

**NOPP 2015 Principal Investigator Annual Report for the
Marine Arctic Ecosystem Study (MARES)**

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LONG-TERM GOALS

The Marine Arctic Ecosystem Study (MARES) is an integrated ecosystem research initiative study to investigate the interrelationship among the physical, biological, and chemical and components of the Eastern Beaufort Sea ecosystem from Kaktovik, Alaska, to the Mackenzie River delta in Canadian waters.

OBJECTIVES

It is important for BOEM and its NOPP partners to study and monitor areas known for high biological productivity and prevalent subsistence use to ensure protection and sustainability. The overarching goals of the study are to provide improved understanding of the interrelationship between physical, biological, chemical, and human systems, incorporating First Nations' traditional knowledge, of the Beaufort Sea ecosystem. Additionally, the MARES program will advance scientific prediction capabilities that link sea ice movement, atmospheric and oceanic processes and river discharge to marine life migration and subsistence harvesting. In 2016, Task Order 1 (TO1) for management and support services continued. The Pilot Phase of the Marine Mammal Tagging and Tracking Program (Task Order 2 – TO2) was successfully completed, the field activity program for the Biophysical and Chemical Oceanography component of the study was initiated (Task Order 3 – TO3), and a new task order (TO4) was awarded to cover the future retrieval of moorings deployed under TO3 and the analysis of the data collected.

APPROACH AND WORK PLAN

Task Order 1 (TO1) – Management Support Services

1. The objective of Task Order (Task Oder 1, M14PD00058) was to provide management oversight for all task orders issued against the base contract. Specific work elements are: project and data management; project coordination; and meeting facilitation.
2. Key Individuals – Gerry Myers and Diane Ingraham, Program Managers; Francis Wiese, Principal Investigator and Technical Director; Jeff Green, Program Director.

Task Order 2 (TO2) - Marine Mammal Tagging and Tracking

1. The overarching goal of the Marine Mammal Program (Task Order 2, M15PD00015) was to provide an improved understanding of relationships between the biophysical and chemical parameters of the ocean and the way different species of marine mammals utilize the arctic ecosystem. The marine mammal pilot field program focused on tagging bearded and spotted seals in 2015 and tracking them into 2016.
2. Animals were tagged with Sea Mammal Research Unit (SMRU) CTD-fluorometer trackers. The CTD-fluorometer trackers transmitted location, environmental (e.g. temperature, salinity, and fluorescence), and dive profile data via satellite while they were attached to the animal and also stored additional higher resolution information. These data will help us understand habitat features that are important to the animals as well as understand behavior associated with oceanographic characteristics.
3. The pilot program was carried out in collaboration with Andy VonDuyke and Robert Suydam from the North Slope Borough (NSB) under the NOAA permit held by the Alaska Department of Fish and Game (ADF&G). Rowenna Gryba, Marine Mammal Scientist, Stantec Consulting, Inc., Brendan Kelly, Senior Scientist University of Alaska, Fairbanks and Francis Wiese, Technical Director, Stantec Consulting, Inc. were key participants from MARES.
4. The data collected from the satellite tags deployed during 2015 is being analyzed using Bayesian switching-state models to infer marine mammal behavior and examining relationships between behaviors and environmental variables collected via the satellite tags.
5. Key Individuals – Rowenna Gryba, Marine Mammal Scientist, Stantec Consulting, Inc., Andy VonDuyke, Wildlife Biologist North Slope Borough, Brendan Kelly, Senior Scientist University of Alaska, Fairbanks and Francis Wiese, Technical Director, Stantec Consulting, Inc.

Task Order 3 – Pilot Biochemical and Physical Oceanography

1. This Task Order (Task Order 3, M15PD00012) was extended (Task Order 3, Mod 1) based on the technical failure of the glider and the failed attempt to deploy moorings in September 2015.
2. Under the modification, a new 6-week glider deployment was planned for mid-August to early October 2016
3. A new mooring deployment cruise was planned for early October 2016 on board the *CCGC Wilfred Laurier*
4. Water and benthic sampling was planned to occur in conjunction with the October 2016 mooring cruise to collect the first carbon cycling measurements in this region.
5. Key Individuals - Robert Pickart, Senior Scientist, Woods Hole Oceanographic Institute; Dave Fissel, Senior Scientist, ASL; Donglai Gong, Scientist, Virginia Institute of Marine Science; Rodger Harvey, Senior Scientist, Old Dominion University; Pamela Neubert, Senior Marine Scientist, Stantec Consulting Inc.; Francis Wiese, Technical Director, Stantec Consulting Inc.

Task Order 4 – Biochemical and Physical Oceanography

1. This Task Order (Task Order 4, M16PD00005), was awarded in September 2016 to cover the recovery of the moorings (deployed under TO3) in October 2017 and the analysis and synthesis of data collected.
2. Key Individuals - Robert Pickart, Senior Scientist, Woods Hole Oceanographic Institute; Dave Fissel, Senior Scientist, ASL; Donglai Gong, Scientist, Virginia Institute of Marine Science; Rodger Harvey, Senior Scientist, Old Dominion University; Pamela Neubert, Senior Marine Scientist, Stantec Consulting Inc.; Carin Ashjian, Senior Scientist, Woods Hole Oceanographic Institute; Matt Charette, Senior Scientist, Woods Hole Oceanographic Institute; John Nelson, President, SeaStar Biotech; Francis Wiese, Technical Director, Stantec Consulting Inc.

WORK COMPLETED

Task Order 1 – Management Support Services

Activities completed were specified management services, preparation of project work plans, subcontractor management, reporting, invoicing and financial management, and coordination with BOEM and its partners. This Task Order ended in December 2015, and management and safety roles performed as part of TO1 were folded into each subsequent Task Order rather than being funded separately.

Task Order 2 - Marine Mammal Tagging and Tracking

Field efforts in 2015 tested the SMRU-CTD tags, tagging methodology, and established communications with local community members for future tagging efforts. This tagging pilot program was carried out in collaboration with the North Slope Borough (NSB) to reduce duplication of effort and to increase efficiency by combining resources and experience. Three spotted seals and two bearded seals were tagged in Dease Inlet and Kugrua Bay, AK under the permit of Alaska Department of Fish and Game (ADF&G). Unsuccessful efforts were made to tag beluga whales at Point Lay, AK and Omalik Lagoon due to the early migration of beluga through the region.

The tags deployed in 2015 transmitted until the end of February, 2016, and provided valuable data on animal movement and their environment. The environmental data collected was reviewed by MARES oceanographers and was deemed to have very few erroneous values. Information on the temperature, salinity and productivity of the water column will be analyzed to the seal tracking results and to identify water bodies used by the animals.

During the 2015-2016 reporting period we initiated the analysis of the movement data using Bayesian state-space switching models, including dive information as covariates, to infer foraging and transiting activity. Foraging activity was compared to environmental variables using Generalized Linear Mixed Models to quantify relationships between activity and the environment. Analysis is on-going and anticipated to be completed in 2017.

Task Order 3 – Biochemical and Physical Oceanography

Field efforts in 2015 served to assess the deployment logistics associated with the Eastern U.S. boundary of the Beaufort Sea during open-ice season in September 2015. The USCG vessel Sycamore arrived at the study location with the necessary mooring devices on board but due to deteriorating sea conditions and much prolonged subsistence whaling activities the vessel was eventually forced to return to port without deploying the mooring devices. An autonomous Slocum glider was deployed immediately north of the study region but a leak was detected during its first dive to 200m and the device had to be recovered. Later investigations found that the leak was caused by a manufacturing error which has since been addressed.

Additional funds were allocated to this Task Order and allowed for a new mooring and glider deployment effort August-October 2016. During the reporting period a 6-week glider deployment was started in mid-August northeast of Kaktovik with plans to sample the Beaufort Sea shelf between Kaktovik and Tuktoyaktuk, focusing especially on the area off Hershel Island (where the moorings were deployed in October 2016) and the Mackenzie trough.

Cruise planning and permitting activities were carried out during the reporting period to deploy a high-resolution cross-shelf biophysical and chemical mooring array in the eastern Beaufort Sea. The mooring deployment cruise was planned for early October 2016 on board the *CCGC Wilfred Laurier* with the additional plan to recover the glider during the mooring deployment effort

Task Order 4 – Biochemical and Physical Oceanography

This Task Order was awarded in the fall of 2016 to provide funding for the expenses related to the recovery of the mooring array in October 2017 and the data analysis and synthesis of the mooring data. Activities related to this Task Order during the reporting period were focused on starting the permitting process and ship logistics.

RESULTS

Task Order 1 – Management Support Services

The required deliverables were submitted on time.

Task Order 2 - Marine Mammal Tagging and Tracking

The pilot program successfully deployed five SMRU-CTD-fluorometry tags on two species of seals in an area where this type of tagging has not been previously performed. The tags transmitted data for 117 to 168 days. Movement varied between species, individuals, and size of animals.

The amount of time spent transiting versus foraging varied temporally and spatially among individuals and between species. The three tagged spotted seals spent more time foraging than transiting in September and October of 2015 while located north of the Bering Strait. Spotted seals tended to forage along multiple sections of the transit track north and south of Bering Strait, and foraged earlier than the bearded seals, even when accounting for their earlier

tagging dates. The bearded seals were different from the spotted seals with more foraging south of the Bering Strait and differences between the two tagged seals. The larger seal spent more time transiting than the smaller seal.

Spotted seals had higher median dive depths during inferred foraging as compared to transiting. Median dive depth reflected nearshore and offshore movements for the bearded seals. The Anselin Morans I analysis highlighted several areas where inferred foraging for both species clustered significantly in space and time. Dives tended to be benthic for both spotted and bearded seals, regardless of whether the seals were foraging or transiting although bearded seals had substantially more benthic than pelagic dives overall.

State-space model results with dive covariates differed from state-space models using only horizontal movement by influencing the location of inferred foraging behavior. Estimates of time spent foraging were not significantly different between models for both species.

The oceanographic data were considered reliable. Environmental metrics and their link to inferred behaviors varied between species and among individuals. For bearded seal, sea surface temperatures differed significantly during inferred foraging and transiting; although inconsistently between the two tagged animals. For spotted seal, surface salinity and maximum fluorescence differed significantly between transiting and foraging with both parameters being higher during foraging. Spotted seals primarily foraged in Bering summer water with Alaskan coastal water being the second most frequented. The bearded seals differed in their preferred use of water bodies one foraged predominantly in Bering summer water while the other foraged primarily in newly ventilated winter water and, to a slightly lesser extent, in remnant winter water.

Task Order 3 – Biochemical and Physical Oceanography

The glider mission was successfully initiated and started collecting data in mid-August. Data will be analyzed once the mission is completed.

Task Order 4 – Biochemical and Physical Oceanography

There are no results to report on for this Task Order.

IMPACT AND APPLICATIONS (*Please note N/A for sections not applicable*)

1. **National Security**
TO2 N/A
TO3 N/A

2. **Economic Development**
TO2 N/A
TO3 N/A

3. **Quality of Life**

Task Order 2 - Marine Mammal Tagging and Tracking

Information collected as part of the larger marine mammal program can be used to help provide information to local communities about potential changes in the accessibility of subsistence species. Overall changes in the ecosystem that may impact marine mammal habitat suitability (e.g., changes in sea ice) can provide information on future ecosystem health.

Task Order 3 – Biochemical and Physical Oceanography

Part of the overarching objective of collecting data on the physical, chemical, and biological oceanographic processes of the Eastern Beaufort is to be able to understand how changes to this system may potentially affect trophic levels ranging from primary production to top-level predators within the arctic ecosystem and how spatial and temporal changes subsequently directly influences the availability of subsistence resources for coastal communities and traditional way of life for this region.

4. Science Education and Communication

TO2 N/A

TO3 N/A

TRANSMISSIONS (Please note N/A in sections that are not applicable)

1. National Security

TO2 N/A

TO3 N/A

2. Economic Development

TO2 N/A

TO3 N/A

3. Quality of Life

TO2 N/A

TO3 N/A

4. Science Education and Communication

TO2 N/A

TO3 N/A

RELATED PROJECTS

ADF&G, NMML and NSB all have marine mammal tagging programs that include the tagging of spotted and bearded seals and beluga whales. Research has been primarily focused on animal movement and habitat use. We have collaborated with both ADF&G and NSB to minimize duplication of efforts and effects on local marine mammal populations and communities.

The NSB has been tagging spotted seals and juvenile bearded seals in the Chukchi Sea, as well as beluga whales. During 2015 we collaborated with the NSB for the ice seal and beluga tagging programs.

<http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects/ice-seals/ringed-seal-research/ringed-seal-research-results-2015-tagging>

<http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects/beluga-whale/beluga-research-eastern-chukchi-sea-stock/beluga-movements-and-satellite-tracking>

ADF&G have also been tagging bearded seals, but focused in the western Chukchi Sea. The MARES 2015 marine mammal tagging was conducted under the ADF&G permit.

<http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.icesealmovements>

NMML has been tagging ice seals, including bearded seals and spotted seals, primarily focused in the Bering and Chukchi Seas.

http://access.afsc.noaa.gov/pubs/posters/pdfs/pLondon05_dive-behavior-spatial-variability.pdf

http://access.afsc.noaa.gov/pubs/posters/pdfs/pBoveng08_movements-bearded.pdf

OUTREACH MATERIALS

Attachment A: Marine Mammal Pilot Program Photos

ATTACHMENT A

Marine Mammal Pilot Program Photos



Photo 1: Sub-adult spotted seal tagged August 20, 2015. Photo credit: Rowenna Gryba

NMFS PERMIT NO. 15324-01



Photo 2: Sub-adult bearded seal tagged September 8, 2015. Photo credit: Brittni Driver



Photo 3: Sub-adult bearded seal tagged September 17, 2015. Photo credit: Andy Von Duyke