Initiating an Arctic Marine Biodiversity Observing Network (AMBON)

Reporting Timeframe: October 1, 2016 to September 30, 2017

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Period of Performance: October 1, 2016 to September 30, 2017
Project Website: http://ambon-us.org

LONG-TERM GOALS

The goal of the Arctic Marine Biodiversity Observing Network (AMBON) project is to demonstrate and build an operational marine biodiversity observation network (MBON) for the US Chukchi Sea continental shelf as a prototype network for the nation. The importance of the Arctic Ocean to global climate and ecosystem processes, and the speed at which climate changes are already occurring in the Arctic, elevate the urgency for coordinated observations of Arctic marine biodiversity. In an end-to-end approach, from microbes to whales, AMBON science experts work with the Alaska Ocean Observing System (AOOS) to coordinate data streams from past and ongoing programs into one observation network for the US Arctic. Important collaborative links connect AMBON to other BON efforts in the nation and on the global scale. Effective data management, integration and dissemination will provide critical information on the status of Arctic ecosystem health and resilience to decision makers and local, regional and global communities.

OBJECTIVES

The objectives of this project are:

1. Apply end-to-end approach in biodiversity observations: microbes, phytoplankton, zooplankton, infauna, epifauna, fish, marine mammals and birds
2. Incorporate environmental data collections (chlorophyll, nutrients, water mass indicators, sediment characteristics)
3. Continue existing time series and close current gaps in taxonomy
4. Integrate and synthesize with past and ongoing research programs in the Chukchi Sea
5. Demonstrate practical metrics for a sustainable observing network for the Arctic and other regions

APPROACH

1. *Proposed scientific and/or technical approach, including data quality requirements*

The AMBON project combines new and ongoing field sampling in the Chukchi Sea, with research cruises in 2015 and 2017. All samples are worked up and data quality-assessed following standard protocols. Data are stored in the Alaska Ocean Observing System (AOOS) workspace to be shared among investigators. Once data processing and QA/QC is completed, data with appropriate metadata are published through the AOOS Data Portal. Through data management in the AOOS database, AMBON also links to other (historical and ongoing) data steams on biodiversity in the Chukchi Sea. AMBON also links through AOOS to other national MBONs. Through the PIs of the project, we ensure that AMBON is also linked with international biodiversity efforts (e.g., Distributed Biological Observatory [DBO], Circumpolar Biodiversity Monitoring Program [CBMP], Ecosystem Studies of Subarctic and Arctic Seas [ESSAS], Group on Earth Observations Biodiversity Observation Network [GeoBON], etc).

2. *The key individuals participating in this work and their roles*

Katrin Iken: Overall project management, epifaunal community
Seth Danielson: Hydrography (CTD measurements, liaison to Chukchi Ecosystem Observatory long-term mooring)
Lee Cooper: Water column and sediment characteristic (chlorophyll a, nutrients, sediment grain size, total organic content, $\delta^{13}C$ and $\delta^{15}N$ values of sediment organic matter), liaison to DBO program
Eric Collins: Microbes (water column, sediment), meiofauna genetic analyses

Russ Hopcroft: macro/meso-zooplankton community
Jacqueline Grebmeier: macrofauna community, phytoplankton species composition, liaison to DBO program
Franz Mueter: fish community
Kathy Kuletz: seabird observations
Kate Stafford: marine mammal observations
Sue Moore: marine mammal observation coordination with other ongoing Arctic programs (e.g., DBO)
Bodil Bluhm: epifauna community, international (European Arctic) liaison (e.g., CBMP)
Rob Bochenek, Stacey Buckelew: Data management and coordination

WORK COMPLETED

Much time during the reporting period was spent continuing to analyze the 2015 data, using 2015 data to add to long-term time series, describe spatial patterns in ecosystem assemblages, assessing spatial and temporal components of biodiversity observing designs, and integrating AMBON data into an international, pan-arctic analysis of the knowledge of biodiversity across ecosystem components. We also spent considerable time preparing and conducting the 2017 summer cruise. Data management has progressed in much of the 2015 data being quality controlled and with metadata appropriate for national data archives.

RESULTS

Here we provide some significant highlights of the results of the work we have completed during the past year.

Highlight 1: Diversity patterns across ecosystem components

We used some of the 2015 data to compare spatial across ecosystem components and in relation to some environmental variables. Here we show patterns in environmental variables bottom temperature, bottom salinity, and grain size, and of the biological ecosystem components bacterial richness, and zooplankton and benthic epifaunal invertebrate community structures (Figure 1). While groupings of high/low richness or community clusters differ among these components, there also were some commonalities. For example, we found distinct richness or community patterns across all ecosystem components along the first part of the ML6 line (Figure 1, red boxes): the nearshore, southern end of the northern study region. In this region we also found distinctly warmer bottom temperatures, less salty conditions in bottom waters, and a low fraction of grain size ≥5 phi (meaning a lack of silt/clay fraction). We also observed high bacterial richness, as well as distinct community clusters for zooplankton and epibenthic invertebrates. A similar example is the distinct inshore-offshore pattern in environmental variables along the DBO3 line in the southern Chukchi Sea (blue boxes in Figure 1). Distinctly warmer and fresher water occurred inshore and the fraction of clay/silt increased offshore. Distinct responses were seen in bacterial richness (higher richness inshore) and in epibenthic community structure, although no structure was reflected in the zooplankton community. From more detailed analyses we know that bacteria and zooplankton respond more to the hydrographic drivers of temperature and salinity while epibenthic invertebrates respond more to sediment characteristics. However, the fact that we can identify regions in the Chukchi Sea where a suite of environmental variables come together to cause distinct patterns across disparate biological response variables is interesting and acts as an example in how we can use AMBON data to inform about important regions within the study area that should be included in long-term observations. As a next step, we will need to

compare these results with data obtained in 2017 to assess how persistent such patterns are for both the environmental and biological components.

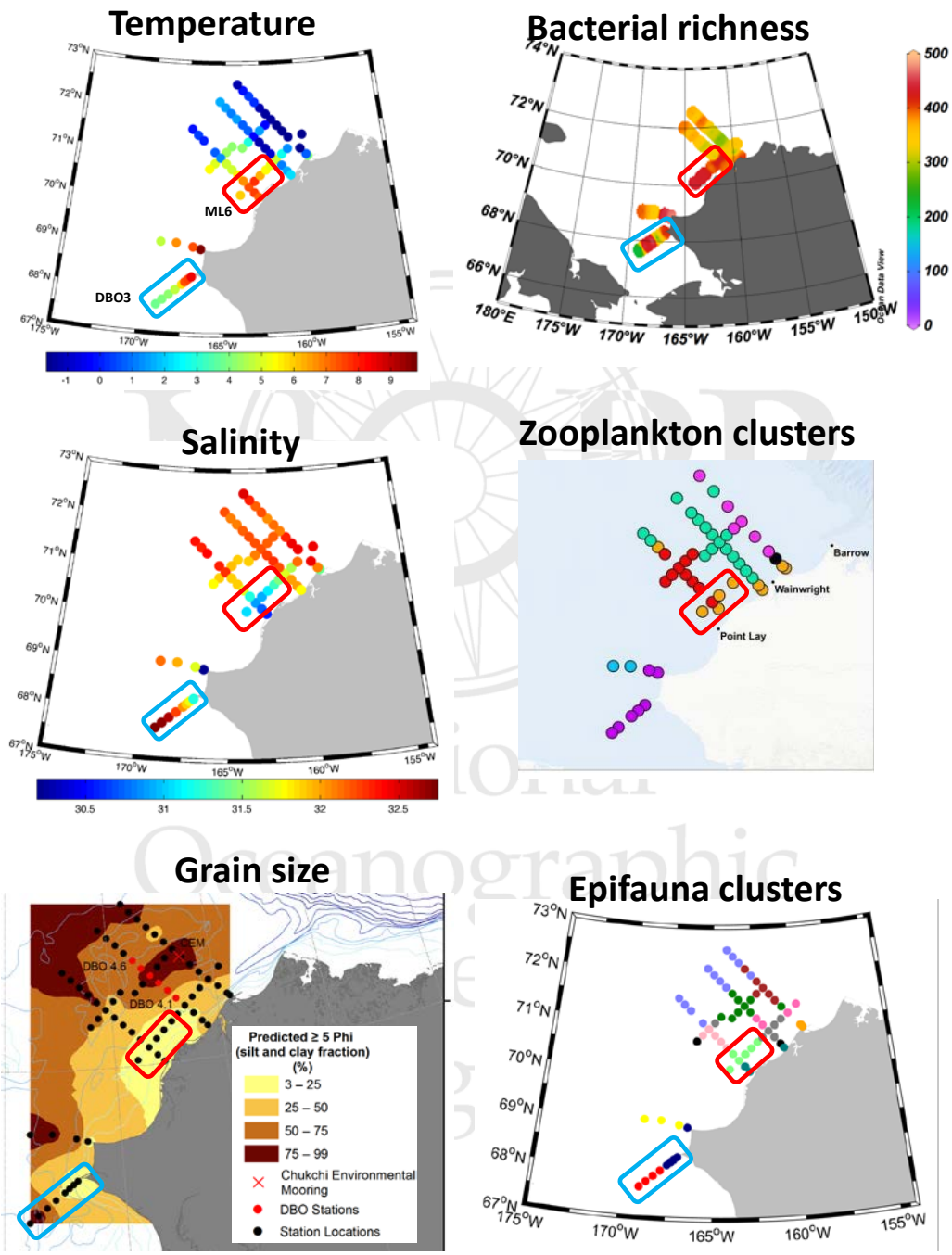

Figure 1: Spatial patterns of bottom temperature, bottom salinity, grain size ≥5 phi, bacterial richness (measured as 16S rRNA sequencing), zooplankton community structure, and epibenthic invertebrate assemblage structure (latter two based on hierarchical clustering). Colored squared indicate regions of comparison. Temperature plot includes transect names referred to in the text.

Highlight 2: Observational design for epibenthos and fish assemblages in the Chukchi Sea

The high logistical efforts and costs associated with arctic work demand the prudent use of existing resources for the most comprehensive information gain. We, therefore, compared the information that can be gained for epibenthic invertebrate and for demersal fish assemblages from two existing long-term observational programs in the Chukchi Sea: the DBO3 and DBO4 transects of the Distributed Biological Observatory (DBO) and the larger, regional-scale Arctic Marine Biodiversity Observing Network (AMBON).

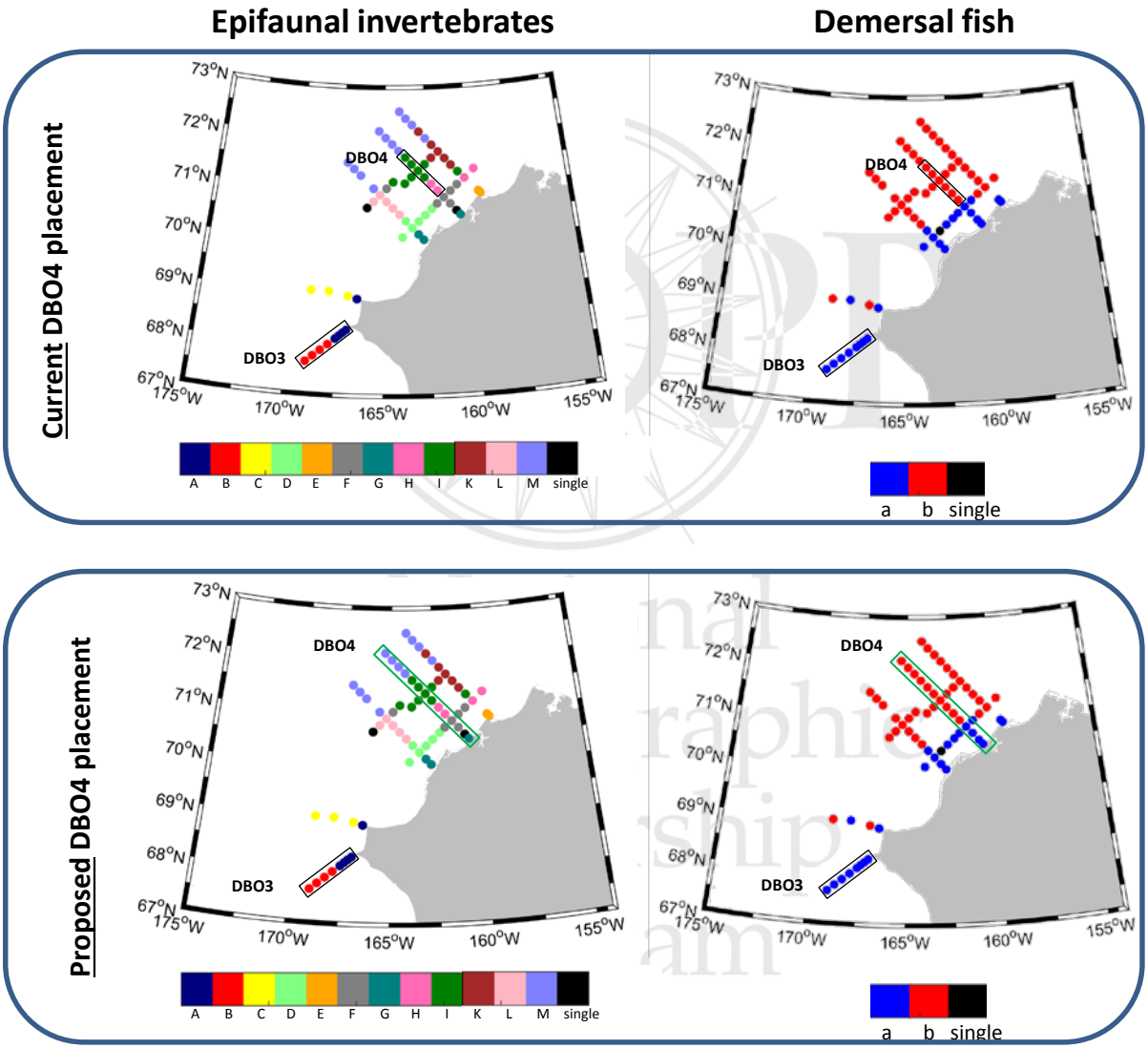

Figure 2: Spatial distribution of epifaunal assemblage clusters (A-M) and demersal fish assemblage clusters (a, b). "Single" refers to stations that did not group with any cluster. Clusters are based on a hierarchical cluster analysis of epifaunal and fish assemblages, respectively, based on fourth-root transformed biomass data and a Bray-Curtis similarity matrix. Current DBO lines are encircled in black in upper panels and proposed extension of the DBO4 line for epifauna and fish monitoring is delineated in green in the lower panels. Cluster colors and letters have no relation between epifauna and fish assemblages.

The two DBO lines captured about 57% of the epibenthic species richness that was observed through the larger-scale AMBON project, with a higher percentage in the more southern DBO3 than the northern DBO4 line. For demersal fishes, both DBO lines combined captured 88 % of the richness from the larger AMBON spatial coverage. The epifaunal assemblage clustered along the south-north and the inshore-offshore axes of the overall study region (Figure 2). Of these, the southern DBO3 line well represented the regional (southern) epifaunal assemblage structure, while the northern DBO4 line only captured a small number of the distinct assemblage clusters. The demersal fish assemblage displayed little spatial structure with only one coastal and one offshore cluster. Again, this structure was well represented by the DBO3 line but less by the DBO4 line. We proposed that extending the northern Chukchi Sea DBO4 line more inshore and offshore would result in better representation of the overall northern Chukchi epifaunal and fish assemblages. In addition, sampling at least the epifaunal assemblage every few years from a larger region such as covered by the AMBON project would create the larger-scale context that is important in spatial planning of long-term observing. The multi-annual stability of epifaunal and, to a lesser extent also fish assemblages, suggests that these components may not need to be sampled on an annual basis and sampling every 2-3 years could still provide sufficient understanding of long-term changes. We have submitted a manuscript detailing these analyses and recommendations to the peer-reviewed journal Deep-Sea Research II.

AMBON and DBO share the same data management platform with AOOS and several personnel links exist (Grebmeier and Moore are co-leads of the DBO). AMBON PIs participated in the recent DBO Data Workshop to ensure smooth interoperability between the two programs. A meeting is planned during the Ocean Sciences Meting in Portland OR in February 2018, to discuss DBO transect placement and biodiversity sampling. An additional sign of the significant collaboration between the two programs was the National Science Foundation's (NSF) contribution of significant funds to the recent AMBON 2017 cruise to ensure coverage of the two DBO lines during the cruise.

Highlight 3: Integration of AMBON data into the State of the Arctic Marine Biodiversity Report (SAMBR)

As part of the AMBON network, several of the PIs are actively involved in the Circumpolar Biodiversity Monitoring Program (CBMP, Arctic Council – Iken, Hopcroft, Collins, Kuletz are CBMP representatives). The CBMP working group has recently produced a new State of the Arctic Marine Biodiversity Report (SAMBR, https://www.caff.is/marine/marine-monitoring-publications/state-of-the-arctic-marine-biodiversity-report) and AMBON data from the 2015 cruise significantly contributed to the knowledge basis for the Chukchi Sea. Specifically, AMBON data contributed to discern pan-arctic patterns in epifaunal invertebrate richness and taxa contributing to richness. The Chukchi Sea epifauna richness is in the mid-range on a pan-arctic level; among the larger taxa contributing to diversity, the Chukchi Sea diversity harbors a relatively larger proportion of bryozoans and comparatively fewer polychaetes, a pattern similar to those along the Siberian coast (Figure 3).

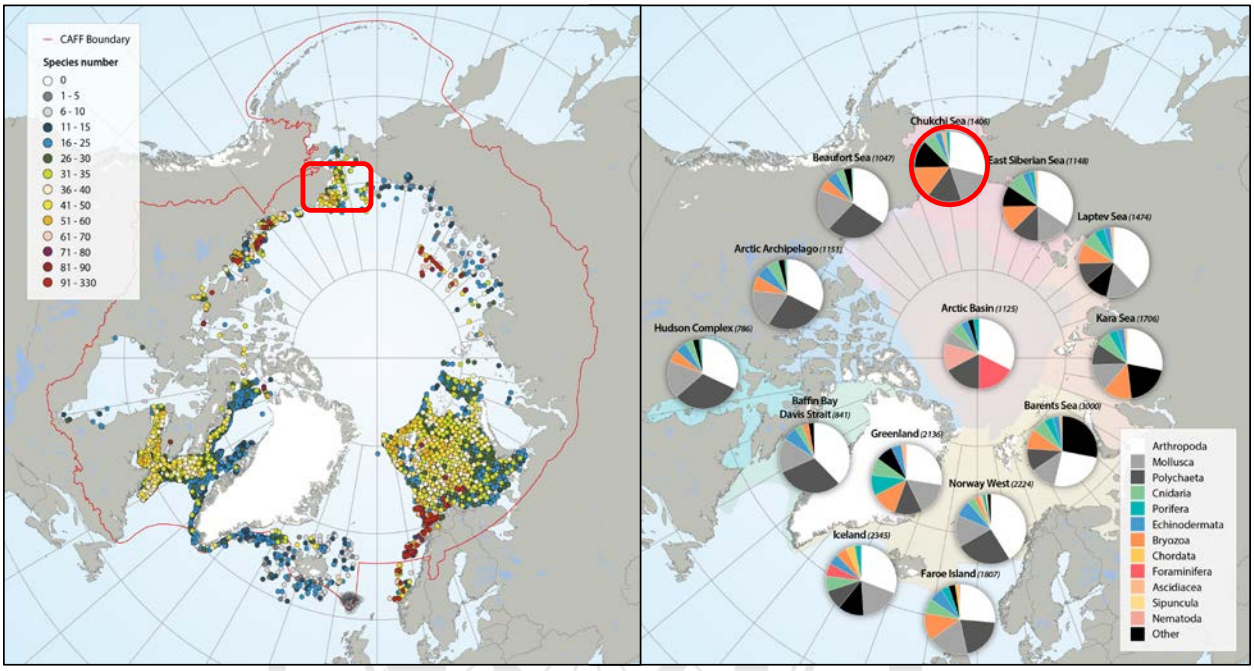

Figure 3: Epifaunal species richness and taxa contributing most to epibenthic diversity in a pan-arctic context. A significant amount of data for the Chukchi Sea was provided by the AMBON 2015 results (red circles).

AMBON seabird data also contributed to the assessment of seabird species population trends. These population trends can only be evaluated if data are being produced on a continuous basis, to which AMBON contributes. This helped to derive at specific population numbers of various seabird species in the Chukchi Sea and an assessment if populations were decreasing, increasing, or unknown (Figure 4).

CBMP Arctic Marine Area	CSMP region	Country	Ivory gull		Glaucous gull		Black-legged kittiwake		Thick-billed murre	
			Total pop.	Trend	Total pop.	Trend	Total pop.	Trend	Total pop.	Trend
Pacific Arctic	5	Russia	-	-	U	S	U	U	U	U
	5	USA	-	-	843	-	57,047	I	125,880	I

CBMP Arctic Marine Area	CSMP region	Country	Common murre		Common eider		Least auklet		Little auk	
			Total pop.	Trend	Total pop.	Trend	Total pop.	Trend	Total pop.	Trend
Pacific Arctic	5	Russia	U	U	U	U	U	U	-	-
	5	USA	147,722	I	173	U	972,500	U	R	-

Figure 4: Population trends through 2015 for priority species. Trend categories are increasing (I; green), stable (S; blue), decreasing (D; yellow) or unknown (U) or rare (R; breeding status unknown); a dash indicates the species does not occur in that region.

Highlight 4: AMBON 2017 field work

With the additional funds contributed by BOEM, NOAA and also the National Science Foundation (NSF) to the AMBON program, we were able to successfully conduct a field season this summer. The 2017 cruise took place 4 August – 25 August on the Norseman II, from Nome to Nome. The survey lines were the same as conducted in 2015, although we were able to add an additional line (BBL) in 2017 because of favorable weather conditions (Figure 5). This additional line bridges the gap between the CL and ML1 lines.

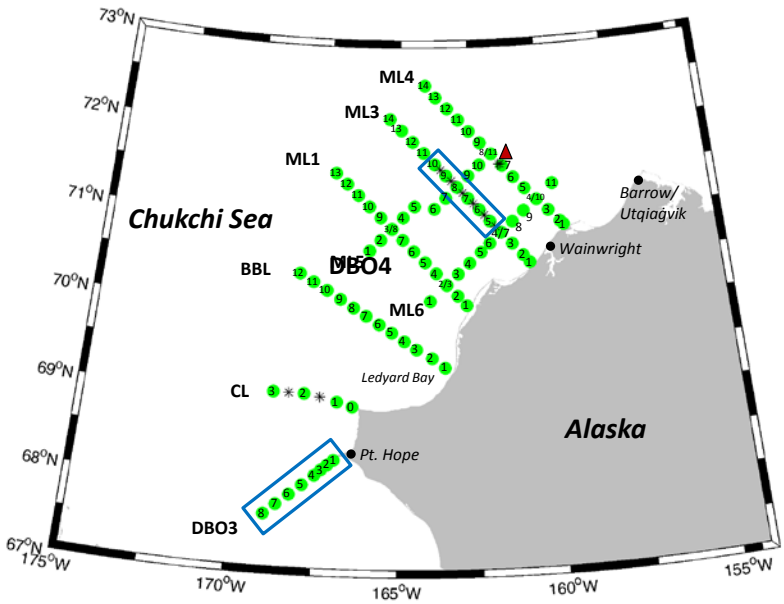

Figure 5: Station map of the AMBON 2017 cruise. Stars represent CTD stations only, red triangle marks the location of the CEO moorings, and the blue boxes indicate location of the DBO3 and DBO4 lines.

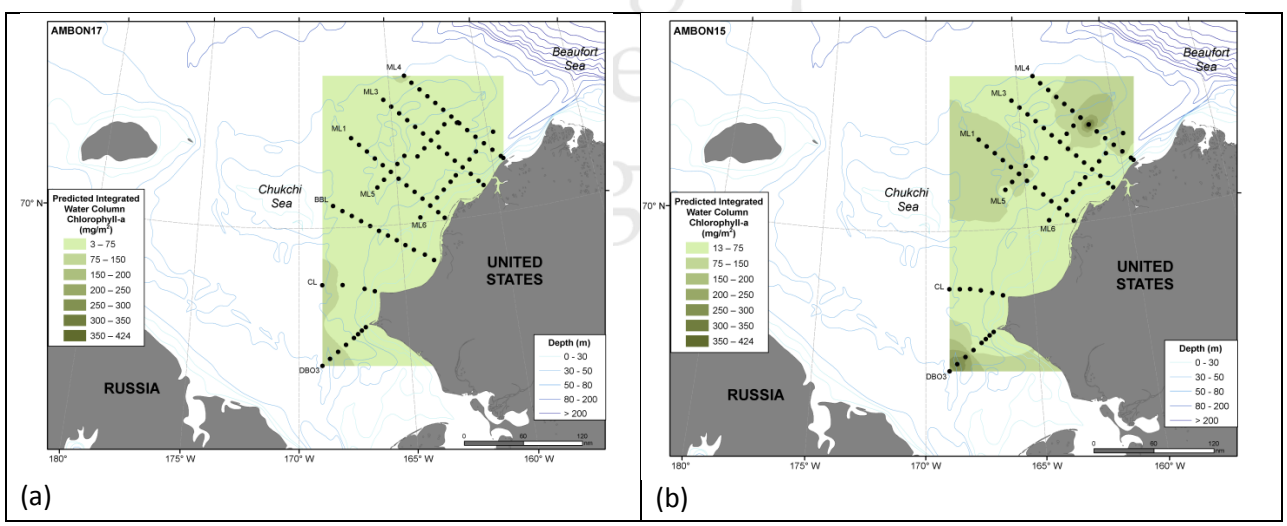

*Figure 6: **a.** Integrated chlorophyll a (mg/m2) in 2017 and **b.** integrated chlorophyll a (mg/m2) in 2015.*

We sampled all ecosystem components as in 2015, from microbes to whales. Here we only provide a few preliminary highlights, as most samples still need to be processed and analyzed. One of the first results shows that the overall water column chl *a* values were lower in 2017 (Figure 6a) than in 2015 (Figure 6b). This finding suggests that the bloom occurred earlier in 2017, before the timing of our cruise.

Zooplankton samples were taken at all stations. As an addition/expansion to the 2015 sampling, we focused specifically on the gelatinous zooplankton, which was very abundant this year, especially ctenophores (e.g., *Mertensia ovum* and *Beroe cucumis*) and some hydromedusae (e.g., *Aglantha digitale* and *Melicertum octocostatum*). Fresh catches were observed on a light table and all jellyfish and ctenophores identified and measured. A total of 21 species were collected, with hydromedusae being the most diverse with 14 species, followed by four species of ctenophores, and three species of scyphomedusae. Gelatinous zooplankton had specific assemblage patterns structured from south to north (Figure 7), following general distribution patterns of major water masses, as characterized by water temperature patterns. Gelatinous zooplankton is considered to become more abundant and ecologically more important in warming conditions, so adding this focus on gelatinous zooplankton sets an important benchmark for future comparisons.

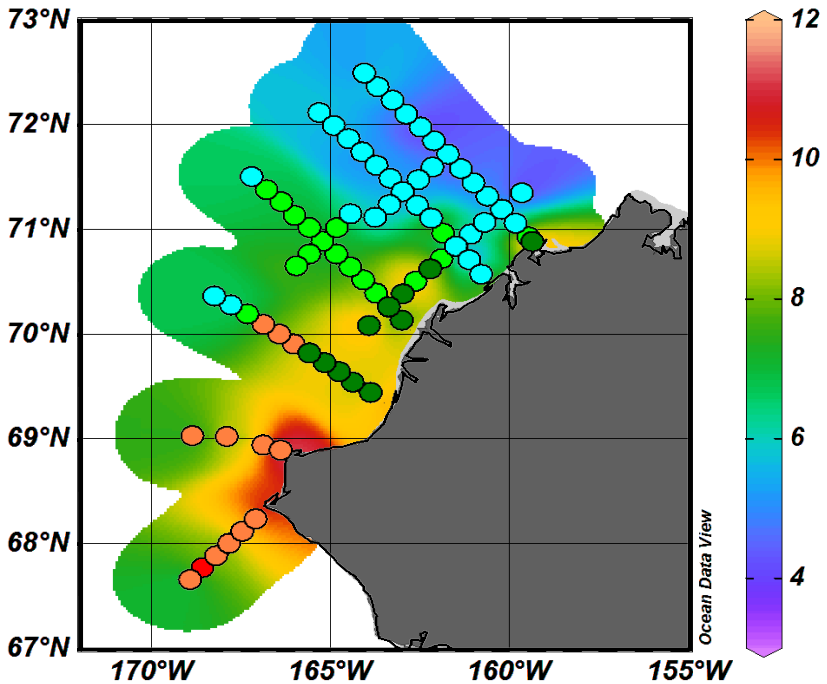

Figure 7: Spatial distribution of gelatinous zooplankton assemblages. Station groups based on Bray-Curtis similarly and weighted-pair hierarchical clustering.

The opportunity to add a transect line between the southern and northern study region (BBL) gave us an opportunity to investigate the distribution of eiders in the study area. The new BBL line originated in Ledyard Bay and extended offshore. The ship continued to follow the operational suggestions recommended to them by U.S. Fish and Wildlife Service for working in the Ledyard Bay Critical Habitat Unit (LBCHU). Flocks of eiders were observed in nearshore waters extending from Wainwright to Point Hope (Figure 8). A few small groups of spectacled eiders were recorded near Icy Cape and a single bird was also seen off Point Hope.

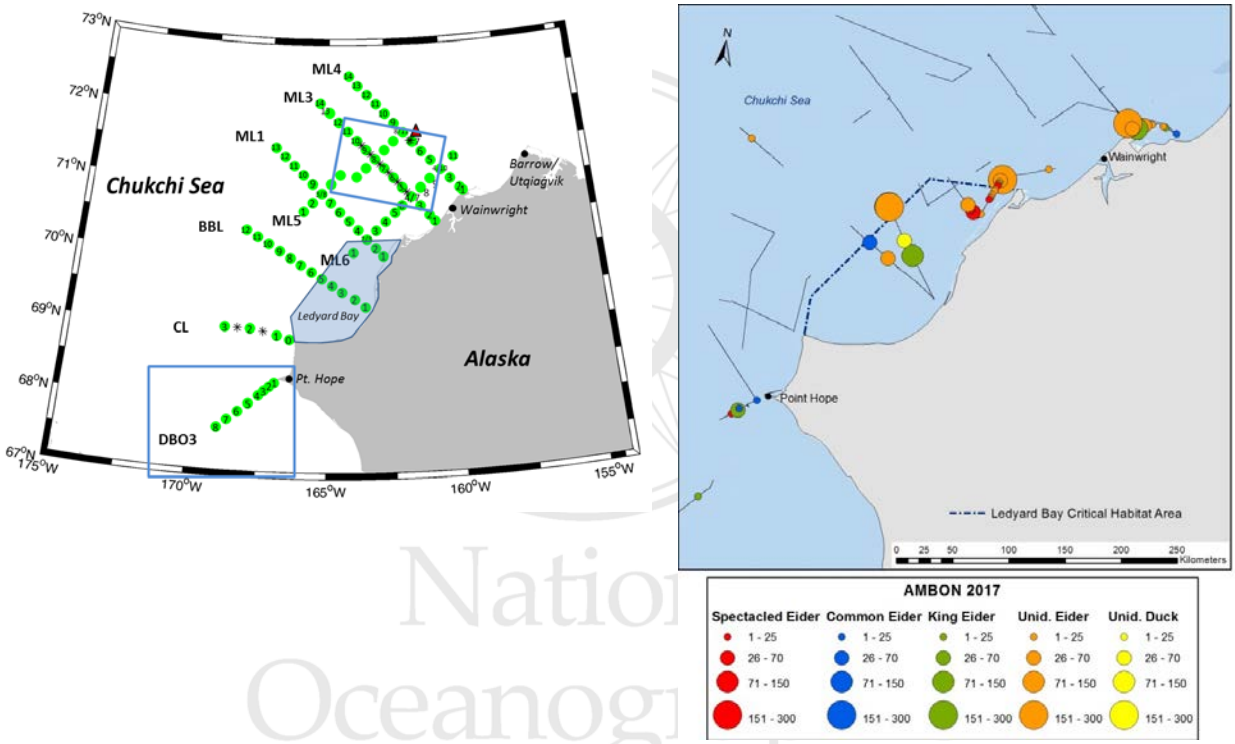

Figure 8: Location of the new BBL line through the Ledyard Bay Critical Habitat Unit. Largest accumulations of eiders were seen just outside the LBCHU.

DELIVERABLES/DATA TRANSMISSIONS

1. **National Security**
   All AMBON data are (and newly produced data will be) publicly available and can be used to address National Security concerns, such as safe resource development, shipping routes

2. **Economic Development (e.g., new product lines, businesses, practices, increased efficiency, new manufacturing techniques)**
   AMBON data cutting across all ecosystem components are available for resources managers and users to develop ecosystem-based management strategies. This can apply to the sustainable use of fisheries and or sustainable extraction of oil and gas resources in the region. The data aid in designing long-term ecosystem observing to support these developments. For example, we have analyzed the regional-scale diversity and assemblage structure data for epibenthic invertebrates and demersal fishes for optimizing the design of long-term observing. We have submitted a manuscript on this analysis to the peer-reviewed journal Deep-Sea Research II:

   Iken K, Mueter F, Grebmeier JM, Cooper LW, Danielson S, Bluhm BA. Does one size fit all? Observational design for epibenthos and fish assemblages in the Chukchi Sea. Submitted to Deep-Sea Research II

3. **Quality of Life (e.g., public health, ecosystem health, coastal resource management)**
   Having the means to develop ecosystem-based and sustainable management strategies is important for public health and well-being. Understanding the effects that currently ongoing and accelerating changes have on the Arctic ecosystem is important information for the global management and mitigation of global climate change.

4. **Science Education and Communication**
   AMBON is actively engaged in science education through the involvement and training of graduate students as the next generation of scientists. Results from the AMBON project are disseminated through presentations at scientific conferences, through peer-reviewed publications, as publicly accessible data from the AOOS Data Portal, and also public presentations. For example, we presented the AMBON work and goals to the local and Native community in Nome (Bering Strait Science Series, August 2017). Scientific presentations during the reporting period were the following:

   Kuletz K, Osnas E, Labunski E, Cushing E. The Distributed Biological Observatory: A means of measuring change in the Arctic seabird community. Pacific Seabird Group, Tacoma, WA, February 2017. Poster.

   Labunski L and Kuletz K. Long-term Seabird Data for a Changing Arctic. Pacific Seabird Group Annual Meeting, Tacoma, WA, February 2017. Oral Presentation.

   Kuletz K. Seabirds of the Pacific Arctic & circumpolar regions. ICES/PAME Central Arctic Working Group, 19-21 April, 2017, Seattle WA. Presentation at workshop; included AMBON program and examples of data collected, preliminary results.

Smoot CA, Hopcroft RR. Zooplankton communities of the Chukchi Sea during August 2015: results from the Arctic Marine Biodiversity Observing Network. Poster presentation at the Alaska Marine Science Symposium. Anchorage AK 23-27 January 2017.

Iken K, Grebmeier J, Cooper L, Danielson S. Small and large-scale variability in Chukchi Sea epibenthos – recommendation for monitoring design. Poster presentation at the Alaska Marine Science Symposium. Anchorage AK 23-27 January 2017.

Smoot CA, Hopcroft RR. Gateway to the Arctic: Summer zooplankton communities of the Chukchi Sea 2008-2015. Aquatic Sciences Meeting, Honolulu HI 26 February-3 March 2017.

The following presentations have been accepted:

Kuletz K, Cushing D, Osnas E, Labunski E, Gall A, Morgan T. Seabirds as Indicators for the Distributed Biological Observatory and Other Long-term Marine Monitoring Programs . Oral presentation at Alaska Marine Science Symposium, January 2018, Anchorage AK

Mendoza-Islas H, Hopcroft RR. Hydromedusae and ctenophores of the northeastern Chukchi Sea during 2017. Poster presentation at Alaska Marine Science Symposium, January 2018, Anchorage AK

Iken K, Mueter F, Danielson S, Cooper LW, Grebmeier JM, Bluhm BA. Epibenthos and Demersal Fish Community Structure in the Chukchi Sea in Relation to Environmental Variables. Poster presentation at Arctic Frontiers, January 2018, Tromso Norway

Kuletz K, Cushing D, Osnas E, Labunski E, Gall A, Morgan T. What the Distributed Biological Observatory Can Tell Us About Seabirds, and Vice Versa. Oral presentation at Ocean Sciences Meeting, February 2018, Portland OR

Mendoza-Islas H, Hopcroft RR. Hydromedusae and ctenophores of the northeastern Chukchi Sea during 2017. Poster presentation at Ocean Sciences Meeting, February 2018, Portland OR

Iken K, Mueter F, Danielson S, Cooper LW, Grebmeier JM, Bluhm BA. Epibenthos and Demersal Fish Community Structure in the Chukchi Sea in Relation to Environmental Variables. Poster presentation at Ocean Sciences Meeting, February 2018, Portland OR

Hopcroft RR, Questel JM, Smoot CA, Clarke-Hopcroft C. Inter-annual Variability of the Zooplankton Communities in the Northeastern Chukchi Sea: a Decadal Perspective. Poster presentation at Ocean Sciences Meeting, February 2018, Portland OR

IMPACTS AND APPLICATIONS

1. National Security

AMBON data provide the knowledge basis for the development of observing strategies. AMBON also links closely in content, goals, location and logistics with the Chukchi Ecosystem Observatory (CEO), a moored multi-sensor array in the north-eastern Chukchi Sea. The AMBON cruises served as a platform to turn-around the mooring array in 2015 and 2017. Data gathered through the AMBON project and the CEO mooring promote National Security and Homeland Defense. For example, the CEO provides data on sea ice, waves, and water column stratification that can be used to improve ice forecast models that impact navigation and impacts of potential

ship traffic. AMBON ecological data promote long-term observing to inform sustainable use of the Arctic marine system.

2. **Economic Development (e.g., new product lines, businesses, practices, increased efficiency, new manufacturing techniques)**
One of the economic developments in the study region is related to potential fisheries. While currently the sustainable harvest limits through the Arctic Fisheries Management Plan are set at zero, AMBON data provide regional-scale data on fin fish and shellfish resources that can inform the management plan. The high quality data can also be used for impact assessment of potential oil and gas extraction activities. Given the sensitivity of the Arctic ecosystem, careful and knowledge-based ecosystem monitoring is necessary. AMBON facilitates the development of sustainable economic practices.

3. **Quality of Life (e.g., public health, ecosystem health, coastal resource management)**
The Arctic Chukchi Sea ecosystem is essential for Native Alaska communities for the subsistence use of marine resources for food and cultural activities. Regionally, the Arctic is an essential part of the rich array of Alaska's marine heritage and resources. Globally, the Arctic connects through atmospheric and oceanographic links to the global climate and is, thus, of global importance. In addition, the Arctic holds great esthetic, emotional and natural value for all people. Biodiversity observations can help maintain ocean health that is a crucial part of maintaining quality of life and local subsistence economies. AMBON data assist with developing appropriate ecosystem-based management strategies for the United States. Observing the existing and changing conditions in the Chukchi Sea on both the physical as well as biological level contributes to a "global early warning system".

4. **Science Education and Communication**
AMBON contributes to science education of graduate students who build the next generation of scientists to continue studying, managing, and caring for the vulnerable Arctic ecosystem. Training involves field techniques, data management, transfer of knowledge through scientific presentations and publications, and public outreach. We also communicate the goals, activities and results of the AMBON project to the public. Specifically, before our field work we presented our field plans to the Alaska Eskimo Whaling Commission (AEWC) and the Alaska Waterways Safety Commission (AWSC) during their December 2016 meeting in Anchorage, AK. We ensured that we respected the whaling times and distance to shore as much as possible. During the cruise, we sent daily updates to >80 individuals, many local community representatives, to inform stakeholders about our progress and findings. We responded to any concerns brought to us by local community members.
We used AMBON data to communicate Chukchi Sea regional patterns in biodiversity across various ecosystem levels in a pan-arctic compilation by the Circumpolar Biodiversity Marine Monitoring Program (CBMP), part of the CAFF Working Group of the Arctic Council.

CAFF. 2017. State of the Arctic Marine Biodiversity: Key Findings and Advice for Monitoring. Conservation of Arctic Flora and Fauna International Secretariat, Akureyri, Iceland. ISBN: 978-9935-431-62-2. https://www.arcticbiodiversity.is/marine (contributing AMBON authors: Eric Collins, Russ Hopcroft, Kathy Kuletz, Katrin Iken)

RELATED PROJECTS

The AMBON group is tightly linked with many other Arctic projects. One particularly good example is the Distributed Biodiversity Observatory (DBO), to which the AMBON project is linked through sampling (two of the AMBON transects are also DBO lines) and contributing data on some ecosystem elements not typically sampled on the DBO lines (e.g., epibenthos, fish, microbes). A sign of the significant collaboration between the two programs was the National Science Foundation's (NSF) contribution of significant funds to the recent AMBON 2017 cruise to ensure coverage of the two DBO lines during the cruise. AMBON is also specifically mentioned as a contributor to DBO sampling in the DBO 10-year implementation plan. AMBON and DBO share the same data management platform with AOOS and several personnel links exist (Grebmeier and Moore are co-leads of the DBO). AMBON PIs participated in the recent DBO Data Workshop to ensure smooth interoperability between the two programs. We also just submitted a manuscript comparing the observation approaches of the two programs and making recommendations for biodiversity sampling strategies along the DBO lines (see above). A meeting is planned during the Ocean Sciences Meting in Portland OR in February 2018, to discuss DBO transect placement and biodiversity sampling. We have submitted a manuscript on an analysis of spatial and temporal observing design considerations that builds on current AMBON and DBO coverages (see above).

Many of the AMBON PIs also are actively engaged in IARPC, the Interagency Arctic Research Policy Committee, which provides us with an excellent tool to update the IARPC members and learn about other initiatives. This is a valuable tool to make our research accessible to managers and decision makers, e.g., from BOEM and NOAA.

On the international level, AMBON is recognized in and contributes to several international Arctic programs, such as the Circumpolar Biodiversity Monitoring Program (CBMP, Arctic Council – Iken, Hopcroft, Collins, Kuletz are CBMP representatives), the Pacific Arctic Group (PAG; Korea, China, Canada, USA, Russia, Japan – Grebmeier representative), and the Ecosystem Studies of Subarctic Seas (regional program of Integrated Marine Biogeochemistry and Ecosystem Research – Mueter representative).

A new satellite-based Seascape project led by Dr. Maria Kavanaugh (OSU), with AMBON PI Grebmeier as co-PI and Iken as collaborator, has been funded by NASA's NSPIRES program. Satellite derived seascapes are also being conducted for the other US –MBONs and thus, create a unifying biogeographic framework for the US-MBON. Extending them to high latitude regions ties the AMBON into the US-MBON. So far, the remote sensing component of the AMBON had been limited. However, this new project ties AMBON even closer to other satellite-based efforts, such as within the DBO (by Drs. Comiso and Frey).

The AMBON group is engaged in collaborations with the other two funded US MBONs and the Tennenbaum MON, to develop lists of essential biodiversity variables and protocols and best practices for data management (DMAC) and eDNA analyses. We are part of the GEO BON Working Group 5.

PUBLICATIONS

We submitted the following manuscript for review to the peer-reviewed journal *Deep-Sea Research II*:

Iken K, Mueter F, Grebmeier JM, Cooper LW, Danielson S, Bluhm BA. Does one size fit all? Observational design for epibenthos and fish assemblages in the Chukchi Sea.

PATENTS

N/A

WORK PLAN

Our work plan during the coming year (October 1, 2017 to September 30, 2018) is multi-faceted:

1. Analyze samples and data obtained during the 2017 field effort
2. Continue preparing and managing data from the 2015 and 2017 field efforts for publication through the AOOS Data Base and DataONE, managed by Axiom Data Science and the AOOS Workspace
3. Continue to work on AMBON data analysis and network with other research programs to expand regional and temporal biodiversity data coverage. We expect to work on a number of manuscripts, for example on decadal zooplankton variability in the northeastern Chukchi Sea; extending previous seabird observations with AMBON data; biological traits of epifaunal invertebrates and demersal fishes of the Chukchi and Beaufort seas; microbial contribution to the sediment carbon pool in the AMBON study region;
4. Work with other observing systems (e.g., the DBO) and AOOS to discuss strategies; a meeting is planned during the 2018 Ocean Sciences Meeting in Portland OR to discuss the observing efforts along the DBO4 line and AMBON data will be essential to guide this discussion.
5. Continue to engage with Arctic international organizations to streamline various national efforts
6. Network with other US MBONs and the Tennenbaum MON to standardize ocean and ecosystem variables in national observing networks
7. Engage with the public and stakeholders to inform them about AMBON

OUTREACH MATERIALS

- AMBON website continued: http://ambon-us.org/
- AMBON is part of NOAA website http://oceanservice.noaa.gov/news/apr16/mbon.html
- AMBON presentation as part of the Bering Science Series in Nome, August 2017
- Radio story on AMBON in Nome at KNOM radio
- News story in Nome Nugget about the AMBON 2017 field effort