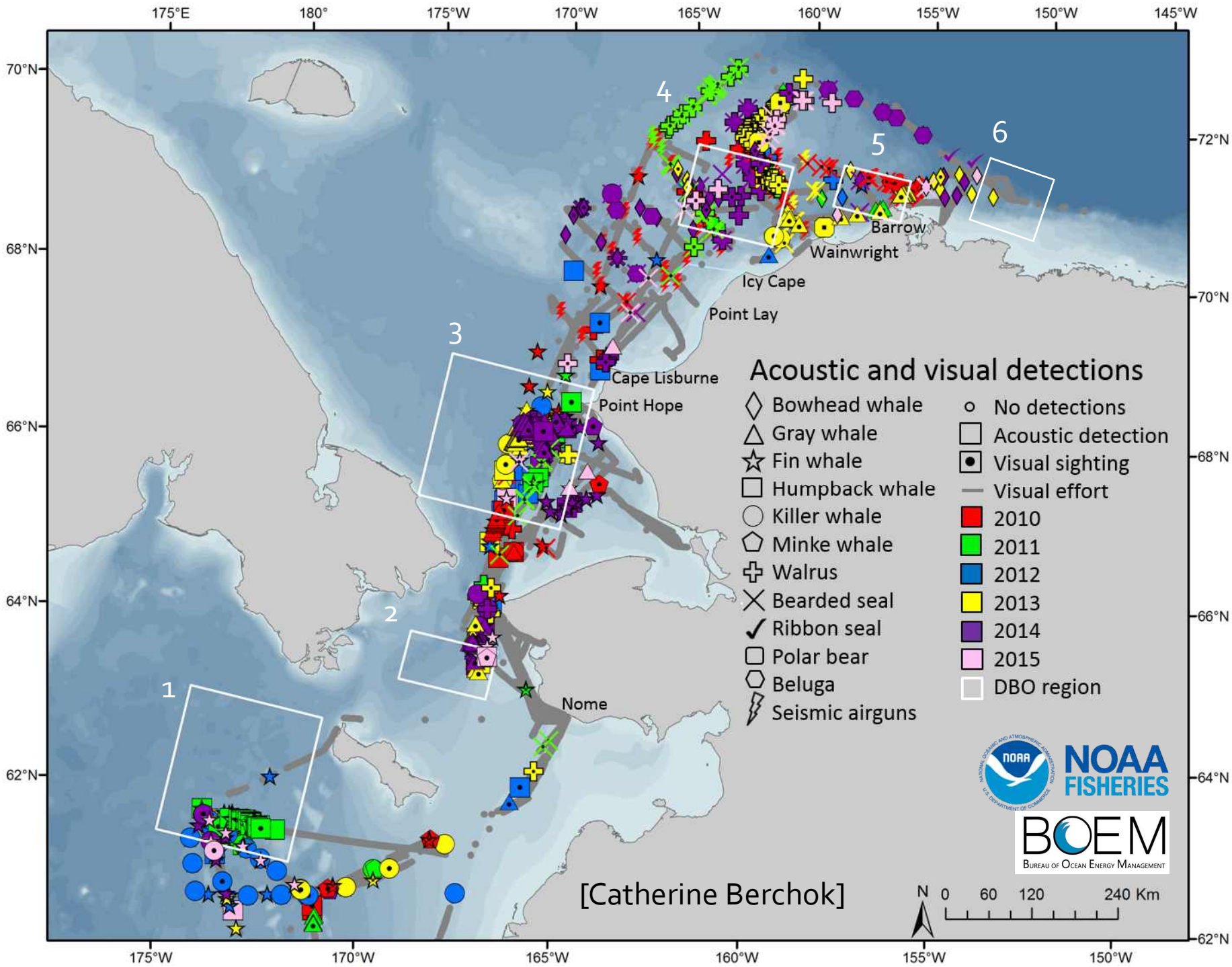
# DBO3-RUSALCA Time Series Site, Macrofaunal Similarity Clustering



# DBO site #3: Southern Chukchi Sea

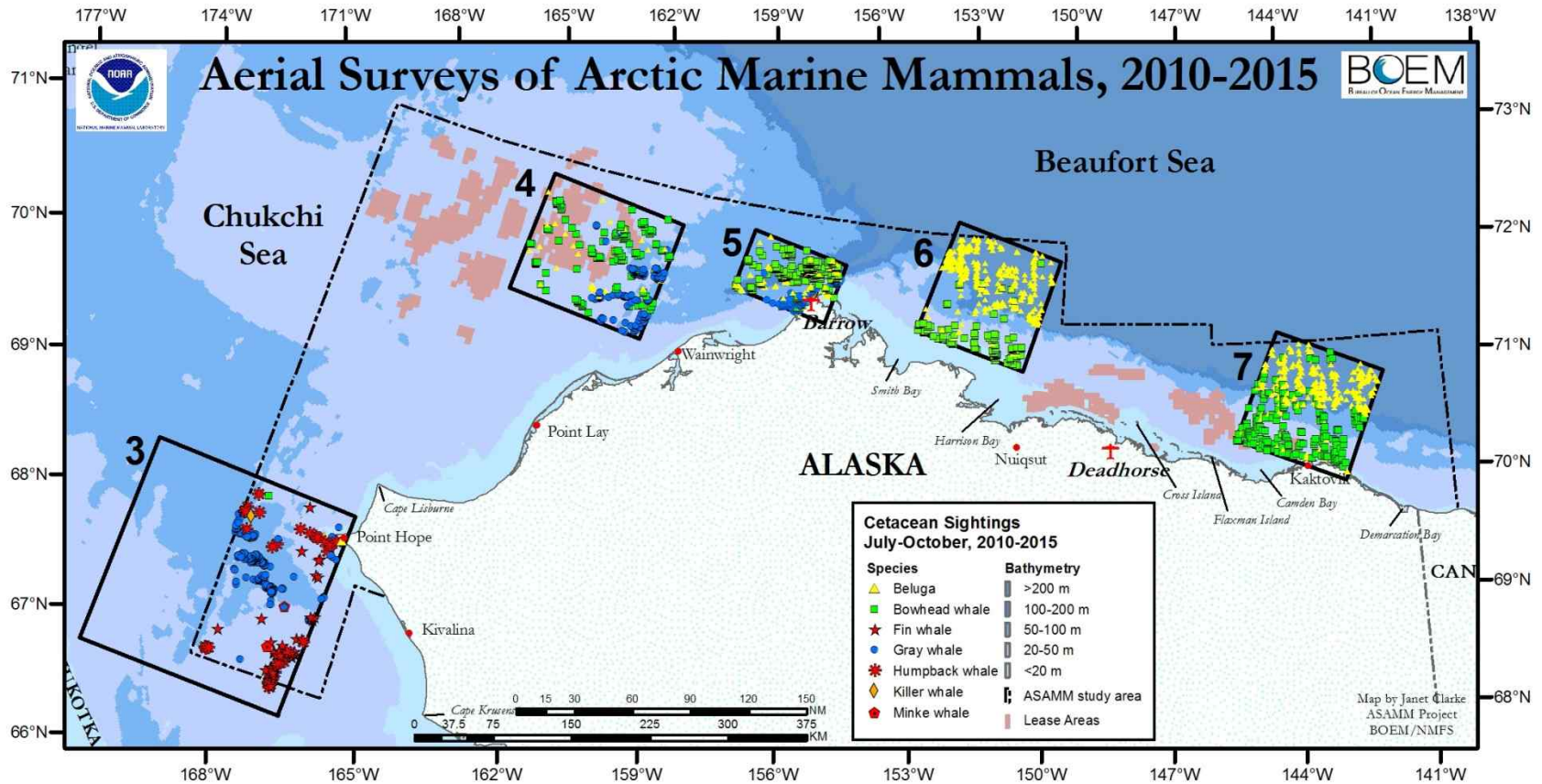


[M. Kedra and J. Grebmeier]



# ASAMM JULY-OCTOBER 2010-2015 Cetacean Sightings

## DBO 3, 4, 5, 6, and 7



**DBO-3 – gray whale hot spot, subarctic cetaceans**  
**DBO-4 and DBO-5 – bowhead whales, gray whales, belugas**  
**DBO-6 and DBO-7 – bowhead whales, belugas**

[Janet Clark]

## ASAMM JULY-OCTOBER 2010-2015 CETACEAN SIGHTINGS

**ASAMM data 1979-2013 are available at:**

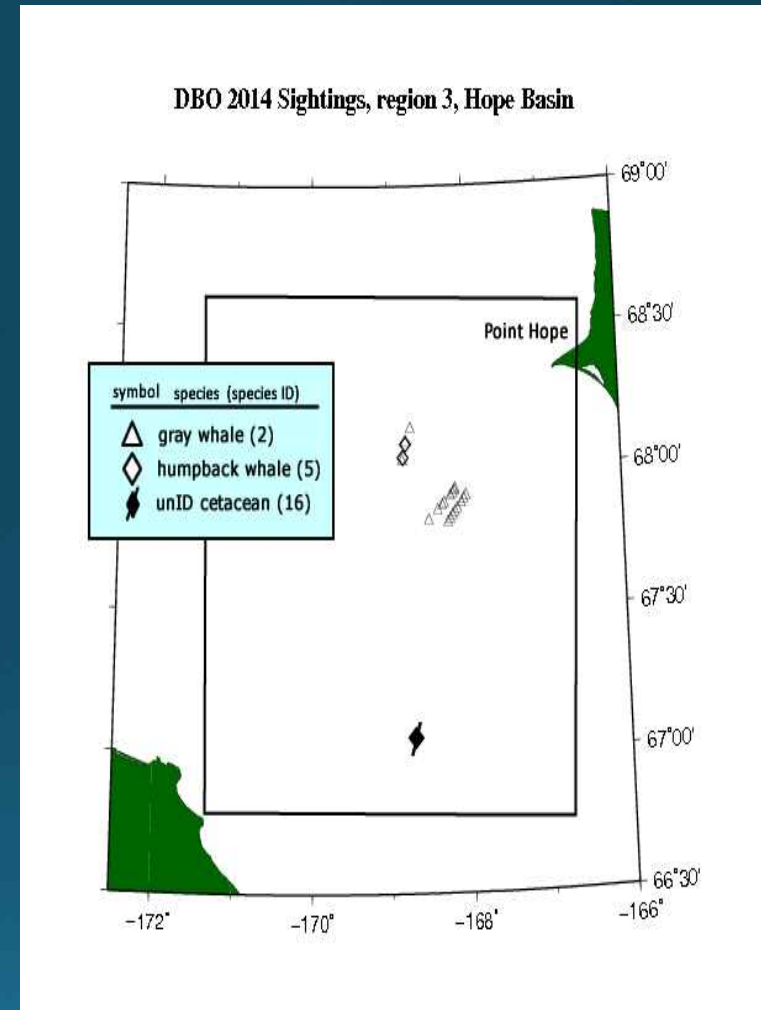
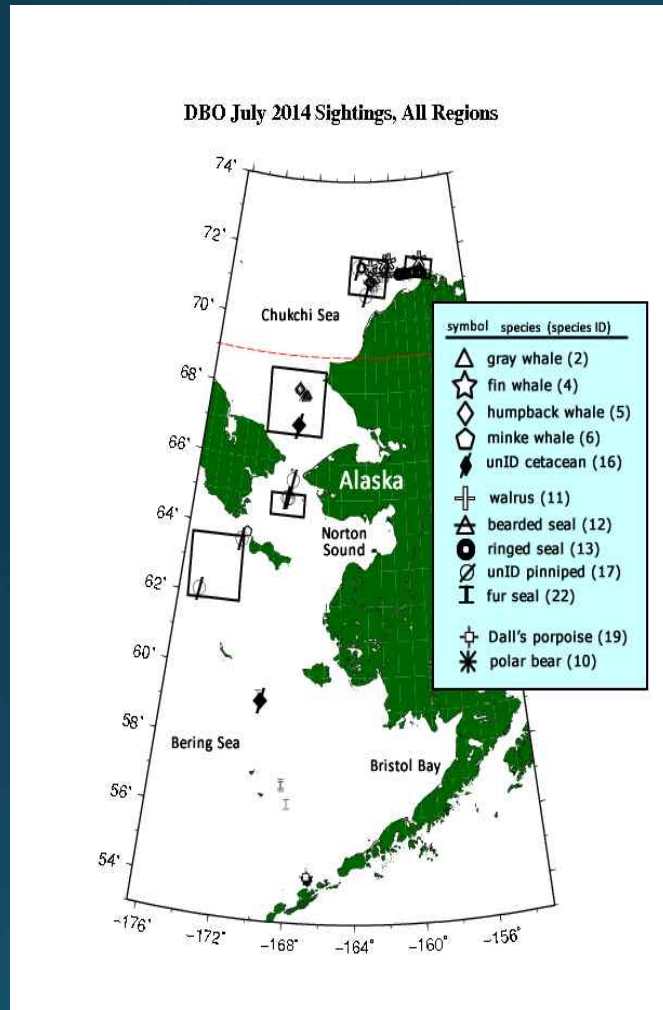
**<http://www.afsc.noaa.gov/NMML/cetacean/bwasp/>**

**The metadata has also been submitted to the EOL BDO Data Archive, which references the above URL.**

**The data are publicly available, and we encourage all to use the ASAMM dataset.**

**We also strongly suggest that you contact Megan Ferguson ([megan.ferguson@noaa.gov](mailto:megan.ferguson@noaa.gov)) or Janet Clarke ([janet.clarke@leidos.com](mailto:janet.clarke@leidos.com)) if you have any questions about the data.**

# Laurier - Marine Mammal Watch – July 2014



Sighting maps & data available on AOOS/AXIOM DBO Workspace

[Sue Moore]



# Seabird Surveys

PI: Kathy Kuletz (USFWS)

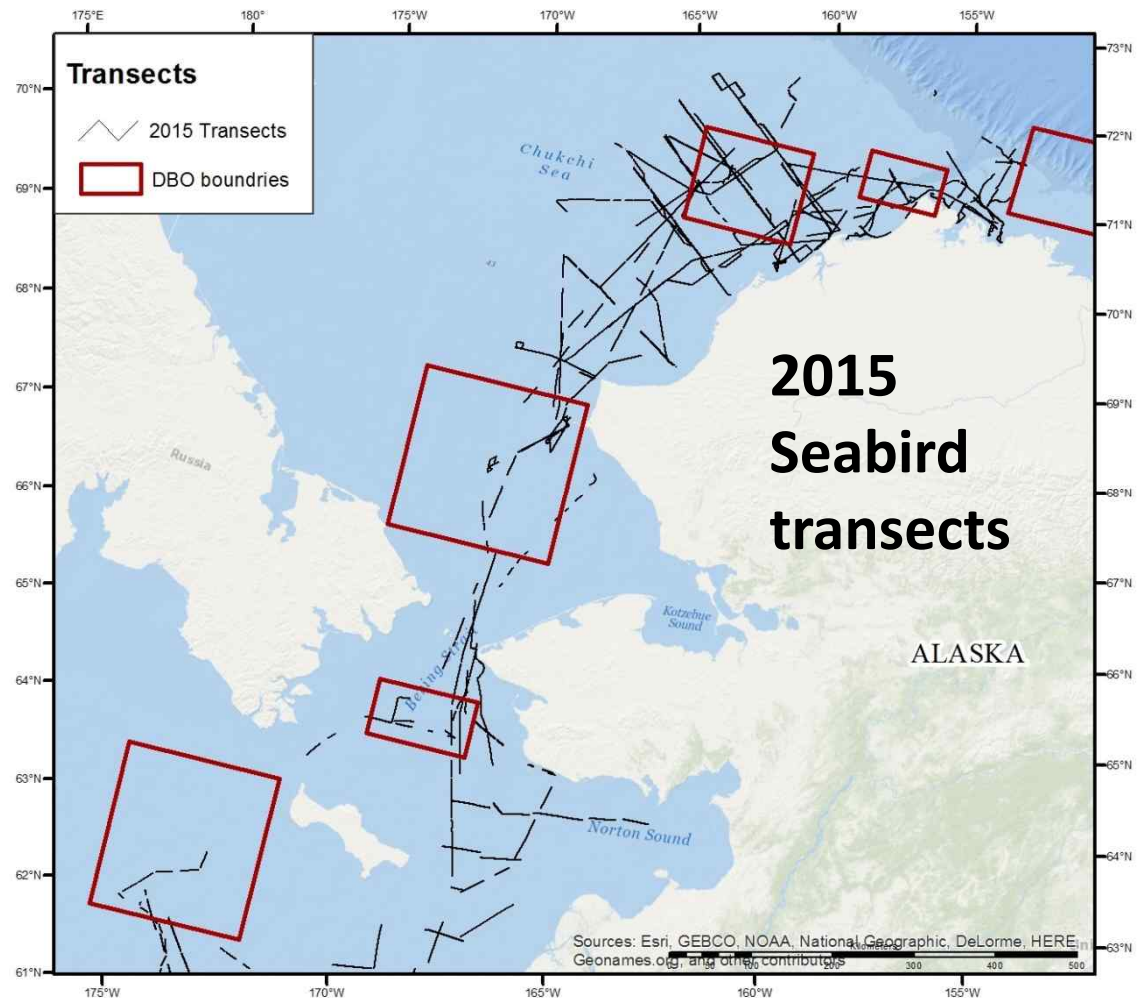
Funding: BOEM, NPRB, USFWS

Collaborators:

NOAA, U.Alaska, U.Mass, USCG,  
Environment Canada, ABR Inc., others



- Depend on ships of opportunity
- Join 3-8 cruises / year in Arctic
- **Goals:**
- Describe spatial/seasonal distribution & spp composition
- Identify physical & biological factors that drive seabird distribution & abundance

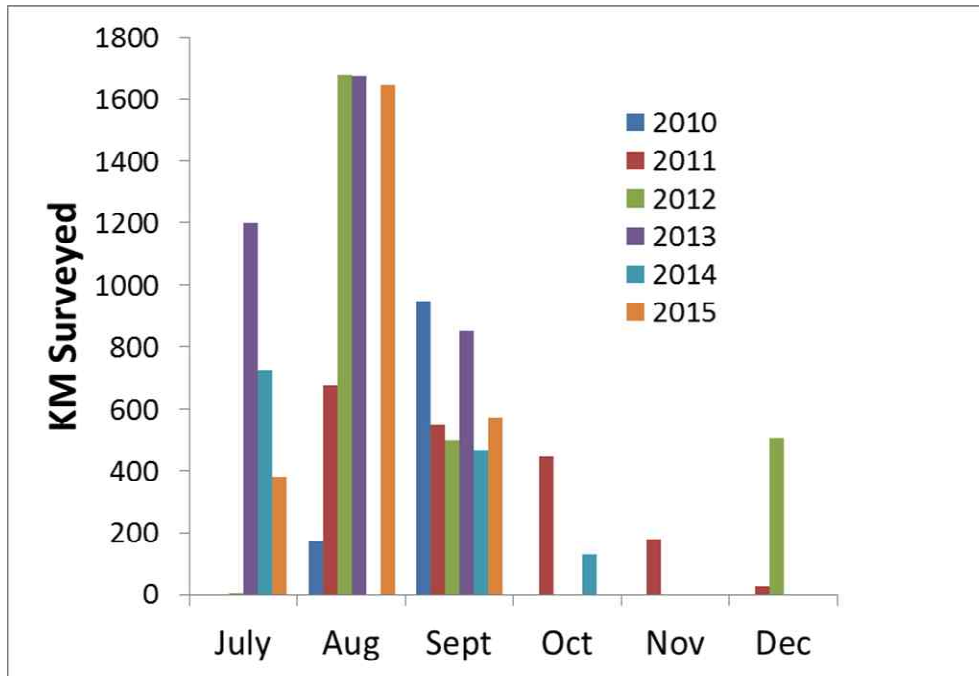


**In 2015**

**15,506 km** surveyed in Alaska waters

**10,160 km** surveyed in N. Bering & Arctic

**2,601 km** surveyed within DBO boxes



## 2010 – 2015 Seabird surveys

Seasonal:

Most surveys in **July – Sept**

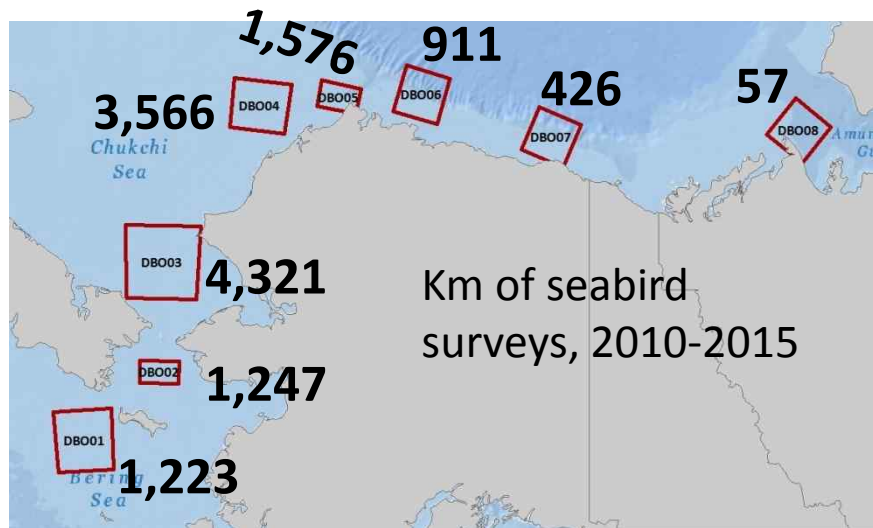
Greatest coverage – **August**

Spatial:

Greatest coverage (Km)

in DBO3, DBO4

**DBO5 = highest density of transects**



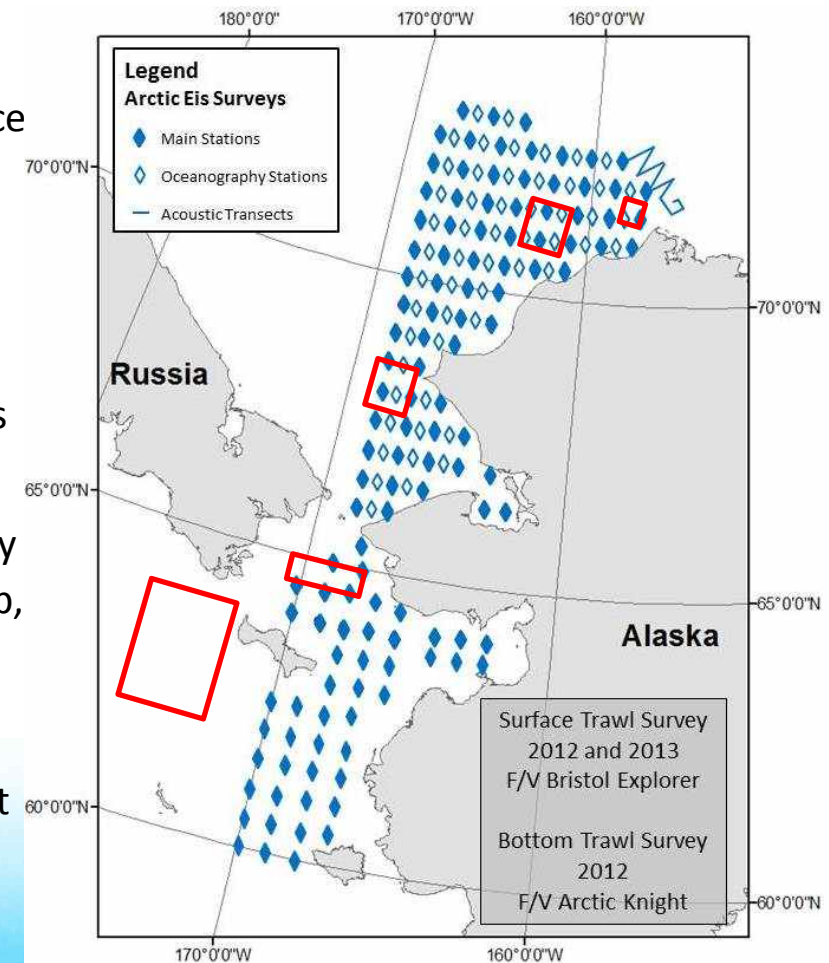
**Best focus for analysis:**

**Aug-Sept, DBOs 2,3,4,5**

# Arctic Ecosystem Integrated Survey

**How:** Three surveys sampling a 30x30 mile grid:

- 2012 and 2013 - The F/V *Bristol Explorer*, conducts surface trawl (top 65'), mid-water trawl, and acoustic surveys to collect data on ocean circulation and physics, water chemistry, plankton, and fishes
- 2012 – The F/V *Alaskan Knight*, conducted bottom trawl surveys in the Chukchi Sea only to collect demersal fishes and invertebrates
- All surveys collect tissue samples and whole fish to study the biology of salmon, Arctic cod, saffron cod, snow crab, capelin, and other fish & invertebrates



Climate impacts on the marine ecosystem, what do we expect in the future (in terms of fish distribution and fishery potential).

Principal Investigators: NOAA- Ed Farley, Bob Lauth

UAF- Fran Mueter- Project Manager Jared Weems

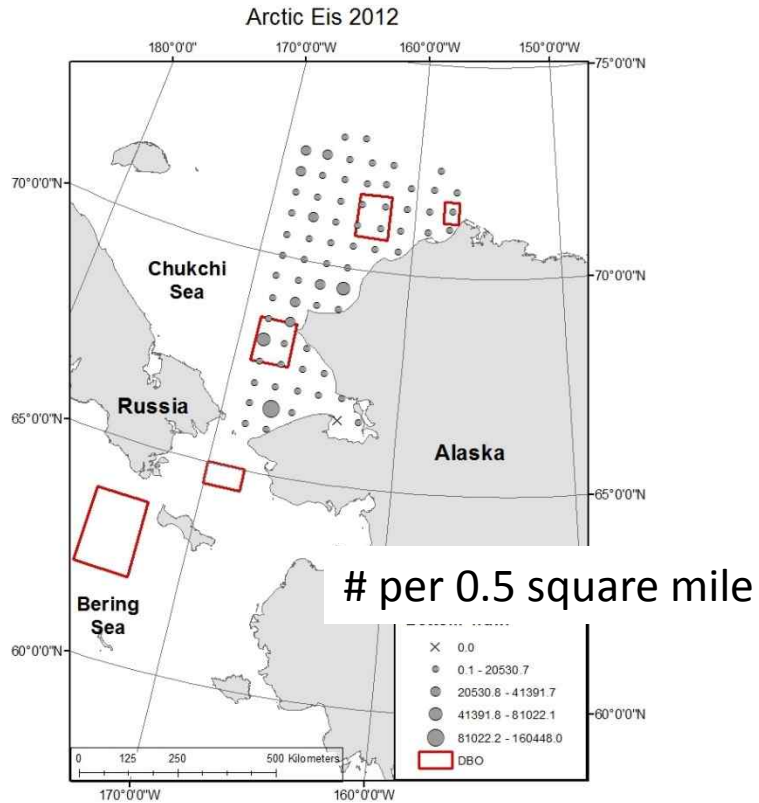
USFWS- Kathy Kuletz - Seabirds



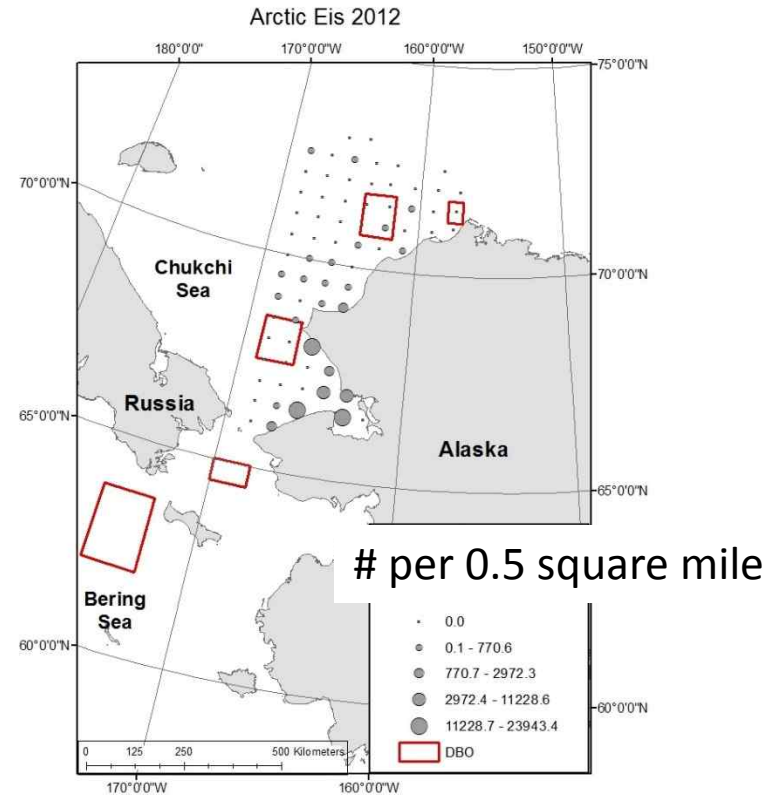
Photo by Elizabeth Calvert Siddon (NOAA/UAF)

# Summer Bottom Distribution and Abundance of Older Arctic and Saffron Cod in Relationship to DBO's

Arctic cod



Saffron cod



Data are from the Arctic Ecosystem Integrated Survey - see <https://web.sfos.uaf.edu/wordpress/arcticeis/> for more information

## **Special DSR Issue-The DBO: A Change Detection Array in the Pacific Arctic Region: 27 papers total (number of papers)**

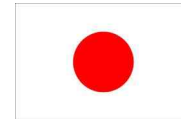
- The Distributed Biological Observatory as a Marine Change Detection Array in the Pacific Arctic: An Introduction (1)
- Satellite observations (2)
- Physical oceanography (2)
- Moorings (physical and biochemical sensors) (3)
- Hydrography and primary production (2)
- Phytoplankton size class and composition (3)
- Zooplankton populations (2)
- Benthic macrofauna and sediment parameters, biodiversity, food web structure (4)
- Benthic epifauna composition and diversity (1)
- Fish (1)
- Seabirds (2)
- Marine mammals (2)
- Modeling (1)
- International collaboration, data sharing and visualization (1)
- Future and DBO Implementation (1)

# Implementation of the Distributed Biological Observatory (DBO)

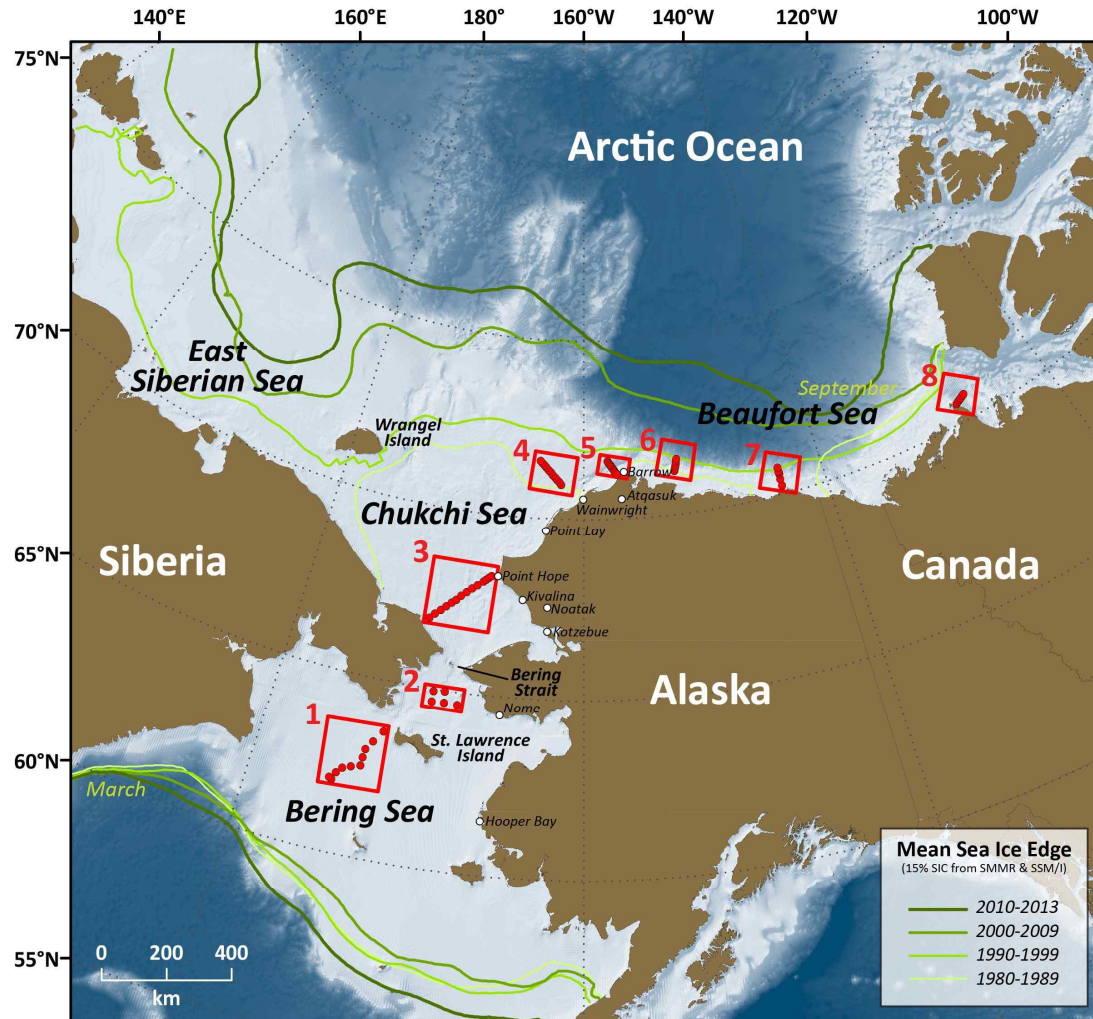


[modified by Karen Frey from Grebmeier et al. 2010, EOS 91]

- Data Sharing Site Established and Supported Through NSF at Earth Observations Laboratory, UCAR: [dbo.eol.ucar.edu](http://dbo.eol.ucar.edu)
- Data Policy Protocol Approved by International Partners. 2015 [http://dbo.eol.ucar.edu/data\\_policy-dbo.html](http://dbo.eol.ucar.edu/data_policy-dbo.html)
- Collaboration Team chaired by Jackie Grebmeier and Sue Moore through US IARPC meets monthly and coordinates US agency efforts. <http://www.iarpccollaborations.org/teams/Distributed-Biological-Observatory>

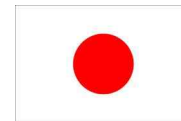


# Implementation of the DBO (continued)



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

- Pacific Marine Arctic Regional Synthesis (PacMARS) project (Shell and ConocoPhillips funding via NPRB funding) facilitated public sharing of annual Sir Wilfrid Laurier cruise data from 2000-present. Posted at EOL site
- DBO discussions at annual PAG meetings (Incheon, Korea in Oct 2015 and Fairbanks AK in Mar 2016); also data meeting in Seattle USA in Mar 2016 sponsored by Pacific Arctic Group and NOAA to share past and upcoming data collections and to coordinate
- Expansion of DBO-type efforts by Canada and Norway



# DBO Interagency Partners

**DBO**





# DBO IMPLEMENTATION PLAN

## ANNUAL CYCLE



[Sue Moore]

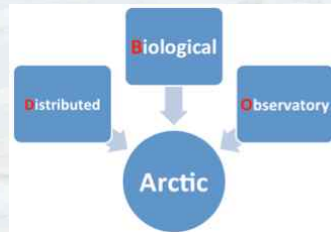
JG2

JG1

# Thank you for your attention.

## Questions and comments?

Thank you to all DBO collaborators, field and laboratory technicians over the years for the time series efforts. Financial support for the science provided by the US NSF, NOAA, BOEM, NASA, and ongoing international science partners in the Pacific Arctic Group.



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



## 슬라이드 34

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**JG2** Jackie Grebmeier, 2011-01-11

**JG1** Jackie Grebmeier, 2011-01-11