

Arctic Integrated Ecosystem Research in the Chukchi and North Bering Seas

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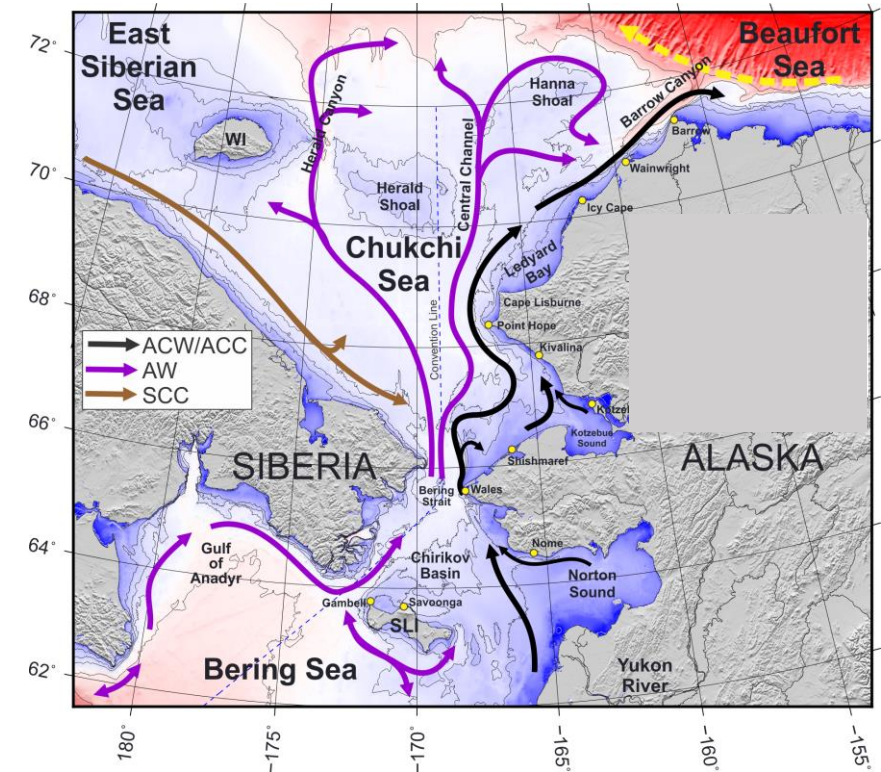
11 institutions involved in research

Funding: North Pacific Research Board, Bureau of Ocean Energy Management, North Slope Borough/Shell Baseline Studies Program, Office of Naval Research Marine Mammals and Biology Program.

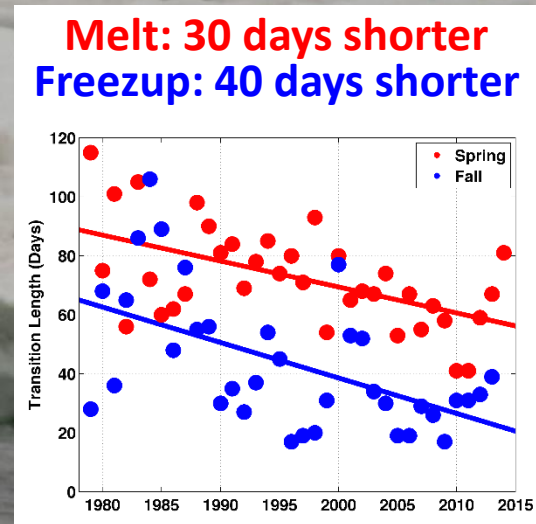


Outline

- Goals
- Surveys and variables sampled
- Examples of year-round, seasonal, interannual & spatial comparisons
 - Temperature, Phytoplankton production and export, Zooplankton community, Fish distribution
- Consequences for humans
- Applications to IEA



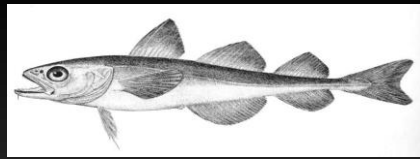
How will reductions in sea ice & associated environmental changes influence the flow of energy through the northern Bering & Chukchi sea ecosystems?



1979 → 2015

Danielson et al., (2017)

How will warming likely affect abundance of fishes and invertebrates?



Arctic cod



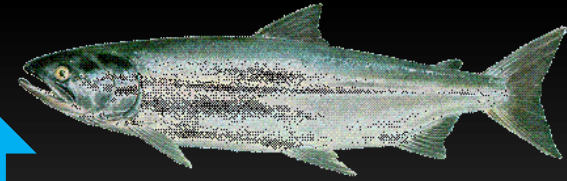
saffron cod



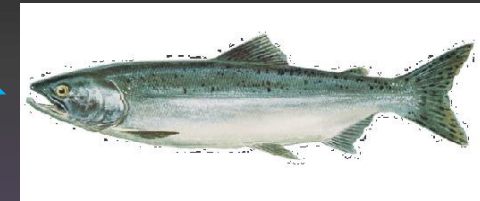
Pacific herring



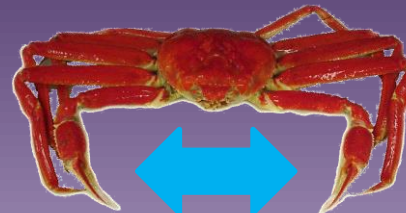
capelin



chum salmon



pink salmon



snow crab



jellyfish

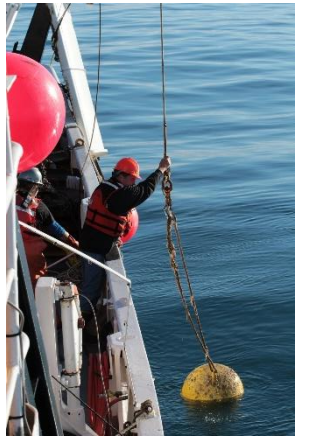


How is food security influenced by environmental vs. socio-economic factors?



Arctic IERP Structure

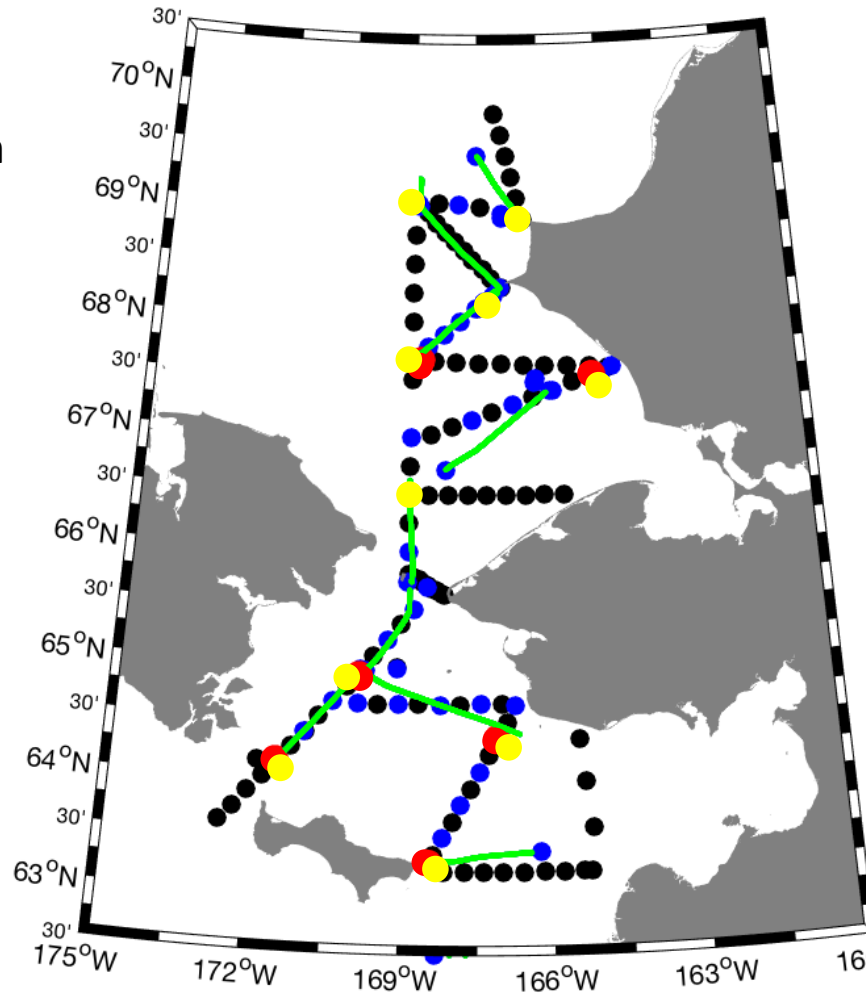
1. **Spring** Field Expeditions 2017 & 2018: Arctic Shelf Growth, Advection, Respiration & Deposition (**ASGARD**) Rate Experiments Project.
2. **Summer** Field Expeditions 2017 & 2019: Arctic Integrated Ecosystem Survey (**Arctic IES phase 2**). Additional surveys in summer 2012 and 2013 (**Arctic IES phase 1**)
3. **Year-round** moorings
4. Social Sciences Component: Chukchi Coastal Communities' Understanding of and Responses to Environmental Change



ASGARD

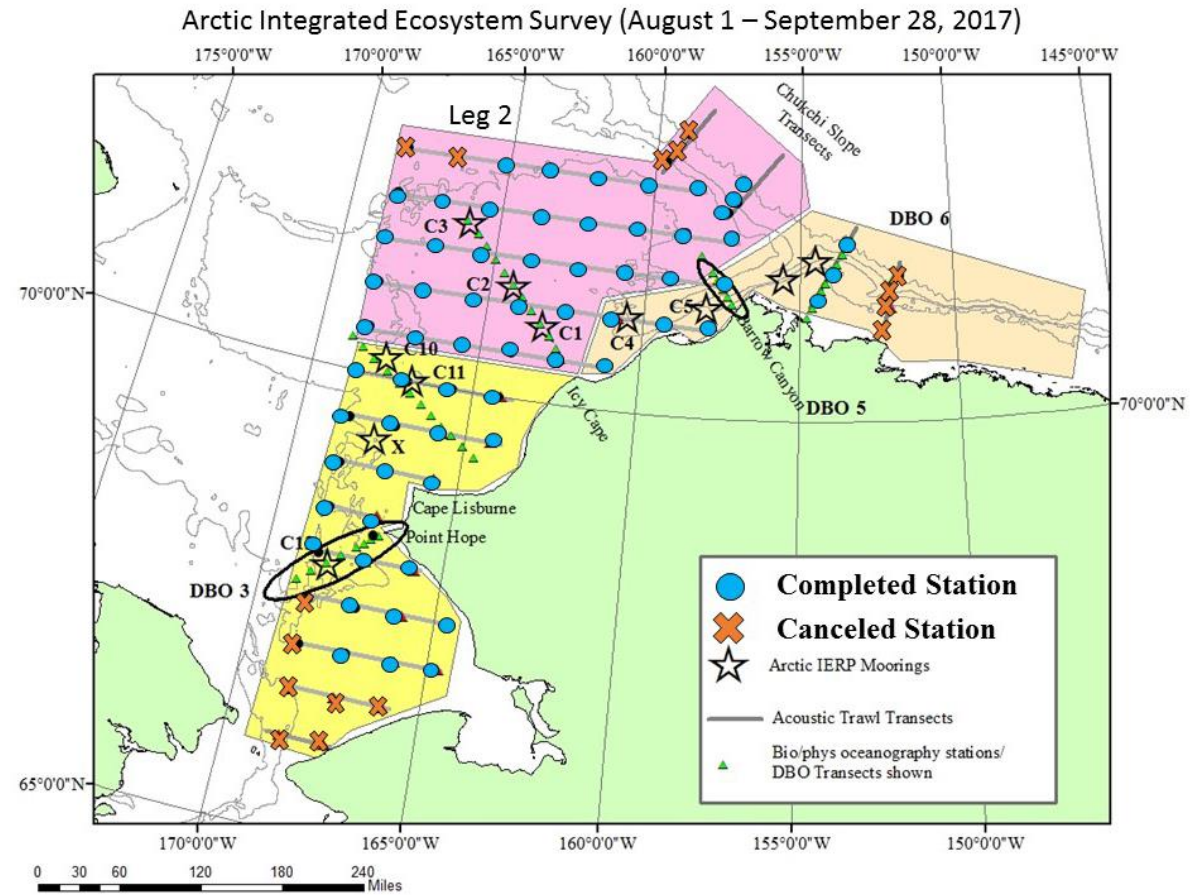
June 2017 & 2018

- Mooring
- Process Station
- 2017 Station
- 2018 Station
- 2018 Acrobat



Arctic IES

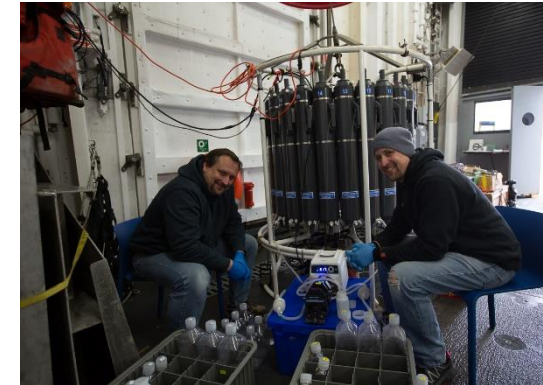
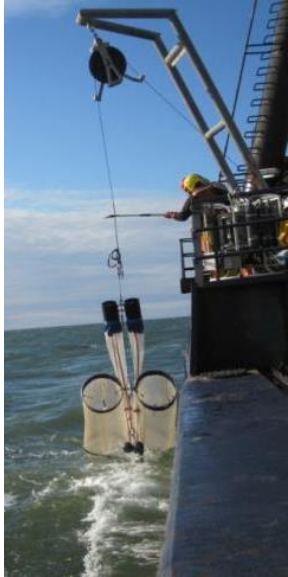
August-September: 2017 & 2019



Survey Components

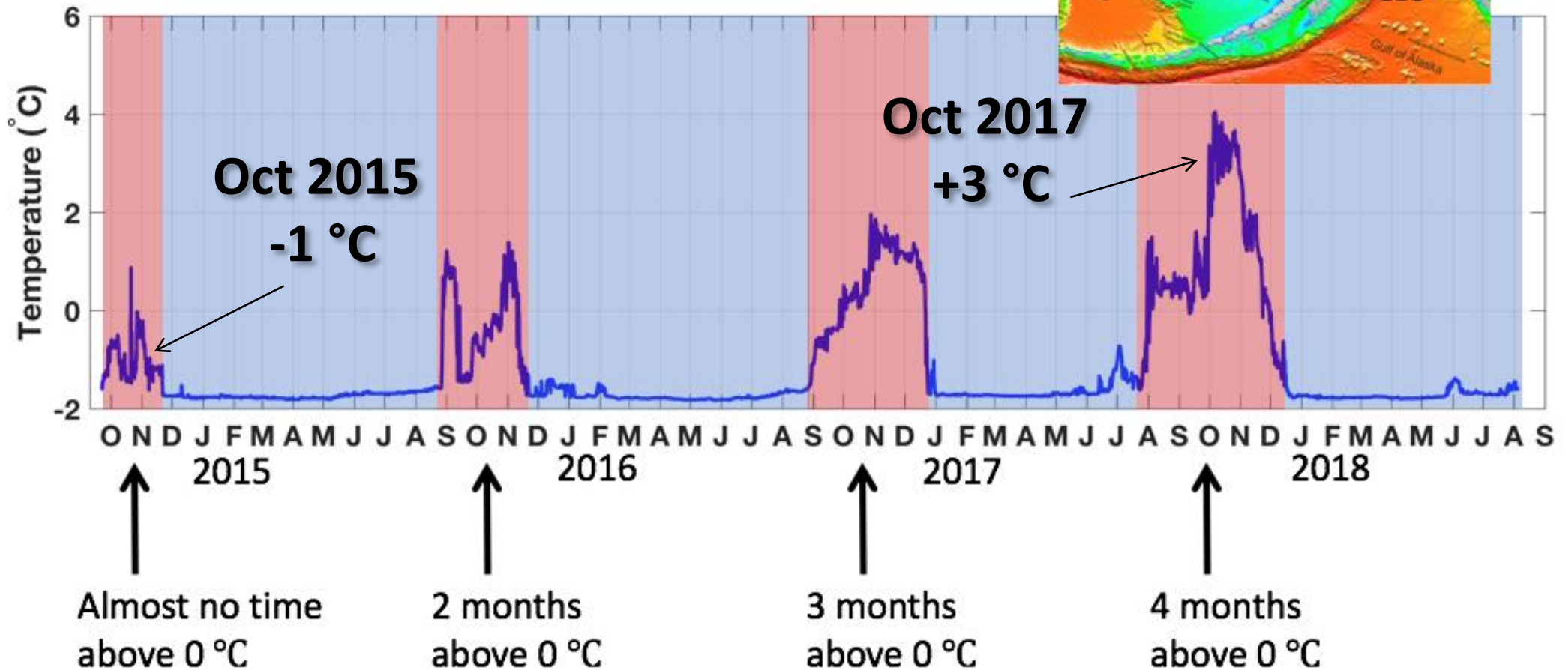
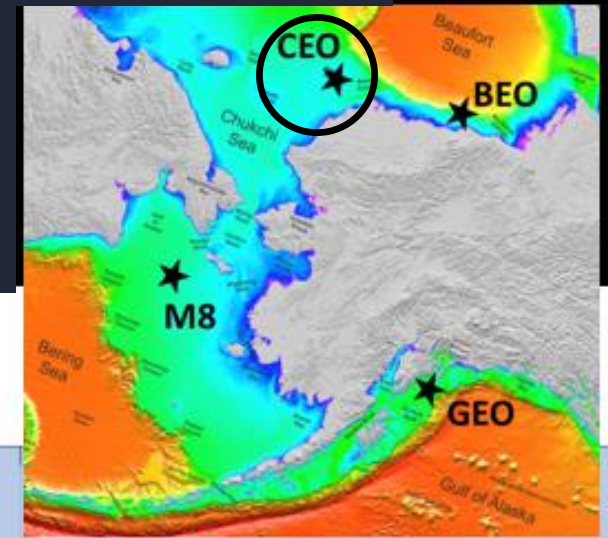
(biomass & rates)

- Underway Currents & Atmospheric Data
- Water: physical, chemical, optical properties
- Particles & sedimentation(ASGARD)
- Microbes (ASGARD)
- Phytoplankton & Harmful algae
- Microzooplankton
- Mesozooplankton
- Ichthyoplankton (Arctic IES)
- Fishes
- Epifauna & (Infauna ASGARD)
- Marine Mammals
- Seabirds
- Trophic transfer: fatty acids & (fish diet Arctic IES)

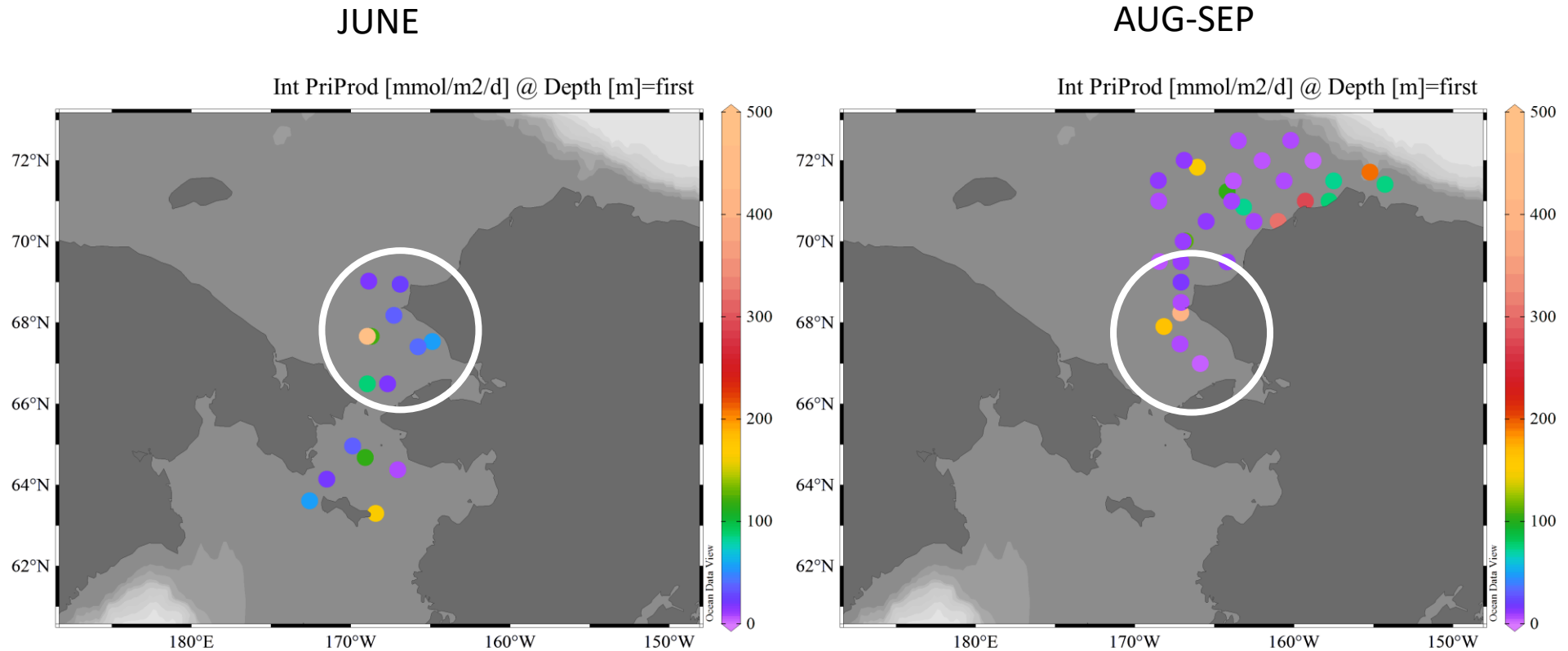


Year-round

CEO near-seafloor temperature



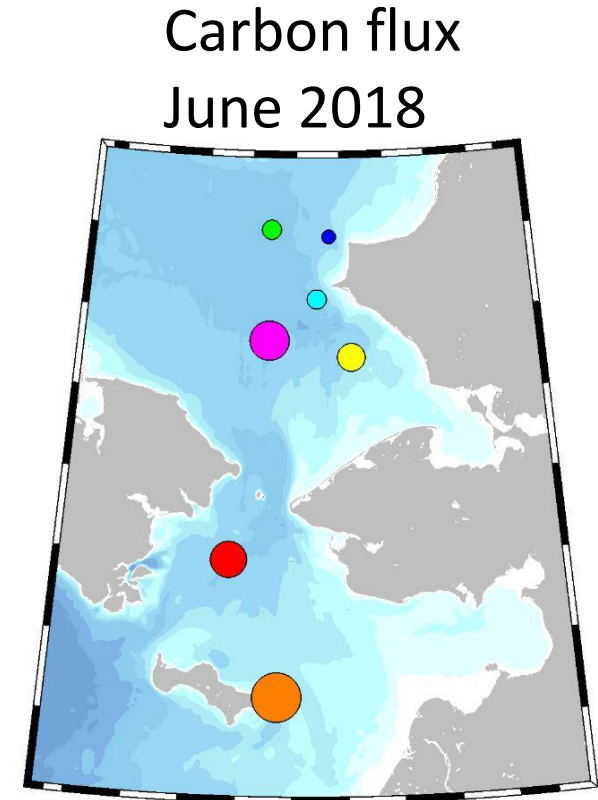
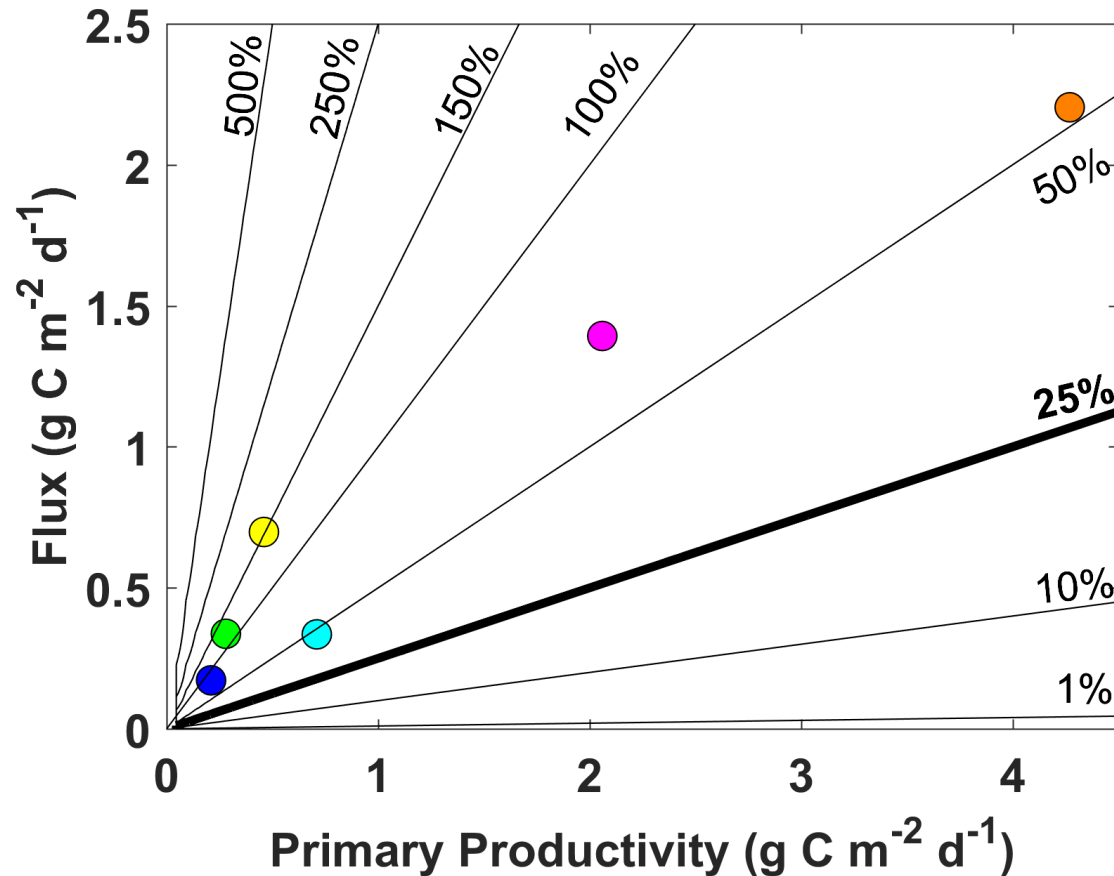
Primary Production (Integrated)-preliminary



- Higher PP in spring than summer.
- Proportion of PP generally aligns with proportion of C-biomass

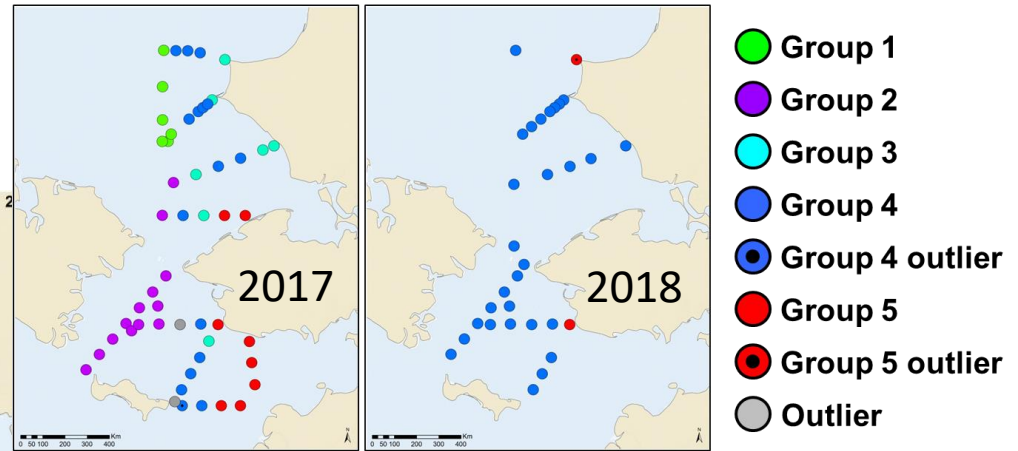
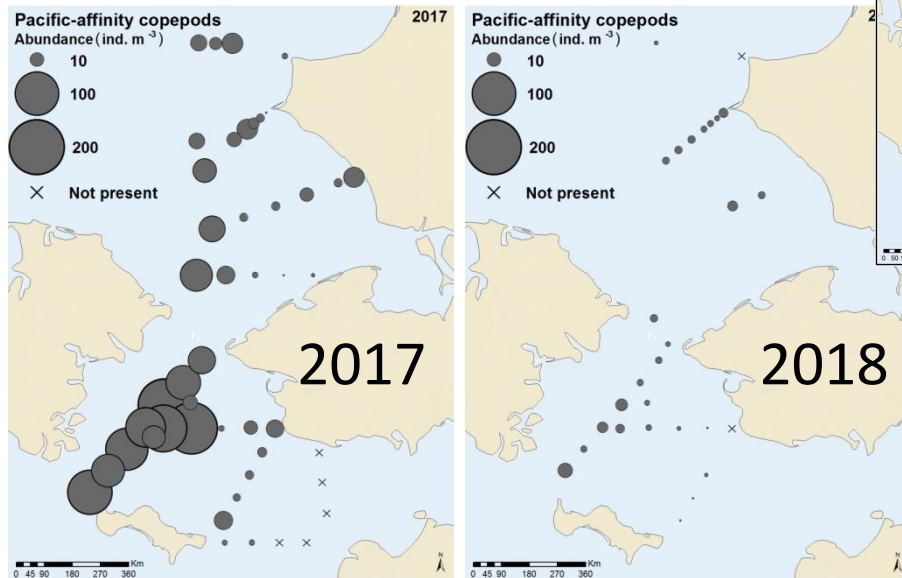
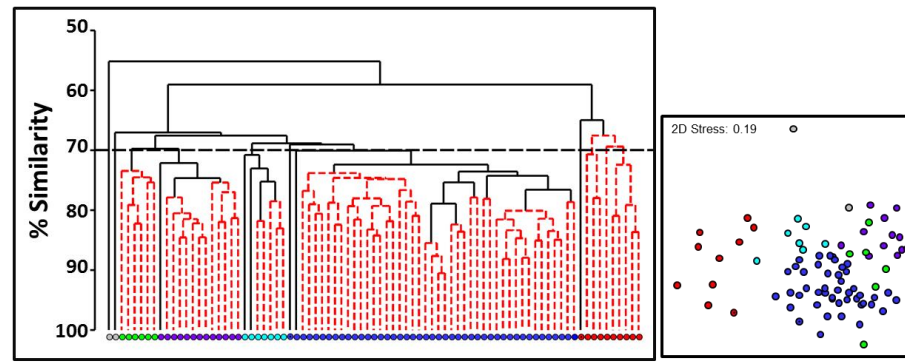
*M. Lomas, Bigelow
L. Eisner, AFSC, NOAA
D. Stockwell, UAF*

Pelagic Export- Highly efficient



$$\text{Export Ratio} = \frac{\text{Sinking Flux}}{\text{Primary Productivity}} \times 100\%$$

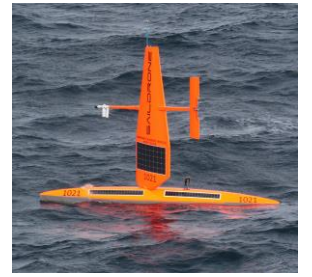
Zooplankton Community Structure, June



Big difference in
Neocalanus abundance
between years

Interannual
& Spatial

Acoustic surveys: Aug-Sept 2012, 2013, 2017 (ship) and 2018 (unmanned surface vehicle)

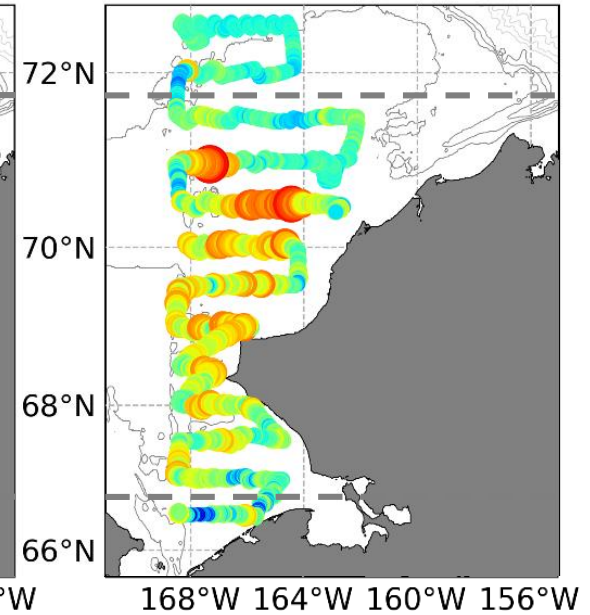
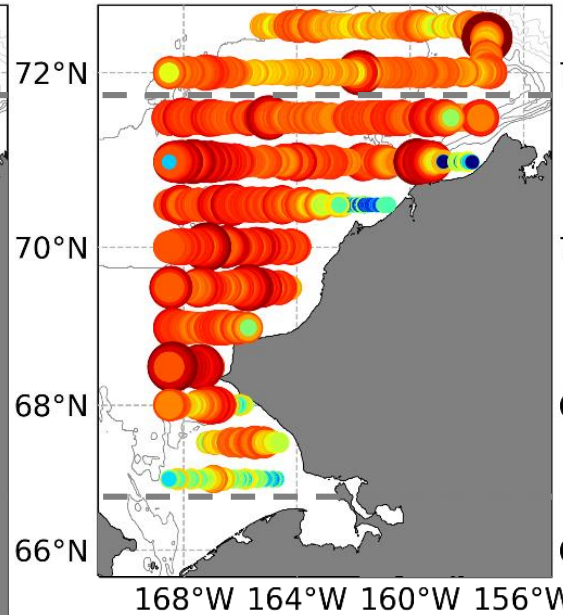
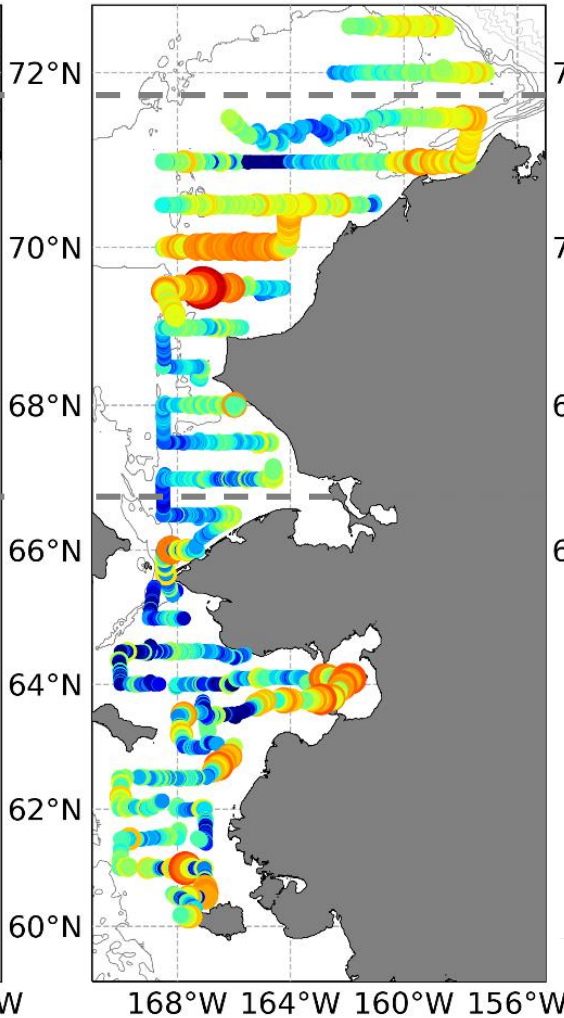
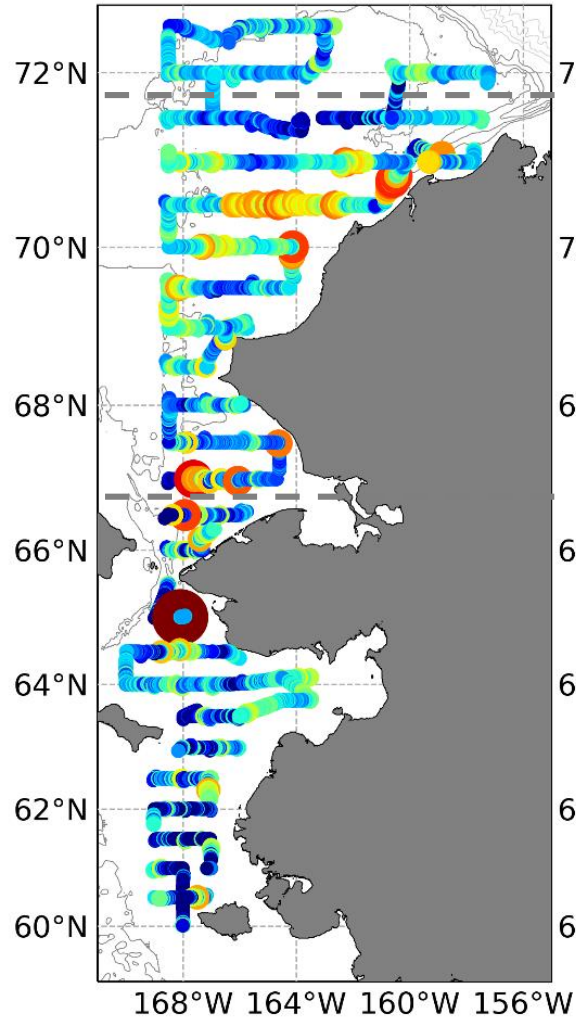


2012

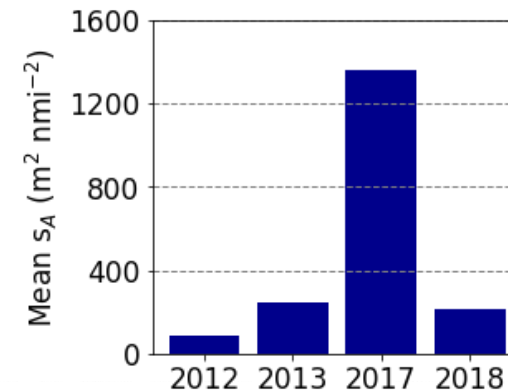
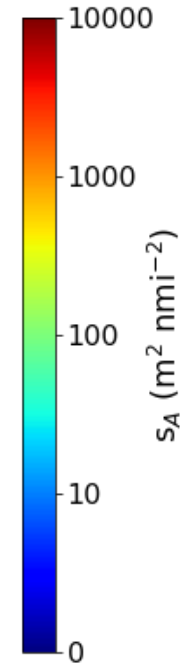
2013

2017

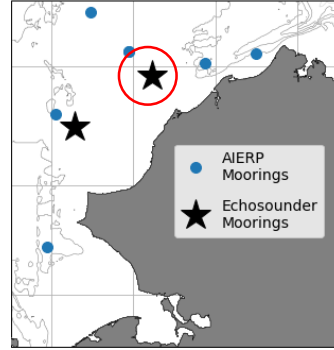
2018



Total
Backscatter
(38kHz)

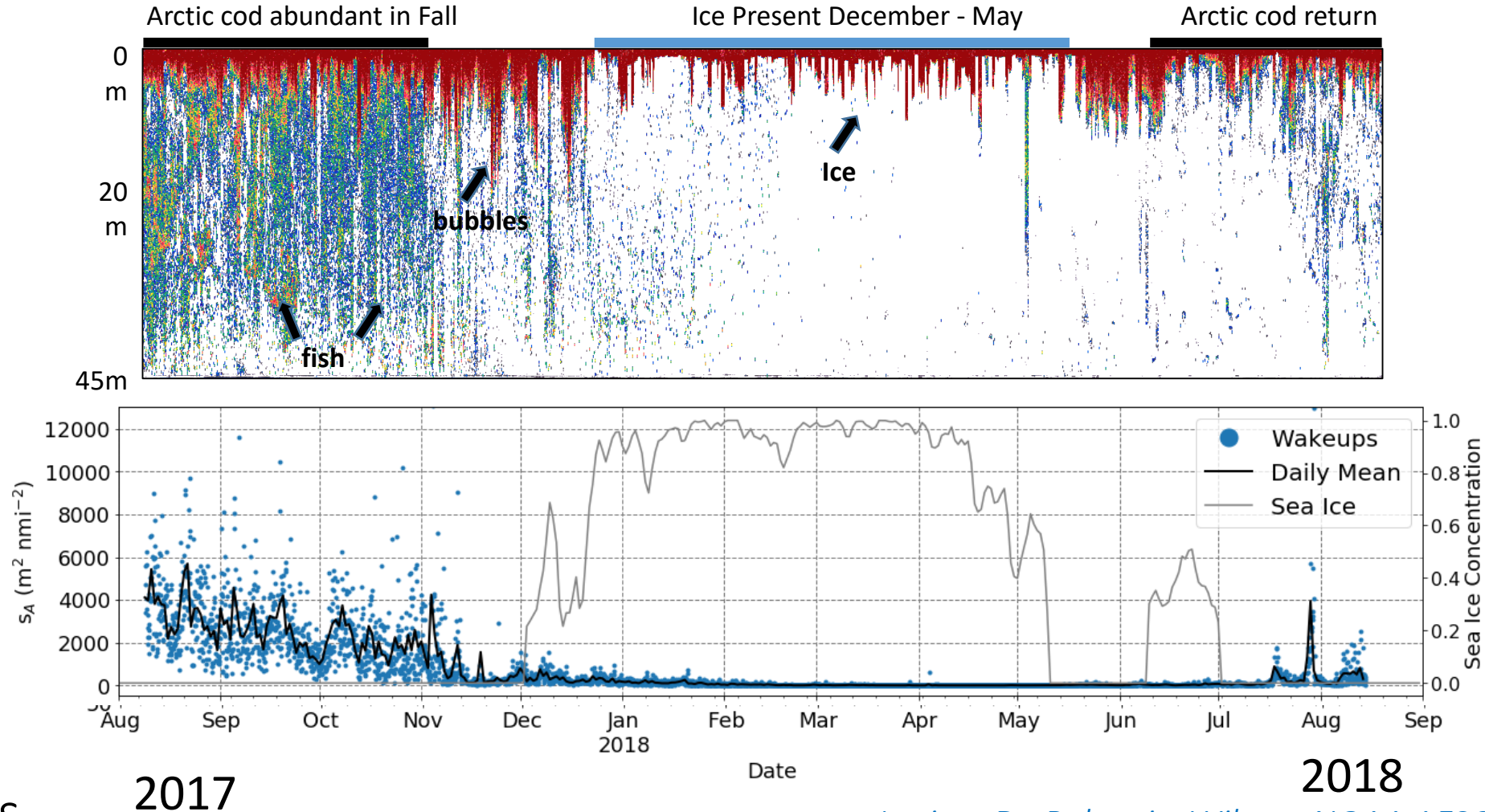


Preliminary data for 2017-2018 echosounder mooring



- Arctic cod disappear in mid-winter and return in spring after ice breakup
- Abundance appears lower summer 2018
- Big drop between years, confirm interannual differences observed in surveys

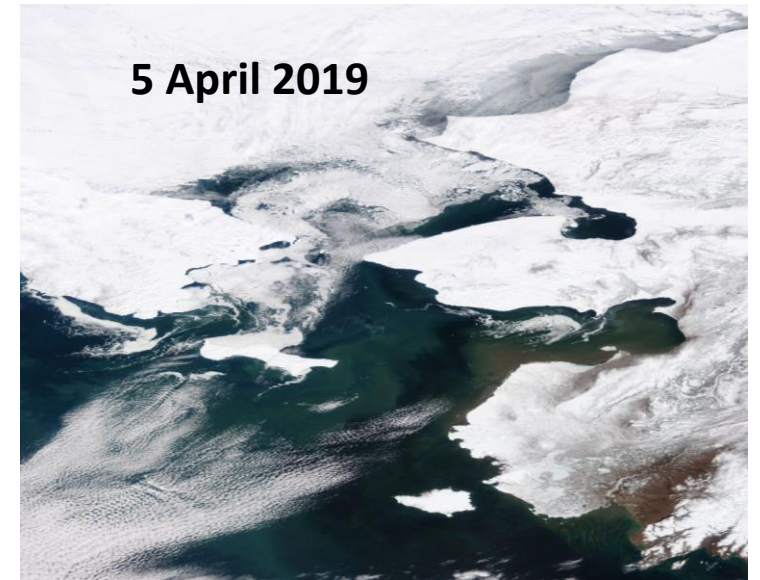
Central Mooring (C1, Icy Cape Line)



Consequences for Humans

(a small & incomplete list)

- Altered seasonality for subsistence hunting
- Altered access to winter hunting grounds
- New subsistence food sources
- New management decisions for commercial fishery oversight
- Increased vessel traffic in ice-free waters
- Conceptual models developed (Huntington et al, in review)



Algal Toxins

Earlier open water:
Likely changes in
timing of arrival of
toxin-producing
phytoplankton

Potential impacts on:

- Food security
- Seabirds
- Marine mammals

> 100 ng/L



> 40 ng/L



> 10 ng/L



~ 1 ng/L

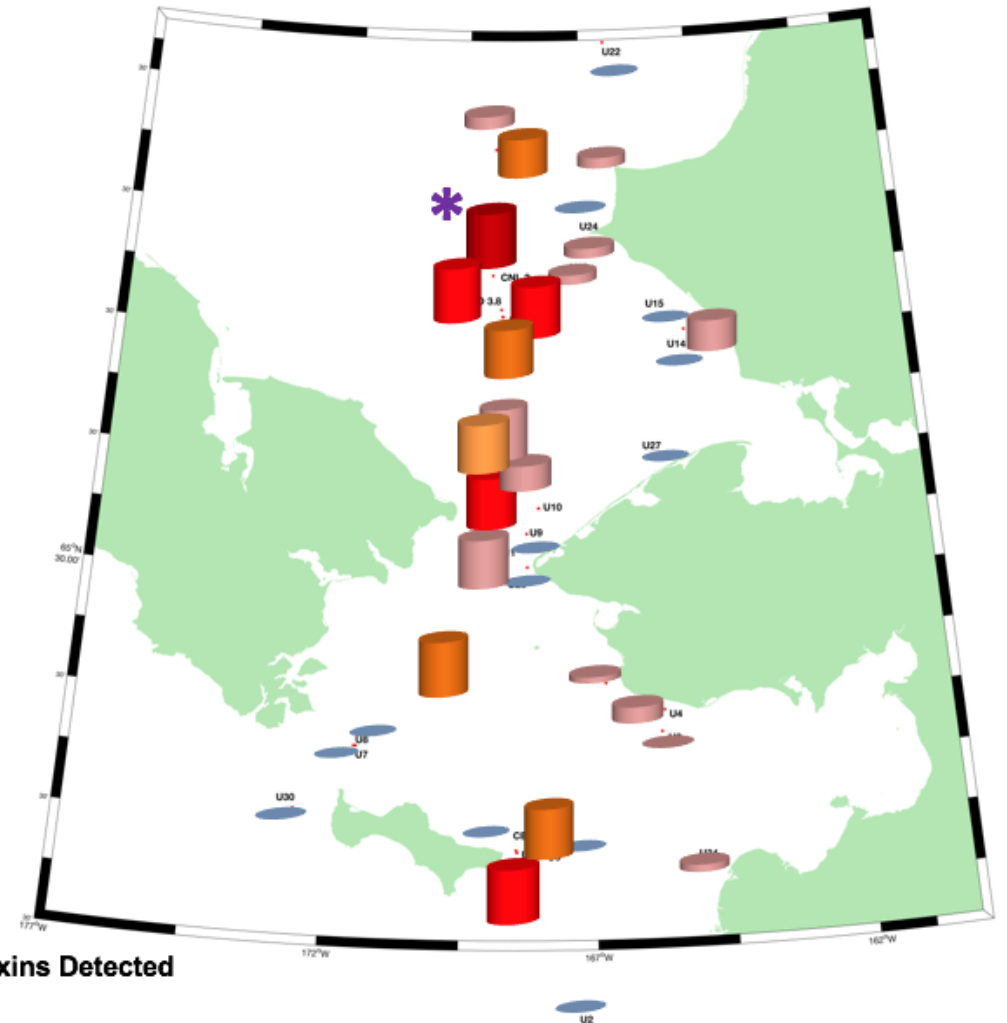


NTD



180.5 ng/L

ASGARD 2017 ASP toxin Distribution June 2017



ASP ~ Domoic Acid, found in some diatoms

Application to IEA

- Fill gaps by conducting field work at under-sampled times of year.
- Use rate-measuring process experiments to better understand carbon turnover and partitioning within the ecosystem.
- Improve our ability to model the ecosystem by collecting data for model parameterizations and evaluations.
- Evaluate mechanisms to better understand and predict effects of climate change (shifting baselines).

