

ARCTIC WHALE ECOLOGY STUDY
(ARCWEST):
USE OF THE CHUKCHI SEA BY
ENDANGERED BALEEN AND
OTHER WHALES
(WESTWARD EXTENSION OF THE BOWFEST)

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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 (BOEM), NMML is conducting a dedicated multi-year study to determine relationships between dominant currents passing from the Bering Sea into and through the Chukchi Sea and prey resources delivered to the Barrow Arch area (an area of high bowhead whale and prey concentrations between Wainwright and Smith Bay), and to provide information about the dynamic nature of those relationships relative to whale distribution and habitat utilization in the eastern Chukchi and extreme western Beaufort Seas. This study will also provide important baseline data on the occurrence, distribution, and habitat use of large whales in an area that is subject to rapid change in climate and human industrial development. This quarterly report covers the period of this study from April through June 2014.

The major activities during the second quarter of 2014 consisted of planning for the 2014 Arctic Whale Ecology Study (ARCWEST)/Chukchi Acoustics, Oceanography, and Zooplankton Study-extension (CHAOZ-X) cruise and the analysis of data collected during the 2013 ARCWEST cruise.

Introduction and objectives

The western Arctic physical climate is rapidly changing. The summer Arctic minimum sea ice extent in September 2012 reached a new record of 3.61 million square kilometers, a further 16% reduction from a record set in 2007 (4.30 million square kilometers). This area was more than 50% less than that of two decades ago. The speed of this ice loss was unexpected, as the consensus of the climate research community was that this level of ice reduction would not be seen for another thirty years. As sea temperature, oceanographic currents, and prey availability are altered by climate change, parallel 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 will also open maritime transportation lanes across the Arctic adding (to a potentially dramatic degree) 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 bowhead (*Balaena mysticetus*), gray (*Eschrichtius robustus*), humpback (*Megaptera novaeangliae*) and fin whales (*Balaenoptera physalus*), mandates 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.

The ARCWEST study has five component projects: visual observation, satellite tagging, passive acoustics, lower trophic level sampling, and physical oceanographic sampling. Each component project is a technical discipline and is coordinated by a Project Leader with extensive experience in that discipline. Visual surveys, along with sonobuoy deployments, will provide distributional data on baleen whales and other marine mammals. Satellite tagging will provide valuable information on both large- and fine-scale movements and habitat use of baleen whales. Passive acoustic moorings will provide year-round assessments of the seasonal occurrence of baleen whales. Concurrently deployed bio-physical moorings offer the potential of correlating whale distribution with biological and physical oceanographic

conditions and indices of potential prey density. Satellite-tracked drifters will examine potential pathways to the areas of high biological importance. Our goal is to use these tools to understand the mechanisms responsible for the high biological activity so that we can predict, in a qualitative way, the effects of climate change on these preferred habitats.

The overall goal of this multi-year IA is to use passive acoustic recorder deployments, visual and passive acoustic surveys, and satellite tagging to explore the distribution and movements of baleen whales in the Bering and Chukchi Seas, particularly the Chukchi Sea planning areas. In addition, oceanographic and lower trophic level sampling and moorings will be used to explore the relationships between currents passing through the Bering Strait and resources delivered to the Barrow Arch area (an area of high bowhead whale and prey concentrations between Wainwright and Smith Bay), and the dynamic nature of those relationships relative to whale distribution and habitat utilization in the eastern Chukchi and extreme western Beaufort Seas.

The specific objectives are:

1. Assess patterns of spatial and temporal use of the Chukchi Sea by endangered bowhead, fin and humpback whales, and beluga and gray whales.
2. Assess the population structure and origin of whales in the region.
3. Evaluate ecological relationships for the species, including physical and biological oceanography that affect critical habitat for these species.
4. Conduct physical and biological oceanographic sampling to further understand the transport and advection of krill and nutrients from the northern Bering Sea through the Bering Strait and to the Barrow Arch area.

Cruise activities and summary

Planning for the 2014 vessel cruise is well underway. Sampling and mooring locations and cruise plans have been developed (see attached cruise plan). A vessel schedule has been developed and will be revised as needed during the survey. 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*. Survey personnel have been contracted. Field equipment and supplies have been purchased. Informational fliers have been developed and distributed to Alaskan villages describing the ARCWEST/CHAOZ-X projects. Analysis of the data collected during the 2013 vessel cruise continues to be processed.

Preliminary data analysis results and planning

Visual Observations Component:

Visual observers for the 2014 ARCWEST/CHAOZ-X survey have been identified and, as needed, contracted.

Photo-ID

Photo-id will be conducted during the tagging leg of the 2014 ARCWEST/CHAOZ-X survey.

Satellite Tagging Component:

Plans and priorities have been developed for the tagging leg of the 2014 ARCWEST/CHAOZ-X survey. The tagging team has been identified and, as needed, contracted. To increase safety during tagging operations, Kennedy, Rone, Zerbini, Berchok, Crance, Grassia, and Ulmke participated in Small Boat Egress training designed to address safety concerns specific to tagging operations. Kennedy, Zerbini, and Rone also met with staff at Cascadia Research Collective to discuss gray whale tagging techniques and ideas.

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 85 minutes of recordings made every 5 hours, for an entire year].

Planned locations for the 2014 ARCWEST moorings (see attached cruise plan for maps) were determined in coordination with the oceanographic and lower trophic level components of ARCWEST. All planned 2014 mooring locations are the same as the 2013 deployments. We also plan to deploy a deep-water Haruphone (Haru Matsumoto, NOAA/PMEL/CIMRS) recorder on its own mooring close to the Stabeno ADCP mooring. This recorder is part of a NOAA-wide 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 ARCWEST 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 Institute (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. Data from ARCWEST is next in line to be analyzed and will be used in an inter-annual comparison of beluga calling in the Barrow Arch (analysis funded by the NOAA S&T Ocean Acoustic program). Furthermore, if the vocal repertoires (dialects) of populations are able to be distinguished from call types, the complete ARCWEST 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 a request was put in for one crate of new sonobuoys, which 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 Lower Trophic Level Component:

Moorings:

Planned locations for the 2014 oceanographic moorings (see attached cruise plan for maps) were determined in coordination with the passive acoustic and lower trophic level components of ARCWEST.

Hydrography & Plankton Sampling:

Locations for lower trophic level and physical/chemical oceanographic sampling (see attached cruise plan for map) were also determined in coordination with the passive acoustic component and based upon previous research and our conceptual model of current flow.

Satellite Tracked Drifters:

Twelve drifters were deployed during 2013 (see attached cruise plan for map). Two of these drifters were still active during the second quarter of 2014 (April, May, and June) and continue to be tracked. A movie showing drifter tracks can be viewed at the following website:

<http://www.pmel.noaa.gov/foci/visualizations/drifter/chuk2014.html>. Previous movies showing drifter tracks since 2011 can be viewed at the following website under the heading *Drifter Movies/Chukchi Sea/2014*: http://www.ecofoci.noaa.gov/efoci_drifters.shtml. Also at this site, movies showing drifter tracks *with ice extent* in 2011, 2012-2013, and 2013-2014 can be downloaded under the heading *Chukchi Sea Drifters with Ice Movies (M4V)*.

Active Acoustics:

The first of the ARCWEST TAPS-6NG instruments were deployed in August 2012. One instrument is part of the middle Icy Cape mooring cluster, and the other is just west of the Wainwright line upstream from the head of Barrow Canyon. Both instruments were recovered during the 2013 ARCWEST cruise and recorded data until the spring of 2013. Post cruise calibration was recently completed. The final processing of the TAPS-6 and TAPS-6NG data will begin in the next quarter, including corrections for surface ice reverberation.

An ADCP was deployed near one of the TAPS6-NG instruments, in the Icy Cape mooring cluster, in August 2012. Due to the relatively high vertical resolution, the ADCP data can be used to help reveal whole water column volume backscatter patterns, such as diel vertical migration of zooplankton, when paired with the TAPS6-NG instruments. The ADCP data has been fully processed and converted from echo intensity units to volume backscatter. Analysis and comparison to the TAPS6-NG will begin soon.

Lower Trophic Level Sample and Data Analyses:

Preserved zooplankton samples from the Tucker sled were inventoried and sent to Poland in November 2013 for processing. The resulting data was returned in May 2014. 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. The data will then be uploaded to the database.

2014 Field Season Planning:

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 7 total units for deployment, mounting on the buoys, etc.

Contribution of data to the Distributed Biological Observatory (DBO)

The ARCWEST program has agreed to contribute data to the DBO Workspace, supported by AOOS/AXIOM. ARCWEST 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 Collaboration Team (http://www.arctic.noaa.gov/dbo/about.html#DBO_Implementation_Team) and is in its early stages. The contribution of information from the ARCWEST 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

Challenges for the 2014 field season included: the scheduling of the vessel survey, obtaining a contract for a research vessel, paying for increases in fuel and vessel costs that have occurred since the ARCWEST proposal was written and approved, as well as mooring costs that have more than doubled.

The vessel charter contract was awarded to KB Fisheries, Inc. on 10 July. The draft schedule had the cruise departing Nome, AK on 8 August. However, the contractor is under a different contract until 20 August. We are working with the contractor to find a new cruise schedule which works.

Costs for a vessel charter are projected to be higher than anticipated in 2011 when the ARCWEST budget was submitted. The draft vessel schedule for 2014 had reduced the number of days dedicated to satellite tagging large whales to meet the projected vessel costs. However, by adding work which is being funded by PMEL, we have been able to increase the dedicated tagging days from 9 to 14 since PMEL is contributing to vessel transit costs. Also to save funds, it is currently planned to not staff the Bering Sea legs of the vessel cruise with marine mammal observers. Sonobuoy deployments will continue on the southbound Bering Sea leg as originally planned.

Due to the 8 September 2013 incident in which the satellite tagging team was flipped overboard during satellite tagging operations involving gray whales (see Appendix 7 of the ARCWEST 2013 Cruise Report ("ARCWEST.CruiseReport2013.pdf")), additional expenses have been incurred due to lost gear and skiff repairs.

Significant meetings held or other contacts made

Clapham, Zerbini, Friday, Rone, and Kennedy met on 29 April 2014 to discuss satellite tagging plans.

Rone, Kennedy, and Zerbini met with John Calambokidis, Robin Baird, and Gretchen Steiger of Cascadia Research Collective on 29 May 2014 to discuss gray whale tagging protocols.

Presentations and Publications

16-18 June 2014 – Garland, Berchok, Castellote. 2014. Spatio-temporal movement patterns of Alaskan beluga (*Delphinapterus leucas*) populations based on vocal peaks and common call types. *Ecoacoustics. Ecology and acoustics: emergent properties from community to landscape*, Museum national d'Histoire naturelle, Paris, France, June 2014 (oral presentation).