# USA Country Report

**Jacqueline M. Grebmeier**
Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, MD, [2]University of Alaska Fairbanks, AK, [3]Wood Hole Oceanographic Institution, MA

Pacific Arctic Group Meeting
June 18, 2018

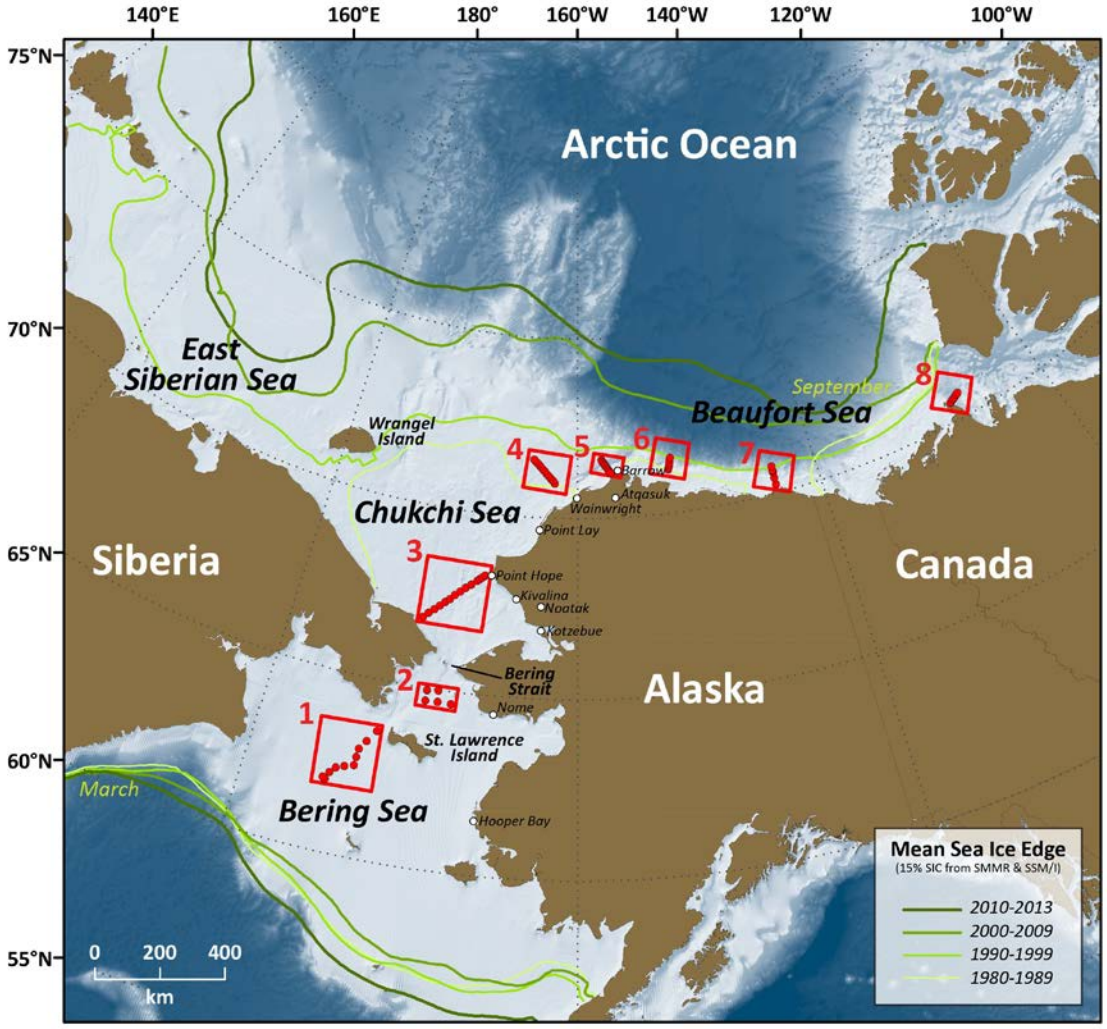
**DBO:** Distributed Biological Observatory
**AMBON:** Arctic Marine Biodiversity Observing Network
**ASGARD:** Arctic Shelf Growth, Advection, Respiration, and Deposition (ASGARD) Rate Measurements Project
**CEO:** Chukchi Environmental Observatory
**Arctic EIS II**: Arctic Ecosystem Integrated Study II
**Beaufort Slope**: The Importance of Shelf Break Upwelling to Upper Trophic Level Ecology in the Western Beaufort Sea
**JOIS/AON-BGOS**: Joint Ocean Ice Study/Arctic Observing Network-Beaufort Gyre Observing System
**Saildrones and Gliders**

# 2018 PAG and DBO Cruise Plan Table (06-17-18)

**2018 PAG and DBO Field Season (version 06_17_18): 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 |
| June 25-July 15 (Dutch Harbor-Dutch Harbor) | Oshoro-maru | 1,2,3 | ArCS project | Toru Hirawake hirawake@salmon.fish.hokudai.ac.jp | Toru Hirawake hirawake@salmon.fish.hokudai.ac.jp |
| July 12-24 (Dutch-Barrow) | Sir Wilfrid Laurier | 1,2,3,4,5 | C30/DBO (AON) | Jackie Grebmeier jgrebmei@umces.edu | John Nelson John.Nelson@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 |
| Aug 27 – Sept 20 (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) |
| Late August (Nome-Barrow) | Araon | | K-AOOS (Korea-Arctic Ocean Observing System | Sung-Ho Kang shkang@kopri.re.kr | Sung-Ho Kang shkang@kopri.re.kr |
| Aug 7-24 (Nome-Nome) | Healy | 2,3,4,5 | Eco-FOCI-DBO/NCIS | Jackie Grebmeier jgrebmei@umces.edu | Robert Pickart <rpickart@whoi.edu> and Jackie Grebmeier jgrebmei@umces.edu |
| Sept (Nome-Nome) | Norseman II | 3 | Bering Strait Mooring Project/AON | Rebecca Woodgate woodgate@apl.washington.edu | Rebecca Woodgate woodgate@apl.washington.edu |
| 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 |
| Late Oct-Nov | Healy | 5,6 | Western Arctic boundary current in a warming climate | Robert Pickart rpickart@whoi.edu | Robert Pickart rpickart@whoi.edu |
| Oct 25-Dec 7 (Sekinehama, Japan, return Shimizue, Japan) | Mirai | - | Japanese Atmospheric cruise; National Institute of Polar Research (NIPR) | Takashi Kikuchi takashik@jamstec.go.jp | Dr. Inoue inoue.jun@nipr.ac.jp |

# 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**

# Arctic Shelf Growth, Advection, Respiration, and Deposition (ASGARD) Rate Measurements Project

Seth Danielson, Arny Blanchard,
Sarah Hardy, Russ Hopcroft,
Andrew McDonnell,
Brenda Norcross, Dean Stockwell

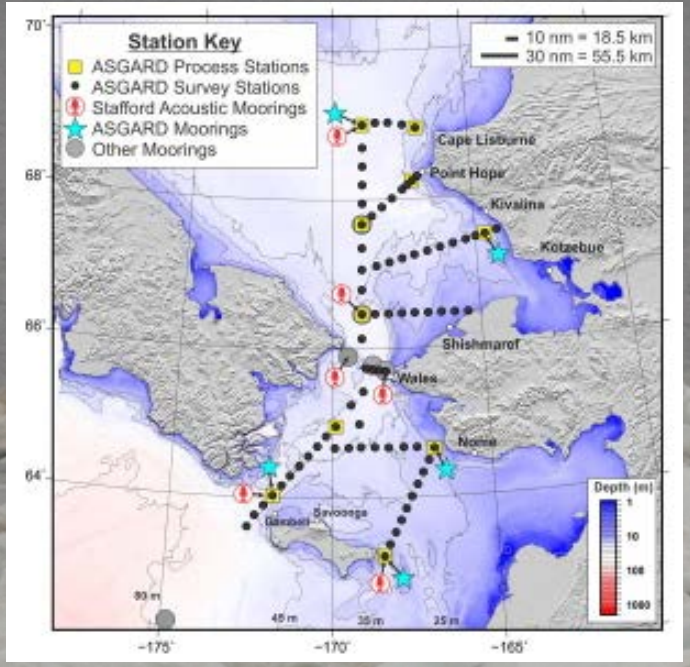
UAF COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks

**June 2017 and June 2018 Research Cruises to the Northern Bering and Southern Chukchi seas**

Lisa Eisner — NOAA
Kate Stafford — University of Washington
Kathy Kuletz — U.S. Fish & Wildlife Service
Mike Lomas — Bigelow Laboratory for Ocean Sciences
Laurie Juranek
Andrew Thurber — OSU Oregon State University, College of Earth, Ocean, and Atmospheric Sciences
Jeff Krause — Dauphin Island Sea Lab, Alabama
Atsushi Yamaguchi — Hokkaido University

North Pacific Research Board Arctic Program

NSF
Department of the Navy ONR Science & Technology
North Pacific Research Board
BOEM Bureau of Ocean Energy Management
Shell
North Slope Borough Dept. of Wildlife Mgmt.




# Guiding research question:

How will reductions in sea ice and the associated environmental changes influence the flow of energy through the northern Bering and Chukchi sea ecosystem?

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**Focus on Process Studies**

- Growth
- Respiration
- Vertical & horizontal fluxes

**ASGARD**


- Microbe community
- Midwater & benthic communities
- Growth & respiration incubations
- Sinking particles
- Nutrient fluxes
- Seabird & marine mammal surveys
- Year-round moorings: passive acoustics, nutrients, currents, light, T/S, fluorescence

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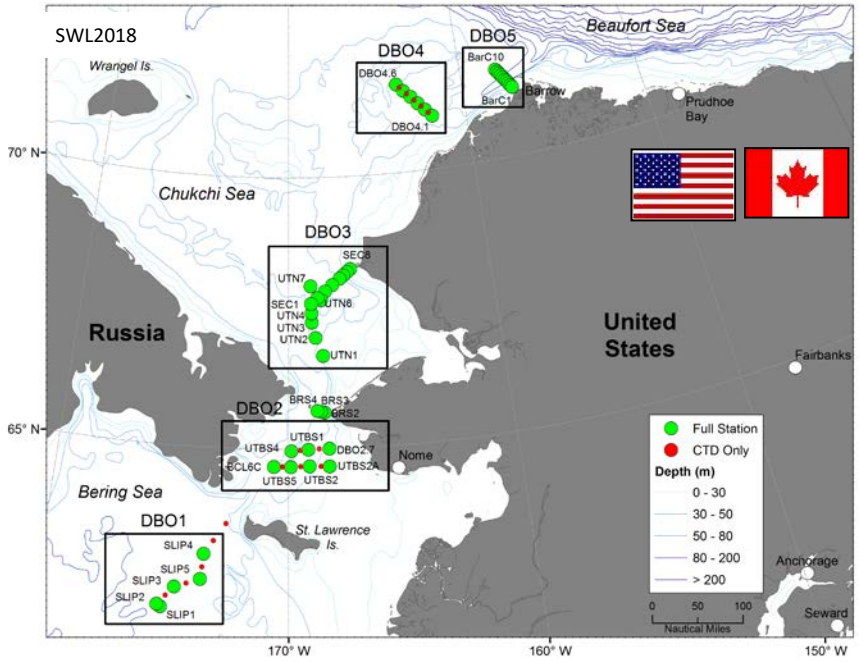
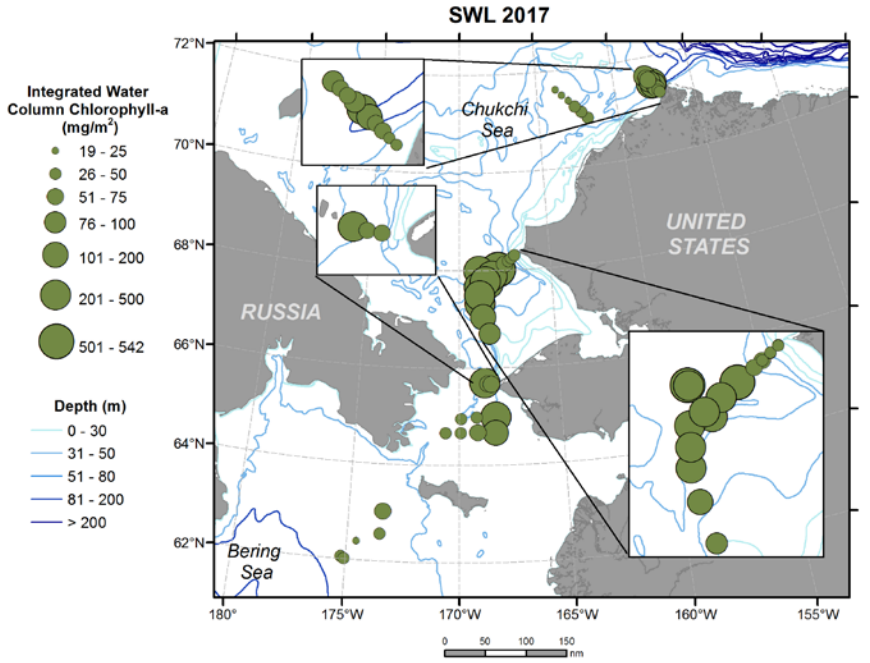
Arctic Program

# Canada's Three Oceans (C30) and the DBO: *CCGS Sir Wilfrid Laurier*, July 13-24, 2018

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





Contacts: John Nelson
John.Nelson@dfo-mpo.gc.ca and
Jackie Grebmeier
jgrebmei@umces.edu


## 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

# DBO Transects: CCGS Sir Wilfrid Laurier (July 14-July 22, 2017)

CTD/Rosette

Bongo nets

Incubation experiments

Laboratory filtrations

Over the side 150kHz ADCP

C-OPS

vanVeen grabs

Bird observations

## Science:

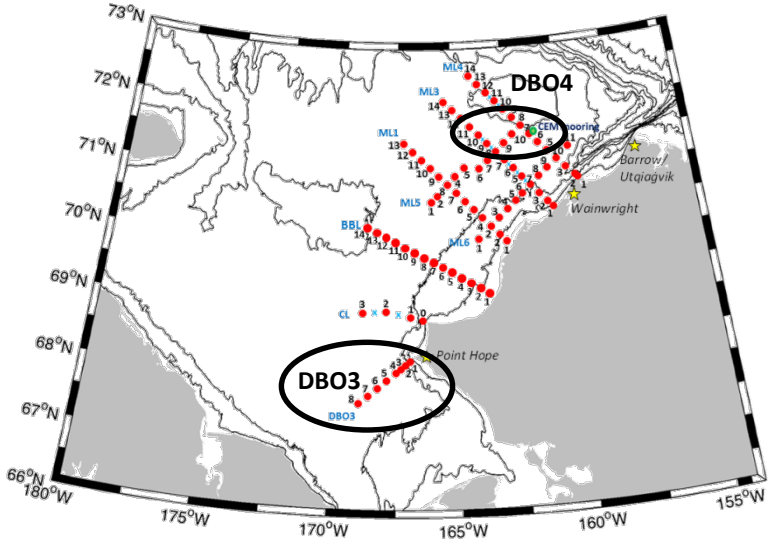
- 62 CTD stations. 45 of these with Rosette sampling (chlorophyll, nutrients, phytoplankton)
- 45 Bongo net hauls for zooplankton
- 42 deployments of 150 kHz ADCP
- 38 Benthic sampling stations with up to 5 vanVeen grabs at each station¥
- 38 Benthic Video-camera recordings
- 20 stations where water was collected for methane and nitrous oxide analysis
- 12 stations were sampled for apparent optical properties
- 4 stations were used for primary productivity incubation experiments
- Seabird and Marine Mammal observations
- Meteorological and position data from ship sensors

Fisheries and Oceans Canada
Pêches et Océans Canada

# AMBON: Arctic Marine Biodiversity Observing Network


**Iken K**[1], Cooper L[2], Danielson S[1], Grebmeier J[2], Mueter F[1], Hopcroft R[1], Stafford K[3], Kuletz K[4], Collins E[1], Kavanaugh M[8], Bluhm B[1,5], Moore S[6], Buckelew S[7], Bochenek R[7]

(1) University of Alaska Fairbanks; USA; (2) University of Maryland, USA; (3) University of Washington, USA; (4) US Fish and Wildlife Service, USA; (5) University of Tromsø, Norway; (6) National Oceanographic and Atmospheric Administration, USA; (7) Alaska Ocean Observing System/AXIOM, USA; (8) Oregon State University




**Focus area:** Chukchi Sea shelf

**Field work:** 2015 and 2017

**Disciplines:** hydrography, microbes, zooplankton, benthos, fish, seabirds, marine mammals, seascapes

**Intent:** Provide biodiversity data
Fill gaps (e.g., microbes)
Continue long-term time series
Providing publicly accessible data

# AMBON17 Data Products from Cruise Report

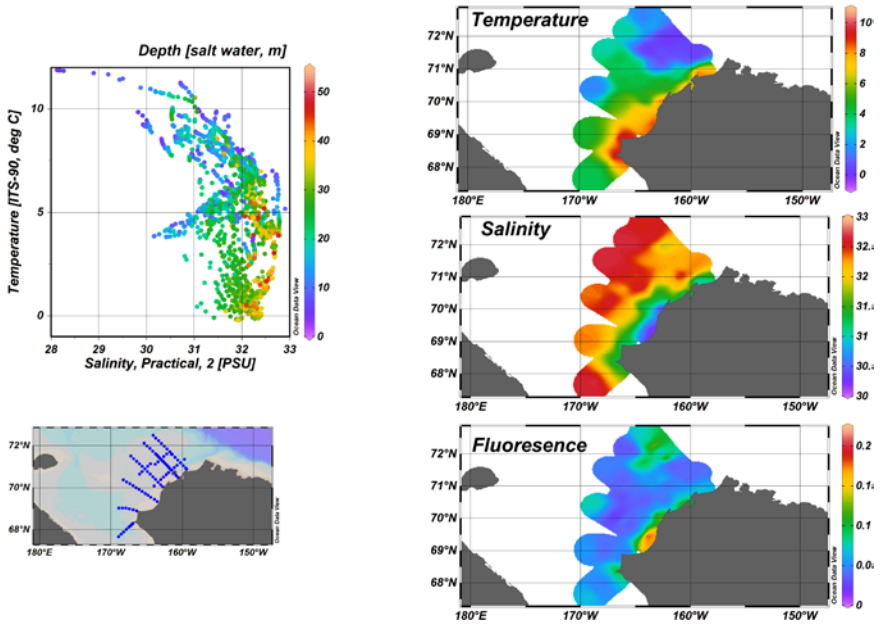



**Figure 2a:** Surface water properties during AMBON 2017.

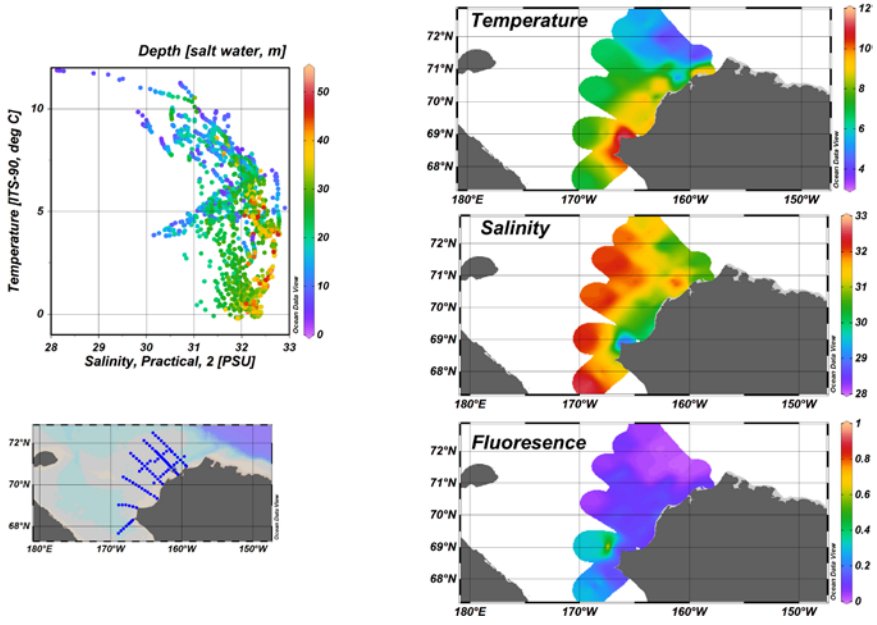



**Figure 2b**: Bottom water properties during AMBON 2017.

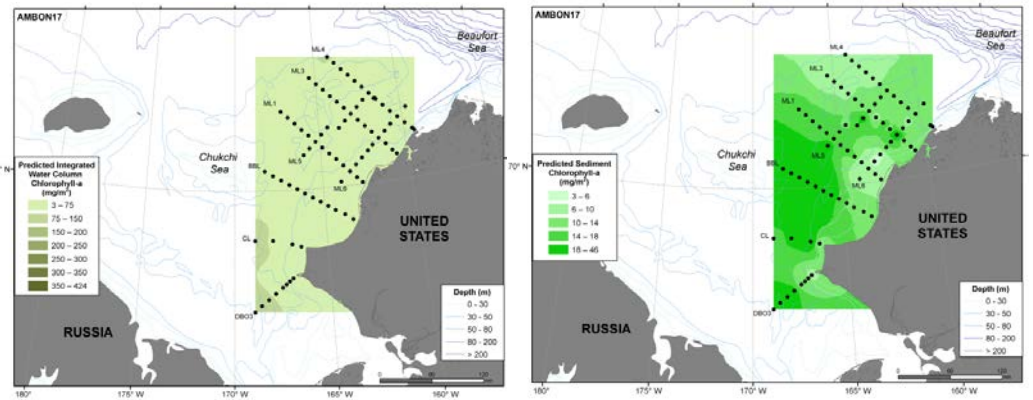



**Figure 8. a**. Integrated chlorophyll a (mg/m2) and **b.** surface sediment chlorophyll a (mg/m2) present in study area during the August AMBON17 cruise.

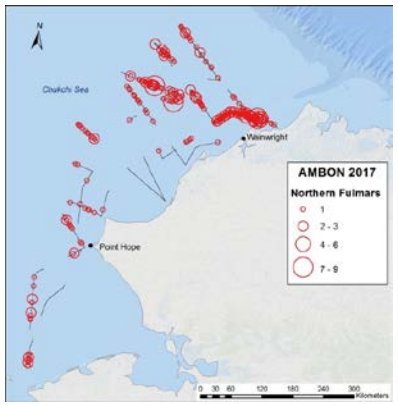



**Figure 12:** Distribution of auklets observed on transect during AMBON 2017.

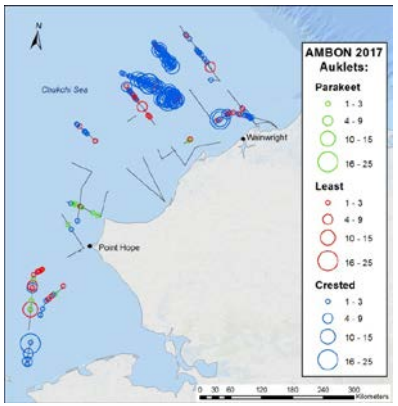



**Figure 13:** Distirubtion of northern fulmars observed on transect during AMBON 2017.

# Bering Strait Mooring Program – July 2017/Sept 2018

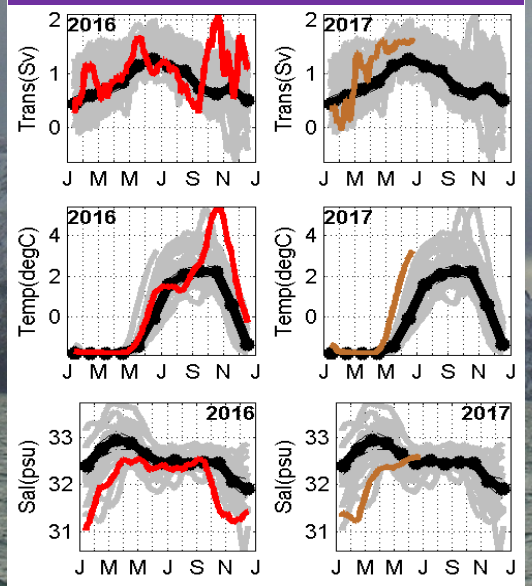
***Rebecca Woodgate*** *University of Washington, Seattle, USA*

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:**

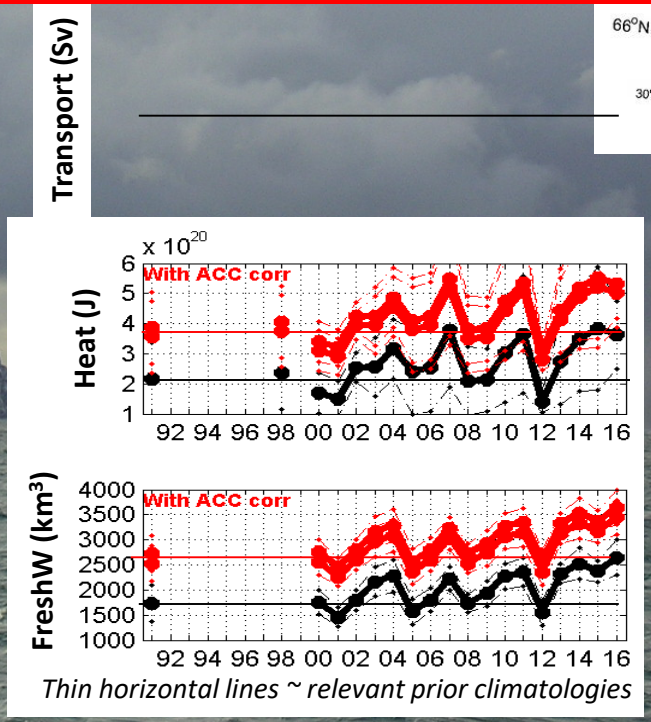
## 2016/2017 Remarkably warm & fresh




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

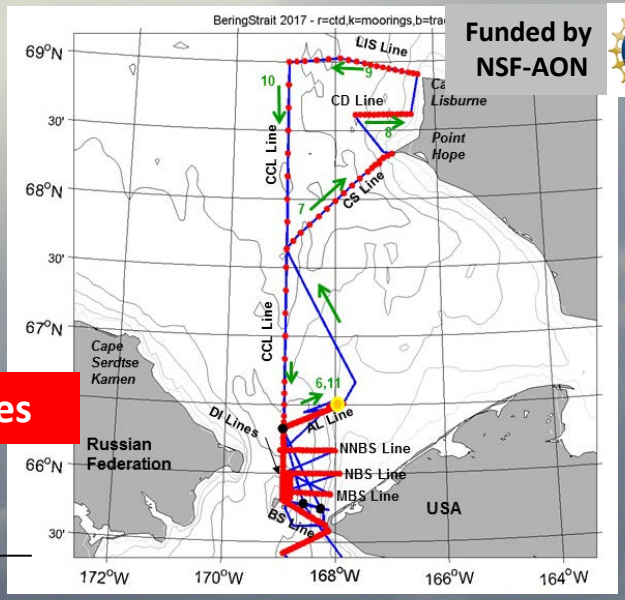
**** Oct 2016 & June 2017 both 3°C warmer than climatology***
**** ~20 day late cooling in 2016***
**** ~15 day early warming in 2017***
**** Salinities 0.5-1psu fresher than climatology***

## 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*

*Find data and papers at:*
***psc.apl.washington.edu/Bstrait.html***

# Moored
# **Chukchi Ecosystem Observatory (CEO)**
# near Hanna Shoal

## Year-round high-resolution time series

**Current Speed & Direction**
**Pressure**
**Temperature**
**Salinity**
**PAR**
**Chlorophyll *a* fluorescence**
**Directional Wave Spectra**
**Acoustic Backscatter**
**@ 38, 125, 200, & 455 KHz**
**Ice Draft (level ice & keels)**
**Significant Wave Height & Direction**
**CDOM**
**Nitrate**
**Dissolved Oxygen**
**Optical Backscatter**
**Passive acoustic recordings**
**pH**
**pCO2**
**Particle size spectra & concentrations**

**Water Sampler:**
**Nutrients**
**Phytoplankton identification**

**Sediment Trap:**
**Chlorophyll *a***
**Phytoplankton identification**
**Total particulate matter (dry wt.)**
**Particulate organic carbon**
**Particulate nitrogen**
**Zooplankton species**
**Zooplankton fecal pellets**

## CEO Relevance

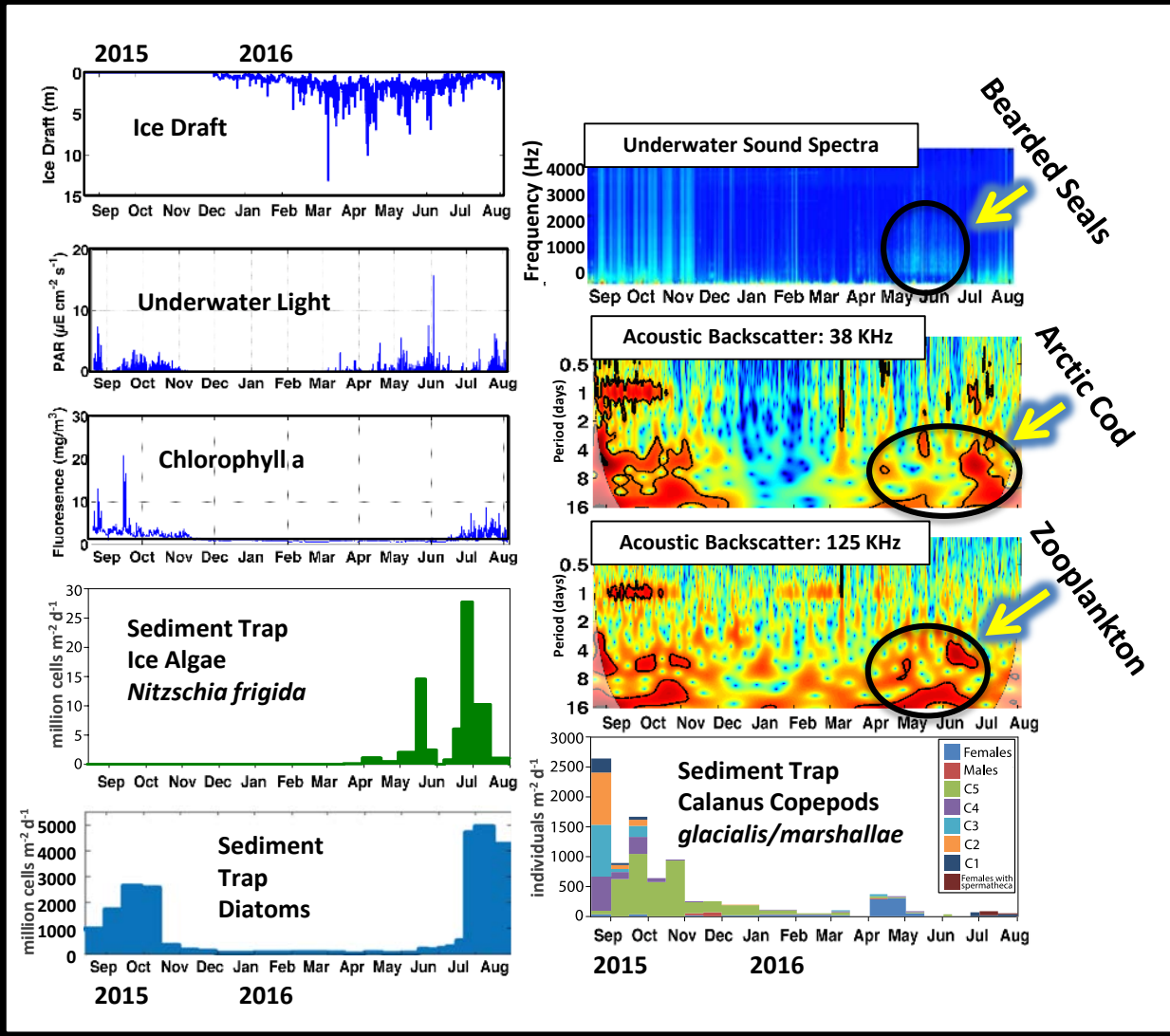
- Developing a better mechanistic understanding of the Arctic marine ecosystem.
- Fostering coordination and cooperation among research programs.
- Enhancing information availability with scientific data, analyses, and products tailored to public stakeholders.

CEO-affiliate scientists: Seth Danielson, Carin Ashjian, Lee Cooper, Jackie Grebmeier, Claudine Hauri, Russ Hopcroft, John Horne, Katrin Iken, Catherine Lalande, Andy Mahoney, Andrew McDonnell, Kate Stafford, Peter Winsor

www.ChukchiEcosystemObservatory for more information

# Views into event timing, magnitude and co-variability

Ship-of-opportunity visits to the mooring site that enable us to recover and redeploy the mooring each year are CRITICAL to this project's success.




www.ChukchiEcosystemObservatory for more information

# Arctic Integrated Ecosystem Survey II

**Ed Farley**, Carol Ladd, Kris Cieciel, Alex DeRobertis, Janet Duffy-Anderson, Lisa Eisner, Jeff Guyon, Dave Kimmel, Ron Heintz, Libby Logerwell, Phyllis Stabeno & Chris Wilson

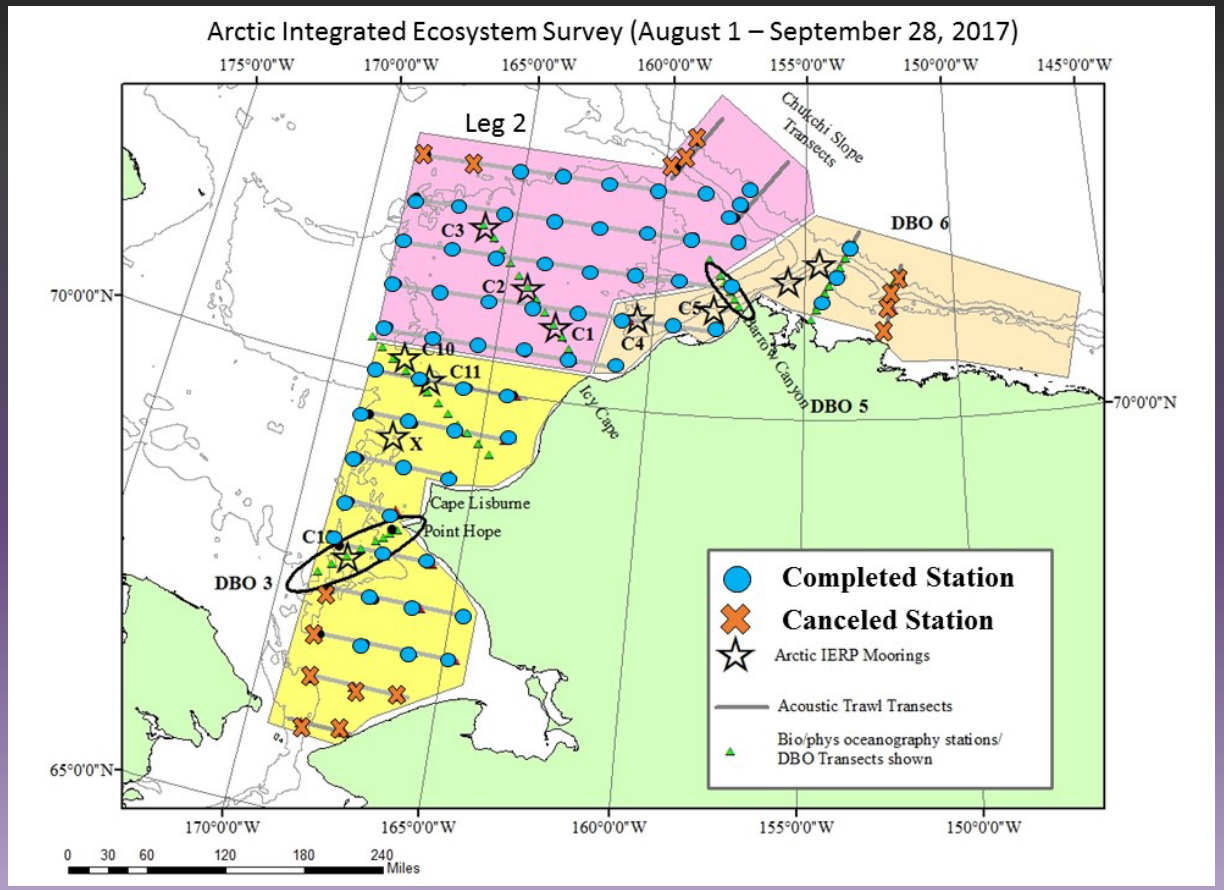
Franz Mueter

Louise Copeman

Ryan McCabe, Calvin Mordy & Danny Grunbaum

Kathy Kuletz

Field sampling: Aug/Sep 2017 and 2019

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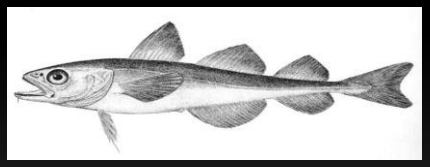
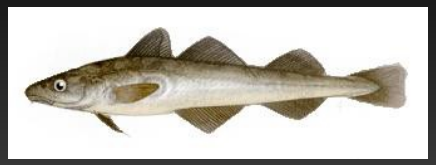
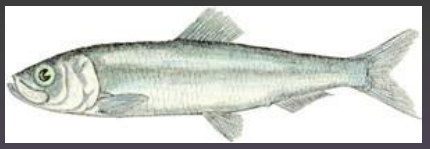
# Overarching question: How Will Warming Likely Affect Abundances of Fishes and Invertebrates?



Arctic cod

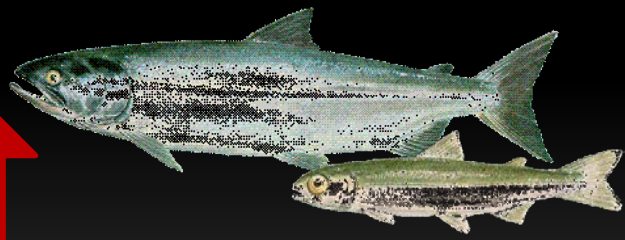


saffron cod

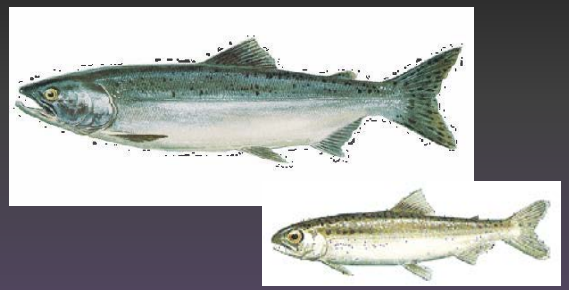


Pacific herring

capelin



chum salmon



pink salmon

snow crab

jellyfish

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# Oceanographic & Fisheries Sampling


Zoo-
plankton

Oceanography

Surface (top 25 m)

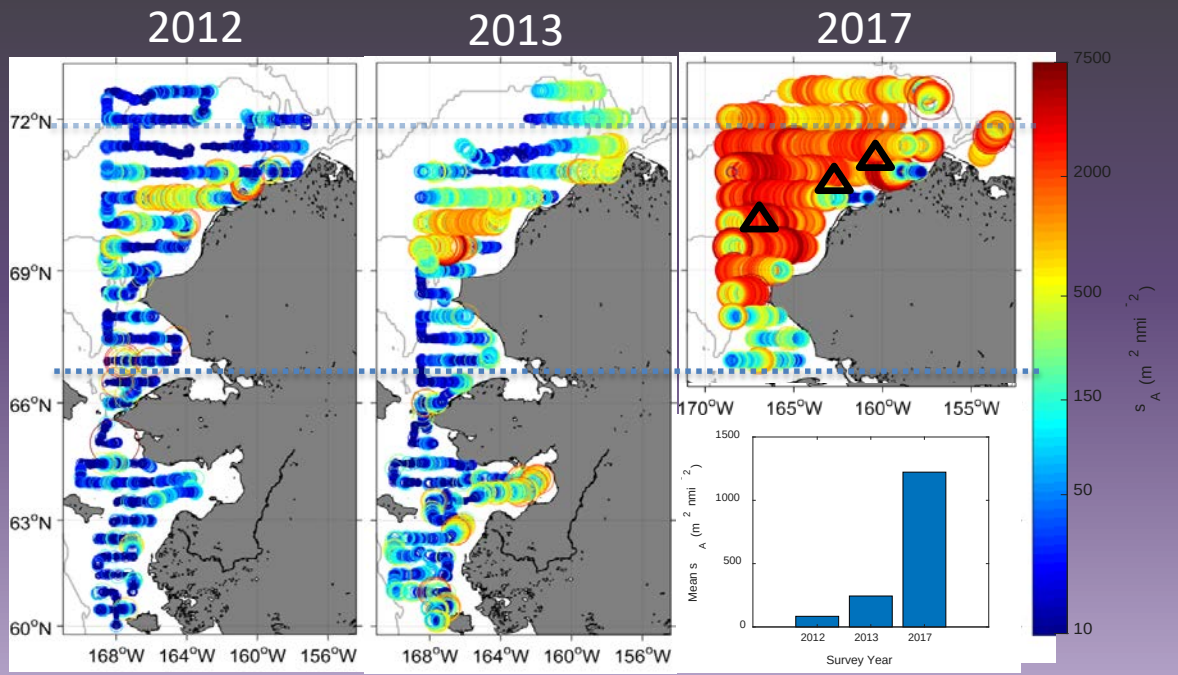

Midwater


Bottom

3 m Plumb Staff
Beam Trawl

Acoustic fish backscatter (38kHz, primarily Arctic cod) in 2012, 2013, and 2017

1. Broader distribution of fish in 2017 (much warmer)
2. Mean backscatter (67°N to 71.5°N) in 2017 was 5x higher than 2013 & 14.5x higher than 2012.

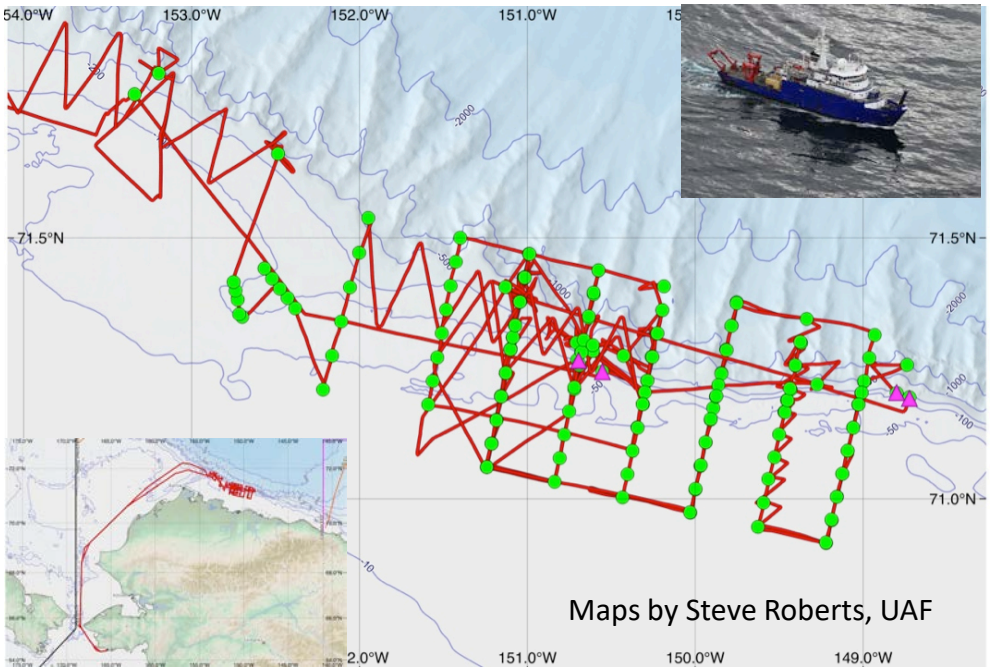


# BEAUFORT SHELF BREAK ECOLOGY – PLANKTON, FISH, AND BELUGAS

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 |

# We think belugas are seen at the shelf break because high numbers of their arctic cod prey are there

## The food chain we want to study:

Plankton (Krill, Copepods) → Arctic Cod → Belugas




Images not to scale

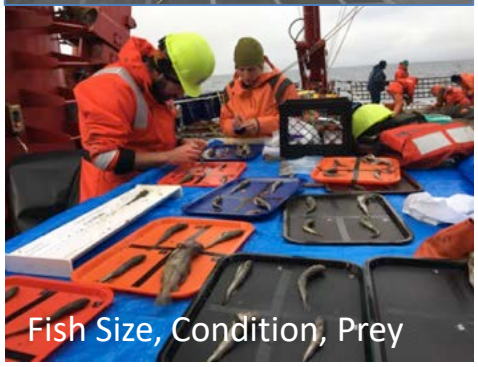
## The mechanism:

Winds from the east followed by low winds concentrates copepod and krill prey that attracts Arctic cod to feed. The cod then are present in high numbers so that belugas can easily find them

# APPROACH

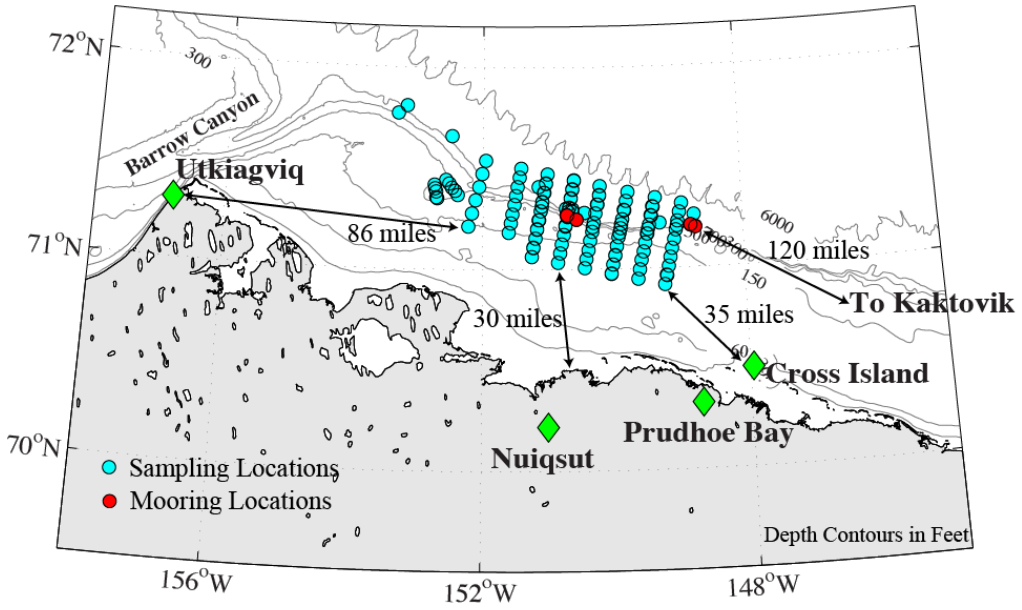




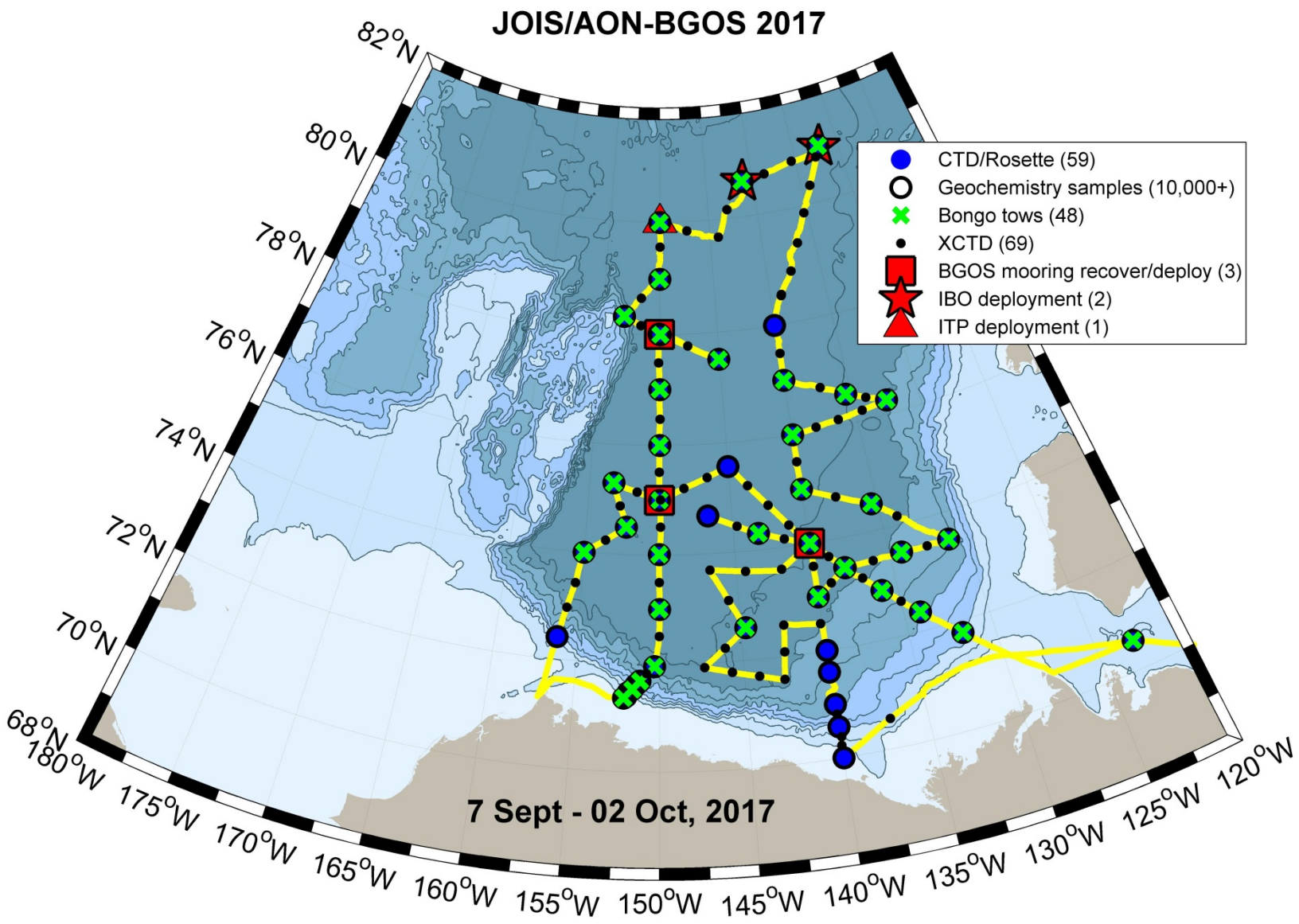



**Potential Sampling Locations**

Aug. 3-27, 2018 (based on 2017 locations)




Cyan: station locations; Red: mooring locations

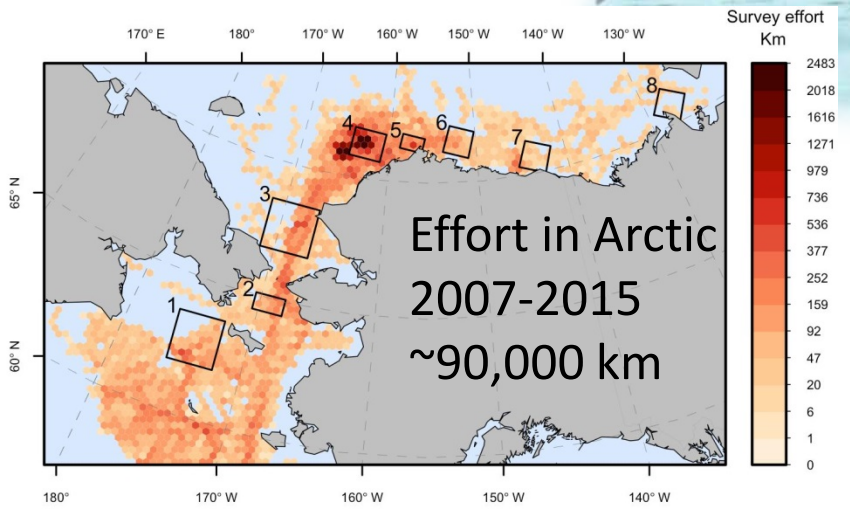



**Thanks to all for a very successful 15th expedition!**

[Bill Williams]

# Seabird Surveys in the Pacific Arctic

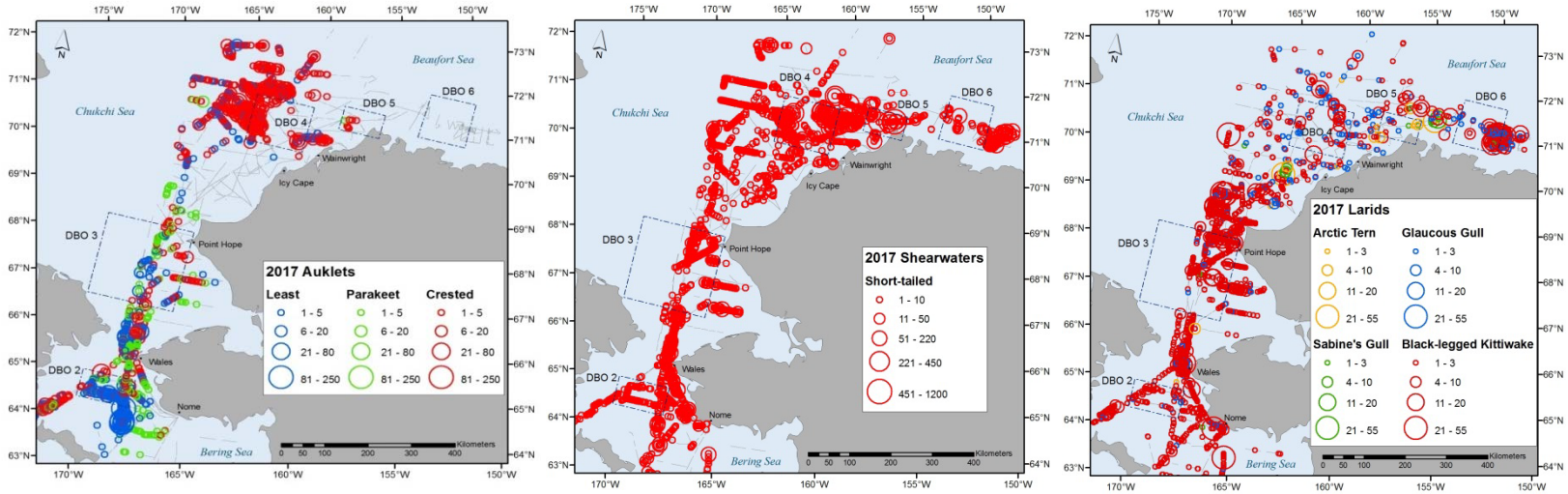
[Kathy Kuletz, USFWS]




**In 2017**

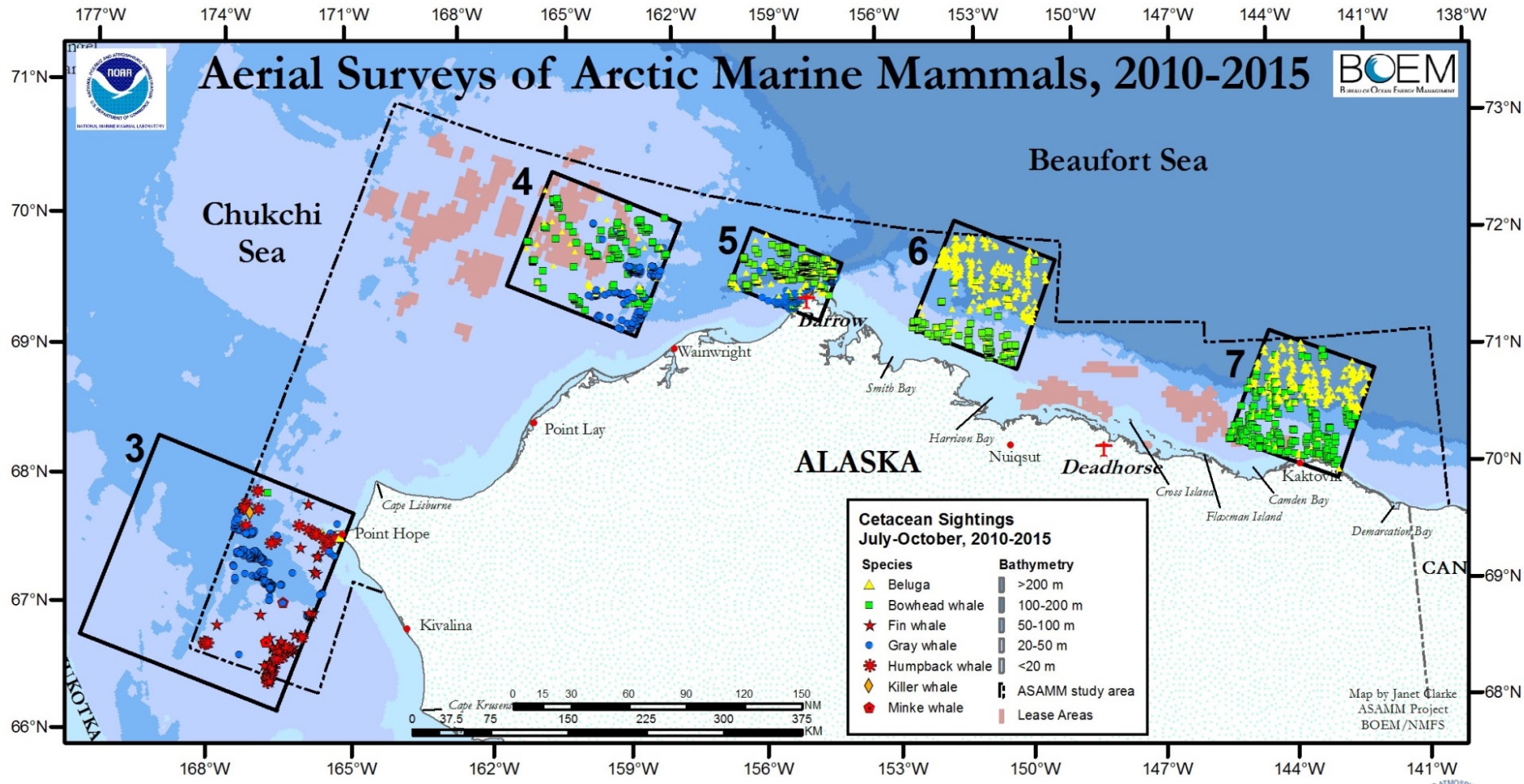
**~ 19,700 km surveyed in**

**North Bering, Chukchi, Beaufort**




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

# 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]

# Innovative Technology for Arctic Exploration

ITAE Pacific Marine Environmental Laboratory

Jessica Cross, NOAA/PMEL, Seattle, Washington, USA


## 2018 Saildrone Projects

**Two Projects in the Pacific Arctic in 2018**
Bering Strait & Chukchi Sea
July through September 2018

Ocean Acidification
- No active acoustics
- Assess important questions about physical circulation, ice melt, ecosystems, and ocean acidification in the region

Fisheries Survey
- Active acoustics
- Understand the fate of the age-0 Arctic cod and other pelagic fish species on the Chukchi shelf

**FOR INFORMATION**
Notice of Operations
https://www.pmel.noaa.gov/itae/mariner-and-public-notice-research-platforms

Saildrone Research Blog
https://www.pmel.noaa.gov/itae/follow-saildrone-2018

Email Updates – sign-up using
https://goo.gl/forms/4fBQkg2GXp3obCn42

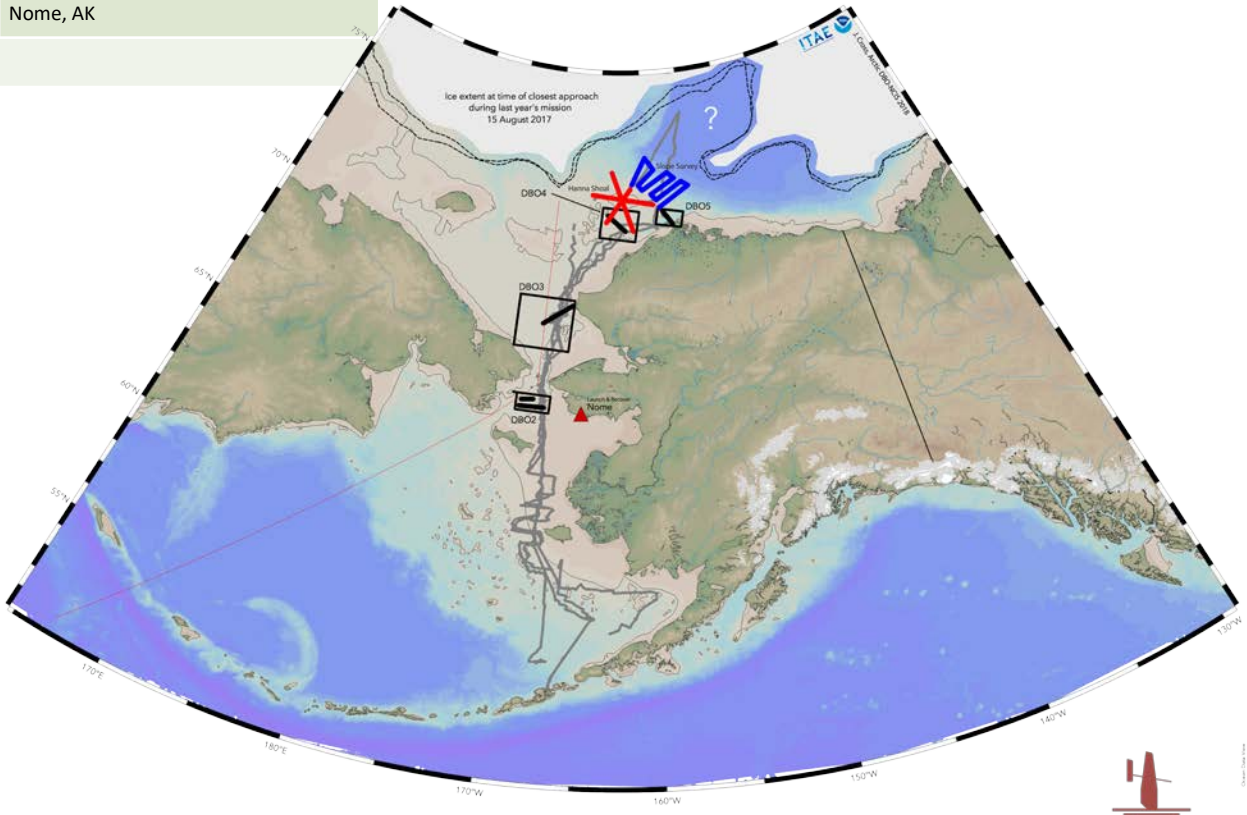
Contact
Heather Tabisola, Research Coordinator
heather.tabisola@noaa.gov, 206.526.6662

# Arctic DBO-NCIS

| Principal Investigator | Jessica Cross, NOAA | Requesting Organization | NOAA's Pacific Marine Environmental Lab<br>Seattle, WA |
|---|---|---|---|
| Mission Name | Arctic-DBO-NCIS | No. of USV | 2 |
| Duration | July-October 2018 | Data Mission Days | 90 (per vehicle) |
| Launch Location | Dutch Harbor, AK | Recovery Location | Nome, AK |
| OPAREA | Chukchi Sea, points North | | |

## Objectives

- Continue sensor and platform development and testing of the ASVC02 system through;
- DBO lines 2, 3, 4, and 5 (1 USV)
- Slope survey (1 USV)
- Calibration activity with USCGC Healy in August
- Shelf survey over Hanna Shoal if time permits
- Basin survey northward towards ice edge if time & ice permits




SAILDRONE

ITAE
Pacific Marine Environmental Laboratory

ARCTIC PROGRAM

OAP
NOAA OCEAN ACIDIFICATION PROGRAM

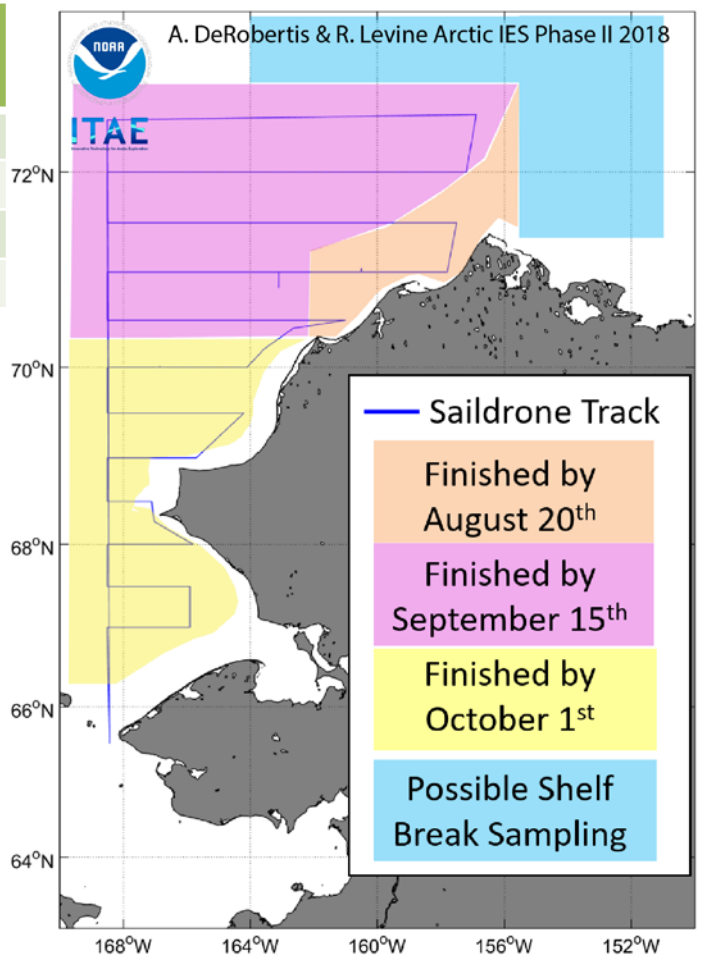
# Arctic IES Phase II

| Principal Investigator | Alex DeRobertis, NOAA | Requesting Organization | NOAA's Pacific Marine Environmental Lab<br>Seattle, WA |
|---|---|---|---|
| Mission Name | Arctic IES PII | No. of USV | 2 |
| Duration | July-October 2018 | Data Mission Days | 90 (per vehicle) |
| Launch Location | Dutch Harbor, AK | Recovery Location | Nome, AK |
| OPAREA | Chukchi Sea, points North | | |

Objectives

**Use real-time information and post-processed data to identify the distribution of Arctic cod based on:**

- Complete acoustic survey of Arctic IES PII (also known as Arctic IERP) survey region.
- Data collected in vicinity 3 of bottom-moored echosounders.
- Real-time data to inform ship-based sampling activity.
- Map distribution of suspected Arctic cod aggregations in deep water over the shelf break as time allows
- Real-time identification of large-scale pelagic fish migration patterns

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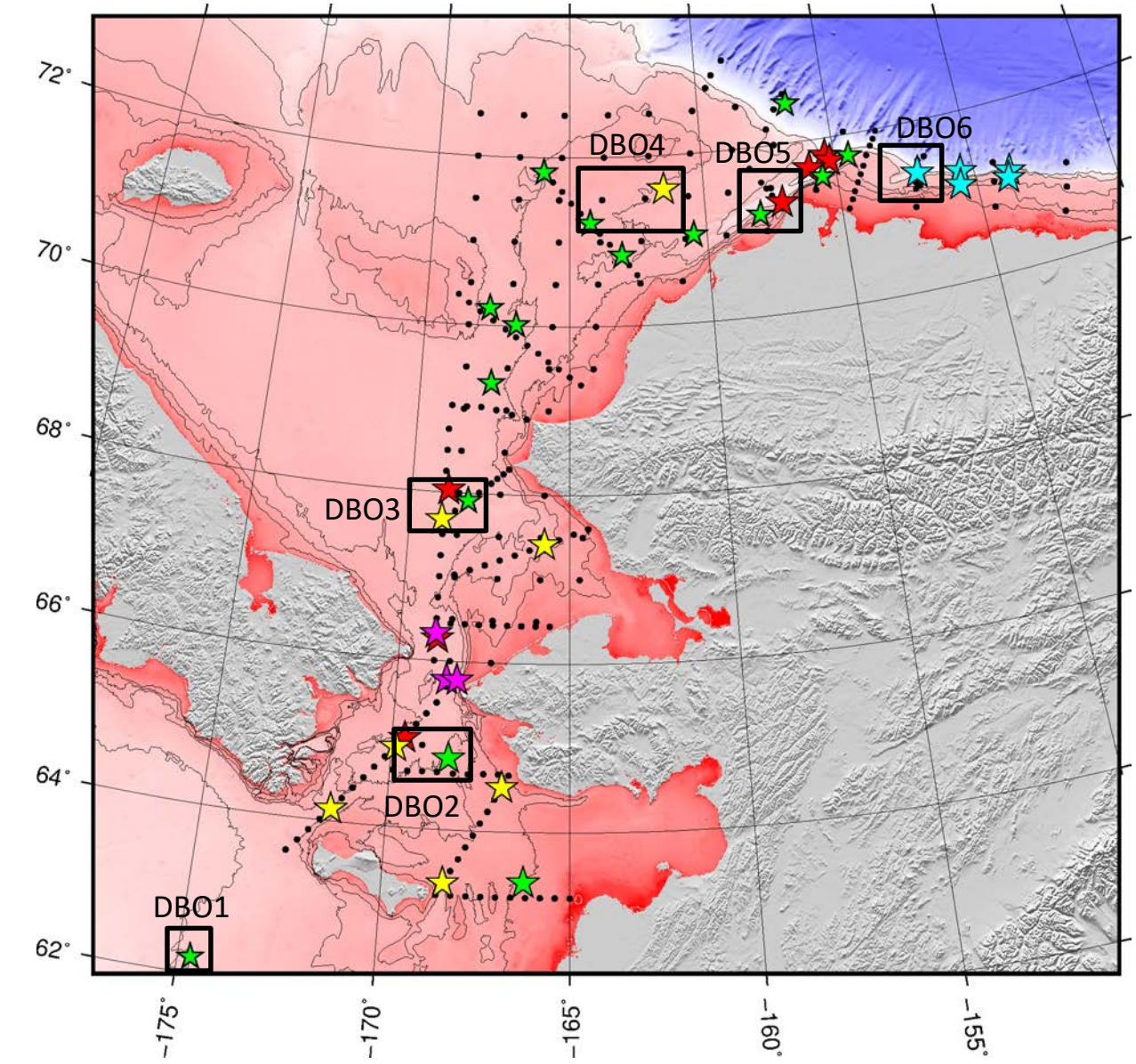
NOAA FISHERIES

SAILDRONE




## AIERP & Other 2017-2018 Moorings

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

[figure courtesy Seth Danielson/UAF; updated with DBO boxes]

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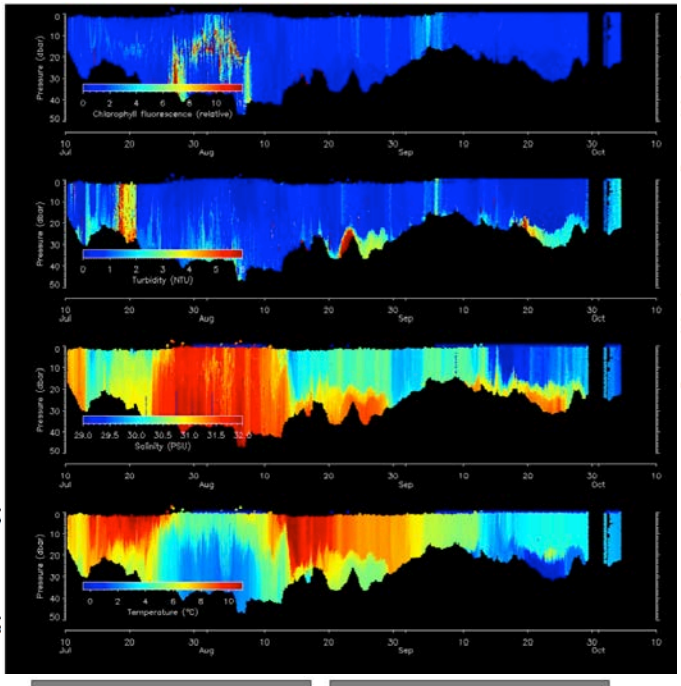
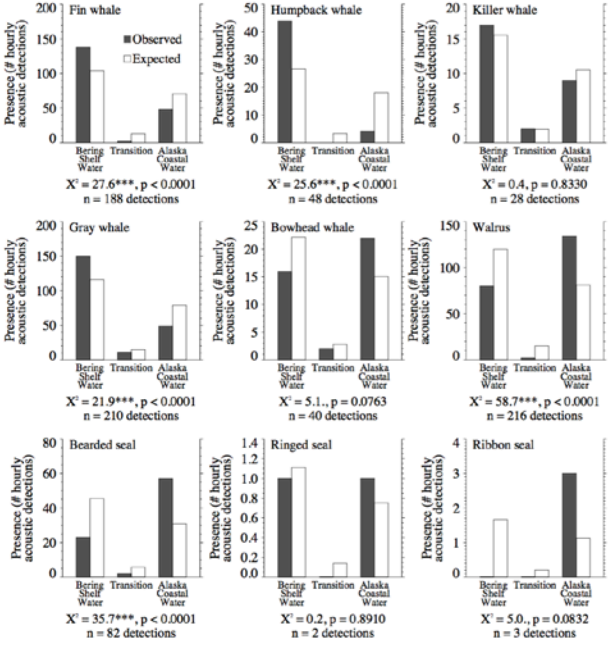
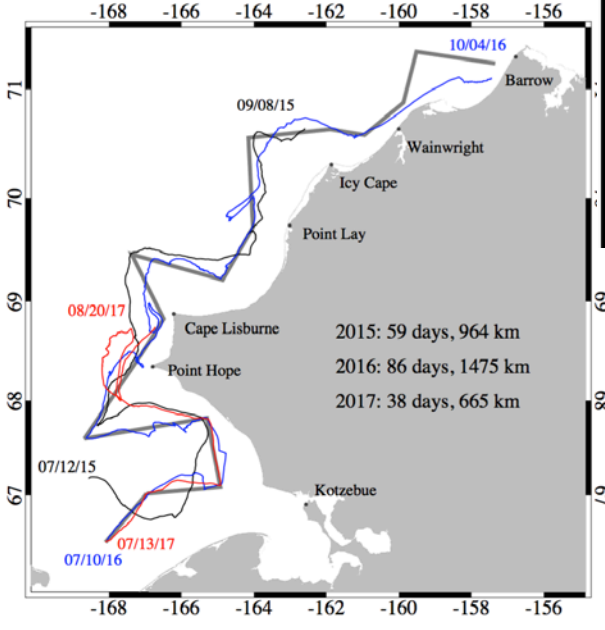
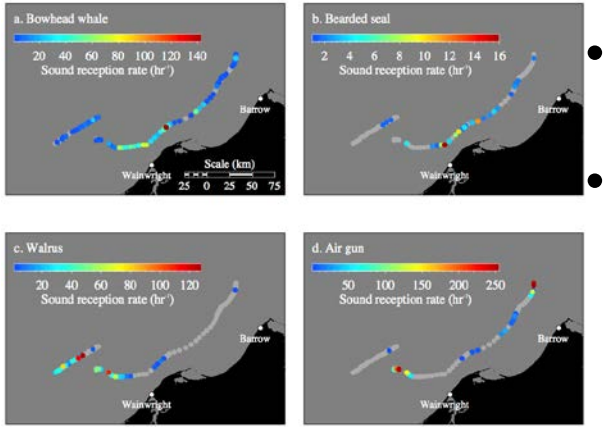
# Glider-Based Passive Acoustic Monitoring in the Arctic

Peter Winsor, Kate Stafford and Mark Baumgartner

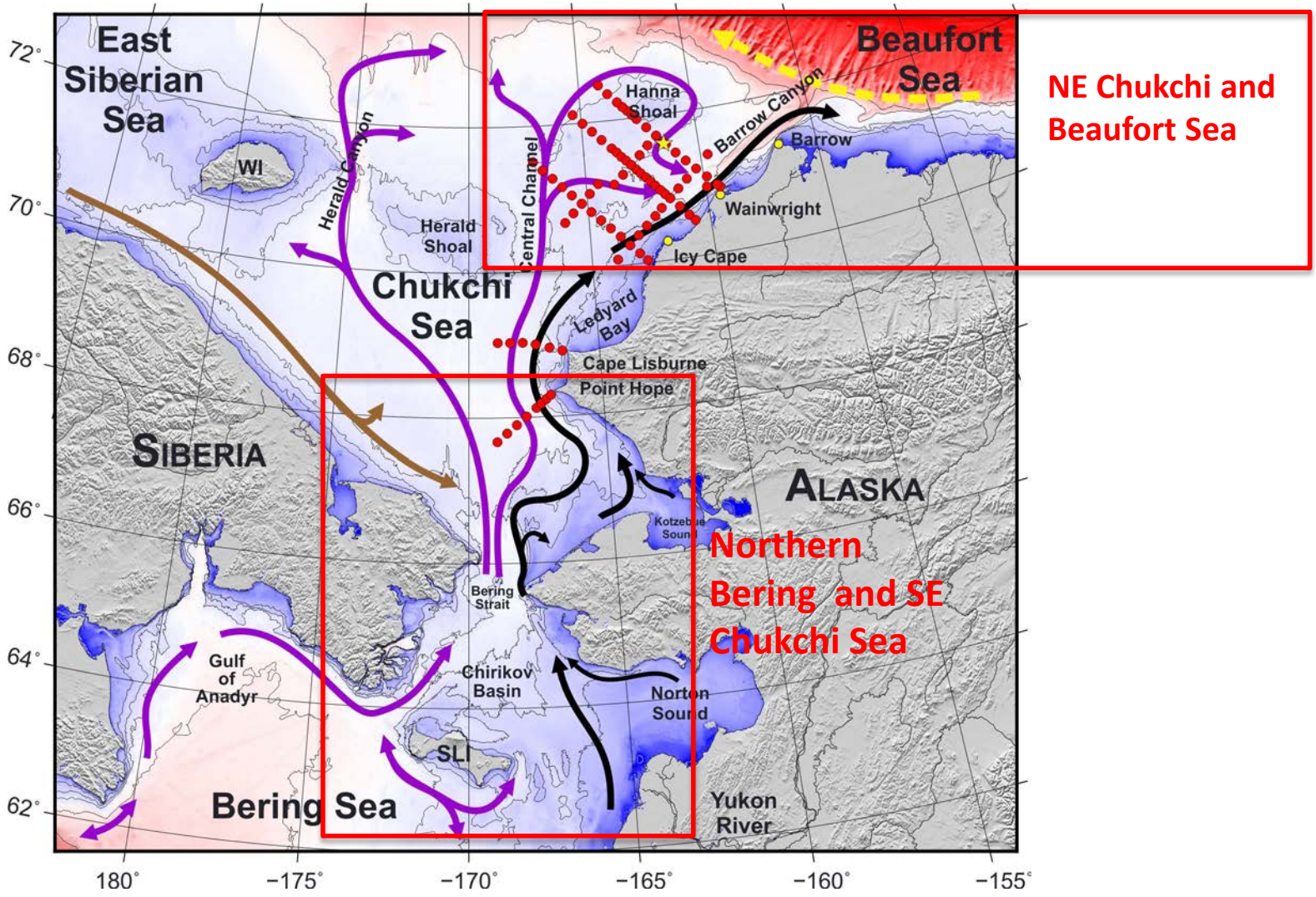




- 90+ days of Autonomous Measurements in Real-Time
- Passive Acoustics, CTD and Bio-optics in a single package

Alaska Ocean Observing System

**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]

# PAG facilitated successful coordination with Barrow whaling community for science needs during subsistence whaling period

- Dr. Motoyo Itoh (JAMSTEC) visited Utqiaġvik (Barrow), Alaska to discuss mooring turnaround request in spring 2018
- Made flyer (right) and gave meeting presentation to Barrow Whaling Captains
- Provided information on sensors on moorings
- Agreement that ship can coming in via specific direction within subsistence hunting area after call in with contact on line

## Planned mooring turn-around in the Barrow Canyon by Canadian Coast Guard icebreaker Sir Wilfrid Laurier in October 2018


Principal Investigator of these moorings: Motoyo Itoh
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2-15 Natsushima, Yokosuka, Kanagawa 237-0061, Japan
Tel. +81-46-867-9488; e-mail: motoyo@jamstec.go.jp

Chief Scientist of SWL: Humfrey Melling
Institute of Ocean Sciences, Fisheries and Oceans Canada
9860 West Saanich Road. PO Box 6000. Sidney BC, Canada V8L 4B2
Tel. 250-363-6552; e-mail: Humfrey.Melling@dfo-mpo.gc.ca

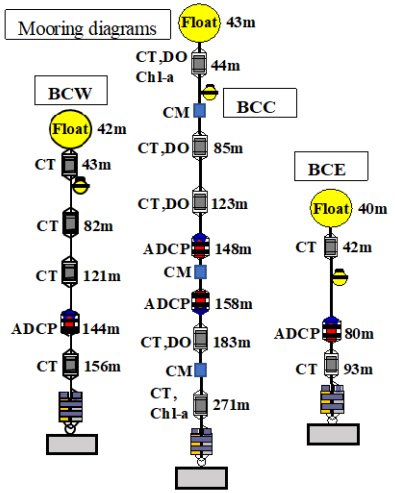

http://www.ccg-gcc.gc.ca/Fleet/Vessel?vessel_id=100

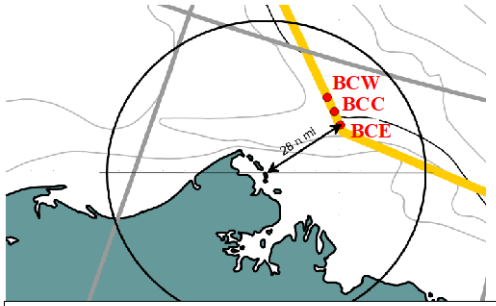
Canadian Coast Guard icebreaker Sir Wilfrid Laurier (SWL, 4662 long tons displacement) has a 23-year history of support to Arctic marine science since 1995. The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) placed its first oceanographic mooring in the Barrow Canyon in 1992 and has maintained three instrumented moorings there, at locations on its axis and on its eastern and western slopes since 2000. The goals of this continuous long-term monitoring have been to detect and quantify on-going changes in the flows, temperatures and salinities of water using this sea valley as a path from the Pacific to the Arctic ocean. The Pacific inflow is an important source of heat, freshwater, ocean nutrients and planktonic lifeforms for the Arctic Oceans, Observed changes in the inflow have been linked to changes in Arctic ice cover, ocean warming and marine productivity. Continuation of this long established "ocean observatory" is critical to continued awareness of Arctic change and to efforts to mitigate and adapt to its effects. Data from the moorings in Barrow Canyon instruments are public on the web:

http://www.jamstec.go.jp/arctic/data_archive_work/mooring/mooring_list.html

SWL has a varied science program in the autumn of 2018 that begins in Cambridge Bay on September 20, continues in the Canadian Beaufort Sea through October 5. She is expected off Nome Alaska by October 15. This leaves a window of 9 days to accomplish planned work in Barrow Canyon and areas to the north-west, to complete the transit from the Canadian Beaufort to Nome and to standby for active whaling, poor weather or heavy ice, when necessary. The tentative date of the ship's arrival at Barrow Canyon is October 7, although a delay of 2-3 days would be possible by changing the sequence of planned work in the Chukchi Sea.

Turn-around (that is, recovery and deployment) of each mooring will require 1-3 hours. The ship's presence in Barrow Canyon will last no longer than 1.5 days, encompassing 8-12 hours of work during daylight, plus possible overnight standby to completion.




BCW (water depth:171m, 71° 47.77' N, 155° 20.68' W)
BCC (water depth:286m, 71° 44.04' N, 155° 09.67' W)
BCE (water depth:107m, 71° 40.38' N, 155° 00.03' W)
There mooring measures
Temperature and salinity (CT), Dissolved Oxygen (DO), Phytoplankton (Chl-a), Current (Current Meter or Acoustic Doppler Current Profilers).

# Thank you for your attention.

## Questions and comments?

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

http://arctic.cbl.umces.edu , http://www.arctic.noaa.gov/dbo
http://pag.arcticportal.org
http://neptune.gsfc.nasa.gov/csb/index.php?section=270
http://arcticdata.io *(Arctic Data Center, then use DBO as search term)*
http://ambon-us.org/, https://mbon.ioos.us/
http://www.ChukchiEcosystemObservatory

BOEM Bureau of Ocean Energy Management
NASA
North Pacific Research Board Arctic Program
National Oceanic and Atmospheric Administration NOAA U.S. Department of Commerce
NSF
PAG Pacific Arctic Group