CHUKCHI ACOUSTIC, OCEANOGRAPHY AND ZOOPLANKTON EXTENSION STUDY: (CHAOZ-X)

QUARTERLY REPORT

Julie Mocklin¹, M.S.
Catherine L. Berchok¹, Ph.D.
Jeff Napp², Ph.D.
Phyllis Stabeno³, Ph.D.
Phillip J. Clapham¹, Ph.D.

¹National Marine Mammal Laboratory
Alaska Fisheries Science Center

²Resource Assessment and Conservation Engineering Division
Alaska Fisheries Science Center

³Pacific Marine Environmental Laboratory
Ocean Environment Research Division

7600 Sand Point Way NE
Seattle, WA 98115

Submitted to the Bureau of Ocean Energy Management (BOEM)
under Inter-Agency Agreement Number M13PG00026

July 2014
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 to document the temporal and spatial distribution of baleen whales near Hanna Shoal in the northeast Chukchi Sea and to relate variations to oceanographic conditions, indices of potential prey density, and anthropogenic activities to improve understanding of the mechanisms responsible for observed high levels of biological activity around the shoal. This quarterly report covers the period between April 1st and June 30th, 2014.

The major activities during this period consisted of preparations for the 2014 field season and data analysis from 2013. Analyses are currently ongoing, and some preliminary results are detailed below.

Introduction and objectives

Hanna Shoal in the NE Chukchi Sea is an area of special biological concern near the boundary between Chukchi and Arctic Basin waters. The reason for this, however, is poorly understood. The shallower waters of the shoal have long been known to trap sea ice which can ground on the shoal, and a recurring polynya is created down current of the grounded ice. In most recent years, floating pack ice in summer persists in this area longer than elsewhere in the Chukchi Sea, often surrounded by open water even to the north. Biological “hot spots” in the Chukchi Sea are thought to be related to strong coupling between pelagic and benthic productivity. A high abundance of bottom fauna is correlated with high pelagic phytoplankton concentrations, possibly associated with an ice edge, which reach the seabed mostly ungrazed. The importance of the Hanna Shoal region to bowhead and gray whales and other marine mammals is not well known. In the 1980’s and 1990’s gray whales were frequently observed feeding near Hanna Shoal (Moore 2000) although they have not been observed during aerial surveys since 2008 (Clarke et al. 2012). Walruses, on the other hand, that were seen offshore during aerial surveys in summer 2011, appeared to show a preference for Hanna Shoal, presumably using the area to feed (Clarke et al. 2012).

The focus of the proposed study is to determine the circulation of water around the Hanna Shoal area, the source of this water (Chukchi Shelf or Arctic Basin) and its eventual destination, and the abundance of large planktonic prey at the shoal. The dynamic nature of this circulation and prey delivery will be studied relative to whale distribution and habitat utilization in the northeastern Chukchi and extreme western Beaufort Seas.

Biophysical moorings will supplement existing data by collecting important information on current flow and water properties in that region, while concurrently deployed passive acoustic moorings will provide 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, indices of potential prey density, and anthropogenic activities). The passive acoustic recordings will also provide baseline information on ambient noise levels throughout this area which is undergoing rapid change. In addition, a passive-acoustic auto-detection buoy will provide near-real-time information on species presence and ambient noise levels. These buoys are in the second stage of development towards their use as a real-time tool for regulators to mitigate the effects of anthropogenic noise.

Our goal is to use the CHAOZ-X sampling tools to understand the mechanisms responsible for the high biological activity around the shoal so that we can predict, in a qualitative way, the effects of climate
change on these preferred habitats. The use of moorings will allow us to quantify transport and water properties, especially during the more than 6 months the region is ice-covered.

The specific objectives are:

1. Refocus the passive acoustic and biophysical monitoring begun under the study “COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales” from the initial lease areas to Hanna Shoal.
2. Describe patterns of current flow, hydrography, ice thickness, light penetration, and concentrations of nutrients, chlorophyll, and large crustacean zooplankton around the shoal.
3. Assess the spatial and temporal distribution of marine mammals in the region of Hanna Shoal.
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. Develop a quantitative description of the Chukchi Sea’s noise budget, as contributed by biotic and abiotic sound sources, and continuous, time-varying metrics of acoustic habitat loss for a suite of arctic marine mammal species.
6. Continue development of a near-real-time passive acoustic monitoring system that can be used as an impact mitigation tool.

Cruise activities and summary

Planning for the 2014 vessel survey is as complete as can be at this stage. Sampling and mooring locations and survey plans have been developed (see attached cruise plan). The Western Acquisition Division processed the paperwork necessary to charter a vessel. The solicitation closed on 14 May. The technical evaluation was completed by NMML staff on 27 May, and the final budget evaluation was submitted 18 June. The contract was awarded to KB Fisheries, Inc. on 10 July for charter vessel services on the R/V Aquila. Paperwork has been submitted to the Western Acquisition Division to hire survey personnel. Field equipment and supplies have been purchased. Informational fliers have been developed for distribution to Alaskan villages describing the ARCWEST/CHAOZ-X projects.

Preliminary data analysis results and planning

Passive Acoustic Component

Long-term passive acoustic recorders:

[Note: All recorders used in this study are Autonomous Underwater Recorders for Acoustic Listening (AURALs, Multi-Électronique, Rimouski, QC, Canada), sampling at a rate of 16 kHz on a duty cycle of 80 minutes of recordings made every 5 hours, for an entire year].

Planned locations for the 2014 CHAOZ-X moorings (see attached cruise plan for maps) were determined in coordination with the oceanographic and lower trophic level components of CHAOZ-X. All planned 2014 mooring locations are the same as the 2013 deployments, with the exception of one additional mooring planned for deployment on Hanna Shoal. We also plan to deploy a deep-water Haruphone (Haru Matsumoto, NOAA/PMEL/CIMRS) recorder on its own mooring close to the Stabeo ADCP mooring. This recorder is part of a NOAA effort (by collaborator Holger Klinck (NOAA/PMEL/CIMRS)) to map deep
water ambient noise throughout the U.S. EEZ. Results from this effort will be made available to the CHAOZ-X study.

For the upcoming analyses, we plan to use our in-house Matlab-based sound analysis program on data pre-processed using a low-frequency detection and classification system (LFDCS by Mark Baumgartner, Woods Hole Oceanographic Institution (WHOI)).

Eliza Ives, tasked with implementing the LFDCS on our data, is continuing to conduct iterative testing of the Chukchi bowhead whale call library. She has completed several rounds of testing the call library’s efficacy against moorings from which she selected the call type exemplars. This process ensures false detection rates and missed detection rates are as low as possible before putting the call library through logistic regression analysis and testing it against novel data sets. Old mooring data are constantly being reformatted from wave files to NetCDF files, the audio format understood by the LFDCS. This process will continue until all our mooring data are reformatted for use and analysis in the LFDCS. She has now moved on to creating a fin whale call library.

Jessica Crance is currently running an analysis of gray whale calls at the low frequency band (0-250Hz) to see if anything is missed by conducting that analysis on the mid-range frequency band (0-800Hz). If the results are the same, then we can run the low-band analyses (just fin whales) with the LFDCS and cut our analysis time by a third.

Ellen Garland, our NRC postdoctoral fellow, has analyzed four 2010-2011 moorings for beluga vocalizations; one in the western Beaufort Sea, two CHAOZ moorings in the Chukchi Sea (inshore and offshore Icy Cape), and one in the northern Bering Sea (M8, deployed under CHAOZ funds). The aim of this study is to identify peaks in beluga vocal activity over a single year to better understand the migratory movements and fine-scale timing of the eastern Beaufort Sea and eastern Chukchi Sea populations as they undertake their extended migrations in the Alaskan Arctic and Subarctic. After overwintering in the Bering Sea, belugas from the eastern Beaufort Sea and eastern Chukchi Sea populations migrated north through the northeastern Chukchi and western Beaufort Seas in multiple waves which were temporally distinct. These results suggest peaks in vocal activity are able to capture fine-scale temporal movements of populations when temporal or spatial differences between detection peaks are large enough to be identified as independent events. This study agrees with the overall understanding of seasonal beluga movements from satellite tagging studies, and highlights the successful application of passive acoustic monitoring to improve our understanding of the fine-scale migratory timing of populations for management and conservation in a region undergoing rapid change. This work was submitted as a manuscript to Polar Biology which is currently under review, and presented at the Biennial Conference on Marine Mammals in December, the Alaska Marine Science Symposium in January, and the Ecology and Acoustics Conference in June. After conducting the spatio-temporal distribution analysis, she has now begun extracting and measuring individual beluga calls to generate a beluga call repertoire for each population. After the repertoires are built, she will investigate the feasibility of using differences in repertoires (dialects) to identify each population, and thus track the migration and movement patterns of different beluga populations based entirely on passive acoustics. Although no CHAOZ-X data is currently being used in her analysis, the data collected from passive acoustic recorders deployed under the CHAOZ-X project will likely be included in future work on belugas. Specifically, if the vocal repertoires (dialects) of populations are able to be distinguished from call types, the CHAOZ-X passive acoustic data set will be invaluable for investigation of movement patterns at the broad scale.
Sonobuoys:

The remaining stock of sonobuoys has been inventoried and one crate of new sonobuoys was picked up in mid-April from the Naval Air Station Whidbey Island. We will have a sufficient number of sonobuoys for the 2014 ARCWEST/CHAOZ-X cruise.

Oceanographic and Zooplankton Component

Hydrographic samples (nutrients, salt, dissolved oxygen and chlorophyll) collected in 2013 were returned to Seattle and processed in our laboratories. Zooplankton samples were returned to Seattle and were shipped in November to the Polish Plankton Sorting and Identification Center for sample analysis. The data from these samples arrived in May. Our next step is to check the data entry by Poland for errors (every handwritten form will be compared to what was entered into the computer in Poland), and corrected.

Assembly, tuning and calibration of the new TAPS6-NG units have been completed. We’ve tuned the units in temperature conditions similar to the Chukchi which will maximize performance. We are currently testing the new units for any coding or mechanical issues. Once this test is complete, we will begin the process of preparing them for deployment, mounting on the buoys, etc. The ‘new’ controller boards require additional redesign, so we installed ‘old’ controllers for this year’s deployments. We expect to deploy 6 instruments in 2014.

Ocean Noise and Real-time Passive Acoustic Monitoring Component

The initiation of effort during this quarter was significantly impacted because of bureaucratic delays in securing funding. Although the proposed start date of funding was shifted to 1 April 2014, we did not obtain official permission to spend until early June, at which time we immediately commenced work on the software code and analysis system for quantifying the ocean noise budget from various types of sound sources in the Arctic. This includes mechanisms by which to evaluate influences from individual sources and the influences from the aggregation of sounds sources. We refer to this topic as acoustic ecology, and we refer to the associated acoustic ecology analytical system as SEDNA.

Cornell continued to make progress with SEDNA for optimization such that the MatLab code can be run on either single systems (e.g., a laptop) or multi-core systems (i.e., a high-performance computer). The latest version of this code was exercised for QA/QC by comparing analytical outputs under the older, established code and the latest version of SEDNA. We refer to the analytical system that involves a multicore machine with NAS, as SEDNA-DELM. A beneficial attribute of this system is that it can ingest acoustic data sets of any size (i.e., data ingestion is size-independent) and with variable file naming conventions (i.e., file name format independent). These capabilities were undertaken because the sizes of raw acoustic data collection efforts are growing and highly variable, and there is no standard file naming convention. These features are intended to enable collaborative coordination of data processing tools and results between Cornell BRP and NOAA-AFSC.

In preparation for the deployment of acoustic equipment in the Chukchi Sea in summer 2014 Cornell shipped its acoustic auto-detection module to WHOI for testing before the entire AB system was shipped to Seward, AK. We also tested and prepared for shipment four MARUs and one double-bubble system as well as their back-up and deployment systems. These will be shipped in late June to coordinate with the departure of the R/V Westward Wind from Seward and Nome. Arrangements are on schedule for a Cornell field technician to sail on the R/V Westward Wind from Nome to deploy the four MARUs and one double-bubble system in association with the AB deployment site. The exact geometry for the recorders is still being finalized at this time, but one possible design is shown in Figure 1, below. The plan is to recover the four MARUs and the AB in early October.
It is important to note that our ability to deploy and recover all this equipment from the Westward Wind is made possible through the generosity of Michael Macrander (Shell, AK) and Caryn Rea (Conoco-Phillips, AK) and the program management support of Sheyna Wisdom. Without this support the AB and MARU research plan would be significantly compromised if not impossible.
Figure 1. Top: Location and general geometry of Cornell deployment for summer-fall 2014. Bottom: zoom-in of top panel to show details of possible deployment configuration. AB refers to the auto-detection buoy. DB refers to the double-bubble recorder that records continuously for 1 year. Numbers refer to the four MARUs.
Contribution of data to the Distributed Biological Observatory (DBO)

The CHAOZ-X program has agreed to contribute data to the DBO Workspace, supported by AOOS/AXIOM. CHAOZ-X principal investigators were invited to join the password-protected Workspace in December 2013, and are in the process of contributing data and data products (maps and figures) as are other DBO contributors. The development of the Workspace is an activity of the DBO Implementation Team (http://www.arctic.noaa.gov/dbo/about.html#DBO_Implementation_Team) and is in its early stages. The contribution of information from the CHAOZ-X program is considered foundational to the development of the Workspace, especially for the visual and acoustic data provided on marine mammals. To date, the 2013 sonobuoy data have been uploaded, as well as a map detailing the location of the currently deployed passive acoustic moorings.

Significant technical, schedule, or cost problems encountered

None

Significant meetings held or other contacts made

None

Presentations and Publications


Literature Cited
