NOAA Technical Memorandum NMFS-AFSC-198

Aleutian Islands Cooperative Acoustic Survey Study for 2006

by
S. J. Barbeaux and D. Fraser

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

September 2009

NOAA Technical Memorandum NMFS

The National Marine Fisheries Service's Alaska Fisheries Science Center uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series reflect sound professional work and may be referenced in the formal scientific and technical literature.

The NMFS-AFSC Technical Memorandum series of the Alaska Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest Fisheries Center. The NMFS-NWFSC series is currently used by the Northwest Fisheries Science Center.

This document should be cited as follows:

Barbeaux, S. J., and D. Fraser. 2009. Aleutian Islands cooperative acoustic survey study for 2006. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-198, 91 p.

NOAA Technical Memorandum NMFS-AFSC-198

Aleutian Islands Cooperative Acoustic Survey Study for 2006

by
S. J. Barbeaux and D. Fraser

Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Seattle, WA 98115
www.afsc.noaa.gov

U.S. DEPARTMENT OF COMMERCE
Gary F. Locke, Secretary
National Oceanic and Atmospheric Administration
Jane Lubchenco, Under Secretary and Administrator
National Marine Fisheries Service
James W. Balsiger, Acting Assistant Administrator for Fisheries

September 2009

This document is available to the public through:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

www.ntis.gov

ABSTRACT

Results from the 2006 Aleutian Islands cooperative acoustic survey study (AICASS) conducted in March – April 2006 are presented. These surveys were part of a cooperative project between the National Marine Fisheries Service, the Aleut Enterprise Corporation, the owners and operators of the FV *Muir Milach*, and Adak Fisheries LLC to test the feasibility of using small (< 35 m) commercial fishing vessels to conduct acoustic surveys on walleye pollock (*Theragra chalcogramma)* in the central Aleutian Islands. To verify the acoustic data and to support the study, 1,000 metric tons (t) of walleye pollock was allocated to be harvested within Steller sea lion critical habitat. The acoustic and biological information from the study is used to assess: 1) if it is feasible to conduct acoustic surveys in the Aleutian Islands using commercial fishing vessels, 2) if the data collected are of sufficient quality for management purposes, and 3) if pollock aggregations in the Aleutian Islands during the winter are sufficiently spatially and temporally stable to allow for biologically reasonable management measures to be enacted.

Six acoustic surveys were successfully completed resulting in precise estimates of pollock biomass in the surveyed areas over time. The abundance trend was stable for the first two surveys, and then declined significantly during the final four surveys. During the study, 965 t of groundfish were harvested, 97% of the harvested groundfish were removed from a 72 square nautical mile area in the center of the study area and 85% of the harvest occurred in the final 11 days of the study. The change in biomass from earlier to later surveys is much larger than the fishing removals, indicating that significant movement of pollock from the study area occurred. Distribution and abundance of pollock, although dynamic in the overall survey area, did remain stable during the times when, and in the areas where there were lower densities of

pollock and lower fishing effort during the survey. Further studies would be needed to evaluate the cause of the decline in the fished area. Two possible ways of capturing this information would be to: 1) expand the survey to encompass the full extent of the pollock movement, and 2) use an acoustic buoy to observe the behavior of pollock in relation to vessel noise and fishing removals.

The scientific objectives of the 2006 AICASS were achieved. The project also fostered an excellent working relationship among NMFS, the Aleut Enterprise Corporation, and the fishing industry. Local participation and stakeholder involvement enhances NMFS ability to provide responsible stewardship of this important marine resource. Future work should consider the expansion of this technique to survey more areas within the Aleutian Islands to determine the status of this stock within Steller sea lion critical habitat.

CONTENTS

Abstract iii

Contents v

Introduction 1

Materials and Methods 3

  Study Areas 3

  Survey Equipment 5

  Sonar-self Noise Test 6

  Acoustic System Calibration 7

  Survey Design 8

  Data Analysis 9

Results 13

  Calibration 13

  Sonar-self Noise Test 13

  Atmospheric and Oceanographic Conditions 14

  Biological Sampling 15

  Distribution and Abundance 17

Discussion 19

Acknowledgments 21

Citations 23

Tables 26

Figures 36

Appendices.. 66

Appendix A: Sonar-self Noise Test 66

Appendix B: Cruise Plan 69

Appendix C: Responses from Participants 78

INTRODUCTION

In March-April 2006 the Aleutian Islands Cooperative Acoustic Survey Study (AICASS) was conducted to assess the feasibility of using a small (< 35 m) commercial fishing vessel to estimate the abundance of walleye pollock (*Theragra chalcogramma*) in waters off the central Aleutian Islands. The project was envisioned as a first step in the development of a cooperative management and cooperative monitoring system that would involve the Aleut Enterprise Corporation (the local Alaska Native corporation that has been allocated the pollock quota for this area), local fishermen, and National Marine Fisheries Service (NMFS). This could potentially lead to a limited pollock harvest that explicitly accounts for the needs of Steller sea lion (*Eumetopias jubatus*) within critical habitat.

In 1998 a large portion of the waters surrounding the Aleutian Islands were designated by NMFS as Steller sea lion (SSL) critical habitat. Commercial fishing for pollock has since been prohibited in these designated areas. In 2003 the Aleut Enterprise Corporation was allocated the rights to all pollock quota for the Aleutian Islands area in order to advance the economic development of the Alaska Native corporation and to help develop Adak Island into a fishing port. Due to the low value of pollock carcasses ($0.09 per pound) and high value of roe ($1.10 per pound) (Dave Fraser, Manager of Adak Fisheries LLC, pers. comm., April 2006) and relatively low densities of pollock in other months, the fishery is thought to only be economically viable during March and April, shortly before spawning. At this time of year, pollock are tightly distributed along the continental slope. The geography of the Aleutian Islands and distribution of SSL haulouts and nurseries are such that only 14 nautical miles (nmi) along the slope edge is available for fishing outside of SSL critical habitat within 200 nmi of the port of Adak. Because of this, interest in opening Aleutian Islands SSL critical habitat areas to pollock fishing has intensified.

Current assessment of the Aleutian Islands pollock stock uses a summer bottom trawl survey that, due to the pelagic nature and seasonal migration of pollock, is not considered to be a reliable measure of its abundance by itself (Barbeaux et al. 2005). Although there is a biennial acoustic survey of the Bogoslof Island region (between 165°W and 170°W longitude) this survey does not cover the area of an expected central Aleutian Islands small boat pollock fishery based out of the port of Adak. At this time, NMFS does not have resources to conduct acoustic surveys of pollock in the Aleutian Islands west of 170°W longitude. Partnering with the Aleut Enterprise Corporation and local fishermen to conduct acoustic surveys is potentially a viable means for NMFS to collect data on this resource under increasing budgetary constraints. If successful, this project could eventually lead to finer spatial and temporal scale management of this species in the Aleutian Islands and advance ecosystem-based management in the North Pacific (U.S. Commission on Ocean Policy 2004). In addition, this project fosters a cooperative and collaborative working relationship between NMFS, the Aleut Enterprise Corporation, and the fishing industry, increasing local participation and responsibility regarding the stewardship of marine resources.

This report provides pollock biomass estimates for the six quantitative surveys conducted between 13 March and 4 April 2006. It also presents the results of sonar-self noise tests and acoustic system calibrations. In addition, this report summarizes observed pollock distribution, size composition, age composition, maturity information, and overall acoustic data quality for all 2006 AICASS surveys.

MATERIALS AND METHODS

The AICASS was conducted aboard the commercial fishing vessel FV *Muir Milach* (Fig.1), a 32 m stern trawler. The study was carried out in three phases: (1) evaluating the commercial fishing vessel's suitability as an acoustic sampling platform; (2) opportunistically collecting acoustic data of pollock distribution around two sites, Kanaga Sound and Atka Island, and (3) direct acoustic and biological data sampling at the Atka Island study site.

Study Areas

Two study areas in the Aleutian Islands management sub-area were proposed; the Kanaga Sound and Atka Island. The Aleutian Islands are an archipelago of more than 300 islands stretching between the Alaska Peninsula in the east to the Kamchatka Peninsula in the west (Fig. 2). The Aleutian Islands management sub-area is composed of the waters surrounding Aleutian Islands within the U.S. EEZ west of 170° West longitude and includes the waters from Carliste Island of the Islands of Four Mountains group in the east to the waters surrounding Attu Island of the Near Islands group in the west. The Kanaga Sound study area is approximately 1,000 square nautical miles (nmi^2) and located north of Tanaga and Kanaga Islands, between 176°15' W and 178°15'W longitude (Fig. 3). The Atka Island study area is approximately 2,200 nmi^2 and is located between 173°30' W and 175°15'W longitude (Fig. 3).

Itinerary

20 Jan -7 Mar	Opportunistic data collection while commercial fishing for Pacific cod.
15 Feb	Sonar- self noise test.
5 Mar	Embark scientist in Adak, AK.
10 Mar	Calibration of acoustic system in Scabbard Bay, AK.
12 Mar	Pacific cod season ends.
13 Mar	Survey 1: Exploration east of North Cape, Atka Island to Seguam Island closure area, 2 nmi spacing.
14-15 Mar	Survey 2: North Cape, Atka Island to Konuiji Island, 1.5 nmi spacing.
16-17 Mar	Delivery 1 to Adak, AK.
19-20 Mar	Delivery 2 to Adak, AK.
21 Mar	Survey 3: Sawtooth survey North Cape, Atka Island to Konoiji Island.
22 Mar	Delivery 3 to Adak, AK.
23-24 Mar	Survey 4: North Cape, Atka Island to Konoiji Island, 1.5nmi spacing.
24 Mar	Survey 5: Cross transect survey on “Knoll”, 0.5 nmi spacing.
25 Mar	Delivery 4 to Adak, AK.
27 Mar	Delivery 5 to Adak, AK.
28-29 Mar	Survey 6: Small parallel survey, 1.0 nmi spacing.
29 Mar	Delivery 6 to Adak, AK.
31 Mar	Delivery 7 to Adak, AK.
1 Apr	Survey 7: Small parallel survey, 1.0 nmi spacing.
3-4 Apr	Survey 8: North Cape, Atka Island to Konoiji Island, 1.5nmi spacing.
4 Apr	Delivery 8 to Adak, AK.
5 Apr	Calibration of acoustic system in Scabbard Bay, AK.
5 Apr	Scientist disembarks vessel at Adak, AK.

Survey Equipment

Acoustic data were recorded with a Simrad ES60 echosounder using a Simrad ES-38B 38kHz split beam transducer. The transducer was installed in a fabricated steel echosounder pod attached to the hull of the FV *Muir Milach*. All acoustic RAW data and OUT files were recorded to a 120 GB external hard drive and backed-up daily to DVD media. The acoustic data were analyzed using SonarData Echoview (V.3.45.58.3257, SonarData Inc.) PC-based post-processing software.

Echosign was sampled and all commercial catches obtained using one of two Aleutian wing pelagic trawls with 8.9 cm mesh codends. The trawls were commercial fishing trawls constructed with full-mesh nylon wings, and polyethylene mesh in the codend and aft section of the body. Mesh size tapered from 110 cm in the forward section to 8.9 cm in the codend. Biological data were collected from all echosign verification and commercial hauls including species composition, pollock fork length (FL) (150 per tow to the nearest 1.0 cm), pollock individual weight (20 per tow measured on an electronic motion-compensated scale to 0.01 kg), and pollock otoliths (20 per tow). Pollock fin clip samples for genetic and stable isotope analyses were collected from two commercial tows. Maturity was assessed for all measured female pollock by visual inspection and categorized as immature, developing, pre-spawning, spawning, and post-spawning. Otolith and fin clip samples were stored in 50% ethanol-water solution. All biological data were recorded onto paper forms and then transferred to a Microsoft Access database. Fork length measurements were also collected for Pacific ocean perch (*Sebastes alutus*; POP), as well as, whole carcass samples for a separate maturity and stable isotope project.

Pollock otoliths were aged by the Age and Growth Program of the Alaska Fisheries Science Center (AFSC) using the revised criteria described in Hollowed et al. (1995). Biomass-at-age composition estimates were made following Kimura (1989) and modified by Dorn (1992) for ages 1 through 14 and age 15 and older treated as a single group. Briefly, length-stratified age data are used to construct age-length keys for each sex. These keys are then applied to the survey length frequency data. Weight-at-length estimates are then applied to obtain an overall biomass-at-age composition.

Physical oceanographic data, including temperature, conductivity, turbidity, and dissolved oxygen, were collected twice per survey and once per calibration from the surface to the least of 320 m or bottom using a Sea-Bird conductivity-temperature-depth (CTD) system.

Sonar-self Noise Test

A sonar-self noise test is a means to assess the noise characteristics of a vessel and determine optimum survey speed where vessel-generated noise does not interfere with survey operations. A sonar-self noise test was conducted on 15 February 2006. Data were recorded while the echosounder was set to passive and the engine throttle was increased in 200 rpm increments every 2 minutes until maximum engine speed was reached (Appendix A). The RAW data were recorded to the echosounder hard drive, then later copied to a compact disc and mailed to the AFSC in Seattle for processing. At the AFSC the data were imported into Echoview and the time-varied gain (TVG) and absorption were removed throughout the range of the data to obtain a reference noise estimate (S_v dB re $1m^{-1}$) at 1 m from the transducer for every second of data collection. A depth of 500 m was chosen for calculating noise level thresholds because pollock had been observed in the study areas at or above 500 m. Noise level at a range of 500 m was simulated by adding the expected TVG and absorption at 500 m to the reference noise estimate using the formula:

$$s_v\,@\,500m = s_v\,@\,1m + \left[20\log_{10}(500)\right] + \left[2\alpha(500)\right],$$

where α = absorption coefficient, here 0.00975 dBm^{-1} (Simmonds and MacLennan 2005). Since our integration threshold levels were to be set at -70 dB, a value of -80 dB was chosen as a maximum noise level at 500 m in order to attain at least a 10:1 signal to noise ratio and the rpm level which came closest to but did not exceed this level was chosen as the optimal surveying speed.

Acoustic System Calibration

Standard sphere calibrations (Foote et al. 1987) of the echosounder system were conducted before the first systematic survey and after the last systematic survey in Scabbard Bay on Adak Island, Alaska. The FV *Muir Milach* was anchored by the bow and stern during the calibrations. Acoustic system settings were recorded and physical oceanographic conditions were measured using the Sea-bird CTD system. A 38.1 mm tungsten carbide sphere was suspended below the transducer using three manual downriggers (Fig. 4). The calibration sphere was stabilized in the water column by suspending a 2.2 kg lead sphere on the same line 5 m below the calibration sphere. On-axis measurements were recorded for 10 minutes, and then the calibration sphere was moved systematically through the acoustic beam in order to map the beam pattern.

Survey Design

In February 2006, during the Pacific cod fishing season, the FV *Muir Milach* collected opportunistic acoustic data within the two proposed study sites in order to assess which area would provide the optimum study location. The Atka Island study site was selected because the area had the highest observed densities of pollock and had less area closed to fishing due to proximity to Steller sea lion haulouts.

To assess abundance and spatial and temporal variability of pollock in SSL critical habitat the study was conducted over a 3-week period with three separate surveys within a designated large survey area (180 nmi^2) west of the North Cape SSL haulout and four smaller surveys over the highest densities of pollock in the large survey area. Surveys were conducted during the day and night. A preliminary survey (Survey 1) was conducted east of North Cape but was not included in this study because it did not cover the region of interest and no verification or commercial trawling was conducted in this area, and thus species composition and biological makeup for the acoustic sign in this area could not be determined. The study was to be composed of three parallel transect surveys with 1.5 nmi spacing (Surveys 2, 4, and 8) in the large survey area and four sawtooth surveys to cover only the area of highest fish density. Because the sawtooth survey design only intermittently intercepted the shelf-break it was found to inadequately survey the observed pollock aggregations and resulted in significant wasted effort; results from this survey (Survey 3) will not be reported in this document. Smaller, higher resolution parallel transect surveys replaced the remaining three sawtooth surveys; one at 0.5 nmi spacing with transects parallel to the bathymetry (Survey 5 at 9 nmi^2) and two at 1.0 nmi spacing with transects perpendicular to the bathymetry (Surveys 6 and 7 at 72 nmi^2 each). Small trawl tows

(< 10 metric tons (t)) were conducted during the surveys to identify acoustic sign. Between survey periods the vessel was allowed to commercial fish until it reached capacity (~165 t) and deliver catch to the Adak Fisheries fish processing plant on Adak Island. Opportunistic acoustic data were recorded during all non-survey periods. In all figures and tables, 15 March 2006 is designated as Survey Day 1. Surveys in this study were conducted from 15 March through 4 April (Table 1), a total of 21 days.

All parallel survey transects were originally designed to sample 5 nmi offshore after the shelf break (181 m isobath) and 1 nmi inshore from the shelf break. To reduce survey time an adaptive strategy was implemented and transects were ended when it was determined that pollock sign was no longer encountered along the transect.

Data Analysis

Processing the AICASS survey data entailed removing the ES60 triangle wave dither (Ryan and Kloser 2003), scrutinizing the data, creating bottom lines, and producing spatially and temporally indexed backscatter densities. The ES60Adjust Version 1.6 software package (Kieth et al. 2005) was used to remove the triangle wave dither. The adjusted data were scrutinized using Echoview software, removing areas of incomplete transmission (missing pings) and partitioning the data into regions of pollock, non-pollock fish, and small unidentified scatterers.

Each transect was divided into 0.5 nmi (for the 1.0 and 1.5 nmi spaced surveys) or, because of the small survey area, 0.25 nmi (for the 0.5 nmi spaced survey) horizontal elementary sampling distance units (ESDU). The depth limit of data analysis was 500 m. For bottom depths shallower than 500 m the sounder-detected bottom (SDB) determined by the Simrad ES60 bottom detection algorithm was used as an initial starting point for defining the bottom depth. The manually adjusted bottom (MAB) was produced by creating a line 0.5 m above the detected bottom, and then reviewing and correcting errors in the line manually. The correction included adjusting the MAB up where it appeared to drop below the apparent bottom and adjusting the MAB down where the bottom detection algorithm incorrectly identified heavy aggregations of pollock as bottom. The most difficult task was assessing bottom where roll-off occurred. Roll-off is an acoustic shadow created by the distortion of acoustic returns from steep and/or complex bottom slopes (Fig. 5).

Two estimates of pollock backscatter density were estimated for each survey, the first was for the area between 15 m from the surface to the MAB and the second was for the area between the MAB and the SDB termed the Shadow zone (Kloser 1996). Backscatter estimates within the regions designated as pollock were exported for the two areas and for each ESDU to produce estimates of pollock backscatter. As a possible measure of the uncertainty of the pollock biomass estimates we used the dead zone (Shadow zone) estimation algorithm (Kloser 1996) provided in Echoview to predict pollock backscatter densities in the Shadow zone. The algorithm calculates the average volume backscatter for each ping from the MAB to 2 m above the MAB and then applies this average to the area of the shadow zone for each ping. The Shadow zone correction has a considerable amount of uncertainty associated with it and it was not used in the primary analysis within this report. Three significant problems exist with this approach: 1) it has not been proven that the near-bottom backscatter is predominantly pollock, 2) a backscatter relationship with depth as one approaches the bottom has not been determined, and 3) this approach assumes the bottom determination is accurate in the steep conditions observed in the Aleutian Islands. If backscatter increases as one approaches bottom and all the backscatter is composed of pollock, then the Shadow zone extrapolation results in a conservative estimate. If the trend is decreasing or a significant amount of the biomass is composed of something other than pollock, then it will be an overestimate (Ona and Mitson 1996).

Pollock backscatter was scaled to biomass using pollock biological data from the 28 verification and commercial trawls conducted in the study area. All length and weight data collected during the study were aggregated for all surveys. All fork lengths were binned to the nearest centimeter (cm). Number (N) of pollock at fork length *l* for each survey *i* was estimated as:

$$N_{il} = \frac{p_l \times s_{Ai}}{4\pi \times 10^{TS_l/10}},$$

where TS_l is the target strength at fork length *l* estimated by using the pollock target strength to length relationship ($TS_l = 20 \log_{10} \mathrm{FL} - 66$ decibels (dB), where FL is the fork length (cm); Traynor 1996), s_{Ai} (nautical area scattering coefficient, $\mathrm{m}^2/\mathrm{nmi}^2$; MacLennan et al. 2002) is the estimated backscatter of pollock in survey *i* and p_l is the proportion of backscatter attributable to pollock at fork length *l* estimated as:

$$p_l = \frac{f_l\left(10^{TS_l/10}\right)}{\sum f_l\left(10^{TS_l/10}\right)},$$

where f_l is the number of pollock at fork length *l* in the length frequency sample.

Biomass (B) for each survey i was then estimated as:

$$B_i = \sum_{l=0}^{\max(l)} N_{il} \times \frac{\hat{W}_l}{1000} \text{ metric tons (t)},$$

where $\hat{W}_l$ is the weight (kg) at fork length l calculated for all surveys using data aggregated from all verification and commercial trawls through a linear regression of the log transformed weight at length data [$\log(\hat{W}_l) = \alpha + \beta \log(FL)$ and therefore $\hat{W}_l = e^{\alpha} \times FL^{\beta}$].

The estimation variance (σ^2) of the backscatter was derived for each survey using a one-dimensional geostatistical method (Petigas 1993, Williamson and Traynor 1996). The one-dimensional geostatistical method was used to compute a measure of precision because it takes into account the spatial structure of the pollock aggregations and survey design. It should be noted that the variance of the estimation only quantifies transect sampling variability and does not include other sources of error (e.g., target strength, trawl sampling, error associated with ageing). The relative precision of the estimation (E) for each survey was calculated using the formula:

$$E_i = \frac{\sqrt{\sigma_i^2}}{s_{A_i}},$$

assuming the error to be normally distributed, the relative biomass confidence intervals (C) of each survey were defined as :

$$C_i = B_i \pm 1.96 B_i E_i .$$

RESULTS

Calibration

Acoustic system calibrations were conducted prior to the first systematic survey on 10 March 2006 and after the final systematic survey on 4 April 2006. No significant differences in gain parameters or transducer beam characteristics were observed (Table 2). A S_A correction factor of -0.58 dB was calculated.

Sonar-self Noise Test

The sonar-self noise test was conducted on 15 February 2006 in approximately 60 m of water. The test revealed a steep incline in noise with increases in engine rpm (Fig. 6). It was determined for optimum performance the engine speed needed to remain below 1,200 rpm while conducting the survey. This engine rpm level resulted in a surveying speed of between 4 and 8 knots, depending on the direction and speed of the current and wind. During calibration it was discovered that an air compressor needed for the steering hydraulics was installed to a bulkhead near the transducer and created a significant amount of noise, greatly affecting the acoustic data quality. The running compressor vibrated the transducer casing introducing interference physically through the receiver. This wasn't discovered during the sonar-self noise test because the compressor was intermittent with a cycle of about 10-15 minutes. To eliminate this noise source the compressor was taken off-line while surveying and the hydraulics were connected to a smaller compressor located away from the transducer. The noise characteristics of the vessel were checked intermittently throughout the duration of the study by running the echosounder with the transponder turned off and assessing the received noise levels. Besides the problem with the compressor, no other noise-related problems were encountered.

Atmospheric and Oceanographic Conditions

The primary factor thought to affect the ability to survey from small vessels in the Aleutian Islands in the winter months is the weather. Between 13 March and 6 April 2006 the winds were primarily southerly, between 90° and 270°, and hourly average wind speed ranged from 0.5 knots to 20.9 knots with a median and mean of 5.9 knots and 6.9 knots, respectively (Fig. 7). Between 13 March and 6 April the maximum daily wind gusts exceeded 30 knots for 19 of the 25 days and exceeded 50 knots for 9 of the 25 days (Figs. 8 and 9). Neither surveying nor commercial fishing could be conducted from 16 March through 17 March due to high southeasterly winds with strong gusts exceeding 50 knots. Although other strong wind events occurred during the survey period they did not affect the ability of the vessel to fish or conduct surveys.

In total, 17 CTD casts were conducted (Table 3): 3 during calibrations, 2 outside the survey area, and 12 within the large survey area (Figs. 10, 11, and 12). Sea temperature at 5 to 10 m from the surface increased during the duration of the study from 3.4 to 3.6 °C (Fig. 13). Average salinity in the survey area between 5 and 50 m was constant at 33.21 PSU, while average salinity between 50 and 225 m increased between 14 March and 3 April from 33.22 to 33.28 PSU (Fig. 14).

Sea-Bird conductivity-temperature-depth system (CTD) casts 5, 11, 12, 13, 14, and 16 were conducted in close proximity near the center of the survey area at the shelf break. The temperature at depth profiles reveal a change between Cast 5 conducted on 14 March, and Cast 11 conducted on 24 March. Cast 5 shows a well-mixed water column at 3.48 °C down to 175 m and then a slight increase of temperature to 3.67 °C at 250 m. In contrast, Cast 11 had considerable stratification; temperature at the surface was 3.60 °C, a decrease with depth to 3.41 °C at 110 m, another decrease with depth to 2.94 °C at 160 m, and then a sharp increase with depth to 3.84 °C at 210 m. Casts 12, 13, 14, and 16 reveal similar, although less severe, stratification through 3 April. Salinity does not show a similar stratification for these casts.

Biological Sampling

Biological data and specimens were collected from 26 of 29 trawl hauls during the study (Table 4 and Fig. 15). Of the 26 trawl hauls sampled, 7 were verification trawls and 19 were commercial trawls. A total of 965 t of groundfish were removed from the survey area. By weight and number, pollock was the most abundant species captured and Pacific ocean perch (*Sebastes alutus*) was the second most abundant (Tables 5 and 6). A total of 2,945 pollock and 842 Pacific ocean perch measurements and 333 pairs of pollock otoliths were collected during the study (Table 7). In addition, 99 pollock tissue samples were collected for genetic and stable isotope analyses.

The size of pollock captured in the verification and commercial trawls varied between 35 cm and 75 cm (Fig. 16) with a mean length of males at 56.9 cm and females at 58.5 cm. For all of the verification and commercial trawl hauls 55% of the pollock were female. Male pollock averaged

1.58 kg while females were somewhat larger, averaging 1.80 kg. Linear regression of the log transformed weight at length data for both male and female pollock resulted in a best fit of:

$$\log\left(\hat{W}\right) = 2.56\log\left(FL\right) - 9.88$$

with an r^2 of 0.67 and P-value << 0.0001 (Fig. 17).

The age data revealed that the age-6 and age-7 pollock (2000 and 1999 year classes) were the most abundant (Fig. 18). The age-14 fish (1992 year class) were the third most abundant. The age-6 pollock (2000 year class) made up 27% of the total biomass and the age-14 pollock made up 14% of the total biomass (Fig. 19). Age-5 fish were larger and heavier than what would be expected given the length and weight pattern observed in the other ages and the age-9 fish were considerably smaller and lighter (Fig. 20). This could be due to the sample sizes, no age-9 female pollock occurred in the otolith sample. An analysis of percent agreement between readers showed that there may have been ageing bias for this data set, particularly for fish between the ages of 11 and 15. For all ages the percent agreement was 56.9 with a plus bias where the tester aged otoliths younger than the reader, but the Bowker's test of symmetry did not show a problem with bias.

The majority (99%) of the female pollock examined for maturity were in pre-spawning (M3) or spawning (M4) condition, 1% of the female pollock were developing (M2), one immature (M1) female pollock was observed, and no post-spawning (M5) fish were encountered throughout the study. There was an increase in the proportion of actively spawning fish at the end of the study (Fig. 21) with 27% of the females examined being in an active spawning condition. Stomach scans conducted sporadically throughout the study revealed that pollock were not feeding at this time.

Distribution and Abundance

Pollock distribution and density were dynamic with a change over the duration of the study and a recognizable diel migration pattern. In Surveys 2 and 4, the densest aggregations of pollock were observed in the center of the large survey area, but in Survey 8, pollock became much less abundant and more spread out with the highest densities occurring towards the edges of the large survey area (Figs. 22-27). Within the large and small survey sites, pollock in detectable quantities occurred continuously from east to west along the shelf break did not extend inshore beyond the 100 m isobath and decreased in density seaward of the shelf break. The one-dimensional covariograms created to assess spatial variance revealed a change in the spatial distribution for the large survey area from larger centrally located patches in Surveys 2 and 4 to smaller, more widely dispersed patches in Survey 8 (Fig. 28). The spatial structure of the pollock distribution in the small survey area remained consistent throughout the study (Fig. 28). Survey 5 was oriented perpendicular to all the other surveys with transects running east and west as opposed to north and south and was conducted over a much smaller area with fewer transects. The difference between the spatial structure observed in Survey 5 and the other surveys suggest some level of anisotropy in pollock aggregations in the Aleutians.

During daylight hours, pollock formed aggregations near the bottom and tended to concentrate on the upper part of the slope at between 180 and 450 m. The bathymetry of the region surveyed was highly irregular and larger aggregations of pollock were observed on areas of the shelf that descended less sharply into the basin, forming shelf extensions. At night the denser aggregations would typically expand towards the surface and away from the shelf break to form a less dense pelagic layer from 100 to 500 m. Movement along the shelf from day to night was evident in the opportunistically collected data and revealed that as fish spread out at night they tended to move along the shelf in the direction of the current but would remain densest in gullies along the shelf break between the shelf extensions.

The estimated abundance of pollock over the duration of the survey changed within both the large and small survey areas (Tables 8-11 and Fig. 29). Estimates of pollock biomass for the large area (180 nmi^2) were 8,810 and 2,845 t with the Shadow zone and 8,234 and 2,314 t without the Shadow zone in Survey 2 and Survey 8, respectively. Pollock biomass estimates for the small area (72 nmi^2) were 6,707 and 677 t with the Shadow zone and 6,485 and 559 t without the Shadow zone in Survey 2 and Survey 8, respectively. For Surveys 2 and 4, 76% and 77% of the large area pollock biomass occurred within the small area, while in Survey 8 only 23% of the biomass occurred within the small area. The relative precision of the survey pollock biomass estimates ranged from 4.75% in Survey 5 to 14.51% in Survey 8 (Tables 8 and 9). The relative precision of the biomass estimates was dependent on transect spacing, but also varied over time as the fish dispersed. The later surveys were less precise than the earlier surveys of the same area suggesting a more irregular distribution of pollock as the study progressed.

DISCUSSION

The 2006 Aleutian Islands cooperative acoustic survey study illustrates that using a small commercial fishing vessel to conduct high quality acoustic surveys of pollock in the central Aleutian Islands is feasible. Six successful surveys were completed resulting in relatively precise estimates of biomass for the survey area over time. An important consideration for collecting high quality acoustic data is ensuring that the vessel meets basic noise thresholds and that the acoustic system is properly calibrated. Although not commonly implemented the sonar-self noise test conducted during this study proved to be essential for collecting quality acoustic data. Running the engines at a higher rate than indicated as optimal by this test would have resulted in poor quality data that would have been difficult to use in quantitative assessments of pollock abundance and had it not been discovered the introduction of intermittent noise by the hydraulic compressor would have resulted in some data being unusable, degrading the quality of the surveys. Additional monitoring of the vessel's noise characteristics by passive listening through the acoustic system also helped ensure data quality throughout the study. Standard sphere calibrations prior to and after the survey provided a means to ensure the acoustic system was appropriately calibrated and remained stable for the duration of the study.

Distribution and abundance of pollock, although dynamic in the overall survey area, did remain stable during the times when, and in the areas where, there was limited fishing. Between Survey 2 and Survey 4, 143 t or 15% of the total harvest was removed from the study area and although there appears to be a declining trend in pollock abundance at this time (14-15 March and 23-24 March) from 8,234 to 6,600 t, this level of decrease is within the margin of error for the two surveys and therefore not statistically significant.

From Survey 4 to Survey 8 (23-24 March to 3-4 April) there was a 65% decline in abundance in the large survey area from 6,680 to 2,180 t and an 89% decline in the small survey area from 5,246 to 559 t. It should be noted that 97% (935 t) of the 965 t harvested during the study was removed from the small survey area and 85% of the harvest was taken in the 11-day period between Survey 4 and Survey 8. The fishing corresponded with the area of high pollock density and showed the largest decline in pollock abundance from 6,485 t on 14-15 March to 559 t on 3-4 April (Fig. 30), a 91% decrease in biomass. The change in biomass is much larger than the fishing removals, indicating that significant movement of pollock from this area occurred between Survey 4 and Survey 8. It is impossible to determine whether or not this movement would have occurred without fishing. The survey area outside of the high pollock density region did not show significant changes in biomass (1,749 to 1,754 t) for this same time period, remaining relatively stable throughout the entire study period. A conservative estimate on the change in biomass over the study period is between 4,000 and 6,000 t—much greater than the amount of pollock caught. A trend in the maturity data shows that the pollock began to show signs of active spawning only at the end of the study period (Fig. 21). This could indicate that fish were moving out of the area to spawn and may account for some of the observed declines.

Although this study demonstrates that commercial fishing vessels can be used to conduct acoustic surveys of pollock aggregations in the Aleutian Islands area, it also clearly shows that pollock aggregations in this region can be highly spatially and temporally dynamic at small scales. The spatial scale of our study would be too restricted to enable proper management of a Central Aleutian Islands' pollock fishery. Further studies are needed to evaluate the cause of the decline in the high pollock density area in order to better address this objective. Two possible ways of bettering our understanding in this area would be to: 1) expand the area of the survey to encompass the full extent of the pollock movement, and 2) use an acoustic buoy (De Robertis and Wilson 2006) to observe the behavior of pollock in relation to vessel noise and fishing removals.

The 2006 AICASS met all of its objectives laid out in the cruise plan (Appendix B) and exempted fishing permit (EFP) and was judged successful by all participants (Appendix C). In addition to achieving its scientific objectives, this project fostered an excellent working relationship between NMFS, the Aleut Enterprise Corporation, and the fishing industry. Local participation and stakeholder involvement enhances stewardship of this resource. Future work should consider the expansion of this technique to survey more areas within the Aleutian Islands to determine the status and dynamics of pollock within Steller sea lion critical habitat.

ACKNOWLEDGMENTS

The author would like to thank the owners, skipper, and crew of the FV *Muir Milach* for their hard work and dedication, without which this project could not have been completed. Cooperation and coordination with the Aleut Corporation and Adak Fisheries LLC. were also essential for the success of this project and I would like to acknowledge Sandra Moeller, Dave Fraser, and Kjetil Solsberg for their help in this regard. The author would also like to thank the staff of the Midwater Assessment and Conservation Engineering group at the AFSC for their help with this project and in particular Taina Honkalehto for her expertise in working with commercial fishing vessels and the ES 60 system in conducting acoustic surveys and Dr. Alex De Robertis for his expertise with sonar self-noise testing.

CITATIONS

Barbeaux, S.J., J. Ianelli, and E. Brown 2005. Stock assessment of Aleutian Islands Region Pollock. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510

De Robertis, A., and C. Wilson 2006. Walleye pollock respond to trawling vessels. ICES J. Mar. Sci. 63 (3): 514-522.

Dorn, M.W. 1992. Detecting environmental covariates of Pacific whiting (*Merluccius productus*) growth using a growth-increment regression model. Fish. Bull.,U.S. 90:260-275.

Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan, and E.J. Simmonds 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. ICES Coop. Res. Rep., Int. Counc. Explor. Sea Coop. Res. Rep. No. 144, 69 p.

Hollowed, A. B., E. Brown, P. Livingston, B. A. Megrey, and C. Wilson. 1995. Walleye pollock. *In* Stock assessment and fishery evaluation report for Gulf of Alaska as projected for 1996. Prepared by the Gulf of Alaska Groundfish Plan Team, North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510.

Kieth, G.J., T.E. Ryan, and R.J. Kloser 2005. ES60Adjust.jar Java Software utility to remove a systematic error in Simrad ES60 data. CSIRO Marine and Atmospheric Research. Castray Esplanade, Hobart 7001, Tasmania, Australia.

Kimura, D.K. 1989. Variability in estimating catch-in-numbers-at-age and its impact on cohort analysis. *In* R.J. Beamish and G.A. McFarlane (eds.), Effects on ocean variability on recruitment and an evaluation of parameters used in stock assessment models. Can. Spec. Publ. Fish. Aquat. Sci. 108:57-66.

Kloser, R.J. 1996. Improved precision of acoustic surveys of benthopelagic fish by means of a deep-towed transducer. ICES J. Mar. Sci. 53: 407-413

MacLennan, D.N., P.G. Fernandesm, and J. Dalen 2002. A consistent approach to definitions and symbols in fisheries acoustics, ICES J. Mar. Sci. 59:365-369.

National Oceanic and Atmospheric Administration (NOAA). 2006. Station ADKA2 - 9461380 - Adak Island, AK. National Data Buoy Center http://www.ndbc.noaa.gov/station_page.php?station=ADKA2, Accessed 13 June 2006.

Ona E., and R.B. Mitson. 1996. Acoustic sampling and signal processing near the seabed: the deadzone revisited, ICES J. Mar. Sci. 53(4):677-690.

Petigas, P. 1993. Geostatistics for fish stock assessments: a review and an acoustic application. ICES J. Mar. Sci. 50: 285-298

Ryan, T.E., and R.J. Kloser 2003. ES 60 triangle wave error – Appendix E. Internal Commonwealth Scientific and Industrial Research Organisation (CSIRO) report.

Simmond, J., and D. MacLennan. 2005. Fisheries Acoustics: Theory and Practice. Blackwell Science Ltd. Oxford, UK.

Traynor, J. 1996. Target strength measurements of walleye pollock (*Theragra chalcogramma*) and Pacific whiting (*Merluccius productus*). ICES J. Mar. Sci. 53: 253-258.

United States Commission on Ocean Policy. 2004. An Ocean Blueprint for the 21st Century Final Report. Washington, D.C.

Williamson, N., and J. Traynor 1996. Application of a one-dimensional geostatistical procedure to fisheries acoustic surveys of Alaskan pollock. ICES J. Mar. Sci. 53: 423-428.

TABLES

Table 1.-- Summary of 2006 Aleutian Islands cooperative acoustic survey studies.

Survey	Dates	Survey Day	Spacing (nmi)	Number of Transects	Survey Area (nmi^2)
2	14-15 Mar.	1	1.5	18	180
4	23-24 Mar.	9	1.5	18	180
5	24 Mar.	10	0.5	7	9
6	28-29 Mar.	14	1.0	12	72
7	1 Apr.	19	1.0	12	72
8	3-4 Apr.	21	1.5	18	180

Table 2.-- Simrad ES 60 38kHz acoustic system settings on the FV *Muir Milach* during 2006 AICASS and results from standard sphere calibrations conducted before and after the survey.

		Survey System Settings	Calibrations 10-Mar	4-Apr
Echosounder:		Simrad ES 60	--	--
Transducer:		ES38B	--	--
Frequency (kHz):		38	--	--
Absorption coefficient (dB/km):		10	--	--
Pulse length (ms):		1.024	--	--
Band width (kHz):		2.43 (wide)	--	--
Transmitted power (W):		2000	--	--
Angle sensitivity:		21.9	--	--
2-way beam angle (dB):		-20.6	--	--
Transducer gain (dB):		26.5	25.0	25.0
Sa Correction (dB):		--	-0.58	-0.58
3 dB beamwidth (deg)				
	Along:	7.10	7.01	7.03
	Athwart:	7.10	7.04	7.09
Angle offset (deg.)				
	Along:	0.00	0.09	0.15
	Athwart:	0.00	-0.04	-0.04
Range (m)		500	--	--
Post-processing Sv theshold (dB):		-70	--	--
Standard sphere TS (dB):		--	-42.16	-42.17
Sphere range from transducer (m)		--	19.25	21.50
Water temp (^{o}C)		--		
	at transducer:	--	3.55	3.89
	at sphere:	--	3.60	3.78
Water salinity (PSU)		--		
	at transducer:	--	32.33	33.15
	at sphere:	--	33.13	33.21

Table 3.-- Conductivity-temperature-depth (CTD) cast information for the 2006 Aleutian Islands cooperative acoustic survey studies.

CAST	TIME	DATE	LONGITUDE (W)	LATITUDE (N)	BOTTOM DEPTH (m)
*1	11:30:00	3/10/2006	-176.50	51.81	62
*2	11:45:00	3/10/2006	-176.50	51.81	62
3	9:35:00	3/13/2006	-174.07	52.44	1126
4	21:00:00	3/13/2006	-173.60	52.28	255
5	22:57:31	3/14/2006	-174.71	52.31	272
6	11:26:14	3/15/2006	-175.15	52.17	344
7	14:50:21	3/21/2006	-175.04	52.18	348
8	21:03:30	3/23/2006	-174.35	52.41	405
9	1:28:39	3/24/2006	-174.52	52.38	121
10	2:01:35	3/24/2006	-174.55	52.39	500
11	21:18:10	3/24/2006	-174.77	52.3	255
12	16:31:42	3/26/2006	-174.76	52.3	231
13	18:25:00	3/28/2006	-174.78	52.29	232
14	8:01:00	4/1/2006	-174.78	52.29	248
15	11:38:30	4/3/2006	-174.4	52.38	281
16	21:16:00	4/3/2006	-174.79	52.29	335
*17	23:00:00	4/4/2006	-176.50	51.81	62

* CTD cast conducted during calibration in Scabbard Bay, Adak Island, AK.

Table 4.-- Verification and commercial trawl haul stations and extrapolated catch data summary from 2006 Aleutian Islands cooperative acoustic survey study.

Haul	Date	*Type	Start Time (ALT)	Start Position Longitude (W)	Start Position Latitude (N)	Depth (m) Bottom	Depth (m) Foot-rope	Pollock Catch (kg)	Pollock Catch number	Other Catch (kg)
1	3/14/2006	V	8:51	-173.5520	52.2824	325.8	307.7	1.6	2	0.0
2	3/14/2006	V	11:10	-173.6910	52.3249	343.9	325.8	4.1	3	9.5
3	3/15/2006	V	2:15	-174.7750	52.3108	362	217.2	1414.9	790	11.2
4	3/15/2006	V	13:41	-175.1527	52.2490	316.75	289.6	974.9	641	68.0
5	3/15/2006	C	20:25	-174.7498	52.3263	407.25	262.45	0.0	0	0.0
6	3/18/2006	C	20:57	-174.9620	52.2112	289.6	235.3	54140.0	31379	0.0
7	3/20/2006	C	2:31	-174.9603	52.2155	307.7	226.25	62957.1	37899	102.9
8	3/20/2006	C	6:31	-174.7552	52.3155	253.4	217.2	24052.5	13508	197.5
9	3/22/2006	C	2:33	-174.8420	52.2664	262.45	226.25	37935.0	21921	0.0
10	3/22/2006	C	5:26	-174.7232	52.3222	298.65	271.5	25290.0	14328	0.0
11	3/22/2006	C	8:44	-174.8937	52.2412	298.65	271.5	4114.0	2457	7886.0
12	3/24/2006	V	15:24	-175.0886	52.2342	316.75	289.6	1208.4	682	291.6
**13	3/24/2006	C	21:54	-174.7198	52.3220	307.7	298.65			
**14	3/25/2006	C	2:15	-174.8833	52.2333	262.45	244.35			
15	3/26/2006	C	17:27	-174.7780	52.3011	235.3	235.3	29504.2	15496	76.8
16	3/26/2006	C	19:05	-174.7758	52.3017	231.68	199.1	41912.8	25684	345.7
17	3/26/2006	C	22:09	-174.7506	52.3174	262.45	235.3	65781.4	35925	1832.2

* Type: V = Verification trawl , C = Commercial trawl, ** Composition sampling was not conducted.

Table 5. --Verification and commercial trawl haul stations and extrapolated catch data summary from 2006 Aleutian Islands cooperative acoustic survey study.

Haul	Date	*Type	Start Time (ALT)	Start Position Longitude (W)	Start Position Latitude (N)	Depth (m) Bottom	Depth (m) Foot-rope	Pollock Catch (kg)	Pollock Catch number	Other Catch (kg)
18	3/27/2006	C	0:40	-174.7967	52.2833	267.88	249.78	20929.7	11976	199.6
19	3/28/2006	C	13:22	-174.7542	52.3147	249.78	226.25	75393.9	39601	503.3
20	3/28/2006	C	16:05	-174.7933	52.2933	231.68	213.58	86016.8	48140	0.0
21	3/30/2006	C	8:25	-174.8683	52.2470	211.77	181	76488.4	41875	0.0
22	3/30/2006	C	11:30	-174.7783	52.2958	238.92	220.82	9268.6	6131	51922.1
23	3/30/2006	C	13:45	-174.7667	52.3117	244.35	199.1	62604.1	37290	8785.1
24	4/1/2006	V	22:20	-174.5950	52.3700	352.95	334.85	380.8	253	4.2
25	4/2/2006	V	0:45	-174.4050	52.4183	452.5	280.55	966.2	504	4.3
26	4/2/2006	C	9:20	-174.8750	52.2413	213.58	188.24	3213.6	1976	16314.2
27	4/2/2006	C	12:30	-174.5600	52.3933	387.34	280.55	23386.5	13569	46.9
28	4/2/2006	C	21:45	-174.7250	52.3083	289.6	289.6	834.1	488	0.6
29	4/2/2006	C	23:35	-174.7633	52.3158	307.7	280.55	11292.2	6864	424.5
30	4/3/2006	C	6:00	-174.5500	52.3958	340.28	333.04	27320.0	16171	19.0

* Type: V = Verification trawl , C = Commercial trawl, ** Composition sampling was not conducted.

Table 6.-- Sampled and extrapolated catch by species from verification and commercial trawl hauls sampled for species composition.

Common Name	Scientific Name	Basket Sampled (kg)	Basket Sampled Number	Extrapolated (kg)	Extrapolated Number	(%)
Walleye pollock	*Theragra chalcogramma*	10,672.19	6,181	747,385.9	425,554	89.4
Pacific ocean perch	*Sebastes alutus*	775.94	1,301	87,817.8	168,496	10.5
Chinook salmon	*Oncorhynchus tshawytscha*	14.31	3	851.4	242	0.1
Northern rockfish	*Sebastes polyspinis*	0.74	2	253.0	617	<0.1
Greenland turbot	*Reinhardtius hippoglossoides*	9.50	1	9.5	1	<0.1
Atka mackerel	*Pleurogrammus monopterygius*	3.39	6	5.5	10	<0.1
Smooth lumpsucker	*Aptocyclus ventricosus*	2.50	1	2.5	1	<0.1
Squid	Teuthoidea	1.19	5	1.5	7	<0.1
Totals		11,479.76	7,500	836,327.1	594,928	

Table 7.-- Species composition and weight from Alaska Department of Fish and Game fish tickets.

Delivery	Date	Pollock (kg)	POP (kg)	P.cod (kg)	Salmon (kg)	Flatfish (kg)	Other (kg)	Total (kg)
D1	17-Mar	2,437	6	0	0	0	0	2,443
D2	19-Mar	54,435	25	20	3	0	0	54,483
D3	20-Mar	87,852	10	0	7	1	1	87,871
D4	22-Mar	69,380	6,317	0	8	0	0	75,705
D5	25-Mar	128,257	868	12	11	1	0	129,150
D6	27-Mar	159,239	1,328	0	15	1	0	160,582
D7	29-Mar	161,430	488	0	0	0	0	161,918
D8	31-Mar	195,189	13,215	3	0	5	0	208,411
D9	4-Apr	74,189	10,018	0	0	0	0	84,206
Total		932,407	32,274	35	44	9	1	964,769

Table 8.-- Number and type of biological data collected during the 2006 Aleutian Islands cooperative acoustic survey study.

	Walleye pollock					Pacific ocean perch
Haul	Length	Weight	Female Maturity	Otolith	Tissue	Length
1	10		5			
2	3					
3	152	20	123			
4	128	20	64			108
6	140	19	84	19		
7	160	20	77	20		
8	147	20	70	20		
9	149	20	63	20		
10	144	20	49	20		
11						154
12	146	19	95	19		166
13	158	20	86	20		
15	144	18	100	18		
16	148	20	100	20		
17	138	19	117	19		
18	121		99			
20	138	50	108	50	50	5
21	101		80			
22	11		4			189
23	99		47			48
24	150		26			
25	129	20	70	20		
26	31	19	25	19		156
27	97	49	20	49	49	
28	200		105			
29	101		15			16
Totals	2,945	373	1,632	333	99	842

Table 9.-- Abundance estimation for 2006 Aleutian Islands cooperative acoustic survey study surveys from the large survey area. Shaded areas indicate use of the shadow zone estimator.

Survey	Area (nmi^2)	Shadow Zone (Y/N)	Biomass (t)	Relative Precision (E_i)	High Biom. (t)	Low Biom. (t)	Density (t / nmi^2)	% in Shadow Zone
2	180	N	8,233.8	8.67%	9,632.5	6,835.1	45.7	
2	180	Y	8,809.9	8.04%	10,198.4	7,421.4	48.9	7%
4	180	N	6,600.4	7.96%	7,630.1	5,570.7	36.7	
4	180	Y	7,980.2	7.87%	9,210.6	6,749.8	44.3	17%
8	180	N	2,313.6	14.51%	2,971.6	1,655.6	12.9	
8	180	Y	2,845.2	14.24%	3,639.0	2,051.4	15.8	19%

Table 10.-- Abundance estimation for 2006 Aleutian Islands cooperative acoustic survey study surveys from the small survey area. Shaded areas indicate use of the shadow zone estimator.

Survey	Area (nmi^2)	Shadow Zone (Y/N)	Biomass (t)	Relative Precision (E_i)	High Biom. (t)	Low Biom. (t)	Density (t / nmi^2)	% in Shadow Zone
2	72	N	6,484.5	12.29%	8,046.1	4,922.9	90.1	
2	72	Y	6,706.6	14.32%	8,589.2	4,824.0	93.1	3%
4	72	N	5,246.4	12.31%	6,512.6	3,980.2	72.9	
4	72	Y	6149.8	11.89%	7,582.5	4,717.1	85.4	14%
5	9	N	890.8	5.29%	983.2	798.4	99.0	
5	9	Y	1,036.6	4.75%	1,133.1	940.1	115.2	15%
6	72	N	3,015.0	6.64%	3,407.4	2,622.6	41.9	
6	72	Y	3,458.5	6.44%	3,894.9	3,022.1	48.0	13%
7	72	N	1,159.0	6.83%	1,314.2	1,003.8	16.1	
7	72	Y	2,179.7	5.05%	2,395.4	1,964.0	30.3	47%
8	72	N	559.2	14.32%	716.1	402.3	7.8	
8	72	Y	677.0	12.96%	848.9	505.1	9.4	17%

Table 11.-- Numbers and biomass in metric tons (t) from large survey area (180 nmi^2). Both numbers and biomass do not include the Shadow zone estimate.

Length	Survey 2		Survey 4		Survey 8	
(cm)	Numbers	Biomass	Numbers	Biomass	Numbers	Biomass
35	1,653	0.76	1,325	0.61	464	0.21
36	1,653	0.82	1,325	0.66	464	0.23
37	0	0.00	0	0.00	0	0.00
38	0	0.00	0	0.00	0	0.00
39	1,653	1.00	1,325	0.81	464	0.28
40	1,653	1.07	1,325	0.86	464	0.30
41	0	0.00	0	0.00	0	0.00
42	1,653	1.21	1,325	0.97	464	0.34
43	1,653	1.29	1,325	1.03	464	0.36
44	13,220	10.94	10,598	8.77	3,715	3.08
45	8,263	7.25	6,623	5.81	2,322	2.04
46	24,788	23.00	19,870	18.43	6,965	6.46
47	26,440	25.92	21,195	20.78	7,429	7.28
48	42,965	44.45	34,442	35.63	12,073	12.49
49	80,973	88.31	64,910	70.79	22,753	24.81
50	125,591	144.25	100,676	115.63	35,290	40.53
51	201,606	243.60	161,612	195.28	56,650	68.45
52	224,742	285.40	180,158	228.78	63,150	80.19
53	287,537	383.40	230,496	307.34	80,795	107.73
54	289,190	404.51	231,821	324.27	81,260	113.66
55	312,325	457.89	250,366	367.06	87,760	128.66
56	355,290	545.48	284,808	437.27	99,833	153.28
57	333,807	536.27	267,587	429.88	93,797	150.69
58	328,850	552.37	263,613	442.79	92,404	155.21
59	343,723	603.18	275,536	483.53	96,583	169.49
60	342,070	626.69	274,211	502.37	96,119	176.09
61	295,800	565.35	237,120	453.20	83,117	158.86
62	271,012	540.00	217,249	432.88	76,152	151.74
63	252,834	524.85	202,678	420.74	71,044	147.48
64	185,081	400.02	148,365	320.67	52,006	112.40
65	156,989	353.05	125,846	283.01	44,112	99.20
66	175,166	409.63	140,417	328.37	49,220	115.10
67	76,016	184.75	60,936	148.10	21,360	51.91
68	56,185	141.83	45,039	113.70	15,788	39.85
69	23,135	60.63	18,546	48.60	6,501	17.04
70	16,525	44.93	13,247	36.02	4,643	12.62
71	1,653	4.66	1,325	3.73	464	1.31
72	3,305	9.66	2,649	7.74	929	2.71
73	0	0.00	0	0.00	0	0.00
74	0	0.00	0	0.00	0	0.00
75	1,653	5.36	1,325	4.30	464	1.51
Total	4,866,648	8,233.78	3,901,213	6,600.38	1,367,484	2,313.62

Table 12.-- Numbers and biomass in metric tons from small survey area. Both numbers and biomass do not include the Shadow zone estimate.

Length	Survey 2 (72 nmi^2)		Survey 4 (72 nmi^2)		Survey 5 (9 nmi^2)		Survey 6 (72 nmi^2)		Survey 7 (72 nmi^2)		Survey 8 (72 nmi^2)	
(cm)	Numbers	Biomass	Numbers	Biomass	Numbers	Biomass	Numbers	Biomass	Numbers	Biomass	Numbers	Biomass
35	1,301	0.60	1,053	0.49	179	0.08	605	0.28	233	0.11	112	0.05
36	1,301	0.64	1,053	0.52	179	0.09	605	0.30	233	0.12	112	0.06
37	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
38	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
39	1,301	0.79	1,053	0.64	179	0.11	605	0.37	233	0.14	112	0.07
40	1,301	0.84	1,053	0.68	179	0.12	605	0.39	233	0.15	112	0.07
41	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
42	1,301	0.96	1,053	0.77	179	0.13	605	0.44	233	0.17	112	0.08
43	1,301	1.02	1,053	0.82	179	0.14	605	0.47	233	0.18	112	0.09
44	10,411	8.62	8,424	6.97	1,430	1.18	4,841	4.01	1,861	1.54	898	0.74
45	6,507	5.71	5,265	4.62	894	0.78	3,026	2.65	1,163	1.02	561	0.49
46	19,521	18.11	15,794	14.65	2,682	2.49	9,077	8.42	3,489	3.24	1,683	1.56
47	20,823	20.41	16,847	16.51	2,860	2.80	9,682	9.49	3,722	3.65	1,796	1.76
48	33,837	35.01	27,377	28.32	4,648	4.81	15,733	16.28	6,048	6.26	2,918	3.02
49	63,770	69.55	51,595	56.27	8,760	9.55	29,650	32.34	11,398	12.43	5,499	6.00
50	98,909	113.60	80,024	91.91	13,587	15.61	45,988	52.82	17,678	20.30	8,530	9.80
51	158,774	191.85	128,460	155.22	21,811	26.35	73,823	89.20	28,378	34.29	13,692	16.54
52	176,994	224.77	143,202	181.85	24,314	30.88	82,294	104.51	31,635	40.17	15,263	19.38
53	226,449	301.94	183,214	244.30	31,107	41.48	105,288	140.39	40,474	53.97	19,528	26.04
54	227,750	318.57	184,267	257.75	31,286	43.76	105,893	148.12	40,706	56.94	19,640	27.47
55	245,970	360.61	199,008	291.76	33,789	49.54	114,365	167.67	43,963	64.45	21,212	31.10
56	279,807	429.59	226,385	347.57	38,437	59.01	130,098	199.74	50,011	76.78	24,130	37.05
57	262,889	422.33	212,696	341.70	36,113	58.02	122,231	196.37	46,987	75.48	22,671	36.42
58	258,984	435.01	209,538	351.96	35,577	59.76	120,416	202.26	46,289	77.75	22,334	37.51
59	270,697	475.04	219,014	384.34	37,186	65.26	125,862	220.87	48,382	84.90	23,344	40.97
60	269,396	493.54	217,961	399.31	37,007	67.80	125,257	229.48	48,150	88.21	23,232	42.56
61	232,956	445.24	188,479	360.23	32,001	61.16	108,314	207.02	41,637	79.58	20,089	38.40
62	213,434	425.28	172,684	344.08	29,320	58.42	99,237	197.73	38,148	76.01	18,406	36.67
63	199,119	413.35	161,102	334.43	27,353	56.78	92,581	192.19	35,589	73.88	17,171	35.65
64	145,760	315.03	117,931	254.89	20,023	43.28	67,772	146.48	26,052	56.31	12,570	27.17
65	123,636	278.04	100,031	224.96	16,984	38.19	57,485	129.28	22,098	49.69	10,662	23.98
66	137,951	322.61	111,613	261.01	18,951	44.32	64,141	150.00	24,656	57.66	11,896	27.82
67	59,866	145.50	48,436	117.72	8,224	19.99	27,835	67.65	10,700	26.00	5,163	12.55
68	44,249	111.70	35,800	90.37	6,078	15.34	20,574	51.93	7,909	19.96	3,816	9.63
69	18,220	47.75	14,741	38.63	2,503	6.56	8,471	22.20	3,256	8.53	1,571	4.12
70	13,014	35.38	10,530	28.63	1,788	4.86	6,051	16.45	2,326	6.32	1,122	3.05
71	1,301	3.67	1,053	2.97	179	0.50	605	1.71	233	0.66	112	0.32
72	2,603	7.61	2,106	6.15	358	1.04	1,210	3.54	465	1.36	224	0.66
73	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
74	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
75	1,301	4.22	1,053	3.42	179	0.58	605	1.96	233	0.75	112	0.36
Total	3,832,708	6,484.48	3,100,946	5,246.42	526,503	890.78	1,782,034	3,014.99	685,028	1,158.98	330,519	559.20

FIGURES

Figure 1.-- FV *Muir Milach*, the 32 m stern trawler used to conduct the 2006 Aleutian Islands cooperative acoustic survey study, at port in Adak, Alaska.

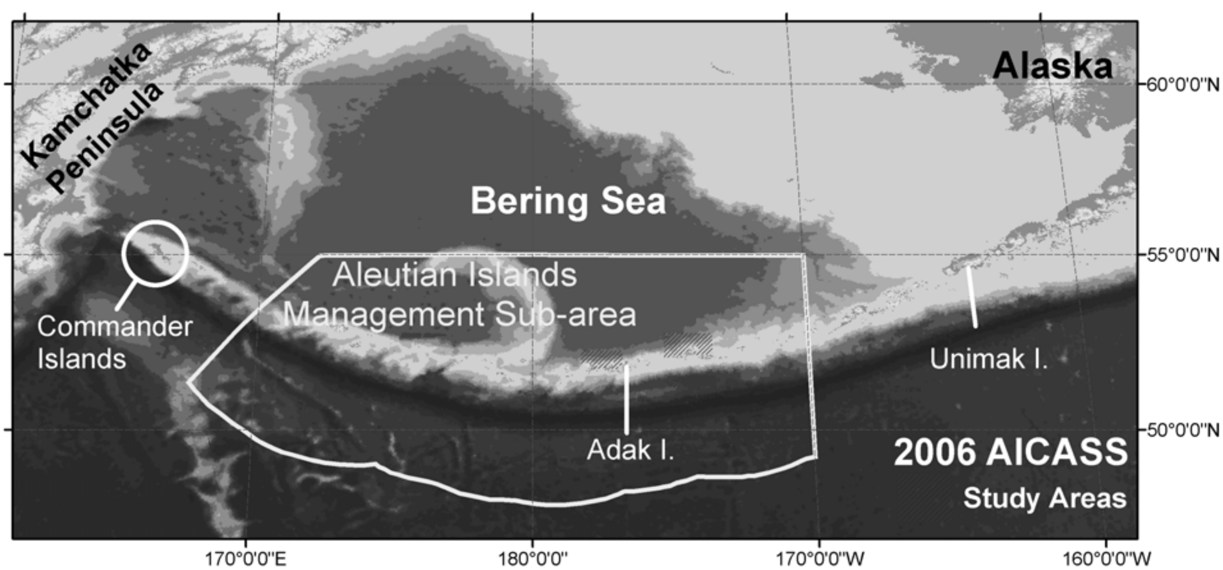


Figure 2.-- Proposed 2006 Aleutian Islands cooperative acoustic survey study area locations.

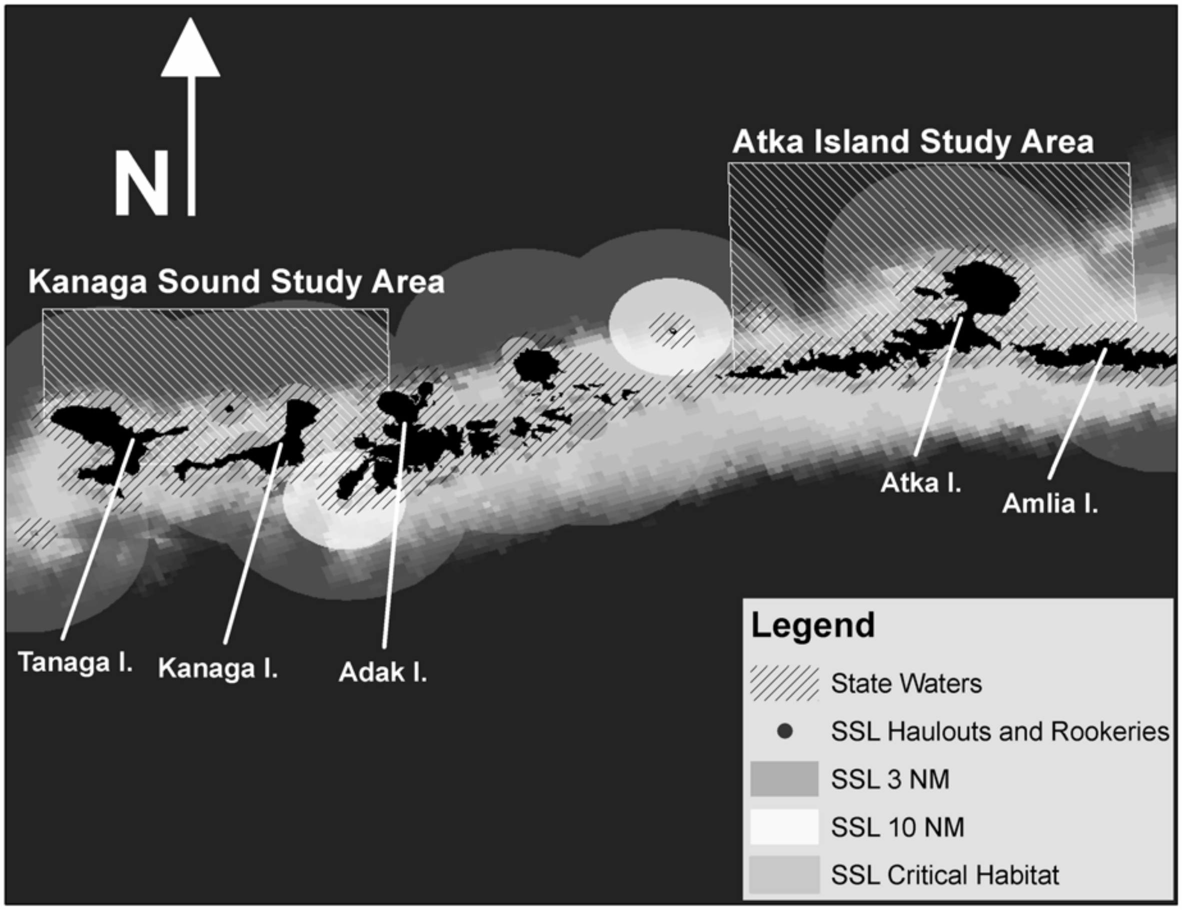


Figure 3.-- 2006 Aleutian Islands cooperative acoustic survey study preliminary study sites.

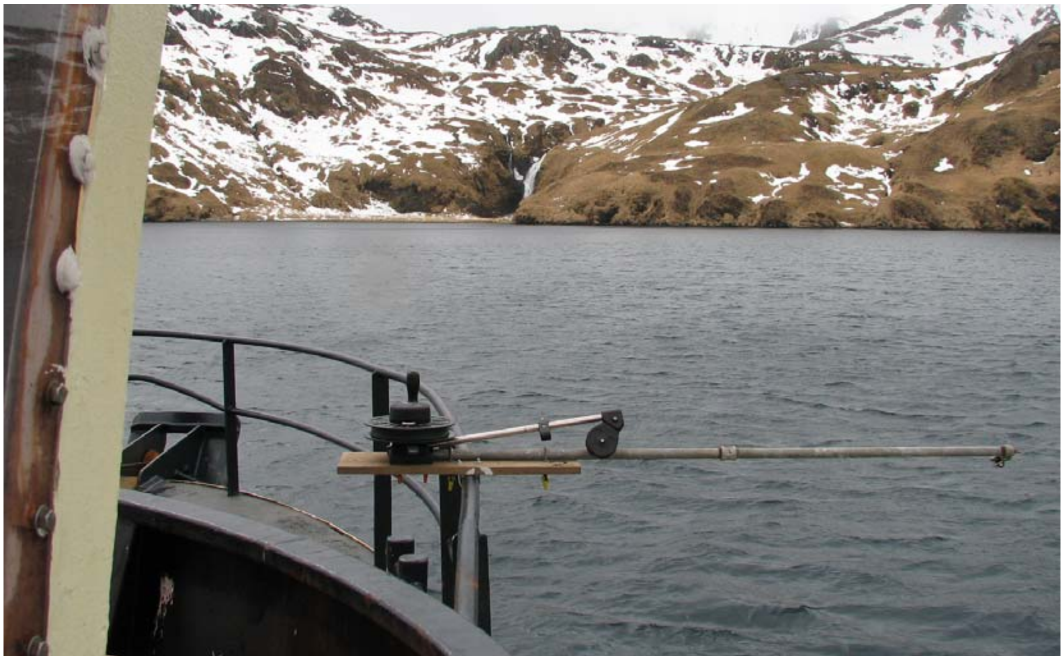


Figure 4.-- Starboard-bow downrigger setup for sphere calibration in Scabbard Bay near Adak Island, Alaska.

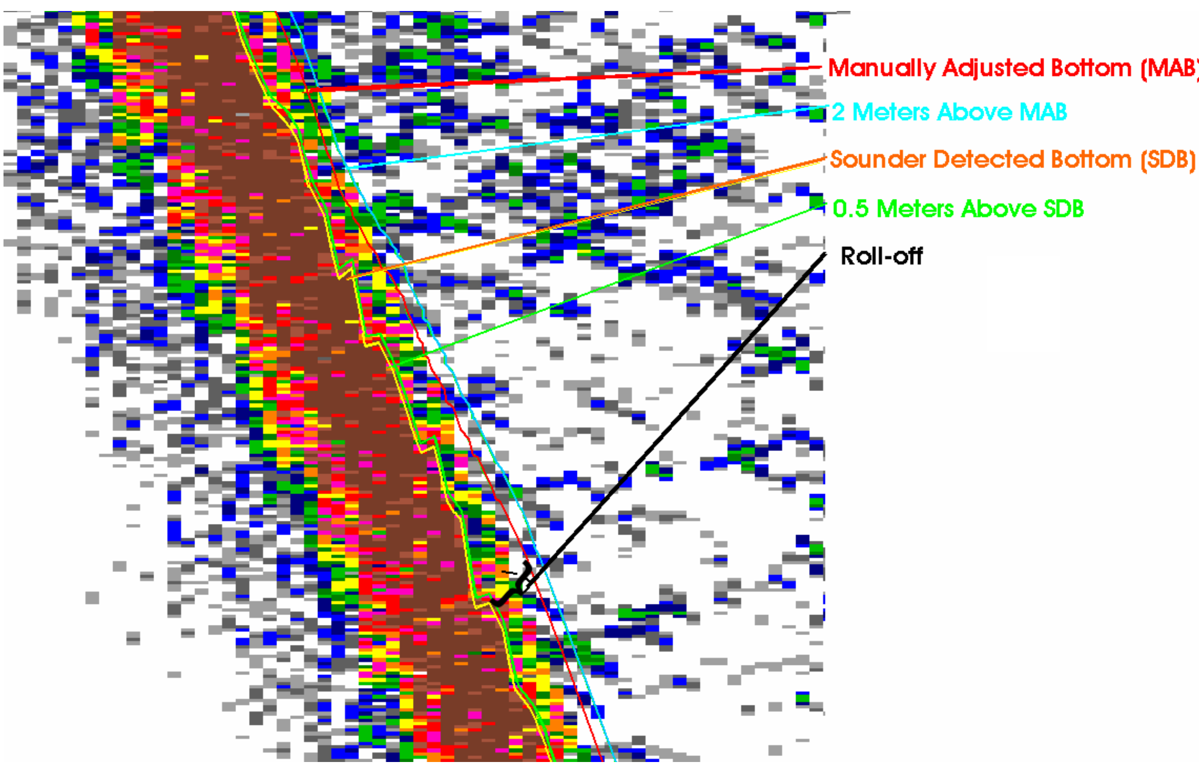


Figure 5.-- Echogram illustrating bottom and roll-off caused by a complex bottom slope.

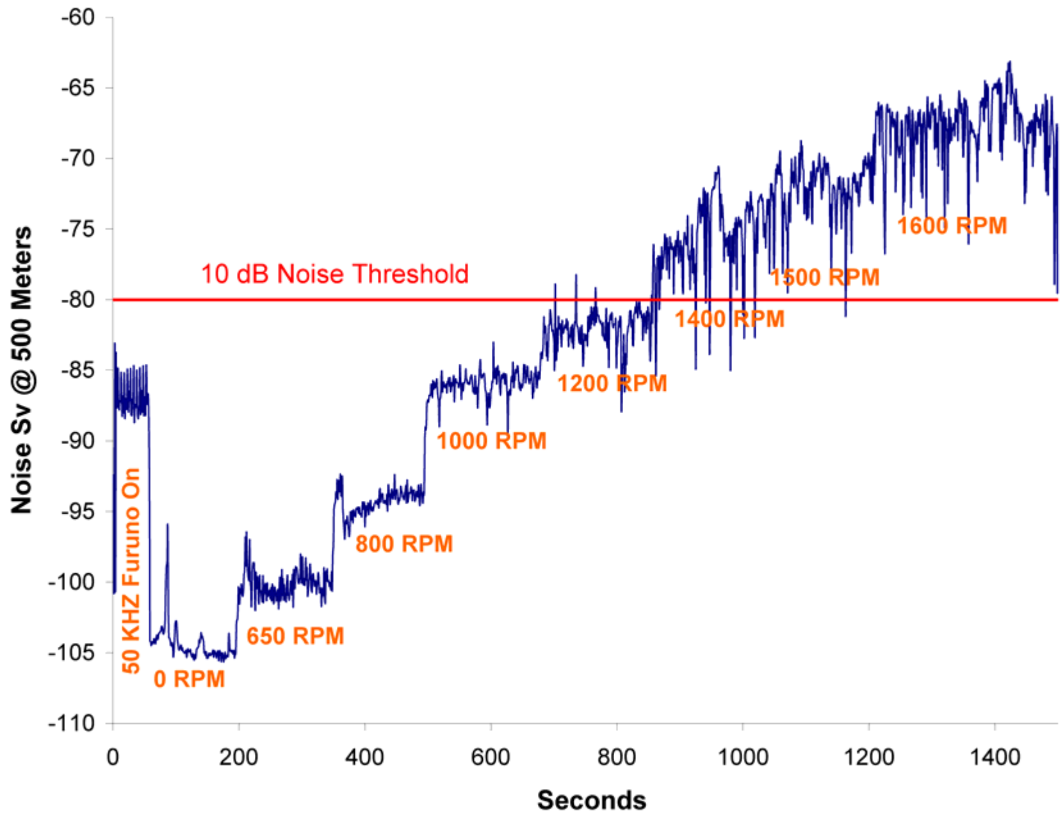


Figure 6.-- FV *Muir Milach* 15 February 2006 sonar-self noise test with -80dB threshold.

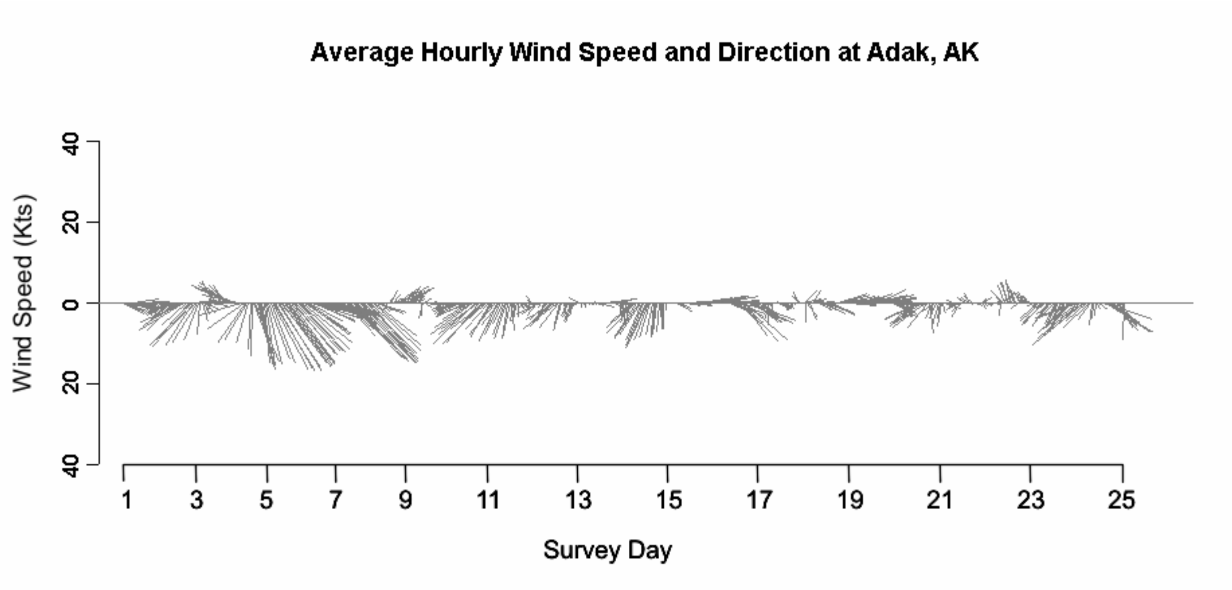


Figure 7.-- Feather plot of average hourly wind speed and direction at Adak, Alaska, station ADKA2 – 9461380 (NOAA 2006) from 12 March through 5 April 2006. Direction of the line indicates wind direction (top of graph is North or 360°) and the length of the line represents wind speed. Survey Day 1 in this figure is 12 March 2006.

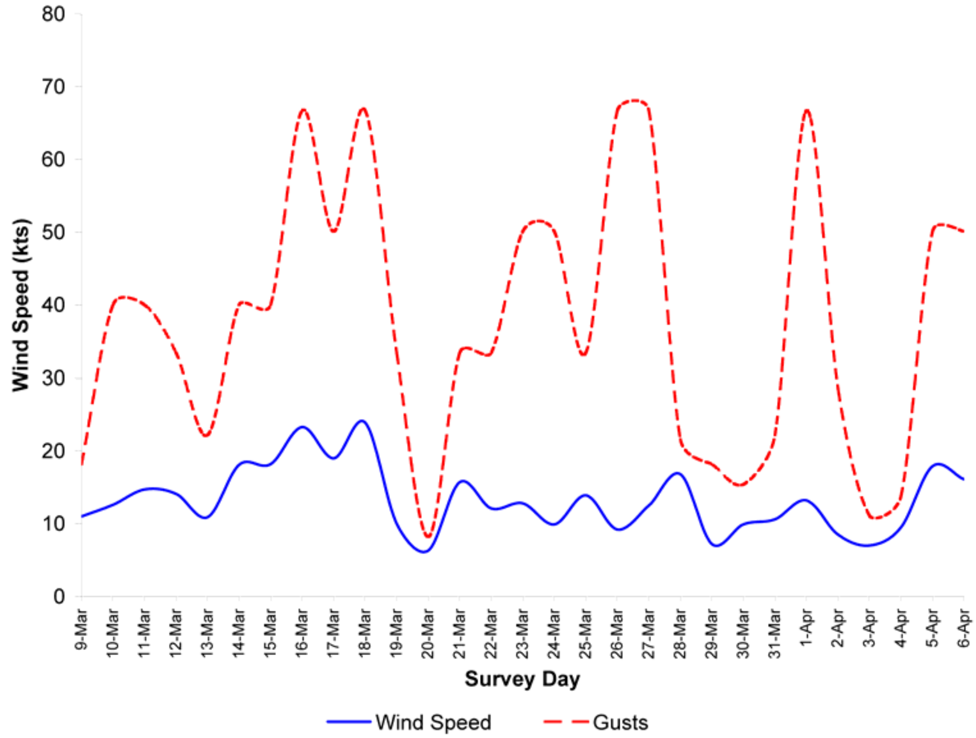


Figure 8.-- Maximum daily wind speed and gusts at Adak, Alaska, station ADKA2 – 9461380 (NOAA 2006) from 9 March through 6 April 2006.

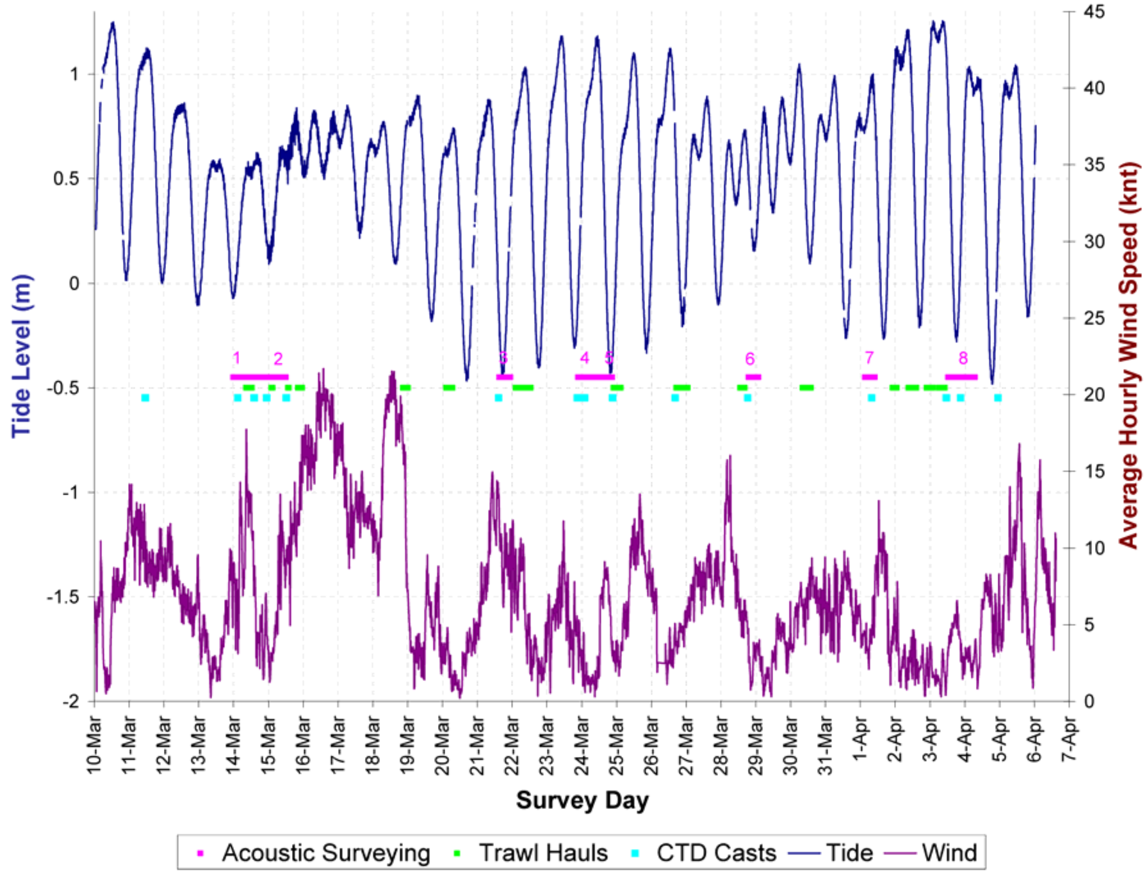


Figure 9.-- Weather and tide timing with survey tasks. Survey numbers are in pink. Wind speed and tide data from Adak, Alaska, station ADKA2 – 9461380 (NOAA 2006).

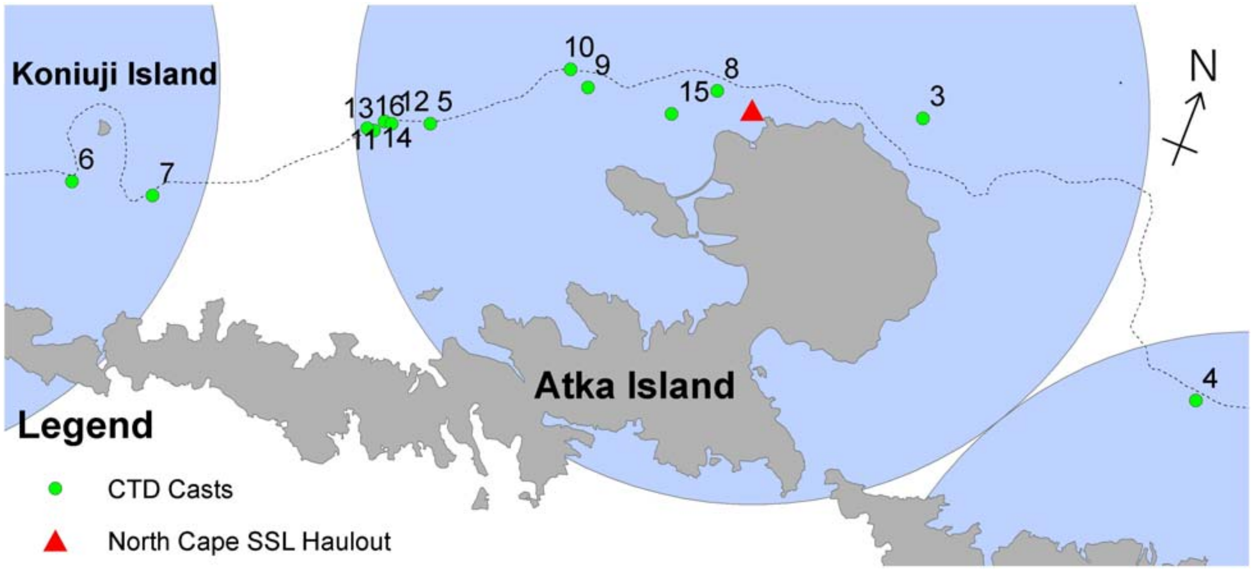


Figure 10.-- Conductivity-temperature-depth (CTD) cast locations. Shaded regions are Steller sea lion critical habitat surrounding haulouts and rookeries.

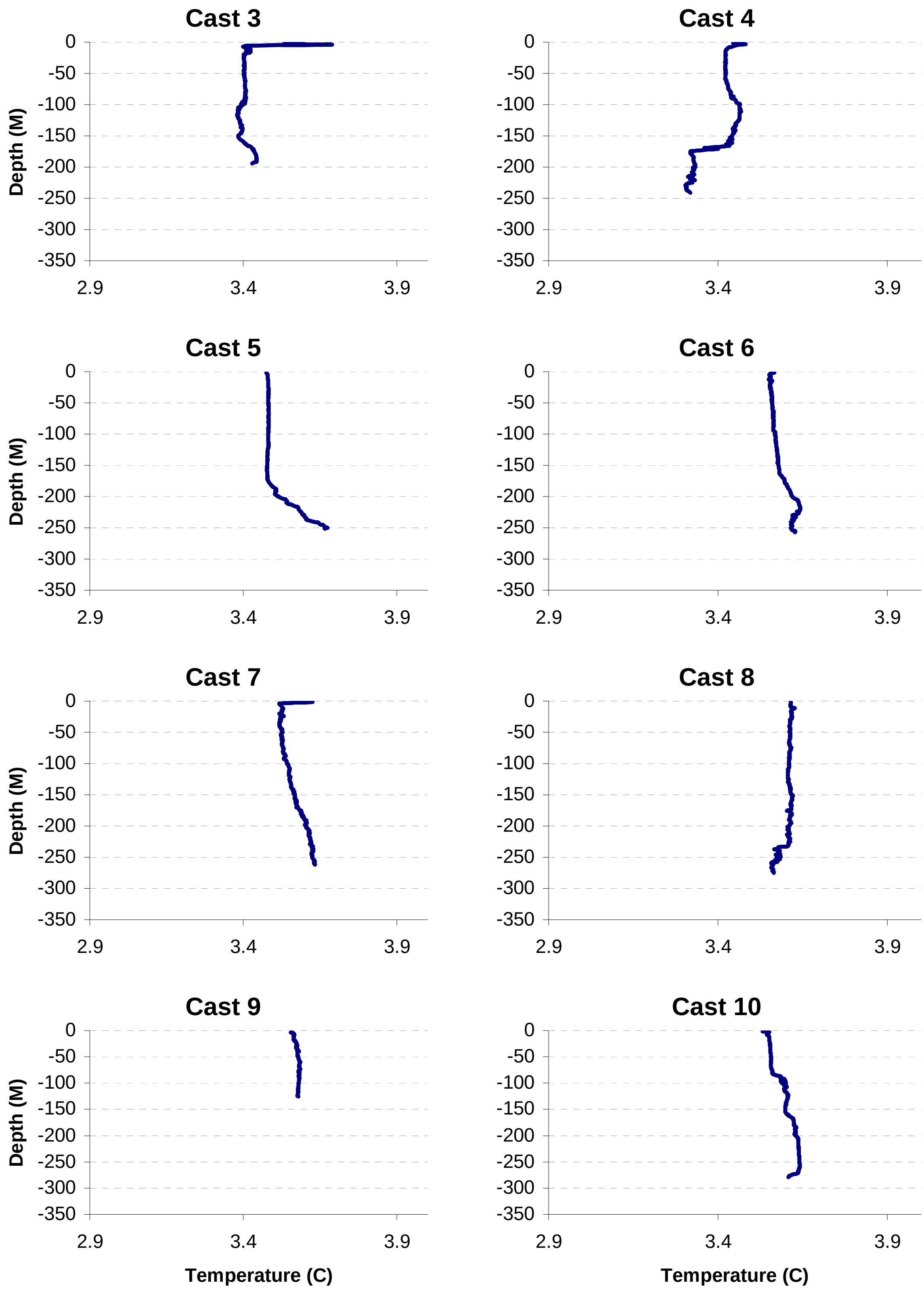


Figure 11.-- Temperature (°C) at depth.

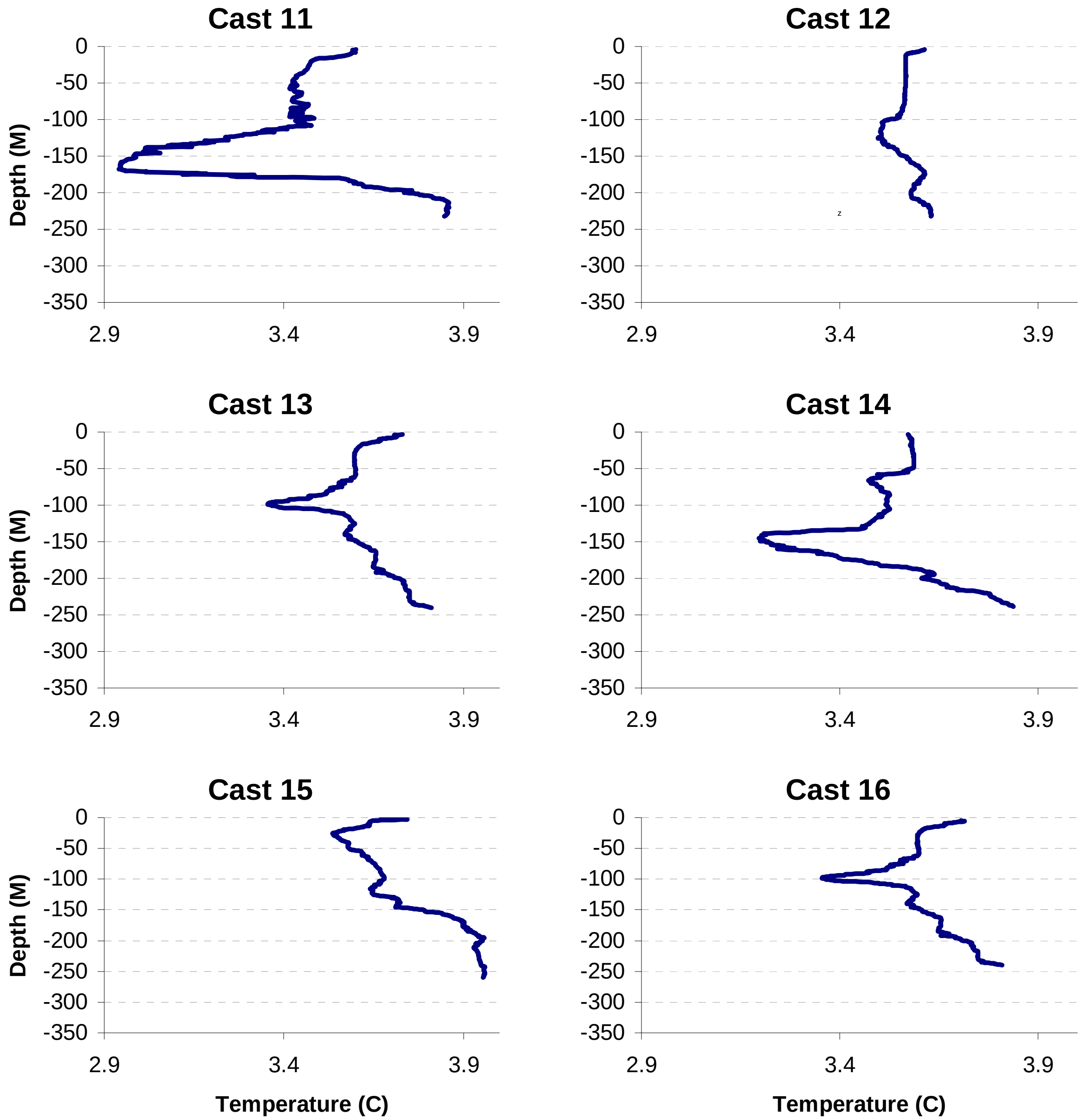


Figure 11. Continued.-- Temperature (°C) at depth.

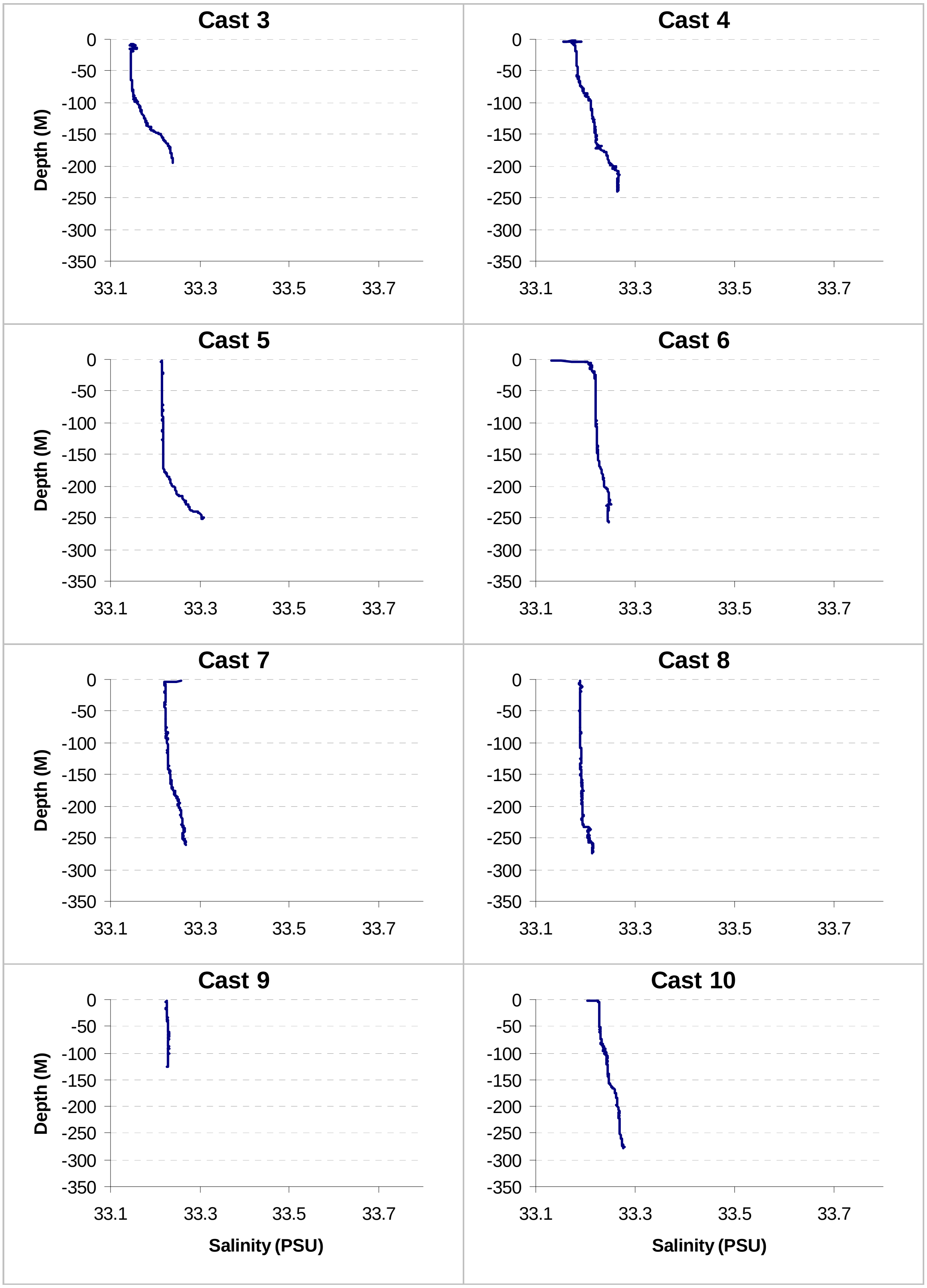


Figure 12.-- Salinity (PSU) at depth.

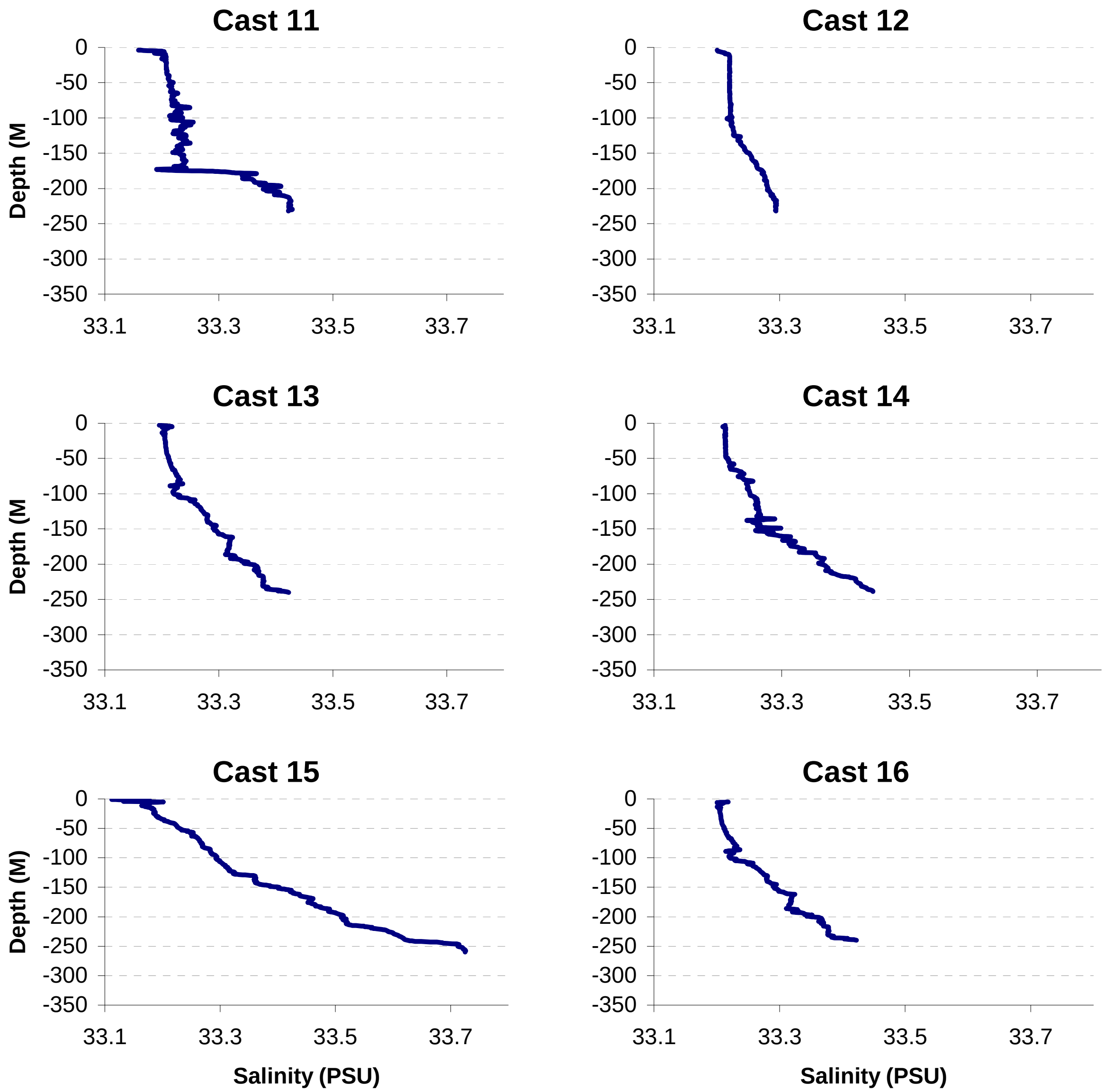


Figure 12. Continued.-- Salinity (PSU) at depth.

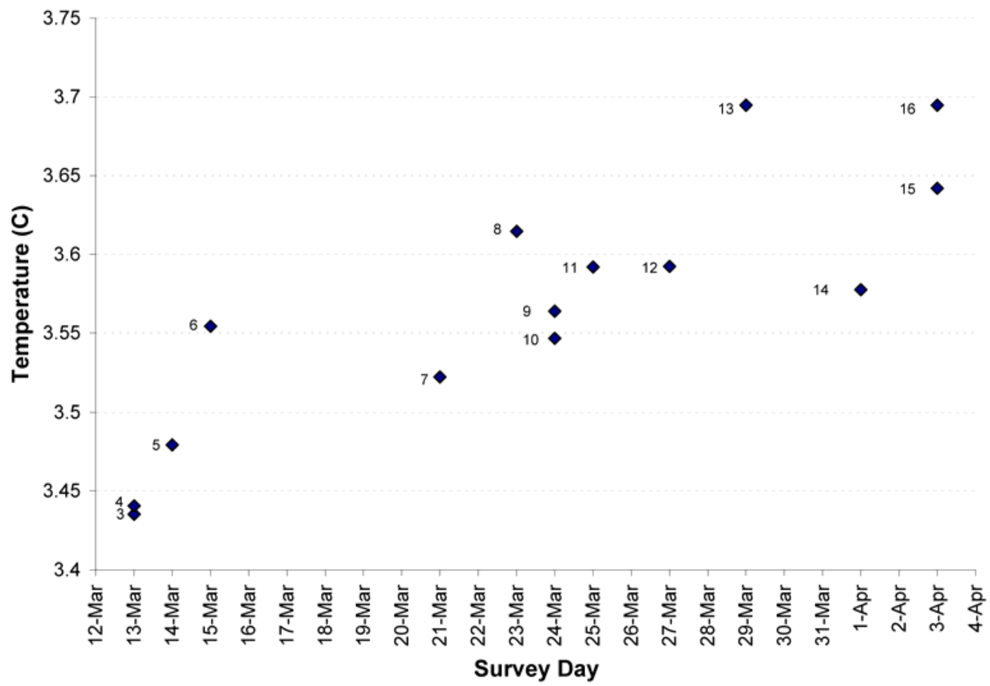


Figure 13.-- Average sea temperature at 5 m to 10 m by Conductivity-temperature-depth (CTD) cast, labels denote CTD cast number.

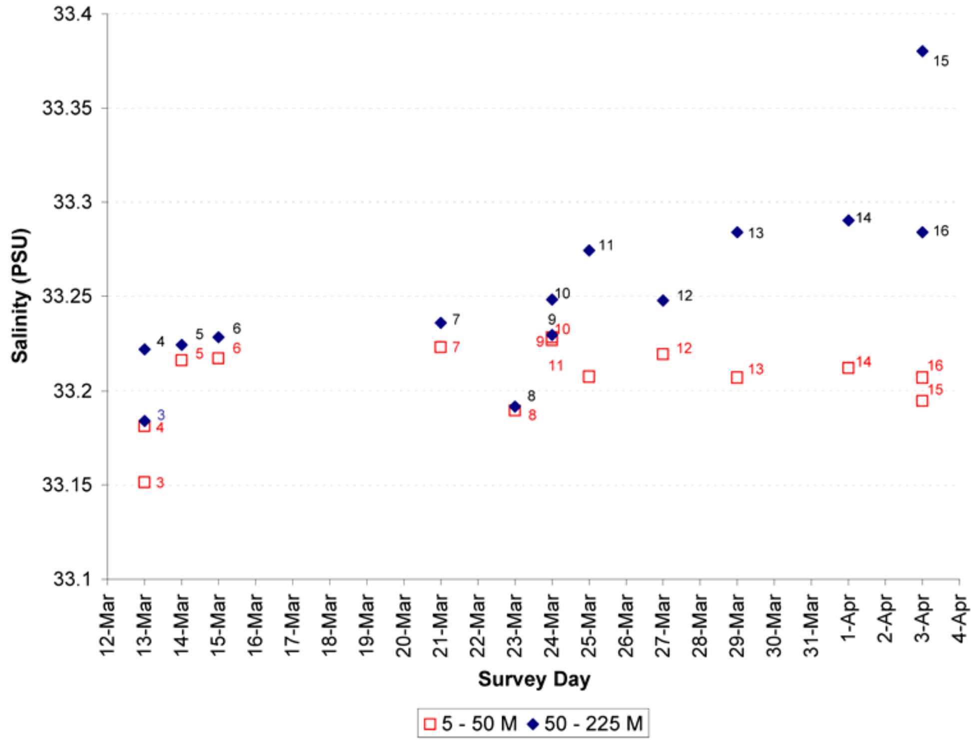


Figure 14.-- Average Salinity at 5 m to 50 m and 50 m to 225 m by Conductivity-temperature-depth (CTD) cast, labels denote CTD cast number.

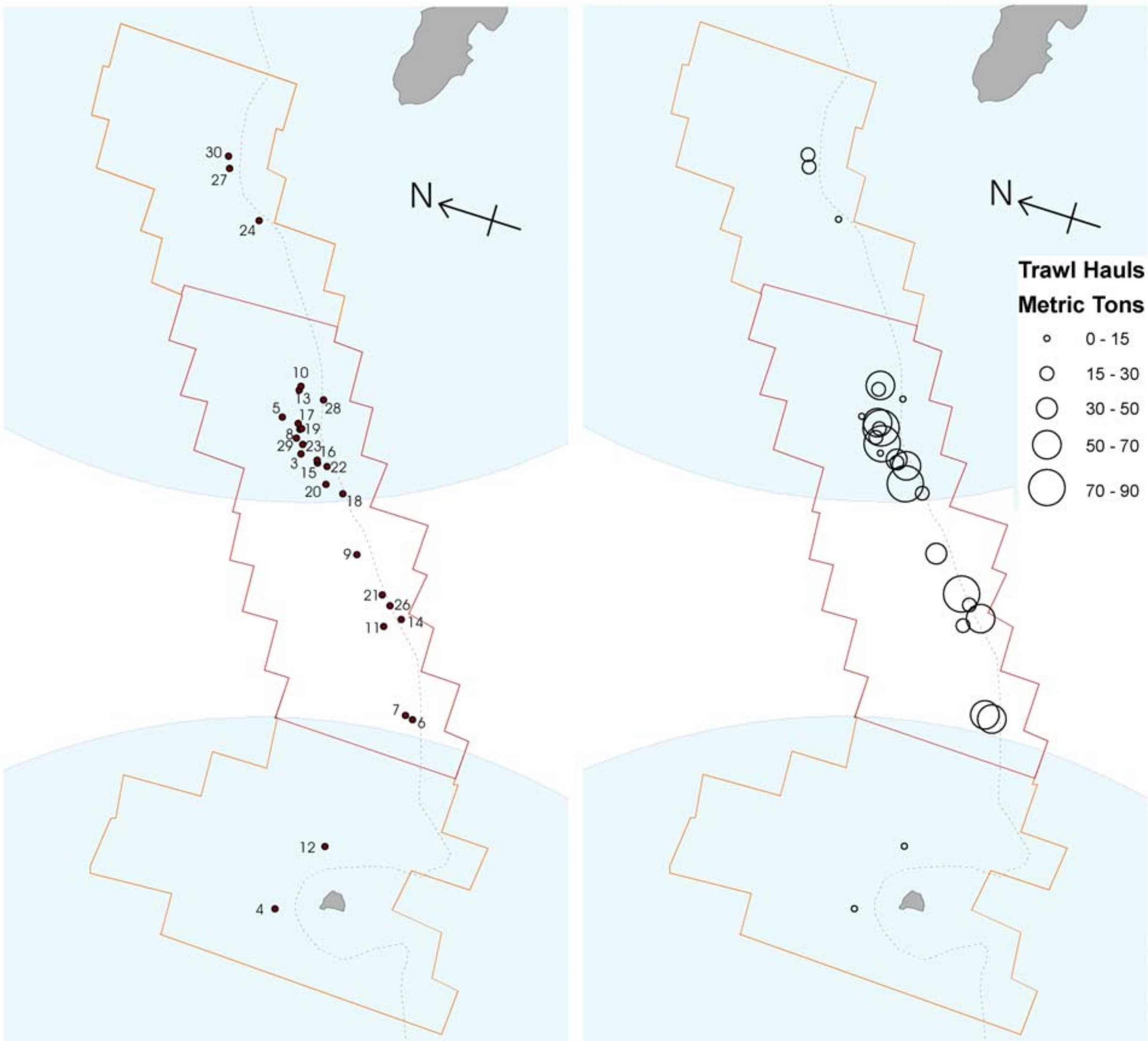


Figure 15.-- Trawl haul start locations (left) and catch (right). The orange line indicates the large survey area (180 nmi^2) and the red indicates the small survey area (72 nmi^2). The blue shaded regions are Steller sea lion critical habitat. Hauls 1, 2, and 25 are not shown because they occurred outside the mapped area, accounting for less than 1 t of catch.

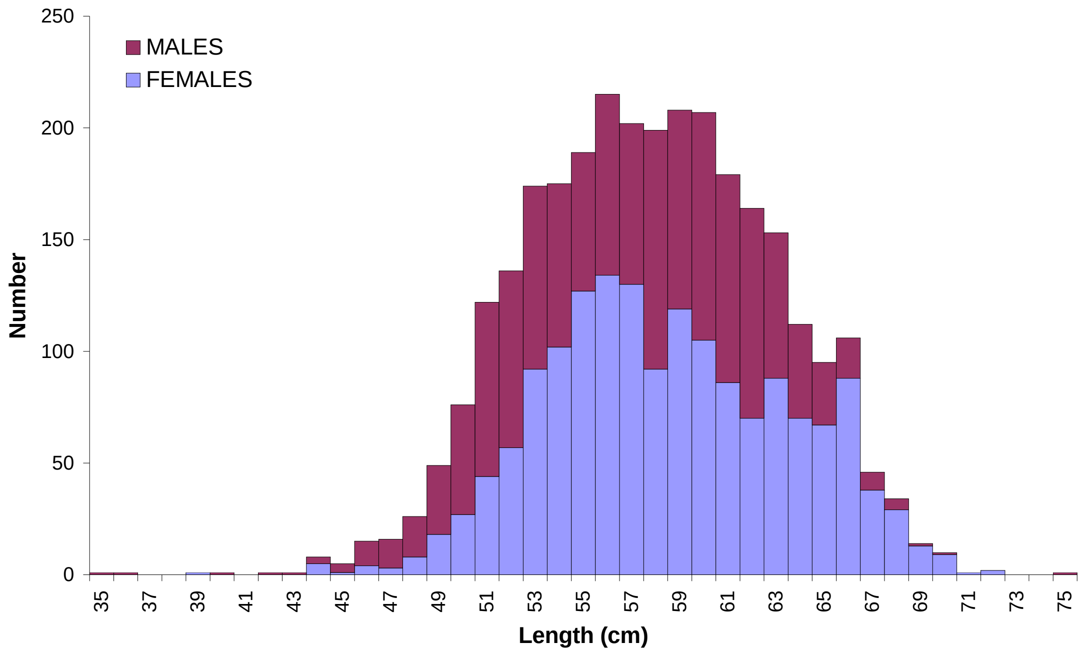


Figure 16.-- Pollock length frequency from the 2006 Aleutian Islands cooperative acoustic survey study.

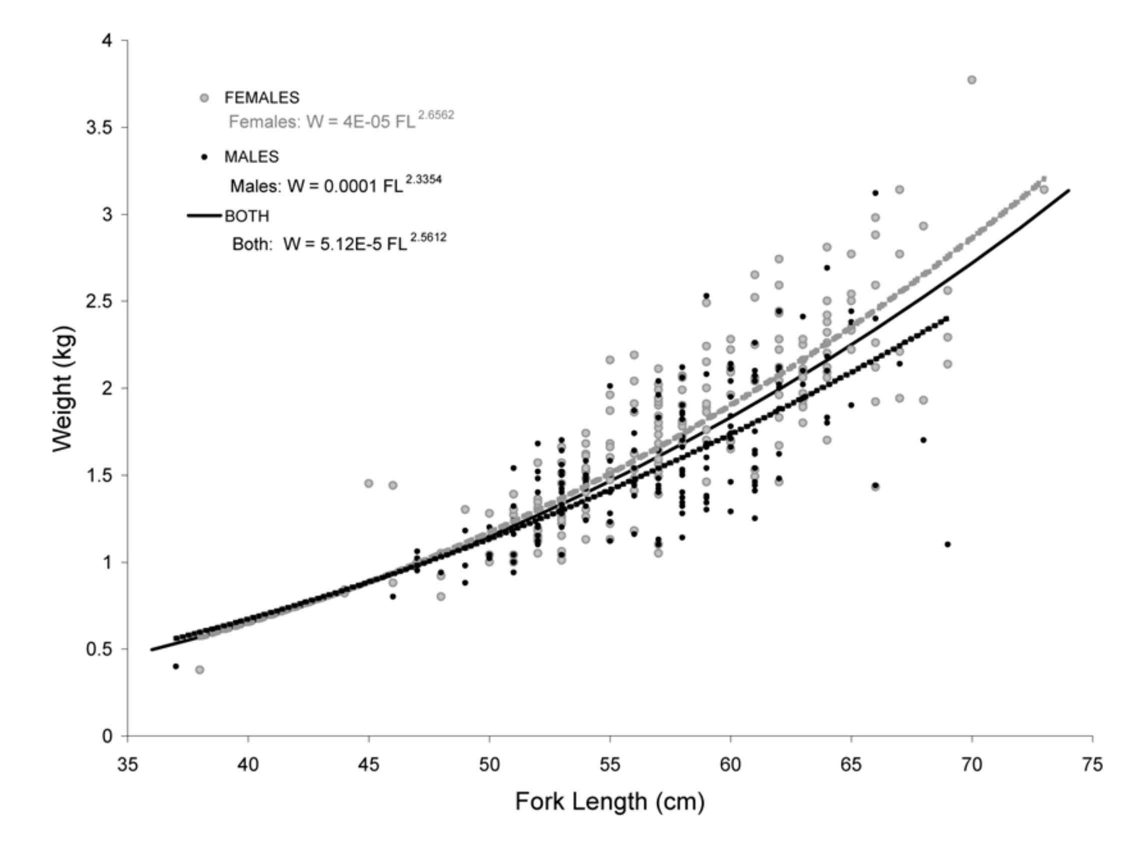


Figure 17.-- 2006 Aleutian Islands cooperative acoustic survey study weight at length from the pollock biological samples and regression fits.

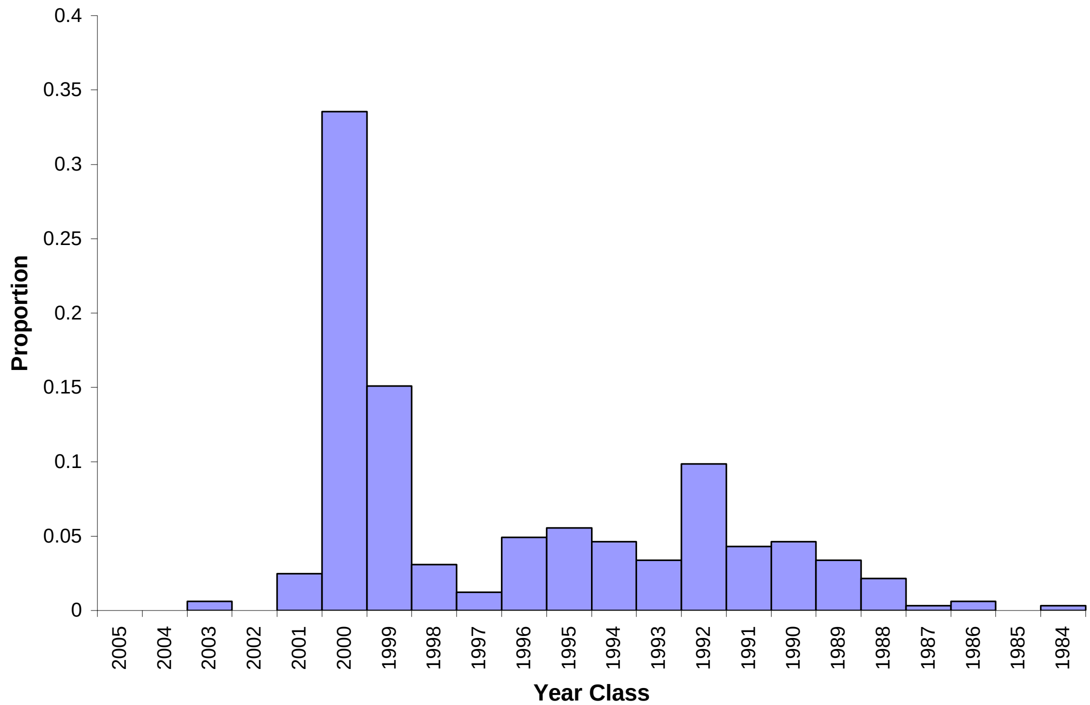


Figure 18.-- Age composition from the otolith data collected during the 2006 Aleutian Islands cooperative acoustic survey study.

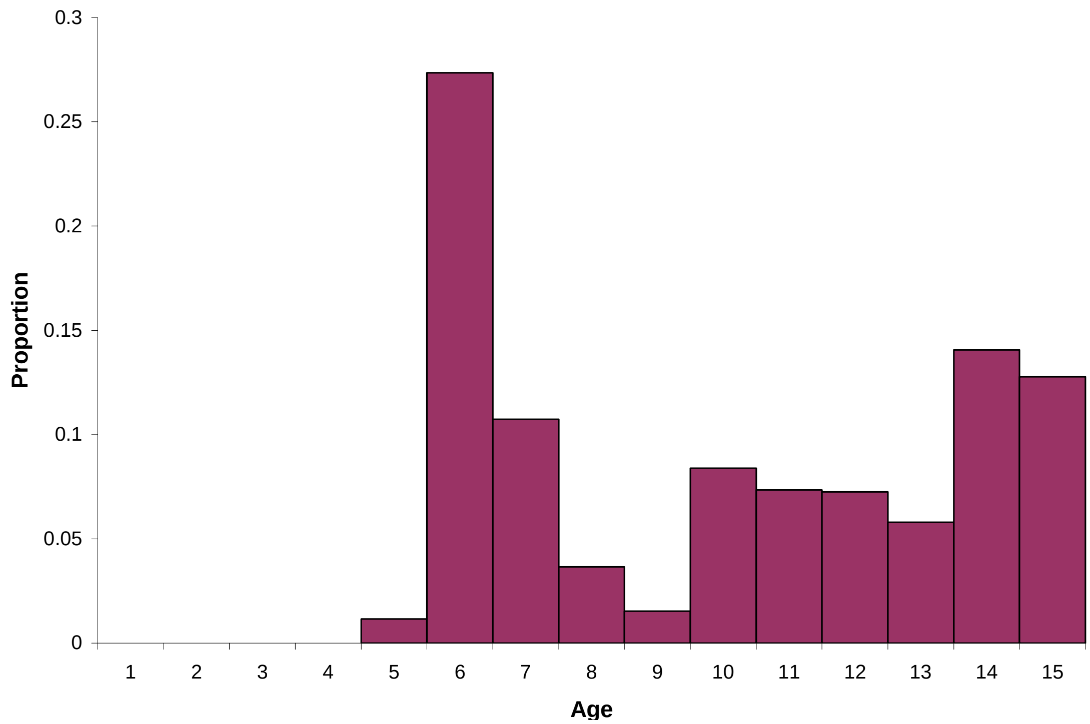


Figure 19.-- Proportion of total weight of fish at age from the 2006 Aleutian Islands cooperative acoustic survey study. The age-15 group represents all fish age-15 and older

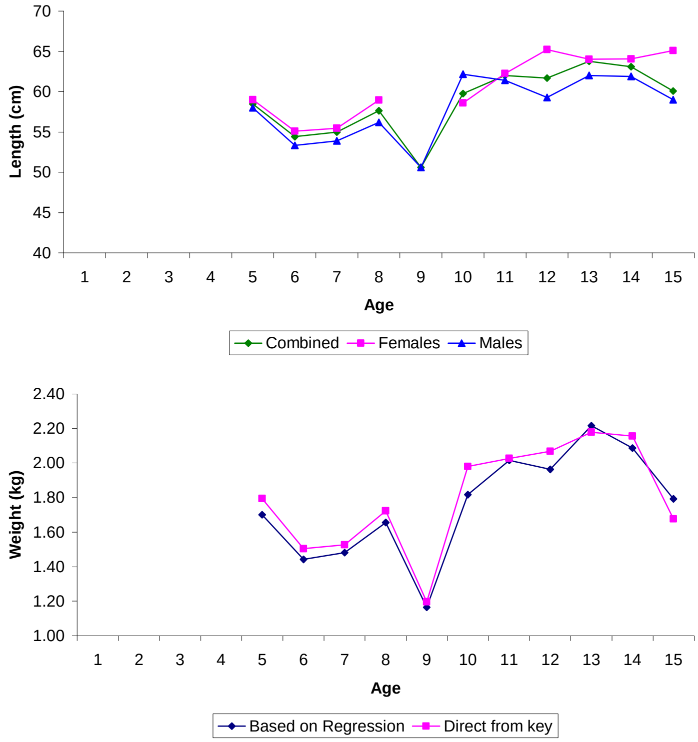
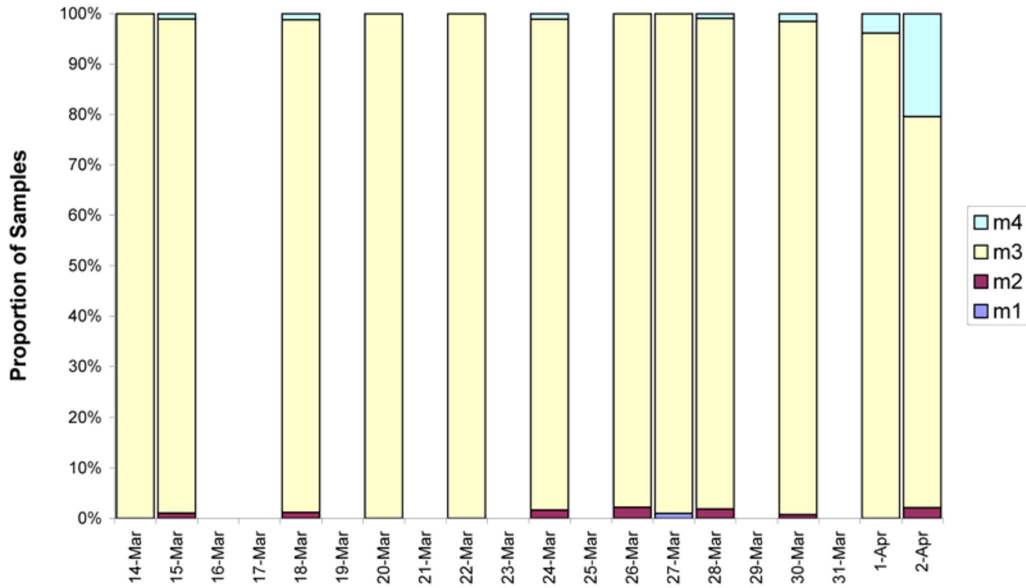


Figure 20.-- Pollock fork length (cm) and weight (kg) at age from 2006 Aleutian Islands cooperative acoustic survey study.

.



	14-Mar	15-Mar	18-Mar	20-Mar	22-Mar	24-Mar	26-Mar	27-Mar	28-Mar	30-Mar	1-Apr	2-Apr
m4	0	2	1	0	0	2	0	0	1	2	1	48
m3	5	183	82	147	112	176	310	98	105	128	25	182
m2	0	2	1	0	0	3	7	0	2	1	0	5
m1	0	0	0	0	0	0	0	1	0	0	0	0

Survey Day

Figure 21.-- Female pollock maturity over the duration of the 2006 Aleutian Islands cooperative acoustic survey study.

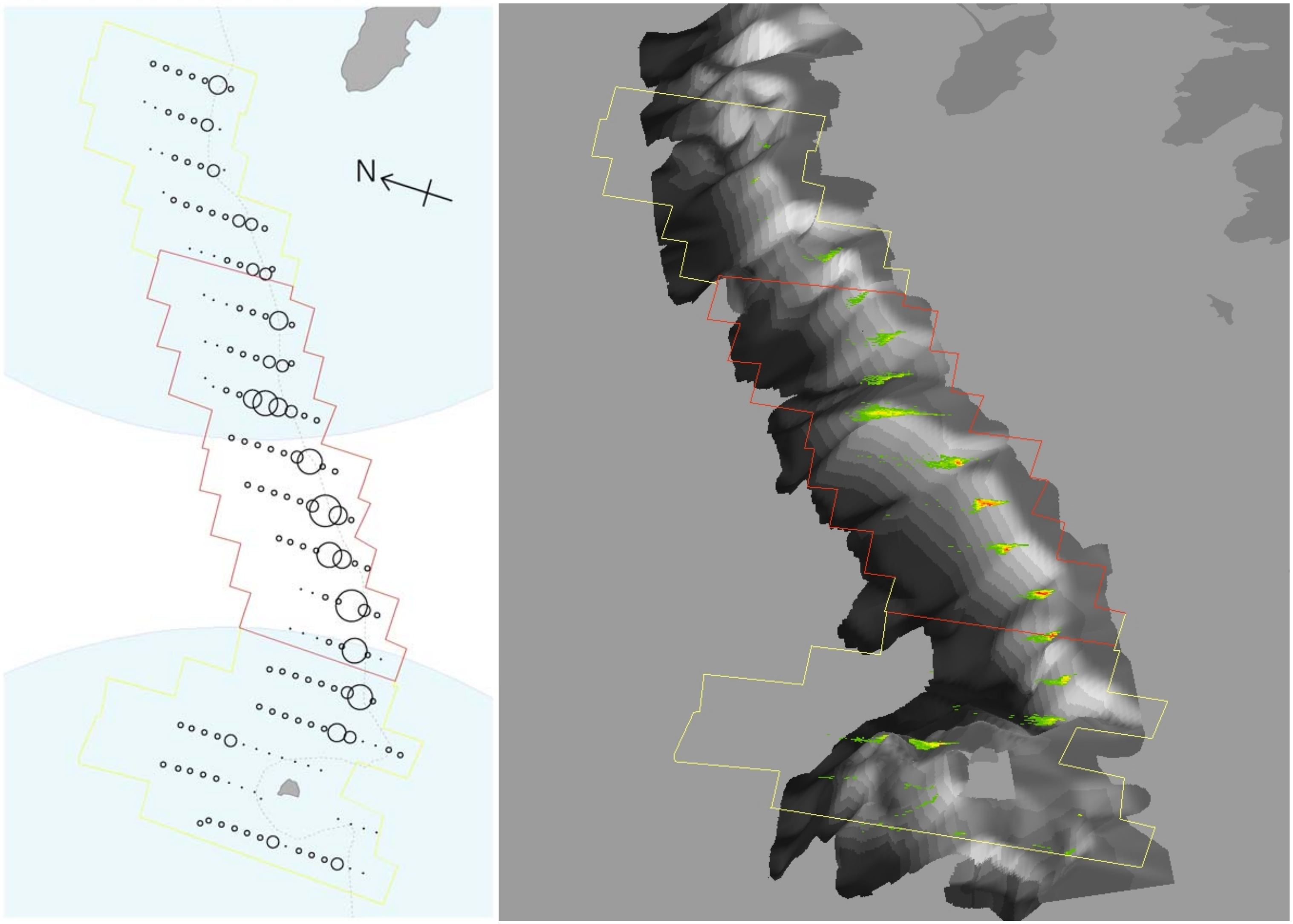


Figure 22.-- 2006 Aleutian Islands cooperative acoustic survey study Survey 2 (15 March 2006) two- and three-dimensional distribution of pollock. In three-dimensional plot green is lowest pollock density and red is the highest density.

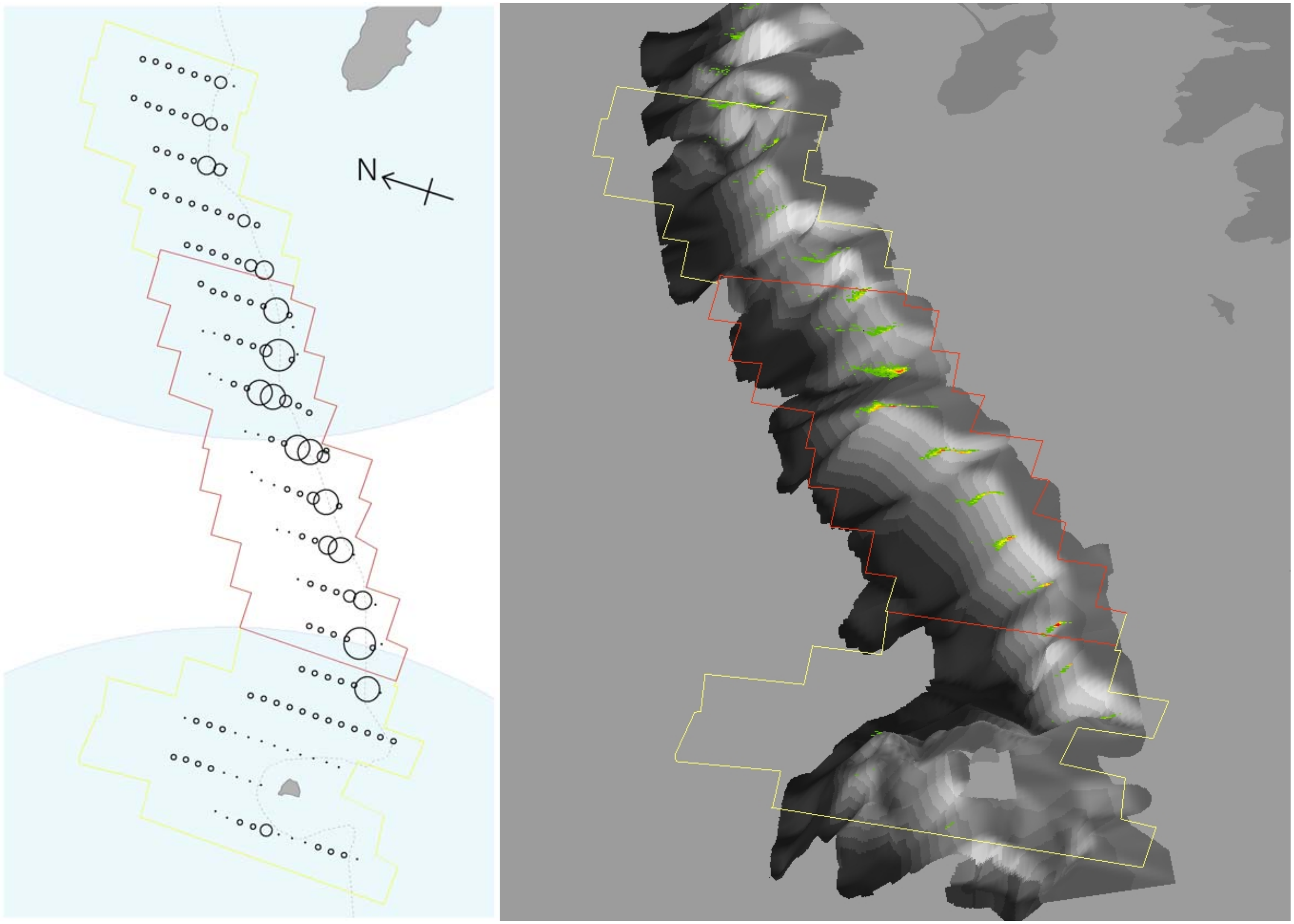


Figure 23.-- 2006 Aleutian Islands cooperative acoustic survey study Survey 4 (23-24 March 2006) two- and three-dimensional distribution of pollock.

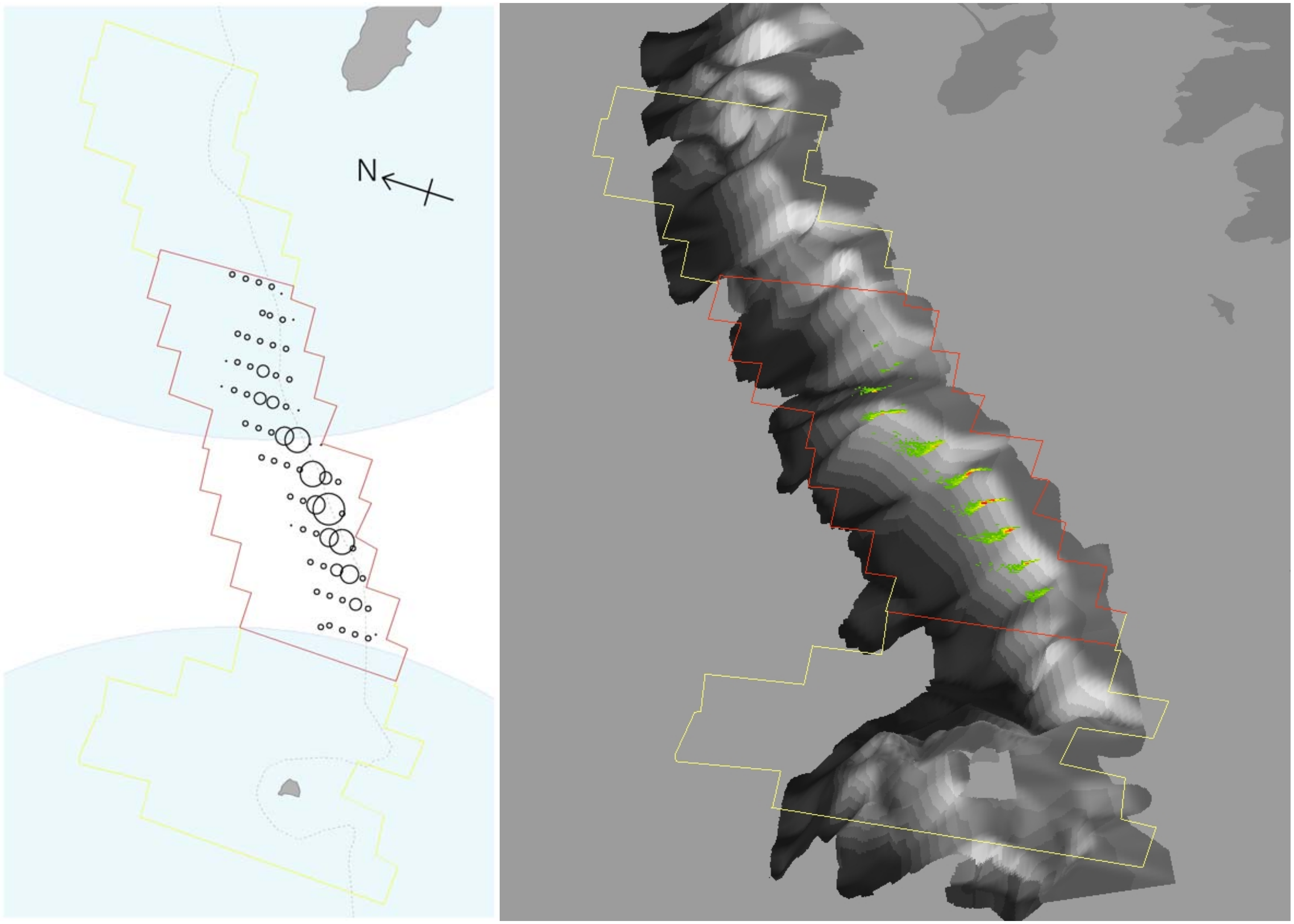


Figure 24.-- 2006 Aleutian Islands cooperative acoustic survey study Survey 6 (28-29 March 2006) two- and three-dimensional distribution of pollock.

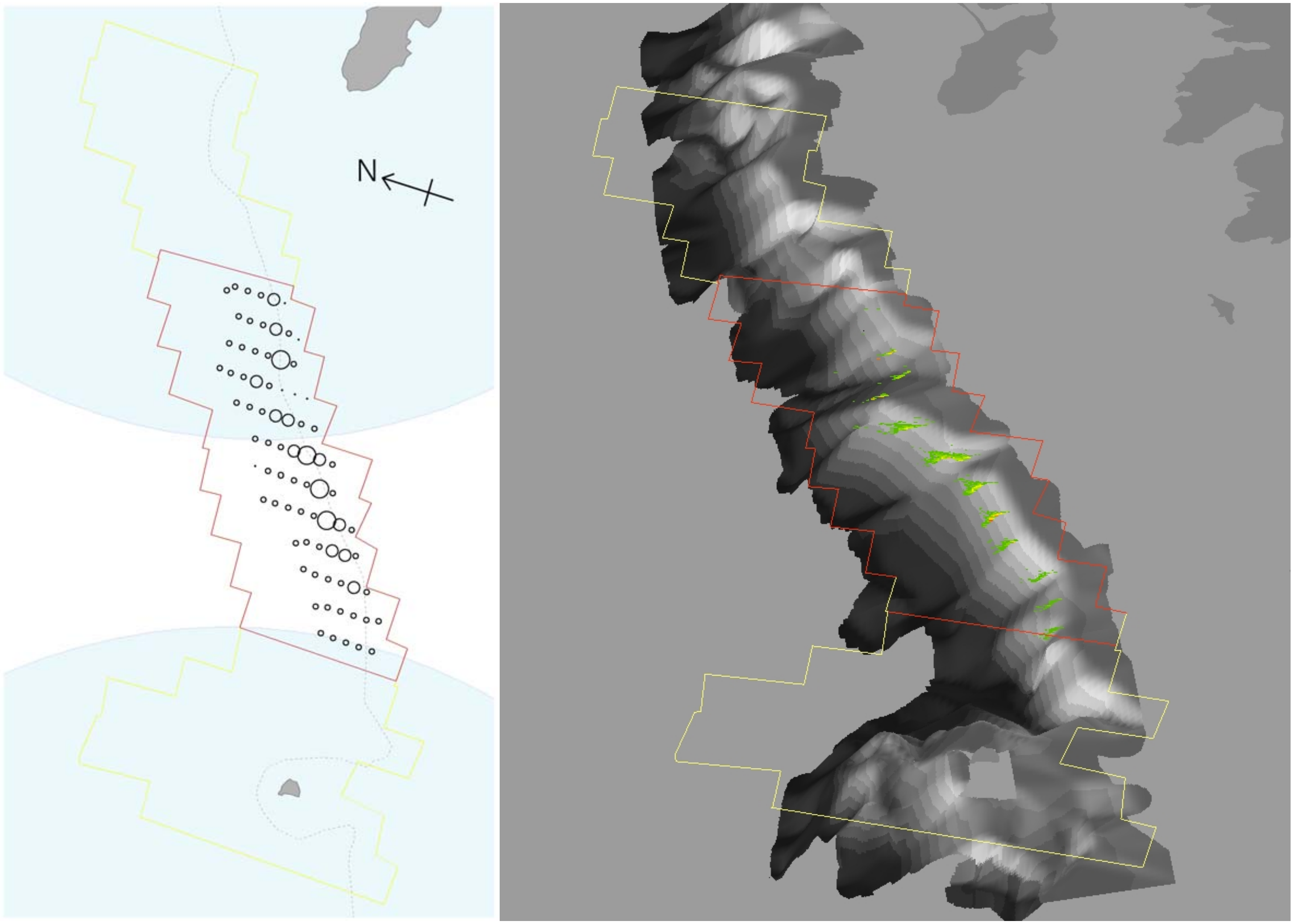


Figure 25.-- 2006 Aleutian Islands cooperative acoustic survey study Survey 7 (1 April 2006) two- and three-dimensional distribution of pollock.

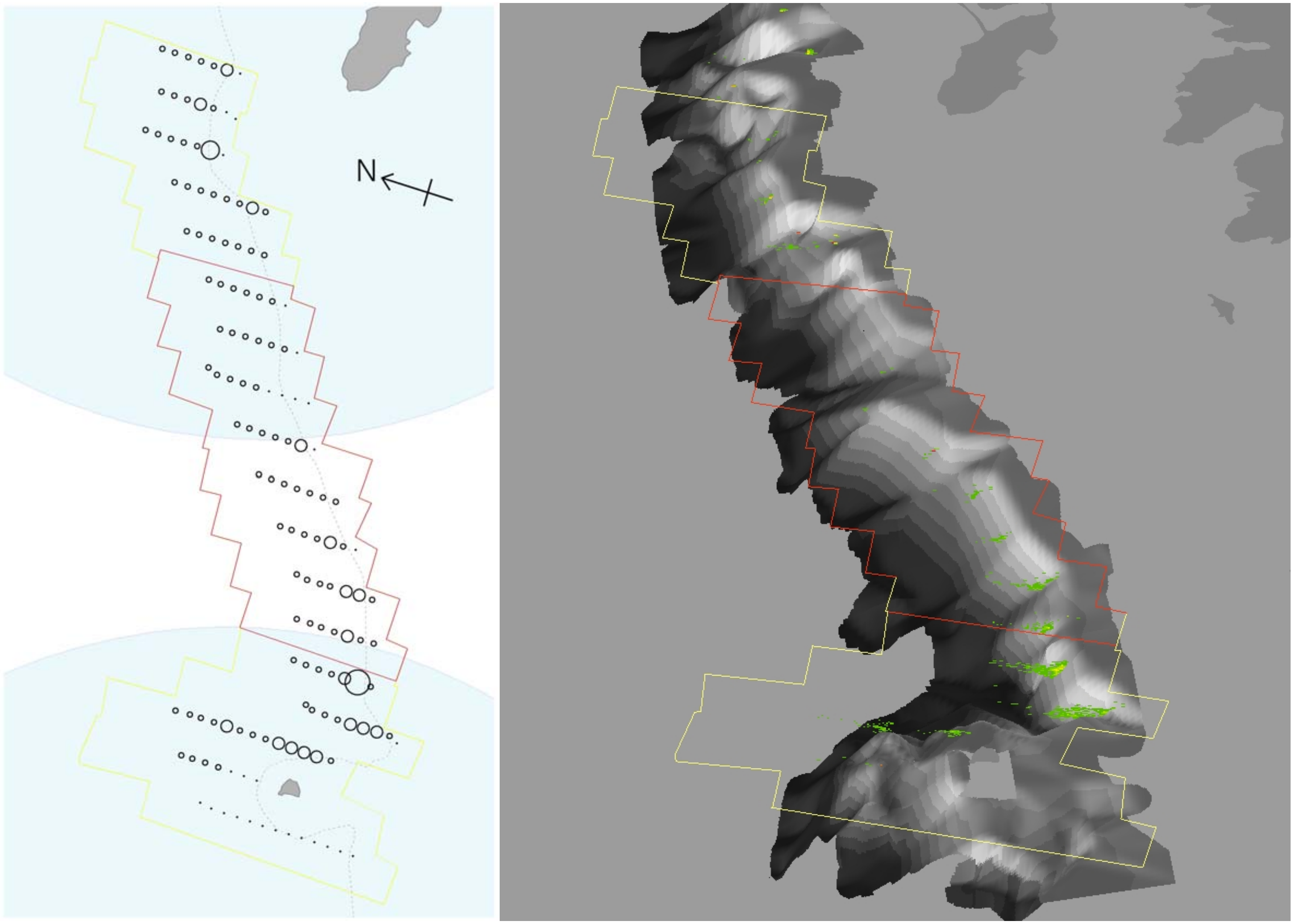


Figure 26.-- 2006 Aleutian Islands cooperative acoustic survey study Survey 8 (3-4 April 2006) two- and three-dimensional distribution of pollock.

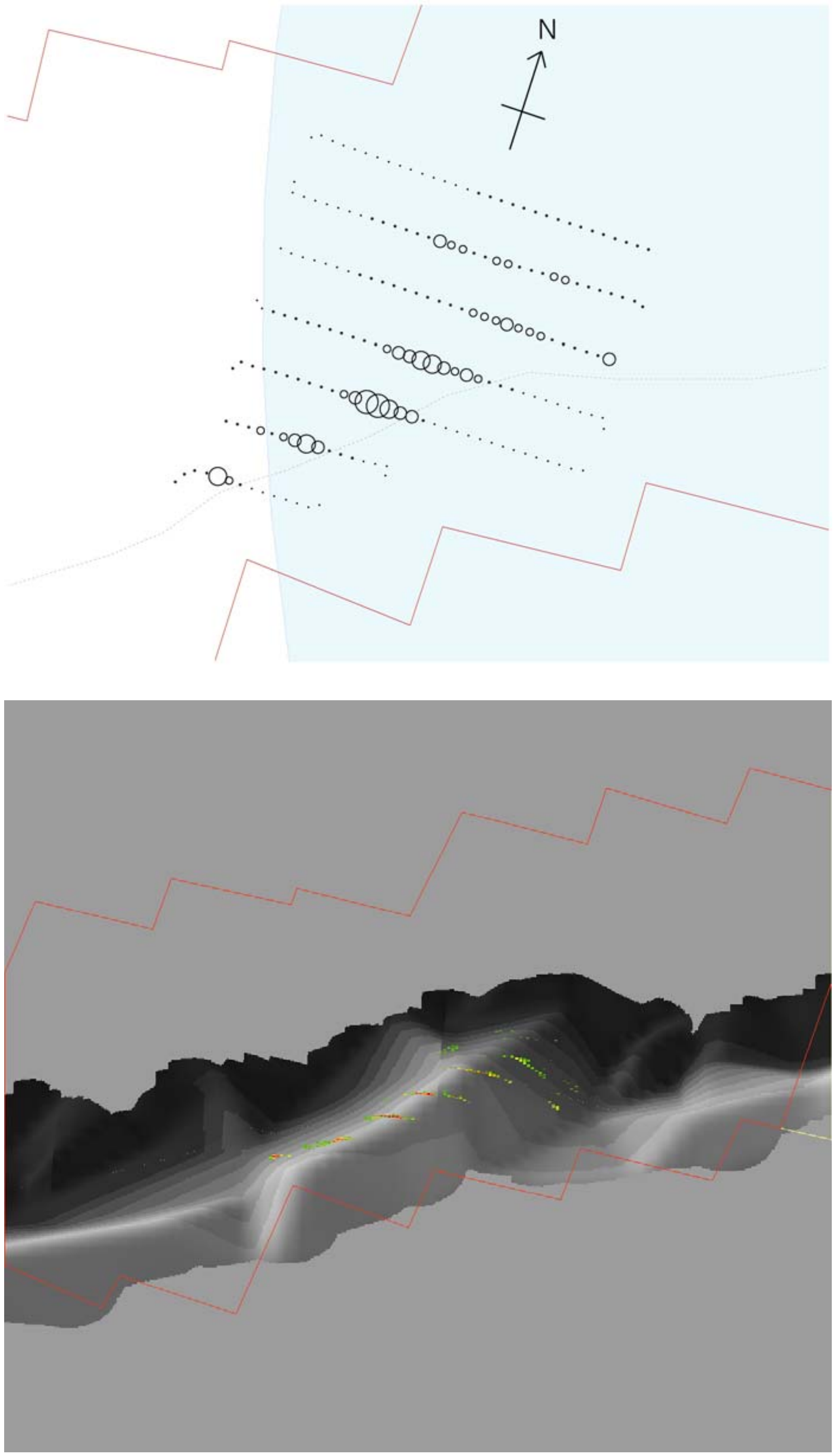


Figure 27.-- 2006 Aleutian Islands cooperative acoustic survey study Survey 5 (24 March 2006) two- and three-dimensional distribution of pollock.

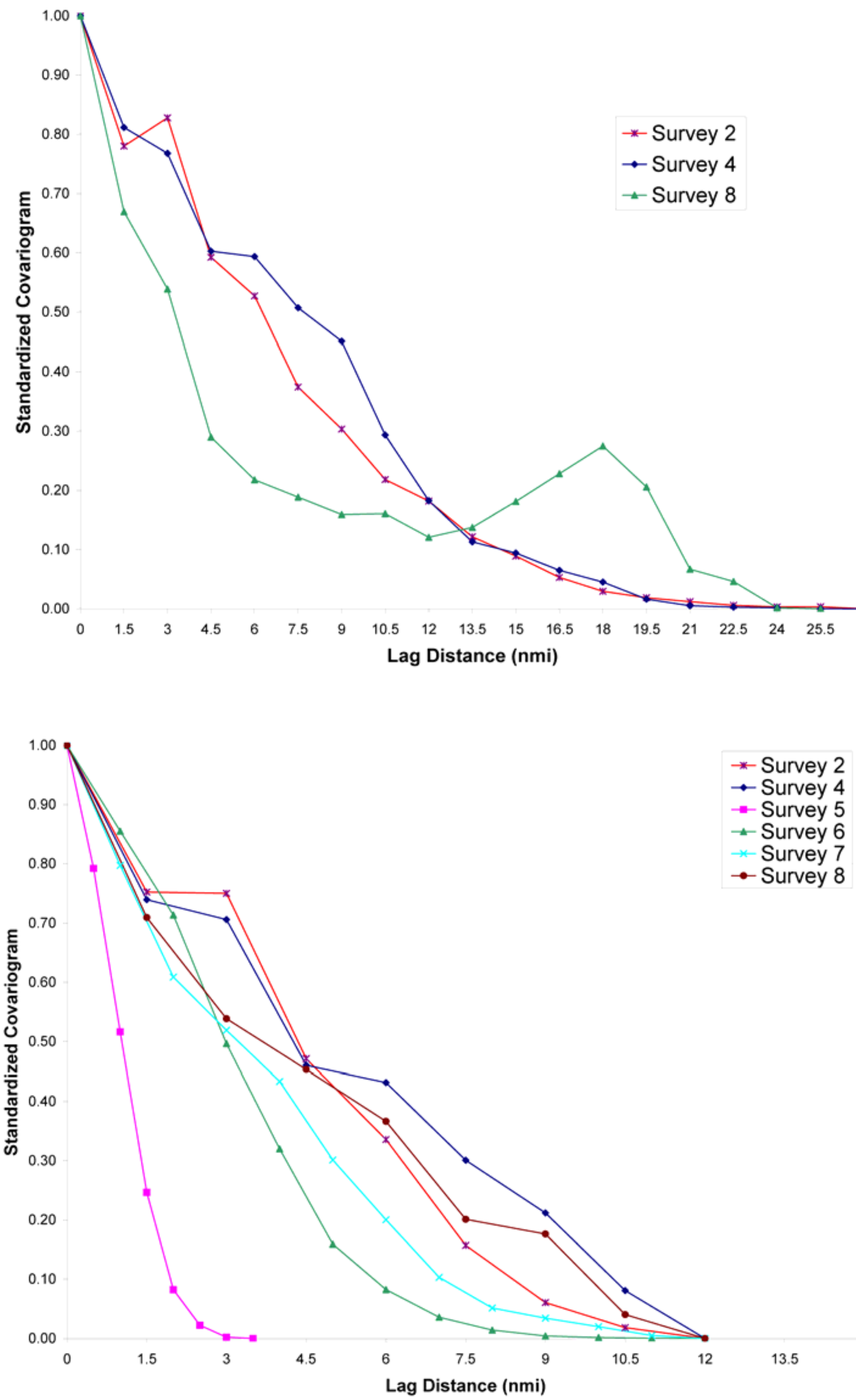
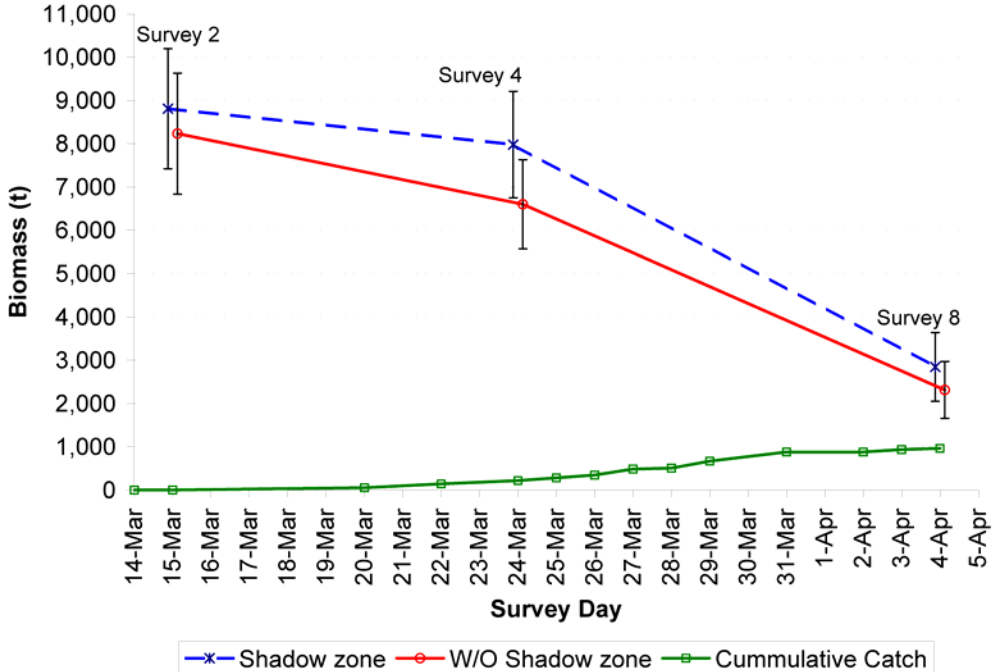


Figure 28.-- One-dimensional standardized covariograms for the large (upper) and small (lower) survey areas.



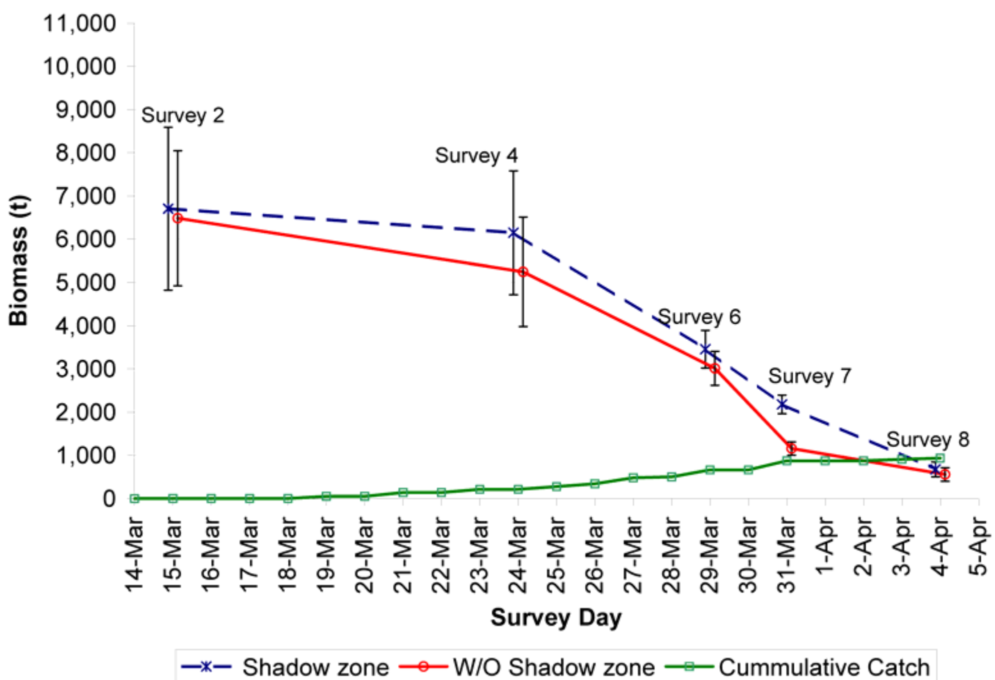


Figure 29.-- Abundance estimation and cumulative catch for large (upper) and small (lower) survey areas. Note error bars are $\pm 1.96 \times E_i \times B_i$. Survey day 1 is 15 March 2006.

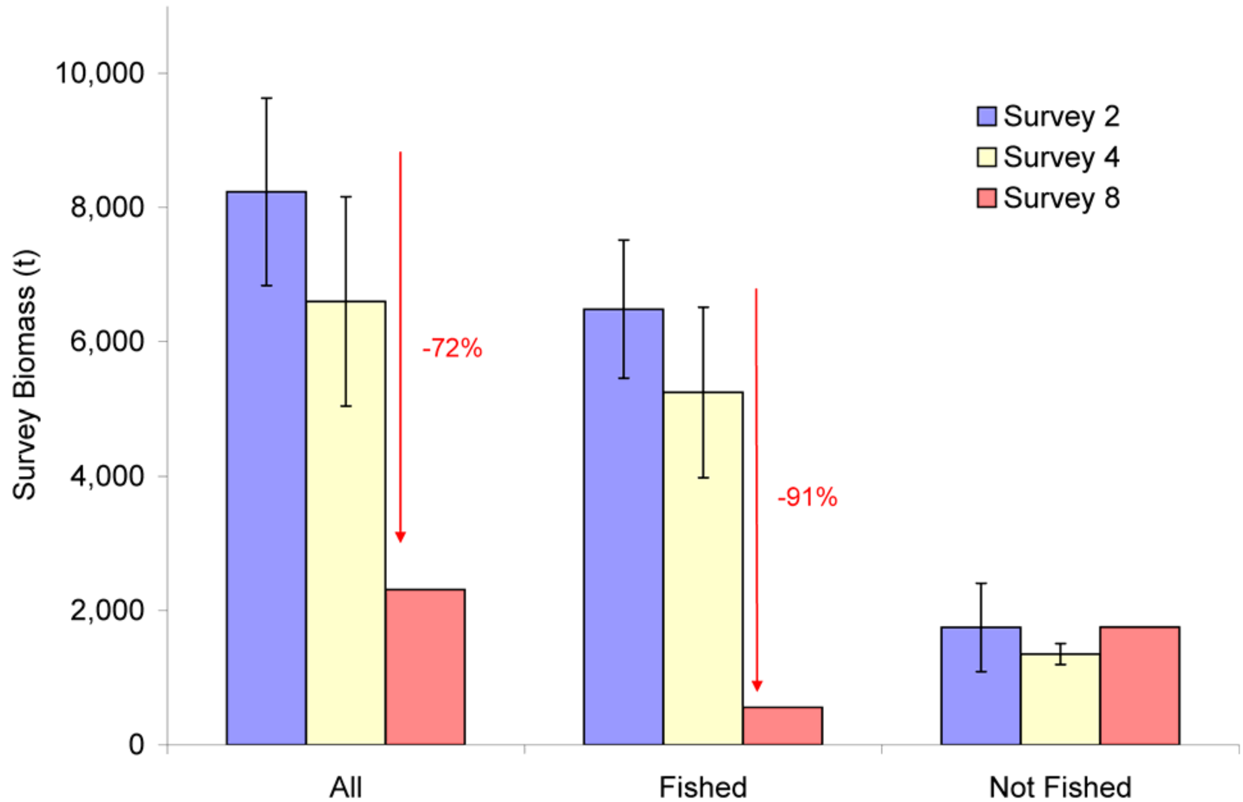


Figure 30.-- Change in abundance for All, Fished, and Not Fished areas. All numbers do not include shadow zone estimates. The Fished area corresponds with the small survey area while All corresponds with the large survey area, and Not Fished corresponds with the large survey area outside of the small survey area. Arrows indicate a significant change in abundance from the first survey. Note: 935 t of the total 965 t caught during the 2006 Aleutian Islands cooperative acoustic survey study were removed from the Fished/small survey area. It should be noted that the fished and unfished areas were identified after the survey and not part of the study design.

APPENDICES

Appendix A: Sonar-self Noise Test

At this time everything should be working with Global Positioning System (GPS) feed into the ES60, we need both ES60 data and GPS to be recorded. To make sure you have GPS feed the Latitude and Longitude should be displayed at the bottom of the ES60 screen. Also make sure the time is correct in Alaskan Standard Time.

Sonar-self noise test instructions:

For this part of the test you should be in deep and safe enough waters so that you do not need the echosounder. You will be turning the pinger off and running the echosounder as a hydrophone to record the noise characteristics of your vessel over a range of speeds. This will tell us how fast we can go when we conduct the acoustic survey. Preferably the weather should be relatively calm. The time of day does not matter.

Step 1: Insert thumb drive into USB port of the ES60. The thumb drive should automatically be recognized as a new drive.

Step 2: In the ES60 program, on the “File” menu in the upper left corner select “Store.” This will open a small window with a number of options.

Step 3: Select the “Browse” button and go to the “Noise_Test” file on the thumb drive.

Step 4: Make sure both the RAW and OUT files are selected to be saved.

Step 5: The Max File size should be about 100 mb.

Step 6: Go back to the main screen.

Step 7: When you are ready to start recording data for this test, right click on the echogram in the **Echogram and Range** view on the display. This will open the Echogram Dialog box. Make sure that the gain is set to "No," and the "Ping Filter" should **not** be on. Then click OK.

Step 8: To turn the pinger off and run silent you need to right-click on where it reads "38 kHz" in the upper left-hand corner of the screen. Another small window will open up with a number of options. Click on the box next to "Passive". The echogram should look blank, you should not see any echosign on the main screen. If you do, then there is a problem, call me.

Note: *The ping rate should not matter here, but standard protocol when sampling generally has a ping rate of 1 ping per second for shallow water(< 50 fathoms) and 1 ping per 2 seconds for deeper water. A faster ping rate may cause overlapping echos and mess up the data.*

Step 9: On the bottom of your screen, left of the Latitude and Longitude readout there should be a small box with a number like 0001 or 0002 , etc… Click on this number, it should turn red. Red means you are recording data to the thumb drive.

Step 10: Start the vessel sitting still for 3 minutes while recording data, then increase speed to 2 knots, keep it there for 2-3 minutes, increase another 2 knots, record data for roughly 2-3 minutes, increase speed another 2 knots, record data for 2-3 minutes, keep doing this until you reach maximum speed.

Step 11: Click the record button again to stop recording. The number should be black. Shut down the ES60 program without shutting down the computer by clicking on the File menu then clicking both the right and left mouse button, while holding these down scroll to the “Shutdown” then release **only the left button**. This should shut the program down, but the computer should still be on. Go down to the bottom right of the screen and single click on the little green arrow icon and close the thumb drive. After it says that it is ok to do so unplug the thumb drive.

Step 12: The next time in port overnight the thumb drive to me and I will do the analysis.

Appendix B: Cruise Plan

FINAL CRUISE INSTRUCTIONS

FV *Muir Milach*
March 11 – April 1, 2006
Chief Scientist: Steven J. Barbeaux

1.0 FINAL CRUISE INSTRUCTIONS

1.1 Cruise Title – Aleutian Islands Pollock Acoustic Survey Feasibility Study

1.2 Cruise Dates:

1.2.1 Departure – Depart Adak, Alaska, at 0500 on Saturday, March 11, 2005.

1.2.2 Arrival – Arrive Adak, Alaska, at 1200 on April 1, 2006**.**

2.0 CRUISE OVERVIEW

Cruise Objectives – The purpose of this study is to test the feasibility of using commercial fishing vessels to conduct acoustic surveys for pollock in the Aleutian Islands subarea. NMFS currently does not have resources to conduct acoustic surveys of pollock in the Aleutian Islands subarea. The acoustic and biological information from the project will be used to determine; 1) if it is feasible to conduct acoustic surveys in the Aleutian Islands subarea using commercial fishing vessels, 2) if the data collected in such a manner is of sufficient quality for management purposes, and 3) if the local aggregations of pollock are stable enough during spawning season to allow for fine scale spatial and temporal management. Additionally, genetic samples will be collected during this study that will be used for stock structure analysis.

The project has three activity phases: (1) evaluating the commercial fishing vessel's appropriateness as an acoustic sampling platform; (2) opportunistically collecting acoustic data of pollock distribution around two sites, Kanaga Sound and Atka Island and (3) direct acoustic and biological data sampling at one of the study sites (up to ten 1 to 3 day trips). To verify the acoustic data and to support the study, 1000 mt of walleye pollock would be harvested within an area that includes waters within 20 nautical miles (nmi) to 0 nmi of Steller sea lion haulouts and rookeries. Conducting the project within Steller sea lion critical habitat is necessary because pollock aggregations must be encountered to support the work, and historical information about the occurrence of pollock indicates that pollock aggregations are likely to occur inside critical habitat.

2.1 Applicability – These instructions present complete information for this cruise.

2.2 Operating Area – Bering Sea

2.3 Participating Organizations

NOAA – Alaska Fisheries Science Center (AFSC)
7600 Sand Point Way N.E., Seattle, Washington 98115-0070

2.4 Personnel

2.4.1 Chief Scientist

Name	Gender	Affiliation	E-mail Address
Steven J. Barbeaux	Male	AFSC	Steve.Barbeaux@noaa.gov
(206) 526-4211			

2.4.2 Participating Scientists

Name	Gender	Affiliation	E-mail Address
Libby Logerwell	Female	AFSC	Libby.Logerwell@noaa.gov
Martin Dorn	Male	AFSC	Martin.Dorn@noaa.gov

2.5 Administrative

2.5.1 Ship Operations

Dave Fraser
Owner FV *Muir Milach*
Telephone: (206) 399-0742
E-mail: dfraser@olympus.net

Dave Wilmore
Captain FV *Muir Milach*
Telephone: (360) 380-2082, Cellular: (360) 319-8267
E-mail: peanutsplace@nas.com

2.5.2 Scientific Operations

Steen J. Barbeaux, AFSC
Telephone: (206) 526-4211
E-mail: Steve.Barbeaux@noaa.gov

Dr. Libby Logerwell, AFSC
Telephone: (206) 526-4231
E-mail: Libby.Logerwell@noaa.gov

3.0 OPERATIONS

3.1.1 **Data To Be Collected** – The purpose of this study is to determine if acoustic surveys can be conducted from commercial fishing vessels using ES60 echosounders. In the course of this study data on the reliability and stability of the echosounder will be collected as well as the specific noise characteristics of the small commercial fishing vessel. This will be done through Sonar-self noise testing and sphere calibrations. Several acoustic surveys of pollock aggregations will be conducted that will entail the collection of both acoustic data from the ES60 as well as biological data collected from verification trawl tows. CTD casts will be made to support both the calibration exercises and the survey effort. Commercial fishing will be conducted to support the study. Sampling of the catch will occur at sea for species composition, pollock length, weight, and age structures. In addition species composition and total delivery data will be collected at the processing plant in Adak.

3.2 **Staging Plan** – The majority of the equipment necessary for the cruise will be loaded onto the FV *Muir Milach* when the ship departs from Dutch Harbor Alaska, in January, 2006. The laptop computers, CTD, and personal gear of the scientists will be carried as luggage and delivered to the boat in Adak at the time of embarkation.

3.3 **De-staging Plan** – The data, computer hardware, and personal gear will be returned with the chief scientist at the end of the study. All other gear will remain on board the ship until the ship returns to Newport, Oregon (June 2006).

3.4 **Cruise Plan** – The first two phases of the project will be conducted without direct scientific supervision. In January the vessel will conduct a Sonar-self noise test while steaming to fishing grounds (See Below). In February and the first part of March the vessel will opportunistically collect acoustic data over the proposed study sites in the course of traveling between port and Pacific cod fishing grounds. In the third phase, a NOAA scientist will board the vessel and depart from Adak, Alaska, at 0500 on Saturday, March 11, 2006 and will conduct an estimated 7 to 10 trips. On the first and last trip an ES60 system calibration will be conducted (See Below). On the first, middle, and last trip replicate parallel transect acoustic surveys of between 140 and 200 nautical miles (nmi) will be conducted of the study area. At least two CTD drops will be made within the study area for each acoustic survey to obtain conductivity and temperature at depth. At the direction of the NOAA scientist trawls hauls of no more then 10mt will be conducted following the acoustic surveys to verify acoustic backscatter and obtain biological samples. The validation tows will be randomly sampled for species composition, the samples will not exceed 1mt. A random subsample of 150 pollock and/or other dominant species will be measured and weighed. All measured pollock will be scanned for maturity. Otolith and fin clip samples will be collected from a subsample of the measured fish. Following the validation tows the vessel will conduct commercial trawl tows until the vessel reaches capacity (~150 t). The vessel will then return to Adak, Alaska to deliver the catch. For the remaining 4 to 7 trips, the vessel will conduct a non-parallel acoustic survey of approximately 65 nmi. The area of the survey will be determined by the NOAA scientist. Following the non-parallel acoustic surveys the vessel will conduct commercial tows until the vessel reaches it carrying capacity, and then will return to port for delivery. All commercial tows will be sampled for species composition. A random subsample of pollock will be measured, weighed, and scanned for maturity. Otolith samples will be collected from a subsample of the measured fish. Each trip and delivery will take an estimated 2 to 3 days, the NOAA scientist is expected to disembark by April 1, 2006.

3.5 **Study Locations** – See Figs. 9.2.1 and 9.2.2

- **Study Operations** – The following are operations to be conducted on this cruise.

3.5.1 **Phase 1: Sonar-self noise testing** – A sonar-self noise test will be conducted in January 2006 while the vessel steams to the Pacific cod fishing grounds. For this part of the study the ES60 echosounder will record data in “passive” mode as the vessel systematically increases speed from 0 knots to maximum in 2 knot increments every three minutes. This exercise will take no more than 45 minutes. The recorded data will then be sent to the Chief Scientist for analysis to determine signal to noise ratios and speed for the optimum survey operations.

3.5.2 **Phase 2: Opportunistic Acoustic Data Collection** – In February, while fishing for Pacific cod, the FV *Muir Milach* will travel within the proposed survey areas going to and from the Pacific cod fishing grounds. While traveling, the vessel will opportunistically collect acoustic data. These data will be sent to the Chief Scientist prior to March 1, for qualitative assessment on relative densities of fish in the study areas. This will help determine study areas and transect layout. The captain of the FV *Muir Milach* will also record weather conditions (wind speed, direction, sea state) while collecting acoustic data during the Pacific cod fishery, these data will be used to assess the quality of acoustic data under various sea conditions.

3.5.3 **Phase 3: ES-60 System Calibration** – Two ES60 System calibrations will be conducted, one prior to the first parallel transect acoustic survey and one following the final acoustic survey. The calibrations will be conducted by the NOAA Scientist as per protocols described in Foote et al. (1987) for sphere calibration of a scientific echosounder.

3.5.4 **Phase 3: CTD measurement** – During each of the calibration exercise and twice during each parallel transect survey CTD casts will be made to assess speed of sound at depth. The CTD will be allowed to acclimate 1 m below the surface for one minute and then lowered via the vessel winch or crane to the bottom and retrieved. CTD cast data will be downloaded to a NOAA laptop and backed up on DVD after each cast.

3.5.5 **Phase 3: Parallel Transect Acoustic Survey** – On the first, middle, and last trip of phase three of the study, replicate parallel transect acoustic surveys of between 140 to 200 nmi will be conducted of either the Atka Island or Kanaga Island study areas (See figures below). The waypoints for these surveys will be determined by the Chief Scientist by March 9, 2006 after review of the opportunistic acoustic data and in consultation with the owner and captain of the FV *Muir Milach*. The survey will consist of parallel transects with between 2 to 4 km spacing with a random start location for the beginning transect. Ping rate during the survey will be one ping per second and vessel speed for the survey will be determined by the Chief Scientist after analysis of the Sonar-self noise test. All acoustic data will be recorded on an external 120GB hard drive and backed-up nightly onto DVDs.

3.5.6 **Phase 3: Non-parallel Transect Acoustic Study** – For each trip in which a parallel transect survey is not conducted a non-parallel transect acoustic survey (~65 nmi) will be conducted. The waypoints of these surveys will be determined after completion of the first parallel survey and will be designed to monitor changes in distribution of the largest densities of pollock in the study area. Ping rate during the survey will be one ping per second and vessel speed for the survey will be determined by the Chief Scientist after analysis of the Sonar-self noise test. All acoustic data will be recorded on an external 120GB hard drive and backed-up nightly onto DVDs.

3.5.7 **Phase 3: Verification Trawling** – At the direction of the NOAA scientist, trawls hauls of no more then 10mt will be conducted following the acoustic surveys to verify acoustic backscatter and obtain biological samples. Although the choice of net will be up to the vessel captain, it is expected that the verification tows will be primarily conducted using a 40' mesh design trawl with a 32 × 14 fm opening. Time, date, and location of each trawl will be recorded using standard observer program trawl haul forms. All validation tows will be measured for total catch and randomly sampled for species composition, the samples will not exceed 1mt. A random subsample of 150 pollock and/or other dominant species will be measured and weighed. All measured pollock will be scanned for maturity. Otolith and fin clip samples will be collected from a subsample of the measured fish. Deck hands on the FV *Muir Milach* will conduct the species composition samples and length measurements under the supervision of the NOAA scientist. Maturity scans, otoliths, and fin clips will be collected by the NOAA scientist. All data will be recorded on deck sheets and later transferred to an access database designed by the Chief Scientist. The Access database will be backed up on DVD nightly.

3.5.8 **Phase 3: Commercial Trawling** – Following the validation tows the vessel will conduct commercial trawl tows until the vessel reaches capacity (~150 t). All commercial trawl locations must be outside of 3 nmi from designated Steller Sea Lion haulout sites, but otherwise will be at the discretion of the vessel captain. Time, date, and location of each trawl will be recorded using standard observer program trawl haul forms. All commercial tows will be measured for total catch and sampled for species composition. A random subsample of pollock will be measured, weighed, and scanned for maturity. Otolith samples will be collected from a subsample of the measured fish. Deck hands on the FV *Muir Milach* will conduct the species composition samples and length measurements under the supervision of the NOAA scientist. Maturity scans, otoliths, and fin clips will be collected by the NOAA scientist. All data will be recorded on deck sheets and later transferred to an access database designed by the Chief Scientist. The Access database will be backed up on DVD nightly. All catch will be delivered to the Adak processing plant where it will be sorted and weighed. Data on total catch composition and weight will be reported to the NOAA scientist prior to embarkation on a following trip.

3.5.9 **Phase 3: Opportunistic Acoustic Data Collection** – During all fishing operations, including searching for fishable aggregations of pollock, and when traveling to and from port, the vessel will continue to collect ES60 acoustic data. These data will be used to qualitatively assess the relative densities and assess the spatial dynamisms of fish within the study areas in between acoustic surveys. In addition these data, in conjunction with catch per unit effort data from the commercial trawl hauls, will be used to assess possible impacts of fishing activities on the pollock aggregations due to the study.

3.6 **Underway Operations** – The following are underway operations to be conducted on this cruise.

- Opportunistic Acoustic data collection

3.7 **Applicable Restrictions** – Commercial trawl tows will not be conducted within 3 nmi of designated Sea Lion Haulout protected areas

3.8 **Small Boat Operations** – None

4.0 FACILITIES

4.1 Equipment and Capabilities Provided by Ship

- Wire speed indicators and readout for quarterdeck, Rowe winch,
- Stern trawl system (winches, wire, electronics, etc.)
- 38kHz SIMRAD ES60 echosounder with GPS feed
- Sea-water hoses and nozzles to wash nets and gear ,
- Adequate deck lighting for night-time operations,
- Navigational equipment including GPS and radar,
- Ship's crane(s) used for loading and/or deploying,
- A Dantrawl "Bering Billionaire" trawl with a 50 fm × 20 fm opening,
- A LFS "glove" trawl with a 45 fm × 18 fm opening,
- A 40' mesh design trawl with a 32 fm × 14 fm opening.

4.2 Equipment and Capabilities Provided by Scientists

- Sea-Bird Electronics' SBE-19 SEACAT system
- AFSC Laptop with SEASOFT software for CTD data collection and processing,
- Electronic 50 kg basket scale, 2 kg scale for individual fish weights,
- 120GB external hard drives, DVD read write drive, and Backup DVDs
- Miscellaneous scientific sampling and processing equipment,
- Data forms,
- Data storage Access database

5.0 DISPOSITION OF DATA AND REPORTS

5.1 The following data products will be included in the cruise data package:

- Calibration Sheets for all ship's and scientific instruments used
- CTD Cast Information
- 120 GB external hard drive logs of ES60 Acoustic Data
- Nightly DVD Backup logs of ES60 Acoustic Data
- Access database log of all fishing activity
- Trawl haul information sheets, trawl haul deck forms
- All data and preliminary analyses will be submitted as an AFSC Processed report

5.2 **Pre- and Post-cruise Meetings** – A pre-cruise meeting will be scheduled with the chief scientist, the vessel captain (via telephone) and the vessel owner on March 5, 2006 in Seattle to determine which of the two study sites will be used. A meeting of the NOAA scientist, the vessel captain, and the vessel crew will be conducted on board the FV *Muir Milach* on March 11, 2006 to discuss operations on board the vessel and assigned duties. In April 2006, a post-cruise meeting will be held in Seattle, Washington with the chief scientist, the vessel owner, and a representative from the Aleut Enterprise Corporation to discuss preliminary results of the survey.

6.0 ADDITIONAL PROJECTS

6.1 **Definition** – Ancillary and piggyback projects are secondary to the objectives of the cruise and should be treated as additional investigations. The difference between the two types of secondary projects is that an ancillary project does not have representation aboard and is accomplished by the ship's force.

6.2 Ancillary Projects – None

6.3 Piggyback Projects – During biological data collection fin clips will also be taken from pollock. In at least two separate hauls, fin clips will be collected from at least 50 randomly selected pollock. Length, weight, sex, and maturity of females will be recorded for each fish. Otolith samples will be collected from each fish and placed in a vial with a unique specimen number. The clips will be placed in separate micro-ampoules containing 95% alcohol and the specimen number recorded on the micro-ampoule. The data will be recorded in an Access database developed by the Chief Scientist. The fin clip samples and associated data will be provided to Dr. Mike Cannino of the AFSC for processing. Otoliths samples will be included in the total otolith samples from the study and processed by the Age and Growth Laboratory at the AFSC.

7.0 HAZARDOUS MATERIALS

7.1 Inventory

Chemical	**Amount**	**Neutralizer**	**Contact**
Alcohol, Reagent, 95%	2 × 1-Liter	3-M Sorbent Pads	Barbeaux

7.2 Material Safety Data Sheet (MSDS) – Submitted separately

8.0 MISCELLANEOUS

Communications – Specific information on how to contact the FV *Muir Milach*

8.1 Important Telephone and Facsimile Numbers and E-mail Addresses

8.1.1 Alaska Fisheries Science Center (AFSC):

Resource Ecology and Fisheries Management (REFM):

- (206) 526-4211 (voice)
- (206) 526-4066 (fax)

E-Mail: Steve.Barbeaux@noaa.gov

8.1.2 Commercial Fishing Vessel FV *Muir Milach* – Telephone and E-mail contacts

Homeport :
Cellular:
INMARSAT Mini-M:
INMARSAT B:
E-Mail:
Other:

9.0 APPENDICES

9.1 Equipment Inventory

Equipment	Quantity	Source
Acoustic Gear		
Laptop Computer	2	Chief Scientist, FIT program
IOMEGA 120GB external drive	4	FIT Program
Calibration Downrigger	4	Chief Scientist
Tungsten-Carbide Calibration Sphere	2	Chief Scientist
Lead Cannonball	2	Chief Scientist
Spiderwire 100 lbs test	300 M	Chief Scientist
Calibration Tools and Parts	1	Chief Scientist
CTD and Cage	1	FIT Program
DVD Read/Write Drive	2	FIT Program
DVD backup discs	10	FIT Program
Biological Sampling		
Flatbed Scale 50 kg, 0.002 kg precision	2	RACE Division
Polycorder	2	RACE Division
Length-Frequency Board	2	RACE Division
Sampling Baskets	10	RACE Division
Otolith Vials	500	RACE Division
Species Id Manual	2	RACE Division
Handheld Deck Computer	2	FIT Program
Otolith Knife	2	FIT Program
Forceps	2	FIT Program
Scalpel	4	FIT Program
Scissors	2	FIT program
Various Zip-lock bags	30	FIT Program
Fin Clip micro-ampoules	100	Dr. Mike Canino
1 Liter 95% Alcohol	1	Dr. Mike Canino
Small Scale 1kg	1	FIT Program
Deck Sheets	100	Observer Program
Safety		
Immersion Suit	2	RACE Division
Life Jacket	2	RACE Division
Boots	2 pair	RACE Division
Wet Weather Gear	2 sets	RACE Division
Personal EPIRB	2	RACE Division
Hardhat	2	RACE Division
Work Gloves	6 pair	FIT Program
Other		
Digital Camera	1	FIT Program
Sleeping Bag	2	FIT Program

9.2 Figures

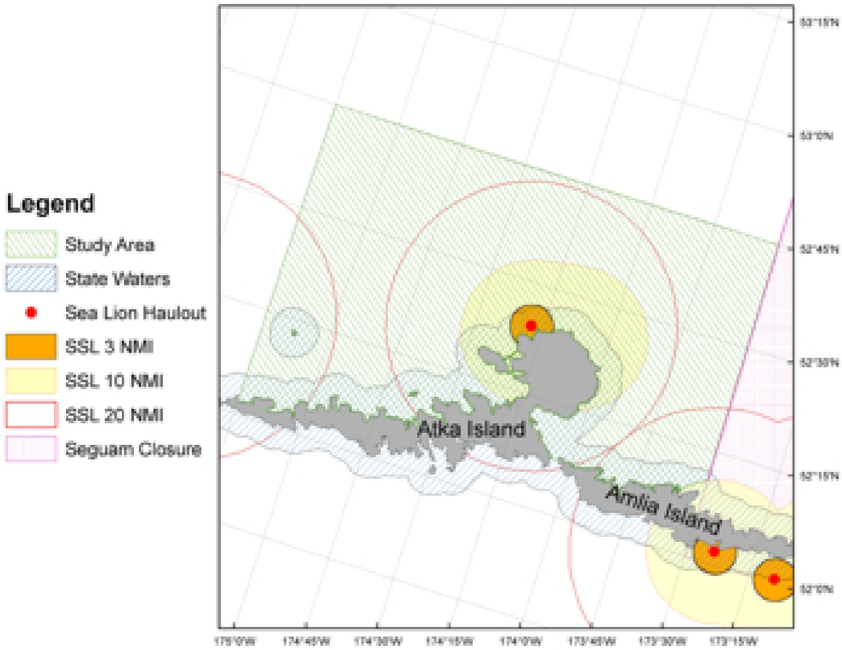


Figure 9.2.1 Atka Island Study Area

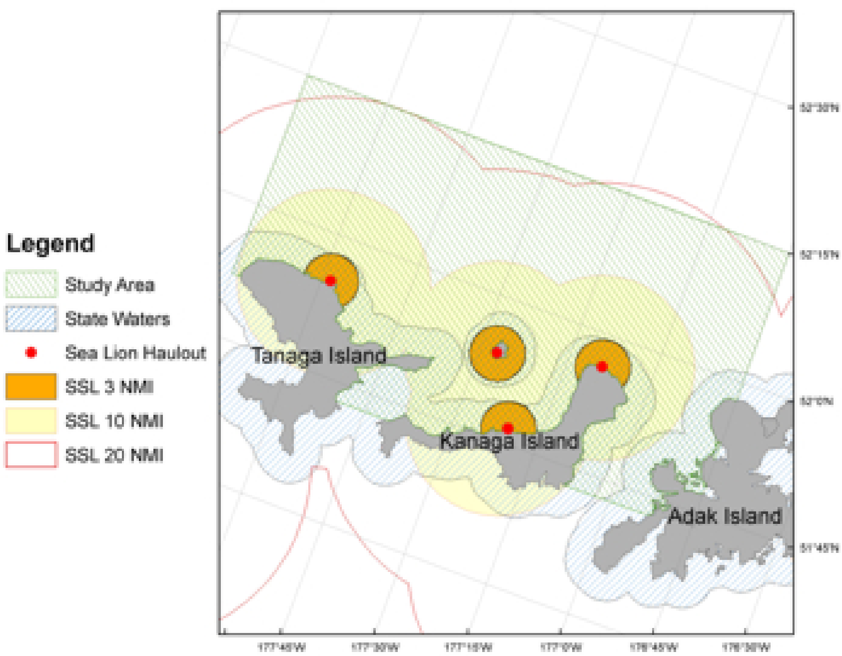


Figure 9.2.2 Kanaga Island Area Study Area

Appendix C: Responses from Participants

The following responses are published verbatim with permission from the respondents. The views expressed here do not constitute the view of the National Marine Fisheries Service.

Dave Fraser – Director of Government Affairs, Adak Fisheries LLC.

1. **What personal objectives did you have for this project? I.E. Why did you participate in this project?**

   The lack of a NMFS hydoacoustic survey for pollock is a major deficiency in the Aleutian Island stock assessment process. It is clear that the NMFS budget does not contain funds to conduct regular hydroacoustic surveys in the foreseeable future. Thus, addressing this problem will require a cooperative research program between NMFS and the stakeholders in the AI pollock fishery.

   Additionally, the AI is the only management area where 100% of SSL Critical Habitat is closed to pollock fishing, yet the vast majority of fishable pollock biomass in the AI is within CH. In order to modify the SSL mitigation measures and achieve a precautionary spatial and temporal dispersion of effort in relation to biomass, we need to know how biomass is in fact distributed. Without surveys that provide the needed information on seasonal biomass distribution, modification of the SSL mitigation measures is difficult.

2. From your own perspective what worked and what didn't.

Given the short lead time between NMFS approval of the project and the beginning of the season and survey, logistics were challenging and more costly than they might otherwise have been with more lead time.

Because the SSL regulations had effectively precluded the processing plant from participating in a directed pollock fishery prior to this season, the opportunity to process this pollock harvested under the EFP was also a "feasibility study" for the plant. Again, the short lead time resulted in logistical challenges in having the needed equipment and technical skills in place. This in turn resulted in the need to limit initial delivery quantities per trip as the plant came up to speed on pollock processing. As a consequence the number of trips and the duration of the project increased, ultimately overlapping with the P. cod B season, which increased both the variable costs and the opportunity costs to the vessel.

While the increased duration was a cost, it also provided a longer period in which to evaluate changes in biomass over time.

3. In your opinion was the AICASS successful? In what ways was it or was it not successful?

All indications are that it was a very successful project. We were able to get good data using a commercial vessel working within the constraints of 'normal' Aleutian Island winter weather, which was the central objective of the feasibility project. It appears further that the quality of the information may be suitable to incorporate into management measures that allow access to areas in proportion to pollock biomass distribution. It was disappointing that the biomass estimates were not higher. Beyond the obvious scientific value of the project, it was very helpful to the processing plant to get information and experience on size composition and roe recovery rates as well as CPUEs of the vessel.

4. **What areas could be improved upon? What would you change?**

   Ideally, we need to "clone" the survey vessel and cover more areas in a synoptic fashion. We also need more lead time in planning.

5. **Did you feel communication between the various parties were adequate?**

   It seemed that we were able to address any concerns that arose during the times that the vessel was in delivering. There was an issue concerning whether other vessels would be allowed to fish in the non-CH areas adjacent to the survey area. The confusion over the bounds of the survey area were addressed in a meeting between the other vessel operators, the plant owner and the NMFS scientist at the plant. My perception was that as a result of the meeting everyone understood each others concerns and an mutually acceptable agreement was reached on how to proceed.

6. **Do you see potential for using this type of data collection (commercial fishing vessels conducting scientific surveys) to improve the management of pollock in the Aleutian Islands? How?**

   Yes. As a mitigation measure for allowing access inside some portions of SSL CH, catch limits could be set on a sub-district basis. Ideally, this could be done in "real time" in-season. If that is not possible due to regulatory constraints on frame worked management, then the survey results could potentially be applied on a one year lag basis as part of the "spec" process.

7. **Would it be beneficial in your view for NMFS to continue to conduct cooperative projects such as this? Why?**

   Yes. Given NMFS budget constraints, this appears to be the only way to supplement the bi-annual bottom trawl survey with hydro-acoustic data.

Dave Wilmore –Master of the FV *Muir Milach* and Partner in Muir Milach Management, Inc.

1. **What personal objectives did you have for this project? I.E. Why did you participate in this project?**

   To further biological not political stock assessment in the AI, and to further increase the viability of the city of Adak as a major fishing port in the state of Alaska. The lack of funding makes this impossible for NMFS to pursue this on their own. The only way to resolve this is to utilize a cooperative research program.

2. **From your own perspective what worked and what didn't.**

   I believe the project as a whole was very successful. We ended up with a significant amount of valuable data. Steve Barbeaux's family background in the fishing industry made working with him an asset as he had an understanding dealing with adverse weather and delivery times.

   The lack of lead time. Missing fishing time, not only in preparation for the fishery (installation of the ES-60), but in the over-run of the estimated time needed to complete the survey. We invariably missed 2-3 days of survey/fishing time per week and this was not computed into the estimate for the survey length.

   Also since lead time was so short the Adak plant was ill prepared at startup so it took them a few deliveries to be able to receive what would be considered a "commercial delivery", of a full boatload. This greatly contributed to the length of the survey.

3. **In your opinion was the AICASS successful? In what ways was it or was it not successful?**

   Yes, I believe the survey was a success. It allowed us access into otherwise "closed" areas to assess the feasibility of a continued AI Pollock fishery. It also made it obvious that if an AI fishery is to succeed we need some sort of reform of the SSL's as the majority of the biomass falls in these areas

4. **What areas could be improved upon? What would you change?**

   Survey lead time would be the primary thing that could be improved upon. We absorbed a lot of out of pocket expense that would otherwise not have occurred had we had a couple of more months of lead time. Also trying to keep survey transects to a reasonable level in terms of fuel consumption which is a huge issue in the amount of run time involved in this type of survey.

5. **Did you feel communication between the various parties were adequate?**

   We had a few issues that came up during the survey. It seemed if we got together and discussed we always came up with a reasonable conclusion that was mutually acceptable.

6. **Do you see potential for using this type of data collection (commercial fishing vessels conducting scientific surveys) to improve the management of pollock in the Aleutian Islands? How?**

   Yes. As NMFS doesn't have the funding to do a complete survey of the AI, it seems that the best way to get "real time" data is to allow commercial vessels to participate. As I found out firsthand I tended to emphasize the need for "good data" over the need to fill the boat under most circumstances. I think that the majority of commercial vessels would be very diligent in the collection of the data as it is "our future".

7. **Would it be beneficial in your view for NMFS to continue to conduct cooperative projects such as this? Why?**

Yes. This is an excellent example of cooperative measures between NMFS and the commercial fishing industry. As it was historically the VERY FIRST survey of this type in the US, I personally find this as an invaluable alternative to expensive government funded acoustic survey work with the value of the fish offsetting the cost of the survey and appears to be the only way to get the data needed to re-open the AI to direct fishing.

Sandra Moller - President of the Aleut Enterprise Corporation

1. **What personal objectives did you have for this project? I.E. Why did you participate in this project?**

   Understanding the resources in our area is critical for our development of Adak. The main economy is fishing and fishing related activities. I have heard many times that "we need to be cautious since we don't have enough information in the Western Aleutians" and that the funding for surveys is lacking or missing. The chance to do this cooperative project was a way to be involved and start a process to hopefully expand the known science in the Aleutians. There has been a lack of adequate study in the Aleutian Islands. Once the pollock fishery was stopped in 1998 the only data was from the summer. This allowed for a winter fishery.

2. **From your own perspective what worked and what didn't.**

   The cooperative effort between the scientists and industry was very good and frankly refreshing. I was not involved too much in the day-to-day part as I was in Anchorage but I felt that I got regular reports from the vessel. More info like a daily report would be nice. The catch reporting could have been more cohesive between the boat and the plant. When I send in the weekly reports to NMFS it should only be sent once. We had a little trouble with that this year.

3. **In your opinion was the AICASS successful? In what ways was it or was it not successful?**

Yes tremendously. By being able to fish inside CH the project gave us information in an area that has not been fished in many years and can compare. The start of gathering any information on the stock size, age, and composition is a great beginning.

4. **What areas could be improved upon? What would you change?**
5. **Did you feel communication between the various parties were adequate?**

   Yes mostly, see above comments

6. **Do you see potential for using this type of data collection (commercial fishing vessels conducting scientific surveys) to improve the management of pollock in the Aleutian Islands? How?**

   Yes. If we could design the survey work so that appropriate open areas were allowed and discussed options for time and space adjustments that would be the best. A version of "adaptive management" I suppose.

7. **Would it be beneficial in your view for NMFS to continue to conduct cooperative projects such as this? Why?**

   Absolutely Yes, The topographic area in the Aleutians requires area specific research. The broad sweep in the relatively flat Bering Sea does not work for the Aleutians.

Steven J. Barbeaux – Research Fisheries Biologist, AFSC, NMFS

1. **What personal objectives did you have for this project? I.E. Why did you participate in this project?**

   The SSC has been reticent to accept the AI pollock stock assessment model due to the high level of uncertainty in stock dynamics. This project promises to provide invaluable data on the abundance and biology of pollock in the Central Aleutian Islands as well as potentially offering an innovative means of managing the stock at finer spatial and temporal resolution. This would not only aide us in achieving our goals for pollock management, but could provide invaluable information on SSL prey fields.

2. **From your own perspective what worked and what didn't.**

   The milestones achieved in this project were:

   1) Opportunistic data collected prior to the formal surveys allowed us to zero in on the most appropriate area to conduct the study.
   2) We were able to successful calibrate the commercial vessel acoustic system.
   3) We were able to conduct a sonar self-noise test, develop testing protocols and noise standards, and determine the optimum running conditions on board the commercial vessel to conduct an acoustic survey. This yielded a 10 to 1 signal to noise ratio for our acoustic data collection, well within acceptable guidelines.
   4) We were able to successful conduct six separate acoustic surveys of pollock in the Atka Island study area over a three-week period. Acoustic surveys had not previously been conducted in this region by the Alaska Fisheries Science Center.

5) The surveys were conducted over different weather and daylight conditions and reveal diel, tidal, and seasonal changes in pollock distribution in the survey area that had previously not been known.
6) 99 tissue samples for genetics work were collected from pollock in the study area. These are the only genetic samples ever collected from pollock in the Aleutian Islands west of Bogoslof Island.
7) Biological data and ototlith samples were collected from 28 hauls conducted in the study area providing the first winter data on the AI pollock stock for the annual stock assessment since the 1998 closure.
8) Although the focus of the study was on pollock additional data were collected on other species (including Pacific Ocean perch specimen for a maturity project conducted by Dr. Scott Heppel at OSU) which may allow for an unprecedented analysis of habitat utilization and spatial and temporal overlap of different species in the Aleutian Islands.
9) Additionally, this project fostered a cooperative and collaborative working relationship between NMFS, the Aleut Corporation, and the fishing industry, which greatly increased local participation and responsibility regarding the stewardship of this important marine resource.

What didn’t work:

1) The Zig-Zag survey type shouldn’t have been considered given the distribution of the fish along a very narrow band at the shelf break.
2) Due to the large mesh of the commercial trawl net we were unable to sample the small scatters observed throughout the survey and assumed to be Mctophids.

3) Start up time at the plant delayed the survey and slowed down fishing once the survey began.
4) Pelagic trawl gear was left in Dutch Harbor and retrieving it delayed the start of the survey and did not allow for biological samples to be collected in the preliminary survey east of North Cape.

3. In your opinion was the AICASS successful? In what ways was it or was it not successful?

Yes, the 2006 AICASS met all of its objectives laid out in the cruise plan and exempted fishing permit (EFP). In addition to achieving its scientific objectives, this project fostered an excellent working relationship between NMFS, the Aleut Enterprise Corporation, and the fishing industry. Local participation and stakeholder involvement enhances NMFS ability to provide responsible stewardship of this important marine resource.

4. What areas could be improved upon? What would you change?

1) More planning time would have made it easier. I think we achieved all of our objectives, but it would have been less hectic in the beginning with more lead time.
2) Increased opportunistic data collection prior to the survey may have help in the decision process for selecting a survey site.
3) A small mesh net liner would have enabled us to sample the small scatters observed throughout the survey.
4) Having the survey gear in Adak ready to go would have helped.

5) Having the plant prepared for the pollock deliveries, i.e. having dock engineers to fix the pumps and not relying on the fishermen to fix these, having enough processors to handle the deliveries, having a night manager to oversee the deliveries, etc… would have helped greatly. Once the plant was up and running properly, about half way through the study, the deliveries went much quicker.
6) I think a few more verification tows over time outside of the main fished area would have made it easier to discern whether there was a difference between the pollock inside and outside of the "fished" area.
7) If at all possible we should try to collect a noise profile for the vessels conducting the surveys to see how close they come to ICES recommendations for survey vessels.

5. Did you feel communication between the various parties were adequate?

Yes, although there were some hiccups in the beginning, a professional and open rapport quickly developed that greatly contributed to the success of this project. Throughout the survey the owners and crew of the FV *Muir Milach* were professional and forthright in communicating their goals. I think this helped to establish a level of trust and quickly establish open communication between all the participants.

6. Do you see potential for using this type of data collection (commercial fishing vessels conducting scientific surveys) to improve the management of pollock in the Aleutian Islands? How?

Yes, there are a number of projects that could be proposed. The first would be to develop a management strategy for the Aleutian Island pollock stock that would incorporate these data in near real time to create spatially and temporally explicit sub-quotas for the region/s surveyed. This would probably be the most straight forward use. It should be noted that once verified there is no real difference between the data collected by commercial fishing vessels and those collected by dedicated research vessels. Projects similar to the Kodiak FIT depletion study could be done in the Aleutians using commercial fishing vessels. The only caveat is that the data must be verified (i.e. noise tests and system calibrations) as thoroughly as those collected from a dedicated research vessel and the survey design must be as rigorously planned and reviewed.

7. **Would it be beneficial in your view for NMFS to continue to conduct cooperative projects such as this? Why?**

I think the number one reason that this project is beneficial and should be continued is that it provides data on the AI pollock stock that otherwise could not be obtained. Given current budget constraints I don’t see the AFSC being able to fund extensive acoustic surveying of the Aleutian Islands sub-region. This may be the only way that a time-line of winter pollock abundance estimates can be acquired for this area. Secondly, as stated earlier this type of project fosters a cooperative and collaborative working relationship between NMFS, the Aleut Corporation, and the fishing industry and increases local participation and responsibility regarding the stewardship of this important marine resource.

RECENT TECHNICAL MEMORANDUMS

Copies of this and other NOAA Technical Memorandums are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22167 (web site: *www.ntis.gov)*. Paper and microfiche copies vary in price.

AFSC-

197 HOFF, G. R., and L. L. BRITT. 2009. Results of the 2008 eastern Bering Sea upper continental slope survey of groundfish and invertebrate resources, 294 p. NTIS number pending.

196 BUCKLEY, T. W., A. GREIG, and J. L. BOLDT. 2009. Describing summer pelagic habitat over the continental shelf in the eastern Bering Sea, 1982-2006, 49 p. NTIS number pending.

195 LAUTH, R. R., and E. ACUNA. 2009. Results of the 2008 Eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate resources, 219 p. NTIS number pending.

194 HONKALEHTO, T., D. JONES, A. MCCARTHY, D. MCKELVEY, M.GUTTORMSEN, K. WILLIAMS, and N. WILLIAMSON. 2009. Results of the echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) on the U.S. and Russian Bering Sea shelf in June and July 2008, 56 p. NTIS number pending.

193 ANGLISS, R. P., and B. M. ALLEN. 2009. Alaska marine mammal stock assessments, 2008, 258 p. NTIS No. PB2009-109548.

192 FOWLER, C. W.,T. E. JEWELL and M. V. LEE. 2009. Harvesting young-of-the-year from large mammal populations: An application of systemic management, 65 p. NTIS No. PB2009105146.

191 BOVENG, P. L., J. L. BENGTSON, T. W. BUCKLEY, M. F. CAMERON, S. P. DAHLE. A. MEGREY, J. E. OVERLAND, and N. J. WILLIAMSON. 2008. Status review of the ribbon seal (*Histriophoca fasciata)*, 115 p. NTIS No. PB2006-104582.

190 HONKALEHTO, T., N. WILLIAMSON, D. JONES, A. MCCARTHY, and D. MCKELVEY. 2008. Results of the echo integration-trawl survey of walleye pollock (*Theragra chalcogramma)* on the U.S. and Russian Bering Sea shelf in June and July 2007, 53 p. NTIS No. PB2009-104581.

189 VON SZALAY, P. G., M. E. WILKINS, and M. M. MARTIN. 2008. Data Report: Gulf of Alaska bottom trawl survey, 247 p. NTIS No. PB2009-103242.

188 TESTA, J. W. (editor). 2008. Fur seal investigations, 2006-2007, 76 p. NTIS No. PB2009-103613.

187 CHILTON. E. A., C. E. ARMISTEAD, and R. J. FOY. 2008. The 2008 Eastern Bering Sea continental shelf bottom trawl survey: Results for commercial crab species, 88 p. NTIS No. PB2009-102142.

186 CHILTON. E. A., L. RUGOLO, C. E. ARMISTEAD, and R. J. FOY. 2008. The 2007 Eastern Bering Sea continental shelf bottom trawl survey: Results for commercial crab species, 85 p. NTIS No. PB2009-102141.

185 ROOPER, C. N., and M. E. WILKINS. 2008. Data Report: 2004 Aleutian Islands bottom trawl survey. 207 p. NTIS No. PB2009-100658.

184 KNOTH, B. A., and R. J. FOY. 2008. Temporal variability in the food habits of arrowtooth flounder (*Atheresthes stomias*) in the Western Gulf of Alaska, 30 p. NTIS No. PB2008-110137.

183 FRITZ, L., M. LYNN, E. KUNISCH, and K. SWEENEY . 2008. Aerial, ship, and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 2005-2007, 70 p. NTIS No. PB2008-111424.

182 HARRIS, P. M., A. D. NEFF, S. W. JOHNSON, and J. F. THEDINGA. 2008. Eelgrass habitat and faunal assemblages in the City and Borough of Juneau, Alaska, 46 p. NTIS No. PB2008-110149.