

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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Executive Summary

Through an Inter-Agency agreement (IA) between the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), 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 January through March 2015.

The major activities during the first quarter of 2015 consisted of planning for the 2015 Arctic Whale Ecology Study (ARCWEST)/Chukchi Acoustics, Oceanography, and Zooplankton Study-extension (CHAOZ-X) cruise, after-season maintenance and testing of the passive acoustic recorders, and the processing and analysis of data collected during the 2013 and 2014 cruises. 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. The ARCWEST team has also been meeting regularly and developing the framework of how the data collected will be integrated to enable multi-disciplinary, synthesis analyses. Highlights of progress and results to date are listed below by objective, with additional details in the main body of the report.

1. Assess patterns of spatial and temporal use of the Chukchi Sea by endangered bowhead, fin and humpback whales, and beluga and gray whales.
 - The acoustics team continues to process the long-term time series in the Chukchi Sea.
 - As part of her work on North Pacific Right Whales, Dana Wright is analyzing data from the Bering Sea for bowhead whale calls, which will provide essential information on movements on the wintering grounds and migratory timing of this important Chukchi species.
 - State-space models applied to telemetry data revealed potentially important foraging habitats.
2. Assess the population structure and origin of whales in the region.
 - Timing of seasonal peaks in beluga whale calling correlates with satellite tag and genetic data which suggests passive acoustics can be used to monitor movements of the individual populations (Garland *et al.*, 2015). A paper on beluga whale vocalizations and call classification from the eastern Beaufort Sea population is in press (Garland *et al.*, in press).
 - Photographs of gray, humpback and killer whales are being compared to existing catalogs.

3. Evaluate ecological relationships for the species, including physical and biological oceanography that affect critical habitat for these species.
 - The Chukchi Acoustics, Oceanography, and Zooplankton Study (CHAOZ) found that bowhead whales remain in the Chukchi Sea until the sea ice is about 1 meter thick. Sea ice thickness and bowhead acoustic data from ARCWEST will be used to validate this finding.
 - ADCP data from the 2011-2012 deployment showed intermittent diel vertical migration of zooplankton.
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.
 - The monthly mean transport at Icy Cape has been explored using CHAOZ (2010–2011), ARCWEST (2012–2013), and CHAOZ-X (2012–2013) data. About a third of the transport remains on the shelf, heading toward the Barrow Arch area.
 - 2013 samples have been processed by Poland, and data analysis should begin soon after QA efforts are completed.
 - 2014 samples were sent to Poland in November 2014 and the data should arrive in May 2015.

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 2015 vessel cruise has begun. Sampling and mooring locations and cruise plans continue to evolve as plans are fine-tuned. The Contracting Officer at the Western Acquisition Division has been notified of our intention to exercise the option year on our vessel contract to charter the R/V *Aquila*. ARCWEST will be vessel sharing with NOAA funded oceanographic work again this year. As part of that cost sharing effort, lower trophic level and physical/chemical oceanographic sampling will be conducted off the NOAA ship *Ronald Brown* from 6 August to 4 September and mooring retrieval/deployment, marine mammal visual survey and sonobuoys effort will be conducted off the R/V *Aquila* (dates to be determined). Field equipment and supplies are being purchased. Passive acoustic staff and a telemetry analyst have been hired through the Joint Institute for the Study of the

Atmosphere and Ocean (JISAO). Analysis of the data collected during the 2013 and 2014 vessel cruises has begun.

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

The acoustics team continue 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 ARCWEST 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. The first two years of this time series is shown in Figure 1 for bowheads at the three moorings off Icy Cape.

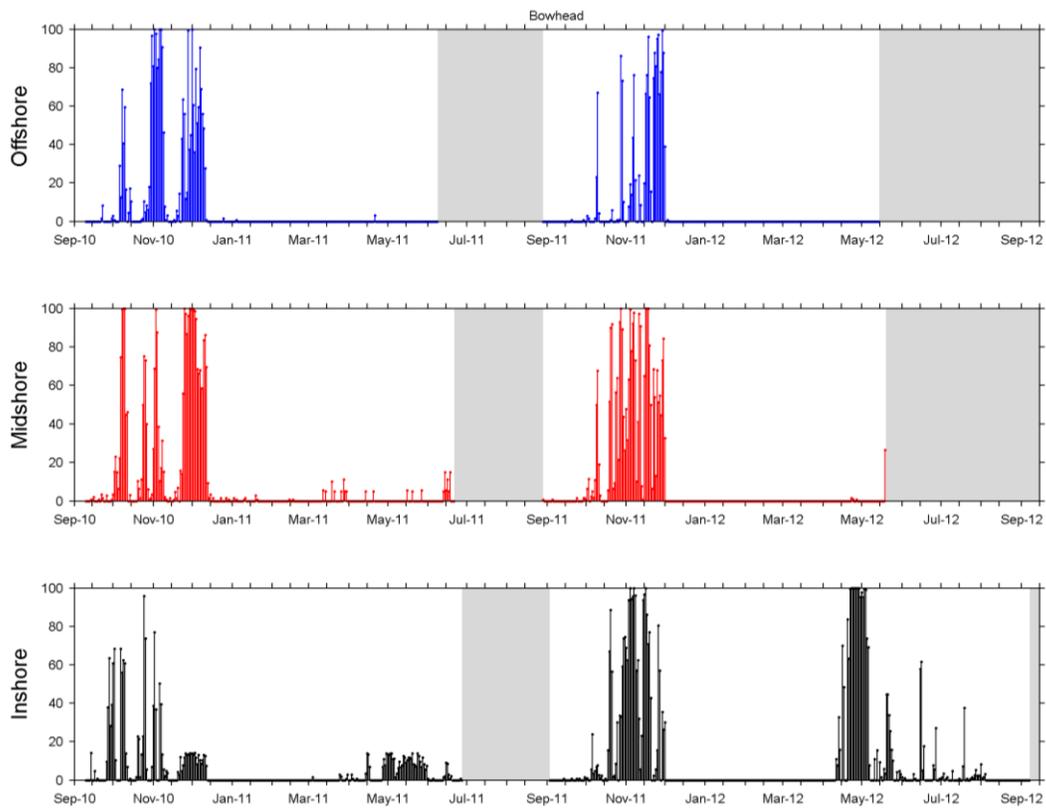


Figure 1. Two-year time series of bowhead whale calls detected on three moorings off Icy Cape, AK. Y-axis shows the percentage of 3 minute time intervals with bowhead calls detected per day. Data collected and analyzed as part of the BOEM-funded CHAOZ project.

A subset of the 2014 moorings will be redeployed 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 other cruise will not be a problem. Locations for the 2015 ARCWEST moorings (Fig. 2) are consistent with those from 2014, which were determined in coordination with the oceanographic and lower trophic level components of ARCWEST. The NOAA-funded mooring HA14, that was deployed last year is a two-year deployment, will not be recovered until 2016. This mooring is part of a NOAA-wide effort to monitor ambient noise throughout the entire US-EEZ.

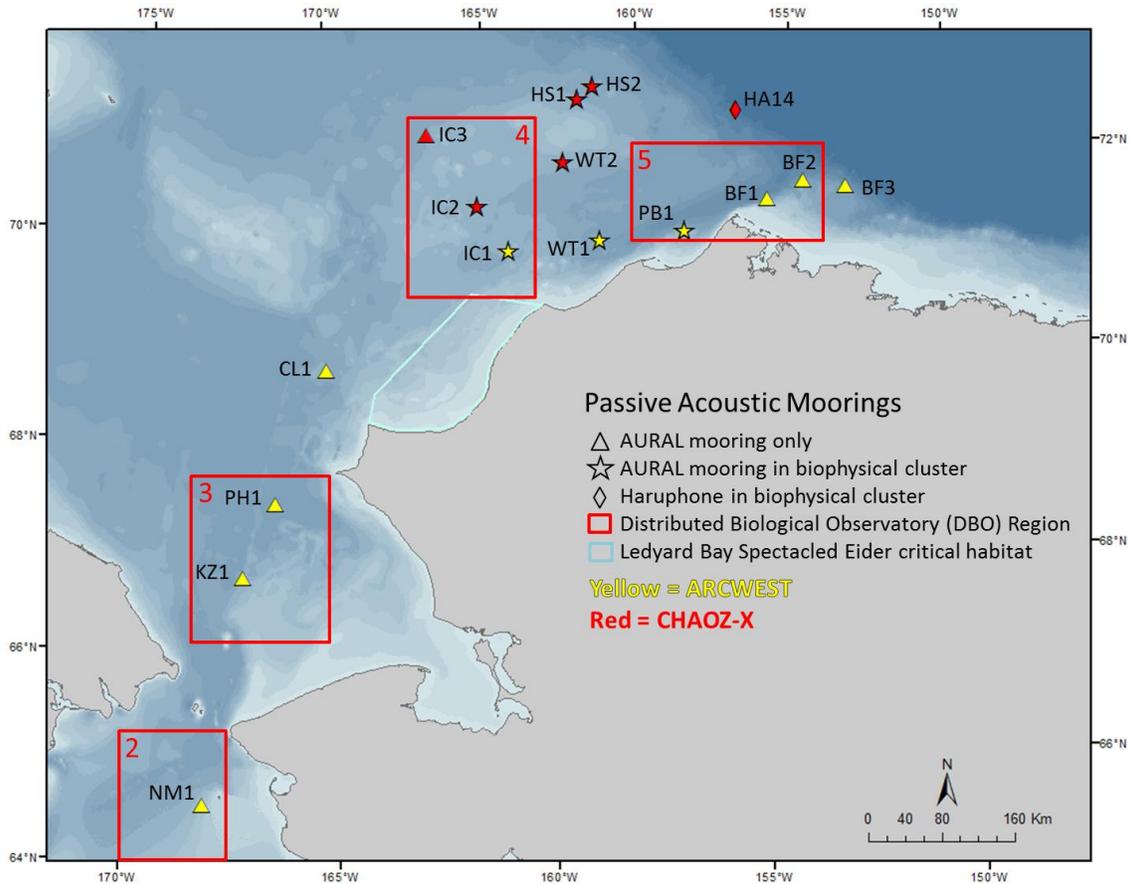


Figure 2. Passive acoustic mooring to be retrieved during the 2015 ARCWEST/CHAOZ-X cruise. Yellow symbols indicate ARCWEST moorings. Both Hanna Shoal (HS1&2) and one of the Wainwright (WT1 or WT2) moorings will not be redeployed in 2015.

The data drives from all 2013 ARCWEST AURALS were 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 are finished being batch converted into spectrogram image files (.png) for low, medium, and high frequency bands.

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

comparison with fin whales is ongoing and should be completed by the next quarterly report. Eliza Ives, who is implementing the LFDCS on our data, has been pulled off this work to help with the manually analysis. Next week she will be back to adjusting the LFDCS for bowhead and fin whales, and will begin work on a ribbon seal detector.

Ellen Garland, our NRC postdoctoral fellow, has moved on to the University of St. Andrews in Scotland as their Newton International Research Fellow. Before she left she completed two papers. The first is on looks at the timing of seasonal peaks in beluga whale calling. These peaks correlate with satellite tag and genetic data which suggests passive acoustics can be used to monitor movements of the individual populations (Garland *et al*, 2015). Her second paper describes beluga whale vocalizations and call classification from the eastern Beaufort Sea population (Garland *et al.*, in press).

In addition to collaborating with us on a multitude of papers (as well as our BOEM-funded project reports) that will be using GAM analyses, Ellen will continue to work with our group on the work she started with the beluga whales by guiding the analyses of Alexandra Ulmke. 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, is working on an analysis of Bering Sea moorings for a project funded by IFAW on the North Pacific Right Whale (NPRW). Because of the similarities in call types between the NPRW, humpbacks, and bowhead whales, Dana is analyzing the data sets for all of these species as well as gray whales. 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. Her first year of effort will focus on the southern and northern Bering Sea shelf (the Aleutian passes, near St. Lawrence Island, and in Norton Sound. 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. The data she is currently processing were collected from moorings deployed as part of ARCWEST.

We have also contributed part of our data set to Heloise Mouy, from JASCO 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 ONR 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 sciences, if they obtain funding from NPRB for a 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 in turn start to implement those detectors on our complete dataset.

Sonobuoys:

Our sonobuoys have gone through their post-season inventory. We will have plenty for the 2015 cruise.

Oceanographic and Lower Trophic Level Component:

Moorings:

Locations for the oceanographic and active acoustic moorings which will be retrieved in 2015 are shown in Figure 3 (yellow stars). See the PMEL mooring website (http://www.pmel.noaa.gov/foci/operations/mooring_plans/2014/aug2014_ContVes_moorings.html¹) for information on the instruments placed on each mooring. A subset of the 2015 moorings will be deployed to maintain the time series even though retrieval in 2016 is currently unfunded. It has not been determined yet whether these moorings will include a passive acoustic TAPS instrument.

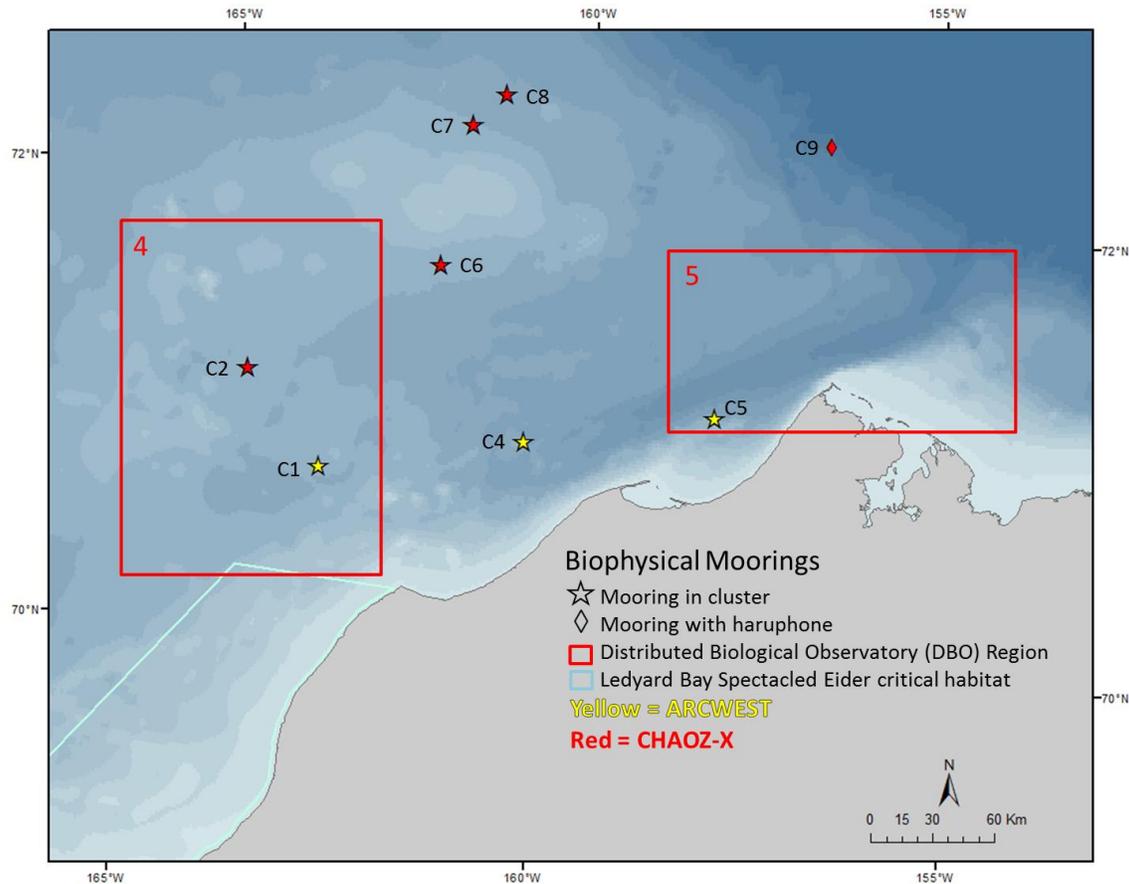


Figure 3. Biophysical mooring clusters to be retrieved during the 2015 ARCWEST/CHAOZ-X cruise. Yellow symbols indicate ARCWEST moorings. Red symbols indicate CHAOZ-X moorings. Moorings to be redeployed in 2015 are still to be determined.

¹ On this webpage subsurface moorings relevant to this project are titled 14CK (i.e., Chukchi Sea 2014) and 14BS (i.e., Bering Sea 2014). The number on the end corresponds to the mooring clusters: 14CKT for the Chukchi Sea (e.g., 14CKT-2A corresponds to C2) or 14BS for the Bering Sea (e.g., 14BS-2C corresponds to M2).

The monthly mean transport at Icy Cape during 2010–2013 was strongly variable during winter and fall (Fig. 4). During spring and summer, however, transport was consistently northward and less variable among years. Yearlong average transport ranged from 0.25–0.45 Sv.

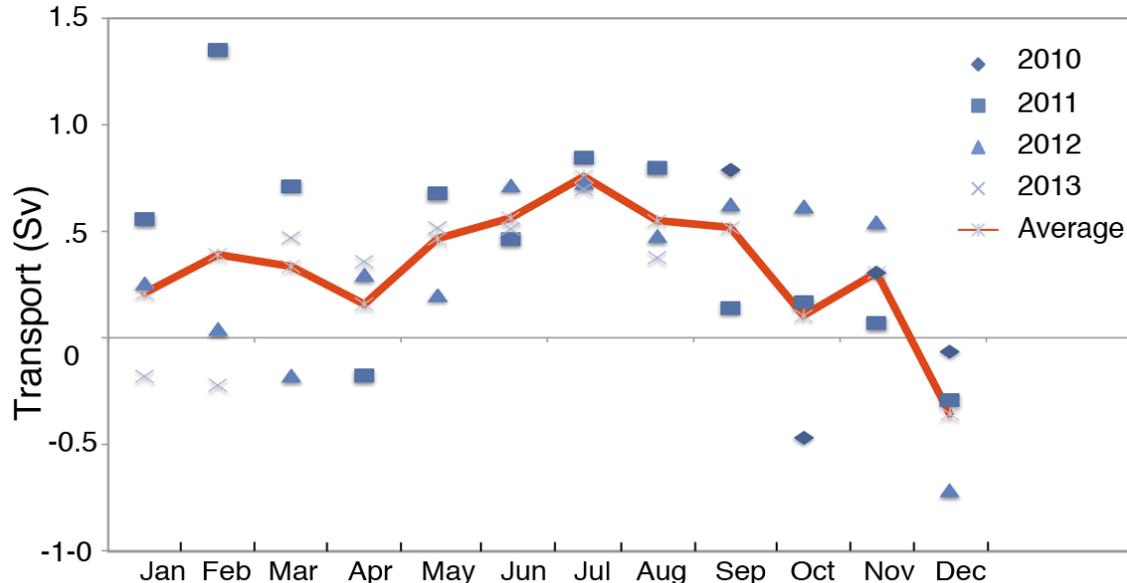


Figure 4. Mean transport per month for four years during 2010–2013 at Icy Cape, Alaska. Means combine the CHAOZ (2010–2011) and ARCWEST/CHAOZ–X (2012–2013) data.

Hydrography & Plankton Sampling:

Locations for lower trophic level and physical/chemical oceanographic sampling (Fig. 5, yellow dots) were also determined in coordination with the passive acoustic component and based upon previous research and our conceptual model of current flow. In 2015, the sampling effort will be conducted off the NOAA ship *Ronald Brown* from 6 August to 4 September. The line off Point Hope (Fig. 5, yellow dots in DBO3) is tentatively scheduled to be sampled if time permits.

Nutrient samples have been processed and are being incorporated into the hydrographic files and uploaded to the database. Chlorophyll samples ($N > 400$) were collected and are stored in a freezer in Seattle. Chlorophyll samples were analyzed in January/February and will be uploaded into the database in the coming weeks.

In addition to the ARCWEST and CHAOZ–X sampling described above, NOAA’s Ocean Exploration (OE) program will be conducting field work in the Chukchi Sea in 2015. In July, the USCGC *Healy* will deploy two wave gliders and an oceanographic mooring; these will be retrieved later in the season. Data from the NOAA’s OE field work will be incorporated into the ARCWEST synthesis analyses.

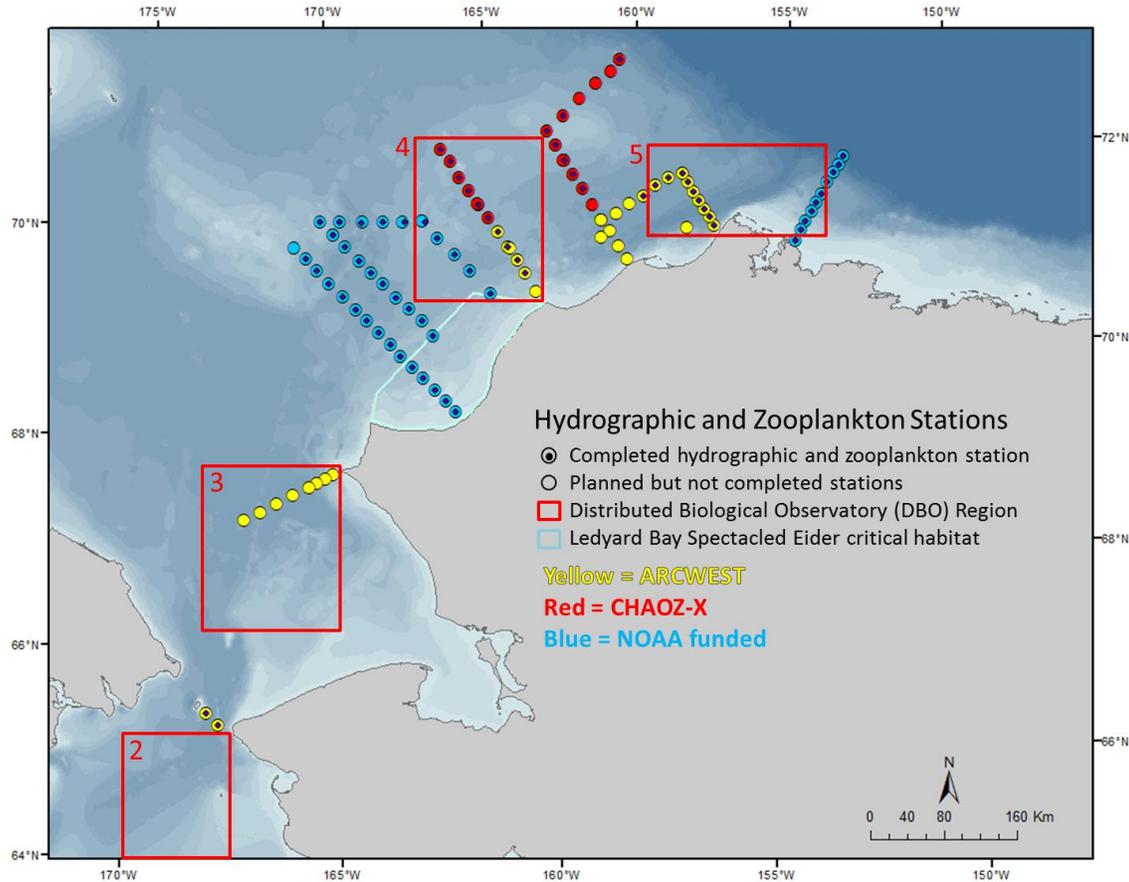


Figure 5. Planned biophysical stations sampled during the 2015 ARCWEST/CHAOZ-X cruise. Yellow symbols indicate ARCWEST stations. Red symbols indicate CHAOZ-X stations. Blue symbols indicated NOAA-funded stations. The line off Point Hope (yellow dots in DBO3) is tentatively scheduled to be sampled if time permits.

Satellite Tracked Drifters:

Due to the late timing of the 2014 cruise, it was not cost effective to deploy the satellite-tacked drifters last year. They will be deployed in 2015 from the USCGC *Healy* (six in July), NOAA ship *Ronald Brown* (three in August) and the ARCWEST cruise (three in September). 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:

We have initially examined data collected in 2013-2014. Unfortunately, it appears that the instruments collected only a small amount of data before failing. We are working hard to understand if this was a software or hardware failure. All indications point to a failure of the controller board to properly execute. We had been working with a contractor for the last several years to redesign this card whose electronics and software are very old and needed to be updated. The contractor delivered a preliminary design and electronic circuit boards were produced from the design for testing and firmware coding.

However, the contractor defaulted on the contract and is not answering our calls. Our in house engineer has made progress building a very simple, but effective controller using a common, easily obtained processor chip. Initial tests in the calibration tank with the new controller installed, showed that the instrument was capable of sending and receiving sound. The next step is to make sure the software code is finalized before doing a much longer test in the calibration tank.

An ADCP was deployed near one of the TAPS6-NG instruments, in the Icy Cape mooring cluster, in August 2011 and retrieved in 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. Wavelet analysis was performed on the ADCP volume backscatter data to examine the dominant modes of temporal variation and to determine strength of these modes across the observation period (Fig. 6). Initial examination of the data shows intermittent diel vertical migration. The analysis presented here is from the CHAOZ study, but similar analyses will be conducted with ARCWEST data.

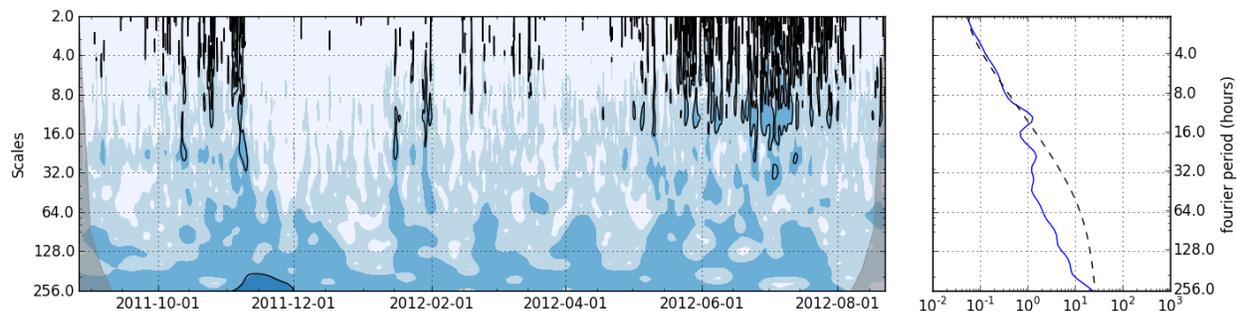


Figure 6. Wavelet analysis of ADCP data. Shown is an analysis of data at 28 m from the instrument deployed at site C3 in 2011. Diel vertical migration, when present, would show in the left panel as dark blue contours between 16 and 32 hrs on the (vertical) "Scales" axis. If diel vertical migration were a significant source of variability over the entire deployment, it would appear in the right panel as a peak on the blue line exceeding the dotted line in the same period (between 16 and 32 hours).

Lower Trophic Level Sample and Data Analyses:

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. We expect that the initial counts of organisms will be returned to us by May of 2015. Our standard QC/QA 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 QC/QA, 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.

2015 Field Season Planning:

If tests on the new controller are successful and considered stable over a longer period of time, we plan on deploying at least one instrument in 2015. We will calibrate the instruments in temperature conditions similar to the Chukchi which will increase the accuracy of the results of the procedure.

Visual Observations Component:

Sightings from the 2013 and 2014 cruise revealed that the distribution of marine mammals was similar between years. Specifically for large whales, relatively high densities of gray whales were observed in at least three different locations: coastal areas off Wainwright and Barrow, off of Point Lay and near the Bering Strait. While occasional sightings of Balaenopterid whales were recorded during the surveys, sighting data suggests that humpback, fin, and minke whale densities in the Chukchi Sea are lower than those seen further to the south in the Bering Sea and the Aleutian Islands (e.g. Friday *et al.*, 2012; 2013; Zerbini *et al.*, 2006). Detailed maps are available in the ARCWEST/CHAOZ-X cruise reports (http://www.afsc.noaa.gov/nmml/PDF/ARCWEST_CruiseReport2013.pdf and http://www.afsc.noaa.gov/nmml/PDF/ARCWEST-CHAOZ-X_CruiseReport2014.pdf).

Photo-ID

In 2013 and 2014, 50 gray whales were photographed in the Chukchi Sea, Bering Strait, and northern Bering Sea. One humpback whale was photographed in 2014 in the Chukchi Sea. In 2013, ~32 killer whales (still being analyzed) were photographed along the Alaskan Peninsula in the Gulf of Alaska and in the Bering and Chukchi Seas. In 2014, ~15 killer whales (still being analyzed) were photographed in the Bering Sea. Individuals are currently being compared to existing catalogs. Additional details are available in the ARCWEST/CHAOZ-X cruise report (http://www.afsc.noaa.gov/nmml/PDF/ARCWEST-CHAOZ-X_CruiseReport2014.pdf).

Satellite Tagging Component:

Additional data analysis is underway with the telemetry data collected in 2012 and 2013. Movement models (e.g. Jonsen *et al.*, 2007; Johnson *et al.*, 2008) have been applied to these data to evaluate fine scale habitat use (Fig. 7). Results show distinct regions of area-restricted search (ARS) off Wainwright, southwest of Pt. Hope, and west of St. Lawrence Island. ARS indicate areas where movement is typically slow and erratic and are often associated with foraging habitats (e.g. Jonsen *et al.*, 2007; Bailey *et al.*, 2010). Figure 8 shows a detailed kernel density estimate for the high-use area southwest of Pt. Hope. These preliminary results are consistent with results from aerial surveys and other telemetry project regarding preferred habitats used by gray whales in the Chukchi Sea.

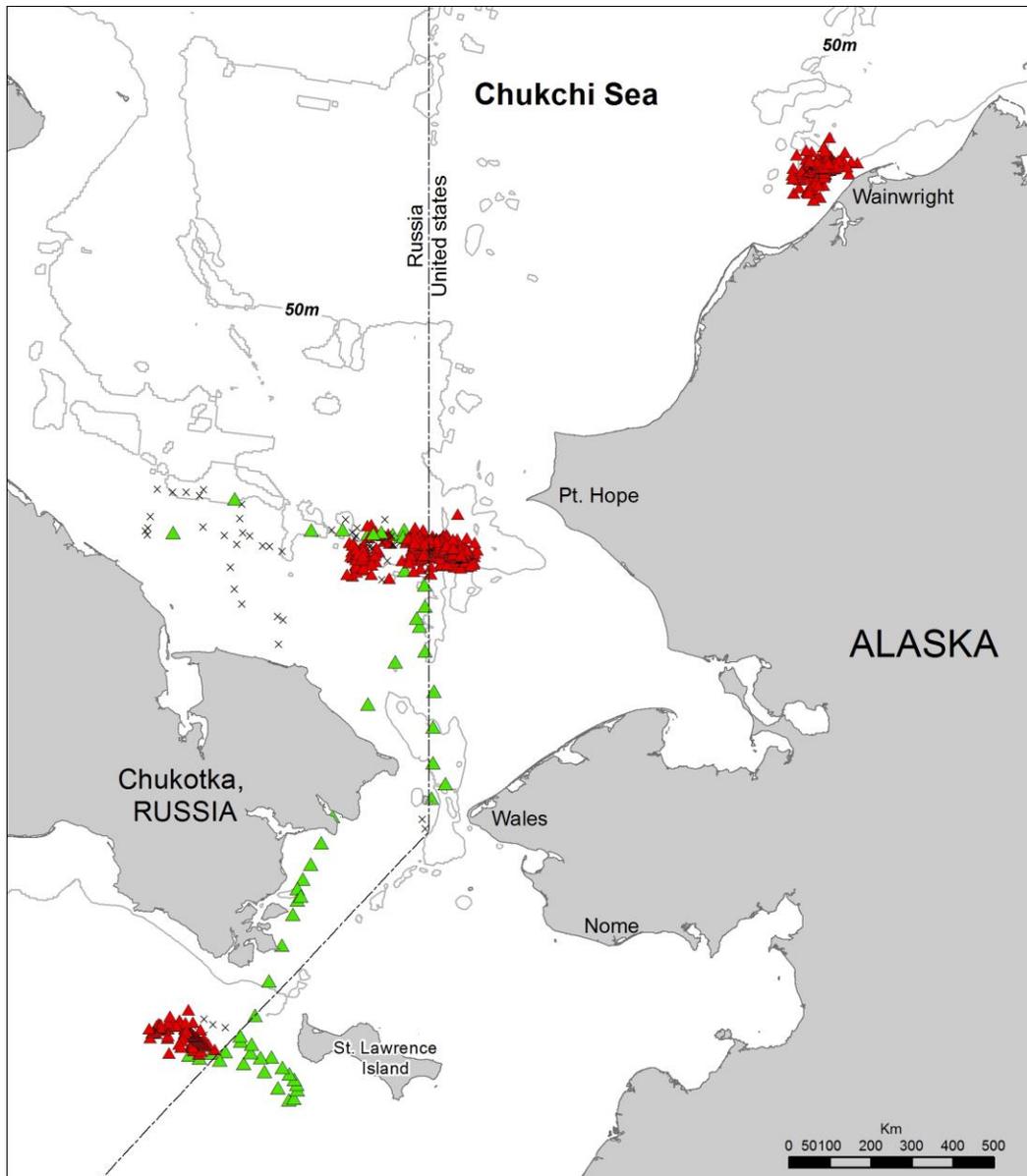


Figure 7. Habitat-use model results. Each triangle represents a switching state-space modeled position at a 6 hour time-step. Red triangles indicate where whales were engaging in area-restricted search (often associated with foraging) and green triangles indicate travel mode.

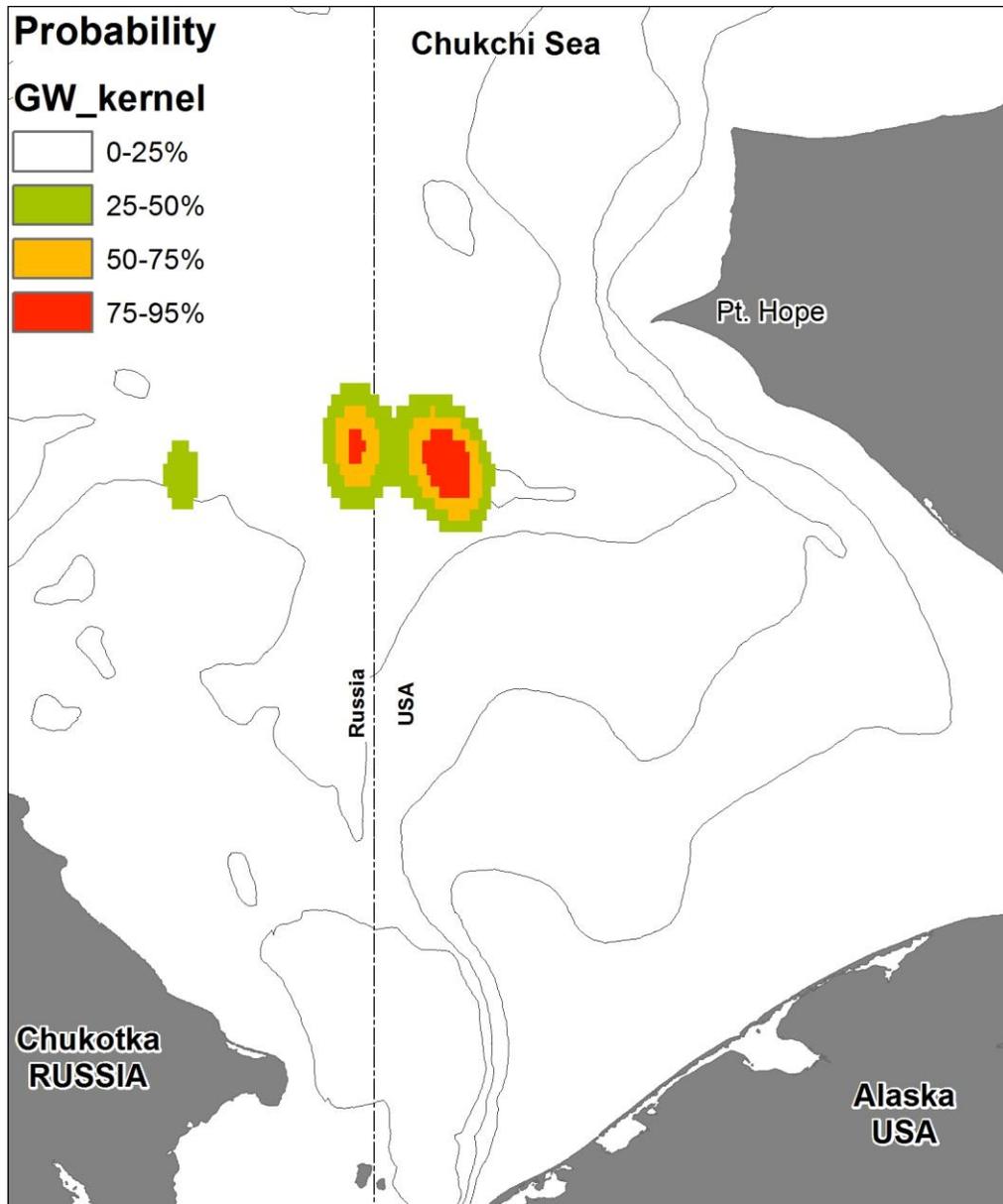


Figure 8. Kernel density estimate of the high-use area off Pt. Hope. Colors indicate the percentage of time a whale is predicted to use each region.

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 Implementation Team (<http://www.arctic.noaa.gov/dbo/about>) 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 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

Challenges for the 2015 field season included: 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 higher than anticipated in 2011 when the ARCWEST budget was submitted. To save funds, we have conducted vessel sharing with PMEL each year. This year, we plan to exercise the option year on our 2014 vessel charter contract with KB Fisheries, Inc. to conduct mooring retrieval and deployment, drifter deployment, and marine mammal visual surveys. We do not have specific dates for the cruise yet, but expect them to be in line with last year's survey effort rather than 2013. As part of that cost sharing effort, lower trophic level and physical/chemical oceanographic sampling will be conducted off the NOAA ship *Ronald Brown* from 6 August to 4 September.

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 (http://www.afsc.noaa.gov/nmml/PDF/ARCWEST_CruiseReport2013.pdf)), additional expenses have been incurred due to lost gear and skiff repairs.

To address budget shortfalls and funds needed to successfully complete the 2015 ARCWEST/CHAOZ-X cruise, a supplemental funding request was submitted to Carol Fairfield on 21 November 2014. This budget detailed the funds needed to: 1) retrieve the moorings deployed in 2014, 2) sample a full suite of hydrographic/plankton stations in 2015, 3) sample the DBO3 line, 4) turnaround 16 passive acoustic moorings and 2 oceanographic and zooplankton clusters as a bridge between ARCWEST/CHAOZ-X and future research, 5) conduct additional satellite tagging to meet the goals on ARCWEST, and 6) replace and/or repair gear lost during the 2013 gray whale incident. On 5 December, clarifications to this request were made including the critical need for the funds to retrieve moorings deployed in 2014. We understand that this request is under consideration.

Significant meetings held or other contacts made

23 January, 2015 – Berchok, Fairfield, Kennedy, Napp, Stabeno and Wang attended an ARCWEST planning meeting.

18 February, 2015 – Berchok, Fairfield, Friday and Crance attended an ARCWEST planning teleconference.

Presentations and Publications

Berchok, C.L. 2015. 2015 ARCWEST/CHAOZ-X Cruise Plans and Overview. Oral presentation at the Annual Alaska Eskimo Whaling Captains Convention, Barrow, AK. 2 – 6 February, 2015.

Berchok, C., Clark, C., Kennedy, A., Napp, J., Stabeno, P. and Wang, M. 2015 Chukchi Sea Whale Ecology Workshop: Introduction. Oral presentation at the BOEM Chukchi Sea Whale Ecology Workshop, Alaska Marine Science Symposium, Anchorage, AK. 23 January, 2015.

Berchok, C., Crance, J., Grassia, S., Ives, E., Garland, E., Mocklin, J., Ulmke, A., Kennedy, A., Rone, B. and Zerbini, A. 2015. Chukchi Sea Whale Ecology Workshop: Marine Mammal Visual and Passive Acoustic Data. Oral presentation at the BOEM Chukchi Sea Whale Ecology Workshop, Alaska Marine Science Symposium, Anchorage, AK. 23 January, 2015.

Berchok, C.L., Crance, J.L., Rone, B.K., and Moore, S.E. 2015. Marine mammal occurrence in the Distributed Biological Observatory (DBO) from ship-based visual and passive acoustic surveys. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, 19-23 January, 2015.

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