

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

Nancy A. Friday<sup>1</sup>, Ph.D.  
Phillip J. Clapham<sup>1</sup>, Ph.D.  
Catherine L. Berchok<sup>1</sup>, Ph.D.  
Jessica L. Crance<sup>1</sup>, M.S.  
Alexandre N. Zerbini<sup>1,4</sup>, Ph.D.  
Brenda K. Rone<sup>1</sup>, M.S.  
Amy S. Kennedy<sup>1,5</sup>, Ph.D.  
Phyllis J. Stabeno<sup>2</sup>, Ph.D.  
Jeffrey M. Napp<sup>3</sup>, Ph.D.

<sup>1</sup>National Marine Mammal Laboratory  
Alaska Fisheries Science Center

<sup>2</sup>Pacific Marine Environmental Laboratory

<sup>3</sup>Resource Assessment and Conservation Engineering Division  
Alaska Fisheries Science Center

7600 Sand Point Way NE  
Seattle, WA 98115

<sup>5</sup>Ocean Associates Incorporated  
4007 N. Abingdon Street  
Arlington, Virginia 22207

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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 July and September 2013.

The major activities during this period consisted of the completion of the Arctic Whale Ecology Study (ARCWEST) cruise from 13 August through 18 September 2013. The cruise took place on the chartered research vessel R/V *Aquila*. Seventeen scientists, technicians, and observers from eight different laboratories and institutions participated on the 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**

Please see the 2013 ARCWEST cruise report (“ARCWEST.CruiseReport2013.pdf”) for a full summary of activities and progress made during the cruise. In addition to work conducted under ARCWEST, moorings were deployed and sampling stations were occupied under the Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ, abbreviated CHAOZ-X) project (see “CHAOZ-X\_QrtReport\_Oct2013.pdf”).

### **Post-cruise data analysis results and planning**

#### Visual Observations Component:

Sightings have been mapped to examine distribution. Detailed maps are available in the ARCWEST cruise report (“ARCWEST.CruiseReport2013.pdf”).

Satellite Tagging Component:

Satellite tags were deployed on five gray whales during the ARCWEST survey: two on 24 August, two on 7 September, and one on 8 September. One of the 24 August tags did not transmit. Preliminary details of the other tags are given in the cruise report (“ARCWEST.CruiseReport2013.pdf”).

Passive Acoustic Component:

*NMML Long-term moorings:*

[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].

In 2012, we used ship time during the final retrieval cruise of the BOEM-funded Chukchi Sea Acoustics, Oceanography, and Zooplankton (CHAOZ) project to redeploy some of our passive acoustics moorings to be retrieved and analyzed under the ARCWEST study (Table 1). These included five moorings in the Chukchi Sea (KZ1, PH1, CL1, IC1, and WT1), three in the Beaufort Sea (BF1-3), and five in the Bering Sea (Figure 1, NM1 and Figure 2 BS1-4). In addition, we placed an AURAL recorder on four non-BOEM-project oceanographic moorings (Stabeno/PMEL) in the Bering Sea (Figure 2, M2, M4, M5, and M8). The exciting news from the 2013 retrievals is that 10 of the 11 recorders that have had their data extracted so far have recorded for the full year as planned, making this our most successful deployment ever. This success is due to a redesign of our AURAL battery packs.

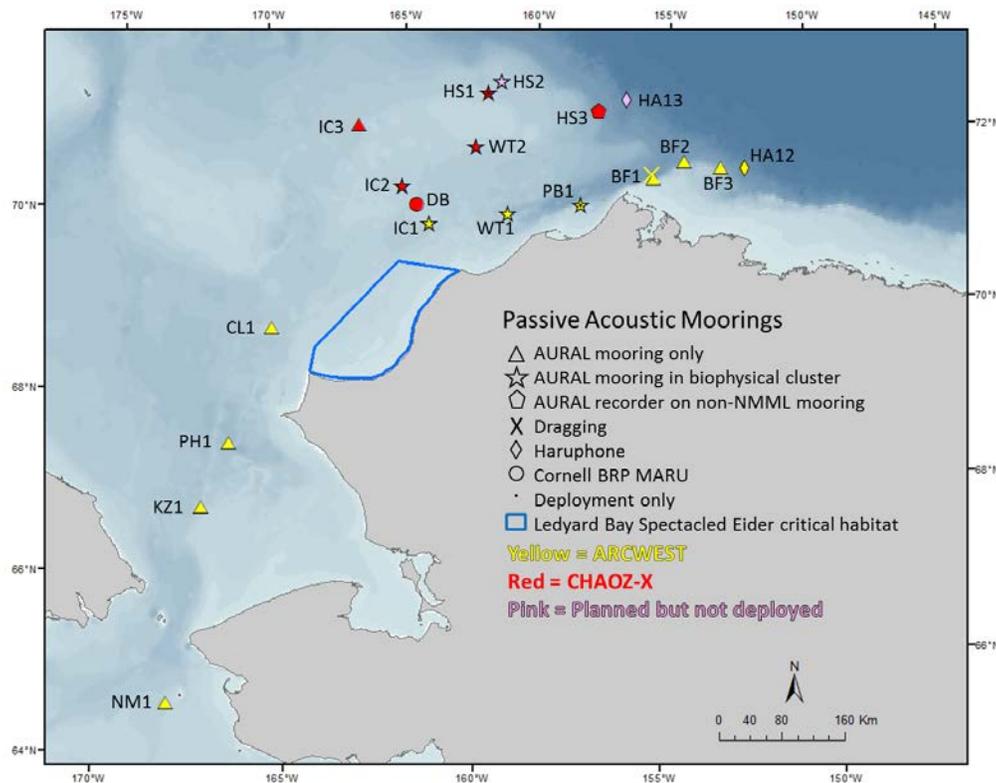


Figure 1. Passive acoustic moorings retrieved and/or deployed north of Nome, Alaska during the 2013 ARCWEST survey cruise. Yellow symbols indicate ARCWEST moorings. Red and pink symbols indicate CHAOZ-X moorings.

We also retrieved the deep-water Haruphone (Haru Matsumoto, NOAA/PMEL/CIMRS) recorder mooring (HA12) in the Beaufort Sea, which has been sent back to collaborator Holger Klinck (NOAA/PMEL/CIMRS) for his ambient noise measurement analysis. This mooring is part of an effort to map deep water ambient noise throughout the U.S. EEZ. Results from this effort will further inform the ARCWEST study.

With the exception of the Haruphone mooring, all of these moorings were redeployed in 2013, along with a sixth Chukchi recorder placed in Peard Bay (Figure 1, PB1). A sea day was funded by a NOAA Fisheries, Office of Science and Technology, Ocean Acoustics Program (NOAA S&T) to deploy an additional recorder in Norton Sound (Figure 2, NS1). Data from this recorder will also eventually supplement ARCWEST results.

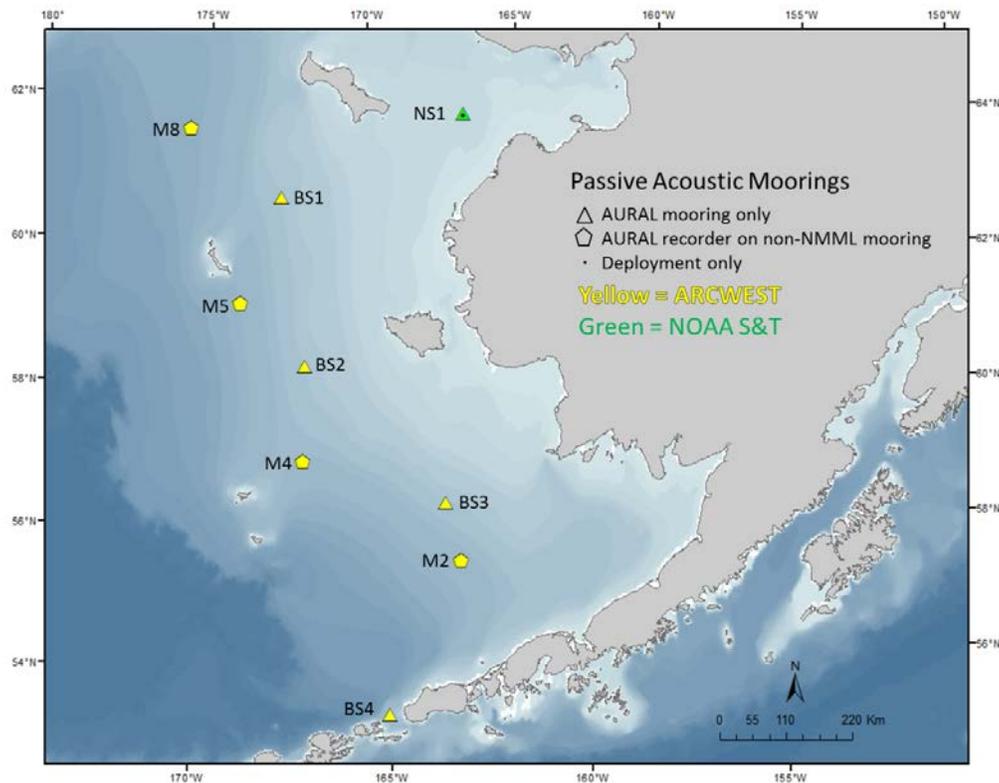


Figure 2. Passive acoustic moorings retrieved and/or deployed in the Bering Sea during the 2013 ARCWEST survey cruise. Yellow symbols indicate ARCWEST moorings. Green symbols indicate NOAA moorings.

The WT1 mooring was located within the ARCWEST biophysical mooring cluster C4 (Figure 3) for both the 2012 and 2013 deployments. The IC1 and PB1 moorings were located within the C1 and C5 biophysical clusters (Figure 3), respectively. Collocating the passive acoustic moorings with the biophysical moorings will allow us to maximize our opportunities to correlate marine mammal presence with biophysical measurements.

For the upcoming analysis, we will 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)). We are beginning to populate the LFDCS with exemplars of the main call types of each species, starting with bowhead and belugas (our best studied species). The LFDCS will then be tested on two CHAOZ data sets that have already been analyzed, to see how well

the system works. If successful, this system will not only reduce the amount of effort expended on each recording – and increase the number of species processed – 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 send out into our study areas in the future.

Table 1. Recording period, position, and depth of all long-term passive acoustic recorders deployed for ARCWEST. Retrieval date (data from mooring not extracted yet).

Mooring	Bio- Phys Cluster	Record Start	Record End	Latitude (N)	Longitude(W)	Depth (m)
AW12_AU_BS2	-	8/12/2012	8/17/2013	59.2437000	-169.4126000	53
AW12_AU_BS1	-	8/13/2012	8/19/2013	61.5877667	-171.3240333	51.5
AW12_AU_NM1	-	8/20/2012	8/23/2013	64.8473500	-168.3897667	42
AW12_AU_KZ1	-	8/21/2012	8/22/2013	67.1248000	-168.6018333	43
AW12_AU_PH1	-	8/22/2012	8/23/2013	67.9089500	-168.1946167	58
AW12_AU_CL1	-	8/23/2012	8/25/13†	69.3068000	-167.6479500	48
AW12_AU_IC1	-	8/25/2012	9/5/2013	70.8171667	-163.1364333	42.5
AW12_AU_WT1	C4	8/30/2012	8/27/13†	71.0458667	-160.5089000	48.7
AW12_AU_BF1	-	No	Data	71.5513000	155.5491000	69
AW12_AU_BF2	-	8/31/2012	9/6/2013	71.7514667	154.4712500	93
AW12_AU_BF3	-	8/31/2012	9/5/2013	71.6885833	153.1763833	103
AW12_AU_BS3	-	8/11/2012	9/13/2013†	57.6699667	-164.7251833	52
AW12_AU_BS4	-	8/10/2012	9/14/13†	54.4284000	-165.2664667	160.9
BS12_AU_05a	-	8/12/2012	8/20/2013	59.9120000	-171.7086667	71
BS12_AU_08a	-	8/14/2012	8/20/2013	62.1945000	-174.6608333	71
BS12_AU_04b	-	9/5/2012	9/12/13†	57.8669667	-168.8724667	72
BS13_AU_02a	-	5/11/2013	9/14/13†	56.8658167	-164.0570667	72
AW13_AU_BS2	-	8/18/2013	-	59.2430833	169.4136000	55.0
AW13_AU_BS1	-	8/21/2013	-	61.5868333	171.3276500	53.7
AW13_AU_NM1	-	8/22/2013	-	64.8483667	168.3905833	44.5
AW13_AU_KZ1	-	8/24/2013	-	67.1232333	168.6047667	44.6
AW13_AU_PH1	-	8/24/2013	-	67.9074500	168.2026500	57.4
AW13_AU_CL1	-	8/26/2013	-	69.3159167	167.6324833	50.0
AW13_AU_IC1	C1	8/28/2013	-	70.8225833	163.1384833	47.5
AW13_AU_WT1	C4	8/29/2013	-	71.0464000	160.5113000	44.5
AW13_AU_PB1	C5	9/2/2013	-	71.2053000	158.0190667	51.5
AW13_AU_BF1	-	9/3/2013	-	71.5529833	155.5321667	76.5
AW13_AU_BF2	-	9/3/2013	-	71.7522667	154.4658833	102.5
AW13_AU_BF3	-	9/3/2013	-	71.6872167	153.1806167	103.5
AW13_AU_BS3	-	9/18/2013	-	57.6703167	164.7161167	51.2
AW13_AU_BS4	-	9/18/2013	-	54.4278667	165.2683333	160.9
BS13_AU_05a	-	8/20/2013	-	59.9099333	171.7053000	73.5
BS13_AU_08a	-	8/20/2013	-	62.1928833	174.6756667	73.5
BS13_AU_04b	-	9/18/2013	-	57.8708833	168.8702500	73.5
BS13_AU_02b	-	9/18/2013	-	56.8626833	164.0594167	71.0

*Sonobuoys:*

All 2013 sonobuoy results can be found in the cruise report (“ARCWEST.CruiseReport2013.pdf”).

Oceanographic and Lower Trophic Level Component:*Moorings:*

All moorings deployed in 2012 were successfully retrieved. Locations for the 2013 oceanographic and active acoustic moorings (Figure 3, yellow stars and diamonds) were determined in coordination with the passive acoustic component of ARCWEST and based upon preliminary findings from the CHAOZ project as well as results reported by other researchers (e.g., Tom Weingartner, University of Alaska Fairbanks (UAF); Robert Pickart, WHOI). See the PMEL mooring website ([http://www.pmel.noaa.gov/foci/operations/mooring\\_plans/2013/jun2013\\_contVes\\_moorings.html](http://www.pmel.noaa.gov/foci/operations/mooring_plans/2013/jun2013_contVes_moorings.html)<sup>1</sup>) for information on the other instruments placed on each mooring.

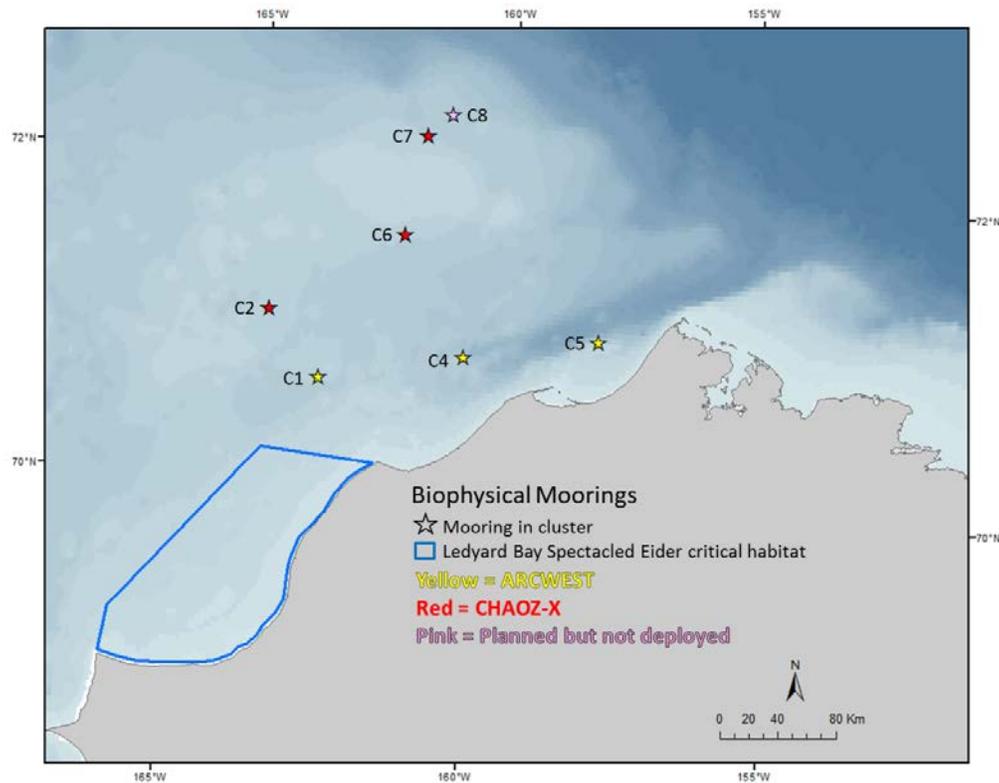


Figure 3. Biophysical mooring clusters retrieved and/or deployed during the 2013 ARCWEST survey cruise. Yellow symbols indicate ARCWEST moorings. Red and pink symbols indicate CHAOZ-X moorings.

<sup>1</sup> On this webpage subsurface moorings relevant to this project are titled 13CK (i.e., Chukchi Sea 2013) and 13BS (i.e., Bering Sea 2013). The number on the end corresponds to the mooring clusters shown in Figure 3 for the Chukchi Sea (e.g., 13CKT-2A corresponds to C2) or Figure 2 for the Bering Sea (e.g., 13BS-2C corresponds to M2).

### Hydrography & Plankton Sampling:

Locations for lower trophic level and physical/chemical oceanographic sampling (Figure 4, yellow dots) were also determined in coordination with the passive acoustic component and based upon previous research and our conceptual model of current flow. Analysis of the biophysical data will begin this fall. First order processing has been done on the recent 2013 cruise CTD samples, and once the salinity samples are run, the final processing of the temperature and salinity data will be completed. Nutrient samples were collected and frozen. These samples will be run in November. Final hydrographic data from the cruise will be uploaded to the data base by 31 December. Chlorophyll samples (> 200) are scheduled to be analyzed by the end of December, but data uploading is dependent upon completion of our new EcoDAAT database.

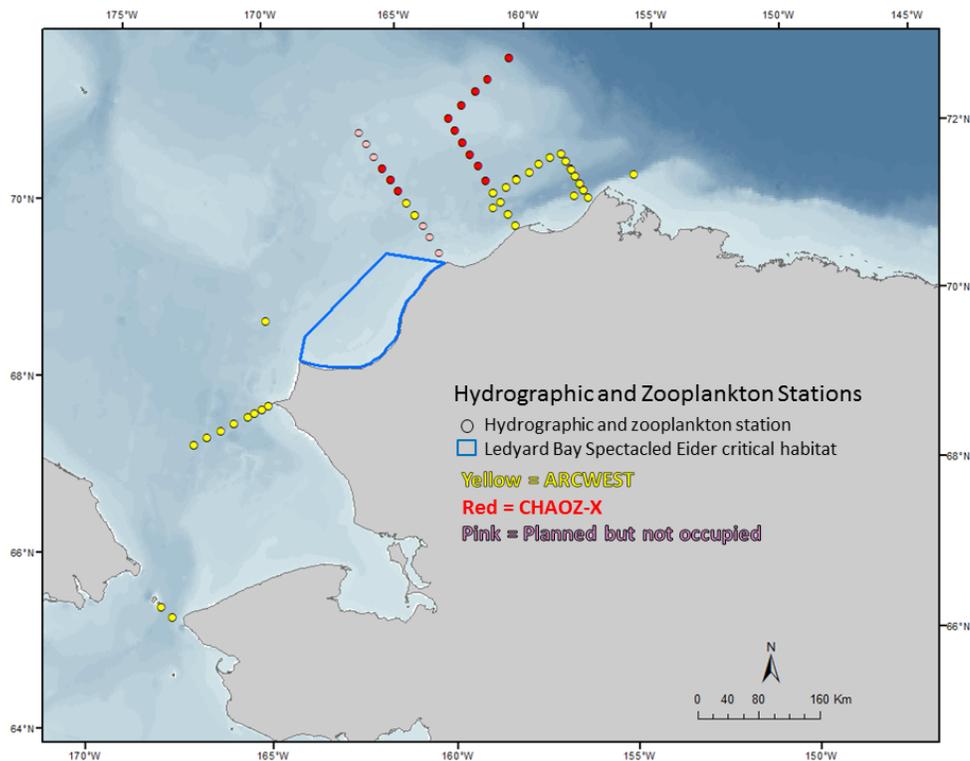


Figure 4. Biophysical stations sampled during the 2013 ARCWEST survey cruise. Yellow symbols indicate ARCWEST stations. Pink inshore symbols indicate ARCWEST stations which were not occupied. Red symbols and pink offshore symbols indicate CHAOZ-X stations.

Because of ice and rough seas, three of the ARCWEST sampling stations were not occupied (Figure 4, first three pink inshore stations on Icy Cape line).

### Satellite Tracked Drifters:

Twelve drifters were deployed during 2013 (Figure 5) and will be tracked. The ice is arriving in the region late this year, and so we are able to measure current speed and direction for a longer fall period this year than last. A movie showing drifter tracks and ice extent can be viewed at the following website under the heading *Chukchi drifters, ice*: [http://www.ecofoci.noaa.gov/efoci\\_drifters.shtml](http://www.ecofoci.noaa.gov/efoci_drifters.shtml).

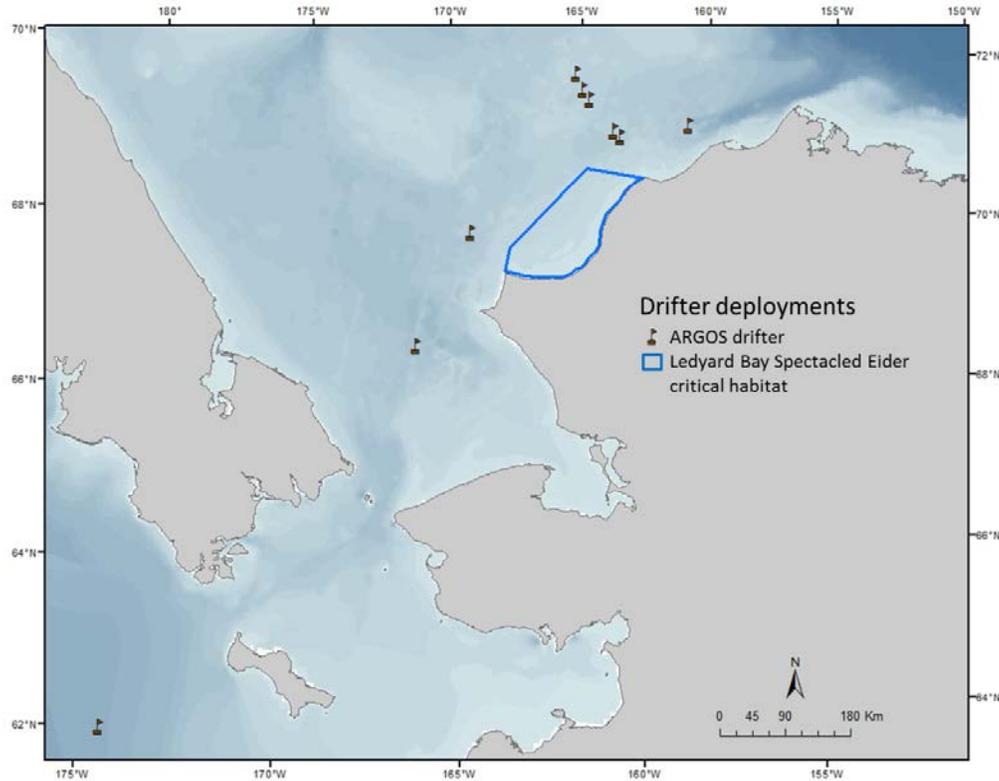


Figure 5. Deployment locations of ARGOS drifters in 2013.

#### *Active Acoustics:*

The single ARCWEST TAPS-6NG instrument deployed in 2012 at site C4 (Figure 3) was successfully recovered. We initially had trouble downloading its data due to issues with the firmware. We are currently examining the quality and duration of the collected data. It appears that the instrument worked until late May/early April (longer than the instrument deployed in 2011), but that it once again worked only sporadically during October, November, and December. The instrument sampled as programmed in August, September, and January -April. We accomplished > 40 tows of the Tucker sled with associated hydrographic and zooplankton acoustic data (TAPS-6). First order data processing on the 2013 TAPS-6 data has been accomplished. Final processing of the data will take place after the first of the year, when the TAPS-6 has a post cruise calibration.

#### *Lower Trophic Level Sample and Data Analyses:*

Preserved zooplankton samples from the Tucker sled were inventoried and sent to Poland in November 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:*

Field season planning for 2014 will begin this fall with a review of last year's field season and an identification of needs for the coming year.

**Significant technical, schedule, or cost problems encountered**

Challenges for the 2013 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, mooring costs that have more than doubled, and obtaining the additional mooring instruments required for the 2013 field season. The last issue is a challenge because the MOU was signed so late in the last fiscal year, that no expenditures or obligations could be made using Year 1 funds. We could not use or access these funds until late in the first quarter of FY13.

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 2013 has reduced the number of days dedicated to satellite tagging large whales to meet the projected vessel costs.

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

**Significant meetings held or other contacts made**

3 July 2013 – Friday, Clapham, Berchok, Zerbini, and Kennedy met to discuss satellite tagging operations on the 2013 vessel survey.

9 July 2013 – Kennedy, Friday, and Berchok contacted Gay Sheffield (UAF Marine Advisory Program, Nome, AK) to solicit advice on community outreach for the Bering Strait region. Sheffield provided a list of suggested revisions to the informational fliers being developed and an expanded list of villages and their contact information. Discussions are also underway to arrange for Napp to give a presentation while in Nome, AK.

**Presentations and Publications**

20 August 2013 – Napp radio interview with KNOM (Nome, AK).

16 August 2013 – Clapham interview for The Nome Nugget.