**AMBON**

**Arctic Marine Biodiversity Observing Network**

*Demonstration project for an observing network to monitor biodiversity in the Arctic from microbes to whales*

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**Marine Biodiversity Observation Network (MBON)**

**All-Hands Meeting**

Silver Spring, Maryland

3 May 2016

[www.ambon-us.org]
Goals

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

Arctic biodiversity from microbes to whales
The Arctic Chukchi Sea

Key Points

Among largest continental shelves globally

Strong south-north gradients

Distinct water masses

Region of dramatic sea ice changes

Historical biological and oceanographic data available

Spring and fall equinox Arctic Ocean sea ice coverage
AMBON sampling region

1st field effort in 2015

RUSALCA:
Russian-American Long-Term Census of the Arctic (NOAA)

CSESP:
Chukchi Sea Environmental Studies Program (industry)

COMIDA:
Chukchi Sea Offshore Monitoring in Drilling Area (BOEM)

DBO:
Distributed Biological Observatory (NSF, other agencies and international partners)

Norseman II
Hydrography

Inshore-offshore gradients  Vertical stratification  Long-term data records (mooring)
**AMBON 2015 Cruise: August-September**

**Chlorophyll and nutrients**

- Integrated water column chl $a$ (left) and sediment chl $a$ (right)

- Water column nutrients at DBO3 (left) and DBO4 (right) - August 2015

[funding through NOPP from NOAA, BOEM and Shell Oil]

**“Hot-spot” Pelagic – benthic coupling**
Phytoplankton taxonomy, with dominance by diatoms in western side maintained by nutrient rich Anadyr and Bering Shelf waters
Dominated by small-bodied copepods numerically: *Oithona similis* and *Pseudocalanus* spp. Predatory chaetognaths and cnidarians make important contributions to biomass, as do large-bodied copepods. Trace numbers of ice-associated taxa: *Tisbe* and *Cyclopina*.
Large-bodied copepods

**Calanus glacialis**
Abundance (individuals m⁻³)
- 10
- 50
- 100
- 500

Not present
Not processed

**Eucalanus bungii**
Abundance (individuals m⁻³)
- 10
- 100
- 500
- 1,000

Not present
Not processed

**Neocalanus spp.**
Abundance (individuals m⁻³)
- 1
- 10
- 100

Not present
Not processed

Pacific expatriates
Meroplankton

Bivalve larvae
Abundance (individuals m\(^{-3}\))

- 100
- 500
- 1,000

Not present
Not processed

Barnacle larvae
Abundance (individuals m\(^{-3}\))

- 10
- 100
- 1,000

Not present
Not processed
Rich benthic communities on the western side of the Bering/Chukchi Sea system 2000-2012 (AMBON15 identifications in progress)

- “foot prints” of high benthic biomass reflect pelagic-benthic coupling and export of carbon to sediments
- infauna dominated by amphipods, bivalves, polychaetes, and sipunculids

[modified from Grebmeier et al. 2015, Prog. Oceanogr.]
Species richness per station

Epifauna

Biomass (log$_{10}$ g wet weight 1000 m$^{-2}$)

High biomass – low diversity

High biomass – high diversity

~80% of expected species
Figure 19: Invertebrates collected to investigate for associated microbes: a. Golfingia margaritacea (Sipuncula); b. Argis sp. (Decapoda); c. Chionoecetes opilio (Decapoda); d. Halocynthia aurantium (Ascidiae); e. Gersemia rubiformis (Cnidaria); f. Neptunea heros (Gastropoda).

[courtesy Katrin Iken]
Demersal fish

Biomass

Species Richness

- Highest biomass in coastal regions
- Highest diversity in central region
- Sculpins, pricklebacks, cods, sandlance

~100% of expected species
Seabird Distribution & Abundance in the Chukchi Sea

Principal Investigator: Kathy Kuletz  (U.S. Fish & Wildlife Service)
Observer & analysis: Dan Cushing  (Polestar Ecological Research LLC)
Observer: Catherine Pham  (Grad Student; Hawaii Pacific Univ.)
Data Management: Elizabeth Labunski  (U.S. Fish & Wildlife Service)

Methods:
Visual surveys using protocol, distance sampling, 300m width
Calculate densities (#/km²); 3-km segments; 40x40km cells
Examine Community, Key species, and Environmental Drivers
Niche separation within genera

Example: *Aethia* auklets

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Preliminary Seabird Community Analysis

Strongest environmental variables: SST & Dist. offshore

- Not found with other species
- with other alcids & kitiwakes
- with loon spp, eiders, gulls

Nearshore

Colder

Offshore

Warmer
Very few mammals in southern region

Walrus and unidentified phocids most common
Experimental Setup-Live clam acidification experiments AMBON/DBO

[Christina Goethel, MS candidate, Marine Estuarine and Environmental Sciences Program, University of Maryland - Chesapeake Biological Laboratory]
Successes and challenges for AMBON

Successes
• AMBON field program 2015: good progress on sample processing, data generation and archive development

Challenges
• End of Shell funding in 2015; cancelled 2016 cruise, all PIs reduced budgets for Years 2-5, 2017 field program will have to be scaled to available funds
• Norseman 2- well-equipped for our field sampling, but limited in size; industry request for 12-hour seabird/marine mammal sampling required longer period at sea
  • Seabirds - ~ 8-15 species appropriate for scaling distribution/abundance relative to variables across study area
  • Benthivores (e.g. walruses, diving ducks, bearded seals) not well represented due to mostly offshore effort (some could be made up with data from other studies)
  • AMBON surveys appropriate for determining relative abundance (densities), distribution, biodiversity; not suitable for population estimates
  • Good linkages for tying species distribution and community composition to relevant environmental & prey data (particularly for more abundant species)
Linking Physics to Biology: the Distributed Biological Observatory (DBO)

- DBO sites (red boxes) are regional “hotspot” transect lines and stations located along a latitudinal gradient (DBO1-5) and longitudinally (DBO6-8)

- DBO sites exhibit high productivity, biodiversity, and/or overall rates of change

- DBO sites serve as a change detection array for consistent monitoring of biophysical responses

- Sites occupied by national and international entities with shared data plan

[modified by Karen Frey from Grebmeier et al. 2010, EOS 91]
- Highest chl a via satellites and field data in Bering Strait and offshore SE Chukchi Sea DBO3 SE Chukchi Sea hotspot
- Use AMBON and DBO field data for calibration studies with NASA

J. C. Comiso, Karen Frey, L. V. Stock, R. A. Gersten, and H. Mitchell, NASA collaborators
Canada’s Three Oceans (C30) and the Distributed Biological Observatory (DBO): *CCGS Sir Wilfrid Laurier*, July 10-22, 2016

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

**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

**Estimated Timeline:**
- July 14-south St. Lawrence Island (DBO1)
- July 15-Chirikov Basin (DBO2)
- July 17: SE Chukchi Sea (DBO3)-closest station 5 nm from coast, estimate time within 12 nm to be 2 hrs
- July 19: NE Chukchi Sea off Wainwright (DBO4)-closest station 30 nm offshore
- July 20: off Barrow (DBO5)-closest station 5 nm from coast, estimate time within 12 nm to be 2 hrs

**Contact:** Dr. Svein Vagle, Canadian Chief Scientist, Jackie Grebmeier, UMCES and PAG, jgrebmei@umces.edu

[www.arctic.noaa.gov/dbo/](http://www.arctic.noaa.gov/dbo/)
Aims of the cruise:

- To investigate the structure and processes in the water column and subsurface (sediment) around the northern Bering Sea, Chukchi/East Siberian Seas in rapid transition.

- To understand the sea ice dynamics and sea ice ecosystem

Period: 2016. 8.3 ~ 8. 19 (ca. 16 days)

Research fields:

- Atmospheric observation
- Satellite remote sensing
- Microbes & plankton ecology
- CO$_2$ systems in water column
- Hydrographic survey
- KOPRI mooring stations (2 sites)
- Sea ice dynamics & ecosystem
Field Measurements:
• Physical: CTD and lowered ADCP, moorings
• Chemical: nutrients, oxygen-18, chlorophyll-a (Chl a),
• Biological: zooplankton (abundance and biomass, growth rates)
• Benthos: macrobenthos abundance, biomass and population structure,
• Sediment: organic carbon/nitrogen content, chl a content, grain size, Cs-137 and Pb-210 content; benthic oxygen uptake and nutrient exchange
• Upper trophic: marine mammal shipboard surveys, passive acoustics on moorings

• Including DBO3 and DBO4
Successes and challenges for “Cross-MBON” Integration

- Joining Chukchi Sea data streams @AOOS.org
- Role recognized in international Arctic programs (CBMP, PAG, ESSAS)
  Circumpolar Biodiversity Monitoring Programme (Arctic Council)
  Pacific Arctic Group (Korea, China, Canada, USA, Russia, Japan)
  Ecosystem Studies of Subarctic Seas (regional program of Integrated Marine Biogeochemistry and Ecosystem Research)
- Need to Grow Coordination with other MBONs
  - Florida Keys and Monterey Bay Sanctuaries MBON
  - Channel Islands MBON
- Provide model for operational marine biodiversity observation network
- Essential Biodiversity Variables (EBV)
- Common methodologies to support concept and promote integrations

Arctic biodiversity from microbes to whales
Data management:

- Ocean Workspace: web-based data storage & sharing tool
- 2015 data: >1,000 AMBON files (1.2 Gb) uploaded
- 7 projects (55%) complete 2015 data with primary analyses
- All 2015 data with preliminary metadata documentation

AOOS public data portals & AMBON website: team can publish 2015 data through Workspace gateway
Outreach Efforts

SCIENCE NOTES
Science for Informed Decisions

April 8, 2016

Dear Reader:

This month’s Science Note presents new findings from the 2015 field season of the Arctic Marine Biodiversity Observing Network study, or AMBON. Last August, researchers began monitoring biodiversity in the Arctic Chukchi Sea from an ecosystem perspective, looking at microbes, whales and everything in between. BOEM is supporting this study to enhance environmental impact assessments and develop better metrics for cumulative impact analysis and a broader perspective of the ecosystem. To learn more, please enjoy reading this month’s Science Note, and feel free to send us your feedback at boempublicaffairs@boem.gov.

Sincerely,
William Y. Brown
Chief Environmental Officer, Bureau of Ocean Energy Management

Arctic study finds high correlation of biomass to species diversity in northern Chukchi Sea

Initial research of Chukchi shelf examines water column, bottom fish, invertebrates, walruses, and seabirds

Last summer, researchers began a five year study to monitor biodiversity in the Arctic Chukchi Sea from an ecosystem perspective, looking at microbes, whales and everything in between. Marine biodiversity is a key indicator of ocean health and critical ecosystem services that contribute to human life. Monitoring it improves our ability to interpret and forecast changes. The unprecedented effects of climate change combined with strong seasonal cycles and increasing human activities in the Arctic make this region particularly important to monitor.

In August 2015, the AMBON team of researchers from the University of Alaska’s School of Fisheries and Ocean Sciences, the University of Maryland, University of Washington, US Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration (NOAA) embarked on their first field effort under this project to sample marine biodiversity on the Chukchi Sea shelf. Despite challenging weather conditions, the team was able to complete sampling of the entire Chukchi shelf from south to north and across the shelf from nearshore to more than 150 miles (250 km) offshore. The Bureau of Ocean Energy Management (BOEM) is

- Press release incorporated into BOEM Science Notes followed by distribution on the web and in social media.
Launching a demonstration project for Arctic marine-biodiversity observing. This year, the Arctic Marine Biodiversity Network (AMBON) will launch the first of three sampling cruises (with others to launch in 2016 and 2017) as part of a five-year demonstration project. These cruises will gather a broad range of Arctic marine-biodiversity data, including bird and mammal observations, water-column analysis (temperature, salinity, chlorophyll-a extraction, nutrients, etc.), and information on microbes and small eukaryotic plankton, zooplankton, sediment cores, and fishes.
Acknowledgements

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Field science team

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