



NORTH PACIFIC RESEARCH BOARD
*Arctic
Program*

2017 Arctic Integrated Ecosystem Studies II (Arctic IES) Project
2017 and 2018

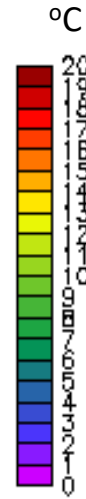
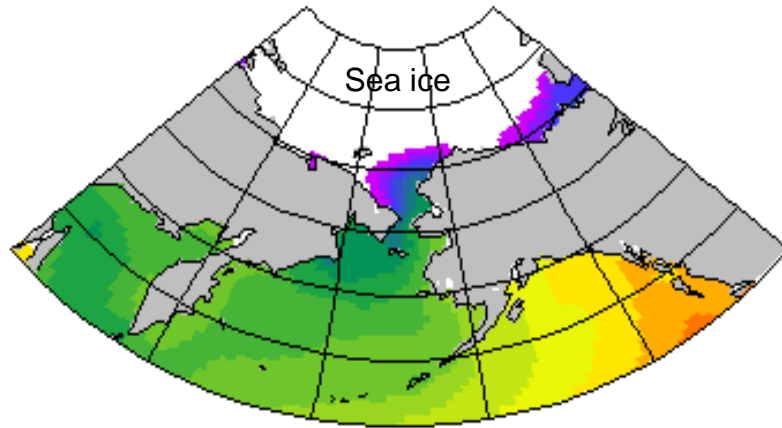
Arctic Integrated Ecosystem Survey

Objective: To understand how climate change will affect the distribution, abundance, and fitness of fishes, seabirds, and marine mammals and the food they depend upon throughout the Chukchi and Beaufort seas.

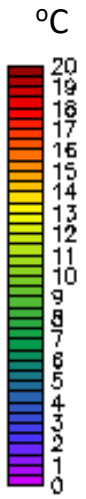
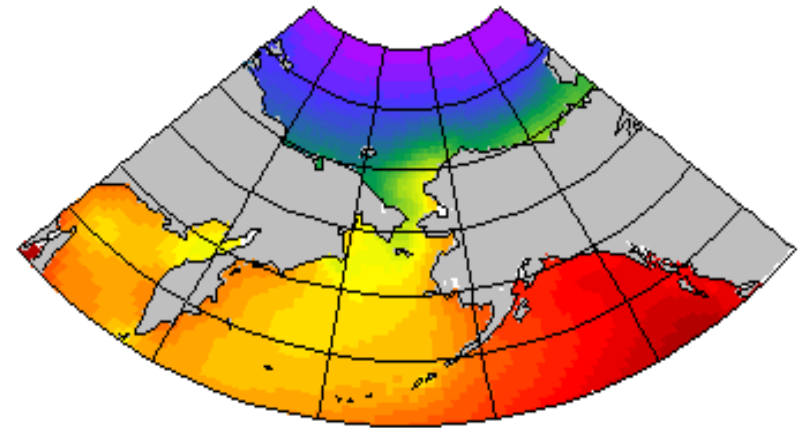


Issue: Rapidly changing Arctic

Current



Projected

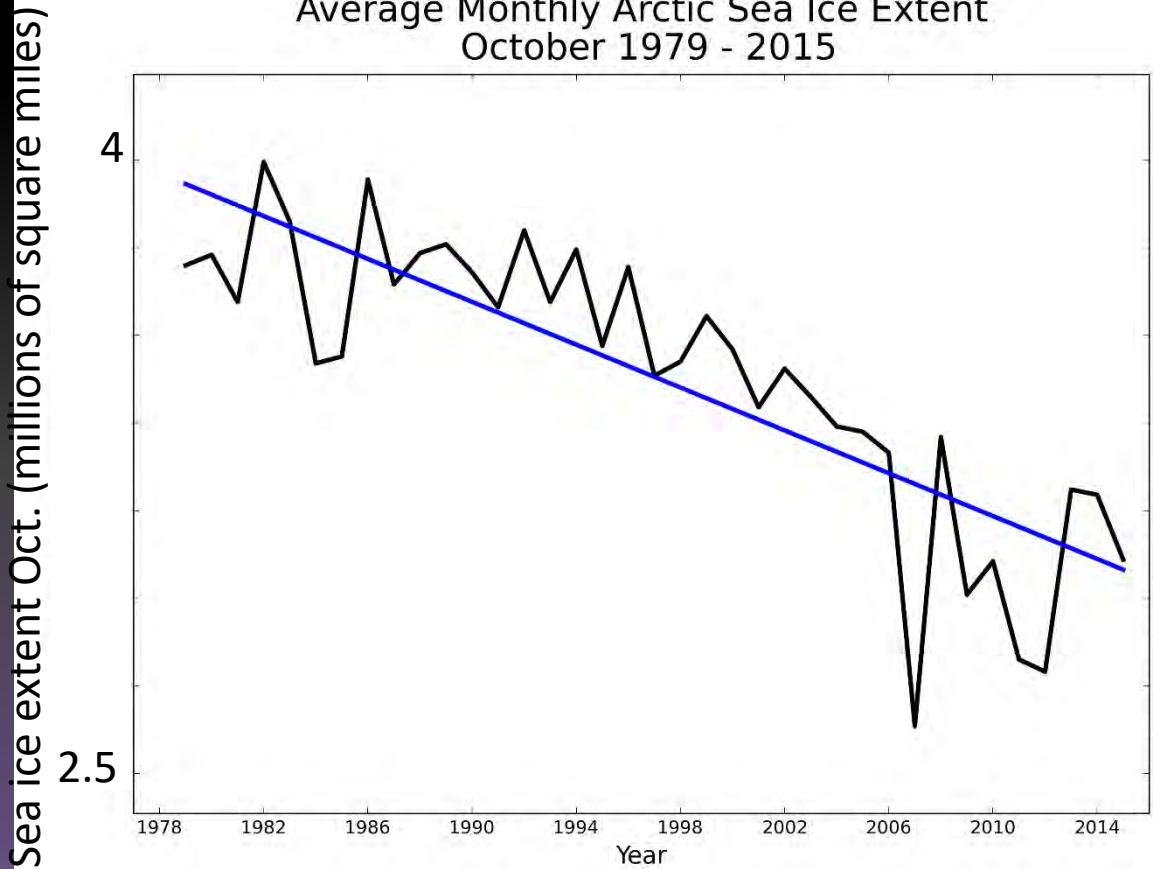


Summer Sea Surface Temperature
(mean of July-Sept) averaged over
1976-2005

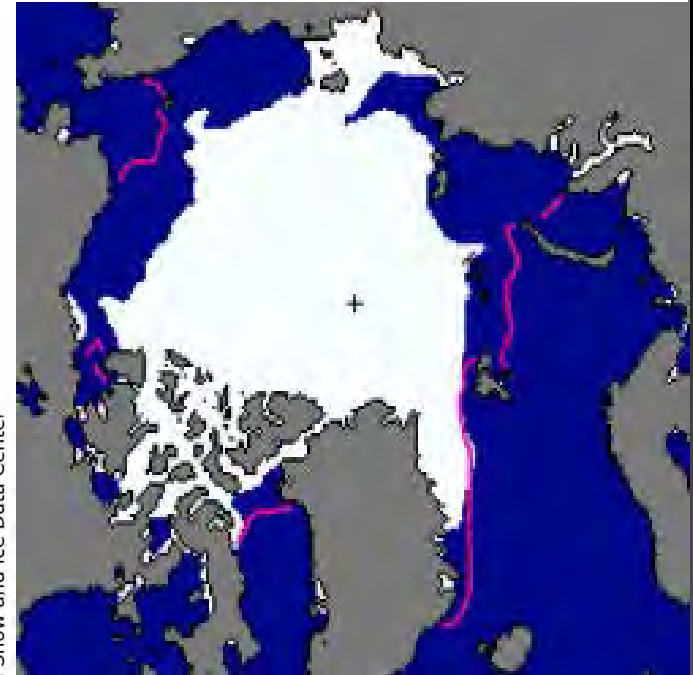
Projected summer Sea Surface
Temperature averaged over
2081-2100

Issue: Declining Sea Ice In The Arctic

Average Monthly Arctic Sea Ice Extent
October 1979 - 2015



Sea Ice Extent October 2016



Monthly Sea Ice Extent

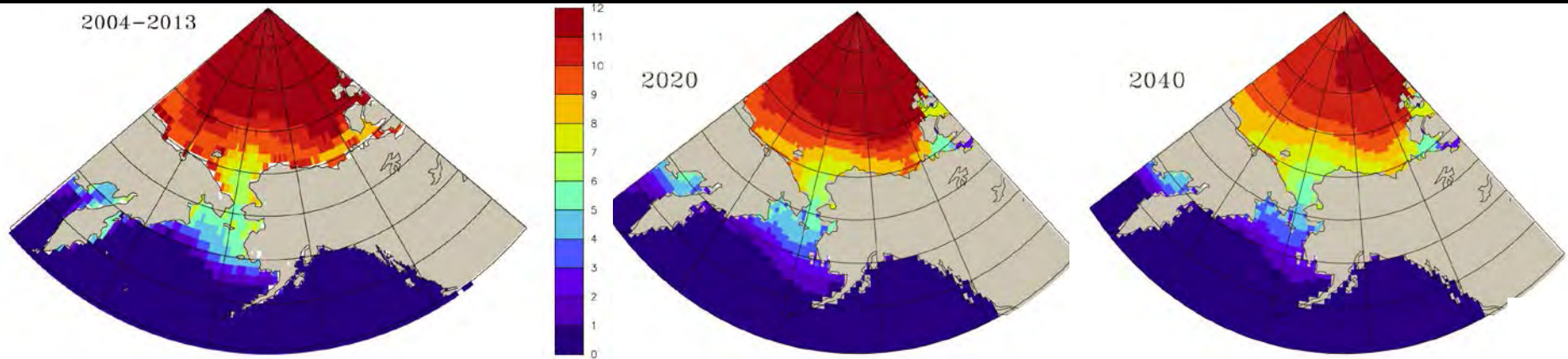
NSIDC October 2016

(2.5 million square miles)

Median Oct SIE 1981 - 2010

Model Projections for Summer Sea Ice and Summer Sea Surface Temperature

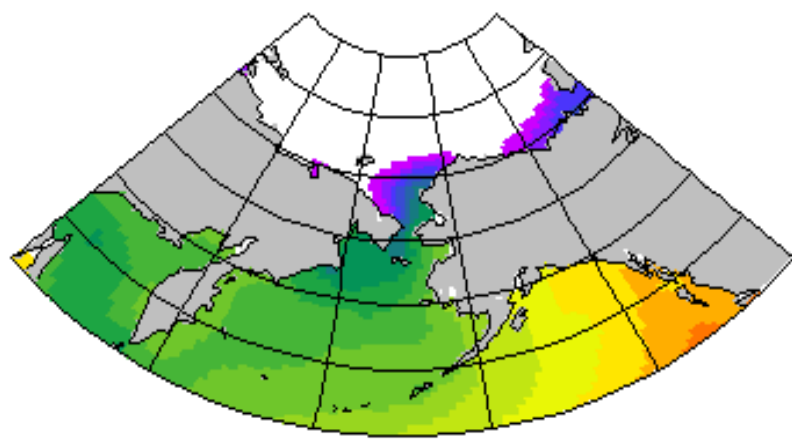
Ice Extent (*Wang and Overland, 2015*).



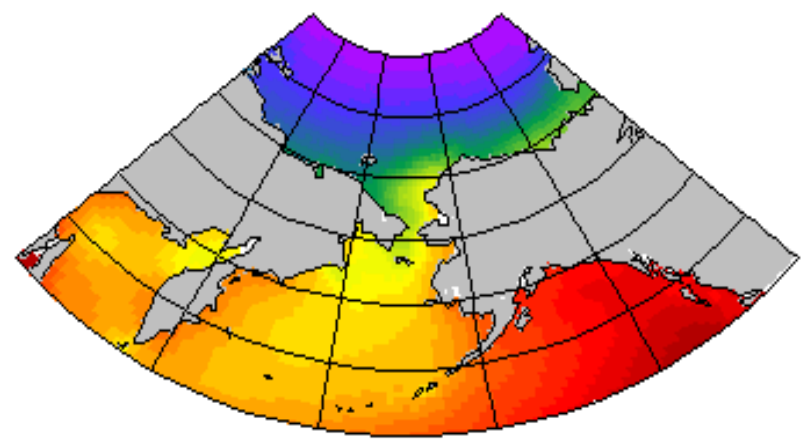
3 months Open Water

5 months Open Water

Sea Temperature Current

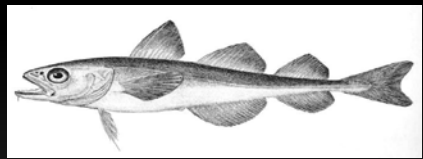


2080



Courtesy of Muyin Wang, Pacific Marine Environmental Laboratory, Seattle, WA

How Will Warming Likely Affect Abundance of Fishes and Invertebrates?



Arctic cod



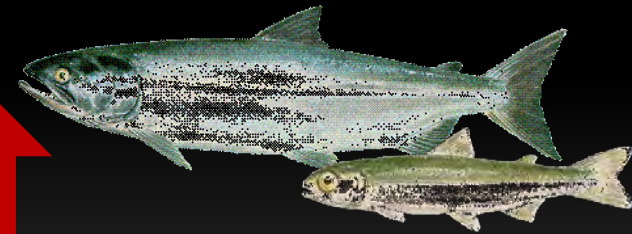
saffron cod



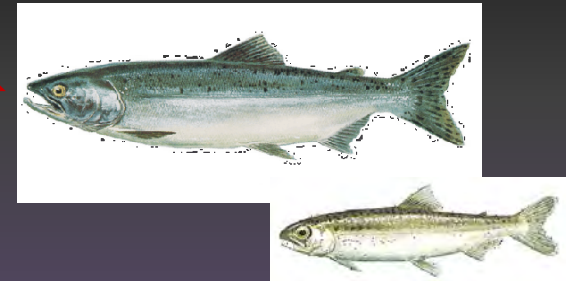
Pacific herring



capelin



chum salmon



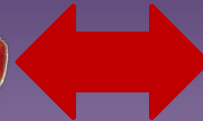
pink salmon



snow crab



jellyfish



US-Russia Research Coordination in the Arctic within ICC

- a. Objectives: Conduct a cooperative research program consisting of surveys and other ecosystem research activities to understand regional structure, function and ecology of indicator species of the northern Bering Sea and Chukchi Sea.
- b. Areas: waters of the northern Bering Sea through Bering Strait and into the Chukchi Sea to the northern extent of the respective EEZs of the Russian Federation and the U.S.
- c. Species of interest: Arctic cod, saffron cod, snow crab, Pacific salmon, capelin, and herring
- d. Cruises: Provide national plans for research in the northern Bering Sea and Chukchi Sea and coordinate research cruises for the years 2017-2019 to collect data and samples on the oceanography and key ecosystem components. Allow for collaborative exchange of scientific personnel to take part in surveys.
- e. Data Management and Exchange: Provide for formal exchange of samples and data collected during the surveys as much as possible.

Source: 2016 US-Russia: A proposal for coordinated research in the Arctic within the Intergovernmental Consultative Committee (ICC) forum

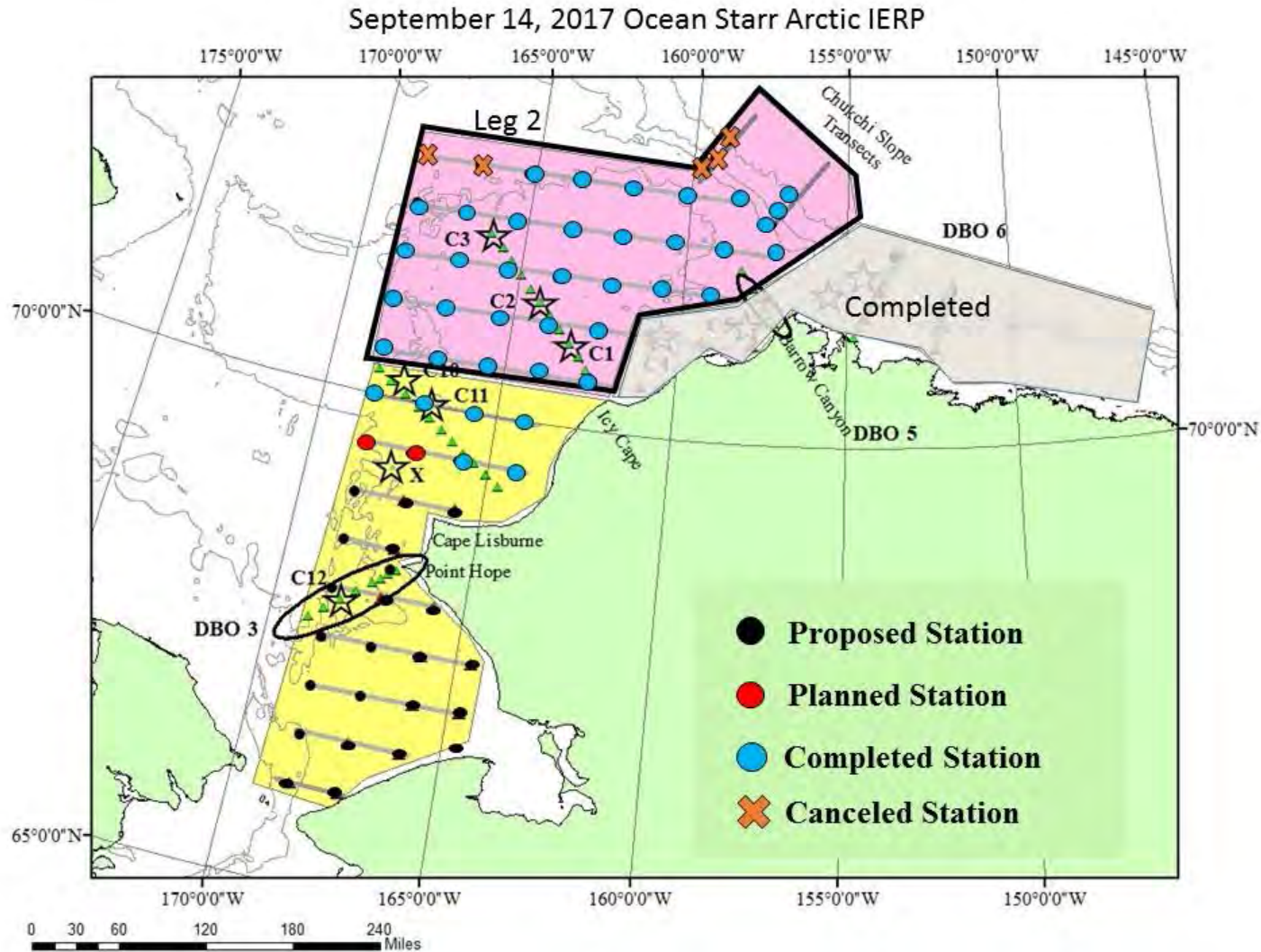
7.2.a Presentation on domestic and international Arctic fisheries research, discussion of areas of cooperation



Chukchi Sea
August to October
2003, 2007, 2012 to 2013, 2017

Northern Bering Sea
September
2002 to 2017 (2008)

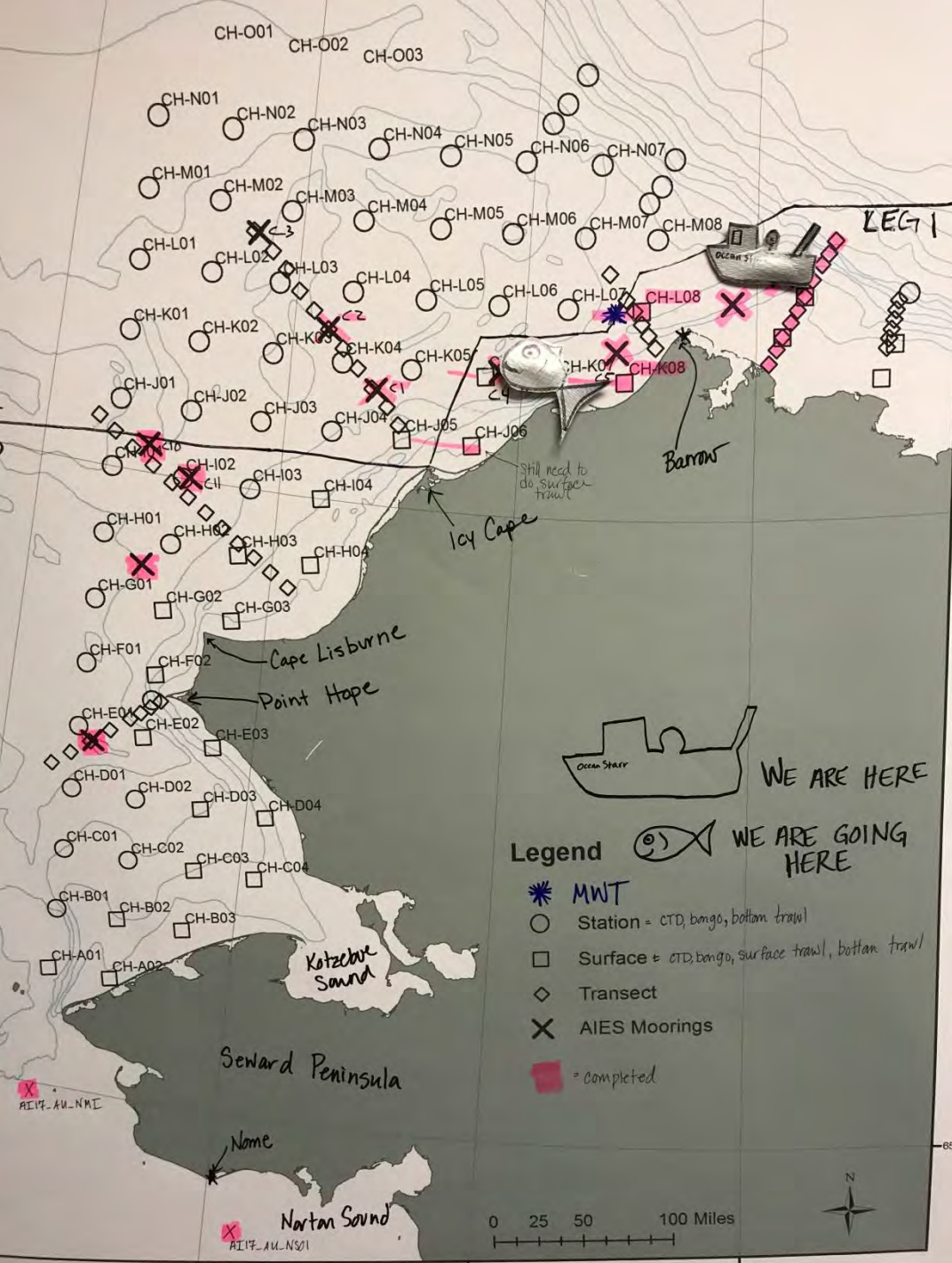
Arctic Integrated Ecosystem Survey 2017



Beaufort Sea: (Light Brown – Aug. 8 to 18)

Chukchi Sea North: (Light Pink – Aug. 24 – Sept. 9)

Chukchi Sea South: (Yellow – Sept. 14 to 30)



International Cooperation

Alexey Somov and Natalia Kuznetsova
TINRO Vladivostok

Igor Grigorov
VNIRO Moscow



Russian Collaboration During Survey



Juday net sample processing
Fish Diet



Juday net at
each station



Fish processing and identification

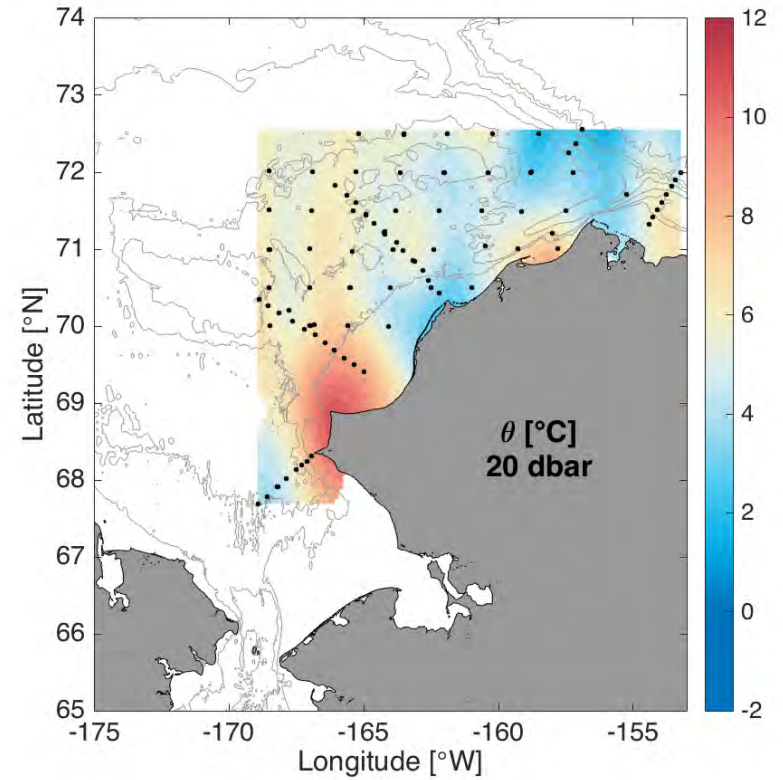
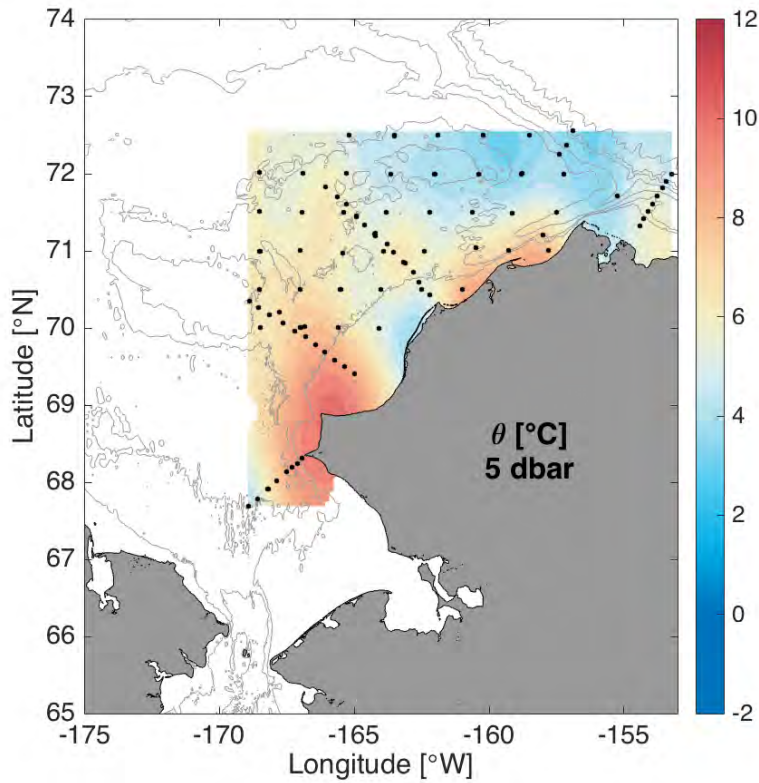
Oceanographic Sampling Gear

CTD and Niskin Bottles for water column properties and Phytoplankton collections

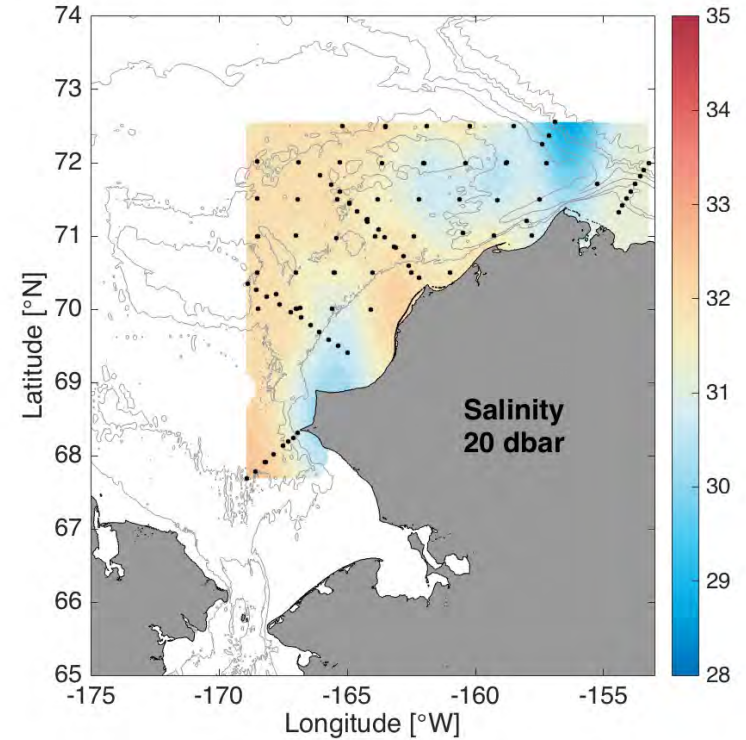
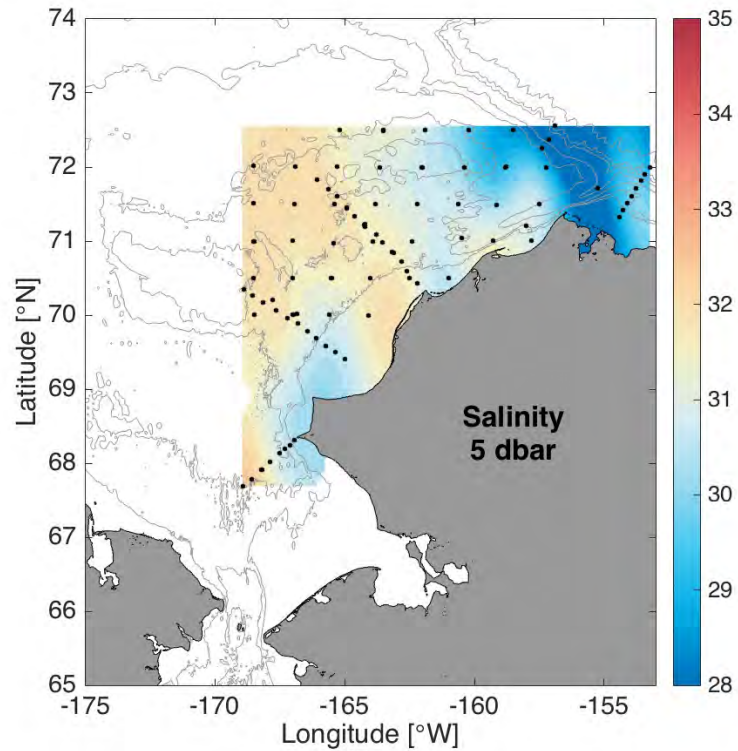
Bongo Nets and Juday net for Zooplankton and Ichthyoplankton



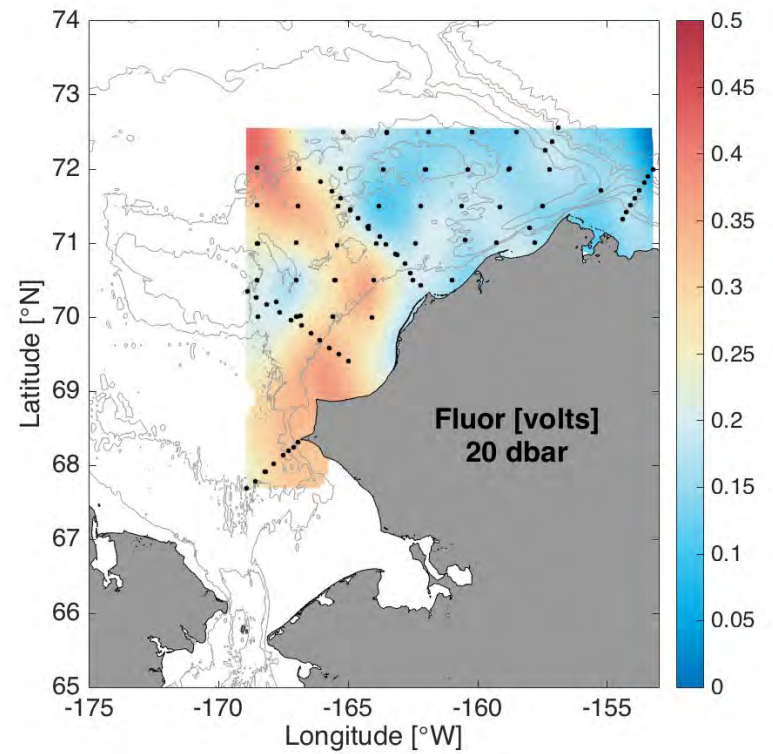
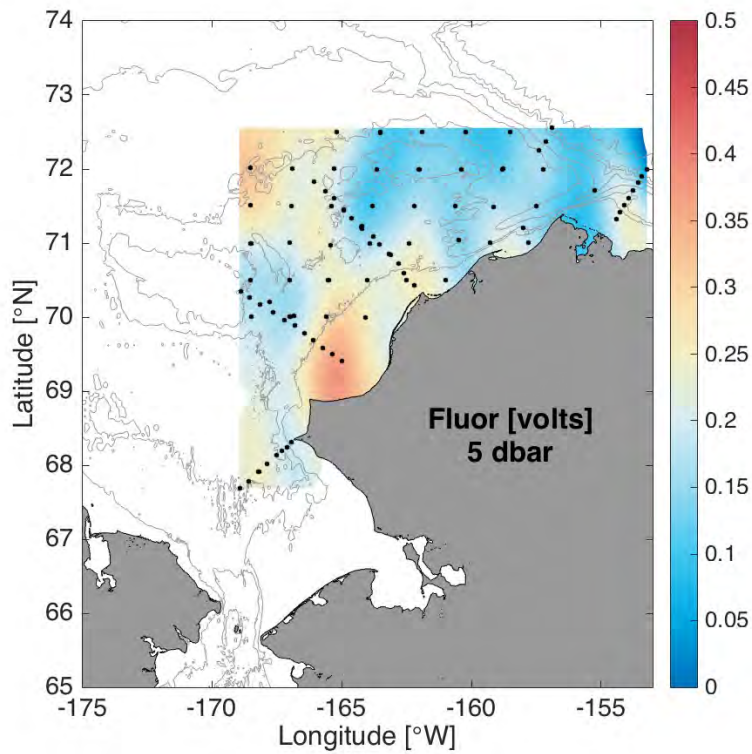
Temperature (C) at 5 and 20 m depth



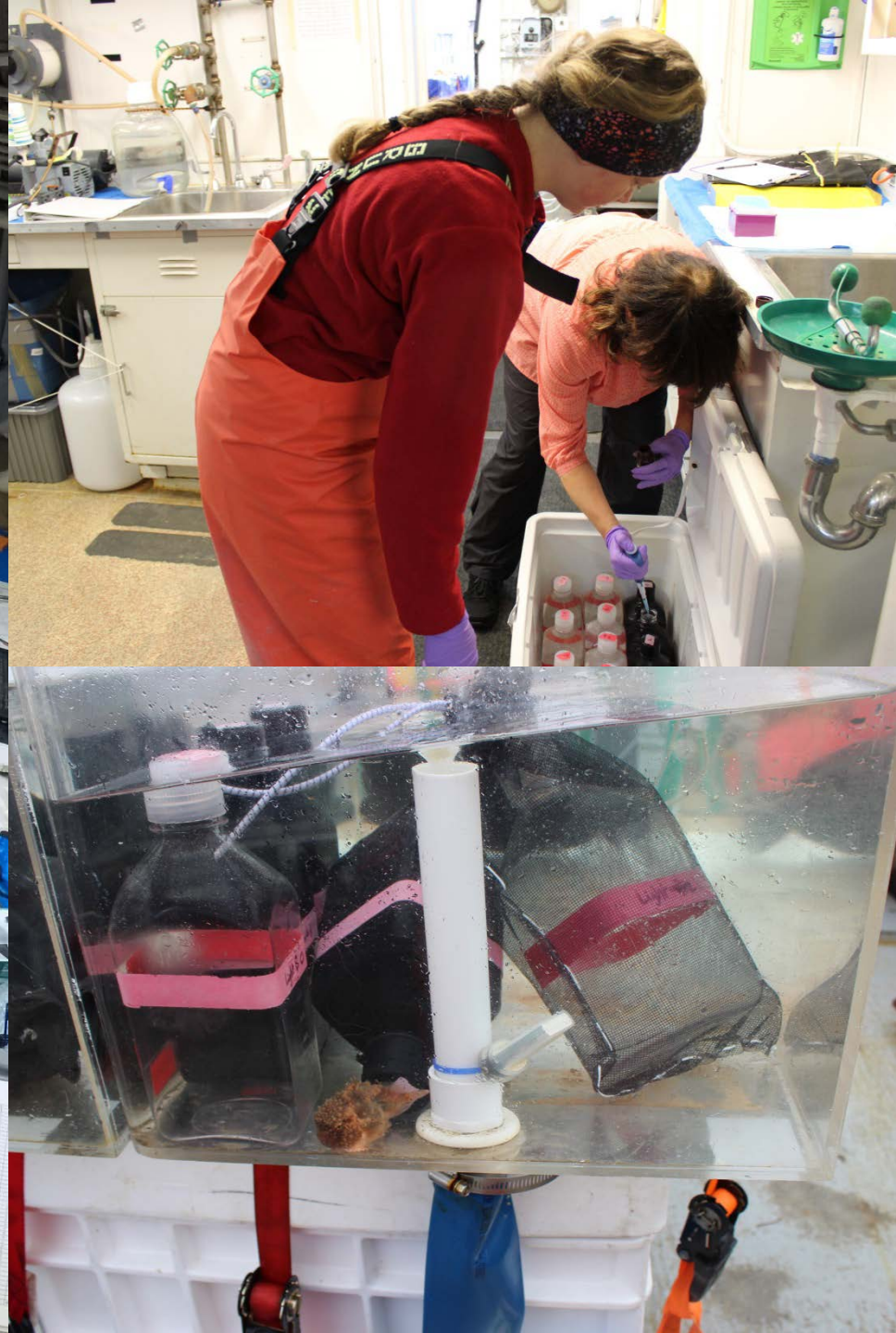
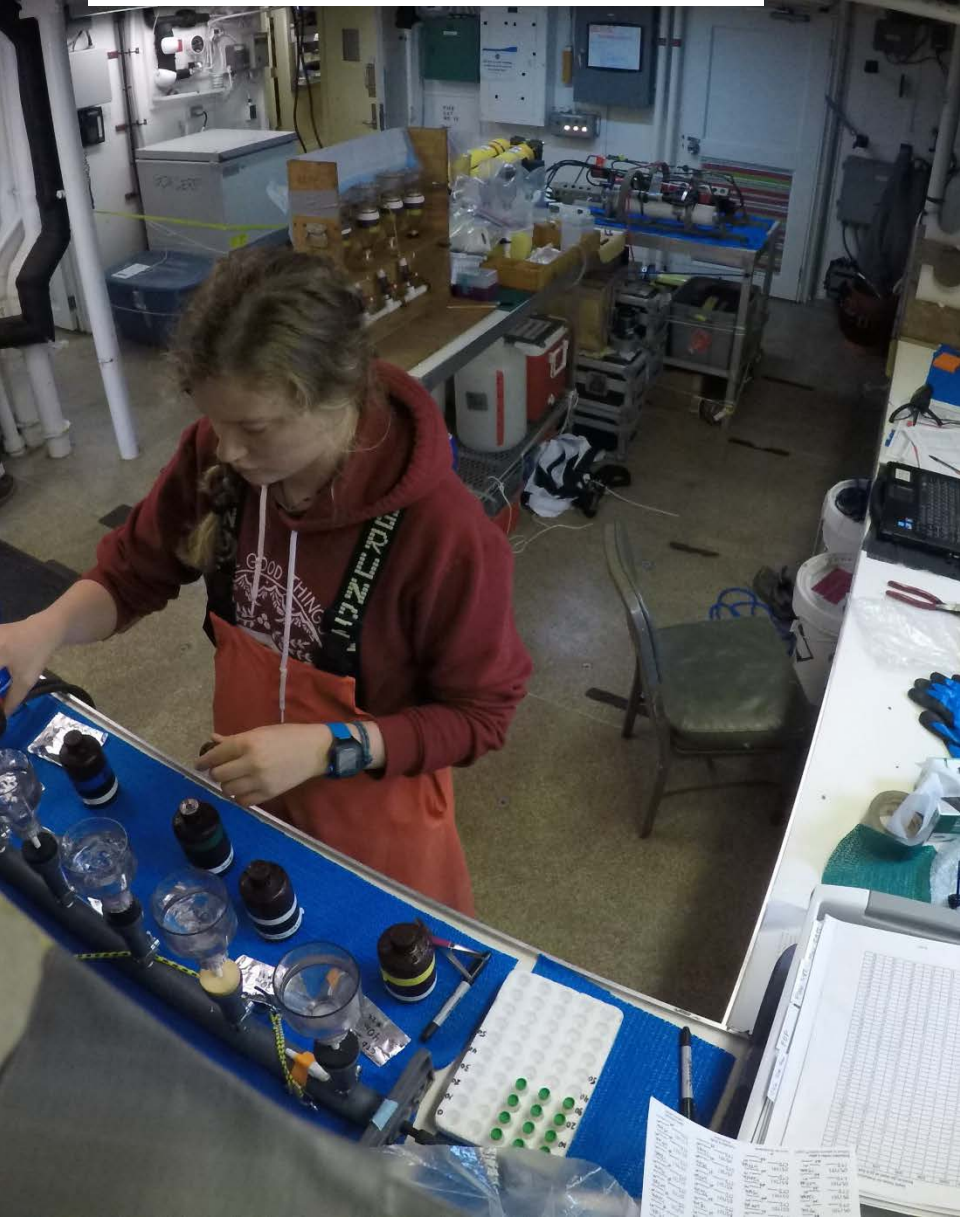
Salinity at 5 and 20 m depth



Fluorescence (volts) at 5 and 20 m depth

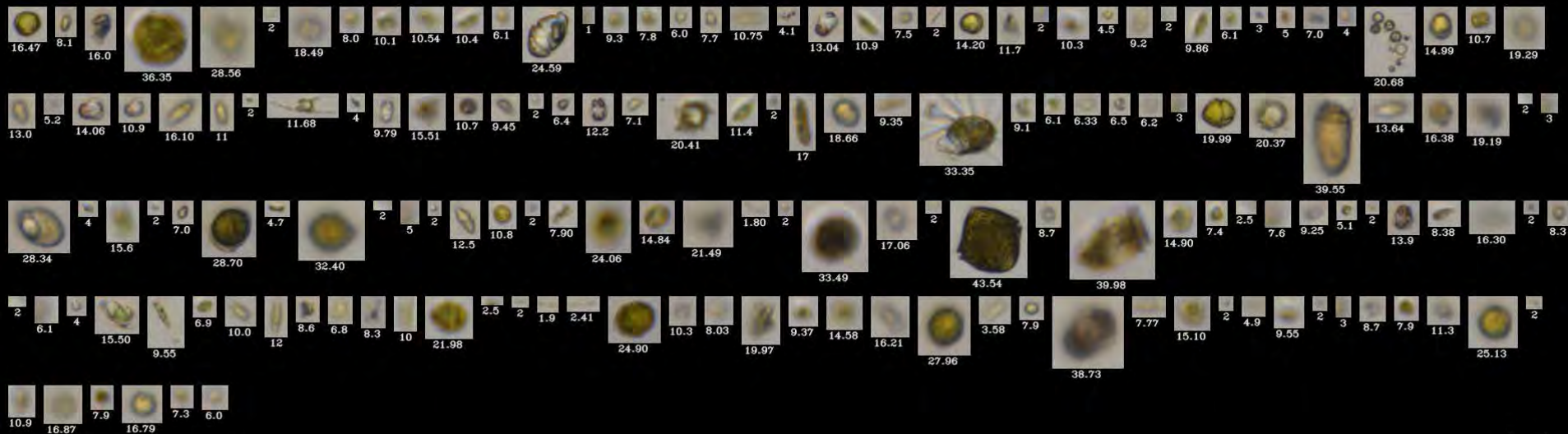
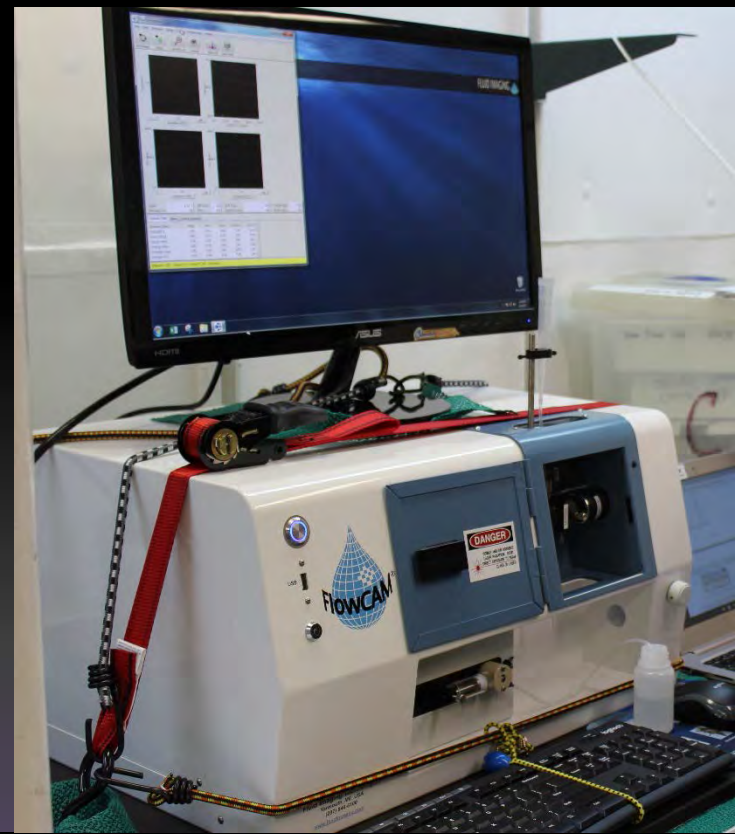


Phytoplankton



Live phytoplankton species identified using a Flow Cam (flow-through microscope with camera)

Subset of photos from a single sample:



Property Shown: Diameter (ABD)

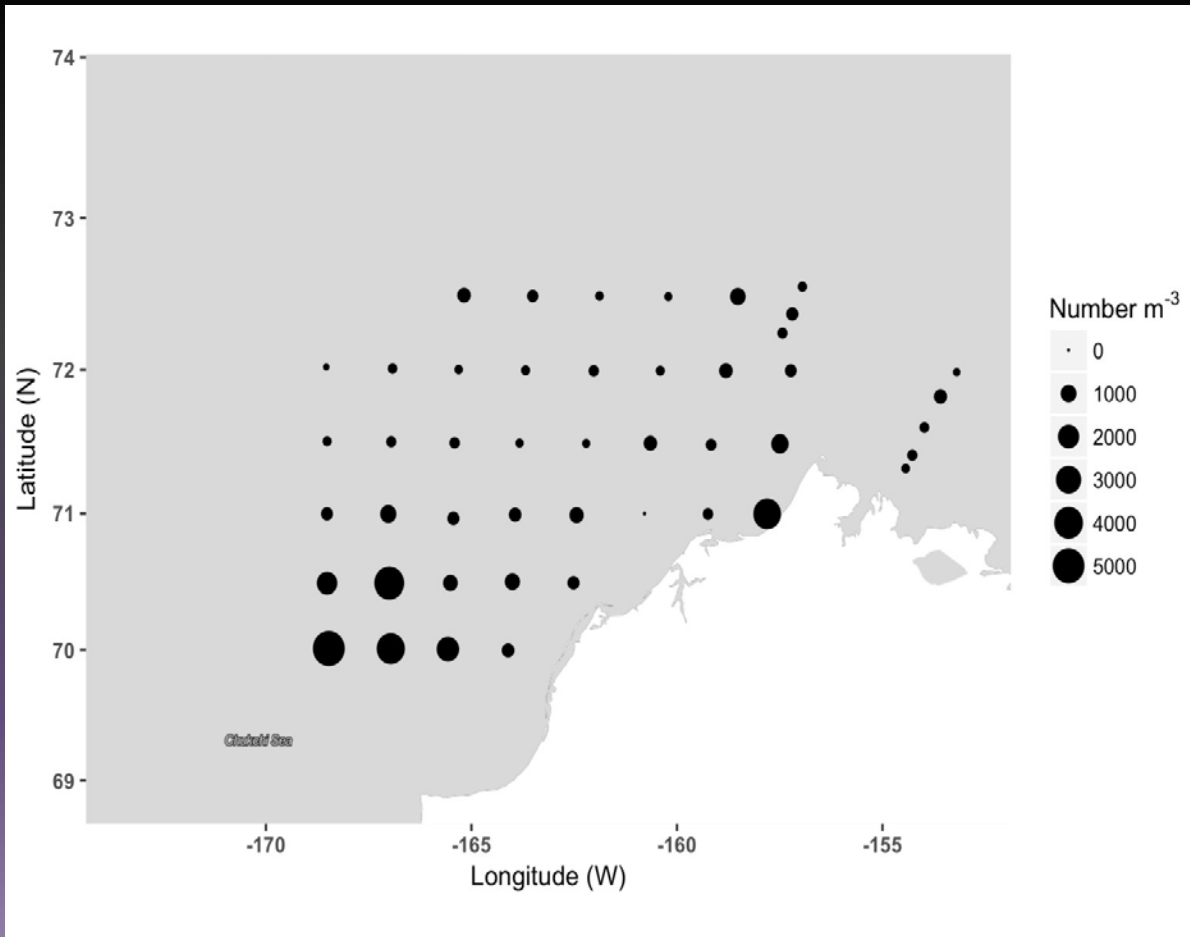
25 μ m

FlowCam Images of Phytoplankton

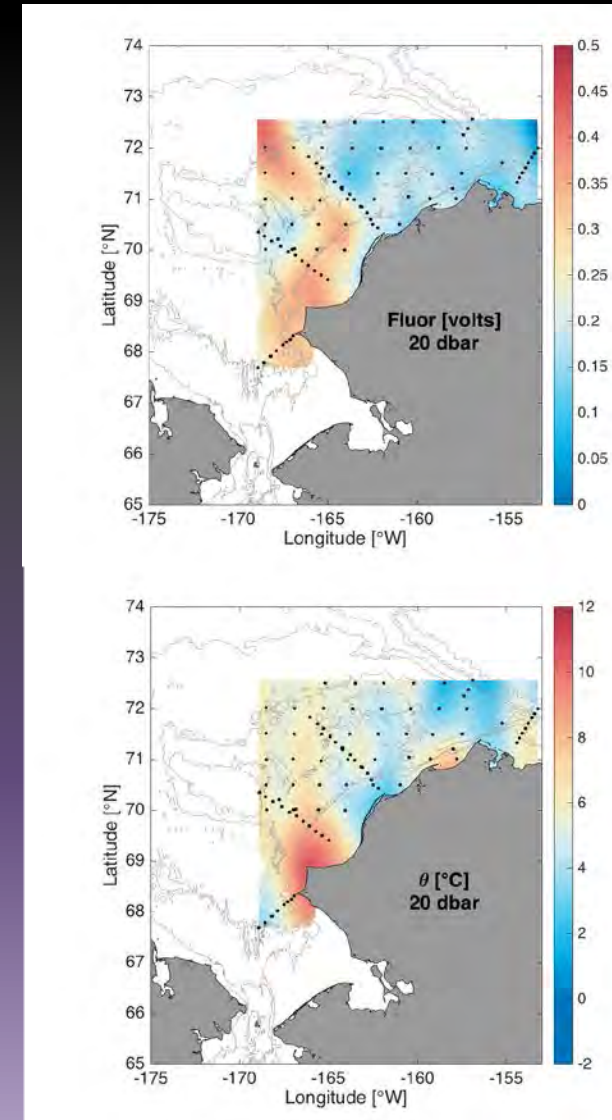


Zooplankton

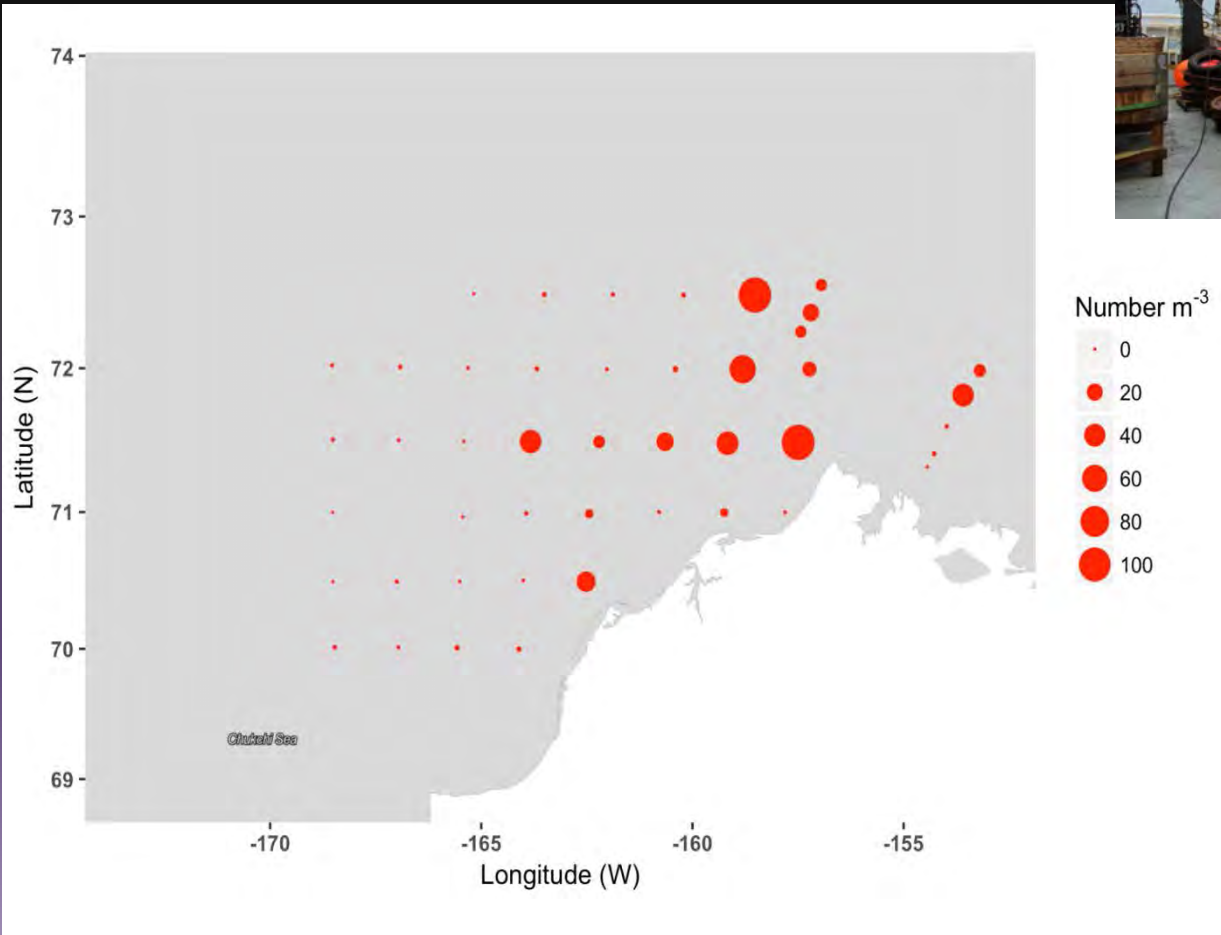
Small copepod (< 2 mm) abundance



Pseudocalanus, Oithon, Metridia, Acartia



Large (> 2mm) zooplankton Bongo Net



Calanus glacialis/marshallae

Beam Trawl







Mix of Fishes - Beam Trawl

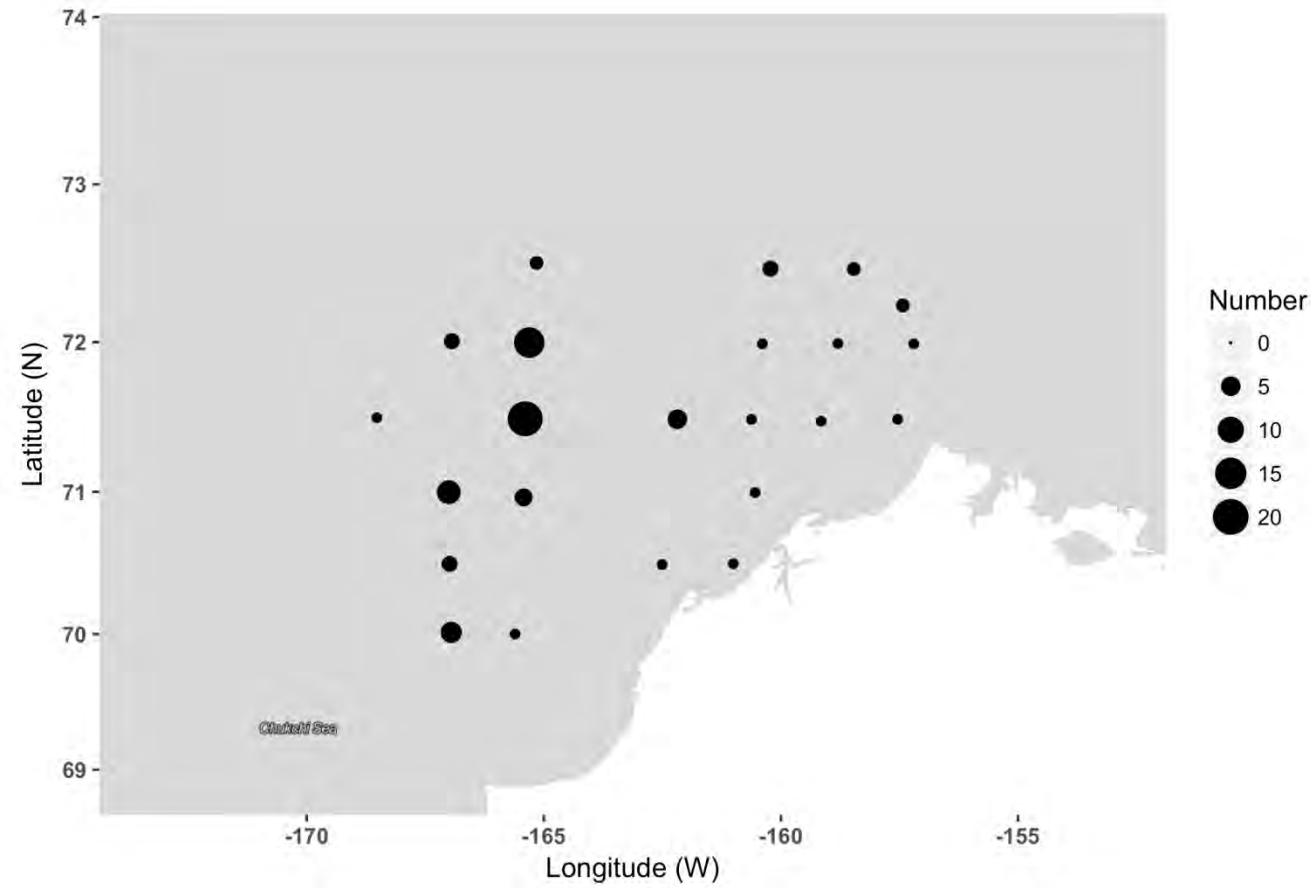


Arctic cod

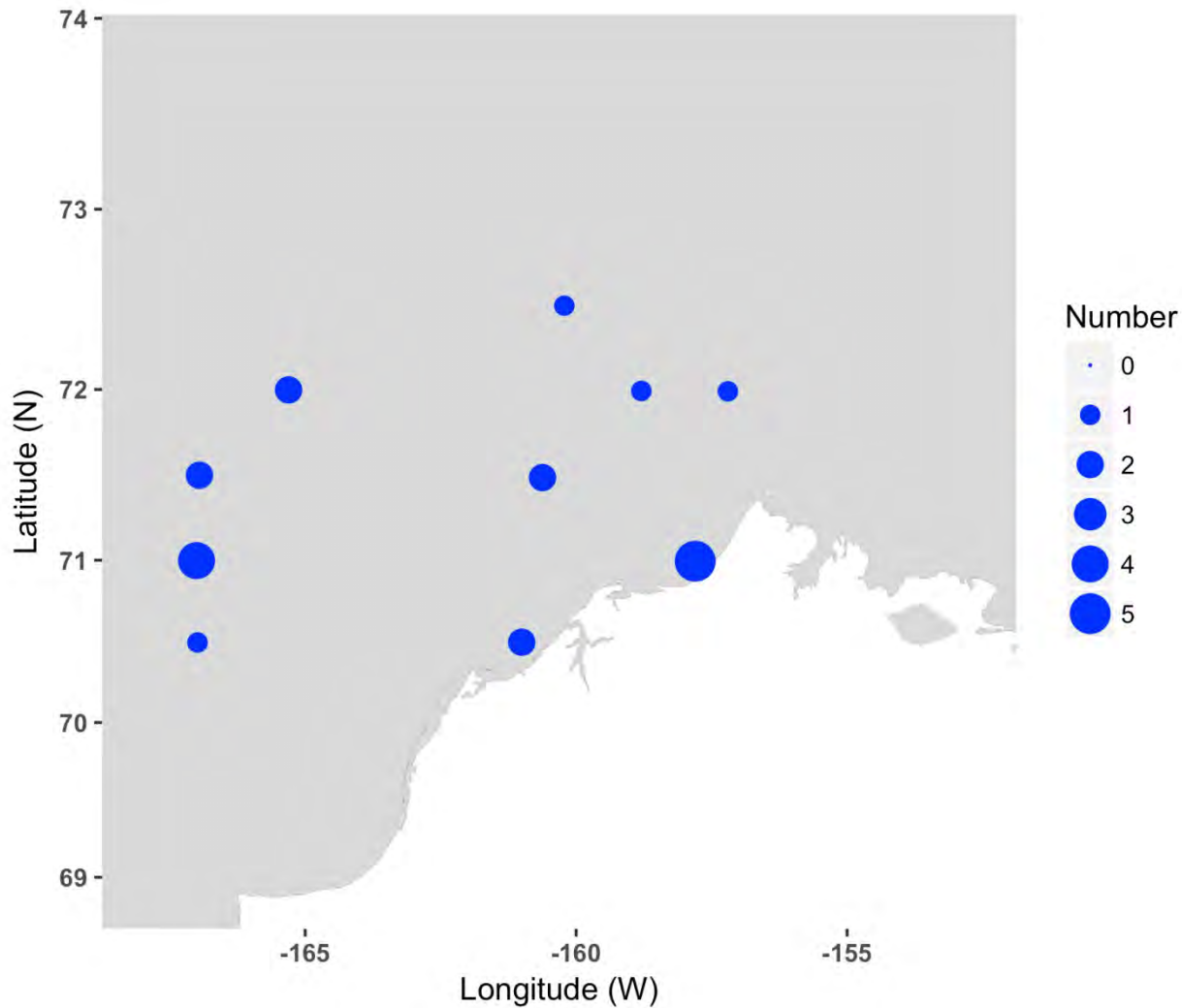




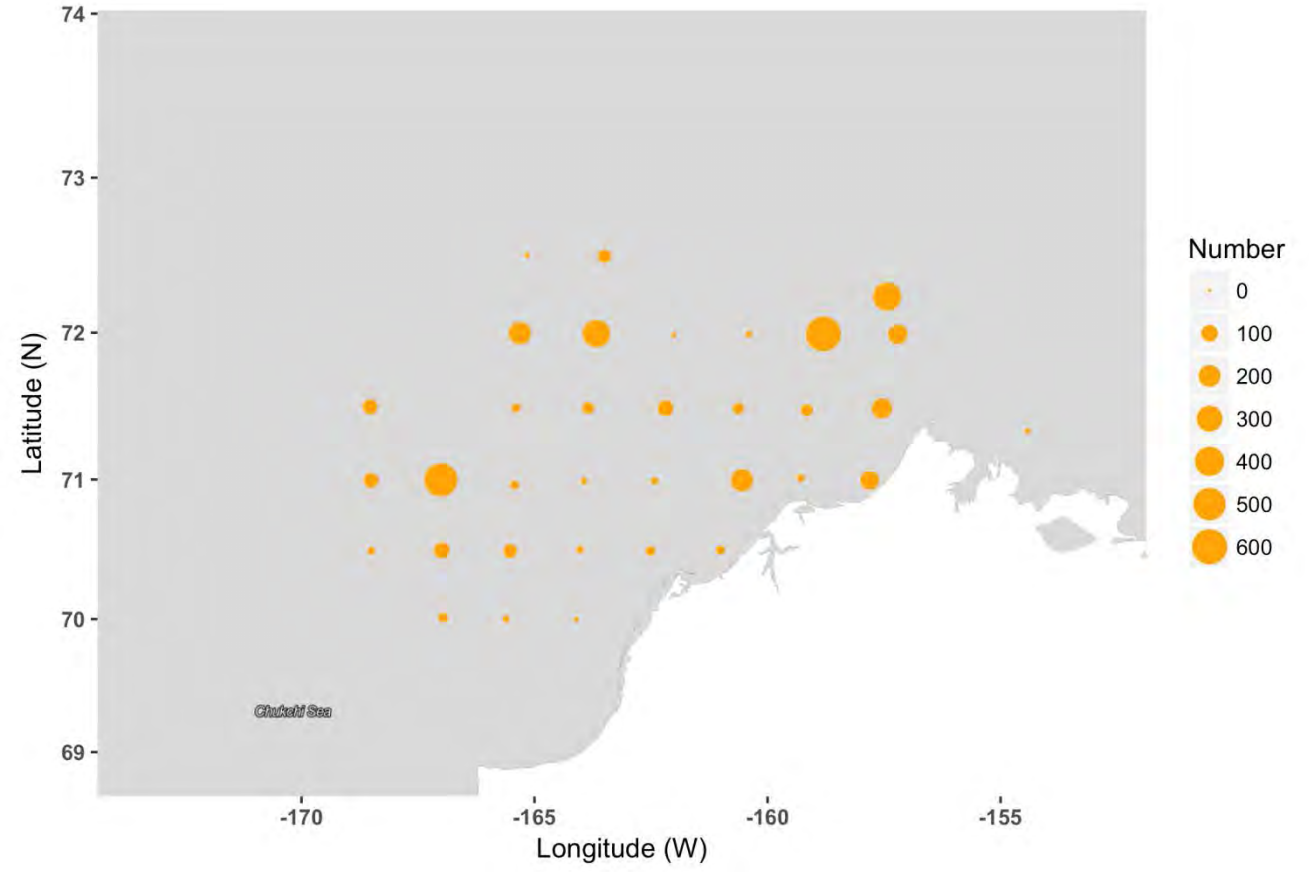
Age 1 + Arctic cod Distribution Beam Trawl (bottom)



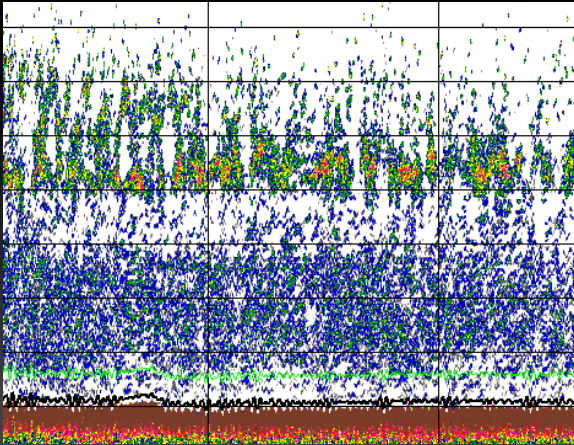
Age 0 and 1+ Walleye Pollock Distribution - Beam Trawl



Snow Crab Distribution Beam Trawl

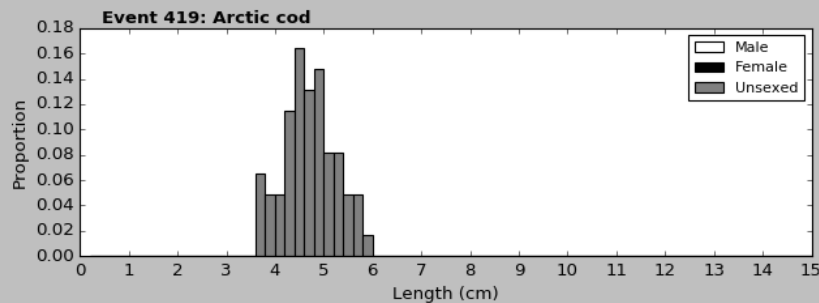
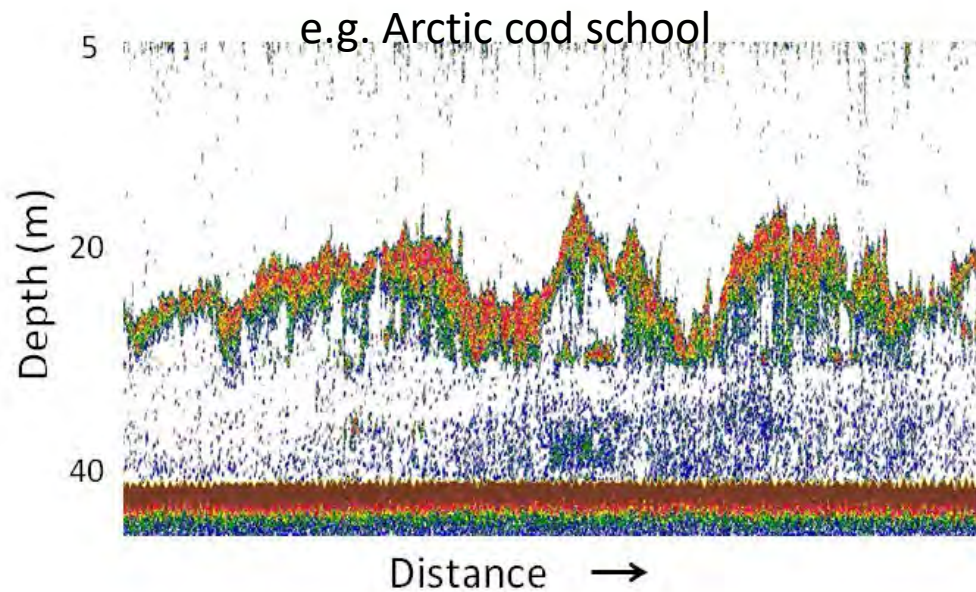


Acoustic-trawl survey



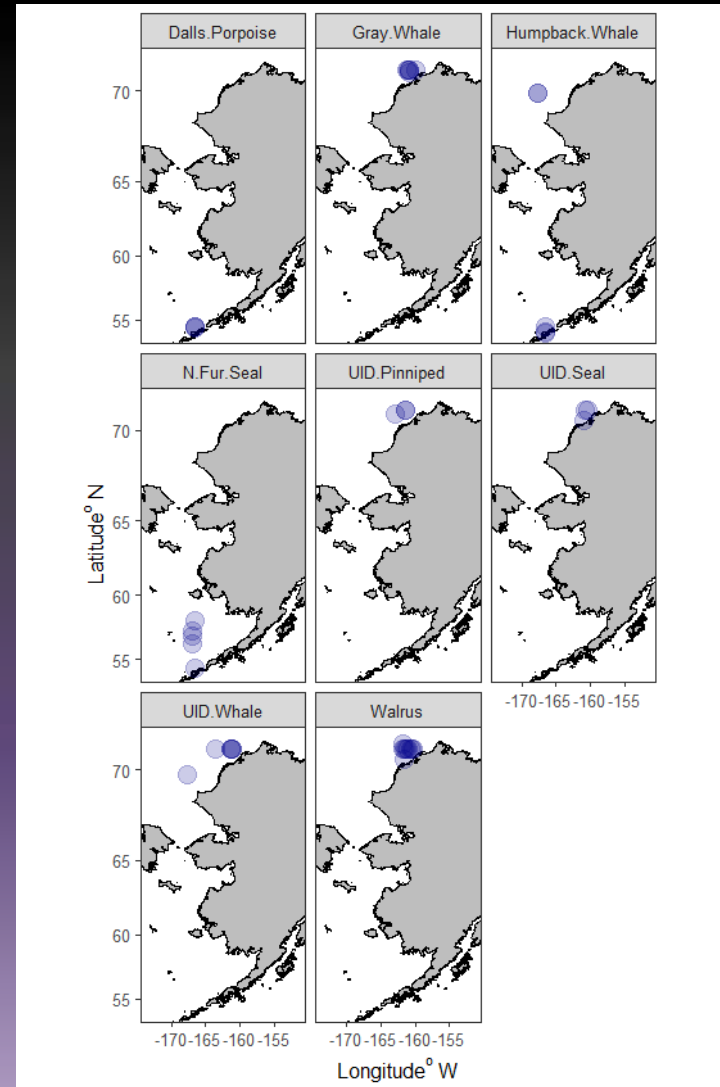
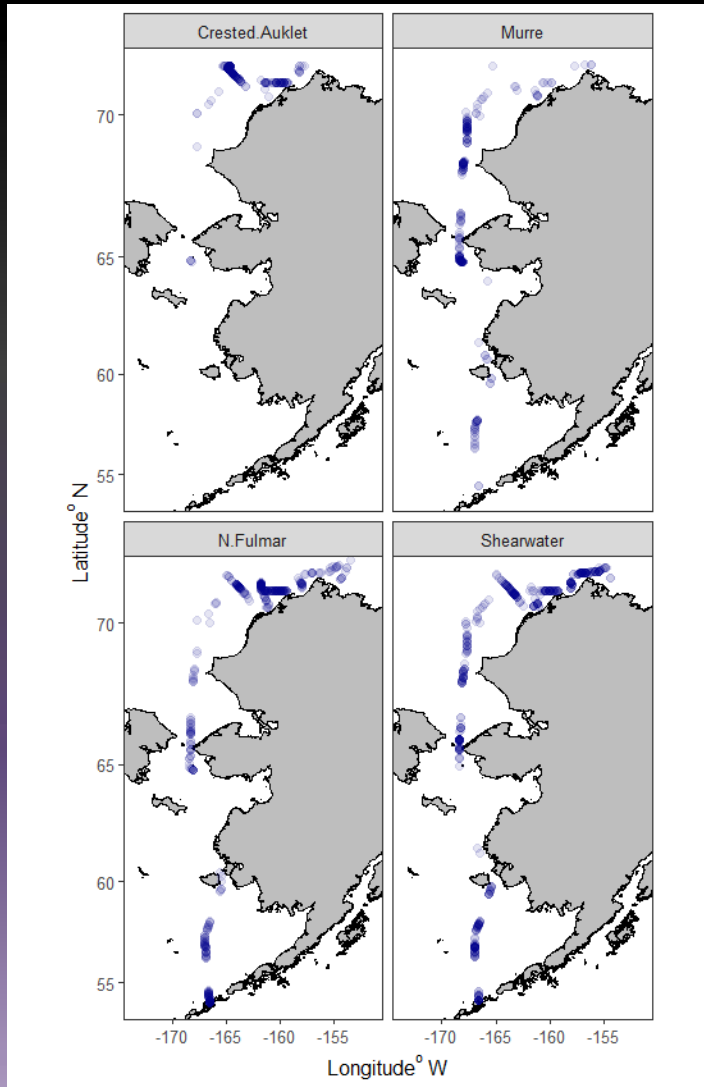
- Many age-0 Arctic cod throughout the surveyed area (72.5 to 70 N).
- Trawl catches were dominated by age-0 Arctic cod. Almost no adults were captured.
- 3 echosounder moorings deployed to examine the year-round distribution of Arctic cod

Age-0 Arctic cod from Midwater



Trawl catch in this school was
99.5% age-0 Arctic cod

Seabird and Mammal Distributions (Leg 1 only)



Conclusions

Increased sea temperatures and open water during summer months may increase phytoplankton and zooplankton abundance in the water column; potential benefit to Bowhead whales and other zooplankton consumers (fishes, birds).

Loss of sea ice and warming summer sea temperatures could have a negative effect on Arctic cod and capelin. Potential positive effect on saffron cod and Pacific salmon (depending on habitat usage). Uncertain if there will be an impact to Beluga whales or others relying on fish for food.

Do not expect to see Pacific cod or walleye pollock moving north into the Arctic in the near future due to winter/spring sea ice cover in the northern Bering Sea and resulting “cold pool” of bottom water during summer.

For more...

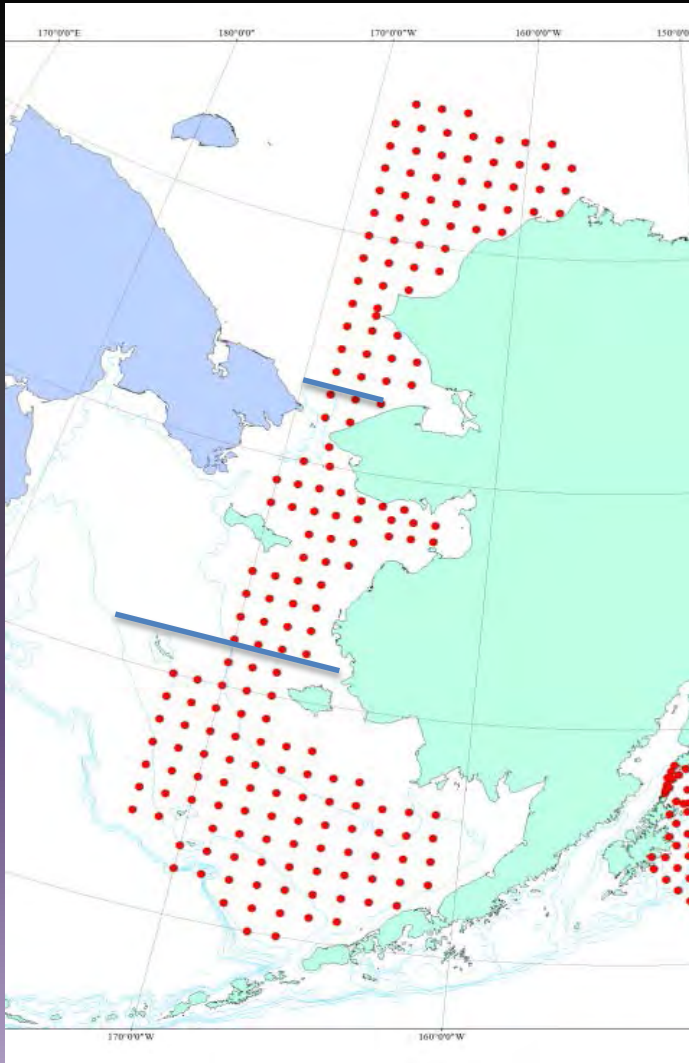
Blog: <https://blog.arctic.nprb.org>
Hundreds of social media postings

And special thanks to

- Captain and crew of *R/V Sikuliaq*
- All *Sikuliaq* cruise participants
- Gay Sheffield
- Funding agencies: NPRB, BOEM, ONR, CAASP, NSF

- Captain and crew of *R/V Ocean Starr*
- North Pacific Research Board
- Bureau of Ocean and Energy Management
- NOAA Alaska Fisheries Science Center
- Scientific colleagues and collaborators

7.2.b Coordinate and finalize research plans for integrated ecosystem research cruises in the northern Bering Sea and the Arctic during 2018/2019



August to October
2003, 2007, 2012 to 2013, 2017
Proposed 2019

September
2002 to 2017 (2008)
Proposed 2018 and 2019

August to October
2000 2012, 2014, 2015, 2016
Proposed 2018