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Echo Integration-trawl Survey Results for Walleye Pollock (*Theragra chalcogramma*) on the Bering Sea Shelf and Slope During Summer 1999 and 2000

by
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U.S. DEPARTMENT OF COMMERCE
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For convenience, the 1999 and 2000 echo integration-trawl survey reports have been bound together as one document. The following individual reports, however, should be cited as follows:

Honkalehto, T., N. Williamson, and S. de Blois. 2002. Echo integration-trawl survey results for walleye pollock (*Theragra chalcogramma*) on the Bering Sea shelf and slope during summer 1999. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-125, 77 p.

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PREFACE

This report contains methodology, results, and some discussion of two summer echo integration-trawl (EIT) surveys of walleye pollock (*Theragra chalcogramma*) on the eastern Bering Sea shelf and slope conducted in 1999 and 2000. This research was carried out by the Midwater Assessment and Conservation Engineering (MACE) Program at the Alaska Fisheries Science Center, Seattle, Washington, as part of a historical time series monitoring the midwater component of Bering Sea walleye pollock. While EIT surveys are completed in conjunction with the AFSC's Groundfish Assessment Program's annual bottom trawl surveys to separately assess the on-bottom component of Bering Sea pollock, bottom trawl results are not presented here. Although EIT survey design and timing were nearly the same between 1999 and 2000, each year's work had a slightly different scope and research team, thus the results are presented sequentially as two separate papers. To the extent possible, subheadings and sections used are the same for each year, but in some cases they differ.

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ABSTRACT

Walleye pollock (*Theragra chalcogramma)* abundance and distribution in midwater were assessed on the eastern Bering Sea shelf and slope between 12 June and 3 August 1999, using echo integration-trawl survey (EIT) techniques aboard the NOAA ship *Miller Freeman.* The survey extended from Port Moller, Alaska, to the U.S./Russia Convention Line. Results showed that pollock were absent east of 162°W long. and were relatively abundant around the Pribilof Islands. West of the Pribilof Islands, pollock were rarely found in water shallower than the 100-m isobath. Highest pollock concentrations were at approximately 173° and 177°W long. In 1999, the center of pollock distribution was south and slightly west of the center of distribution observed during previous years (1994,1996,1997). Age distribution was similar east and west of the Pribilofs. The 1996 year class predominated, followed in order of decreasing importance by 1995 and 1992 in the east, and by 1997 and 1995 in the west. Age-1 pollock (1998 year class) were rarely observed. Estimated pollock abundance between 14 m from the surface and 3 m off-bottom was 3.29 million metric tons (t) and 9.6 million fish. East of 170°W long., estimated pollock abundance was 0.89 million t. West of 170°W long., estimated biomass was 2.41 million t. Nine percent (0.30 million t) of the total biomass was inside the Steller sea lion Conservation Area (SCA). Proportions of pollock biomass estimated east and west of 170°W long. and inside and outside the SCA were similar to that observed during summer EIT surveys conducted during the 1990s. Estimated pollock abundance in a small region of extended trackline in the "horseshoe area" outside of our normal survey area was 0.060 million t during the first pass through the area on Leg 1 of the cruise, and 0.058 million t during the second pass at the end of Leg 2. Future surveys will include trackline extensions into this area.

CONTENTS

INTRODUCTION

Walleye pollock (*Theragra chalcogramma*) is a gadid fish species that ranges from continental shelf waters of the northeastern Pacific Ocean across the entire Bering Sea, along the Kamchatka Peninsula, into the Okhotsk Sea and the Sea of Japan. It supports one of the largest single-species fisheries in the world. Eastern Bering Sea (EBS) pollock is a primary prey species for declining Steller sea lion (*Eumetopias jubatus*) populations (Loughlin 1998) inhabiting rookeries adjacent to historically important pollock fishing grounds. Currently, eastern Bering Sea pollock is under close scrutiny in order to quantify relationships between pollock abundance, sea lions, and ecosystem effects of pollock removal by the fishery.

Summer echo integration-trawl (EIT) surveys of Bering Sea pollock were conducted triennially between 1979 and 1994, and in 1996, 1997, and 1999. Results presented here are from the main EIT pollock survey carried out 12 June to 29 July 1999 westward from north of Port Moller, Alaska (160°20'W long.) to the U.S./Russia Convention Line (178°55'W long.), and from trackline resurveyed 1 to 3 August in the "horseshoe area"–here defined as the region west of Unimak Pass encompassing the 200-m isobath between approximately 165° to 167°W long., and between 55°N lat. and the Aleutian Island chain. The primary cruise objective was to estimate pollock abundance and distribution in the pelagic zone between 3 m off bottom and 14 m from the surface throughout the eastern Bering Sea shelf. Because of the attention focused on Steller sea lions and available pollock prey in the horseshoe area and because of industry requests that we survey more of that area, we added extra transects during the main survey and later re-surveyed part of the horseshoe area. The objectives of adding survey trackline were thus to assess pollock abundance in the horseshoe area outside the normal survey area, and to quantify temporal change in that area's pollock abundance during the summer.

Secondary research objectives were to collect pollock target strength (TS) data, to test an acoustic buoy system, and to complete other scientific research projects as requested by Alaska Fisheries Science Center (AFSC) scientists and other researchers (see Appendix II). Two

Russian scientists from the Pacific Research Institute of Fisheries and Oceanography (TINRO), Vladivostok, Russia, participated in this EIT survey. Scientists from the AFSC's National Marine Mammal Laboratory monitored populations of whales and seabirds throughout the cruise (Moore et al. 2000).

METHODS

Itinerary (Alaska Daylight Time)

<u>Leg 1</u>

7-12 June	Embark scientists in Kodiak; acoustic system calibration in Ugak Bay, Alaska.
	Transit to Bering Sea. Equipment tests.
12 June-3 July	Echo integration-trawl survey of the EBS shelf (transects 1 to18).
4-5 July	In port Dutch Harbor, Alaska.

<u>Leg 2</u>

6-29 July	Acoustic system calibration in Captains Bay. Echo integration-trawl survey of the EBS shelf (transects 19 to 29).
1-3 August	EIT replicate survey of the horseshoe area. Acoustic system calibration in Captains Bay.
4-5 August	Leg 2 end. In port Dutch Harbor.

<u>Leg 3</u>

6-13 August	Acoustic buoy trials.
14 August	End of cruise.

The survey was conducted on board the NOAA ship *Miller Freeman*, a 66-m stern trawler equipped for fisheries and oceanographic research. Scientific personnel are listed in Appendix I.

Acoustic Equipment

Acoustic data were collected with a Simrad EK500 quantitative echo-sounding system (Bodholt et al. 1989; Simrad 1993a, Bodholt 1990, Bodholt and Solli 1992). Two Simrad split-beam transducers, one operating at 38 kHz and the other at 120 kHz, were mounted on the bottom of the vessel's centerboard. With the centerboard fully extended, the transducers were 9 m below the water surface. Echo integration data sampled with a horizontal resolution of about 9 m and a vertical resolution of 0.5 to 2.0 m, and target strength data were collected simultaneously at both frequencies. Data from the 38-kHz transducer were processed on a SUN workstation using Simrad BI500 echo integration and TS data analysis software (Foote et al. 1991, Simrad 1993b). Acoustic system settings used during the collection were based on results from calibrations (Table 1) and on experience from prior surveys. Acoustic system components, computers, and supporting electronic equipment were housed in a dedicated acoustic laboratory inside the vessel.

Digital echograms were scrutinized to apportion acoustic information into three echosign types, pollock, non-pollock fish, and an invertebrate/fish species mixture. Echograms were recorded on color printers to aid researchers in assigning echosign. SeaPlot (Advanced Marine Technology Corp., Box 1848, Seattle, WA 98111-1848) navigation and charting software was used to log position information obtained from a Geographical Positioning System (GPS). Results presented in this report were based on 38-kHz data.

Trawl Gear

Midwater and near-bottom echosign was sampled with an Aleutian Wing 30/26 trawl (AWT). This trawl had full-mesh wings constructed of nylon with polyethylene toward the aft section of the body and the codend (Fig. 1). The headrope and footrope each measured 81.7 m (268 ft). Mesh sizes tapered from 325.1 cm (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. A 3.2-cm (1.25-in) codend liner was used. The AWT was fished with 82.3 m (270 ft) of 1.9-cm (0.75-in) diameter 8×19 non-rotational dandylines, and either 340.2-kg (750-lb), 226.8-kg (500-lb), or 113.4-kg (250-lb) tom weights on each side.

Fish on bottom were sampled with an 83/112 bottom trawl without roller gear (hereafter referred to as "bottom trawl"; Fig. 2). Net mesh sizes ranged from 10.2 cm (4 in) forward and 8.9 cm (3.5 in) in the codend to 3.2 cm (1.25 in) in the codend liner. Headrope and footrope lengths were 25.6 m and 34.1 m (83.9 ft and 111.9 ft), respectively, and the breastlines measured 3.4 m and 3.2 m (11.3 ft and 10.5 ft). The bottom trawl was fished with 54.9-m (180-ft) double dandylines.

A Methot trawl (Fig. 3) and a bongo net system were used to sample age-0 gadids (these were mainly age-0 pollock, but as Pacific cod (*Gadus macrocephalus)* may also have been captured, final identification to species was made in the laboratory after the cruise) and macrozooplankton. The Methot trawl had a rigid square frame with 2.27-m (89.5 in) sides forming the mouth of the net. Mesh sizes were 2 mm × 3 mm (0.08 in × 0.12 in) in the body of the net and 1 mm (0.04 in) in the codend. To generate additional downward force, a 1.83-m (6-ft) dihedral depressor modified from an Isaacs-Kidd midwater trawl was suspended from the square frame. The trawl was attached to a single cable that was fed through the ship's stern-mounted A-frame and deployed off the stern ramp. A calibrated General Oceanics flow meter was attached to the mouth of the Methot trawl to determine the volume of water filtered during trawling. The bongo net system consisted of a 60-cm bongo frame with 505-μm mesh nets and a 40-kg lead weight used as a depressor. It was deployed from the ship's starboard winch.

Age-0 gadids and zooplankton were also targeted with a Marinovich trawl (Fig. 4). Meshes in the Marinovich trawl measured 7.6 cm (3.0 in) forward, 3.2 cm (1.3 in) in the codend, and 0.32 cm (0.125 in) in the codend liner. Headrope and footrope lengths were each 9.1 m (30 ft).

Five-m^2 (53.8-ft^2) "Fishbuster" trawl doors [1,247.4 kg (2,750 lb)] were used with the AWT, bottom trawl, and Marinovich trawl. To prevent the trawl doors from overspreading and damaging the Marinovich trawl when it was towed, a 15.24-m (50-ft) long, 2.5-cm (1-in) diameter restrictor line was used. From each trawl door, two 16.8-m (55-ft) long, 1.9-cm (0.75-in) diameter, 8×19 wire ropes connected to a single 82.3-m (270-ft), 1.9-cm (0.75-in) bridle. At the net end of the bridle, the restrictor was attached across to the single bridle on the other side.

Two pairs of 18.3-m long (60-ft), 1.3-cm (0.5-in) diameter 6×19 wire ropes led aft from the restrictor line to the head and foot ropes.

A WESMAR third wire or a Furuno wireless net sounder system attached to the head rope of the AWT, bottom trawl, and Marinovich trawl hauls monitored vertical net opening, headrope depth, and water temperature. A Scanmar sounder system monitored Methot trawl depths with a depth sensor attached to the top of the Methot trawl frame. Vertical net openings averaged 21.4 m for the AWT, 2.2 m for the bottom trawl, and 2.0 m for the Marinovich trawl.

Water temperature at depth and tow profiles for all trawls was obtained by attaching a small, retrievable micro-bathythermograph (MBT; Richard Brancker Research, Ltd.) to the net headrope, or, with Methot trawls, to the frame. Water temperature and salinity profile data were collected at calibration sites, at the end of transects 23 to 29 along the U.S./Russia Convention Line, and at other selected locations with a conductivity-temperature-depth (CTD; Sea-Bird Inc.) system. Sea surface temperature, salinity, barometric pressure, true wind speed, true wind direction, ship speed, pitch, roll, and main engine pitch/RPM were collected and stored on the *Miller Freeman*'s Scientific Computing System (SCS).

Survey Design

The main 1999 EIT survey (Fig. 5) consisted of two segments. During Leg 1, we surveyed transects 1 through 18 between 12 June and 3 July. During Leg 2, we surveyed transects 19 through 29 between 6 and 29 July. The approximately 6,100 nautical mile (nmi) survey trackline consisted of parallel north-south transects that began near Port Moller, Alaska, and proceeded westward to the U.S./Russia Convention Line. Southern transect endpoints were either limited by the Alaska Peninsula and the Aleutian Island chain (transects 1 to 12) or the shelf break (transects 13 to 29). Northern endpoints of transects 1 to 20 were based on historical pollock distribution and were moved northward if significant fish echosign was observed. Bottom depths at these endpoints were about 56 to 85 m. As permission to enter the Russia Exclusive Economic Zone (EEZ) was not granted, transects 21 to 29 ended at the U.S./Russia Convention Line. Bottom depths at transect endpoints along the convention line increased westward from 77 m to 252 m. Survey timing was approximately one month earlier than the three previous summer Bering Sea surveys (1994, 1996, 1997). Transects were designed to coincide with lines of groundfish trawl stations sampled by demersal survey vessels and were spaced 20 nmi apart except in the horseshoe area where transects 9 to 12 were extended and spacing was 10 nmi. These tracklines were modified to better quantify pollock distribution in the horseshoe area both within and outside the historical survey area.

Since we were not able to survey the Cape Navarin area in the Russian EEZ, we used the time originally allocated for that to resurvey the horseshoe area (extended transects 9 to 12) at the end of Leg 2 between 1 and 3 August at 10-nmi spacing, and to deploy an acoustic buoy system (9 to 13 August, Leg 3 of the cruise) to study fish avoidance reactions to a factory trawler and to the *Miller Freeman*.

The EIT survey was conducted between sunrise and sunset; night operations consisted primarily of collecting pollock TS data and Methot trawl sampling for age-0 gadids and zooplankton. Daylight ranged from about 16.75 hours to 18.75 hours depending on latitude and date. Vessel speed during survey data collection averaged 12 knots.

Trawl hauls were made on echosign to provide information on walleye pollock and to identify associated biota. The decision to trawl in a particular area was based on absolute density of echosign, change in echosign appearance (suggesting a potential change in size or species), and/or to maintain adequate spatial coverage. Researchers processed the catches using standard catch sorting and enumeration procedures (random sampling techniques; Traynor and Nelson 1985, MACE Sampling Manual[1]). Catches less than about 1,500 kg were completely sorted; larger catches were usually subsampled. Total numbers and weights were determined for all species. Weights were determined to the nearest 0.1 kg for the sorted portions of the catch using an electronic, motion-compensating scale (60-kg Marel M2000). Walleye pollock were subsampled to determine fork length (FL) composition by sex, as well as to collect stomachs, otoliths, maturity, and individual length-weight measurements. Individual fish weights were

[1]Midwater Assessment and Conservation Engineering (MACE) Sampling Manual. 2001. Unpublished document. Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle WA 98115.

determined to the nearest 2 g using a 6-kg Marel M2000 scale, and lengths of fish greater than about 5 cm FL were determined to the nearest centimeter (e.g., a fish measuring between 49.5 cm FL and 50.5 cm FL was recorded as 50 cm FL) using a polycorder measuring device (a combination of bar code reader and hand-held computer, Sigler 1994). Lengths of micronekton including age-0 gadids were determined to the nearest millimeter and recorded manually. Ages were determined from fish otoliths using the break-and-burn method by scientists in the AFSC Age and Growth Lab. Sexual maturity was determined by visual inspection and was categorized as immature, developing, pre-spawning, spawning, and post-spawning. Samples of age-0 gadids for young-of-the-year walleye pollock studies were either preserved in formalin or frozen whole. Stomach samples for food habits studies were preserved in 10% formalin, and fish otoliths were preserved in 50% ethanol.

Methot trawl hauls to sample micronekton and zooplankton were towed obliquely with one or two (targeted tow) exceptions. Catches were divided into gelatinous and non-gelatinous plankton. Jellyfish were weighed and discarded. Non-jellyfish portions were split into fish and non-fish and grouped by species or to the extent possible by visual cues. Fish lengths were measured to the nearest millimeter and individuals were frozen. Invertebrates were preserved in formalin for later identification to species.

Calibrations using standard sphere techniques were made to monitor acoustic system performance. During calibrations, the *Miller Freeman* was anchored at bow and stern. Two copper calibration spheres, 23 mm (120-kHz sphere, TS = -40.3 dB) and 60 mm (38-kHz sphere, TS = -33.6 dB) diameters, were suspended at about 25 m and 30 m, respectively, below the centerboard-mounted transducers. Weather, sea state conditions, and acoustic system settings were recorded. After each sphere was centered on the acoustic axis, split-beam target strength and echo integration data were collected to determine acoustic system gain parameters. The average of 10 on-axis target strength and 10 on-axis integration values were recorded. Transducer beam characteristics were measured using a Simrad software program (EKLOBES). Each sphere was pulled through its corresponding transducer beam, TS data were collected on a grid of angle coordinates, and beam shape was estimated (Foote et al. 1987). A CTD was deployed to measure water temperature at the transducer faces and sphere depths.

Target strength data, which are used to scale echo integration data to estimates of absolute fish abundance, were collected on fish when conditions were suitable, that is, relatively calm seas, low fish density at ranges less than 150 m from the transducer, single species, and unimodal size distribution. Low fish density usually occurred after sunset. A midwater trawl was conducted to determine whether species and size distribution were appropriate. If so, the EK500 echosounder was set to ping interval 0 to maximize the number of data points collected. The vessel was passed repeatedly over the fish at speeds of 1 to 3 kts while collecting acoustic target strength data. After data collection, another midwater trawl was made to ensure that fish size/species composition had not changed. Trace data were transferred from the SUN workstation to a laptop PC and processed with Sonardata software (Echoview). Results from analysis of these data will be reported elsewhere.

Echo integration-trawl survey methodology depends on a number of assumptions. For example, we assume that pollock do not react to vessel or trawl noise in ways that adversely affect our data collection. One objective of this cruise was to collect acoustic data from an acoustic buoy to help determine the effects of ship and trawl noise on the behavior of walleye pollock. These results will be reported elsewhere.

Data Analysis

Estimates of pollock abundance were derived by combining echo integration and trawl data. Echo integration data from 14 m below the surface to within 0.5 m of the bottom, or in the upper 1,000 m of water, were examined for pollock echosign and stored in a database. Pollock echosign data were classified into two types based on appearance 1) aggregations near or on bottom which were usually fish ranging in size from juveniles to adults, and 2) discrete mid-water schools in the upper water column which were usually juveniles. Pollock length data sampled from 107 hauls were aggregated into 25 analytical strata according to echosign distribution, similarity in size composition data, and geographic proximity of hauls. Average pollock backscattering strength along each 0.5 nmi of transect was multiplied by transect width to estimate area backscattering for transect segments. Area backscattering from individual segments were summed to compute total pollock area backscattering for each analytical stratum. They were then scaled using a previously derived relationship between TS and fish fork length

(FL), TS = 20 Log FL - 66 (Traynor 1996) and the length composition data, to estimate numbers of pollock by size. A length-weight relationship observed from the trawl data was applied to estimate biomass of pollock for each 1-cm length category. Age-specific estimates of biomass and numbers were computed using two age-length keys (east and west of 170°W long.) constructed from the ages and lengths of pollock collected from the trawl catch. Vertical distribution of pollock biomass (weighted by total biomass) was computed for each transect using echo integration data collected between 0.5 m from the bottom and 14 m from the surface.

Biomass was estimated 1) for the survey area normally covered as in 1991, 1994, 1996, and 1997, excluding data from extended transects in the horseshoe area in 1999, 2) for the entire geographic area covered by the survey, and 3) for the portion of the horseshoe area not normally covered in the survey. To estimate pollock population and biomass on the Bering Sea shelf, we used midwater and bottom hauls 1 to 116 except for those that caught too few fish. We used hauls 7, 10 to 12, 15, and 20 to 23 to scale horseshoe area data. Estimates were made for pollock in midwater, with midwater defined as the water column from 14 m below the surface waters to within 3 m from bottom. Pollock occurring between the bottom and 3 m off bottom were assessed by the 1999 eastern Bering Sea bottom trawl survey for groundfish and crab. Population estimates described were for the normal triennial EIT survey area without added horseshoe trackline, unless stated otherwise. Pollock abundance and distribution were compared and contrasted between known biophysical-oceanographic regions of the Bering Sea shelf (Kinder and Schumacher 1981, Coachman 1986): east and west of 170°W long. (Pribilof Islands), and for bottom depths less than 50 m, 50 to 100 m, 100 to 200 m, and greater than 200 m. Because it is not normally surveyed to the extent that it was in 1999, the horseshoe area was treated as a separate stratum. Summary tables include some data collected after the main survey during the acoustic buoy work.

Error bounds on the acoustic data were derived using a one-dimensional (1D) geostatistical approach described in Petitgas (1993), Williamson and Traynor (1996), and Rivoirard et al. (2000). We chose geostatistical methods for computation of error (± 2 relative estimation error) because they account for the observed spatial structure and thus provide more realistic estimates of error than those derived from the random sample variance. The 1D method required equal spacing between transects and no fewer than 10 transects (Petitgas, pers. comm.). Sampling error bounds on the acoustic data were then used to provide confidence intervals on the estimates of biomass. These error bounds quantified only acoustic data sampling variability and hence should be treated as preliminary. Other sources of error (e.g., target strength, trawl sampling, echosign identification) were not included.

RESULTS AND DISCUSSION

Calibration

Three acoustic system calibrations were made in conjunction with the cruise: in Ugak Bay, Alaska, prior to the start of Leg 1, and at the ends of Legs 1 and 2 in Captains Bay, Alaska (Table 1). No significant differences were observed in either the 38-kHz or 120-kHz systems during that time period.

Target Strength

On ten occasions during the survey, suitable conditions were encountered and TS data were collected (Table 2). On each occasion, associated trawl hauls confirmed that 1) pollock was the dominant species in the catch and 2) pollock size composition was unimodal. For preliminary analysis of the acoustic data, a low-density section of the water column was selected and targets accepted within 3 dB of the acoustic axis were averaged to provide estimates of TS. For pollock 36 to 49 cm in length, variability about TS = 20 log FL -66, the relationship used to scale acoustic data to abundance (Fig. 6), was similar to that reported in Traynor (1996). Further analyses such as checks on the probability of multiple targets, the effect of beam pattern location, and the depth dependence of TS are required to finalize these results.

Oceanographic Conditions

Physical oceanographic data from 173 MBT casts, 13 CTD casts, and continuous surface thermo-salinograph recordings (Tables 3-5 and Figs. 7-12) showed that summer 1999 was extremely cold. Surface water temperatures encountered during the survey ranged from just above 0°C to slightly above 8°C (Fig. 7). Surface water temperatures observed north of the Alaska Peninsula and Unimak Island in mid-June were colder than surface temperatures observed in the northwest survey area in July which by then had begun to stratify. Relatively cool surface water surrounded the Pribilof Islands, especially near St. Paul Island. Average surface water temperature in 1999 (6°C) was 3° to 4°C cooler than during the 1996 (9°C) and 1997 (10°C) EIT surveys, respectively. Salinity of surface water ranged from about 30.2 to just over 33.2 (Fig. 8), and decreased to the north. Bottom temperatures observed during annual bottom trawl surveys were much lower in 1999 than in 1998 (Fig. 9, T. Sample, pers. commun. Alaska Fisheries Science Center, Seattle WA 98115). Midwater temperatures at 50 m depth revealed cold water features in the northwest near 60°N lat.,176°W long., and adjacent to the U.S./Russia convention line (Fig. 10). In each case, temperatures at 50 m were less than -1°C. Along the U.S./Russia Convention Line the depth of the mixed layer was about 20 m (Figs. 11 and 12). Near bottom, warmer, more saline water from the Aleutian Basin appeared to be mixing with colder water on the shelf.

Biological Sampling

Between mid-June and mid-August 1999, we conducted 108 midwater trawl hauls (103 AWT, 1 bottom trawl flown in midwater, and 4 Marinovich), 14 bottom trawls, 48 Methot trawls, and 2 bongo net tows to identify echosign and collect biological data and samples (Tables 4-10, Figs. 13 and 14). During the main Bering Sea shelf EIT survey, pollock was the dominant catch species in 99 AWT and 13 bottom trawl hauls, accounting for about 96% and 79%, respectively, of catch composition by weight (Tables 6 and 7). About 5% of bottom trawl haul catch was composed of Pacific cod and about 8% of three species of sole (yellowfin *(Limanda aspera)*, flathead *(Hippoglossoides elassodon)*, and rock *(Lepidopsetta* sp.*)* sole). All arctic cod (*Boreogadus saida*) encountered during the survey were caught in haul 65, the northernmost tow which also had the coldest recorded gear temperature (-1.7°C).

Jellyfish were consistently caught by all gear types (Tables 6-8). *Chrysaora* sp. jellyfish were second to pollock in abundance by weight in AWT hauls. Jellyfish catch per unit effort (CPUE) in midwater trawls was highest on the outer shelf (100-200 m) near the 100-m isobath in the horseshoe area, near Pribilof Canyon southeast of St. George Island, and near Zhemchug Canyon south of St. Matthew Island (Fig. 15). Jellyfish comprised 93% of the catch from Methot tows (Table 8) and 96% of the catch from Marinovich tows by weight.

Almost 42,000 pollock fork lengths were recorded, and just under 5,000 otoliths were collected during the survey (Table 9). On average, 350 pollock lengths were measured and 41 pollock otoliths were collected from each haul. Over 1,500 pollock stomachs were collected (Table 10) from selected AWT and bottom trawl hauls for food habits analyses. Age-1 pollock from 8 hauls were collected for several special study requests (see Appendix II).

Age-0 gadid density was highest near 55°N lat., 167°W long., and south of St. Matthew Island at 59°N lat. (Fig. 16). Although Methot trawl hauls caught more jellyfish and euphausiid zooplankton by weight, several hundred age-0 gadids were caught. A few age-0 gadids were also retained in 2 AWT hauls. Most of the age-0 gadids caught were small relative to lengths of age-0 gadids we have typically caught during past summer Bering Sea shelf surveys, possibly due to earlier timing of the survey in 1999 than in past survey years. Bongo tows, made primarily in conjunction with North Pacific right whale (*Eubalaena glacialis*) sightings, caught jellyfish, age-0 gadids, other juvenile fishes, and a mixed species assemblage of zooplankton.

Pollock captured in midwater and bottom trawls ranged from 9 to 79 cm in length. Adult pollock (≥30 cm FL) were captured in most trawl hauls. Most smaller fish (< 30 cm FL) were encountered on transects 5 and 6, north of the Pribilof Islands, and south of St. Matthew Island along a northwest-southeast band between transect 21 and transect 29 near Pervenets Canyon (Fig. 17). Pollock smaller than 20 cm FL (age-1 pollock) were only occasionally captured. Length to weight regression curves fit using Microsoft Excel Solver for length and weight data from pollock caught in midwater and bottom trawl hauls were similar between males and females (Fig. 18), leading to the use of a single, sexes combined, length-weight regression relationship for subsequent population analysis. Trawl haul sex ratios averaged 52% male over the entire survey, ranging from a minimum of 25% to a maximum of 76%. Male catch compositions were higher in trawls made east of the Pribilof Islands (Fig. 19). A decline in the male sex ratio with increasing trawl gear depths (Fig. 20) and bottom depths was observed. Most pollock observed were in developing or post-spawning maturity stages (Fig. 21). When combined, these two stages accounted for 78% and 79% of males and females, respectively. Very few pre-spawning or spawning pollock were observed.

Mean fork length at age for pollock (sexes combined), as determined from trawl catch data where otoliths were collected, ranged from about 12 cm FL at age 1 to about 59 or 60 cm FL by age 11 (Fig. 22). The oldest pollock aged was 18. For all ages, mean length at age appeared to be larger east of 170°W long. than west of 170°W long., with the exception of age 1, where too few were observed in the east to make a comparison. For this reason, we used two separate age-length keys when computing abundance at age estimates.

Pollock Distribution and Abundance

Bering Sea shelf

Pollock (from 14 m below the surface to 3 m off bottom) were absent or at very low densities in the eastern portion of the survey area. No pollock were observed on transects 1 to 3. Pollock were first observed on transect 4 and they increased in density at 165°W long., northwest of Unimak Island. Abundance of pollock was lower between 166°and 167°W long. and then increased again. Thereafter, pollock were present on each transect from about 168°W long. westward to the U.S./Russia Convention Line (Fig. 23). West of the Pribilof Islands, pollock were rarely found where bottom depths were shallower than 100 m. The highest pollock concentrations occurred on the outer shelf (between the 100 and 200 m isobaths) at approximately 173°W long. (transect 21) and 177°W long. (transect 27) east of Zhemchug and Pervenets Canyons, respectively, and on transect 28 near the 200-m shelf break. In several of these areas dense pollock aggregations occupied most of the water column (Fig. 24).

Other echosign observed, categorized using trawl catch information and experience from prior surveys, were attributed to non-pollock fish and an undifferentiated mixture of jellyfish, macrozooplankton, age-0 gadids, and individual fishes. The latter was classified as an invertebrate-fish species mixture. Distribution of this invertebrate-fish species mixture was different than that for echosign attributed to age 1 and older pollock (Fig. 25). This species mixture was mainly observed in the middle shelf region (where bottom depths were shallower than 100 m), and was most concentrated northwest of the Pribilof Islands and south of St. Matthew Island. Since this mixture of backscatter cannot be easily scaled to biomass, its magnitude in any given location is not well known, and its representation here is not comparable to that for pollock biomass which has been properly scaled.

Vertical distribution of biomass (weighted by total biomass) for each transect (Fig. 26), averaged about 80% off bottom (3 m off to 14 m from the surface) and 20% near bottom (0.5 m to 3 m off bottom). Biomass was lower and fish were found closer to bottom on eastern transects. Western transects had higher biomass and had more of it distributed above 3 m off bottom.

When the 1999 area surveyed was matched to the areas surveyed in 1994, 1996, and 1997, estimated pollock biomass was 3.29 million metric tons (t) and estimated numbers were 9.6 billion. The 95% confidence interval around the estimated biomass was 2.93-3.64 million t.

Proportions of pollock biomass estimated east and west of 170°W long. and inside and outside the SCA were similar in summer 1999 to that observed during previous summer EIT surveys conducted in the 1990s. About 9% of the estimated biomass (0.30 million t) was located in the SCA, 18% (0.58 million t) was east of 170°W long. but outside the SCA, and 73 % (2.41 million t) was west of 170°W long. (Table 11). East of the Pribilof Islands (east of 170°W long.), modal lengths were 36, 46, and 25 cm (Fig. 27). Inside the SCA, the 25-cm length mode (age-2 pollock – see Fig. 22) was absent and a greater proportion of fish larger than about 50 cm was present in contrast to outside the SCA (Fig. 28). West of the Pribilof Islands, modal lengths were smaller – 30, 22, and 45 cm. Estimated pollock abundance between 14 m from the surface and 3 m off-bottom for the total survey area, including extended transects in the horseshoe area, was 3.35 million t and 9.7 billion fish.

Pollock abundance and length composition were compared and contrasted by region, bottom depth, and longitude (Fig. 29). East of 170°W long. on the middle shelf (between the 50 and 100 m isobaths) pollock with modal lengths at 45 cm and 37 cm (and to a lesser extent 25 cm) predominated and abundance was about 981 million fish at 0.47 million t. About the same number of pollock (957 million) were observed east of 170°W long. on the outer shelf (between the 100 and 200 m isobaths), but most were about 36-cm fork length, and biomass was lower (0.390 million t). East of 170°W long. in water deeper than 200 m (excluding the horseshoe area), far fewer pollock were observed (23 million, 0.013 million t). West of 170°W long. on the middle shelf, we estimated that there were about 694 million fish (0.320 million t) with a peak at the 45-cm length mode and additional modes at 22 to 23 cm (age 2) and 13-cm (age 1) pollock. The vast majority of pollock inhabited waters west of 170°W long. on the outer shelf (about 7 billion fish, 2.08 million t), comprising 30, 22, 38, and 45 cm modal fork lengths, in order of decreasing importance. We also observed a few 13-cm (age-1) fish. In offshore waters deeper than 200 m and west of 170°W long., very few pollock were encountered (12 million fish, less than 0.01 million t).

In 1999, estimated pollock abundance at length (Table 12) indicated lower numbers of 12 to 18 cm fish and higher numbers of 28 to 33 cm fish in contrast to numbers from 1994, 1996, and 1997 EIT survey estimates. Estimated abundance at age (Table 13) revealed that in 1999, the 28 to 33 cm length mode was age-3 pollock from the 1996 year class. In 1999, age-3 pollock were followed, in order of decreasing importance, by the age 4 (1995), age 2 (1997), and age 7 (1992) year classes, and age distribution was similar east and west of the Pribilof Islands (Fig. 30).

Horseshoe area transects

The Bering Sea region to the west of Unimak Pass surrounding the 200-m isobath is referred to by fishermen and scientists as the "horseshoe area". Previous summer EBS shelf EIT surveys have covered only part of this area. In 1999, in response to concerns that this area may hold significant quantities of pollock and should be surveyed, we added and extended transects in this region. After an initial pass through the area during Leg 1 in mid-June as part of our larger survey effort, we returned to the area at the end of Leg 2 between 1 and 3 August to look for changes in distribution and abundance. During both passes (Fig. 31), large aggregations of pollock were observed between Unimak Pass and 166°W long. West of 166°W long., very little pollock echosign was encountered, and then only at the shelf break next to the Aleutian Islands. However, during pass 1 (Fig. 31a), most pollock were concentrated on the slope between Akun and Akutan Islands. In August, during the second pass through the area (Fig. 31b), pollock were more dispersed to the north and west of Akutan Island. Pollock in the horseshoe area were much larger than those observed elsewhere on the EBS shelf (Fig. 29) – averaging about 55-cm FL. Estimated abundance in the area was about the same for both passes; 0.060 million t during pass 1 and 0.058 million t during pass 2. Future surveys will include trackline extensions into this area.

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Table 1. Summary of sphere calibrations conducted before, during, and after the summer 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf and slope.

Date (GMT)	Location	Freq (kHz)	Water temp (°C) at Transducer[1]	Water temp (°C) at Sphere	Sphere Range from Transducer (m)	TS[2] Gain (dB)	SV[2] Gain (dB)	3dB Beam[2] Width (deg.)	Angle Offset[2] Along	Angle Offset[2] Athwart
30 Mar	Port Susan, WA	38	8.4	8.5	30.0	25.9	25.7	6.94	-0.07	0.05
		120	8.4	8.4	24.2	25.9	26.5	--	--	--
8 Jun	Ugak Bay, AK	38	6.5	4.2	32.1	25.6	25.5	6.94	-0.08	-0.01
		120	6.5	4.9	25.9	25.7	25.7	7.26	-0.17	0.22
7 Jul	Captains Bay, AK	38	6.7	4.0	30.6	25.7	25.5	6.91	-0.07	0.05
		120	6.7	4.5	24.0	25.5	25.5	7.40	-0.15	-0.04
4 Aug	Captains Bay, AK	38	6.8	4.6	28.4	25.8	25.4	6.95	-0.08	0.03
		120	6.8	5.0	22.4	25.6	25.6	7.45	0.04	-0.14
Jun-Aug	System settings during survey	38	--	--	--	25.7	25.5	6.90	-0.08	-0.01
		120	--	--	--	25.7	25.7	7.30	-0.17	0.22

[1] The transducer was located approximately 9 m below the water surface.

[2] Gain and beam pattern terms are defined in the "Operator Manual for Simrad EK500 Scientific Echo Sounder (1993)" available from Simrad Subsea A/S , Strandpromenaden 50, P.O. Box 111 N-3191 Horten, Norway.

Table 2. Pollock target strength data collection during the summer 1999 EIT survey of eastern Bering Sea shelf and slope.

Date (GMT)	Time (GMT)	Analysis depth (m)	Associated hauls	Percent pollock (fish nos.)	Percent pollock (wt.)	Mean Pollock length (cm)	(std. dev.)
20 Jun	0915-1355	40-125 (130)	17	100	99.9	36.7	3.0
			18	100	100	36.6	6.0
			19	100	99.8	35.4	4.0
30 Jun	1036-1254	30-60	44	97.9	91.8	42.2	3.5
			230				
12 Jul	1040-1241	60-120	59	99.9	98.9	47.8	3.9
			60	100	99.4	48.0	3.0
15 Jul	1209-1337	60-103	66	98.7	95.4	45.6	3.0
			67	99.3	94.2	46.1	3.0
16 Jul	1029-1232	60-109	71	100	87.1	42.2	5.2
			72	100	91	45.4	3.3
18 Jul	0004-0130	40-110	76	48.8	40.2	44.6	3.4
	0347-0542		77	100	97.5	38.0	5.4
			78	100	97.8	41.6	4.9
			239				
	1006-1309	*					
19 Jul	1135-1304	30-90	82	98.4	97.7	46.4	3.1
			83	99.8	91.9	47.0	3.9
			240				
20 Jul	1032-1253	60-95	84	94.6	93.2	48.6	3.6
			85	98.1	72.4	49.7	3.8
			241				
24 Jul	1105-1120	60-105	93	98.2	78.8	47.2	3.3
	1321-1453						
28 Jul	0950-1027	70-160	112	92.4	99.8	43.3	5.1

*no analysis yet

Table 3. Summary of conductivity-temperature-depth (CTD) casts conducted during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf and slope.

Cast number	Date	Drop time (GMT)	Drop position Latitude (°N)		Longitude (°W)		Station	Bottom depth (m)	Unit serial number
501	8 Jun	11:42	57	29.70	152	51.86	Ugak Bay calibration	64	647
502	9 Jun	20:50	54	57.47	156	48.68	transit, Gulf of Alaska	900	94
503	7 Jul	7:05	53	52.04	166	34.71	Captains Bay calibration	99	647
504	8 Jul	14:12	55	57.83	170	44.67	Transect 18.1	>1,500	94
505	19 Jul	7:06	61	5.79	174	56.70	Transect 23.0	93	94
506	19 Jul	22:47	62	31.83	175	20.10	Transect 23.0	80	647
507	20 Jul	1:17	62	13.30	175	57.97	Transect 24.0	92	647
508	24 Jul	17:16	61	54.48	176	34.56	Transect 25.1	105	647
509	24 Jul	19:45	61	35.47	177	10.33	Transect 26.0	117	647
510	28 Jul	6:36	61	17.36	177	45.84	Transect 27.0	142	647
511	28 Jul	9:09	60	58.42	178	19.95	Transect 28.0	164	647
512	30 Jul	5:12	60	39.77	178	55.78	Transect 29.0	257	647
513	4 Aug	3:36	53	51.65	166	34.84	Captains Bay calibration	87	647

Table 4. Trawl stations and summary of catch data from the summer 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf and slope.

Haul No.	Gear Type [1]	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Latitude (N)		Start position Longitude (W)		Depth (m) Gear	Depth (m) Bottom	Temp. (deg. C) Gear	Temp. (deg. C) Surface	MBT profile no. [2]	Pollock catch (kg)	Pollock catch (number)	Other catch (kg)
1	30	14 Jun	19:39	31	56	52.54	162	47.33	64	64	0.6	2.7	7	550.0	689	622.8
2	317	15 Jun	9:53	30	55	47.60	163	24.87	55	91	2.3	5.1	8	1,152.6	4,036	42.6
3	305	15 Jun	12:09	20	55	47.67	163	25.41	13	90	3.3	5.2	9	0.0	0	6.9
4	30	15 Jun	16:06	29	55	52.22	163	25.19	92	92	2.2	5.1	10	3,432.5	6,135	637.5
5	317	15 Jun	18:50	23	55	53.09	163	24.88	67	91	2.1	5.3	11	992.7	1,559	181.1
6	30	16 Jun	0:28	10	55	12.07	163	25.70	43	43	4	5.8	12	2,020.0	3,980	1,230.0
7	30	16 Jun	17:26	10	56	20.87	164	0.56	88	88	1.1	5.1	15	1,698.2	2,060	111.8
8	317	17 Jun	16:50	12	55	33.55	164	35.49	83	102	3	5.3	18	700.9	1,336	135.7
9	317	17 Jun	21:07	37	55	7.93	164	35.38	81	93	4.6	5.7	19	141.8	211	65.0
10	317	18 Jun	7:53	20	54	42.61	165	8.94	77	86	4.6	5.4	20	2,165.9	3,450	19.1
11	317	18 Jun	9:40	25	54	42.55	165	9.27	65	86	4.6	4.8	21	383.2	590	46.1
12	317	18 Jun	12:14	20	54	46.21	165	9.02	82	104	4.6	5.1	22	444.5	564	1.7
13	317	18 Jun	18:08	15	55	21.63	165	10.69	90	112	3.9	6	23	1,985.1	4,398	34.9
14	305	18 Jun	21:27	32	55	34.43	165	10.54	29	110	3.9	6.2	24	0.6	1	180.2
15	317	19 Jun	1:44	12	55	58.27	165	11.51	85	97	2.7	6.4	25	612.0	835	174.6
16	317	19 Jun	22:53	15	55	51.25	165	48.29	38	115	5.2	6.3	29	3.6	4	235.6
17	317	20 Jun	6:47	2	54	57.22	165	45.04	120	133	3.7	5.2	30	3,211.4	8,547	2.6
18	317	20 Jun	8:21	7	54	59.92	165	46.22	99	132	4.2	5.2	31	193.1	498	0.0
19	317	20 Jun	14:47	29	54	56.86	165	44.89	107	131	4.1	5.2	32	1,226.9	3,600	2.1
20	317	20 Jun	21:22	33	54	24.44	165	42.56	155	163	4.1	5.7	33	97.8	84	2.4

Table 4. Continued

Haul No.	Gear Type [1]	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Latitude (N)		Longitude (W)		Depth (m) Gear	Bottom	Temp. (deg. C) Gear	Surface	MBT profile no. [2]	Pollock catch (kg)	(number)	Other catch (kg)
21	317	21 Jun	0:56	60	54	26.76	165	43.41	160	348	4	5.9	34	204.8	187	0.0
22	317	21 Jun	9:30	11	54	38.54	165	27.15	139	189	4.7	4.2	35	60.2	67	0.0
23	317	21 Jun	10:42	16	54	38.86	165	27.22	181	184	4.1	5	36	293.4	332	3.5
24	317	21 Jun	21:40	7	54	49.00	166	1.52	152	163	3.4	5.9	39	2,274.3	5,097	5.7
25	30	22 Jun	21:03	8	54	1.56	166	52.10	318	418	4.7	5.4	--	0.9	1	18.4
26	317	23 Jun	19:11	35	56	16.29	166	25.17	98	108	1.8	6.8	44	1,605.4	2,662	104.6
27	317	24 Jun	18:10	20	56	35.74	167	3.14	90	101	2.3	6.5	48	1,075.1	3,202	112.2
28	305	24 Jun	21:21	30	56	19.20	167	1.72	15	116	--	6.6	49	0.0	0	64.1
29	317	25 Jun	5:09	27	55	20.64	166	57.51	104	141	3.5	6.3	50	2,680.4	7,706	9.6
30	317	25 Jun	21:28	20	55	56.02	167	36.08	118	133	3.5	6.7	54	8,060.6	23,406	139.4
31	317	26 Jun	3:22	27	56	41.06	167	40.50	90	102	2.3	7.2	55	7,000.0	30,620	0.0
32	317	26 Jun	8:38	6	57	10.60	167	43.21	73	76	2.6	6.8	56	520.8	628	30.5
33	305	26 Jun	19:40	18	57	45.71	168	13.66	44	71	2.4	5.6	58	0.0	0	7.7
34	30	26 Jun	21:48	15	57	51.86	168	25.56	71	71	2.2	5.7	59	3,051.4	4,413	498.6
35	317	27 Jun	9:46	25	57	25.62	168	22.75	65	73	2.5	6.5	60	708.8	932	21.0
36	317	27 Jun	11:45	15	57	20.28	168	21.74	69	69	2.8	6.5	61	926.6	1,326	20.7
37	317	27 Jun	18:44	21	56	57.62	168	19.81	77	84	2.5	6.6	63	1,283.7	2,717	166.3
38	317	27 Jun	23:36	10	56	41.58	168	18.68	89	107	2.3	6.9	64	1,981.1	6,121	48.9
39	317	28 Jun	10:18	15	55	59.60	168	12.92	145	151	3.4	7.1	65	311.2	388	0.0
40	317	29 Jun	1:34	1	56	24.35	168	52.10	111	118	3.1	7.2	68	1,526.0	3,459	34.0
41	30	29 Jun	8:32	30	57	21.95	168	58.97	71	71	2.2	6.8	69	898.7	1,551	551.3
42	317	29 Jun	10:46	18	57	21.93	168	59.24	61	73	2.2	6.5	70	721.0	1,320	30.5

Table 4. Continued

Haul No.	Gear Type [1]	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Latitude (N)		Longitude (W)		Depth (m) Gear	Bottom	Temp. (deg. C) Gear	Surface	MBT profile no. [2]	Pollock catch (kg)	(number)	Other catch (kg)
43	30	29 Jun	16:47	14	57	40.93	169	1.54	68	68	0.9	6.3	73	2,551.7	3,834	38.3
44	317	30 Jun	9:27	30	57	5.02	169	30.83	54	65	2.4	5.2	74	1,228.9	2,405	109.1
45	317	1 Jul	1:36	6	56	30.24	170	5.97	90	106	2.9	5.8	76	1,552.6	2,515	67.4
46	30	1 Jul	9:07	10	57	32.61	170	15.49	72	72	2.5	5.8	77	54.3	205	359.5
47	317	1 Jul	10:45	20	57	32.15	170	15.31	67	71	2.5	5.7	78	763.0	1,399	68.1
48	30	2 Jul	2:21	15	58	4.61	170	58.27	87	87	1.2	6	80	3,628.2	5,777	221.8
49	317	2 Jul	10:27	10	57	53.99	170	56.44	77	87	1.8	6.4	81	752.2	4,231	59.2
50	317	2 Jul	17:52	20	56	54.90	170	46.25	95	104	3	6	83	1,882.2	3,402	42.8
51	317	8 Jul	20:23	19	56	42.95	171	20.92	109	119	2.7	7.2	85	339.8	717	4.7
52	317	9 Jul	0:39	17	57	9.56	171	26.97	102	105	2.7	6.9	86	877.0	1,474	55.0
53	317	9 Jul	8:45	20	58	21.21	171	39.85	90	97	0.8	6.7	87	909.2	1,605	29.2
54	30	11 Jul	1:03	25	58	58.20	172	25.51	100	100	0.5	6.8	90	570.2	808	366.6
55	317	11 Jul	5:49	25	58	26.18	172	19.77	90	103	1.2	6.9	91	1,416.4	2,550	93.6
56	317	11 Jul	17:06	20	57	44.09	172	10.36	98	108	1.9	7.1	94	2,706.6	5,444	93.4
57	317	11 Jul	20:24	7	57	31.80	172	8.18	104	109	2.1	7.3	95	102.8	199	36.9
58	317	11 Jul	23:55	15	57	9.79	172	3.52	102	113	2.9	7.3	96	663.0	1,027	96.8
59	317	12 Jul	9:30	35	56	55.28	172	37.24	105	128	3.2	7.7	97	581.2	763	6.4
60	317	12 Jul	13:37	35	56	55.12	172	37.26	105	128	3.2	7.7	98	711.9	939	4.2
61	317	12 Jul	20:12	10	57	30.94	172	46.99	116	121	2.3	7.3	99	1,974.0	4,472	0.0
62	317	13 Jul	0:21	6	57	57.53	172	52.52	109	110	2.1	7.3	100	12,746.5	34,370	253.5
63	317	13 Jul	5:57	3	58	47.04	173	1.11	92	113	1.7	7.6	101	13,833.5	38,371	166.5
64	317	13 Jul	9:57	27	58	57.54	173	3.84	68	108	2.3	7.4	102	557.0	3,174	18.6

Table 4. Continued

Haul No.	Gear Type [1]	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Latitude (N)		Longitude (W)		Depth (m) Gear	Bottom	Temp. (deg. C) Gear	Surface	MBT profile no. [2]	Pollock catch (kg)	(number)	Other catch (kg)
65	317	14 Jul	12:01	12	63	1.91	173	58.65	69	76	-1.7	7.7	105	0.1	10	71.7
66	317	15 Jul	11:08	25	59	37.31	173	53.32	95	107	1.1	7.5	--	409.8	659	19.8
67	317	15 Jul	14:11	26	59	38.70	173	53.78	102	107	0.9	7.2	107	348.6	552	21.3
68	317	15 Jul	22:25	15	59	14.14	173	47.06	105	112	1.2	7.6	108	949.1	2,422	108.1
69	317	16 Jul	1:24	33	59	5.30	173	44.82	57	116	3.9	8.8	109	769.1	1,691	252.9
70	317	16 Jul	3:07	6	59	2.93	173	44.23	66	116	3.5	8.7	110	630.6	1,516	39.1
71	317	16 Jul	9:38	15	58	6.18	173	30.77	90	113	2.5	7.8	111	278.7	484	41.4
72	317	16 Jul	13:29	21	58	6.42	173	31.09	101	113	2.5	7.7	112	743.1	1,116	73.3
73	317	16 Jul	18:47	5	57	57.53	173	28.25	118	120	2.4	7.7	113	2,821.7	6,718	93.3
74	317	17 Jul	12:11	2	57	40.58	173	23.89	124	148	3	7.5	114	225.9	347	2.3
75	317	17 Jul	22:31	4	59	5.03	174	22.52	104	124	1.8	7.7	115	1,962.5	8,522	97.5
76	317	18 Jul	2:14	45	59	9.87	174	24.60	88	122	1.7	7.7	116	171.1	286	254.4
77	317	18 Jul	8:32	45	59	9.30	174	23.71	93	123	1.7	7.7	118	3,628.1	8,987	91.9
78	317	18 Jul	14:00	42	59	9.42	174	23.88	91	123	1.6	7.6	119	551.6	1,077	12.2
79	317	18 Jul	18:37	10	59	36.48	174	32.01	104	120	1.2	7.4	120	2,014.0	5,292	46.0
80	317	18 Jul	23:22	20	60	13.64	174	41.85	98	106	0.5	7.2	121	928.0	1,547	55.8
81	317	19 Jul	3:30	35	60	42.37	174	49.53	86	100	0.1	7.1	122	1,748.9	4,511	21.1
82	317	19 Jul	8:48	13	60	58.23	174	53.84	73	95	-0.9	6.7	123	1,529.7	2,333	36.3
83	317	19 Jul	13:43	17	60	59.31	174	54.18	88	94	-0.3	6.7	125	604.2	879	52.9
84	317	20 Jul	8:27	25	61	25.77	175	41.86	92	99	-1.1	6.9	127	736.2	1,015	53.3
85	317	20 Jul	13:42	31	61	28.01	175	42.13	91	98	-1.2	6.5	129	163.5	212	62.3
86	317	20 Jul	20:35	37	60	32.70	175	27.74	94	110	0.7	7.5	130	1,260.3	3,795	65.3

Table 4. Continued

Haul No.	Gear Type [1]	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Latitude (N)		Longitude (W)		Depth (m) Gear	Bottom	Temp. (deg. C) Gear	Surface	MBT profile no. [2]	Pollock catch (kg)	(number)	Other catch (kg)
87	317	21 Jul	16:44	1	57	52.70	172	55.40	112	113	2.3	7.8	131	1,003.4	2,193	27.4
88	30	23 Jul	3:00	30	58	30.79	175	30.98	147	147	2.4	7.2	132	31.8	1,585	312.3
89	317	23 Jul	10:36	20	59	29.88	175	24.94	115	137	1.9	7.9	133	221.2	612	14.0
90	317	23 Jul	18:56	12	59	56.07	175	56.94	126	133	1.7	7.8	136	853.5	2,593	7.3
91	317	23 Jul	23:28	18	60	30.78	176	7.90	109	122	1.1	7.3	137	1,022.1	3,334	77.9
92	317	24 Jul	3:52	20	61	4.51	176	19.01	98	113	0.4	7.3	138	496.3	755	50.2
93	317	24 Jul	12:10	33	61	31.14	176	30.09	101	110	-0.2	7	139	184.6	272	49.6
94	317	24 Jul	21:59	13	61	27.31	177	7.43	106	119	0.3	7.3	140	526.8	815	45.1
95	317	25 Jul	3:25	27	60	44.27	176	52.42	108	131	0.6	7.1	141	833.9	1,875	31.8
96	317	25 Jul	6:41	4	60	37.18	176	49.99	118	133	0.9	7.3	142	1,328.0	3,963	2.0
97	317	25 Jul	10:52	20	60	22.25	176	45.30	112	139	1.4	7.6	144	575.1	2,426	4.4
98	317	25 Jul	18:34	21	60	4.38	176	39.20	104	144	0.3	7.5	146	8.9	29	3.1
99	317	25 Jul	20:30	2	60	4.75	176	39.54	120	143	0.1	7.4	147	2,449.0	16,046	11.0
100	317	26 Jul	3:27	19	59	10.80	176	19.05	94	140	0.3	7.7	148	1,415.7	7,377	4.3
101	317	26 Jul	5:16	9	59	11.64	176	18.57	126	140	0.3	7.7	149	2,812.0	19,191	6.0
102	317	26 Jul	13:40	28	58	34.73	176	8.37	201	245	3.1	7.7	150	110.2	138	0.8
103	317	26 Jul	20:01	9	58	51.05	176	53.19	120	127	1.4	7.5	151	548.8	2,836	6.6
104	317	26 Jul	22:10	25	58	45.72	176	51.46	75	128	2.4	7.5	152	1.7	10	3.3
105	317	27 Jul	0:38	3	58	41.69	176	50.07	118	133	2.1	7.7	153	686.9	3,412	0.0
106	30	27 Jul	5:29	30	59	22.67	177	4.63	153	153	1.1	7.8	154	2,414.4	3,853	125.6
107	317	27 Jul	9:34	20	59	39.65	177	11.04	111	188	1.7	7.8	155	774.5	2,560	2.2
108	317	27 Jul	11:26	10	59	36.41	177	10.29	60	181	0.3	7.7	156	308.6	1,472	1.5

Table 4. Continued

Haul No.	Gear Type [1]	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Latitude (N)		Longitude (W)		Depth (m) Gear	Bottom	Temp. (deg. C) Gear	Surface	MBT profile no. [2]	Pollock catch (kg)	(number)	Other catch (kg)
109	317	27 Jul	16:40	2	59	33.55	177	8.09	142	158	1.9	7.5	158	2,170.9	9,863	4.1
110	317	27 Jul	18:52	11	59	46.75	177	13.67	54	145	0.8	7.7	159	1,985.7	14,342	4.3
111	317	28 Jul	4:42	25	61	11.34	177	43.41	133	144	0.3	7.4	160	913.9	1,272	8.0
112	317	28 Jul	12:22	20	60	53.99	178	18.73	134	166	0.4	7.4	161	393.9	692	0.8
113	317	28 Jul	23:41	18	59	50.27	177	54.74	129	144	0.7	7.7	164	1,133.8	7,761	0.0
114	317	29 Jul	7:13	20	58	48.76	177	31.33	125	141	2.7	7.7	165	435.2	2,405	0.0
115	317	29 Jul	9:15	25	58	51.23	177	31.72	89	138	2.8	7.4	166	1,889.4	7,607	6.6
116	30	29 Jul	23:39	30	59	55.61	178	35.80	142	142	0.6	7.1	167	1,006.6	1,877	638.6
117	317	2 Aug	22:21	13	55	3.39	164	52.79	95	104	6.3	7.6	168	176.0	187	403.2
118	317	9 Aug	4:48	21	58	36.41	172	57.26	101	112	2.3	8	169	528.6	1,552	101.0
119	30	10 Aug	1:51	2	59	2.69	175	4.55	132	132	2.2	7.6	170	947.8	1,499	10.4
120	317	11 Aug	10:23	25	59	2.88	175	2.20	122	132	1.3	7.7	171	839.7	1,710	13.2
121	317	12 Aug	0:36	20	59	3.78	174	56.28	126	129	2.1	8.3	172	891.6	2,277	3.0
122	317	13 Aug	0:48	8	59	34.00	176	20.23	109	137	0.2	7.7	173	961.9	4,740	1.3

[1] Gear type 317 = Aleutian wing trawl, 30 = 83/112 bottom trawl, and 305 = Marinovich trawl

[2] MBT (micro-bathythermograph) recorder = Brancker XL-200

Note -- gear depth is referenced to trawl foot rope.

Table 5. Methot trawl and bongo net stations from the summer 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf. Hauls 201-248 were Methot trawls and hauls 301-302 were bongo net tows.

Haul No.	Date	Time (GMT)	Duration (minutes)	Start Position Latitude (°N)		Start Position Longitude (°W)		Depth (m) Gear*	Depth (m) Bottom	Temp. (°C) Gear*	Temp. (°C) Surface	MBT No.
201	12 Jun	11:44	8	56	36.47	160	23.01	52	55	1.2	2.0	2
202	13 Jun	9:00	5	56	38.73	161	15.20	66	71	0.8	1.8	3
203	13 Jun	10:35	9	56	49.56	161	34.10	76	83	-0.1	2.6	4
204	14 Jun	9:47	7	56	20.32	162	49.32	73	79	1.4	4.6	5
205	14 Jun	11:33	8	56	2.92	162	49.65	72	81	1.9	4.8	6
206	16 Jun	10:12	9	56	23.51	163	43.00	77	85	1.1	5.0	13
207	16 Jun	12:02	13	56	23.85	164	14.90	75	85	0.9	4.8	14
208	17 Jun	10:43	9	56	12.74	164	35.69	83	91	1.4	5.3	16
209	17 Jun	12:00	13	56	2.99	164	25.08	85	93	1.5	5.3	17
210	19 Jun	9:03	6	57	19.15	165	14.17	63	69	-1.0	5.1	26
211	19 Jun	11:14	10	57	20.79	165	52.65	59	69	-0.3	4.9	27
212	19 Jun	13:11	13	57	0.78	165	50.39	63	73	-0.1	5.5	28
213	21 Jun	11:51	20	54	39.24	165	27.38	102	221	4.4	5.3	37
214	21 Jun	13:25	29	54	47.68	165	31.21	168	177	3.4	5.9	38
215	22 Jun	13:12	20	54	59.70	166	55.28	148	158	3.4	6.0	40
216	23 Jun	9:34	21	56	0.23	166	23.70	116	126	3.3	6.6	42
217	23 Jun	12:19	19	55	34.54	166	22.64	117	128	3.5	6.3	43
218	24 Jun	10:27	14	56	47.10	167	3.46	79	85	--	--	--
219	24 Jun	11:52	8	56	54.07	166	42.42	67	77	2.4	6.3	46
220	24 Jun	13:30	10	57	1.42	167	4.51	69	75	3.0	5.6	47
221	25 Jun	9:49	21	55	14.68	167	19.73	138	150	3.4	6.2	51
222	25 Jun	10:27	24	55	14.71	167	19.65	15	150	6.0	6.2	52
223	25 Jun	12:43	34	55	0.31	167	31.15	207	337	3.7	5.8	53
224	26 Jun	12:06	11	57	40.25	167	45.62	61	70	2.0	5.8	57
225	27 Jun	13:05	11	57	23.08	168	22.65	63	74	2.8	6.3	62
226	28 Jun	11:33	25	55	57.85	168	14.37	140	150	3.3	6.9	66
227	28 Jun	13:16	35	56	4.04	168	30.81	201	483	3.4	6.9	67
228	29 Jun	12:04	13	57	24.06	169	0.93	63	72	2.2	6.5	71
229	29 Jun	13:09	14	57	24.70	169	16.73	65	74	2.0	6.5	72
230	30 Jun	13:03	10	57	4.89	169	36.45	54	62	2.5	5.8	75
231	1 Jul	12:54	11	57	43.14	170	16.81	67	74	1.3	5.9	79
232	2 Jul	13:51	11	57	24.25	170	52.34	82	85	2.6	5.9	82
233	9 Jul	10:07	13	58	20.13	171	39.85	91	97	0.9	6.7	88
234	9 Jul	12:12	10	58	19.88	171	1.08	76	85	0.6	6.3	89
235	11 Jul	10:06	23	57	59.67	172	14.23	96	106	1.6	6.9	92
236	11 Jul	12:27	16	57	59.94	171	36.55	92	99	--	6.9	93
237	13 Jul	11:57	20	58	59.96	173	4.89	101	108	1.1	7.0	103
238	13 Jul	13:11	21	59	0.35	172	54.72	94	106	1.0	7.2	104

Table 5. Continued.

Haul No.	Date	Time (GMT)	Duration (minutes)	Start Position Latitude (°N)		Start Position Longitude (°W)		Depth (m) Gear*	Depth (m) Bottom	Temp. (°C) Gear*	Temp. (°C) Surface	MBT No.
239	18 Jul	6:26	29	59	8.99	174	24.35	117	124	1.7	7.7	117
240	19 Jul	10:59	10	60	58.82	174	51.32	55	94	-0.7	6.7	124
241	20 Jul	9:52	11	61	26.20	175	42.33	57	99	-1.5	6.9	128
242	23 Jul	11:55	11	59	29.87	175	25.09	70	137	1.6	7.7	134
243	23 Jul	13:36	17	59	20.20	175	44.80	109	138	1.9	7.6	135
244	25 Jul	9:23	23	60	21.60	176	45.16	130	140	1.6	7.4	143
245	25 Jul	12:58	27	60	19.70	176	23.15	125	131	1.6	7.7	145
246	27 Jul	12:25	34	59	38.05	177	10.37	186	197	2.5	7.9	157
247	28 Jul	14:49	28	60	54.38	178	18.72	153	166	0.4	6.7	162
248	28 Jul	16:04	28	60	54.05	178	19.86	153	167	0.4	6.7	163
301	15 Jun	3:57	9	56	32.53	163	28.30	71	80	--	4.6	--
302	1 Aug	6:48	8	56	52.07	163	32.92	66	71	--	8.7	--

* Maximum depth reached during the haul.

Table 6. Catch by species from midwater hauls (99 Aleutian wing trawls and one bottom trawl towed in midwater) conducted during Legs 1 and 2 of the 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf.

Common name	Scientific name	Weight (kg)	Percent	Numbers
walleye pollock	*Theragra chalcogramma*	135,878.3	96.3	398,949
chrysaora jellyfish	*Chrysaora* sp.	4,591.5	3.3	--
jellyfish unidentified	Scyphozoa	346.3	0.2	--
Pacific cod	*Gadus macrocephalus*	114.2	0.1	28
Pacific sleeper shark	*Somniosus pacificus*	32.3	<0.1	1
Arctic cod	*Boreogadus saida*	31.3	<0.1	933
rock sole	*Lepidopsetta* sp.	31.1	<0.1	78
Pacific halibut	*Hippoglossus stenolepis*	19.0	<0.1	2
smooth lumpsucker	*Aptocyclus ventricosus*	15.5	<0.1	9
yellowfin sole	*Limanda aspera*	14.6	<0.1	36
flathead sole	*Hippoglossoides elassodon*	7.8	<0.1	15
chum salmon	*Oncorhynchus keta*	5.4	<0.1	2
Greenland turbot	*Reinhardtius hippoglossoides*	5.4	<0.1	1
great sculpin	*Myoxocephalus polyacanthocephalus*	5.0	<0.1	1
arrowtooth flounder	*Atheresthes stomias*	4.7	<0.1	8
eulachon	*Thaleichthys pacificus*	3.1	<0.1	43
Pacific herring	*Clupea pallasi*	2.8	<0.1	10
magistrate armhook squid	*Berryteuthis magister*	2.4	<0.1	5
Pacific lamprey	*Lampetra tridentata*	2.3	<0.1	5
sturgeon poacher	*Podothecus acipenserinus*	1.6	<0.1	20
sculpin unidentified	Cottidae	1.5	<0.1	2
Alaska plaice	*Pleuronectes quadrituberculatus*	1.4	<0.1	1
Pacific ocean perch	*Sebastes alutus*	0.9	<0.1	1
squid unidentified	Teuthoidea	0.5	<0.1	10
rockfish unidentified	*Sebastes* sp.	0.4	<0.1	1
basketstarfish	*Gorgonocephalus eucnemis*	0.4	<0.1	1
northern shrimp	*Pandalus borealis*	0.3	<0.1	56
snail unidentified	Gastropoda	0.1	<0.1	2
Pacific sandfish	*Trichodon trichodon*	0.1	<0.1	1
poacher unidentified	Agonidae	0.1	<0.1	1
salps unidentified	Thaliacea	0.1	<0.1	1
Totals		141,120.3		400,223

Table 7. Catch by species from 14 bottom trawl hauls conducted during Legs 1 and 2 of the 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf.

Common name	Scientific name	Weight (kg)	Percent	Numbers
walleye pollock	*Theragra chalcogramma*	21,908.9	79.3	36,768
Pacific cod	*Gadus macrocephalus*	1,314.0	4.8	758
yellowfin sole	*Limanda aspera*	1,057.6	3.8	3,938
flathead sole	*Hippoglossoides elassodon*	629.7	2.3	1,939
unsorted shab	--	442.7	1.6	--
rock sole	*Lepidopsetta* sp.	412.9	1.5	2,105
starfish unidentified	Asteroidea	354.4	1.3	5,441
chrysaora jellyfish	*Chrysaora* sp.	337.0	1.2	46
tunicate unidentified	Ascidiacea	160.2	0.6	760
Alaska skate	*Bathyraja parmifera*	146.0	0.5	40
arrowtooth flounder	*Atheresthes stomias*	119.6	0.4	164
Alaska plaice	*Pleuronectes quadrituberculatus*	102.6	0.4	153
skate unidentified	Rajidae	81.5	0.3	13
hermit crab unidentified	Paguridae	79.4	0.3	1,254
basketstarfish	*Gorgonocephalus eucnemis*	78.1	0.3	303
Pacific halibut	*Hippoglossus stenolepis*	66.5	0.2	18
snail unidentified	Gastropoda	53.1	0.2	564
bivalve unidentified	Bivalvia	50.4	0.2	10
red king crab	*Paralithodes camtschaticus*	45.6	0.2	28
opilio tanner crab	*Chionoecetes opilio*	30.4	0.1	76
great sculpin	*Myoxocephalus polyacanthocephalus*	24.4	0.1	8
sea mouse unidentified	Aphroditidae	19.5	0.1	507
Greenland turbot	*Reinhardtius hippoglossoides*	17.6	0.1	6
giant wrymouth	*Cryptacanthodes giganteus*	12.5	<0.1	1
Tanner crab	*Chionoecetes bairdi*	12.1	<0.1	116
sea anemone unidentified	Actiniaria	11.6	<0.1	70
Aleutian skate	*Bathyraja aleutica*	9.3	<0.1	5
empty bivalve shells	Bivalvia	8.5	<0.1	7
bigmouth sculpin	*Hemitripterus bolini*	7.8	<0.1	3
searcher	*Bathymaster signatus*	6.5	<0.1	30
sponge hermit	*Pagurus brandti*	5.6	<0.1	60
sculpin unidentified	Cottidae	5.5	<0.1	6
rex sole	*Glyptocephalus zachirus*	5.1	<0.1	10
tanner crab unidentified	*Chionoecetes* sp.	3.0	<0.1	20
sturgeon poacher	*Podothecus acipenserinus*	2.6	<0.1	57
jellyfish unidentified	Scyphozoa	2.5	<0.1	13
empty gastropod shells	Gastropoda	2.3	<0.1	--
Pacific herring	*Clupea pallasi*	2.3	<0.1	10

Table 7. Continued.

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
starry flounder	*Platichthys stellatus*	2.0	<0.1	1
Neptune whelk unidentified	*Neptunea* sp.	1.8	<0.1	9
sponge unidentified	Porifera	1.5	<0.1	--
sea urchin unidentified	Echinoidea	1.5	<0.1	24
Pacific lyre crab	*Hyas lyratus*	1.3	<0.1	10
yellow Irish lord	*Hemilepidotus jordani*	0.9	<0.1	1
Pacific ocean perch	*Sebastes alutus*	0.9	<0.1	1
poacher unidentified	Agonidae	0.8	<0.1	15
tunicate unidentified	*Aplidium* sp.	0.5	<0.1	1
rockfish unidentified	*Sebastes* sp.	0.4	<0.1	1
eulachon	*Thaleichthys pacificus*	0.4	<0.1	5
shrimp unidentified	Decapoda	0.3	<0.1	63
wattled eelpout	*Lycodes palearis*	0.1	<0.1	3
northern shrimp	*Pandalus borealis*	0.1	<0.1	15
thorny sculpin	*Icelus spiniger*	0.1	<0.1	4
crangonid shrimp unidentified	Crangonidae	<0.1	<0.1	17
Totals		27,642.0		55,477

Table 8. Catch by species from 48 Methot trawl hauls conducted during the 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf.

Common name	Scientific name	Weight (kg)	Percent	Numbers
chrysaora jellyfish	*Chrysaora* sp.	362.7	93.1	1,015
euphausiid unidentified	Euphausiacea	22.3	5.7	--
jellyfish unidentified	Scyphozoa	2.9	0.7	354
walleye pollock (age 1+)	*Theragra chalcogramma*	1.1	0.3	2
Pacific lamprey	*Lampetra tridentata*	0.6	0.1	1
shrimp unidentified	Decapoda	<0.1	<0.1	11
salps unidentified	Thaliacea	<0.1	<0.1	8
age-0 fish unidentified	Osteichthyes	<0.1	<0.1	404
amphipod unidentified	Amphipoda	<0.1	<0.1	21
lanternfish unidentified	Myctophidae	<0.1	<0.1	5
comb jelly unidentified	Ctenophora	<0.1	<0.1	1
northern smoothtongue	*Leuroglossus schmidti*	<0.1	<0.1	1
squid unidentified	Teuthoidea	<0.1	<0.1	7
crab unidentified	Brachyura	<0.1	<0.1	1
age-0 flatfish	Pleuronectiformes	<0.1	<0.1	11
sawback poacher	*Sarritor frenatus*	<0.1	<0.1	1
sturgeon poacher	*Podothecus acipenserinus*	<0.1	<0.1	1
Totals		389.6		1,844

Table 9. Inventory (numbers of fish) of pollock biological samples and measurements collected during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf and slope.

Haul	Length	Maturity	Otoliths	Fish weight
1	689	136	103	136
2	344	73	73	73
4	366	66	56	66
5	426	51	0	51
6	336	108	108	108
7	375	115	56	115
8	380	108	108	108
9	211	83	59	83
10	318	43	43	43
11	304	55	55	55
12	310	77	77	77
13	371	75	75	75
14	1	0	0	0
15	309	84	51	84
16	4	4	0	4
17	387	87	50	87
18	354	79	38	79
19	435	70	0	70
20	84	57	57	57
21	187	54	54	54
22	67	0	0	0
23	332	66	66	66
24	375	86	50	86
25	1	0	0	0
26	354	57	57	57
27	512	87	87	87
29	386	103	56	103
30	297	49	49	49
31	600	176	50	176
32	295	35	35	35
34	411	52	52	52
35	307	43	43	43
36	367	46	46	46
37	319	47	47	47
38	390	45	45	45
39	350	38	38	38
40	643	71	50	71
41	367	50	28	50
42	414	55	55	55
43	348	55	0	55
44	329	42	28	42

Table 9. Continued

Haul	Length	Maturity	Otoliths	Fish weight
45	345	50	28	50
46	205	0	0	0
47	335	40	28	40
48	333	60	28	60
49	366	104	43	104
50	388	53	28	53
51	452	71	71	71
52	430	54	54	54
53	312	41	41	41
54	302	42	42	42
55	421	51	51	51
56	340	47	47	47
57	199	44	44	44
58	296	45	45	45
59	270	37	37	37
60	294	129	0	129
61	323	44	44	44
62	398	55	55	55
63	402	59	59	59
64	497	52	52	52
65	10	0	0	0
66	323	32	32	32
67	356	99	16	99
68	649	50	50	50
69	489	64	64	64
70	467	0	0	0
71	308	40	40	40
72	324	96	0	96
73	426	88	54	88
74	314	33	33	33
75	480	78	78	78
76	227	59	50	59
77	398	60	60	60
78	380	72	0	72
79	443	82	55	82
80	323	53	53	53
81	472	63	63	63
82	313	92	50	92
83	372	95	0	95
84	294	93	47	93
85	212	86	0	86
86	611	74	74	74
87	370	58	58	58
88	285	19	19	19
89	496	91	91	91
90	297	57	57	57

Table 9. Continued

Haul	Length	Maturity	Otoliths	Fish weight
91	344	65	65	65
92	369	55	55	55
93	272	184	48	184
94	335	47	47	47
95	405	54	54	54
96	411	53	53	53
97	523	76	54	76
98	29	0	0	0
99	578	70	70	70
100	442	52	52	52
101	432	0	0	0
102	138	68	52	68
103	428	50	50	50
104	10	0	0	0
105	402	50	50	50
106	294	41	41	41
107	296	50	50	50
108	367	25	25	25
109	481	51	51	51
110	714	55	55	55
111	356	44	44	44
112	293	172	53	172
113	688	58	58	58
114	450	50	50	50
115	326	40	40	40
116	578	43	43	43
117	187	0	0	0
118	471	145	0	145
119	408	117	0	117
120	394	92	0	92
121	475	118	0	118
122	266	39	0	39
238	1	0	0	0
Totals	42,365	7,304	4,946	7,304

Table 10. Inventory (numbers of fish) of biological samples collected for other research projects during the summer 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf and slope.

Haul	Pollock stomachs	Jellyfish predation study[1]	Genetics study on adult pollock	Cold pool study with age-1 pollock	Observer Program fish ID training	Pollock for study on seabird diet
1	18	X[4]	-	15	-	X
2	15	-	-	-	-	-
3	-	-	-	-	-	-
4	7	-	-	-	X	-
5	20	-	-	-	-	-
6	26	-	-	-	-	-
7	20	X	-	-	-	-
8	20	X	-	-	X	-
9	21	X	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	-	X	-
12	22	-	-	-	-	-
13	21	X	-	-	-	-
14	-	X	-	-	X	-
15	20	X	-	-	-	-
16	-	X	-	-	-	-
17	19	-	-	-	-	-
18	20	-	-	-	-	-
19	-	-	-	-	-	-
20	-	-	-	-	-	-
21	15	-	-	-	-	-
22	-	-	-	-	-	-
23	20	-	-	-	-	-
24	19	-	-	-	-	-
25	-	-	-	-	-	-
26	20	X	-	-	-	-
27	22	X	-	-	-	-
28	-	X	-	-	-	-
29	20	-	-	-	-	-
30	23	-	-	-	-	-
31	20	-	-	-	-	-
32	20	-	-	-	-	-
33	-	X	-	-	-	-
34	19	-	-	-	-	-
35	-	-	-	-	-	-
36	19	-	-	-	-	-
37	22	-	-	-	-	-
38	21	-	-	-	-	-
39	-	-	-	-	-	-
40	27	-	-	-	-	-

Table 10. Continued.

Haul	Pollock stomachs	Jellyfish predation study[1]	Genetics study on adult pollock	Cold pool study with age-1 pollock	Observer Program fish ID training	Pollock for study on seabird diet
41	-	-	-	-	-	-
42	20	-	-	-	-	-
43	9	-	-	-	-	-
44	15	-	-	-	-	-
45	20	-	-	-	-	-
46	-	-	-	-	-	-
47	15	-	-	15	-	X
48	16	-	-	-	-	-
49	20	-	-	10	-	X
50	10	-	-	15	-	X
51	22	-	-	-	-	-
52	21	-	-	-	-	-
53	21	-	-	-	-	-
54	20	-	-	-	-	-
55	20	-	-	-	-	-
56	20	-	-	-	-	-
57	-	-	-	-	-	-
58	20	-	-	-	-	-
59	19	-	-	-	-	-
60	20	-	-	-	-	-
61	23	-	-	-	-	-
62	20	-	-	-	-	-
63	20	-	-	-	-	-
64	-	-	-	-	-	-
65	-	-	-	10[2]	-	X[3]
66	20	-	-	-	-	-
67	20	-	-	-	-	-
68	20	-	-	-	-	-
69	20	-	-	-	-	-
70	-	-	-	-	-	-
71	19	-	-	-	-	-
72	20	-	-	-	-	-
73	21	-	-	-	-	-
74	20	-	-	-	-	-
75	20	-	-	-	-	-
76	20	-	-	-	-	-
77	20	-	-	-	-	-
78	20	-	-	-	-	-
79	20	-	-	-	-	-
80	20	-	-	-	-	-
81	20	-	-	-	-	-
82	16	-	-	-	-	-
83	20	X	-	-	-	-

Table 10. Continued.

Haul	Pollock stomachs	Jellyfish predation study[1]	Genetics study on adult pollock	Cold pool study with age-1 pollock	Observer Program fish ID training	Pollock for study on seabird diet
84	16	-	-	-	-	-
85	-	X	-	-	-	-
86	20	-	-	-	-	-
87	20	-	-	-	-	-
88	15	-	-	15	-	X
89	-	-	-	15	-	X
90	19	-	-	-	-	-
91	20	-	-	-	-	-
92	20	-	-	-	-	-
93	-	-	-	-	-	-
94	20	-	-	-	-	-
95	20	-	-	-	-	-
96	20	-	-	-	-	-
97	-	-	-	-	-	-
98	-	-	-	-	-	-
99	22	-	-	-	-	-
100	20	-	-	-	-	-
101	-	-	-	-	-	-
102	-	-	-	-	-	-
103	20	-	-	-	-	-
104	-	-	-	-	-	-
105	20	-	-	-	-	-
106	20	-	-	-	-	-
107	7	-	-	-	-	-
108	7	-	-	-	-	-
109	-	-	-	-	-	-
110	-	-	-	-	-	-
111	-	-	>100	-	-	-
112	-	-	-	-	-	-
113	-	-	-	-	-	-
114	-	-	-	-	-	-
115	-	-	-	-	-	-
116	-	-	-	15	-	X
Totals	1,549	14 hauls	>100	110	4 hauls	8 hauls

[1] Whole specimens frozen and/or bell diameters measured
[2] 15 Arctic Cod were collected along with pollock
[3] Just Arctic Cod were collected for seabird study in haul 65
[4] "X" indicates a collection was made, but numbers were not specified.

Table 11. Distribution of pollock between areas from summer echo integration-trawl surveys on the Bering Sea shelf, 1994-1999. Data are estimated pollock biomass between 14 m below the surface and 3 m off bottom. 95% confidence intervals on the acoustic data are indicated.

	Date	Area (nmi)^2	Biomass (million metric tons, top) and percent of total (bottom)			Total biomass (million metric tons)	95% confidence intervals (million metric tons)
			SCA	E170-SCA	W170		
Summer 1994	Jul 9-Aug 19	78,251	0.312 10.8	0.399 13.8	2.18 75.4	2.89	2.64-3.14
Summer 1996	Jul 20-Aug 30	93,810	0.215 9.3	0.269 11.7	1.83 79.0	2.31	2.15-2.48
Summer 1997	Jul 17-Sept 4	102,770	0.246 9.5	0.527 20.3	1.82 70.2	2.59	2.42-2.77
Summer 1999	Jun 7-Aug 5*	103,670	0.299 9.1	0.579 17.6	2.41 73.2	3.29	2.95-3.62

* Note: 4 weeks earlier than previous years' surveys

SCA = Sea lion Conservation Area

E170 - SCA = East of 170° W minus SCA

W170 = West of 170° W

Table 12. Estimated length composition (numbers, and biomass in metric tons) of pollock between 14 m below the surface and 3 m off bottom from Bering Sea shelf echo integration-trawl surveys, 1994-1999. No surveys were made in 1995 or 1998; 1999 estimates exclude fish from additional sampling in the "horseshoe area" between Unimak and 167° W long.

Length cm	1994 numbers	1994 biomass	1996 numbers	1996 biomass	1997 numbers	1997 biomass	1999 numbers	1999 biomass
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	12,000	<1
10	0	0	0	0	2,040,091	14	118,000	1
11	403,454	4	0	0	191,766	2	4,782,000	59
12	5,438,489	71	469,009	6	30,133,862	394	14,434,000	227
13	44,786,130	744	5,440,654	92	238,097,743	4,148	22,713,000	445
14	94,230,303	1,937	38,195,786	804	1,416,213,800	31,282	22,353,000	538
15	179,818,601	4,520	131,291,144	3,384	2,949,251,909	81,544	16,200,000	472
16	166,052,138	5,040	227,769,656	7,098	3,364,001,432	111,182	5,203,000	181
17	105,162,213	3,817	317,309,141	11,818	2,207,832,139	84,460	5,198,100	214
18	129,712,572	5,553	215,264,283	9,485	1,309,127,112	58,223	12,916,000	623
19	212,540,168	10,655	115,387,007	5,960	569,513,724	28,768	44,599,674	2,499
20	381,962,413	22,244	64,786,967	3,892	181,058,279	10,677	152,569,000	9,852
21	589,692,635	39,601	37,201,244	2,579	74,898,658	4,900	251,491,000	18,587
22	794,281,878	61,100	64,413,079	5,121	81,072,644	6,101	314,306,000	26,421
23	788,346,245	69,048	60,239,187	5,458	150,801,675	12,962	288,898,000	27,464
24	772,579,542	76,622	70,323,929	7,221	255,934,709	24,999	220,314,000	23,562
25	581,453,595	64,967	47,676,938	5,520	408,069,005	45,081	164,372,000	19,681
26	372,264,663	46,652	38,316,026	4,979	458,825,996	56,998	188,577,000	25,168
27	198,974,449	27,847	33,634,805	4,884	519,671,058	72,339	256,036,000	37,933
28	122,072,840	19,028	60,159,826	9,721	422,680,421	65,700	302,469,000	49,557
29	135,898,925	23,550	85,069,866	15,240	296,501,881	51,328	419,155,094	75,679
30	138,254,204	26,437	122,805,260	24,307	175,362,673	33,691	435,283,000	86,321
31	178,831,898	37,756	183,983,881	40,104	115,827,267	24,685	417,133,000	90,579
32	234,800,791	54,180	240,983,960	57,669	79,115,853	18,522	410,190,619	97,251
33	239,386,111	60,378	341,561,316	89,480	69,153,145	17,709	372,648,094	96,204
34	291,495,311	80,001	408,412,676	116,812	68,831,366	19,201	393,576,238	110,357
35	296,566,484	88,546	458,383,388	142,771	89,483,675	27,148	415,935,025	126,368
36	326,662,387	105,903	477,948,250	161,724	146,277,669	48,272	433,114,135	142,256
37	343,988,551	120,806	400,981,865	147,067	220,620,650	79,075	393,544,360	139,441
38	305,794,247	116,110	333,418,937	132,264	321,353,999	124,841	403,471,754	153,908
39	294,822,563	121,143	253,697,765	108,629	397,122,202	166,999	359,069,435	147,178
40	311,312,228	137,651	214,239,900	98,825	397,831,256	180,668	304,475,580	133,859
41	271,091,178	129,335	168,179,883	83,422	350,373,449	171,750	243,059,138	114,415
42	289,525,945	149,294	154,985,328	82,523	292,974,428	154,670	240,381,579	120,957
43	273,093,348	152,526	149,273,880	85,177	222,045,066	125,886	265,325,613	142,492
44	243,930,127	147,017	133,456,326	81,478	172,493,746	104,750	321,315,240	183,897

Table 12. Continued.

Length cm	1994 numbers	1994 biomass	1996 numbers	1996 biomass	1997 numbers	1997 biomass	1999 numbers	1999 biomass
45	256,581,267	166,444	117,958,530	76,937	125,076,374	81,320	328,569,201	200,114
46	216,089,020	149,720	103,478,353	71,999	93,201,588	64,736	304,970,590	197,389
47	177,931,447	131,130	98,391,677	72,930	74,746,108	55,323	238,840,411	164,067
48	148,147,507	115,921	94,287,281	74,352	59,369,545	46,750	182,908,334	133,183
49	73,109,657	60,566	83,667,405	70,102	45,505,504	38,100	122,899,083	94,742
50	66,743,098	58,531	79,868,730	71,016	40,225,664	35,728	88,162,787	71,872
51	33,152,175	30,462	72,517,408	68,346	33,097,316	31,145	60,415,087	52,026
52	30,346,604	29,789	60,208,703	60,080	31,717,275	31,560	42,151,711	38,303
53	18,152,585	18,463	50,892,246	53,710	29,586,587	31,087	33,020,441	31,630
54	15,675,954	16,856	38,438,723	42,859	23,911,828	26,500	26,896,129	27,130
55	18,572,945	21,296	25,630,381	30,163	19,765,603	23,075	16,140,838	17,129
56	11,047,085	13,207	14,067,686	17,456	14,582,953	17,914	9,257,989	10,327
57	9,522,816	11,943	7,648,570	9,998	10,614,767	13,712	9,400,500	11,013
58	4,849,080	6,368	7,684,916	10,573	8,598,728	11,671	5,680,904	6,984
59	2,955,222	4,167	3,016,960	4,365	5,980,507	8,530	3,238,590	4,174
60	3,472,708	5,001	4,712,509	7,163	3,450,368	5,155	3,039,256	4,104
61	6,625,433	10,199	2,877,304	4,591	4,579,765	7,172	2,401,173	3,394
62	1,394,820	2,285	1,790,793	2,998	1,554,685	2,550	2,120,946	3,135
63	710,356	1,196	284,053	498	2,010,470	3,448	616,704	953
64	485,146	844	590,027	1,084	470,101	843	573,697	925
65	1,858,892	3,382	850,982	1,637	811,152	1,531	927,283	1,562
66	771,212	1,467	349,784	704	315,348	617	1,421,100	2,497
67	970,292	1,929	658,978	1,386	1,268,513	2,622	477,890	876
68	1,455,438	3,021	0	0	193,823	413	297,000	567
69	0	0	0	0	586,331	1,351	294,000	585
70	1,925,093	4,349	0	0	99,347	230	0	0
71	485,146	1,142	107,149	267	0	0	1,000	3
72	970,292	2,380	0	0	0	0	107,000	238
73	485,146	1,239	0	0	48,456	126	156,000	362
74	0	0	0	0	0	0	0	0
75	485,146	1,340	0	0	0	0	36,000	90
76	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0
78	485,146	1,503	0	0	0	0	0	0
79	0	0	0	0	0	0	387,000	1,118
80	0	0	0	0	0	0	0	0
Total	10,820,685,348	2,888,217	6,525,242,306	2,312,724	18,686,155,051	2,594,175	9,600,647,321	3,285,138

Table 13. Estimated age composition (numbers and biomass in metric tons) of pollock between 14 m below the surface and 3 m off bottom from summer Bering Sea shelf echo integration-trawl surveys, 1991-99.

age	1991 numbers	1991 biomass	1994 numbers	1994 biomass	1996 numbers	1996 biomass	1997 numbers	1997 biomass	1999 numbers	1999 biomass
1	639,267,538	23,287	610,179,216	17,145	972,336,344	36,729	12,359,975,135	417,793	111,865,503	3,292
2	5,942,329,255	761,659	4,781,070,859	425,278	446,396,599	35,346	2,745,213,184	369,889	1,587,614,967	156,582
3	967,026,421	177,102	1,336,016,997	312,406	520,371,331	118,661	386,231,751	99,481	3,596,956,974	847,384
4	214,547,946	74,684	1,655,749,641	641,253	2,686,481,600	888,844	490,934,742	188,606	1,683,593,411	640,179
5	224,129,227	117,402	1,898,148,804	1,067,206	820,736,359	395,993	1,921,457,657	920,972	582,565,536	271,735
6	133,045,368	82,075	296,098,661	187,194	509,295,056	341,780	384,350,572	235,012	273,945,610	164,348
7	119,732,088	89,228	71,188,880	50,142	434,354,034	359,912	205,223,678	161,266	1,169,058,192	751,526
8	38,685,293	31,354	65,181,763	55,332	84,868,860	72,471	142,456,226	139,477	400,235,038	278,937
9	37,037,006	35,670	31,894,001	30,906	16,722,781	16,254	32,713,336	34,217	104,643,576	84,612
10	14,667,193	16,855	23,150,815	26,354	6,274,944	6,567	3,876,643	4,441	66,873,683	62,513
11	16,038,739	19,283	8,533,707	10,512	5,698,888	6,906	4,934,766	6,117	14,464,537	14,229
12	5,275,012	7,041	19,274,752	27,856	12,145,110	17,082	2,010,470	3,448	6,471,546	7,184
13	7,862,405	8,275	4,794,652	6,731	1,307,937	1,532	2,209,210	4,493	1,670,280	1,497
14	4,588,258	4,401	5,660,366	7,679	4,783,178	7,035	2,281,822	3,817	0	0
15	2,035,526	2,040	1,158,244	2,111	2,385,493	3,807	2,020,927	2,876	135,694	175
16	1,459,803	1,913	7,917,902	12,521	540,919	905	0	0	135,694	175
17	380,810	375	3,945,915	4,804	0	0	0	0	0	0
18	679,082	632	0	0	540,919	905	0	0	421,866	711
19	0	0	718,233	798	0	0	0	0	0	0
20	0	0	0	0	0	0	262,924	277	0	0
21	380,810	375	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
Total	8,369,167,780	1,453,653	10,820,683,408	2,886,228	6,525,240,352	2,310,729	18,686,153,043	2,592,182	9,600,652,107	3,285,079

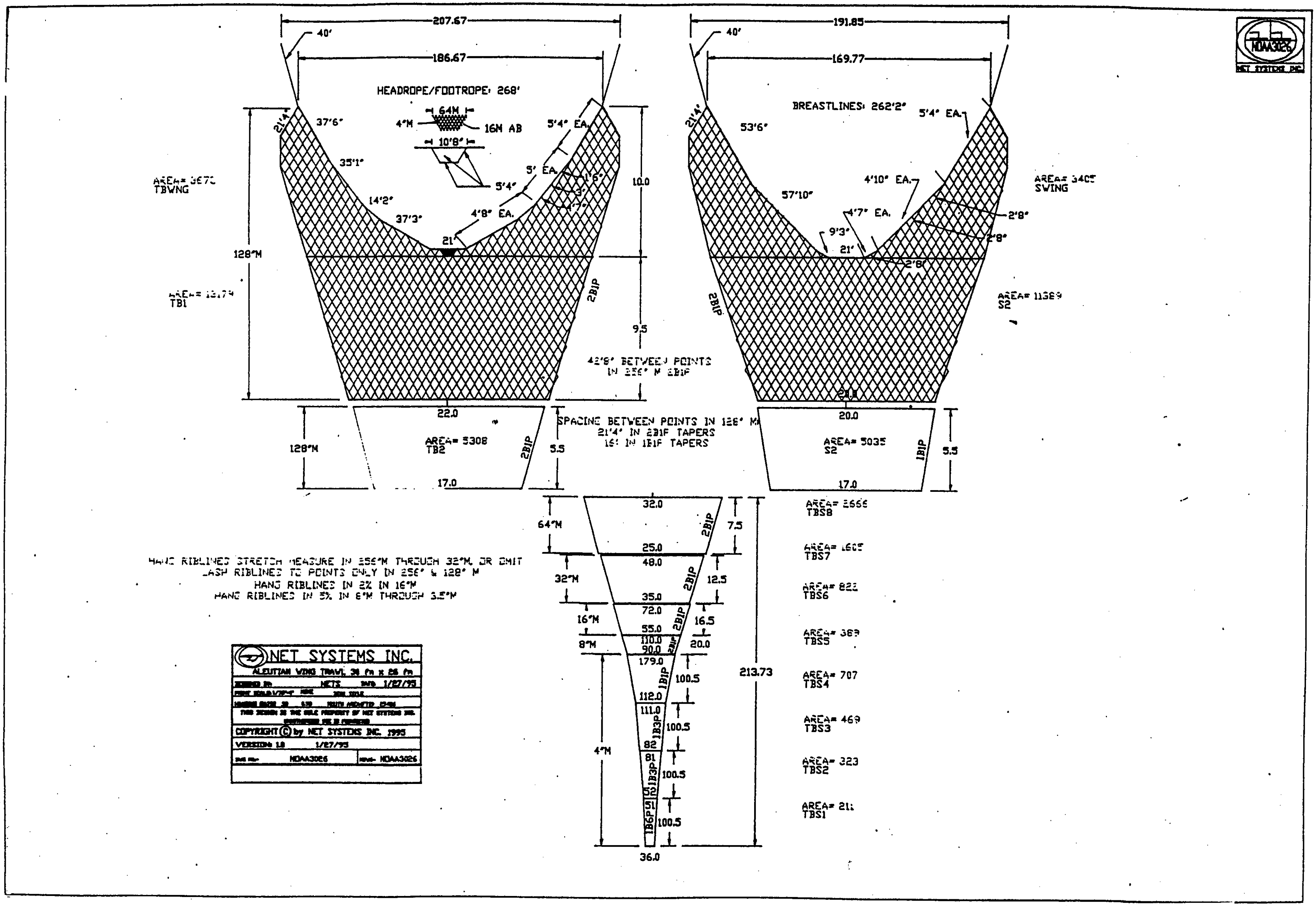


Figure 1. Diagram of the Aleutian Wing Trawl (AWT) used during the summer 1999 echo integration-trawl survey of the Bering Sea shelf and slope.

83/112 EASTERN

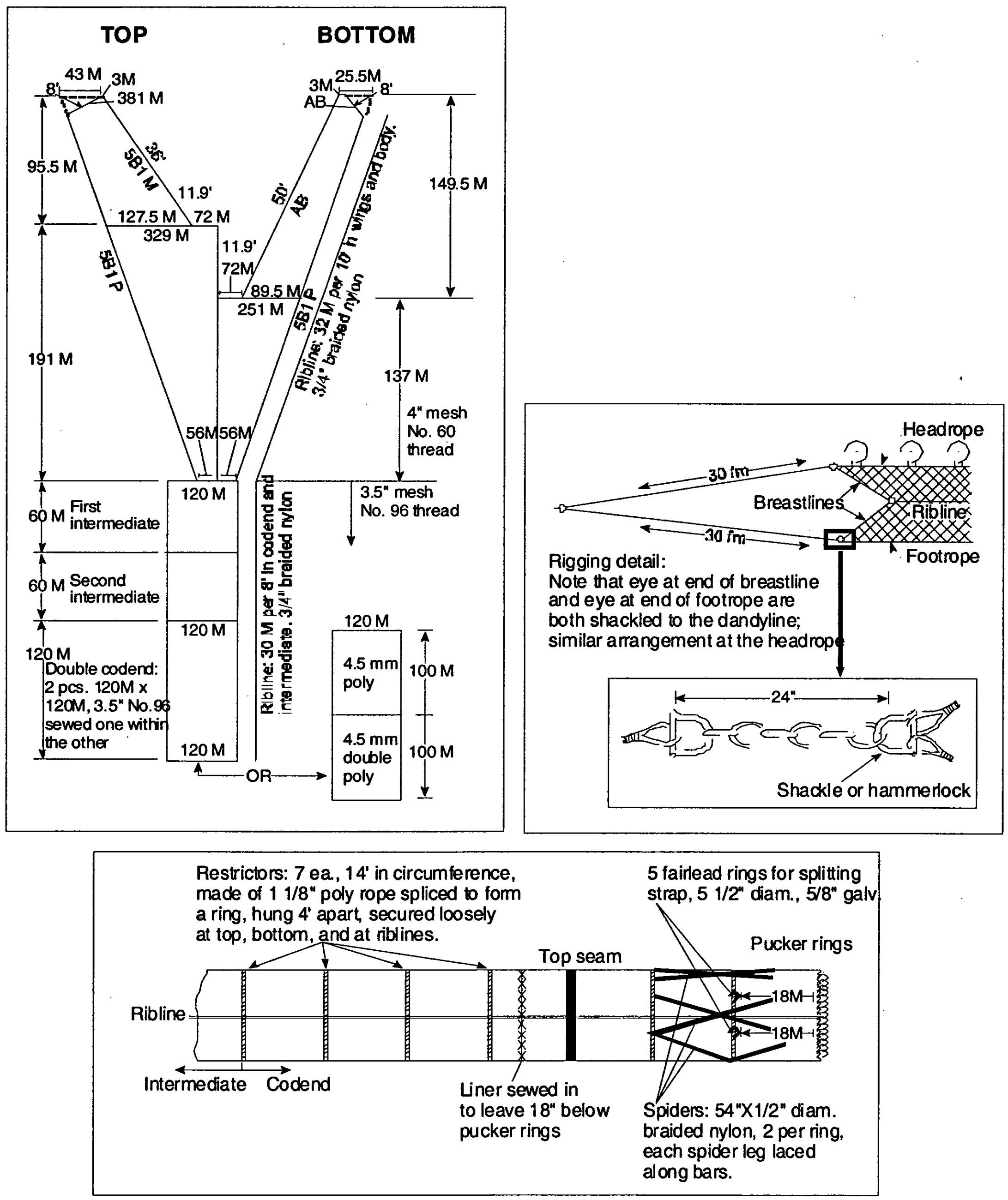


Figure 2.--Diagram of the 83/112 eastern bottom trawl used during the 1999 summer echo integration-trawl survey of the Bering Sea shelf and slope.

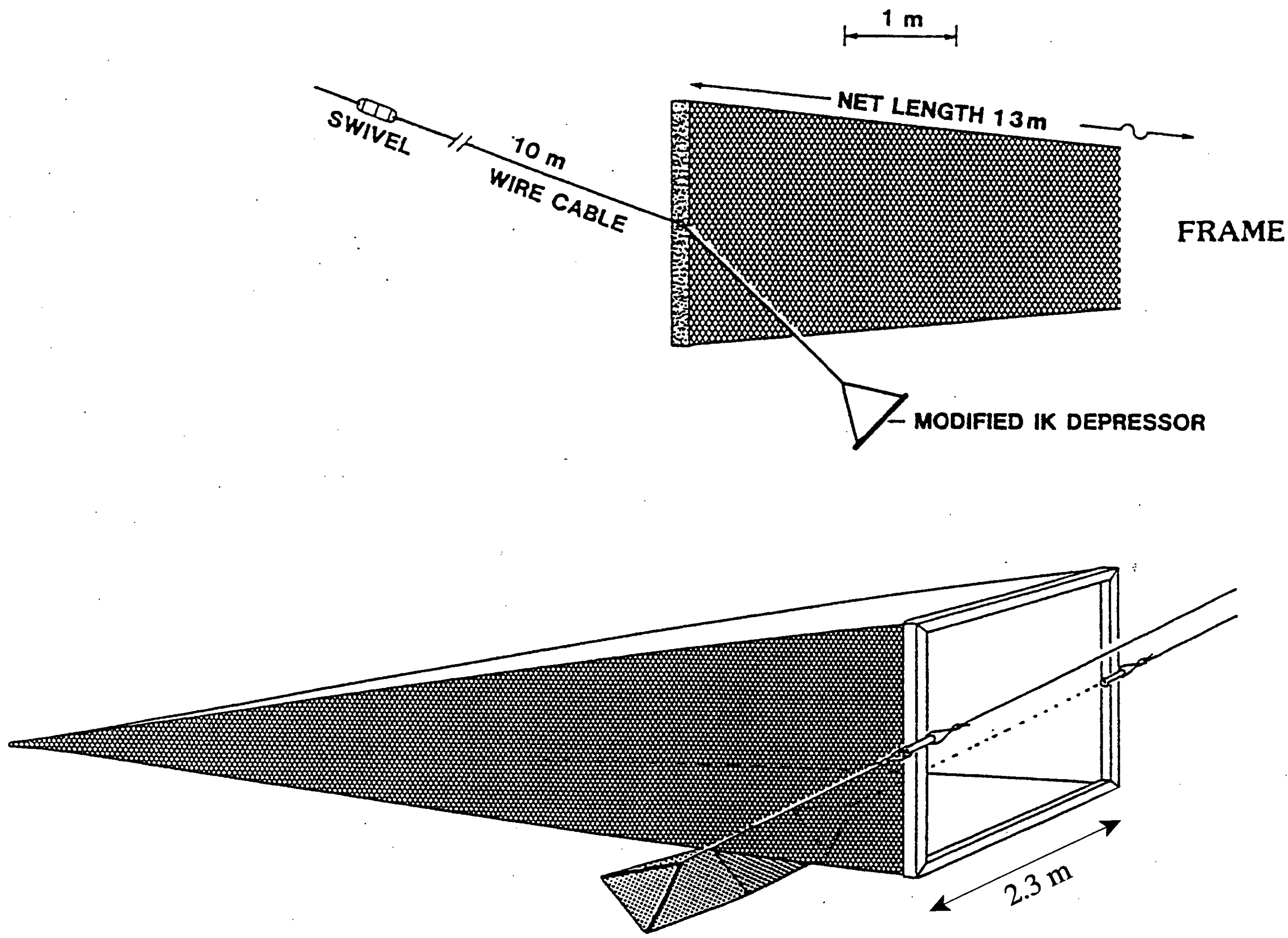


Figure 3. Diagram of the Methot trawl used during the summer 1999 echo integration-trawl survey of the Bering Sea shelf and slope.

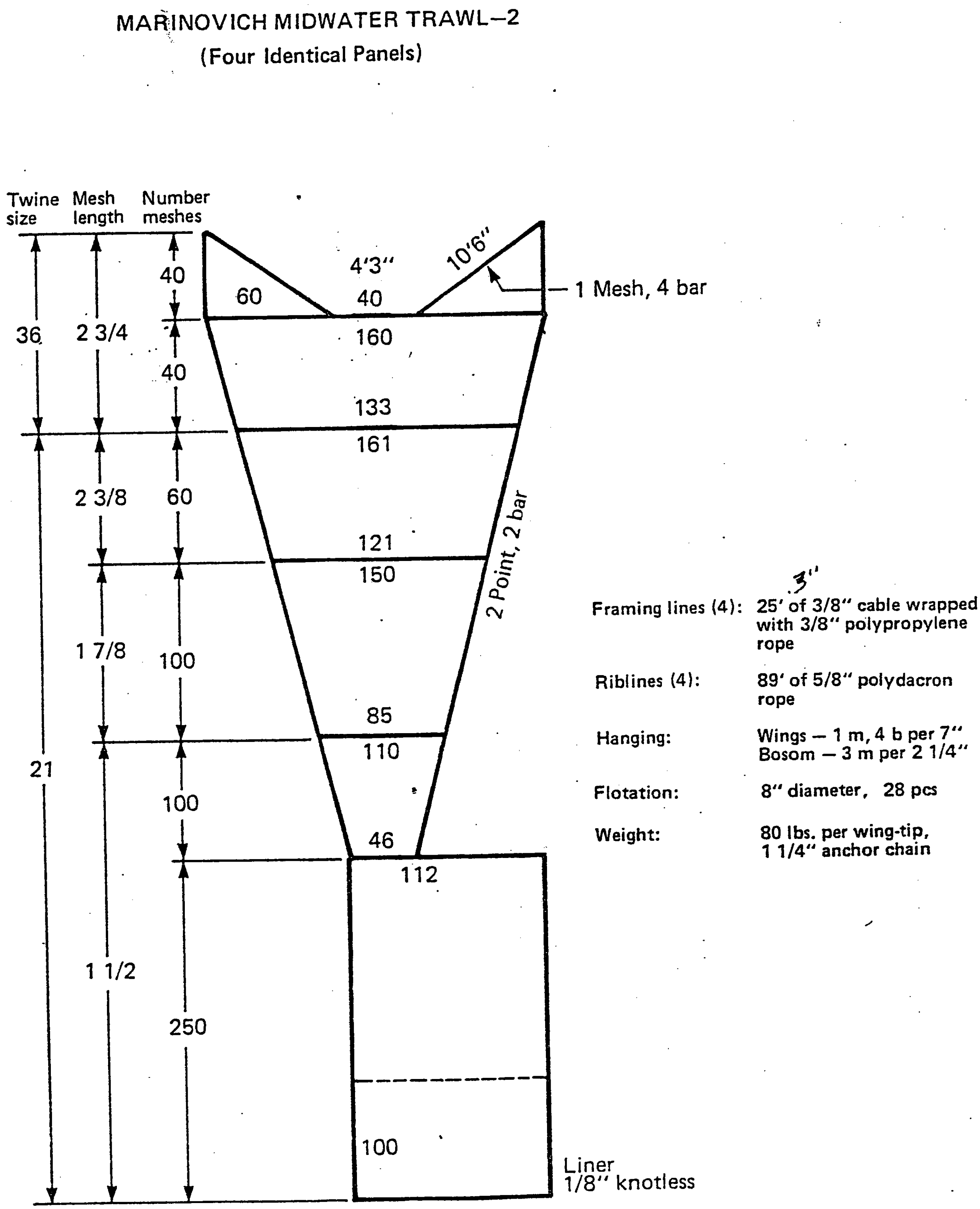


Figure 4. Diagram of the Marinovich trawl used during the summer 1999 echo integration-trawl survey of the Bering Sea shelf and slope.

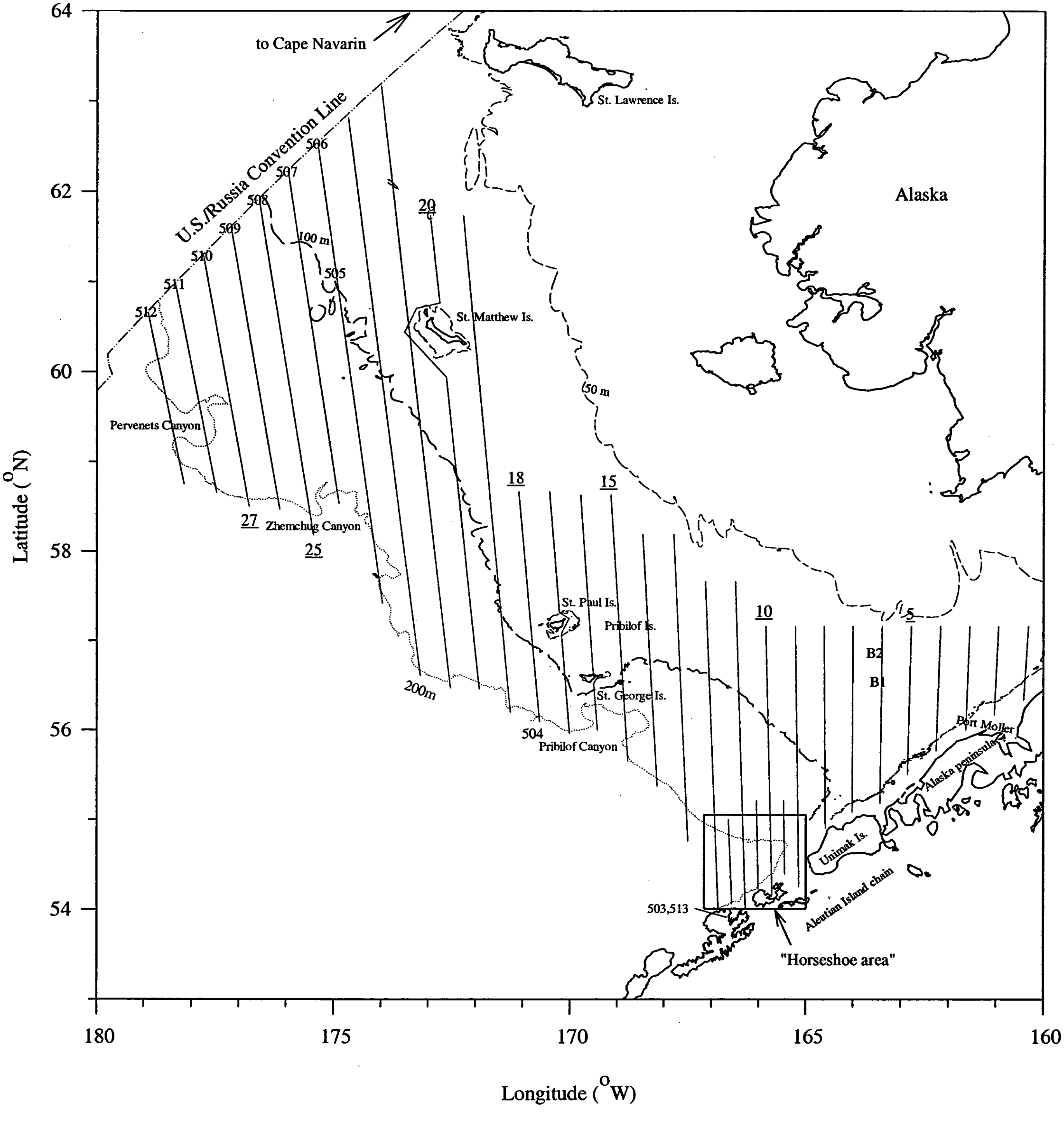


Figure 5. Transect lines from the summer 1999 pollock echo integration-trawl survey, with CTD cast locations. Underlined numbers indicate transect sequence. "B" indicates a CTD done in conjunction with a Bongo net tow. CTD 501 was in Ugak Bay, Kodiak Island, Alaska, and 502 was southeast of Kodiak Island.

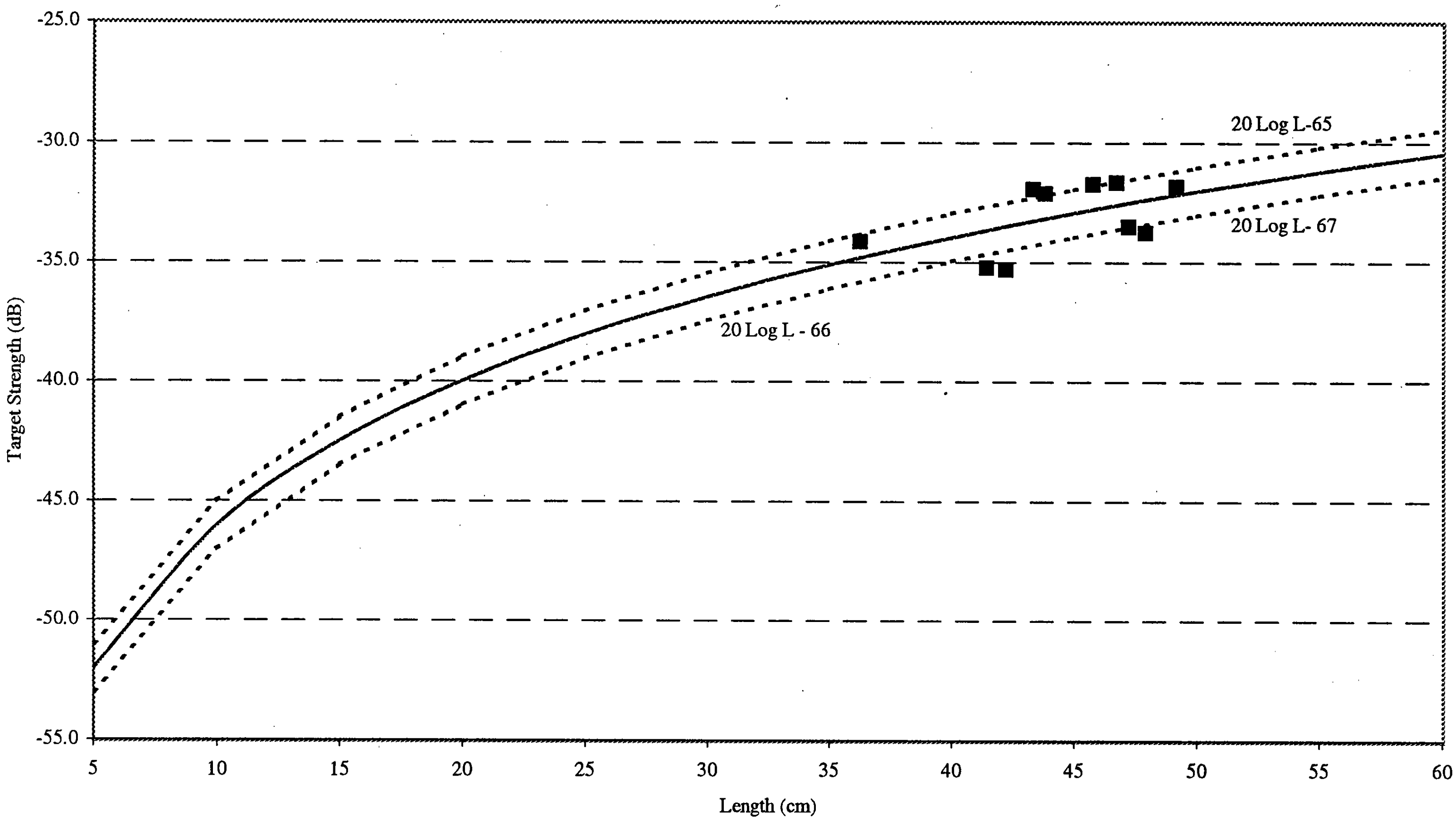


Figure 6. Preliminary results of in situ target strength measurements of pollock collected during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf and slope. For reference, TS=20 Log L -66 curve (solid line) is plotted along with TS=20 Log L-65 and TS = 20 Log L-67 curves (dashed lines).

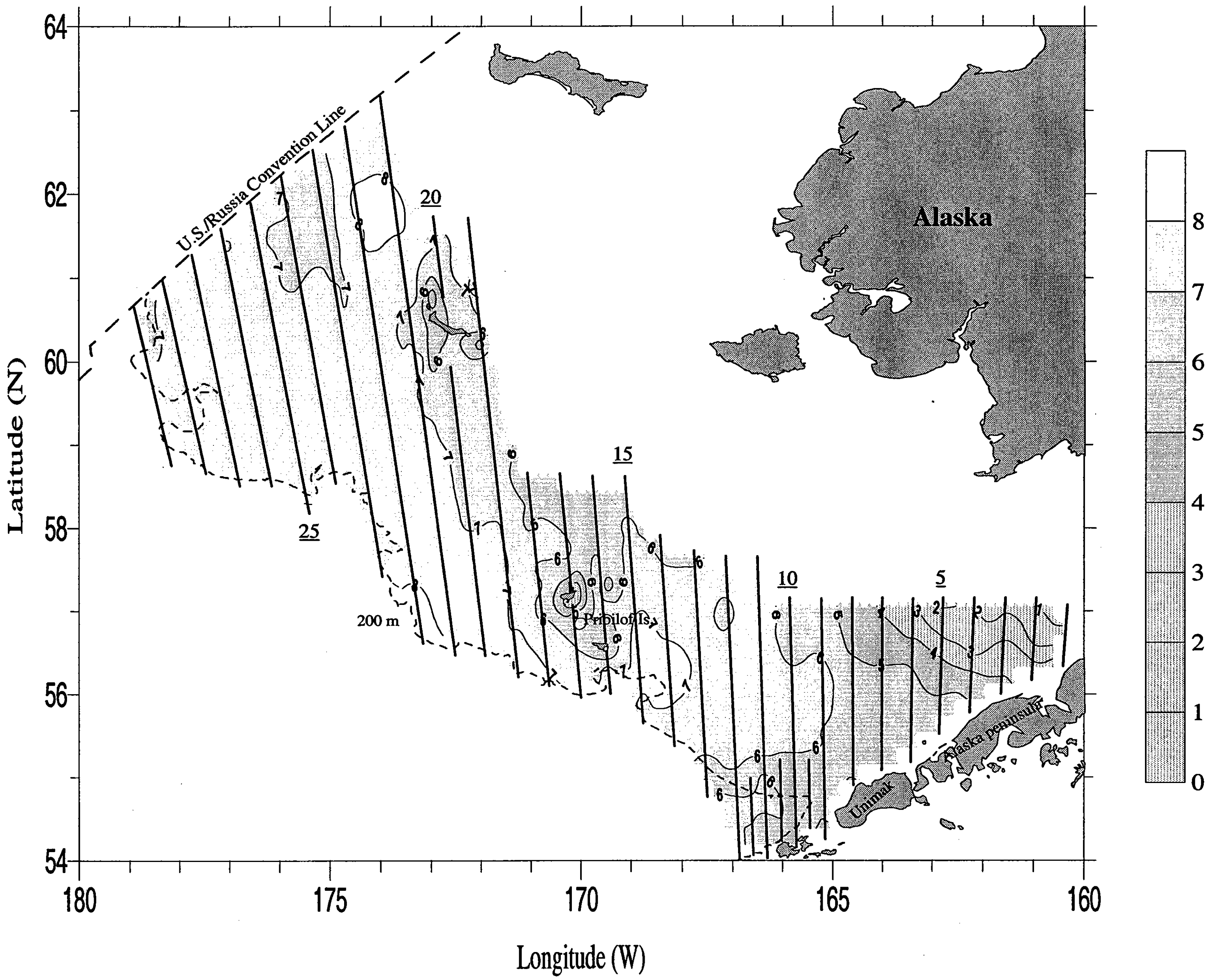


Figure 7. Transect lines with surface temperature contours (in degrees C) during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Underlined numbers indicate transect sequence.

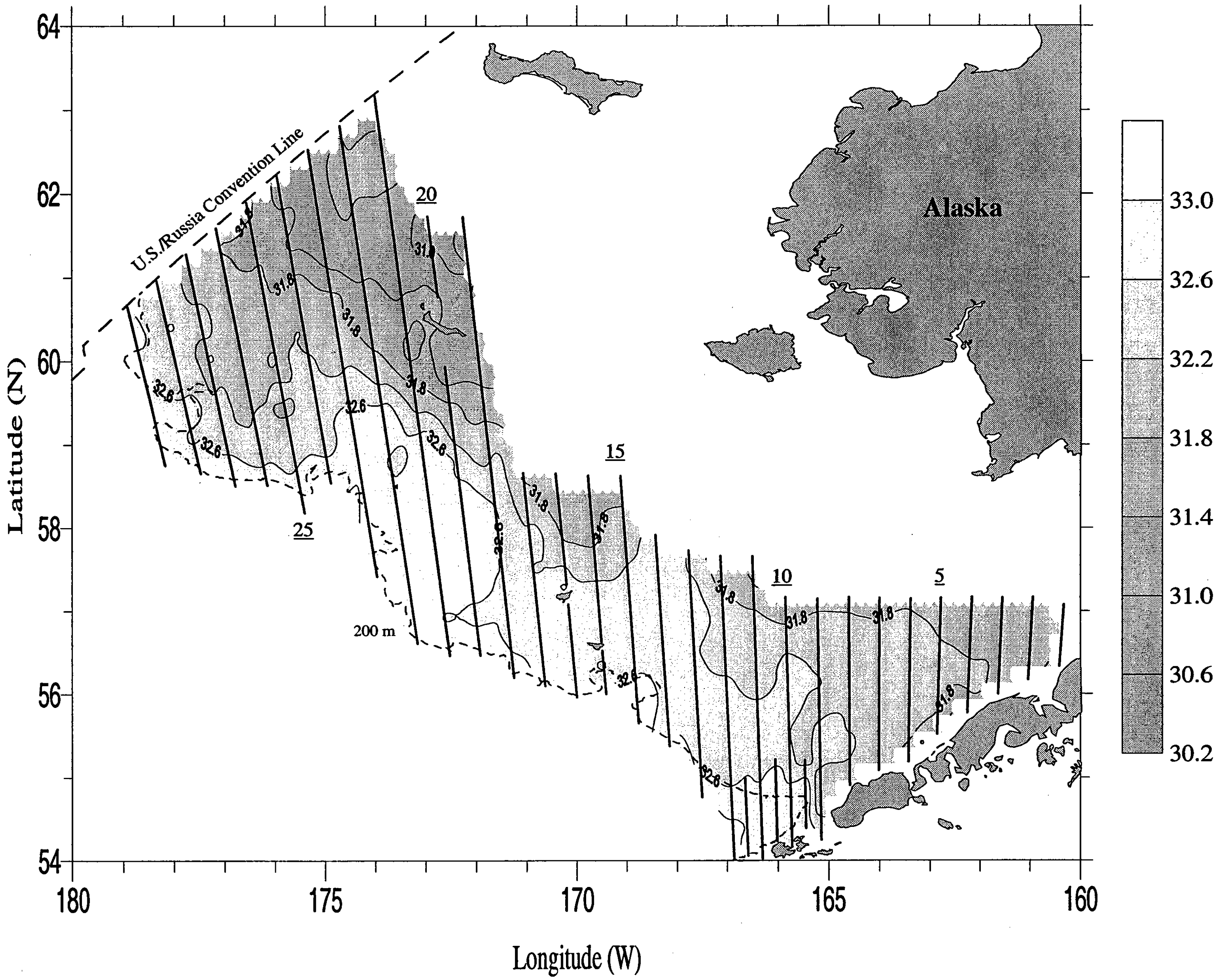
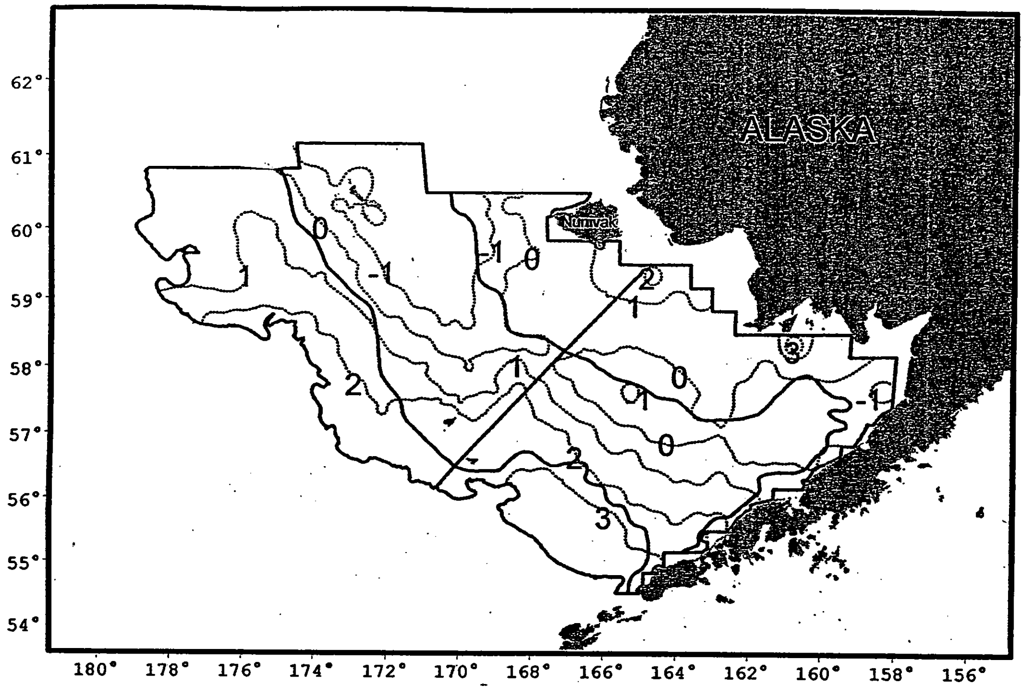


Figure 8. Transect lines with surface salinity contours (in ppt) during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Underlined numbers indicate transect sequence.



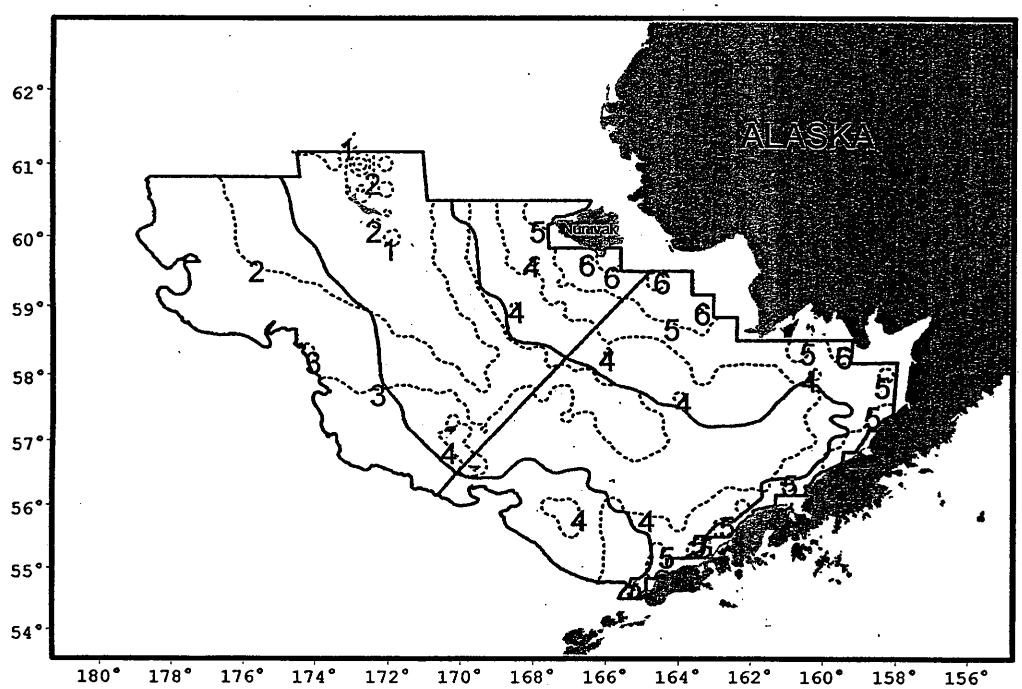


Figure 9. Near bottom water temperatures (°C) observed during the summer 1999 (top) and summer 1998 (bottom) eastern Bering Sea crab and groundfish surveys. (T. Sample, pers. commun. Alaska Fisheries Science Center, Seattle, WA 98115).

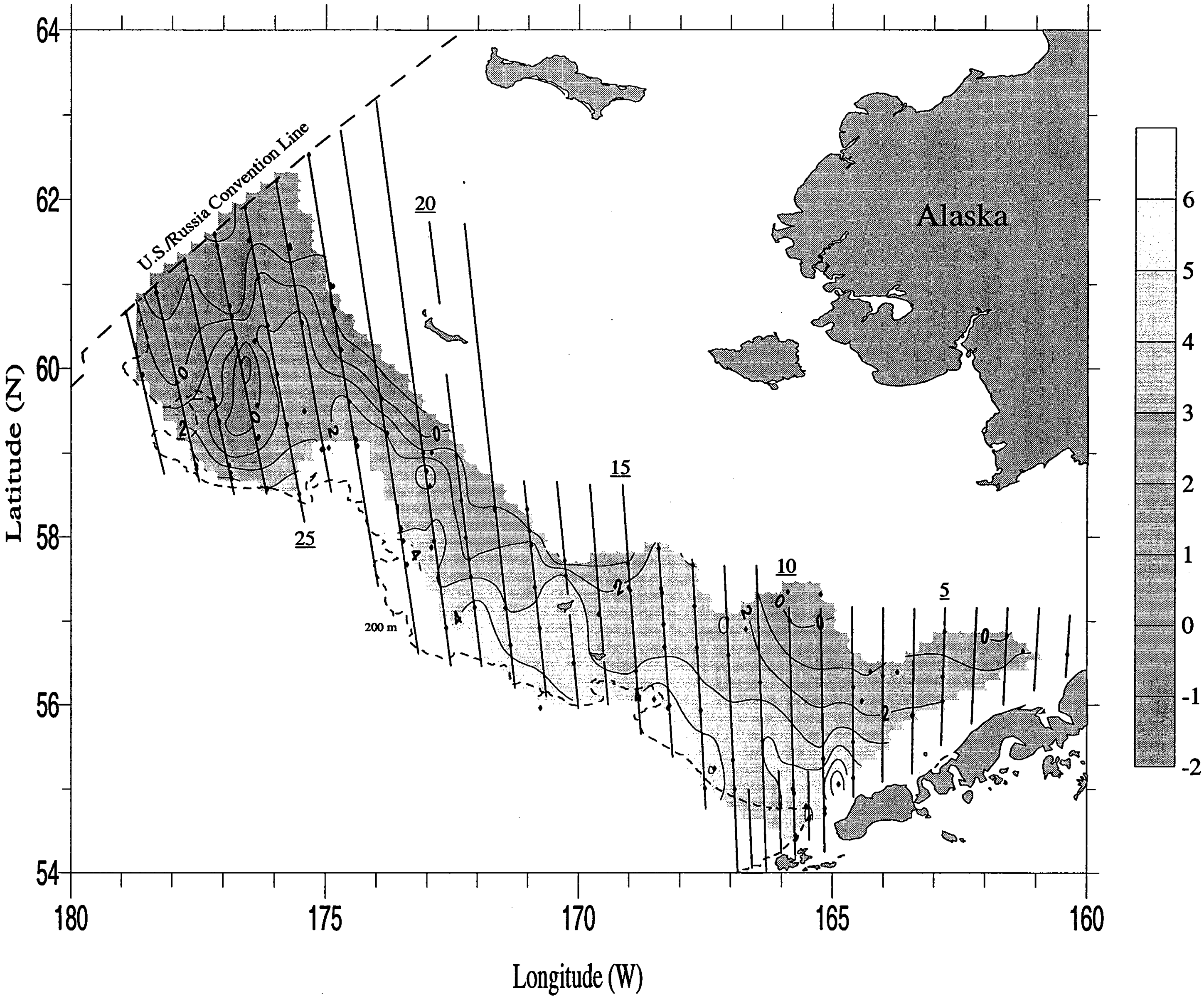


Figure 10. Transect lines with temperature contours at 50-m water depth (degrees C) during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Underlined numbers indicate transect sequence, and diamonds indicate locations of vertical temperature profiles.

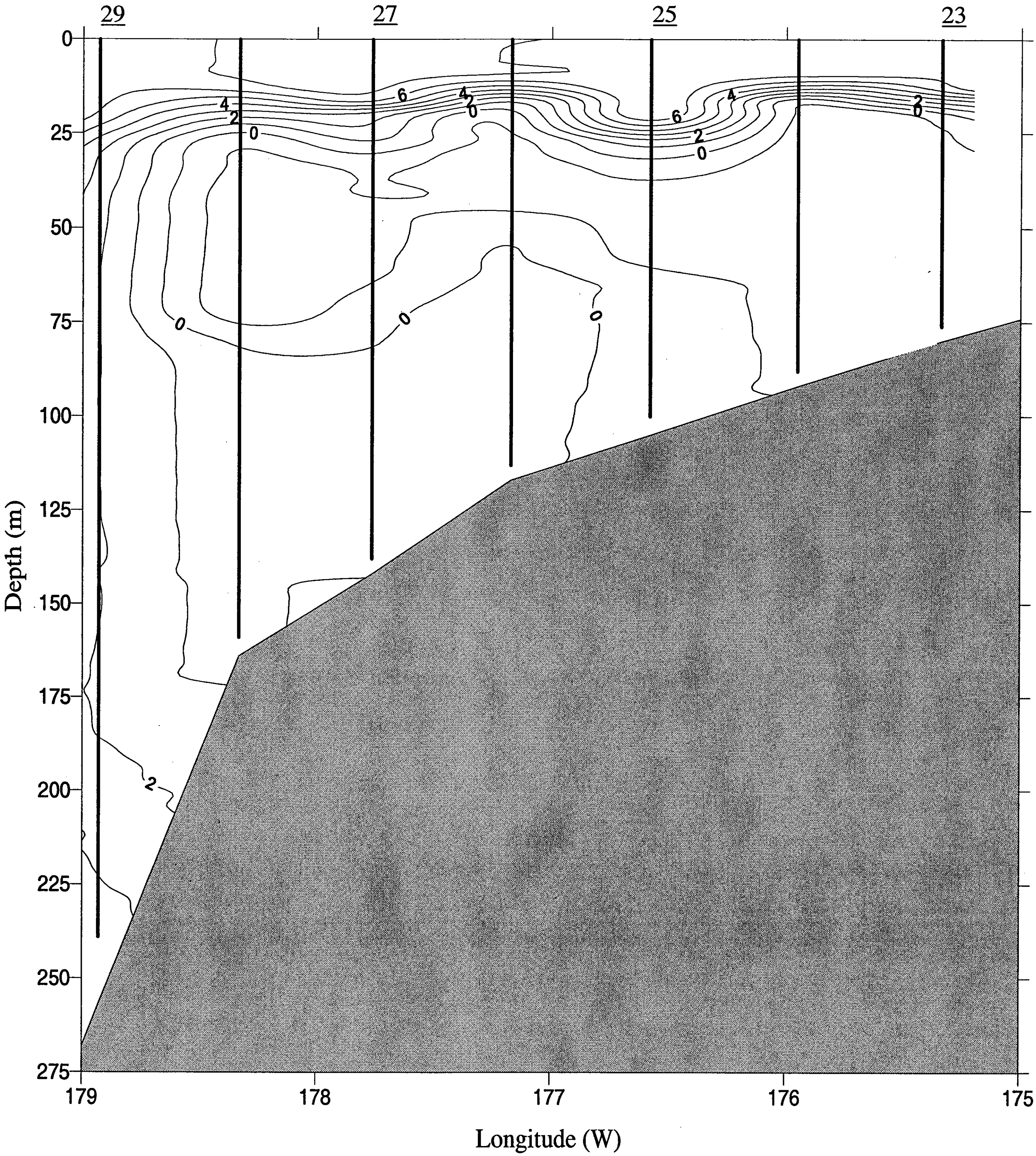


Figure 11. Water column temperature profile (degrees C) along the U.S./Russia Convention Line during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Vertical lines represent CTD casts taken at northern extents of transects whose sequence is indicated by underlined numbers.

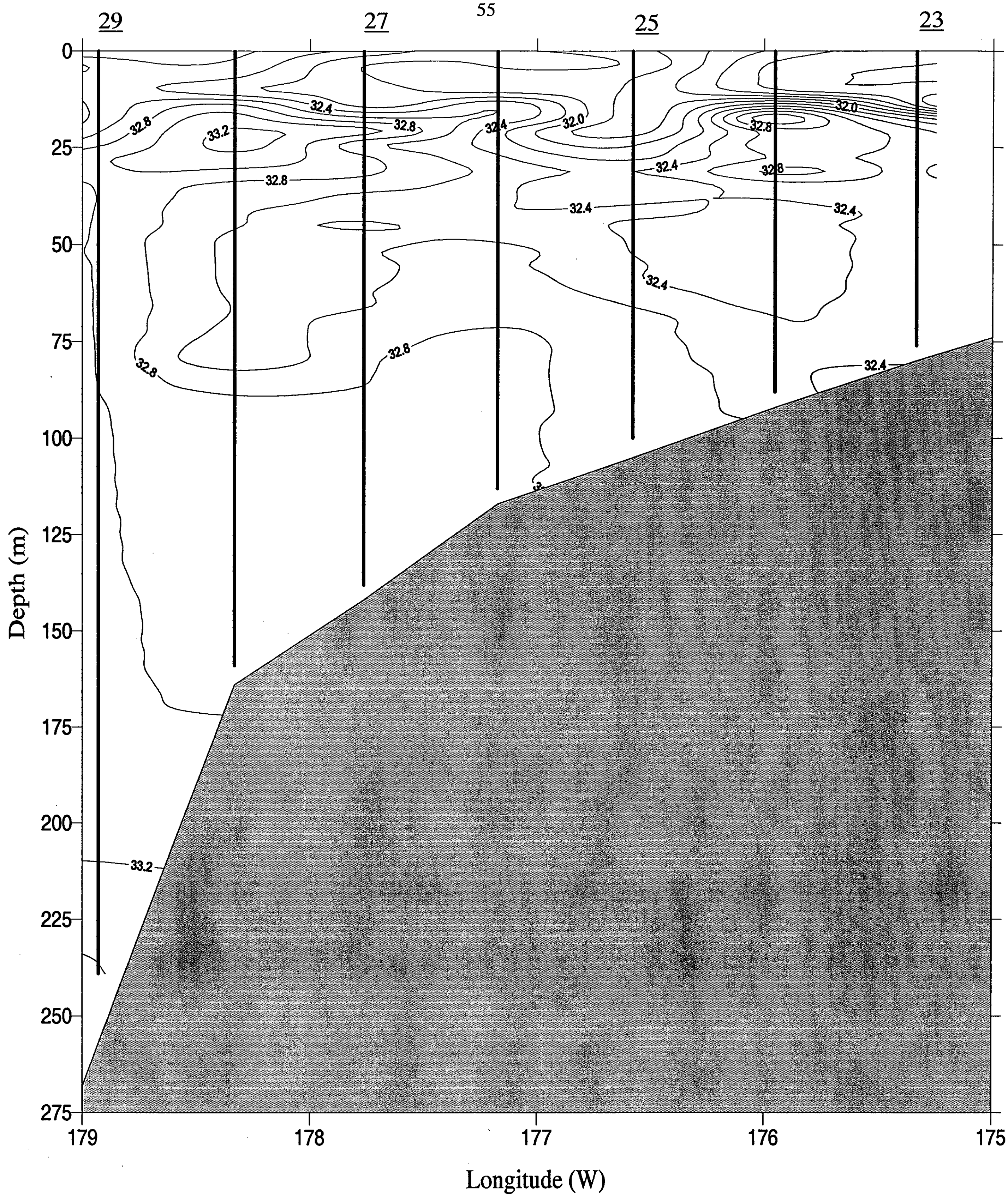


Figure 12. Water column salinity profile (ppt) along the U.S./Russia Convention Line during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Vertical lines represent CTD casts taken at northern extents of transects whose sequence is indicated by underlined numbers.

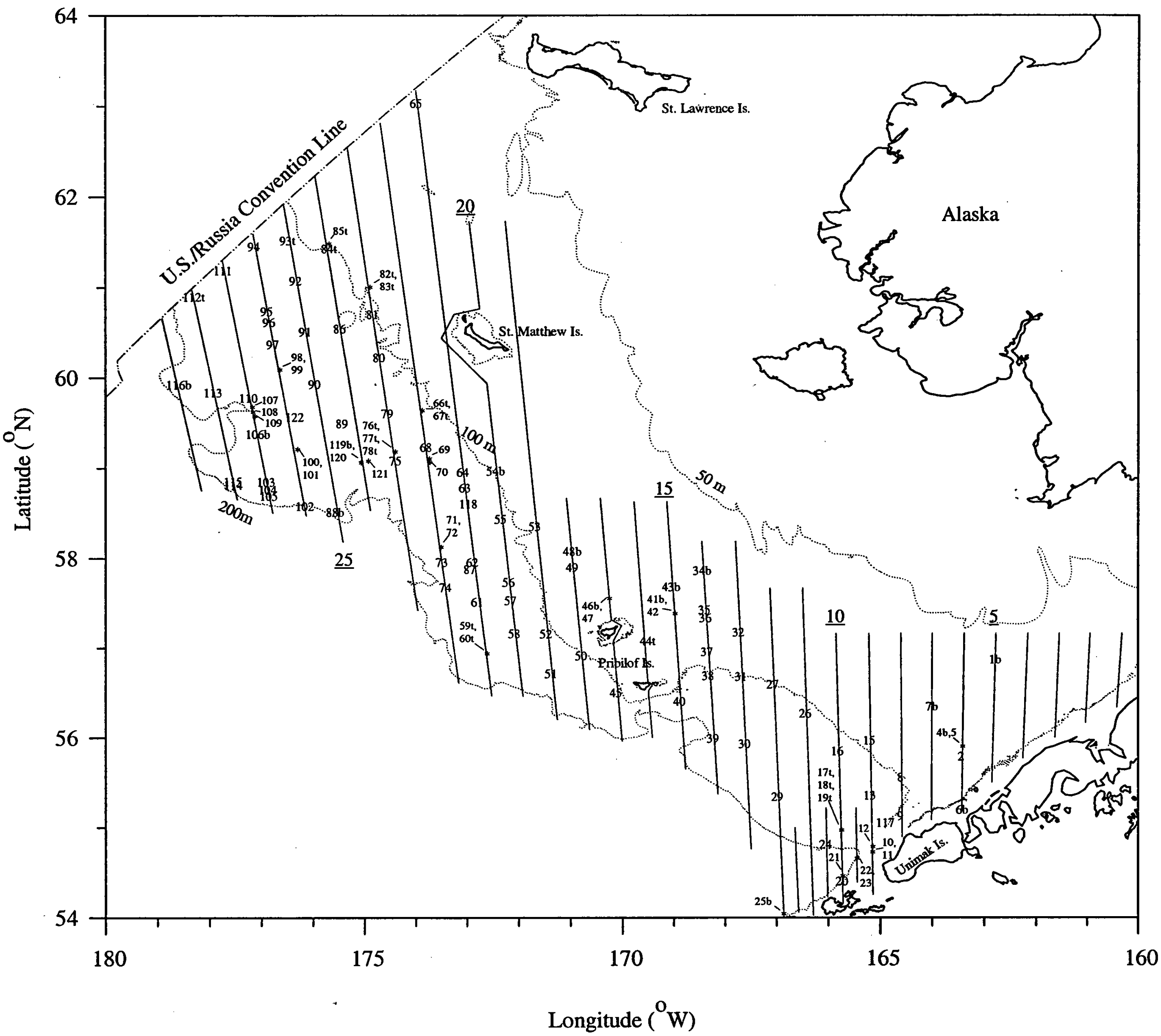


Figure 13. Transect lines with midwater and bottom ("b") trawl haul locations during the summer 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf and slope. A "t" indicates a target strength tow. Underlined numbers indicate transect sequence.

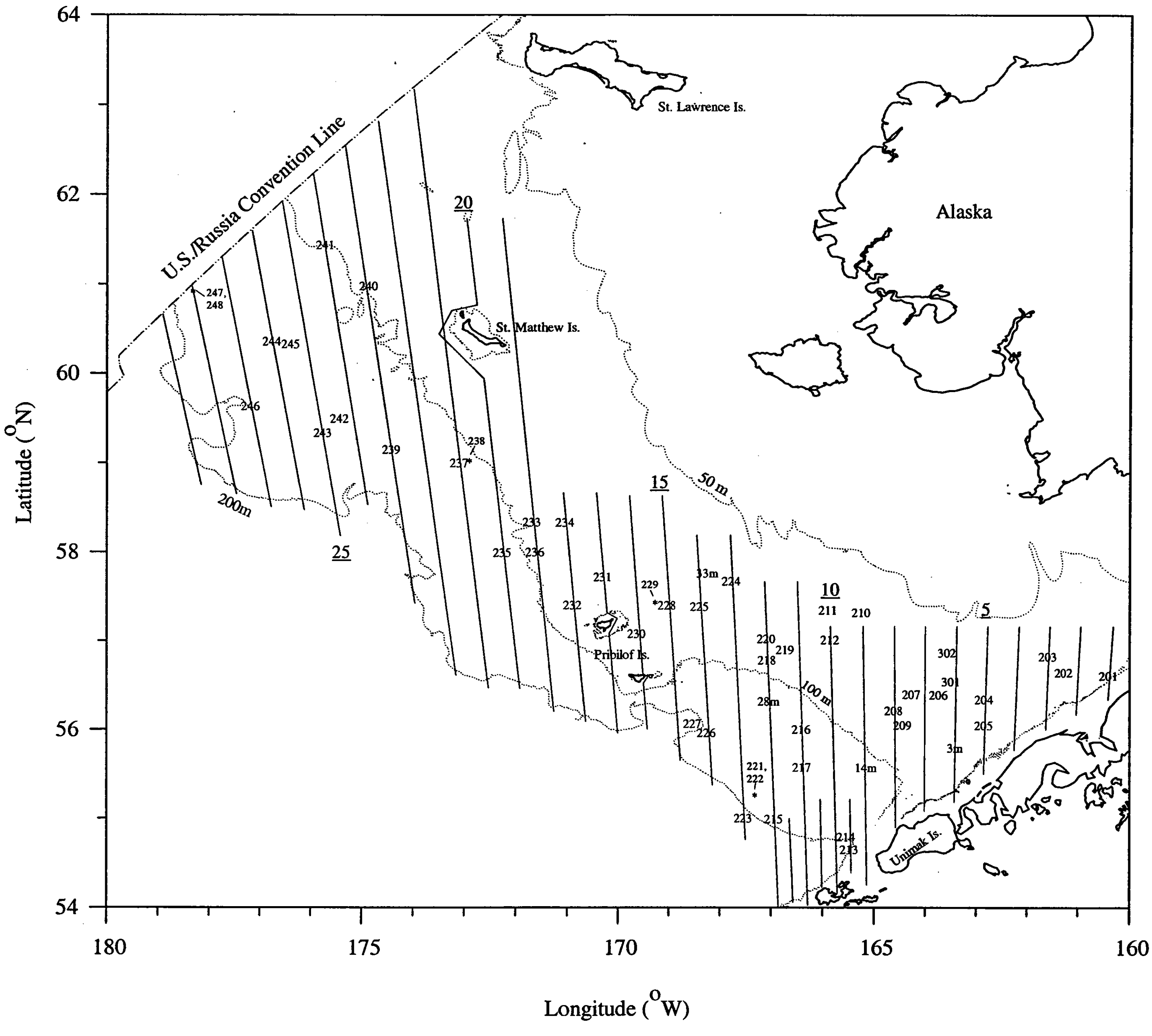


Figure 14. Transect lines with haul locations for the Marinovich ("m") and Methot trawl (201-248) and bongo net (301-302) during the summer 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf and slope. Underlined numbers indicate transect sequence.

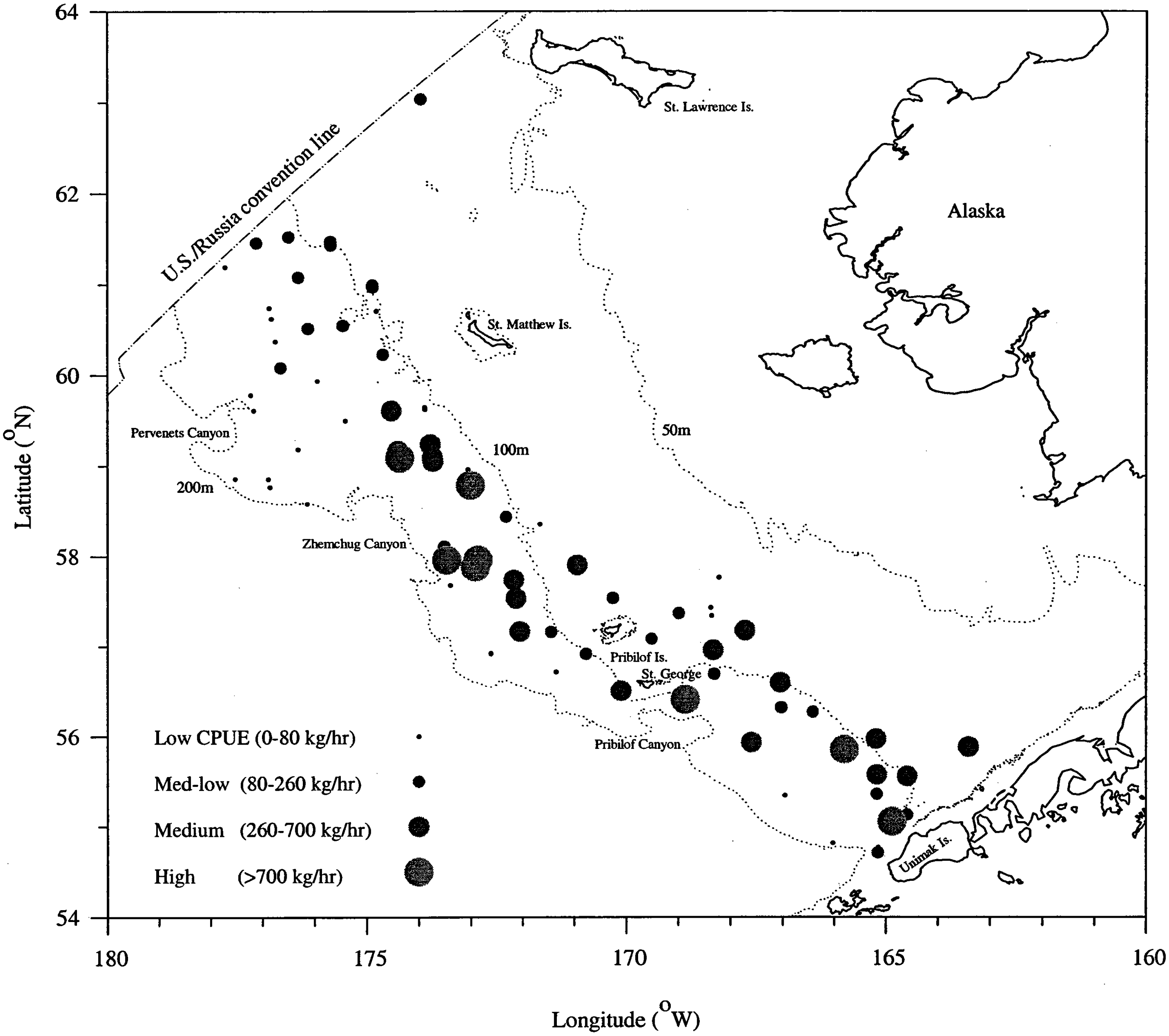


Figure 15. Jellyfish CPUE in midwater hauls during the summer 1999 echo integration-trawl survey of pollock on the eastern Bering Sea shelf.

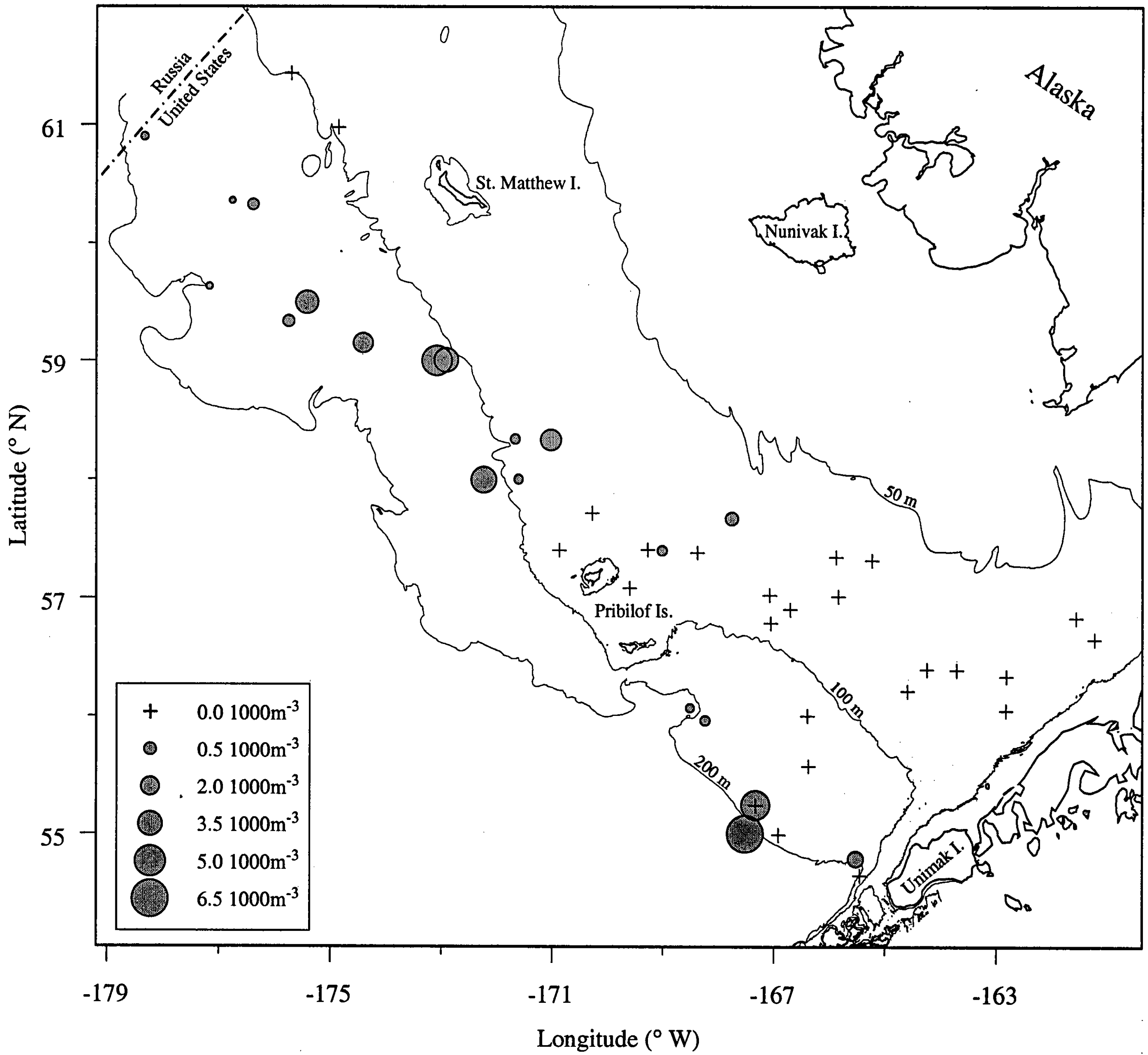


Figure 16. Density of age-0 gadids (numbers per $1000m^3$) at Methot trawl sampling stations during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf.

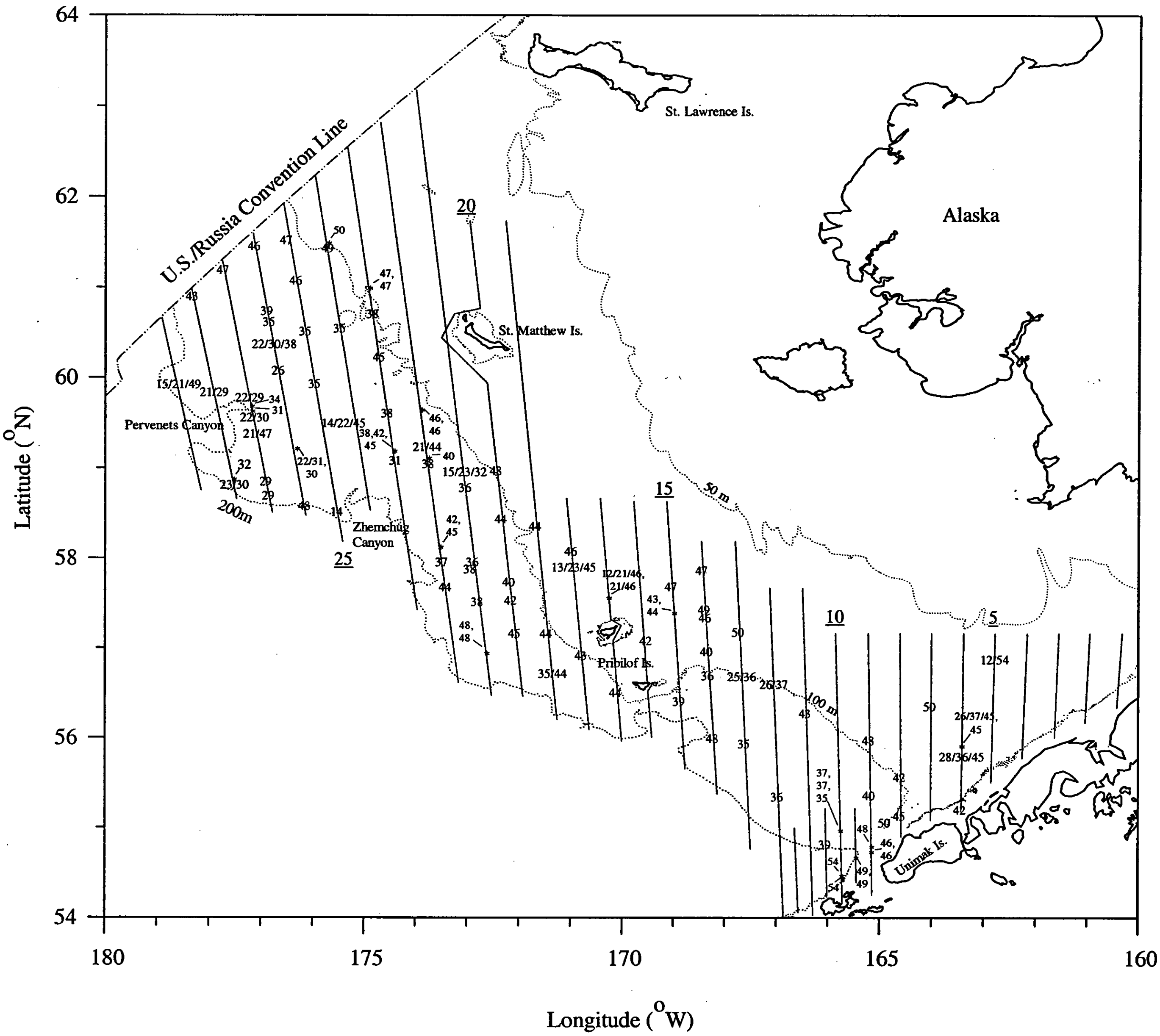


Figure 17. Transect lines with trawl haul average lengths (single value) for unimodal size compositions or length modes (e.g., 14/22/45) for multimodal size compositions during Legs 1 and 2 of the summer 1999 pollock echo integration-trawl survey of the eastern Bering Sea shelf and slope. Haul locations where fewer than 50 pollock were caught were excluded. Underlined numbers indicate transect sequence.

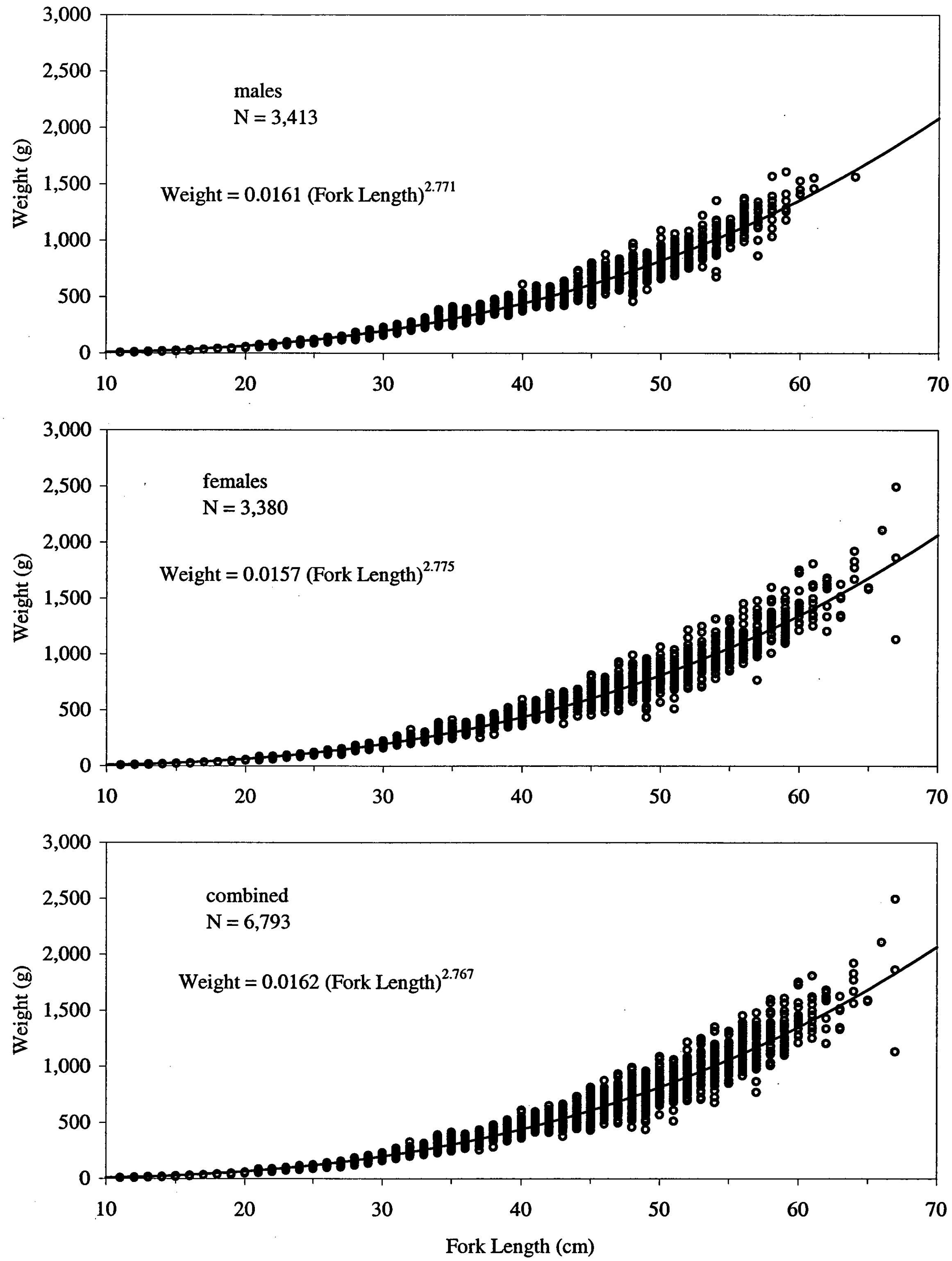


Figure 18. Length weight regressions with observed values and best-fit curve for male, female, and all pollock during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf.

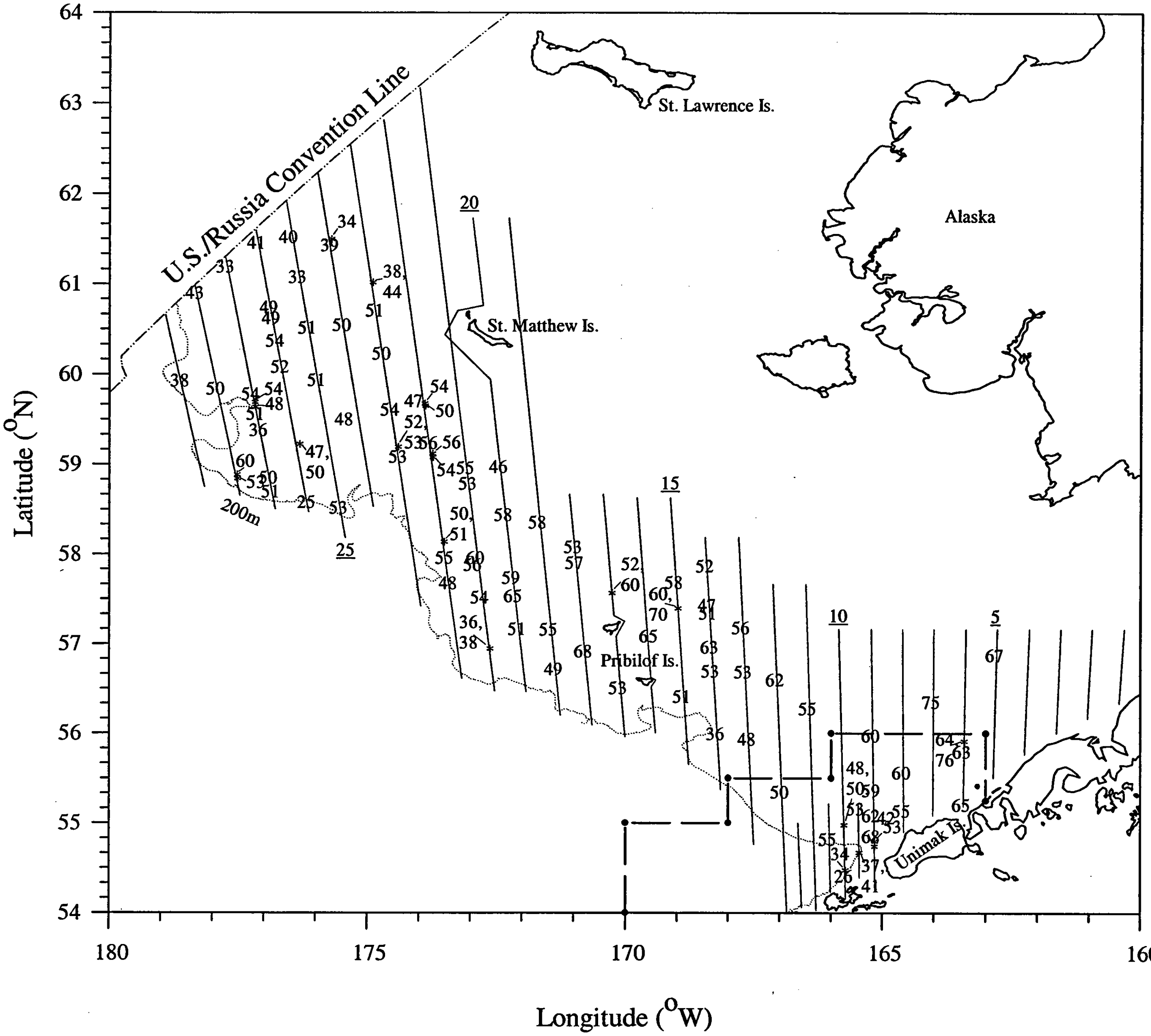


Figure 19. Transect lines and percent male pollock in the catch at trawl haul locations during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Haul locations where fewer than 50 pollock were caught were excluded. Transect numbers are underlined, and the Steller sea lion Conservation Area (SCA) is outlined.

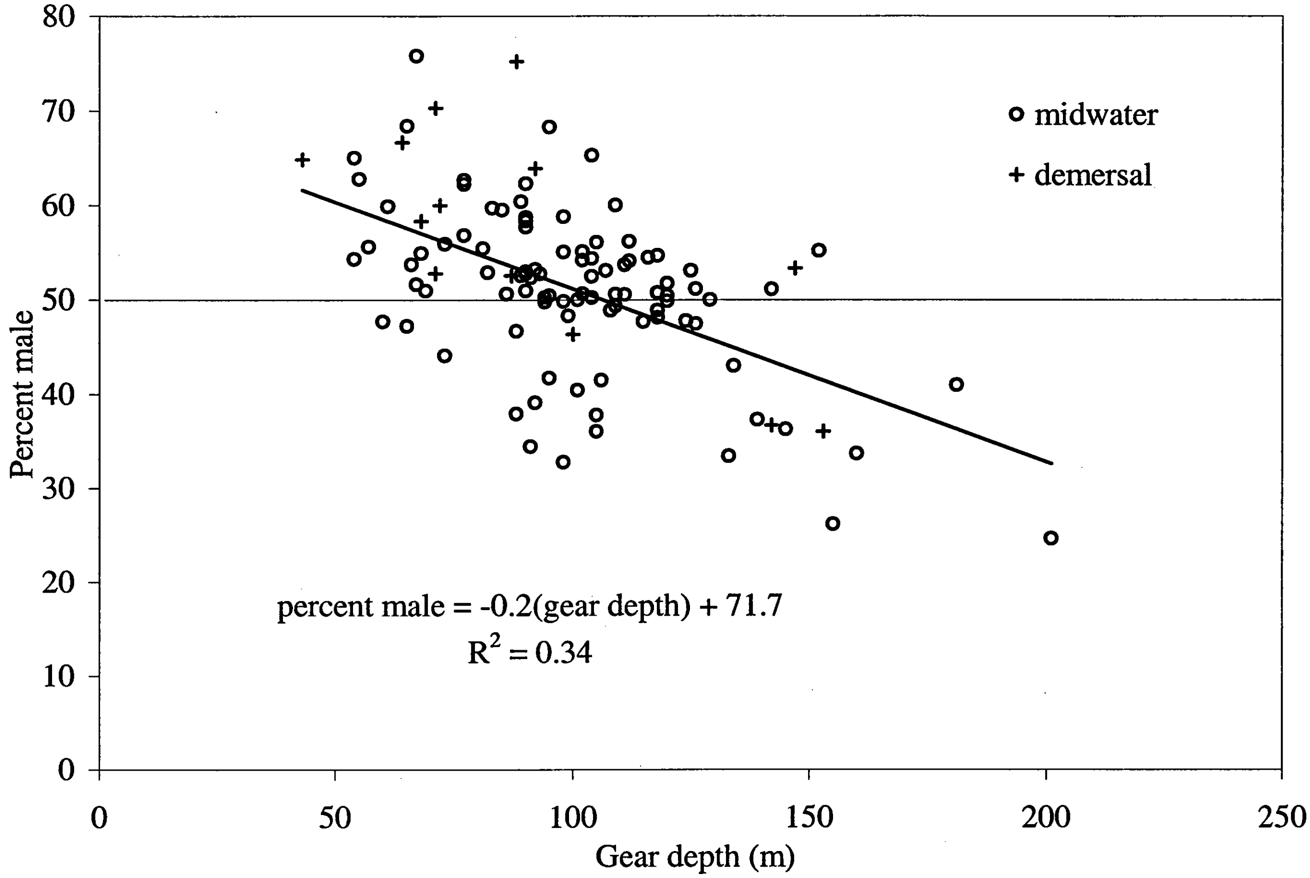


Figure 20. Trawl haul male pollock catch percentage as a function of gear depth during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Hauls catching fewer than 50 pollock were excluded.

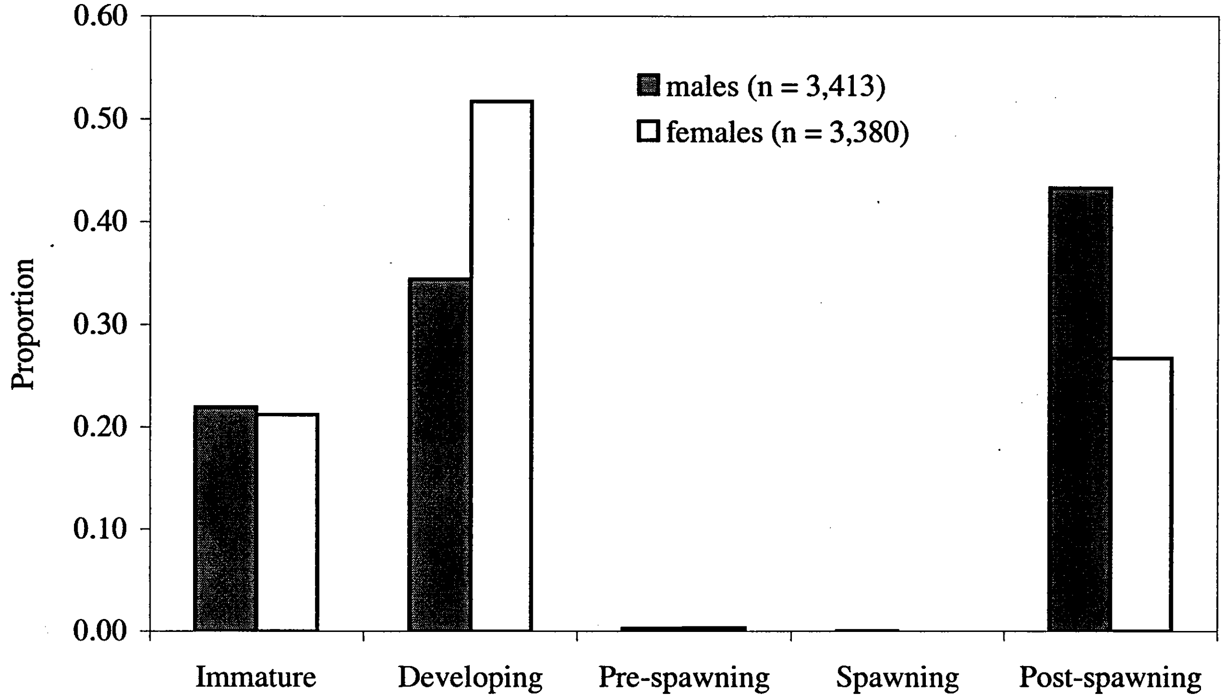


Figure 21. Maturity stages of pollock observed during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf.

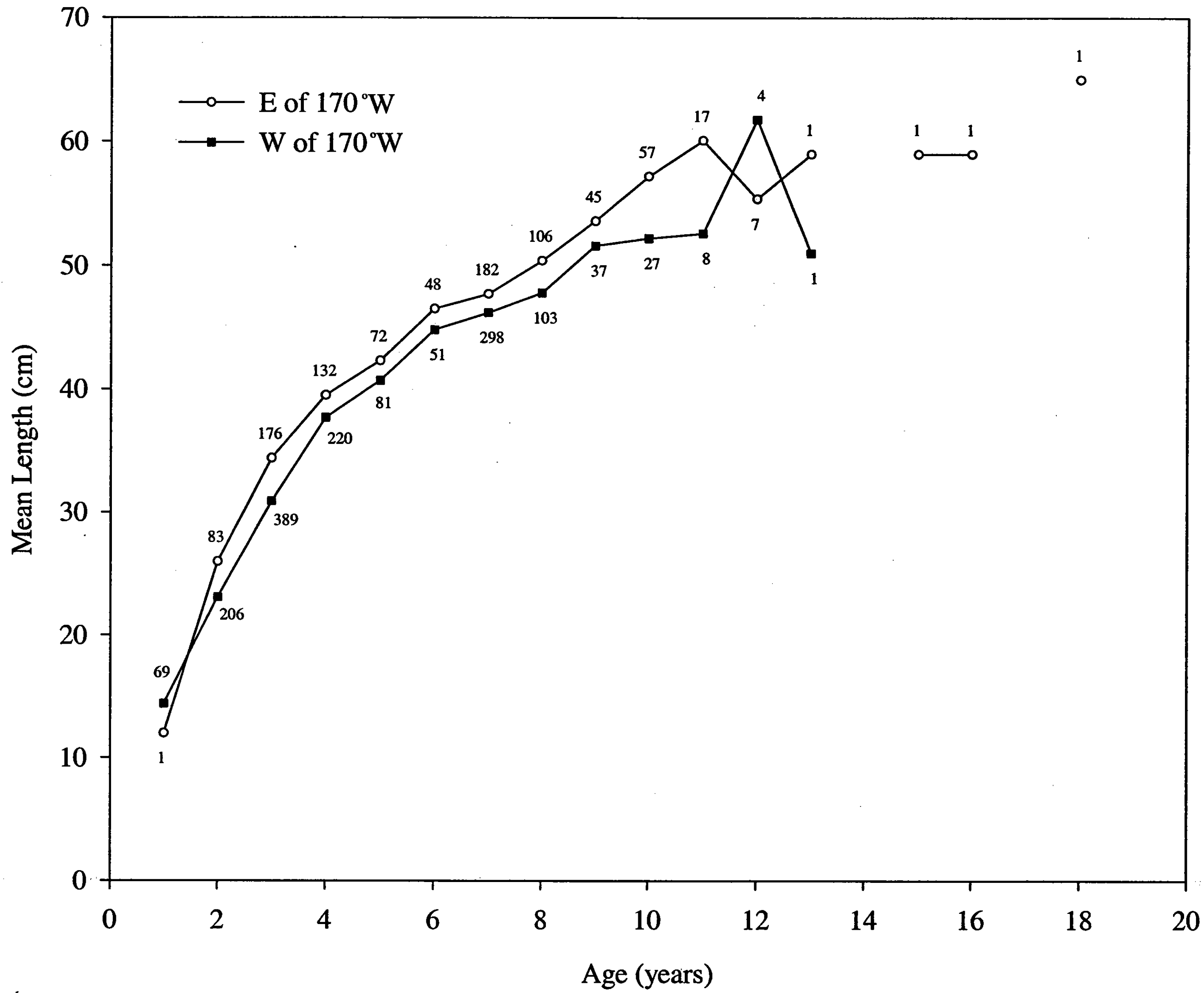


Figure 22. Mean lengths at age of walleye pollock collected during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Numbers indicate sample sizes.

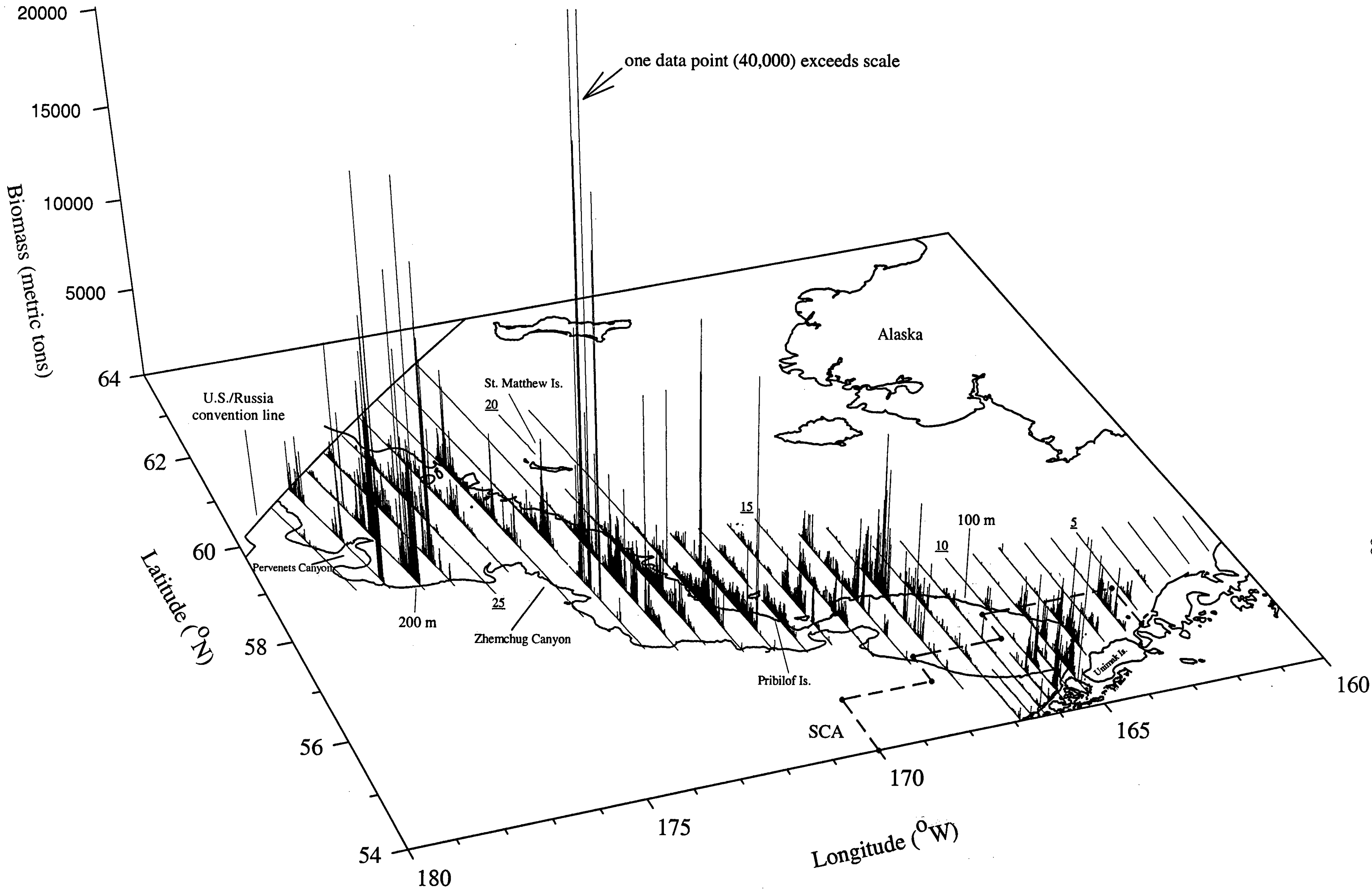


Figure 23. Estimated pollock biomass (tons) between 3 m off bottom and 14 m from the surface along tracklines surveyed during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Transect numbers are underlined, and the Steller sea lion conservation area (SCA) is outlined.

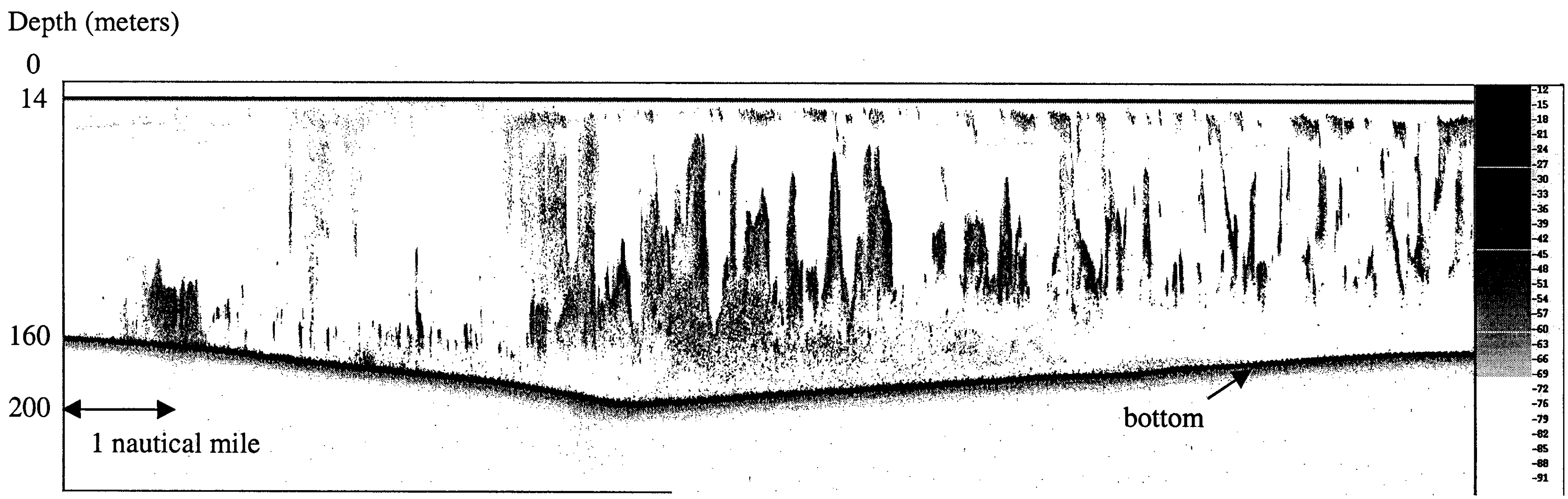


Figure 24. Pollock echosign observed along transect 27 east of Pervenets Canyon from the 1999 summer echo integration-trawl survey of the Bering Sea shelf and slope. Echosign density increases with increasing darkness of grayscale (at right). Total trackline distance shown is 10 nautical miles.

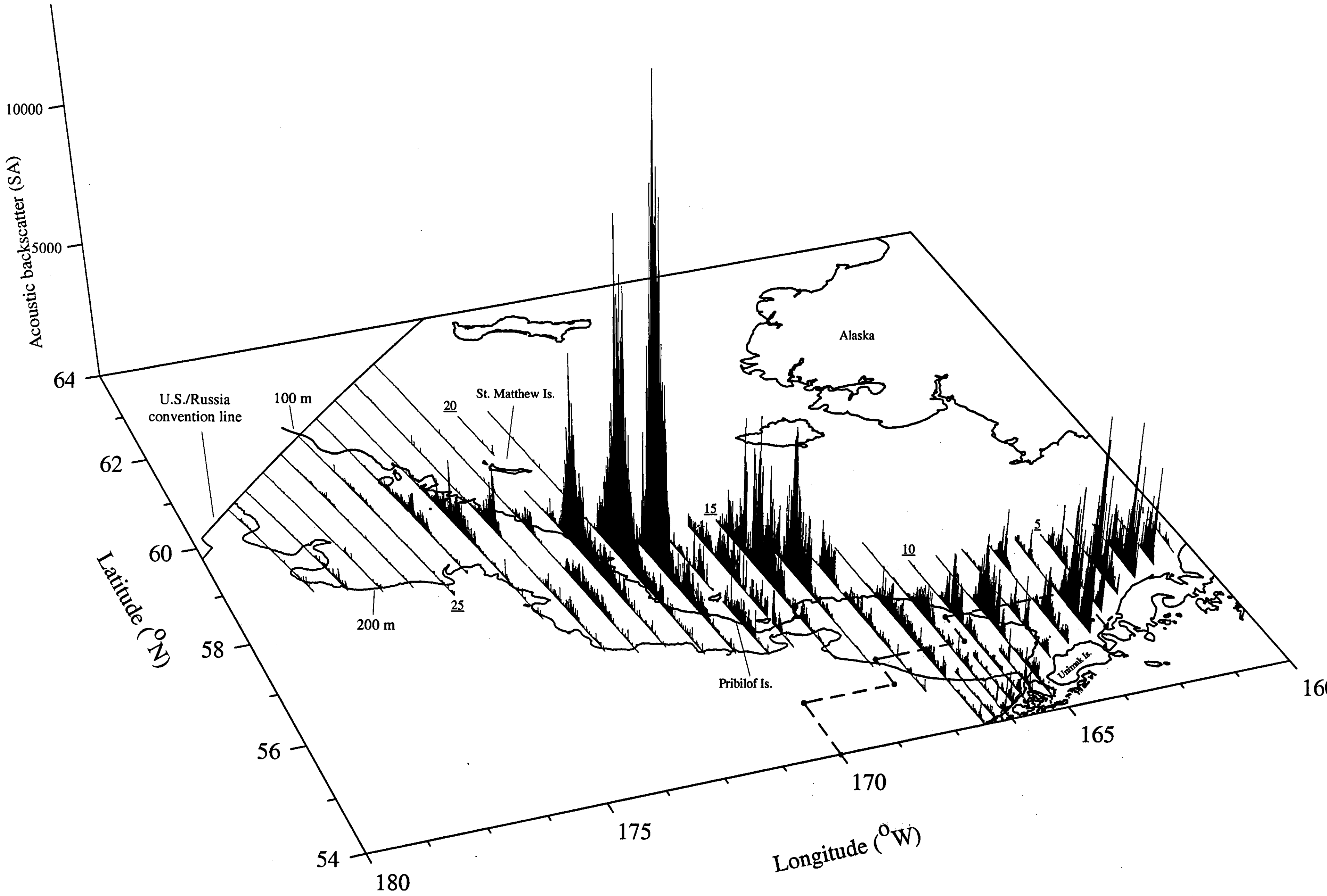


Figure 25. Acoustic backscatter attributed to an invertebrate-fish mixture along trackline during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. Transect numbers are underlined, and the sea lion conservation area (SCA) is outlined. Backscatter data are not scaled to biomass.

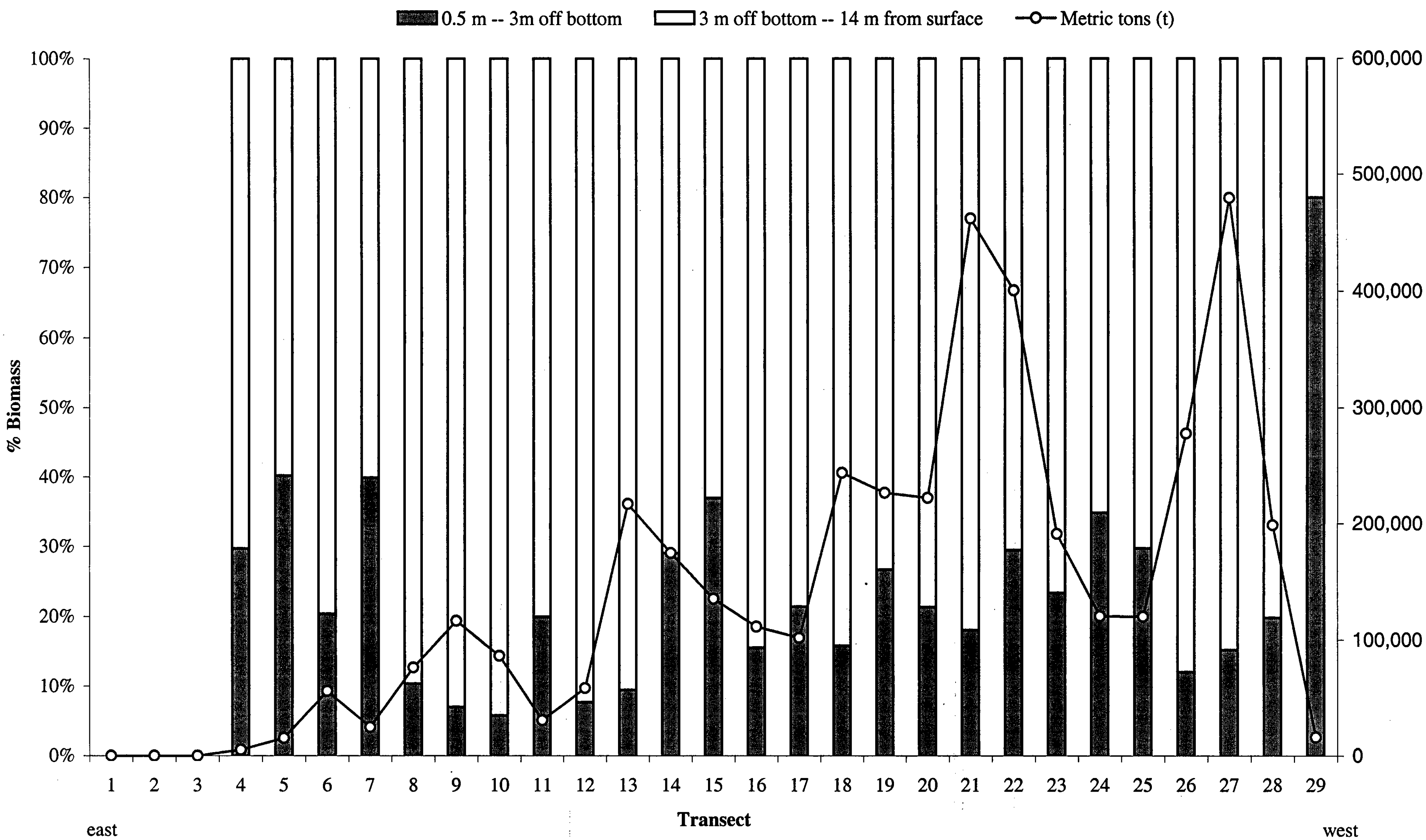


Figure 26. Vertical distribution of pollock (% biomass) and total pollock biomass (metric tons, t) by transect during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf. No pollock were observed on transects 1-3.

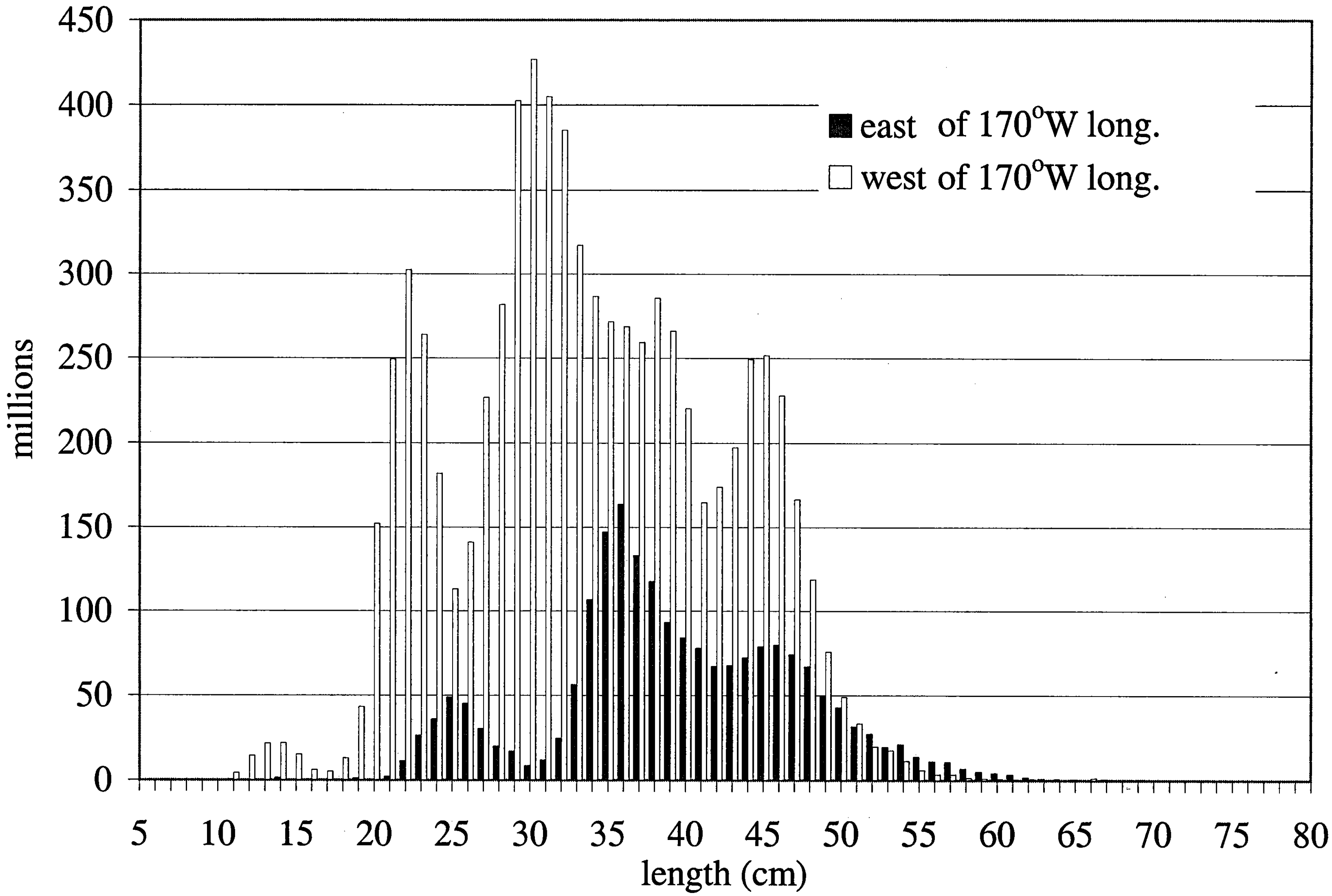


Figure 27. Estimated length composition of walleye pollock (millions of fish) east and west of 170°W long. between 14 m from the surface and 3 m off bottom from the summer 1999 echo integration-trawl survey of the Bering Sea shelf.

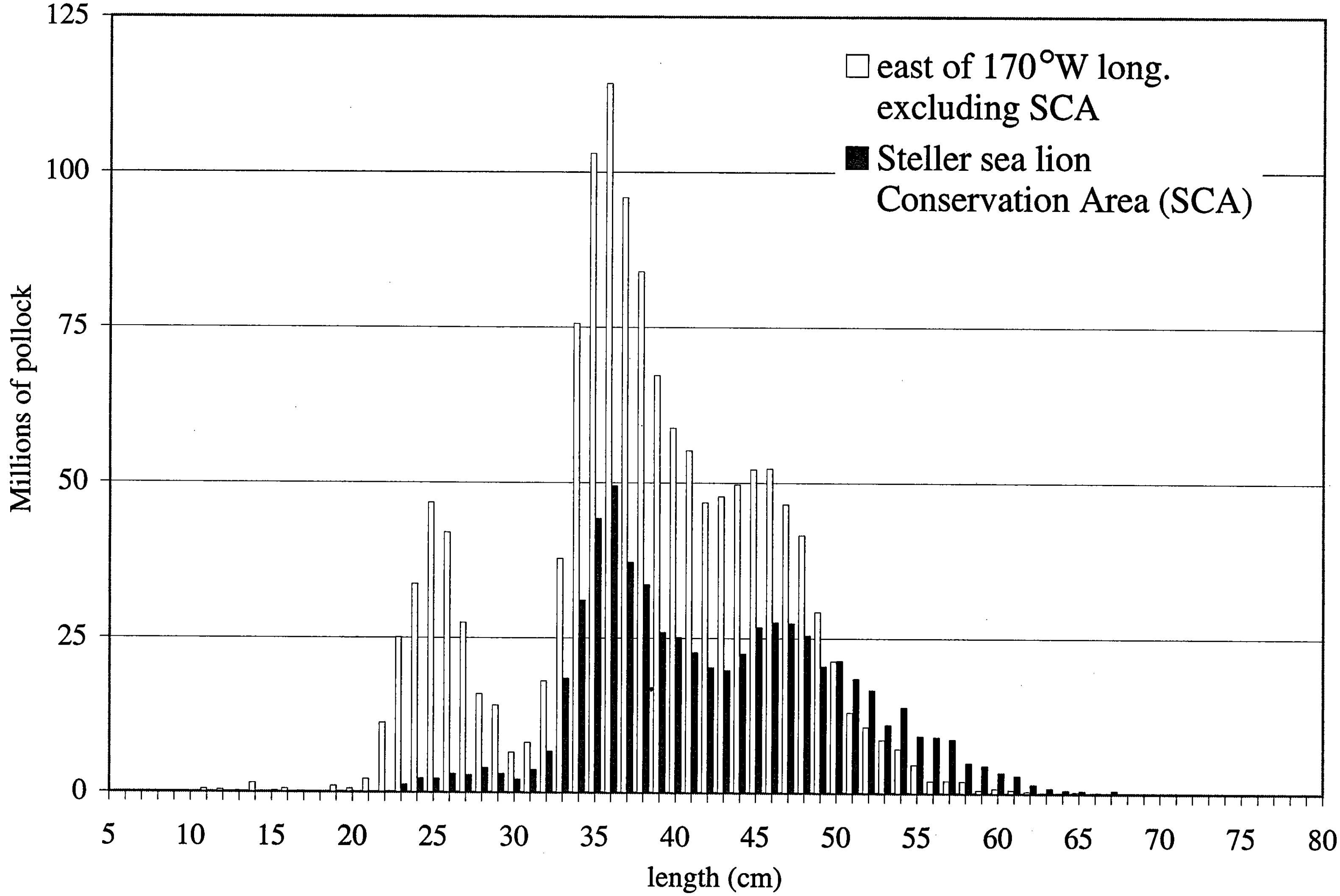


Figure 28. Estimated length composition of walleye pollock (millions of fish) east of 170°W long. between 14 m from the surface and 3 m off bottom from the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf.

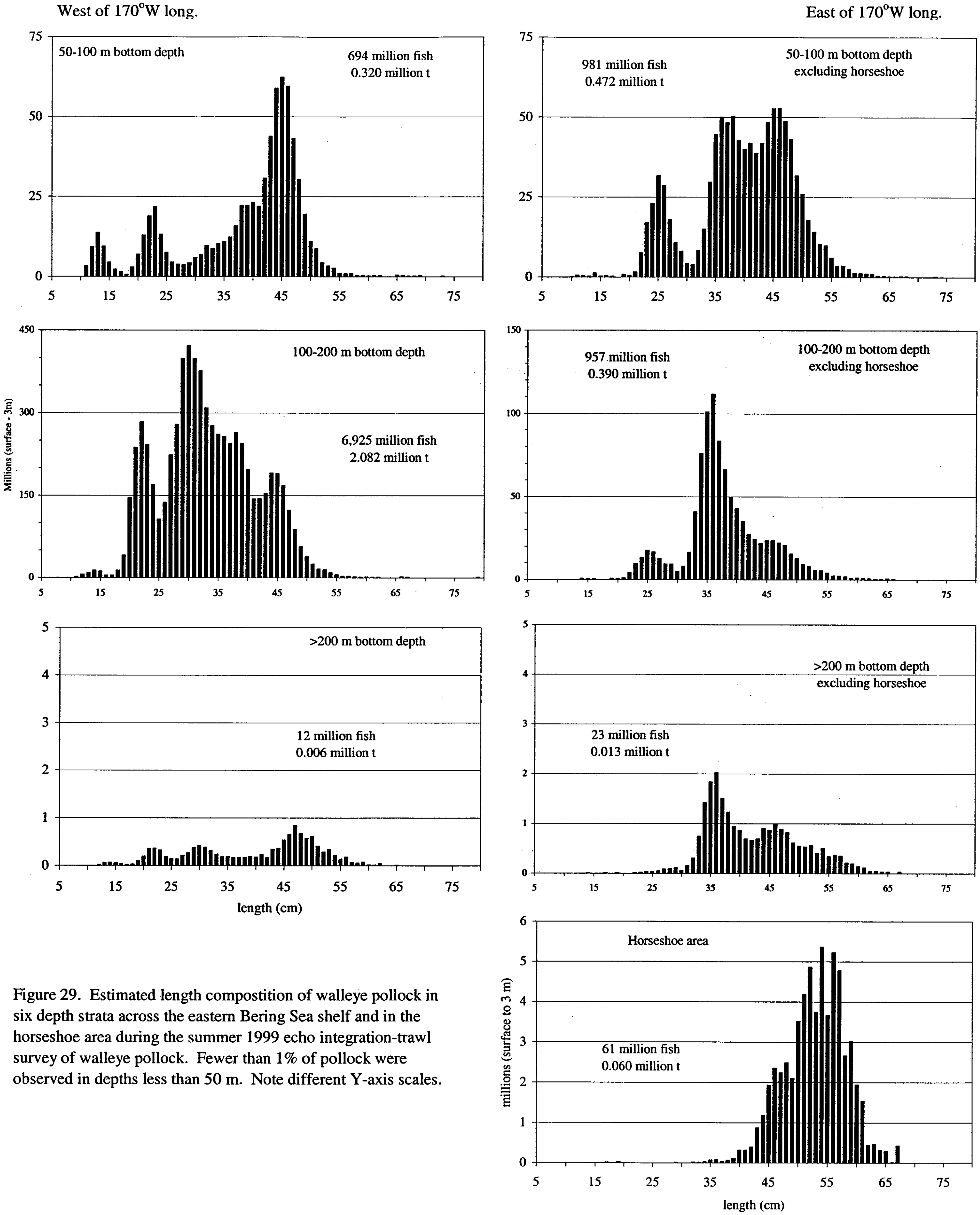


Figure 29. Estimated length compostition of walleye pollock in six depth strata across the eastern Bering Sea shelf and in the horseshoe area during the summer 1999 echo integration-trawl survey of walleye pollock. Fewer than 1% of pollock were observed in depths less than 50 m. Note different Y-axis scales.

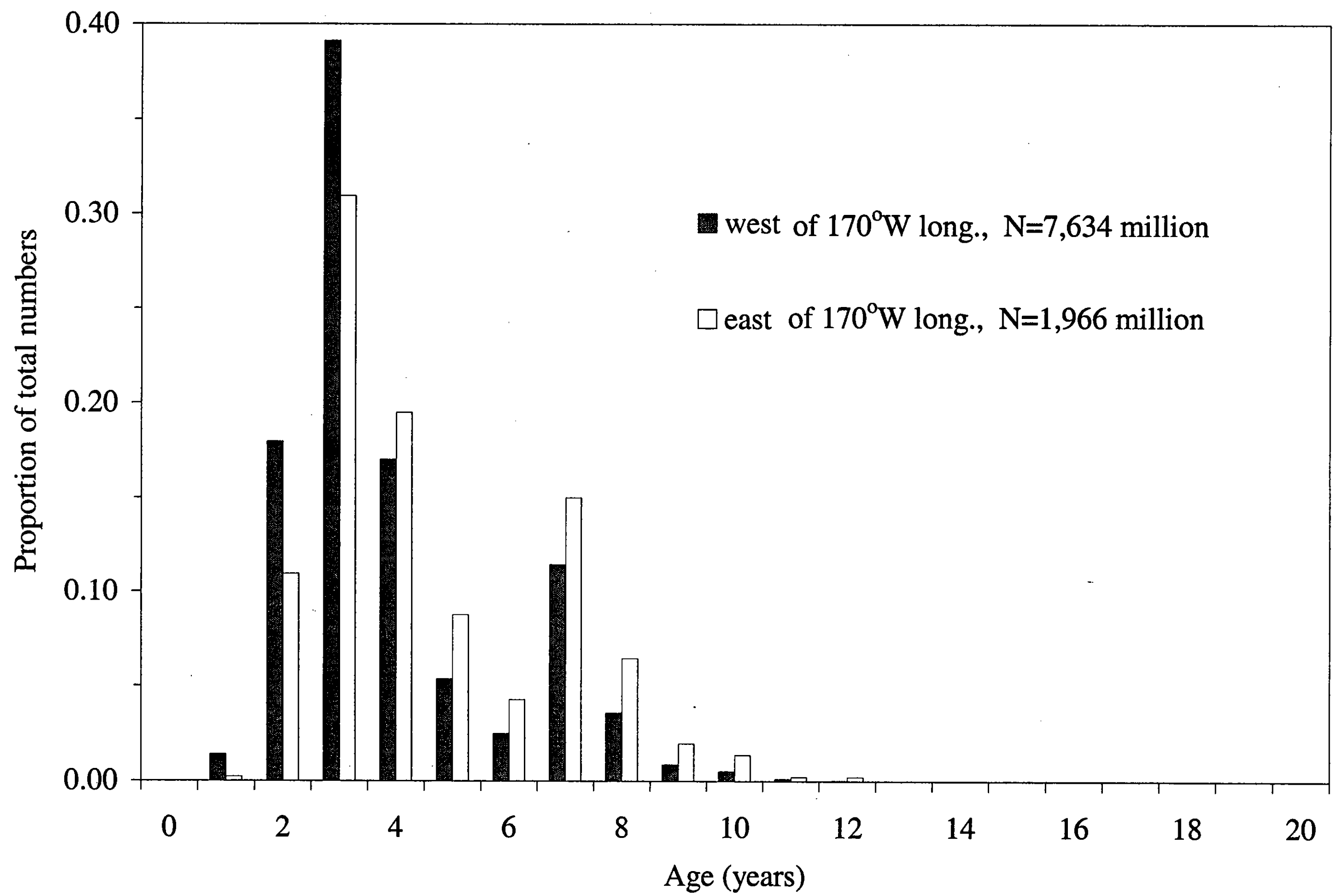


Figure 30. Proportional population-at-age estimate obtained during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf.

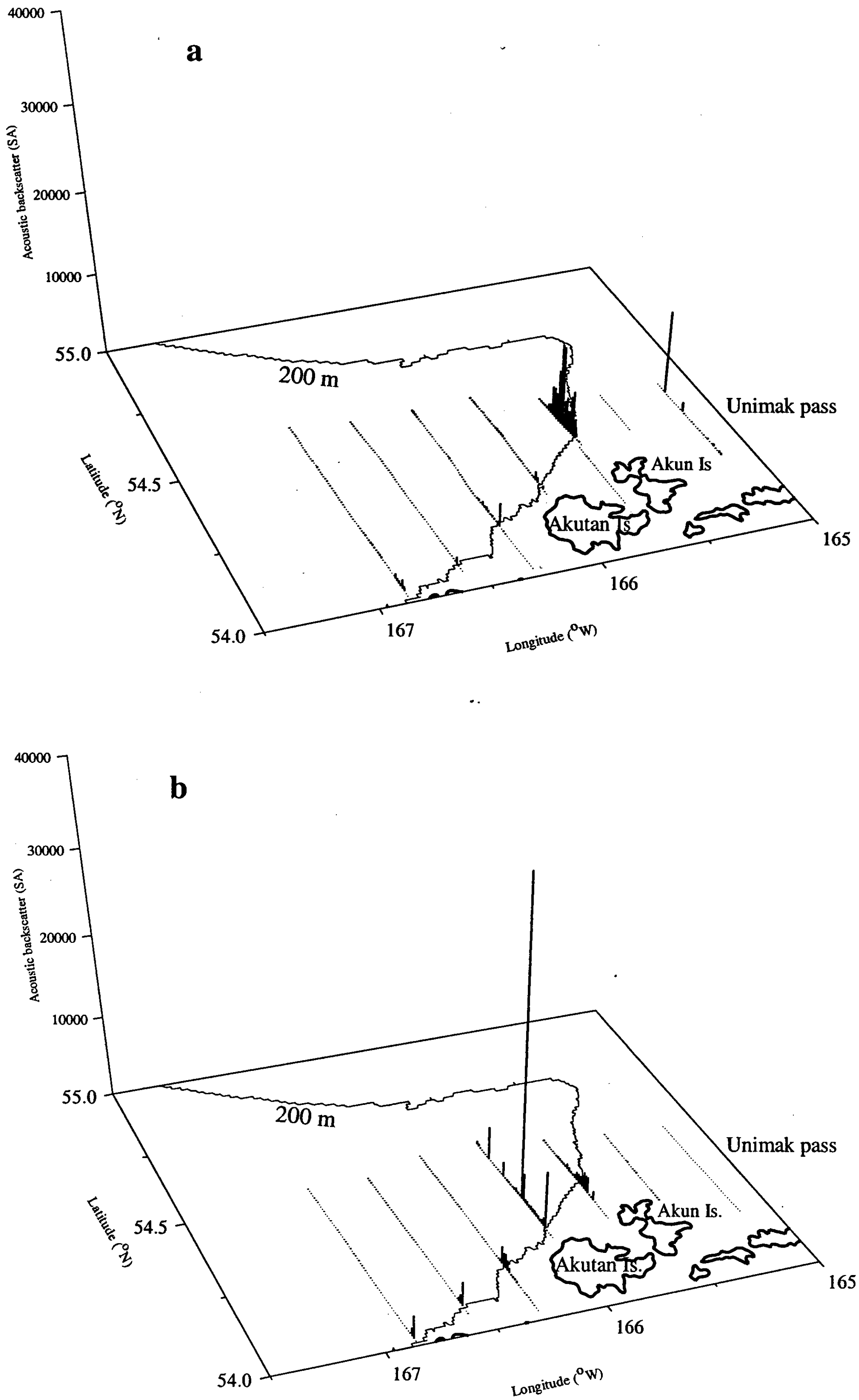


Figure 31. Pollock acoustic backscatter along extended tracklines surveyed in mid-June (a), and along tracklines re-surveyed 1-3 August (b) in the "horseshoe area" during the summer 1999 echo integration-trawl survey of the eastern Bering Sea shelf.

Appendix I

Scientific personnel

The principal investigator was Neal Williamson (206) 526-6417, AFSC, Seattle, WA.

Leg 1 (7 June- 3 July)

Name	Sex/ Nationality	Position	Organization
Chris Wilson	M/USA	Chief Scientist	MACE
Daniel Twohig	M/USA	Instrument Chief	MACE (7-9 June)
Mike Guttormsen	M/USA	Fish. Biologist	MACE
Kevin Landgraf	M/USA	Fish. Biologist	MACE
Steve de Blois	M/USA	Fish. Biologist	MACE
Tony Christney	M/Canada	Acoustician	QTC
Cyndy Tynan	F/USA	Biologist	NWFSC
Todd Pusser	M/USA	Biologist	NMML
Scott Sinclair	M/USA	Biologist	NMML
Alexander Nikolayev	M/Russia	Acoustician	TINRO
Mikhail Stepanenko	M/Russia	Fish. Biologist	TINRO
Julia Lott	F/USA	Teacher at Sea	NOAA

Leg 2 (6 July - 4 August)

Name	Sex/ Nationality	Position	Organization
Neal Williamson	M/USA	Fish. Biologist	MACE
Taina Honkalehto	F/USA	Fish. Biologist	MACE
Kevin Landgraf	M/USA	Fish. Biologist	MACE

Steve de Blois	M/USA	Fish. Biologist	MACE
Tony Christney	M/Canada	Acoustician	QTC
Lori Mazzuca	F/USA	Biologist	NMML
Todd Pusser	M/USA	Biologist	NMML
Mike Newcomer	M/USA	Biologist	
Alexander Nikolayev	M/Russia	Acoustician	TINRO
Mikhail Stepanenko	M/Russia	Fish. Biologist	TINRO
Bill Patton	M/USA	Fish. Biologist	MACE
Debra Merrill	F/USA	Teacher at Sea	NOAA

Leg 3 (6-14 August)

Name	Sex/ Nationality	Position	Organization
Chris Wilson	M/USA	Chief Scientist	MACE
Mike Guttormsen	M/USA	Fish. Biologist	MACE
Kevin Landgraf	M/USA	Fish. Biologist	MACE
Lisa Bertram	F/USA	Teacher at Sea	NOAA

MACE - Midwater Assessment and Conservation Engineering, AFSC, Seattle, WA

NMML - National Marine Mammal Laboratory, AFSC, Seattle WA

NOAA - National Oceanic and Atmospheric Association, Seattle WA

NWFSC - Northwest Fisheries Science Center, Seattle, WA

QTC - Quester Tangent Corporation, Inc., Sidney, BC, Canada

TINRO - Pacific Research Institute of Fisheries and Oceanography, Vladivostok, Russia

Appendix II

Other Research Projects–List of Contacts

Leg 1

1. Juvenile pollock for seabird diet study (Daniel D. Roby, U. of Alaska, 541-737-1955)

Legs 2 and 3

1. Pollock fin clips for genetics study on adult pollock (Mike Canino, UW/AFSC, 206-526-2097)

Legs 1, 2, and 3

1. Pollock stomach collections (Pat Livingston, AFSC, 206-526-4242)
2. Cold pool study on age-1 pollock (Tina Wyllie-Echieverria, Brigham Young University, 801-356-3118)
3. Observer Program fish ID training: Pacific cod, Atka mackerel, small rockfish, and sablefish collection (Sheryl Corey, AFSC, 206-526-4227)
4. Jellyfish predation study: jellyfish stomach sample/length composition collection (Ric Brodeur, AFSC, 541-867-0336)
5. Salmon catch composition data and collection of juvenile chum salmon for otoliths (Ed Farley, AFSC Auke Bay Laboratory, 907-789-6085).

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<u>AFSC-</u>

123 ROBSON , B. W. (editor). 2001. Fur seal investigations, 1999, 52 p. NTIS No. PB2002-100418.

122 SEASE, J. L., W. P. TAYLOR, T. R. LOUGHLIN, and K. W. PITCHER. 2001. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus)* in Alaska, June and July 1999 and 2000, 52 p. NTIS No. PB2001-107277.

121 BRITT, L. L., and M. H. MARTIN. 2001. Data report: 1999 Gulf of Alaska bottom trawl survey, 249 p. NTIS No. PB2001-105324

120 LAUTH, R. R. 2001. The 2000 Pacific west coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition, 284 p. NTIS No. PB2001-105327.

119 FERRERO, R. C., HILL, D. P. DEMASTER, P. S. HILL, M. M. MUTO, and A. L. LOPEZ. 2000. Alaska marine mammal stock assessments, 2000, 191p. NTIS No. PB2001-102015.

118 WILSON, C. D., M. A. GUTTORMSEN, K. COOKE, M. W. SAUNDERS, and R. KIESER. 2000. Echo integration-trawl survey of Pacific hake, *Merluccius productus*, off the Pacific coast of the United States and Canada during July-August, 1998, 103 p. NTIS No. PB2000-108482.

117 ORR, J. W., M. A. BROWN, and D. C. BAKER. 2000. Guide to rockfishes (Scorpaenidae) of the genera *Sebastes*, *Sebastolobus*, and *Adelosebastes* of the northeast Pacific Ocean, second edition, 47 p. NTIS No. PB2001-100757.

116 WION, D. A., and R. A. MCCONNAUGHEY (editors). 2000. Mobile fishing gear effects on benthic habitats: A bibliography, 163 p. NTIS No. PB2000-108106.

115 LAUTH, R. R. 2000. The 1999 Pacific west coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition, 287 p. NTIS No. PB2000-106004.

114 SHAW, F. R., M. E. WILKINS, K. L. WEINBERG, M. ZIMMERMANN, and R. R. LAUTH. 2000. The 1998 Pacific west coast bottom trawl survey of groundfish resources: Estimates of distribution, abundance, and length and age composition, 138 p. + Appendices. NTIS No. PB2000-105410.

113 ROBSON, B. W. (editor). 2000. Fur seal investigations, 1998, 101 p. NTIS No. PB2000-104258.

112 YANG, M-S., and M. W. NELSON. 2000. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990, 1993, and 1996, 174 p. NTIS No. PB2000-103403.

111 BUSBY, M. S., A. C. MATARESE, and K. L. MEIR. 2000. Annual, seasonal, and diel composition of larval and juvenile fishes collected by dip-net in Clam Bay, Puget Sound, Washington, from 1985 to 1995, 36 p. NTIS No. PB2000-103424.

110 HILL, P. S., and D. P. DEMASTER. 1999. Alaska marine mammal stock assessments, 1999, 166 p. NTIS PB2000-102844.

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