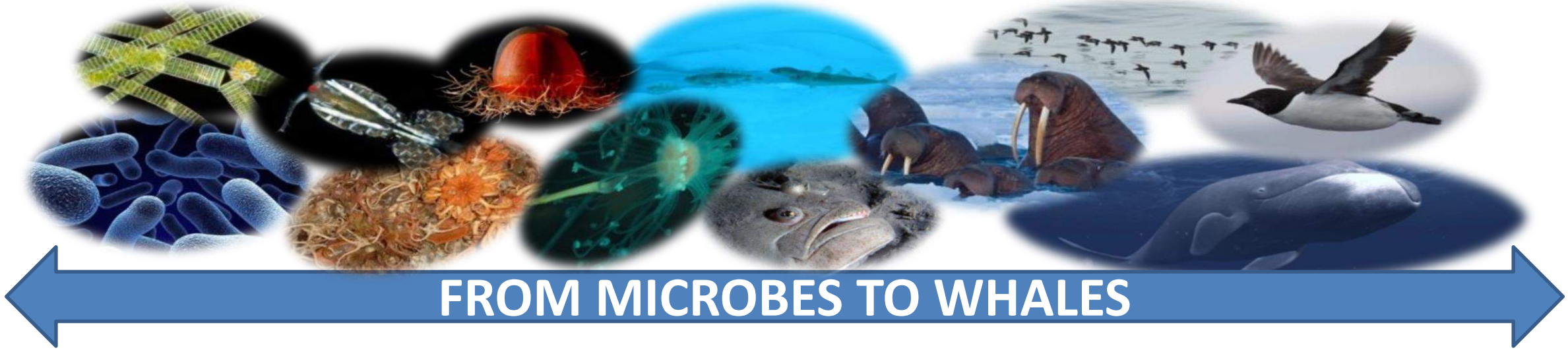



# AMBON: Arctic Marine Biodiversity Observing Network

**Iken K[1], Cooper L[2], Grebmeier J[2], Danielson S[1], Mueter F[1], Hopcroft R[1], Stafford K[3], Kuletz K[4], Collins E[1], Kavanaugh M[6], Bluhm B[1,5], Moore S[3], 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) Oregon State University, USA; (7) Alaska Ocean Observing System/AXIOM, USA

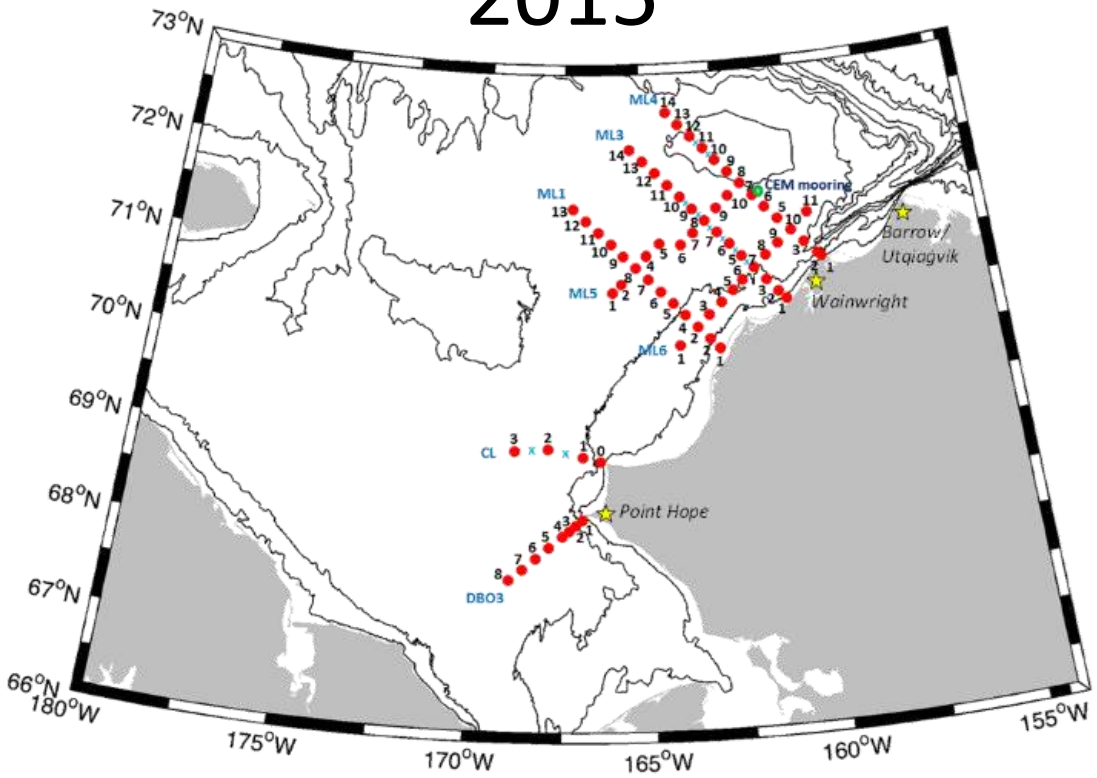
## Core themes and what we have learned

- **Observation**:
  Close current gaps in taxonomic and spatial coverage in biodiversity observation on the Chukchi shelf
- **Integration**:
  Integrate with past and ongoing research programs on US Arctic shelf into Arctic biodiversity observation network
- **Demonstration**:
  Demonstrate at a regional level how a MBON could be developed in other regions and ecosystems
- **Pan-Arctic linkages**:
  Link with other programs on pan-Arctic level

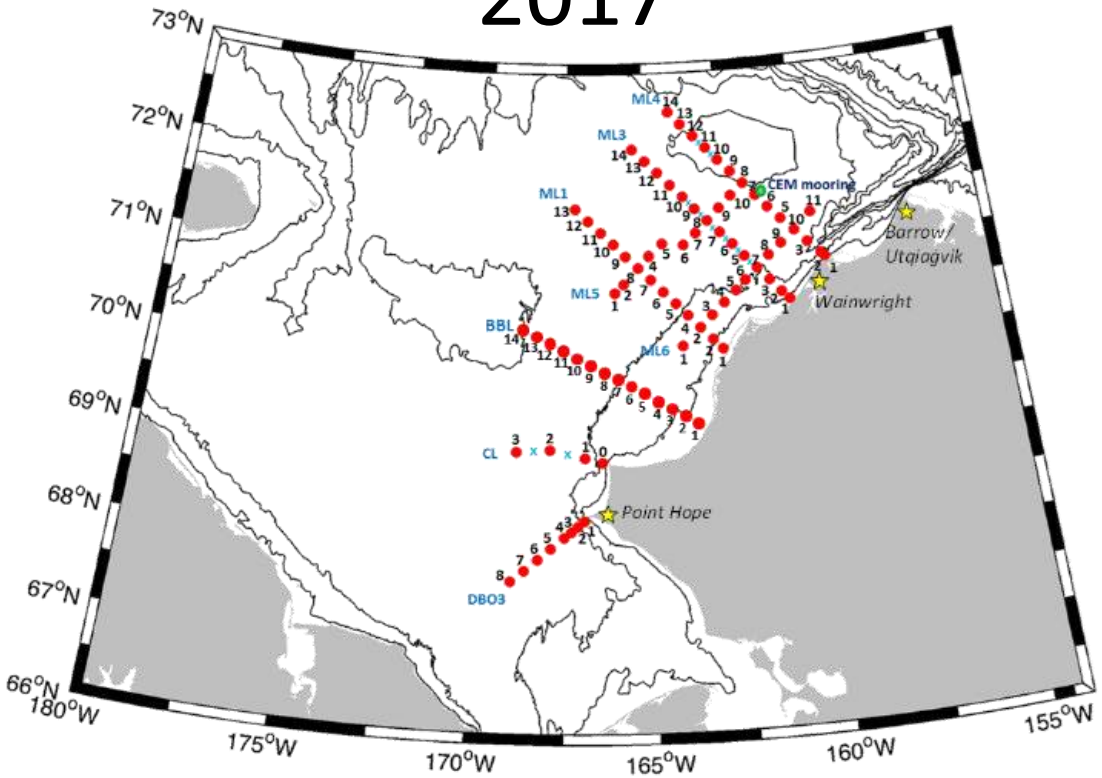
# Observation

## AMBON field sampling

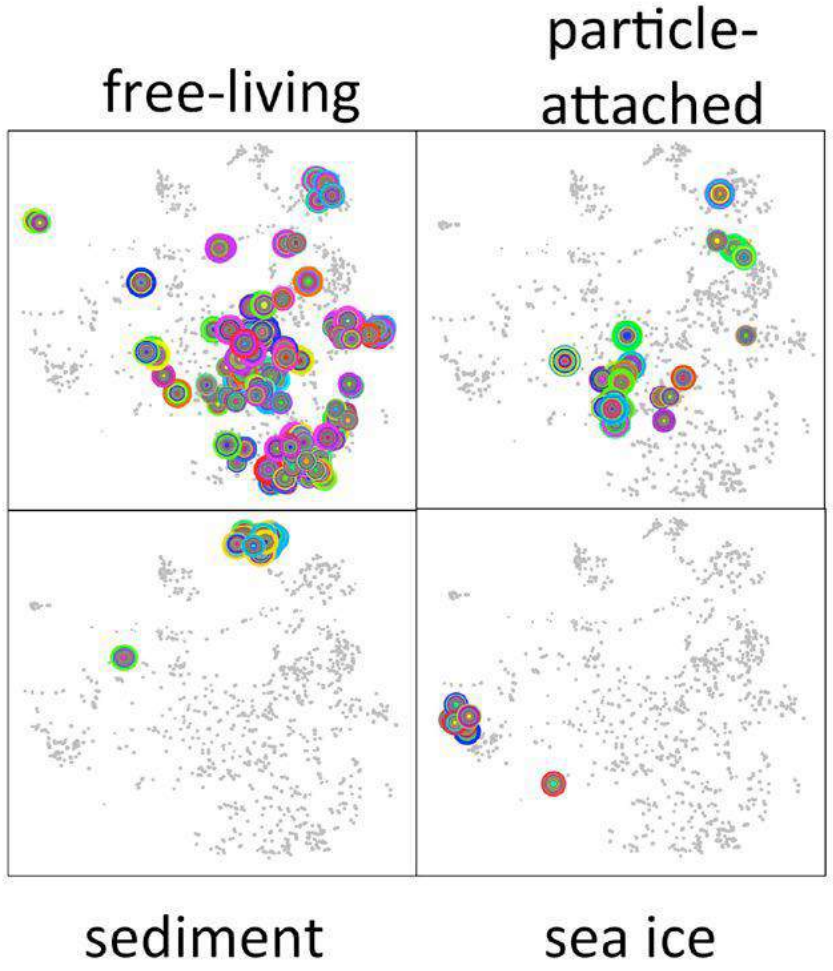
2015



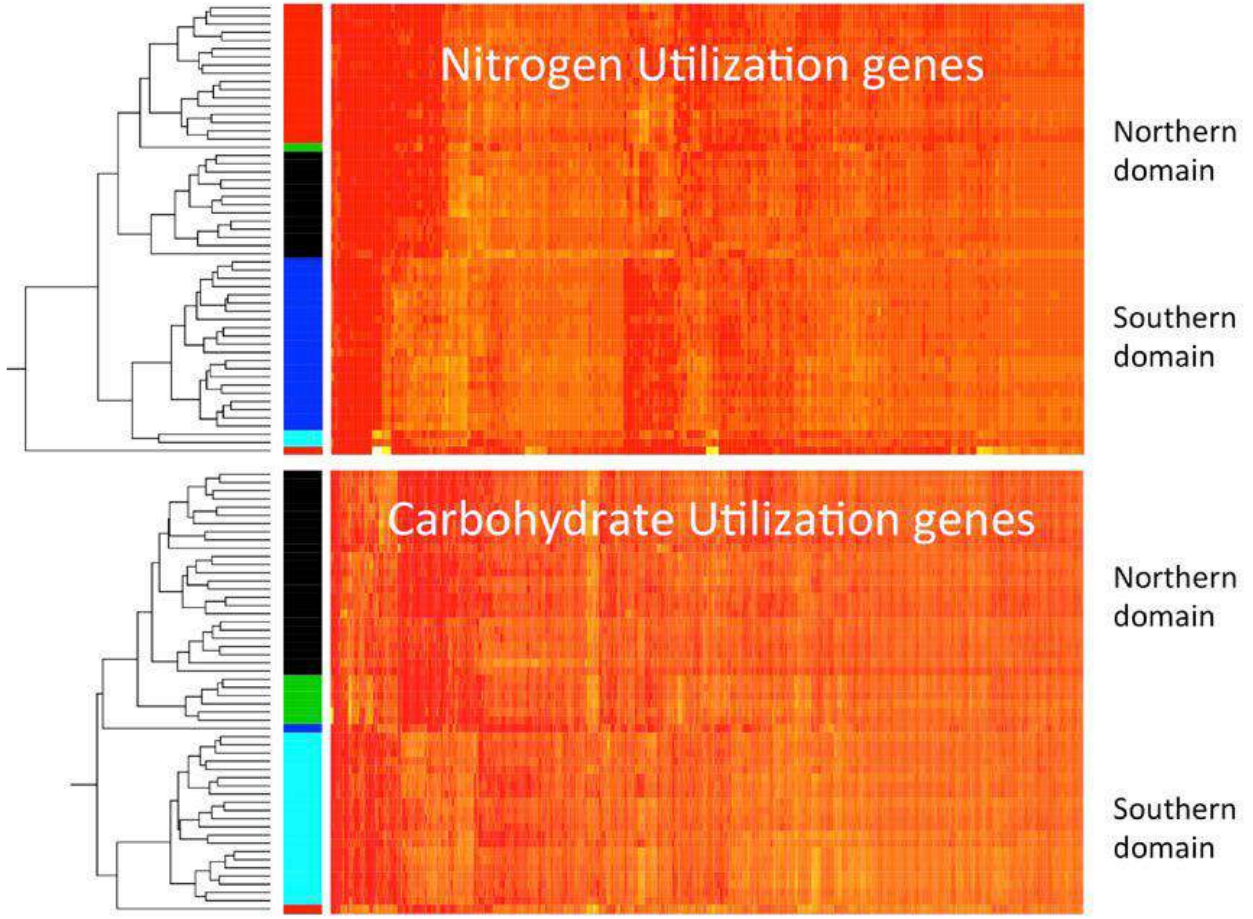

2017




# Observation



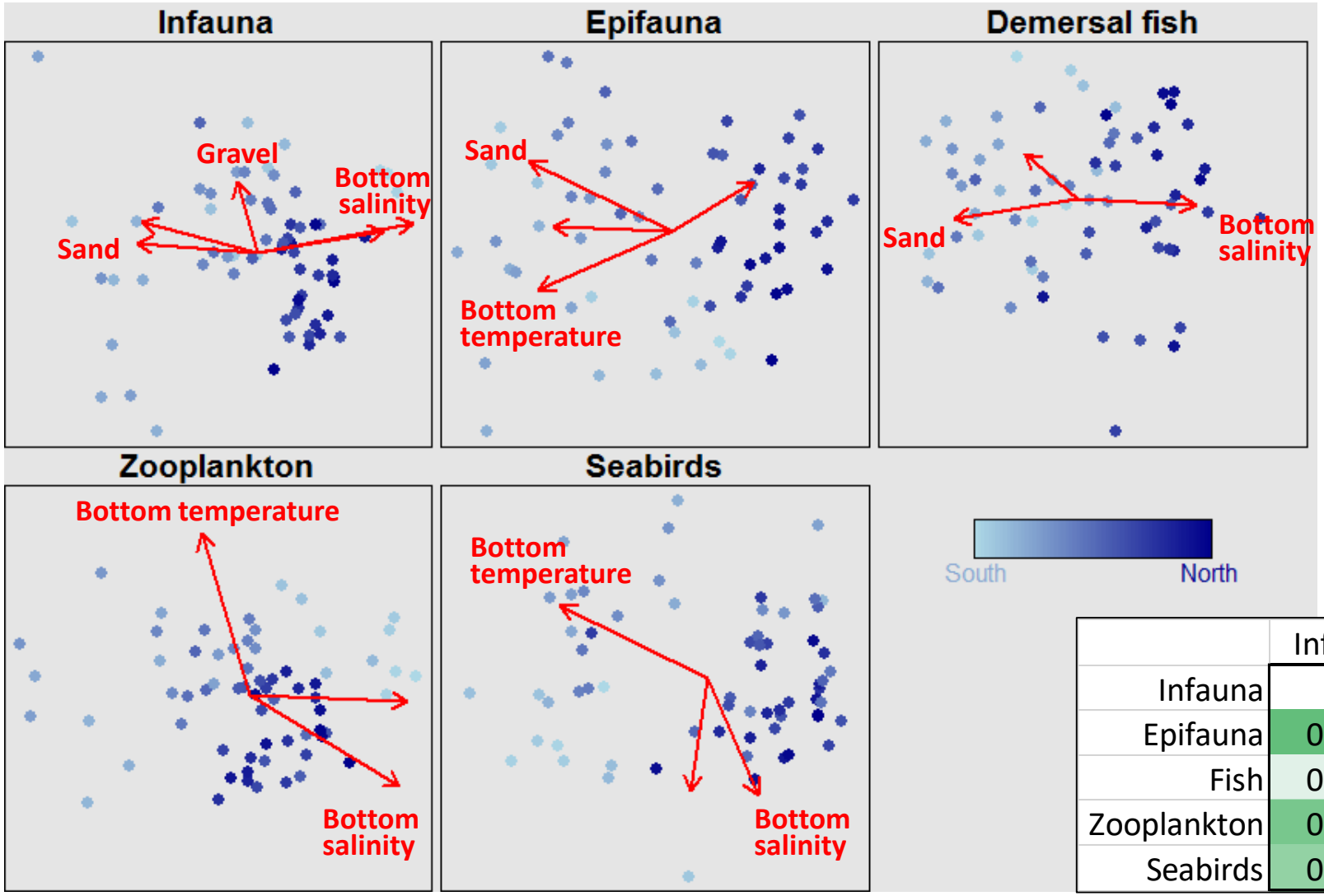

- New baselines for microbial size fraction
- > 10,000 molecular species of microbes (OTUs)




→ Microbial community strongly structured by habitat (left) and region (right).

# Observation

## Community ordinations, AMBON 2015 (65 stations)




- Benthic communities primarily associated with **sediment gradients** and **bottom water type**
- Zooplankton & seabirds associated with bottom waters (<u>not</u> surface)
- South → North gradient
- Modest to strong correlations among communities
- <u>Key species</u> link communities

### Mantel correlations among communities

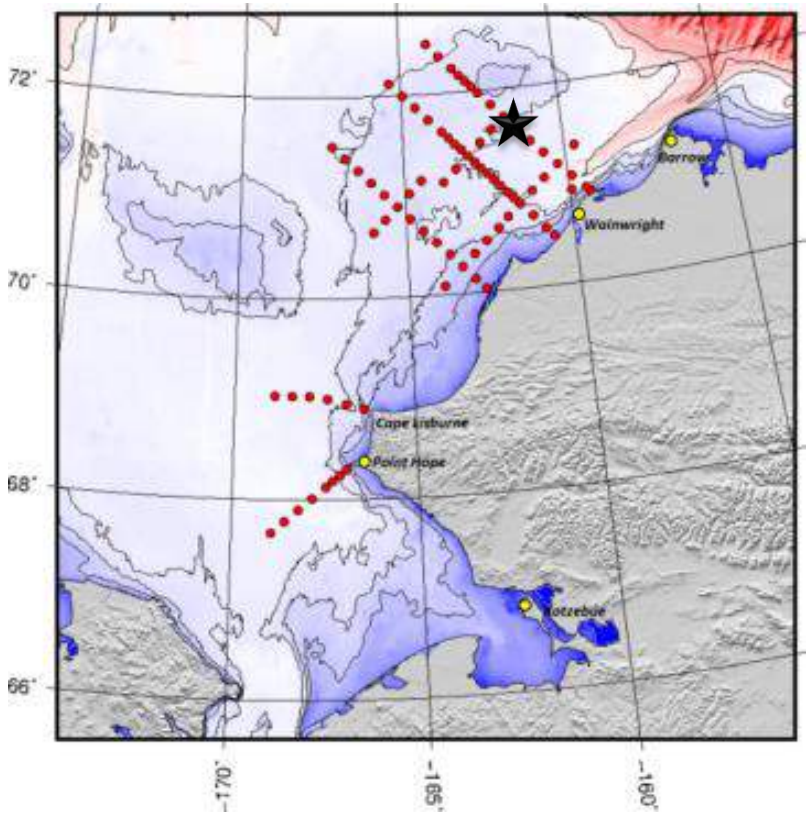
| | Infauna | Epifauna | Fish | Zooplankton | Seabirds |
|---|---|---|---|---|---|
| Infauna | | <0.001 | 0.001 | <0.001 | <0.001 |
| Epifauna | 0.504 | | <0.001 | <0.001 | <0.001 |
| Fish | 0.157 | 0.414 | | <0.001 | 0.032 |
| Zooplankton | 0.448 | 0.352 | 0.185 | | <0.001 |
| Seabirds | 0.373 | 0.331 | 0.080 | 0.414 | |

# Integration

Integrate with past and ongoing research programs on US Arctic shelf into Arctic biodiversity observation network

# Integration

→ **Connecting short-term (cruise) with long-term (mooring) observations**




## Chukchi Ecosystem Observatory, CEM2-16

Latitude 71° 35.976' N Longitude 161° 31.621' W

Deployment DateGMT 4 August, 2016 Deployment TimeGMT 04:33:14

**Height (Top)**

**-11.97 m**

### 36 meters below surface

| | | |
|---|---|---|
| Xeos Locator Beacon | SN | 300234063212650 |
| SUNA V2:NO3 | SN | 801 |
| Acoustic Zooplankton Fish Profiler | SN | 55063 |
| SeaCAT (P/T/S) | SN | 4604 |
| (PAR 70612 /Triplet 1417) | | |
| SeapHOx (P/T/S/pH/Ox) | SN | 1340 |
| HydroC (pCO2) | SN | BAT-7S12P-0416-001 |
| LISST | SN | 1557 |

2.54 meters 3/8" line
2 14" Vinny floats

S-L-S

**-7.615 m**

Sediment Trap

S-L-S

1.74 meters 3/8" line
2 14" Vinny floats

S-L-S

**-3.065 m**

**Acoustic Releases:**
**Dual Push-Off Release Transponders**

| | | | |
|---|---|---|---|
| **SN#1** | **36429** | **SN#2** | **36430** |
| **Enable** | **414254** | **Enable** | **414306** |
| **Disable** | **414277** | **Disable** | **414325** |
| **Release** | **431712** | **Release** | **431731** |

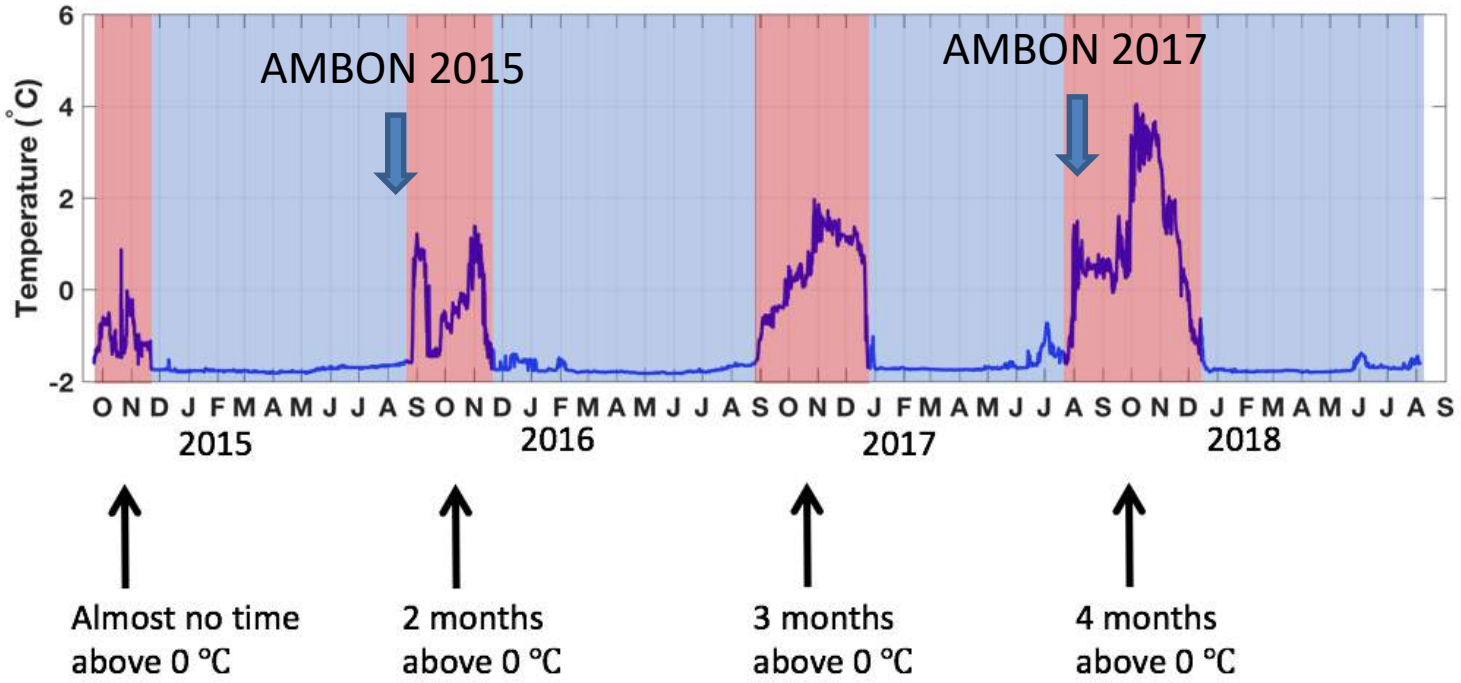
**Anchor at depth of 48 meters**

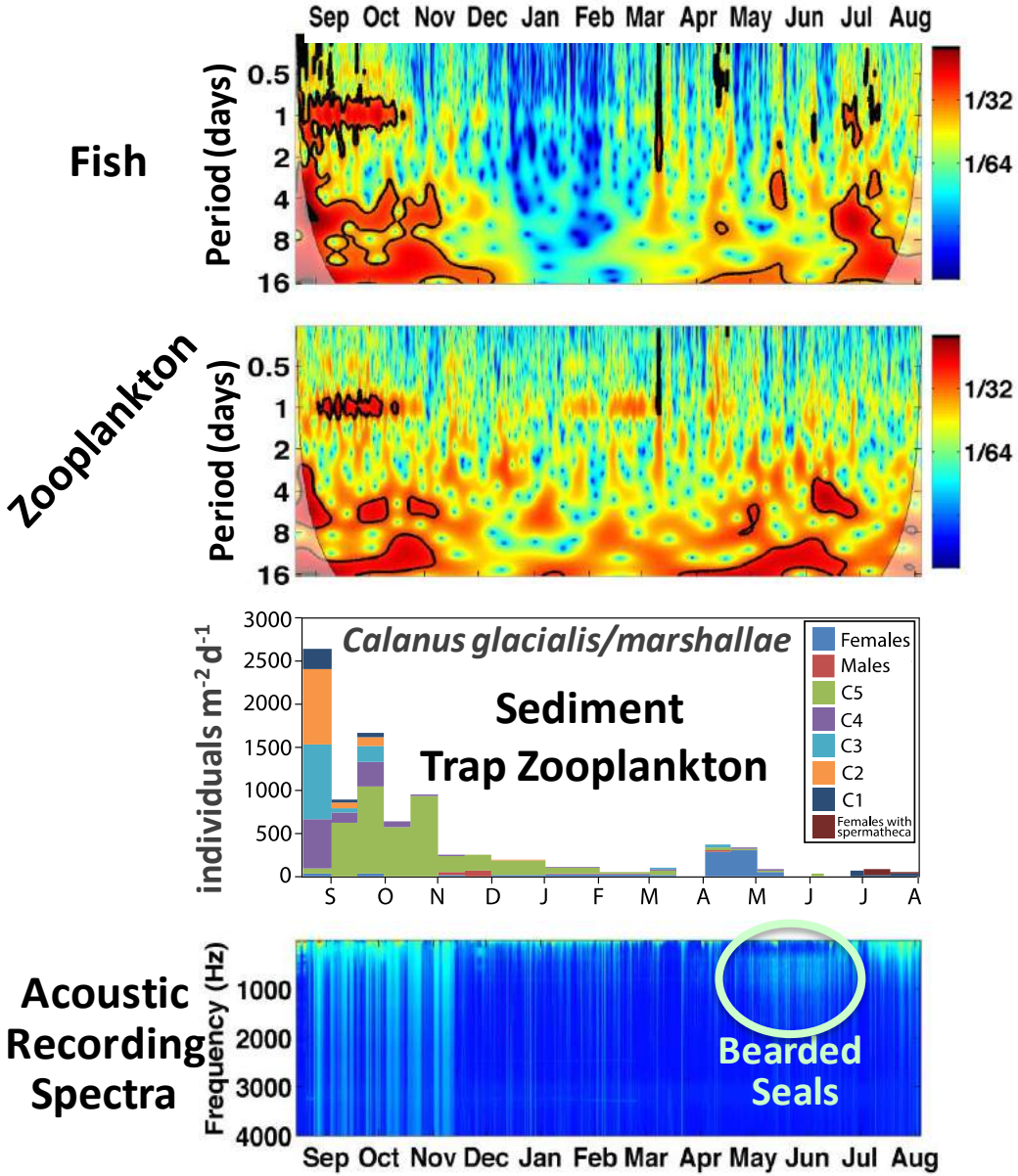
www.chukchiecosystemobservatory.org

# Integration

Moorings provide seasonal and longer-term context for AMBON sampling

Near-bottom temperature at the CEO site since 2015

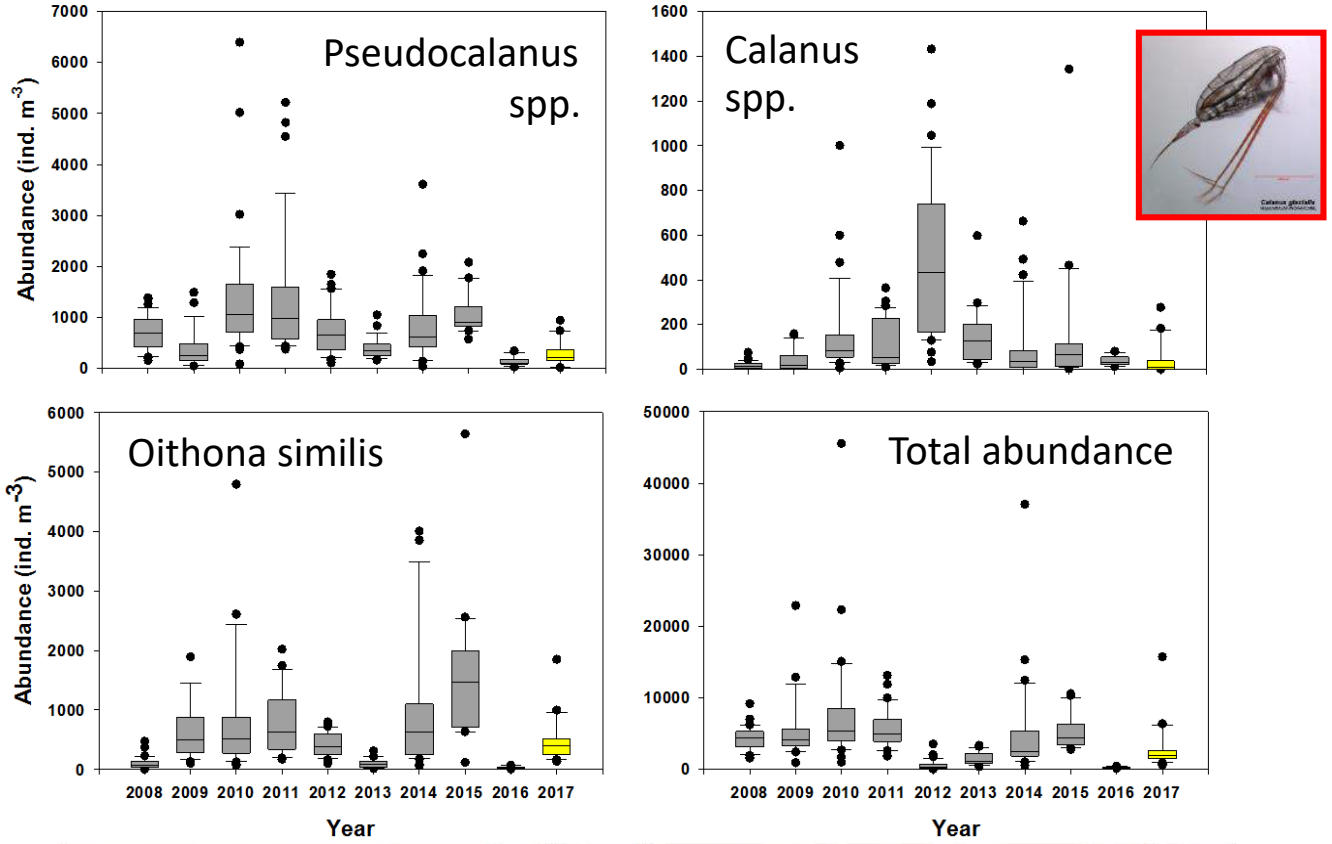


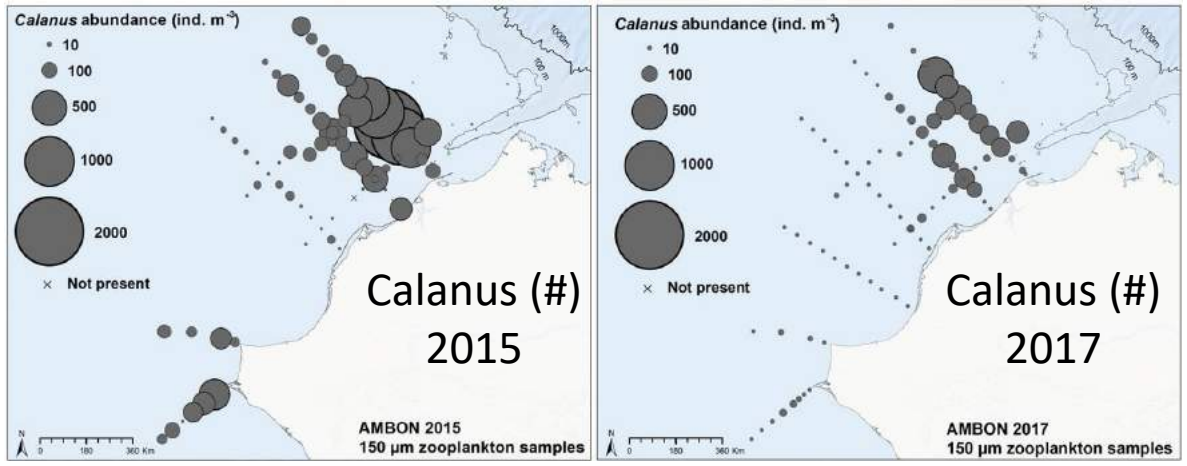



# Integration

→ Integrating AMBON data with existing time series

- Example: 10 years of zooplankton observations
  - Abundances during AMBON years within range of previously observed abundances
  - Relatively low abundances in 2016/17 (warm years)
  - Long-term increase in zooplankton biomass of Pacific origin, 1946-2012 (Ershova et al. 2015)

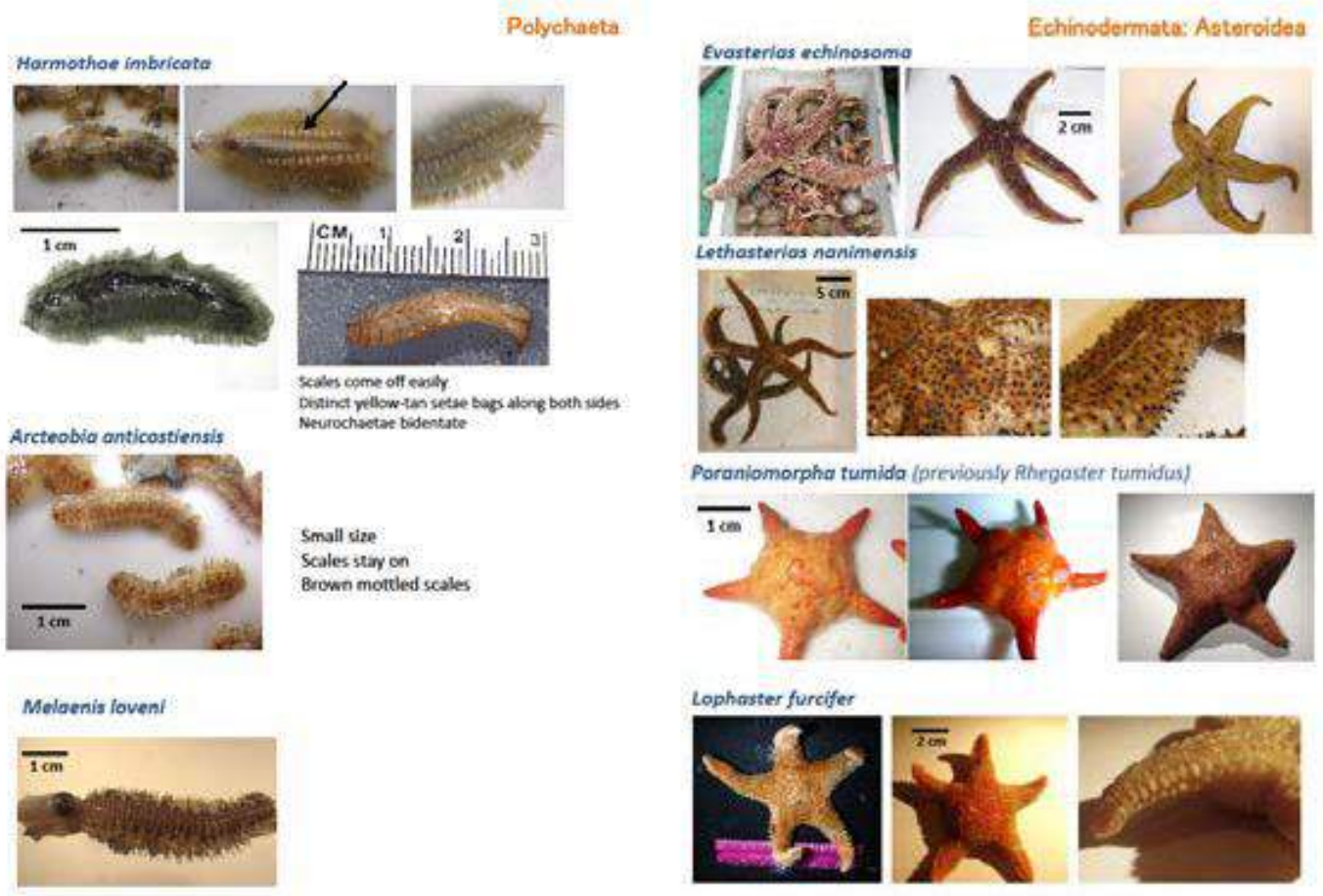


# Integration

→ Integrating new taxonomic understanding

Building capacity and enhancing taxonomic expertise by compiling online picture identification guides for Arctic benthos




**Five volumes**:

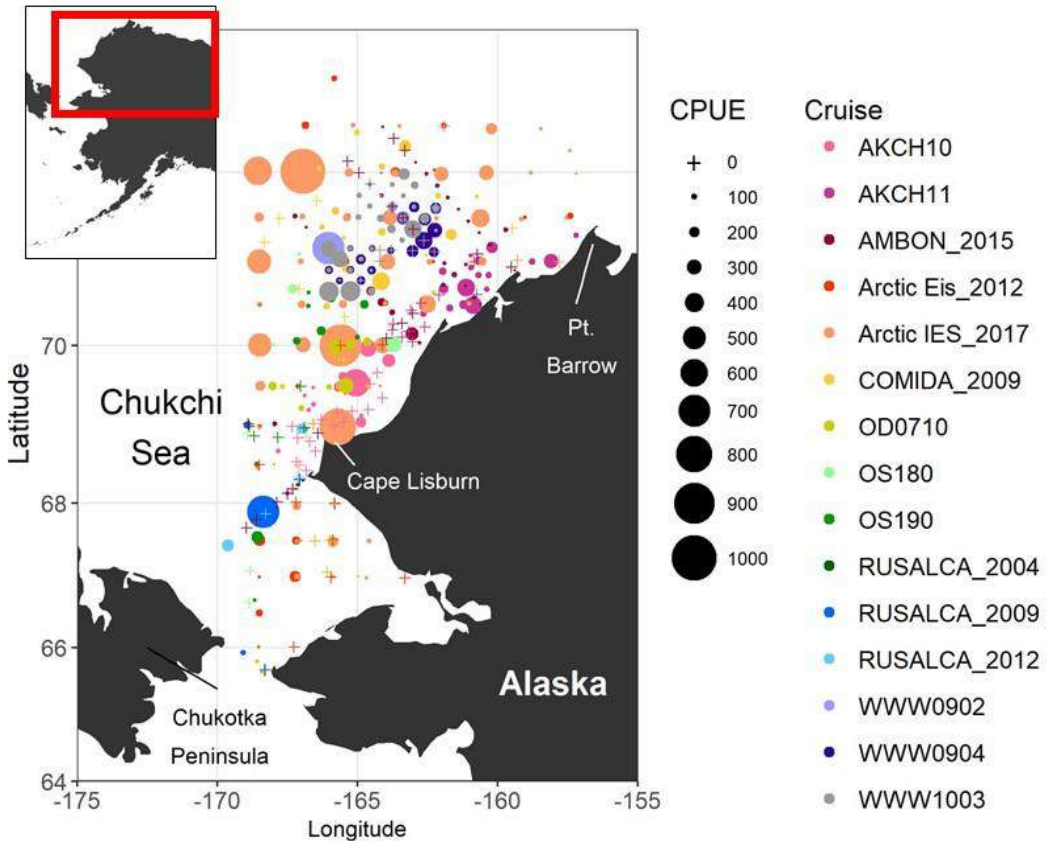
- Echinodermata
- Arthropoda
- Mollusca
- Annelida
- Miscellaneous Taxa

Currently in beta-testing
(NOAA collaborators)

# Integration

→ Integrating results from AMBON with other studies on data-poor stocks

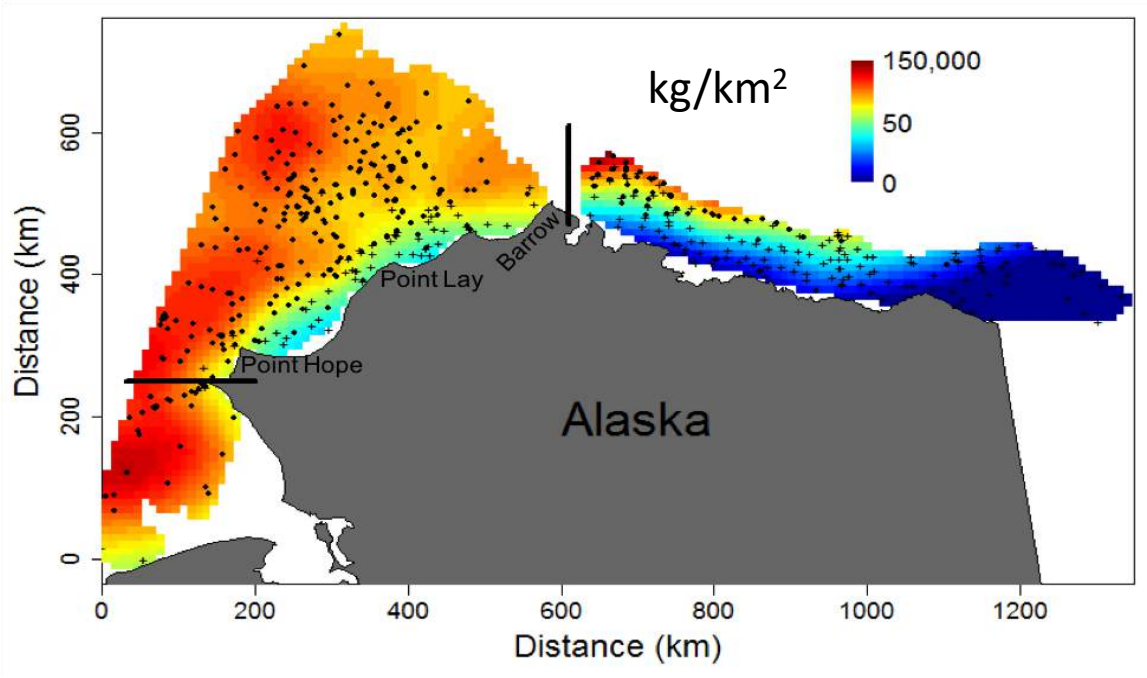
## Arctic cod life history




- Documenting ontogenetic migrations of Arctic Cod

Forster et al. (In Prep)

## Snow Crab assessment

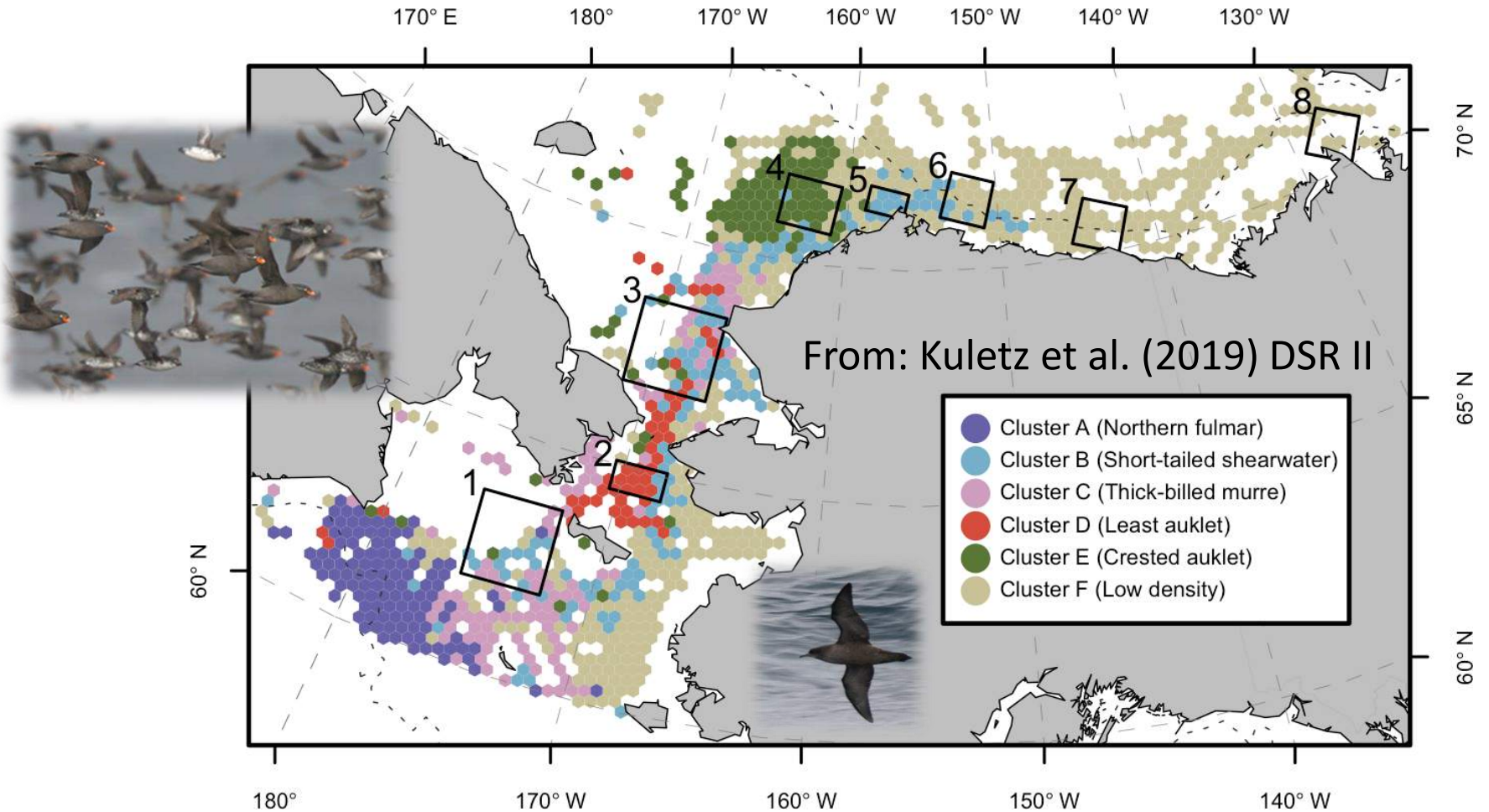



- Estimated biomass: 810,200 mt (474,000 – 1,759,200 mt)
- Updated & region-specific life history parameters
  - Maturity curves
  - Fecundity

Divine et al. (In Revision)

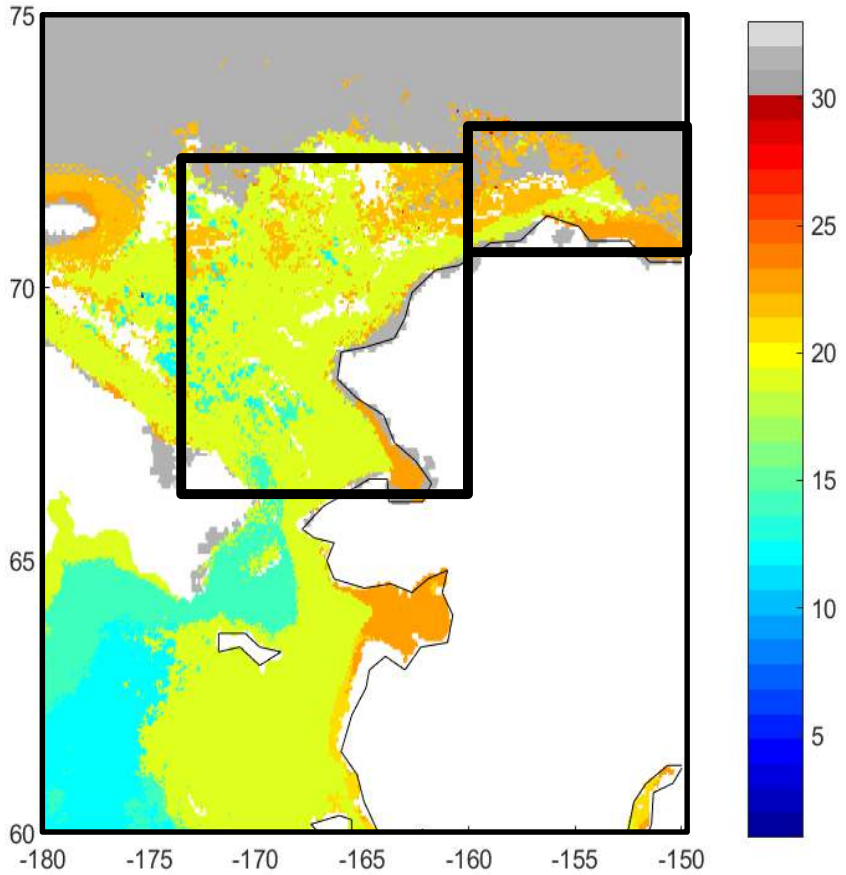
# Integration → Integrating seabird data across multiple surveys (2007-2015)

- Six clusters (identified by dominant species) - 5 occur in AMBON region
- Integration with DBO network (black boxes)
- Integration with other programs
  - Arctic IERP
  - NOAA surveys
  - and many more…

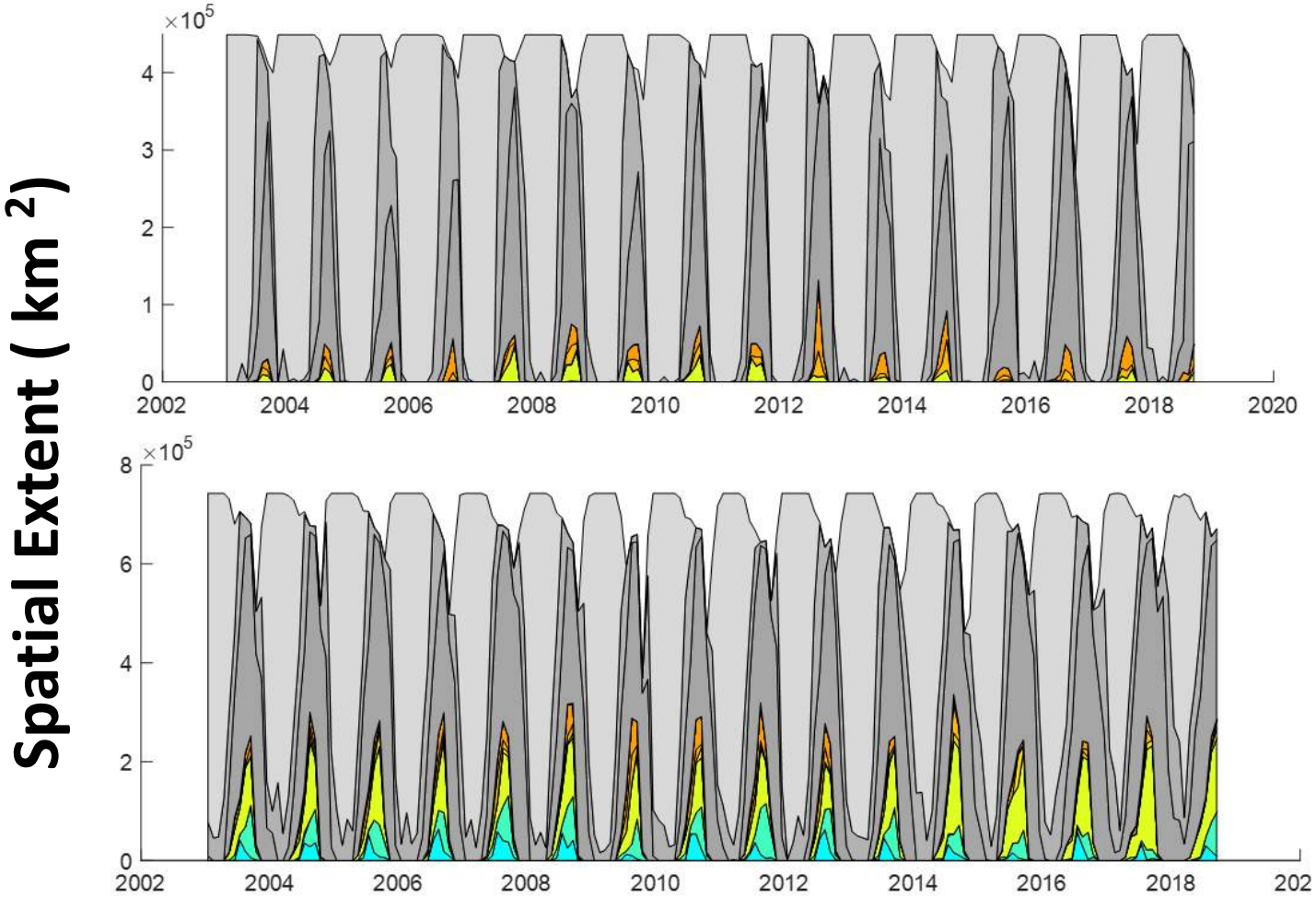


# Integration

→ Integration with NSPIRES (NASA) project on seascapes




Dominant Seascape: Spatial Variability



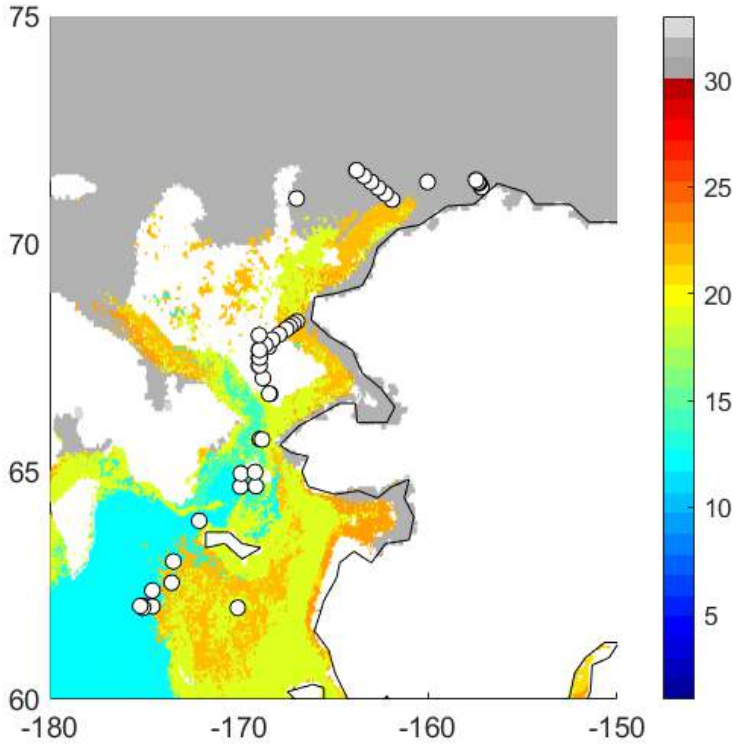

Areal extent of habitats in Beaufort Sea (top) and Chukchi Sea (bottom)

# Integration

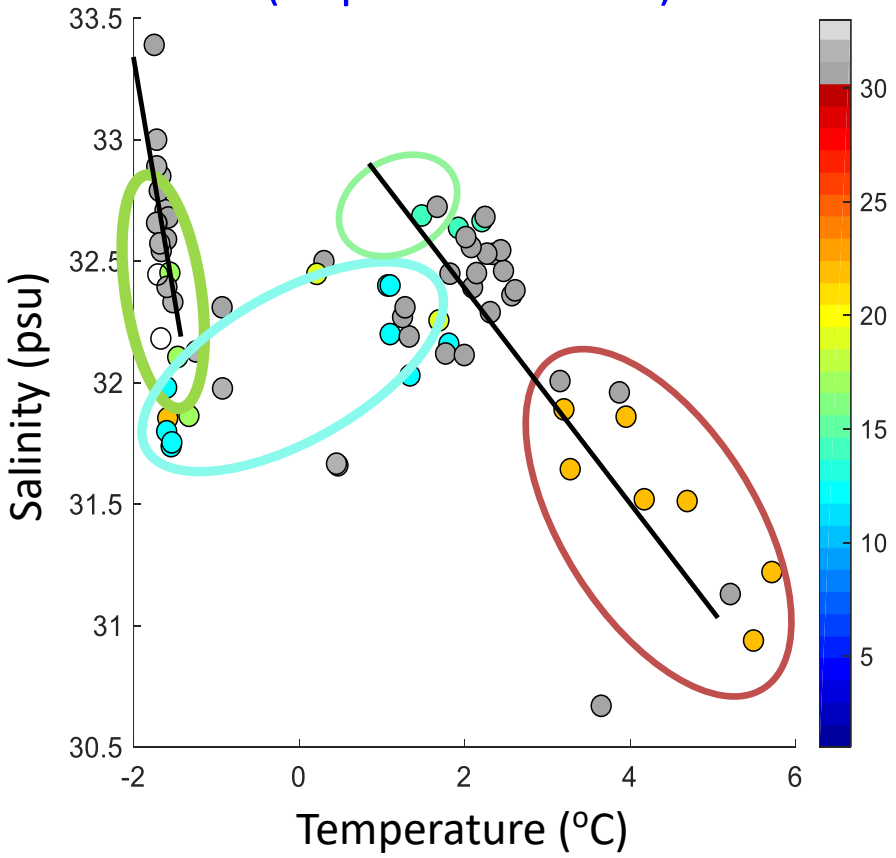
→ Integration with NSPIRES (NASA) project

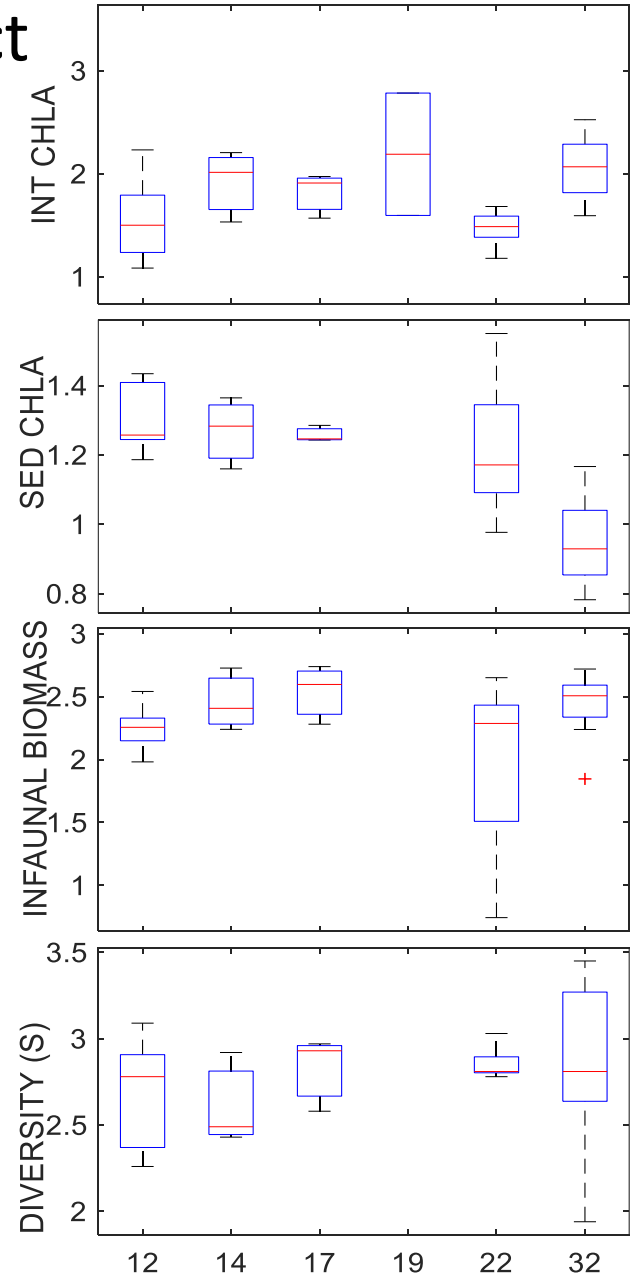
## Distributed Biological Observatory: Do satellite seascapes reflect meaningful benthic patterns?

Dominant Seascape (July):
DBO sites 2013 and 2014

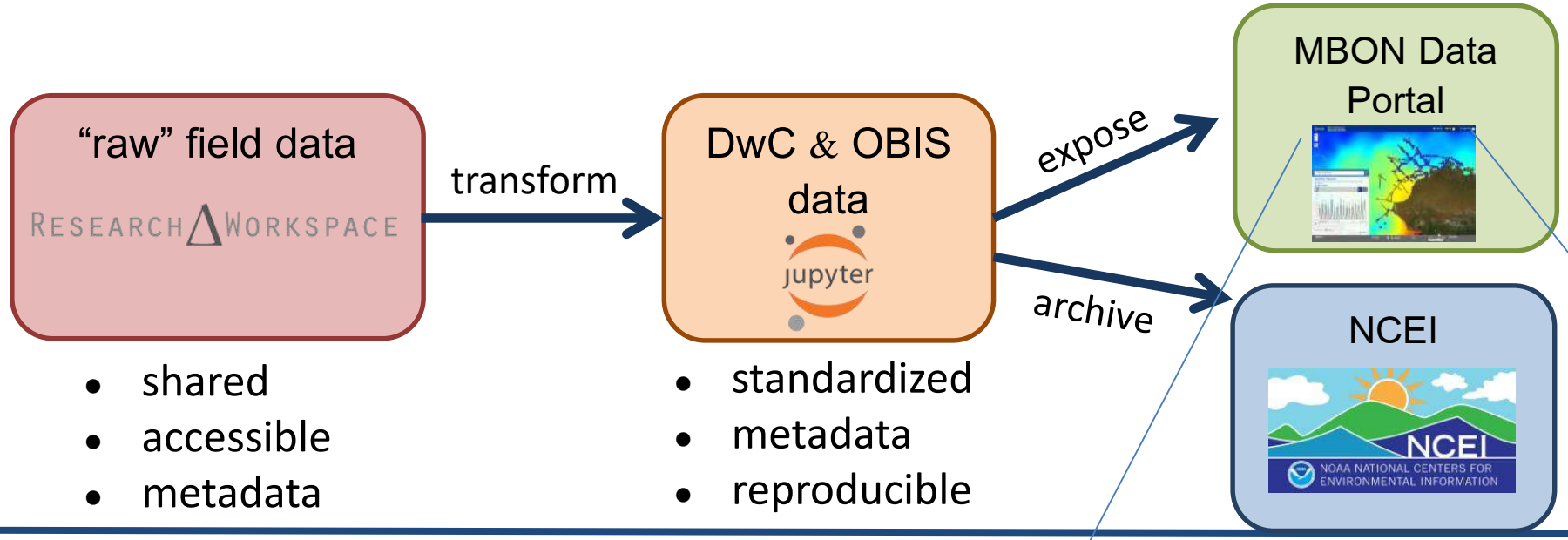



Benthic Temp and Salinity
(Depth= 40-130 m)



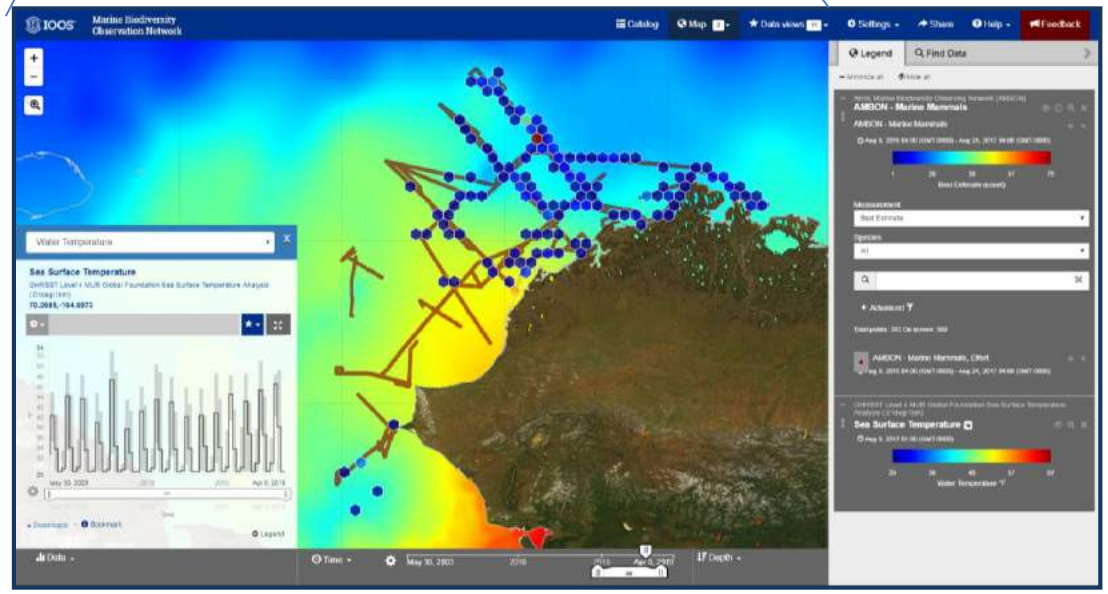



# Integration → Integrating AMBON data into national archives & data portals




**Example:**

- Cruise track
- 2015-17 marine mammals
- Sea surface temperature




Stafford, Kate (2018). Vessel line-transect surveys of Arctic marine mammals in the Chuckchi Sea, Arctic Marine Biodiversity Observing Network (AMBON) research cruise, 2015-2017 (NCEI Accession 0177802 & NCEI Accession 0177817). Version 1.1. NOAA NCEI. Dataset.

# Demonstration

Demonstrate at a regional level how a MBON could be developed in other regions and ecosystems

# Demonstration

- Based on AMBON experience, developed guidelines for sampling design (Iken et al 2018)
- Developed simulation approach to evaluate alternative sampling designs for estimating species richness and abundance
- Similar analysis of trade-offs associated with different spatial coverage for seabird surveys

Contents lists available at ScienceDirect

Deep-Sea Research Part II

journal homepage: www.elsevier.com/locate/dsr2


Developing an observational design for epibenthos and fish assemblages in the Chukchi Sea

K. Iken[a,*], F. Mueter[a], J.M. Grebmeier[b], L.W. Cooper[b], S.L. Danielson[a], B.A. Bluhm[c]

[a] College of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, AK, USA
[b] University of Maryland Center for Environmental Science, Solomons, MD, USA
[c] Department of Arctic and Marine Biology, UiT – the Arctic University of Norway, Tromsø, Norway

# Pan-Arctic Linkages

Link with other programs on pan-Arctic level

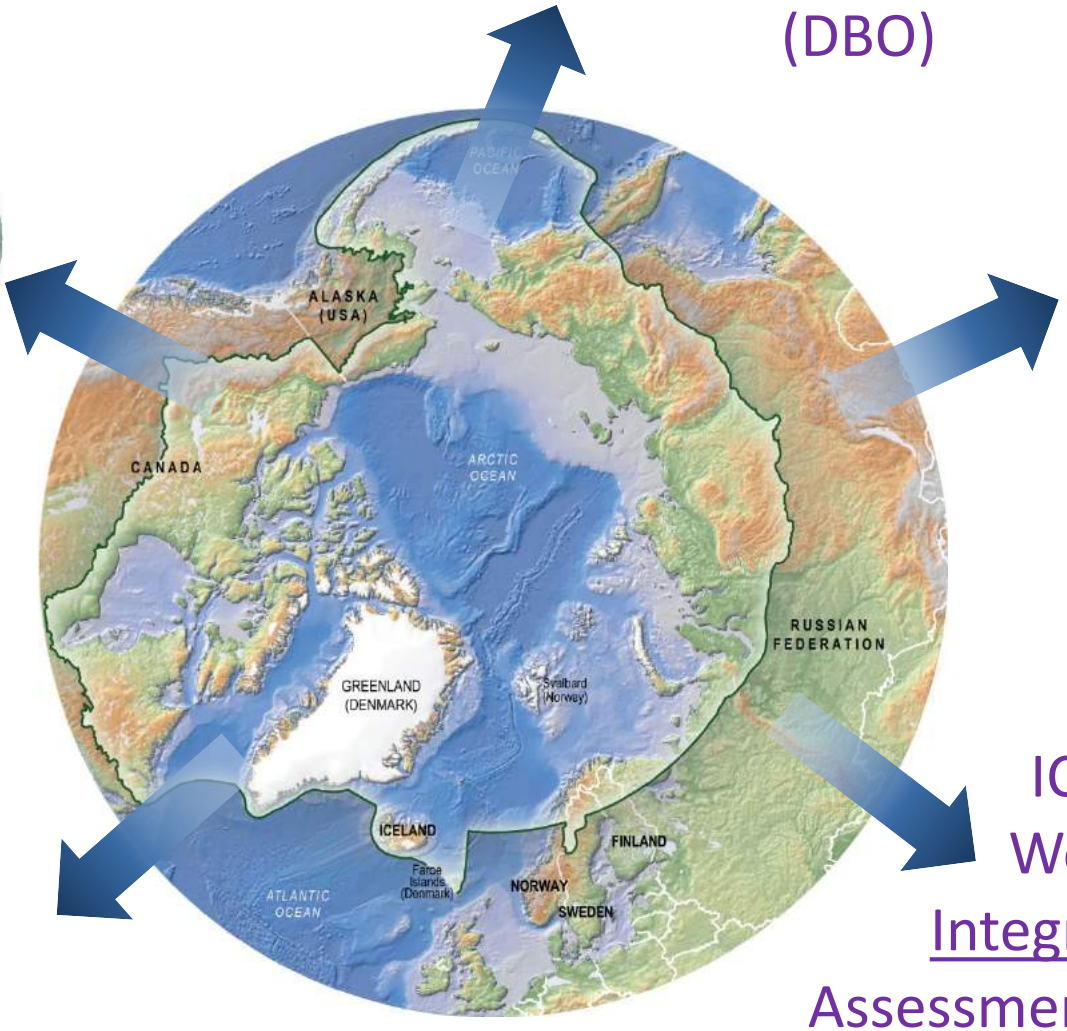
# Pan-Arctic Linkages

Ecosystem Studies of Subarctic and Arctic Seas

ESSAS

(an IMBER program)

Pacific Arctic Group (DBO)

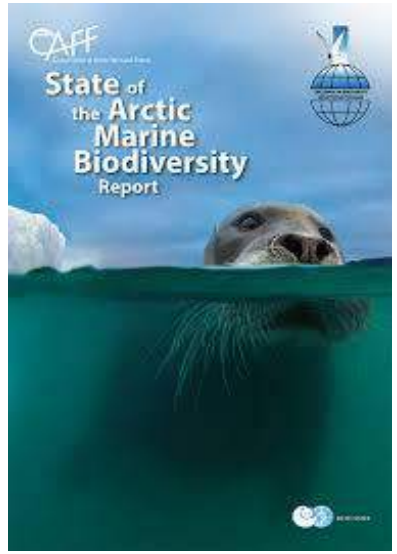


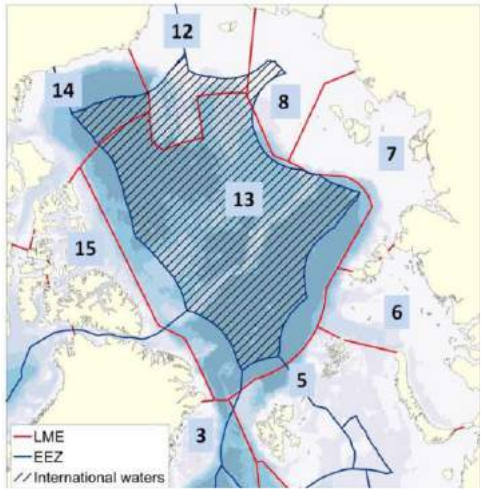

Circumpolar Biodiversity Monitoring Program (CBMP)

ARCTIC COUNCIL

CAFF

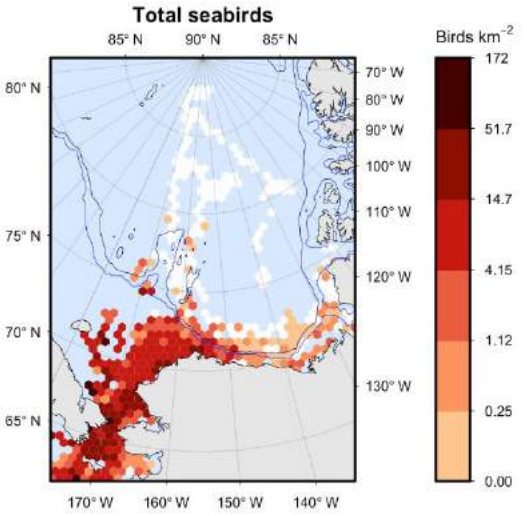
Conservation of Arctic Flora and Fauna




FisCAO: Fisheries in the Central Arctic Ocean

ICES/PICES/PAME Working Group on Integrated Ecosystem Assessment of the Central Arctic Ocean (Interim Report)

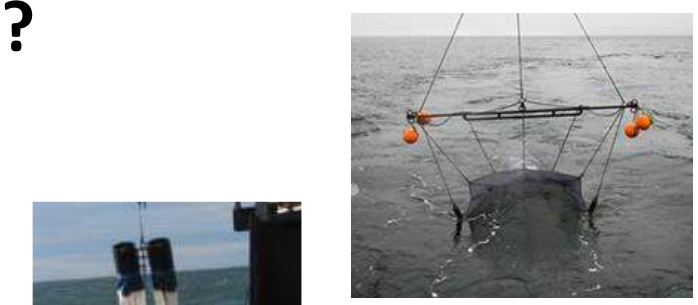


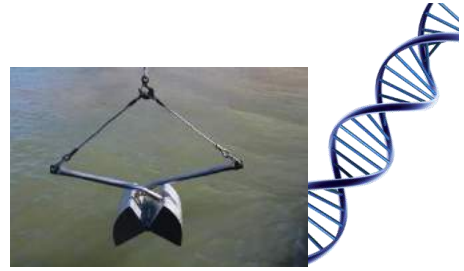
# Is our approach valid & sustainable?

**Is our approach valid & sustainable?**

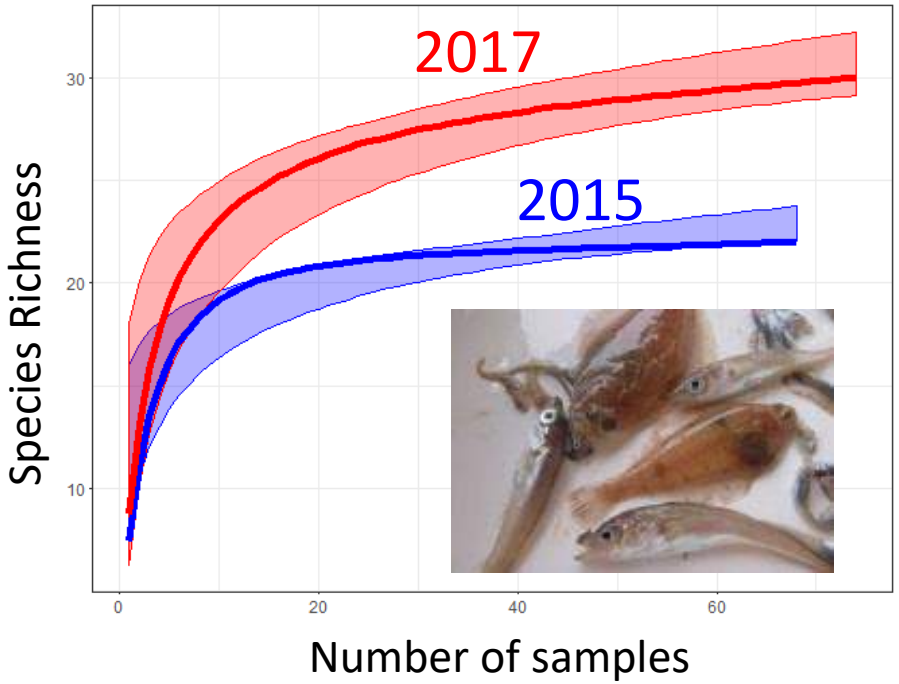
# Validity

- Are we sampling target communities effectively & representatively?





- Are we able to quantify uncertainties appropriately and detect signals?

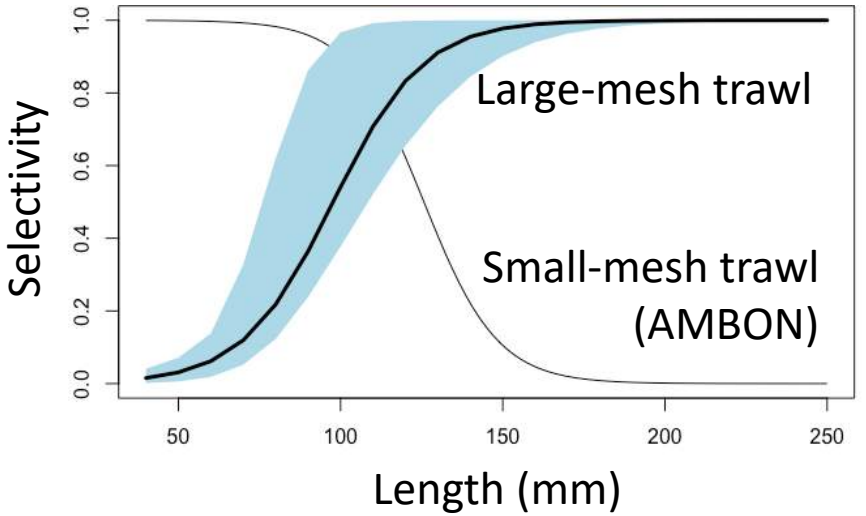


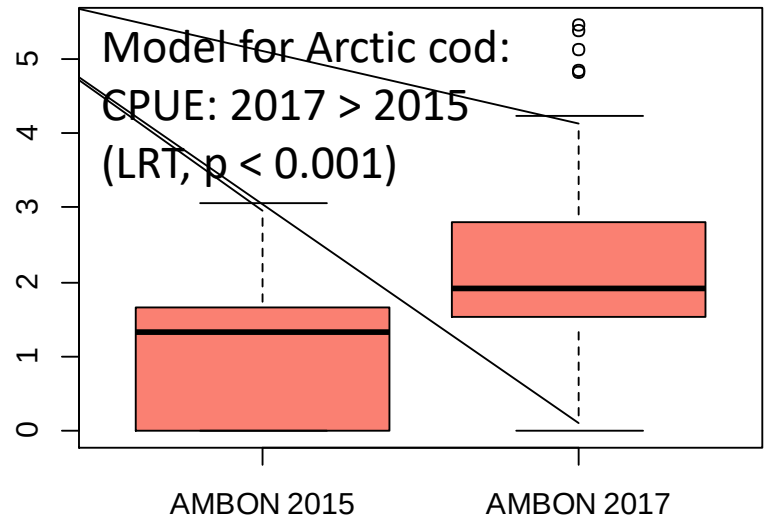
**Is our approach valid & sustainable?**

# Validity

- Sampling approaches validated for most communities, but some limitations remain
  - **gear selectivity** (e.g., fish)
  - **taxonomic uncertainties** (e.g., juvenile stages)
  - **missing baselines** (e.g., eDNA).
- Validity of approach for meeting certain **performance measures** (e.g., estimating species richness or species abundances within a prescribed margin of error) is being tested through a **simulation approach**.

Gear selectivity (Arctic cod)



**Is our approach valid & sustainable?**

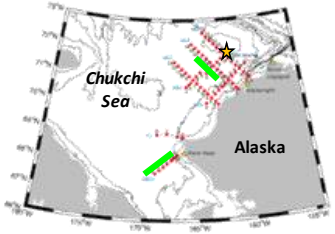
# Sustainability

- Costly and logistically challenging field work that is required for long-term monitoring in the Arctic may be **best achieved through collaboration with other research projects**
- Exploring alternative **sampling designs** through a simulation approach can help determine efficient and effective designs

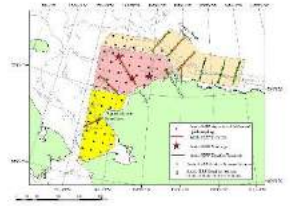
CEO


DBO-NCIS


AMBON



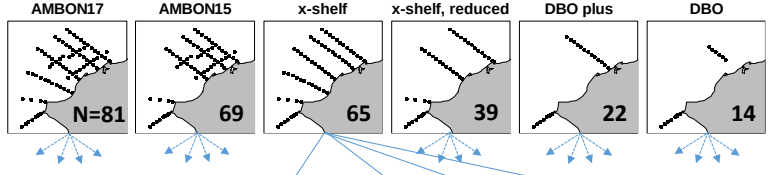

Arctic IES II



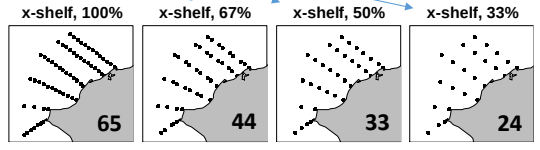
Simulating sampling under reduced designs…

**1. Select index** e.g. Species richness/diversity, abundance/biomass of selected taxa

**2. Select design**




**3. Select sampling density**

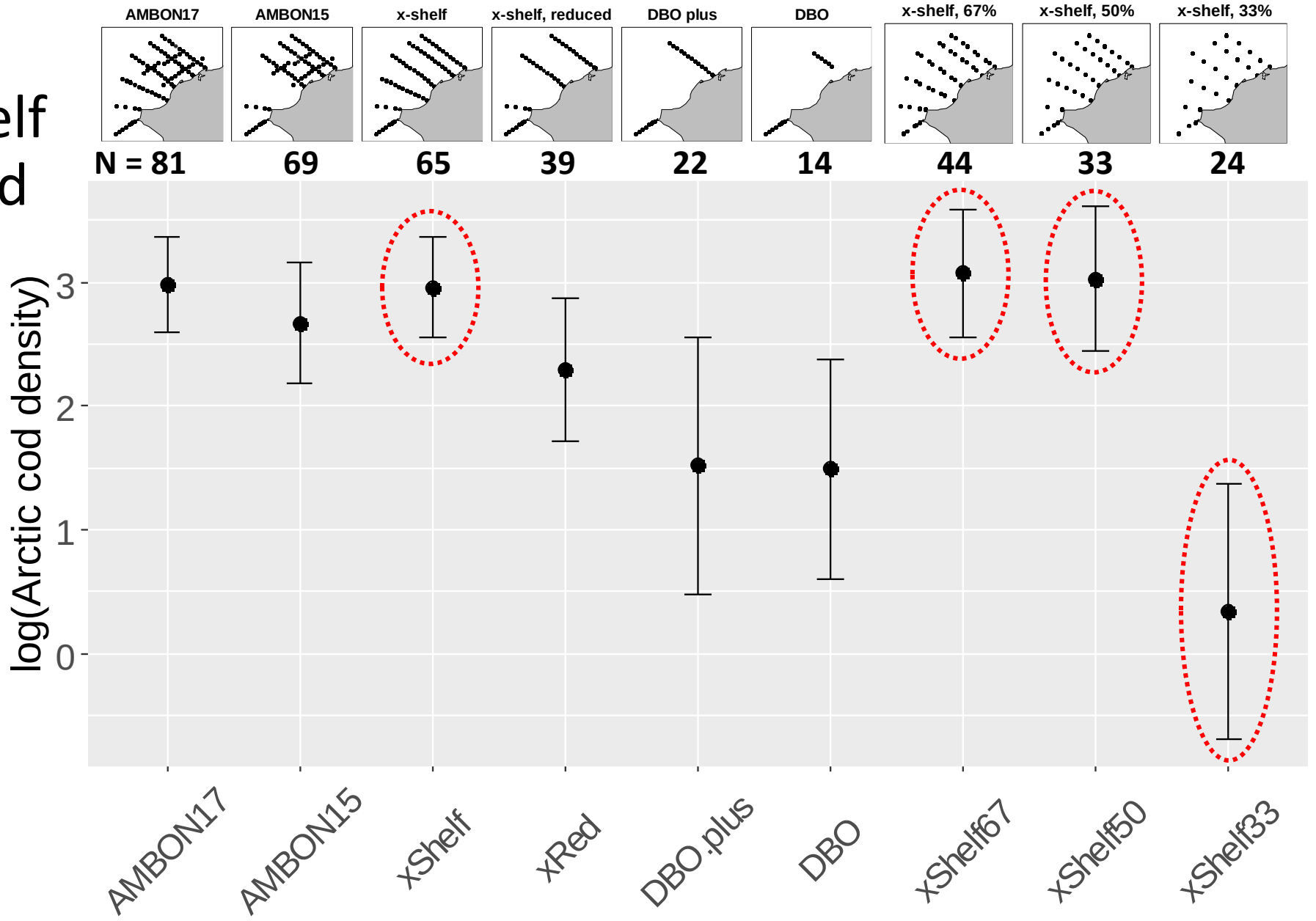


# Evaluating alternative sampling designs

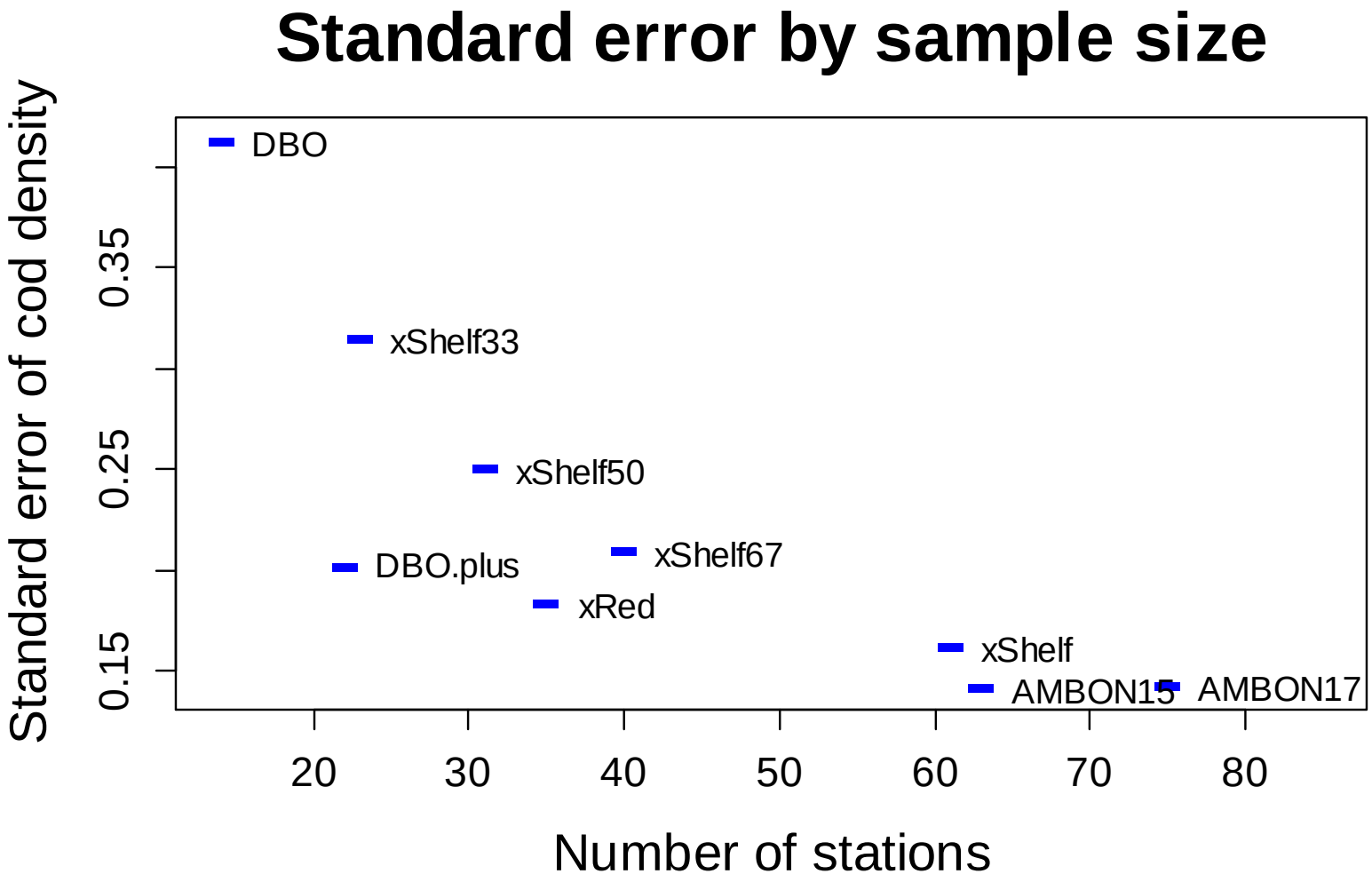
1. **Select index** e.g. Species richness/diversity, abundance/biomass of selected taxa
2. **Select design**
3. **Select sampling density**
4. **Compute indices & evaluate performance**

## Preliminary results:

- Dropping along-shelf transects associated with least ‘cost’
- Further reducing station spacing by 50% may be acceptable for some goals
- Any design with < 30 stations generally had poor performance



- Standard errors can be low for the reduced x-shelf design that dropped up to 50% of stations
- 'DBO+' performed well for some measures



**Are there certain methodologies that should be expanded, or some that were less effective?**

## Methodologies to expand:

Expand year-round seasonal sampling (mooring collections):

- eDNA, passive & active acoustic, phytoplankton & zooplankton
- Spring & winter samples (e.g. under-ice sampling)
- Continue linking to larger-scale sampling for spatial variability, connectivity and shifting distributions

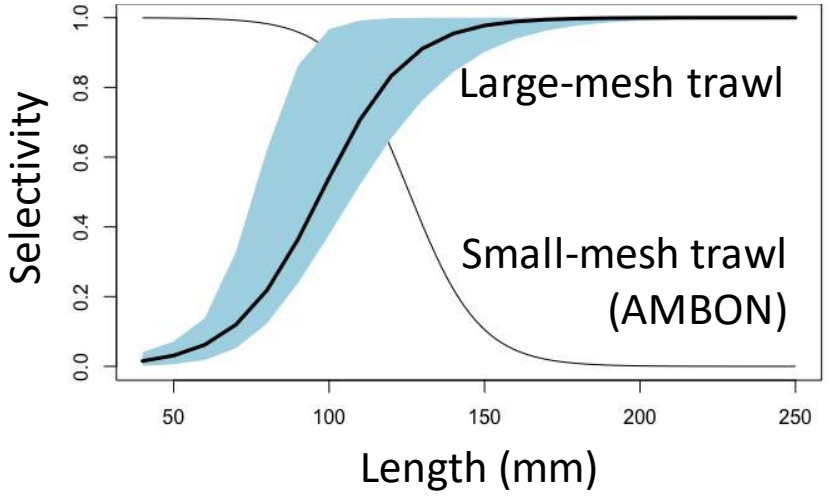
## New methodologies to include:

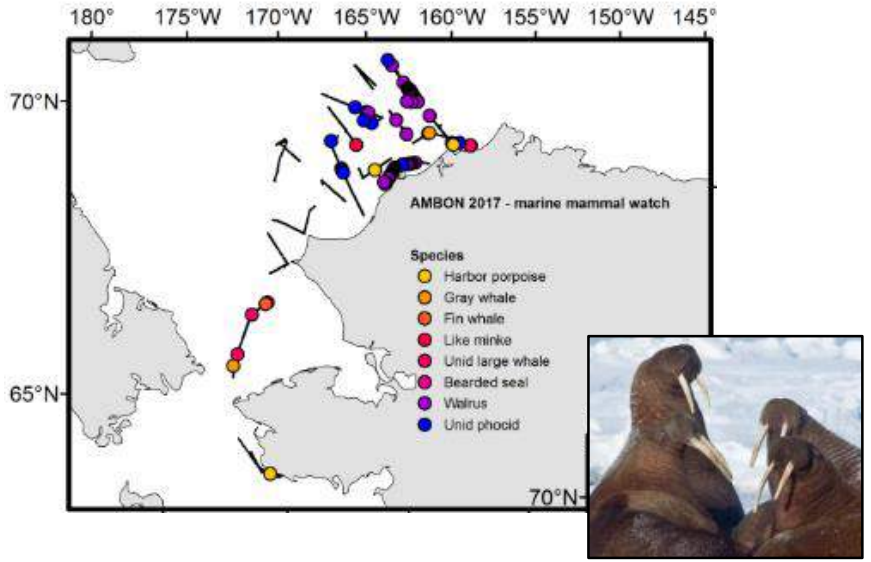
- Functional diversity analysis (started for AMBON epibenthos)
- eDNA fungal diversity and biomass component (added 2017, w/ UiT, Norway)
- eDNA: molecular markers for metazoans
- Gelatinous zooplankton (started for AMBON in 2017)

**Are there certain methodologies that should be expanded, or some that were less effective?**

## Less effective methodologies:

- Gear selectivity of small mesh trawl may limit sampling of large fishes and invertebrates
- Species identifications for some assemblages (zooplankton, infauna) very time consuming
- Mammal observations without dedicated mammal observer limit detectability and species identifications



## What aspects of the project are we likely to continue going forward?

- Continued sampling of <u>all</u> ecosystem components important for integrated view
- Maximize sampling through collaborations with other projects
- Reduce spatial coverage or limit frequency for some components (based on simulations)

## Communication / training

- 9 publications to date, 30 oral presentations, 17 posters
- Training for 10 graduate students (field, lab, analytical)
- Training for one post-doc

## Products actively in use

- MBON Data Portal: 16 published datasets
- NCEI archive: 6 datasets (10 pending)
- North Pacific Pelagic Seabird Database
- Identification guide (Arctic benthos)
- Shiny App (microbial discovery)

## Engagement

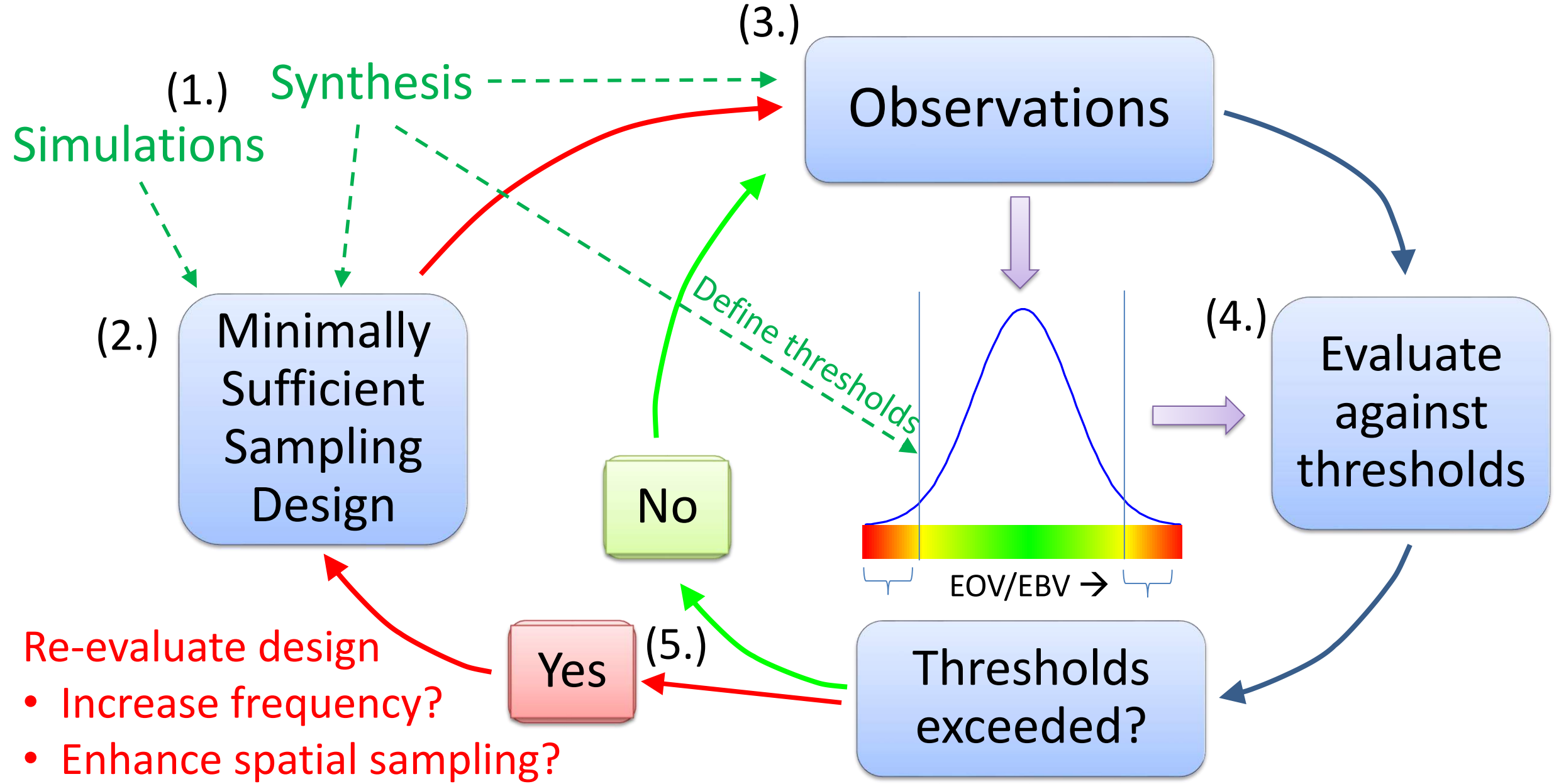
- Local stakeholders (Bering Strait)
- BOEM, NOAA, NPFMC
- Interagency Arctic Research Policy Committee (IARPC)
- Arctic Council (CAFF/CBMP, PAME)
- ICES/PICES (WGICA, Chukchi IEA)

**Key recommendations to the community & federal agencies about how to construct and maintain a long-term MBON in U. S. waters to meet both scientific and natural resource managerial needs**

- Develop a "minimally sufficient" sampling design, <u>through collaborations with and by building on existing programs</u>
  - Sampling should encompass major Chukchi Sea mater masses
  - If based on DBO lines, expand DBO line both inshore and offshore
  - Using a (slightly) reduced number of cross-shelf transects with current or reduced AMBON station spacing is most effective for multiple objectives
- Include and <u>expand use of eDNA</u> in any MBON design
- Continue / expand year-round sampling of biodiversity components at CEO moorings (eDNA, passive & active acoustics, particle fluxes)

**Key recommendations to the community & federal agencies about how to construct and maintain a long-term MBON in U. S. waters to meet both scientific and natural resource managerial needs**

- For seabirds, integrate offshore surveys with colony-based monitoring (currently minimal)
- Develop a step-wise approach to monitoring for biodiversity under challenging Arctic conditions (*adapted from Grebmeier et al., in prep*):
  1. Synthesis of historical observations to re-assess needs & priorities
  2. Develop thresholds & criteria that trigger enhanced sampling or modifications to existing sampling designs
     - Increased frequency
     - Adaptation of spatial sampling design (for example, if shifts occur)
  3. Develop new thresholds and repeat!


(3.)
Observations
(1.)
Synthesis
Simulations
(2.)
Minimally Sufficient Sampling Design
Define thresholds
No
(4.)
Evaluate against thresholds
EOV/EBV →
Thresholds exceeded?
(5.)
Yes
Re-evaluate design
• Increase frequency?
• Enhance spatial sampling?

Thank you!