

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

QUARTERLY REPORT

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

July 2015

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, 2015.

The major activities during this period consisted of preparations for the 2015 field season and data analysis from 2014. Analyses are currently ongoing, and some preliminary results are detailed below. The acoustics group is also mid-way through implementing a passive acoustics database (Tethys, Roch et al., 2013), as part of a pilot project with NGDC to archive the data and make it publically accessible.

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 seldom been observed during aerial surveys since 2008 (Clarke et al. 2014). Walrus, on the other hand, are still commonly seen near Hanna Shoal, presumably using the area to feed (Clarke et al. 2014).

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 2015 vessel survey is as complete as can be at this stage. The cruise will take place between 6-26 September and survey activities will be split between the R/V *Aquila* and the NOAA Ship *Ronald Brown* to reduce costs. Mooring retrieval and deployment, passive acoustic monitoring, and visual surveys will be conducted on board the R/V *Aquila*. Biophysical sampling (CTD’s and plankton net tows) will take place on board the NOAA Ship *Ronald Brown*. Sampling and mooring locations and survey plans have been developed (see attached cruise plan). 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

Marine Mammal 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 2015 CHAOZ-X moorings (see attached cruise plan for maps) were determined in coordination with the oceanographic and lower trophic level components of CHAOZ-X. A subset of the 2014 CHAOZ-X moorings will be redeployed during the ARCWEST/CHAOZ-X cruise in 2015 to maintain the long-term time series even though retrieval in 2016 is currently unfunded. The acoustic releases have a usable battery life of six years, and so collecting these recorders opportunistically by piggybacking on another cruise should not be a problem. The deep-water Haruphone (Haru Matsumoto, NOAA/PMEL/CIMRS) recorder mooring deployed in 2014 is a two-year deployment and will not be recovered until 2016. 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.

The acoustics team continues to process the data from the moored passive acoustic recorders to obtain the seasonal distribution of the following species: bowhead, gray, fin, humpback, minke, killer, beluga, sperm and right whales; bearded and ribbon seals, unidentified seals, and walrus. Vessel noise, airguns, and ice noise are also analyzed. When the CHAOZ-X project is completed there will be at least a six-year time record on the Icy Cape mooring line; as recordings began there in 2010 as part of the CHAOZ project.

For future 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 Institute (WHOI)). However, until this is fully operational, we will continue to process data manually. This system is still not performing adequately for bowhead whales. The first round of results from the fin whale tests were not as successful as we'd hoped. A NOAA Hollings scholar, Sirishti Dasarathy, and an intern, Nick Tucker, have been analyzing two moorings for fin whale vocalizations. Once complete, their results will be incorporated into the fin whale call library and the LFDCS will be re-tested for efficiency.

Ellen Garland, our NRC postdoctoral fellow, has moved on to the University of St. Andrews in Scotland as their Newton International Research Fellow. She continues to collaborate with us on a multiple papers (as well as our BOEM-funded project reports) that will be using GAM analyses. Ellen will also continue to guide Alexandra Ulmke in the analyses of beluga calls. Alex will be processing the data from a temporal calling peak suggested to be the Eastern Chukchi population of belugas and will develop a call repertoire from that population. After this work is

completed she will then compare the results to those from the Eastern Beaufort population to see if the populations can be differentiated by their call repertoires.

Our newest team member, Dana Wright, continues her work on an analysis of Bering Sea moorings for a project funded by IFAW on the North Pacific Right Whale (NPRW). A side product of this effort will be a description of the spatio-temporal distribution of bowheads on their wintering grounds in the Bering Sea. We are hoping to obtain a second year of funding so that she can continue this work in the mid-latitudes of the shelf and complete the overall picture of the spatio-temporal distribution of bowhead whales on the Bering Sea shelf.

We have also contributed part of our data set to Heloise Mouy, from JASCO Applied Sciences. She will be working on determining the spatio-temporal distribution of ribbon seals in the Bering, Chukchi, and Beaufort Seas. She is also writing a proposal to the Office of Naval Research to do the same, using our same data set, with spotted seals. We have also agreed to contribute part of our data set to Xavier Mouy and Julien Delarue, also from JASCO Applied Sciences, if they obtain funding from the North Pacific Research Board (NPRB) to conduct broad-scale walrus analyses. In each case, autodetectors will be developed and compared with our full manual analysis. If the results are good, we will then begin to implement those detectors on our complete dataset. In addition, data from some Bering Sea moorings were sent to Aaron Thode (Scripps Institution of Oceanography) and Julien Bonnel (Université Européenne de Bretagne) in a collaborative project to try and differentiate between North Pacific right whale and humpback whale upsweep calls (often confused between the two species). By analyzing the time-of-arrivals of different multipaths of the calls, they hope to determine the depth at which the call was made, and use this information to attempt to distinguish between right whales and humpback whales based on calling depth.

Sonobuoys:

Our sonobuoys have gone through their post-season inventory. We will have a sufficient number of sonobuoys for the 2015 ARCWEST/CHAOZ-X cruise.

Oceanographic and Zooplankton Component

Eleven biophysical moorings will be retrieved and two biophysical moorings will be redeployed in 2015 (see attached cruise plan). A new addition in 2015 is that NOAA's Ocean Exploration program will be deploying an oceanographic mooring and two wave gliders in the study area; those data will help inform this research.

Hydrographic samples (nutrients, salt, dissolved oxygen and chlorophyll) were returned to Seattle and processed in our laboratories. The same stations will be sampled again in 2015.

Greater than 225 zooplankton samples were collected and preserved on the 2014 cruise. All samples were sent to the Polish Plankton Sorting and Identification Center in Szczecin, Poland and counts of organisms were returned to us in June of 2015. Our standard QA/QC procedures will be applied where every handwritten form will be compared to what was entered into the computer in Poland and corrected as needed. After QA/QC, the data will then be uploaded to the database. We have finished the transition of our new database, however, we only have

data available up until 2012. The 2013 data should be uploaded and available for analysis later this year. Chlorophyll samples were analyzed and uploaded into the database.

Ocean Noise and Real-time Passive Acoustic Monitoring Component

In 2014, five MARUs were recovered, along with the single Db that was deployed in 2013 (Db-2013) and the AB-2014. All data have been extracted and processed (except for MARU-5 which failed to record data). The two Dbs that were deployed in August 2014 operated throughout the year and will be recovered in summer 2015 (Figure 1).



Figure 1. Deployment arrangement of the five Cornell MARUs relative to the auto-detection buoy (AB-2014) and the two Db-2013 bubbles (Db-1 and Db-2). MARU-5 was the unit that failed to record data.

The data from the AB was used in post-processing analysis to evaluate and quantify the performance of the real-time software detection system. That comparative analysis is ongoing.

Similar acoustic analyses were also completed on the data from Db-2013 and the AB-2014. Initial evaluation of these analyses revealed that the areas sampled by the MARUs and AB-2014 were very quiet by comparison to earlier years. In fact, for major portions of time evidence suggests that ambient noise levels were below the noise floor of the recording instruments.

Post-doctoral Fellow, Yu Shiu, is still working on translating acoustic occurrence data (e.g. detections per unit time per unit area) into density estimates. This is a primary reason why we deployed the five MARUs as a set of distributed recorders, with only partial overlap in their individual acoustic detection areas, rather than as a more tightly spaced array that might be used to locate, track and count the number of acoustically active whales.

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 will continue to contribute data and data products (maps and figures). The development of the Workspace is an activity of the DBO Implementation Team (<http://www.arctic.noaa.gov/dbo/about>) 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 and 2014 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

16-18 April 2015: J. Crance attends a MMC-NMFS Acoustic Surveying Technology Workshop as the acoustic representative for the Alaska Fisheries Science Center. The survey, which was held at the Southwest Fisheries Science Center, discussed current abilities, limitations, and research needs in the field of passive acoustic monitoring as they relate to marine mammal stock assessment.

28 May 2015: C. Berchok and J. Crance presented at the annual Sonobuoy Liaison Working Group (SLWG) meeting at NAS Whidbey Island and met with sonobuoy suppliers.

Presentations and Publications

None.

Literature Cited

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