# CHAOZ (CHukchi Acoustic, Oceanographic, and Zooplankton) Study

## 2012 Cruise Report

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**SUMMARY**

The final CHAOZ (CHukchi Acoustic, Oceanographic, and Zooplankton) cruise took place on board the R/V *Aquila*. The cruise began in Dutch Harbor, AK on August 8, 2012 and ended in Dutch Harbor on September 7, 2012. Chief Scientists were Dr. Catherine Berchok, who led a team of 17 scientists representing eight different laboratories (for full personnel list, see Appendix 1), and Jessica Crance, who led the final Bering Sea leg of the cruise. In summary, a total of 23 passive acoustic and 16 oceanographic moorings were retrieved, and 20 passive acoustic and 12 oceanographic moorings were redeployed. A total of 70 hydrographic and 59 zooplankton stations were conducted, eight drifters were deployed, 24 hour passive acoustic monitoring (via sonobuoy deployments) occurred, and over 1,100 nm were surveyed for marine mammal and bird observations.

**BACKGROUND**

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 than that of two decades ago. The Arctic also experienced very low ice concentrations during the summer of 2011. The speed 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 thirty years. As sea temperature, oceanographic currents, and prey availability are altered by this climate change, changes in baleen whale species composition and distribution are expected (and evidenced already by local knowledge and opportunistic sightings). In addition, the observed northward retreat of the summer sea ice edge 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 combination of increasing anthropogenic impacts coupled with the steadily increasing abundance and related seasonal range expansion by the bowhead, gray, humpback, and fin 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.

This study has four component projects: oceanography, passive acoustics, zooplankton, and climate modeling. Each component project is a technical discipline and is coordinated by a Project Leader with extensive experience in that discipline. Passive acoustic moorings, deployed concurrently with bio-physical moorings will provide previously unattainable 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, climate, indices of potential prey density, and anthropogenic activities). Moorings permit observations during long periods when ice covers the region, especially during the critical spring and early summer periods when spring phytoplankton blooms occur. Such measurements are virtually impossible to obtain from ships, because of the relatively short duration of cruises and severe limitations in the availability of ships able to work in ice-covered seas.

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 changes in those variables to oceanographic conditions, indices of potential prey availability, and anthropogenic activities.

**OBJECTIVES**

The specific objectives are:

1. Assess the year-round seasonal occurrence of bowhead, gray, and other whale calls in the Chukchi Sea.
2. Estimate the 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 in order to establish predictive variables to describe large whale occurrence.

**OVERVIEW**

The track taken by the ship is represented in Figure 1. Please see the report below for a description of the stations/activities.

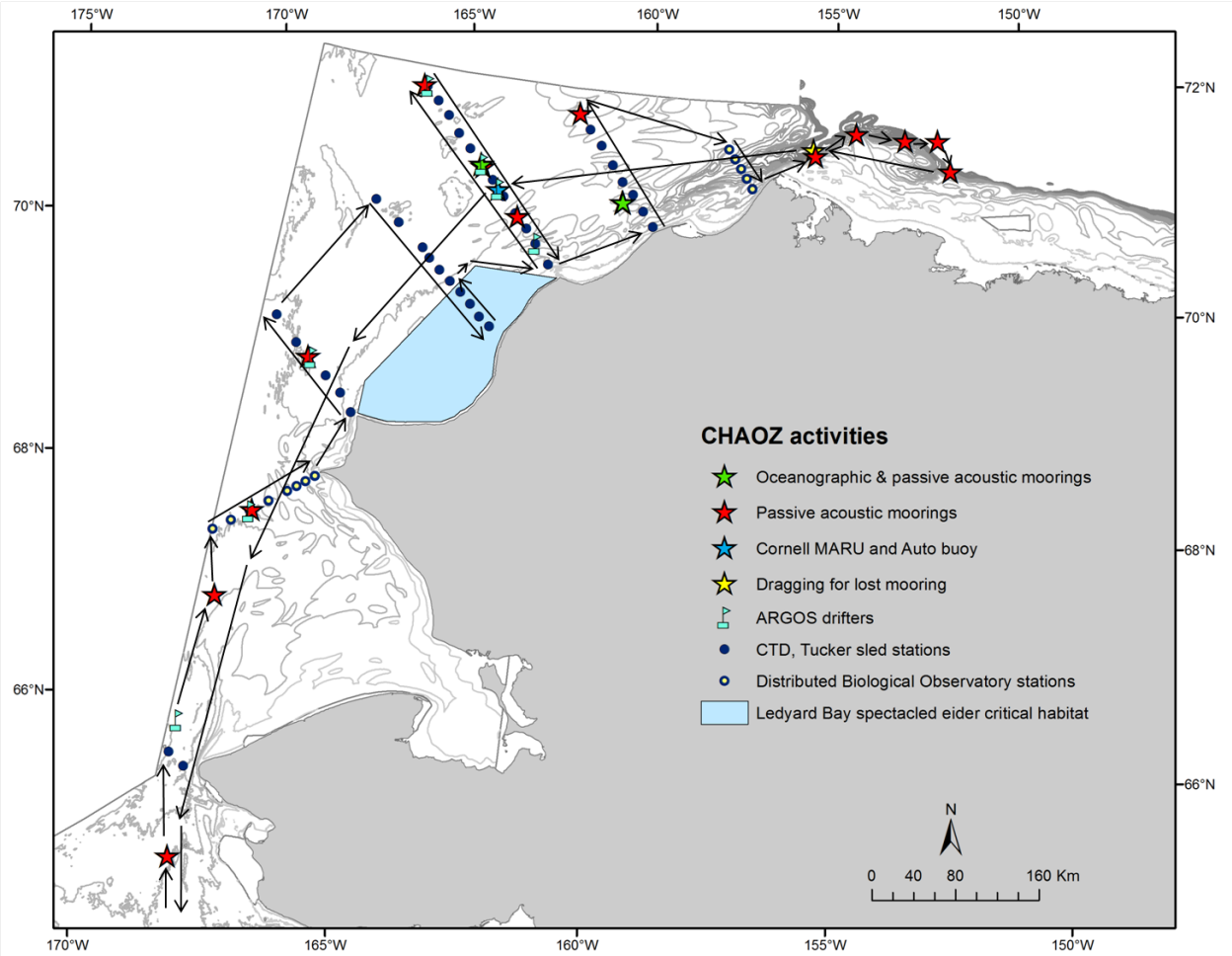


Figure 1. Trackline taken by the vessel during the 2012 CHAOZ cruise.

## RESULTS

### Acoustic component

*Mooring deployments*

This year was the last field season for the CHAOZ project. All moorings deployed for the project were retrieved. However, since the ship time required to redeploy these moorings was minimal, we redeployed a full suite of passive acoustic moorings for the ARCWEST project during the CHAOZ cruise. This allows for an additional year of data for ARCWEST, but also contributes to the long-term time series of data collected by the CHAOZ project.

Three arrays of long-term passive acoustic recorders (Figure 2) were deployed in the Chukchi Sea offshore of Icy Cape during the 2011 cruise. These moorings were retrieved during the 2012 cruise, and only one instrument per cluster was redeployed (Table 1; Figure 5). In addition to the three instruments redeployed off Icy Cape, 6 recorders were deployed throughout the Chukchi to increase the coverage area (Table 1; Figure 5). These instruments (Autonomous Underwater Recorder for Acoustic Listening (AURAL), Multi-Électronique Inc.) recorded at a sampling rate of 16 kHz on a duty cycle of 85 minutes every 5 hours, for an entire year. This duty cycle staggers the recording loop so that the recording period advances by one hour each day. This overall pattern repeats every six days, producing a large

sample size for all time periods equally. One of the recorders retrieved from the middle Icy Cape array has been checked and recorded from September until late May. We have had problems in previous years with AURALs stopping two to three months short of the programmed full year due to dead batteries. This year we have switched batteries from Duracell to Panasonic, as well as switched to a different diode in the battery packs, in the hopes that the batteries last the full year. See Appendix 6 for mooring designs.

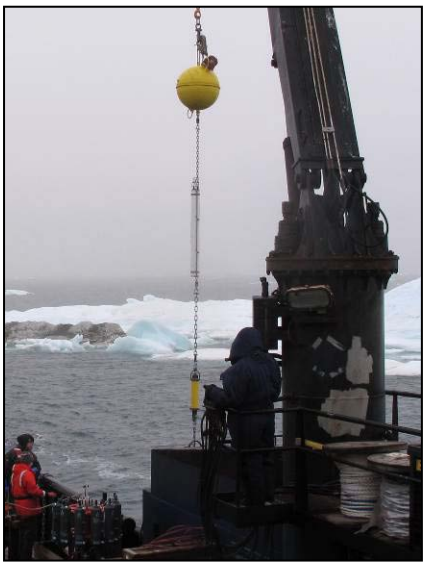


Figure 2. Long-term passive acoustic mooring being deployed near ice.

Five additional passive acoustic moorings were deployed off Barrow for the ARCWEST project; three AURALs were deployed in an arc along the 100m line, one AURAL was deployed on the east end of this arc for Kate Stafford's (Univ. Wash., Applied Physics Laboratory) NSF funded AON project, and one Haruphone (Haru Matsumoto, CIMRS/NOAA, Newport, OR) (Table 1, Figure 5). The Haruphone mooring was deployed in collaboration with Dr. Holger Klinck (CIMRS/NOAA, Newport, OR). The mooring was deployed at a depth of 1000m, with the Haruphone at 500m. It is set to record continuously at 5000Hz. The recordings from this instrument will be used to conduct ambient noise measurements off Barrow, which will be compared to those from other regions of the world. Furthermore, the four EAR (Ecological Acoustic Recorder, Marc Lammers, Oceanwide Science Institute, Honolulu, HI) moorings deployed along the 50m isobaths in the Bering Sea in 2011 were recovered during the initial transit from Dutch Harbor to Nome, and AURAL recorders were redeployed in the same locations (Figure 6).

Figure 3. MARU recorder being retrieved.

The double-capacity MARU (Marine Acoustic Recording Unit, Figure 3) deployed by the Bioacoustics Research Program (BRP, Cornell University) in 2011 was retrieved and redeployed in the same location (Table 1; Figure 5, blue star). As with the other moorings for this project, the MARU will be deployed for a full year, recording continuously up to 1kHz.

This year, the auto-detection buoy, a joint Cornell BRP and WHOI project, was deployed in the same location as the MARU (Figures 4, 5). This surface buoy has a built-in auto-detector that will distinguish bowhead calls from other species. Once a call of interest is detected, a sample of the call is sent to a land-based station via an Iridium link where it is verified by an acoustic technician. Furthermore, this auto-detection buoy will measure ambient noise and send segments of sound files to the station for analysis.


Figure 4. Auto-buoy shortly after deployment.

Table 1. Date and location of passive acoustic mooring deployments

| Date | Time (ADT) | Mooring name | Instrument | Latitude | Longitude | Depth (m) |
|---|---|---|---|---|---|---|
| 8/12/12 | 12:55 | AW12_AU_BS1 | AURAL | 61° 35.266 | -171° 19.442 | 52 |
| 8/10/12 | 9:19 | AW12_AU_BS2 | AURAL | 59° 14.662 | -169° 24.756 | 53 |
| 8/9/12 | 11:27 | AW12_AU_BS3 | AURAL | 57° 40.198 | -164° 43.511 | 52 |
| 8/8/12 | 14:15 | AW12_AU_BS4 | AURAL | 54° 25.704 | -165° 15.988 | 164 |
| 8/15/12 | 19:54 | AW12_AU_NM1 | AURAL | 64° 50.841 | -168° 23.386 | 42 |
| 8/17/12 | 21:51 | AW12_AU_KZ1 | AURAL | 67° 07.488 | -168° 36.111 | 43 |
| 8/18/12 | 13:17 | AW12_AU_PH1 | AURAL | 67° 54.537 | -168° 11.677 | 58 |
| 8/19/12 | 16:38 | AW12_AU_CL1 | AURAL | 69° 18.408 | -167° 38.877 | 48 |
| 8/21/12 | 8:48 | AW12_AU_IC1 | AURAL | 70° 49.030 | -163° 08.186 | 42 |
| 8/21/12 | 20:52 | AW12_AU_IC2 | AURAL | 71° 12.119 | -164° 11.934 | 42 |
| 8/22/12 | 8:56 | AW12_AU_IC3 | AURAL | 71° 49.753 | -166° 04.295 | 42 |
| 8/26/12 | 9:51 | AW12_AU_WT1 | AURAL | 71° 02.752 | -160° 30.534 | 49 |
| 8/26/12 | 19:21 | AW12_AU_WT2 | AURAL | 71° 46.938 | -161° 50.931 | 41 |
| 8/27/12 | 15:01 | AW12_AU_BF1 | AURAL | 71° 33.078 | -155° 32.946 | 69 |
| 8/27/12 | 17:58 | AW12_AU_BF2 | AURAL | 71° 45.088 | -154° 28.275 | 93 |
| 8/27/12 | 21:06 | AW12_AU_BF3 | AURAL | 71° 41.315 | -153° 10.583 | 103 |
| 8/27/12 | 23:57 | AW12_HA_BF1 | HARU | 71° 40.841 | -152° 18.777 | 1053 |
| 8/28/12 | 2:57 | AO12_AU_1 | AURAL | 71° 24.760 | -152° 00.104 | 188 |
| 8/29/12 | 18:20 | DBPU 197 | MARU | 71° 01.541 | -163° 43.772 | 42 |
| 8/29/12 | 20:30 | CZ_AB1 | Auto-buoy | 70° 59.954 | -163° 40.561 | 42 |

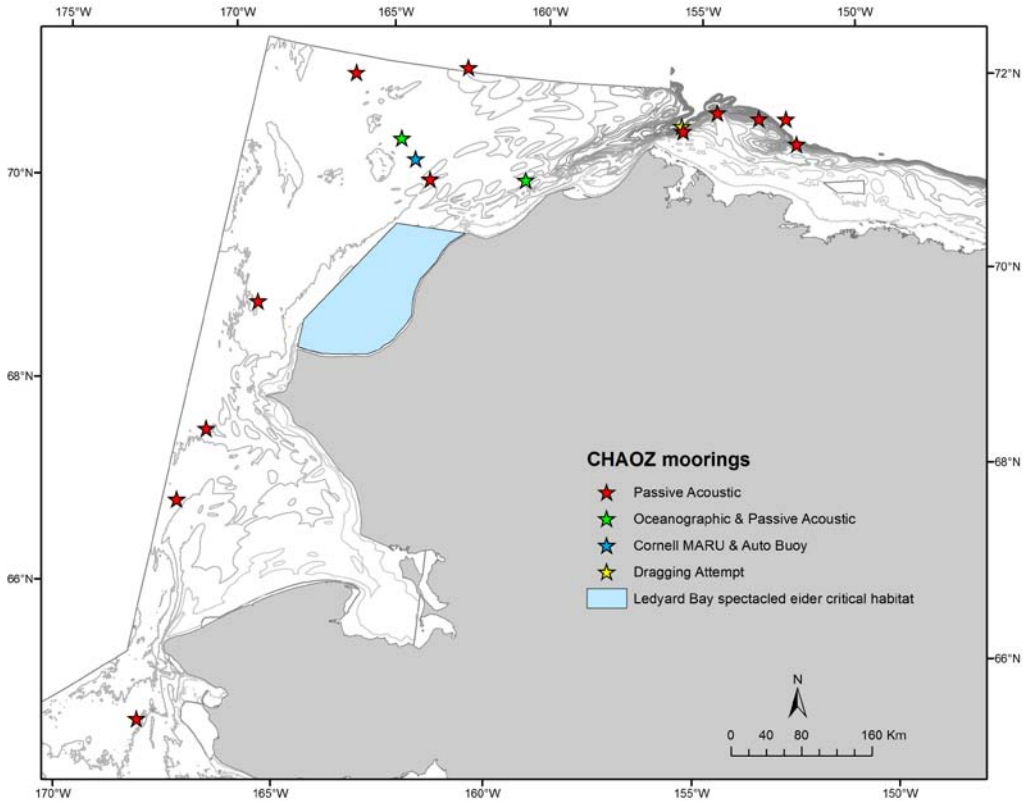



Figure 5. Location of passive acoustic and oceanographic moorings deployed in the Chukchi Sea.

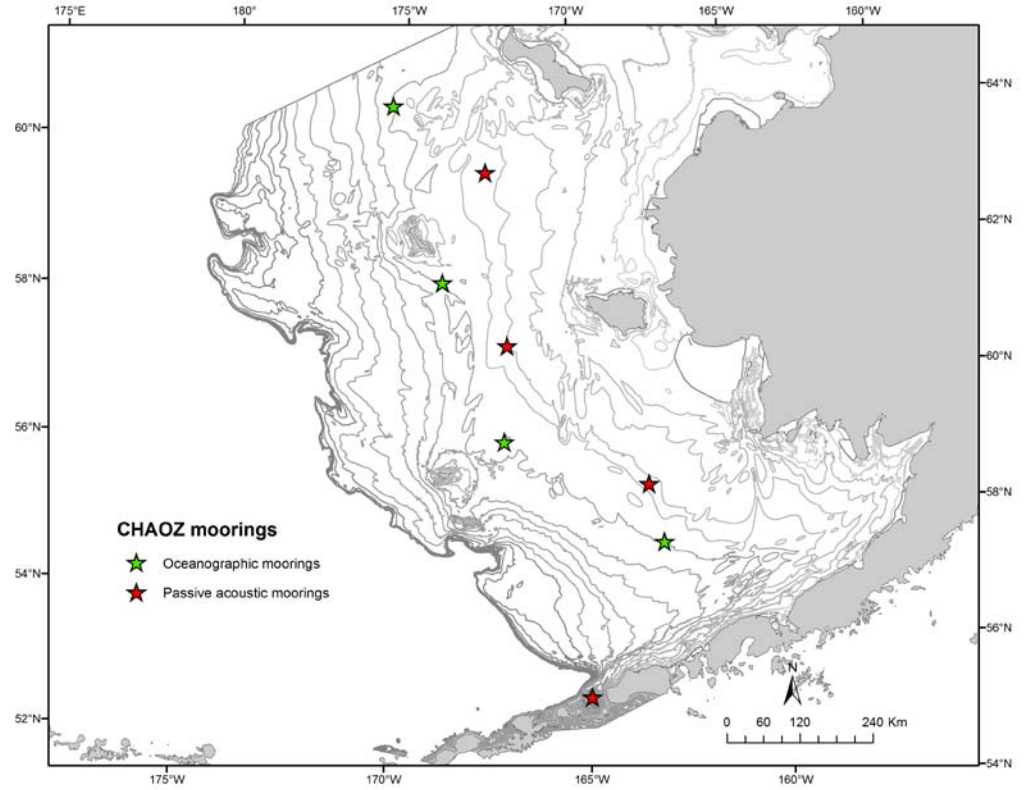



Figure 6. Location of passive acoustic and oceanographic moorings deployed in the Bering Sea.

*Sonobuoy monitoring*

Throughout the survey sonobuoys were deployed approximately every 2-3 hours to obtain an evenly-sampled cross-survey census of marine mammal vocalizations. When transiting through low whale density areas, sonobuoys were deployed every three hours; however, when in areas of high whale density, or when trying to localize on a calling species of interest, near-continuous recording occurred. Six types of sonobuoys were used: 77C, 53F, 53E, 53D, 57B, and 77B. The 57B's are an omnidirectional sonobuoy capable of recording up to 22 kHz. 53F and 53E sonobuoys have either omnidirectional or DiFAR (Directional Frequency Analysis and Recording) capabilities, and the 53D and 77C sonobuoys were DiFAR only. When in DiFAR mode, the maximum frequency range is 2.5 kHz, thus the buoys were often deployed in omni mode when possible (and when it was not important to get a bearing to the animal) to achieve the full bandwidth. We discovered that during the sonobuoy programming process, we would pull out the top float portion, thus inadvertently disabling the depth settings by pulling out the pins, causing the sonobuoys to deploy to their deepest depth setting of 1000ft, causing the recordings to be masked by the noise from the sensor dragging along the bottom. Thus, modifications (taping and tying) had to be made to all sonobuoys except the 57B to shorten the deployment depth (Figure 7). Furthermore, the 53F sonobuoys arrived with dead display batteries, requiring us to replace the dead battery with a new one.

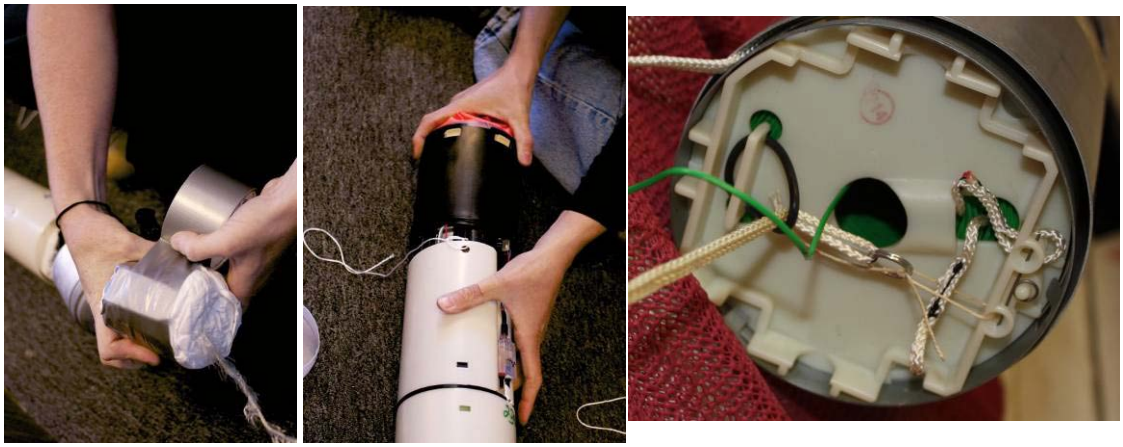


Figure 7. Modifying sonobuoys. Left and middle: Taping and tying up the 77C. Right: tying up a 53E.

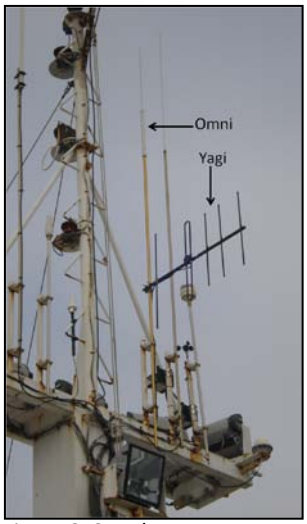



Figure 8. Sonobuoy antennas placed in the crow's nest.

There were two preamplified antennas installed on the vessel, an omnidirectional antenna as well as a Yagi directional antenna. Both antennas (and preamps) were placed up in the crow's nest of the vessel with the directional antenna facing astern (Figure 8). The Yagi was used primarily during transit when the sonobuoy was guaranteed to be behind the vessel, and the omnidirectional antenna was used for monitoring multiple sonobuoys simultaneously, or when the sonobuoy was not directly behind the vessel. The acoustics station in the bridge is shown in Figure 9. A total of 227 sonobuoys were deployed during the cruise (Appendix 2). Of these, 98 were 77C's (88 SPW, 10 UND), 63 were 53D's (53 UND, 9 SPW, 1 MAG), 11 were 53E's (10 HEE, 1 SPW), 49 were 53F's (4 SPW, 45 UND), 4 were 57B (3 MAG, 1 SPW), and 2 were MAG 77B's. The overall sonobuoy success rate was 86.7%.

Reception range when using the omnidirectional antenna was approximately 10-12 miles. When the directional Yagi antenna was used, reception range averaged 14 miles, with a maximum of 18 miles. Species heard include humpback, fin, bowhead, killer whales, minke whales, North Pacific right whales, walrus, bearded seals, possible beluga and gray whales, and a number of unidentified calls. The location of the sonobuoys and species detected are shown in Figures 10 and 11 for the Chukchi/Beaufort and Bering Seas respectively.

Figure 9. Acoustic station in the bridge.

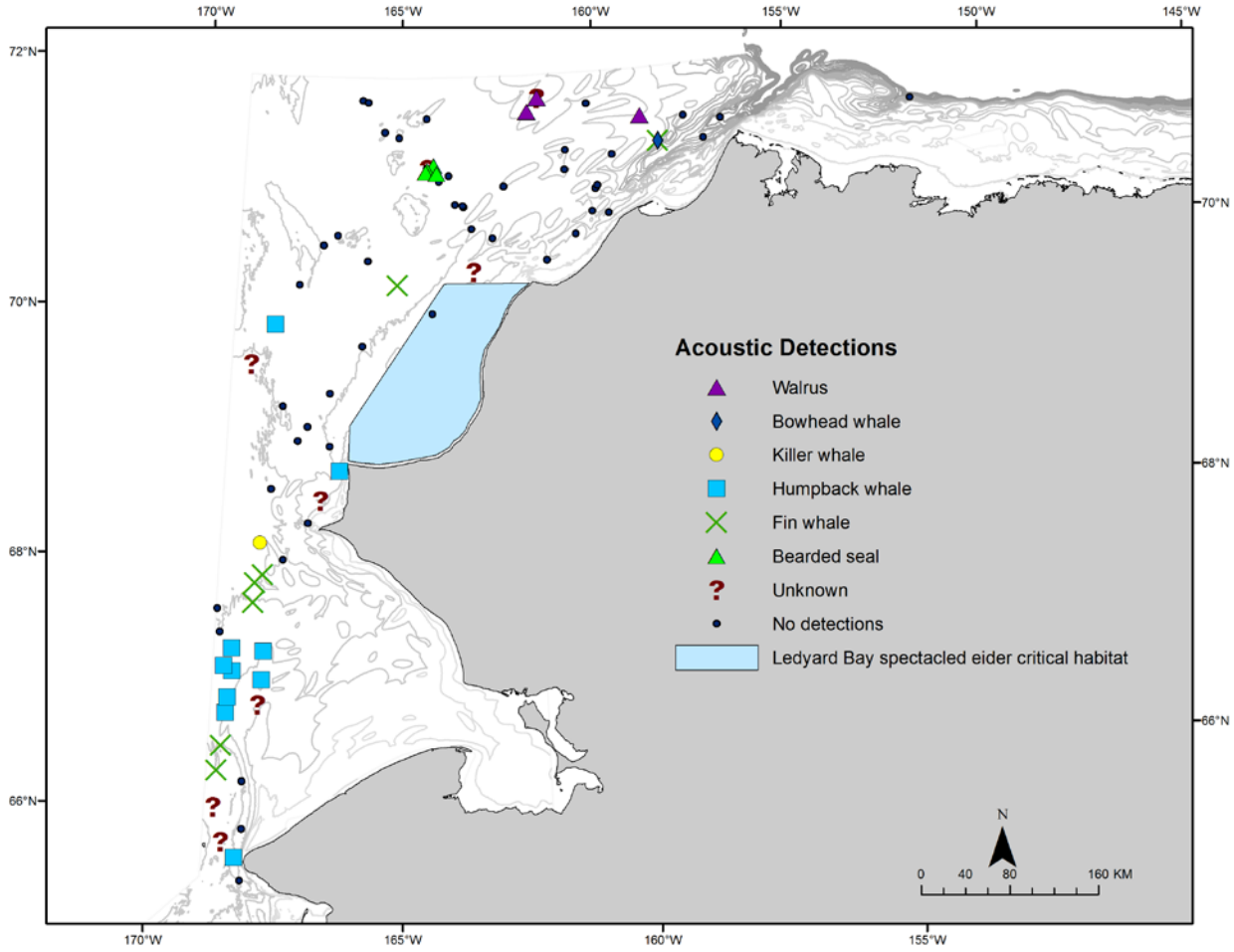



Figure 10. Sonobuoy deployment and acoustic detections in the Chukchi Sea

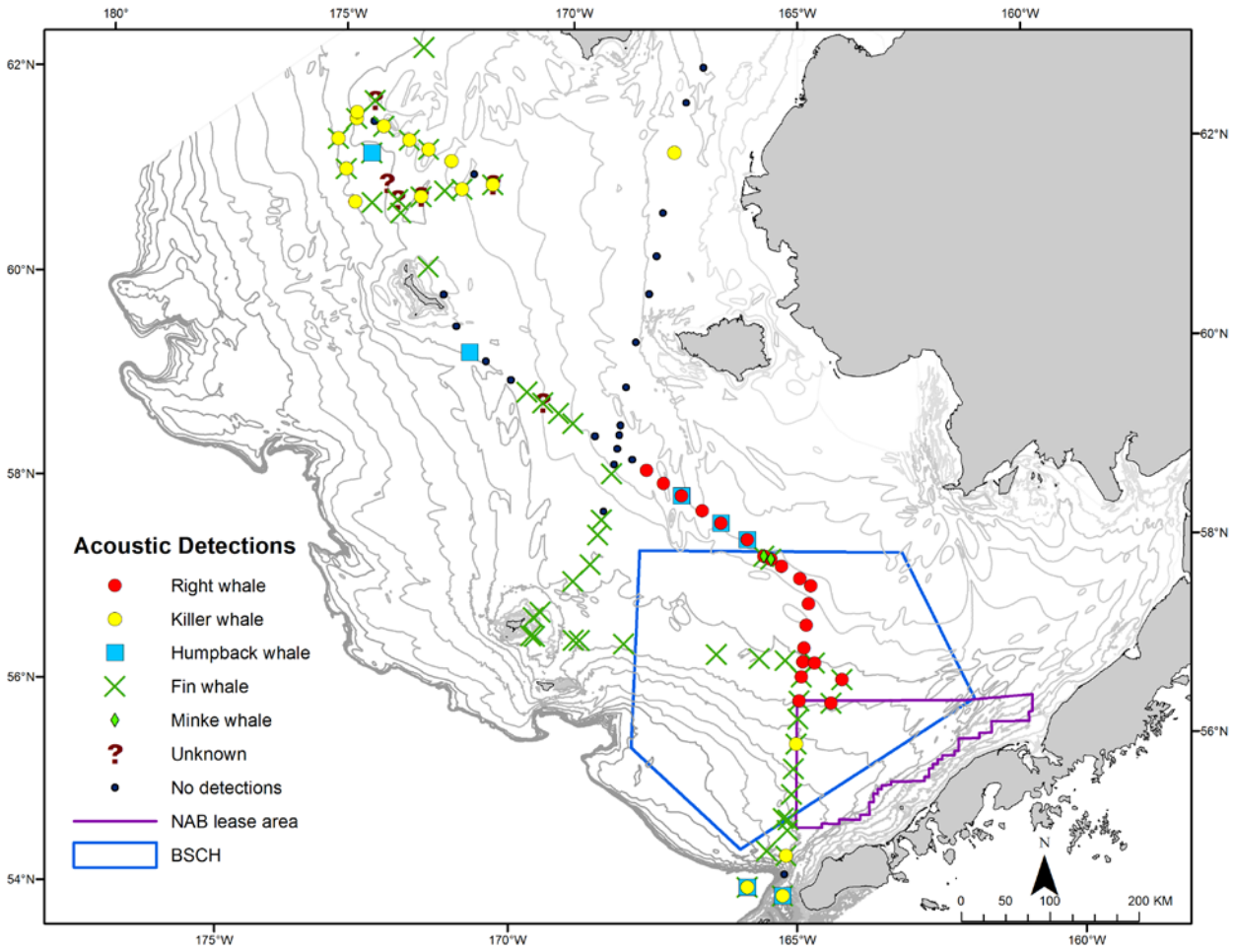



Figure 11. Sonobuoy deployment and acoustic detections in the Bering Sea

**Oceanographic component**

*Long-term moorings*

During the 2011 CHAOZ cruise, in the middle of each passive acoustic array, a cluster of oceanographic moorings (Figure 12) was deployed. These clusters were successfully retrieved, and two clusters were redeployed during the 2012 cruise: one at the middle Icy Cape site, and one off Wainwright (Table 2; Figure 14). Again, because ship time for deploying the moorings was minimal, these moorings were redeployed for the ARCWEST project to gain an additional year of data. Each cluster consisted of an "ice mooring" containing an ASL upward-looking ice profiler and an RCM9 current meter (which also measured temperature and oxygen, and either salinity or turbidity), and a "Bio mooring" containing a 600 KHz RDI ADCP, and a linked set of instruments (a Seacat, an eco-fluorometer, a PAR sensor, and an ISUS nitrate meter), and an upward looking TAPS-6NG (Tracor Acoustic Profiling System Next Generation) instrument to measure

Figure 12. Oceanographic current meter mooring being deployed.

Figure 13. Oceanographic mooring with surface float being recovered.

zooplankton bio-volume and size distribution. These moorings collect various oceanographic measurements for a full year. The Icy Cape mooring continues our monitoring of this area, and the new site west of the Wainwright line is to detect pulses of water and krill advected up the axis of Barrow Canyon.

In addition to these moorings, during the initial and return transits to and from Dutch Harbor, we retrieved and redeployed eight oceanographic moorings at four different sites (two moorings at each location) along the 70m isobaths for PMEL (Table 2; Figure 6). This included the retrieval of the large surface float mooring at M2 (Figure 13).

Table 2. Date and location of oceanographic mooring deployments and ARGOS drifters. ADCP = Acoustic Doppler Current Profiler; RCM = Recording Current Meter; TAPS = Tracor Acoustic Profiler System.

| Date | Time (ALT) | Mooring name | Instrument | Latitude | Longitude |
|---|---|---|---|---|---|
| 8/10/12 | 20:51 | 12BSP-5A | 600 KHz ADCP | 59° 54.72 | -171° 42.54 |
| 8/10/12 | 22:02 | 12BS-5A | RCM9, ASL | 59° 54.74 | -171° 42.14 |
| 8/11/12 | 17:36 | 12BSP-8A | 600 KHz ADCP | 62° 11.67 | -174° 39.65 |
| 8/11/12 | 19:14 | 12BS-8A | RCM9, ASL | 62° 11.66 | -174° 40.07 |
| 8/23/11 | 21:18 | 12CKT-2A | TAPS-8 | 71° 12.984 | -164° 14.830 |
| 8/23/11 | 21:43 | 12CKP-2A | 600 KHz ADCP | 71° 13.239 | -164° 14.741 |
| 8/23/11 | 22:12 | 12CKIP-2A | RCM9, ASL | 71° 13.393 | -164° 15.612 |
| 8/26/12 | 15:31 | 12CKT-4A | TAPS-8 | 71° 02.490 | -160° 29.975 |
| 8/26/12 | 15:44 | 12CKP-4A | 600 KHz ADCP | 71° 02.693 | -160° 29.415 |
| 8/26/12 | 16:02 | 12CKIP-4A | RCM9, ASL | 71° 02.460 | -160° 29.583 |
| 9/3/12 | 8:44 | 12BSP-4B | 600 KHz ADCP | 57° 52.018 | -168° 52.348 |
| 9/3/12 | 10:46 | 12BS-4B | RCM9, ASL | 57° 51.982 | -168° 53.052 |
| 9/7/12 | 17:20 | 12BSP-2A | 600 KHz ADCP | 56° 51.941 | -164° 03.440 |
| 9/7/12 | 18:12 | 12BS-2A | RCM9, ASL | 56° 52.081 | -164° 03.358 |
| 8/15/12 | 16:25 | 111598 | ARGOS drifter | 64° 3.99 | -169° 35.14 |
| 8/17/12 | 6:36 | 106696 | ARGOS drifter | 65° 59.69 | -168° 47.84 |
| 8/19/12 | 9:04 | 111968 | ARGOS drifter | 67° 53.92 | -168° 13.72 |
| 8/20/12 | 8:15 | 119600 | ARGOS drifter | 69° 17.61 | -167° 35.66 |
| 8/24/12 | 20:47 | 106697 | ARGOS drifter | 71° 13.33 | -164° 12.40 |
| 8/25/12 | 4:23 | 111967 | ARGOS drifter | 71° 49.41 | -165° 58.06 |
| 8/25/12 | 18:16 | 119594 | ARGOS drifter | 70° 43.26 | -162° 52.22 |
| 8/30/12 | 5:00 | 119595 | ARGOS drifter | 69° 00.12 | -167° 29.46 |

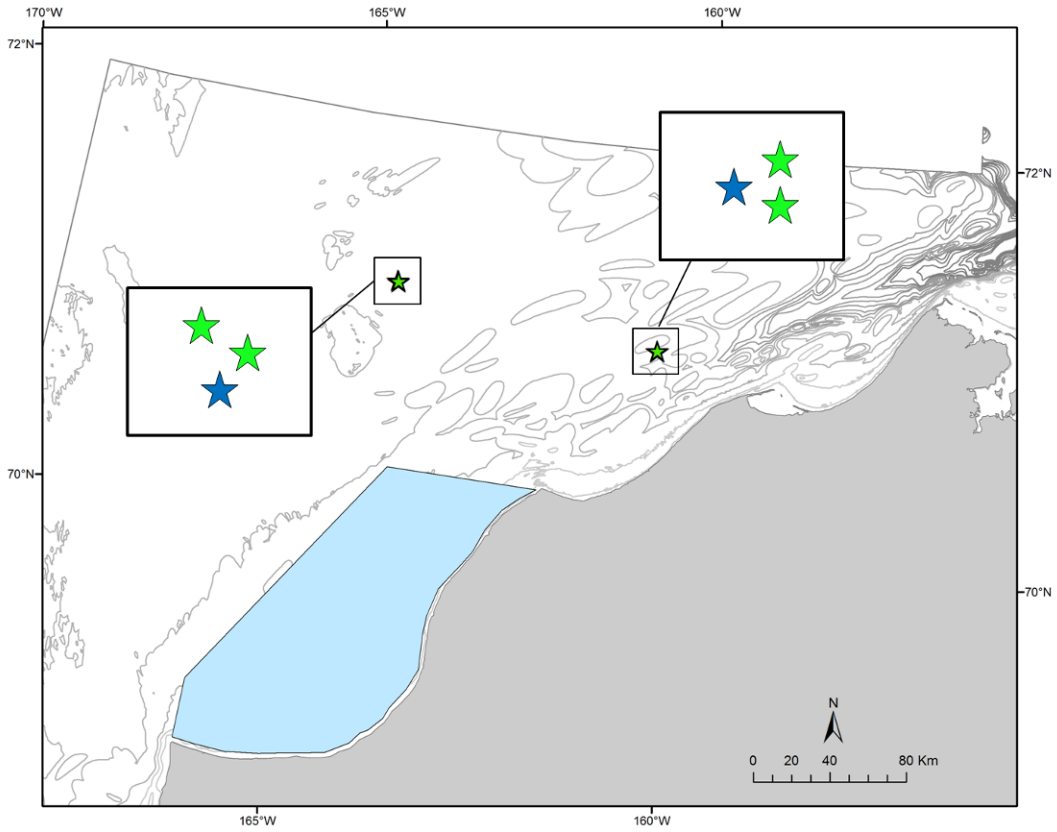



Figure 14. Location of oceanographic moorings deployed in the Chukchi Sea. Green stars represent ice moorings; blue stars represent moorings with the TAPS-6NG instruments.

*Hydrography stations*

At each mooring site, along six transect lines in the Chukchi, at two sites in the Bering Strait, and an additional site at Schpanberg Strait, hydrographic data (temperature, conductivity, nutrients, and chlorophyll) were collected (Tables 3-4; Figures 15 and 17). Methods included 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 (Figure 15) with dual temperature, conductivity and oxygen sensors. Nutrient and chlorophyll samples were collected from Niskin bottles at discrete depths and frozen for analysis at a later date at the NOAA laboratories in Seattle. Dissolved oxygen samples were taken at every other cast to help calibrate the oxygen sensors on the CTD. A complete report on individual stations can be found in Appendix 3.

Figure 15. CTD being deployed.

At eight locations in the northern Bering and Chukchi Seas, ARGOS drifters were deployed off the stern of the ship (Figures 16 and 18). Four additional drifters were deployed from the USCGC HEALY. These free-floating instruments were drogued at 30 m and drift along with the currents; their location is determined via satellite. The first drifter was deployed in the northern Bering Sea, near the site of the

Figure 16. ARGOS drifter being deployed off the stern by Bill Floering and Sigrid Salo.

M8 oceanographic mooring. The remaining seven were deployed in the Chukchi: one in the Bering Strait, one southwest of Point Hope, one northwest of Cape Lisburne, and four off Icy Cape. These drifters will look at the advection of water from the Bering into the Chukchi Sea. The farthest offshore drifter was deployed near Hanna Shoal to examine the circulation around this bathymetric feature. A movie of the drifters can found at http://www.pmel.noaa.gov/foci/visualizations/drifter/chuk2012.html. The first month of movie shows trajectory of drifters deployed last year. The length of the "tail" of each drifter is five days.

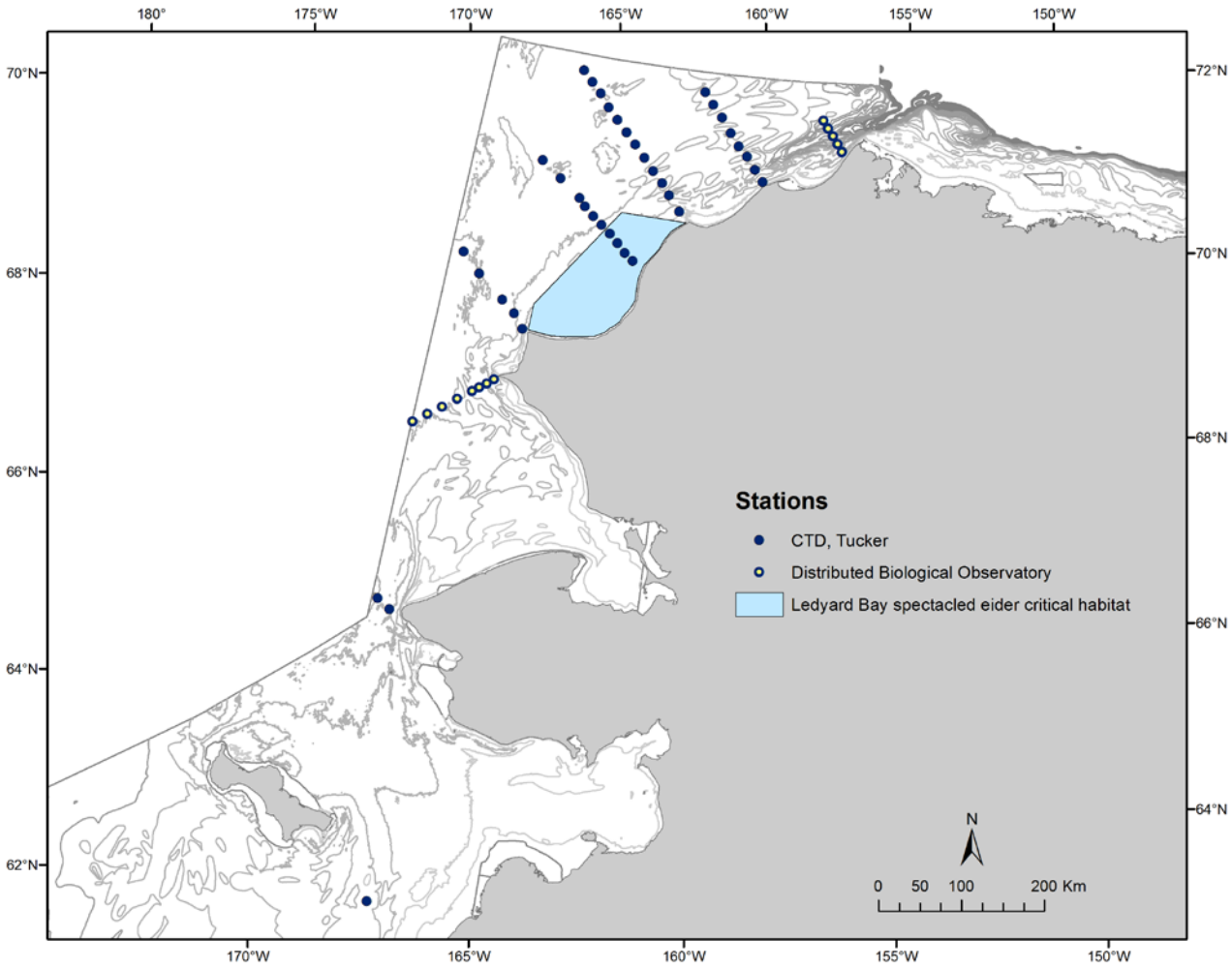



Figure 17. Location of all hydrography and zooplankton stations in the Chukchi Sea.

Table 3. Summary of hydrographic and zooplankton operations

| Gear | Number Tows/Casts |
|---|---|
| SeaBird FastCAT (SBE 49) CTD | 56 |
| SeaBird *911plus* CTD without bottle samples (CTD) | 10 |
| SeaBird *911plus* CTD with bottle samples (CTDB) | 56 |
| 25 cm (ID) modified Clarke-Bumpus (Lg-CB) w. 153 µm mesh net | 52 |
| 1 $m^2$ Epibenthic Tucker sled (SLED) w. 335 µm mesh nets | 59 |
| Tracor Acoustic Profiler w. 6 frequencies (TAPS-6) | 64 |

Table 4. Summary of hydrographic and zooplankton samples

| Sample Type | Number Tows/Casts | Number Samples |
|---|---|---|
| Zooplankton collected for acoustic density measurements (AcoustDn) | 2 | 2 |
| Extracted chlorophyll (Chlor) | 55 | 276 |
| Dissolved oxygen (DO2) | 66 | |
| FastCat SBE 49 attached to Epibenthis Tucker sled (FCAT) | 56 | |
| Stimulated fluorescence collected during CTD casts (Fluor) | 66 | |
| Nutrients (NutPMEL) | 56 | 286 |
| Photosynthetically Active Radiation data collected during CTD (PAR) | 66 | |
| Zooplankton preserved in formalin (QTowF) | 59 | 168 |
| Tracor Acoustic Profiling System (TAPS-6) | 64 | |
| Zooplankton collected for fatty acids (ZoopFA) | 1 | 10 |
| Zooplankton collected for stable isotopes (ZoopSI) | 1 | 5 |

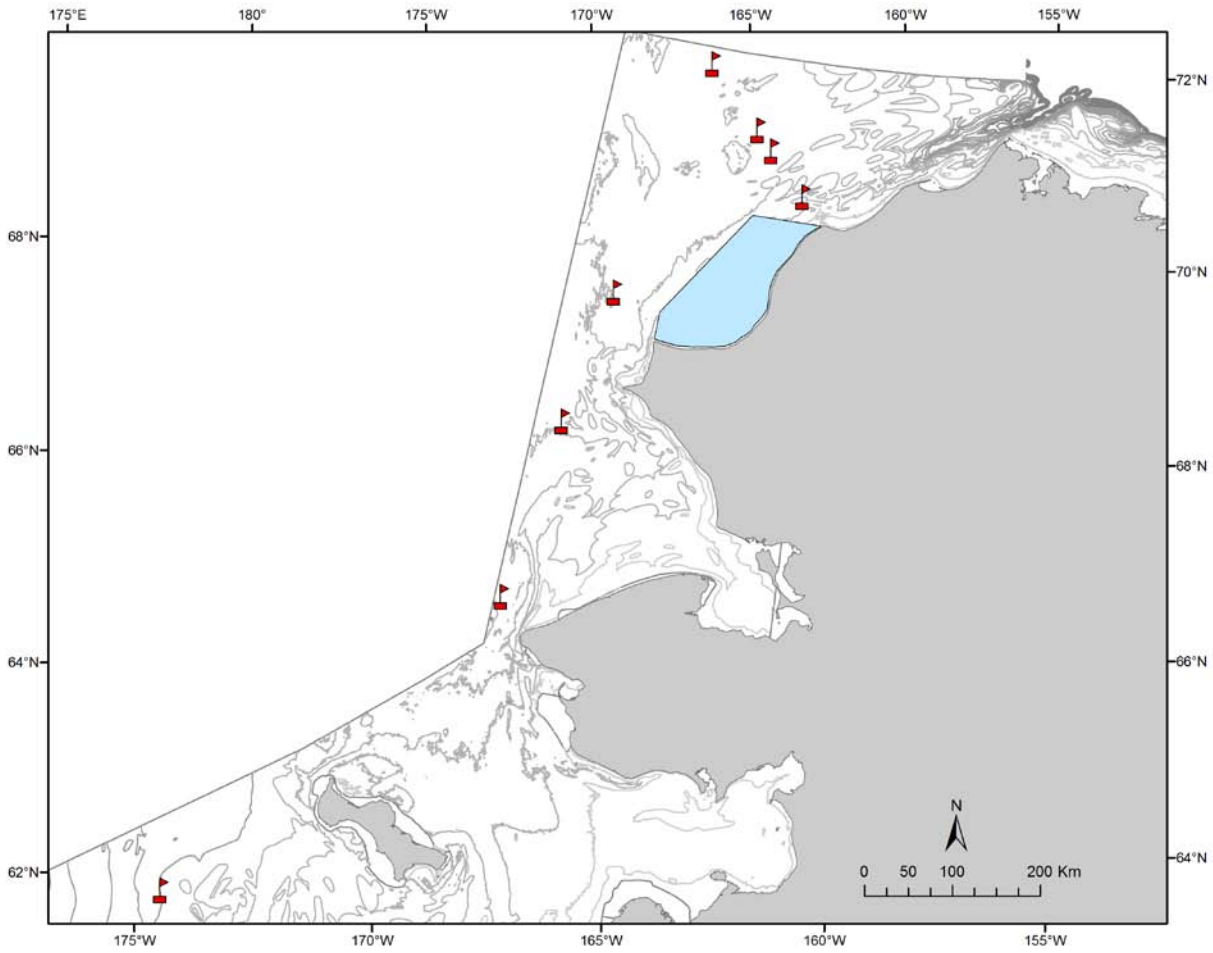


Figure 18. Deployment location of ARGOS drifters (red flags).

**Zooplankton component**

At 59 of the 66 stations occupied we also obtained zooplankton samples with a 1 $m^2$ epibenthic Tucker sled (Figures 19-20). A full metadata report on the CTD and net tow stations can be found in the electronic document entitled "1AQ12_rptCruiseSummary.pdf". Two, 333 µm mesh nets were used for most of the tows – one was opened and closed while the sled was on the bottom and the other was used to obtain plankton from the ocean bottom to the surface. A 25 cm net with 150 µm mesh was suspended in the net that profiled the water column. In addition, acoustic measurements of zooplankton backscatter were


Figure 20. Tucker sled being rinsed after deployment. SeaBird FastCat is visible behind the top of the frame, but the TAPS-6 was removed for this tow.


Figure 19. Tucker sled being retrieved. The TAPS-6 instrument was removed for this tow.

obtained from the sled with a TAPS-6 instrument mounted on the top of the sled and pointing down into the tow path and temperature/conductivity measurements of the water column were obtained with a SeaBird FastCat mounted on the sled behind the net mouth. Both Tucker nets contained a General Oceanic flow meter to estimate volume filtered. All zooplankton samples were preserved in a Formalin:seawater mixture and will be send to the Polish Plankton Sorting and Identification Center for processing. Zooplankton species data should be available by May of 2013.

**Visual surveys**

*Marine mammal observations*

A rotating team of three scientists collected sighting data using standard line transect methods during on-effort status. Operations began at 08:00 and ceased at 20:00, or as long as conditions would allow. A full observation period lasted 80 minutes (40 minutes in each position) and was followed by a 40 min rest period. One observer (port) was stationed on the ship's bridge wing. The observer used 25x 'big-eye' binoculars with reticles to scan from 90° port to 90° starboard (Figure 21). The data recorder was positioned on the bridge and surveyed the trackline with 7x50 binoculars while scanning through the viewing area of the primary observer. When a sighting was detected, the primary observer conveyed to the recorder the horizontal angle and number of reticles from the horizon to the initial sighting. Additional information collected was sighting cue, course and speed, species identity, and best, low, and high estimates of group size. The computer program WINCRUZ (available at http://swfsc.nmfs.noaa.gov/PRD/softwares/software.html) was used to record all sighting and environmental data (e.g., cloud cover, wind speed and direction, and sea conditions).

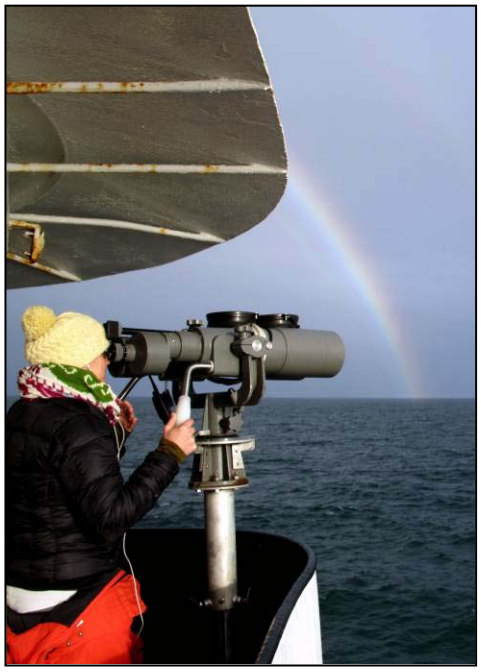


Figure 21. Marine mammal observer Brenda Rone using the Big Eye binoculars.

On-effort status was defined as a visible horizon, Beaufort sea state 5 or lower, and survey speed of ~9 knots through the water. Fog effort corresponded to observations conducted under poor visibility (no horizon) but with a Beaufort sea state 5 or less. Under unacceptable weather conditions (visibility ≤ 0.5 nautical miles (nm) and/or sea state ≥ 6), off-effort watches on the bridge were conducted. One observer was positioned on the bridge to record off-effort sightings and environmental data. Visual operations were conducted between oceanographic stations, mooring sites and transits between transects. A data recorder/observer was positioned on the bridge at all times between 08:00 and 20:00 under unacceptable survey conditions and while stationary during oceanographic operations. At the cruise leader's discretion, line transect survey effort was temporarily suspended to allow closer approaches to sightings for photo-identification.

*Photo-identification*

Identification photographs of target species were obtained to allow evaluation of movements of animals during the survey and comparison to existing catalogs. Highest priority species for photo-identification on the CHAOZ survey were North Pacific right, blue, killer, fin, gray, and humpback whales. When the observers located a target species, the visual survey effort was suspended and the primary survey vessel was directed to obtain photographs of the animals. The vessel was positioned for the best lighting and

angle so that photographs could be obtained of each species' identifiable marks. Photographs were taken using Canon 50D, 7D and Nikon D200 autofocus digital cameras equipped with a 100-400 and 80-200 mm zoom lens. All photographs were reviewed, and the highest quality identification photograph(s) of each animal were selected to be compared to existing photo-identification catalogs from the Bering and Chukchi Seas and along the Aleutian Chain.

*Satellite Telemetry*

Satellite telemetry was conducted for the ARCWEST project on an opportunistic basis at the discretion of the chief scientist, taking weather, time of day, and oceanographic operations planning into consideration. Once a tagging candidate was located, our 24' rigid hulled inflatable boat (RHIB) was launched with a coxswain, tagger, data recorder and photographer on board. Satellite transmitters were attached to the body of the whales using the Air Rocket Transmitter System (ARTS), which is a modified marine safety pneumatic line thrower. Tagging took place from a bow platform with the RHIB positioned approximately 6-10m perpendicular from the animal.

Whales were tagged with the implantable configuration of the SPOT 5 transmitters produced by Wildlife Computers (Redmond, WA). These instruments are cylindrical in shape and contain an ARGOS satellite PTT. When deployed, approximately 4 cm of the tag remains external to the body of the whale, with an antenna extending out of the distal end of the tag. The tags were duty-cycled to record from 02:00-08:00 and 14:00-20:00GMT daily in order to maximize battery life and transmission rate. Follow-up photo-documentation of tag placement and animal behavior was attempted for 20-30min after deployment. Tag deployment and follow-up photo-documentation were performed according to regulations and restrictions specified in the existing permits issued by the NMFS to the National Marine Mammal Laboratory (permit #14245).

*Visual Survey Effort and Sightings*

The survey covered a total of 657 nm on-effort while fog effort legs accounted for 330 nm (Table 5, Figures 22-24). There were a total of 189 sightings (951 individuals) of 13 confirmed marine mammal species; these consisted of bowhead, killer, fin, humpback, gray, and minke whales, as well as harbor porpoise, walrus, fur, bearded, spotted seals, Steller sea lions, and polar bear. Additionally, there were 68 sightings (70 individuals) of unidentified large whales and seals (Figures 22-24). For a complete listing of sightings, see Appendix 4.

Table 5. Completed visual effort for marine mammal observation

| **Effort type** | **Effort (nm)** |
|---|---|
| On Effort | 657 |
| Fog Effort | 330 |
| **Total** | **987** |

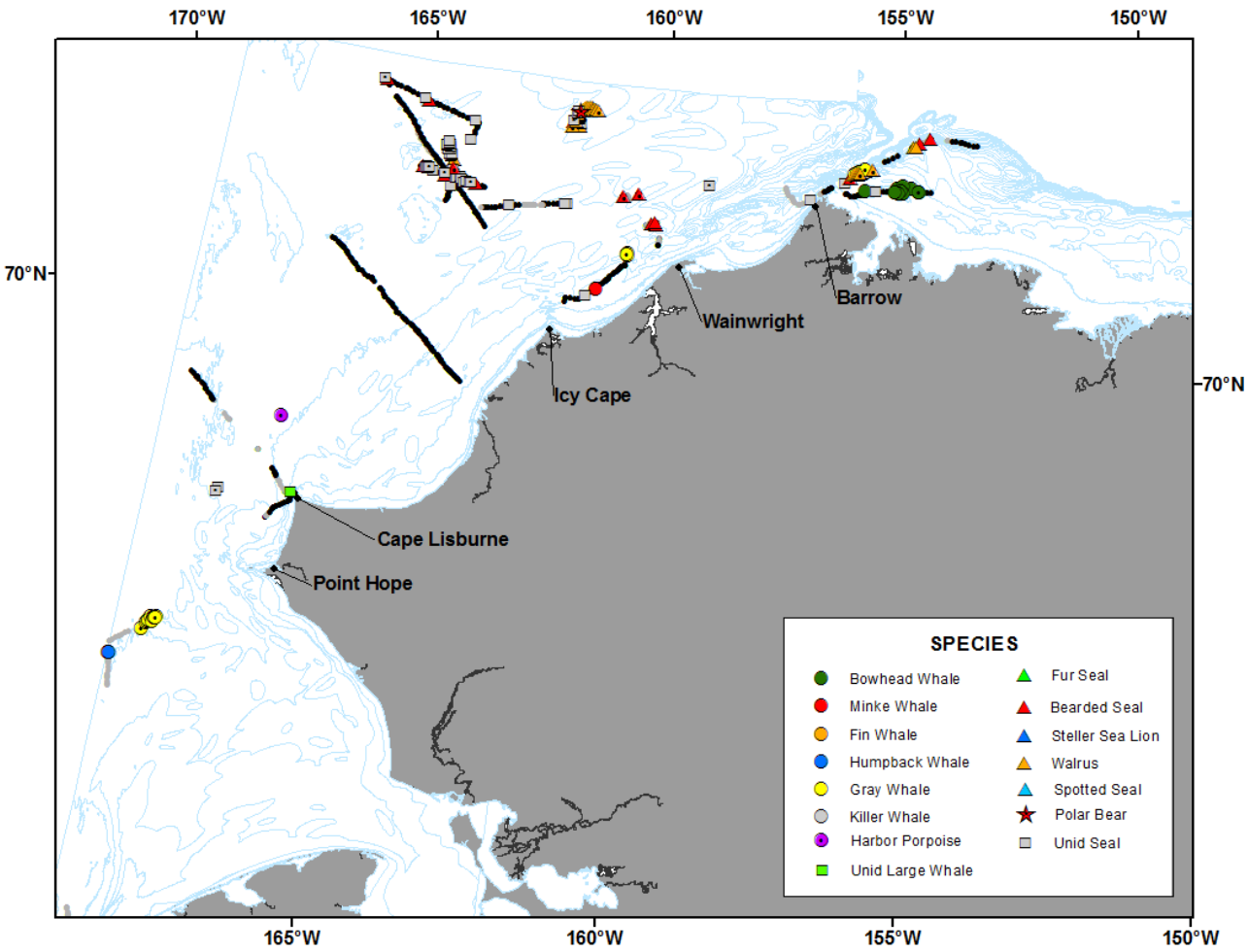



Figure 22. Marine mammal sightings and effort data from the CHAOZ 2012 research cruise, Barrow to Bering Strait (open symbol = on-effort sightings, dotted symbol = off-effort sightings; on effort = black, fog effort = gray).

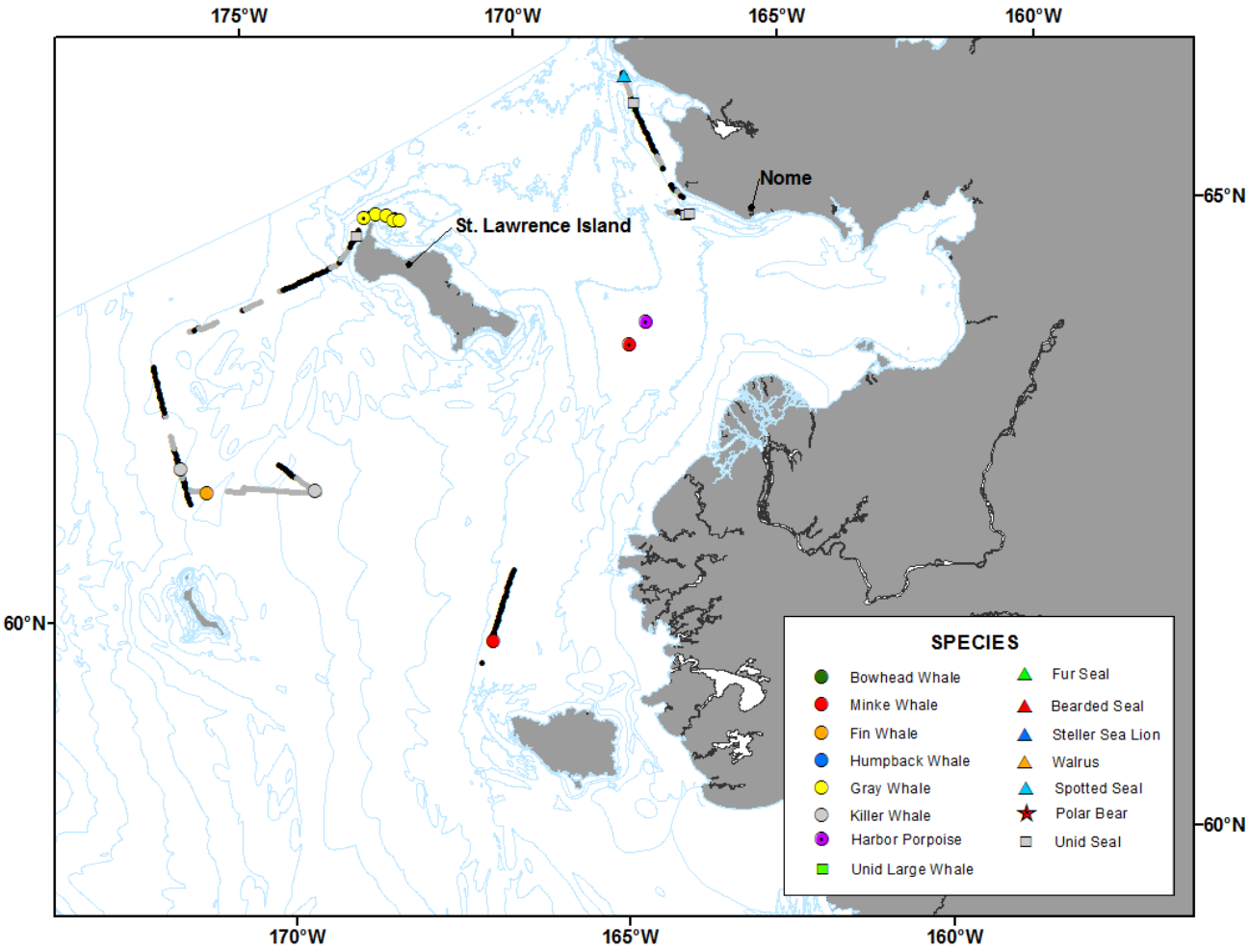



Figure 23. Marine mammal sightings and effort data from the CHAOZ 2012 research cruise, Bering Strait to Nunivak Island (open symbol = on-effort sightings, dotted symbol = off-effort sightings; on effort = black, fog effort = gray).

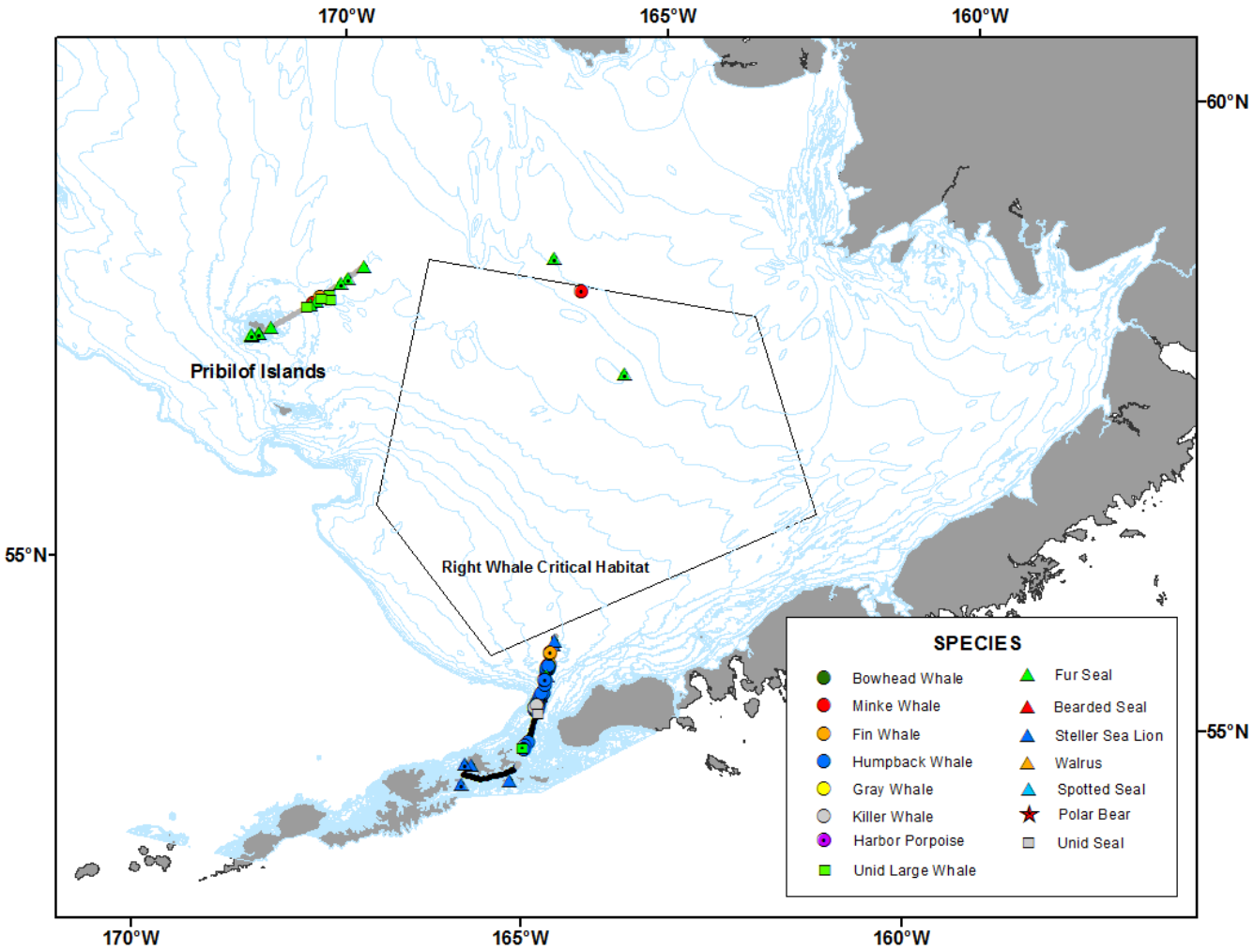



Figure 24. Marine mammal sightings and effort data from the CHAOZ 2012 research cruise, Bristol Bay and the Aleutian Islands (open symbol = on-effort sightings, dotted symbol = off-effort sightings; on effort = black, fog effort = gray).

*Photo-identification*

Photographs were obtained from the following species: one fluke from an adult female humpback whale, sighted with a calf; left and right dorsal and saddle patch of an adult male killer whale, and four gray whales (one right flank, one right flank and fluke – see satellite tagging section, one left flank and fluke, one fluke). All photos will be matched to existing catalogs and archived for future photo-identification projects.

*Satellite Telemetry*

One gray whale was tagged during this study, 16 miles offshore from Wainwright, Alaska, on 25 August. The whale was judged to be a juvenile based on size. The tag transmitted for 48 days, until 11 October 2012 (Figure 25). The animal remained within 25nm of the deployment site for the duration of the tag and occupied relatively shallow waters (20-50m in depth) to the south of Hanna Shoal. Given that there were several animals in the area during deployment and many visible mud plumes, it is highly likely that this whale has been feeding in a particularly dense prey patch.


Figure 25. August and September locations (red dots) of the gray whale tagged off Wainwright during CHAOZ 2012. The yellow star marks the tagging location (70.8N, 160.5W).

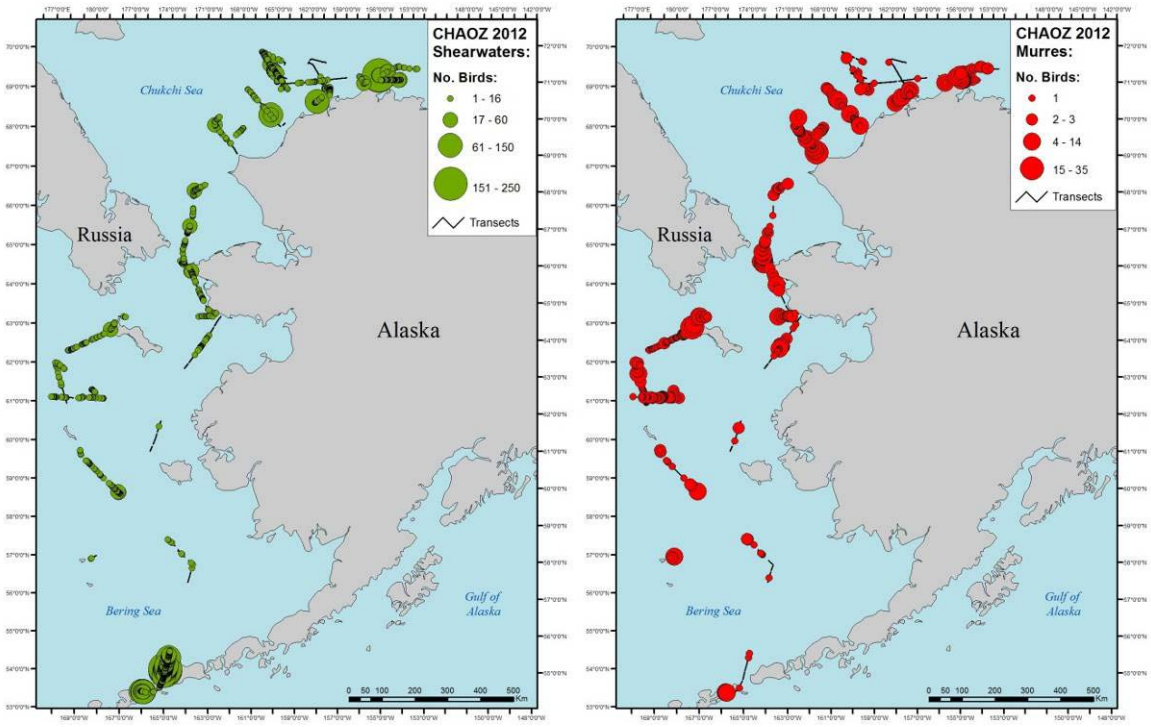
Figure 26. The seabird observer Andy Bankert

*Sea bird observations*

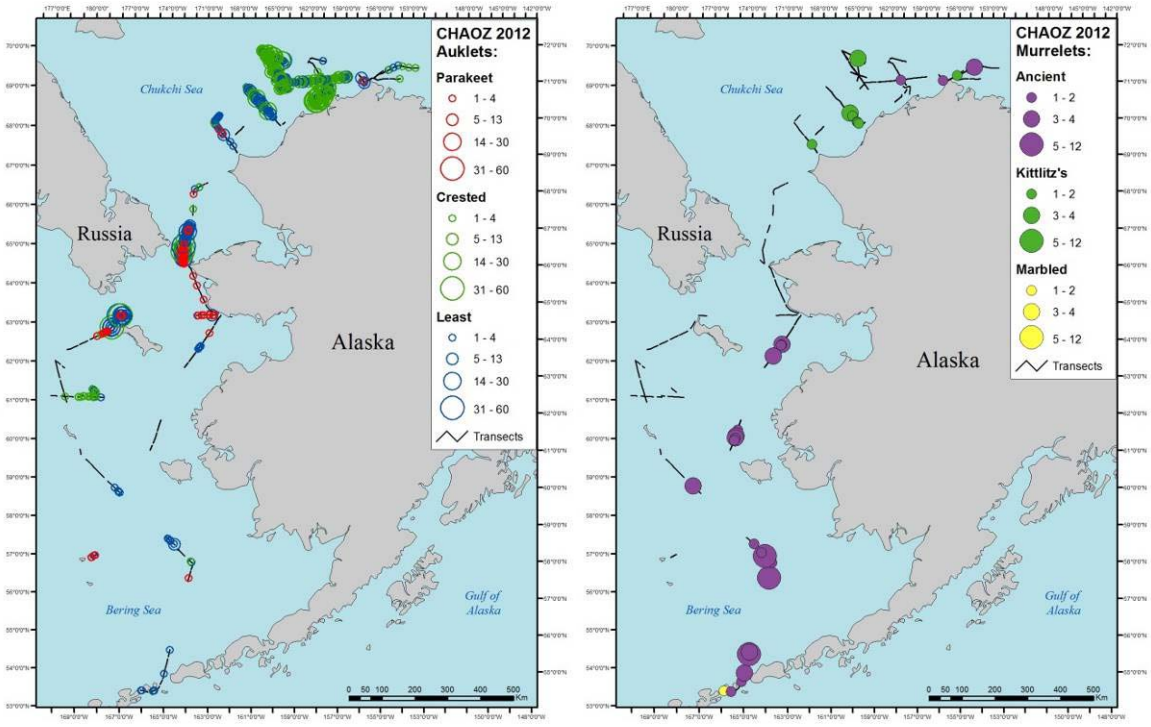
Surveys were conducted using U.S. Fish and Wildlife Service Protocols. Observations were made from the port side of the bridge during daylight hours while the ship was underway. The observer scanned the water ahead of the ship using hand-held 10x binoculars if necessary for identification and recorded all birds and mammals within a 300-m, 90$^{o}$ arc from the bow to the beam (Figure 26). Transect times varied from 13 to 121 minutes at vessel speeds of 9 – 10 knots. We used strip transect methodology and three distance bins extending from the vessel: 0-100 m, 101-200 m, and 201-300 m and recorded the animal's behavior (flying, on water, on ice). During this cruise we frequently had to reduce the transect window to 200 m or 100 m due to heavy fog or rough seas, or

could not survey at all. Rare birds, large flocks, and mammals beyond 300 m or on the starboard side ('off transect') were also recorded but will not be included in density calculations. Birds on the water were counted continuously whereas flying birds were recorded during quick 'Scans' of the transect window, with scan intervals based on ship speed. Observations were entered directly into a GPS-integrated laptop computer using the program DLOG3 (Ford Ecological Consultants, Inc.). Location data was also recorded automatically at 20 sec intervals, providing continuous records on weather, Beaufort sea state, ice coverage, glare, and observation conditions.

The observer conducted 148 transects totaling 176 survey hours, with 1398 km and 1874 km surveyed in the Bering Sea and Chukchi/Beaufort seas, respectively. A complete list of all species seen, including number of counts, can be found in Appendix 5. A total of 31,663 birds from 34 species were recorded on transect, with > 60% of those being shearwaters. Short-tailed shearwater was the most abundant bird in both the Bering and Chukchi seas, with large aggregations near Unimak Pass and Pt. Barrow (Figure 27). Common murre and thick-billed murre were widely and fairly evenly distributed (Figure 28). Tufted puffin was the most abundant alcid in the Bering Sea. *Aethia* auklets (least, crested, and parakeet) were also abundant in the north Bering Sea and were the most abundant alcids in the Chukchi (Figure 29). Red phalarope was the fourth most abundant species in the Chukchi Sea. Ancient murrelets were observed throughout the eastern Bering Sea shelf, and this species and other small alcids (parakeet, least, and crested auklets, and Kittlitz's murrelet) were found near Barrow (Figures 29-30); this is further north than the range maps for these species in most field guides. A Cassin's auklet near St. Matthew's Island and 3 fork-tailed storm-petrels near Nome were also north of their normal range. Severe weather forced some land birds to land on the boat, including Pectoral Sandpiper, Long-billed Dowitcher, Eastern Yellow Wagtail, Bluethroat, Northern Wheatear, Arctic Warbler, Hoary Redpoll, and White-winged Crossbill.




Figures 27 (left) and 28 (right). Shearwater (green) and common and thick-billed murre (red) distribution during the CHAOZ cruise.




Figures 29 (left) and 30 (right). Distribution of A*ethia auklets* (left) and three murrelet species (right) during the CHAOZ cruise.

**Dragging and recovery attempts**

A small array of three long-term passive acoustic AURAL recorders was deployed for the BOWFEST project in 2008. Recovery efforts from the USCGC HEALY in 2009 were unsuccessful, and time constraints prevented dragging operations during that cruise. These recorders were located closer to the edge of Barrow Canyon than in previous years, and it is thought that either the strong currents worked off the flotation or a landslide occurred, the result being that two moorings were found to be horizontal when they were interrogated prior to recovery in 2009. Attempts at dragging for these moorings were made during the 2010 and 2011 CHAOZ cruises, but were unsuccessful. Only one of these recorders is still in a position to allow for dragging operations (Figure 5, yellow star). During the CHAOZ cruise, several hours were spent attempting to recover this mooring using our winch to drag for the mooring (Figure 31). All attempts at recovery were unsuccessful.

Figure 31. Jessica Crance operating the winch during dragging ops.

**ACKNOWLEDGMENTS**

This project would not be possible without funding from the Bureau of Ocean Energy Management (BOEM). We would also like to thank Capt. Robin Fitch *(I&E Director Marine Science, Office of the Assistant Secretary of the Navy)*, Theresa Yost *(Naval Operational Logistics Support Center)*, Jeff Leonhard *(Naval Surface Warfare Center, Crane Division)*, and Todd Mequet *(Applied Logistics Services, Inc)* for providing the sonobuoys. We are extremely grateful to Captain Kale Garcia and the crew of the R/V *Aquila* for their help and assistance during the cruise, and helping to make the cruise a success.

**APPENDICES**

**Appendix 1.** List of personnel

| Position | Name | Nationality | Institution |
|---|---|---|---|
| Chief Scientist | Catherine Berchok | United States | NMML |
| Lead Oceanography | Bill Floering (on behalf of Phyllis Stabeno) | United States | PMEL |
| Lead Zooplankton | Jeff Napp | United States | AFSC (RACE) |
| Lead Acoustician/Chief Scientist (last Bering Sea leg) | Jessica Crance | United States | NMML |
| Acoustician | Dana Wright | United States | Univ. Alaska Fairbanks |
| Acoustician /Mammal observer | Stephanie Grassia | United States | NMML |
| Senior Mammal Observer | Brenda Rone | United States | NMML |
| Mammal Observer/tagger | Amy Kennedy | United States | NMML |
| Mammal Observer/acoustician | Jessica Thompson | United States | NMML |
| Oceanography | Sigrid Salo | United States | PMEL |
| Zoo- & Ichthyoplankton | Steve Porter | United States | AFSC (RACE) |
| Zoo- & Ichthyoplankton | Adam Spear | United States | AFSC (RACE) |
| MARU technician | Jason Michalec | United States | Cornell Univ. (BRP) |
| WHOI auto-buoy technician | John Kemp | United States | Woods Hole Oceanographic Institution (WHOI) |
| Bird observer | Andy Bankert | United States | US Fish and Wildlife Service |
| Oceanographic technician | Sam Denes | United States | Penn State University |
| Oceanographic technician | Dan Naber | United States | Univ. Alaska Fairbanks |

**Appendix 2.** Sonobuoy deployment date, time, position (decimal degrees), and species detected (1=detected, 0=not detected, 2=maybe)

| Buoy # | Date | Time | Depth (m) | Latitude | Longitude | Right whale Gunshot | Right whale Upsweep | Bowhead | Humpback | Fin whale | Killer whale | Walrus | Gray whale | Minke | Unknown | Bearded Seal | Beluga |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8/8/2012 | 8:15:43 | 70 | 54.03278 | -166.17872 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 8/8/2012 | 15:01:41 | 112 | 54.5328 | -165.25107 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 8/8/2012 | 16:22:42 | 132 | 54.75058 | -165.22557 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 8/8/2012 | 17:35:44 | 112 | 54.93855 | -165.19113 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 8/8/2012 | 19:16:54 | 112 | 55.19732 | -165.16540 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 8/8/2012 | 19:50:04 | 110 | 55.28292 | -165.15535 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 8/8/2012 | 19:57:50 | 110 | 55.30292 | -165.15377 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 8/8/2012 | 21:37:58 | 107 | 55.56323 | -165.09365 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 8/8/2012 | 23:15:37 | 96 | 55.82217 | -165.06003 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 8/9/2012 | 0:48:22 | 93.5 | 56.07269 | -165.01408 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 8/9/2012 | 2:18:30 | 89 | 56.32762 | -164.98233 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 8/9/2012 | 3:36:02 | 78 | 56.51093 | -164.95567 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 8/9/2012 | 4:54:55 | 74.8 | 56.72647 | -164.91837 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 8/9/2012 | 5:05:52 | 74 | 56.75472 | -164.91380 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 8/9/2012 | 6:04:53 | 70.5 | 56.90532 | -164.89047 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 8/9/2012 | 7:00:20 | 68 | 57.04548 | -164.86895 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 8/9/2012 | 8:32:39 | 65 | 57.27895 | -164.82343 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 8/9/2012 | 9:57:22 | 61 | 57.4966 | -164.77930 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 8/9/2012 | 11:35:16 | 52 | 57.6764 | -164.73715 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 8/9/2012 | 12:22:23 | 52 | 57.75147 | -164.93962 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 8/9/2012 | 14:15:59 | 52 | 57.87453 | -165.29277 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 8/9/2012 | 15:05:16 | 52 | 57.9466 | -165.49652 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 23 | 8/9/2012 | 15:46:14 | 52.5 | 57.97528 | -165.63277 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 8/9/2012 | 15:54:37 | 52.5 | 57.97513 | -165.63198 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 8/9/2012 | 16:05:13 | 52.5 | 57.9765 | -165.63223 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 26 | 8/9/2012 | 19:01:54 | 46.5 | 58.14212 | -165.94750 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 8/9/2012 | 21:03:57 | 45.5 | 58.3034 | -166.46230 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | 8/9/2012 | 22:28:54 | 43.6 | 58.42745 | -166.82722 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 8/10/2012 | 0:03:51 | 42 | 58.57023 | -167.23552 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 8/10/2012 | 1:26:38 | 41 | 58.68962 | -167.59058 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 8/10/2012 | 2:49:29 | 41 | 58.81462 | -167.93210 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 8/10/2012 | 4:01:09 | 41 | 58.91463 | -168.22705 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 8/10/2012 | 5:16:07 | 44.4 | 59.0189 | -168.52932 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 8/10/2012 | 7:01:33 | 46 | 59.1353 | -168.98028 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 8/10/2012 | 9:27:59 | 52 | 59.24898 | -169.42260 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 8/10/2012 | 10:36:01 | 56 | 59.33998 | -169.71762 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 8/10/2012 | 11:49:12 | 60.5 | 59.43465 | -170.04628 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 38 | 8/10/2012 | 13:02:48 | 64 | 59.53162 | -170.37525 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 8/10/2012 | 14:23:14 | 67.5 | 59.64133 | -170.72882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 8/10/2012 | 16:27:50 | 71 | 59.80527 | -171.25307 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 8/10/2012 | 17:48:10 | 70 | 59.88125 | -171.59593 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 8/10/2012 | 23:26:58 | 62 | 60.09065 | -171.88165 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 8/10/2012 | 23:43:47 | 58.1 | 60.1281 | -171.91983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 44 | 8/11/2012 | 2:02:23 | 57.2 | 60.43528 | -172.25005 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 8/11/2012 | 4:10:08 | 51 | 60.69505 | -172.62083 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 8/11/2012 | 6:16:27 | 61 | 60.96148 | -172.97963 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 47 | 8/11/2012 | 8:12:10 | 71.5 | 61.20578 | -173.32140 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 48 | 8/11/2012 | 10:10:37 | 72 | 61.46303 | -173.66502 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49 | 8/11/2012 | 10:19:35 | 72 | 61.48298 | -173.69155 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 50 | 8/11/2012 | 12:28:29 | 71 | 61.7692 | -174.09202 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 51 | 8/11/2012 | 14:48:34 | 70 | 62.09203 | -174.51733 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 8/11/2012 | 22:35:32 | 65 | 62.09127 | -174.14357 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 8/11/2012 | 23:25:06 | 63 | 62.05763 | -173.96535 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 8/11/2012 | 23:37:45 | 62.3 | 62.04928 | -173.91987 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 8/12/2012 | 2:07:56 | 60.5 | 61.95535 | -173.39473 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56 | 8/12/2012 | 2:25:31 | 60.3 | 61.94495 | -173.33348 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57 | 8/12/2012 | 4:29:14 | 60 | 61.87462 | -172.90487 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 58 | 8/12/2012 | 6:36:33 | 58 | 61.7926 | -172.42568 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 8/12/2012 | 6:46:22 | 58 | 61.78538 | -172.38822 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 8/12/2012 | 8:52:34 | 56 | 61.68668 | -171.90898 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 61 | 8/12/2012 | 9:00:10 | 56 | 61.6804 | -171.87995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 62 | 8/12/2012 | 10:51:13 | 52 | 61.5966 | -171.46813 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 63 | 8/12/2012 | 10:56:27 | 52 | 61.59228 | -171.45632 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 64 | 8/12/2012 | 15:05:47 | 57 | 61.52273 | -172.00562 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 65 | 8/12/2012 | 15:23:22 | 58.7 | 61.5147 | -172.09907 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66 | 8/12/2012 | 16:32:11 | 63.2 | 61.47987 | -172.46122 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 8/12/2012 | 18:21:59 | 67.4 | 61.39302 | -172.92330 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 8/12/2012 | 18:24:57 | 68 | 61.39107 | -172.93827 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 69 | 8/12/2012 | 20:00:21 | 72 | 61.33153 | -173.41420 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| 70 | 8/12/2012 | 21:42:21 | 75 | 61.2714 | -173.93917 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | 8/12/2012 | 22:55:21 | 78.4 | 61.25528 | -174.29020 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 8/13/2012 | 0:54:10 | 79.3 | 61.53877 | -174.54712 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 8/13/2012 | 1:08:37 | 79.1 | 61.57382 | -174.58040 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 8/13/2012 | 3:07:50 | 78.2 | 61.86465 | -174.84550 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 8/13/2012 | 4:26:55 | 71.8 | 62.15537 | -174.52992 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 76 | 8/13/2012 | 6:28:21 | 62 | 62.29588 | -174.17787 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | 8/13/2012 | 7:57:40 | 68 | 62.52485 | -174.23927 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 78 | 8/13/2012 | 9:40:56 | 68 | 62.6883 | -173.77590 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 79 | 8/13/2012 | 9:54:31 | 68 | 62.7128 | -173.71653 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 80 | 8/13/2012 | 10:48:48 | 68 | 62.81112 | -173.48135 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81 | 8/13/2012 | 11:28:42 | 66.5 | 62.88332 | -173.30497 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 82 | 8/13/2012 | 11:34:25 | 67 | 62.8937 | -173.27965 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 83 | 8/13/2012 | 13:31:04 | 63.8 | 63.1075 | -172.75882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 84 | 8/13/2012 | 13:32:50 | 63.8 | 63.11057 | -172.75073 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 85 | 8/13/2012 | 16:16:57 | 53.5 | 63.40458 | -172.03388 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 86 | 8/13/2012 | 19:47:59 | 21.8 | 63.87802 | -171.35258 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 87 | 8/14/2012 | 0:41:08 | 36.4 | 64.0734 | -169.49740 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 88 | 8/14/2012 | 3:39:42 | 36.5 | 64.18768 | -168.39695 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 89 | 8/14/2012 | 5:00:57 | 34 | 64.2348 | -167.91115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90 | 8/15/2012 | 20:01:02 | 42 | 64.85635 | -168.37707 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 91 | 8/15/2012 | 20:31:59 | 39 | 64.90177 | -168.23355 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 92 | 8/15/2012 | 23:10:00 | 45.1 | 64.24277 | -168.13527 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 93 | 8/16/2012 | 0:33:30 | 44 | 65.48383 | -168.19467 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 94 | 8/17/2012 | 7:32:51 | 47.5 | 65.66797 | -168.32708 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 95 | 8/17/2012 | 13:16:07 | 51.1 | 65.78847 | -168.60195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 96 | 8/17/2012 | 15:06:06 | 52.5 | 66.06973 | -168.79045 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 97 | 8/17/2012 | 17:07:14 | 46.6 | 66.36613 | -168.76682 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 98 | 8/17/2012 | 18:23:03 | 47.4 | 66.57013 | -168.70557 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 99 | 8/17/2012 | 20:00:28 | 36 | 66.83437 | -168.65213 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100 | 8/17/2012 | 22:22:39 | 43 | 67.17527 | -168.56405 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 101 | 8/17/2012 | 23:42:49 | 46.5 | 67.36063 | -168.59948 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 102 | 8/18/2012 | 1:48:28 | 41.5 | 67.3452 | -167.93520 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 103 | 8/18/2012 | 3:40:29 | 35.5 | 67.11473 | -167.94270 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 104 | 8/18/2012 | 5:15:32 | 30.5 | 66.90903 | -167.99645 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 105 | 8/18/2012 | 7:12:35 | 38 | 66.92377 | -168.63568 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 106 | 8/18/2012 | 7:28:38 | 38 | 66.96153 | -168.63400 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107 | 8/18/2012 | 9:09:06 | 46 | 67.21212 | -168.74202 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 108 | 8/18/2012 | 11:00:02 | 48 | 67.48405 | -168.87437 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 109 | 8/18/2012 | 12:35:25 | 48.6 | 67.67412 | -168.94827 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 8/18/2012 | 15:38:56 | 49.8 | 67.82868 | -168.46573 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 111 | 8/18/2012 | 17:57:30 | 53.5 | 67.96582 | -168.02048 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 112 | 8/18/2012 | 20:07:37 | 50 | 68.09015 | -167.59763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 113 | 8/19/2012 | 4:13:38 | 32 | 68.39157 | -167.08885 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 114 | 8/19/2012 | 5:20:46 | 26 | 68.49435 | -166.93597 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 115 | 8/19/2012 | 6:24:11 | 30 | 68.57829 | -166.82120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 116 | 8/19/2012 | 9:03:22 | 30 | 68.82295 | -166.41377 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 117 | 8/19/2012 | 11:45:20 | 38 | 69.0175 | -166.65472 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 118 | 8/19/2012 | 14:27:23 | 43.1 | 69.17375 | -167.17032 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 119 | 8/19/2012 | 17:03:08 | 48 | 69.33248 | -167.74393 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 120 | 8/19/2012 | 21:26:19 | 49 | 69.64445 | -168.55417 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 121 | 8/19/2012 | 21:34:17 | 49 | 69.66152 | -168.52777 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 122 | 8/20/2012 | 0:02:56 | 46 | 69.98967 | -168.00722 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 123 | 8/20/2012 | 2:30:48 | 47.1 | 70.3157 | -167.47018 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 124 | 8/20/2012 | 4:57:34 | 47.7 | 70.64177 | -166.92913 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 125 | 8/20/2012 | 7:31:58 | 41 | 70.72457 | -166.58358 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 126 | 8/20/2012 | 8:02:09 | 41 | 70.67802 | -166.38735 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 127 | 8/20/2012 | 10:01:32 | 41 | 70.52145 | -165.85087 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 128 | 8/20/2012 | 13:40:21 | 41 | 70.32728 | -165.13372 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 129 | 8/20/2012 | 17:02:49 | 33 | 70.09602 | -164.29852 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 130 | 8/21/2012 | 2:23:59 | 31.5 | 70.42487 | -163.28970 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 131 | 8/21/2012 | 5:57:01 | 42.7 | 70.77455 | -163.31795 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 132 | 8/21/2012 | 10:51:24 | 43 | 70.95383 | -163.50533 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 133 | 8/21/2012 | 12:37:56 | 41 | 71.16272 | -164.09732 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 134 | 8/21/2012 | 17:30:39 | 42 | 71.2177 | -164.16030 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 135 | 8/22/2012 | 2:30:32 | 17 | 71.56255 | -165.45097 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 136 | 8/22/2012 | 5:59:04 | 17 | 71.81595 | -166.02938 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 137 | 8/22/2012 | 15:01:31 | 25 | 71.27147 | -164.39825 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 138 | 8/23/2012 | 1:41:53 | 45.1 | 71.30023 | -164.22368 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 139 | 8/23/2012 | 1:53:48 | 44.5 | 71.29133 | -164.22480 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 140 | 8/23/2012 | 5:51:03 | 46.5 | 71.2482 | -164.41930 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 141 | 8/23/2012 | 6:24:23 | 45.5 | 71.25283 | -164.38855 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 142 | 8/23/2012 | 13:57:19 | 40.7 | 71.20693 | -163.85762 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 143 | 8/23/2012 | 19:30:30 | 45 | 71.23795 | -164.42630 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 144 | 8/24/2012 | 4:58:54 | 41.5 | 71.22773 | -164.15925 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 145 | 8/24/2012 | 8:34:12 | 39.5 | 71.67187 | -164.38640 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 146 | 8/24/2012 | 12:40:42 | 41.5 | 71.80135 | -165.88702 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 147 | 8/24/2012 | 16:03:25 | 40.7 | 71.51712 | -165.08655 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 148 | 8/24/2012 | 19:07:24 | 46.5 | 71.26405 | -164.38767 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 149 | 8/24/2012 | 23:09:35 | 43 | 70.96365 | -163.52802 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 150 | 8/25/2012 | 2:31:38 | 39.5 | 70.69705 | -162.80947 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 151 | 8/25/2012 | 6:53:03 | 25 | 70.50528 | -161.51373 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 152 | 8/25/2012 | 8:55:52 | 42 | 70.70113 | -160.76623 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 153 | 8/25/2012 | 13:08:56 | 52.8 | 70.87207 | -160.34422 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 154 | 8/25/2012 | 13:21:27 | 52.8 | 70.87223 | -160.32732 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 155 | 8/25/2012 | 18:28:35 | 51.5 | 71.05683 | -160.20153 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 156 | 8/25/2012 | 20:41:16 | 45.1 | 70.85068 | -159.92332 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 157 | 8/26/2012 | 8:06:56 | 51.5 | 71.07882 | -160.15193 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 158 | 8/26/2012 | 12:27:35 | 45.7 | 71.37885 | -160.89448 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 159 | 8/26/2012 | 17:26:48 | 42 | 71.70402 | -161.82297 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 160 | 8/26/2012 | 20:28:18 | 40 | 71.81378 | -161.54335 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 161 | 8/26/2012 | 23:12:54 | 46.9 | 71.7421 | -160.28313 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 162 | 8/27/2012 | 2:21:35 | 51.9 | 71.60857 | -158.93877 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 163 | 8/27/2012 | 5:43:06 | 62 | 71.57468 | -157.82302 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 164 | 8/27/2012 | 8:33:42 | 112 | 71.37655 | -157.38295 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 165 | 8/28/2012 | 0:07:32 | 1000 | 71.67515 | -152.30360 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 166 | 8/28/2012 | 0:33:55 | 450 | 71.61423 | -152.24595 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 167 | 8/28/2012 | 3:15:05 | 176 | 71.41327 | -152.06695 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 168 | 8/29/2012 | 1:27:18 | 200 | 71.59313 | -155.77385 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 169 | 8/29/2012 | 1:43:25 | 212 | 71.58418 | -155.88778 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 170 | 8/29/2012 | 4:13:12 | 148 | 71.51793 | -156.89205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 171 | 8/29/2012 | 7:38:08 | 68 | 71.39192 | -158.53415 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 172 | 8/29/2012 | 10:00:54 | 50 | 71.31742 | -159.73035 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 173 | 8/29/2012 | 12:38:28 | 47 | 71.22187 | -160.94423 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 174 | 8/29/2012 | 15:28:40 | 43 | 71.121 | -162.38103 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 175 | 8/29/2012 | 15:42:22 | 43 | 71.11425 | -162.49317 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 176 | 8/29/2012 | 22:00:07 | 42 | 70.97457 | -163.71097 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 177 | 8/30/2012 | 0:15:48 | 44.5 | 70.66712 | -164.32560 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 178 | 8/30/2012 | 3:28:46 | 40 | 70.23675 | -165.17692 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 179 | 8/30/2012 | 6:34:01 | 40 | 69.83045 | -165.95792 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 180 | 8/30/2012 | 9:30:37 | 40 | 69.44635 | -166.67827 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 181 | 8/30/2012 | 12:34:14 | 46 | 69.05428 | -167.38450 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 182 | 8/30/2012 | 15:34:00 | 52 | 68.66027 | -167.92980 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 183 | 8/30/2012 | 18:31:12 | 52 | 68.22105 | -168.11408 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 184 | 8/30/2012 | 20:39:25 | 58 | 67.89692 | -168.18350 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 185 | 8/30/2012 | 21:41:33 | 48.1 | 67.73697 | -168.20310 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 186 | 8/31/2012 | 0:27:29 | 41.6 | 67.30662 | -168.24743 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 187 | 8/31/2012 | 3:31:31 | 28.8 | 66.82103 | -168.33128 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 188 | 8/31/2012 | 6:32:38 | 48 | 66.3529 | -168.27015 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 189 | 8/31/2012 | 6:57:37 | 52 | 66.28868 | -168.25183 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 190 | 8/31/2012 | 9:32:48 | 45 | 65.90148 | -168.20467 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 191 | 9/1/2012 | 21:33:10 | 27 | 62.91753 | -167.07643 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 192 | 9/2/2012 | 0:09:55 | 26.7 | 62.5516 | -167.42652 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 193 | 9/2/2012 | 3:40:21 | 23.5 | 62.0449 | -167.64010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 194 | 9/2/2012 | 4:35:11 | 23.5 | 61.9008 | -167.68582 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 195 | 9/2/2012 | 5:43:24 | 23.5 | 61.71892 | -167.75045 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 196 | 9/2/2012 | 7:31:51 | 24.8 | 61.42708 | -167.83575 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 197 | 9/2/2012 | 10:18:55 | 26 | 60.98827 | -167.92613 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 198 | 9/2/2012 | 12:46:04 | 26.2 | 60.61985 | -168.03478 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 199 | 9/2/2012 | 12:54:00 | 27.1 | 60.59998 | -168.04327 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | 9/2/2012 | 16:04:27 | 38.5 | 60.10582 | -168.26415 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 201 | 9/2/2012 | 19:06:06 | 37.2 | 59.64347 | -168.41883 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 202 | 9/2/2012 | 21:46:53 | 40.3 | 59.2599 | -168.49305 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 203 | 9/2/2012 | 22:28:49 | 40 | 59.15897 | -168.50243 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 204 | 9/3/2012 | 0:31:00 | 48 | 58.85578 | -168.57777 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 205 | 9/3/2012 | 1:06:34 | 51 | 58.76367 | -168.60585 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 206 | 9/3/2012 | 3:30:49 | 63 | 58.37783 | -168.72760 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 207 | 9/3/2012 | 4:03:24 | 65 | 58.29152 | -168.75742 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 208 | 9/3/2012 | 5:02:10 | 67 | 58.13822 | -168.81137 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209 | 9/3/2012 | 11:06:29 | 70 | 57.836 | -168.92437 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 210 | 9/3/2012 | 12:42:18 | 67.7 | 57.65268 | -169.22568 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 211 | 9/3/2012 | 15:27:58 | 53.9 | 57.31987 | -169.80610 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 212 | 9/3/2012 | 15:57:43 | 45.5 | 57.26117 | -169.92527 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 213 | 9/5/2012 | 18:34:18 | 58 | 57.07418 | -169.94427 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 214 | 9/5/2012 | 18:49:19 | 58 | 57.07055 | -169.87758 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 215 | 9/5/2012 | 21:29:58 | 75.9 | 57.05725 | -169.15645 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 216 | 9/5/2012 | 21:54:02 | 77 | 57.05623 | -169.04212 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 217 | 9/6/2012 | 0:39:47 | 79 | 57.048 | -168.21880 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 218 | 9/6/2012 | 6:30:47 | 73 | 56.97273 | -166.49245 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 219 | 9/6/2012 | 9:29:14 | 71 | 56.94013 | -165.69603 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 9/6/2012 | 11:16:14 | 71 | 56.9208 | -165.21178 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 221 | 9/6/2012 | 13:12:11 | 70.6 | 56.89603 | -164.67143 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 222 | 9/6/2012 | 21:01:48 | 71 | 56.72592 | -164.16750 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 223 | 9/6/2012 | 22:56:32 | 79.1 | 56.48525 | -164.37495 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 224 | 9/7/2012 | 7:12:21 | 119 | 55.33353 | -165.23150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 225 | 9/7/2012 | 7:17:55 | 119 | 55.32013 | -165.24298 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 226 | 9/7/2012 | 9:37:27 | 121 | 54.98813 | -165.52793 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 227 | 9/7/2012 | 12:26:53 | 35 | 54.61737 | -165.86710 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

**Appendix 3.** CTD and net tow station report

A metadata report on the CTD and net tow stations can be found in the companion electronic document entitled "1AQ12_rptCruiseSummary.pdf".

**Appendix 4.** Marine mammal sightings (individuals) from the CHAOZ 2012 research cruise.

| Species | On-Effort | Off-Effort | Total |
|---|---|---|---|
| **Cetaceans** | | | |
| Fin Whale | 6(9) | 3(8) | 9(17) |
| Humpback Whale | 33(81) | 4(9) | 37(90) |
| Gray Whale | 6(11) | 19(43) | 25(54) |
| Minke Whale | 3(4) | 2(2) | 5(6) |
| Bowhead Whale | 9(11) | 1(3) | 10(14) |
| Harbor Porpoise | 0 | 2(5) | 2(5) |
| Killer Whale | 4(9) | 0 | 4(9) |
| Unid Large Whale | 5(6) | 1(1) | 6(7) |
| *Total Cetacean* | *66(131)* | *32(71)* | *98(202)* |
| **Other** | | | |
| Fur Seal | 7(7) | 10(11) | 17(18) |
| Bearded Seal | 11(11) | 5(5) | 16(16) |
| Spotted Seal | 1(1) | 0 | 1(1) |
| Walrus | 5(10) | 51(336) | 56(346) |
| Steller Sea Lion | 4(24) | 2(350) | 6(374) |
| Unid Seal | 51(52) | 11(11) | 62(63) |
| Polar Bear | 0 | 1(1) | 1(1) |
| *Total Other* | *79(105)* | *80(714)* | *159(819)* |
| **Total** | **145(236)** | **112(785)** | **257(1021)** |

**Appendix 5.** Summary of all marine birds observed on transect during the CHAOZ 2012 research cruise.

| Birds | Scientific Name | Bering Sea | Chukchi & Beaufort Sea |
|---|---|---|---|
| Red-throated Loon | *Gavia stellata* | | 4 |
| Pacific Loon | *Gavia pacifica* | 1 | 6 |
| Unidentified Loon | *Gavia spp.* | | 1 |
| Black-footed Albatross | *Phoebastria nigripes* | 1 | |
| Northern Fulmar | *Fulmarus glacialis* | 383 | 88 |
| Short-tailed Shearwater | *Puffinus tenuirostris* | 478 | 4,332 |
| Unid. Dark Shearwater | *Puffinus spp.* | 16,187 | 51 |
| Fork-tailed Storm-Petrel | *Oceanodroma furcata* | 47 | |
| Double-crested Cormorant | *Phalacrocorax auritus* | 1 | |
| Pelagic Cormorant | *Phalacrocorax pelagicus* | 1 | |
| Common Eider | *Somateria mollissima* | 1 | 6 |
| King Eider | *Somateria spectabilis* | | 15 |
| Unidentified Eider | *Somateria spp.* | | 2 |
| Long-tailed Duck | *Clangula hyemalis* | 7 | 50 |
| Pectoral Sandpiper | *Calidris melanotos* | | 3 |
| Red Phalarope | *Phalaropus fulicarius* | 92 | 748 |
| Unidentified Shorebird | Family *Scolopacidae* | | 15 |
| Long-tailed Jaeger | *Stercorarius longicaudus* | 1 | 2 |
| Pomarine Jaeger | *Stercorarius pomarinus* | 7 | 13 |
| Unidentified Jaeger | *Stercorarius spp.* | 1 | |
| Glaucous Gull | *Larus hyperboreus* | 6 | 13 |
| Glaucous-winged Gull | *Larus glaucescens* | 18 | |
| Unidentified Gull | *Larus spp.* | 3 | |
| Black-legged Kittiwake | *Rissa tridactyla* | 113 | 48 |
| Sabine's Gull | *Xema sabini* | 5 | 27 |
| Arctic Tern | *Sterna paradisaea* | 21 | 26 |
| Common Murre | *Uria aalge* | 229 | 170 |
| Thick-billed Murre | *Uria lomvia* | 263 | 416 |
| Unidentified Murre | *Uria Spp.* | 191 | 327 |
| Black Guillemot | *Cepphus grylle* | | 1 |
| Pigeon Guillemot | *Cepphus columba* | | 2 |
| Marbled Murrelet | *Brachyramphus marmoratu* | 2 | |
| Kittlitz's Murrelet | *Brachyramphus brevirostris* | | 18 |
| Ancient Murrelet | *Synthliboramphus antiquus* | 78 | 7 |
| Cassin's Auklet | *Ptychoramphus aleuticus* | 59 | |
| Parakeet Auklet | *Aethia psittacula* | 34 | 44 |
| Crested Auklet | *Aethia cristatella* | 449 | 2,620 |
| Whiskered Auklet | *Aethia pygmaea* | 214 | |
| Least Auklet | *Aethia pusilla* | 511 | 1,906 |
| Horned Puffin | *Fratercula corniculata* | 11 | 31 |
| Tufted Puffin | *Fratercula cirrhata* | 1,099 | 54 |
| Unidentified Alcid | Family *Alcidae* | 57 | 46 |
| Total | | 20,571 | 11,092 |

**Appendix 6.** Mooring designs (all mooring designs provided by Rick Miller from the PMEL mooring shop at NOAA (Seattle, WA)).

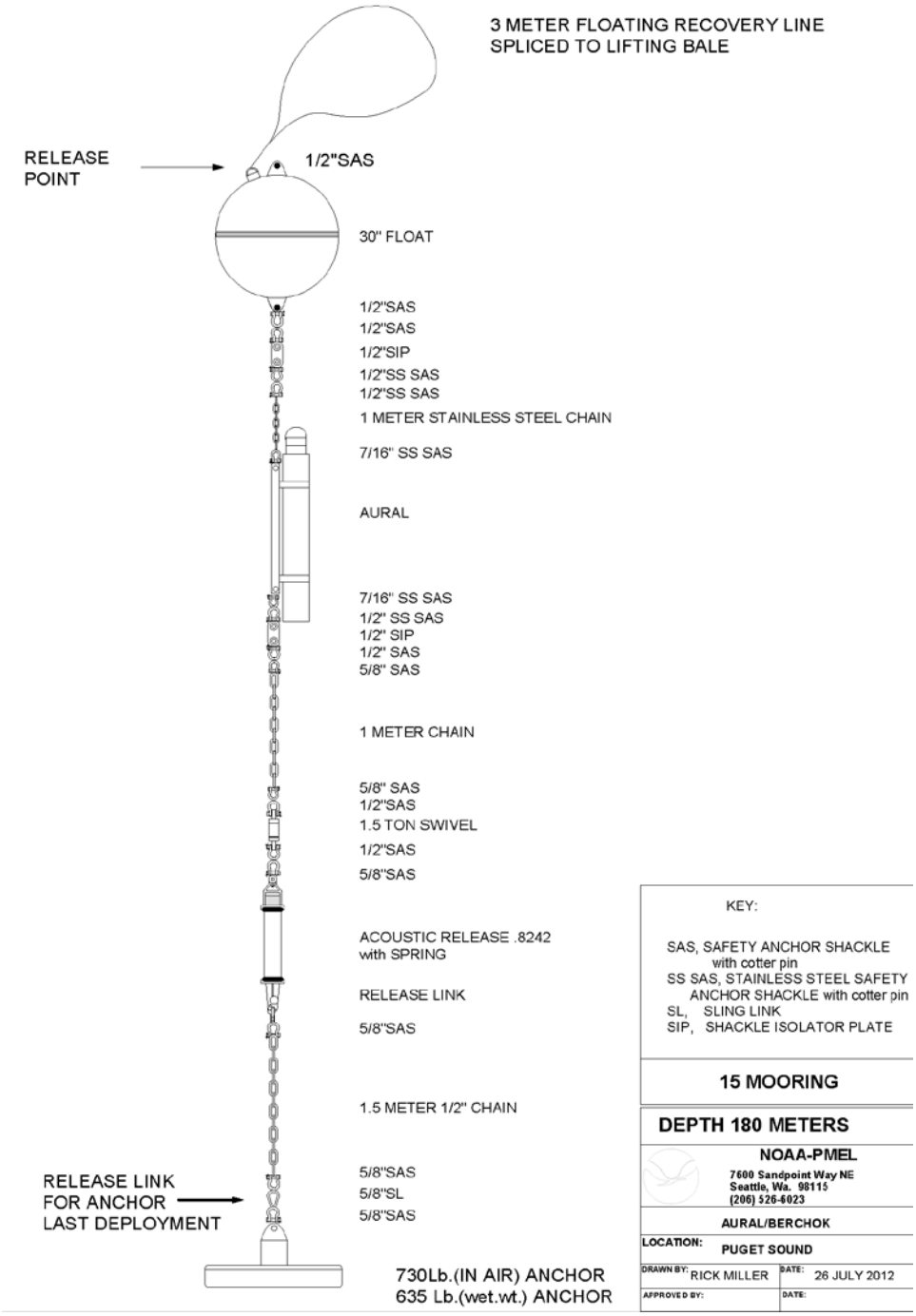



Figure 1. Mooring design for the passive acoustic moorings.

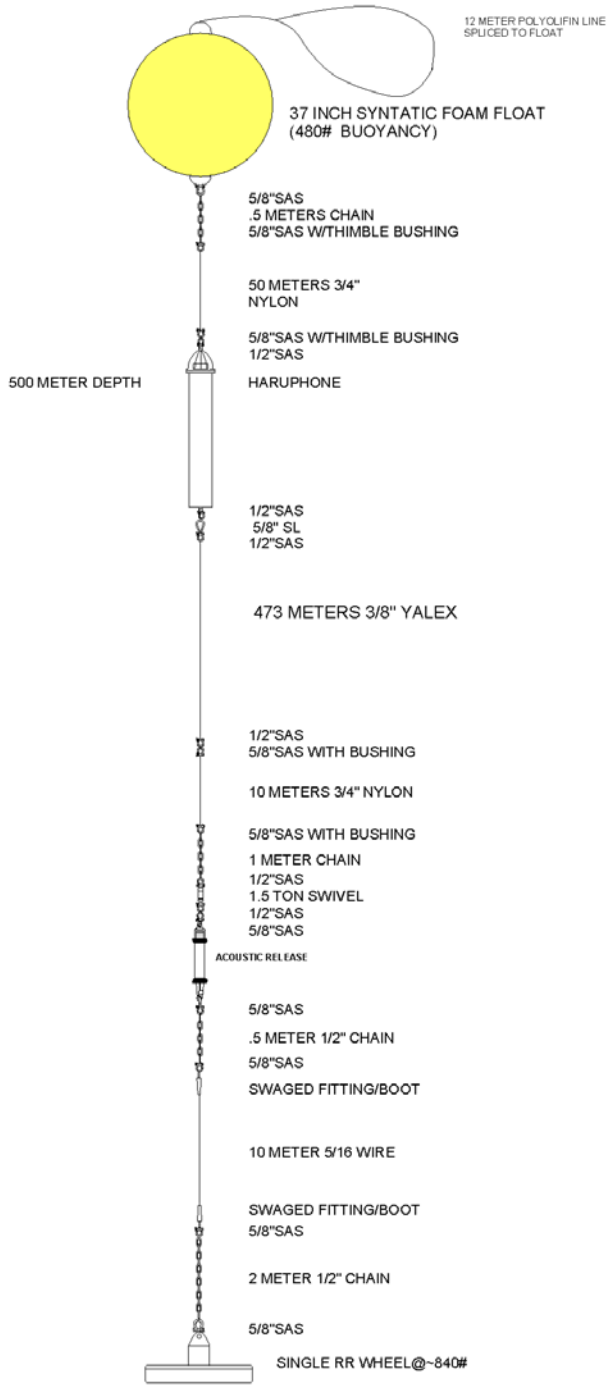



Figure 2. Mooring design for Haruphone mooring, deployed in 1000m.

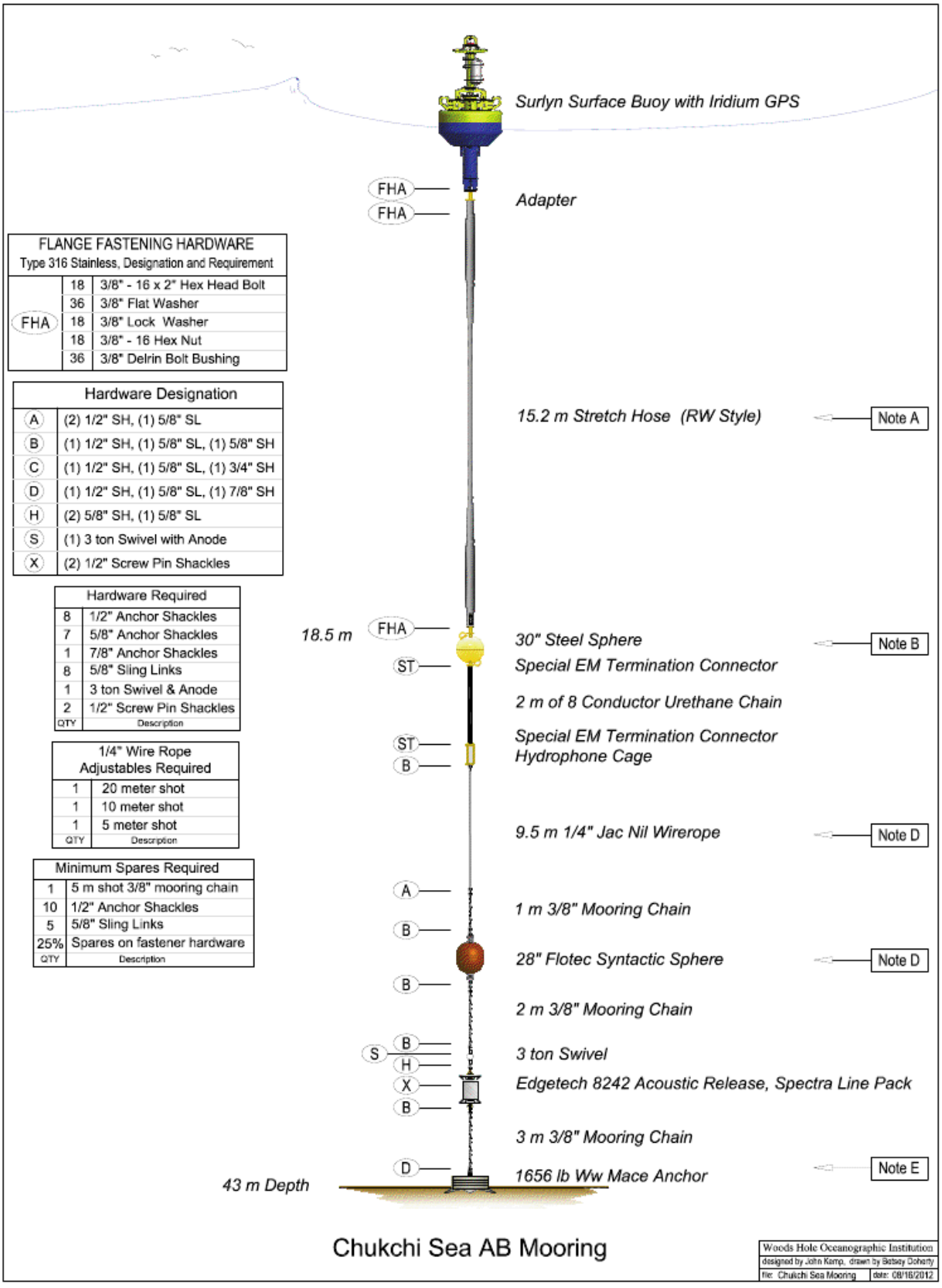
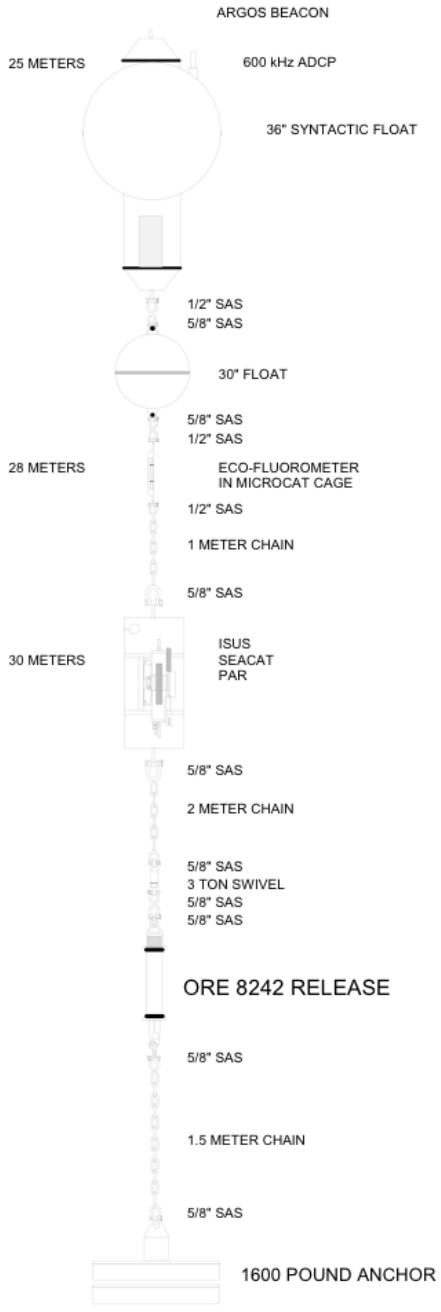



Figure 3. Mooring design for the WHOI/Cornell auto-detection buoy (design by John Kemp, WHOI).




| INSTRUMENT | DEPTH M | SERIAL NO. |
|---|---|---|
| 600kHzADCP | 25 | |
| ECOFLO | 28 | |
| ISUS | 30 | |
| SEACAT | 30 | |
| PAR | 30 | |
| BOTTOM | 35 | |

**NOAA-PMEL-FOCI**
7600 Sandpoint Way NE
Seattle, Wa. 98115
(206) 526-6175

**MOORING:** 10CKP-2A

**LOCATION:**

DRAWN BY: Rick Miller DATE: 7 JULY 2010

APPROVED BY: DATE:

Figure 4. Mooring design for 12CKP1a, 12CKP2a and 12CKP3a. In addition to the 600 kHz ADCP (currents), this mooring contains instruments to measure nitrate (ISUS), temperature and salinity (Seacat), fluorescence (EcoFluorometer) and Photosynthetically active radiation (PAR).

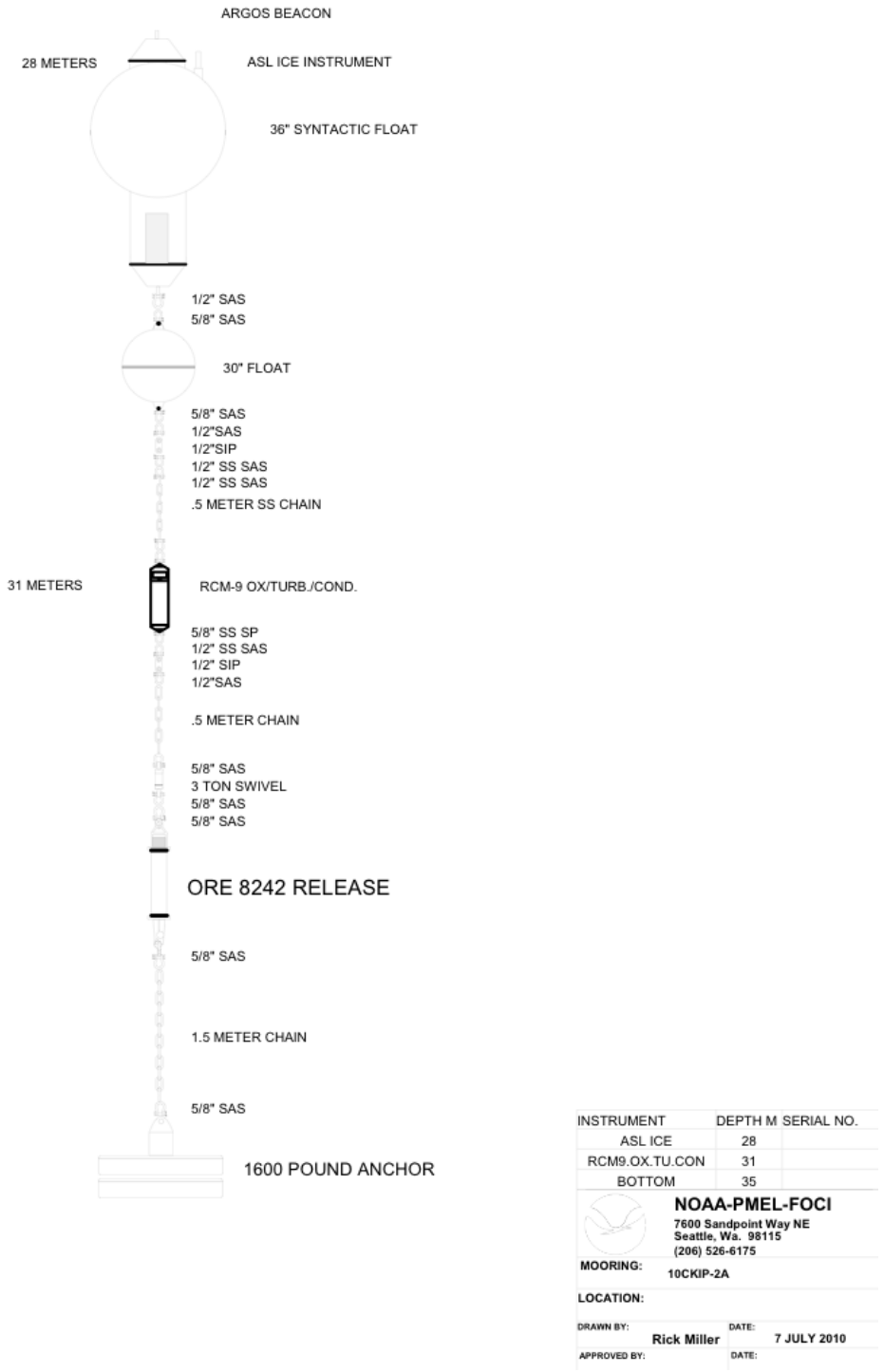



Figure 5. Mooring design for 12CKIP1a, 12CKIP2a and 12CKIP3a. In addition to the ASL ice instrument (measures ice thickness), this mooring contains RCM9 that measures currents at one depth, temperature, oxygen, and turbidity.

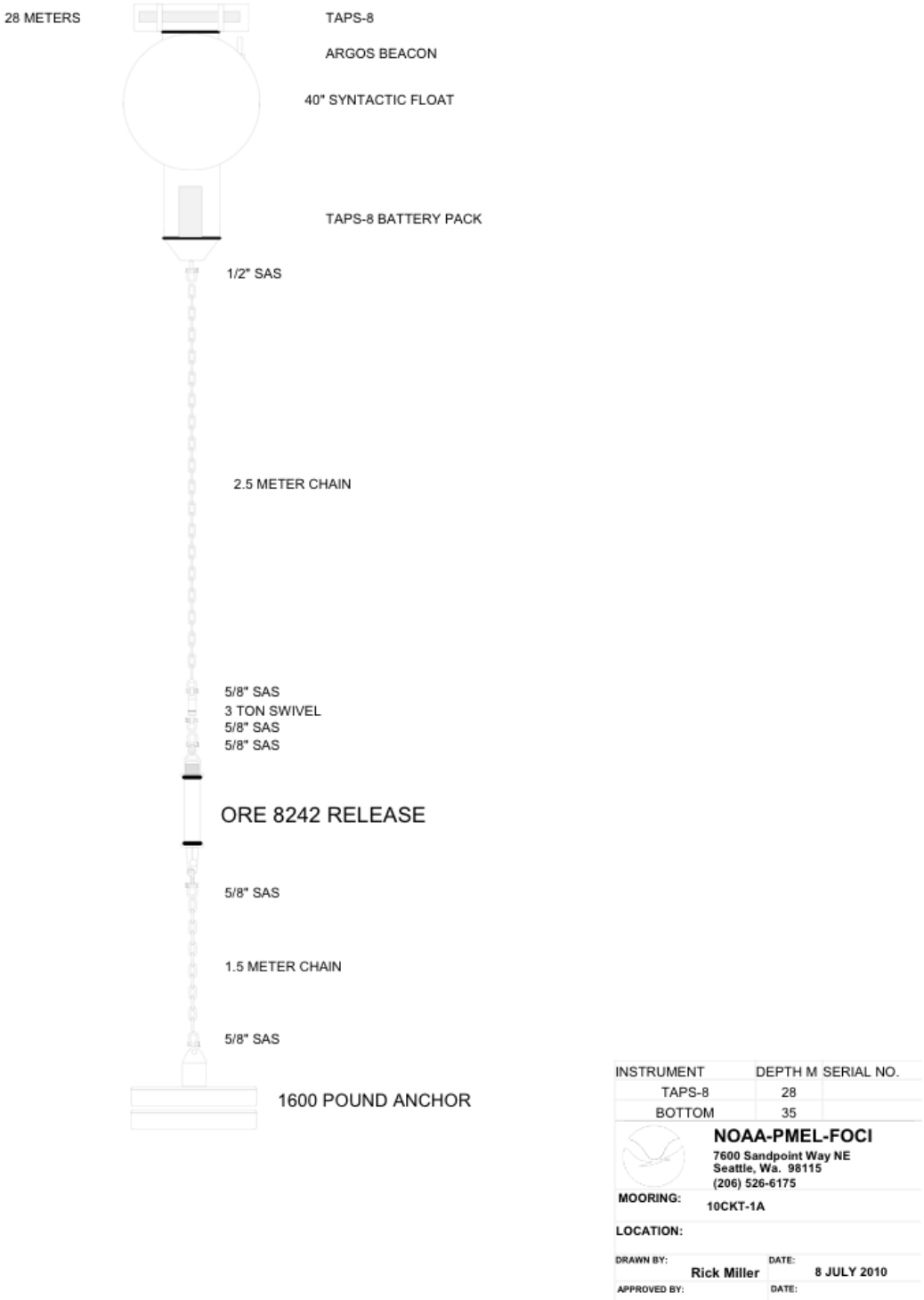



Figure 6. Design for mooring 12CKT. The TAPS-8 is an instrument that acoustically measures zooplankton bio-volume. The TAPS-8 was replaced with the TAPS-6NG in 2012. Small modifications were made to the top float to accommodate this change.