

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

Nancy A. Friday¹, Ph.D.
Phillip J. Clapham¹, Ph.D.
Catherine L. Berchok¹, Ph.D.
Jessica L. Crance¹, M.S.
Alexandre N. Zerbini^{1,4}, Ph.D.
Brenda K. Rone¹, M.S.
Amy S. Kennedy^{1,5}, Ph.D.
Phyllis J. Stabeno², Ph.D.
Jeffrey M. Napp³, Ph.D.

¹National Marine Mammal Laboratory
Alaska Fisheries Science Center

²Pacific Marine Environmental Laboratory

³Resource Assessment and Conservation Engineering Division
Alaska Fisheries Science Center

7600 Sand Point Way NE
Seattle, WA 98115

⁵Ocean Associates Incorporated
4007 N. Abingdon Street
Arlington, Virginia 22207

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 between January and March 2014.

The major activities during the first 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 has begun. Sampling and mooring locations and cruise plans continue to evolve as plans are fine-tuned. The paperwork necessary to charter a vessel is being processed by the Western Acquisition Division and AFSC staff has been replying to questions as needed. Field equipment and supplies are being purchased. Several contracts for passive acoustic staff have been submitted and/or awarded. Analysis of the data collected during the 2013 vessel cruise has begun.

Post-cruise data analysis results and planning

Visual Observations Component:

Paperwork has been submitted to the Western Acquisition Division to hire cruise personnel. Analysis of the 2013 visual data was completed in 2013.

Photo-ID

Analysis of the 2013 photo-id data was completed in 2013.

Satellite Tagging Component:

Analysis of the 2013 satellite tagging data was completed in 2013.

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].

The data drives from all ARCWEST AURALS have been extracted, and the raw files batch converted into ten-minute wave files with file names indicating the date, time, project, and mooring for that recording. The wave files have also been batch converted into spectrogram image files (.png) for low, medium, and high frequency bands. All AURALS have been cleaned and inspected, and some faulty (or damaged from dragging) parts have been sent back to the manufacturer for repair.

Planned locations for the 2014 ARCWEST moorings (Fig. 1, yellow triangles and stars) 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. Stars indicate those passive acoustic moorings that are part of a cluster with oceanographic moorings.

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)). If successful, this system will not only reduce the amount of effort expended on each recording, but it will allow us to obtain results for all species of interest. It will also allow us to fine-tune any auto-detection devices installed on gliders or auto-detection buoys that we may deploy in our study areas in the future.

Eliza Ives, tasked with implementing the LFDCS on our data, is in the process of conducting iterative testing of the Chukchi bowhead whale call library. She has completed a couple 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. Once she is very confident the bowhead call library will perform well against any of our data sets, she will move onto creating a fin whale call library.

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

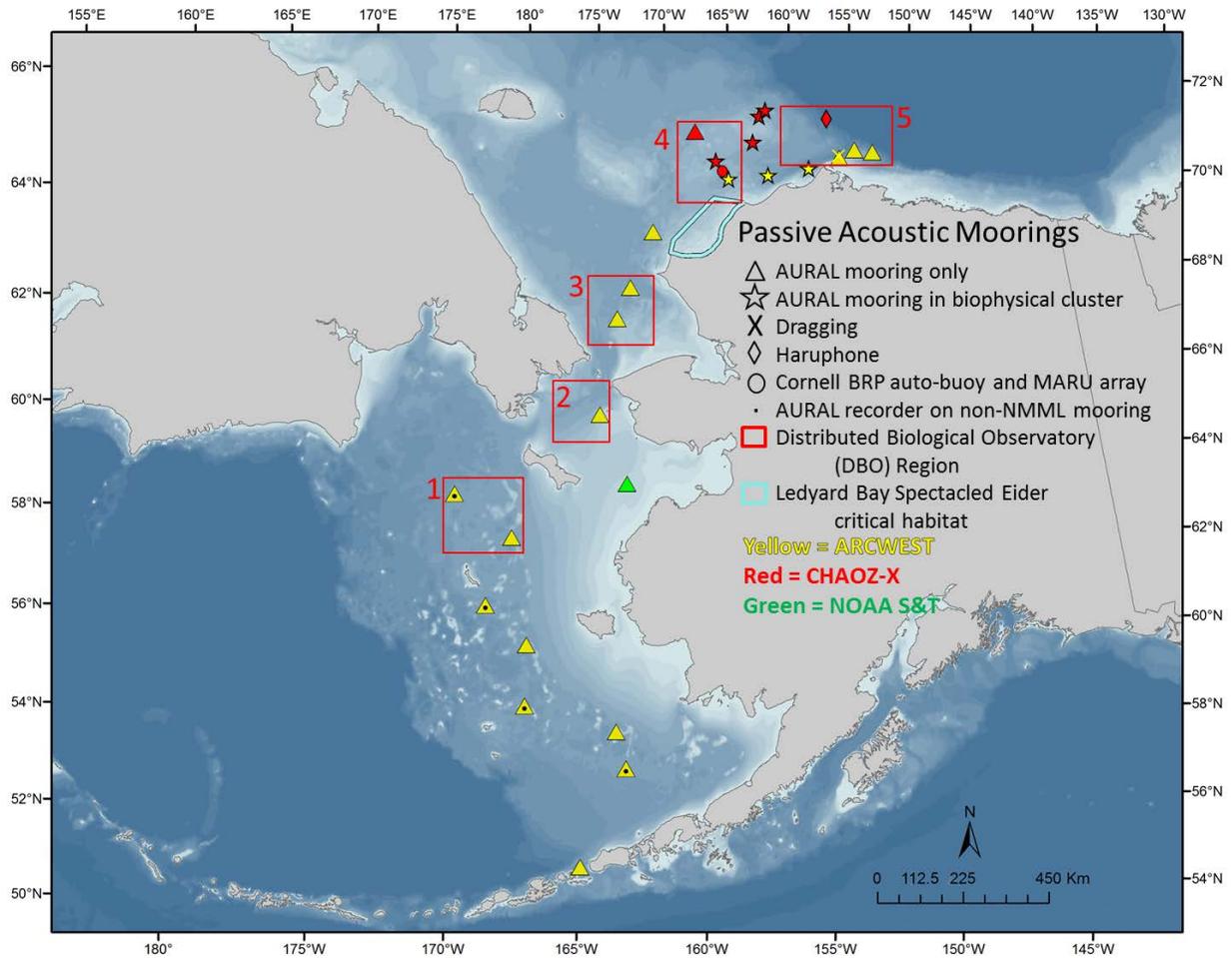


Figure 1. Planned passive acoustic moorings to be retrieved and/or deployed during the 2014 ARCWEST/CHAOZ-X cruise. Yellow symbols indicate ARCWEST moorings. Red symbols indicate CHAOZ-X moorings. Green symbols indicate NOAA-funded moorings.

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. After conducting the spatio-temporal distribution analysis and presenting those data at the Biennial Conference on Marine Mammals in December 2013 and the Alaska Marine Science Symposium in January 2014, 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 ARCWEST data is currently being used in her analysis, the data collected from passive acoustic recorders deployed under the ARCWEST 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 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, to be 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:

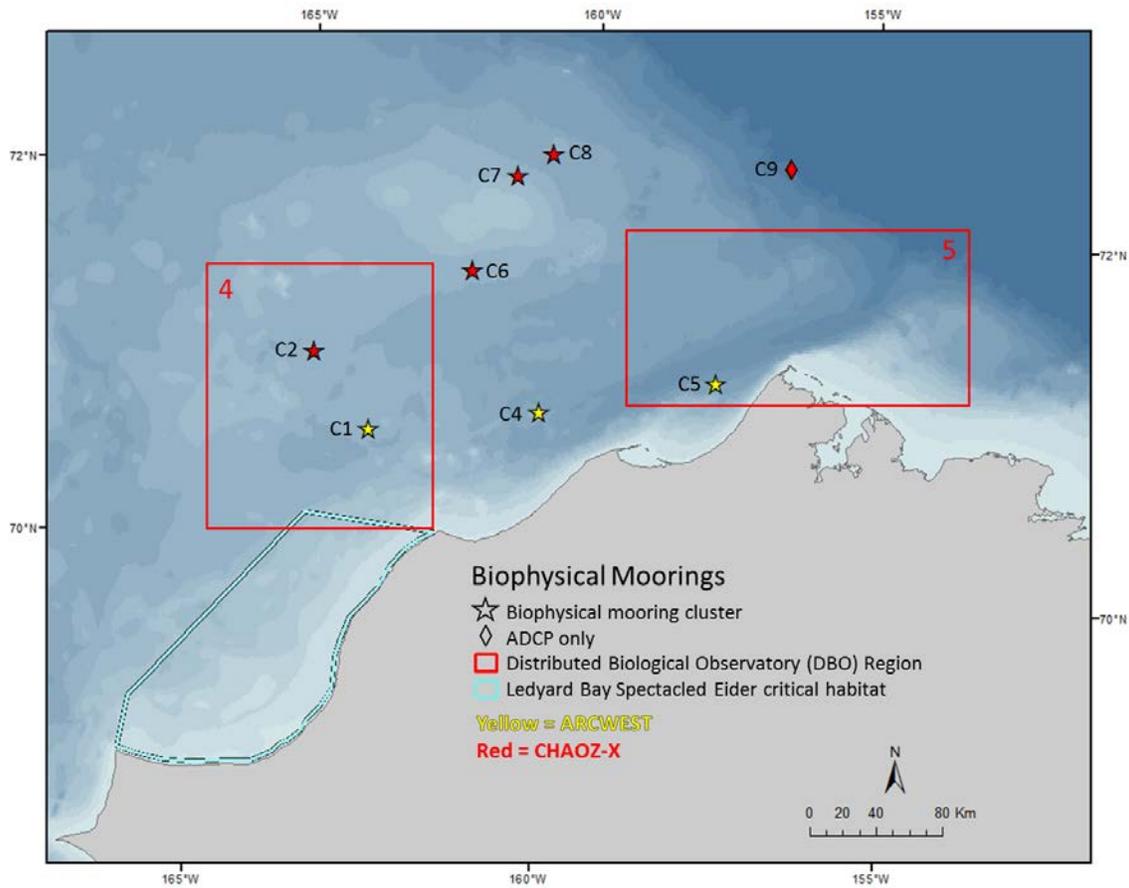


Figure 2. Planned biophysical mooring clusters to be retrieved and/or deployed during the 2014 ARCWEST/CHAOZ-X cruise. Yellow symbols indicate ARCWEST moorings. Red symbols indicate CHAOZ-X moorings.

Planned locations for the 2014 oceanographic moorings (Fig. 2, yellow stars) 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 (Fig. 3, yellow dots) were also determined in coordination with the passive acoustic component and based upon previous research and our conceptual model of current flow. Final hydrographic data from the cruise was uploaded to the database in January 2014. Chlorophyll samples (> 200) were also completed in January 2014, but data uploading is dependent upon completion of our new EcoDAAT database.

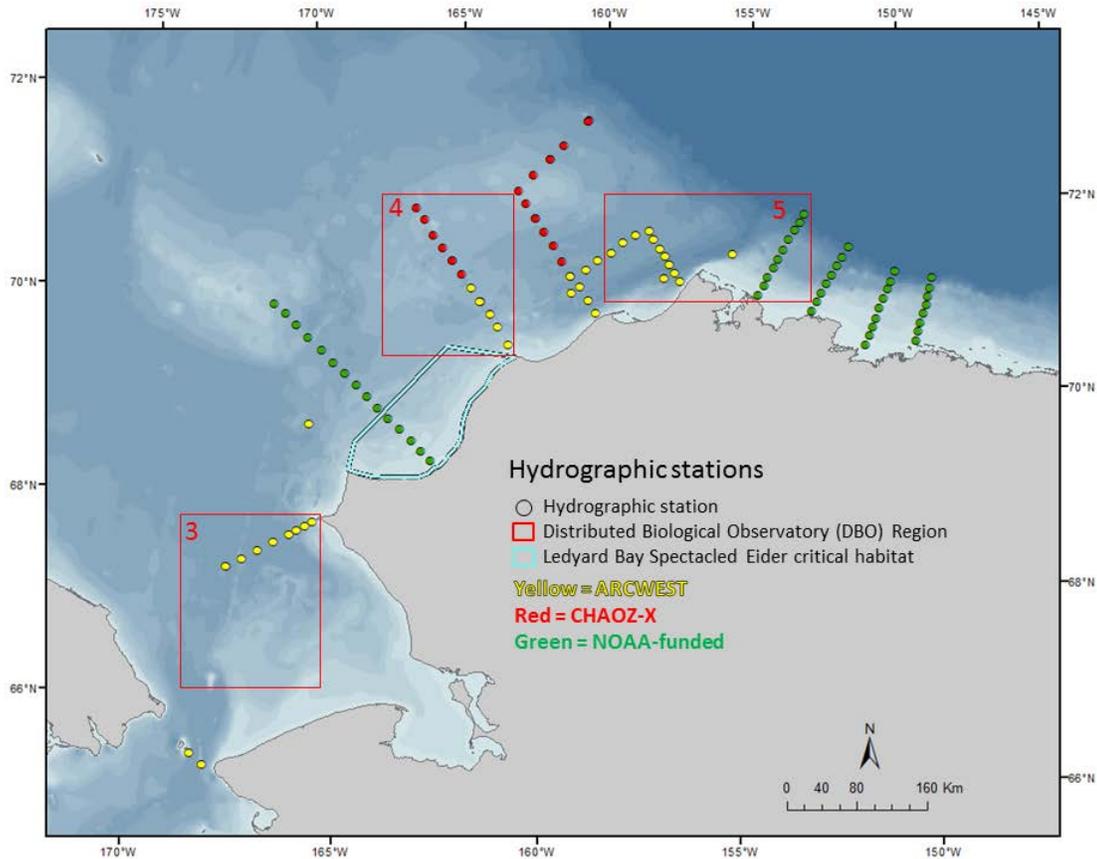


Figure 3. Planned biophysical stations to be sampled during the 2014 ARCWEST/CHAOZ-X cruise. Yellow symbols indicate ARCWEST stations. Red symbols indicate CHAOZ-X stations. Green symbols indicated NOAA-funded stations.

Satellite Tracked Drifters:

Twelve drifters were deployed during 2013 (Fig. 4). Several of these drifters were still active during the first quarter of 2014 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)*.

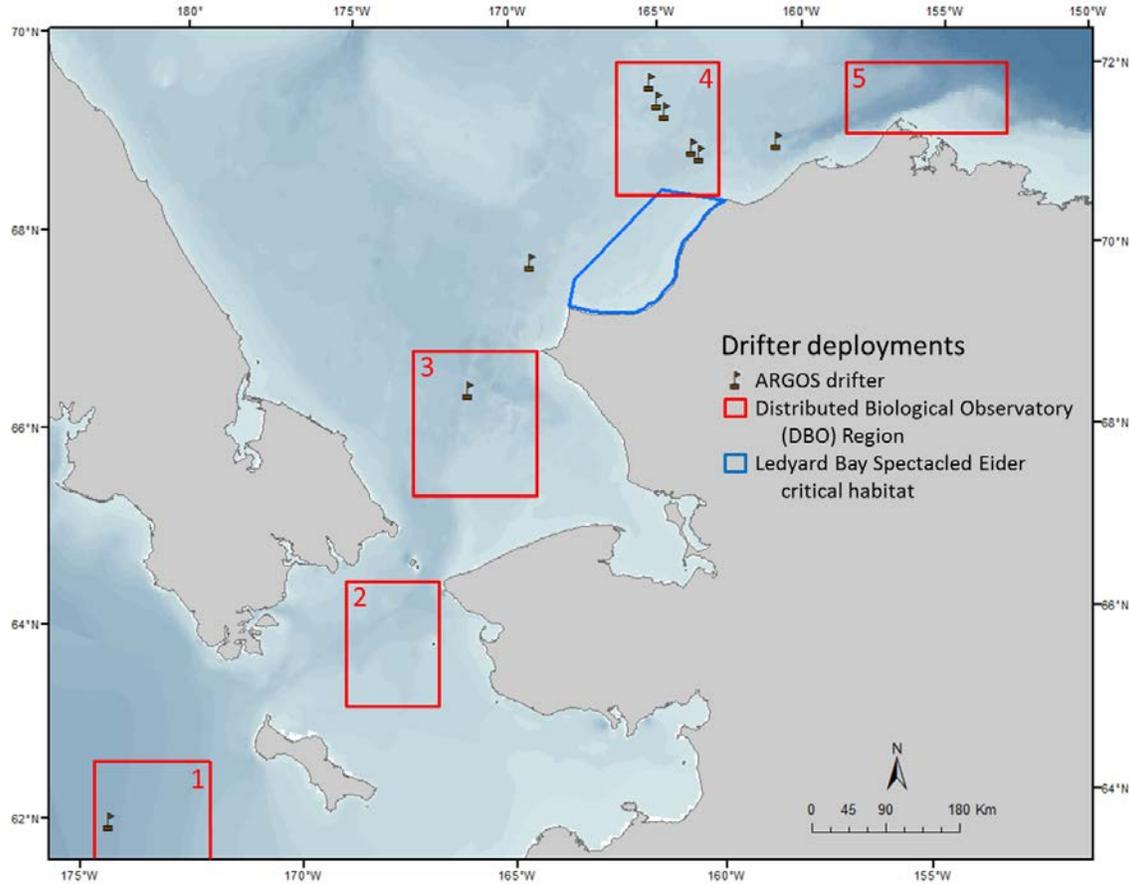


Figure 4. Deployment locations of ARGOS drifters in 2013.

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. We have finished with correcting the data for noise and surface reverberation. We are currently working on an in-house calibration setup so that we can more accurately correct for the extreme temperatures (<2 °C) at depth in the Arctic. The final processing of the TAPS-6 and TAPS-6NG data will begin in the next few weeks, after the post cruise calibration.

An ADCP was deployed near one of the TAPS6-NG instruments, in the Icy Cape mooring cluster, in August 2012. The ADCP intended use is to measure current velocities, thus it is not calibrated to provide information regarding the size or abundance of organisms. However, due 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 TAPS-6NG instruments. The ADCP data has been fully processed and converted from echo intensity units to volume backscatter.

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. It is anticipated that the resulting data will be returned by 30 May 2014. After applying our standard QC/QA procedures those data will be ready for uploading in a database.

2014 Field Season Planning:

The first quarter of 2014 was spent placing orders for new floats, pressure canisters, batteries, electronic components, etc. with the plan of constructing new TAPS-6NG units. We procured enough components, transducers, instrument pressure cases, batteries, and mooring floats to build 5 new instruments to be deployed in 2014. Combined with 1 of the 2 instruments recovered in 2013, we are planning on deploying 6 total instruments in 2014. Our next step is to begin the tuning, assembly, and calibration processes.

Contribution of data to the Distributed Biological Observatory (DBO)

The ARCWEST program has agreed to contribute data to the DBO Workspace, supported by AOS/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 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 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: 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.

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 Bering Sea legs 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. NMML staff are still determining the exact cost of the skiff repairs.

Significant meetings held or other contacts made

9 January 2014 – Friday, Zerbini, Kennedy and Rone met to discuss the ARCWEST tagging subproject.

15 January 2014 – Berchok, Stabeno, Napp, and Adam Spear met to discuss the cruise plan for the 2014 field season

22 January 2014 – Berchok, Napp, and Stabeno presented the ARCWEST/CHAOZ-X draft field season plan at the 2014 Arctic Field Season Coordination Briefing convened by Sheyna Wisdom of Olgoonik Fairweather during AMSS.

23 January 2014 – Friday (via phone), Clapham, Berchok, Stabeno, Napp, Jeff Denton (BOEM), and Carol Fairfield (BOEM) held an ARCWEST coordination meeting at AMSS.

Presentations and Publications

20 January 2014 – Crance, Berchok, Grassia, Ives, Rone, Kennedy, Gatzke, Vazquez Morquecho, Friday, Clapham. 2014. Passive acoustic, visual, and satellite telemetry results from the first ARCWEST cruise, 2013. *Alaska Marine Science Symposium*, Anchorage, AK, January 2014 (poster).

26 February 2014 – Stabeno, Kachel, Ladd, Napp. 2014. The CHAOZ Project: Influence of climate variability on the northeastern Chukchi ecosystem. *2014 Ocean Sciences Meeting*, Honolulu, HI, February 2014 (oral presentation).