PASSIVE ACOUSTIC DETECTION
AND MONITORING
OF ENDANGERED WHALES
IN THE ARCTIC (BEAUFORT, CHUKCHI)

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Executive Summary

Through an Inter-Agency agreement (IA) between the National Marine Mammal Laboratory (NMML) and the Minerals Management Service (MMS), NMML is conducting a dedicated multi-year study of the distribution and relative abundance of endangered whales in the Chukchi Sea Planning Area and relate variation in those variables to oceanographic conditions, indices of potential prey density, and anthropogenic activities. This quarterly report covers the period between 28 January 2010 and 15 April 2010.

The major activities during this period consisted of planning and preparing for the upcoming Chukchi Sea Acoustics, Oceanography, and Zooplankton (CHAOZ) cruise that is tentatively scheduled for 24 August through 20 September 2010. The cruise will take place on a chartered vessel yet to be determined. To date, 13 scientists, technicians, and observers are scheduled to participate on the cruise.

Introduction and objectives

The western Arctic physical climate is rapidly changing. The summer minimum sea ice extent in 2007 and 2008 covered an area which was 37% less that the area coverage of two decades ago and 20% less than the previous minimum coverage in 2005 (Stroeve et al., 2008). The rapidity of these changes was unexpected, as the consensus of the climate research community just a few years ago was that such changes would not be seen for another 30 years, as expected from the CO2 anthropogenic contribution alone (Wang and Overland 2009).

Baleen whales are subject to changes in environmental variables such as oceanographic currents, sea temperature, sea ice cover, prey availability, and anthropogenic impacts. Furthermore, extreme ice-retreat and climate warming in the western Arctic over the last decade are expected to lead to changes in species composition and distribution, evidenced already through local knowledge and opportunistic observations.

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. This change, coupled with steadily increasing abundance and related seasonal range expansion by the bowhead, gray, humpback, fin, and possibly other whales, indicates 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.

Acoustic monitoring and satellite-tracking in the Chukchi Sea Planning Area year-round for several years will provide a previously unattainable assessment of the seasonal occurrence of large whales in this region and their response to environmental changes (including climate and anthropogenic use of the area). These data when integrated with data from concurrent monitoring of oceanographic conditions will enhance attempts to explain finer-scale variability in whale occurrence and relative abundance. Moorings permit observations during ice covered periods and the critical spring and early summer when spring phytoplankton occurs. Such measurements are impossible to obtain from ships, because of the relatively short duration they spend in the area.

The overall goal of this multi-year IA study is to document the distribution and relative abundance of bowhead, humpback, right, fin, gray, and other whales in areas of potential seismic surveying, drilling, construction, and production activities and relate variation in those variables to oceanographic conditions, indices of potential prey density, and anthropogenic activities. The proposed study will have 4 component projects: oceanography, passive acoustics, zooplankton, and climate modeling. Each component project is a technical discipline and will be coordinated by a Project Leader with extensive experience in that discipline.

The specific objectives are:

1. Assess the year-round seasonal occurrence of bowhead, gray, and other whale calls in the Chukchi Sea.
2. Estimate relative abundance.
3. Obtain two full years of biophysical measurements on the shallow Chukchi shelf utilizing moorings at three sites, and collect hydrographic and lower trophic level data during deployment/recovery of the moorings.
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. Rerun the National Center for Atmospheric Research (NCAR) climate model (Community Climate System Model: CCSM) for future projections using the sea ice extents from 2007/2008 as initial conditions.
6. Analyze multiple ensemble members from the NCAR model and other IPCC models to assess the future variability of sea ice cover and extended sea ice free seasons during fall for the Chukchi Sea.
7. Evaluate whether changes in seasonal sea ice extent are resulting in a northward shift of Bering Sea cetacean species such as fin, humpback, and North Pacific right whales.
8. Provide long-term estimates of habitat use for large whale species and compare this with predictions about annual ice coverage in order to establish predictive variables to describe large whale occurrence.

Summary of work performed and overall progress made against the schedule:

Cruise planning summary

Equipment: A significant amount of scientific and safety equipment is required for this cruise. The cruise coordinator has been working to ensure that all of the cruise participants will have the necessary equipment (such as Big-eye binoculars, oceanographic sampling gear, satellite phones, mustang suits, flares, air horns) for the cruise. Small boat safety inspections and maintenance have been completed. The vessel contract is in its final days of posting in the federal register and should be awarded by May.

Personnel: There will be a maximum of 13 scientists aboard the research vessels on the survey. Scheduling, travel logistics, contracting and observer hiring is well underway and should be complete in plenty of time for the August cruise.

Oceanographic mooring and sampling planning

- We investigated depth of ice in the region and found that the keel depth of ice can be as deep as 28 m. Since we are deploying moorings in water depths of less than ~40 m, we have designed all our moorings to be within 6 m of the bottom. This will entail deploying 2 moorings at each site. All moorings have been designed, all equipment is being prepared. Most of the mooring equipment and hardware will be on board and depart Seattle when our vessel does.
- We have refurbished our CTD rosette and obtained 8 Niskin bottles for use on the cruise. We plan to measure temperature (dual sensors), salinity (dual sensors), oxygen (dual sensors), fluorescence and PAR.
- When we examined the ship that we expect to use, there was no suitable place to prepare instruments or position the deck units and computers. To resolve this it was most cost effective to buy a modified container to work in. This has been done and will be delivered to our vessel once the contract is awarded. This container will be used by all parties on the cruise.
- We have already purchased and are currently testing one instrument to measure ice thickness. We have placed orders for the other two instruments.
- We have purchased the Seacats and the ADCP. All other equipment has been calibrated and is being prepared for shipment when our vessel departs Seattle.
- Noting the loss of moorings by several groups who worked in the area last year, we have decided to deploy a pop-up tag on each mooring. We have used these tags before. They are a relatively cheap form of insurance. The tags are programmed to pop to the surface on a predetermined date. If a mooring is dragged by ice or ships then the tag will indicate the mooring’s location. This is important on a shallow shelf, because the acoustic releases can only be “heard” over a relatively short distance. We have used these tags before and plan to use ones that we already own.
- Due to the late signing of the IA between MMS and NOAA, we will deploy one existing TAPS 8 instrument from the Bering Sea on the Chukchi mooring and use a TAPS 6 instrument on the CTD (in profiling mode) during the cruise. Both instruments were calibrated this past winter. The profiling instrument will help us interpret both the net data and the longer term mooring data.
• We are investigating methods and equipment necessary to obtain samples of inorganic suspended material near the bottom to assess its contribution to the scattering signal.
• We ordered a new, smaller (0.5 m²) Tucker sled for use on the charter vessel.
• We began repairs/maintenance to our oceanographic winch in preparation for the cruise.
• Tom Weingartner (UAF) will also come onboard for three days to deploy his moorings in the NE Chukchi near the Barrow Canyon.
• Most of the PIs attended the Alaska Marine Science Symposium to learn about other proposed research being conducted in the study area. In addition, we attended the MMS field season coordination meeting held to introduce all of the scientists working in the area. Last, we have been active letting the communities know about our summer plans, for instance, the goals and general sampling area was presented at a recent meeting of the North Slope Science Initiative (NSSI) by R. Angliss.

![Figure 1](image.png)

Figure 1. Mooring designs for the a) oceanographic and b) passive acoustic array components of the study. Moorings designed by Henderick Miller (NOAA/PMEL).

Passive acoustic mooring and monitoring planning

There will be two components to the passive acoustic monitoring field-work plan: three five-unit arrays of AURAL recorder subsurface moorings (NMML), and one real-time auto-detection buoy (Cornell University)

Passive acoustic arrays:

• As per the first item of the oceanography planning, we will be using the mooring type designed for the Bering Sea lease area as it is compact, rugged, and low to the seafloor (Figure 1b). The moorings are being prepared. Acoustic releases have been purchased and decksets reserved for the cruise. We borrowed 15 steel floats from PMEL, which we had sandblasted and repainted as suggested by PMEL.
• We have submitted the paperwork for acquisition of the AURAL passive acoustic recorders, calibration pingers, and recorder batteries. The pinger contract has been awarded and the other two are in their final stages of processing.
• We are in the process of submitting a contract to lease a self-contained trawling winch to use for dragging for the three AURAL moorings from the MMS funded BOWFEST project, that were unrecoverable off Barrow Canyon in 2009.
• We are close to finalizing our plans for the locations of the arrays (Figure 2). We plan to place the pentagonal arrays around each of the oceanographic mooring clusters.

Auto-Detection buoy:

• The Bioacoustics Research group at Cornell University is finalizing its plans for the deployment of an auto-detection buoy capable of auto-detecting bowhead whales. They are investigating the possibility of deploying the buoy from another vessel earlier in the season to extend the deployment time of the buoy. They will use a well-tested buoy design. We should be receiving their proposal for this work in the next few days.

Modeling component planning

There are two types of modeling planned for this year: Climate modeling from the Overland group and Cumulative noise modeling from Chris Clark’s group at Cornell University.

Climate Modeling:

• We have contacted NCAR about using their system to project sea ice in the Chukchi Sea over the next year.
• We have inquired and learned that the next International Panel on Climate Change (IPCC) set of model results for their Fifth Assessment report will become available in early winter 2011. This set of models is the latest contribution from all of the modeling centers in the world which project future climate. Our group was a leader in evaluation of the last set of models from their Fourth Assessment Report, and one of our tasks will be an early comprehensive evaluation and analysis of these new results.
• We have established the priority of a) reviewing existing information for the Chukchi, b) working with the NCAR model, c) preparation in terms of computer analysis codes for the IPCC 5th assessment report.

Cumulative Noise Modeling:

• The Bioacoustics Research group at Cornell University should be submitting their proposal to us in the next few days.

Visual/ passive acoustics observations planning

Three marine mammal observers will be aboard to conduct a visual survey whenever the vessel is transiting between stations or ports during daylight hours. Two observers will use 25x Big-Eye binoculars to call out sightings, and the data recorder will have 7x50 hand-held binoculars to identify animals close to the vessel. Each position will rotate every 40 minutes. If a species of interest is located, the observers will collect as much information as they can on their current course and will only divert from track at the discretion of the Chief Scientist. While on station, the mammal observers will either take a break (depending on the duration of the previous transit) or will assist the Chief Scientist with the oceanographic data collection. If a right whale is spotted while on station, it may be possible to launch a small boat for biopsy and photo-identification purposes, but this is entirely situation-dependent and will not interfere with the main focus of the cruise. There will also be a seabird observer onboard from the US Fish and Wildlife Service.

Throughout the cruise there will also be passive acoustic monitoring using DiFAR sonobuoys. Acoustics is a critical component as it can easily detect calling whales from 20 km away, even when visual observations are
limited by darkness, high sea states, or fog. Once whale calls are detected, and the bearing to the whale is calculated, the ship can be diverted towards the calls if time permits. If necessary, a second sonobuoy can be deployed and a more accurate cross bearing location of the calling whale can be obtained. The receiving gear necessary for sonobuoy operations will be installed on the charter vessel prior to its departure from Seattle.

**Survey design**

Once our mooring locations and CTD/net tow survey lines have been finalized, these data will be entered into a cruise planning program which will provide waypoints and time estimates for the various components of the cruise and allow us to determine the best schedule of activities. The cruise dates have us departing Nome on August 24, arriving in the study area by August 27, working for 18 days, then transiting back to Nome for a touch-and-go on September 16, arriving back in Dutch Harbor on September 20.

![Figure 2. Proposed mooring locations for the oceanographic (blue stars) and passive acoustic (red pentagons) moorings. Locations shown in relation to lease areas and proposed industry passive acoustic monitoring activities.](image)

**Significant meetings held or other contacts made**

Berchok, Crance, Stabeno, and Napp have met several times to discuss cruise planning and coordination progress and set-backs. Personnel, equipment, logistics, and budget issues are discussed. Stabeno has met with Overland to discuss modeling progress.