

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

ANNUAL 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 document the temporal and spatial distribution of baleen whales near Hanna Shoal in the northeast Chukchi Sea and relate variations to oceanographic conditions, indices of potential prey density, and anthropogenic activities to improve understanding of the mechanisms responsible for observed high levels of biological activity around the Shoal. This annual report covers the first year of this study between July and December 2013. The major activities during this period consisted of getting the Inter-Agency agreement signed and fieldwork onboard the ARCWEST survey cruise.

## Introduction and objectives

Hanna Shoal in the NE Chukchi Sea is an area of special biological concern near the boundary between Chukchi and Arctic Basin waters. The reason for this, however, is poorly understood. The shallower waters of the shoal have long been known to trap sea ice which can ground on the shoal, and a recurring polynya is created down current of the grounded ice. In most recent years, floating pack ice in summer persists in this area longer than elsewhere in the Chukchi Sea, often surrounded by open water even to the north. Biological “hot spots” in the Chukchi Sea are thought to be related to strong coupling between pelagic and benthic productivity. A high abundance of bottom fauna is correlated with high pelagic phytoplankton concentrations, possibly associated with an ice edge, which reached the seabed mostly ungrazed. The importance of the Hanna Shoal region to bowhead and gray whales and other marine mammals is not well known. In the 1980’s and 1990’s gray whales were frequently observed feeding near Hanna Shoal (Moore 2000) although they have not been observed during aerial surveys since 2008 (Clarke et al. 2012). Walruses, on the other hand, that were seen offshore during aerial surveys in summer 2011, appeared to show a preference for Hanna Shoal, presumably using the area to feed (Clarke et al. 2012).

The focus of the proposed study is to determine the circulation of water around the Hanna Shoal area, the source of this water (Chukchi Shelf or Arctic Basin) and its eventual destination, and the abundance of large planktonic prey at the shoal. The dynamic nature of this circulation and prey delivery will be studied relative to whale distribution and habitat utilization in the northeastern Chukchi and extreme western Beaufort Seas.

Biophysical moorings will supplement existing data by collecting important information on current flow and water properties in that region, while concurrently deployed passive acoustic moorings will provide year-round assessments of the seasonal occurrence of bowhead, humpback, right, fin, gray, and other whales in this planning area and their response to environmental changes (including oceanographic conditions, indices of potential prey density, and anthropogenic activities). The passive acoustic recordings will also provide baseline information on ambient noise levels throughout this area which is undergoing rapid change. In addition, a passive-acoustic auto-detection buoy will provide near-real-time information on species presence and ambient noise levels. These buoys are in the second stage of development towards their use as a real-time tool for regulators to mitigate the effects of anthropogenic noise.

Our goal is to use the CHAOZ-X sampling tools to understand the mechanisms responsible for the high biological activity around the shoal, so that we can predict, in a qualitative way, the effects of climate

change on these preferred habitats. The use of moorings will allow us to quantify transport and water properties, especially during the more than 6 months the region is ice-covered.

The specific objectives are:

1. Refocus the passive acoustic and biophysical monitoring begun under the study “COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales” from the initial lease areas to Hanna Shoal.
2. Describe patterns of current flow, hydrography, ice thickness, light penetration, and concentrations of nutrients, chlorophyll, and large crustacean zooplankton around the Shoal.
3. Assess the spatial and temporal distribution of marine mammals in the region of Hanna Shoal.
4. Evaluate the extent to which variability in environmental conditions such as sea ice, oceanic currents, water temperature and salinity, and prey abundance influence whale distribution and relative abundance.
5. Develop a quantitative description of the Chukchi Sea’s noise budget, as contributed by biotic and abiotic sound sources, and continuous, time-varying metrics of acoustic habitat loss for a suite of arctic marine mammal species.
6. Continue development of a near-real-time passive acoustic monitoring system that can be used as an impact mitigation tool.

### **Cruise activities and summary**

Please see the 2013 ARCWEST cruise report (“ARCWEST.CruiseReport2013.pdf”) for a full summary of CHAOZ-X activities and progress made during the cruise.

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

#### Passive Acoustic Component

In 2012 we used ship time during the final retrieval cruise of the BOEM-funded CHAOZ project to redeploy some of our passive acoustics moorings, under the assumption they would be retrieved and analyzed under the CHAOZ-X study. The three moorings retrieved included both the offshore (IC3) and mid-shore (IC2) Icy Cape moorings as well as the offshore Wainwright (WT2) mooring (Table 1 & Figure 1). We redeployed four moorings - all of the ones above, plus a new one on the Hanna Shoal line (Figure 1; HS1). All moorings in 2013 except for IC3 are located within biophysical mooring clusters (Figure 2; see Table 1 for mooring cluster association) to maximize our opportunities to correlate marine mammal presence with biophysical measurements. We were able to deploy all the CHAOZ-X moorings except for the second one along the Hanna Shoal line (Figure 1; HS2) – since funds did not arrive in time to build the biophysical moorings intended for that cluster. There were also plans to deploy (from the USCGC *Healy*) a Haruphone (Haru Matsumoto, NOAA/PMEL/CIMRS) recorder to measure deep ocean ambient noise (a collaboration with Holger Klinck (NOAA/PMEL/CIMRS)) on a Stabeno oceanographic mooring further east of the Pickart (Bob Pickart/WHOI) mooring line (Figure 1, HA13), but the government shutdown prevented that mooring from being deployed. However, we did place one AURAL recorder on one of the Pickart (WHOI) oceanographic moorings located on the eastern slope of Hanna Shoal (Figure 1; HS3).

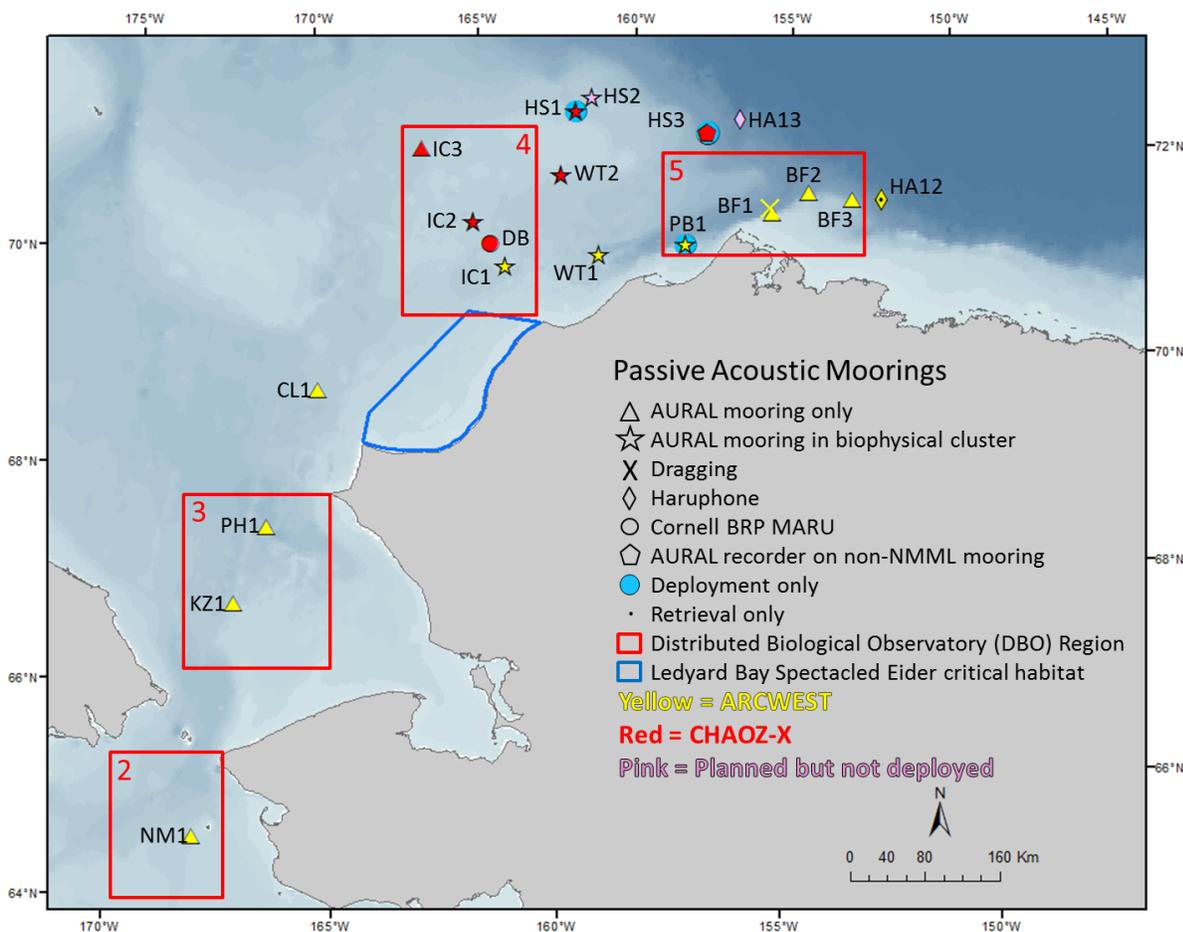
We will use our in-house Matlab-based sound analysis program on data pre-processed using a low-frequency detection and classification system (LFDCS - Mark Baumgartner/WHOI). We are beginning to populate the LFDCS with exemplars of the main call types of each species, starting with bowhead and belugas (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.

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

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

Mooring	Bio-Phys Cluster	Record Start	Record End	Latitude (N)	Longitude(W)	Depth (m)
CX12_AU_IC3	-	8/28/2012	8/26/2013	71.8292167	166.0715833	44.5
CX12_AU_IC2	C2	8/27/2012	8/27/2013†	71.2019833	164.1989000	45.0
CX12_AU_WT2	-	8/30/2012	8/28/2013†	71.7802833	161.8550167	43.5
CX13_AU_IC3	-	8/28/2013	-	71.8313833	166.0736667	47.5
CX13_AU_IC2	C2	8/28/2013	-	71.2048167	164.2106500	47.5
CX13_AU_WT2	C6	8/30/2013	-	71.7802833	161.8550167	43.5
CX13_AU_HS1	C7	8/30/2013	-	72.4269167	161.6286167	47.5
CX13_AU_HS3	-	10/29/2013	-	72.3362500	157.4482167	163.0



**Figure 1.** Passive acoustic moorings retrieved and/or deployed during the 2013 ARCWEST survey cruise. Red symbols indicate CHAOZ-X moorings.

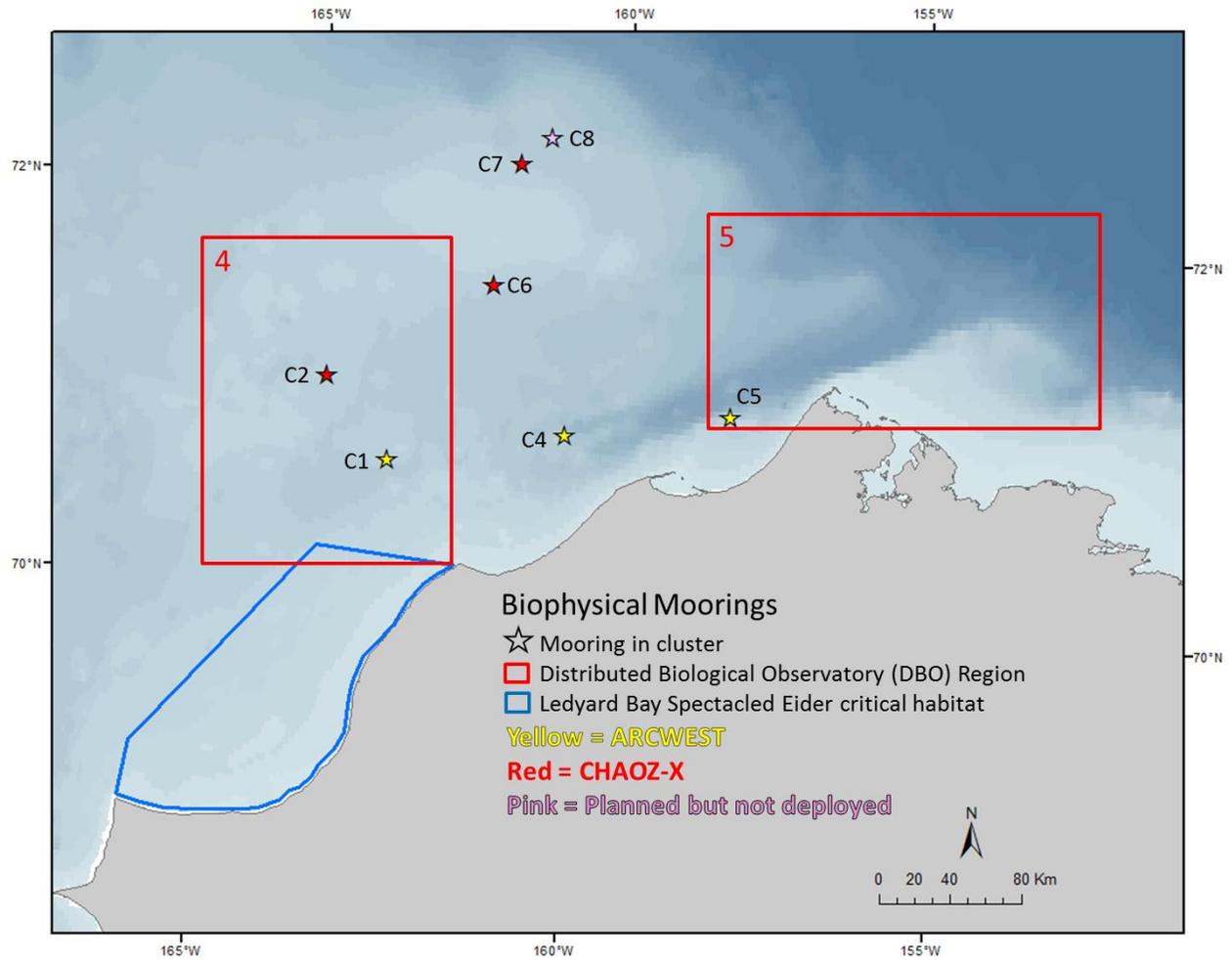
### Oceanographic and Zooplankton Component

The oceanographers retrieved 3 moorings at site C2 and deployed clusters of moorings at sites C2, C6, and C7 for CHAOZ-X on the BOEM-funded ARCWEST cruise (Figure 2). At sites C2 and C6 we deployed 3 moorings each (ADCP, Ice Profiler, and TAPS-6NG) and at site C7 we deployed only the ADCP and Ice Profiler moorings. See the following website for other instruments placed on each mooring: ([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>). Mooring cluster C8 was not deployed due to the late arrival of funding and another deployment was hindered by the government shutdown (see Passive Acoustic Component above). All instruments were programmed to sample throughout the year. The TAPS-6NG instruments utilized a new, more powerful battery pack and new pressure cases.

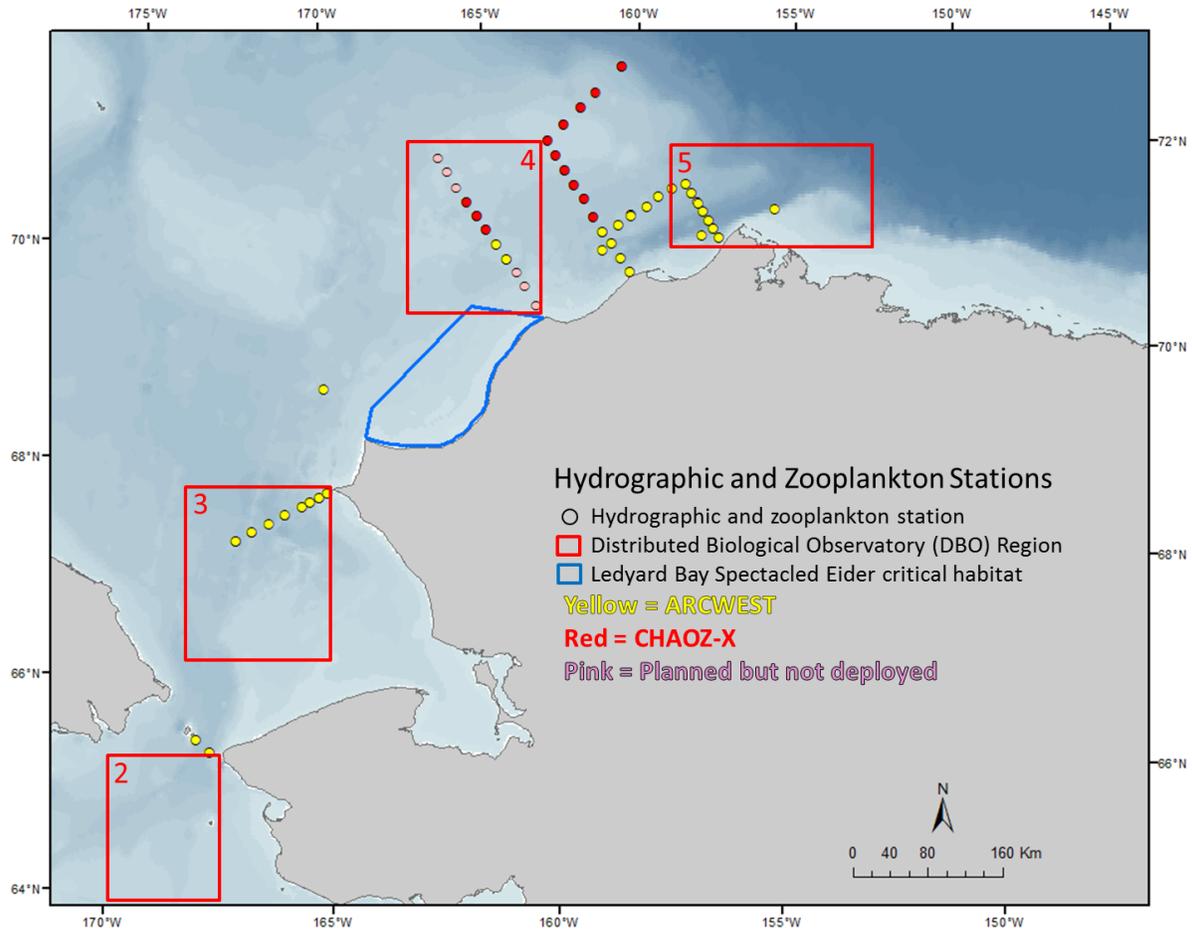
In addition, plankton tows and hydrographic stations (CTD, nutrients, dissolved oxygen and chlorophyll a) were conducted across the southern and northeastern flanks of Hanna Shoal (Figure 3). The transect began off Wainwright with a series of four ARCWEST stations, continued from the southern flank to the top of Hanna Shoal with 6 CHAOZ-X stations and then doglegged to the northeast with four more stations towards the shelf break. Hydrographic samples (nutrients, salt, dissolved oxygen and chlorophyll) were returned to Seattle and will be processed in our laboratories. Fluorometric analysis of chlorophyll samples was completed in the first week in January. Zooplankton samples were returned to Seattle and were shipped in November to the Polish Plankton Sorting and Identification Center for sample analysis.

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



**Figure 2.** Biophysical mooring clusters retrieved and/or deployed during the 2013 ARCWEST survey cruise. Red symbols indicate CHAOZ-X moorings.



**Figure 3.** Biophysical stations (hydrography and plankton) sampled during the 2013 ARCWEST survey cruise. Red symbols indicate CHAOZ-X stations.

**OCEAN NOISE AND REAL-TIME PASSIVE ACOUSTIC MONITORING**

The Bioacoustics Research Program (BRP) at Cornell retrieved and redeployed one double-MARU recorder mooring for CHAOZ-X on the BOEM-funded ARCWEST cruise (Figure 1, red circle: DB). The BRP is currently partnered with the Woods Hole Oceanographic Institution (WHOI; Don Peters), which is working on a joint-institute (Cooperative Institute for the North Atlantic Region, CINAR) proposal to conduct the auto-detection buoy and noise modeling work for the CHAOZ-X project. This proposal should be submitted soon, and will be awarded pending transfer of FY14 funds from BOEM to NOAA.

**2014 Field Season Planning**

This fall the oceanographers began purchasing components to build an additional TAPS-6NG for deployment in 2014. Purchases will continue through the winter and spring. New sets of transducers began arriving in December. In addition, a design for a new controller board for the TAPS-6NG with lower power consumption, additional data storage and a more modern programming interface was

delivered. Prototype boards were ordered in fall and testing of the new design is to begin during winter/spring.

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

None

**Significant meetings held or other contacts made**

None

**Presentations and Publications**

None

**Literature Cited**

Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2012. Distribution and Relative Abundance of Marine Mammals in the Alaskan Chukchi and Beaufort Seas, 2011. Annual Report, OCS Study BOEM 2012-009. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Moore, S. E. 2000. Variability in cetacean distribution and habitat section in the Alaskan Arctic, autumn 1982-91. *Arctic*. 53:448-460.