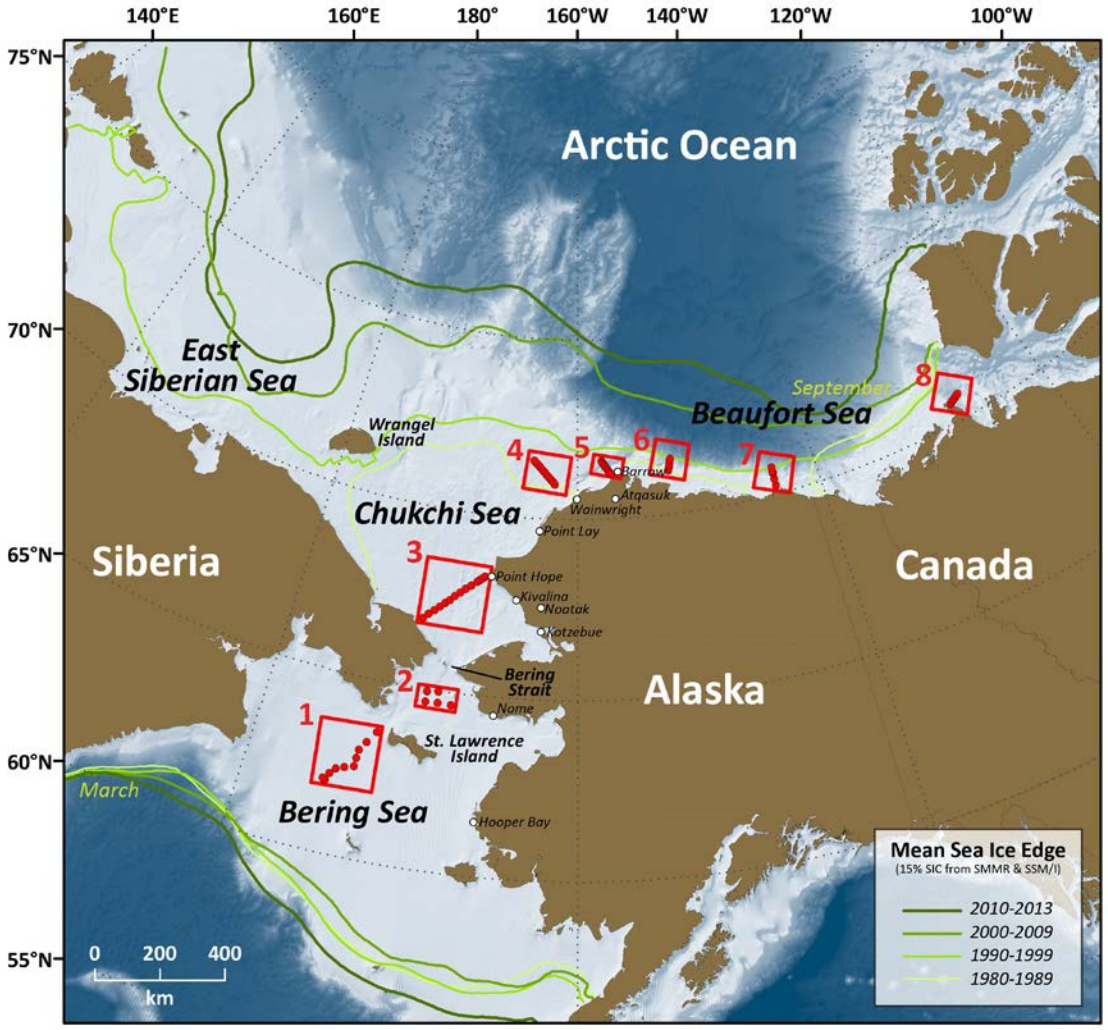
US Country Report

Jaccqueline Grebmeier
Member, PAG Executive Committee, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, Maryland, USA

Pacific Arctic Group Meeting
November 6, 2017
PMEL/NOAA
Seattle, Washington, USA

http://pag.arcticportal.org/

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



[updated 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 serve as a change detection array for the identification and consistent monitoring of biophysical responses**
- **Sites occupied by national and international entities with shared data plan**

2018 PAG and DBO Field Plan-Draft 11/06/17

2018 PAG and DBO Field Season (version 11_06_17): Sampling Contributors. Projects Key: AON=US Arctic Observing Network (National Science Foundation); ArCS=Arctic Challenge for Sustainability; ArcticEIS2=Arctic Ecosystem Integrated Survey, ASGARD=Arctic Shelf Growth, Advection, Respiration and Deposition Rate Experiment, C30=Canada's Three Oceans; CHINARE=Chinese Arctic Research Expedition; DBO=Distributed Biological Observatory, JAMSTEC= Japan Agency for Marine-Earth Science and Technology; KOPRI = Korea Polar Research Institute; NOAA=National Oceanic and Atmospheric Administration; Office of Naval Research (ONR) Marginal Ice Zone (MIZ) project; PMEL=Pacific Marine Environmental Laboratory; RUSALCA=Russian-American Long-term Census of the Arctic. **DBO Region Key**: DBO1=So. St. Lawrence Is., DBO2=Chirikov Basin, DBO3=So Chukchi Sea, DBO4=NE Chukchi Sea, DBO5=Barrow Canyon, DBO6=East Beaufort Sea, DBO7-Beaufort Sea Central, DBO8=Bathurst polynya region.

Dates 2018 (Port calls)	Ship	DBO Region	Projects	PAG contact	Chief Scientist
June 1-25 (Seward-Nome)	Sikuliaq	2, 3	ASGARD	Seth Danielson sldanielson@alaska.edu	Seth Danielson sldanielson@alaska.edu
7-15 July (Nome-Nome)	Norseman II	3	Bering Strait Mooring Project/AON	Rebecca Woodgate woodgate@apl.washington.edu	Rebecca Woodgate woodgate@apl.washington.edu
July 29-July 17 (Dutch Harbor rerturn)	Oshoro-maru	1,2,3	ArCS project	Toru Hirawake hirawake@salmon.fish.hokudai.ac.jp	Atsushi Ooki ooki@fish.hokudai.ac.jp
July 10-22 (Dutch-Barrow)	Sir Wilfrid Laurier	1,2,3,4,5	C30/DBO (AON)	Jackie Grebmeier jgrebmei@umces.edu	Svein Vagle Svein.Vagle@dfo-mpo.gc.ca
July-Sept (Shanghai-Shanghai)	Xuelong	3	CHINARE	Jianfeng He hejianfeng@pric.org.cn	Jianfeng He hejianfeng@pric.org.cn
Aug 3-27 (Nome-Nome)	Sikuliaq	6	Shelf Break Ecology	Frank Rack frack@nsf.gov	Carin Ashjian cashjian@whoi.edu
Late Aug – Sept (Dutch-Nome-Nome-Dutch)	F/V Northwest Explorer	1,2	Northern Bering Sea Assessment	Ed.Farley@noaa.gov	Kris Cieciel, kristin.cieciel@noaa.gov (Leg 1); Ed Farley, ed.farley@noaa.gov (Leg 2)
Aug 7-27 (Nome-Barrow)	Araon	3+Chukchi Borderland	K-AOOS (Korea-Arctic Ocean Observing System	Sung-Ho Kang shkang@kopri.re.kr	Sung-Ho Kang shkang@kopri.re.kr
August (Nome-Nome)	Healy	2,3,4,5	FOCI-DBO/NCIS	Jackie Grebmeier jgrebmei@umces.edu	phyllis.stabeno@noaa.gov and Robert Pickart rpickart@whoi.edu
September	Healy	5,6	Western Arctic boundary current in a warming climate	Robert Pickart rpickart@whoi.edu	Robert Pickart rpickart@whoi.edu
Sept 19-Oct 13 (Dutch)	Healy	-	Navy-CANAPE	Frank Rack frack@nsf.gov	Navy
Sept 22-Oct 6 (Dutch Harbor-Kodiak)	Dyson	1 and M8	EcoFOCI	Phyllis Stabeno, Phyllis.stabeno@noaa.gov	Geoff Lebon geoffrey.t.lebon@noaa.gov
Sept -Oct	Louis S. St-Laurent	-	JOIS/AON-BGOS	Bill.Williams@dfo-mpo.gc.ca	Bill.Williams@dfo-mpo.gc.ca
Oct	Sir Wilfrid Laurier	4,8	C30	Bill.Williams@dfo-mpo.gc.ca	Humfrey.Melling@dfo-mpo.gc.ca
November	Mirai	-	Japanese Atmospheric cruise; National Institute of Polar Research (NIPR)	Takashi Kikuchi takashik@jamstec.go.jp	Dr. Inoue (inoue.jun@nipr.ac.jp) at

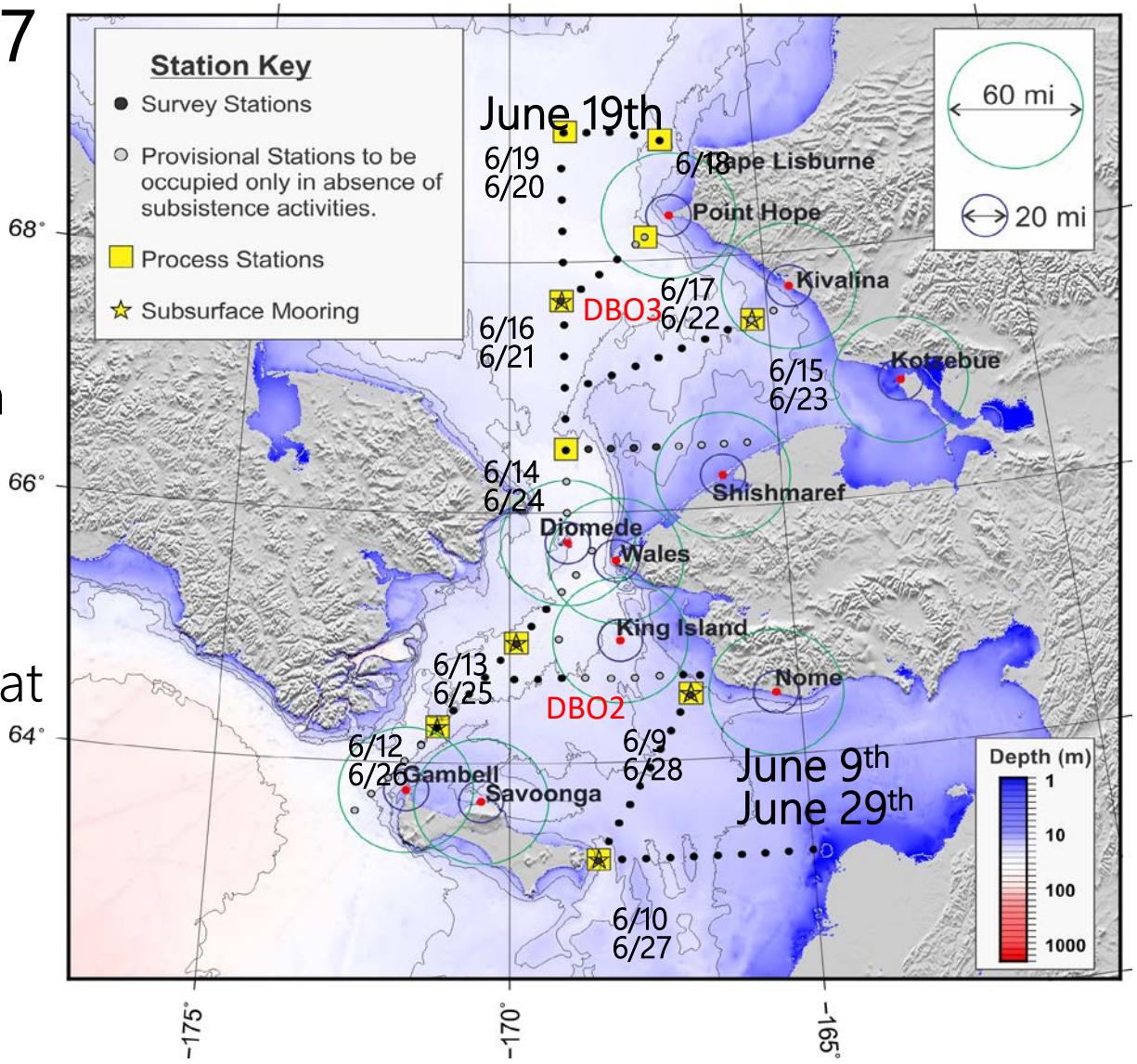
ASGARD Project 2017

1st: Process Studies

Set up experiments that require multi-day incubations. Deploy moorings. Epibenthic fish sampling.

2nd: Synoptic Surveys

Multi-station transects that cross biogeographical domains. More fishing.



- June 2017 & 2018 on R/V Sikuliaq
- 2017/18 and 2018/19 moorings

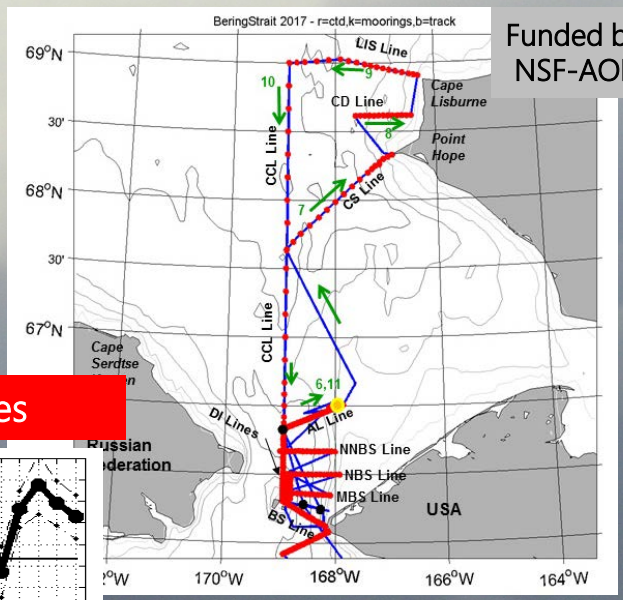
[Seth Danielson, UAF]

Bering Strait Mooring Program – 2017 Updates

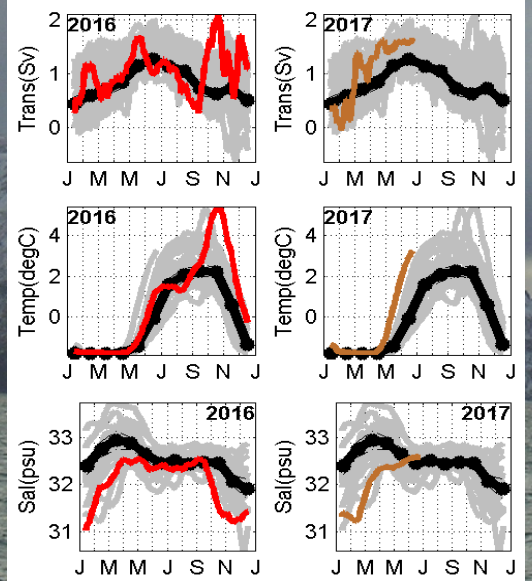
Rebecca Woodgate *University of Washington, Seattle, USA*

Funded by NSF-AON

Our July 2017 Norseman 2 cruise recovered & redeployed the 3 Bering Strait moorings, and took CTD sections, finding the Chukchi remarkably warm. Recovered data show:

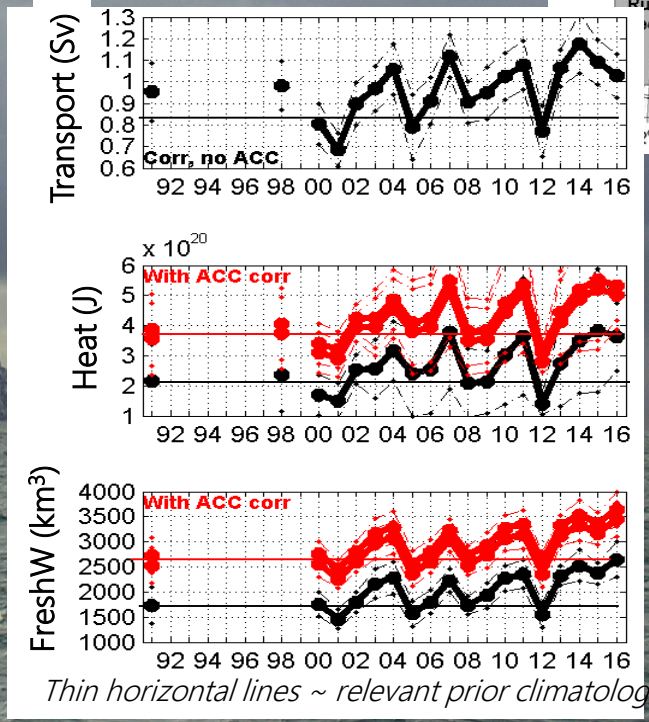


2016/2017 Remarkably warm & fresh



Color=2016 or 2017 30day smoothed data. Black = climatology; Grey=all past years

Still Increasing annual mean fluxes



Thin horizontal lines ~ relevant prior climatologies

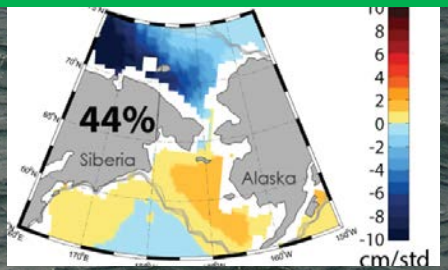
Trans ≥1Sv; FW~3500km³/yr *(cf 34.8psu)*
Heat ~5x10²⁰J/yr ~15TW *(cf -1.9°C)*

Recent papers document also:
* trends in seasonal changes
* flow increase driven by pressure head, far field forcing;
* patterns of the pressure head forcing, finding flow dominantly driven from the Arctic

Woodgate 2017 in review PiO
Peralta-Ferriz & Woodgate 2017 GRL

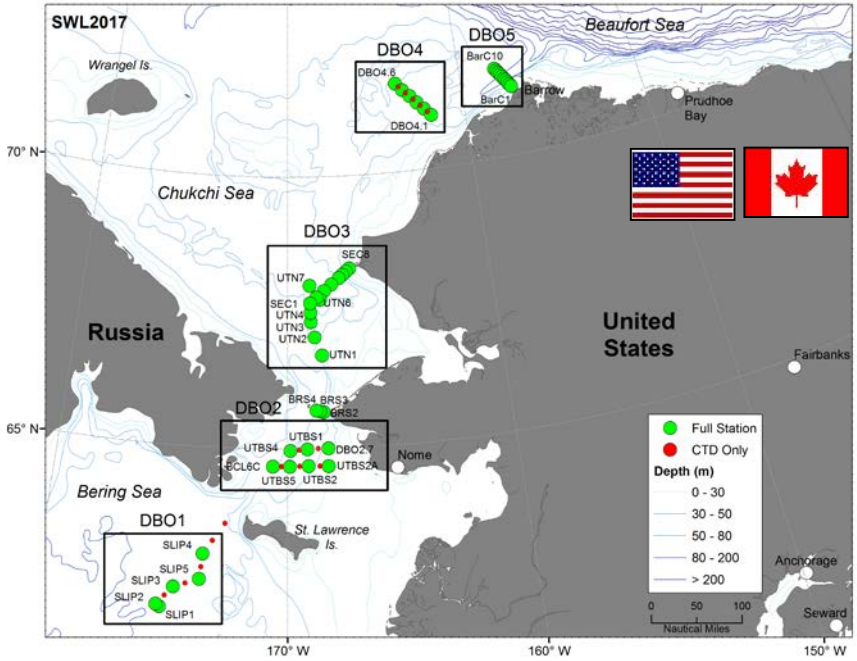
* *Oct 2016 & June 2017 both 3°C warmer than climatology*
* *~20 day late cooling in 2016*
* *~15 day early warming in 2017*
* *Salinities 0.5-1psu fresher than climatology*

Find data and papers at:
psc.apl.washington.edu/Bstrait.htm l



Canada's Three Oceans (C30) and the DBO: *CCGS Sir Wilfrid Laurier*, July 10-22, 2017

Focus: sampling along latitudinal transect lines developed as a "change detection array" for consistent monitoring of biophysical responses to changing environmental conditions



Canadian Component:

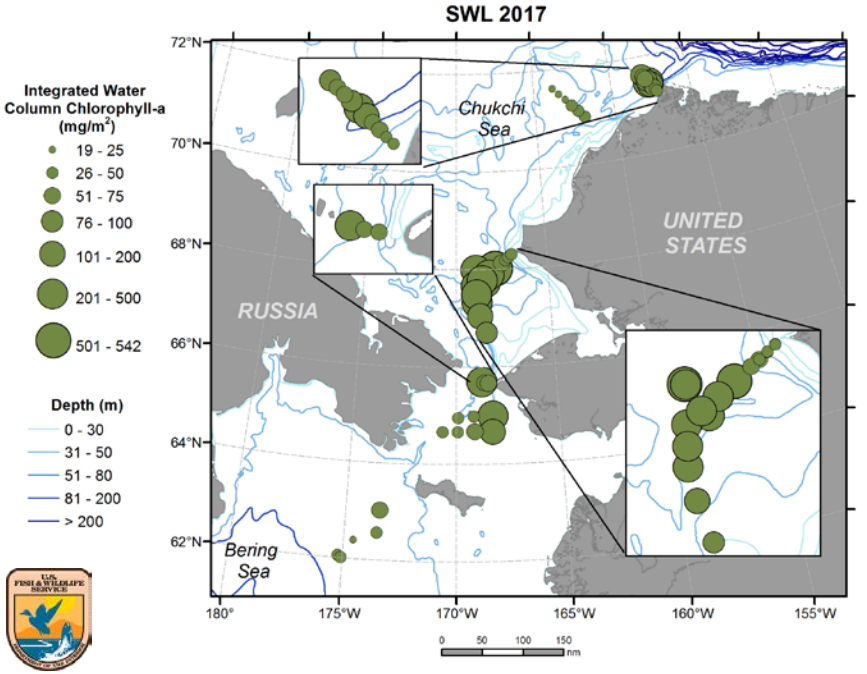
Svein Vagle, DFO/IOS (Chief Scientist), Nina Nemcek, DFO/IOS; Diana Varela, U Victoria; Sile Kafrissen, U Victoria; Annaliese Meye, U Victoria; John Nelson, Seastar Biotech; Lauren Howell, Vancouver Aquarium

US Component:

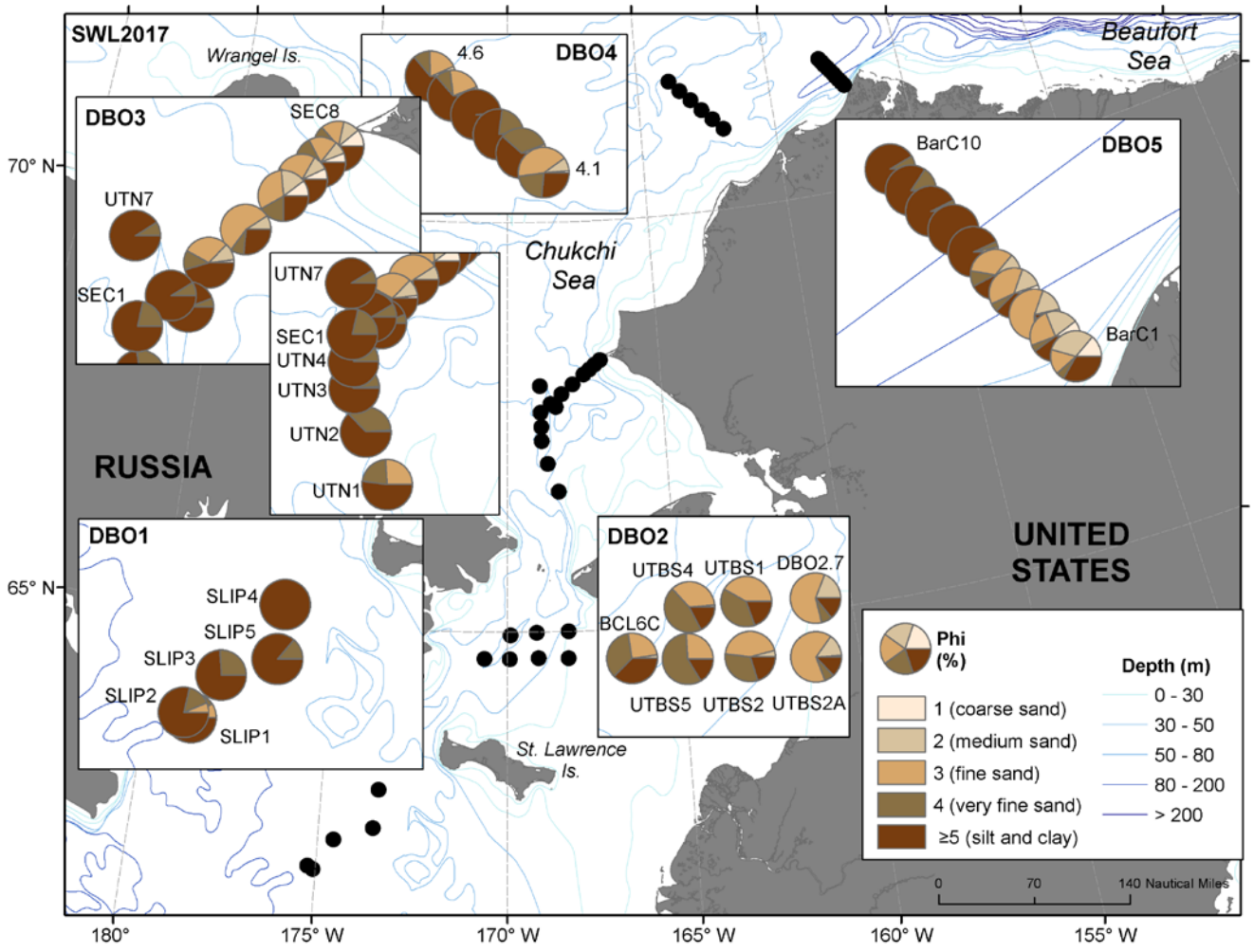
Jacqueline Grebmeier, CBL; Lee Cooper, CBL; Christina Goethel, CBL; Basia Oleszczuk, Poland; Kristen Shake, Clark U; Melisha Santiago, Clark U; Elizabeth Labunski, USFWS

DBO data collections

- Seawater temperature and salinity; velocity measurements
- Nutrients, chlorophyll, carbon products, CDOM
- Phytoplankton, zooplankton and macrobenthic abundance, biomass, community structure
- Marine mammal and seabird surveys



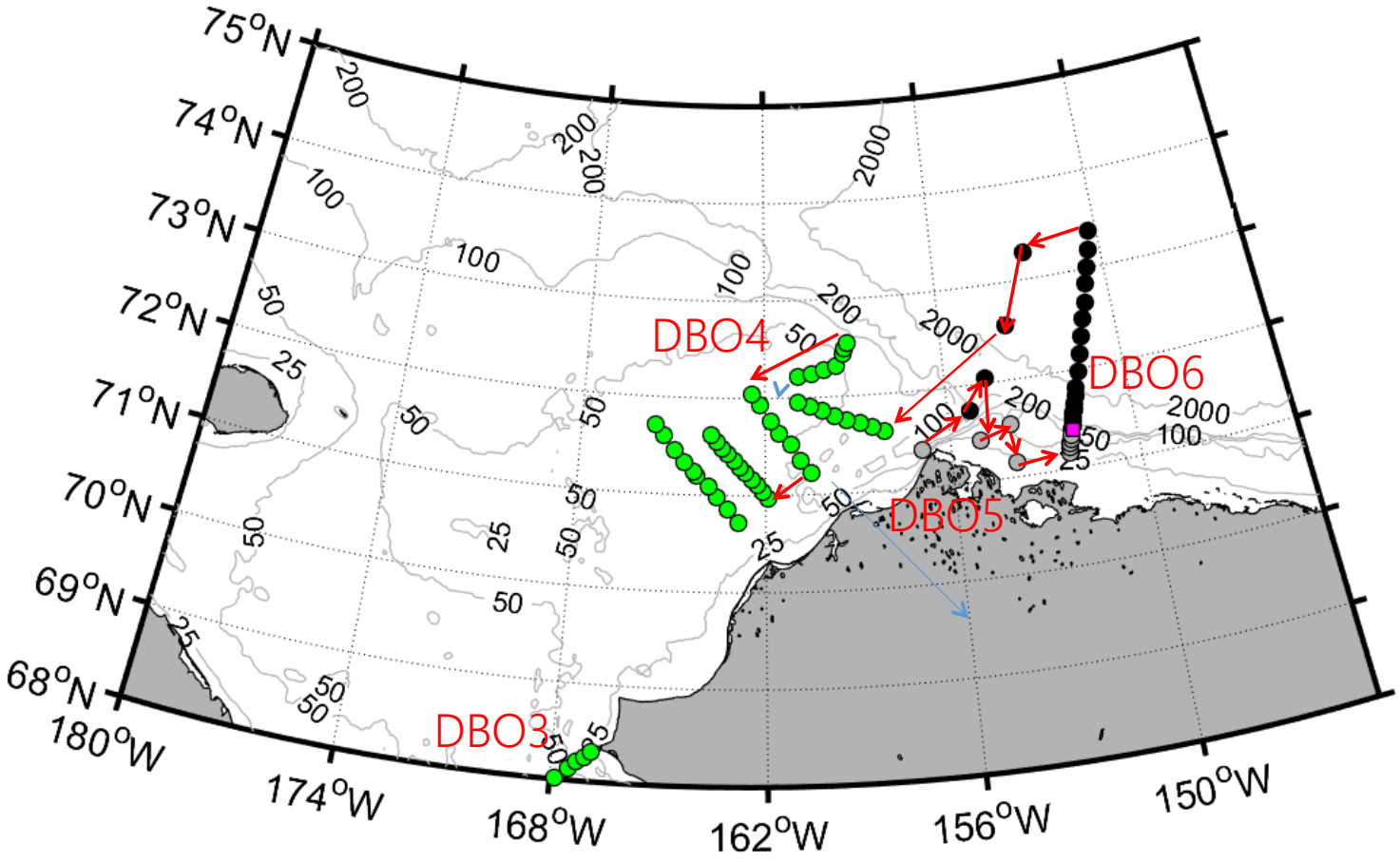
SWL17 Example data product: Sediment grain size for DBO1-5



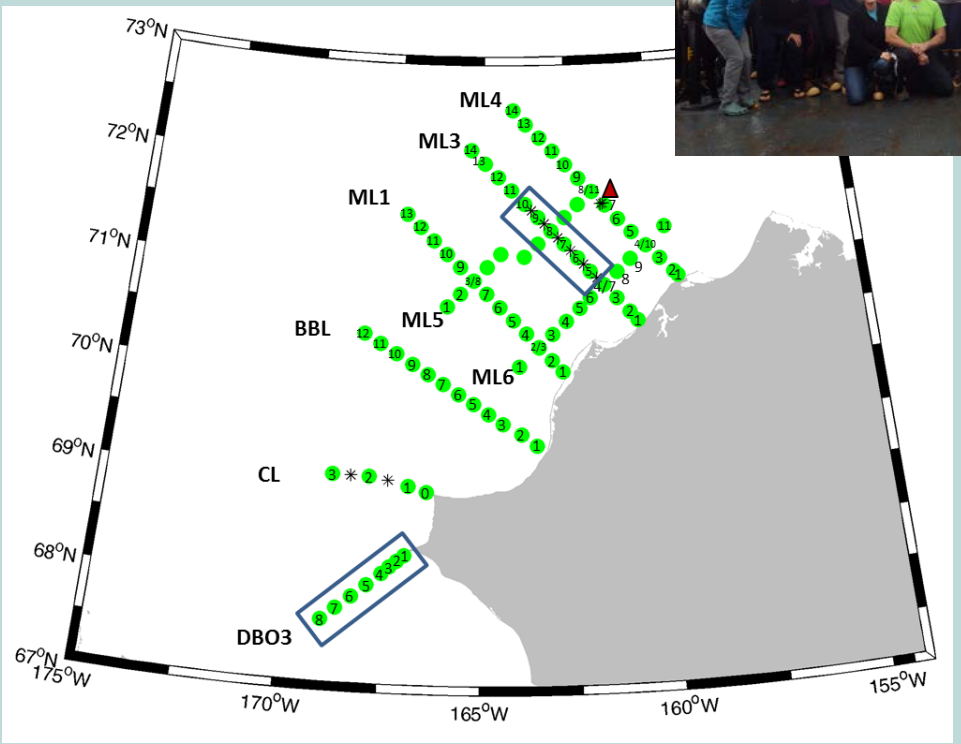
- Highest % total organic carbon content in silt & clay regions in lower current areas
- High silt & clay in DBO1, offshore DBO3 sites, DBO4.4, and western half of DBO5
- High TOC and silt/clay coincident with higher benthic biomass
- Lowest silt & clay content in sandy area of DBO 2 (Chirikov Basin), eastern part of DBO3-DBO5 in Alaska Coastal water

[Grebmeier and Cooper]

Laura Juranek (OSU) and Rachel Seper August 9-23, 2017 cruise (DBO 3,4,5,6)
Primary Productivity and Nitrogen Cycling



Arctic Marine Biodiversity Observing Network (AMBON); NOAA/BOEM/Shell August 2017 (Norseman II), including DBO3 & 4, CEO moorings



Station map of the AMBON 2017 cruise. Stars indicate CTD stations only, red triangle indicates location of the CEO moorings, and the blue boxes indicate location of the DBO3 and DBO4 lines

- Lead Katrin Iken (UAF);Co-PIs: Seth Danielson, Eric Collins, Russ Hopcroft, Franz Mueter
- co-PIS: Jackie Grebmeier, Lee Cooper (CBL/UMCES
- Sue Moore (NOAA), Kathy Kuletz (USFWS)
- T/S
- Chlorophyll, nutrients
- Phytoplankton and zooplankton composition
- Macrofauna and epifauna
- Fishes
- Marine mammal and seabird surveys

AMBON17 Data Products from Cruise Report

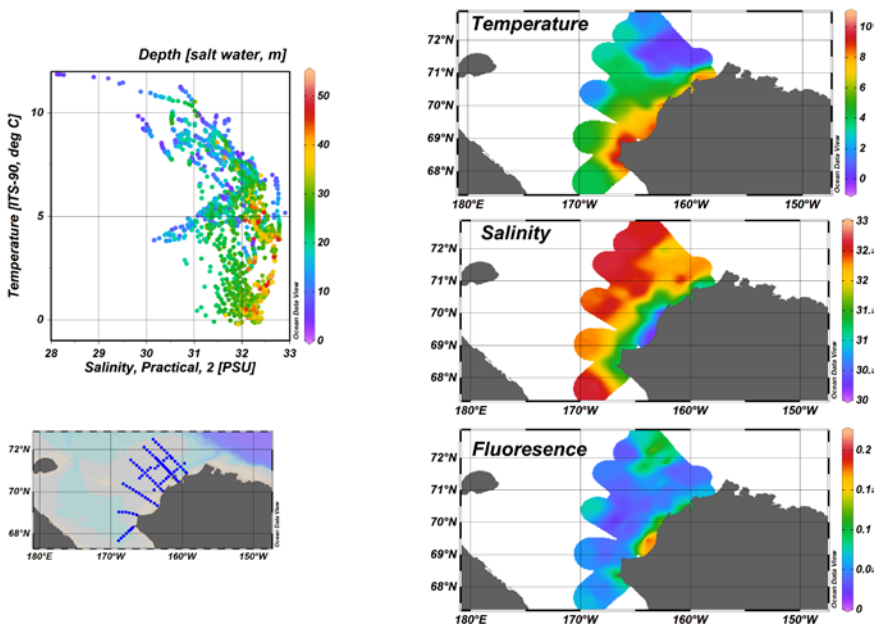


Figure 2a: Surface water properties during AMBON 2017.

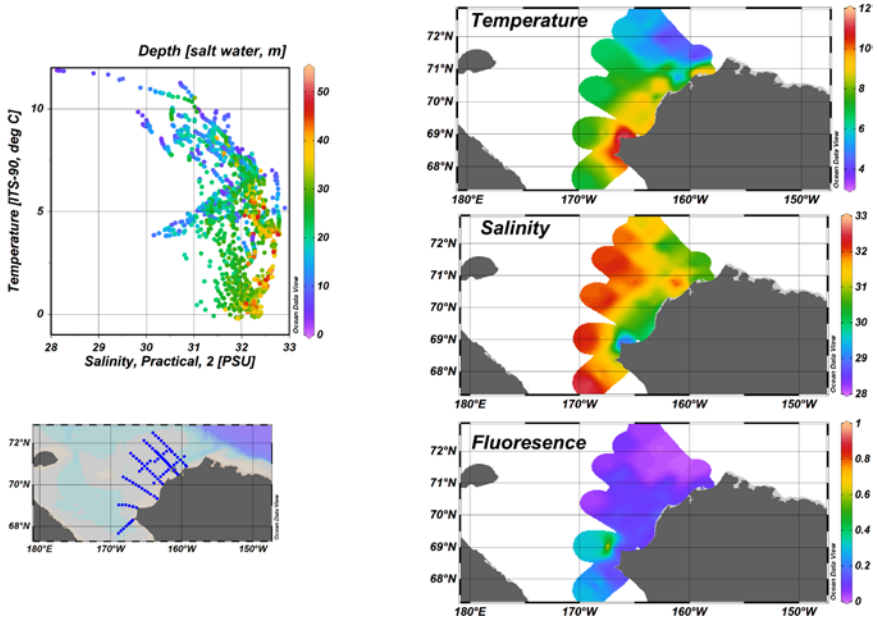


Figure 2b: Bottom water properties during AMBON 2017.

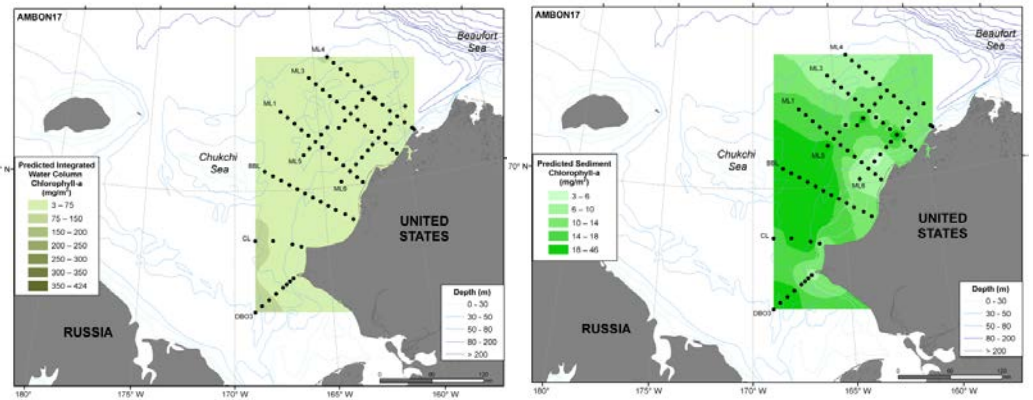


Figure 8. a. Integrated chlorophyll a (mg/m2) and **b.** surface sediment chlorophyll a (mg/m2) present in study area during the August AMBON17 cruise.

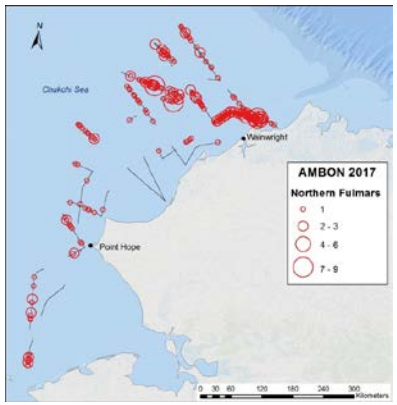


Figure 12: Distribution of auklets observed on transect during AMBON 2017.

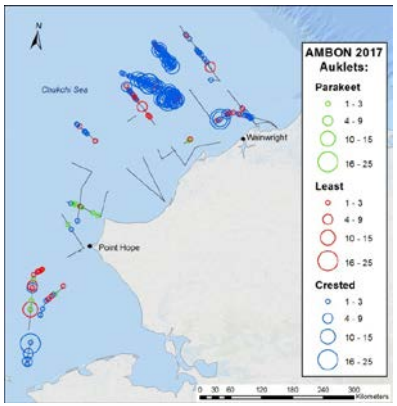


Figure 13: Distirubtion of northern fulmars observed on transect during AMBON 2017.

NE CHUKCHI ECOSYSTEM OBSERVATORY (CEO) 2015-2017 MEASUREMENTS:

Pressure, Temperature, Salinity

Significant Wave Height & Direction

Directional Wave Spectra

Ice Draft (level ice thickness & keels)

Passive acoustic recordings

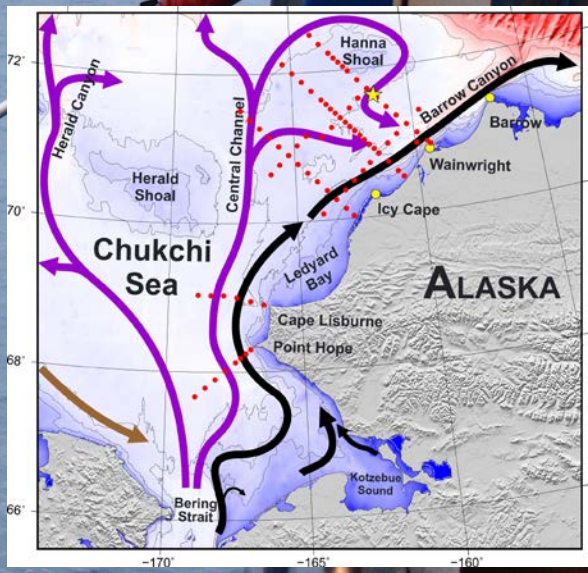
Acoustic Backscatter: 38, 125, 200 & 455 KHz

Chlorophyll a fluorescence

Optical Backscatter, PAR

CDOM, NO3, DO

Webcam



- **24-bottle Sediment Trap (Catherine Lalande, Canada):**
  - **Chlorophyll a**
  - **Phytoplankton identification**
  - **Total particulate matter (dry weight)**
  - **Particulate organic carbon**
  - **Particulate nitrogen**
  - **Zooplankton species**
  - **Zooplankton fecal pellets**

[AOOS support]

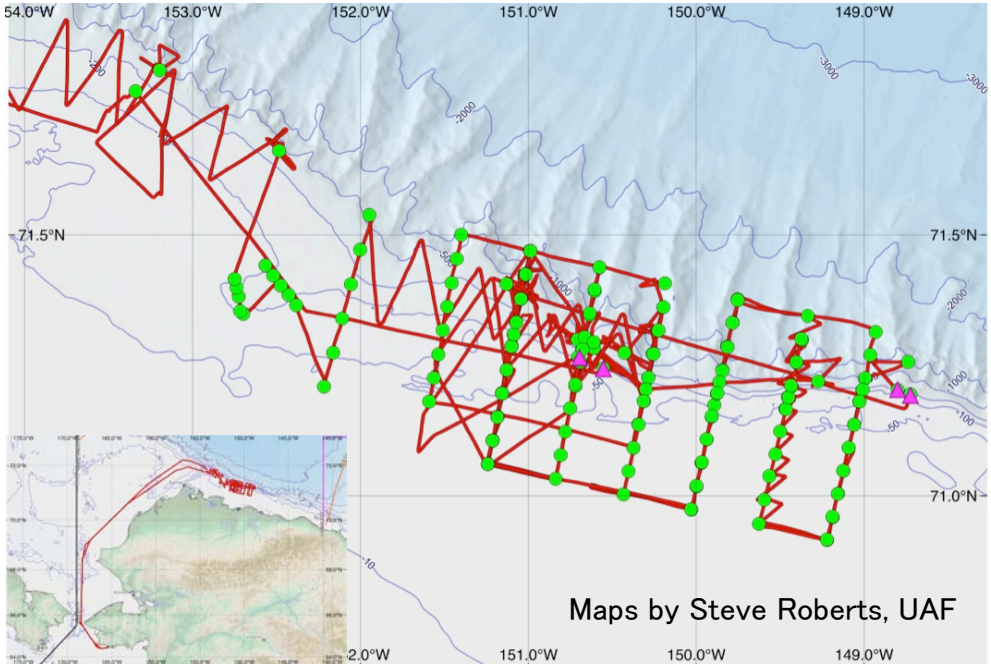
[Seth Danielson, UAF}

BEAUFORT SHELF BREAK ECOLOGY – PLANKTON, FISH, AND BELUGAS

August 25 – September 18, 2017, *R/V Sikuliaq*

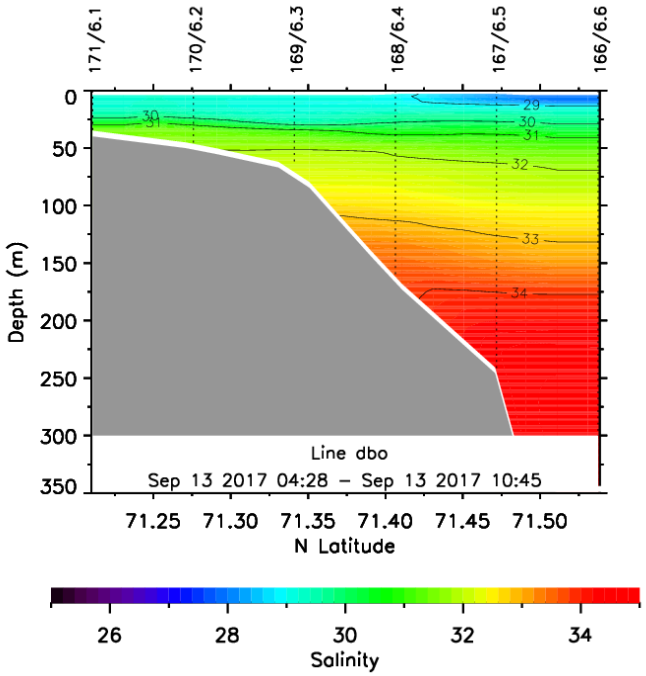
C. Ashjian, R. Campbell, M. Jech, K. Kuletz, J. Llopiz, M. Lowe, S. Okkonen, K. Stafford, J. Zhang

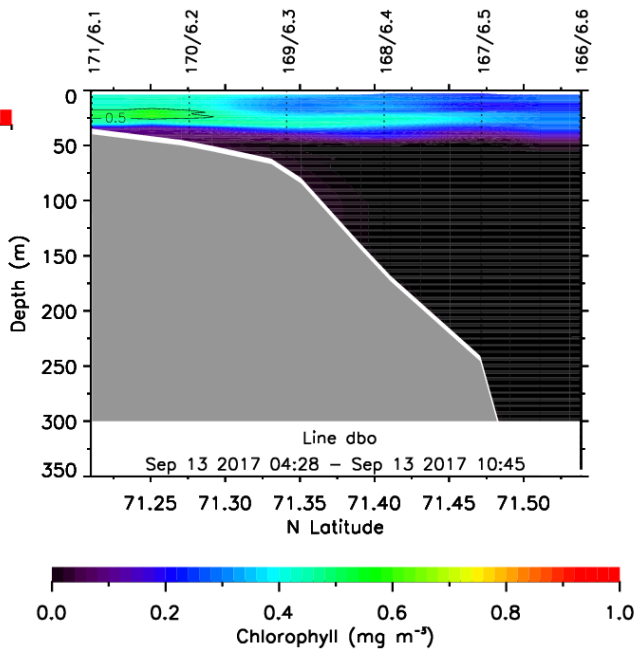
Are beluga whales found along the shelf break because they can find high abundances of their Arctic cod prey there and are these abundances driven by shelf break upwelling of plankton? How will this change in the future?

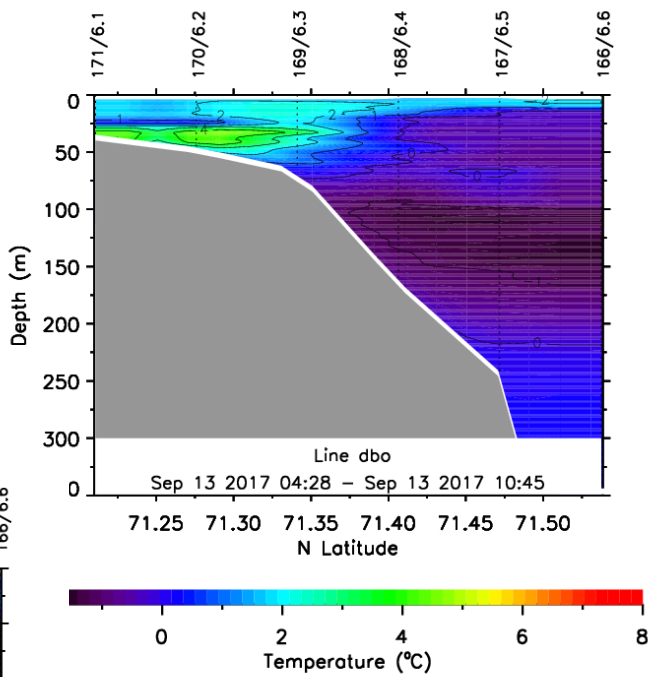


Activity	Number
Stations	184
Bongo Tows	37
CTD Casts	184
Fish Trawls	16
Mooring Deployments	4
Ring Nets	4
Slocum Glider Recovery	1
Tucker Trawls	69

Preliminary Results: Beaufort Shelf Break Ecology



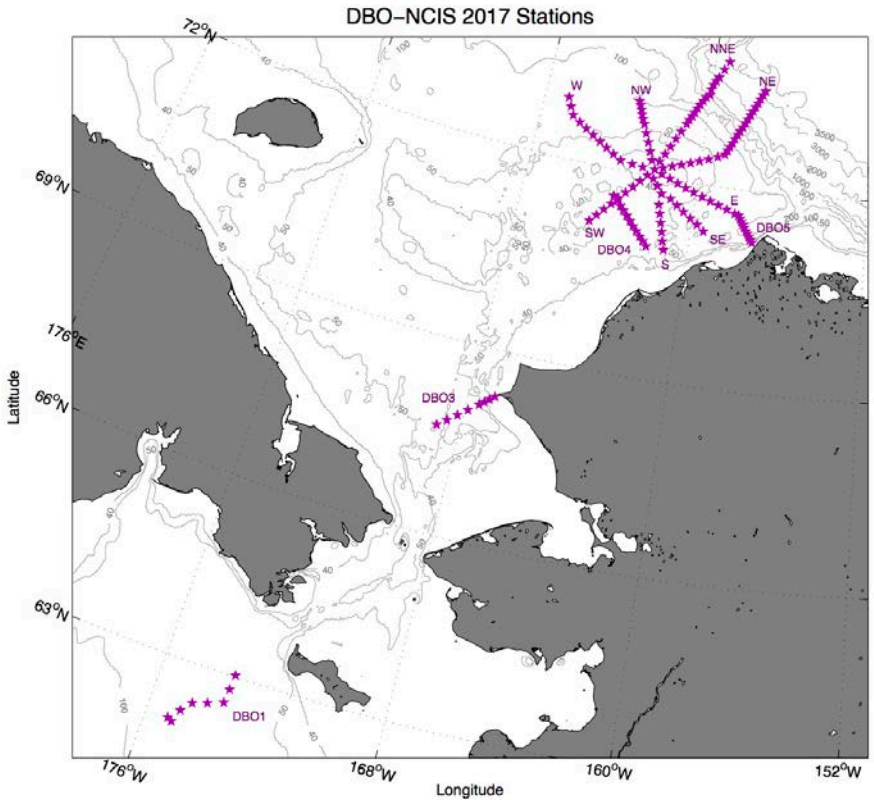




2017 DBO-NCIS (Northern Chukchi Sea Integrated Study)
NOAA Arctic Research Program (WHOI, UMCES and NOAA PMEL)
Aug 28 Aug-Sept 13, 2017 (Dutch-Dutch, Alaska)

Chief Scientist: Robert Pickart, WHOI
Co-Chief Scientist, Jackie Grebmeier, UMCES

Objectives: (1) occupy DBO lines 3-5 in the Chukchi Sea for suite of water column and benthic measurements; and (2) process study of the NE Chukchi shelf to understand the physical-biological links that result in the biological hot spots in this region.

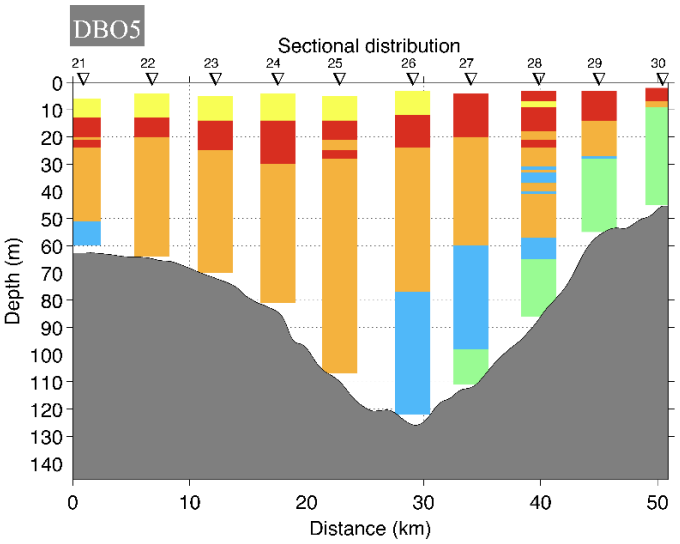


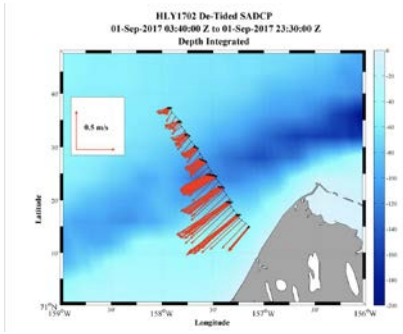
Field Measurements:

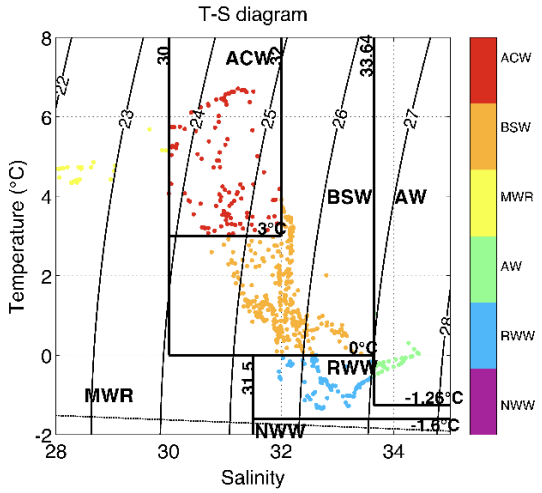
- Water mass properties and circulation, R. Pickart (WHOI)
- Nutrients and chlorophyll, C. Mordy (PMEL)
- Dissolved inorganic carbon and total alkalinity, J. Cross (PMEL)
- Mesozooplankton and larval fish, J. Duffy-Anderson (NMFS)
- Macrofauna, sediment characteristics, and sea ice melt tracers (δ18), J. Grebmeier and L. Cooper (UMCES)
- Aerosols, J. Creamean (NOAA)
- Dissolved nitrous oxide and isotopes, A. Bourbonnais (WHOI)
- Water sampling biases (C. Paver, UMCES)
- Dissolved methane and underway methane sampling, C. Magen (UMCES)
- Ostracod distributions, L. Gemery (USGS)
- Microbes, E. Collins (UAF)
- Marine mammals, S. Moore (NMFS)
- Seabirds, K. Kuletz (USFWS)

2017 DBO-NCIS: Preliminary Results

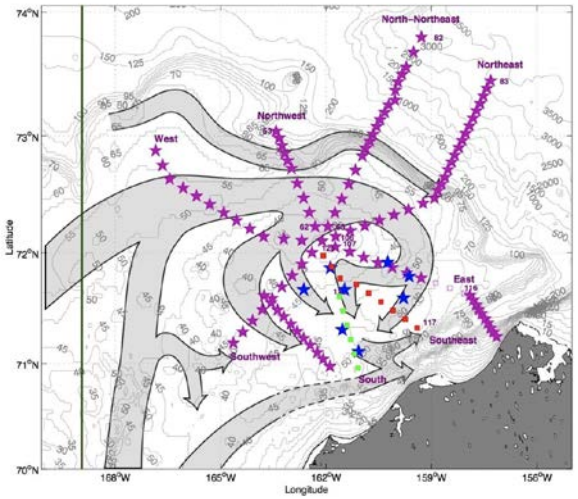
Below. Water mass type across DBO5, upper Barrow Canyon





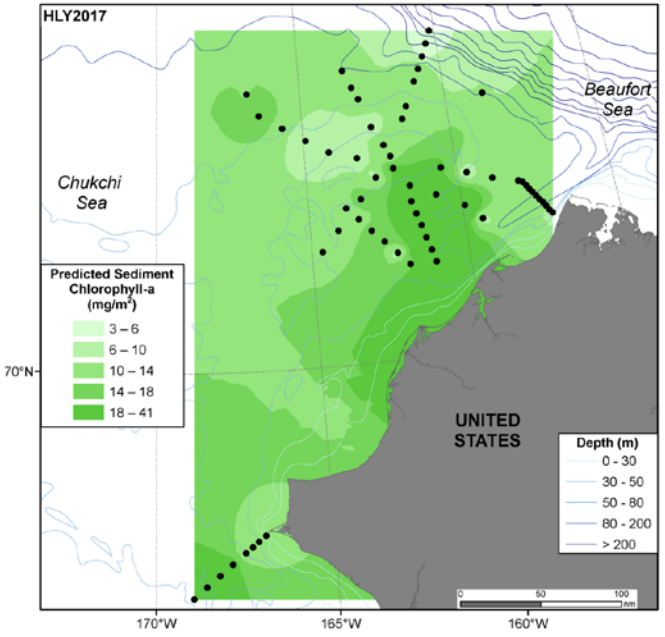


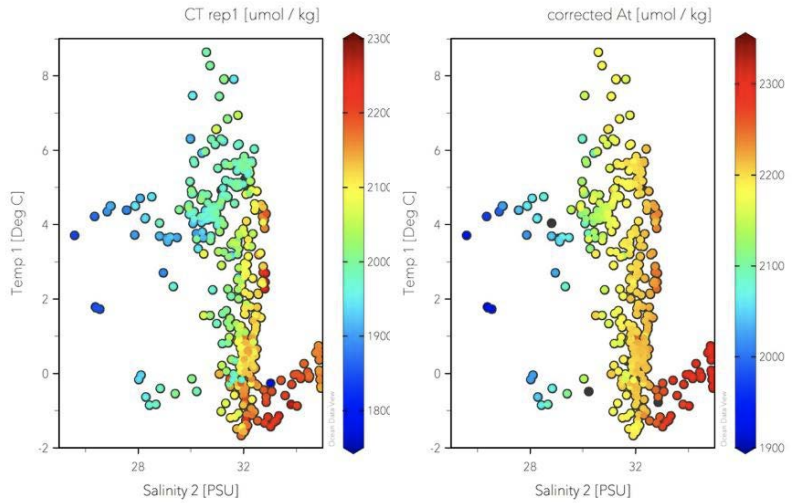
ACW: Alaskan coastal water; BSW: Bering summer water; MWR: Melt water/river water
AW: Altantic water; NWW: Newly ventilated winter water; RWW: Remnant winter water



Above. Revised sampling SECS in benthic hotspot.

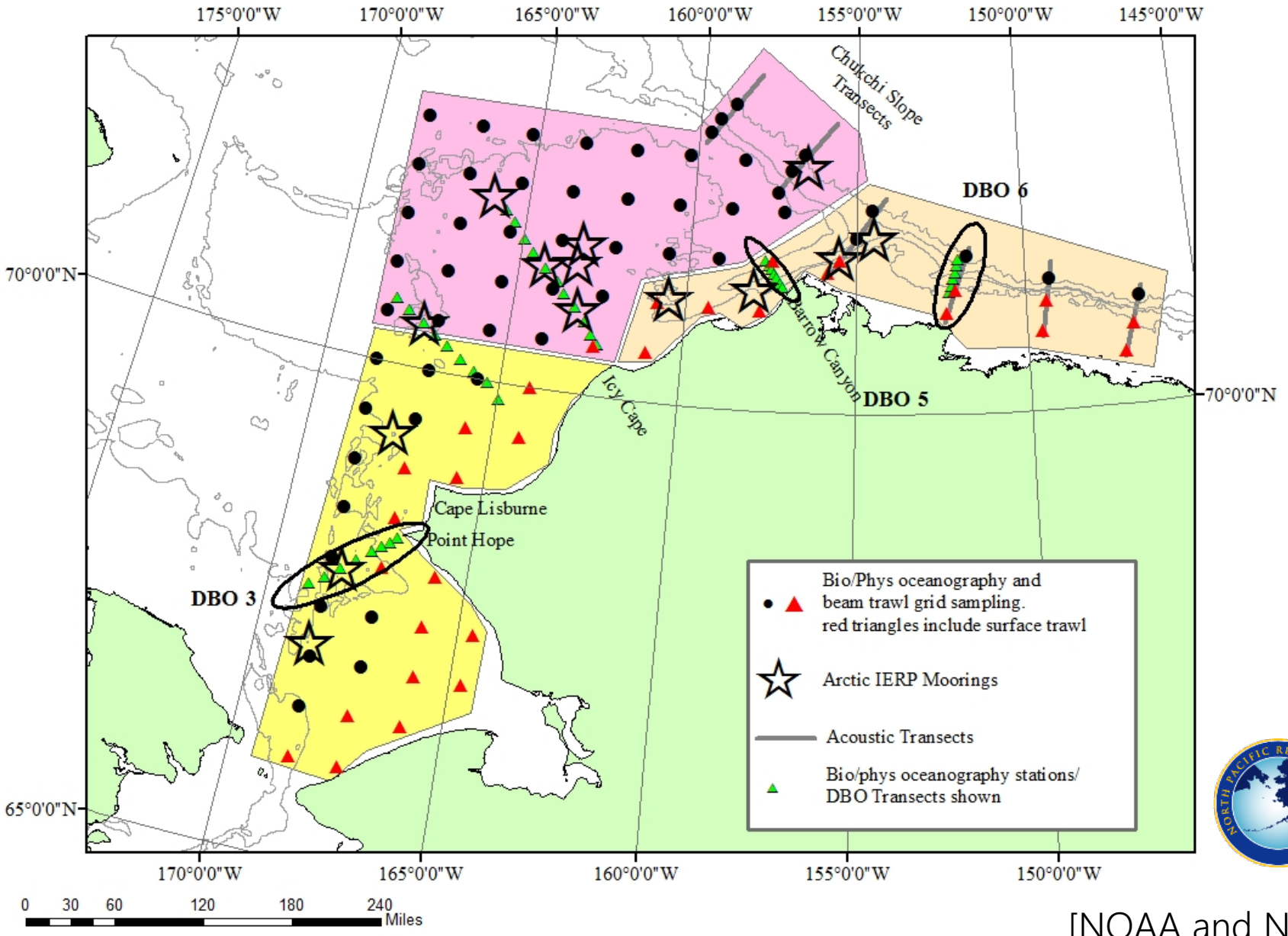
Below. Surface sediment chlorophyll a (mg/m2)





Left. Scatter plots showing the distribution of total inorganic carbon (CT, µmol kg-1, left) and total alkalinity (AT, µmol kg-1, right)

Arctic Ecosystem Integrated Survey: ArcticEIS2 (NOAA)-August/Sept 2017 and 2019



[NOAA and NPRB

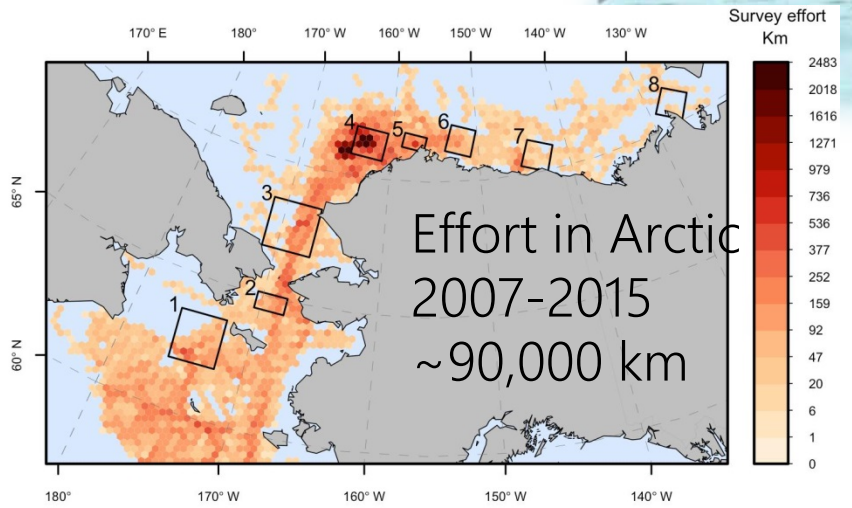
Seabird Surveys - Platforms in 2017

Principal Investigator : Kathy Kuletz (U.S. Fish & Wildlife Service)

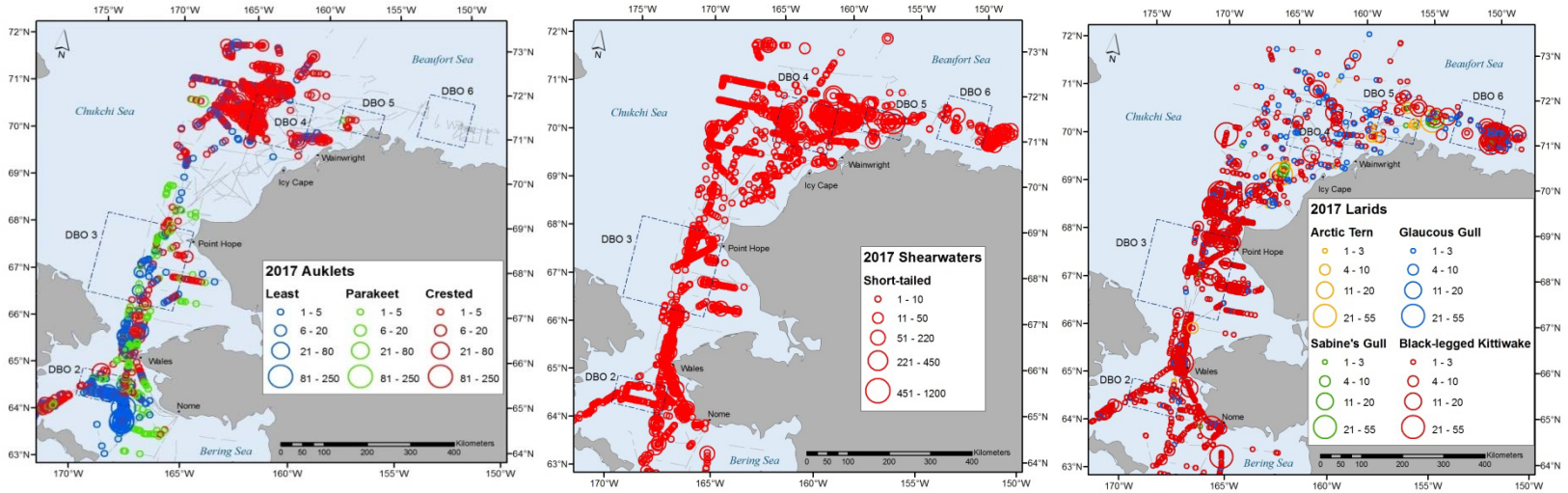
- **Arctic IERP** (NPRB/BOEM /NOAA Ecosystem Study/ E. Farley)
- **ASGARD** (ArcticShelfGrowthAdvectionRespirationDeposition/S. Danielson)
- **AMBON** (Arctic Marine Biodiversity Observation Network/ K. Iken)
- **Canadian Icebreaker cruises** (3-Oceans/ J. Grebmeier & S. Vagle)
- **NCIS – DBO** (NSF/ WHOI/R. Pickart)
- **North Bering Sea Fish Surveys** (NOAA/ J. Murphy)

Planned 2018-2020: ASGARD, AIERP, 3-Oceans, NBS, others….

Seabird Surveys in the Pacific Arctic

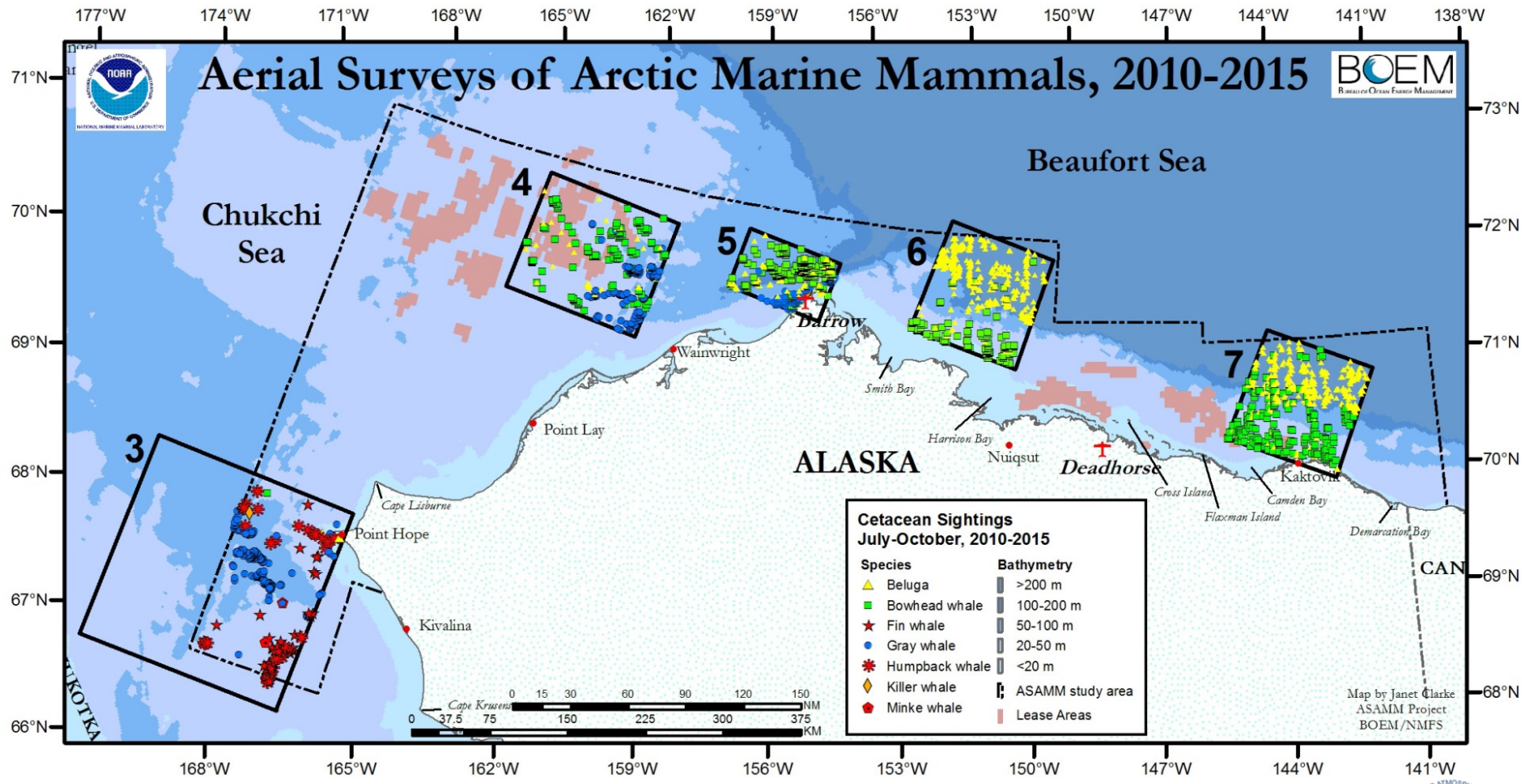


In 2017
~ 19,700 km surveyed in
North Bering, Chukchi, Beaufort



2017 Distribution of Auklets (3 spp), Short-tailed shearwaters, Larids (4

DBO 3, 4, 5, 6, and 7



DBO-3 – gray whale hot spot, subarctic cetaceans

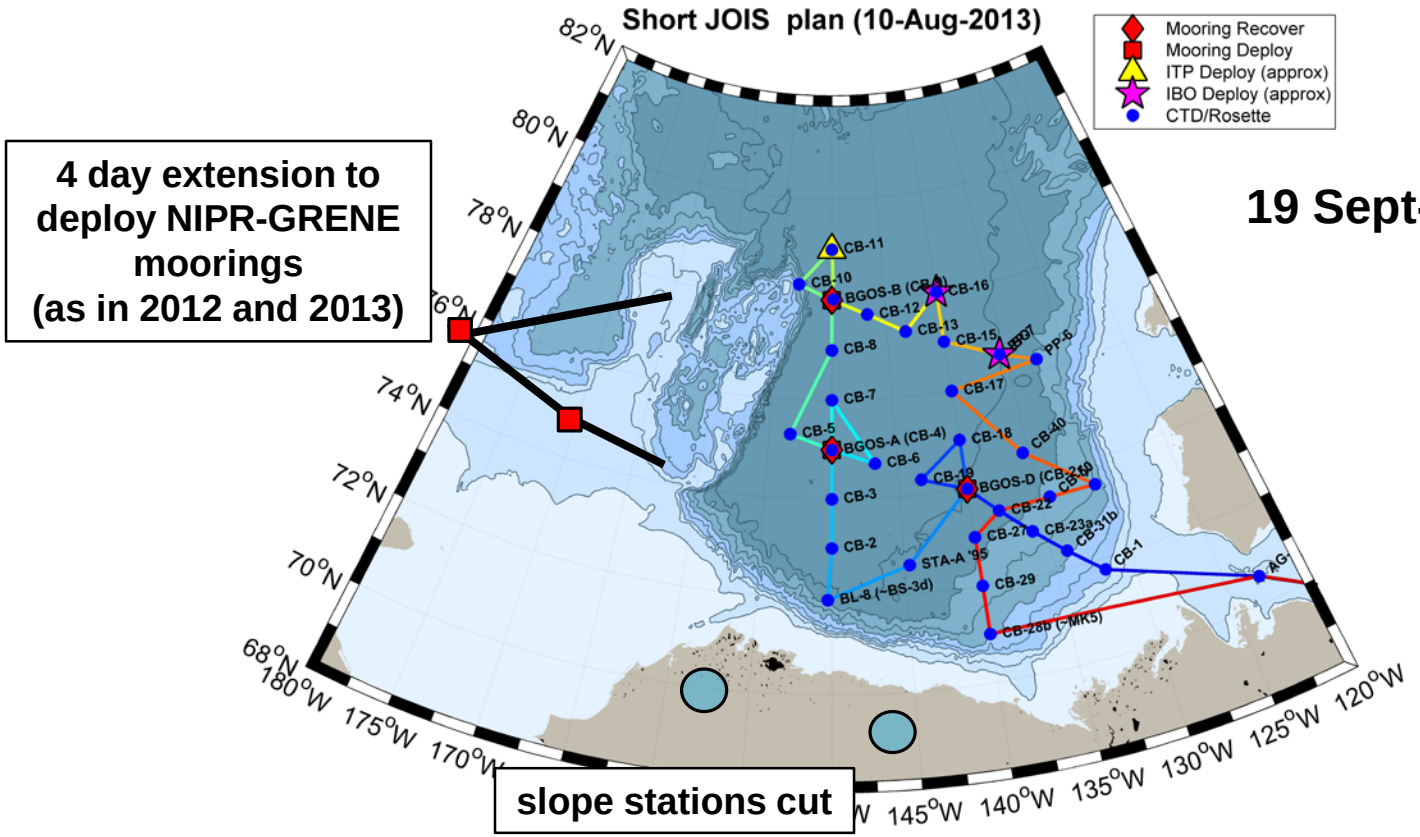
DBO-4 and DBO-5 – bowhead whales, gray whales, belugas

DBO-6 and DBO-7 – bowhead whales, belugas

http://www.afsc.noaa.gov/NMML/cetacean/bwasp/

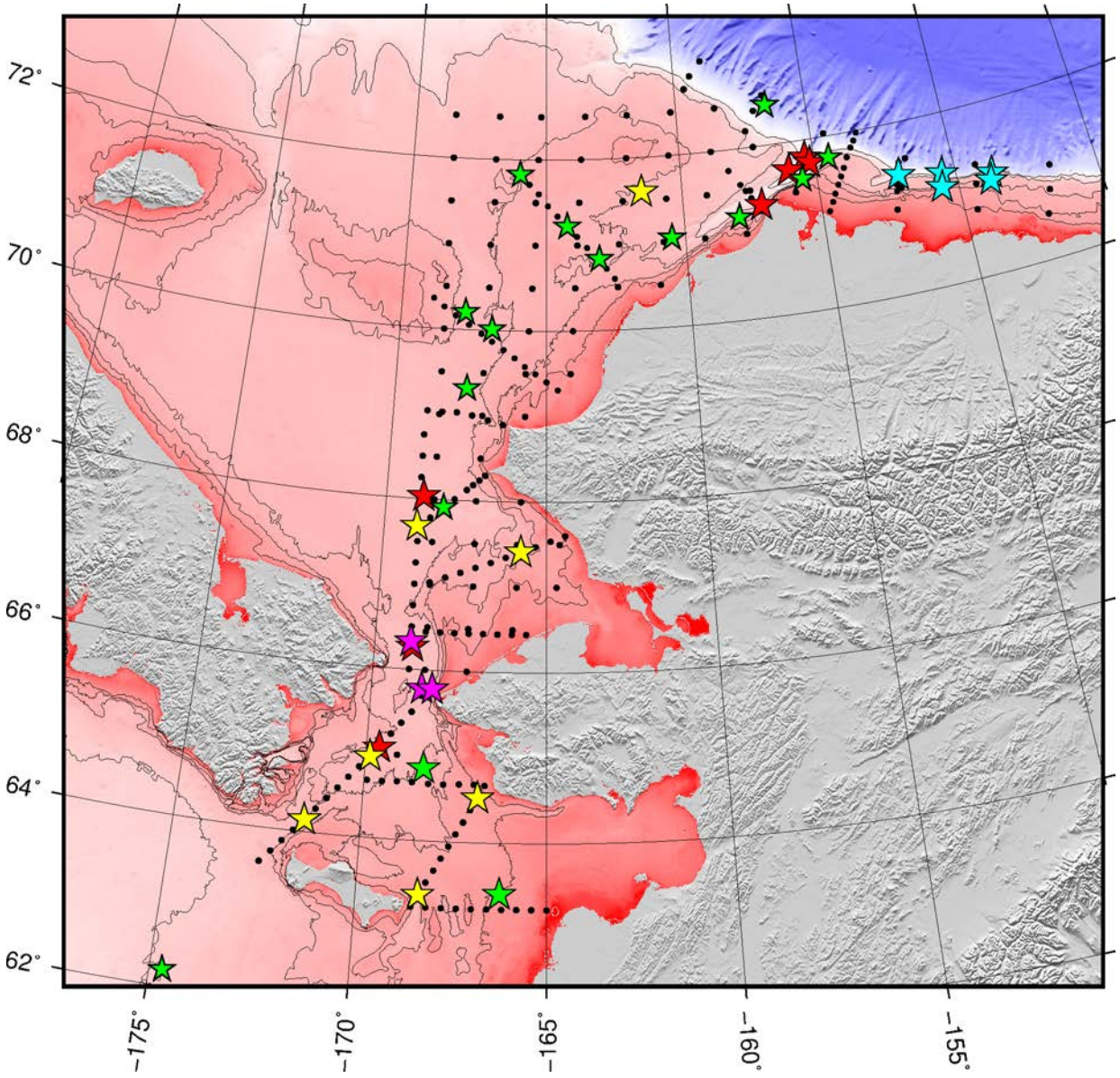
[Janet Clark]

SCIENCE-BASIN JOIS/AON BGOS (CANADA-USA-JAPAN)



JOIS=Joint Ocean-Ice Study; AON=Arctic Observing Network; BGOS=Beaufort Gyre Observing System

(courtesy Bill Williams, IOS)



AIERP & Other 2017-2018 Moorings

- UAF
- NOAA PMEL & NMML
- UW-APL
- ArCS & JAMSTEC
- WHOI & WHOI/UAF

[courtesy Seth Danielson/UAF]

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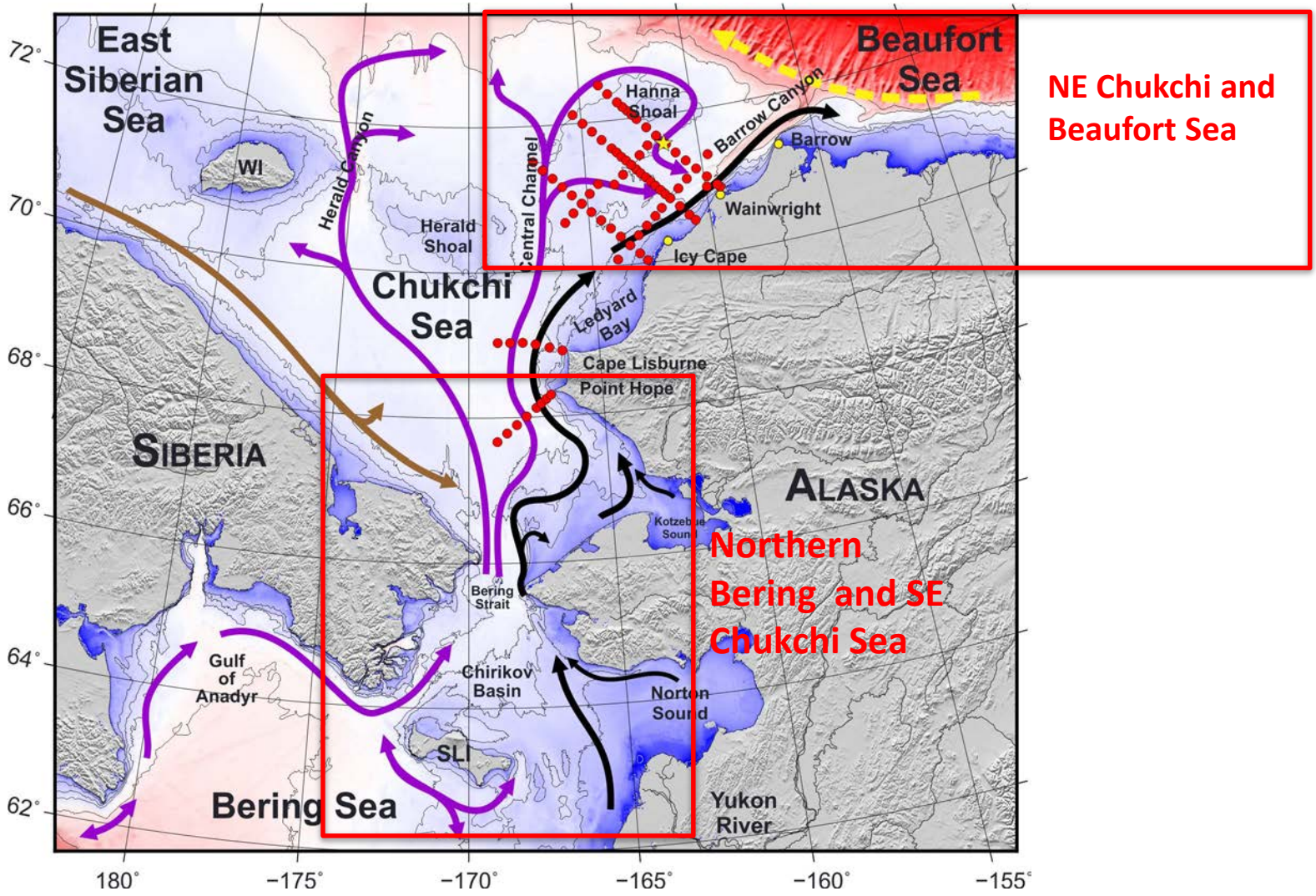
Science access during subsistence whaling: April-May and Sept-Oct periods

-need to interface with coastal communities through new Arctic Waterways Safety Committee to interface with Alaska Eskimo Whaling Commission, Eskimo Walrus Commission, and other parties; see http://www.arcticwaterways.org/



[modified from S. Danielsen map 2015]

Thank you for your attention.

Questions and comments?

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