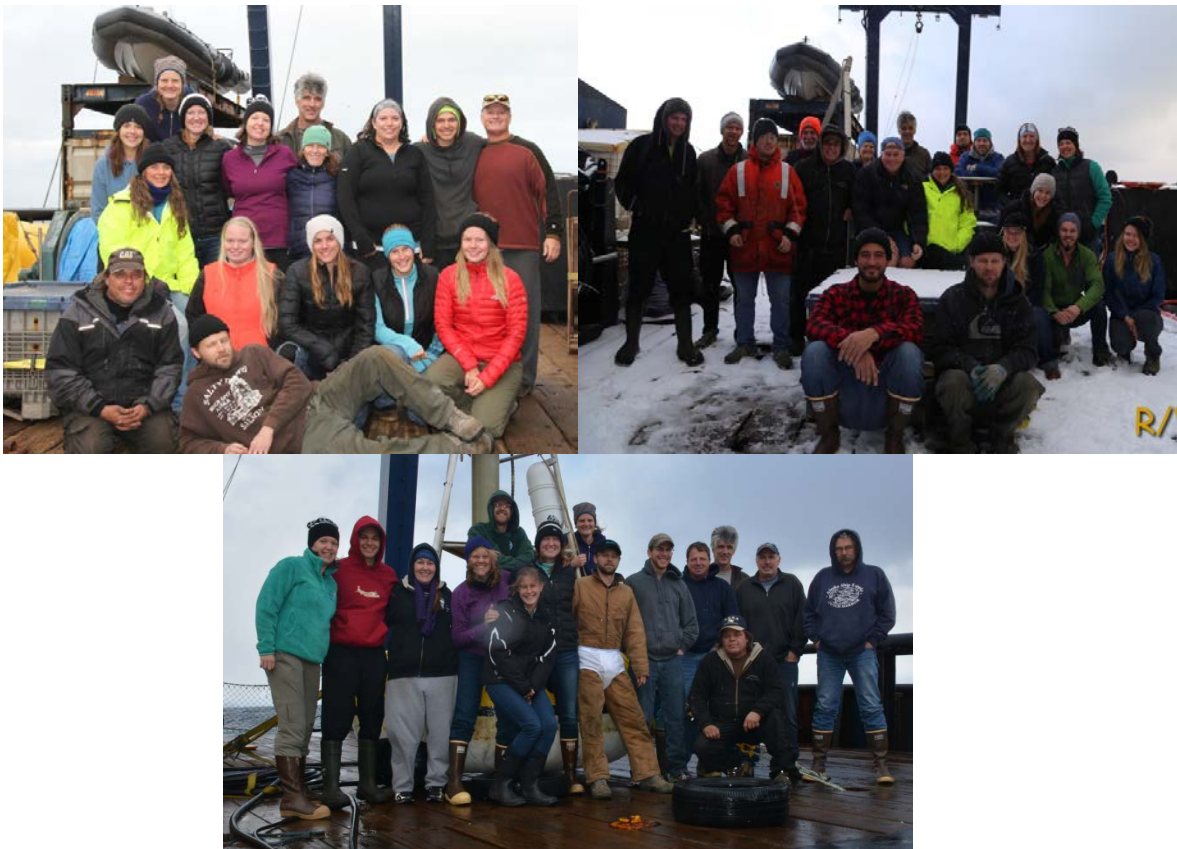


Arctic Whale Ecology Study (ARCWEST)/ Chukchi Acoustics, Oceanography, and Zooplankton Study-extension (CHAOZ-X) 2014 Cruise Report

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SUMMARY

The 2014 Arctic Whale Ecology Study (ARCWEST)/Chukchi Acoustics, Oceanography, and Zooplankton Study-extension (CHAOZ-X) cruise took place on board the R/V *Aquila*. The cruise began in Nome, AK on 7 September 2014 and ended in Dutch Harbor, AK on 20 October 2014. Chief Scientist was Dr. Catherine Berchok, and the survey team consisted of 21 scientists representing nine different laboratories (for full personnel list, see Appendix 1). In summary, a total of 20 passive acoustic and 17 oceanographic moorings were retrieved, and 21 passive acoustic and 27 oceanographic moorings were redeployed. A total of 80 hydrographic and 61 zooplankton stations were conducted, 305 sonobuoys were deployed for 24 hour passive acoustic monitoring, over 1,500 nm surveyed for marine mammals and over 450 nm surveyed for seabirds.

BACKGROUND

The western Arctic physical climate is rapidly changing. The summer Arctic minimum sea ice extent in September 2012 reached a new record of 3.61 million square kilometers, a further 16% reduction from a record set in 2007 (4.30 million square kilometers). This area was more than 50% less than that of two decades ago. The speed of this ice loss was unexpected, as the consensus of the climate research community was that this level of ice reduction would not be seen for another thirty years. As sea temperature, oceanographic currents, and prey availability are altered by climate change, parallel changes in baleen whale species composition, abundance and distribution are expected (and evidenced already by local knowledge and opportunistic sightings). In addition, the observed northward retreat of the minimum extent of summer sea ice has the potential to create opportunities for the expansion of oil and gas-related exploration and development into previously closed seasons and localities in the Alaskan Arctic. It will also open maritime transportation lanes across the Arctic adding (to a potentially dramatic degree) to the ambient noise in the environment. This combination of increasing anthropogenic impacts, coupled with the steadily increasing abundance and related seasonal range expansion by bowhead (*Balaena mysticetus*), gray (*Eschrichtius robustus*), humpback (*Megaptera novaeangliae*) and fin whales (*Balaenoptera physalus*), mandates that more complete information on the year-round presence of large whales is needed in the Chukchi Sea planning area. Timing and location of whale migrations may play an important role in assessing where, when or how exploration or

access to petroleum reserves may be conducted, to mitigate or minimize the impact on protected species.

The ARCWEST study has five component projects: visual observation, satellite tagging, passive acoustics, lower trophic level sampling, and physical oceanographic sampling. Each component project is a technical discipline and is coordinated by a Project Leader with extensive experience in that discipline. Visual surveys, along with sonobuoy deployments, will provide distributional data on baleen whales and other marine mammals. Satellite tagging will provide valuable information on both large- and fine-scale movements and habitat use of baleen whales. Passive acoustic moorings will provide year-round assessments of the seasonal occurrence of baleen whales. Concurrently deployed bio-physical moorings offer the potential of correlating whale distribution with biological and physical oceanographic conditions and indices of potential prey density. Satellite-tracked drifters will examine potential pathways to the areas of high biological importance. Our goal is to use these tools to understand the mechanisms responsible for the high biological activity so that we can predict, in a qualitative way, the effects of climate change on these preferred habitats.

The overall goal of this multi-year IA is to use passive acoustic recorder deployments, visual and passive acoustic surveys, and satellite tagging to explore the distribution and movements of baleen whales in the Bering and Chukchi Seas, particularly the Chukchi Sea planning areas. In addition, oceanographic and lower trophic level sampling and moorings will be used to explore the relationships between currents passing through the Bering Strait and resources delivered to the Barrow Arch area (an area of high bowhead whale and prey concentrations between Wainwright and Smith Bay), and the dynamic nature of those relationships relative to whale distribution and habitat utilization in the eastern Chukchi and extreme western Beaufort Seas.

Although the majority of funding for this cruise came from the ARCWEST Project, some of the funding came from the BOEM-funded Chukchi Acoustics, Oceanography, and Zooplankton Study extension (CHAOZ-X). The focus of CHAOZ-X is to determine the circulation of water around the Hanna Shoal area, the source of this water (Chukchi Shelf or Arctic Basin), the abundance of large planktonic prey at the shoal, and the eventual destination of the water that circulates around the shoal. The dynamic nature of this circulation and prey delivery will be studied relative to whale distribution and habitat utilization in the northeastern Chukchi and extreme western Beaufort Seas. ARCWEST and CHAOZ-X share the same mooring design and sampling strategies (with the exception of satellite tagging which is an ARCWEST-only effort). Thus, the cruise is referred to as the ARCWEST/CHAOZ-X survey.

As in previous years, funding was provided by the Pacific Marine Environmental Laboratory to retrieve and deploy oceanographic moorings in the Bering Sea. Funds were also provided by a NMML grant from the NOAA Science and Technology (S&T)/Ocean Acoustics Program to deploy one AURAL mooring in Norton Sound, as well as from a grant in collaboration with Holger Klinck (PMEL-OSU/CIMRS) to deploy a deep water haruphone mooring to measure ambient noise in the Beaufort Sea.

OBJECTIVES

The specific objectives of the ARCWEST study are:

1. Assess patterns of spatial and temporal use of the Chukchi Sea by endangered bowhead, fin and humpback whales, and beluga and gray whales.
2. Assess the population structure and origin of whales in the region.
3. Evaluate ecological relationships for the species, including physical and biological oceanography that affect critical habitat for these species.
4. Conduct physical and biological oceanographic sampling to further understand the transport and advection of krill and nutrients from the northern Bering Sea through the Bering Strait and to the Barrow Arch area.

The specific objectives of the CHAOZ-X study are:

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

OVERVIEW

An overview of the activities undertaken during the 2014 ARCWEST/CHAOZ-X cruise is represented in Figure 1. Please see the report below for a description of the stations/activities.

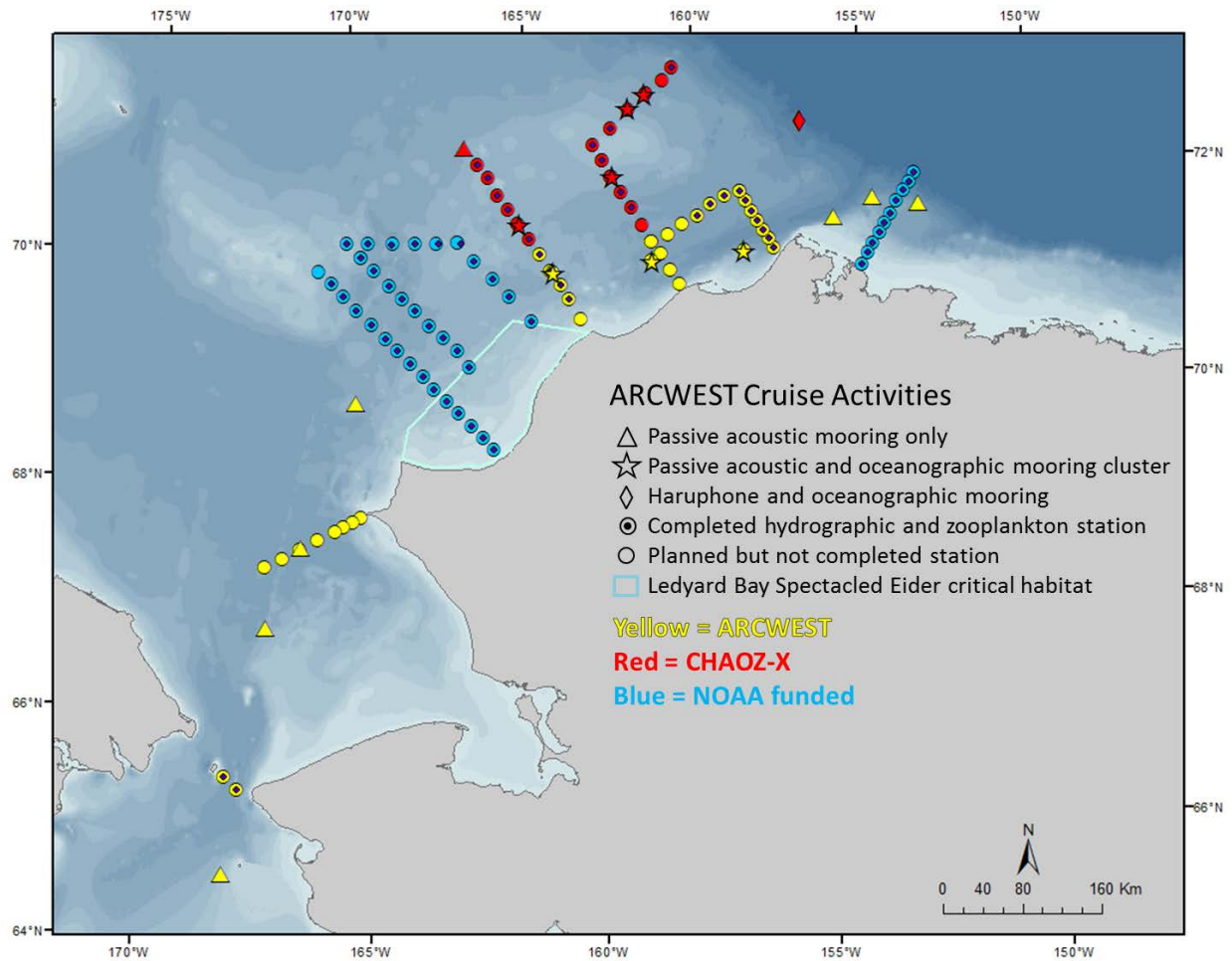


Figure 1. Overview of activities undertaken during the 2014 ARCWEST/CHAOZ-X cruise.

RESULTS

Because this cruise was a joint effort between ARCWEST and CHAOZ-X, we have color-coded the mooring and station maps below with yellow symbols for ARCWEST and red symbols for CHAOZ-X, all other colors represent moorings/stations paid for by other funding sources.

Acoustic Component

Mooring deployments

NMML

All NMML passive acoustic recorder moorings (Figure 2, Appendix 6) use Autonomous Underwater Recorder for Acoustic Listening (AURAL, Multi-Électronique, Rimouski, QC) instruments. These AURALS recorded at a sampling rate of 16 kHz on a duty cycle of 80 minutes of recordings made every 5 hours, for an entire year. This duty cycle staggers the recording loop so that the recording period advances by one hour each



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

day. This overall pattern repeats every six days, producing a large sample size for all time periods equally.

In 2013, 19 AURAL moorings were deployed: 14 for ARCWEST and 5 for CHAOZ-X. In addition, 4 AURAL recorders (funded by ARCWEST) were turned around on non-BOEM, PMEL moorings in the Bering Sea (Table 1 and Figure 4, M2,M4,M5,M8), and one AURAL recorder was deployed under NOAA S&T funds in Norton Sound, for a total of 24 recorders deployed. Two of these moorings in the Bering Sea (AW13_AU_BS3 and M2) were fished up in the fall of 2013. M2 was redeployed in May of 2014, and AW13_AU_BS3 was redeployed in a different location in May as AW14_AU_BS5.

All but one of these moorings were retrieved in 2014. We were unable to retrieve NMML mooring AW14_AU_BS5, despite numerous hours spent searching around the deployment area. We suspect this mooring was accidentally caught in a fishing trawl and dragged to a different location. All moorings were redeployed in 2014 in the same location (Table 1; Figures 3-4).

Table 1. Date and location of passive acoustic mooring deployments. Cluster refers to the oceanographic mooring cluster with which the AURAL is co-located. For Project: AW = ARCWEST, CX = CHAOZ-X, and O = Other.

Moorings Name	Cluster	Latitude	Longitude	Depth (m)	Project	Deployment date	Time (GMT)
AW14_AU_BS4	-	54.42828°	-165.27°	165	AW	10/20/2014	18:12
BS14_AU_02b*	M2	56.87112°	-164.055°	71	AW	10/19/2014	22:16
AW14_AU_BS3	-	57.6714°	-164.719°	64	AW	10/19/2014	10:13
BS14_AU_04b*	M4	57.88235°	-168.879°	70	AW	10/17/2014	21:13
AW14_AU_BS2	-	59.24293°	-169.414°	65	AW	10/17/2014	5:42
BS14_AU_05b*	M5	59.91315°	-171.709°	70	AW	10/16/2014	19:50
BS14_AU_08b*	M8	62.18987°	-174.689°	70	AW	10/15/2014	23:05
AW14_AU_BS1	-	61.58618°	-171.327°	63	AW	10/15/2014	1:25
ST14_AU_NS1	-	63.39978°	-166.241°	24	O	10/14/2014	5:16
NSR-01	C9	72.44955°	-156.602°	859	O	10/1/2014	0:29
AW14_AU_WT1	C4	71.03725°	-160.506°	50	AW	10/10/2014	3:56
CX14_AU_WT2	C6	71.78167°	-161.858°	42	CX	10/4/2014	18:23
CX14_AU_HS2	C8	72.58005°	-161.218°	54	CX	10/2/2014	22:56
CX14_AU_HS1	C7	72.42793°	-161.629°	42	CX	10/2/2014	17:54
AW14_AU_BF3	-	71.68828°	-153.178°	123	AW	9/30/2014	9:38
AW14_AU_BF2	-	71.75083°	-154.465°	109	AW	9/29/2014	14:20
AW14_AU_BF1	-	71.55313°	-155.532°	82	AW	9/29/2014	10:44
AW14_AU_PB1	C5	71.20668°	-158.014°	52	AW	9/29/2014	2:30
CX14_AU_IC3	-	71.83128°	-166.078°	51	CX	9/26/2014	15:05
CX14_AU_IC2	C2	71.21453°	-164.238°	50	CX	9/26/2014	2:58
AW14_AU_IC1	C1	70.82272°	-163.139°	50	AW	9/25/2014	15:32
AW14_AU_CL1	-	69.31735°	-167.63°	59	AW	9/24/2014	15:37
AW14_AU_KZ1	-	67.12355°	-168.604°	51	AW	9/24/2014	7:44
AW14_AU_NM1	-	64.84863°	-168.39°	48	AW	9/21/2014	6:08
AW14_AU_PH1	-	67.90793°	-168.202°	68	AW	9/15/2014	1:45

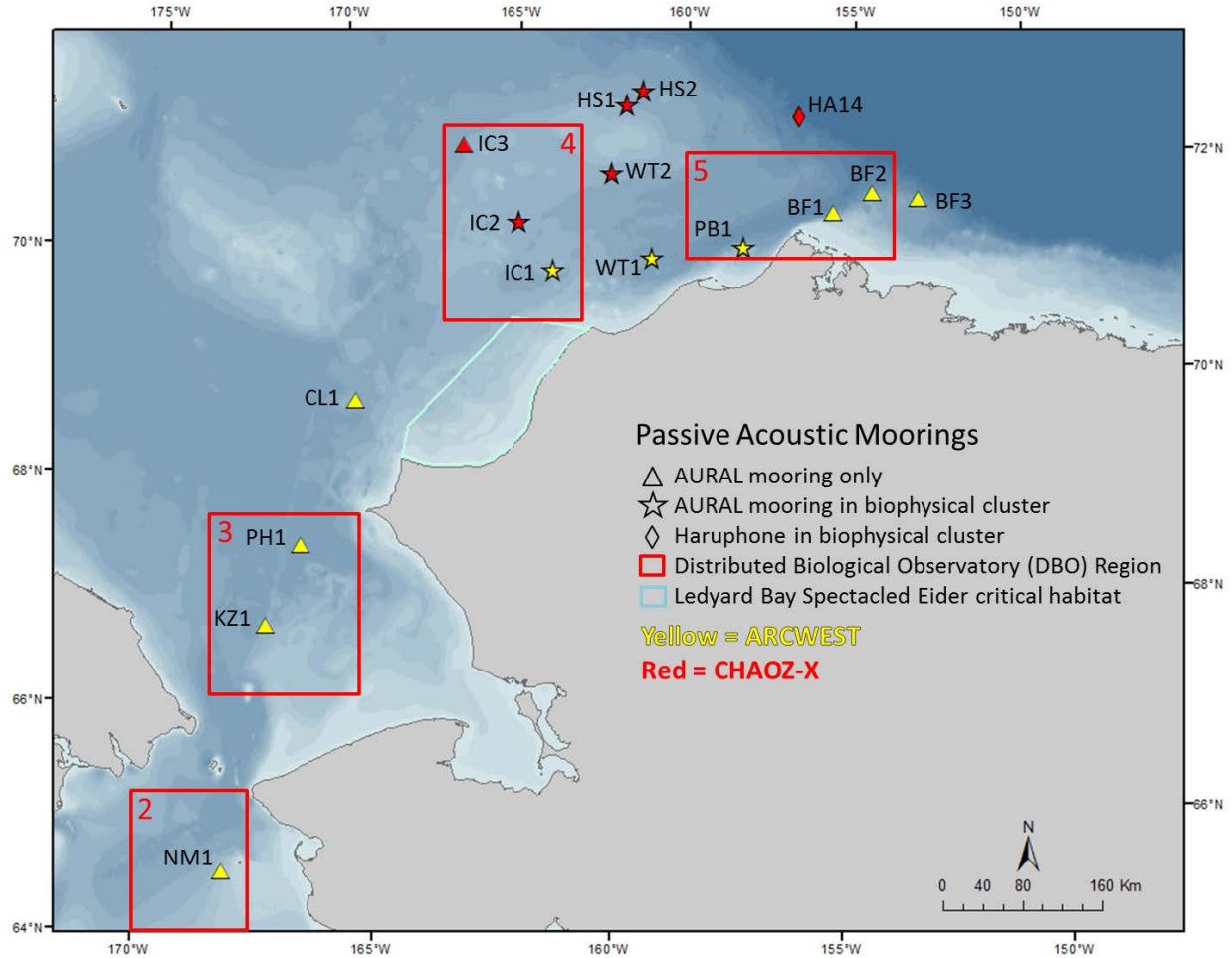


Figure 3. Location of passive acoustic moorings deployed in the Chukchi Sea.

The NMML passive acoustic moorings were spread out to cover as much of the migration routes of our arctic marine mammal species as possible extending from Unimak Pass in the Bering Sea up to 153W (just west of Cape Halkett off Barrow, AK). We also placed our recorders within the eight biophysical mooring clusters (Table 1 & Figure 3) deployed by Stabeno and Napp to allow future correlations to be made between marine mammal calling presence and oceanographic and zooplankton measurements.

We are extremely excited to report that, of the 24 recorders we have extracted data from, 22 recorded for the full year. One recorder in the Beaufort Sea (AW13_AU_BF1) stopped two weeks prior to retrieval (but still lasted over one year), and one in the Chukchi Sea (CX13_AU_WT2) stopped recording after only three months. We suspect the recorders were bumped (perhaps by ice) while the hard drive was spinning, which caused them to fail. One recorder in the Bering Sea (AW13_AU_BS2) did not record at all, which is likely an internal software problem. See Figure A.1 for mooring design.

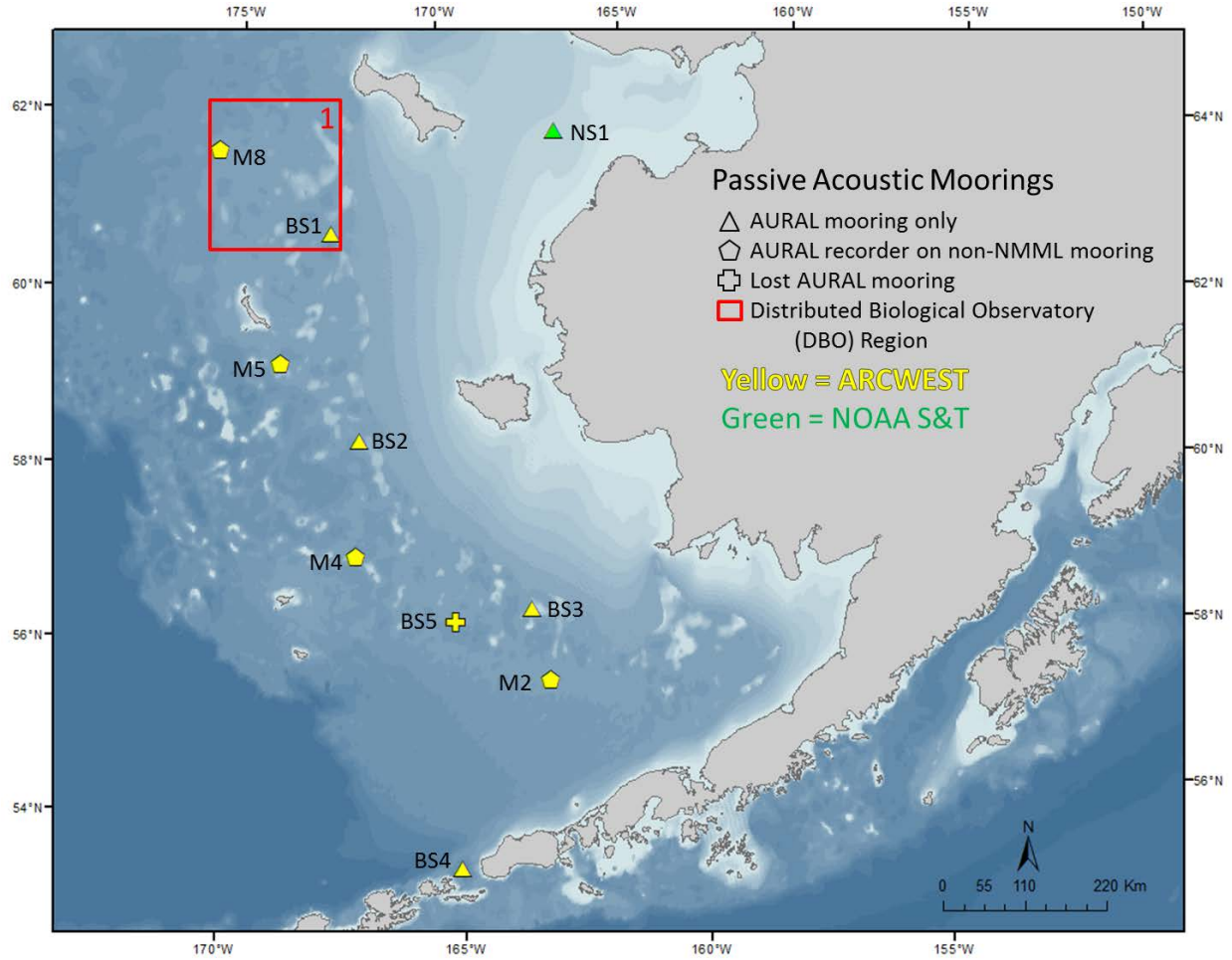


Figure 4. Location of passive acoustic moorings deployed in the Bering Sea.

Cornell

The retrieval and deployment of the Cornell Auto-detection buoy for the CHAOZ-X project was undertaken on another vessel to maximize its deployment time for the season. Details of this deployment, as well as the deployment of their supporting MARU recorder moorings can be found in the October 2014 CHAOZ-X quarterly report.

Other

During the ARCWEST cruise, we serviced a few moorings that were along our route for other projects and/or researchers. We deployed a deep-water haruphone mooring (Figure 3, HA14; Figure 5) that is a NOAA-funded collaborative effort with Holger Klinck (PMEL-OSU/CIMRS) to measure deep water ambient noise throughout the United States EEZ. In the Bering Sea, one day of ship time was funded by a NMML grant from the NOAA S&T, Ocean Acoustics Program to retrieve and redeploy one AURAL mooring in Norton Sound (Figure 4, NS1). Although the primary goal of the Norton Sound mooring is to record beluga calls, data on ambient noise and other marine mammals from that mooring will be used to inform ARCWEST.

The grand total of passive acoustic moorings retrieved and deployed during the ARCWEST survey is therefore 23 and 25, respectively.

Sonobuoy monitoring



Figure 6. Preparing a sonobuoy for deployment.

During the first leg of the survey, when satellite tagging large whales was a priority, sonobuoys were deployed continuously to attempt to localize calling whales (Figure 6). During legs 2 and 3, while transiting, sonobuoys were deployed approximately every 2-3 hours to obtain an evenly-sampled cross-survey census of marine mammal vocalizations. Two types of sonobuoys were used: 77C and 53F. The 53F sonobuoys have either omnidirectional or DiFAR (Directional Frequency Analysis and Recording) capabilities, and the 77C sonobuoys were DiFAR only. When in DiFAR mode, the maximum frequency range is 2.5 kHz, thus the 53F sonobuoys were deployed in omnidirectional mode to achieve full bandwidth when it was not important to get a bearing to the animal. In 2012, we discovered that when we would pull out the top float portion during the sonobuoy programming process, we were inadvertently pulling out the

depth setting pins and disabling the depth setting, which was causing the sonobuoys to deploy to their deepest depth setting of 1000ft. Thus, modifications (taping and tying) had to be made to all sonobuoys to shorten the deployment depth. Furthermore, some of the 53F surplus sonobuoys we receive from the U.S. Navy have dead display batteries, which require replacement with a new battery.

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 7). The omnidirectional antenna was used primarily during the tagging portion of the cruise, as multiple sonobuoys were being monitored simultaneously and the vessel was frequently changing course. The Yagi antenna was used primarily during transit when the sonobuoy was guaranteed to be behind the vessel. The acoustics station in the bridge is shown in Figure 8.

A total of 305 sonobuoys were deployed during the cruise (Appendix 2). Of these, 97 were Sparton 77C's and 208 were 53F's (106 Sparton, 102 Undersea Systems). The overall sonobuoy success rate was lower than in previous years, at 83%.



Figure 7. Sonobuoy antennas placed in the crow's nest.



Figure 8. Acoustic station in the bridge.

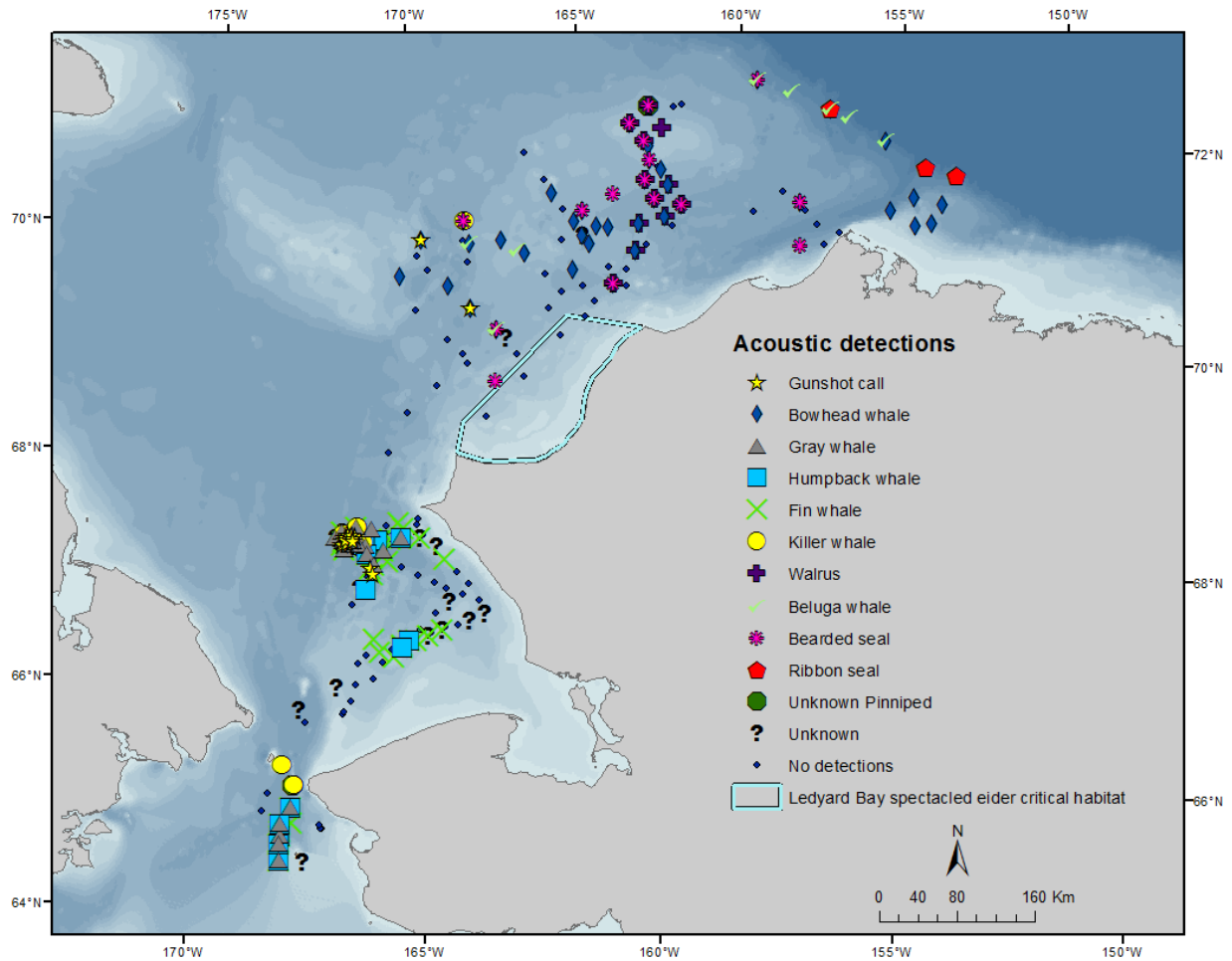


Figure 9. Sonobuoy deployment and acoustic detections in the Chukchi Sea.

The location of the sonobuoys and species detected are shown in Figures 9 and 10 for the Chukchi/Beaufort and Bering Seas respectively. The most common species detected in the Chukchi/Beaufort were fin whales, detected on 25% of sonobuoys, followed by bowhead and gray whales (19% and 17%, respectively), and humpback whales (12%). Other species detected include gunshot calls, walrus, and bearded seals (each 7.6%), killer whales (6.7%), belugas (4%), ribbon seals (1.4%), and a number of unidentified calls (14%). The most common species detected in the Bering Sea were fin whales, detected on 58% of sonobuoys, followed by humpback whales (31%) and gunshot calls (13%). Other species detected include killer whales (9%), right whales (2%), and minke whales (2%).

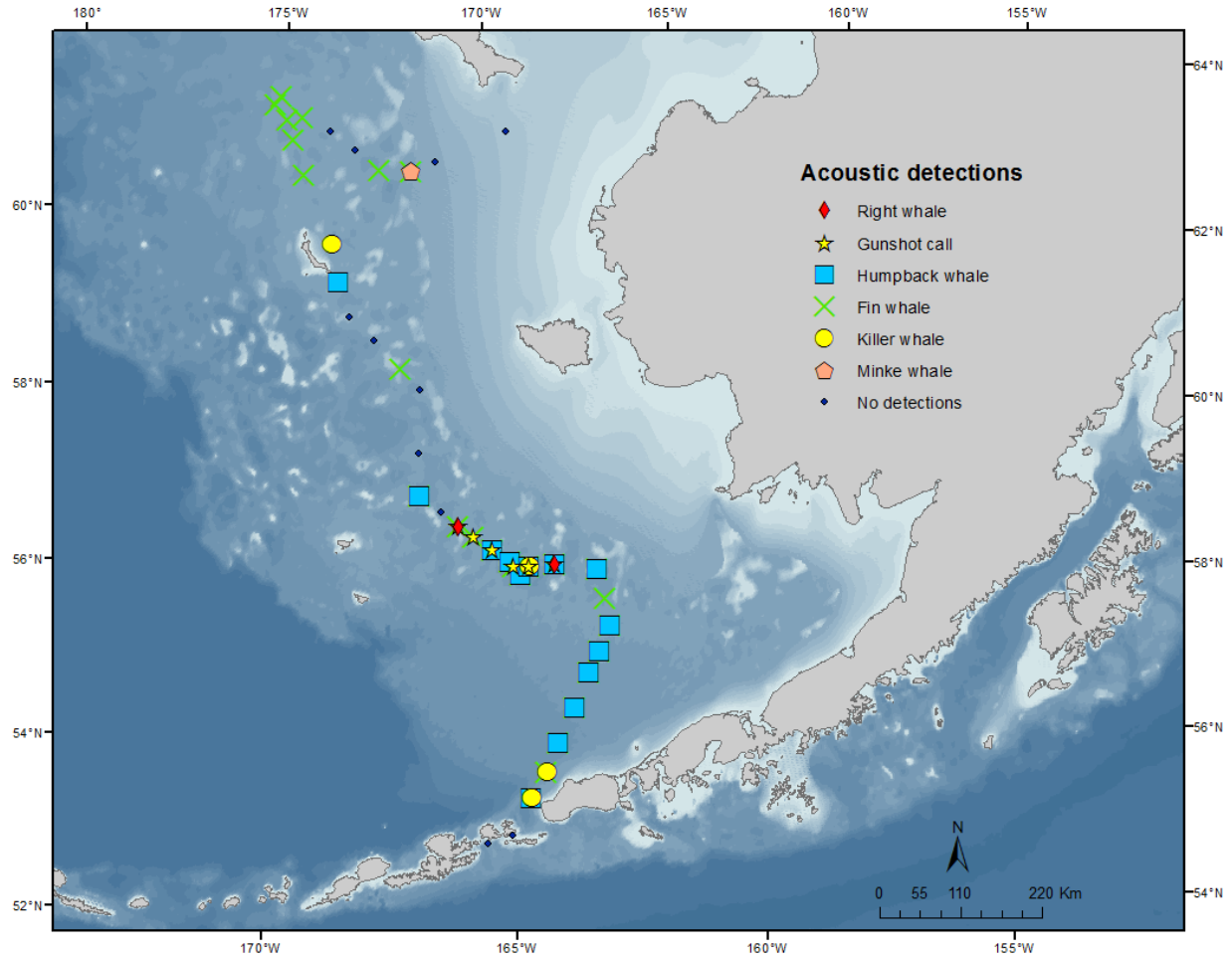


Figure 10. Sonobuoy deployment and acoustic detections in the Bering Sea.

Oceanographic Component

Long-term moorings

All moorings deployed in 2013 for ARCWEST were successfully retrieved, and all were redeployed, in addition to two new clusters. Each cluster consisted of two or three moorings: 1) an “Ice mooring” containing an ASL upward-looking ice profiler and an RCM9 current meter, 2) an RDI ADCP, and a linked set of instruments (Figure 11); a SeaCat, an eco-fluorometer, a par sensor, and an ISUS nitrate meter, and 3) an upward looking TAPS-6NG (Tracor Acoustic Profiling System, Next Generation) instrument to measure zooplankton bio-volume and size distribution. TAPS-6NG assembly consists of a PVC block at



Figure 11. Oceanographic ADCP mooring being deployed.



Figure 12.

the top containing 6 transducers, a 40" syntactic foam ADCP float, an electronic controller pressure case (inside the float) and two PVC pressure cases containing batteries (Figure 12). These instruments are engineered to optimize the detection of krill.

Three mooring clusters were deployed under ARCWEST: C1, C4, and C5 (Table 2, Figure 13). These three clusters each contained all three moorings and were deployed in the same location as the previous year. Five additional mooring clusters were deployed for CHAOZ-X (C2, C6, C7, C8, and C9). Sites C2 and C8 have all three of the moorings listed above, while sites C6 and C7 have only two moorings each. C6 contains the ice profiler and the ADCP current profiler, while C7 contains the TAPS zooplankton mooring and the ADCP. Site C9 contains only the ADCP current profiler, and was deployed in a cluster with the deep-water Haruphone (see Acoustics section above). The moored instruments will collect various oceanographic measurements, including temperature, pressure, depth, salinity, conductivity, and fluorescence for a full year. See the PMEL mooring website (http://www.pmel.noaa.gov/foci/operations/mooring_plans/2013/jun2013_contVes_moorings.html¹) for information on the other instruments placed on each mooring and Appendix 6 for mooring diagrams.

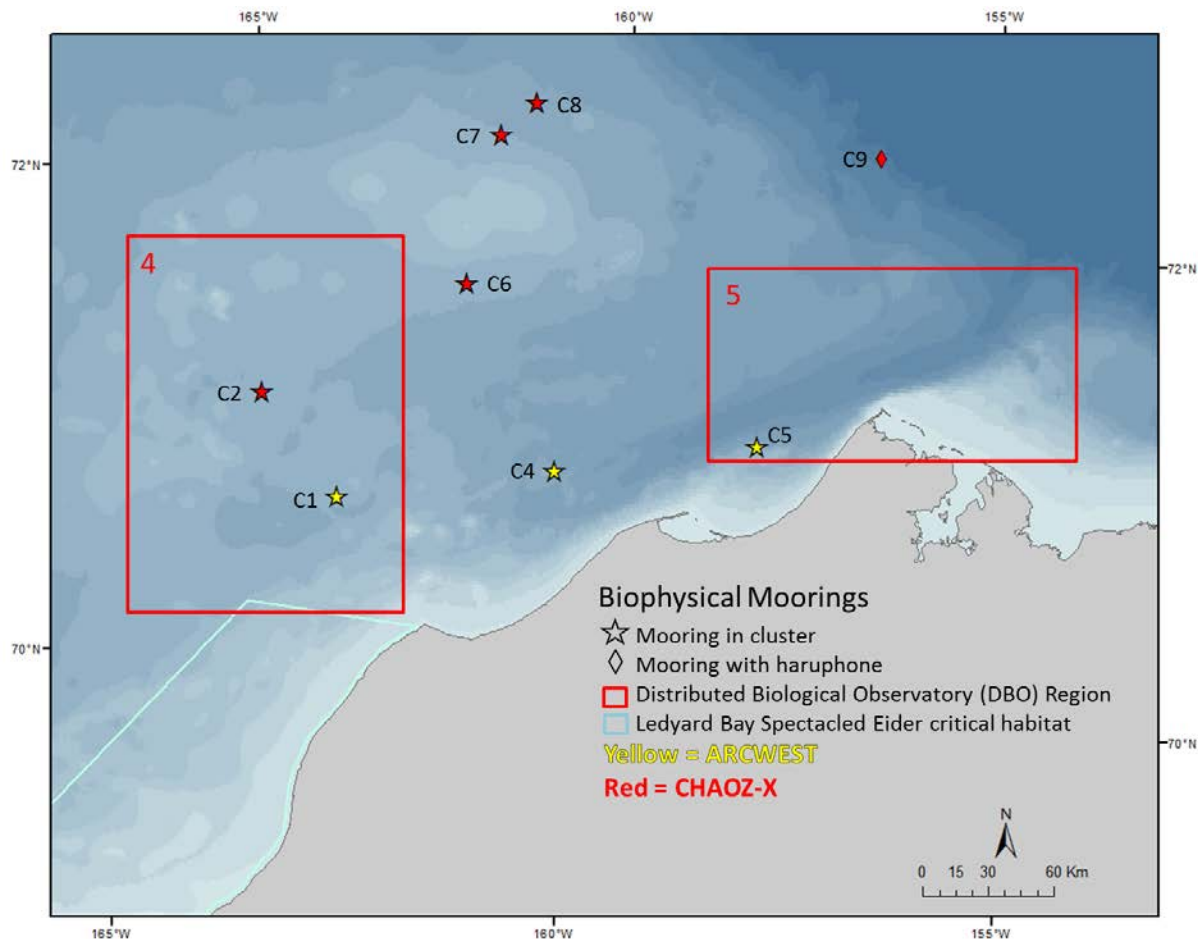


Figure 13. Location of oceanographic mooring clusters deployed in the Chukchi Sea.

¹ On this webpage subsurface moorings relevant to this project are titled 14CK (i.e., Chukchi Sea 2014) and 14BS (i.e., Bering Sea 2014). The number on the end corresponds to the mooring clusters shown in Figure 13 for the Chukchi Sea (e.g., 14CKT-2A corresponds to C2) or Figure 4 for the Bering Sea (e.g., 14BS-2B corresponds to M2).

Table 2. Date and location of oceanographic mooring deployments in the Chukchi Sea. ADCP = Acoustic Doppler Current Profiler; RCM = Recording Current Meter; TAPS = Tracor Acoustic Profiler System. For Project, AW = ARCWEST, CX = CHAOZ-X, O = other.

Mooring Name	Latitude	Longitude	Instrument	Project	Deployment date	Time (GMT)
14CKIP-1A	70.8352°	-163.115°	Ice profiler, RCM	AW	9/25/2014	18:16
14CKT-1A	70.84°	-163.122°	TAPS-8, MC	AW	9/25/2014	19:26
14CKP-1A	70.83068°	-163.119°	ADCP, ISUS, SC/PAR	AW	9/25/2014	18:59
14CKIP-2A	71.22°	-164.24°	Ice profiler, RCM	CX	9/26/2014	5:06
14CKT-2A	71.22963°	-164.213°	TAPS-8, MC	CX	9/26/2014	5:42
14CKP-2A	71.22925°	-164.246°	ADCP, ISUS, SC/PAR	CX	9/26/2014	5:28
14CKIP-4A	71.04067°	-160.517°	Ice profiler, RCM	AW	10/10/2014	4:29
14CKT-4A	71.04023°	-160.495°	TAPS-8, MC	AW	10/10/2014	4:54
14CKP-4A	71.04348°	-160.505°	ADCP, ISUS, SC/PAR	AW	10/10/2014	4:12
14CKT-5A	71.21067°	-158.002°	TAPS-8, MC	AW	9/29/2014	2:57
14CKP-5A	71.20662°	-158.002°	ADCP, ISUS, SC/PAR	AW	9/29/2014	3:13
14CKIP-6A	71.77417°	-161.864°	Ice profiler, RCM	CX	10/4/2014	19:08
14CKP-6A	71.77667°	-161.879°	ADCP, ISUS, SC/PAR	CX	10/4/2014	18:47
14CKT-7A	72.42098°	-161.631°	TAPS-8, MC	CX	10/2/2014	19:15
14CKP-7A	72.42458°	-161.621°	ADCP, ISUS, SC/PAR	CX	10/2/2014	18:39
14CKIP-8A	72.58633°	-161.215°	Ice profiler, RCM	CX	10/2/2014	23:16
14CKT-8A	72.583°	-161.226°	TAPS-8, MC	CX	10/2/2014	22:39
14CKP-8A	72.583°	-161.205°	ADCP, ISUS, SC/PAR	CX	10/2/2014	23:36
14CKP-9A	72.45788°	-156.565°	ADCP, ISUS, SC/PAR	O	10/1/2014	4:28

In addition to the above 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 (M2, M4, M5, M8, Table 3; Figure 4, pentagons). This included the retrieval of the large surface float mooring at M2 (Figure 14).



Figure 14. Oceanographic mooring with surface float.

Table 3. Date and location of oceanographic mooring deployments in the Bering Sea. ADCP = Acoustic Doppler Current Profiler; RCM = Recording Current Meter; PAL = Passive Acoustic Listener

Mooring	Latitude	Longitude	Instrument	Date	Time
13BS-2B	56.8689°	164.0629°	ECO, SC, Ni, RCM9, temp, MC, PCO2	9/13/13	07:45
13BSP-2B	56.8711°	164.0547°	ADCP, AURAL, AWCP, PAL	9/14/13	17:00
13BS-4B	57.8669°	168.8726°	ECO, SC, temp, MC	9/12/13	22:40
13BSP-4B	57.8823°	168.8790°	ADCP, AURAL	9/12/13	03:00
13BS-5B	59.9177°	171.7124°	ECO, SC, temp, MC	8/17/13	02:35
13BSP-5B	59.9132°	171.7089°	ADCP, AURAL, AWCP, PAL	8/17/13	04:40
13BS-8B	62.1951°	174.6833°	ECO, SC, temp, MC	8/18/13	03:28
13BSP-8B	62.1898°	174.6889°	ADCP, AURAL, AWCP	8/18/13	05:08

Hydrography stations

At each mooring site, along numerous transect lines in the Chukchi and Beaufort Seas, and at two sites in the Bering Strait, hydrographic data (temperature, conductivity, nutrients, and chlorophyll a) were collected (Tables 4 and 5, Figures 15 and 16). 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 with water 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.



Figure 15. CTD being deployed.

Table 4. Summary of hydrographic and zooplankton operations

Gear	Number Tows/Casts
Seabird SeaCAT CTD	65
CTD with bottle samples	86
10" inner diameter modified Clarke-Bumpus	65
Mooring deployment or recovery	11
Epibenthic tucker sled	65
Tracor Acoustic Profiler w. 6 frequencies	63

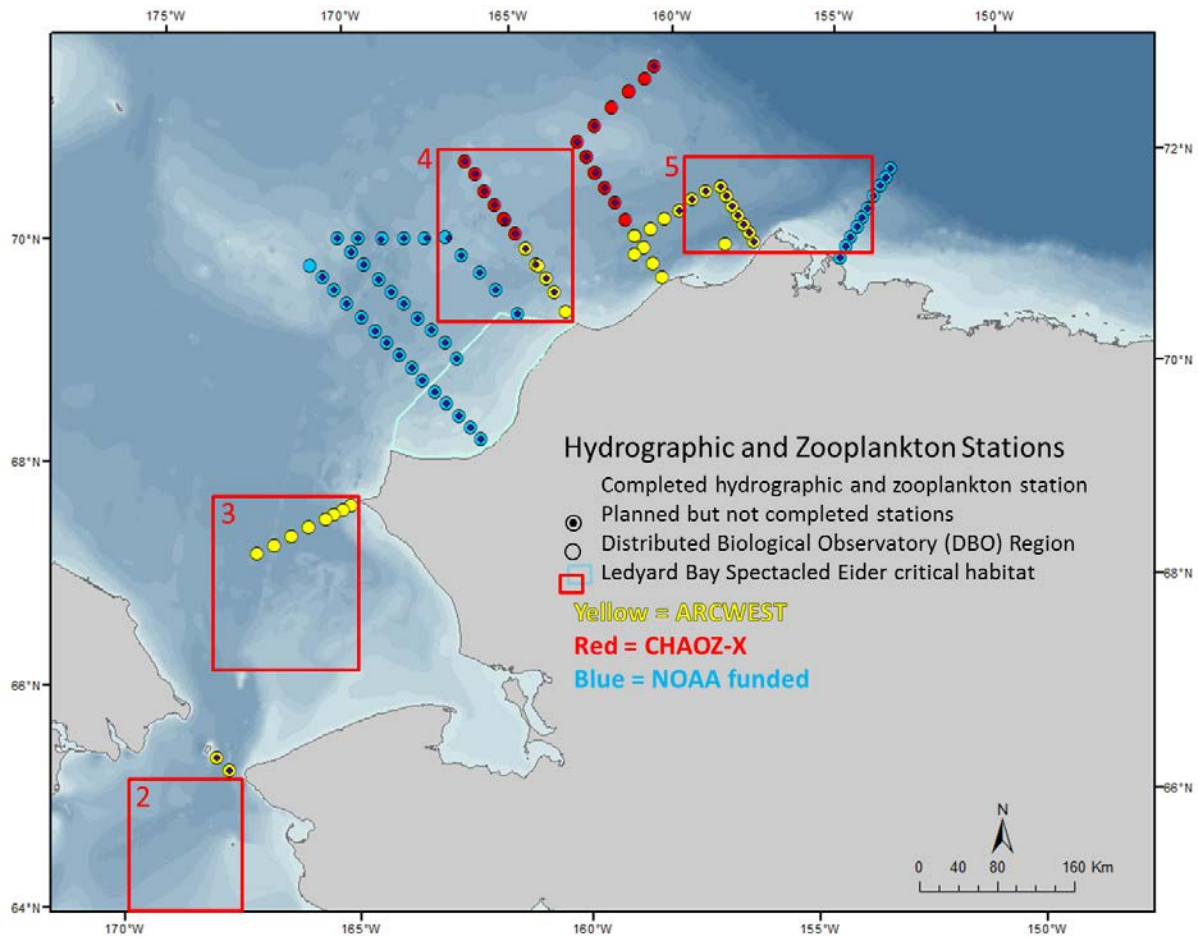


Figure 16. Location of all hydrography and zooplankton stations in the Chukchi Sea.

Table 5. Summary of hydrographic and zooplankton samples

Sample Type	# Tows/Casts	# Samples
Extracted chlorophyll	86	423
SeaBird CTD	86	86
Stimulated fluorescence collected during CTD casts	85	85
Nutrient samples collected from CTD casts	86	438
oxygen samples for CTD probe calibration	85	85
Photosynthetically Active Radiation data collected during CTD casts	86	86
Quantitative tow preserved in formalin	171	225
Salinity sample	27	32
Vertical profule of acoustic backscatter from 6 freq. TAPS	63	63
Zooplankton collected for fatty acids (ZoopFA)	3	15
Zooplankton collected for stable isotopes (ZoopSI)	3	14

Although no drifters were deployed this year, due to the late timing of the cruise, an animation showing drifter tracks and ice extent from previous years can be viewed at the following website under the heading *Chukchi drifters, ice*: http://www.ecofoci.noaa.gov/efoci_drifters.shtml

Zooplankton Component

At 61 stations we also obtained zooplankton samples with a 1 m² epibenthic Tucker sled (Figures 17 and 18). A full report on the CTD and net tow stations can be found in the electronic document entitled “rptCruiseSummary2014.pdf” (referenced in Appendix 3). Two, 500 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 Clarke-Bumpus style net with 150 µm mesh was suspended in the Tucker net that profiled the entire water column. In addition, acoustic measurements of zooplankton backscatter were obtained from the sled with a TAPS-6 instrument mounted on the top of the sled and pointing down into the tow path. 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 were sent to the Polish Plankton Sorting and Identification Center for processing. Zooplankton species data should be available by May of 2014.



Figure 17. Tucker sled with the custom bridal to prevent the wire from twisting.

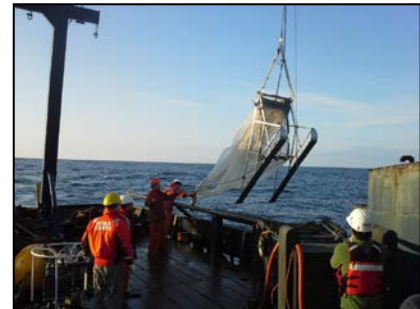


Figure 18. Tucker sled being deployed.

Marine Mammal Component

All operations were performed according to regulations and restrictions specified in the existing permits issued by the NMFS to the National Marine Mammal Laboratory (permit #14245).

Marine mammal observations

During the first leg (satellite tagging), visual effort was conducted by a team of five scientists. A rotating team collected sighting data using standard line-transect methods during on-effort status. Visual operations were conducted to document all marine mammal sightings, but specifically to locate large whales (gray, fin, and humpback whales) for tagging. Operations began at 08:30 and ceased at 22:00, or as long as weather conditions would allow. A full observation period lasted 60 minutes (30 minutes in each position) and was followed by a 60 min rest period. One observer was positioned in front of the wheelhouse. This observer used 25x ‘big-eye’ binoculars with reticles to scan from 90° port to 90° starboard. The data recorder was positioned on the bridge and



Figure 19. Marine mammal observer uses the Big Eye binoculars.

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 the horizontal angle and number of reticles from the horizon of the initial sighting to the recorder. Sighting cue, course and speed, species identity, and best, low, and high estimates of group size were also recorded. The computer program *WinCruz* (<https://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/WinCruz.pdf>) was used to record all sighting, effort and environmental data (e.g., cloud cover, precipitation, and sea conditions). On-effort status was defined as a visibility greater than 2 nautical miles (nmi), Beaufort sea state ≤ 5 , and survey speed of ~ 9 knots through the water. Under unacceptable weather conditions (visibility < 2 nmi 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.

For the second and third leg, visual surveys were conducted by fewer observers: one observer on the second leg and two observers on the third leg. On the second leg, observations occurred between oceanographic stations, mooring sites, and transits between transects. On the third leg, observations were conducted on transits between mooring sites. The observers either stood watch outside using 25x 'big eye' and 7x50 binoculars or inside the wheelhouse using 7x50 binoculars. Environmental conditions for on-effort status were defined the same as the first leg. Daylight decreased rapidly, and by the end of the survey, operations began at 11:00 and ceased around 19:00.

The survey covered a total of 1,663 nm on-effort (Table 6, Figures 21-22). There were a total of 233 sightings (362 individuals) of 8 confirmed marine mammal species; these consisted of bowhead, killer, humpback, gray, and minke whales, harbor porpoise, walrus, and Northern fur seals (Appendix 4, Figures 21-22). Additionally, there were 100 sightings (127 individuals) of unidentified cetaceans and pinnipeds.



Figure 20. Gray whale flukes (photo by Niemeyer)

Table 6. Completed visual effort for the ARCWEST/CHAOZ-X 2014 research cruise.

Survey Leg	Effort (nm)	Effort (km)
Leg 1	417	773
Leg 2	961	1,779
Leg 3	285	528
Total	1,663	3,080

Photo-identification and Satellite Telemetry

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 ARCWEST survey were killer, fin, gray and humpback whales. When the observers located a target species, 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 Nikon D200 and D300 autofocus digital SLR cameras equipped with 80-200 mm zoom lens. All

photographs were reviewed, and the highest quality identification photograph(s) of each animal will be compared to existing photo-identification catalogs from the Bering and Chukchi Seas and along the Aleutian Chain.

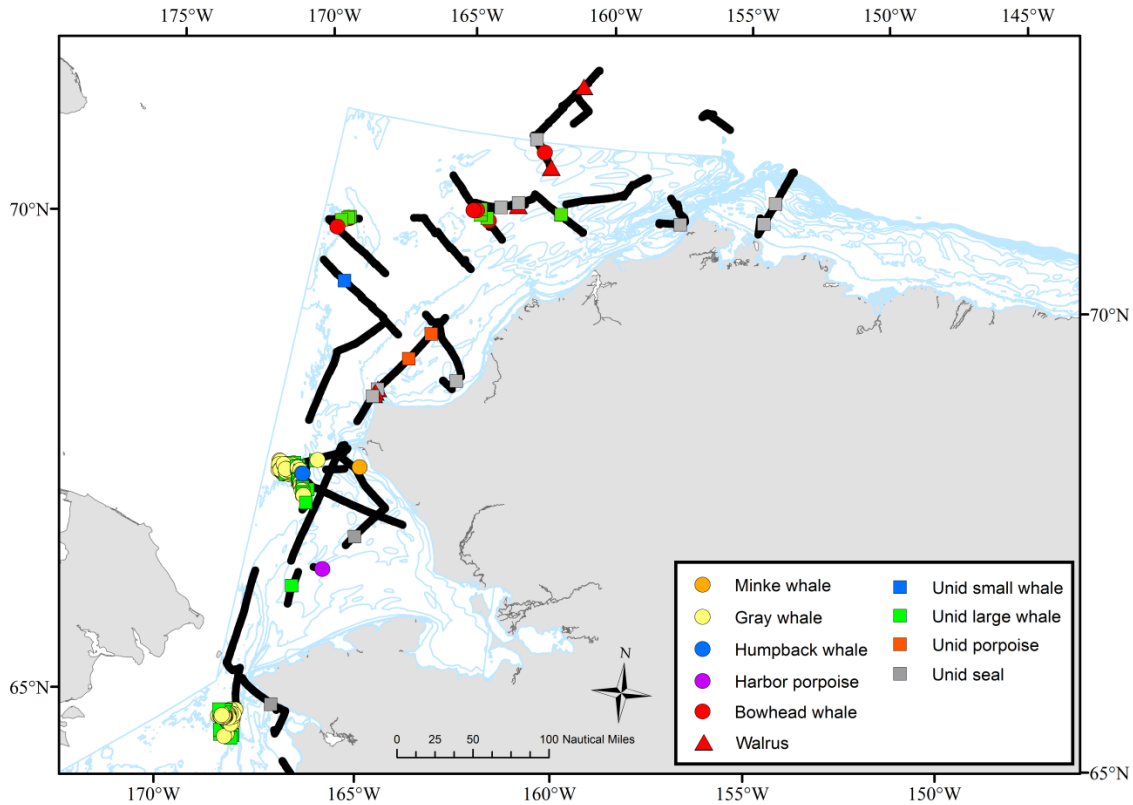


Figure 21. – Marine mammal on-effort sightings and effort data from the ARCWEST/CHAOZ-X 2014 research cruise, Barrow to Bering Strait.

Satellite telemetry operations were the focus of the first leg of this survey. Once a tagging candidate was located during telemetry operations, a 23’ rigid hulled inflatable boat (RHIB) was launched; a coxswain, tagger, data recorder, and photographer were on board during each tagging event. Tagging was to take place from a bow platform with the RHIB positioned approximately 5m perpendicular from the animal. A second RHIB was always deployed to follow the tagging boat as a safety precaution.

Satellite transmitters were to be attached to the body of the whales using an Air Rocket Transmitter System (ARTS), which is a modified marine safety pneumatic line thrower. Whales were to be tagged with the implantable configuration of the SPOT 5 and MK-10a 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 from 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 to be attempted for 20-30min after deployment.

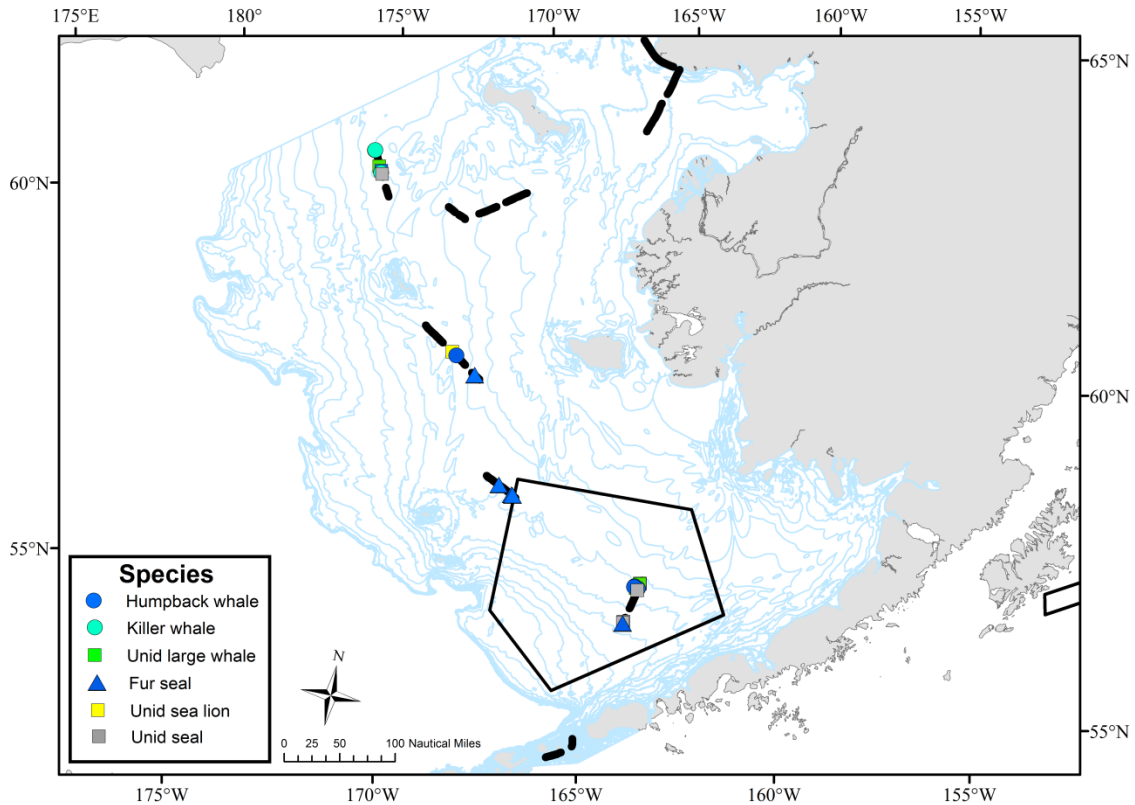


Figure 22. – Marine mammal on-effort sightings and effort data from the ARCWEST/CHAOZ-X 2014 research cruise, Bering Sea.

After departing Nome, AK on the evening of 8 September, 2014, the vessel headed to the last reported sighting of a large aggregation of humpback and fin whales (~ 75 animals) south of Point Hope, AK in the Chukchi Sea from the Aerial Survey of Arctic Marine Mammals project (ASAMM) conducted on 4 September, 2014 (Flight 232). However, after arriving in the area on 10 September, 2014, no animals were visually sighted or acoustically detected (using sonobuoys). We proceeded to the well-known gray whale hotspot located offshore, southwest of Point Hope. As in the previous years, many gray whales were located in this area and we worked this area for much of the tagging leg. For the final few days of the leg, the weather forecast for the Chukchi Sea deteriorated (30+ knot winds), and it was decided to head south with hopes of better weather conditions. We located another large aggregation of gray whales just west of King Island below the Bering Strait.

Inclement weather prevailed throughout a majority of the tagging leg. Small boat operations were hindered by either one or a combination of high sea state, a large persistent ground swell, and fog. The small boat was launched on four days (September 12th, 14th, 15th, and 21st, 2014). The small boat was launched the first two days with the objective of collecting photographs and biopsies. Sea conditions were inadequate for tagging operations. Photographs were collected but close approaches for biopsies

were hindered by conditions. The seas were calm on September 15th; however, thick fog was present. The fog lifted, the boats were launched, and within minutes, the fog closed back in. On the final day, September 21st, winds were switching from the north to the south which provided a 3-hr window of calm sea conditions. However, we were unable to locate any approachable gray whales during this brief window; photographs were collected.

Photographs were obtained from gray, humpback and killer whales. All photos will be matched to existing catalogs and archived for future photo-identification projects. Unfortunately, due to high sea states and uncooperative animals, zero satellite tags were deployed despite every effort by the tagging team. These whales aggressively avoid vessel approaches and were unworkable in the sea states. No biopsies were obtained of any animals.

Seabird observations

Seabird observations were conducted starting in Nome, AK on 23 September and continuing until the following Nome in-port on 12 October. Data collected will be processed and archived into the North Pacific Pelagic Seabird Database (USFWS and USGS, Anchorage, Alaska) and with the Bureau of Ocean Energy Management (BOEM). These surveys were funded by BOEM under project title 'Seabird Distribution and Abundance in the Offshore Environment' (study AK-10-10).

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° arc from the bow to the beam. 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, foraging). During this cruise we occasionally had to reduce the transect window to 200 m or 100 m due to rough seas, and at times we could not survey at all. Survey efforts in the Chukchi and Beaufort Seas were difficult this year due to severe weather, heavy seas, and fog that limited visibility. 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 or on ice, or actively foraging were counted continuously whereas flying birds were recorded during quick 'Scans' of the transect window, with scan intervals based on ship speed (typically about 1 per min). Observations were entered directly into a GPS-integrated laptop computer using the program DLOG3 (A.G. Ford Consultants, Portland, OR). Location data was also recorded automatically at 20 sec intervals, providing continuous records on weather, Beaufort Sea State, ice coverage, glare, and observation conditions.



Figure 23. Seabird observer VanBuskirk.

The observer (Figure 23) conducted 55 transects that covered 909 km during the cruise. The majority of the surveys were conducted in the Chukchi Sea with 50 transects totaling 848 km surveyed. In the western Beaufort Sea and northern Bering Sea, survey effort totaled 5 transects (61 km) and 2 transects (25 km), respectively. In this report we present the total number of marine birds and marine mammals recorded in all regions surveyed. A total of 4,408 marine birds of 25 species were recorded on-transect. Overall, the most common species of marine birds observed were auklets (*Aethia* spp), kittiwakes (*Rissa*

spp), murre (*Uria* spp), and long-tailed ducks (Appendix 5). Planktivorous crested and least auklets accounted for the majority of birds recorded and comprised 66% of total birds observed in 2014. In contrast, during the 2013 ARCWEST cruise, the most abundant species was the short-tailed shearwater (Figure 24a) which comprised 50% of total birds that year. In 2014, short-tailed shearwaters were nearly absent in the study area (Figure 24b) and comprised 2% of total birds observed.

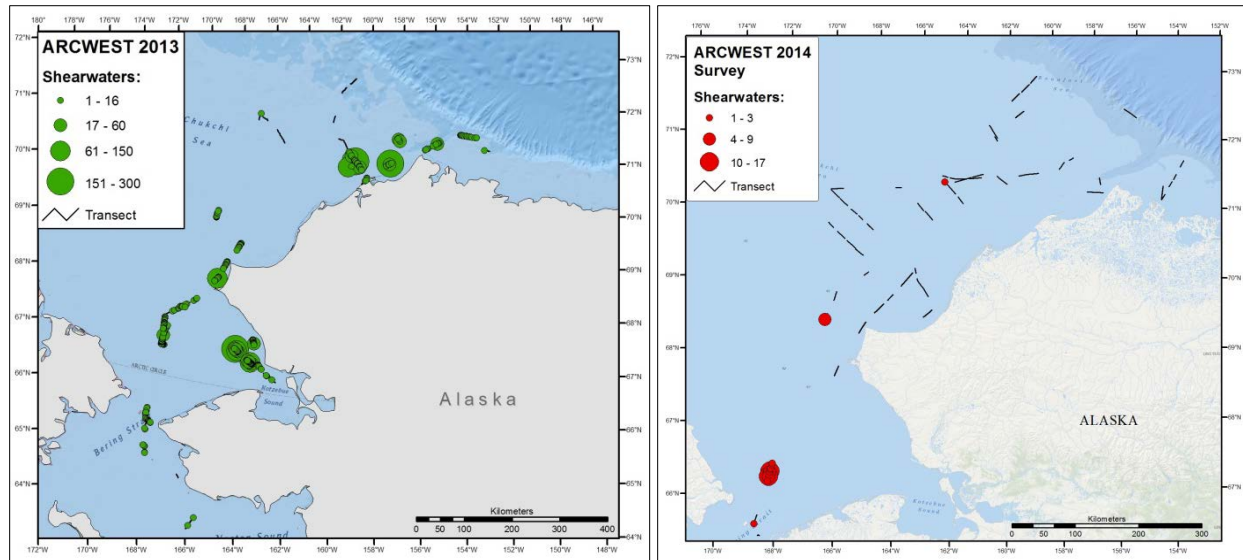
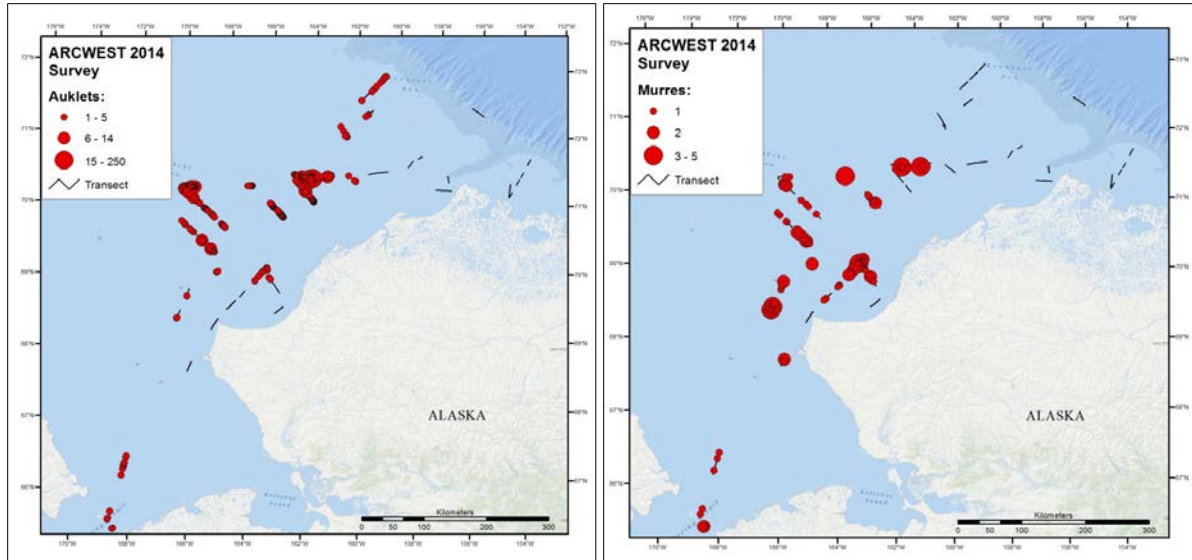


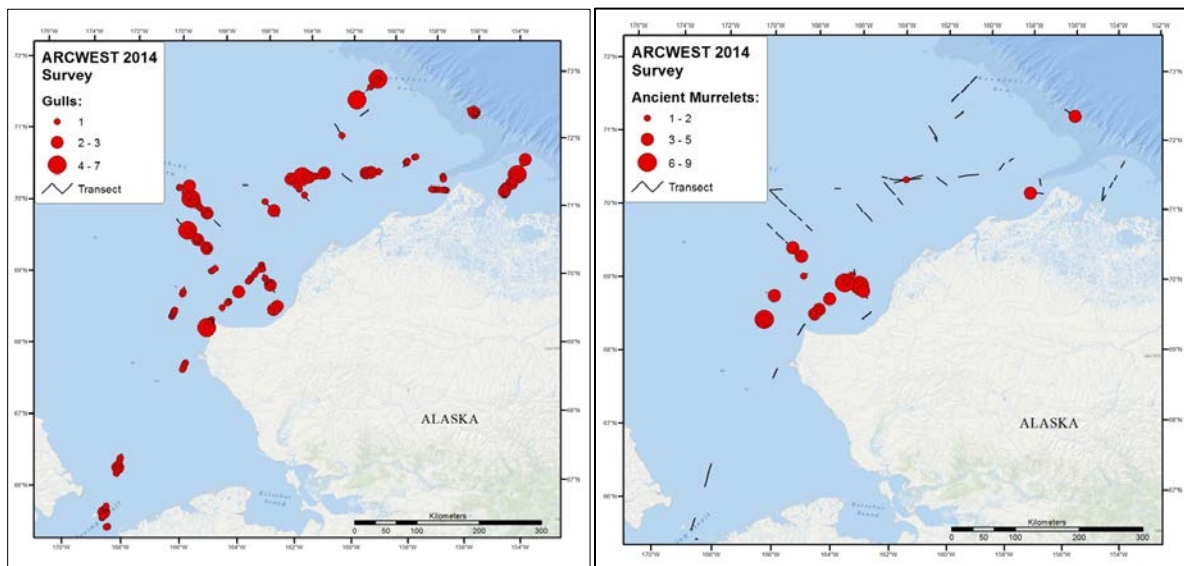
Figure 24a (left) and 24b (right). Shearwater distribution during the 2013 (left) and 2014 (right) ARCWEST cruise.

Aethia auklets occurred from the Bering Strait north to approximately 73N (Figure 25) with the highest concentrations in offshore waters northwest of Cape Lisburne and ~ 140 km northwest of Wainwright, near southern Herald and Hanna shoals, respectively. Near Hanna Shoal, the observer recorded large rafts of (possibly feeding) crested auklets on and off transect; the rafts of auklets ranged from 100 to 300 birds, in the vicinity of 71.09.45N x 163.36.84W. Auklets were absent from surveyed waters west and east of Point Barrow. Thick-billed and common murre were also relatively abundant in the study area and comprised ~6% of total birds recorded. Murre were generally concentrated in the southern and central part of the Chukchi Sea in offshore waters from Point Hope to approximately 71.5N (Figure 26). The distribution and abundance of murre in 2014 was comparable to what was observed in 2013. Gull species, primarily black-legged kittiwakes (~ 6% of total) and glaucous gulls (2%), were the most widely distributed seabirds during our surveys; they were recorded from the Bering Strait to 73N in the Chukchi Sea, and in the western Beaufort Sea (Figure 27). Large numbers of ancient murrelets, which must have migrated from the southern Bering Sea after the breeding season, were also observed, comprising ~3% of total birds (Figure 28).

Spatial and temporal differences in survey coverage may have resulted in the much lower numbers of shearwaters detected in the Chukchi Sea in 2014, although shearwater numbers appeared to be low in two earlier cruises this year. Possibly the later survey period in 2014 (starting about a month later than in 2013) meant that shearwaters had already begun their southward migration to breeding areas in the southern hemisphere. Furthermore, areas that contained high concentrations of shearwaters in 2013, such as Kotzebue Sound and near shore waters west of Barrow, were not surveyed in 2014 (Figure 24b).



Figures 25 (left) and 26 (right). *Aethia* auklets (left) and thick-billed and common murres (right) distribution during the 2014 ARCWEST cruise.



Figures 27 (left) and 28 (right). *Laridae* Gulls (left) and ancient murrelets (right) distribution during the 2014 ARCWEST 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. Only one of these recorders is still in a position to allow for dragging operations. Unfortunately this year we did not have sufficient time to attempt to recover this mooring. We were successful; however, in dragging for the ice profiler mooring (located at the C2 site), that had a faulty acoustic release.

ACKNOWLEDGMENTS

This project would not be possible without funding from the Bureau of Ocean Energy Management (BOEM). Special thanks to Carol Fairfield and Heather Crowley (BOEM) for their continued project support. We also 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 and Edward Rainey (*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	Institution
Chief Scientist (12 Aug–9 Sep) Lead Acoustics	Catherine Berchok	NMML/AFSC
Acoustician	Jessica Crance	NMML/AFSC
Lead Oceanography (22 Sept – 13 Oct)	Dave Rivera	PMEL
Lead Oceanography (13-20 Oct)	Bill Floering (on behalf of Stabeno)	PMEL
Lead Zooplankton	Adam Spear	RACE/AFSC
Lead Visual Operations Senior Mammal Observer	Brenda Rone (on behalf of Zerbini)	NMML/AFSC
Lead Satellite Tagging Mammal Observer Small Boat Officer	Amy Kennedy (on behalf of Zerbini)	NMML/AFSC
Acoustician	Stephanie Grassia	NMML/AFSC
Acoustician	Eliza Ives	NMML/AFSC
Mammal Observer	Jennifer Gatzke	NOAA/NEFSC
Mammal Observer	Misty Niemeyer	IFAW
Mammal Observer	Alex Ulmke	NMML/AFSC
Mammal Observer	Carol Fairfield	BOEM
Oceanography	David Strausz	PMEL
Oceanography	Geoff Lebon	PMEL
Oceanography	Dan Langis	PMEL
Zoo- & Ichthyoplankton	Eric Wisegarver	RACE/AFSC
Zoo- & Ichthyoplankton	Mike Canino	RACE/AFSC
Seabird observer	Raymond VanBuskirk	U.S. Fish and Wildlife Service
Independent acoustician	Chad Smith	Penn State Univ.
Independent oceanographer	Dan Naber	Univ. Alaska Fairbanks

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

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinniped	Ribbon	Beluga	Unknown	
1	9/8/2014	0:38:25	65.24916	-167.6295	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	9/8/2014	0:48:36	65.24833	-167.66183	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	9/8/2014	0:58:07	65.282	-167.69583	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	9/8/2014	8:26:50	66.31818	-167.68652	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	9/8/2014	8:44:49	66.34448	-167.66003	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	9/8/2014	9:39:48	66.42503	-167.58187	27.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	9/8/2014	10:03:12	66.45883	-167.55208	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	9/8/2014	11:24:55	66.61557	-167.53835	32.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	9/8/2014	13:52:05	66.89202	-167.4201	40.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	9/8/2014	15:38:11	67.06028	-167.31723	44.5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11	9/8/2014	16:52:14	66.95053	-167.13022	44	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12	9/8/2014	20:02:46	66.93927	-166.78118	43.2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
13	9/9/2014	0:00:22	67.06397	-166.6424	44	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
14	9/9/2014	0:56:05	67.12952	-166.3494	41	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
15	9/9/2014	1:47:28	67.19	-166.08287	40	0	0	0	0	1	0	0	0	0	0	2	0	0	0	1
16	9/9/2014	2:46:50	67.26095	-165.77472	37	0	0	0	0	1	0	0	0	0	0	2	0	0	0	1
17	9/9/2014	3:48:05	67.33183	-165.45127	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	9/9/2014	4:40:14	67.38883	-165.1939	38	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1
19	9/9/2014	6:22:07	67.48575	-164.85622	38	0	0	0	2	0	0	0	2	0	0	0	0	0	0	1
20	9/9/2014	8:51:40	67.58875	-165.04458	47.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	9/9/2014	10:09:00	67.6209	-165.46203	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	9/9/2014	11:27:09	67.6516	-165.87533	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	9/9/2014	12:25:22	67.68005	-166.18313	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	9/9/2014	13:41:12	67.71723	-166.59038	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	9/9/2014	14:58:13	67.75827	-167.00808	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	9/9/2014	16:03:25	67.7932	-167.3645	65	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
27	9/9/2014	17:21:25	67.8541	-167.74098	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	9/9/2014	17:43:26	67.88625	-167.81757	72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	9/9/2014	18:40:34	67.98687	-167.82008	63.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	9/9/2014	20:59:56	67.93652	-168.26657	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	9/9/2014	21:21:39	67.92553	-168.39017	68	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
32	9/9/2014	22:34:05	67.89993	-168.71658	61	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
33	9/10/2014	5:10:02	67.9698	-168.5816	68	2	0	0	0	1	0	0	1	0	0	0	0	0	0	1
34	9/10/2014	6:43:39	67.88948	-168.51413	63	0	0	0	2	1	1	0	1	0	0	0	0	0	0	1

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown
35	9/10/2014	13:54:56	67.95205	-168.58972	71	0	0	0	0	0	1	0	0	0	0	0	0	0	0
36	9/10/2014	15:09:46	68.00932	-168.53258	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	9/10/2014	19:05:13	67.83122	-168.53017	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	9/10/2014	19:22:48	67.84967	-168.52317	60	1	0	0	0	1	0	0	0	0	0	0	0	0	0
39	9/11/2014	0:45:49	67.89065	-168.40472	65	1	0	0	0	0	1	0	1	0	0	0	0	0	0
40	9/11/2014	3:00:12	67.87342	-168.41418	65	1	0	0	0	1	1	0	1	0	0	0	0	0	0
41	9/11/2014	3:59:10	67.81257	-168.44828	58	0	0	0	0	1	0	0	1	0	0	0	0	0	0
42	9/11/2014	11:38:17	67.81038	-168.37395	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	9/11/2014	13:00:42	67.91213	-168.30192	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	9/11/2014	13:06:36	67.92033	-168.29777	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	9/11/2014	14:11:40	67.94403	-168.2782	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	9/11/2014	14:37:34	67.95465	-168.26238	65	1	0	0	0	2	1	0	1	0	0	0	0	0	1
47	9/11/2014	16:43:17	67.93702	-168.42895	65	1	0	0	0	1	1	0	1	0	0	0	0	0	0
48	9/11/2014	22:47:46	67.94867	-168.2513	67	1	0	0	0	0	1	0	1	0	0	0	0	0	0
49	9/11/2014	23:29:26	67.94662	-168.31088	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	9/12/2014	0:52:37	67.94658	-168.43725	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	9/12/2014	1:01:19	67.94518	-168.4319	65	1	0	0	0	0	0	0	1	0	0	0	0	0	0
52	9/12/2014	7:15:40	67.94418	-168.25423	63	0	0	0	0	0	0	0	1	0	0	0	0	0	0
53	9/12/2014	13:56:11	68.04725	-167.90893	60	0	0	0	0	0	0	0	1	0	0	0	0	0	0
54	9/12/2014	15:03:49	68.10805	-167.58362	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	9/12/2014	16:04:42	68.16627	-167.28545	52	0	0	0	0	1	0	0	0	0	0	0	0	0	0
56	9/12/2014	17:38:25	68.25782	-166.81583	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	9/12/2014	17:58:57	68.29227	-166.74802	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	9/13/2014	12:44:15	68.07767	-166.60472	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	9/13/2014	13:00:50	68.06627	-166.7128	47	0	0	0	2	1	0	0	0	0	0	0	0	0	1
60	9/13/2014	14:07:06	68.02632	-167.15168	59	0	0	0	1	1	0	0	1	0	0	0	0	0	0
61	9/13/2014	15:31:53	67.96612	-167.70122	60	0	0	0	1	1	0	0	0	0	0	0	0	0	0
62	9/13/2014	16:29:50	67.91808	-168.05648	69	0	0	0	1	1	1	0	2	0	0	0	0	0	1
63	9/13/2014	17:46:43	67.8713	-168.32917	68	0	0	0	1	1	1	1	1	0	0	0	0	0	0
64	9/14/2014	1:17:23	68.03645	-168.27113	67	0	0	0	2	1	1	1	1	0	0	0	0	0	1
65	9/14/2014	3:54:26	67.9173	-168.41145	67	0	0	0	1	1	1	1	1	0	0	0	0	0	0
66	9/14/2014	11:50:47	67.91898	-168.46958	70	1	0	0	1	1	0	0	1	0	0	0	0	0	0
67	9/14/2014	13:51:22	67.96072	-168.3575	65	1	0	0	1	1	0	0	1	0	0	0	0	0	0
68	9/14/2014	19:28:01	67.90387	-168.45685	68	1	0	0	1	1	2	2	1	0	0	0	0	0	1

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown
69	9/14/2014	21:45:41	67.92553	-168.30265	67	1	0	0	1	1	2	2	1	0	0	0	0	0	1
70	9/15/2014	3:37:36	67.9136	-168.38648	68	0	0	0	1	1	0	0	0	0	0	0	0	0	0
71	9/15/2014	5:11:37	67.89187	-168.3361	68	0	0	0	1	1	0	0	1	0	0	0	0	0	0
72	9/15/2014	5:56:46	67.9437	-168.3674	70	0	0	0	1	1	0	0	1	0	0	0	0	0	0
73	9/15/2014	13:33:38	67.9552	-168.32098	70	0	0	0	0	1	0	0	1	0	0	0	0	0	0
74	9/15/2014	20:45:59	67.91615	-168.12788	70	0	0	0	1	1	0	0	1	0	0	0	0	0	0
75	9/15/2014	23:40:17	67.88513	-167.96332	73	0	0	0	1	1	0	0	1	0	0	0	0	0	0
76	9/16/2014	4:53:41	67.9326	-168.03042	70	0	0	0	1	1	0	0	2	0	0	0	0	0	1
77	9/16/2014	5:47:01	67.885	-168.12727	71	0	0	0	1	1	0	0	1	0	0	0	0	0	0
78	9/16/2014	12:25:16	67.81577	-167.88478	68	0	0	0	1	1	0	0	1	0	0	0	0	0	0
79	9/16/2014	13:34:02	67.69253	-167.73133	59	1	0	0	0	1	0	0	2	0	0	0	0	0	1
80	9/16/2014	14:03:24	67.63945	-167.66427	60.8	1	0	0	2	1	0	0	2	0	0	0	0	0	1
81	9/16/2014	15:28:21	67.48932	-167.74193	52	0	0	0	1	0	0	0	2	0	0	0	0	0	1
82	9/16/2014	16:48:17	67.35215	-167.91937	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	9/16/2014	16:56:56	67.33755	-167.93878	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	9/16/2014	17:52:15	67.32238	-168.00215	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	9/16/2014	20:37:38	67.48812	-167.90795	56	0	0	0	0	2	0	0	0	0	0	0	0	0	1
86	9/16/2014	22:47:44	67.62273	-167.8057	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	9/17/2014	0:07:15	67.72533	-167.689	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88	9/17/2014	0:17:03	67.73788	-167.67598	57	0	0	0	0	1	0	0	1	0	0	0	0	0	0
89	9/17/2014	1:58:27	67.87382	-167.5304	70	0	0	0	0	1	0	0	1	0	0	0	0	0	0
90	9/17/2014	3:28:46	67.99868	-167.40827	55	0	0	0	0	1	2	0	0	0	0	0	0	0	1
91	9/17/2014	5:13:18	68.11672	-167.15365	50	0	0	0	0	1	0	0	0	0	0	0	0	0	0
92	9/17/2014	7:12:51	68.22898	-166.86088	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	9/17/2014	7:31:14	68.26165	-166.8464	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94	9/17/2014	10:11:06	68.175	-166.8478	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	9/17/2014	12:35:12	68.02225	-166.26832	31.5	0	0	0	0	0	0	0	0	0	0	2	0	0	1
96	9/17/2014	13:52:10	67.91655	-166.02842	45	0	0	0	0	1	0	0	0	0	0	0	0	0	0
97	9/17/2014	15:16:41	67.8162	-165.69372	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	9/17/2014	16:32:47	67.72235	-165.373	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	9/17/2014	18:13:21	67.56007	-165.698	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	9/17/2014	18:26:14	67.53868	-165.73868	46	0	0	0	2	0	0	0	0	0	0	0	0	0	1
101	9/17/2014	19:50:59	67.40082	-166.0009	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102	9/17/2014	21:34:31	67.2289	-166.30458	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown	
103	9/17/2014	23:14:21	67.1124	-166.50222	45	0	0	0	1	1	0	2	2	0	0	0	0	0	0	1
104	9/18/2014	0:10:36	67.04235	-166.63428	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105	9/18/2014	0:13:56	67.03778	-166.64273	43	0	0	0	1	1	0	0	2	0	0	0	0	0	0	1
106	9/18/2014	2:47:43	66.99287	-166.86978	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
107	9/18/2014	4:15:26	66.85803	-167.02523	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108	9/18/2014	5:46:40	66.70215	-167.15693	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109	9/18/2014	9:04:15	66.80772	-167.56632	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	9/18/2014	11:04:56	66.55515	-167.93813	25	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1
111	9/18/2014	14:06:40	66.16977	-168.47247	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112	9/18/2014	18:59:47	65.54663	-168.89648	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113	9/18/2014	19:10:34	65.5299	-168.9083	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
114	9/18/2014	19:23:41	65.50945	-168.92218	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115	9/18/2014	19:55:16	65.46035	-168.95597	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
116	9/18/2014	21:50:43	65.28728	-169.00013	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117	9/20/2014	13:22:22	65.60213	-168.34067	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
118	9/20/2014	16:39:13	65.4613	-168.4219	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119	9/20/2014	17:14:41	65.37785	-168.39077	68	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
120	9/20/2014	18:09:44	65.25037	-168.29618	59	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
121	9/20/2014	19:45:42	65.10252	-168.47865	59	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
122	9/20/2014	22:52:15	64.87812	-168.3961	49	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
123	9/21/2014	1:11:19	65.0332	-168.47688	54	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
124	9/21/2014	3:32:55	65.19955	-168.53748	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125	9/21/2014	3:47:46	65.21825	-168.53683	56	0	0	0	1	1	0	2	1	0	0	0	0	0	0	1
126	9/21/2014	14:05:29	65.14485	-168.49293	56	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
127	9/21/2014	21:02:01	64.91367	-167.88528	42	0	0	0	2	0	0	0	2	0	0	0	0	0	0	1
128	9/23/2014	7:19:56	65.5903	-168.42928	58	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
129	9/23/2014	14:53:09	65.74665	-168.80177	60	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
130	9/23/2014	17:41:23	66.2332	-168.6807	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	9/23/2014	17:56:53	66.27773	-168.66828	63	0	0	2	2	0	0	0	2	0	0	0	0	0	0	1
132	9/23/2014	21:03:00	67.79963	-168.59798	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133	9/24/2014	1:59:03	67.44092	-168.46285	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
134	9/24/2014	5:07:54	67.90963	-168.30482	67	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
135	9/24/2014	8:02:24	68.3503	-168.10998	62	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
136	9/24/2014	10:56:43	68.77892	-167.8976	56	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown
137	9/24/2014	13:39:49	69.17498	-167.65145	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138	9/24/2014	17:32:12	69.478	-167.02725	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139	9/24/2014	19:59:07	69.7342	-166.35355	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140	9/24/2014	22:58:43	70.04295	-165.49868	47	0	0	0	0	0	0	2	0	0	0	0	0	0	1
141	9/25/2014	2:20:04	70.37892	-164.4982	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
142	9/25/2014	5:04:22	70.63477	-163.69475	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
143	9/25/2014	14:47:47	70.83043	-163.03148	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144	9/25/2014	14:53:44	70.84068	-163.06077	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	9/25/2014	17:15:02	71.0722	-163.787	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	9/25/2014	17:32:17	71.10033	-163.88463	48	0	0	1	0	0	2	0	0	0	0	0	0	0	1
147	9/26/2014	2:05:14	71.43897	-164.88165	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148	9/26/2014	2:12:20	71.45228	-164.9202	48	0	0	1	0	0	0	0	0	0	0	0	0	0	0
149	9/26/2014	5:14:31	71.77953	-165.8834	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	9/26/2014	11:03:07	71.55913	-165.19138	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	9/26/2014	14:43:36	71.31203	-164.54675	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152	9/26/2014	19:06:19	71.05427	-163.71445	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153	9/26/2014	19:17:34	71.03605	-163.67425	50	0	0	1	0	0	0	0	2	0	0	0	0	0	0
154	9/26/2014	23:10:41	70.77872	-163.99273	49	0	0	1	0	0	0	0	0	0	0	0	0	0	0
155	9/27/2014	2:13:39	70.69048	-162.4958	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	9/27/2014	5:12:31	71.03562	-162.37638	52	0	0	1	0	0	0	1	0	0	0	0	0	0	0
157	9/27/2014	8:16:19	71.29285	-161.46938	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
158	9/27/2014	8:25:44	71.30628	-161.44163	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159	9/27/2014	10:57:58	71.39755	-160.5635	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	9/27/2014	11:16:42	71.40413	-160.45088	56	0	0	2	0	0	0	0	0	0	0	0	0	0	0
161	9/27/2014	16:10:48	71.50492	-159.23013	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162	9/27/2014	16:14:39	71.50607	-159.2175	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
163	9/27/2014	20:13:51	71.72082	-158.42888	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164	9/27/2014	23:10:57	71.65407	-157.94795	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165	9/27/2014	23:17:59	71.64177	-157.92663	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	9/27/2014	23:26:38	71.62512	-157.89808	71	0	0	1	0	0	0	0	0	1	0	0	0	0	0
167	9/28/2014	8:10:32	71.55407	-157.76252	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168	9/28/2014	11:13:56	71.42137	-157.42178	142	0	0	0	0	0	0	0	0	0	0	0	0	0	0
169	9/28/2014	14:08:36	71.24467	-157.16623	98	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	9/28/2014	20:08:21	71.21413	-157.88433	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown
171	9/28/2014	20:14:09	71.21467	-157.83898	54	0	0	0	0	0	2	0	0	1	0	0	0	0	0
172	9/28/2014	22:58:25	71.35375	-156.77752	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0
173	9/29/2014	3:20:00	71.58837	-155.32648	93	0	0	1	0	0	0	0	0	0	0	0	0	0	0
174	9/29/2014	5:02:20	71.70908	-154.67828	78	0	0	1	0	0	0	0	0	0	0	0	0	0	0
175	9/29/2014	8:32:59	71.43727	-154.62293	32	0	0	1	0	0	0	0	0	0	0	0	0	0	0
176	9/29/2014	15:09:48	71.46625	-154.15602	48	0	0	1	0	0	0	0	0	0	0	0	0	0	0
177	9/29/2014	17:20:52	71.6408	-153.877	55	0	0	1	0	0	0	0	0	0	0	0	0	0	0
178	9/29/2014	21:20:44	71.90533	-153.4441	1250	0	0	0	0	0	0	0	0	0	0	0	1	0	0
179	9/30/2014	2:11:50	71.72632	-153.32365	137	0	0	2	0	0	0	0	0	0	0	0	2	0	0
180	9/30/2014	5:10:13	71.97513	-154.2918	358	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	9/30/2014	5:17:29	71.9867	-154.33702	600	0	0	0	0	0	0	0	0	0	0	0	1	0	0
182	9/30/2014	8:16:55	72.24033	-155.51385	370	0	0	1	0	0	0	0	0	0	0	2	0	1	0
183	9/30/2014	11:15:00	72.4532	-156.59482	950	0	0	0	0	0	0	0	0	0	0	0	0	1	0
184	9/30/2014	22:55:30	72.52142	-157.15568	320	0	0	1	0	0	0	0	0	0	0	0	1	1	0
185	10/1/2014	2:02:51	72.66867	-158.33022	250	0	0	0	0	0	0	0	0	0	0	0	0	1	0
186	10/1/2014	5:10:32	72.76253	-159.40488	143	0	0	0	0	0	0	0	0	0	0	0	0	0	0
187	10/1/2014	5:16:54	72.76319	-159.40531	138	0	0	1	0	0	0	0	0	1	0	0	0	1	0
188	10/1/2014	7:57:39	72.8432	-160.24037	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0
189	10/1/2014	11:39:04	72.71708	-160.84918	60	0	0	0	0	0	0	0	0	0	0	2	0	0	0
190	10/1/2014	14:13:09	72.725	-161.48692	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	10/1/2014	17:48:43	72.2123	-162.07155	34	0	0	2	0	0	0	1	0	2	0	0	0	0	0
192	10/1/2014	20:01:31	72.06355	-162.52163	40	0	0	1	0	0	0	1	0	1	0	0	0	0	0
193	10/1/2014	23:01:01	72.21432	-163.0002	42	0	0	1	0	0	0	1	0	1	0	0	0	0	0
194	10/2/2014	5:08:42	72.40797	-162.54423	45	0	0	1	0	0	0	1	0	1	0	1	0	0	0
195	10/2/2014	8:21:06	72.42572	-161.82067	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	10/2/2014	12:08:10	72.44753	-161.57877	49	0	0	2	0	0	0	0	0	0	0	0	0	0	0
197	10/2/2014	18:15:42	72.4046	-160.7048	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198	10/2/2014	19:12:13	72.30483	-161.00532	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199	10/2/2014	19:23:53	72.28343	-161.07143	40	0	0	2	0	0	0	0	0	2	0	0	0	0	0
200	10/2/2014	22:58:46	71.89392	-162.30762	40	0	0	1	0	0	0	0	0	1	0	0	0	0	0
201	10/3/2014	1:59:04	71.53535	-163.20393	47	0	0	0	0	0	0	0	0	1	0	0	0	0	0
202	10/3/2014	5:09:11	71.33727	-163.98373	50	0	0	1	0	0	0	0	0	1	0	0	0	0	0
203	10/3/2014	15:20:17	71.22127	-164.15992	49	0	0	1	0	0	0	0	0	0	0	0	0	0	0
204	10/3/2014	17:10:51	71.20793	-163.5412	19	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown
205	10/3/2014	20:17:42	71.28555	-162.3763	51	0	0	1	0	0	0	1	0	0	0	0	0	0	0
206	10/3/2014	21:57:55	71.37802	-161.66498	50	0	0	1	0	0	0	1	0	0	0	0	0	0	0
207	10/4/2014	1:58:21	71.53115	-162.03245	50	0	0	1	0	0	0	1	0	1	0	0	0	0	0
208	10/4/2014	5:10:30	71.70035	-162.35922	47	0	0	1	0	0	0	1	0	1	0	0	0	0	0
209	10/4/2014	12:58:48	71.817	-161.93885	43	0	0	1	0	0	0	0	0	0	0	0	0	0	0
210	10/4/2014	15:32:23	72.02577	-162.38653	37	0	0	1	0	0	0	0	0	0	0	0	0	0	0
211	10/4/2014	18:18:47	71.84492	-162.03323	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
212	10/4/2014	20:08:03	71.68608	-161.66615	50	0	0	1	0	0	0	1	0	0	0	0	0	0	0
213	10/4/2014	22:59:23	71.50758	-161.26783	54	0	0	1	0	0	0	1	0	1	0	0	0	0	0
214	10/5/2014	2:07:23	71.09898	-162.11122	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
215	10/5/2014	5:11:40	70.6969	-162.85657	45	0	0	1	0	0	0	1	0	1	0	0	0	0	0
216	10/5/2014	8:31:14	70.35615	-163.50027	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0
217	10/5/2014	12:59:03	70.54617	-164.22312	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0
218	10/5/2014	15:04:30	70.6857	-164.74995	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
219	10/5/2014	17:28:47	70.82085	-165.306	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	10/5/2014	17:47:30	70.85173	-165.38867	47	0	0	1	0	0	0	0	0	0	0	0	0	0	0
221	10/5/2014	20:09:30	70.94005	-166.06848	47	0	0	1	0	0	0	0	0	0	0	0	0	0	0
222	10/5/2014	23:41:11	70.85133	-166.92073	51	0	0	1	0	0	0	0	0	0	0	0	0	1	0
223	10/6/2014	5:12:16	71.0455	-167.20937	49	0	0	1	0	0	1	0	0	1	0	0	0	2	0
224	10/6/2014	8:19:03	70.85795	-167.11388	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
225	10/6/2014	11:39:39	70.78307	-168.22165	45	1	0	1	0	0	0	0	0	0	0	0	0	0	0
226	10/6/2014	14:44:37	70.62592	-168.26487	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
227	10/6/2014	17:46:38	70.42937	-167.3062	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0
228	10/6/2014	17:54:30	70.41698	-167.25732	56	0	0	1	0	0	0	0	0	0	0	0	0	0	0
229	10/6/2014	20:31:07	70.25613	-166.5616	52	1	0	1	0	0	0	2	0	0	0	0	0	0	0
230	10/6/2014	23:40:40	70.08508	-165.75067	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
231	10/6/2014	23:47:35	70.09482	-165.75867	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
232	10/6/2014	23:56:05	70.10727	-165.76917	50	0	0	1	0	0	0	0	0	1	0	0	0	1	0
233	10/7/2014	9:58:24	69.90332	-165.14065	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0
234	10/7/2014	14:04:18	69.58542	-164.28477	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
235	10/8/2014	0:40:55	69.55445	-165.60423	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0
236	10/8/2014	0:46:57	69.5611	-165.63302	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0
237	10/8/2014	0:56:13	69.56413	-165.66208	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
238	10/8/2014	5:15:02	69.6199	-165.54627	40	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown
239	10/8/2014	11:01:57	69.74258	-166.30545	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0
240	10/8/2014	12:13:07	69.81617	-166.5454	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
241	10/8/2014	13:59:27	69.92103	-167.01532	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
242	10/8/2014	17:05:42	70.12748	-167.95082	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0
243	10/8/2014	17:09:06	70.13215	-167.97325	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0
244	10/8/2014	21:46:10	70.4128	-168.56905	46	0	0	1	0	0	0	0	0	0	0	0	0	0	0
245	10/8/2014	23:28:52	70.51833	-167.89122	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
246	10/9/2014	2:06:09	70.67222	-166.88562	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
247	10/9/2014	5:21:44	70.85978	-165.5937	47	0	0	0	0	0	0	0	0	0	0	0	0	1	0
248	10/9/2014	8:03:33	71.02728	-164.4955	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0
249	10/9/2014	8:11:42	71.0354	-164.43922	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	10/9/2014	11:03:58	71.21838	-163.21148	51	0	0	1	0	0	0	0	0	0	0	0	0	0	0
251	10/9/2014	13:57:48	71.39522	-162.1537	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
252	10/10/2014	2:27:37	70.85572	-162.53798	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0
253	10/10/2014	2:35:59	70.83845	-162.57428	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
254	10/10/2014	5:04:48	70.53138	-163.24772	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
255	10/10/2014	5:14:46	70.51088	-163.29352	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
256	10/10/2014	8:09:20	70.14607	-164.08257	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0
257	10/10/2014	11:15:11	69.73033	-164.82918	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
258	10/10/2014	11:23:55	69.71058	-164.86318	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
259	10/10/2014	14:39:23	69.27833	-165.6467	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
260	10/10/2014	16:24:51	69.05163	-166.09918	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
261	10/14/2014	7:13:32	62.46403	-168.78328	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0
262	10/14/2014	10:01:31	62.2125	-169.55665	45	0	0	0	0	0	0	0	0	0	0	0	0	2	0
263	10/14/2014	12:59:10	61.93325	-170.33027	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
264	10/14/2014	13:09:02	61.91808	-170.37025	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0
265	10/14/2014	15:18:16	61.7311	-170.90095	59	0	0	0	0	1	0	0	0	0	1	0	0	0	0
266	10/14/2014	19:01:13	61.65023	-171.70168	66	0	0	0	0	1	0	0	0	0	0	0	0	0	0
267	10/14/2014	22:01:59	61.7941	-172.44152	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
268	10/15/2014	1:00:33	61.9343	-173.19715	72	0	0	0	0	0	0	0	0	0	0	0	0	0	0
269	10/15/2014	3:59:57	62.00093	-173.95117	78	0	0	0	0	1	0	0	0	0	0	0	0	0	0
270	10/15/2014	7:04:26	62.05227	-174.73393	70	0	0	0	0	1	0	0	0	0	0	0	0	0	0
271	10/15/2014	15:22:43	62.17315	-174.65402	70	0	0	0	0	1	0	0	0	0	0	0	0	0	0
272	10/15/2014	17:21:31	61.92722	-174.3129	70	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Appendix 2 continued

Station #	Date	Time	Latitude	Longitude	Depth (m)	Gunshot call	Right whale	Bowhead	Humpback	Fin	Orca	Walrus	Gray	Bearded seal	Minke	Unk. Pinn.	Ribbon	Beluga	Unknown
273	10/15/2014	19:03:55	61.70797	-174.01662	75	0	0	0	0	1	0	0	0	0	0	0	0	0	0
274	10/15/2014	22:00:23	61.33923	-173.49855	74	0	0	0	0	1	0	0	0	0	0	0	0	0	0
275	10/16/2014	1:03:56	60.98772	-172.92485	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0
276	10/16/2014	4:03:00	60.63605	-172.37775	60	0	0	0	0	0	1	0	0	0	0	0	0	0	0
277	10/16/2014	7:05:37	60.22072	-171.95083	59	0	0	0	1	2	0	0	0	0	0	0	0	0	0
278	10/16/2014	13:17:28	59.84277	-171.45898	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
279	10/16/2014	16:01:16	59.64452	-170.7428	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	10/16/2014	19:01:56	59.39028	-169.95283	60	0	0	0	0	1	0	0	0	0	0	0	0	0	0
281	10/16/2014	22:11:47	59.19018	-169.39682	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0
282	10/17/2014	1:04:37	58.81477	-169.26733	70	0	0	0	2	0	0	0	0	0	0	2	0	0	0
283	10/17/2014	4:02:25	58.43793	-169.10122	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0
284	10/17/2014	14:44:56	57.94395	-168.85427	75	0	0	0	1	1	0	0	0	0	0	0	0	0	0
285	10/17/2014	17:24:24	57.81707	-168.30638	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
286	10/17/2014	19:49:52	57.68955	-167.84255	68	1	1	0	0	1	0	0	0	0	0	2	0	0	0
287	10/17/2014	22:04:50	57.60132	-167.44422	70	1	0	0	0	1	0	0	0	0	0	0	0	0	0
288	10/18/2014	1:04:36	57.48598	-166.98168	75	1	0	0	1	1	0	0	0	0	0	0	0	0	0
289	10/18/2014	4:01:34	57.39127	-166.54397	68	0	0	0	1	1	0	0	0	0	0	0	0	0	0
290	10/18/2014	7:08:57	57.26158	-166.24248	66	0	0	0	1	1	0	0	0	0	0	0	0	0	0
291	10/18/2014	17:24:13	57.35162	-166.43492	68	1	0	0	0	1	0	0	0	0	0	0	0	0	0
292	10/18/2014	19:05:43	57.38105	-166.1007	68	1	0	0	1	1	1	0	0	0	0	0	0	0	0
293	10/18/2014	22:03:52	57.47003	-165.53507	68	1	1	0	1	1	0	0	0	0	0	0	0	0	0
294	10/19/2014	0:57:18	57.65848	-164.9671	70	2	0	0	0	0	0	0	0	0	0	0	0	0	0
295	10/19/2014	4:06:21	57.4865	-164.56302	67	0	0	0	1	1	0	0	0	0	0	0	0	0	0
296	10/19/2014	7:02:52	57.15775	-164.29837	67	0	0	0	0	1	0	0	0	0	0	0	0	0	0
297	10/19/2014	14:59:17	56.83617	-164.0882	71	0	0	0	1	1	0	0	0	0	0	0	0	0	0
298	10/19/2014	17:14:25	56.51383	-164.2485	79	0	0	0	1	1	0	0	0	0	0	0	0	0	0
299	10/19/2014	19:05:47	56.24543	-164.38658	88	0	0	0	1	1	0	0	0	0	0	0	0	0	0
300	10/19/2014	22:05:20	55.78857	-164.5819	113	2	0	0	1	1	0	0	0	0	0	0	0	0	0
301	10/20/2014	1:05:18	55.33138	-164.80443	124	0	0	0	1	1	0	0	0	0	0	0	0	0	0
302	10/20/2014	4:04:50	54.9665	-164.9596	98	0	0	0	0	1	1	0	0	0	0	0	0	0	0
303	10/20/2014	7:06:35	54.61882	-165.16202	83	0	0	0	1	0	1	0	0	0	0	0	0	0	0
304	10/20/2014	12:59:45	54.12975	-165.92298	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
305	10/20/2014	15:25:34	53.9775	-165.90472	134	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3. CTD and net tow station report

A report on the CTD and net tow stations between 22 September and 12 October can be found in the electronic document entitled “rptCruiseSummary2014.pdf”.

Appendix 4. Marine mammal sightings (individuals) from the ARCWEST/CHAOZ-X 2014 research cruise.

Species	On-Effort	Off-Effort	Total
Cetaceans			
Humpback Whale	6(7)	0	6(7)
Gray Whale*	67(88)	137(220)	204(308)
Minke Whale	0	1(1)	1(1)
Bowhead Whale	7(14)	0	7(14)
Harbor Porpoise	0	1(2)	1(2)
Killer Whale	0	3(14)	3(14)
Unid Large Whale	36(51)	43(53)	79(104)
Unid Small Whale	2(2)	0	2(2)
Unid Porpoise	1(1)	1(1)	2(2)
<i>Total Cetacean</i>	<i>119(163)</i>	<i>186(291)</i>	<i>305(454)</i>
Other			
Fur Seal	5(6)	0	5(6)
Walrus	4(7)	2(3)	6(10)
Unid Seal	14(16)	2(2)	16(18)
Unid Sea Lion	1(1)	0	1(1)
<i>Total Other</i>	<i>24(30)</i>	<i>4(5)</i>	<i>28(35)</i>
Total	143(193)	193(296)	333(489)

* Several days of dedicated tagging operations were conducted in a high gray whale density area near Pt. Hope and King Island. Therefore, these numbers likely reflect a significant number of duplicate sightings and should be considered artificially high. A large portion of the unidentified large whales were in these same areas. Scientists plotted all sightings to keep track of animals in the area prior to and during small boat operations.

Appendix 5. Number of marine birds observed on-transect during 2014 ARCWEST cruise.

Common Name	Scientific Name	Total	% Total
Common Eider	<i>Somateria mollissima</i>	17	0.7
King Eider	<i>Somateria spectabilis</i>	11	0.4
Spectacled Eider	<i>Somateria fischeri</i>	8	0.3
Unid. Eider	<i>Somateria spp.</i>	11	0.4
Steller's Eider	<i>Polysticta stelleri</i>	1	0.04
Long-tailed Duck	<i>Clangula hyemalis</i>	86	3.5
White-winged Scoter	<i>Melanitta deglandi</i>	1	0.04
Yellow-billed Loon	<i>Gavia adamsii</i>	3	0.1
Pacific Loon	<i>Gavia pacifica</i>	15	0.6
Unid. Loon	<i>Gavia spp.</i>	3	0.1
Northern Fulmar	<i>Fulmarus glacialis</i>	18	0.7
Short-tailed Shearwater	<i>Puffinus tenuirostris</i>	50	2.0
Pelagic Cormorant	<i>Phalacrocorax pelagicus</i>	1	0.04
Red Phalarope	<i>Phalaropus fulicarius</i>	23	0.9
Pomarine Jaeger	<i>Stercorarius pomarinus</i>	1	0.04
Black-legged Kittiwake	<i>Rissa tridactyla</i>	140	5.7
Glaucous Gull	<i>Larus hyperboreus</i>	49	2.0
Ross's Gull	<i>Rhodostethia rosea</i>	25	1.0
Common Murre	<i>Uria aalge</i>	10	0.4
Thick-billed Murre	<i>Uria lomvia</i>	135	5.5
Unid. Murre	<i>Uria Spp.</i>	1	0.0
Kittlitz's Murrelet	<i>Brachyramphus brevirostris</i>	13	0.5
Ancient Murrelet	<i>Synthliboramphus antiquus</i>	82	3.3
Least Auklet	<i>Aethia pusilla</i>	395	16.1
Parakeet Auklet	<i>Aethia psittacula</i>	40	1.6
Crested Auklet	<i>Aethia cristatella</i>	1,229	50.0
Unid. Small Alcid	<i>Aethia spp</i>	5	0.2
Horned Puffin	<i>Fratercula corniculata</i>	51	2.1
Tufted Puffin	<i>Fratercula cirrhata</i>	35	1.4

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

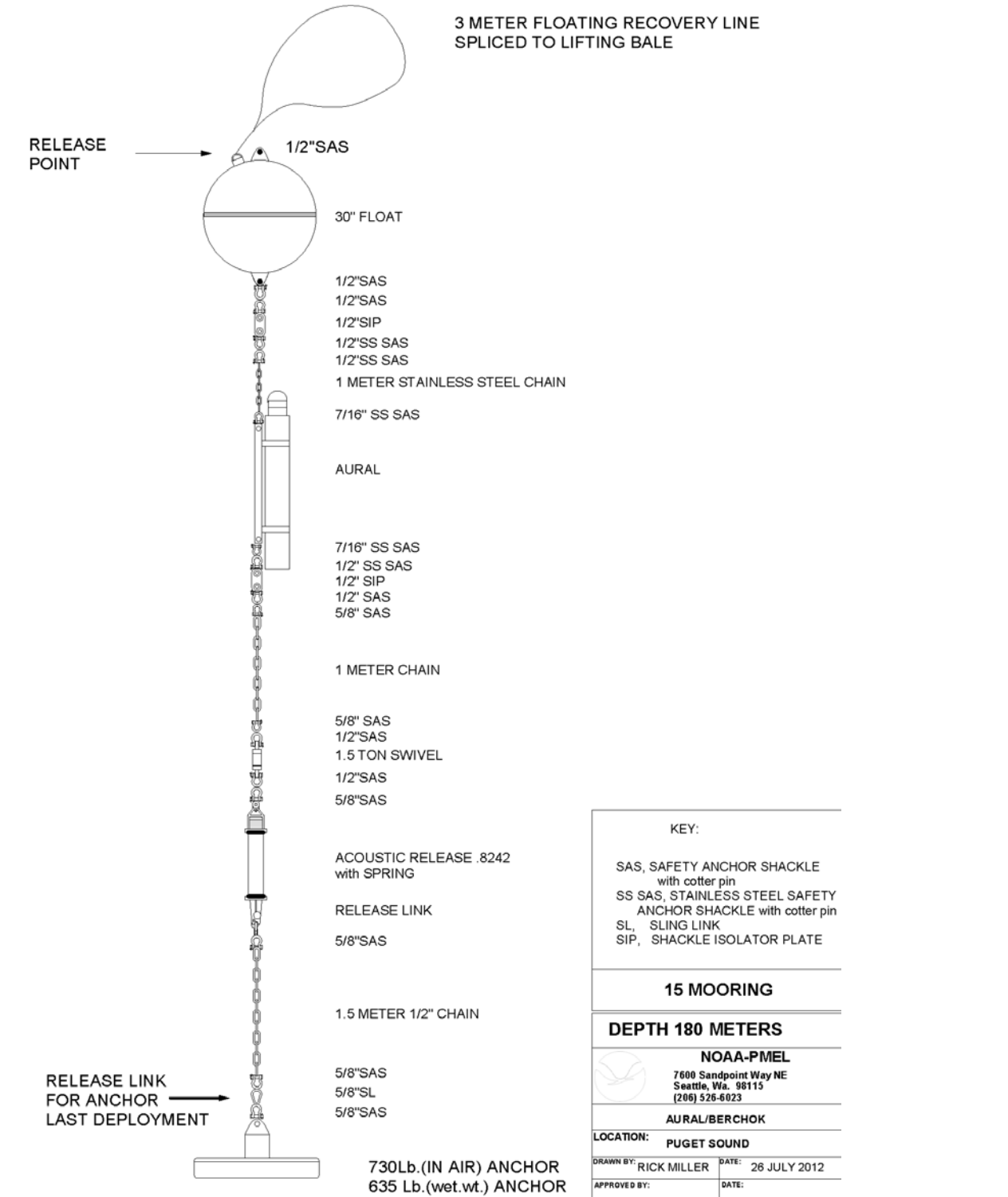


Figure A6.1. Mooring design for the passive acoustic moorings.

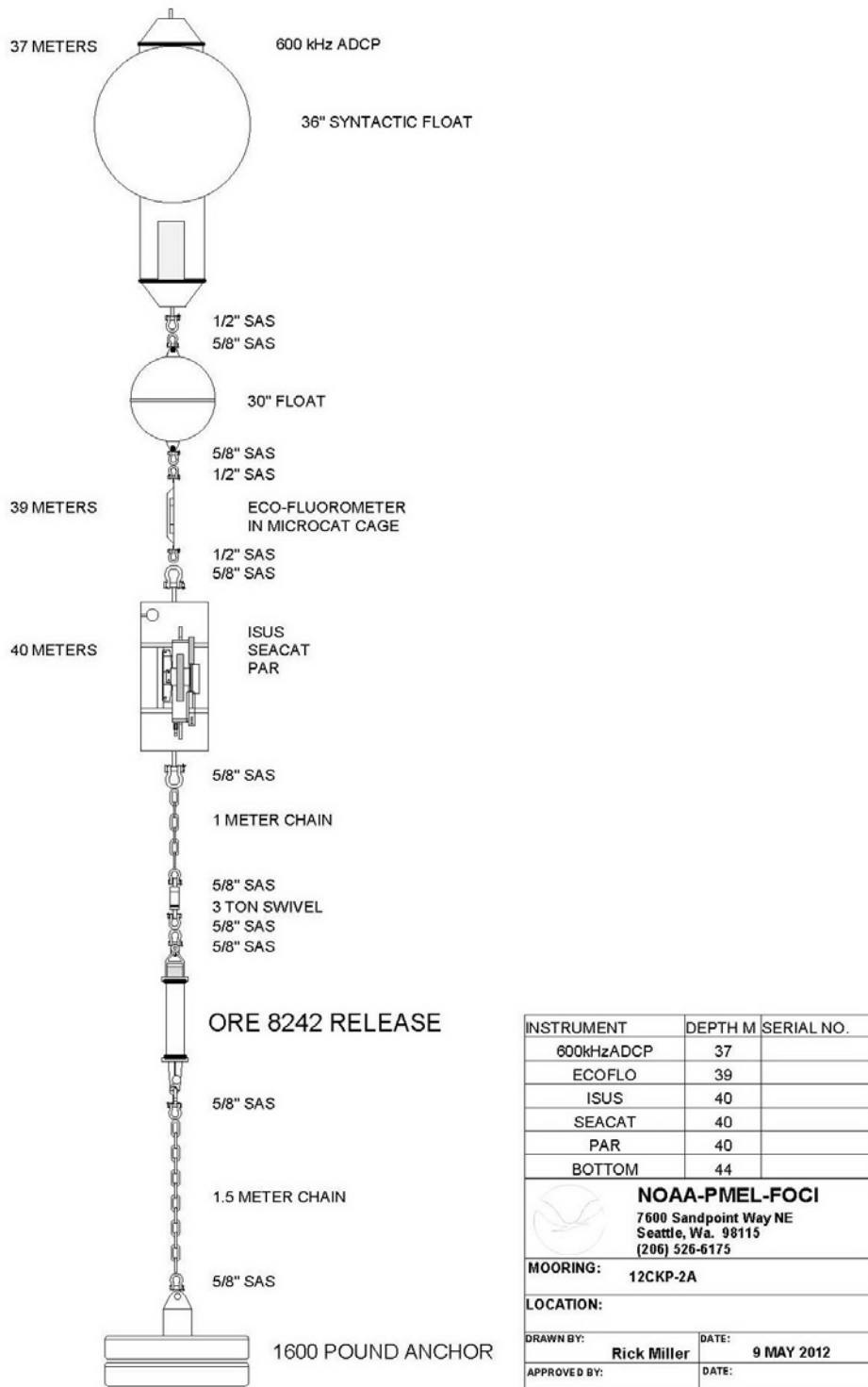
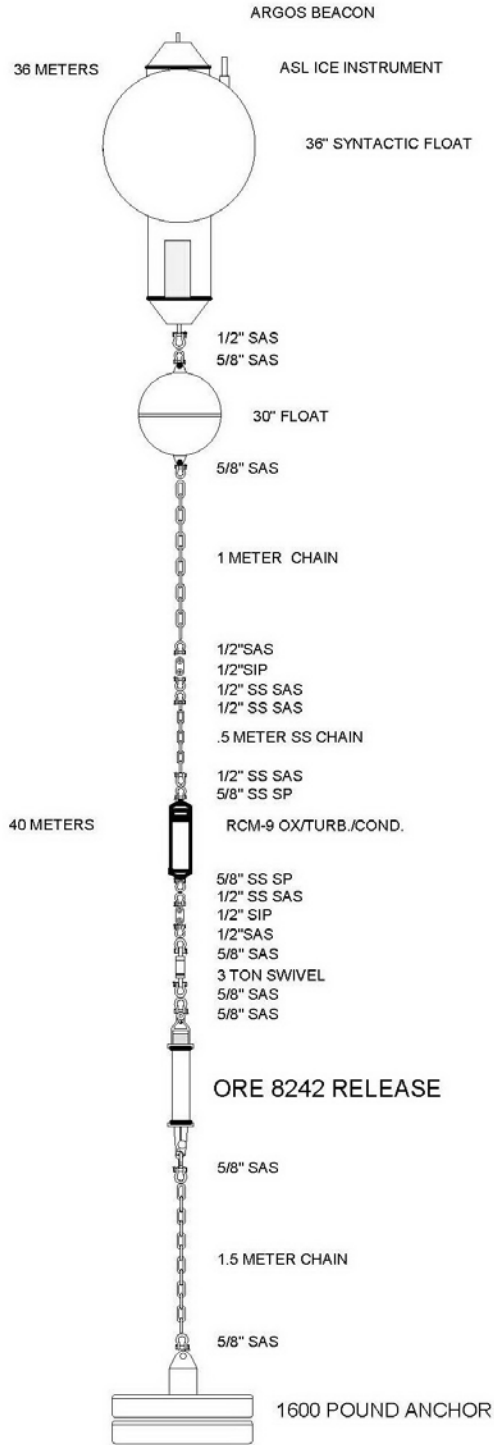


Figure A6.2. Mooring design for 14CKP moorings. In addition to the 600 kHz ADCP (currents), this mooring contains instruments to measure nitrate (ISUS), temperature and salinity (Seacat), fluorescence (EcoFluorometer) and Photosynthetically active radiation (PAR).




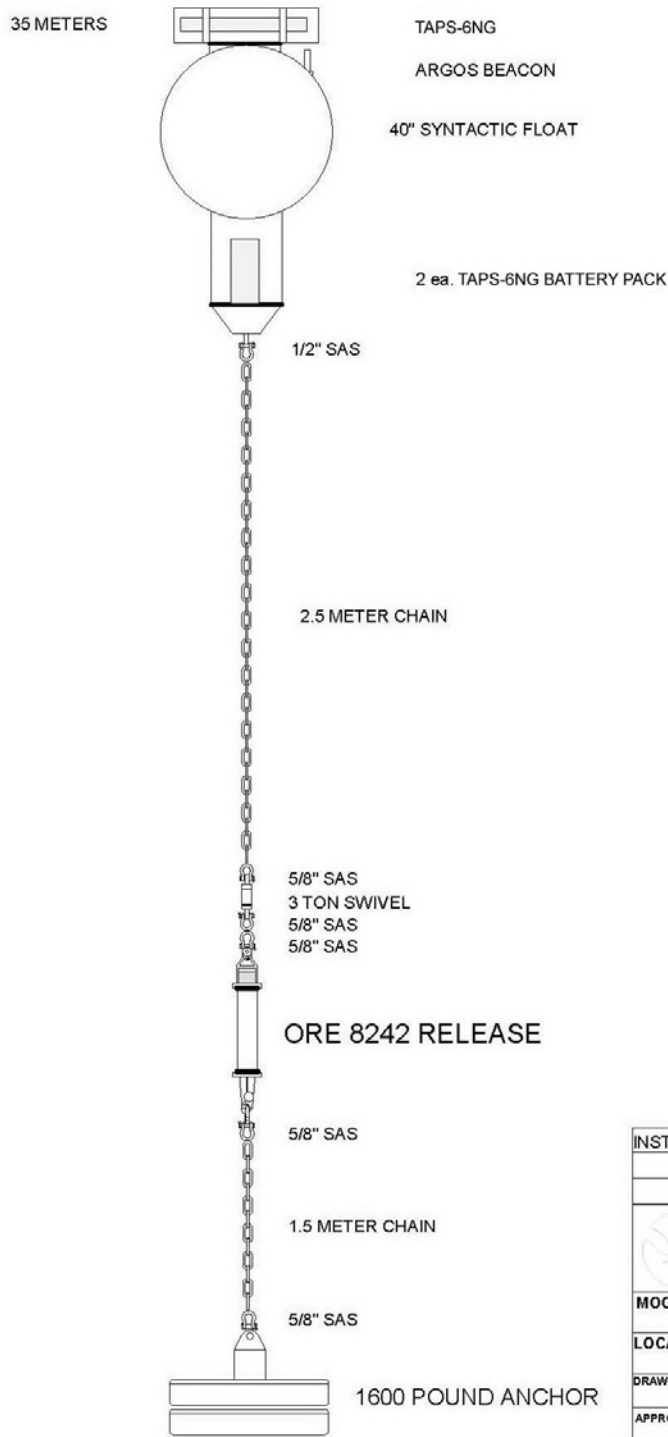
INSTRUMENT	DEPTH M	SERIAL NO.
ASL ICE	36	
RCM9.OX.TU.CON	40	
BOTTOM	43	
 NOAA-PMEL-FOCI 7600 Sandpoint Way NE Seattle, Wa. 98115 (206) 526-6175		
MOORING:	12CKIP-1A	
LOCATION:		
DRAWN BY:	Rick Miller	DATE: 9 MAY 2012
APPROVED BY:		DATE:

Figure A6.3. Mooring design for 14CKIP moorings. In addition to the ASL ice instrument (measures ice thickness), this mooring contains RCM9 that measures currents at one depth, temperature, oxygen, and turbidity.




INSTRUMENT	DEPTH M	SERIAL NO.
TAPS-6NG	35	
BOTTOM	42	
 NOAA-PMEL-FOCI 7600 Sandpoint Way NE Seattle, Wa. 98115 (206) 526-0175		
MOORING:	12CKT-2A	
LOCATION:		
DRAWN BY:	DATE:	
Rick Miller	9 MAY 2012	
APPROVED BY:	DATE:	

Figure A6.4. Design for moorings 14CKT moorings. The TAPS-6NG is an instrument that acoustically measures zooplankton bio-volume and is optimized to detect krill.