

PASSIVE ACOUSTIC DETECTION
AND MONITORING
OF ENDANGERED WHALES
IN THE ARCTIC (BEAUFORT, CHUKCHI)

&

ECOSYSTEM OBSERVATIONS IN THE CHUKCHI SEA:
BIOPHYSICAL MOORINGS AND CLIMATE MODELING

QUARTERLY REPORT

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Executive Summary

Through an Inter-Agency agreement (IA) between the National Marine Mammal Laboratory (NMML) and the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE), NMML is conducting a dedicated multi-year study of the distribution and relative abundance of endangered whales in the Chukchi Sea Planning Area and relate variation in those parameters to oceanographic conditions, indices of potential prey density, and anthropogenic activities. This quarterly report covers the period between January and April 2011.

The major activities during this period consisted of the preparation for the Chukchi Sea Acoustics, Oceanography, and Zooplankton (CHAOZ) cruise that will take place from 5 August through 6 September 2011. The cruise will take place on a TBD chartered vessel.

Where possible, analyses have begun, and the preliminary results are detailed below. In addition, work has begun on the modeling component of the project, which aims to predict the impact of climate change on the sea-ice characteristics and physical variables in the Chukchi Sea.

Introduction and objectives

The western Arctic physical climate is rapidly changing. The summer minimum sea ice extent in 2007 and 2008 covered an area which was 37% less than that of two decades ago. The speed of these changes was unexpected, as the consensus of the climate research community just a few years ago was that such changes would not be seen for another thirty years. As sea temperature, oceanographic currents, and prey availability are altered by climate change, changes in baleen whale species composition, abundance, and distribution are expected (and evidenced already by local knowledge and opportunistic sightings). In addition, the observed northward retreat of the minimum extent of summer sea ice has the potential to create opportunities for the expansion of oil and gas-related exploration and development into previously closed seasons and localities in the Alaskan Arctic. It may also open maritime transportation lanes across the Arctic adding to the ambient noise in the environment. This combination of increasing anthropogenic impacts coupled with the steadily increasing abundance and related seasonal range expansion by the bowhead, gray, humpback, and fin whales, indicates that more complete information on the year-round presence of large whales is needed in the Chukchi Sea planning area. Timing and location of whale migrations may play an important role in assessing where, when, or how exploration or access to petroleum reserves may be conducted to mitigate or minimize the impact on protected species.

This study has four component projects: oceanography, passive acoustics, zooplankton, and climate modeling. Each component project is a technical discipline and will be coordinated by a Project Leader with extensive experience in that discipline. Passive acoustic moorings, deployed concurrently with bio-physical moorings will provide previously unattainable year-round assessments of the seasonal occurrence of bowhead, humpback, right, fin, gray, and other whales in this planning area and their response to environmental changes (including oceanographic conditions, climate, indices of potential prey density, and anthropogenic activities). Moorings permit observations during long periods when ice covers the region, especially during the critical spring and early summer periods when spring phytoplankton blooms occur. Such measurements are virtually impossible to obtain from ships, because of the relatively short duration of cruises and severe limitations in the availability of ships able to work in ice-covered seas.

The overall goal of this multi-year IA study is to document the distribution and relative abundance of bowhead, humpback, right, fin, gray, and other whales in areas of potential seismic surveying, drilling, construction, and production activities and relate changes in those variables to oceanographic conditions, indices of potential prey density, and anthropogenic activities.

The specific objectives are:

1. Assess the year-round seasonal occurrence of bowhead, gray, and other whale calls in the Chukchi Sea.
2. Estimate relative abundance of these whales.
3. Obtain two full years of biophysical measurements on the shallow Chukchi shelf utilizing moorings at three sites, and collect hydrographic and lower trophic level data during deployment/recovery of the moorings.
4. Evaluate the extent to which variability in environmental conditions such as sea ice, oceanic currents, water temperature and salinity, and prey abundance influence whale distribution and relative abundance.

5. Run the National Center for Atmospheric Research (NCAR) climate model (Community Climate System Model: CCSM) for future projections using the sea ice extents from 2007/2008 as initial conditions.
6. Analyze multiple ensemble members from the NCAR model and other IPCC models to assess the future variability of sea ice cover and extended sea ice free seasons during fall for the Chukchi Sea.
7. Evaluate whether changes in seasonal sea ice extent are resulting in a northward shift of Bering Sea cetacean species such as fin, humpback, and North Pacific right whales.
8. Provide long-term estimates of habitat use for large whale species and compare this with predictions about annual ice coverage to establish predictive variables that describe large whale occurrence.

ACOUSTICS COMPONENT

Preliminary results

NMML Long-term moorings:

The data from the long-term passive acoustic recorders will not be available for analysis until they are retrieved in one year. Modifications to existing array localization code will be completed in the summer by Berchok.

Sonobuoys:

A total of 102 sonobuoys were deployed during the cruise. A preliminary analysis of species detected was conducted and the results are shown in Figures 1 and 2. The most commonly detected species were fin whales (*Balaenoptera physalus*), bowhead whales (*Balaena mysticetus*), and walrus (*Odobenus rosmarus*).

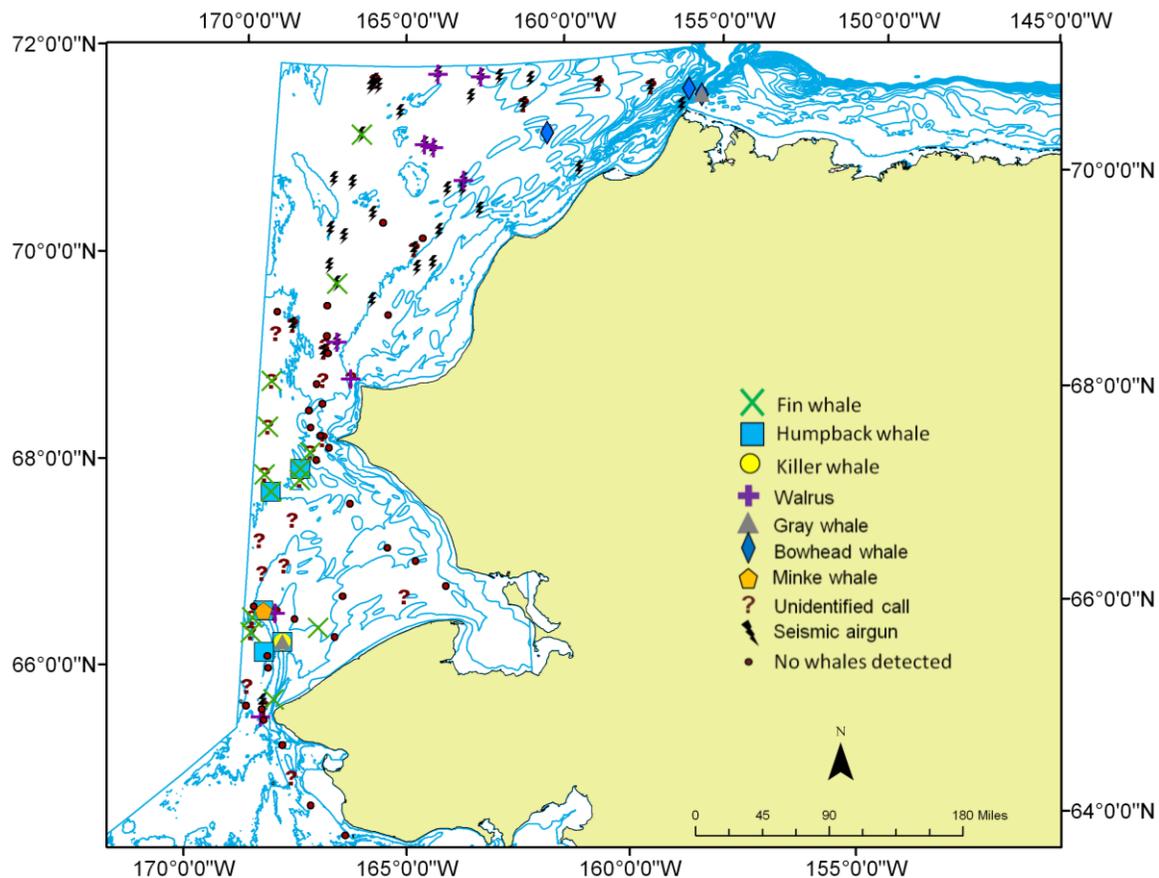


Figure 1. Sonobuoy deployment and acoustic detections in the Chukchi Sea

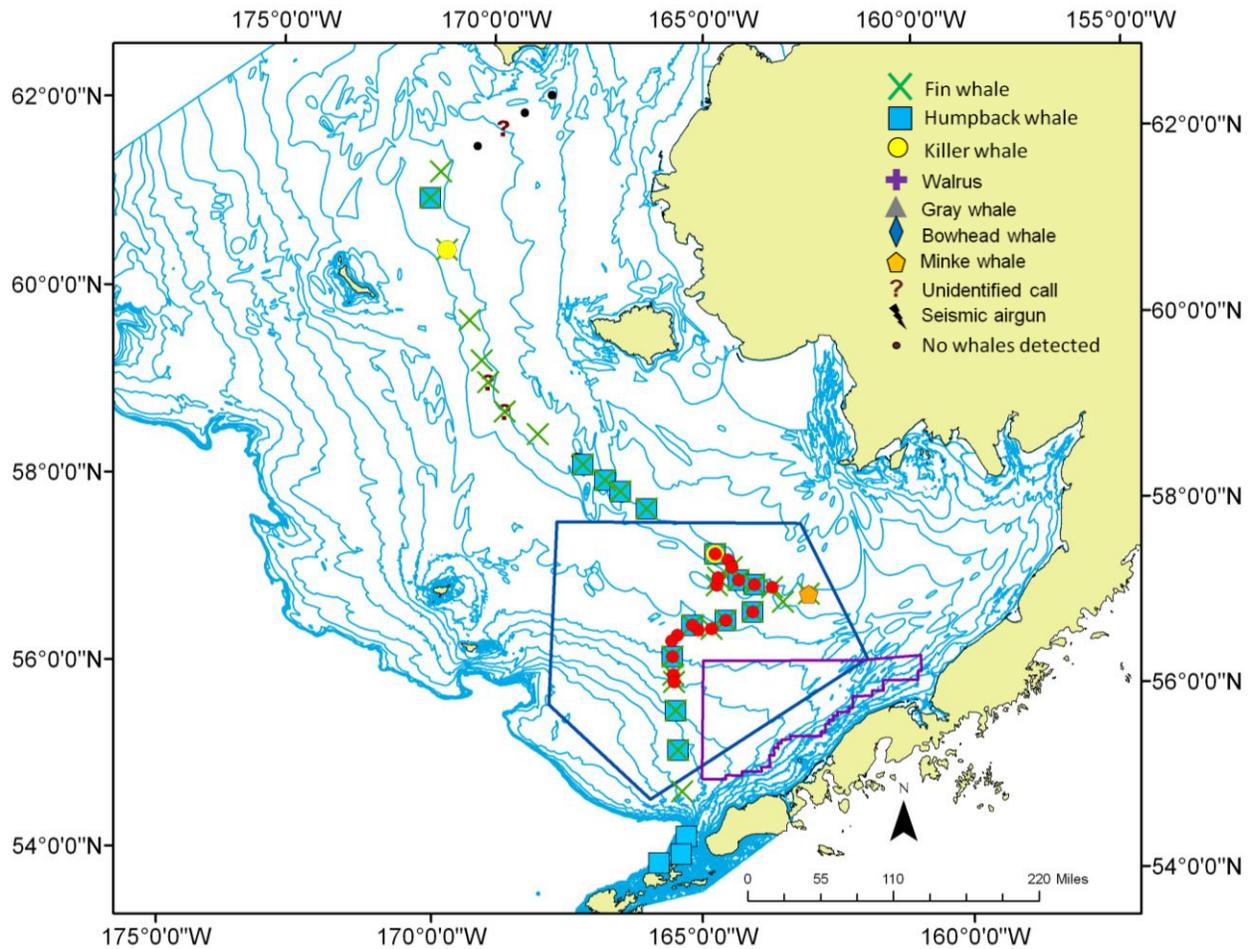


Figure 2. Sonobuoy deployment and acoustic detections in the Bering Sea.

2011 preparations and analysis plans

The closing date on the vessel contract for the 2011 field season is April 26th, at which time a vessel will be selected from those vendors that submitted a bid. All paperwork for hiring field contractors has been submitted, and our team has been selected. The equipment purchase orders, submitted early this spring, have been awarded and all equipment should be delivered no later than mid-May. The dragging winch is currently at the manufacturer, having additional modifications done. We just found out that the type of wire on our winch is not well suited to our application, and modification or replacement alternatives are being discussed.

Berchok designed an acoustic analysis program, implemented in Matlab, which is being used for all data analysis. Using this program, spectrograms are generated of all sound files, and are then analyzed for presence of desired species or call type. Current short-term plans include an in-depth analysis of real-time sonobuoy recordings made during the cruise. When possible, localizations of calling whales will be run to produce a finer scale analysis of whale distribution within the Chukchi and Bering Seas.

OCEANOGRAPHIC COMPONENT

Preliminary results

Long-term moorings:

We successfully deployed seven moorings, which will measure biophysical data (temperature, salinity, current speed and direction, nitrate, light, ice thickness) at three sites in the Chukchi Sea along the Wainwright line. The data from the long-term sensors will not be available for analysis until they are retrieved in one year.

Shipboard measurements:

Temperature, salinity and nutrients were measured on each hydrographic line. First order processing was completed for temperature and salinity for a poster presented at the Alaska Marine Science Symposium meeting in January (Figure 3).

Satellite Remote Sensing:

Preliminary processing of relevant satellite remote sensing products was begun during this period (Figure 4). We are investigating the value of images showing sea surface temperature, true ocean color, and satellite-derived chlorophyll.

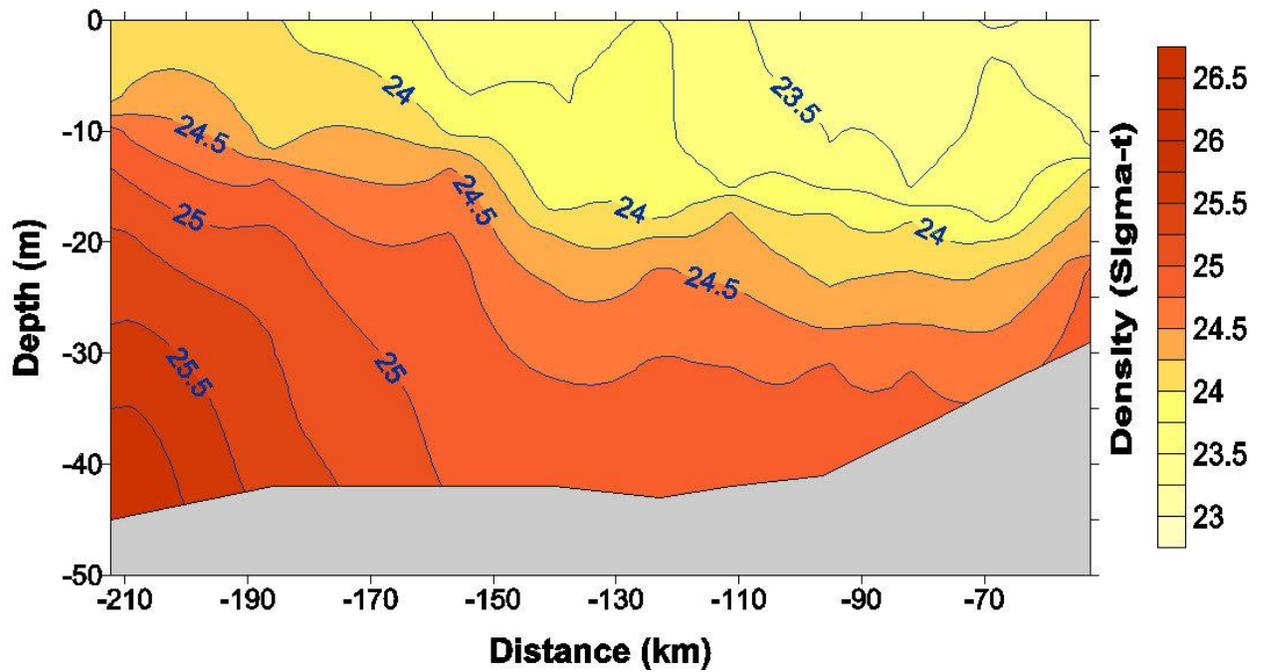
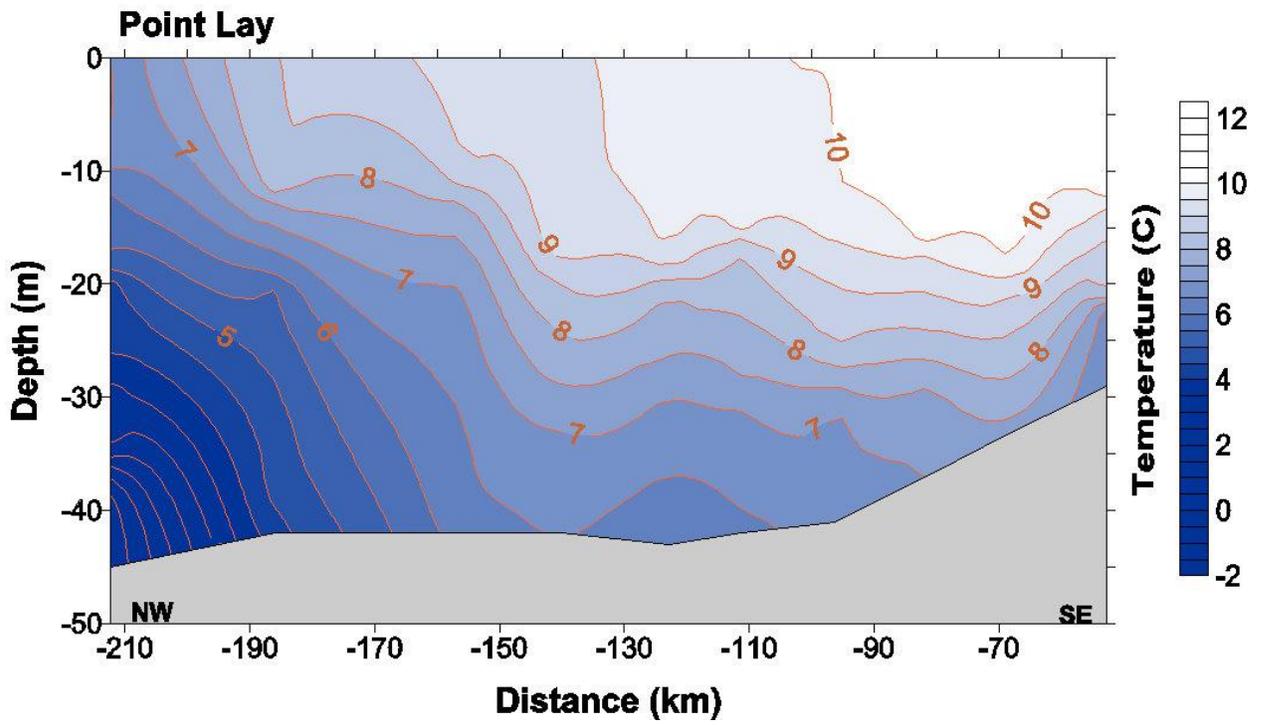


Figure 3. Preliminary temperature (top) and density (bottom) data from transect off Point Lay.

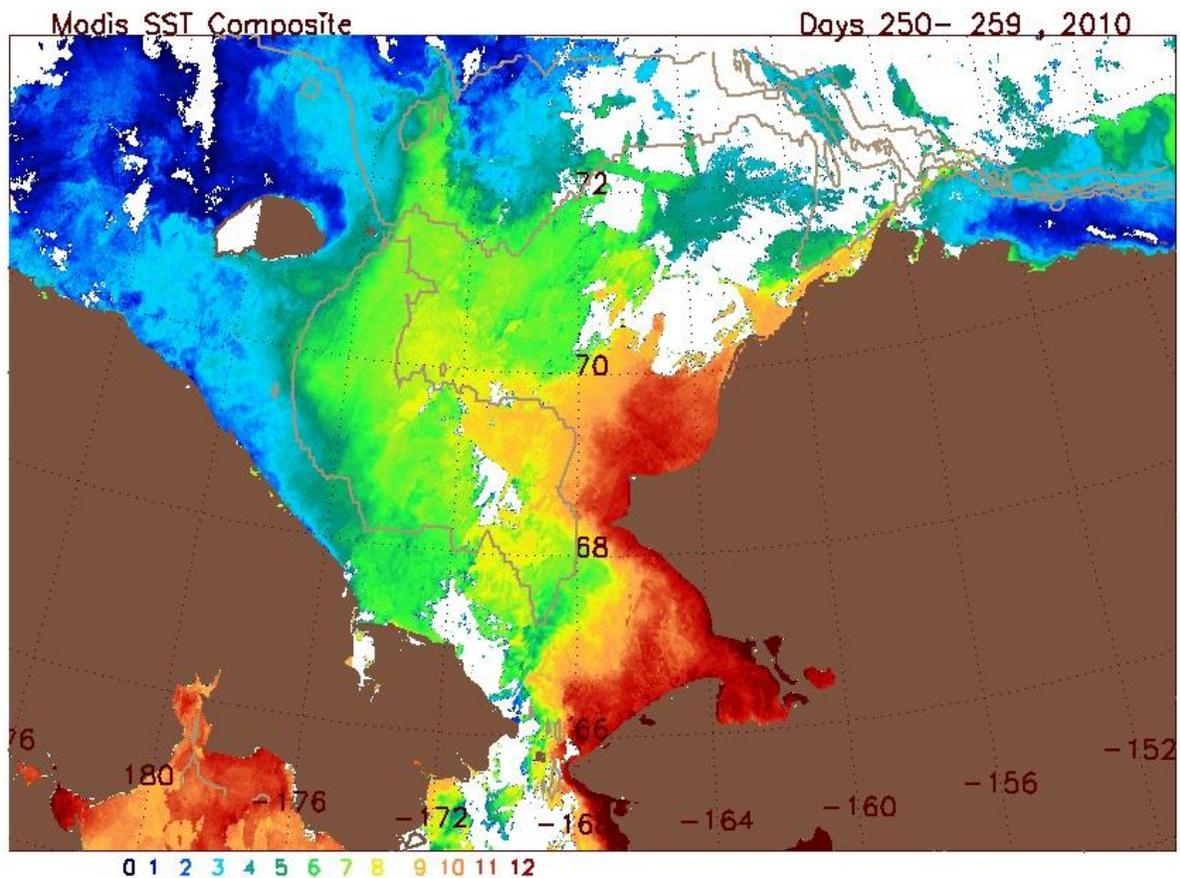


Figure 4. Sea surface temperature composite image (Julian Days 250 – 259; 7 – 16 September) of the Chukchi Sea.

2011 preparations and analysis plans

Data Analysis:

Once the salinity samples are run on a laboratory salinometer, the final processing of the temperature and salinity data from the CTD and (2) SeaCats will be completed. Final hydrographic data from the cruise will be uploaded to the data base by February 1, and hydrographic sections will be completed. Nutrient samples collected during the cruise have been processed. They will be integrated into the hydrography files before submission to the database.

We are in the process of comparing the results from the CTD cast with the data collected by the SeaCAT on the net tows. Once the final quality control of all the data is completed, we will examine water properties and identify probable sources of water. We are also analyzing a variety of satellite images which will provide further information on special scales for temperature and chlorophyll.

We have continued to monitor the amount of ice in the Chukchi this winter. The extremely low areal sea-ice coverage in the Arctic in January may have an impact on ice coverage in the Chukchi. Sea-ice extent in the Bering Sea has been moderate this past winter, with significant winds out of the south, which created polynyas on the north coastal regions (e.g. Fig. 5). We are developing a database of ice coverage that will assist in the analysis of the data recovered from the moorings.



Figure 5. Satellite image of ice cover on March 4, 2011.

Cruise Preparation:

We have begun preparation for the summer cruise of 2011. This includes purchase of equipment and repair of the CTD which was damaged in 2010. It is awaiting the transfer of funds to complete repairs. Personnel for the upcoming cruise have been selected and notified. Further improvements/modifications are being made to the laboratory van purchased for this project to make the best use of that space. Mooring designs have been finalized and purchase and calibration of the remaining sensors have begun. This year a second oceanographic winch with conducting cable will be carried by the ship in case the primary winch fails, along with a second deck unit. Routine maintenance to that winch will occur in the second quarter.

In addition, two satellite tracked drifters (provided through other funding) will be deployed in the Bering Strait in July on a ship of opportunity. We hope these drifters will give us a better understanding of pathways of the flow through the Bering Strait. They will be deployed approximately one month before our cruise. The drifters will have drogues at 20m. Discussions are underway to improve measurements around Hanna Shoal.

ZOOPLANKTON COMPONENT

Preliminary results

Zooplankton Net Samples:

The Polish Plankton Sorting and Identification Center began processing our preserved samples from last summer. The coarse mesh net samples (333 μm) were completed, but still need to undergo quality control checks from the lead taxonomist. The fine mesh samples (150 μm) were begun but not finished at the end of the quarter. We expect all samples to be completed with quality control checks and the data transmitted to us by the end of the next quarter.

Chlorophyll:

Frozen chlorophyll samples will be processed during the second quarter.

2011 preparations and analysis plans

TAPS-8 Design and construction:

Design and construction of the new TAPS instruments is on schedule. A second contract was successfully procured with Oceantronics for the services of Mr. Charles Greenlaw, one of the original TAPS designers. All printed circuit boards have been designed and the Gerber files transferred to NOAA. One of the boards has been printed and locally assembled with its electronic components (Controller Card with Single Board Computer). Other cards (Transmitter, Receiver, and Tuning) are either being printed or have been printed and are being assembled. A Purchase Order was let for the individual transducers (Transonics) and we are awaiting their delivery (early May). The instrument pressure cases have been obtained and the end caps drilled for the connectors, internal supports made. The connectors were ordered and should arrive soon. Testing of the Controller card, system assembly and calibration are scheduled to occur in the second quarter.

Acoustic Data Processing:

Mr. Adam Spear was hired 3 January 2011 to assist with the processing of the zooplankton acoustics data. During the first quarter he familiarized himself with the existing TAPS processing software and extended the programs to utilize far-field data collected by the instruments. He also successfully coded a low-pass filter routine in MatLab for the moored TAPS data so that we can statistically compare the TAPS timeseries to the data from other moored instruments (e.g. T,S, nitrate, fluorescence). We are currently working to tune the parameters of the inverse solution to optimize the estimates of both total biovolume and size frequency distributions for a two-model application (truncated fluid sphere for copepods and Distorted Wave Bjorn Approximation for euphausiids).

Cruise Preparation:

We have begun making purchases necessary for the upcoming field season. The winch was delivered to JK Fabrication for repair and modifications necessary to make it easier to repair and maintain at sea. Personnel for the upcoming cruise have been selected.

OCEAN NOISE AND REAL-TIME PASSIVE ACOUSTIC MONITORING

Preliminary analysis

A mutual decision was made by NMML and Bioacoustics Research Program (BRP) at Cornell University to postpone deployment of their auto-detection buoy until the 2012 field season. However, during the 2010 CHAOZ cruise, a double capacity MARU was deployed. This will be retrieved and redeployed during the 2011 cruise, at which point analyses will begin.

2011 preparations and analysis plans

The Cornell contract, with an updated proposal and budget, is currently being processed by the contracting department. Noise modeling will begin after the contract is awarded.

CLIMATE MODELING COMPONENT

Preliminary results

We participated in the BOEMRE Oil Spill Risk Analysis (OSRA) workshop held in McLean, VA in March, during which M. Wang presented. Very active discussions and good feedback occurred during the workshop. We also participated in the Polar Climate Working Group workshop at the National Center for Atmospheric Research (NCAR) in Boulder, CO (Feb 28-Mar 1), where we discussed model collaborative work with NCAR scientists. In addition, we set up an account to access NCAR's model outputs and became a member of the Community Earth System Model (CESM) modeling community.

Significant meetings held or other contacts made

1/19/11: Berchok, Napp, and Moore met with other Chukchi Sea Principal Investigators at the Alaska Marine Science Symposium to discuss 2011 field programs.

1/17/11 – 1/20/11: Most of the PIs attended the Alaska Marine Science Symposium to present work from the CHAOZ field season and to learn about other proposed research being conducted in the study area. In addition, we attended the Chukchi Sea coordination meeting held to introduce all of the scientists working in the area. Last, we have been active letting the communities know about our summer plans, for instance, the goals and general sampling area was presented at a recent meeting of the North Slope Science Initiative (NSSI) by R. Angliss (March 29 - 31).

2/7/11: Berchok, Crance, Napp, and Stabeno met to discuss the CHAOZ project, current results, and field survey logistics.

2/11: Wang and Stabeno met to discuss the modeling component of the CHAOZ project.

3/1/11: Berchok and Crance met with Sue Moore and Phillip Clapham to discuss a potential visit with Cornell's Bioacoustic Research Program (BRP) in Ithaca, NY, and ideas for a more multi-collaborative approach with the BRP.

3/22/11: Moore met with Jim Overland (& Jackie Grebmeier, by phone) to discuss integration of marine mammal visual and acoustic data from cruises in the N. Bering and Chukchi Seas (including CHAOZ) for presentation at the Distributed Biological Observatory (DBO) Workshop, held in conjunction with Arctic Science Summit Week.

Presentations

Berchok, C.L., S. Moore, J.M. Napp, J. Overland, and P. Stabeno. "Bringing CHAOZ to the Arctic". Alaska Marine Science Symposium, 17-21 January 2011. Anchorage, AK.

Berchok, C.L., "Passive Acoustics", presented at the 2011 Arctic Stakeholder Open-Water Workshop. March 7-9, 2011. Anchorage, AK [*Half of talk was about the CHAOZ project results*].

Crance, J.L., C.L. Berchok, A. Kennedy, B. Rone, E. Küsel, J. Thompson, and P.J. Clapham. "Visual and acoustic survey results during the 2010 CHAOZ cruise". Alaska Marine Science Symposium, 17-21 January 2011. Anchorage, AK.

Moore, S.E. "Including Fish, Seabirds and Marine Mammals in the DBO", presented (by Grebmeier) at the DBO Workshop. March 27, 2011. Seoul, Korea.

Napp, J.M. and P. Stabeno. "CHAOZ: CHukchi Acoustics, Oceanography, and Zooplankton, Part II". Alaska Marine Science Symposium, 17-21 January 2011. Anchorage, AK.

Wang, M., J.E. Overland, and P. Stabeno. "Future status of the Chukchi Sea seen from global climate models". Alaska Marine Science Symposium, 17-21 January 2011. Anchorage, AK.

Wang, M., J.E. Overland, and P. Stabeno, "Examples of using global climate models for Bering Sea marine ecosystem projection", Jan 17-21, 2011, Alaska Marine Science Symposium. Anchorage, AK

Wang, M. "The changing Arctic: observation and model study", presented at the BOEMRE Oil Spill Risk Analysis (OSRA) workshop. March 19-21, 2011. McLean, VA. This was a summary of work done a few months ago about Chukchi SAT and sea ice analysis and projection based on IPCC models.