2013 Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative Project Final Product[1]

2013 Surface / Midwater Trawl and Oceanographic Survey of the Northeastern Bering Sea and Chukchi Sea

by:

Franz Mueter[2], Ed Farley[3], Alex De Robertis[4], Jim, Murphy[3], Lisa Eisner[3], Kathy Kuletz[5], and Jared Weems[2]

[2]University of Alaska, Fairbanks, School of Fisheries and Ocean Sciences
17101 Point Lena Loop Road, Juneau, AK 99801

[3]NOAA Alaska Fisheries Science Center, Ecosystem Monitoring and Assessment Program, 17109 Point Lena Loop Road, Juneau, AK 99801

[4]NOAA Alaska Fisheries Science Center, Midwater Assessment and Conservation Engineering Program, 7600 Sand Point Way N.E., Seattle, WA 98115

[5]U.S. Fish and Wildlife Service, 1011 E. Tudor Rd., Anchorage, AK 99503

January 20, 2014

1 Final products of AYK Sustainable Salmon Initiative-sponsored research are made available to the Initiatives Partners and the public in the interest of rapid dissemination of information that may be useful in salmon management, research, or administration. Sponsorship of the project by the AYK SSI does not necessarily imply that the findings or conclusions are endorsed by the AYK SSI.

Participating Institutions:

University of Alaska, Fairbanks, School of Fisheries and Ocean Sciences
17101 Point Lena Loop Road, Juneau, AK 99801

University of Alaska, Fairbanks, School of Fisheries and Ocean Sciences
905 N. Koyukuk Drive, Fairbanks, AK 99775

NOAA Alaska Fisheries Science Center, Midwater Assessment and Conservation Engineering Program, 7600 Sand Point Way N.E., Seattle, WA 98115

NOAA Alaska Fisheries Science Center, Ecosystem Monitoring and Assessment Program, 17109 Point Lena Loop Road, Juneau, AK 99801

U.S. Fish and Wildlife Service, 1011 E. Tudor Rd., Anchorage, AK 99503

Alaska Department of Fish and Game, Commercial Fisheries Division
333 Raspberry Road, Anchorage, AK 9951

Contract Agreements and Numbers:

Coastal Impact Assistance Program (U.S. F&WS) and the University of Alaska Fairbanks
10-CIAP-010, F12AF00188
Bureau of Ocean Energy Management and the University of Alaska Fairbanks
M12AC00009
Bureau of Ocean Energy Management and the Alaska Fisheries Science Center (NOAA)
M12PG00018
Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYKSSI) and the
Alaska Fisheries Science Center (NOAA)

Abstract:

Scientists from the University of Alaska, Alaska Fisheries Science Center, U.S. Fish and Wildlife Service, and Alaska Department of Fish and Game, conducted the Arctic Ecosystem Integrated Survey (Arctic Eis) within the Chukchi Sea (CS) and Northeastern Bering Sea (NEBS) from August 1 to September 29, 2013. The survey was designed to provide an ecosystem baseline assessment to assist efforts to evaluate effects of climate change and oil and gas development in Arctic marine ecosystems. A broad range of marine ecosystem characteristics were collected, including physical and biological oceanographic characteristics, Arctic marine food webs, and species characteristics of fish, seabirds, and marine mammals utilizing the Chukchi Sea and Northeastern Bering Sea shelf.

Table of Contents:

FUNDING SUPPORT

The State of Alaska's Coastal Impact Assistance Program (CIAP) provided funding for 40 days-at-sea (DAS), the U.S. Bureau of Ocean Energy Management (BOEM) provided funding for 10 DAS, and the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYKSSI) provided funding for 10 DAS. CIAP provided additional funding support for graduate student research, and for assistance with survey logistics, program management, data management, and data analysis. Funding for the collaborative seabird and marine mammal surveys was provided by BOEM (IA No. M10PG00050) with in-kind support from U.S. Fish and Wildlife Service.

INTRODUCTION

Scientists from the University of Alaska, Alaska Fisheries Science Center, U.S. Fish and Wildlife Service, and Alaska Department of Fish and Game, conducted the Arctic Ecosystem Integrated Survey (Arctic Eis) within the Chukchi Sea (CS) and Northeastern Bering Sea (NEBS) from August 1 to September 29, 2013. The survey was designed to provide an ecosystem baseline assessment to assist efforts to evaluate effects of climate change and oil and gas development in Arctic marine ecosystems. A broad range of marine ecosystem characteristics were collected, including physical and biological oceanographic characteristics, Arctic marine food webs, and species characteristics of fish, seabirds, and marine mammals utilizing the Chukchi Sea and Northeastern Bering Sea shelf.

SURVEY OBJECTIVES

1. Describe the community structure, biomass, energetic status, diets, and biological composition of epi-pelagic nekton including Arctic cod, saffron cod, Pacific salmon, prickleback, jellyfish, herring, capelin and sand lance.
2. Collect target strength data and multi-frequency acoustic echo integration data using hull mounted transducers for use in estimates of the abundance of pelagic nekton.
3. Compare and contrast pelagic and epi-pelagic fish communities and food web structure in the northeastern Bering Sea and Chukchi Sea using surface and targeted mid-water trawls (location determined based on acoustic observations).

4. Collect electronic oceanographic data at trawl stations and at 15 nm intervals along transects, including CTD (Conductivity-temperature-depth) vertical profiles of temperature, salinity, light transmission, chlorophyll a fluorescence, dissolved oxygen and photosynthetic available radiation (PAR).
5. Continuously (along-track) collect sea surface temperature, salinity, chlorophyll a fluorescence data (sea chest/thermosalinograph) and above surface PAR (Hobo PAR sensor and data logger).
6. Collect biological oceanographic samples (water and plankton) at trawl stations and plankton at 15 nm EW intervals between stations; i.e. zoo- and ichthyoplankton data using a 20 and 60 cm bongo samplers with a SBE49 CTD (oblique tow with 150 µm and 505µm nets, respectively to near bottom or 200 m).
7. Conduct paired trawl experiments using modified Marinovich and Cantrawl nets to determine net selectivity and presence/absence of pelagic fish (5 to 10 comparisons during the survey).
8. Conduct acoustic transects from Chukchi Sea to Beaufort Basin to determine distribution of age 1+ Arctic cod (2 days at sea).
9. Deploy four oceanographic drifters within the survey area during leg 1+2.
10. Conduct visual surveys for marine birds and mammals while the vessel is in transit, particularly when transiting between sampling stations.

SPECIAL PROJECTS

Over 4000 samples were saved for 11 special projects from the trawl catches. Special projects include energetics (Heintz-NMFS), isotopes (Andrews-NMFS and Marsh-UAF), otoliths (Boswell-Louisiana International University, Helser-NMFS, and Sutton-UAF), stomachs (Aydin-NMFS), genetics (Guyon-NMFS, Gharrett-UAF), insulin growth factor (Prechtl-UAF). For catches that were insufficient to meet all the special study sample size requests, the samples were taken to Ted Stephens Marine Research Institute (TSMRI) for prioritization. These requests were made prior to sailing and can be found detailed in the 2013 Pre-Cruise Planning Report submitted to our funders, CIAP and BOEM, and available at: https://web.sfos.uaf.edu/wordpress/arcticeis/?page_id=1636.

SURVEY DESIGN

The *F/V Bristol Explorer* was chartered for a total of 60 days at sea (DAS) for research trawl, plankton, and oceanographic sampling during the 2013 Arctic EIS survey. The *F/V Bristol Explorer* is a 180 foot commercial fishing vessel, constructed of steel (blue), with house forward (white) and owned by B&N Fisheries 1959 NW Dock Place #3000, Seattle, WA 98107 (Figure 1). The charter began in Dutch Harbor, Alaska on August 1 and ended in Dutch Harbor on September 29, 2013 (Table 1). The *F/V Bristol Explorer* made intermediate port calls to Nome, Alaska on August 20 and September 11 to exchange scientific personnel (Table 2). For reporting purposes, the survey area is divided into the NEBS (60°N to the Bering Strait: 65.5°N) and the CS (Region north of

the Bering Strait; Figure 2) that correspond to the large marine ecosystems sampled during the survey. Survey events with date, time, and location are included in Appendix 1. Sampling began in the Chukchi Sea (CS) just north of the Bering Strait and progressed from south to north in the Chukchi Sea during the first two legs of the survey. The northeastern Bering Sea (NEBS) region was sampled during the third leg of the survey and stations within this region were sampled from north to south. An alphanumeric station name was assigned to all station locations occupied during the 2012 and 2013 surveys (Figure 2). Station coordinates within the CS were based on a uniform 30 nm square grid pattern consistent with the 2012 survey grid. Station coordinates in the NEBS were based on a grid pattern used in previous surveys by AFSC in the NEBS (each degree of longitude and 0.5 degrees of latitude).

A total of 195 stations were sampled in 2013 (Figure 3). A total of 40 main stations, 62 oceanography stations, and 50 mid-water tows targeting backscatter were completed within the CS (Appendix 1). Sea ice was first encountered at approximately 70N and some stations were abandoned or sampled off location due to ice. A total of 42 main stations and one midwater tow targeting backscatter were completed within the NEBS (Table 3). No oceanography stations at 15 nmi intervals were planned for the NEBS region, although plankton and oceanographic data were collected at the main stations.

Daily sampling efforts throughout the survey were detailed by our Chief Scientists in Daily Field Updates submitted to our Project Administrators. The Daily Field Updates were then made available to over 160+ project investigators, regional collaborators, and Native Alaskan organizations through email communications, as well as, to the public through our website (https://web.sfos.uaf.edu/wordpress/arcticeis/?page_id=275).

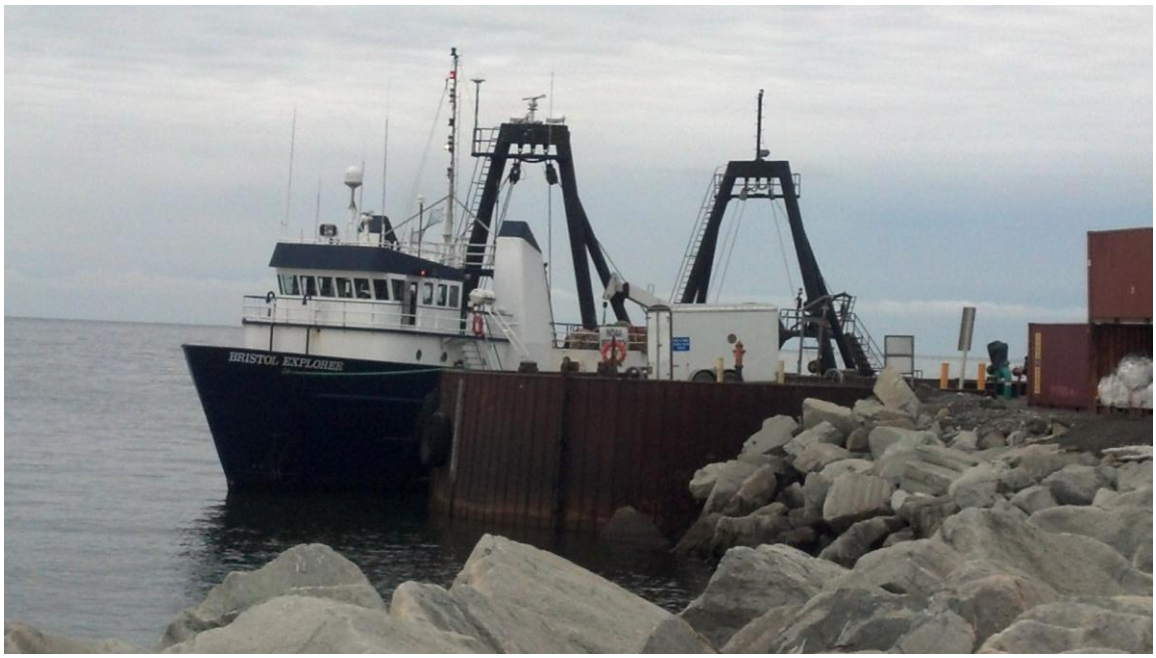


Figure 1. The *F/V Bristol Explorer* docked in Nome, Alaska during a crew exchange. (Photo Credit: Kevin Taylor)

Table 1. Cruise itinerary for the Arctic Ecosystem Integrated Survey (Arctic Eis) on the *F/V Bristol Explorer*, August 1 – September 29, 2013.

Date	Location/Activity
Aug 1	Dutch Harbor, scientists embark and load sample equipment
Aug 2	Complete loading
Aug 3	leave Dutch Harbor: travel to Bering Strait
Aug 6	Drop off malfunctioning CTD in Nome for repair
Aug 7	Begin sampling southern Chukchi Sea (leg 1)
Aug 13	Echo sounder calibration
Aug 18	Transit to Nome, AK
Aug 20	Port Call Nome
Aug 21	Transit to northern Chukchi Sea (leg 2)
Aug 22	Sample stations in northern Chukchi Sea
Sep 6-7	Acoustic Transects in northern Chukchi Sea
Sep 9	Transit to Nome, AK
Sep 10	Sample two northern-most Bering Sea Strait stations
Sep 11	Port Call Nome – Outreach Efforts
Sep 12	Sample stations in northern Bering Sea (leg 3)
Sep 25-26	Flooding Event and Salvaging of Samples and Gear
Sep 27	Transit to Dutch Harbor
Sep 29	Offload gear, end survey

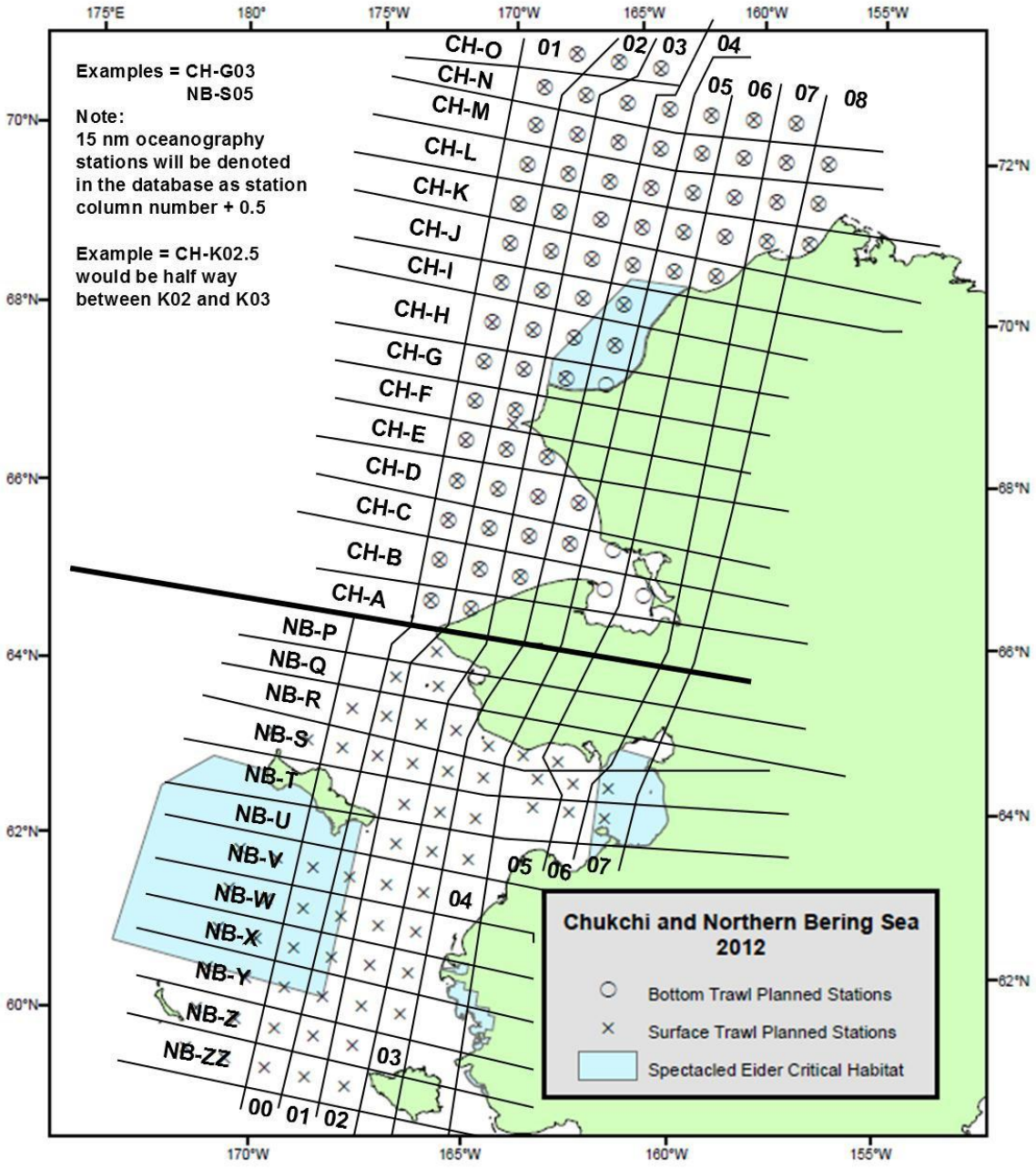


Figure 2. Master station names and coordinates for the Arctic Ecosystem Integrated Survey (Arctic Eis) aboard the *F/V Bristol Explorer* during 2012 and 2013.

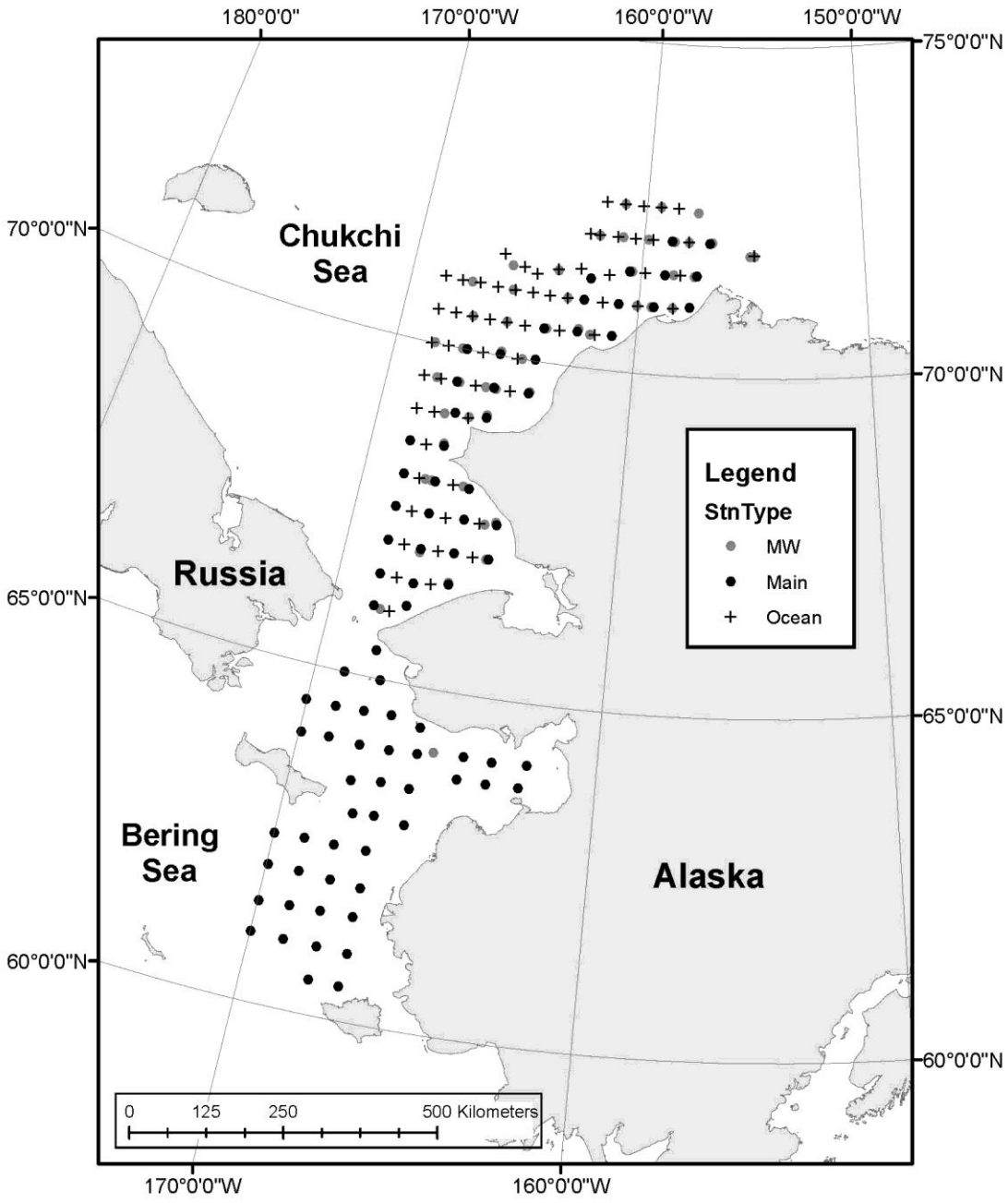


Figure 3. Station locations for the 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) (dark dot = surface/oceanography; grey dot = midwater; + = oceanography) aboard the *F/V Bristol Explorer*.

SCIENTIFIC PERSONNEL

Scientists from the University of Alaska (UAF), Alaska Fisheries Science Center (AFSC, *AFSC Contractor), U.S. Fish and Wildlife Service (USFWS), and Alaska Department of Fish and Game (ADFG) conducted the Arctic Ecosystem Integrated Survey (Arctic Eis) within the Chukchi Sea (CS) and Northeastern Bering Sea (NEBS) from August 1 to September 29, 2013 (Table 2).

Table 2. Scientific personnel aboard the *F/V Bristol Explorer* during the Arctic Eis survey, August-September 2013.

Name (Last, First)	Title	Date Aboard	Date Disembark	Gender	Affiliation	Legs
Farley, Ed	Chief Scientist	8/1	8/20	M	AFSC	1
Wilson, Chris	Lead Acoustician	8/1	8/20	M	AFSC	1
Strasburger, Wes	Res Fish Biol	8/1	8/20	M	AFSC*	1
Vega, Stacy	Res Fish Biol	8/1	8/20	F	UAF	1
Zeller, Tamara	Sea Bird Obs	8/1	8/20	F	USFWS	1
Taylor, Kevin	Acoustician	8/1	9/11	M	AFSC*	1, 2
Andrews, Alex	Chief Scientist	8/21	9/11	M	AFSC	2
Mueter, Franz	Lead PI	8/21	9/11	M	UAF	2
Sme, Noel	Res Fish Biol	8/21	9/11	F	UAF	2
Pham, Catherine	Sea Bird Obs	8/21	9/29	F	USFWS	2, 3
Weems, Jared	Program Manager	8/21	9/29	M	UAF/AFSC*	2, 3
Prechtl, Melissa	Res Fish Biol	9/12	9/29	F	UAF	3
Murphy, Jim	Chief Scientist	9/12	9/29	M	AFSC	3
Gann, Jeanette	Oceanographer	9/12	9/29	F	AFSC	3
Howard, Katie	Res Fish Biol	9/12	9/29	F	ADFG	3

DELIVERABLES

This cruise report reflects the completion and final report of this project.

PROJECT DATA

All project data is available on-line at the AOOS Arctic EIS ocean workspace https://workspace.aoos.org/login. AYKSSI will be given login access to this data portal through data sharing agreements with the Arctic EIS project; the data sharing agreement is included with this final report.

OCEANOGRAPHIC DATA AND COLLECTIONS

Lisa Eisner (AFSC Principal Investigator)
Jeanette Gann (AFSC Research Oceanographer)

Oceanographic data were collected at each trawl station and at oceanographic stations spaced at 15 nm intervals along transects in the CS (Figure 3). Vertical profiles of salinity, temperature, chlorophyll a fluorescence, light attenuation (beam c), photosynthetic available radiation (PAR) and dissolved oxygen, were obtained from surface to near bottom depths at each trawl station using a conductivity, temperature, and depth meter (CTD) with ancillary sensors (SBE 25, 9-11 plus or FastCat CTD, Sea-Bird Electronics, Inc, Bellevue, WA). Continuous along-track measurements of surface temperature and salinity was collected using a thermosalinograph (SBE-45, Sea-Bird Electronics, Inc.) from mid-Leg 2 through the end of the survey. Water samples for nutrients (N, P, Si) and chlorophyll a (total and size fractionated) were collected at the surface and below the pycnocline using 5-L Niskin bottles. Salinity and oxygen samples to calibrate the CTD were collected intermittently as per the protocol.

Several problems developed during the 2013 field survey. On leg 1, some variables (e.g. chla fluorescence, oxygen) were not collected, since our primary CTD malfunctioned, and we had to use a backup CTD that did not contain all sensors. We also had to string Niskin bottles instead of using our primary CTD with a carousel, thus, only 4 water sample depths could be collected at each station (Figure 4). A new CTD was installed prior to leg 2 and these problems were alleviated (Figure 5). On leg 3, due to the flooding of freezers, all chlorophyll a samples for that leg were destroyed (due to thawing), some leg 3 nutrient samples are also unusable since labels were scraped off during the flood, and all $\delta^{18}O$ samples were destroyed. Thermosalinograph data were not collected for leg 1 and during the start of leg 2 due to plumbing issues.

In the CS, CTD casts were conducted at 104 stations. Discrete water samples were collected with Niskin bottles during CTD casts at 58 of these stations. In the NEBS, CTD casts and water samples were collected at 45 stations. Preliminary observations for 2013 in the NE Chukchi Sea indicate that temperature decreased and salinity increased from inshore to offshore, similar to 2012. Near the ice edge, the freshwater sill was prominent with very cold temperatures (-1.5 °C) below the shallow thermocline or freshwater sill. In Barrow Canyon there was a freshwater sill on top of Shelf/Pacific water on top of Atlantic water from the north. This was the location where Age1+ Arctic Cod were caught (Figure 6).

Surface (5m) seawater temperature anomalies were evaluated for the northeastern Bering Sea (NBS) (60 to 65.5 °N) over bathymetry ~20-60 m depth from 2002 to 2013. Preliminary analysis suggests the 2013 mean surface temperature was 7.7 ^{0}C, close to the 12 year average (Figure 7). 2013 CTD temperature data in addition to other parameters for the eastern Chukchi Sea are currently being processed, but will be available soon.

Figure 4. Science and ship crew stringing Niskin bottles directly to the winch line during leg 1 due to the broken CTD unit. (Photo Credit: Stacy Vega)

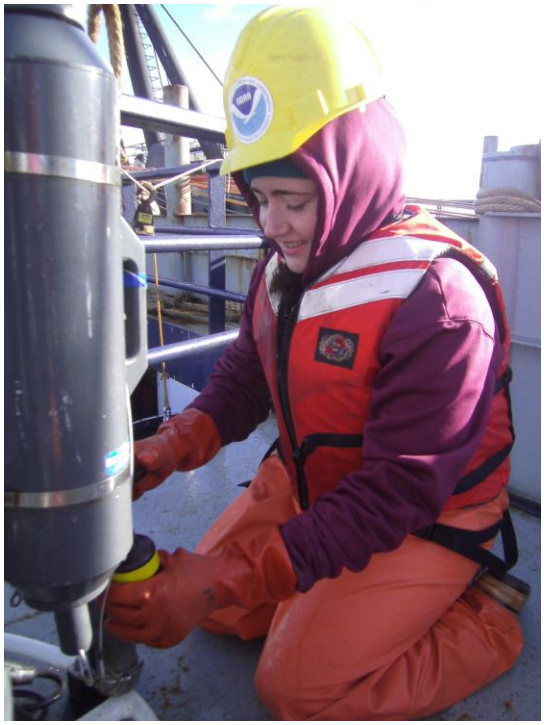


Figure 5. UAF Graduate Student Noel Sme sampling from the CTD Carousel Bottles on leg 2. (Credit: Jared Weems)

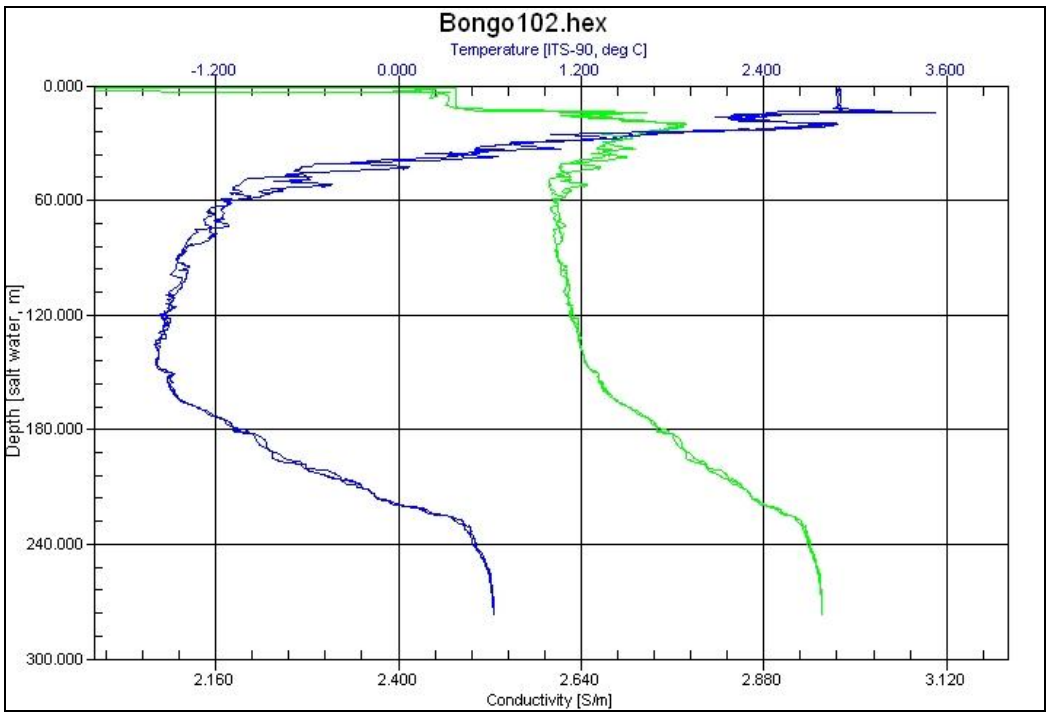
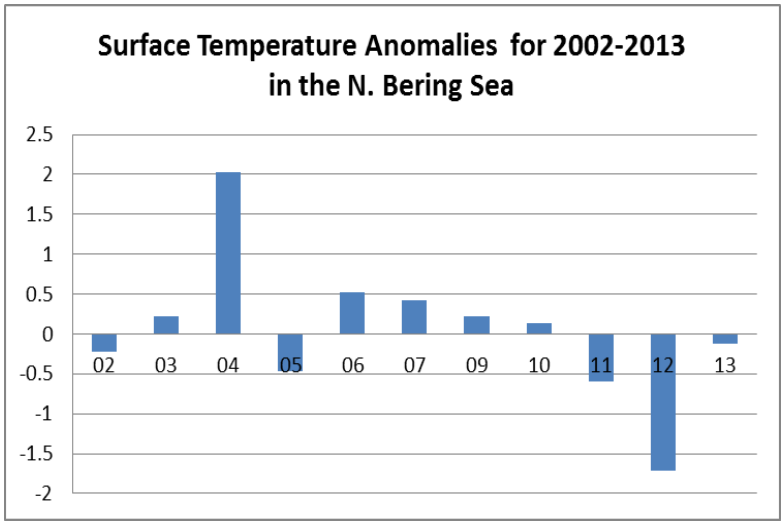


Figure 6. Beaufort Canyon Station #152 (BEAUF-M10) FastCat oceanographic profile. (Credit: AFSC)



Year	Mean T (°C)	Anomaly
2002	7.58	-0.22
2003	8.03	0.22
2004	9.83	2.03
2005	7.33	-0.47
2006	8.33	0.52
2007	8.22	0.42
2009	8.03	0.23
2010	7.93	0.13
2011	7.21	-0.60
2012	6.09	-1.71
2013	7.68	-0.13

Average Temp = 7.80

Figure 7. Preliminary surface seawater temperature anamolies suggest near average oceanographic conditions in 2013 and significantly warmer temperatures than our 2012 sampling period. Supporting temperture and anomaly values are included to the right. (Credit: AFSC)

ZOOPLANKTON AND ICHTHYOPLANKTON DATA AND COLLECTIONS

Jared Weems (Cruise Participant and Program Manager)
Alexei Pinchuk (UAF Zooplankton Principal Investigator)
Morgan Busby (AFSC Ichthyoplankton Principal Investigator)

Zooplankton and ichthyoplankton (larval fish) samples were collected at each trawl station from surface to near bottom using double oblique bongo (60-cm diameter frame with 505 micron mesh nets) and 150 micron mesh. Both 60-cm (505 μm mesh) and 20-cm (153 μm mesh) bongos were deployed for plankton sampling. Three samples were preserved in 5% buffered formalin-filled jars at each station (Figure 8A); one sample from the 60-cm collected for the Fisheries Oceanography Coordinated Investigations group for ichthyoplankton and one each from the 60-cm and 20-cm to Dr. Alexei Pinchuk for zooplankton quantification. Sampling protocols were consistent with SOPs from last year and can be referenced in the Pre-Cruise Report with detailed Sample Request Forms. In the rare occasion where a 60-cm sample was accidentally lost or deemed unusable (e.g. plugged codend due to large jellyfish), the remaining sample was saved for Dr. Pinchuk rather than FOCI ichthyoplankton, as later sample transfer could be accomplished.

With the destruction of the FOCI Zooplankton Data Sheets during the flooding event, specific information on plankton sampling is not readily available at this time. This loss is potentially devastating for zooplankton processing as water volume filtration estimates using flow-through meter values is no longer directly possible. Reconstruction estimates for these missing values are underway using the acoustic streaming GPS data, CLAMS log event time stamps, and FastCat 25 data. Water filtration efficiency will have to be estimated as well, TBD. No physical samples were lost as they were isolated from the flood waters. Future suggestions include electronic back-ups of this data daily while at sea and/or programming this function into the CLAMS catch system.

Missing data sheets not-withstanding, the CLAMS catch log recorded a total of 143 combination Bongo/FastCat casts during the 2013 cruise. Only 1 cast was made with the FastCat instrument only, Station BEAUF-M10 Event #255, to gather oceanographic information to match the Midwater Trawl for Age+1 Arctic cod in the Beaufort Canyon (Figure 6). At this time, Dr. Alexei Pinchuk reports having received 11 boxes of 500 ml samples and 2 boxes of 250 ml samples. This translates into an approximate total of 292 zooplankton samples. Dr. Morgan Busby reports having received approximately 130 1L ichthyoplankton samples in Seattle. All processing of these samples is pending further volumetric calibration success.

Additionally, biological samples were collected for three separate zooplankton projects; these samples were taken from the FOCI Ichthyoplankton 60-cm Bongo samples prior to being fixed in Formalin solution (Figure 8B). In the Chukchi Sea, Jen Marsh, Ph.D. student with Dr. Franz Mueter, requested 5-10 *Neocalanus cristatus* and 30 *Calanus marshallae/glacialis* frozen samples per station frozen on slides for stable isotope analyses. A total of 100 Bongo stations were sampled in the CS, of which she has 75 sample slides for stable isotope and trophic food web analyses. Alex Andrews (AFSC) collected 3-10 frozen samples of *Themisto* sp. Amphipods and *Thysanoessa* sp.

Euphuasiids per station when available for stable isotope trophic level analysis. His sampling sheets were also destroyed in the flood, along with his Leg 3 frozen collection. Legs 1 and 2 samples are still viable, though determination of sample location may be missing. Jared Weems (UAF/AFSC*) collected 3-15 crab larvae (zoea and megalopae) per station when available for species identification and trophic level analysis. These were collected and frozen in small epivials on Legs 2 and 3, though all 89 samples were destroyed or rendered unusable in the flooding event. However, the CS samples were recovered and species IDs were able to be verified. Chukchi taxa include mostly *Telmessus cheiragonas* megalopae, Majidae (*Hyas sp*. and *Chionoecetes opilio*) zoea, and Paguridae zoea. *Telmessus cheiragonas* was particularly abundant near the ice edge along the Alaska coast and near Hanna Shoal. Northern Bering taxa include mostly Majidae (*Hyas sp*. and *Chionoecetes opilio*) megalopae and Paguridae zoea (Figure 9A).

Overall, many of the same patterns seen last year in 2012 seem to have been observed in 2013. Gelatinous ctenophores, which bioluminesce a brilliant purple-pink, and Larvaceans, bodies outlined in bright orange (probably *Fritillaria*), were detected in the Chukchi Sea, especially when close to the ice edge. The transparent mucus material (slime) caught near the ice in 2012 was not observed in 2013 however. Chaetognaths were relatively abundant throughout the CS and NEBS. Copepods, euphausiids, and larval crabs were observed throughout, though levels dropped near the ice edge (exception *T. cheiragonas* megalopae). In the NEBS in particular, a trend of more abundant large *Themisto* sp. amphipods and large Calanoid copepods at offshore stations and Chaetognaths, crab larvae, and fish eggs/larvae at inshore stations was seen. Amphipod abundance could be associated with higher abundances of large jellys offshore, as *Themisto* likely utilizes jelly tentacles as pelagic habitat. The final sampling station, #195, appeared to have very different species assemblages dominated by small benthic Gammarid amphipods and a fiber-like (cotton candy) phytoplankton. In the small mesh nets of the 20-cm Bongo, we observed mostly *Pseudocalanus* sp. and clumps of algal fragments throughout the sampling region.

Larval fishes caught in the bongo nets were not identified in 2013, as larval fish taxonomists were not on board (e.g. Figure 9B). Identifications in 2012 by Mr. Morgan Busby last year included Arctic Cod (Gadidae), Arctic Staghorn Sculpin (Cottidae), Alligatorfish, and Arctic Alligatorfish (Agonidae), Arctic and daubed shanny (Stichaeidae), Alaska Plaice, Bering Flounder, Longhead Dab, and Yellowfin Sole (Pleuronectidae). In 2013, the CanTrawl also allowed collection of a few transforming Greenland Halibut larvae, which have been sent to AFSC Principle Investigator Dr. Janet Duffy-Anderson in Seattle for verification.

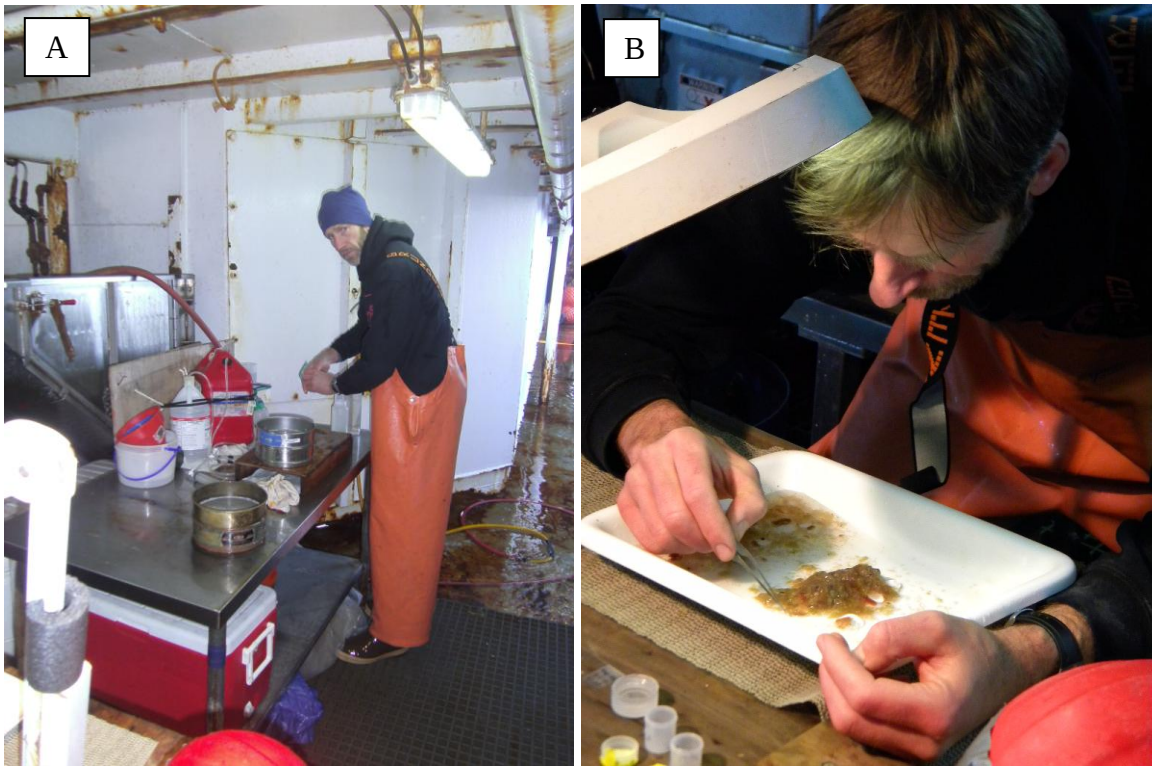


Figure 8. Lead PI Dr. Franz Mueter A) prepares to fix each bongo sample in Formalin-filled sample jars, and B) sorts through a 60 cm bongo sample for copepods, amphipods, euphausiids, and crab larvae. (Photo Credit: Jared Weems)

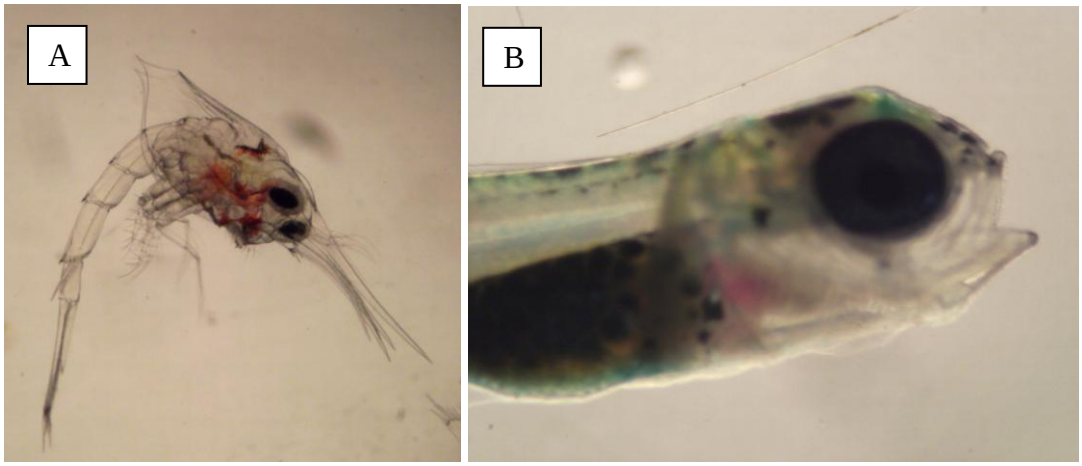


Figure 9. Zooplankton specimens under the dissecting microscope. A) Paguridae (hermit) crab zoea and B) the hexagrammid *Hexagrammos stelleri* (Whitespotted Greenling), photo ID verified by Morgan Busby. (Photo credit: Jared Weems)

SURFACE TRAWL DATA AND COLLECTIONS

Ed Farley (AFSC Principal Investigator)
Alex Andrews (AFSC Fisheries Research Biologist)
Jim Murphy (AFSC Fisheries Research Biologist)
Wesley Strasburger (AFSC Contractor)*

Fish species of particular interest in surface trawl samples included ice-adapted Arctic fish species, such as Arctic cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*), which are key components of the Arctic marine ecosystem. Subarctic species such as walleye pollock (*Theragra chalcogramma*), and salmon (*Oncorhynchus* spp.) were also of particular interest and importance, as these species distributions are expanding northward in response to warming of Arctic marine habitats. Forage fish species such as Pacific herring (*Clupea pallasi*), capelin (*Mallotus villosus*), and Pacific sand lance (*Ammodytes hexapterus*), were also of interest as they provide an important prey base for many species of fish, seabird and marine mammals in this region.

Surface trawl methods

A Cantrawl model 400/601 (made by Cantrawl Pacific Ltd., Richmond, B.C.) midwater rope trawl (Figure 10) was modified to fish at the surface with adjustments to trawl setbacks and floats along the headrope. The Cantrawl 400/601 trawl has hexagonal mesh in the wings and body, is 198 m in length, a headrope length of 120 m, and a 12-mm mesh liner in the codend. The trawl was configured with three 60-m bridle legs (top, middle, and bottom) constructed of ¾" TSII jacketed spectra that connect the trawl to two steel alloy 5-m^2 fixed bail trawl doors from Noreastern Trawl (NETS) (Figure 11). Total weight of each door was approximately 613 kg and included a 91-kg steel plate added to the shoe of each door to increase vertical stability of the doors when trawling near the surface. Trawl bridals were constructed of three polyform floats (one 80-cm-A5 buoy and two 60-cm-A4 buoys) attached to the headrope on both wingtips with ¾" c-links, and two F4 polyform floats were attached to either side of the net sonar kite at the headrope to help keep the headrope at the surface (Figure 12); a 120-kg chain was used to allocate the weight along the footrope. Main warp was set between 274 to 360 meters, and trawl speeds were approximately 4.0-4.5 knots.

The Catch Logger for Acoustic Midwater Surveys (CLAMS) software developed by scientists within the MACE program at AFSC was used to record all data associated with surface and midwater trawl events. The standard configuration of CLAMS (data structure and interface used for pollock stock assessment surveys) was modified by AFSC to specifically address data collection needs of the Arctic Eis survey. Program modifications to CLAMS were completed by Kevin Taylor with assistance from Jim Murphy, Alex Andrews, and Wes Strasburger. All biological data were entered electronically into the CLAMS database from ruggedized deck computers manufactured by SmallPC (SDC100HB-AD16-BT-WL) through a wireless network to a laptop in the ship's wheelhouse. Lengths were collected electronically with Ichthysticks, an electronic fish length board developed by the MACE program at AFSC, and weights were collected electronically with either a 6kg or 60kg motion compensated MAREL scales calibrated to

the ship's motion at each station. Codend weights were recorded on occasion with a wireless tension link load cell (WLCTL2-10K) manufactured by Load Cell Central using the ships crane hoist (Figure 13A). In addition to net mensuration data recorded from the ship's net sonar, footrope and headrope depths of surface and mid-water trawls were recorded with Seabird SBE39 temperature and depth sensors. All trawl catches were sorted by species and catch in weight and numbers were estimated (Figure 13B). Specimens were tracked with specimen tags with specimen numbers and corresponding barcodes, and specimen comments identifying the sample request associated with each specimen. Barcode readers were set up for scanning specimen tags, but it was found that hand entering specimen numbers was quicker than using the scanners due to the difficulty the scanners had in reading the Arctic Eis barcodes. Different scanners (possibly barcode wands) or different barcode tag formats will be required to fully implement the barcode tracking system in the future. Biological data were collected following collection protocols for the survey (Appendix 2-4). Specimen collections were completed following sample requests from participating and collaborating scientists (see Pre-Cruise Report for specific requests).

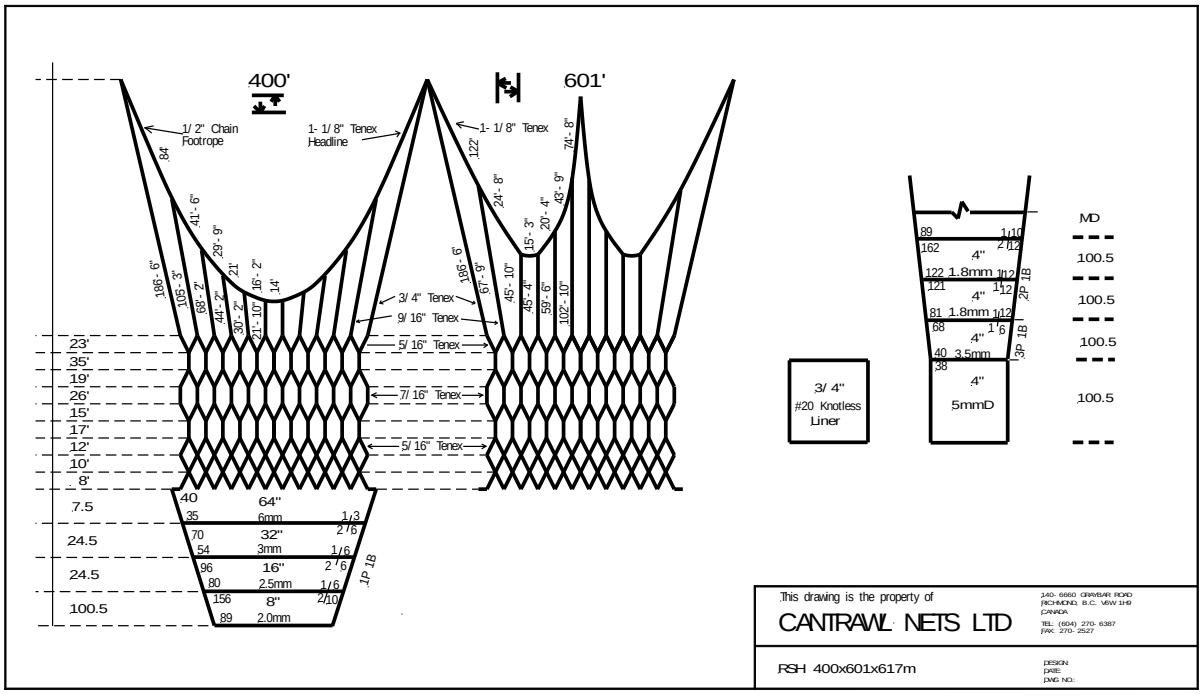
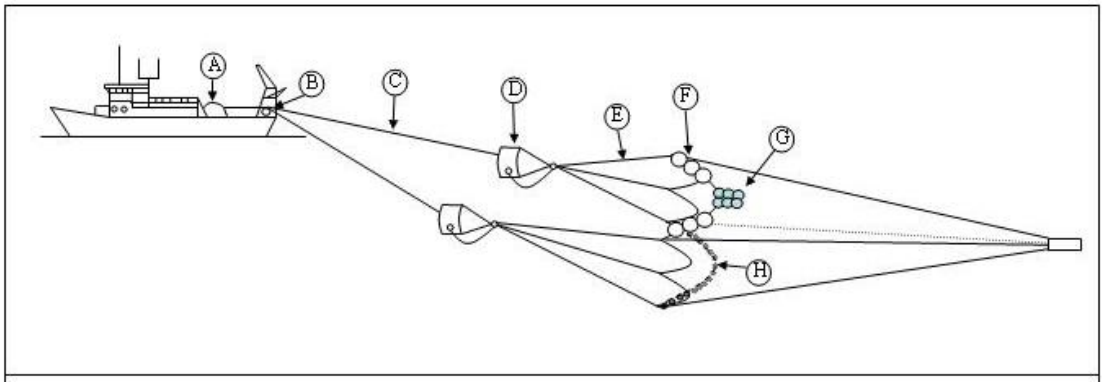


Figure 10. Net diagram of the Cantrawl 400/601 trawl used during surface trawl stations during the Arctic Ecosystem Integrated Survey (Arctic Eis) survey, August to September, 2013.



A) Trawl winch B) Top roller C) Warp 29 mm

D) Steel alloy 5m² trawl doors (613 kg)

E) Net bridle 19 mm diameter 60 m length x 3 x 2

F) Wingtip bouyancy: 6 polyform floats (2 x 80 cm, 4 x 60cm)

G) Net sounder bouyancy 6 x 31 cm center hole trawl floats

H) Allocated footrope weight (120 kg)

Figure 11. Cantrawl 400/601 surface trawl configuration during the Arctic Ecosystem Integrated Survey (Arctic Eis) survey, August to September, 2013 (two F4 polyform floats were used for net sounder buoyancy rather than center-hole trawl floats).

Figure 12. A stern view of the ship while the Cantrawl was being retrieved after a standard 30 minute tow. Note the trailing buoys used to keep the headrope at the surface. (Photo Credit: Jared Weems)

Figure 13. A) The crane hoisting the catch codend from stern to amidships. B) Science crew sorting a typical catch in northeastern Bering Sea on leg 3. From left: Chief Scientist Jim Murphy, Katie Howard, and Jared Weems. (Photo Credit: Melissa Prechtl)

Surface trawl catch data

Total surface trawl catch for 40 surface trawl stations in the CS resulted in the catch of 35 species or species groups with a biomass of 1,207 kg and an estimated catch of 61,761 individual fish and invertebrate species (Table 3). The largest catch biomass by species in the CS consisted of the jellyfish species, Sea Nettle (*Chrysaora melanaster),* at 940 kg. Pacific herring (*Clupea pallasi)* had the largest fish biomass in surface trawls in the CS at 74 kg, followed by capelin (*Mallotus villosus*) at 58 kg. Age-0 Arctic cod (*Boreogadus saida*) were the most abundant species in surface trawl catches in the CS with a total catch of 39,290 individuals, followed by capelin with a total catch of 14,180 individuals.

Total surface trawl catch for 43 surface trawl stations in the NEBS also resulted in the catch of 35 species or species groups with a catch biomass of 9,115 kg and an estimated catch of 317,245 individual fish and invertebrate species. Similar to the CS, the largest catch biomass by species in the NEBS was *Chrysaora melanaster* at 6,571 kg. Also similar to the CS, Pacific herring (*Clupea pallasi)* had the largest fish biomass in surface trawls in the NEBS at 1,142 kg (combined life-history stages catches), followed by capelin (*Mallotus villosus*) at 627 kg. Age-0 Pacific herring were the most abundant species in surface trawl catches in the NEBS with a total catch of 186,430 individuals. Similar to the CS, capelin were the second most abundant species at 72,710.

Figures 15-25 provide information on the spatial distribution of surface trawl catch of pelagic nekton species of particular interest. *Chrysaora melanaster,* the dominant biomass in both the CS and NEBS was caught at every location sampled by the survey except three stations in the southern Chukchi Sea (Figure 15). Age-0 Arctic cod were distributed primarily from 69.5°N and above with only a few individuals captured between the Bering Strait and 69.5°N (Figure 16). No age-0 Arctic cod were captured in the NEBS. Pacific herring were distributed primarily within the NEBS; however, herring were captured at several stations in the CS (Figure 17). Pollock were primarily captured

in the NEBS (only 2 individuals were caught in the CS) (Figure 18). Nearly all of the pollock catch consisted of the age-1 pollock life-history stage. Capelin were distributed throughout the study area with the largest catch occurring offshore of Norton Sound in the Bering Strait region (Figure 19). However, capelin were captured at every station north of 70°N, just not at particularly high densities. Age-0 saffron cod were captured in both the CS and NEBS (Figure 20). Juvenile (first year in the ocean) Chinook salmon were only captured in NEBS and the largest catches were in Norton Sound (Figure 21). Juvenile chum, pink, and coho salmon were captured in both the CS and NEBS with the largest catches occurring in the NEBS (Figures 22-24). Only a few juvenile sockeye salmon were captured and all were caught in the NEBS (Figure 25).

Additionally, Jared Weems (AFSC* Contractor) collected and maintained several live fish during leg 3 for outreach efforts in Dutch Harbor and Juneau. This project was carried out to capture and retain live Arctic fish species for use in educational activities with Unalaska City Schools 6th grade students and visitor aquaria displays at the Ted Stevens Marine Research Institute (Figure 14). These specimens were maintained on board with the ships seawater flow through system, in Dutch Harbor in collaboration with Unisea, Inc., and transported to Juneau in cooled, sealed containers as checked baggage to be placed in TSMRI seawater tanks. Specimens included: Northern Rock Sole (3), Alaska Plaice (1), Starry Flounder (1), Ninespine Stickleback (5), Sturgeon Poacher (2), Whitespotted Greenling (10), Great Sculpin (1), and Bering Wolffish (1). This was conducted under State of Alaska Fish Resource Permit No. CF-13-113.

Figure 14. Students from Unalaska City schools 6th grade class observe a Northern Rock Sole while they learn about Arctic marine ecosystems on October 1, 2013. (Photo Credit: Jared Weems)

Table 3. Total weight and number of marine fishes and invertebrates caught during surface trawl sampling during the Arctic Ecosystem Integrated Survey (Arctic Eis, 2013) in the Chukchi Sea and Northern Bering Sea. Northern Bering Sea stations were between 60° and 65.5°N, Chukchi stations were between 65.5° and 72.5°N.

	Chukchi Sea		Northern Bering Sea	
Common Name	**Total Weight (kg)**	**Total Number**	**Total Weight (kg)**	**Total Number**
Aequorea sp.	0.926	6*	20.635	*
Alaska Plaice			0.348	1
Amphipod, unident.	0.022	*	0.143	*
Arctic alligatorfish	0.001	3		
Arctic Cod (Age 0)	29.320	39290		
Arctic Cod	0.220	29	0.010	1
Arctic Lamprey	0.066	1	3.396	50
Arctic Staghorn Sculpin	0.010	31		
Bering Wolffish (Juv)	0.251	28	0.067	2
Capelin (Age 0)	1.685	1637	0.156	138
Capelin	58.348	14180	627.025	72710
Chinook Salmon (Imm)			30.850	8
Chinook Salmon (Juv)			76.681	522
Chum Salmon (Imm)	48.930	10	243.865	51
Chum Salmon (Juv)	0.956	54	69.308	1157
Coho Salmon (Juv)	0.158	2	9.775	33
Crested Sculpin	0.012	6		
Gonatus spp.			0.081	8
Great Sculpin			0.124	1
Eelpouts	0.003	3		
Flatfish (Larv)	0.008	10		
Fried Egg Jellyfish	0.140	2*		
Greenland Halibut (Larv)	0.006	6	0.002	2
Euphausiids	0.001	*		
Lion's Mane	43.092	1336*	63.617	505*
Longhead Dab (Larv)			0.002	2
Moon jelly			1.941	38*
Nine-spine Stickleback			30.734	33537
Pacific Cod (Age 0)			0.008	2
Pacific Herring (Age 0)			488.168	186430
Pacific Herring	74.012	576	653.638	14628
Pacific Sand Lance (Age 0)	0.195	462	0.001	1
Pink Salmon (Juv)	2.721	184	98.376	2980
Poacher, unident.	0.001	1		
Pollock (Age 0)			2.021	715
Pollock (Age 1)	0.014	2	91.090	2790
Pollock			1.272	2
Prickleback	0.160	334	0.001	1
Rainbow Smelt (Age 0)			1.697	310

Table 3 (Con't). Total weight and number of marine fishes and invertebrates caught during surface trawl sampling during the Arctic Ecosystem Integrated Survey (Arctic Eis, 2013) in the Chukchi Sea and Northern Bering Sea.

	Chukchi Sea		Northern Bering Sea	
Common Name	**Total Weight (kg)**	**Total Number**	**Total Weight (kg)**	**Total Number**
Rainbow Smelt	0.079	1	18.349	563
Rockfish, unident.			0.001	1
Saffron Cod (Age 0)	3.436	3222	1.173	279
Saffron Cod			1.667	22
Sculpins, super-family	0.087	10		
Scyphozoa, unident.	0.016	*	0.111	*
Sea Nettle	940.010	1743*	6571.444	4773*
Shorthorn sculpin	0.823	1202		
Shrimp, unident.	0.004	4*		
Snailfish, unident.	0.002	2		
Sockeye Salmon (Imm)			1.160	1
Sockeye Salmon (Juv)			0.622	7
Squid, unident.			0.012	2
Starry Flounder			1.640	5
Sturgeon Poacher			0.131	2
Tubenose poacher			0.002	1
Whitecross jellyfish	0.024	*	0.001	*
Whitespotted Greenling			0.348	40
Yellowfin Sole			1.325	10
Salps, unident.	0.002	1*		
Veteran Poacher	0.001	1		

* Many gelatinous or invertebrate species were not in suitable condition to generate count estimates. These numbers represent the total catch from stations with an adequate sample size to calculate a total catch number from the total biomass, and are not representative of the entire survey.

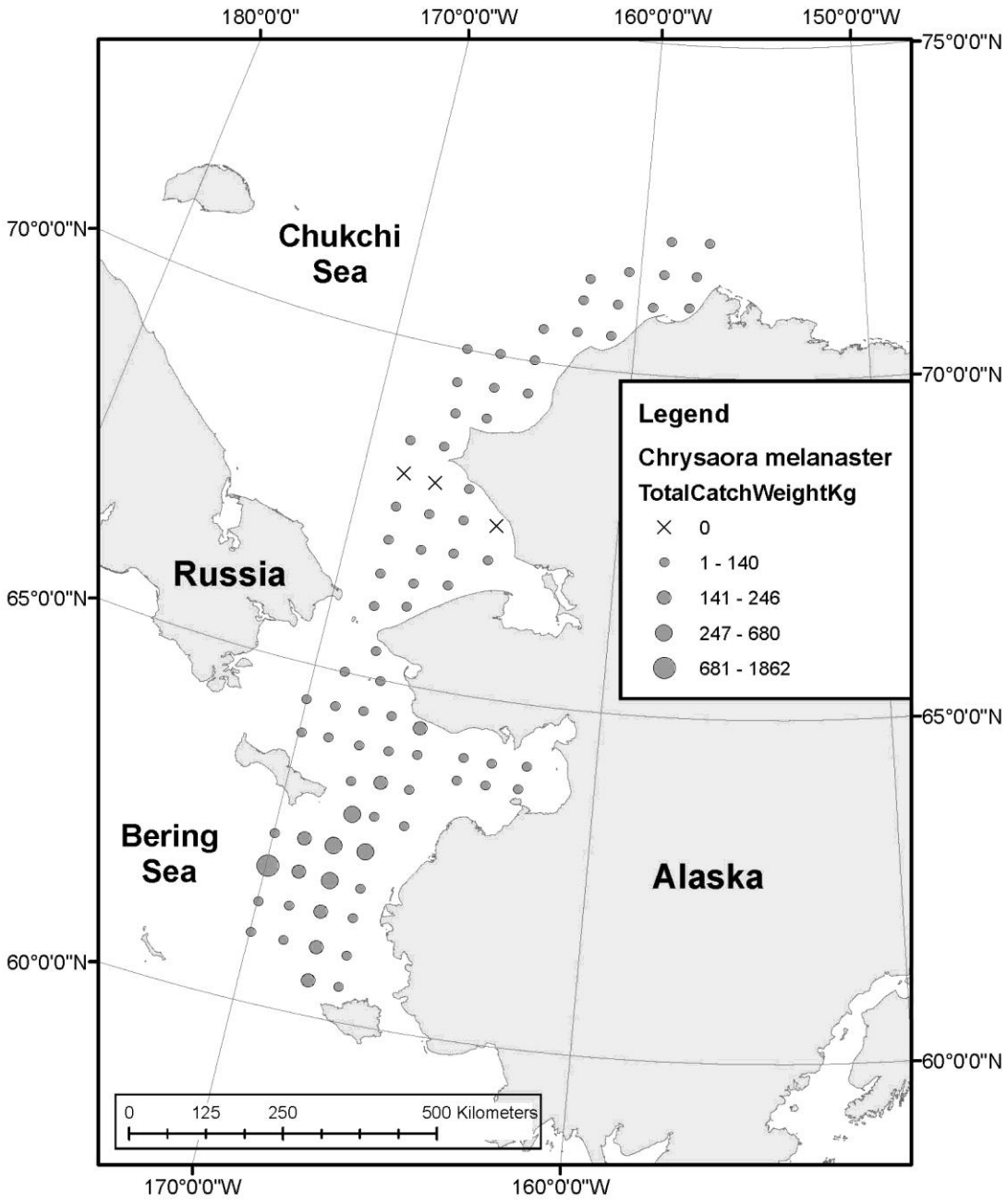


Figure 15. Surface trawl catch distribution of *Chrysaora melanaster* (weight (kg)) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

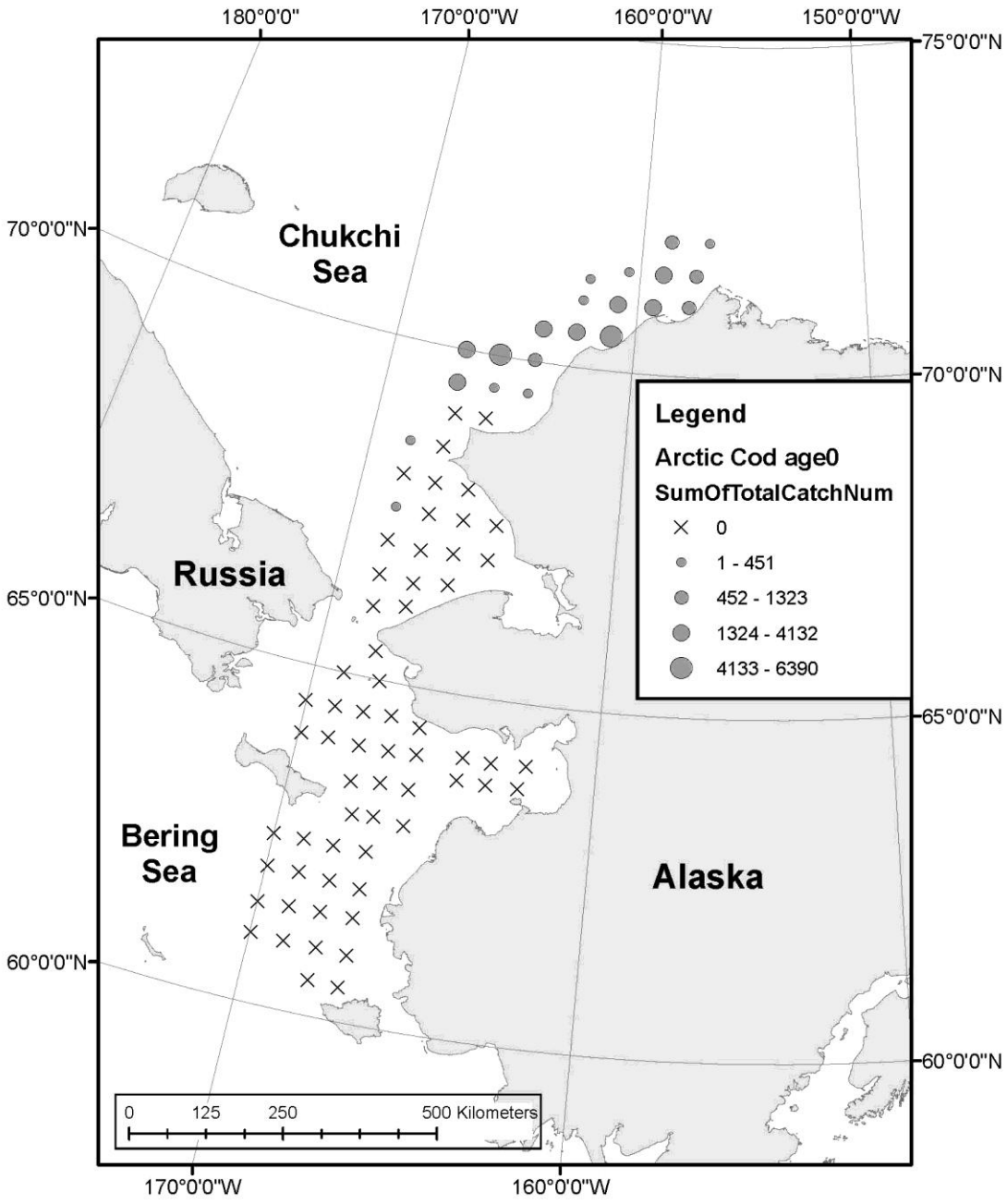


Figure 16. Surface trawl catch distribution of age-0 Arctic cod (number of fish) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

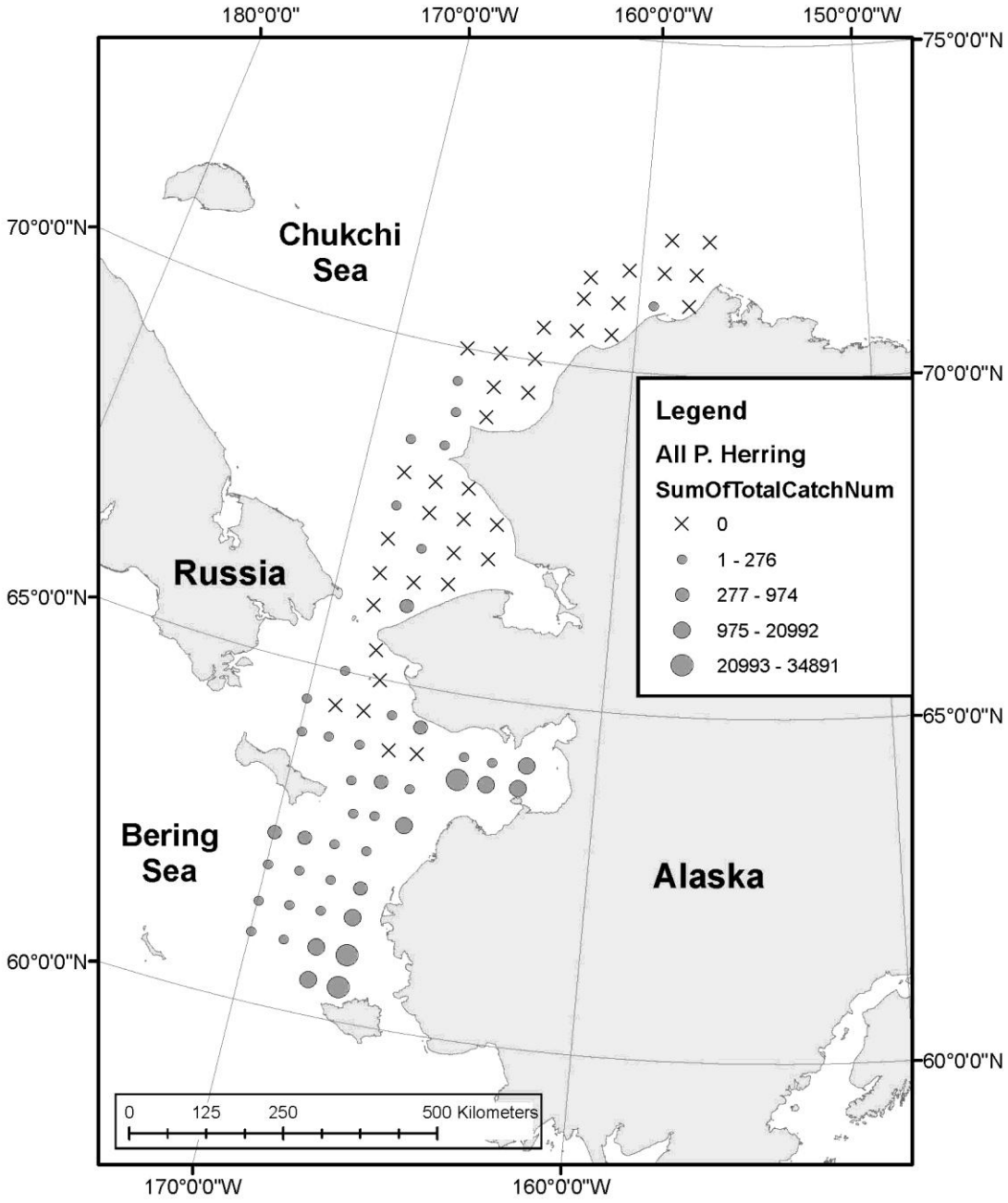


Figure 17. Surface trawl catch distribution of Pacific herring (number of fish) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

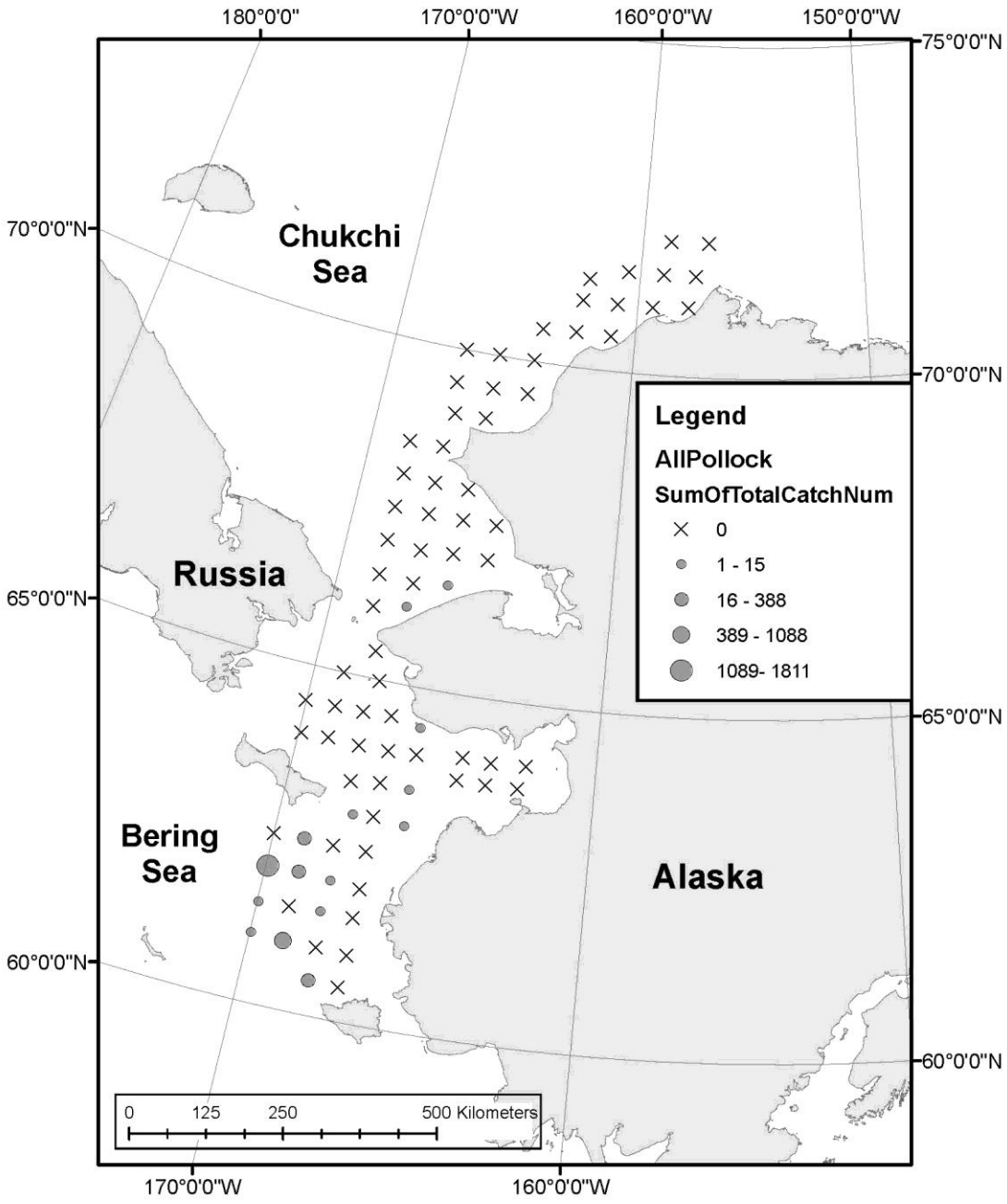


Figure 18. Distribution of walleye pollock (number captured in the trawl) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

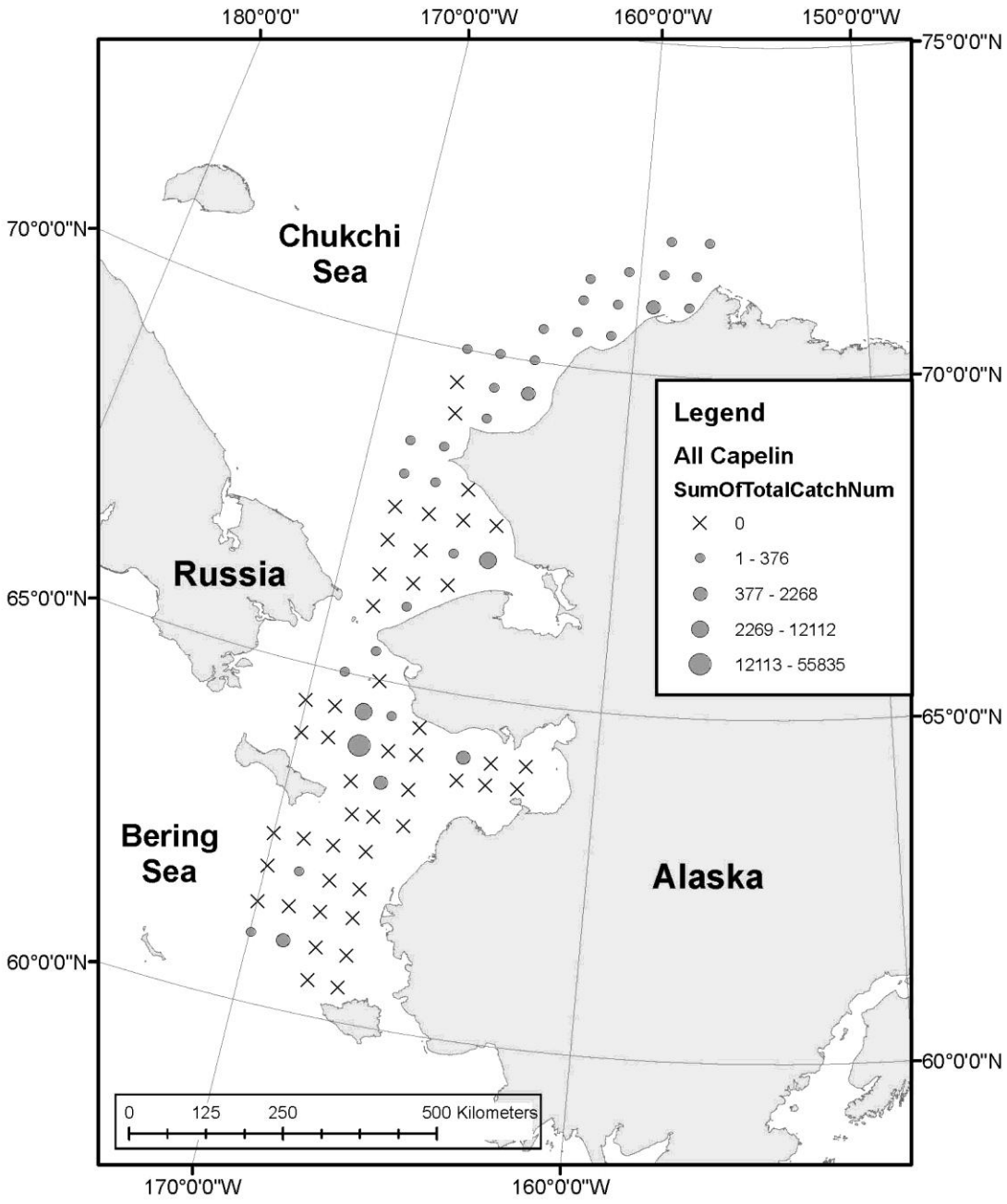


Figure 19. Surface trawl catch distribution of capelin (number of fish) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

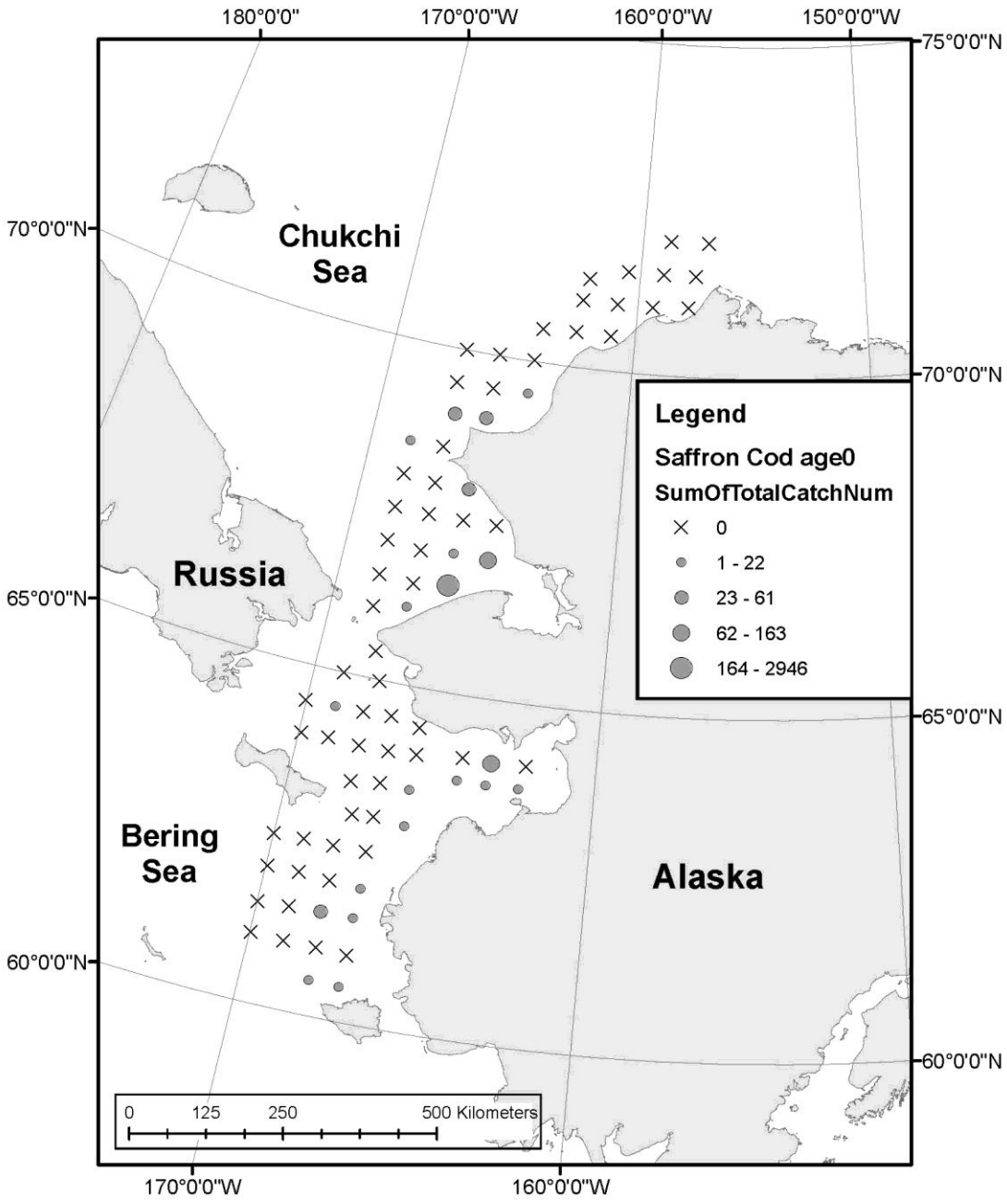


Figure 20. Surface trawl catch distribution of age-0 saffron cod (number of fish) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

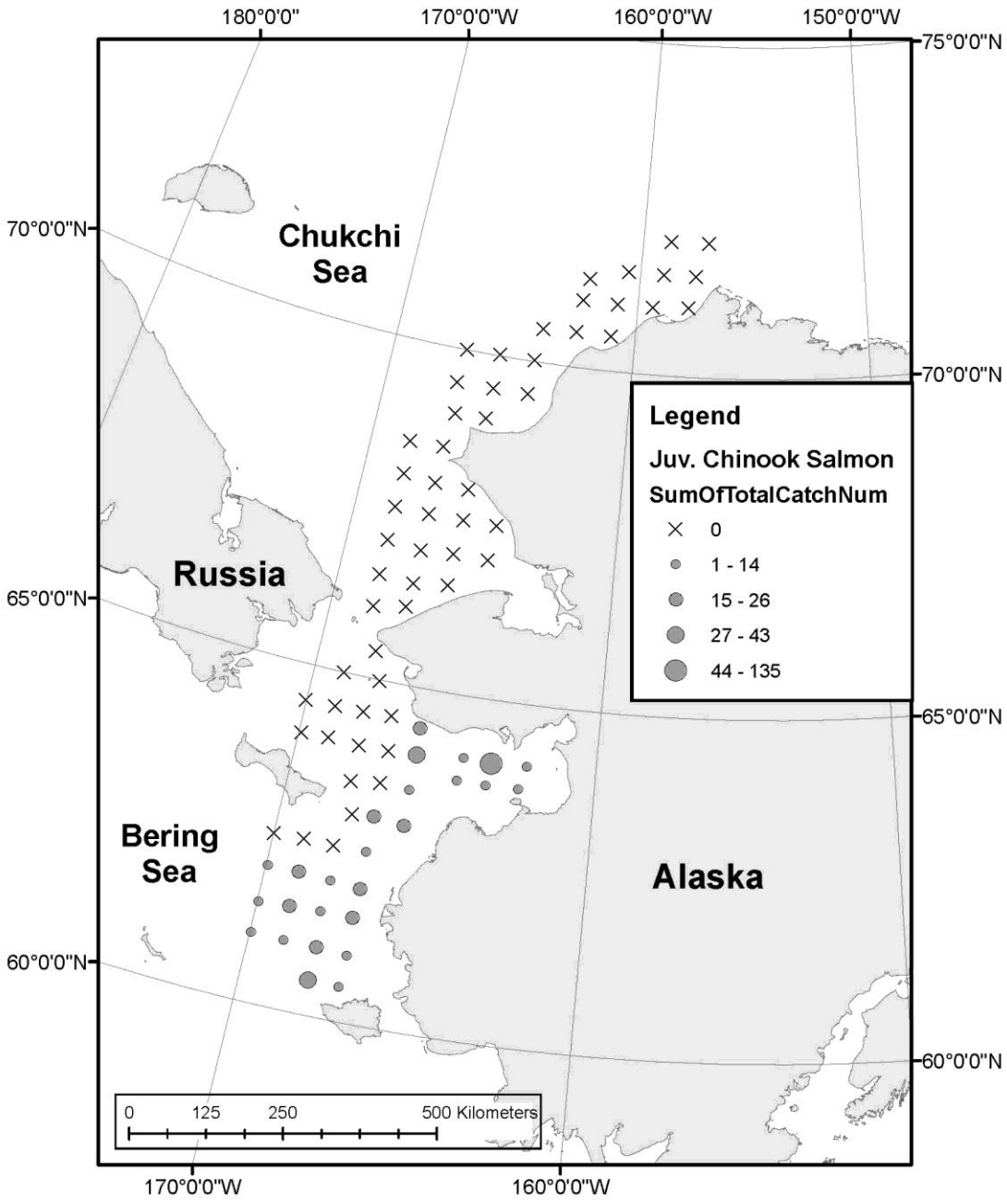


Figure 21. Distribution of juvenile Chinook salmon (number captured in the trawl) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

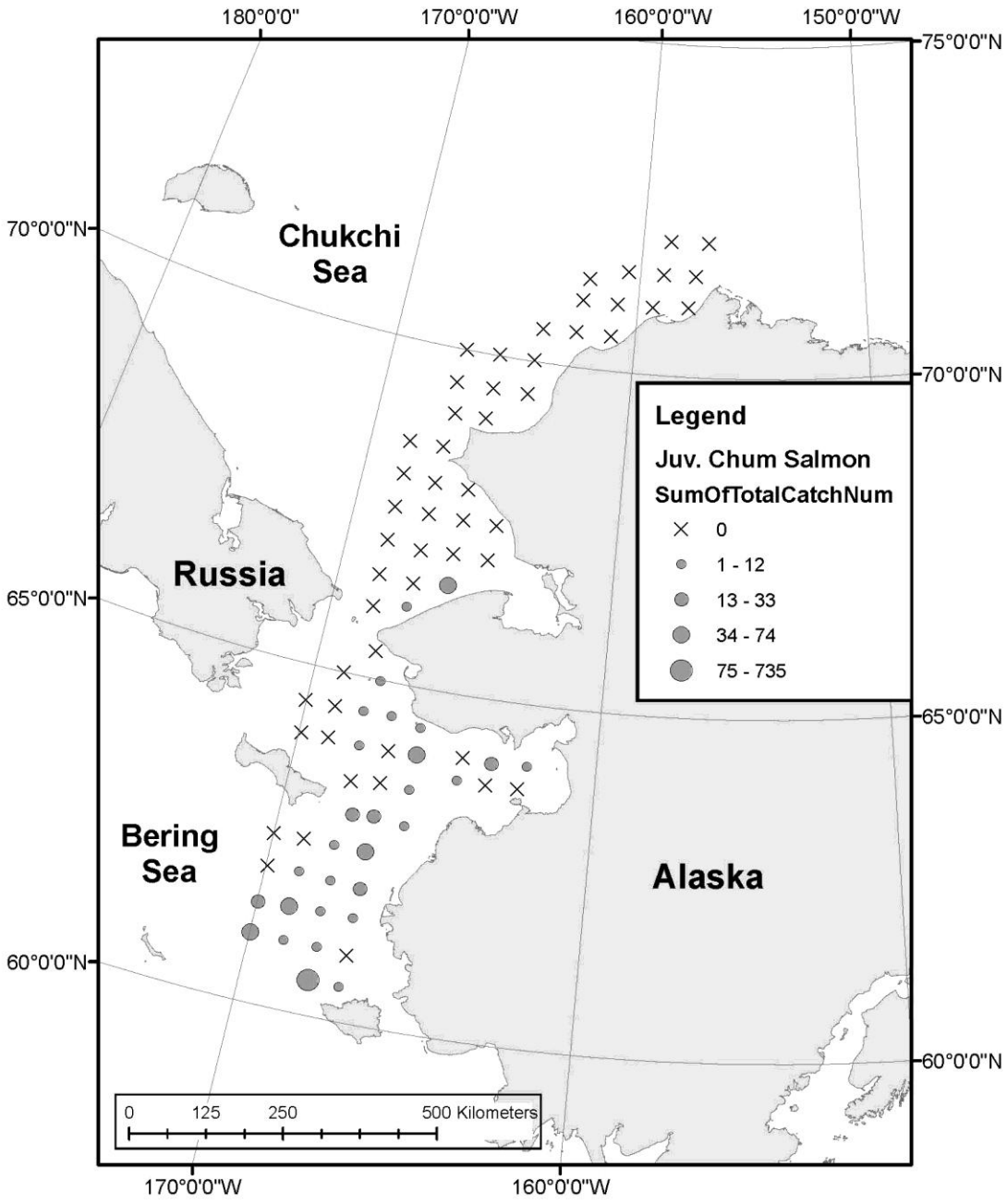


Figure 22. Distribution of juvenile chum salmon (number captured in the trawl) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

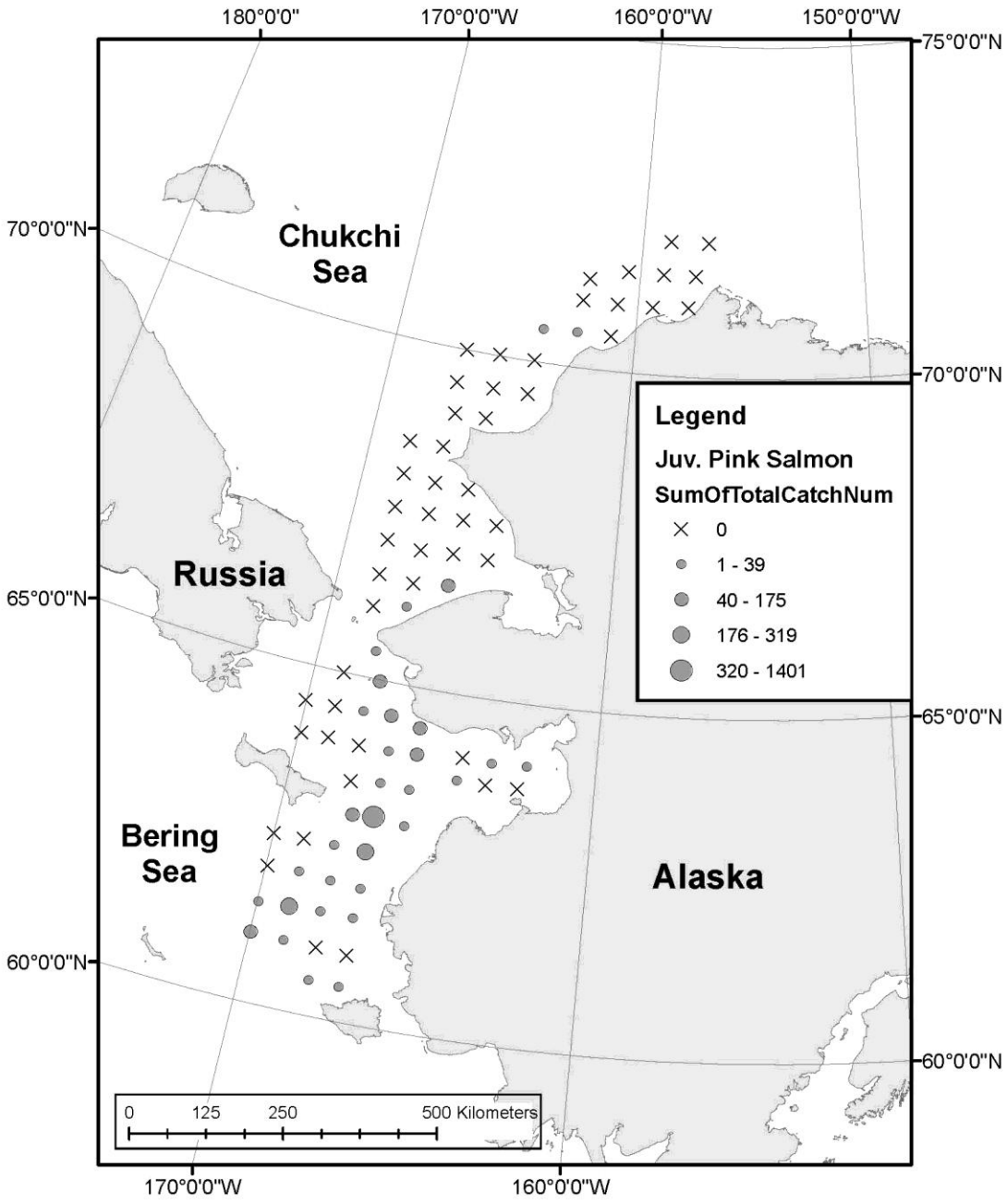


Figure 23. Distribution of juvenile pink salmon (number captured in the trawl) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

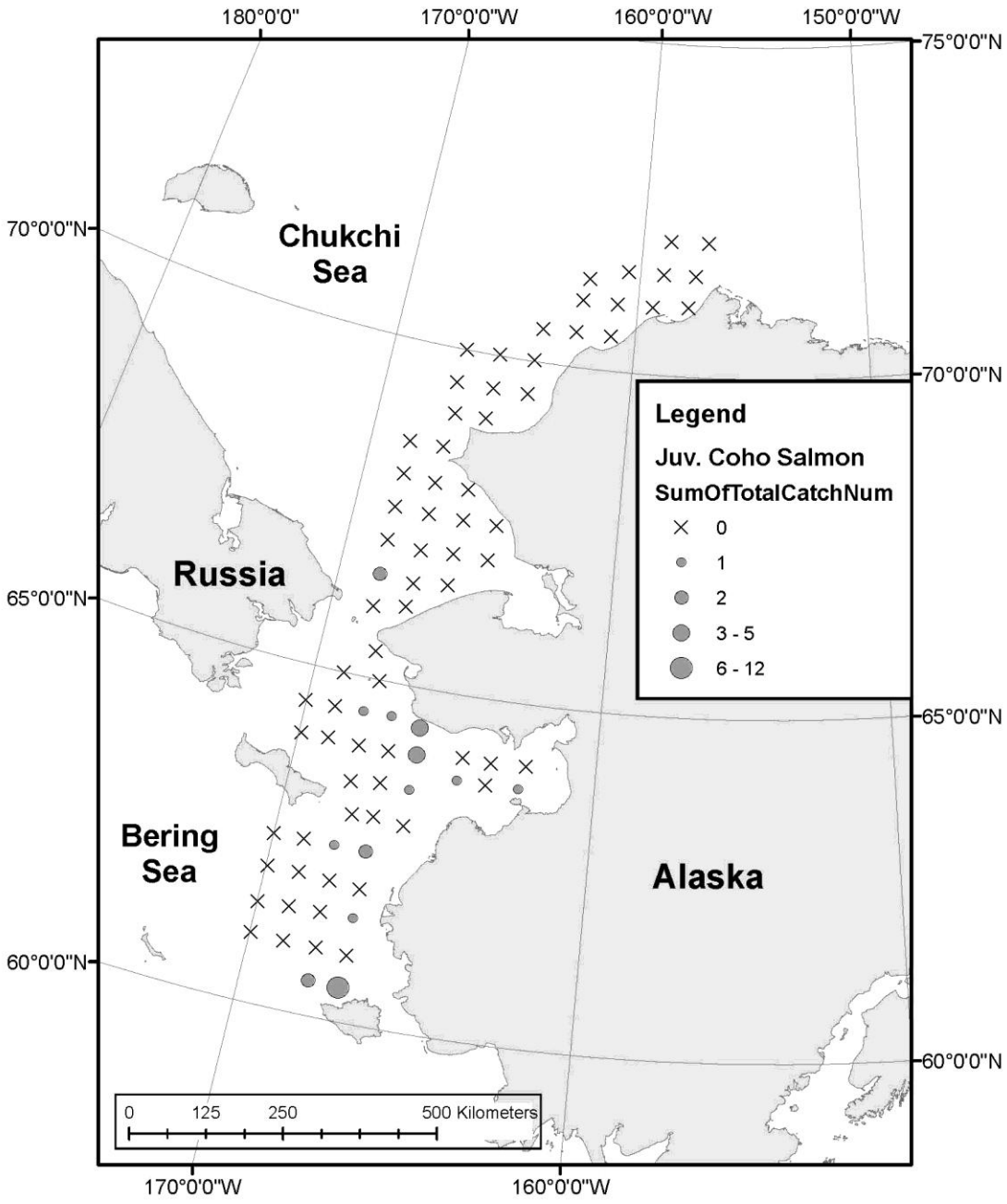


Figure 24. Distribution of juvenile coho salmon (number captured in the trawl) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

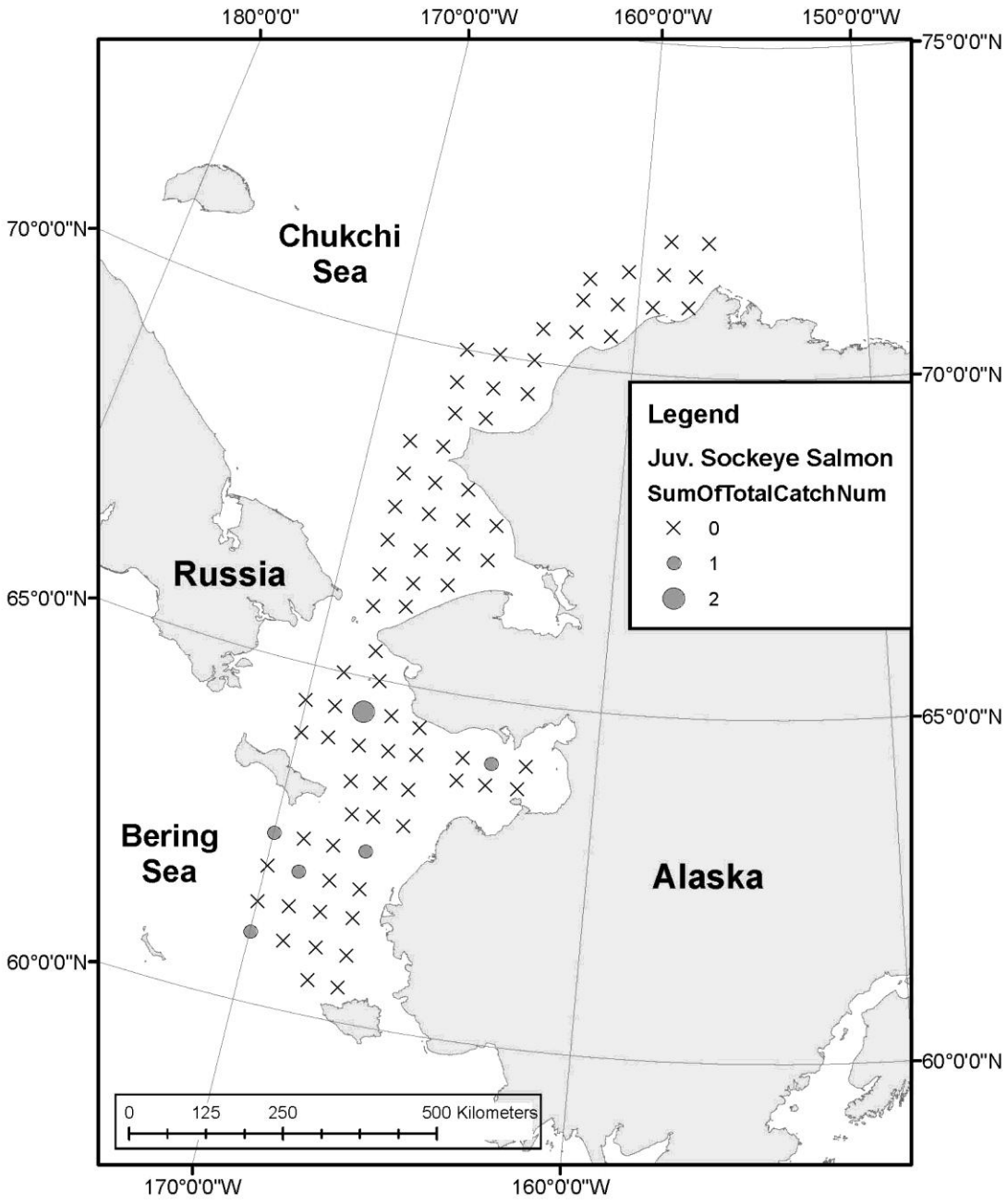


Figure 25. Distribution of juvenile sockeye salmon (number captured in the trawl) during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

JUVENILE CHINOOK SALMON ABUNDANCE INDEX

Jim Murphy (AFSC Principal Investigator)
Katie Howard (ADFG Regional Research Supervisort)

Significant harvest restrictions, including the closure of commercial fisheries and reductions in subsistence fisheries, have been implemented in response to declining production levels of Yukon River Chinook salmon stocks. Causes of their production decline are unclear; however concurrent declines throughout the Yukon River drainage, production declines in other regions of Alaska, and the presence of bycatch in marine fisheries all emphasize the influence of broad-scale multi-stock dynamics. Improved understanding of processes impacting marine survival provides insight into production dynamics at this ecological scale.

The development of a juvenile Chinook salmon abundance index in the northern Bering Sea has been the focus of previous juvenile research. A preliminary estimate of the 2013 juvenile abundance index is included to allow survey data from 2013 to be placed within the context juvenile production for the last 10 years (Table 4). Data from 2003-2011 are reported in Murphy et al. (2013). The 2013 juvenile abundance index is the highest year on record, approximately 30% higher than 2003, which has been the largest juvenile index for the past nine years. Analysis of the CTD and genetic data collected during 2012 and 2013 are not yet complete; these data are required for the standardized index (Canadian Juvenile Index) that is linked to the adult population.

Table 4. Juvenile Chinook salmon abundance index, mixed layer depth (MLD) correction, Canadian-origin stock proportions, and the Canadian-origin juvenile index for Northern Bering Sea surface trawl surveys.

Juvenile Year	Juvenile Index (1,000s)	MLD correction	Canadian Stock Proportion	Canadian Juvenile Index (1,000s)
2003	4,728	0.14	0.43	2,302
2004	2,064	0.12	0.52	1,189
2005	2,563	0.29	0.47	1,556
2006	1,179	0.13	0.46	608
2007	2,748	0.16	0.48	1,523
2008				
2009	1,846	0.01	0.45	842
2010	1,558	0.05	0.43	702
2011	3,209	0.16	0.46	1,703
2012[1,2]	1,223	*NA*	*NA*	*NA*
2013[1,2]	6,222	*NA*	*NA*	*NA*

1 -- Juvenile Index is preliminary.
2 – Mixed layer depth correction and Canadian-origin stock proportions not available.

References

Murphy, J., K. Howard, L. Eisner, A. Andrews, W. Templin, C. Guthrie, K. Cox, and E. Farley. 2013. Linking abundance, distribution, and size of juvenile Yukon River Chinook salmon to survival in the Northern Bering Sea. North Pacific Anadromous Fish Commission Technical Report 9:25-30.
http://www.npafc.org/new/publications/Technical Report/TR9/Murphy et al.pdf

MIDWATER TRAWL AND ACOUSTIC DATA

Alex De Robertis (AFSC Principal Investigator)
Chris Wilson (AFSC Principal Investigator)
Kevin Taylor (AFSC, Ocean Associates)*

A modified Marinovich box trawl (hereafter mod-Marinovich) was used to target the acoustic backscatter throughout the water column (Figure 26). The trawl total length was 21.3 m. Headrope, footrope, and breastline lengths were 7.6 m each. Mesh sizes tapered from 6.4 cm (2.5 in.) in the leading part of the trawl to 3.8 cm (1.5 in.) in the codend. The aft 3.4 m of the codend was fitted with a 2x3 mm oval mesh liner. The trawl was fished with 55 m (30 fathom) bridles and the 5 m^2 alloy doors used with the Cantrawl. The trawl mouth opening was about 6 m in the vertical and 8 m in the horizontal when towed at speeds of 2.5 -3.5 knots.

The selectivity of the mod-Marinovich trawl was quantified by permanently attaching 8 recapture nets to the outside of the trawl to capture organisms that were not retained. The methods for this selectivity work generally followed those developed by Williams *et al.* (2011). The recapture bags were approximately 4.6 m (15 ft) long with a nominal mouth opening of roughly 0.46 m^2 (5 ft^2), and constructed of 2x3 mm oval mesh. An analysis of the selectivity of the mod-Marinovich trawl from recapture net analysis is currently underway.

A standard sphere calibration to characterize the sensitivity of the 38 and 120 kHz ES60 split beam echosounder aboard the *F/V Bristol Explorer* was attempted in Captain's Bay before leaving Dutch Harbor on 04 August 2013, but a nonfunctioning CTD resulted in uncertain calibration results. A more accurate sphere calibration was accomplished with a functioning CTD on 13 August 2013 while the vessel was drifting in the Chukchi Sea. The system gain values from this calibration were within 0.2 dB (5 % in linear units) and 0.3 dB (7% in linear units) of the 2012 calibrations for the 38 and 120 kHz echosounders, respectively.

Acoustic backscatter was continuously recorded during the duration of the cruise for all three legs (Figure 27). An AFSC acoustician was onboard for the first two legs of the project, which covered the Chukchi Sea. Large aggregations of age-0 Arctic cod dominated the backscatter north of 69° N. Jellyfish (primarily *Chrysaora melanaster* and *Cyanea capillata*) and a mixture of fishes (primarily juvenile stages of saffron cod, capelin, sculpin, and sand lance) were also observed throughout the Chukchi Sea survey area. Several dense aggregations of Pacific herring were observed just north of the Bering Strait. Substantial backscatter was also observed from age-0 saffron cod between Point Hope and Kotzebue Sound in the nearshore region. About 66% of the backscatter was observed below the ~20 m depth sampled by the surface Cantrawl hauls. The presence of sea ice in the northern part of the Chukchi Sea required modifications to the survey track line. Bubbles introduced under the transducers in rough seas degraded the acoustic data quality in some cases. Acoustic backscatter collected on leg 3 has not yet been analyzed or quality checked.

A total of 50 mod-Marinovich trawl hauls targeted the dominant acoustic layers to provide species classification and other biological information necessary to convert the acoustic data into estimates of animal abundance. Fourteen of these hauls were paired with the Cantrawl surface trawl hauls to estimate the trawl selectivity between these two nets (Figure 28).

A reconnaissance survey along the western edge of the Beaufort Basin shelf break including Barrow Canyon was conducted during 6-7 September (i.e., NE corner of the Chukchi study area, see Figure 28). The objective of this survey effort was to determine whether acoustically detectable levels of age 1+ Arctic cod existed in the deeper waters over the shelf break. Deeper areas in the vicinity of the shelf break were not surveyed in 2012. Six transect lines were oriented perpendicular to bathymetric contours between about 50m to 1300m bottom depths. Three mod-Marinovich trawl hauls were used to classify the scattering layers during this reconnaissance survey. No dense fish aggregations were observed in deep water, although a low intensity scattering layer was detected at 250m in the center of Barrow Canyon over bottom depths of about 325-350 m (Figure 29). A mod-Marinovich haul of 1-hr duration targeted the deep layer and yielded 44 age 1+ Arctic cod and 141 age-0 Arctic cod. Upon retrieval of the trawl, it was discovered that one of the recapture nets had become entangled with the codend, and likely affected the catch retention rate. A second haul targeting the near-surface layer yielded no age 1+ Arctic cod and 952 age-0 Arctic cod. This suggests that the deep scattering layer was composed mostly of age 1+ Arctic cod, whereas the shallow scattering layer was mostly age-0 Arctic cod.

The flooding aboard the Bristol Explorer resulted in the loss of scientific equipment and some data from time-depth recorders used to measure the depth of the net.

References

Williams, K., Punt, A. E., Wilson, C. D., and Horne, J. K. 2011. Length-selective retention of walleye pollock, Theragra chalcogramma, by midwater trawls. – ICES Journal of Marine Science, 68: 119–129.

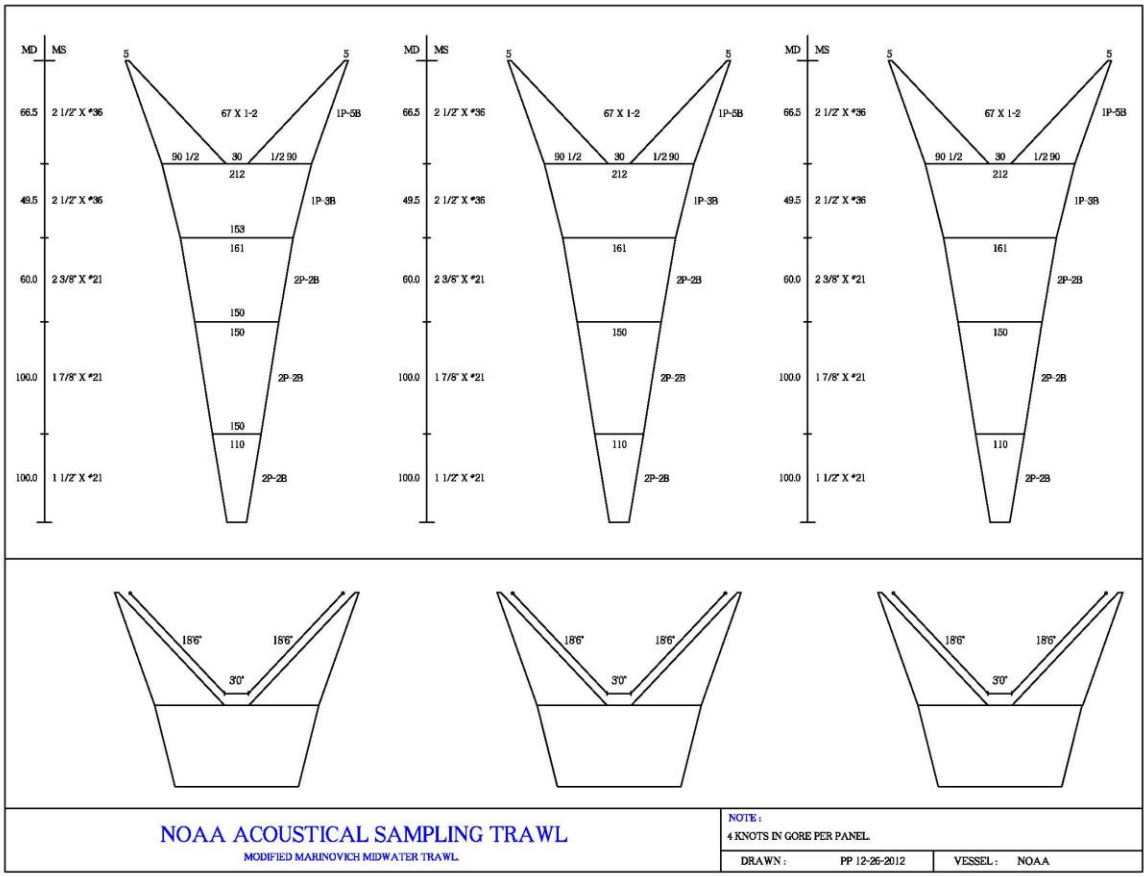


Figure 26. Net diagram of the modified Marinovich trawl used during midwater trawl stations during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

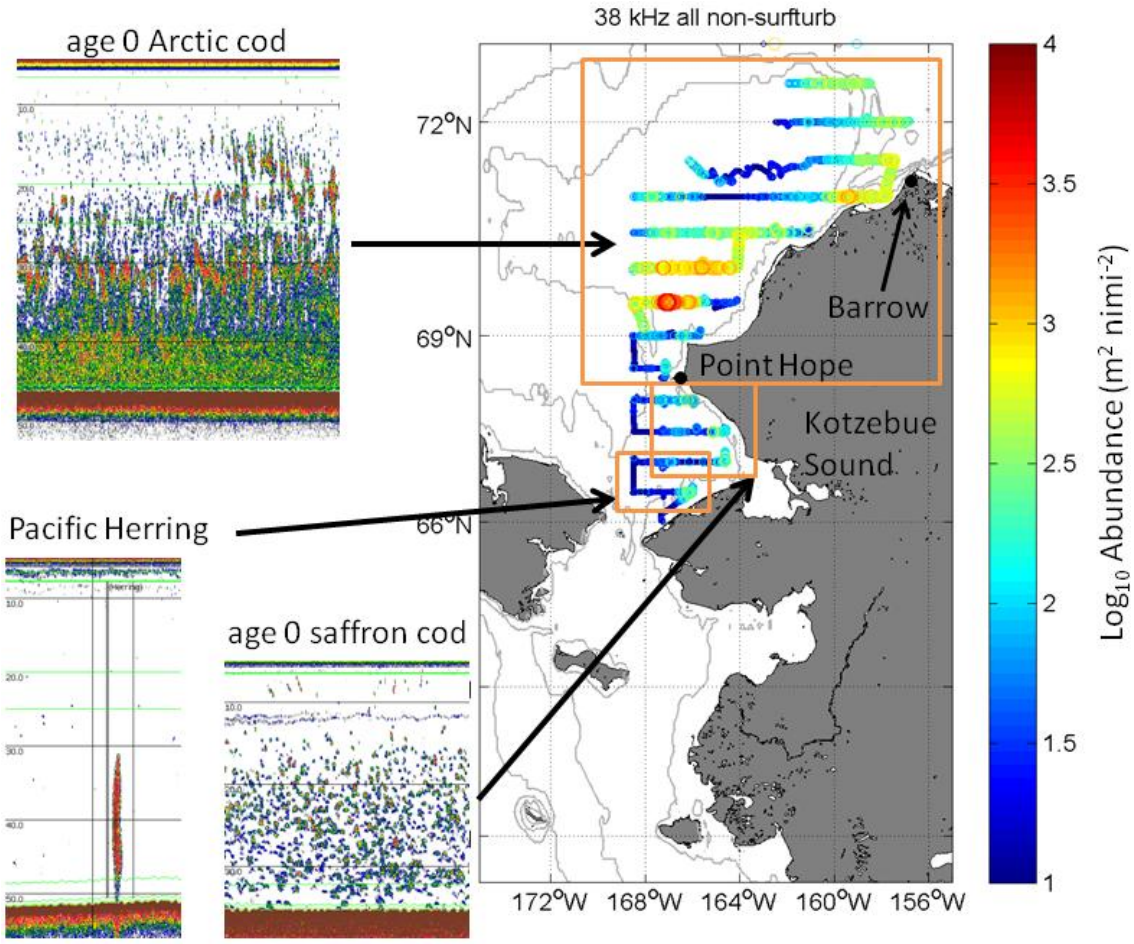


Figure 27. Preliminary map of acoustic backscatter strength observed along the cruise track from fishes and jellyfish during legs 1 and 2. Boxes demarcate areas of high backscatter that were dominated by age-0 Arctic cod, age-0 saffron cod, or Pacific Herring and example echograms of each species are shown. Symbol size and color along the ship track are proportional to the logarithm of acoustic backscatter and fish abundance. The 25, 50, 70, and 200 m depth contours are depicted as gray lines.

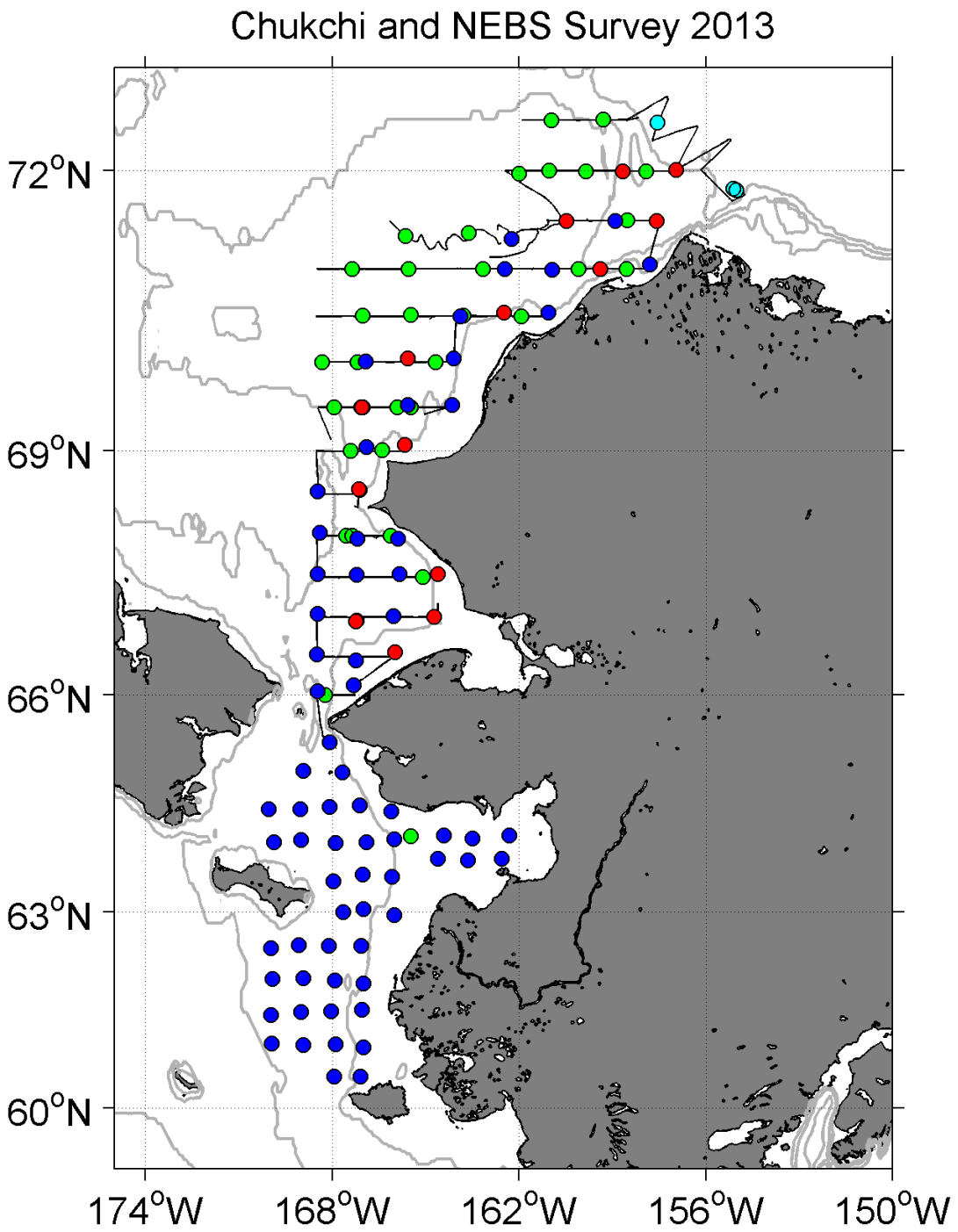


Figure 28. Haul locations using Cantrawl surface trawl (blue dots), modified Marinovich midwater trawl (green dots) and where paired trawling occurred (red dots). The vessel track during Legs 1 and 2 is depicted as a black line connecting stations in the Chukchi Sea. The cross bathymetric transects and cyan dot symbols north of Barrow (~72˚N, northeast corner of image) represent the reconnaissance survey for age 1+ Arctic cod. The 25, 50 and 100m bathymetric lines are depicted as gray lines.

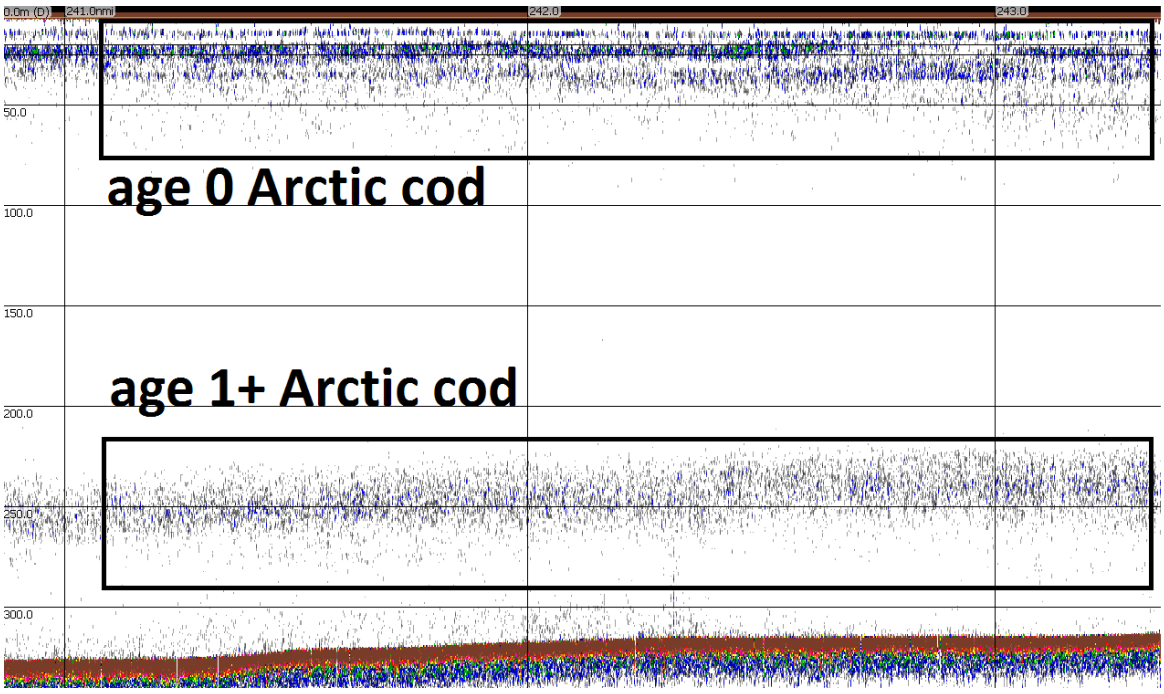


Figure 29. Echogram of age 1+ Arctic cod in Barrow Canyon from reconnaissance survey. The scattering layer centered near 20 m was dominated by age-0 Arctic cod. The deep scattering layer is attributed to low densities of age 1+ Arctic cod. Modified Marinovich trawl hauls targeted both the shallow and deep scattering layers for species classification.

MARINE BIRDS AND MARINE MAMMAL OBSERVATIONS

Kathy Kuletz (USFWS Principal Investigator)
Tamara Zeller and A. Catherine Pham (USFWS observers)
Elizabeth Labunski (USFWS GIS).

Introduction

In conjunction with the 2013 Arctic Ecosystem Integrated Survey (Arctic Eis), the U.S. Fish and Wildlife Service (USFWS) conducted marine bird and mammal surveys concurrent with oceanographic and biological sampling onboard the *F/V Bristol Explorer*. A single observer conducted surveys on each of three Arctic EIS cruise legs, with Tamara Zeller on leg 1 and Athena Catherine Pham on legs 2 and 3. Processed data will be archived in the North Pacific Pelagic Seabird Database (USFWS and US Geological Survey, 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'.

The cruise departed Dutch Harbor, AK on the *F/V Bristol Explorer* on 3 August 2013 for surveys in the Chukchi Sea and the northern Bering Sea, and returned to Dutch Harbor on 28 September. The cruise consisted of three legs, each encompassing a different area: August 1 – 19 in the southern Chukchi Sea, August 20 – September 11 in the northern Chukchi Sea and into the Beaufort basin, and September 12 – 28 in the northern Bering Sea. Over the course of the entire cruise we surveyed a total of 5,686 km within the Arctic Eis study area and 445 km during Bering Sea transits. In total, we recorded 39 species of birds, with 18,354 birds on transect and 28,866 birds off transect (outside our survey window of 300m). We also recorded 13 species of marine mammals, with 113 on transect and 1812 off transect.

Methods

Seabird surveys were conducted whenever the vessel was traveling and visibility was at least 100m. All sightings within 300m and a 90° arc forward from the line of travel were recorded. Birds, marine mammals, and debris on the water were recorded continuously, while flying birds were recorded during 'scans' at intervals of typically ~ 1 min^{-1} (depending on vessel speed) to avoid overestimating. We recorded the species, number of individuals, behavior (on water, on ice, during scan, flying), and distance bin (0-100m, 101-200m, 201-300m). For rare birds or mammals or unusual events or large groups of animals we recorded sightings beyond 300m (off transect), but these will not be included in density calculations. Identification was to the most accurate taxonomic level possible. Environmental variables such as sea state, weather, and ice cover were recorded and updated as necessary.

All surveying was conducted from the port side of the bridge, with data entered directly into a laptop computer using survey software DLog3 (A.G. Ford, Inc., Portland OR) and set to Greenwich Mean Time. The vessel's GPS could not be used, thus we used a Garmin 60CSx connected to the laptop for continuous latitude and longitude coordinates.

Binoculars (10x42) were used to aid in identification, and a digital camera was occasionally used to confirm identification. A marked wooden dowel was used to verify distance estimates.

Results

Leg 1

During leg 1, 66 transects (mean = 1.8 hrs) were completed with at total survey time of 120.5 hours over 16 days. Surveys were conducted from Dutch Harbor to Point Hope with stops in Nome on 6 August to drop off a malfunctioning CTD and back to Nome on 19 August for crew change. Survey conditions were variable with some heavy fog at times but weather or sea state did not preclude surveying on any day during leg 1. In general, most bird and marine mammal sightings during leg 1 occurred from Dutch Harbor to St. Matthew Island in the southern Bering Sea, although there were isolated "hot spots" near Cape Thompson (near a seabird colony) and Hope Basin (Gray Whale feeding area) in the southern Chukchi Sea. Norton Sound was particularly lacking in bird life although two Minke Whales (*Balaenoptera acutorostrata scammoni*) were observed breaching in this area.

A total of 29 identifiable bird species were observed on leg 1 (Table 4). The Northern Fulmar (*Fulmarus glacialis*) was the most abundant species making up 38% of all on-transect sightings; the majority were sighted between Dutch Harbor and St. Matthew Island. Several fulmars were also observed foraging on *Melanaster* spp (jellyfish) and may have been feeding on the zooplankton associated with these jellyfish species (Ed Farley, personal communication). The next most abundant species were Short-tailed Shearwaters (*Puffinus tenuirostris,* 8%; Figure 30+31*)*, Thick-billed Murres (*Uria lomvia,* 8%*)* and Common Murres (*U. aalge*, 5%; Figure 32), and Black-legged Kittiwakes (*Rissa tridactyla*, 7%). Many murres of both species were observed with small fish in their bills, presumably to be delivered to chicks at their colonies.

Other sightings of note were three Marbled Murrelets (*Brachyramphus marmoratus*), two in breeding plumage and one bird in black and white basic plumage, and one Kittlitz's Murrelet (*Brachyramphus brevirostris*) in breeding plumage, all observed south of St. Matthew Island. Ancient Murrelets (*Synthliboramphus antiquus*) with chicks were also observed south of St. Matthew Island. A kittiwake presenting plumage characteristics consistent with a Black-legged Kittiwake but with orange legs was observed in Bering Strait and large numbers of Red Phalaropes (*Phalaropus fulicarius)* (Figure 33) were noted in association with Gray Whales (*Eschrichtius robustus*) (Figure 34) feeding in the Hope Basin of the southern Chukchi Sea. Foraging flocks of birds were noted near Cape Thompson and consisted of murre spp., kittiwakes, large gulls, and other large alcids. Several large flocks of eiders were also observed between Point Hope and Cape Thomson but were too far away to verify species.

Northern Fur Seals (*Callorhinus ursinus*) and Dall's Porpoise (*Phocoenoides dalli*) were the most abundant marine mammals on transect during leg 1. All the fur seals were observed between Dutch Harbor and St. Matthew Island. We did not encounter any

debris during this leg. Three dead birds were observed on transect, including Ancient Murrelet, Northern Fulmar, and a male Spectacled Eider (*Somateria fischeri)*. All dead birds were observed individually but were encountered within a 3 hour time period, just north of St. Matthew Island.

Leg 2

During leg 2, 114 transects (mean = 1.5 hrs) were conducted for a total of 179.3 hours over 22 days. On 3 September AST, no surveys were conducted due to rough seas. Additionally, the northernmost transects were constrained by the presence of ice. A total of 36 bird species were recorded with Short-tailed Shearwaters the most abundant at 28% of all on-transect sightings (Table 4). The highest numbers of shearwaters were seen along the northern coast of Alaska between Point Franklin and Point Barrow (Figure 31); they were sighted in varying numbers each day but were completely absent within the ice. Second most abundant were the Red and Red-Necked Phalaropes at 20% of all on-transect sightings. Phalaropes were particularly concentrated along the ice edge where they were observed feeding (likely on algae-grazing zooplankton); they were also seen in relatively high numbers in association with Gray Whales and in the vicinity of Ledyard Bay and Icy Cape (Figure 33). These phalaropes were all in the process of molting, which complicated species identification.

Other common species (≥1% of all on-transect sightings) included Black-legged Kittiwakes, Crested Auklets (*Aethia cristatella*) and Least Auklets (*A. pusilla*) (Figure 35), Common and Thick-billed Murres, and Tufted Puffins (*Fratercula cirrhata*) (Table 4). Most, if not all, Crested Auklets sighted on this leg appeared to be flightless, and a number of these were definitely molting their flight feathers, indicating that the Chukchi might be an important molting area. While a number of the congeneric Least Auklets appeared to be molting based on the appearance of their plumage, few, if any, appeared to be flightless.

Bird sightings of note during leg 2 included a Snowy Owl (*Bubo scandiacus*) over the Beaufort basin, a large number of flocks of Pacific Loons (*Gavia pacifica*) flying west over the Beaufort basin, a pair of Peregrine Falcons (*Falco peregrinus*) near King Island, a Thayer's Gull (*Larus thayeri*), and Spectacled Eiders. The Snowy Owl and Pacific Loons were sighted while the vessel was conducting exploratory acoustics transects along the edge of the Beaufort Sea.

During leg 2 we sighted seven species of marine mammals (Table 5). Noteworthy were the 1 September sightings of a Polar Bear (*Ursus maritimus*) loafing on an ice cake and ~ 20 groups of Pacific Walrus (*Odobenus rosmarus divergens*, Figure 34); the walrus totaled in the hundreds and possibly over one thousand, and were hauled out on ice cakes in close proximity to each other. Other marine mammal sightings included Gray Whales, Humpback Whales (*Megaptera novaeangliae*), Bearded Seals (*Erignathus barbatus*), a Ribbon Seal (*Histriophoca fasciata*), and Orcas (*Orcinus orca*). We recorded 17 pieces of marine debris, none of which appeared to be of Japanese origin.

Leg 3

During leg 3, 44 transects (mean = 1.9 hrs) were conducted for a total of 84.6 hours over 13 days. Rough weather precluded surveys on part or all of the days on September 17 and 24-27. A total of 38 bird species were sighted during leg 3, although the abundance of birds was greatly reduced compared to leg 2 (Table 4). The most common species was the Least Auklet, which made up 32% of all on-transect sightings. Nearly all of these sightings (95%) were in the Chirikov Basin north of St. Lawrence Island (Figure 35), where they were observed foraging; a few of these birds appeared to be flightless. The next most abundant species was the Short-tailed Shearwater at 28% of all on-transect sightings.

Other commonly sighted species on leg 3 included Ancient Murrelets, Black-Legged Kittiwakes, Common and Thick-billed Murres, Crested Auklets, Parakeet Auklets (*Aethia psittacula*) (Figure 35), and Red and Red-Necked Phalaropes (Figure 33, Table 4). Most alcids sighted on leg 3 were seen foraging in the vicinity of St. Lawrence Island (i.e. auklets, Figure 35). Species of interest sighted during this leg included a Marbled Murrelet, a Red-Breasted Merganser (*Mergus serrator*), a Red-Necked Grebe (*Podiceps grisegena*), Spectacled Eiders, Steller's Eiders (*Polysticta stelleri*), a Vega Gull (*Larus argentatus vegae*), and Yellow-Billed Loons (*Gavia adamsii*) (Table 4).

There were few marine mammals sighted during this leg - only four Gray Whales off transect and two Minke Whales on transect were recorded (Table 5). On leg 3, 25 pieces of marine debris were recorded, none of which appeared to be of Japanese origin.

Figure 30. Short-tailed Shearwater. (Photo Credit: Catherine Pham)

Table 5. Marine birds observed during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013. Birds on transect were within 300m of one side of the vessel. Counts include transits from/to Dutch Harbor, outside the Arctic Eis area.

	Leg 1		Leg 2		Leg 3		Total		
Species	**On transect**	**%**	**On transect**	**%**	**On transect**	**%**	**On transect**	**%**	**Off transect**
Pacific Loon	1	0.03	28	0.27	5	0.13	34	0.19	87
Red-Throated Loon	.	.	2	0.02	1	0.03	3	0.02	1
Yellow-Billed Loon	.	.	1	0.01	3	0.08	4	0.02	6
Gavia spp.	.	.	9	0.09	0	0	9	0.05	42
Northern Fulmar	1506	38.25	86	0.82	45	1.15	1637	8.92	156
Sooty Shearwater	.	.	.	.	1	0.03	1	0.01	0
Short-Tailed Shearwater	315	8.00	5756	54.7	1109	28.4	7180	39.10	24477
Dark shearwater spp.	80	2.03	3	0.03	5	0.13	88	0.48	358
Fork-tailed Storm-Petrel	208	5.28	2	0.02	4	0.1	214	1.17	0
Pelagic Cormorant	2	0.05	10	0.1	6	0.15	18	0.10	18
Red-Breasted Merganser	.	.	.	.	1	0.03	1	0.01	0
King Eider	.	.	.	.	3	0.08	3	0.02	43
Common Eider	72	1.83	.	.	.	.	72	0.39	0
Spectacled Eider	.	.	0	0	7	0.18	7	0.04	17
Steller's Eider	.	.	.	.	3	0.08	3	0.02	0
Long-Tailed Duck	.	.	9	0.09	5	0.13	14	0.08	22
Duck spp.	.	.	2	0.02	2	0.05	4	0.02	10
Somateria spp.	0	0	0	0	11	0.28	11	0.06	540
Sharp-Tailed Sandpiper	.	.	1	0.01	.	.	1	0.01	1
Red Phalarope	77	1.96	451	4.29	74	1.9	602	3.28	72
Red-Necked Phalarope	.	.	36	0.34	5	0.13	41	0.22	0
Phalaropus spp.	10	0.25	1540	14.6	110	2.82	1660	9.04	463
Charadriiformes	2	0.05	21	0.2	24	0.62	47	0.26	47
Long-Tailed Jaeger	1	0.03	.	.	1	0.03	2	0.01	0
Parasitic Jaeger	3	0.08	5	0.05	3	0.08	11	0.06	13
Pomarine Jaeger	10	0.25	24	0.23	18	0.46	52	0.28	27
Stercorariidae	5	0.13	0	0	2	0.05	7	0.04	12
Arctic Tern	16	0.41	3	0.03	1	0.03	20	0.11	2
Glaucous Gull	1	0.03	92	0.87	38	0.97	131	0.71	180
Glaucous-Winged Gull	6	0.15	2	0.02	19	0.49	27	0.15	101
Herring Gull	1	0.03	3	0.03	5	0.13	9	0.05	19
Black-Legged Kittiwake	282	7.16	382	3.63	154	3.95	818	4.46	570
Red Legged Kittiwake	4	0.10	.	.	.	.	4	0.02	0
Sabine's Gull	2	0.05	7	0.07	3	0.08	12	0.07	9
Slaty-Backed Gull	.	.	.	.	2	0.05	2	0.01	0
Larus spp.	3	0.08	3	0.03	5	0.13	11	0.06	101

Table 5. – continued.

	Leg 1		Leg 2		Leg 3		Total		
Species	**On transect**	**%**	**On transect**	**%**	**On transect**	**%**	**On transect**	**%**	**Off transect**
Common Murre	209	5.31	280	2.66	105	2.69	594	3.24	15
Thick-Billed Murre	315	8.00	194	1.84	171	4.38	680	3.70	32
Uria spp.	207	5.26	215	2.04	68	1.74	490	2.67	950
Pigeon Guillemot	.	.	5	0.05	.	.	5	0.03	0
Kittlitz's Murrelet	1	0.03	1	0.01	.	.	2	0.01	0
Marbled Murrelet	3	0.08	.	.	1	0.03	4	0.02	0
Brachyramphus spp.	4	0.10	1	0.01	5	0.13	10	0.05	3
Ancient Murrelet	59	1.50	15	0.14	65	1.67	139	0.76	30
Murrelet spp.	.	.	2	0.02	3	0.08	5	0.03	5
Crested Auklet	41	1.04	718	6.82	253	6.49	1012	5.51	98
Least Auklet	187	4.75	318	3.02	1235	31.7	1740	9.48	86
Parakeet Auklet	54	1.37	27	0.26	181	4.64	262	1.43	13
Aethia spp.	103	2.62	36	0.34	72	1.85	211	1.15	32
Horned Puffin	64	1.63	59	0.56	17	0.44	140	0.76	50
Tufted Puffin	71	1.80	153	1.45	31	0.79	255	1.39	151
Alcidae	10	0.25	20	0.19	15	0.38	45	0.25	7
Total	**3,935**		**10,522**		**3,897**		**18,354**		**28,866**

Table 6. Marine mammal observations recorded during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013. Mammals on transect were within 300m from the vessel. Counts include transits outside the Arctic Eis area. Most marine mammals observed were beyond our 300m transect width.

	Leg 3			Leg 2			Leg 3			Total		
Species	**On transect**	**%**	**Off transect**	**On transect**	**%**	**Off transect**	**On transect**	**%**	**Off transect**	**On transect**	**%**	**Off transect**
Gray Whale	1	4.2	21	5	5.8	44	0	0	4	6	5.3	69
Fin Whale	0	0.0	3	.	.	.	.	.	.	0	0.0	3
Humpback Whale	0	0.0	1	1	1.2	2	.	.	.	1	0.9	3
Minke Whale	2	8.3	1	.	.	.	2	100	0	4	3.5	1
Orca	.	.	.	0	0.0	6	.	.	.	0	0.0	6
Dall's Porpoise	8	33.3	4	.	.	.	.	.	.	8	7.1	4
Harbor Porpoise	1	4.2	0	.	.	.	.	.	.	1	0.9	0
Cetacea spp.	1	4.2	*5*	1	1.2	24	.	.	.	2	1.8	29
Bearded Seal	.	.	.	4	4.6	6	.	.	.	4	3.5	6
Harbor Seal	0	0.0	1	.	.	.	.	.	.	0	0.0	1
Ribbon Seal	.	.	.	0	0.0	1	.	.	.	0	0.0	1
Pinnipedia spp.	.	.	.	4	4.6	1	.	.	.	4	3.5	1
Northern Fur Seal	8	33.3	1	.	.	.	.	.	.	8	7.1	1
Pacific Walrus	.	.	.	66	75.9	1680	.	.	.	66	58.4	1680
Phocidae spp.	*3*	12.5	*0*	5	5.8	7	.	.	.	8	7.1	7
Polar Bear	.	.	.	1	1.2	0	.	.	.	1	0.9	0
Total	**24**		**37**	**87**		**1771**	**2**		**4**	**113**		**1812**

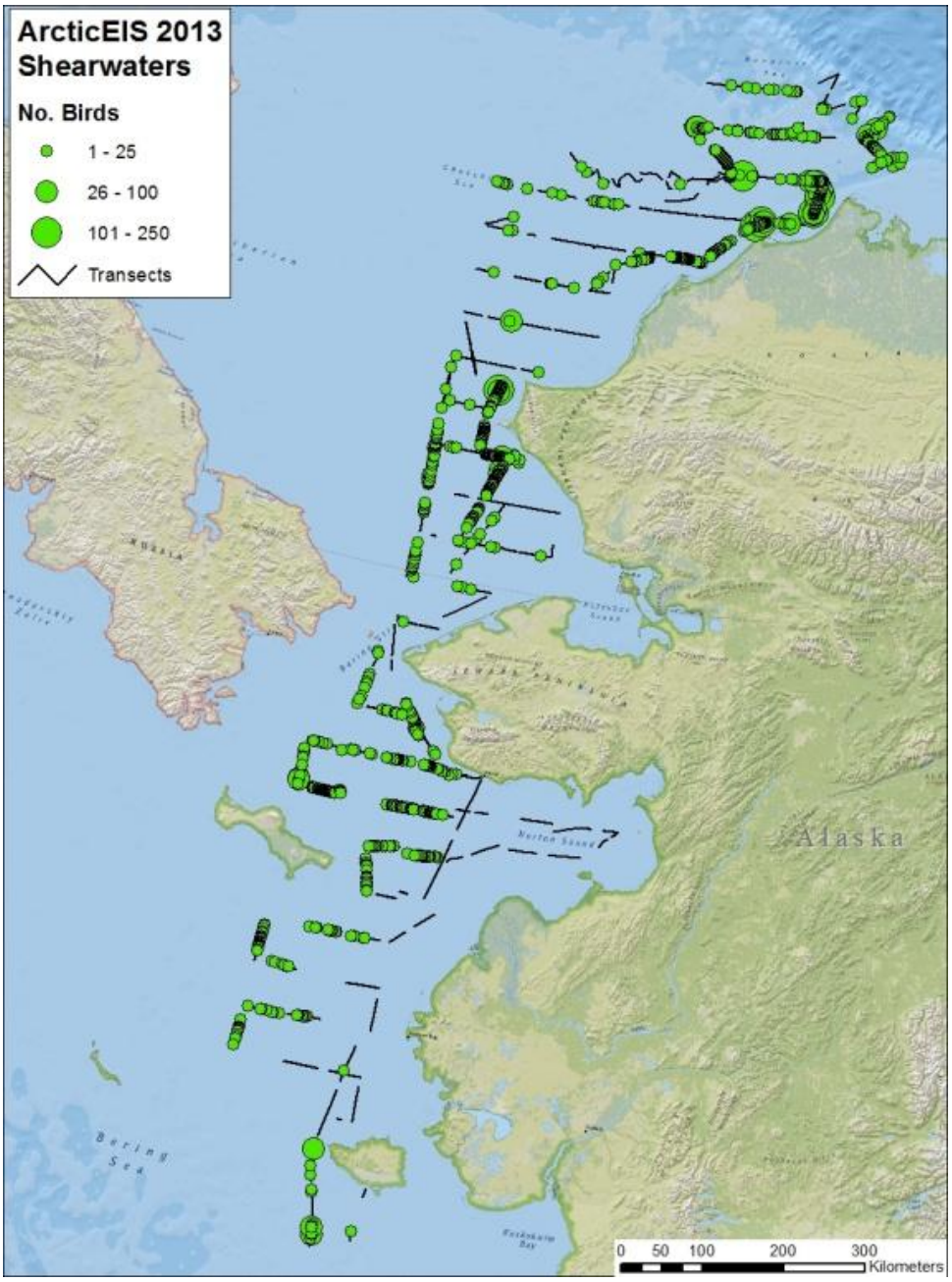


Figure 31. Short-tailed shearwater sightings during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

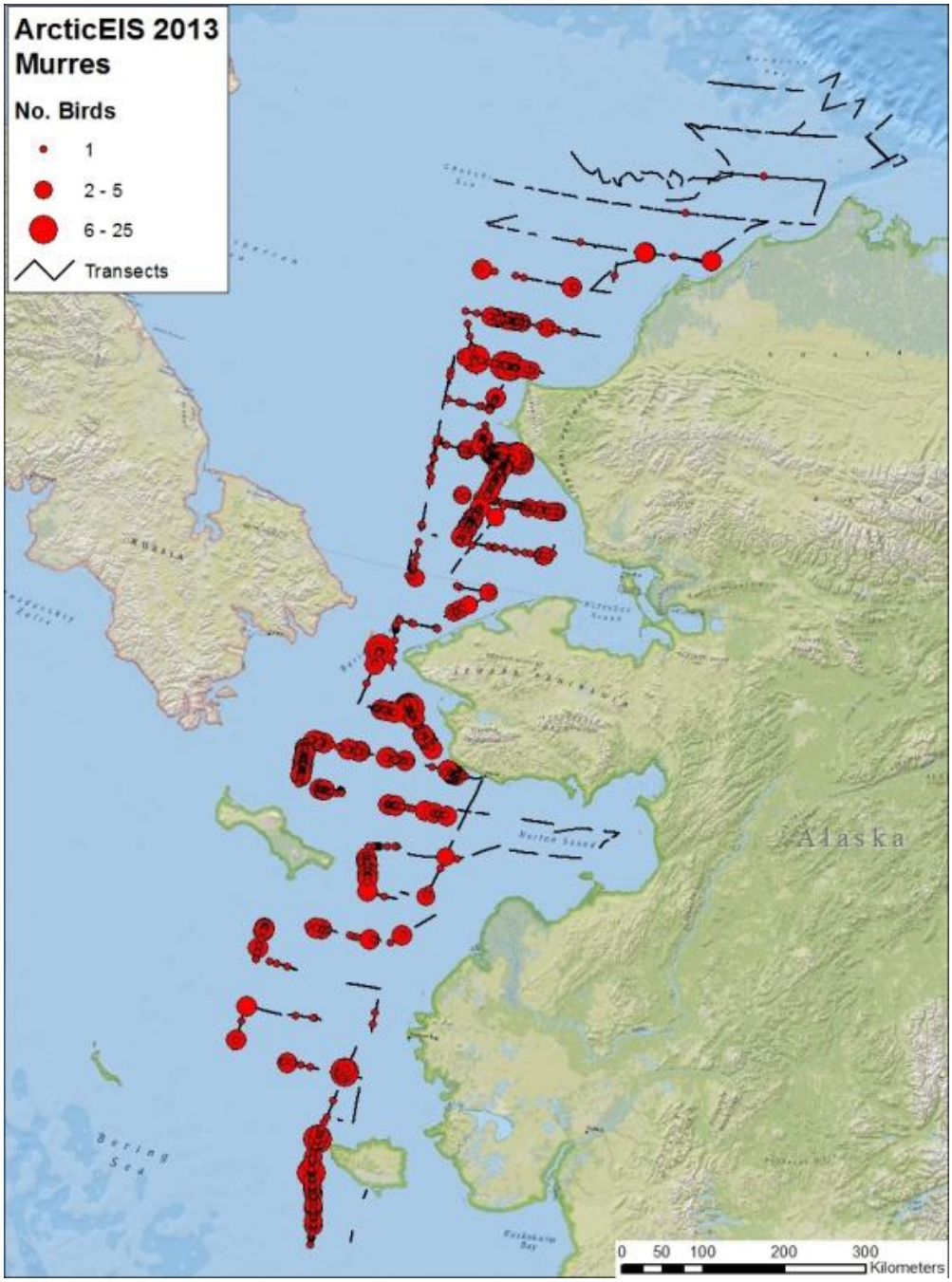


Figure 32. Common and Thick-billed murre sightings during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

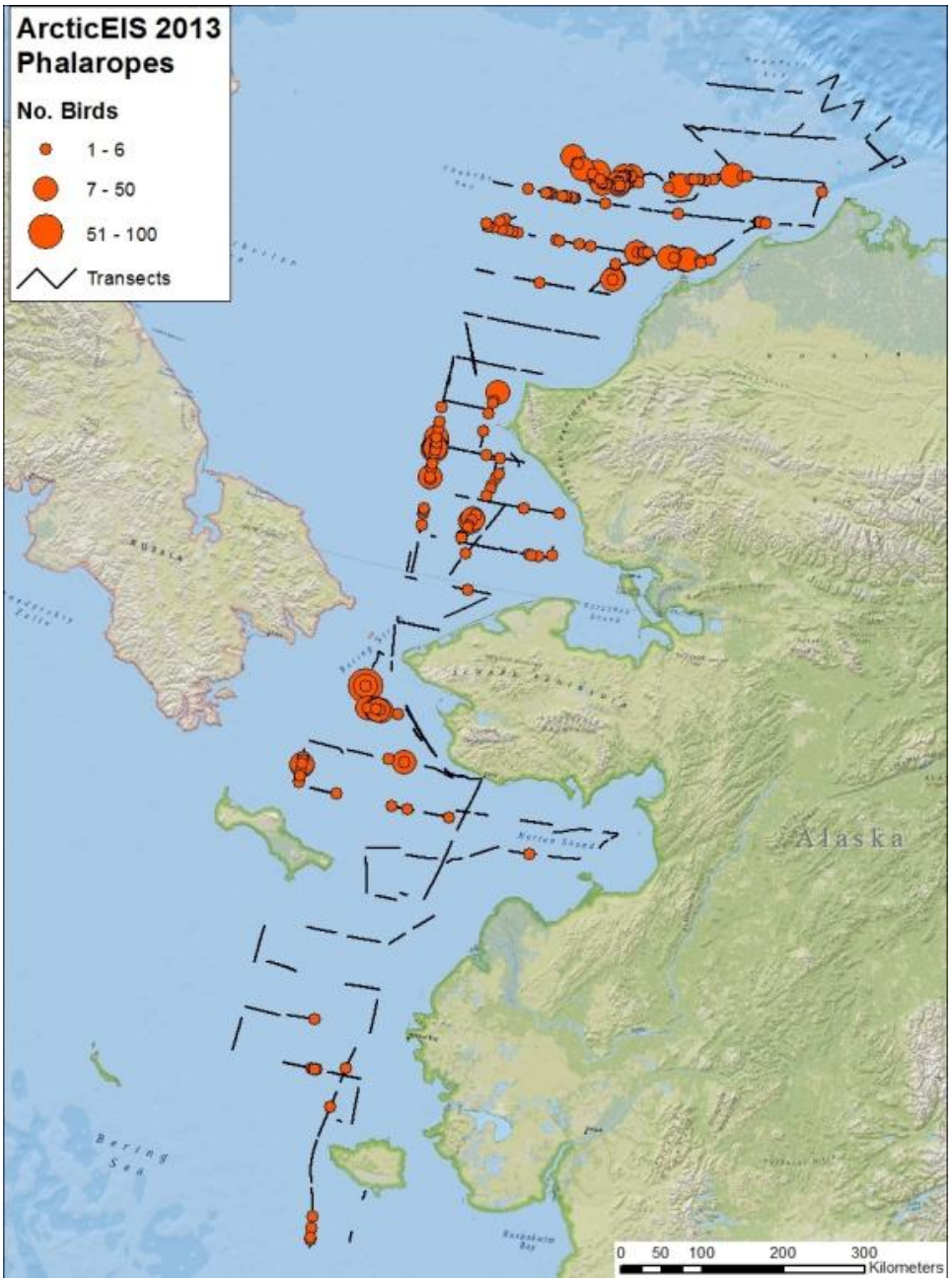


Figure 33. Red and Red-necked phalaropes during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

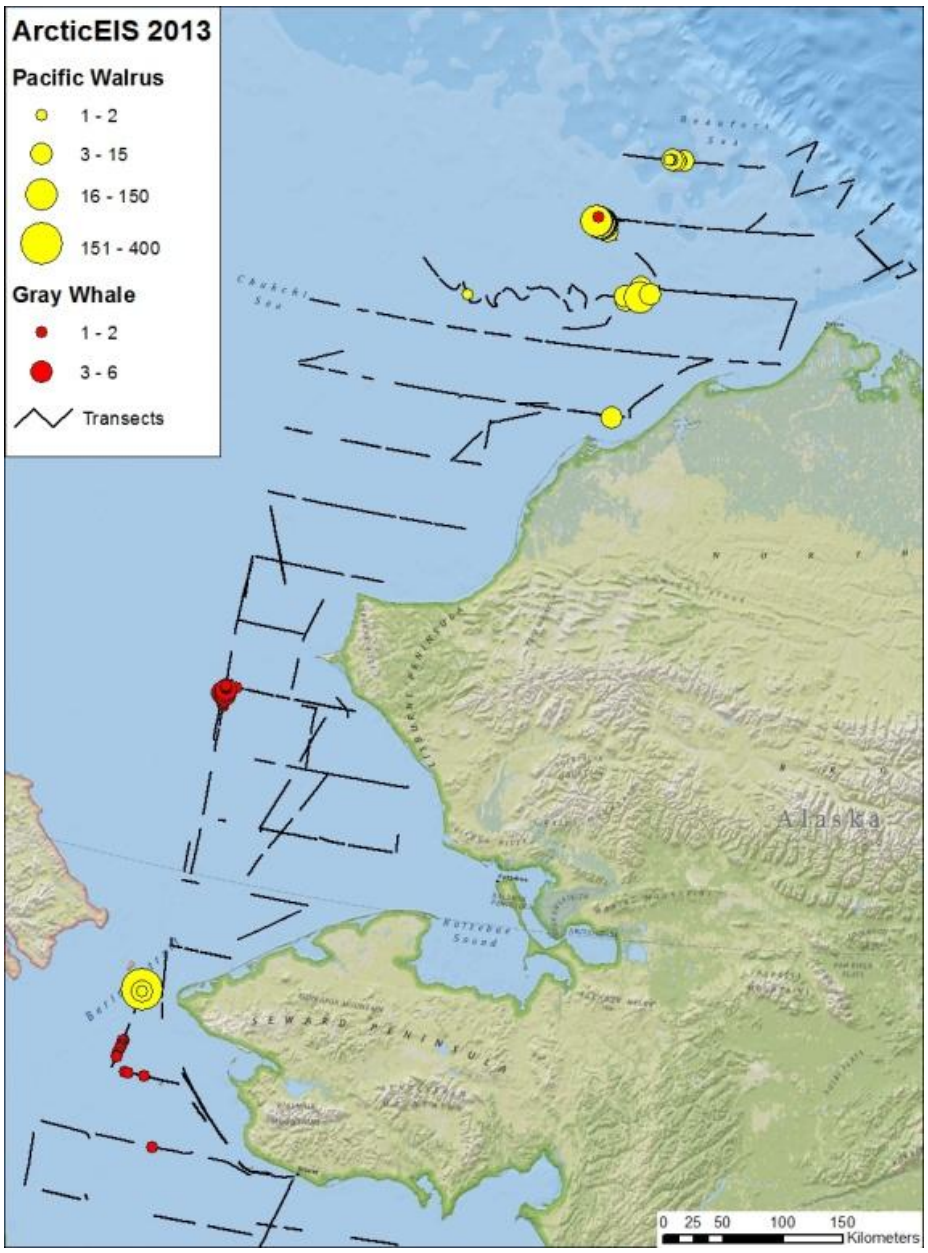


Figure 34. Sightings of Pacific Walrus and Gray Whales during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

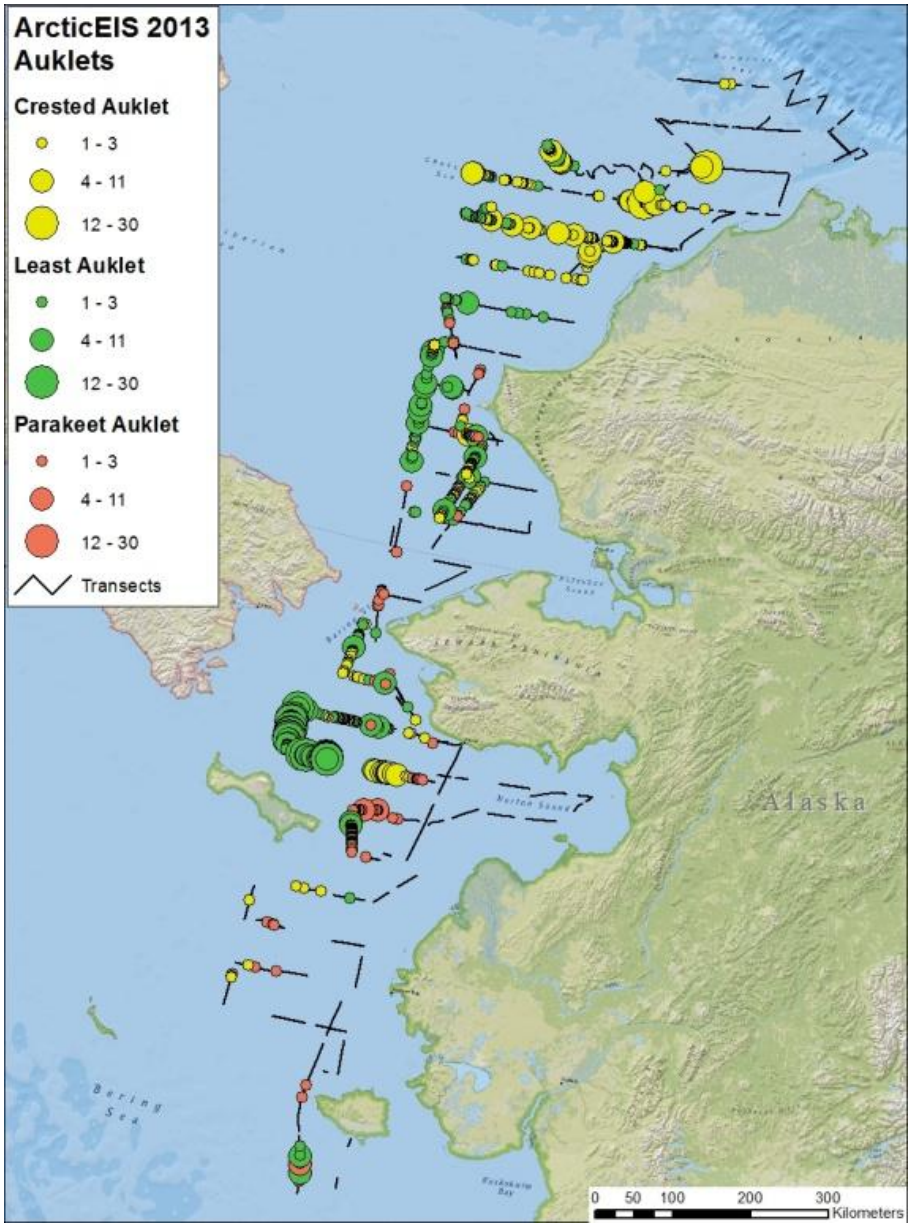


Figure 35. Sightings of Crested, Least, and Parakeet Auklets during the Arctic Ecosystem Integrated Survey (Arctic Eis), August to September, 2013.

SUMMARY OF THE FLOODING EVENT ABOARD THE F/V BRISTOL EXPLORER BY THE CHIEF SCIENTIST DURING LEG 3 (JIM MURPHY)

At approximately 1:00 am on September 25 the captain requested all scientists to report to the wheelhouse and explained that the ship was taking on water. The crew had determined that the water was coming from the starboard generator room. The captain also alerted us that the mid-ship deck, referred to the refrigeration flat, was flooded due to water flowing from the generator room to the mid-ship deck through air vents between the two rooms. The refrigeration flat had water tight doors with combing approximately 1 ½ feet above the floor, which prevent the water from flowing freely from the room. The freezers containing scientific samples and scientific equipment were in the refrigeration flat; I asked about the state of the freezers and frozen samples and requested that the samples be secured as soon as possible and transferred to the ship's walk-in freezer.

The source of the water was logically identified as the 3" seawater coolant line to the starboard generator. Since the line also supplied coolant to the port generator it was not possible to shut down the water flow without shutting down the last generator. The watertight door to the generator room could not be opened directly due to the water pressure on the door. To gain access to the generator room, the crew had to cut a hole in the aft bulkhead of the generator room to allow water to drain out into the factory deck which drained over the side of the ship. During the attempt to open the door to the generator room, damage in the refrigeration deck (possibly a Freon bottle) caused the entire area to be flooded with Freon and efforts to gain access to the generator room were halted until it was safe to return. Once the water level was lowered to the point where the door to the generator room could be opened, the crew entered the generator room, secured the line, and focused their efforts to dewater the refrigeration flat and secure equipment and samples. The scientists were permitted to return to their rooms and the ship returned to the south side of Nunivak Island to anchor up and address the damage caused by the flooding.

Although the water level in the refrigeration flat never exceeded the height of the door combing, the relatively large size of the mid-ship deck and the ship's motion resulted in significant damage to most of the equipment and gear present in the deck in a short amount of time. The four freezers containing scientific samples and other cases and equipment present on this deck broke free from the retaining lines causing significant damage to themselves, the scientific samples and gear within them, and other items present in the deck. Containers without watertight seals were flooded with seawater and containers without the durability to withstand the crushing effect of the four floating freezers were destroyed.

The wind began to shift to the south on the evening of the 25th. The ship pulled anchor and jogged into the seas until the wind shifted to the North mid-day on the 26th and then we began our transit to Dutch. The vessel arrived in Dutch Harbor on the morning of the 28th and we began offloading scientific gear and samples at around 9:00 am.

Appendix 1. Station information for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea. S = surface trawl; M = midwater trawl; x indicates a sample was taken.

Station ID	Date (GMT)	Time (GMT)	CTD	Bongo	Trawl	Bottom Depth (m)	Lat_dd	Lon_dd
1	8/7/2013	16:37:50	x	x	S	41	65.40	-168.06
2	8/7/2013	23:36:15	x	x	S	53	66.03	-168.48
3	8/8/2013	02:12:28			M	50	66.00	-168.23
4	8/8/2013	04:03:14	x	x		17	66.00	-167.89
5	8/8/2013	16:06:19	x	x	S	22	66.12	-167.33
6	8/8/2013	21:46:32	x	x	S	19	66.54	-166.00
7	8/8/2013	22:50:17			M	20	66.57	-166.00
8	8/9/2013	01:40:27	x	x		22	66.50	-166.63
9	8/9/2013	04:08:53	x	x	S	29	66.47	-167.25
10	8/9/2013	14:33:31	x	x		24	66.50	-167.87
11	8/9/2013	17:22:23	x	x	S	51	66.51	-168.51
12	8/9/2013	22:24:49	x	x	S	39	67.02	-168.49
13	8/10/2013	04:44:47	x	x		35	67.00	-167.87
14	8/10/2013	15:11:14	x	x	S	39	66.98	-167.22
15	8/10/2013	16:29:08			M	37	66.93	-167.25
16	8/10/2013	19:17:09	x	x		37	67.00	-166.59
17	8/10/2013	21:44:29	x	x	S	26	67.01	-166.00
18	8/11/2013	00:45:04	x	x		27	67.00	-165.30
19	8/11/2013	03:03:15	x	x	S	27	67.00	-164.70
20	8/11/2013	04:06:54			M	26	67.00	-164.78
21	8/11/2013	15:04:18	x	x	S	29	67.52	-164.59
22	8/11/2013	16:04:53			M	29	67.56	-164.64
23	8/11/2013	18:46:24	x	x		35	67.50	-165.25
24	8/11/2013	19:28:27			M	35	67.50	-165.06
25	8/11/2013	22:45:40	x	x	S	40	67.52	-165.86
26	8/12/2013	01:45:35	x	x		45	67.50	-166.55
27	8/12/2013	04:11:17	x	x	S	46	67.52	-167.19
28	8/12/2013	14:31:32	x	x		46	67.50	-167.85
29	8/12/2013	17:06:57	x	x	S	48	67.52	-168.48
30	8/12/2013	21:40:30	x	x	S	58	68.02	-168.44
31	8/13/2013	00:40:17	x	x		52	68.00	-167.83
32	8/13/2013	02:13:10			M	51	68.00	-167.60
33	8/13/2013	04:10:21			M	55	68.00	-167.35
34	8/13/2013	15:07:15	x	x	S	56	67.99	-167.19
35	8/13/2013	18:04:09	x	x		42	68.00	-166.50
36	8/14/2013	01:32:29			M	30	68.00	-166.09
37	8/14/2013	03:42:20	x	x	S	30	67.98	-165.87
38	8/14/2013	15:52:32	x	x	S	35	68.53	-167.14
39	8/14/2013	16:59:06			M	37	68.57	-167.15

Appendix 1 (Con't). Station information for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea. S = surface trawl; M = midwater trawl; x indicates a sample was taken.

Station_ID	Date (GMT)	Time (GMT)	CTD	Bongo	Trawl	Bottom Depth (m)	Lat_dd	Lon_dd
40	8/14/2013	20:00:26	x	x		54	68.50	-167.83
41	8/14/2013	22:27:19	x	x	S	52	68.51	-168.49
42	8/15/2013	02:41:04	x	x		51	69.00	-168.51
43	8/15/2013	15:21:17	x	x	S	22	69.06	-165.68
44	8/15/2013	16:23:25			M	24	69.09	-165.67
45	8/15/2013	19:15:14	x	x		32	69.00	-166.41
46	8/15/2013	19:41:32			M	31	69.02	-166.39
47	8/15/2013	23:53:44	x	x	S	47	69.04	-166.95
48	8/16/2013	02:35:13			M	47	69.00	-167.37
49	8/16/2013	04:07:21	x	x		49	69.00	-167.80
50	8/16/2013	16:22:05	x	x	S	23	69.51	-164.18
51	8/16/2013	17:19:36			M	23	69.53	-164.12
52	8/16/2013	19:47:38	x	x		30	69.50	-164.92
53	8/16/2013	21:29:39			M	34	69.50	-165.52
54	8/16/2013	22:58:38	x	x	S	35	69.51	-165.60
55	8/17/2013	01:19:22			M	38	69.50	-165.94
56	8/17/2013	03:01:13	x	x		40	69.50	-166.35
57	8/17/2013	14:45:47			M	46	69.50	-167.06
58	8/17/2013	15:28:28			M	46	69.50	-167.03
59	8/17/2013	17:18:06	x	x	S	48	69.50	-167.12
60	8/17/2013	21:07:19	x	x		48	69.50	-167.80
61	8/17/2013	22:05:45			M	49	69.50	-167.97
62	8/18/2013	00:16:37	x	x		51	69.50	-168.50
63	8/22/2013	15:14:59	x	x		43	69.99	-168.49
64	8/22/2013	16:50:39			M	45	70.00	-168.36
65	8/22/2013	19:08:54	x	x		48	70.00	-167.76
66	8/22/2013	21:12:55			M	46	70.00	-167.17
67	8/22/2013	22:48:21	x	x	S	47	70.00	-166.98
68	8/23/2013	04:07:35	x	x		45	70.00	-166.30
69	8/23/2013	15:41:31	x	x	S	41	70.02	-165.58
70	8/23/2013	16:39:14			M	42	70.06	-165.56
71	8/23/2013	19:26:46	x	x		38	70.00	-164.84
72	8/23/2013	20:06:19			M	37	70.00	-164.66
73	8/23/2013	22:46:46	x	x	S	31	70.02	-164.11
74	8/24/2013	02:57:10	x	x	S	43	70.50	-163.94
75	8/24/2013	15:29:10	x	x	S	25	70.52	-161.04
76	8/24/2013	18:28:03	x	x		26	70.50	-161.77
77	8/24/2013	19:10:08			M	23	70.50	-161.97
78	8/24/2013	22:28:20	x	x	S	36	70.52	-162.51
79	8/24/2013	23:54:01			M	36	70.56	-162.47

Appendix 1 (Con't). Station information for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea. S = surface trawl; M = midwater trawl; x indicates a sample was taken.

Station_ID	Date (GMT)	Time (GMT)	CTD	Bongo	Trawl	Bottom Depth (m)	Lat_dd	Lon_dd
80	8/25/2013	02:14:11	x	x		37	70.50	-163.27
81	8/25/2013	03:41:47			M	43	70.50	-163.84
82	8/25/2013	15:01:03	x	x		45	70.50	-164.75
83	8/25/2013	17:01:36	x	x		44	70.50	-165.54
84	8/25/2013	17:19:42			M	44	70.51	-165.53
85	8/25/2013	19:48:59	x	x		45	70.50	-166.27
86	8/25/2013	21:42:04	x	x		50	70.50	-167.03
87	8/25/2013	22:30:30			M	51	70.50	-167.00
88	8/26/2013	00:47:35	x	x		49	70.50	-167.76
89	8/26/2013	03:26:51	x	x		40	70.50	-168.52
90	8/26/2013	15:18:45	x	x		41	71.00	-165.40
91	8/26/2013	16:26:08			M	42	71.00	-165.50
92	8/26/2013	18:22:41	x	x		43	71.00	-166.19
93	8/26/2013	20:23:29	x	x		45	71.01	-166.97
94	8/26/2013	22:09:19			M	46	71.00	-167.31
95	8/26/2013	23:42:38	x	x		47	71.00	-167.74
96	8/27/2013	01:47:11	x	x		47	71.01	-168.50
97	8/27/2013	17:20:58	x	x		37	71.00	-164.65
98	8/27/2013	20:00:31	x	x		43	71.00	-163.88
99	8/27/2013	22:25:31	x	x		46	71.00	-163.11
100	8/27/2013	22:36:22			M	45	71.00	-163.12
101	8/28/2013	02:22:15	x	x	S	46	71.00	-162.40
102	8/28/2013	15:00:56	x	x		48	71.00	-161.58
103	8/28/2013	17:25:31	x	x	S	46	71.00	-160.89
104	8/28/2013	20:13:41	x	x		60	71.00	-160.05
105	8/28/2013	20:25:04			M	58	71.00	-160.07
106	8/28/2013	23:31:05	x	x	S	56	71.00	-159.35
107	8/29/2013	00:27:08			M	61	71.00	-159.44
108	8/29/2013	03:22:55	x	x		22	71.00	-158.51
109	8/29/2013	03:31:54			M	22	71.00	-158.53
110	8/29/2013	15:36:00	x	x	S	26	71.03	-157.78
111	8/29/2013	20:21:30	x	x	S	104	71.50	-157.53
112	8/29/2013	21:18:07			M	87	71.49	-157.64
113	8/30/2013	00:04:02	x	x		63	71.50	-158.27
114	8/30/2013	00:58:44			M	58	71.50	-158.57
115	8/30/2013	03:43:00	x	x	S	54	71.49	-158.97
116	8/30/2013	15:00:05	x	x		50	71.50	-159.84
117	8/30/2013	17:14:30	x	x	S	47	71.50	-160.54
118	8/30/2013	18:12:14			M	48	71.50	-160.41
119	8/31/2013	01:17:45	x	x	S	45	71.33	-162.22

Appendix 1 (Con't). Station information for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea. S = surface trawl; M = midwater trawl; x indicates a sample was taken.

Station_ID	Date (GMT)	Time (GMT)	CTD	Bongo	Trawl	Bottom Depth (m)	Lat_dd	Lon_dd
120	8/31/2013	04:01:27	x	x		44	71.46	-162.69
121	8/31/2013	18:11:53	x	x		43	71.40	-163.67
122	8/31/2013	18:25:20			M	43	71.39	-163.65
123	8/31/2013	23:43:08	x	x		45	71.29	-164.59
124	9/1/2013	02:22:33	x	x		42	71.36	-165.17
125	9/1/2013	04:03:24			M	43	71.35	-165.70
126	9/1/2013	06:21:02	x	x		44	71.50	-166.14
127	9/1/2013	19:25:57	x	x		47	71.42	-161.40
128	9/2/2013	03:20:27	x	x		33	72.00	-162.47
129	9/2/2013	15:20:44	x	x		33	72.00	-162.04
130	9/2/2013	15:31:28			M	34	71.99	-162.02
131	9/2/2013	18:05:55	x	x		35	72.00	-161.22
132	9/2/2013	18:53:34			M	37	72.00	-160.96
133	9/2/2013	21:32:25	x	x		39	72.00	-160.41
134	9/2/2013	23:14:26			M	36	72.00	-159.82
135	9/3/2013	00:55:17	x	x		43	72.00	-159.60
136	9/4/2013	15:19:50	x	x	S	93	72.00	-157.01
137	9/4/2013	16:18:55			M	100	72.01	-156.89
138	9/4/2013	21:03:39	x	x		67	72.00	-157.97
139	9/4/2013	21:17:29			M	66	72.00	-157.97
140	9/5/2013	00:58:55	x	x	S	55	72.00	-158.74
141	9/5/2013	01:58:20			M	55	71.99	-158.62
142	9/5/2013	15:26:59	x	x		61	72.50	-158.54
143	9/5/2013	17:48:06	x	x		51	72.50	-159.36
144	9/5/2013	17:59:22			M	50	72.50	-159.35
145	9/5/2013	21:17:20	x	x		48	72.50	-160.18
146	9/5/2013	23:04:45	x	x		46	72.50	-161.03
147	9/5/2013	23:15:07			M	45	72.50	-161.01
148	9/6/2013	02:05:14	x	x		44	72.50	-161.88
149	9/6/2013	21:51:41			M	204	72.45	-157.59
150	9/8/2013	00:15:09			M	327	71.82	-154.97
151	9/8/2013	01:59:13			M	229	71.82	-155.18
152	9/8/2013	03:07:39	x	x		289	71.83	-154.99
153	9/10/2013	21:56:50	x	x	S	50	65.00	-168.97
154	9/11/2013	02:38:45	x	x	S	37	64.98	-167.70
155	9/12/2013	17:19:23	x	x	S	28	64.42	-166.06
156	9/12/2013	21:47:24	x	x	S	28	64.52	-167.09
157	9/13/2013	01:27:46	x	x	S	37	64.50	-168.04
158	9/13/2013	16:42:10	x	x	S	42	64.48	-169.01
159	9/13/2013	20:56:25	x	x	S	46	64.48	-170.02

Appendix 1 (Con't). Station information for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea. S = surface trawl; M = midwater trawl; x indicates a sample was taken.

Station_ID	Date (GMT)	Time (GMT)	CTD	Bongo	Trawl	Bottom Depth (m)	Lat_dd	Lon_dd
160	9/14/2013	01:04:39	x	x	S	36	64.00	-169.92
161	9/14/2013	04:27:04	x	x	S	36	64.02	-169.00
162	9/14/2013	16:30:31	x	x	S	37	64.00	-167.94
163	9/14/2013	20:12:10	x	x	S	33	64.01	-166.95
164	9/15/2013	00:07:22	x	x	S	22	64.03	-166.00
165	9/15/2013	03:37:57			M	19	64.09	-165.47
166	9/15/2013	16:25:01	x	x	S	21	64.10	-164.46
167	9/15/2013	20:15:32	x	x	S	24	64.08	-163.51
168	9/16/2013	12:40:00	x	x	S	21	64.10	-162.33
169	9/16/2013	16:21:09	x	x	S	17	63.76	-162.53
170	9/16/2013	19:57:50	x	x	S	16	63.75	-163.60
171	9/16/2013	23:08:16	x	x	S	16	63.76	-164.57
172	9/17/2013	16:31:25	x	x	S	25	63.51	-166.06
173	9/18/2013	16:30:01	x	x	S	27	63.53	-167.01
174	9/18/2013	20:36:12	x	x	S	33	63.47	-167.97
175	9/19/2013	00:26:48	x	x	S	25	63.00	-167.69
176	9/19/2013	03:41:27	x	x	S	26	63.03	-167.01
177	9/19/2013	16:26:31	x	x	S	21	62.98	-166.01
178	9/19/2013	21:40:00	x	x	S	34	62.51	-167.04
179	9/20/2013	01:30:52	x	x	S	30	62.50	-168.07
180	9/20/2013	05:06:07	x	x	S	33	62.51	-169.04
181	9/20/2013	16:35:42	x	x	S	37	62.48	-170.00
182	9/20/2013	21:04:23	x	x	S	46	62.01	-169.95
183	9/21/2013	02:49:46	x	x	S	39	62.02	-168.97
184	9/21/2013	16:28:44	x	x	S	28	61.99	-167.96
185	9/21/2013	20:25:43	x	x	S	30	61.96	-166.99
186	9/22/2013	00:19:02	x	x	S	23	61.53	-167.04
187	9/22/2013	16:38:04	x	x	S	28	61.52	-168.05
188	9/22/2013	20:49:50	x	x	S	37	61.50	-169.02
189	9/23/2013	01:06:47	x	x	S	47	61.47	-169.97
190	9/23/2013	04:55:11	x	x	S	48	61.01	-169.97
191	9/23/2013	16:28:46	x	x	S	38	61.00	-168.96
192	9/23/2013	20:19:01	x	x	S	29	61.00	-167.94
193	9/23/2013	23:49:01	x	x	S	27	60.98	-167.00
194	9/24/2013	03:39:02	x	x	S	27	60.50	-167.06
195	9/24/2013	16:27:55	x	x	S	29	60.51	-167.97

Appendix 2. Non-salmon collection overview for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea.

Length and weigh 50 to 100 specimens. Small fish (e.g. age-0) may be too small for individual weights, in this case, use bulk weight for length subsample.

Note: Unless otherwise noted these sample sizes are per station.

Arctic Cod (*Boreogadus saida*) **If < 35 fish then length, weigh, assign bar codes, and individually saran wrap samples. Label these bulk samples as TSMRI (these bulk samples will be prioritized and split back in the lab.**

- **Isotopes (Andrews):** 5 fish (freeze whole fish in individual bags); sample across size range
- **Diets (Aydin):** 5 stomachs (freeze or preserve whole fish in single bag); sample across size range; do not need individual length/weight data.
- **Genetics (Guyon):** 150 fish per region preferably from a single station (freeze whole fish in single bag); 900 total for entire survey
- **Energetics (Heintz):** 6-9 fish, minimum of 3 (freeze whole fish in individual bags); 250 total for entire survey; sample across size range; fill out provided bag labels
- **Otoliths (Helser):** 10 fish; (freeze whole fish in individual bags); sample across size range
- **Isotopes (Marsh): Chukchi Only;** 3-10 fish (freeze whole fish in individual bags); sample across size range

Saffron Cod (*Eleginus gracilis*) **If < 39 fish then length, weigh, assign bar codes, and individually saran wrap samples. Label these bulk samples as TSMRI (these bulk samples will be prioritized and split back in the lab.**

- **Isotopes (Andrews):** 5 fish (freeze whole fish in individual bags); sample across size range
- **Diets (Aydin):** 5 stomachs (freeze or preserve whole fish in single bag); sample across size range
- **Genetics (Gharrett/Sme):** 100 fish per region (Norton Sound, Northern Chukchi, Southern Chukchi/Kotzebue Sound) preferably from one or two adjacent stations (see map on data request); 300 total for entire survey. TSMRI protocol is sufficient for low catches. Otherwise, cut ½ inch plug of muscle flank tissue and place in vial with 1mL DNA preservative
- **Energetics (Heintz):** 6-9 fish, minimum of 3 (freeze whole fish in individual bags); 250 total for entire survey; sample across size range; fill out provided bag labels
- **Otoliths (Helser):** 10 fish (freeze whole fish in individual bags); sample across size range
- **Isotopes (Marsh): Chukchi Only;** 10 fish (freeze whole fish in individual bags); sample across size range

Walleye Pollock (*Theragra chalcogramma*) **If < 24 fish then length, weigh, assign bar codes, and individually saran wrap samples. Label these bulk samples as TSMRI (these bulk samples will be prioritized and split back in the lab.**

- **Diets (Aydin):** 5 stomachs (freeze or preserve whole fish in single bag); sample across size range
- **Energetics (Heintz):** 6-9 fish, minimum of 3 (freeze whole fish in individual bags); 250 total for entire survey. **Juveniles only**; fill out provided bag labels
- **Isotopes (Marsh): Chukchi Only;** 10 fish (freeze whole fish in individual bags)**;** sample across size range
- **Isotopes (Andrews):** 5 fish (freeze whole fish in individual bags); sample across size range

Appendix 2 (Cont.). Non-salmon collection overview for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea.

Capelin (*Mallotus villosus*) **If < 22 fish then length, weigh, assign bar codes, and individually saran wrap samples. Label these bulk samples as TSMRI (these bulk samples will be prioritized and split back in the lab.**

- **Diets (Aydin):** 5 stomachs (freeze or preserve whole fish in single bag); sample across size range
- **Genetics (Guyon):** 150 fish per region preferably from a single station (freeze whole fish in single bag); 900 total for entire survey
- **Energetics (Heintz):** 6-9 fish, minimum of 3 (freeze whole fish in individual bags); 250 total for entire survey; sample across size range; fill out provided bag labels
- **Otoliths (Helser):** 10 fish (freeze whole fish in individual bags); sample across size range
- **Isotopes (Marsh): Chukchi Only;** 3-10 fish (freeze whole fish in individual bags); sample across size range

Herring (*Clupea pallasii)* **If < 14 fish then length, weigh, assign bar codes, and individually saran wrap samples. Label these bulk samples as TSMRI (these bulk samples will be prioritized and split back in the lab.**

- **Diets (Aydin):** 5 stomachs (freeze or preserve whole fish in single bag); sample across size range
- **Energetics (Heintz):** 6-9 fish, minimum of 3 (freeze whole fish in individual bags); 250 total for entire survey; sample across size range; fill out provided bag labels
- **Isotopes (Marsh): Chukchi Only;** 10 fish (freeze whole fish in individual bags); sample across size range

Sand lance (*Ammodytes hexapterus)* **If < 8 fish then length, weigh, assign bar codes, and individually saran wrap samples. Label these bulk samples as TSMRI (these bulk samples will be prioritized and split back in the lab.**

- **Diets (Aydin):** 10 stomachs (freeze or preserve whole fish in single bag); sample across size range
- **Isotopes (Marsh): Chukchi Only;** 10 fish (freeze whole fish in individual bags)**;** sample across size range

Rainbow smelt (*Osmerus mordax)*

- **Diets (Aydin):** 10 stomachs (freeze or preserve whole fish in single bag); sample across size range

Eelpouts

- **Energetics (Heintz):** 6-9 fish (freeze whole fish in individual bags); 250 total for entire survey; fill out provided bag labels

Shorthorn sculpin (*Myoxocephalus scorpius)*

- **Isotopes (Marsh): Chukchi Only;** 10 fish (freeze whole fish in individual bags); sample across size range

Age-0 Greenland Halibut

- **Duffy-Anderson:** Freeze whole, all age-0 Greenland Halibut collected from surface trawls at -20 degrees C or colder.

Salmon shark

- **Tribuzio:** fin clip (freeze piece the size of a finger nail – KEEP FROZEN)

Lamprey

- **Murphy:** All specimens (freeze whole fish in individual bags)

Jellyfish

- Separate by species, for each species measure first 50 and take individual weights. Weigh remaining jellyfish by species and record total weight.

**** All unidentified species are to be frozen whole with station data and brought back to the lab for ID verification.**

Appendix 3. Salmon collection overview for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea.

Juveniles (0-320 mm) Unless otherwise noted, these sample sizes are per station. Length and weigh 50 specimens of each species. Note any fin clips, scarring, parasites, any skeletal deformities. Take photographs of fish with any unusual features. Collect scales from preferred region and place onto numbered gum card. Whole fish samples are saved for energetics (*Prechtl, Howard, Fergusson*), genetics (*Guthrie, Kondzela*), otoliths (*Vega, Sutton, Murphy*), add barcode tag to bag and freeze at -20. Heads are saved for genetics (*Guthrie, Kondzela*) and otoliths (*Vega, Sutton, Murphy*), wrap heads with barcodes in saran wrap, freeze at -20.

Juvenile Chinook (*Oncorhynchus tshawytscha*)

- **IGF** (*Prechtl, Beckman*): fish 1-10
- **Whole Fish**: Fish 1-50 (except for thiamin and nutrition samples)
- **Stomach contents (***Strasburger*): Fish 3-12, Remove stomach contents, record content weight, and preserve in 10% seawater buffered formalin in a nalgene bottle by haul. Return empty stomach to whole body carcass (**whole fish sample**) to allow energetic analysis. Label bottle by species and haul. Flag stomach as yes in CLAMS
- (**NORTHERN BERING) Thiamine/ Nutrition** (*Strasburger, Horstmann*): 20-30 fish (**entire survey**), select from hauls with large catches. Remove liver and two muscle tissue samples (wrap liver and one muscle tissue in foil for *Horstmann*) place in separate whirl pack bags and include barcode number. Remove head, label with barcode and freeze at -20. Wrap carcass in foil, freeze at -80. Remove stomach and preserve in 10% seawater buffered formalin place in soil bag **labeled with barcode** number and place in a nalgene bottle labeled by species and haul. Add THIAMINE to CLAMS notes.

Juvenile Chum (*Oncorhynchus keta*)

- **IGF**: fish 1-10
- **Whole Fish**: Fish 1-2
- **Heads:** Fish 3-50
- **Stomachs** (*Strasburger, Fergusson, Prechtl)*: Fish 3-12, Remove stomachs and preserve in 10% seawater buffered formalin in a nalgene bottle by haul. Label bottle by species and haul. Flag stomach as yes in CLAMS.
- (**CHUKCHI) Isotopes** (*Marsh*): Fish 3-17, remove dorsal tissue sample freeze with barcode #, note in CLAMS.
- (**NORTHERN BERING) Thiamine/ Nutrition** (*Strasburger, Horstmann*): Same as Chinook protocol.

Appendix 3 (Cont.). Salmon collection overview for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea.

Juvenile Pink (*Oncorhynchus gorbuscha*)

- **IGF**: Fish 1-10
- **Whole Fish**: Fish 1-2
- **Stomachs**: Fish 3-12, same protocol as chums.
- **(CHUKCHI) Isotopes**: Fish 3-17, same protocol as chum.

Juvenile Coho (*Oncorhynchus kisutch*) & Sockeye (*Oncorhynchus nerka*)

- **Whole Fish**: Fish 1-2
- **Heads**: Fish 3-50
- **Stomachs**: Fish 3-12, same protocol as chums.

Immature/maturing chum (*O. keta*) & Chinook (*O. tshawytscha*) (>320 mm)

Record length, weight, sex and maturity for 50 specimens of each species. Note any fin clips, scarring, parasites, any skeletal deformities. Take photographs of fish with any unusual features. Collect scales from preferred region and place onto numbered gum card

- **Stomachs** (*Strasburger, Horstmann*): Fish 1-10, Remove stomachs and intestines, label with barcodes and freeze at -80.
- **Genetics** (*Guthrie, Kondzela*): Fish 1-50, Remove axillary process, place in coin envelop and write barcode number on envelope.
- **(CHUKCHI) Isotopes** (*Marsh*) Fish 1-15, Remove dorsal tissue sample freeze with barcode #, note in CLAMS.
- (**NORTHERN BERING) Otoliths** *(Murphy)* Collect otoliths for age determination and thermal marks. Remove otoliths and place in coin envelop with axillary process.
- (**NORTHERN BERING) Thiamine/Nutrition** (*Strasburger, Horstmann*) Fish 1-10, Remove two samples ~20g of muscle tissue and whole liver sample, wrap one muscle tissue and the liver tissue in foil for *Horstmann*, label all with barcodes and freeze at -80. Add THIAMINE to CLAMS notes.
- (**NORTHERN BERING) Gonads** *(Horstmann*) Collect and weigh 2-3 (**entire survey**) representative samples of immature gonads and all mature gonads, label with barcodes, wrap in foil and freeze at -80.

Appendix 4. Jellyfish collection overview for the F/V *Bristol Explorer* during the August through September, 2013 Arctic Ecosystem Integrated Survey (Arctic Eis) in the Chukchi Sea and Northern Bering Sea.

For all trawl catches:

- Separate jellyfish on sorting table by genus/species into baskets, being careful not to further damage the bodies, and for each species sort into "whole" jellyfish versus pieces (broken jellyfish) baskets.

For each genus/species

- Prior to bell measuring, orient jellies with mouth down (convex side facing upwards and the opening is facing the table).
- Measure the first 50 jellyfish for 'True Bell' diameter in centimeters (a noticeable line around the bell-see photo), and take individual weights in kilograms of each measured jellyfish.
- Count one basket of "whole" jellyfish and weigh. Combine remaining whole jellyfish for a total weight. Combine all pieces for a total weight. Record on jellyfish data sheet (all data) and non-salmon data form (total weight by species only).
- If subsampling a catch make several notes and show all calculations, be very clear as to how the subsampling occurred. Be sure to record data on fish data sheet .

If short on time

- Only measure bell diameters for 25 individuals of each species and take individual weights. Weigh remaining pieces and combine remaining "whole" jellyfish by species for total weight.

If super short on time and spirit is crushed (this should not happen for every tow)

- Measure bell diameter for 25 individuals of each species and take total weights of remaining sorted jellyfish.