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

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

QUARTERLY REPORT

Catherine L. Berchok[1], Ph.D.
Phillip J. Clapham[1], Ph.D.
Jessica Crance[1], M.S.
Sue E. Moore[2], Ph.D.
Jeff Napp[3], Ph.D.
James Overland[4], Ph.D.
Phyllis Stabeno[4], Ph.D.
Christopher Clark[5], Ph.D.

[1]National Marine Mammal Laboratory
Alaska Fisheries Science Center

[2]National Marine Fisheries Service
Office of Science & Technology

[3]Resource Assessment and Conservation Engineering Division
Alaska Fisheries Science Center

[4]Pacific Marine Environmental Laboratory
Ocean Environment Research Division

7600 Sand Point Way NE
Seattle, WA 98115

[5]Bioacoustics Research Program, Cornell University
159 Sapsucker Woods Road, Ithaca, NY 14850

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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 (BOEM), 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 16th and April 15th 2013.

The major activities during this period consisted of data analysis and synthesis. In addition, although the CHAOZ field work portion of the study has concluded, we will continue to deploy instruments and collect data to maintain the extensive dataset established during CHAOZ. These instruments will be deployed under the Arctic Whale Ecology Study (ARCWEST). This cruise will take place from 12 August through 17 September 2013 on a TBD chartered vessel. Analyses are currently ongoing, and some preliminary results are detailed below.

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 is 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

The last deployments of the long-term passive acoustic recorders were retrieved in fall 2012 on the last CHAOZ cruise and analyses are ongoing. These units recorded on a duty cycle of 85 minutes every 5 hours, at a sampling rate of 16kHz. Table 1 lists the 15 passive acoustic moorings, and the actual time period when they were recording data. Preliminary analyses of the 2010-2011 units consist of one recorder from each array being analyzed for presence of bowhead, gray, fin, and beluga whales, and bearded seals. Results from these analyses are shown in Figures 1-3.

All moorings have three strong peaks of bowhead call detection during the fall with the majority of animals out of the area by the end of December; however, only the inshore IC3 mooring (A3, Figure 1) shows a strong bowhead presence the following spring. The two strongest peaks of bowhead whale call detection in the spring at A3 correlates with the two peaks in beluga call detection. Beluga presence has been analyzed for the inshore IC3 (A3, Figure 1) and offshore IC11 (C2, Figure 3) moorings. The inshore mooring shows a single fall migration peak and a bimodal peak in beluga presence in spring. We hypothesize that the first spring peak may be caused by animals from the eastern Beaufort stock migrating north, and the second spring peak from the eastern Chukchi stock. In contrast to the high, although sporadic, levels of presence on the inshore mooring, beluga presence on the offshore mooring (C2) was considerably lower. A single weak migration peak was detected in both fall and spring. Despite a reduced presence offshore, belugas are utilizing this area to migrate in both directions. Future analyses of the common calls types within each peak will be undertaken in an attempt to assign beluga stocks to each peak in vocal presence, to aid in the understanding of movement patterns within the region. All plots show a consistent near-year-round bearded seal presence. Fin whales were not detected on any of the moorings.

Although the CHAOZ field seasons are complete, moorings were redeployed in the 2012 field season. Because ship time required to redeploy the moorings was minimal, and the cost to refurbish a mooring is low, we redeployed a full suite of moorings for the ARCWEST project. This allows for an additional

year of data for ARCWEST, but also contributes to the long-term time series of data collected by the CHAOZ project. One recorder was placed at each Icy Cape site in place of the five-unit array, and several new locations were added.

Table 1. Recording period, position, and depth of all long-term passive acoustic recorders deployed off Icy Cape, AK from 2011-2012. The 'A' moorings were deployed at inshore IC3, 'B' moorings at middle IC6, and 'C' moorings at offshore IC11.

Mooring Name	Start date	End date	Latitude	Longitude	Depth (m)
CZ11_AU_A01	9/3/2011	4/22/2012	70.8734667	-163.2211333	44.0
CZ11_AU_A02	9/3/2011	4/22/2012	70.8572333	-163.1183333	43.5
CZ11_AU_A03	9/3/2011	9/7/2012	70.8167667	-163.1361167	43.5
CZ11_AU_A04	9/3/2011	12/11/2011	70.8097667	-163.2478000	43.7
CZ11_AU_A05	9/3/2011	9/30/2012	70.8475500	-163.3094500	43.8
CZ11_AU_B01	8/29/2011	5/8/2012	71.2524167	-164.2744333	43.5
CZ11_AU_B02	8/29/2011	5/3/2012	71.2353000	-164.1929333	43.9
CZ11_AU_B03	8/29/2011	5/19/2012	71.2016333	-164.1979167	44.3
CZ11_AU_B04	8/29/2011	5/24/2012	71.1962667	-164.2944000	45.2
CZ11_AU_B05	8/29/2011	5/4/2012	71.2286000	-164.3439833	44.4
CZ11_AU_C01	8/29/2011	5/29/2012	71.8536500	-165.9983167	43.5
CZ11_AU_C02	8/29/2011	5/14/2012	71.8319000	-165.9005500	42.6
CZ11_AU_C03	8/29/2011	6/5/2012	71.8022500	-165.9272667	42.7
CZ11_AU_C04	8/29/2011	4/6/2012	71.7985833	-166.0287833	43.3
CZ11_AU_C05	8/29/2011	5/9/2012	71.8290333	-166.0714500	43.7

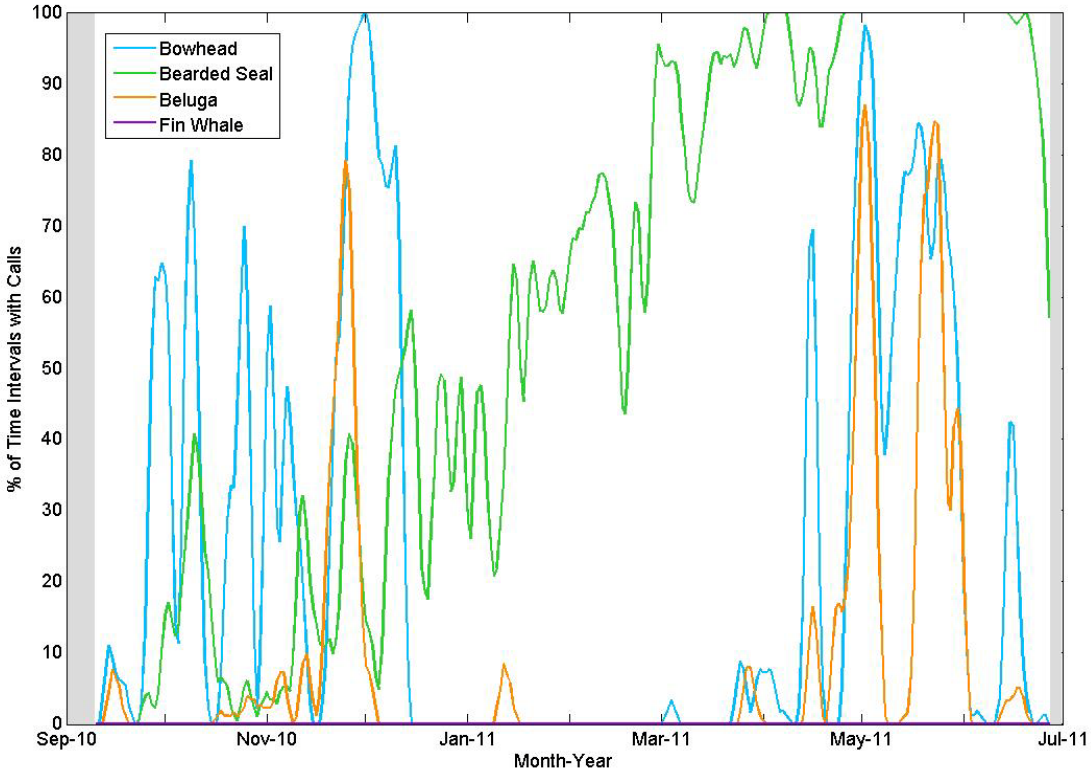


Figure 1. Seasonal acoustic detections of bowhead whales, bearded seals, beluga, and fin whales on 2010 recorder CZ10_AU_A03 at the inshore mooring IC3 off Icy Cape, AK (September 10, 2010 – June 27, 2011). Results are presented as a 3 day moving average of the number of time intervals per day with calls detected.

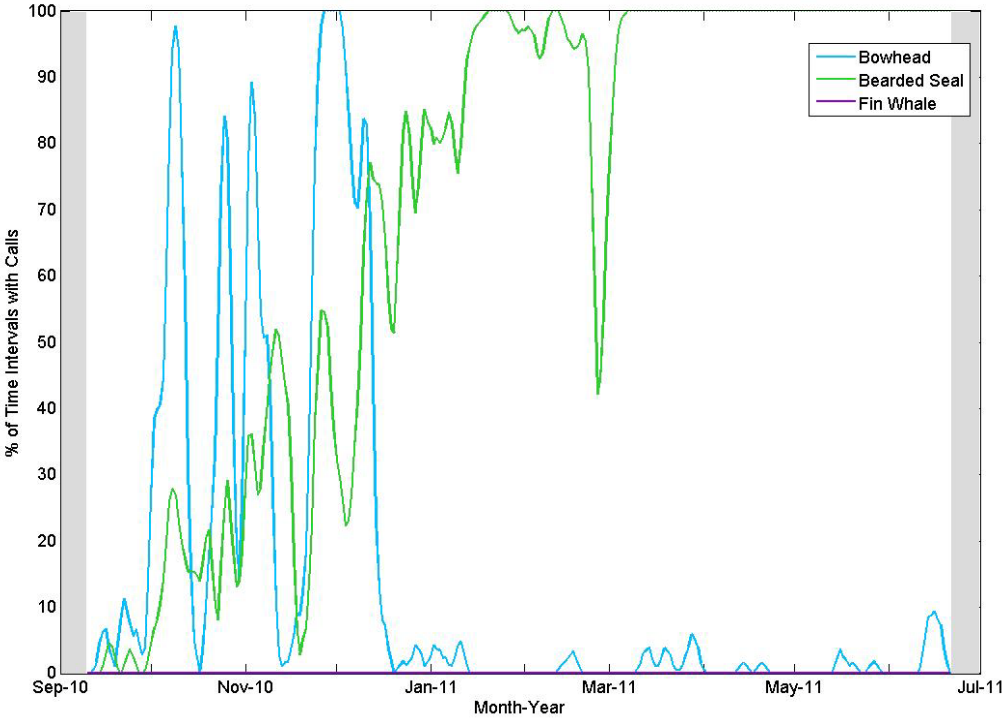


Figure 2. Seasonal acoustic detections of bowhead whales, bearded seals, and fin whales on 2010 recorder CZ10_AU_B03 at the middle mooring IC6 off Icy Cape, AK (September 10, 2010 – June 21, 2011). Results are presented as a 3 day moving average of the number of time intervals per day with calls detected.

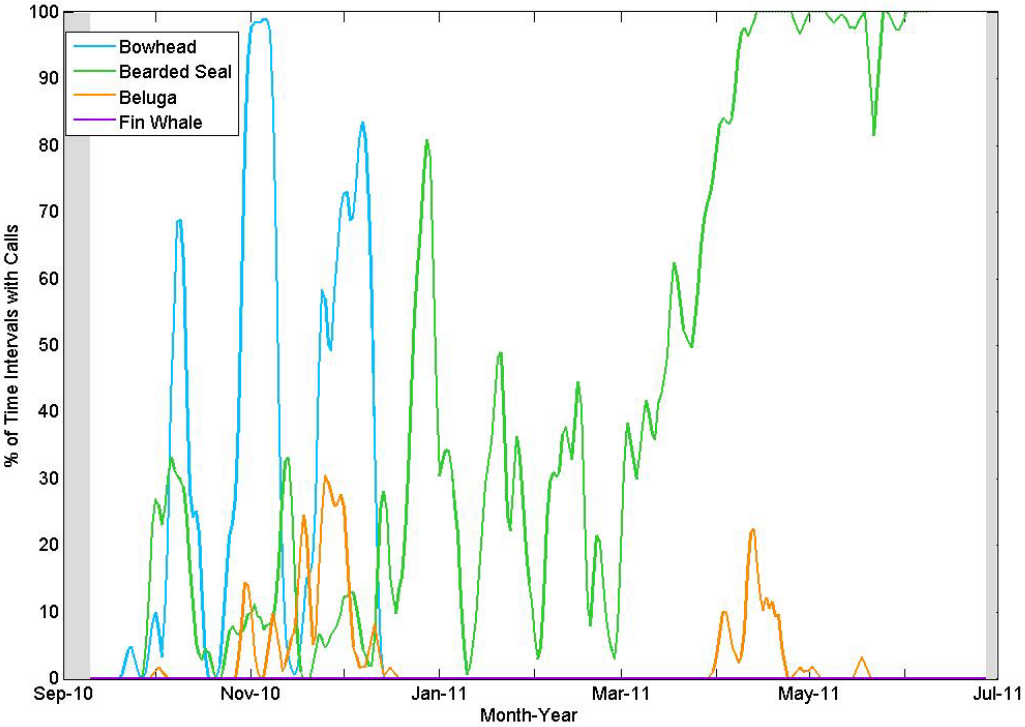


Figure 3. Seasonal acoustic detections of bowhead whales, bearded seals, beluga, and fin whales on 2010 recorder CZ10_AU_C02 at the offshore mooring IC11 off Icy Cape, AK (September 10, 2010 – June 8, 2011). Results are presented as a 3 day moving average of the number of time intervals per day with calls detected.

2013 preparations and analysis plans

Data analysis of the 2011-2012 long-term moorings has begun. We have been running a new version of our Matlab-based SoundChecker program to allow for simultaneous multi-species analysis of the recorders. The code has also been modified to allow for keyboard shortcuts, hopefully reducing some repetitive stress injuries.

We will also be implementing the Baumgartner (WHOI) low-frequency detection and classification system (LFDCS). We have a workshop with Dr. Baumgartner on April 15-16, 2013 to get the system started. If successful, this system will reduce the amount of effort expended on each recording. It will also allow us to fine-tune any auto-detection devices installed on gliders we may send out into our study areas in the future.

Most effort in 2013 will be spend integrating our passive acoustics results with those from the oceanography and zooplankton components.

OCEANOGRAPHIC COMPONENT

Preliminary results

Long-term moorings:
All data from moorings have been processed and analysis has begun. Offshore mooring IC11 (A3) is located at 71.82°N and 165.98°W. Ice arrived at the offshore IC11 (A3) area on November 22, 2011, and was present on June 14, 2012 (end of phase 02 data). The deepest keels in 2012 occurred on April 16 (28.7m) and May 2 (26.5m). This is compared to 2010-2011 data where ice arrived on November 2, 2010 and was melted by June 17, 2011, with open water November 22 – December 1, 2010. Deepest keels in 2011 occurred on April 19 (20.14m) and June 8 (19.48m).

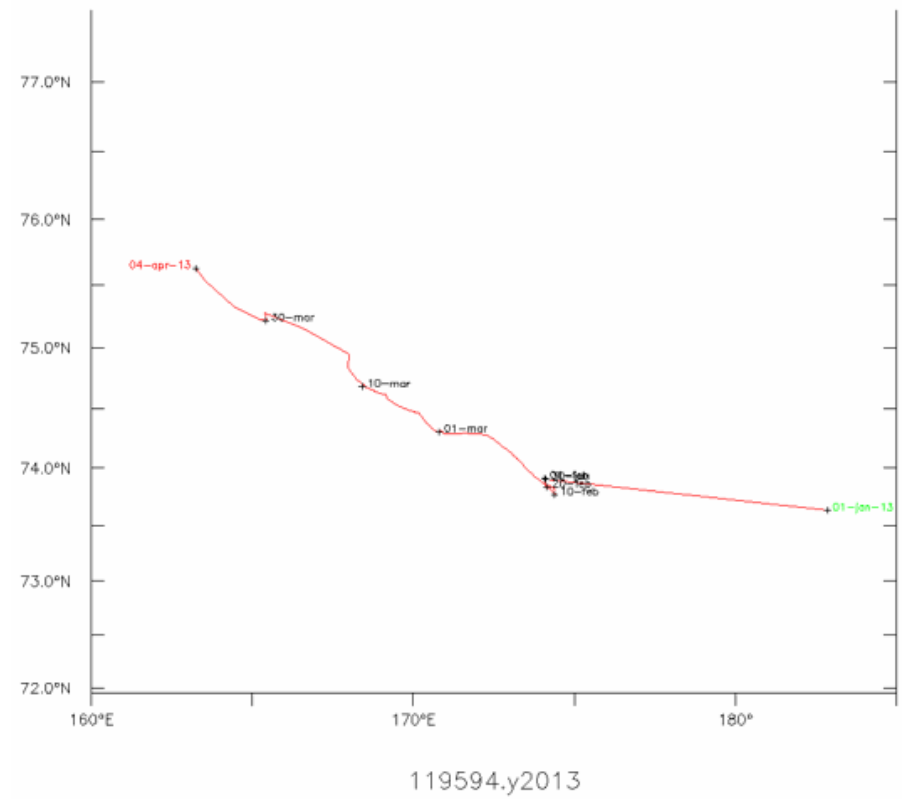
Ice thickness and area coverage data from 2010-2011 were used in the interpretation of zooplankton ACDP backscatter data presented at the Alaska Marine Science Symposium (AMSS) meeting in January 2013. These data helped confirm when ice left the region and when ADCP backscatter was attributed to zooplankton and not ice.

Satellite-tracked drifters:
In August 2012, 12 satellite-tracked drifters were deployed. By January 2013, five were still transmitting. Each was trapped in the sea ice. When the ice began to break up in the Beaufort Sea, most of the drifters moved rapidly eastward. The trajectories of two drifters are shown in Figure 4. Also see an animation of the drifter trajectories at: http://www.pmel.noaa.gov/foci/visualizations/drifter/chuk2013.html

2013 preparations and analysis plans

In the coming year our effort will be placed on completing analysis of all mooring, drifter, satellite, and hydrographic data and then synthesizing these data with the other components of the project (mammals, zooplankton, and climate). For example, examining oceanographic conditions during the times when marine mammal vocalizations are detected in each subregion; examining oceanographic conditions during the times when zooplankton volume backscatter is high; documenting cross-shelf and inter-annual variability in measured variables; examining oceanographic conditions and vocalizations in polynyas and during the spring and fall transitions; and working to understand how loss of sea ice affects upper ocean processes.

A.



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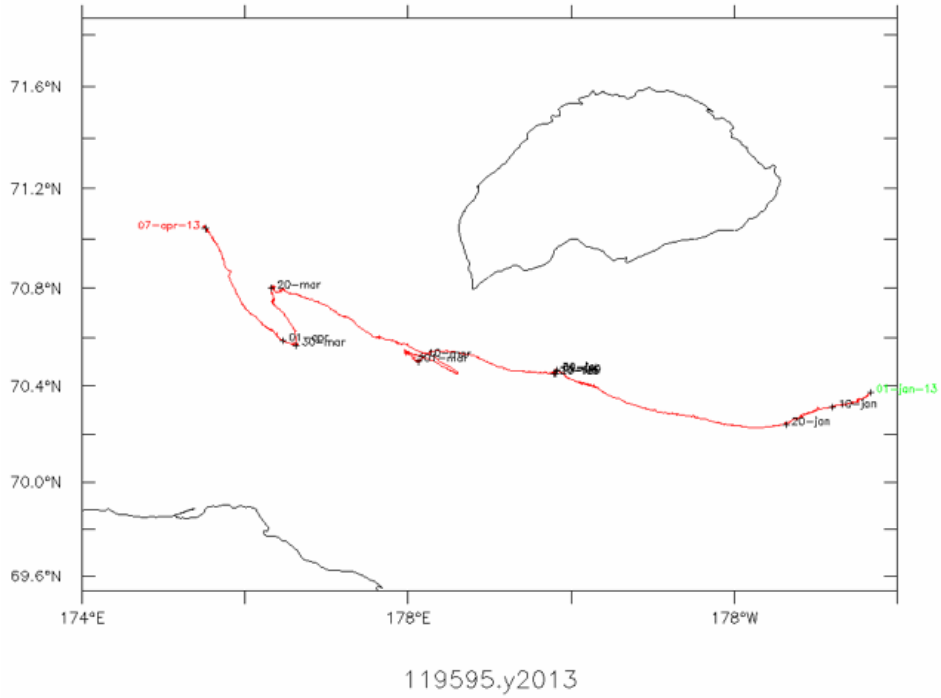

Figure 4. (A) Buoy 119594 and (B) Buoy 119595 both trapped in the ice and not transmitting regularly. Dates are indicated on the plot (approximately every 10 days).

ZOOPLANKTON COMPONENT

Zooplankton Acoustics

Work is proceeding on analyzing acoustics data. The deployment from 2011-2012 had only a few months of data due to battery issues. We've been analyzing ADCP backscatter data as well to get the maximum amount of data from all possible instruments. Below is an example of ADCP backscatter from 2010 at the inshore site along the Icy Cape line (Figure 5). The ADCP appears to capture the spring bloom and increase in zooplankton biomass. We carefully compared these plots to both ice thickness measurements and satellite images of ice cover to ensure we knew when ice was present over the mooring and possibly contributing to the backscatter. You can also see diel vertical movement within the water column. Data from all three ADCP units were processed for backscatter and were included in our AMSS presentation. Figures of zooplankton backscatter are being compared with results from the passive acoustic recorders to understand if the temporal patterns in plankton acoustic backscatter match the timing of when marine mammals migrate through the area.

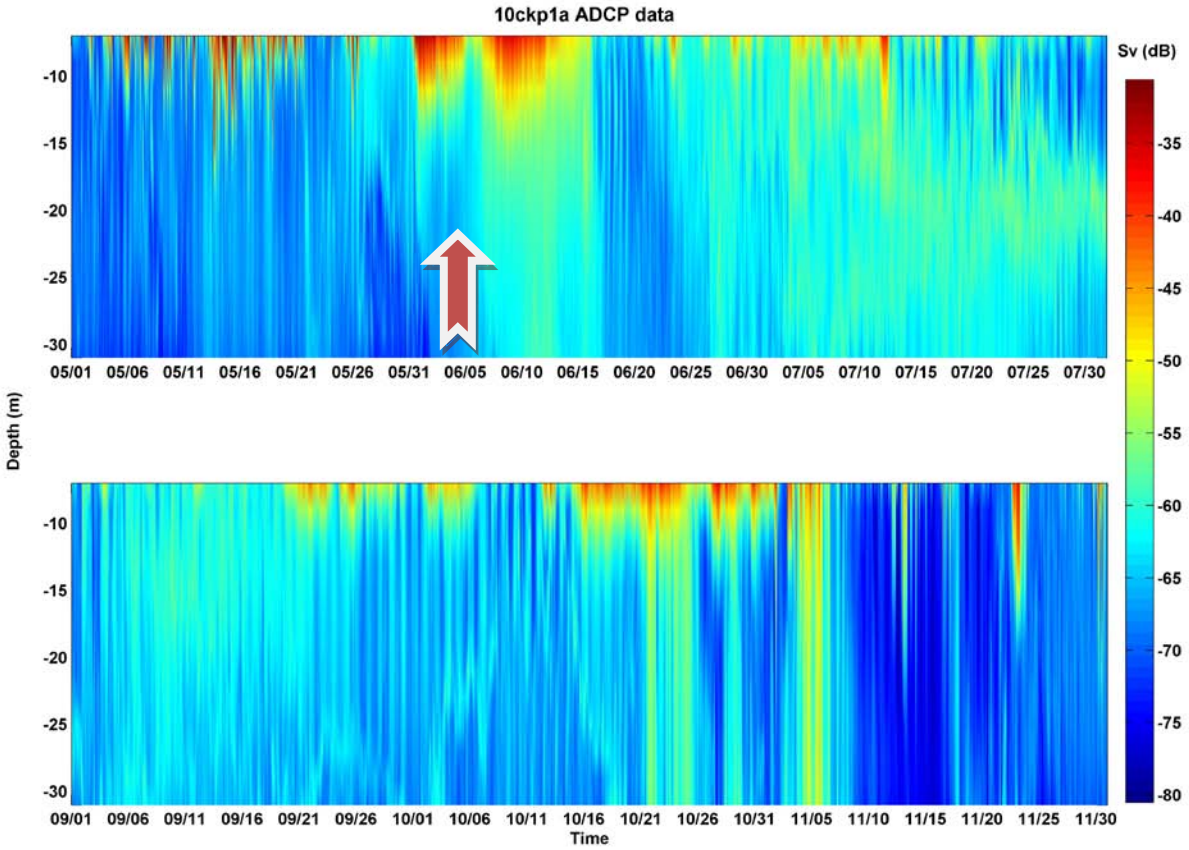

Figure 5. ADCP zooplankton backscatter from 2010-2011 at inshore IC3. Top panel: Spring – mid Summer. Bottom panel: late Summer – Fall. Red arrow in spring was the date after which no ice was present over the mooring as indicated by satellite imagery and *in situ* ice thickness measurements. Onset of ice in fall is not indicated in this figure.

Preserved Zooplankton Samples

Data sheets for preserved zooplankton samples from the August 2012 cruise have been returned from Poland. The Recruitment Processes Program is in the middle of creating a new Oracle database to replace our older Access database. The new data entry module is not yet complete; we anticipate that it will be finished midway through the second quarter of 2013. Once finished we will be able to enter the CHAOZ 2012 zooplankton data into the appropriate data tables.

Data from the 2010 and 2011 samples have been verified, uploaded to our old database, and used in the oral presentation at AMSS. The vast majority of the euphausiids we collected with our Tucker Sled during our cruises in 2010 and 2011 were early juvenile stages (furcilia), not adults (Figure 6). Stratified net tows with the Tucker Sled also revealed that concentrations of adult euphausiids were as prevalent in the bottom 1m of water as they were in the entire water column (Figure 7). This demonstrated the necessity of using a sampler that is able to capture and retain organisms in close proximity to the seafloor. Finally, in 2011 we observed the remnants of a cross shelf transport event while sampling our grid. The presence of the arctic copepod, *Calanus hyperboreus*, was evidence for either Arctic Ocean or Beaufort Sea water on the shelf (Figure 8). This could have occurred either as up-canyon transport through Barrow Canyon or a distinct cross-shelf transport event over the shelf break west of the canyon. *C. hyperboreus* was not observed over the shelf in 2010, but was observed by us and others working in the region during the late summer of 2011.

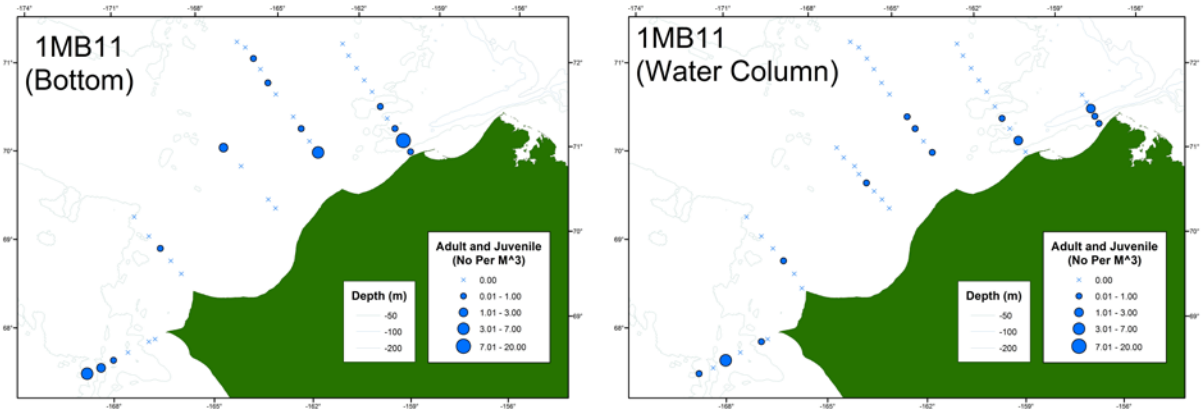

Figure 6. Distribution and concentration of early juvenile stage euphausiids in the CHAOZ sampling area in August 2010 (1AE10) and 2011 (1MB11).

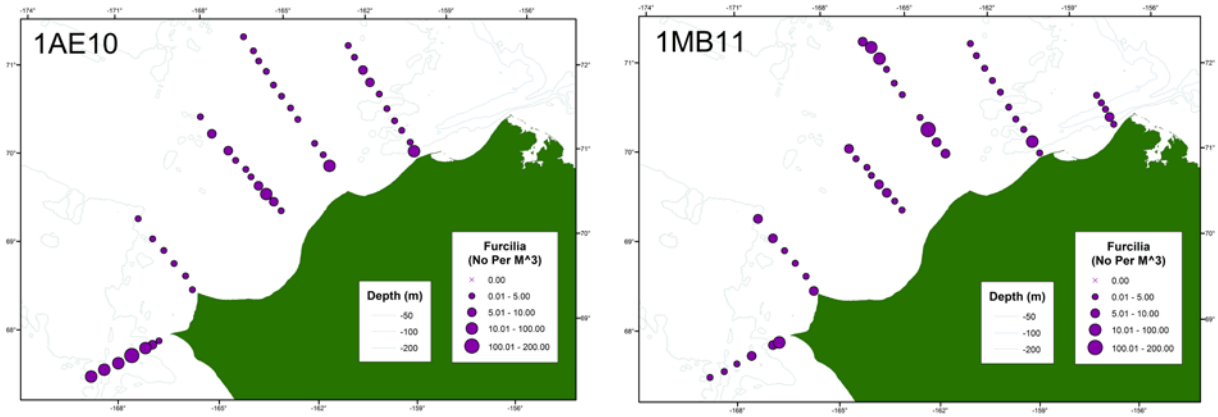

Figure 7. Distribution and abundance of adult and juvenile euphausiids in August 2011. Left panel are data from within 1m of the bottom. Right panel are data from the remainder of the water column.

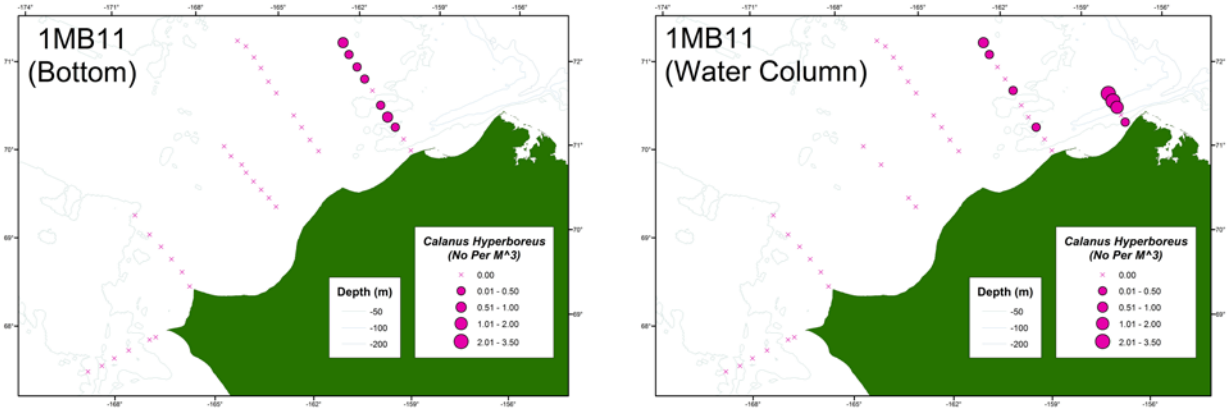

Figure 8. Distribution and abundance of the large Arctic copepod *Calanus hyperboreus* in August 2011. Left panel are data from within 1m of the bottom. Right panel are data from the remainder of the water column.

2013 analysis plans

We will focus on further analysis of TAPS, ADCP, and zooplankton net data in 2013. The objective is to bring as much of the material as possible into a form that can be used for peer-reviewed publication and our final report. We are currently working on a short note for *Geophysical Research Letters*, tentatively titled "An integrated ocean observing approach to understanding the effects of climate variability in the NE Chukchi Sea." We also continue to work on several different aspects of acoustic methods to improve future measurements of arctic zooplankton. Our controller card contract has completed the functional specifications stage and is in the design stage. A preliminary design was delivered and is being reviewed. We also continue to conduct a literature review for better zooplankton scattering models. Emerging literature shows that euphausiid material properties (sound speed and density contrasts) are a function of their size and lipid content, not just size. How to obtain and use this new information is the subject of our investigations.

Other Activities: Napp gave an oral presentation at the AMSS meeting to bring together some of the CHAOZ physical and biological information. The presentation by Napp, Berchok, Stabeno, and Moore was titled "An integrated ocean observing approach to understanding the effects of climate variability in the NE Chukchi Sea." Napp and L. Logerwell (AFSC) are planning a Synthesis of Arctic Research (SOAR) project workshop in May to synthesize what we know about the small pelagic fishes of the Chukchi region.

OCEAN NOISE AND REAL-TIME PASSIVE ACOUSTIC MONITORING

Auto-Detection Buoy System (AB)

The AB monitoring system was deployed and actively transmitted between 09 Aug and 09 Nov 2012. Between mid-November 2012 through the week of 11 March 2013, the AB was stored at the dock facilities in Seward, AK. In mid-March, the AB system was retrieved by WHOI's Jeff Pietro. From WHOI, the electronics canister including the onboard flashcard, was shipped to Cornell via UPS and received in Ithaca on 14 March 2013. Downloading has confirmed that the continuous audio data were successfully stored as 8 kHz .flac files on the buoy. They were also converted and made available as .aiff files.

Those data have been backed up and appropriate analyses are being designed. With detailed analyses, we hope to assess the system's detection performance, and implement adjustments as necessary for future deployments. The AB monitoring system will not be deployed on the 2013 field survey, but preparations are being made for a 2014 deployment.

Marine Autonomous Recording Unit (MARU)

Over the past year, the acoustic data from both CHAOZ MARUs (2010-11 and 2011-12) have been analyzed using custom-developed tools (Dugan *et al.*, in prep) to investigate the acoustic environment surrounding oil and gas leases in the Chukchi Sea.

Early in this quarter, cumulative distributions of Sound Equivalent Levels (L_{eq}) were calculated for each month of each deployment (Figure 9). Results show that open water months (September and October) present the most elevated levels; 50% of the time during Sept/Oct, mean L_{eq} are ~14 dB higher than the 50% mean value of most other months. By examining spectrograms from September and October in detail, this result is consistent with the presence of multiple nearby seismic activities, which are only possible in ice-free conditions.

In 2011-2012, other months like August and November present "transition" L_{eq} levels, in between those elevated ones from September/October and the baseline of the rest of the year. We hypothesize that portions of these months could be becoming ice-free, and seismic surveys may be taking advantage of the extended season to shoot during the late weeks of August or early weeks of November. All of these results were presented in late January at the Alaska Marine Science Symposium in the form of a poster.

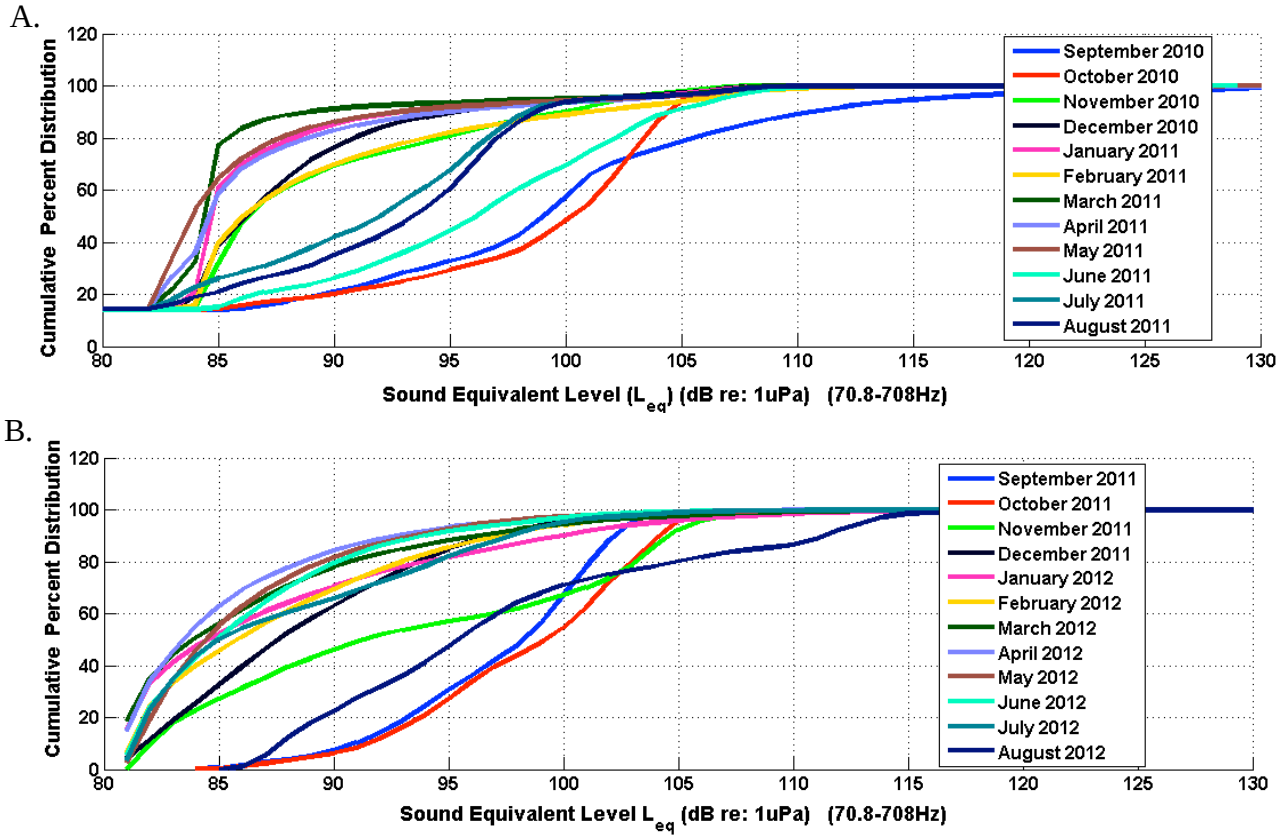

Figure 9. Cumulative Percent Distribution of monthly L_{eq} in the 70.8-708 Hz band for acoustic data from (A) MARU 2010-2011; and (B) MARU 2011-2012.

Manual analysis of the MARU data began in late March 2013. The objective of the manual extraction effort will be to create an index of acoustic presence/no presence for two focal "species": bowhead whales and seismic activity. Three other opportunistic species abundant in the area will also be noted: walrus, bearded seals, and beluga whales. The protocol relies on the visual inspection of spectrograms (in 5-minute-page format) using the software RAVEN. Figure 10 illustrates spectrograms corresponding to

calls from four categories being extracted in the manual analysis. Each day is divided into two periods when acoustic presence/no presence is reported: 0:00 to 11:59 and 12:00 to 23:59. Given that the 2010-2011 acoustic data was 50% duty cycled but 2011-2012 recorded continuously, for each 12-hour period, only 30 minutes of every hour are inspected. Once the first occurrences of bowhead and seismic are marked, the entire 12-hour period is characterized as having that particular species present. All twelve 30-minute intervals corresponding to a period are inspected completely only in the case when no bowhead or seismic are found. The three opportunistic species are only marked if they occur before satisfying the criteria of extracting the first bowhead or seismic sound. In the end, these data will provide an index of acoustic presence/no presence of bowhead and seismic in 12-hour bin resolution, allowing for a correlation analysis between the two variables.

Some of the concerns reported by the manual analysis team thus far relate to:

- Difficulty in recognizing distant seismic impulses that have lost some of the original impulse characteristics (spreading over time, loss of high frequencies, etc.).
- Questions whether those distant "smudged" seismic impulses should be reported in the same category as clear, distinct seismic activity (probably occurring closer to the receiver).
- Cases of stand-alone explosive sounds that resemble a seismic impulse, but are not part of a repetitive train. Possible sources: array misfire, seal bomb, whaling shot?
- Unknown biological sounds, potentially belonging to gray whales or humpbacks.

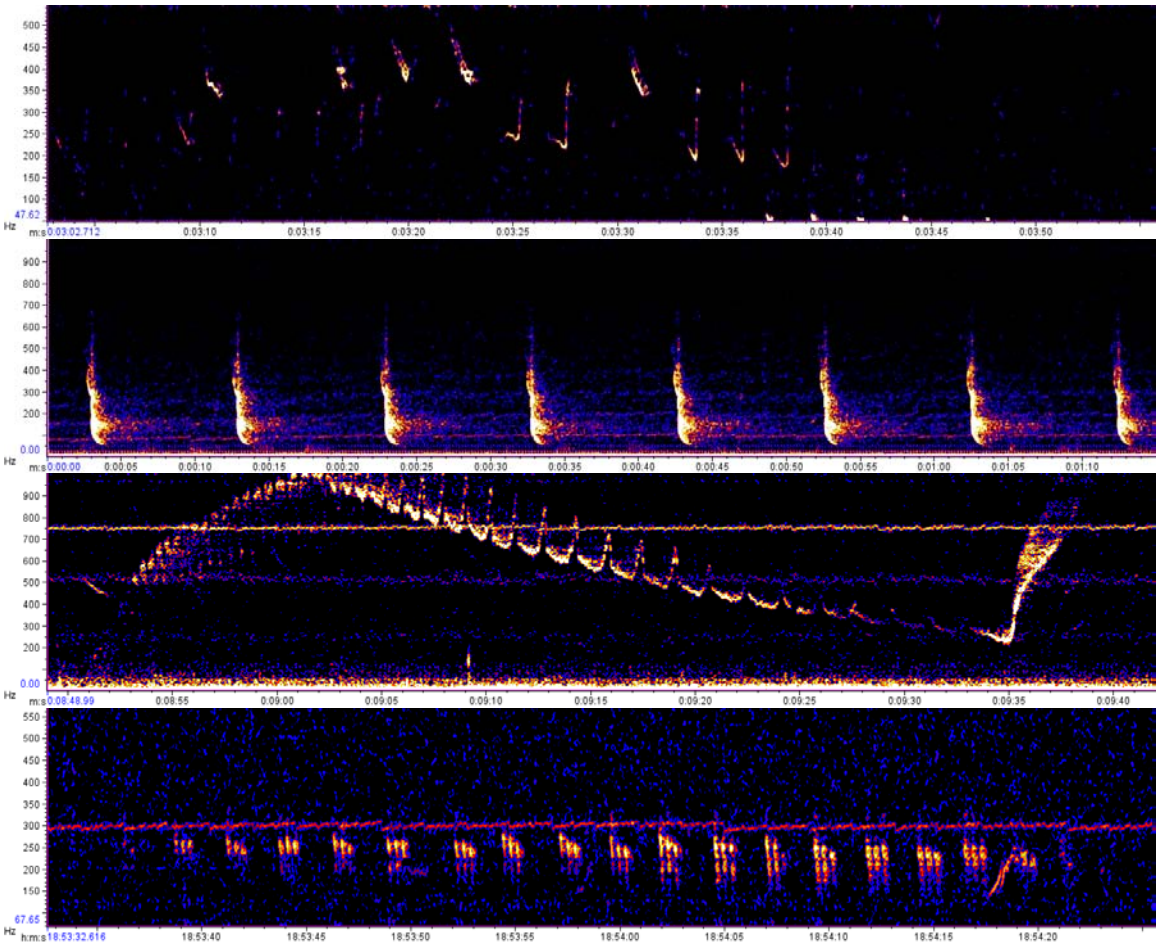

Figure 10. Sample spectrograms for some of the categories extracted from the MARU 2010-2011 acoustic data via visual analysis: (a) bowhead whale call sequence (song); (b) seismic activity; (c) bearded seal; d) unknown source

2013 preparations and analysis plans

Aside from continuing the manual analysis, the next step will be to estimate what the background ambient levels would have been in the absence of seismic surveys, in order to quantify the impact specifically due to that disturbance. For this, we will look at times before/after the seismic survey and model the contribution of other natural noise sources, like wind. Furthermore, an automated seismic detector developed at BRP (Dugan *et al.*, in prep) will be applied to the data, with the purpose of extracting detailed metrics that characterize each impulse in time and frequency, as well as the seconds that immediately follow each shot.

Acknowledgments: The CHAOZ MARU manual analysis effort at BRP is lead by Russ Charif and Ann M. Warde, and performed by research analysts: Kristin Hodge, Kaitlin Palmer, Elizabeth McDonald, Emily T. Griffiths, and Maureen E. Loman. We thank them all for supplying the spectrograms shown in Figure 10.

CLIMATE MODELING COMPONENT

We have successfully completed three simulation runs, each consisting of 30 years of simulation using CESM1.0 configuration (CAM2 for atmospheric component, CLM2 for the land surface component, CICE for sea ice model, and POP2 for ocean component). These four model components are joined via the coupler, CPL. The runs were initialized with low sea ice coverage under RCP6.0 emissions scenario, and the outputs were compared with the original CCSM4 runs. We also compared model results (currents, temperature, salinity and sea ice thickness) at the Chukchi Sea Icy Cape mooring sites (IC3, IC6 and IC11) with observations. The CESM simulated seasonal cycle of ocean temperature is in agreement with observations, although during ice free months the simulated ocean temperature at 40m depth is higher than that observed at the moorings. The simulated ice thickness is within the range of observations, but the model only simulated a single peak in the salinity profile, whereas observations depicted twin peaks at the middle and offshore mooring sites IC6 and IC11. A manuscript about future climate projections by IPCC AR4 models over the Bering the Chukchi Seas was published in *Deep-Sea Research II* in 2012. (Wang *et al.* 2012). Dr. Wang and Dr. Overland published another paper using the updated CMIP5 model outputs in GRL entitled “A sea ice free summer Arctic within 30 years: An update from CMIP5 models”.

Significant meetings held or other contacts made

23 January 2013: Berchok hosted “What the Phonation - Identifying Arctic sounds” workshop during the Alaska Marine Science Symposium. Attendees include: Catherine Berchok, Jessica Crance, Stephanie Grassia, Ellen Garland, and Jessica Thompson (AFSC/NMML); Julien Delarue and Heloise Mouy (JASCO Research); Josh Jones (Scripps Institution of Oceanography); Susanna Blackwell (Greeneridge Sciences); Chris Clark and Melania Guerra (Cornell University); and Kalyn MacIntyre (Univ. Washington).

27 February – 1 March 2013: Berchok provided an overview of CHAOZ at the Distributed Biological Observatory (DBO) data workshop hosted by Sue Moore in Seattle.

27-28 February 2013: Ellen Garland attended a workshop an internal NOAA workshop in DC entitled “NOAA Ocean Noise Strategy”, in which ocean noise and potential management applications were discussed to come up with an strategy to minimize ocean noise.

11 April 2013: Berchok participated in NOPP conference call on the implementation of the acoustic metadata database developed by Marie Roch (San Diego State U.). A meeting is planned for early May in San Diego to help with the porting of data to the database.

Presentations and Publications

Clark, C. W., C.L. Berchok, S. Blackwell, J. Citta, D. Hannay, J. Jones, L. Quakenbush, and K.M. Stafford. "A year in the acoustic world of Western Arctic bowhead whales". In prep.

Crance, J.L. and C.L. Berchok. "Farthest northeast acoustic detection of a fin whale (*Balaenoptera physalus*) in the Alaskan Chukchi Sea." In prep.

Garland, E.C., C.L. Berchok, and M. Castellote. 2013. "Spatio-temporal distribution of Alaskan beluga (*Delphinapterus leucas*) populations based on acoustic monitoring." Poster presentation at the Alaska Marine Science Symposium, 21-25 January 2013. Anchorage, AK.

Grassia, S.L., C.L. Berchok, Crance, J.L., B.K. Rone, A. Kennedy, and P.J. Clapham. 2013. "Short- and long-term distribution of marine mammals in the Chukchi Sea." Poster presentation at the Alaska Marine Science Symposium, 21-25 January 2013. Anchorage, AK.

Guerra, M. A.N. Rice, D.W. Ponirakis, and C.W. Clark. 2013. "Characterization of the inter-annual ambient noise baseline off Icy Cape, Alaska, and its primary sources (2010-2012)." Poster presentation at the Alaska Marine Science Symposium, 21-25 January 2013. Anchorage, AK.

MacIntyre, K. 2013. "Acoustic detection of bearded seals (*Erignathus barbatus*) in the Bering, Chukchi, and Beaufort Seas 2008-2011." Oral presentation at the Alaska Marine Science Symposium, 21-25 January 2013. Anchorage, AK.

Napp, J.M., C.L. Berchok, P.J. Stabeno, and S.E. Moore. 2013. "An integrated ocean observing approach to understanding the effects of climate variability in the NE Chukchi Sea." Oral presentation at the Alaska Marine Science Symposium, 21-25 January 2013. Anchorage, AK.

Napp, J.M., C.L. Berchok, P.J. Stabeno, and S.E. Moore. 2013. "Steps toward an integrated ocean observing approach to understanding the effects of climate variability in the NE Chukchi Sea." Oral presentation by Moore at the 28th Lowell Wakefield Symposium, 26-29 March 2013. Anchorage, AK.

Wang, M. 2013. "A sea ice free summer Arctic within 30 years: An update from CMIP5 models." Oral presentation at the Alaska Marine Science Symposium, 21-25 January 2013. Anchorage, AK.