

Chukchi Acoustic, Oceanographic, and Zooplankton (CHAOZ) Study 2012

DATES: 8 AUGUST - 5 SEPTEMBER 2012

R/V Aquila

I. Cruise Overview

Cruise Title – CHAOZ 2012

Cruise Dates: August 8 – September 5, 2012

Departure – Dutch Harbor, AK – 8 August 0500 ADT

Arrival – Dutch Harbor, AK – 5 September, 2100 ADT

Operating Area – Bering, Chukchi, and Beaufort Seas

A. Summary of objectives

There are three goals for this study:

1. Determine general presence and detailed movements of bowhead, fin, gray, and humpback whales in oil and gas lease areas using long-term passive acoustic recorder arrays, sonobuoys, shipboard visual observations, and opportunistic satellite tracking.
2. Monitor ecosystem change through the use of long-term biophysical moorings, shipboard observations and climate numerical models.
3. Assess the response of the whales to environmental changes (including climate and anthropogenic use of the area) by integrating the biophysical, passive acoustic, and large whale biology data sets.

These findings will be useful for formulating designs of mitigation for human activities in the region. In particular, these data will be used to support National Environmental Policy Act analysis and documentation for Chukchi Lease Sales, Draft Proposed Programs, and monitoring, as well as ESA consultations, Marine Mammal Protection Act permitting, and preparation of Biological Evaluations and Biological Opinions. The main components of this study include passive acoustic recorder and oceanographic instrument deployments, as well as biophysical (CTD and plankton tow) stations. In addition, a passive acoustic survey (using sonobuoys) and visual observation survey will be undertaken during transit to and from the mooring sites.

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 of these whales.
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. Run 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 to establish predictive variables that describe large whale occurrence.

B. Operating area

The primary operating area will be within and transiting to and from the Chukchi Sea. Primary mooring locations will be perpendicular to the coast, in between the Burger and Klondike leases, as well as offshore of Wainwright, Peard Bay, Cape Lisburne, Point Hope, and south Bering Strait (Figure 1). CTD and Tucker tow transects will be on five separate lines perpendicular to the coast, extending out for approximately 100 km (blue circles, Figure 1). Passive acoustic moorings for the BOEM funded BOWFEST project will be retrieved and redeployed as part of the BOEM funded ArcWest project off Barrow, AK. PMEL's oceanographic moorings and four additional passive acoustic moorings (ArcWest) will be deployed along the 70 m and 50m isobaths in the Bering Sea (Figure 2).

An auto-detection buoy (see below) will be deployed off Icy Cape for a period of approximately two months.

During transit to and from stations or the working area, and during non-mooring ops, sonobuoy deployments and visual observations will be made at the chief acoustic scientist's discretion. Five days of sea time are being paid for by the upcoming ArcWest project to conduct preliminary satellite tagging on target species such as humpback, fin, and gray whales.

C. Participating institutions

The primary participating institutions for this cruise will be the National Marine Mammal Laboratory (NMML), Resource Assessment and Conservation Engineering (RACE) and the Pacific Marine Environmental Laboratory (PMEL) as well as researchers from the NMFS Office of Protected Resources Permits, U.S. Fish and Wildlife Service, Cornell University, University of Alaska Fairbanks, Penn State University, and Marine Acoustic Consultants, LLC.

D. Personnel

The Chief Scientist of the cruise is Dr. Catherine Berchok, who will also be leading the Acoustics component. Bill Floering will lead the Oceanographic component on behalf of Dr. Phyllis Staben, Dr. Jeffrey Napp will take the lead on the Zooplankton component, and Brenda Rone will lead the visual operations. Andy Bankert will be working independently on seabird observations. All personnel sailing on CHAOZ 12 are listed in Table 1. There will be no more than fifteen (15) scientists on board at any given time. Personnel may need to be modified prior to the cruise due to extenuating circumstances.

Table 1. Personnel

| Position | Name | Nationality | Institution |
|-----------------------------------|---|---------------|--------------------------------|
| Chief Scientist Lead Acoustics | Catherine Berchok | United States | NMML/AFSC |
| Lead Oceanography | Bill Floering (on behalf of Stabeno) | United States | PMEL |
| Lead Zooplankton | Jeff Napp | United States | RACE/AFSC |
| Acoustician | Jessica Crance | United States | NMML/AFSC |
| Acoustician | Dana Wright | United States | Univ. Alaska Fairbanks |
| Senior Mammal Observer | Brenda Rone | United States | NMML/AFSC |
| Mammal Observer | Amy Kennedy | United States | NMML/AFSC |
| Mammal Observer/acoustician | Stephanie Grassia | United States | NMML/AFSC |
| Mammal Observer/acoustician | Jessica Thompson | United States | NMML/AFSC |
| Oceanography | Sigrid Salo | United States | PMEL |
| Zoo- & Ichthyoplankton | Steve Porter | United States | RACE/AFSC |
| Zoo- & Ichthyoplankton | Adam Spear | United States | RACE/AFSC |
| Seabird observer | Andy Bankert | United States | U.S. Fish and Wildlife Service |
| *Double Bubble MARU technician | Jason Michalec | United States | Cornell University BRP |
| *Auto buoy technician | Kris Newhall | United States | Cornell University BRP |
| *Independent acoustician | Sam Denes | United States | Penn State Univ. |
| *Independent oceanographer | Dan Naber | United States | Univ. Alaska Fairbanks |

* Personnel only on board for one leg of the cruise.

E. Administrative

Scientific Operations

Primary point of contact for this cruise is Catherine Berchok: Catherine.Berchok@noaa.gov, 206-526-6331.

Required clearances: these consist of the following: (i) medical history and emergency info form submitted to captain by all scientific personnel; (ii) foreign clearance for all non-US citizens (listed by nationality on Table 1); (iii) research permits to conduct the work (all scientific operations with marine mammals will be conducted under NMFS permit number 782-1719 issued to NMML with the Senior Mammal Observer identified as the Co-Investigator; and (iv) certification of all small boat operators in accordance with current NOAA requirements for coxswains. It is the Chief Scientist's responsibility to ensure that all clearances are obtained in a timely fashion prior to the cruise.

II. Operations

A. Data to be collected

Data to be collected on this cruise include the following: acoustic data and whale tracks obtained from long-term acoustic recorder arrays; acoustic recordings of species detected on sonobuoy deployments; acoustic recordings from real-time auto-detection buoy; oceanographic measurements including water temperature, salinity, dissolved nitrate concentration, chlorophyll fluorescence, turbidity and dissolved oxygen concentration; zooplankton and ichthyoplankton net and acoustic samples; date, time and location of all sightings of marine mammals and seabirds as well as group characteristics; photographic data for individual identification; data associated with satellite tracking of individual animals; and data associated with biopsy sampling of individual animals.

B. Staging plan and cruise plan

The staging plan for the cruise will be as follows (all dates and times are on or about):

6th August: Personnel arrive in Dutch Harbor, AK. Most necessary equipment loading and set-up will have been conducted prior to the vessel's arrival in Dutch Harbor. Any remaining equipment will be loaded on the 6th or 7th.

8th August: Vessel departs Dutch Harbor. Visual and acoustic surveys conducted and moorings retrieved/deployed during transit.

12th August: Spend up to 5 days deploying satellite tags on individual animals (weather permitting).

18th August: Arrive in Nome, AK. Additional personnel board the vessel.

18th – 28th August: Vessel in survey area; mooring, oceanographic, and CTD/net tow ops conducted.

28th – 30th August: Vessel in seas off Barrow, AK for mooring and dragging ops. Personnel exchange will occur at earliest opportunity (weather dependent).

30th August: Vessel begins transit to Nome, AK.

1st September: Vessel stops for in-port at Nome, AK. Some scientific personnel disembark, one additional scientist boards for return transit to Dutch Harbor.

1st - 5th September: Vessel transits to Dutch Harbor, AK. Remaining Bering Sea PMEL and EAR moorings deployed along transit. Any remaining time spent conducting survey for North Pacific right whales.

5th September: Vessel arrives in Dutch Harbor, AK. All remaining scientists disembark.

Visual ops and acoustic surveys will be conducted during the transit to/from the working area as well as during non-mooring ops.

The cruise plan is to deploy a total of 34 moorings (20 acoustic, 14 oceanographic), 17 of which will be in the primary working area (11 acoustic, 6 oceanographic), as well as collect various oceanographic measurements. A biophysical transect off Point Hope as part of the International Distributed Biological Observatory (DBO) initiative will also be conducted. In addition to the mooring and oceanographic work, the vessel will transit to Barrow, AK to deploy 4 additional passive acoustic moorings, as well as attempt the recovery of 3 moorings lost the previous year. A biophysical transect across Barrow Canyon as part of the DBO initiative will also be conducted. Further details of mooring, oceanographic, and dragging operations are given below.

C. Mooring deployments

During the 2011 CHAOZ cruise, three tight arrays of long-term acoustic recorders were deployed in the Chukchi Sea (Figure 3, purple pentagons). During the 2012 CHAOZ cruise, these recorders will be

retrieved and only one recorder will be redeployed at each of the three locations. These recorders are based on a proven cold and shallow water design and will be run on a duty cycle of 1.583 hours on and 5 hours off, at a sampling rate of 16 kHz, for an entire year (365 days). This duty cycle creates a staggered recording loop with the recording period advancing by one hour each day, with the overall pattern repeating every six days, so that a large sample size will be equally obtained for all time periods. Additional passive acoustic moorings will be deployed at various locations throughout the Chukchi Sea (red stars, Figure 1).

In 2010 and 2011, a double-bubble MARU (Marine Acoustic Recording Unit) for the Bioacoustics Research Group (Cornell University) was deployed in the location originally designated for the auto-buoy (Figure 1, blue star). This will be retrieved and redeployed in 2012 to maintain the consistent long-term data set. The BRP have used the data recorded on these units to fine-tune their auto-detection buoy. The auto-detection buoy is a surface mooring that automatically detects and classifies biological signals of interest, and transmits via satellite the signal to a land-based station. Technicians at the land-based station confirm the signal as a species of interest, and notify the vessel of the presence of that species. This buoy has had great success in detecting North Atlantic right whales, and also had success in 2009 during a demonstration deployment for North Pacific right whales in the southeastern Bering Sea. The auto-detection buoy will be deployed for a period of approximately two months this year. It will be deployed during the CHAOZ cruise, and retrieved by the USCGC *Healy* in October.

Off Icy Cape in the middle of each passive acoustic array, a cluster of oceanographic moorings were deployed (Figure 3, yellow/blue circles). The offshore array moorings will be retrieved and not redeployed. The center array moorings and the TAPS6 will be retrieved and redeployed in the same location. The inshore array moorings will be moved closer to the Wainwright line and will also have a TAPS6. The upward-looking TAPS-6NG was built specifically to detect and quantify euphausiids. These moorings will collect various oceanographic measurements, including temperature, pressure, depth, salinity, conductivity, and fluorescence.

After all moorings have been retrieved and redeployed and all oceanographic data are collected, the vessel will transit to Barrow, AK to retrieve and redeploy four passive acoustic moorings and attempt to recover a mooring lost in 2009 (see below). During the final transit from Nome, AK to Dutch Harbor, AK, the vessel will retrieve and redeploy 2 (M4 and M2) PMEL and 4 EAR (Ecological Acoustic Recorder) moorings (Figure 2). The EAR recorders will be replaced with AURAL recorders. PMEL moorings M5 and M8 will be retrieved and redeployed during the transit north from Dutch Harbor to Nome, AK.

D. Hydrography and zooplankton net tows

At each mooring site, and along the transect between moorings and other selected stations in the northern part of the Bering and in the Chukchi Sea, hydrographic data (temperature, conductivity, nutrients, chlorophyll, and oxygen) and zooplankton will be collected (blue circles, Figure 1). All hydrographic casts include high-resolution vertical profiling of water properties (including temperature, salinity, chlorophyll fluorescence, PAR, dissolved O₂) to within 4m of the bottom using a Seabird 911Plus CTD with dual temperature, conductivity and oxygen sensors. Oxygen samples will be titrated on board to ensure quality of data from the CTD oxygen sensors. Nutrient and chlorophyll samples will be collected onboard and frozen for analysis at a later date at the NOAA laboratories in Seattle.

Samples for mesozooplankton and micronekton will be collected with a 1 m² Tucker Sled which allows us to collect samples right next to the bottom (and does a better job of capturing larger prey such as euphausiids). The mesh size for the Tucker nets will be 0.333 mm and the two primary nets will have 25 cm diameter Clarke-Bumpus net frames inside them with 0.150 mm mesh to capture small zooplankton.

The net samples will also contain ichthyoplankton (fish larvae) that will be identified and enumerated as part of the study. All processing of the samples will be done after the completion of the cruise.

E. Dragging operations

In an attempt to recover one of the moorings lost in 2009, a hydraulic winch, cable, and modified scallop dredge will be used to drag the bottom to recover the moorings. All dragging ops will be time and weather permitting, and conducted at the discretion of the Captain and Chief Scientist.

F. Underway operations (visual and acoustic monitoring)

As noted above, during transit to and from the working area and during non-mooring ops, passive acoustic monitoring and visual searches will be conducted. Directional sonobuoys will be deployed from the vessel and used to obtain cross-bearings to individual vocalizing whales. Visual surveys will be conducted during daylight operational hours, weather permitting.

G. Small boat operations

We will be bringing one of our own rigid hulled inflatable boats (previously discussed with the Captain) on this cruise to use during marine mammal operations. The small boat crew shall consist of a qualified coxswain (who is a member of the scientific party), a photographer, and a tagger/biopsier. Weather and time permitting, the small boat will be deployed in the presence of whales at the discretion of the Chief Scientist and Captain. Small boat operations shall consist of approaching the whale and maneuvering into position to obtain photographs, biopsy samples, and satellite tagging. The coxswain will have final say in the operation of the small boat, but as long as he/she feels that safety is not compromised will take direction from the lead scientist in the vessel. The following people have completed the required NOAA Small boat certifications and training:

Amy Kennedy
Brenda Rone
Catherine Berchok
Jessica Crance
Stephanie Grassia

Safety checks/status reports will be performed by VHF radio every hour, during which the small boat coxswain will provide current location and activity information to the Bridge. Small boat operations will be conducted within visual range of the ship at all time. A loss of communication plan will be developed at the start of the cruise with the Captain.

Launching of the small boat will be subject to weather conditions and undertaken only at the discretion of the Captain. During launch and retrieval, all appropriate safety procedures shall be maintained.

G. De-staging plan

Prior to disembarking, scientists will ensure that all staterooms and lab spaces are cleaned. All equipment will be packed, stored, and secured on the vessel for its return to Seattle. Offloading of the vessel will occur in Seattle, WA at the NOAA Sand Point Pier.

VII. Facilities

A. *Equipment and capabilities provided by ship (itemized)*

Outlet on the bridge to provide power to the acoustic monitoring station and visual survey computer.
Immersion suits for all scientists on board
Satellite communications and internet access, if available
Storage space on deck for 8 crates of sonobuoys, 17 recorders and 10 oceanographic instruments (each 6' long), 2 surface buoys (each 8' in diameter), 5 – 1600 lb anchors, 24 - 800 lb anchors, 28 acoustic releases (each 3' long), 15 - 30" steel floats (150 lbs each), all necessary mooring equipment, 1 RHIB.
Deck space for two oceanographic winches and one hydraulic winch (see below) including the necessary electrical (480 VAC 3 phase) and hydraulic power supply.
Deck Crane: Self contained 40HP electro-hydraulic power pack and controls: 18,000lb. w/ 65' lift; 4,000lb. lift capacity at full extension.
Enclosed van for laboratory and working space

B. *Equipment and capabilities provided by scientists (itemized with estimate of weights included)*

17 acoustic recorders (200 lbs and 6' each)
10 oceanographic moorings (200 lbs and 6' each)
2 surface buoys (8' diameter each)
28 acoustic releases (50 lbs and 3' each)
5 – 1600 lb anchors
26 anchors (20 x 800 lbs each, 10 x 1600 lbs each)
15 - 30" steel floats (150 lbs each)
CTD cage (800 lbs and 4' x 4')
Tucker sled for plankton tow ops (200 lbs, 4' x 6')
One single drum hydraulic winch for dragging ops (3,000lbs; 4' x 4').
Two single drum electrohydraulic winches for CTD and net tow ops (3,000 lbs; 6' x 4').
8 crates of sonobuoys (6500-7500lbs)
Associated sonobuoy equipment including extraction tools and 3 redeployable units.
Sonobuoy receiver system, including antennas, masts, mounting brackets, preamplifiers, cables, receivers, laptop, hard drives, plus spares and necessary assembly tools
One 22' Zodiac RHIB (*Radar*) w/115hp Yamaha 4-stroke outboard engine and trailer (3,000lbs)
Big eye binoculars (2 pairs), stands and mounts
GPS receivers and antennas for survey computer
GPS and antenna for van
Hand-held VHF radios
Laptop computers
Camera equipment
Biopsy collection gear
Satellite tagging equipment, including 2 compressed air tanks
Mustang flotation suits for all small boat participants and watch-standers
Float coats for work on deck
All required lab materials and supplies

VIII. Disposition of Data and Reports

A. Data responsibilities

At the end of the field work, the Chief Scientist and project coordinator will submit a cruise data summary to BOEM and to the Project Leaders.

B. Pre- and post-cruise meetings

These shall be arranged at the discretion of the Captain and Chief Scientist.

C. Ship operation evaluation report

After the cruise, a Ship Operation Evaluation form is to be completed by the Chief Scientist with suggestions for improvements to future operations aboard this vessel.

VI. Miscellaneous

A. Scientific berthing

Berths shall be made available as follows:

- 1 room: 1 female
- 2 rooms: 2 females
- 1 room: 4 females
- 1 room: 1 male
- 2 rooms: 4 males

A list of all scientific personnel is given above. Preferred specific personnel berthing arrangements will be coordinated with vessel.

B. Medical forms and emergency contacts

All scientific personnel shall have completed and submitted all required medical forms three weeks prior to sailing. A list of emergency contacts for scientific staff will be provided to the Captain prior to the cruise.

C. Shipboard safety

All scientific staff shall be briefed on shipboard safety procedures and their compliance with these monitored by the Captain and the Chief Scientist.

D. Communications

There will be one satellite phone on board the vessel for limited use. One phone call will be made every day to a land based contact at NMML giving our current status and position. Emails will be sent/received sparingly at the Chief Scientist's discretion. PMEL's Iridium: 8816-315-33586

Communications between the bridge, deck, small boat, visual observers and acousticians will be by VHF radio.

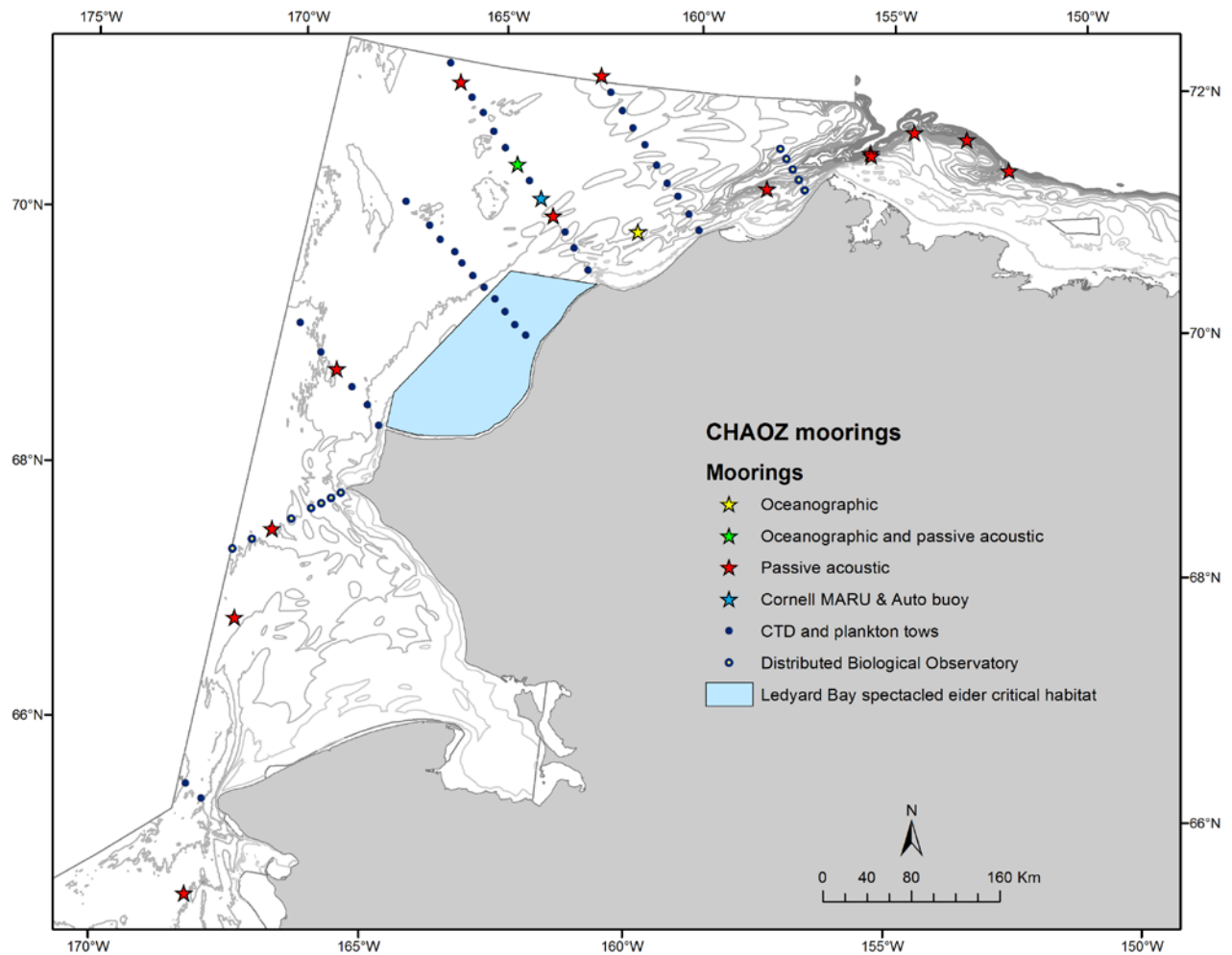


Figure 1. Detailed map of the main research area of the study showing the location of the mooring deployments and CTD/net tow stations. Red stars represent the passive acoustic moorings. Yellow star represents oceanographic moorings. Green star represents the cluster of passive acoustic and oceanographic moorings. The blue star represents the Cornell MARU and auto-buoy. Dark blue circles represent the CTD and Tucker tow stations. Stations marked with a yellow dot are part of the Distributed Biological Observatory.

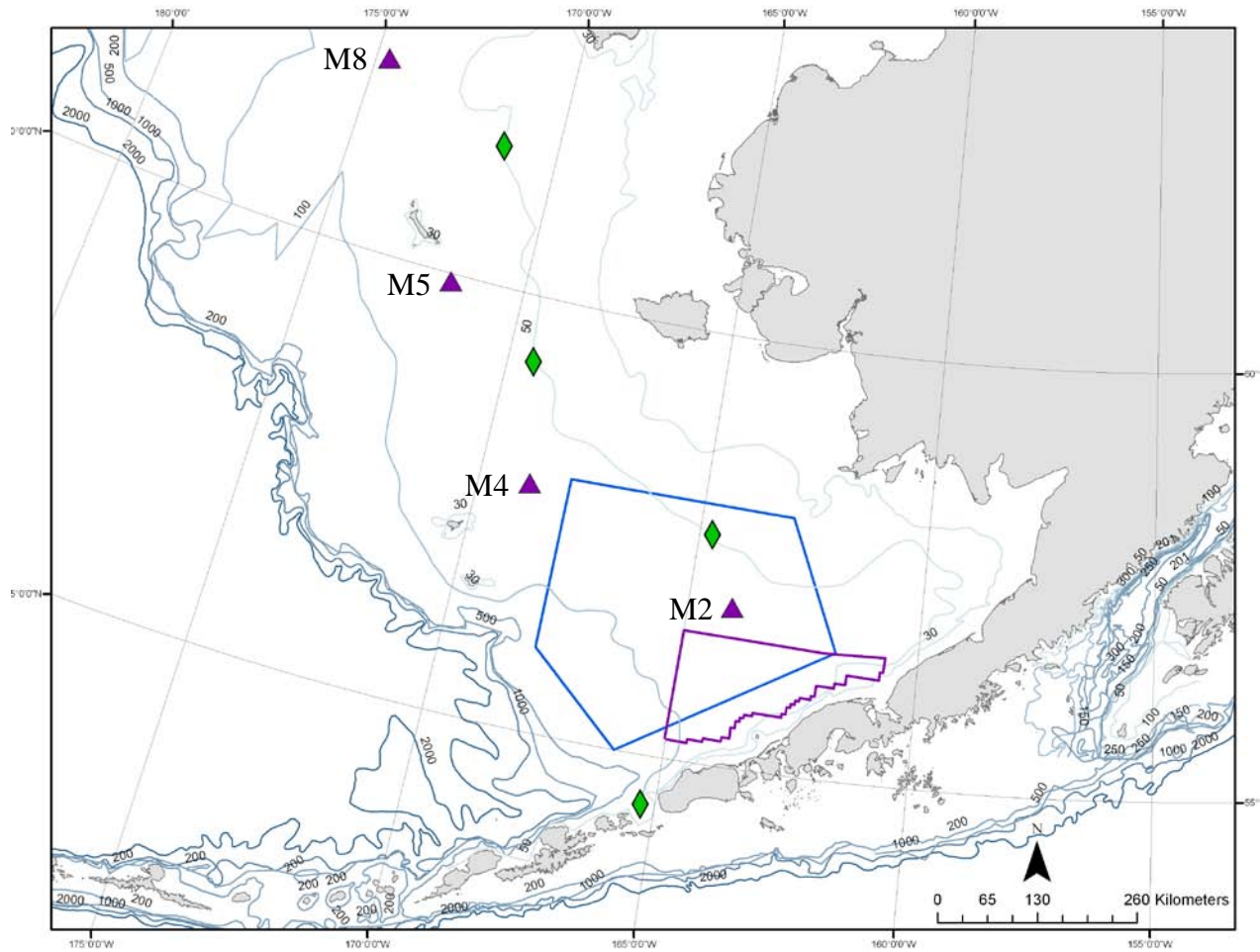


Figure 2. Map of the Bering Sea showing location of PMEL and EAR moorings that will be retrieved and redeployed during the transit to and from Dutch Harbor. Green diamonds represent EAR (Ecological Acoustic Recorder) moorings. The EAR recorders will be replaced with AURAL recorders starting in 2012. Purple triangles represent PMEL moorings. M5 and M8 will be turned around during the transit from Dutch Harbor to Nome, AK. M2 and M4 will be turned around on the return transit from Nome to Dutch Harbor, AK. Blue outline represents North Pacific right whale critical habitat, purple outline represents North Aleutian Basin lease area.

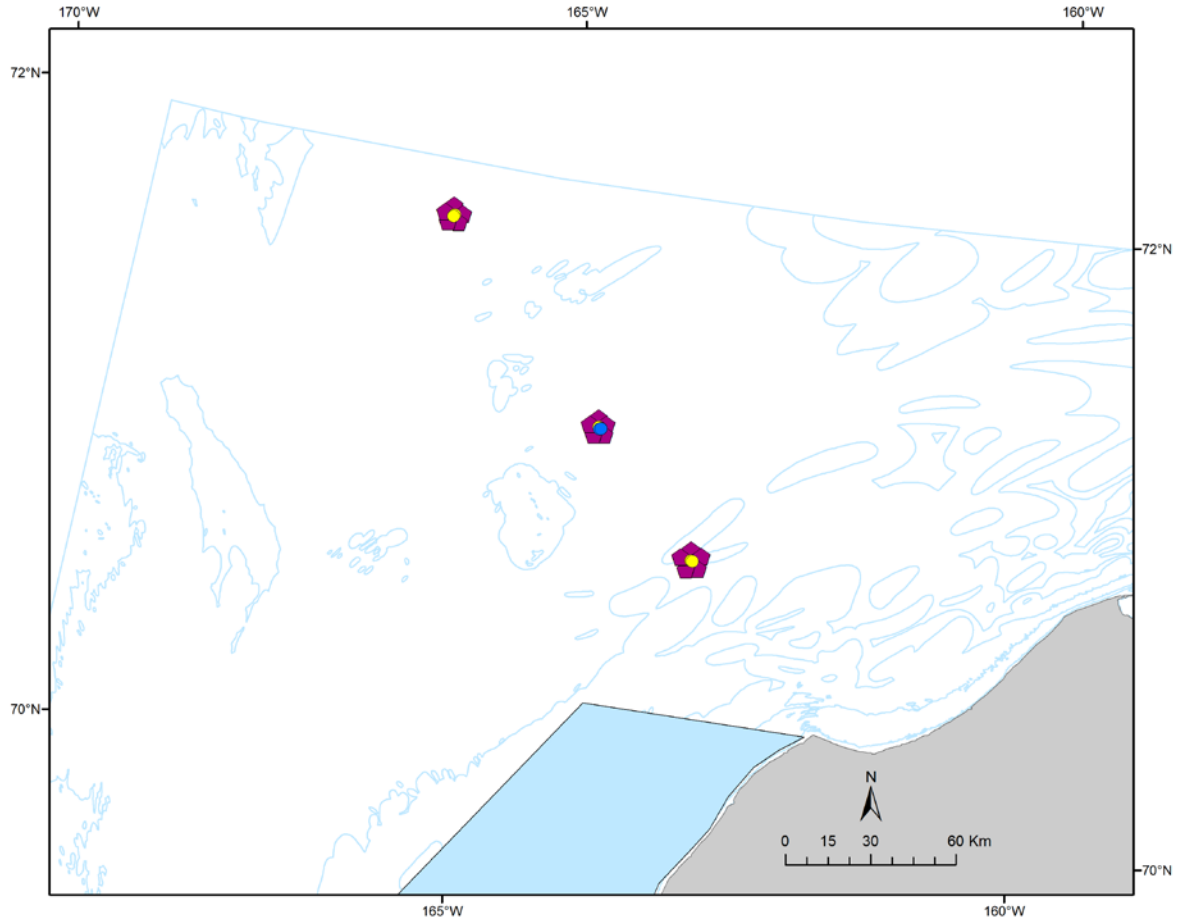


Figure 3. Map showing location of the 2011 three arrays of five passive acoustic recorders (purple pentagons) that will be retrieved this year. Only one recorder will be redeployed at each of the three sites. Yellow circles represent oceanographic moorings. Blue circle represents the oceanographic moorings that contain the TAPS instruments. The blue moorings will be redeployed in 2012. The offshore yellow moorings will be retrieved only, and the inshore yellow moorings will be shifted east towards the Wainwright line (see Figure 1).