Alaska Fisheries Science Center

National Marine Fisheries Service

U.S DEPARTMENT OF COMMERCE

AFSC PROCESSED REPORT 2002-04

Results of the Echo Integration-trawl Survey for Walleye Pollock (*Theragra chalcogramma*) on the Bering Sea Shelf and Slope in June and July 2002

December 2002

Notice to Users of this Document

In the process of scanning the original printed document into Adobe Acrobat .PDF format, slight differences in formatting can occur; page numbers in the .PDF may not match the original printed document, and some characters or symbols may not translate.

This document is being made available in .PDF format for the convenience of users; however, the accuracy and correctness of the document can only be certified as was presented in the original hard copy format.

Results of the Echo Integration-trawl Survey for Walleye Pollock (*Theragra chalcogramma*) on the Bering Sea Shelf and Slope in June and July 2002

by Taina Honkalehto, Neal Williamson, Denise McKelvey and Sarah Stienessen

December 2002

CONTENTS

Introduction

Methods 1

Itinerary 2
Acoustic Equipment 2
Trawl Gear 3
Oceanographic Equipment...3
Survey design 3
Data analysis 5

Results and Discussion 6

Calibration 6
Oceanographic Conditions 6
Echosign...7
Biological Sampling 7
Distribution and Abundance 8

Acknowledgements 10

Citations 10

Scientific Personnel...11

INTRODUCTION

Scientists from the Midwater Assessment and Conservation Engineering (MACE) Program of the Alaska Fisheries Science Center (AFSC) conduct research surveys of Bering Sea walleye pollock (*Theragra chalcogramma*) to estimate pollock distribution and abundance. Results presented here are from the echo integration-trawl (EIT) survey carried out between 4 June and 30 July 2002 on the eastern Bering Sea (EBS) continental shelf aboard the NOAA ship *Miller Freeman*. The principal objective of the survey was to collect echo integration and trawl data to estimate midwater pollock abundance and distribution. This report summarizes observed pollock distribution, size composition and maturity information, and provides pollock biomass estimates. It also summarizes oceanographic observations and acoustic system calibration results. In addition to the EIT survey work, scientists from the National Marine Mammal Laboratory (NMML) conducted a marine mammal sighting survey along the EIT survey track. The AFSC survey was conducted in cooperation with the research vessel *TINRO* from TINRO-Centre, Vladivostok, Russia. Intership calibration was conducted between the TINRO and the *Miller Freeman*. Results of the NMML sighting survey, the RV *TINRO* survey and intership calibration will be reported elsewhere.

METHODS

<u>Itinerary</u>

Leg 1

3 Jun	Embark scientists in Kodiak, AK
4-6 Jun	Depart Kodiak 1500; calibration of acoustic system in Three Saints Bay, Kodiak Island, AK.
7 Jun	Transit to Bering Sea.
8 Jun	Calibration of acoustic system in Lost Harbor, Akutan Bay, AK.
9 Jun-2 Jul	Echo integration-trawl survey of the EBS shelf through waypoint 20.1; personnel exchange in Dutch Harbor, AK on 17 June.

2-3 Jul Transit to Dutch Harbor; arrive 0900 3 July.

4-5 Jul Inport Dutch Harbor.

Leg 2

6 Jul Depart Dutch Harbor 1200; calibration of acoustic systems in Captains Bay, Unalaska Island, AK.

7 Jul Transit to waypoint 21.0

8-24 Jul Echo integration-trawl survey of the EBS shelf through waypoint 29.1; intership calibration of scientific acoustic systems with the Russian RV *TINRO* 19-20 July.

25-28 Jul Transit to Dutch Harbor collecting acoustic data along 3 east-west oriented transects.

29 Jul Calibration of acoustic system in Humpback Bay, Unalaska Island.

30 Jul Arrive Dutch Harbor 1200; end of cruise.

Acoustic Equipment

Acoustic data were collected with Simrad EK500[1] (Bodholt et al. 1989, Bodholt and Solli 1992) and EK60 (Simrad 2001) quantitative echo-sounding systems on the NOAA ship *Miller Freeman*, a 66-m stern trawler equipped for fisheries and oceanographic research. Three split-beam transducers (38 kHz, 120 kHz, and 200 kHz) were mounted on the bottom of the vessel's retractable centerboard extending 9 m below the water surface. System electronics were housed inside the vessel in a permanent laboratory space dedicated to acoustics. 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 using the EK500 echo sounder at 38 and 120 kHz frequencies. Data were collected between 14 m from the surface (5 m below the

[1] Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA..

centerboard-mounted transducer) and 0.5 m from the bottom; however pollock biomass estimates were obtained from acoustic data collected above 3 m off bottom. The depth limit of acoustic data collection was 1,000 m. Acoustic data were collected with the Simrad EK60 echo at 200 kHz frequency using SonarData Echolog Software. Results presented here are based on the 38 kHz data.

Trawl Gear

Midwater and bottom trawl nets were used to sample observed echosign. Midwater and near-bottom echosign was sampled using an Aleutian wing 30/26 trawl (midwater trawl). On or near bottom echosign was sampled with an 83-112 bottom trawl without roller gear. The vertical net opening and headrope depth were monitored during all hauls using a WESMAR third wire netsounder system or a Furuno acoustic link netsounder system attached to the trawl headrope. For midwater trawl hauls, the net opening ranged from 9 to 35 m and averaged 24 m. For bottom trawl hauls, the net opening ranged from 2 to 4 m and averaged 3 m. Both nets were fished with 5 m^2 Fishbuster trawl doors. A Methot trawl was used to target age-0 pollock and macrozooplankton. Detailed descriptions of all gear may be found in Honkalehto et al. (2002).

Oceanographic Equipment

Physical oceanographic data collected during the cruise included temperature/depth profiles obtained with a Sea-Bird Electronics temperature-depth probe (SBE-39) attached to the trawl headrope and conductivity-temperature-depth (CTD) profiles collected with a Sea-Bird CTD system at calibration sites and other locations. Sea surface temperature and salinity, and other environmental data were collected using the *Miller Freeman's* Scientific Computing System (SCS). Ocean current profile data were obtained using the vessel's centerboard-mounted acoustic Doppler current profiler system operating continuously in water-profiling mode.

Survey Design

The survey design consisted of 28 north-south transects spaced 20 nautical miles (nmi) apart over the Bering Sea shelf from Port Moller, Alaska, to the U.S./Russia Convention Line (Fig. 1).

Transects were chosen to coincide with lines of groundfish trawl stations sampled about 2 weeks earlier by bottom trawl survey vessels. Southern transect endpoints were either limited by the Alaska Peninsula and the Aleutian Island chain (Transects 2 through 11) or were beyond the continental shelf break (Transects 12 through 29). Northern endpoints of Transects 2 through 24 were based initially on historical pollock distributions and extended northward if significant fish echosign was observed. Since permission to enter the Russian Exclusive Economic Zone (EEZ) was not granted, northern extents of Transects 25 through 28 ended at the U.S./Russia Convention Line. Echo integration and trawl data were collected during daylight hours (typically between 0600 and 2400, depending on calendar date and location). Nighttime operations included additional trawling, target strength (TS) data collection, and acoustic system testing. Acoustic system settings used during the collection (Table 1) were based on results from acoustic system calibrations and on experience from summer EBS shelf surveys. Pollock were sampled (MACE Sampling Manual)[2] to determine sex, fork length (FL), body weight, age, maturity, and ovary weight. Maturity was determined by visual inspection and categorized as immature, developing, pre-spawning, spawning, or post-spawning. Further biological sampling details may be found in Honkalehto et al.(2002).

Standard sphere acoustic system calibrations were made prior to the Bering Sea shelf survey and at the beginning and end of Leg 2 to measure acoustic system performance for both the echosounders at each frequency. During calibrations, the NOAA ship *Miller Freeman* was anchored at bow and stern. Weather, sea state conditions, and acoustic system settings were recorded. Two copper calibration spheres, 23 mm (120-kHz sphere, TS = -40.3 dB) and 60 mm (38-kHz sphere, TS = -33.6 dB) diameters, and one tungsten carbide sphere (200-kHz sphere, TS= -39.5) were suspended between 20 and 45 m below the centerboard-mounted transducers depending on the sphere and system being calibrated. 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. Transducer beam characteristics were measured using a

---

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

Simrad software program (EKLOBES). This was accomplished by pulling each sphere through its corresponding transducer beam and collecting target strength data on a grid of angle coordinates (Foote et al. 1987).

Data Analysis

Scientists scrutinized the 38 kHz data using Simrad BI500 echo integration and target strength data analysis software (Foote et al. 1991, Simrad 1993) aided by digital echograms to partition the acoustic information into Type 1 pollock (near bottom and midwater schools), Type 2 pollock (midwater schools higher in the water column that were primarily juvenile pollock), non-pollock fish, and an undifferentiated invertebrate/fish mixture. Echosign data were stored in a relational database on a SUN workstation. Pollock length data from 108 hauls were aggregated into 31 analytical strata based on echosign type, geographic proximity of hauls, and similarity in size composition data. 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 segments were summed to compute total pollock area backscattering for each analytical stratum. These values were then scaled using a previously derived relationship between target strength and fish length (TS = 20 Log FL - 66; Traynor 1996) and the length composition data, resulting in an estimate of numbers of pollock by size. Two length-weight relationships observed from trawl data were applied to estimate pollock biomass for each length category, one for pollock east of 170°W and one for pollock west of 170°W. Age data for the summer 2002 EIT survey were not available when this analysis was completed.

Relative estimation errors associated with spatial structure observed in the acoustic data were derived using a one-dimensional (1D) geostatistical method as described by Petitgas (1993), Williamson and Traynor (1996), and Rivoirard et al. (2000). Relative estimation error is defined as the ratio of the square root of the estimation variance to the estimate of acoustic abundance--the average transect backscatter multiplied by transect area. Geostatistical methods were used for computation of error because they account for the observed spatial structure. These errors quantify only transect sampling variability. Other sources of error (e.g., target strength, trawl sampling, error associated with ageing) are not included.

RESULTS and DISCUSSION

Calibration

Five acoustic system calibrations were conducted during the summer 2002 field season (Table 2). During the first calibration in Three Saints Bay, prior to starting the survey trackline, a broken wire was discovered in the transducer cable. Once the wire was repaired, the system was calibrated two additional times prior to the survey start to be certain that it was functioning properly. No significant differences in gain parameters or transducer beam characteristics were observed for the 38-kHz EK500 collection system used for biomass estimation.

Oceanographic conditions

MBT casts provided temperature profiles from nearly all of the 135 opportunistic midwater, bottom and Methot trawl stations (Table 3). In addition, 13 CTD samples were collected either in association with calibration sites, with selected trawl hauls, or at selected points along the survey trackline. Continuous sampling of sea surface temperature revealed that in June, from the Pribilof Islands eastward, coolest surface waters (< about 6°C) were at the north ends of Transects 2 through 6 and warmest waters (> 8°C) were along Transects 12 and 13 between 166°W and 168°W. During July, west of the Pribilof Islands, coolest surface waters (< about 6°C) were observed at the north ends of Transects 18 through 21; warmest surface waters (> 8°C) were observed west of about 173°W (Fig. 2). Surface temperatures observed during summer 2002 were similar to those observed in 2000 but warmer than those observed in 1999. In 2002, the average surface temperature was 7.2°C whereas it was 7.7°C in 2000. Average surface temperature was 6.4°C in 1999. Bottom temperatures (Fig. 3) observed during the summer 2002 bottom trawl survey of groundfish showed that across most of the eastern Bering Sea shelf the bottom water was warmer than 2°C; water colder than 2°C (known as the cold pool) was observed on the northwestern shelf surrounding St. Matthew Island and west to the U.S.-Russia Convention Line. The average bottom temperature was 3.3°C, warmer than in either 2000 (2.2°C) or 1999 (0.7°C) (T. Sample, pers. commun.)[3].

Echosign

Four different types of echosign were identified. Two of these sign types contained pollock. The first formed from low to high density layers rising from the bottom into midwater during daytime and was either composed of adult pollock or was a mixture of juvenile and adult pollock. The second type consisted of midwater echosign forming discrete schools during the day in the upper water column, and was composed of juvenile pollock 10 to 35 cm in length (ages 1 to 3). This second pollock echosign type was observed less frequently than the first, and was usually associated with near bottom layers of the first type. During the night pollock tended to disperse throughout the water column. A third echosign type was unidentified (non-pollock) fish. The fourth type was attributed to an undifferentiated mixture of jellyfish, macrozooplankton, age-0 pollock, and individual fishes, and was classified as an invertebrate-fish species mixture. Most of this echosign type was observed on the six eastern-most transects and north of the Pribilof Islands on Transects 14 to 18 in areas where bottom depths were less than 100 m. Very little of this echosign type was observed west of St. Matthew Island.

Biological sampling

Biological data and specimens were collected from 135 trawl hauls (Table 3, Fig. 1): 108 using the midwater trawl; 18 using the bottom trawl; and 9 using the Methot trawl. Walleye pollock was the dominant species captured by weight in midwater and bottom trawl hauls (Tables 4 and 5). Jellyfish (Scyphozoa) were the next most abundant species group sampled in midwater trawl hauls by weight and Pacific cod (*Gadus macrocephalus*) were the next most abundant by weight in bottom trawl hauls. Methot trawl hauls caught mainly jellyfish and euphausiids (Table 6).

---

[3] T. Sample, Groundfish Assessment Program, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle WA 98115.

During the cruise 40,234 pollock lengths were measured, 5,466 maturities were categorized, and 3,233 pairs of otoliths were collected from pollock obtained in trawl hauls (Table 7). Weight at length curves from the trawl data (Fig. 4) indicated that differences in fish weight at length east and west of 170°W increased from 2 g (at 15 cm) to 90 g (at 55 cm). This along with historical observations showing biological differences between pollock east and west of 170°W leads to the use of two length-weight regressions for pollock population analysis. Among pollock of both sexes larger than 29 cm fork length (approximately 3-years and older), fewer than 1% were actively spawning and the majority (72% of males and 70% of females) were developing (Fig. 5). Of the 3,233 pollock otolith pairs collected, 2,200 were submitted for age reading (Fig. 6). The numbers of otoliths east and west of 170°W were each reduced using a random subsampling scheme that sought to preserve the shape of the overall specimen length-frequency distribution while retaining sufficient samples across the range of lengths sampled. Age information from this EIT survey was not available for use in population at age estimation at the time of this report.

Distribution and Abundance

Pollock were observed on all transects (Fig. 7). They were most dense north of Unimak Island (Transects 5-10), and south and west of St. Matthew Island (Transects 19-25). Juvenile pollock forming discrete midwater schools were observed between Transects 8 and 12, due south of St. Matthew Island on Transect 20, and west of St. Matthew Island near the 100 m isobath (Transects 23 to 26). A patch of age-1 juveniles was observed on Transect 28 near the 155-m isobath.

Estimated pollock abundance in the midwater region (14 m from the surface to 3 m off bottom) was 3.62 million metric tons (t) (Table 8), or 1.21 billion fish (Table 9, Fig. 8a). The relative estimation error was 3.1%. East of 170°W, estimated pollock abundance was 1.44 million t (40% of the total biomass, representing 3.89 billion fish). West of 170°W, estimated abundance was 2.18 million t (60% of the total biomass, representing 8.23 billion fish). About 18% of the total biomass was inside the Steller sea lion Conservation Area (SCA) . Proportions of estimated pollock biomass east of 170°W and inside the SCA, were higher in summer 2002 as compared with recent summer EIT surveys (Table 8).

Population estimates indicated that the predominant length mode east of 170°W was 27 cm (2-year-old pollock), with additional modes at 49 cm, 37 cm, and 15 cm (Fig. 8b). West of 170°W the predominant length modes for pollock were 24 cm (2-year-old pollock) and 31 cm, with additional modes at 39 cm, 45 cm and 15 cm. The 31 cm mode (probably 3-year-old pollock) was not observed in the east. Pollock length modes observed east of 170°W inside and outside of the SCA were similar except that the 27-cm mode was more abundant inside and the 37-cm mode was more evident outside the SCA (Fig 8c). Expressing pollock numbers at length as age groups (less than 20 cm, 21-29 cm, and greater than or equal to 30 cm; representing ages 1, 2, and 3 and older, respectively) shows that east of 170°W, 51% are 2-year-olds, 46% are 3-years and older, and 3% are 1-year-olds. Within the SCA, 2-year old pollock comprise about 60% of the total numbers, and 1-year olds about 6%, with three-year and older pollock making up the remaining 34%. West of 170°W, 2-year-olds comprise about 38% by numbers, 3-years and older about 55%, and 1-year-olds about 7%.

Overall pollock abundance in midwater in 2002 was higher than that in 2000 (3.62 vs. 3.05 million t, Table 9). The estimated numbers of 21-29 cm (2-year old) pollock in 2002 (the 2000 year class) were greater than the numbers of that length class estimated from the summer 1994 EIT survey (the 1992 year class). The 1992 year class was considered to be above average in abundance.

ACKNOWLEDGMENTS

The authors would like to thank the officers and crew of the NOAA ship *Miller Freeman* for their proficient field support.

CITATIONS

Bodholt, H., H. Nes, and H. Solli. 1989. A new echo sounder system. Proc. Instit. of Acoust. 11(3):123-130.

Bodholt, H., and H. Solli. 1992. Split beam techniques used in Simrad EK500 to measure target strength, p.16-31. *In* World Fisheries Congress, May 1992, Athens, Greece.

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

Foote, K.G., H. P.Knudsen, R. J. Korneliussen, P. E. Nordbo, and K. Roang. 1991. Postprocessing system for echo sounder data. J. Acoust. Soc. Am. 90:37-47.

Honkalehto, T., W. Patton, S. de Blois and N. Williamson. 2002. Echo integration-trawl survey results for walleye pollock (*Theragra chalcogramma*) on the Bering Sea shelf and slope during summer 2000. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-126, 66 p.

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

Rivoirard, J., J. Simmonds, K.G. Foote, P. Fernandez, and N. Bez. 2000. Geostatistics for estimating fish abundance. Blackwell Science Ltd., Osney Mead, Oxford OX2 0EL, England. 206 p.

Simrad. 1993. Simrad BI500 post-processing system reference manuals V5.20. Simrad Subsea A/S, Strandpromenenaden 50, Box 111, N-3191 Horten, Norway.

Simrad. 2001. Simrad EK60 scientific echo sounder instruction manual Base Version Rev.C. Simrad Subsea A/S, Strandpromenenaden 50, Box 111, N-3191 Horten, Norway.

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

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

SCIENTIFIC PERSONNEL

Name	Sex/Nationality	Position	Organization
		Leg 1 (4 June-3 July)	
Taina Honkalehto	F/USA	Chief Scientist	MACE
William Karp	M/USA	Fish. Biologist	MACE
Steve de Blois	M/USA	Fish. Biologist	MACE
Elaina Jorgensen	F/USA	Fish. Biologist	MACE (4-16 June)
Dale Hanson	M/USA	Fish. Biologist	MACE (16 June-3 July)

Mike Brown	M/USA	Computer Spec.	MACE
Laura Morse	F/USA	Biologist	NMML
Stephanie Norman	F/USA	Biologist	NMML
Suzanne Yin	F/USA	Biologist	NMML
Alexander Nikolayev	M/Russia	Acoustician	TINRO
Mikhail Stepanenko	M/Russia	Fish. Biologist	TINRO

Leg 2 (6-30 July)

Neal Williamson	M/USA	Chief Scientist	MACE
John Horne	M/Canada	Fish. Biologist	UW
Denise McKelvey	F/USA	Fish. Biologist	MACE
Sarah Stienessen	F/USA	Fish. Biologist	MACE
Laura Morse	F/USA	Biologist	NMML
Doug Kinzey	M/USA	Biologist	NMML
Paula Olson	F/USA	Biologist	NMML
Alexander Nikolayev	M/Russia	Acoustician	TINRO
Mikhail Stepanenko	M/Russia	Fish Biologist	TINRO
David Walker	M/USA	Teacher at sea	NOAA

MACE - Midwater Assessment and Conservation Engineering Program,
Alaska Fisheries Science Center, Seattle, WA
NMML - National Marine Mammal Laboratory, AFSC, Seattle WA
NOAA - National Oceanic and Atmospheric Association, Seattle WA
TINRO - TINRO-Centre, Vladivostok, Russia
UW - University of Washington, Seattle WA.

Table 1. Acoustic system description and settings for the summer 2002 echo integration-trawl survey of walleye pollock on the eastern Bering Sea shelf and slope, MF2002-08.

Echosounder:	Simrad EK 500	
Transducer:	ES38B	ES120-7C
Frequency:	38 kHz	120 kHz
Transducer depth:	9.15 m	9.15 m
Absorption coefficient:	10 dB/km	29 dB/km leg 1 38 dB/km leg 2
Pulse length:	Medium (1 ms)	Medium (0.3 ms)
Band width:	Wide (3.8 kHz)	Narrow (1.2 kHz)
Transmitted power:	2000 W	1000 W
Angle sensitivity:	21.9	23.0
2-Way beam angle:	-20.7	-21.0
TS transducer gain:	25.8	27.1
Sv transducer gain:	25.7	27.1
3 dB beamwidth		
Along:	6.90	6.70
Athwart:	6.80	6.70
Angle offset		
Along:	-0.08	-0.23
Athwart:	0.03	-0.14
Range (m):	100, 250, 500, 100(	100, 250
Post-processing		
Sv threshold:	-69 dB	--

[1] 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. Results from standard sphere acoustic system calibrations conducted before, during, and after the summer 2002 echo integration-trawl survey of walleye pollock on the eastern Bering Sea shelf and slope, MF2002-08.

Date	Location	Frequency (kHz)	Water Temp (°C) at Transducer[1]	Water Temp (°C) at Sphere	Sphere Range from Transducer (m)	TS Gain[2] (dB)	Sv Gain[2] (dB)	3-dB Beam Width (deg) Along	3-dB Beam Width (deg) Athwart	Angle Offset (deg) Along	Angle Offset (deg) Athwart
5-Jun	Three Saints Bay	38	aborted -- broken wire in transducer cable								
6-Jun	Three Saints Bay	38	8.0	6.9	44.5	25.8	25.5	6.96	6.89	-0.01	-0.02
		120	8.0	7.0	39.1	25.8	26.0	6.91	6.92	0.05	0.08
9-Jun	Lost Harbor, Akutan	38	5.4	5.3	22.9	25.8	25.8	6.91	6.75	-0.07	0.04
7-Jul	Captains Bay, AK	38	6.9	4.4	30.3	25.7	25.6	6.92	6.80	-0.09	0.01
		120	6.9	4.4	20.7	26.1	26.3				
29-Jul	Humpback Bay	38	8.2	6.4	29.2	25.7	25.3	6.87	6.80	-0.11	0.02
		120	8.2	6.6	24.6	27.1	27.3	6.69	6.66	-0.06	0.04

[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 3. Trawl station and catch data summary from the summer 2002 eastern Bering sea shelf/slope walleye pollock echo integration-trawl survey, MF2002-08.

Haul no.	Gear type[1]	Date	Start time (GMT)	Duration (minutes)	Start Position Latitude		Longitude		Depth (m) Gear[2]	Bottom	Temp. (deg. C) Gear[3]	Surface	Profile No.[4]	Pollock catch (kg)[5]	number	Total catch (kg)
1	83-112	10 Jun	17:53	17	56	28.81	161	35.73	66	66	3.8	5.7	--	1,095.2	2,538	295.3
2	AWT	10 Jun	22:00	20	56	55.61	161	34.05	67	74	2.3	4.9	303	0.0	0	67.3
3	83-112	11 Jun	3:09	15	57	4.67	162	9.80	58	58	3.1	4.6	304	204.7	139	414.7
4	AWT	11 Jun	11:35	28	56	5.68	162	14.10	68	76	3.7	6.2	306	173.5	215	80.4
5	83-112	11 Jun	20:15	10	55	46.83	162	50.20	68	68	3.3	6.5	307	1,039.9	1,046	92.5
6	83-112	12 Jun	9:00	10	56	37.02	163	23.72	78	78	2.5	5.9	308	4.1	3	34.4
7	AWT	12 Jun	10:36	30	56	37.15	163	23.77	69	77	2.5	5.8	309	14.0	15	14.9
8	AWT	12 Jun	19:54	16	55	39.16	163	25.20	65	81	3.1	7	312	307.9	363	331.0
9	83-112	13 Jun	2:22	14	55	13.92	164	0.71	57	57	4.8	7.1	313	776.6	733	283.1
10	AWT	13 Jun	3:45	10	55	13.65	164	0.73	58	58	4.8	6.8	314	54.7	58	382.2
11	AWT	13 Jun	9:08	60	55	56.40	164	0.41	63	93	2.7	6.9	315	477.6	717	22.1
12	AWT	14 Jun	5:16	15	55	55.89	164	36.88	77	95	2.9	7.1	316	501.2	1,753	42.1
13	AWT	14 Jun	10:04	30	55	29.59	164	36.11	66	102	5.2	7.2	317	1,384.1	9,364	18.9
14	AWT	14 Jun	12:14	33	55	29.76	164	36.40	90	102	4.7	7.1	318	496.8	3,362	16.5
15	AWT	14 Jun	19:31	21	55	18.95	164	36.04	72	102	5.4	7.1	319	843.0	5,288	122.2
16	83-112	14 Jun	21:18	10	55	14.08	164	35.86	101	101	4.2	6.5	320	480.3	491	31.2
17	AWT	15 Jun	0:02	30	55	3.33	164	35.10	54	63	5.6	7.1	321	149.6	133	168.1
18	AWT	15 Jun	10:51	20	54	54.98	165	9.92	104	112	5.5	5.8	322	893.4	919	2.4
19	AWT	15 Jun	20:50	25	55	39.02	165	12.25	105	110	4.4	6.6	323	319.3	467	36.2
20	AWT	15 Jun	23:34	10	55	47.56	165	11.92	73	101	4.6	6.9	324	974.3	6,818	15.8
21	83-112	16 Jun	19:06	20	56	33.81	165	49.49	82	82	2.7	7.1	325	238.0	340	110.0
22	AWT	16 Jun	22:32	21	56	10.48	165	48.44	90	98	4.3	9.8	326	654.6	5,404	18.1
23	AWT	17 Jun	3:50	4	55	45.55	165	47.23	101	110	4.6	7.3	327	1,478.6	9,249	26.5
24	AWT	17 Jun	7:08	10	55	22.86	165	46.24	101	120	4.3	8.6	328	139.6	154	13.8
25	83-112	17 Jun	21:27	10	54	20.85	165	43.84	96	96	4.9	8	329	30.4	35	0.0
26	AWT	18 Jun	6:37	6	54	9.38	166	17.94	123	141	5.6	8.4	330	1,188.7	1,832	0.0
27	AWT	18 Jun	11:36	15	54	25.38	165	39.96	150	150	4.4	8.3	332	191.5	187	4.4

Table 3. Continued.

Haul no.	Gear type[1]	Date	Start time (GMT)	Duration (minutes)	Start Position Latitude	Start Position Longitude	Depth (m) Gear[2]	Depth (m) Bottom	Temp. (deg. C) Gear[3]	Temp. (deg. C) Surface	Profile No.[4]	Pollock catch (kg)[5]	Pollock catch number	Other catch (kg)
28	AWT	18 Jun	14:37	13	54 22.19	165 45.16	128	137	5.5	7.9	333	6,019.7	8,818	0.0
29	AWT	19 Jun	3:56	2	56 13.52	166 24.99	96	109	4.6	8.3	334	1,796.2	11,317	30.1
30	AWT	19 Jun	10:54	10	56 28.81	166 25.66	51	99	5.7	9.6	335	61.2	402	23.3
31	AWT	20 Jun	0:00	26	57 4.44	167 5.23	71	74	3	13.3	336	27.0	32	42.6
32	AWT	20 Jun	3:53	15	56 39.27	167 3.34	93	96	3	12.2	337	813.3	3,326	38.4
33	AWT	20 Jun	5:03	30	56 38.41	167 3.26	46	96	6.5	12.2	338	3.1	8	153.9
34	AWT	20 Jun	8:42	12	56 17.24	167 1.49	77	117	4.3	9.9	339	639.8	2,311	3.4
35	AWT	20 Jun	10:52	30	56 24.35	167 1.88	52	112	6.6	10.2	340	466.7	2,704	2.6
36	AWT	21 Jun	9:23	15	55 33.15	167 33.68	128	138	3.6	9.8	341	593.8	639	6.8
37	AWT	21 Jun	18:12	17	55 57.70	167 36.14	124	132	3.8	8.7	342	1,466.4	1,517	10.5
38	AWT	21 Jun	23:45	7	56 42.35	167 40.43	89	96	3	10.1	343	1,110.1	2,855	43.6
39	AWT	23 Jun	0:39	13	56 38.59	168 18.13	96	108	3.2	10.1	345	788.8	1,509	11.7
40	AWT	23 Jun	7:08	18	55 51.96	168 12.93	137	142	3.8	9.2	346	1,792.9	1,685	1.6
41	83-112	23 Jun	18:42	30	55 29.74	168 9.92	155	155	3.8	8.3	347	185.6	150	308.5
42	AWT	24 Jun	2:51	9	56 23.24	168 51.73	113	128	3.5	10	348	591.4	845	0.0
43	AWT	24 Jun	8:01	10	56 52.71	168 55.02	60	85	3.5	9.7	349	607.0	1,986	24.4
44	AWT	24 Jun	17:50	15	57 12.88	168 57.66	72	75	3.6	9.5	350	184.0	331	16.6
45	AWT	25 Jun	9:17	40	57 59.20	169 41.60	59	71	2.3	9.1	351	295.1	460	24.2
46	AWT	25 Jun	17:51	17	57 25.48	169 37.09	67	71	--	8.4	--	905.1	1,901	18.5
47	AWT	26 Jun	9:17	30	56 21.23	170 4.10	104	110	3.4	9.8	354	716.8	1,305	4.1
48	AWT	26 Jun	17:31	26	56 46.17	170 5.68	84	90	4.5	9.8	355	937.0	1,273	86.3
49	AWT	27 Jun	1:12	16	57 45.36	170 17.05	69	73	2.7	9.8	356	375.9	1,302	18.3
50	AWT	27 Jun	22:25	60	59 11.55	171 10.84	70	77	0.8	7.8	358	539.3	603	418.2
51	AWT	28 Jun	5:00	12	58 24.67	171 2.49	79	84	2.4	7.6	359	1,426.1	7,648	96.6
52	AWT	28 Jun	9:37	20	57 49.23	170 56.00	66	87	3.5	10.3	360	437.2	844	18.2
53	AWT	28 Jun	13:57	25	57 49.47	170 56.05	68	87	3.5	9.7	361	531.3	816	4.0
54	AWT	28 Jun	19:26	16	57 5.14	170 48.47	85	88	3.9	9.7	362	409.0	644	57.0
55	AWT	28 Jun	23:31	13	56 36.58	170 43.61	107	115	3.9	10.3	363	390.3	723	3.0
56	83-112	29 Jun	2:56	19	56 15.71	170 40.21	124	124	3.8	9.6	364	1,378.7	1,465	351.3
57	AWT	29 Jun	12:02	20	56 39.49	171 22.02	114	121	3.6	10	365	488.6	593	0.0

Table 3. Continued.

Haul no.	Gear type[1]	Date	Start time (GMT)	Duration (minutes)	Start Position Latitude		Start Position Longitude		Depth (m) Gear[2]	Depth (m) Bottom	Temp. (deg. C) Gear[3]	Temp. (deg. C) Surface	Profile No.[4]	Pollock catch (kg)[5]	Pollock catch number	Other catch (kg)
58	AWT	29 Jun	20:29	28	57	16.85	171	26.61	99	102	3.6	10.3	366	287.5	538	3.3
59	83-112	30 Jun	2:20	15	58	0.75	171	34.26	98	98	3.1	10.4	367	1,307.6	2,919	392.4
60	AWT	30 Jun	6:25	37	58	30.08	171	38.56	81	95	2.5	10.4	368	181.6	612	22.3
61	AWT	30 Jun	10:44	20	59	1.86	171	46.28	78	87	1.2	9.3	369	320.4	565	31.2
62	AWT	1 Jul	19:00	9	58	59.69	172	24.58	85	99	2	9.7	370	163.4	318	5.7
63	83-112	1 Jul	21:28	15	58	48.67	172	22.97	101	101	2.4	9.9	371	559.7	1,288	79.0
64	AWT	2 Jul	0:13	12	58	34.15	172	19.74	49	102	6	10.2	372	1,096.5	6,009	1.0
65	AWT	2 Jul	8:22	25	57	14.46	172	3.56	100	111	3.5	10.3	373	138.9	174	0.0
66	AWT	2 Jul	12:49	20	57	14.34	172	3.37	104	111	3.5	10.5	374	17.1	188	0.0
67	83-112	8 Jul	20:42	20	57	26.38	172	43.46	118	118	3.5	10.8	375	895.7	1,185	36.2
68	AWT	9 Jul	2:06	30	58	7.61	172	52.02	86	108	3.5	10.1	376	185.9	234	7.6
69	AWT	9 Jul	9:16	4	59	0.29	173	3.34	77	107	2.9	10.6	377	827.6	2,931	8.6
70	AWT	9 Jul	12:57	17	58	54.43	173	2.66	93	109	3.1	10.2	378	287.2	771	0.5
71	AWT	9 Jul	14:18	21	58	55.61	173	2.17	47	109	5.8	10.2	379	0.1	1	124.9
72	83-112	9 Jul	19:39	23	59	37.98	173	11.49	96	96	1.6	9	380	589.2	938	12.5
73	AWT	10 Jul	1:05	18	60	9.57	173	18.59	57	67	4.5	8.4	--	2.5	2	25.1
74	83-112	10 Jul	18:50	15	60	22.91	174	4.15	90	90	1.6	7.5	382	2,083.4	5,481	104.6
75	83-112	10 Jul	23:23	20	59	55.50	173	57.32	100	100	1.9	9.2	383	72.5	141	21.4
76	AWT	11 Jul	3:35	11	59	39.21	173	53.19	96	106	4.9	9.8	384	641.4	1,573	24.8
77	AWT	11 Jul	6:47	9	59	23.54	173	49.12	63	110	4.4	10	385	450.9	1,746	80.1
78	AWT	11 Jul	21:27	25	58	43.13	173	40.51	109	127	3.3	9.9	386	190.5	278	7.5
79	AWT	12 Jul	6:09	25	57	34.77	173	23.22	136	137	3.6	10.3	387	1,769.6	2,540	0.0
80	83-112	12 Jul	10:59	12	57	33.50	173	21.15	136	136	3.5	10.1	388	226.8	295	6.4
81	AWT	12 Jul	18:16	12	57	47.07	174	15.74	227	234	3.4	10.3	389	0.0	0	20.4
82	AWT	12 Jul	22:55	36	57	43.37	174	7.23	96	116	4	10.6	390	0.0	0	600.1
83	AWT	13 Jul	19:12	46	57	41.11	173	53.82	101	110	3.7	10.1	391	0.0	0	1.1
84	AWT	14 Jul	6:40	60	58	52.70	174	20.46	114	133	3.3	10.2	392	474.2	577	19.4
85	AWT	14 Jul	12:19	17	58	55.34	174	21.09	98	132	3.3	10.1	393	224.0	289	3.5
86	AWT	14 Jul	18:50	27	59	28.20	174	29.74	114	121	2.8	9.9	396	288.4	396	96.7
87	AWT	14 Jul	22:19	39	59	47.70	174	34.65	47	113	6.4	10.3	397	203.8	1,147	420.5

Table 3. Continued.

Haul no.	Gear type[1]	Date	Start time (GMT)	Duration (minutes)	Start Position Latitude		Longitude		Depth (m) Gear[2]	Bottom	Temp. (deg. C) Gear[3]	Surface	Profile No.[4]	Pollock catch (kg)[5]	number	Other catch (kg)
88	AWT	15 Jul	1:15	9	59	42.85	174	33.65	111	115	2.4	10.5	398	867.7	5,636	45.3
89	AWT	15 Jul	3:54	41	59	37.06	174	32.02	91	117	2.5	10.5	399	19.4	48	54.7
90	AWT	15 Jul	10:15	12	60	1.48	174	38.56	42	110	6.7	10.1	400	202.7	1,414	44.7
91	AWT	15 Jul	12:39	15	60	7.64	174	40.19	97	107	1.9	10.1	401	895.3	2,248	2.4
92	AWT	15 Jul	16:23	9	60	29.62	174	46.36	94	101	1.7	9.2	402	222.9	666	49.6
93	AWT	15 Jul	19:36	8	60	49.56	174	51.69	88	96	1.2	9.2	403	1,373.3	3,707	23.6
94	AWT	16 Jul	4:02	15	61	8.62	175	38.56	42	101	4	9.6	404	46.0	260	176.1
95	AWT	16 Jul	7:54	10	60	50.56	175	32.96	89	107	2.1	9.4	405	340.4	1,327	77.6
96	AWT	16 Jul	14:23	11	60	38.17	175	29.21	90	109	1.9	9.6	406	525.9	1,790	8.9
97	AWT	16 Jul	17:46	17	60	34.71	175	28.31	57	107	2.7	10	407	711.7	5,107	135.2
98	AWT	16 Jul	21:41	26	60	10.39	175	21.30	56	115	4.2	11	408	406.7	3,208	117.3
99	AWT	17 Jul	8:28	40	58	38.72	174	55.74	302	302	3.2	11.7	409	4.6	4	16.5
100	83-112	17 Jul	10:43	29	58	38.65	174	56.76	313	313	3.3	11.4	410	0.0	0	0.0
101	AWT	18 Jul	3:16	4	59	39.54	175	51.83	126	137	2.3	11.4	411	735.4	2,827	2.2
102	AWT	18 Jul	15:41	11	60	38.08	176	5.93	93	119	1.6	10.4	412	535.8	2,744	13.5
103	AWT	18 Jul	19:22	16	61	2.11	176	17.68	105	112	1.7	9.9	413	422.5	533	16.9
104	AWT	18 Jul	23:45	7	61	33.83	176	27.75	101	107	0.4	9.9	414	3,294.2	7,350	25.8
105	AWT	19 Jul	9:18	4	60	49.56	176	54.59	97	127	2	10.4	415	527.5	2,694	22.5
106	AWT	20 Jul	23:53	14	60	46.70	176	53.61	98	127	2	10.3	417	456.9	1,385	19.3
107	AWT	21 Jul	8:47	6	59	39.43	176	31.32	103	137	2.1	11.2	418	425.8	3,227	0.0
108	AWT	21 Jul	11:24	10	59	39.83	176	31.52	40	137	6.4	9.1	419	229.0	2,579	0.0
109	AWT	21 Jul	19:35	12	59	17.95	176	26.14	127	137	2.2	10.3	421	1,482.5	2,136	2.6
110	AWT	22 Jul	17:27	11	59	53.03	177	18.00	125	136	1.8	9.9	422	425.8	1,901	4.6
111	AWT	23 Jul	0:26	17	60	50.29	177	35.74	125	138	1.6	10.2	423	680.2	1,877	0.0
112	AWT	23 Jul	6:59	9	60	58.25	178	20.68	158	162	2.2	10	424	805.4	3,540	1.7
113	AWT	23 Jul	9:05	22	60	58.20	178	21.05	156	162	2.2	10	425	136.2	755	4.7
114	AWT	23 Jul	11:21	20	60	58.28	178	20.68	152	162	2.1	10.1	426	104.9	438	8.0
115	AWT	23 Jul	13:30	20	60	58.24	178	20.73	148	162	2.1	9.8	427	61.7	251	2.0
116	AWT	23 Jul	17:19	5	60	42.88	178	15.41	138	165	2.2	10.1	428	671.8	3,588	3.1
117	AWT	23 Jul	21:09	3	60	18.74	178	7.51	100	156	2.4	10.4	429	1,723.3	48,918	10.7

Table 3. Continued.

Haul no.	Gear type[1]	Date	Start time (GMT)	Duration (minutes)	Start Position Latitude		Start Position Longitude		Depth (m) Gear[2]	Depth (m) Bottom	Temp. (deg. C) Gear[3]	Temp. (deg. C) Surface	Profile No.[4]	Pollock catch (kg)[5]	Pollock catch number	Other catch (kg)
118	AWT	24 Jul	11:52	6	60	18.86	178	16.27	49	163	7.4	10.1	430	570.7	14,779	9.9
119	AWT	25 Jul	10:15	8	59	54.10	177	53.15	121	142	1.9	10.4	431	292.8	939	0.0
120	AWT	25 Jul	12:09	11	59	54.12	177	53.46	107	142	1.9	10.2	432	106.5	350	0.5
121	AWT	25 Jul	13:17	12	59	54.05	177	54.72	108	143	1.9	9.9	433	290.7	1,021	1.5
122	AWT	26 Jul	9:50	11	59	6.57	173	53.03	113	118	3.3	11.9	434	394.3	892	0.0
123	AWT	26 Jul	14:24	29	59	3.39	173	56.03	89	119	3.4	11.4	435	19.4	132	0.2
124	AWT	27 Jul	9:18	9	57	54.00	170	16.76	49	75	6.3	11.8	436	2.2	97	112.0
125	AWT	28 Jul	9:33	15	55	30.02	166	10.67	116	126	6.1	11.3	437	388.5	876	11.6
126	AWT	28 Jul	14:03	31	55	28.81	166	12.37	98	126	5	9.4	438	256.3	712	18.8
201	Methot	11 Jun	9:32	11	56	4.46	162	14.08	75	76	3.7	6.2	305	0.0	0	6.4
202	Methot	12 Jun	12:48	26	56	37.70	163	23.77	38	77	4.2	5.8	310	Trace	45	5.4
203	Methot	12 Jun	13:51	15	56	37.59	163	23.76	54	77	2.5	5.7	311	Trace	25	1.9
204	Methot	18 Jun	2:30	13	54	25.43	165	42.72	71	257	5.4	--	331	0.0	0	11.3
205	Methot	22 Jun	16:33	23	57	51.36	168	25.39	35	71	3	9	344	0.0	0	1.7
206	Methot	25 Jun	23:14	13	56	37.48	169	30.74	21	48	5.3	6	353	Trace	26	0.7
207	Methot	27 Jun	13:54	26	60	0.00	170	38.74	64	65	1.4	7.8	357	Trace	13	9.6
208	Methot	14 Jul	13:28	16	58	56.22	174	21.24	122	130	3.2	10.1	394	Trace	13	0.8
209	Methot	21 Jul	14:23	9	59	39.60	176	32.00	135	137	1.8	10.1	420	0.0	0	0.7

[1] Gear type: AWT=Aleutian wing trawl, 83-112 = 83-112 bottom trawl, Methot=Methot trawl

[2] Gear depth is defined as the trawl footrope depth.

[3] Gear temperature was measured at the trawl headrope depth.

[4] Temperature data collected with Sea-Bird SBE39

[5] Trace indicates less than 0.1kg captured.

Table 4. Catch by species from 108 Aleutian wing trawl hauls conducted during the summer 2002 pollock echo integration-trawl survey of the eastern Bering Sea shelf/slope, MF2002-08.

Common name	Scientific name	Weight (kg)	Weight (%)	Numbers
walleye pollock	*Theragra chalcogramma*	63,063.8	92.5	257,540
jellyfish	Scyphozoa	4,144.1	6.1	531
northern rockfish	*Sebastes polyspinis*	324.3	0.5	648
Pacific ocean perch	*Sebastes alutus*	280.6	0.4	1,217
chrysaora jellyfish	*Chrysaora* sp.	124.1	0.2	-
Pacific cod	*Gadus macrocephalus*	98.2	0.1	34
chum salmon	*Oncorhynchus keta*	26.7	< 0.1	8
coho salmon	*Oncorhynchus kisutch*	17.2	< 0.1	6
eulachon	*Thaleichthys pacificus*	11.7	< 0.1	159
yellowfin sole	*Limanda aspera*	10.5	< 0.1	19
squid	Teuthoidea	10.3	< 0.1	-
flathead sole	*Hippoglossoides elassodon*	7.2	< 0.1	13
smooth lumpsucker	*Aptocyclus ventricosus*	5.4	< 0.1	3
dusky rockfish	*Sebastes ciliatus*	4.0	< 0.1	2
chinook salmon	*Oncorhynchus tshawytscha*	3.8	< 0.1	1
shrimp	*Pandalas* sp.	3.7	< 0.1	1,260
rock sole	*Lepidopsetta* sp.	3.4	< 0.1	8
Pacific lamprey	*Lampetra tridentata*	2.9	< 0.1	7
arrowtooth flounder	*Atheresthes stomias*	2.8	< 0.1	4
lumpsucker	Cyclopterinae	2.3	< 0.1	1
great sculpin	*Myoxocephalus polyacanthocephalus*	1.3	< 0.1	1
magistrate armhook squid	*Berryteuthis magister*	1.3	< 0.1	10
capelin	*Mallotus villosus*	1.0	< 0.1	37
Pacific herring	*Clupea pallasi*	1.0	< 0.1	2
northern shrimp	*Pandalus borealis*	0.4	< 0.1	67
sturgeon poacher	*Podothecus acipenserinus*	0.4	< 0.1	6
Alaska plaice	*Pleuronectes quadrituberculatus*	0.3	< 0.1	1
prowfish	*Zaprora silenus*	0.2	< 0.1	1
Atka mackerel	*Pleurogrammus monopterygius*	0.2	< 0.1	1
bigfin eelpout	*Lycodes cortezianus*	0.1	< 0.1	1
daubed shanny	*Lumpenus maculatus*	0.0	< 0.1	1
lanternfish	Myctophidae	0.0	< 0.1	1
Totals		68,153.0		261,590

Table 5. Catch by species from 18 bottom trawl hauls conducted during the summer 2002 pollock echo integration-trawl survey of the eastern Bering Sea shelf/slope, MF2002-08.

Common name	Scientific name	Weight (kg)	Weight (%)	Numbers
walleye pollock	*Theragra chalcogramma*	11,168.4	81.3	19,187
Pacific cod	*Gadus macrocephalus*	357.0	2.6	147
yellowfin sole	*Limanda aspera*	337.8	2.5	1,372
flathead sole	*Hippoglossoides elassodon*	274.7	2.0	678
arrowtooth flounder	*Atheresthes stomias*	273.8	2.0	373
jellyfish	Scyphozoa	239.0	1.7	4
rock sole	*Lepidopsetta* sp.	227.9	1.7	872
starfish	Asteroidea	136.9	1.0	2,278
basketstar	*Gorgonocephalus eucnemis*	90.4	0.7	439
red king crab	*Paralithodes camtschaticus*	87.2	0.6	43
Pacific halibut	*Hippoglossus stenolepis*	70.3	0.5	14
Alaska plaice	*Pleuronectes quadrituberculatus*	67.6	0.5	74
hermit crab	Paguridae	50.4	0.4	619
Alaska skate	*Bathyraja parmifera*	47.8	0.3	11
rex sole	*Glyptocephalus zachirus*	45.2	0.3	122
snail	Gastropoda	43.6	0.3	423
sea urchin	Echinacea	41.5	0.3	1,139
octopus	Octopodidae	36.2	0.3	2
great sculpin	*Myoxocephalus polyacanthocephalus*	26.8	0.2	8
sea anemone	Actiniaria	26.0	0.2	103
empty gastropod shells		17.3	0.1	219
Tanner crab	*Chionoecetes bairdi*	16.4	0.1	184
snow crab	*Chionoecetes opilio*	10.1	0.1	63
brittlestarfish	Ophiuroid	7.6	0.1	1,969
starry flounder	*Platichthys stellatus*	6.8	< 0.1	5
sponge	Porifera	4.6	< 0.1	77
Aleutian skate	*Bathyraja aleutica*	4.2	< 0.1	5
bigmouth sculpin	*Hemitripterus bolini*	3.0	< 0.1	1
	Neptunea sp.	2.5	< 0.1	7
sea cucumber	Holothuroidea	2.3	< 0.1	4
Greenland turbot	*Reinhardtius hippoglossoides*	2.1	< 0.1	2
skate egg case		2.1	< 0.1	63
eelpout	Zoarcidae	1.6	< 0.1	6
plain sculpin	*Myoxocephalus jaok*	1.3	< 0.1	1
cockle	Veneroida	1.3	< 0.1	29
butter sole	*Isopsetta isolepis*	1.1	< 0.1	4
hairy triton	*Fusitriton* sp.	0.9	< 0.1	11
Kamchatka flounder	*Atheresthes evermanni*	0.9	< 0.1	1
snail eggs		0.8	< 0.1	4
sturgeon poacher	*Podothecus acipenserinus*	0.8	< 0.1	9
bivalve unidentifed	Pelecypoda	0.6	< 0.1	5
Atka mackerel	*Pleurogrammus monopterygius*	0.5	< 0.1	1
Pacific herring	*Clupea pallasi*	0.5	< 0.1	2
salmon snailfish	*Careproctus rastrinus*	0.4	< 0.1	1
empty bivalve shells		0.4	< 0.1	1

Table 5 continued

Common name	Scientific name	Weight (kg)	Weight (%)	Numbers
spinyhead sculpin	*Dasycottus setiger*	0.4	< 0.1	1
circumboreal toad crab	*Hyas coarctatus*	0.4	< 0.1	13
ronquil	Bathymasteridae	0.3	< 0.1	1
rose sea star	*Crossaster papposus*	0.3	< 0.1	17
shortfin eelpout	*Lycodes brevipes*	0.3	< 0.1	6
sea pen or sea whip	Pennatulacea	0.3	< 0.1	10
crab	Brachyura	0.2	< 0.1	2
tunicate	*Ascidian unident.*	0.3	< 0.1	4
melon snail	*Volutopsius* sp.	0.1	< 0.1	4
thorny sculpin	*Icelus spiniger*	0.1	< 0.1	7
nudibranch	*Nudibranchia unident.*	0.1	< 0.1	1
bat sea star	*Ceramaster sp.*	0.1	< 0.1	1
rusty moonsnail	*Natica russa*	0.1	< 0.1	9
shrimp	*Pandalas* sp.	0.1	< 0.1	11
scale worm	*Polynoidae*	0.1	< 0.1	11
Pacific lyre crab	*Hyas lyratus*	0.1	< 0.1	7
tanner crab	*Chionoecetes* sp.	0.0	< 0.1	5
graceful decorator crab	*Oregonia gracilis*	0.0	< 0.1	1
sand dollar	Echinoidea	0.0	< 0.1	1
bryozoan	Ectoprocta	0.0	< 0.1	1
shrimp	*Crangon* sp.	0.0	< 0.1	2
capelin	*Mallotus villosus*	0.0	< 0.1	1
squid	Teuthoidea	0.0	< 0.1	1
sea mouse	Aphroditidae	0.0	< 0.1	1
Totals		13,741.9		30,700

Table 6. Catch by species from 9 Methot trawl hauls conducted during the summer 2002 pollock echo integration-trawl survey of the eastern Bering Sea shelf/slope, MF2002-08.

Common name	Scientific name	Weight (kg)	Weight (%)	Numbers
jellyfish	Scyphozoa	20.6	53.7	56
euphausiid	Euphausiacea	14.0	36.6	2951
mottled sea star	*Evasterias troschelii*	1.4	3.7	1
salps	Thaliacea	1.2	3.1	7
yellowfin sole	*Limanda aspera*	0.6	1.4	2
flathead sole	*Hippoglossoides elassodon*	0.4	1.1	2
crangonid shrimp	Crangonidae	0.0	< 0.1	65
flatfish larvae	Pleuronectiformes	0.0	< 0.1	560
amphipod	Amphipoda	0.0	< 0.1	261
walleye pollock	*Theragra chalcogramma*	0.0	< 0.1	122
fish larvae	Teleostei	0.0	< 0.1	21
codlings	Moridae	0.0	< 0.1	205
rockfish	*Sebastes* sp.	0.0	< 0.1	64
polychaete worm	Polychaeta	0.0	< 0.1	17
Totals		38.3		4,334

Table 7. Numbers of walleye pollock biological samples and other fish specimens collected during the summer 2002 pollock echo integration-trawl survey of the eastern Bering Sea shelf/slope, MF2002-08.

				Weight		TINRO	Sea Lion	Outreach Classroom
Haul	Length	Maturity	Otoliths	Fish	Gonad	collection[1]	Fish Prey	Specimens
1	394	82	40	82	-	50	x	x
2	-	-	-	-	-	-	-	-
3	139	82	40	82	-	50	-	x
4	215	58	58	58	-	-	-	-
5	336	90	42	90	-	-	-	-
6	3	-	-	-	-	-	-	-
7	15	-	-	-	-	-	-	-
8	308	55	40	55	-	-	-	-
9	402	67	42	67	1	-	-	x
10	58	-	-	-	-	-	x	-
11	372	-	-	-	-	-	-	x
12	429	81	41	81	-	-	-	-
13	521	73	41	73	-	-	-	-
14	440	124	39	124	-	-	-	-
15	297	80	40	80	-	50	x	-
16	394	97	40	97	-	-	-	-
17	133	87	40	87	2	-	-	-
18	357	93	40	93	-	-	-	-
19	347	119	43	119	-	-	-	-
20	367	48	-	48	-	-	-	-
21	281	59	40	59	-	-	-	-
22	418	107	40	107	-	50	-	-
23	427	46	7	46	-	-	-	-
24	154	68	43	68	1	-	-	-
25	35	35	35	35	-	-	-	-
26	433	96	46	96	-	-	-	-
27	187	64	40	64	-	-	x	-
28	475	50	39	50	-	-	-	-
29	397	56	39	56	-	-	-	-
30	353	49	-	49	-	-	-	-
31	32	32	32	32	-	-	-	-
32	285	36	36	36	-	-	-	-
33	8	-	-	-	-	-	-	-
34	382	54	41	54	-	-	-	-
35	334	60	-	60	-	-	-	-
36	406	84	41	84	-	-	-	x
37	341	49	40	49	-	50	-	-
38	285	48	48	48	1	50	-	-
39	472	84	40	84	2	50	-	-
40	358	84	40	84	2	-	-	-
41	150	31	31	31	-	-	-	x
42	383	84	40	84	1	-	-	-
43	704	90	46	90	1	-	-	-
44	331	24	24	24	-	-	-	-
45	298	39	25	39	-	-	-	-
46	448	45	25	45	-	50	-	-

Table 7 continued

Haul	Length	Maturity	Otoliths	Weight		TINRO	Sea Lion	Outreach Classroom
				Fish	Gonad	collection[1]	Fish Prey	Specimens
47	464	50	21	50	-	-	x	-
48	345	45	25	45	1	50	-	-
49	419	57	24	57	-	-	-	-
50	387	59	26	59	3	50	-	-
51	584	59	20	59	-	-	-	-
52	461	66	25	66	1		-	-
53	331	-	-	-	-	-	-	-
54	339	41	25	41	-	-	-	-
55	342	59	26	59	1	-	-	-
56	397	57	25	57	2	-	-	-
57	363	38	24	38	-	-	-	-
58	482	56	25	56	-	-	-	x
59	499	59	25	59	-	-	x	-
60	350	50	25	50	-	-	-	-
61	327	47	25	47	-	-	-	-
62	318	58	25	58	-	-	-	-
63	495	53	25	55	-	50	-	-
64	459	60	25	60	-	-	-	-
65	174	34	20	34	-	-	-	-
66	188	-	-	-	-	-	x	-
67	351	55	55	55	-	50	-	-
68	234	44	44	44	-	-	-	-
69	533	50	41	50	-	-	-	-
70	586	-	-	185	-	-	-	-
71	1	-	-	-	-	-	-	-
72	310	42	42	42	-	50	-	-
73	2	2	-	2	-	-	-	-
74	492	53	53	53	-	-	x	x
75	141	40	40	40	-	-	-	-
76	324	40	40	40	-	-	-	-
77	334	40	40	40	-	-	-	-
78	278	41	41	41	-	-	-	-
79	332	40	40	40	-	-	-	-
80	295	-	-	-	-	-	-	-
81	-	-	-	-	-	-	-	-
82	-	-	-	-	-	-	-	-
83	-	-	-	-	-	-	-	-
84	304	37	37	37	-	-	-	-
85	289	99	-	99	-	-	-	-
86	309	35	35	35	-	50	-	x
87	341	43	43	43	-	-	-	-
88	570	36	36	36	-	-	-	-
89	48	-	-	-	-	-	-	-
90	344	34	34	34	-	-	-	-
91	307	41	41	41	-	-	-	-
92	338	33	33	33	-	-	-	-
93	361	38	38	38	-	-	-	-
94	260	35	35	35	-	-	-	-
95	355	36	36	36	-	-	-	-

Table 7 continued

Haul	Length	Maturity	Otoliths	Weight: Fish	Weight: Gonad	TINRO collection[1]	Sea Lion Fish Prey	Outreach Classroom Specimens
96	443	52	35	52	-	-	-	-
97	413	57	35	57	-	50	-	-
98	310	-	-	-	-	-	-	-
99	4	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-
101	428	36	36	36	-	-	-	-
102	452	53	35	53	-	50	-	-
103	301	32	32	32	-	50	-	-
104	405	35	35	35	-	50	-	-
105	471	34	34	34	-	-	-	-
106	280	-	-	-	-	-	-	-
107	668	36	36	36	-	-	-	-
108	598	53	35	53	-	-	-	-
109	329	47	47	47	-	50	-	-
110	398	32	32	32	-	-	-	-
111	309	35	35	35	-	-	-	-
112	365	35	35	35	-	-	-	-
113	252	29	-	29	-	-	-	-
114	438	-	-	-	-	-	-	-
115	251	-	-	-	-	-	-	-
116	323	45	34	45	-	50	-	-
117	391	37	37	37	-	-	-	-
118	362	-	-	-	-	-	-	-
119	333	36	36	36	-	-	-	-
120	350	0	0	0	-	-	-	-
121	442	0	0	0	-	-	-	-
122	325	76	0	76	-	-	-	-
123	132	0	0	0	-	-	-	-
124	97	0	0	0	-	-	-	-
125	389	98	0	98	-	-	-	-
126	308	36	0	36	-	-	-	-
Totals	40,234	5,466	3,233	5,653	19	1,000	8 sites	9 sites

[1]TINRO center biological sampling includes weight, length, sex, maturity, stomach contents, and otolith collection.

Table 8. Abundance of pollock by area from summer echo integration-trawl surveys on the Bering Sea shelf, 1994-2002. Data are estimated pollock biomass between 14 m below the surface and 3 m off bottom. Relative estimation error for the acoustic data is indicated.

Date		**Area** (nmi)^2	**Biomass (million metric tons, top) and percent of total (bottom)** **SCA**	**E170-SCA**	**W170**	**Total Biomass (million metric tons)**	**Relative estimation error**
Summer 1994	9 Jul-19 Aug	78,251	0.312	0.399	2.18	2.89	0.047
			10.8	13.8	75.4		
Summer 1996	20 Jul-30 Aug	93,810	0.215	0.269	1.83	2.31	0.039
			9.3	11.7	79.0		
Summer 1997	17 Jul-4 Sept	102,770	0.246	0.527	1.82	2.59	0.037
			9.5	20.3	70.2		
Summer 1999	7 Jun-5 Aug	103,670	0.299	0.579	2.41	3.29	0.055
			9.1	17.6	73.2		
Summer 2000	7 Jun-2 Aug	106,140	0.393	0.498	2.16	3.05	0.032
			12.9	16.3	70.8		
Summer 2002	4 Jun -30 Jul	99,526	0.647	0.797	2.18	3.62	0.031
			17.9	22.0	60.1		

SCA = Sea lion Conservation Area
E170 - SCA = East of 170°W minus SCA
W170 = West of 170°W

Table 9. Estimated length composition (numbers in millions, 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, 1994-2002. No surveys were made in 1995, 1998 or 2001; 1999 estimates exclude fish from additional sampling in the "horseshoe area" between Unimak and 167°W.

Length (cm)	1994 numbers (millions)	1994 biomass (tons)	1996 numbers (millions)	1996 biomass (tons)	1997 numbers (millions)	1997 biomass (tons)	1999 numbers (millions)	1999 biomass (tons)	2000 numbers (millions)	2000 biomass (tons)	2002 numbers (millions)	2002 biomass (tons)
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0.031	<1	0	0
9	0	0	0	0	0	0	0.012	<1	0.031	<1	0	0
10	0	0	0	0	2.040	14	0.118	1	0.763	8	0.014	<1
11	0.403	4	0	0	0.192	2	4.782	59	2.296	30	0.77	9
12	5.438	71	0.469	6	30.134	394	14.434	227	5.500	88	4.695	75
13	44.786	744	5.441	92	238.098	4,148	22.713	445	19.257	370	21.36	428
14	94.230	1,937	38.196	804	1,416.214	31,282	22.353	538	36.696	859	100.475	2,488
15	179.819	4,520	131.291	3,384	2,949.252	81,544	16.200	472	56.690	1,613	194.975	5,841
16	166.052	5,040	227.770	7,098	3,364.001	111,182	5.203	181	79.567	2,713	178.722	6,393
17	105.162	3,817	317.309	11,818	2,207.832	84,460	5.198	214	50.812	2,055	99.737	4,231
18	129.713	5,553	215.264	9,485	1,309.127	58,223	12.916	623	22.388	1,064	33.471	1,664
19	212.540	10,655	115.387	5,960	569.514	28,768	44.600	2,499	30.274	1,677	40.071	2,284
20	381.962	22,244	64.787	3,892	181.058	10,677	152.569	9,852	47.160	3,017	61.896	4,072
21	589.693	39,601	37.201	2,579	74.899	4,900	251.491	18,587	92.375	6,782	162.631	12,242
22	794.282	61,100	64.413	5,121	81.073	6,101	314.306	26,421	136.409	11,419	289.689	24,828
23	788.346	69,048	60.239	5,458	150.802	12,962	288.898	27,464	185.756	17,629	485.717	47,351
24	772.580	76,622	70.324	7,221	255.935	24,999	220.314	23,562	186.043	19,911	734.726	81,309
25	581.454	64,967	47.677	5,520	408.069	45,081	164.372	19,681	207.954	24,970	859.818	107,760
26	372.265	46,652	38.316	4,979	458.826	56,998	188.577	25,168	186.914	25,070	832.358	117,666
27	198.974	27,847	33.635	4,884	519.671	72,339	256.036	37,933	187.684	28,002	718.035	113,478
28	122.073	19,028	60.160	9,721	422.680	65,700	302.469	49,557	168.927	27,927	516.419	89,827
29	135.899	23,550	85.070	15,240	296.502	51,328	419.155	75,679	164.764	30,072	491.259	92,941
30	138.254	26,437	122.805	24,307	175.363	33,691	435.283	86,321	167.171	33,574	507.568	104,158

Table 9. Continued.

Length (cm)	1994 numbers (millions)	1994 biomass (tons)	1996 numbers (millions)	1996 biomass (tons)	1997 numbers (millions)	1997 biomass (tons)	1999 numbers (millions)	1999 biomass (tons)	2000 numbers (millions)	2000 biomass (tons)	2002 numbers (millions)	2002 biomass (tons)
31	178.832	37,756	183.984	40,104	115.827	24,685	417.133	90,579	169.720	37,396	592.862	132,640
32	234.801	54,180	240.984	57,669	79.116	18,522	410.191	97,251	167.231	40,301	539.676	131,538
33	239.386	60,378	341.561	89,480	69.153	17,709	372.648	96,204	188.702	49,614	533.403	141,718
34	291.495	80,001	408.413	116,812	68.831	19,201	393.576	110,357	221.592	63,403	421.169	122,045
35	296.566	88,546	458.383	142,771	89.484	27,148	415.935	126,368	332.901	103,387	291.898	92,414
36	326.662	105,903	477.948	161,724	146.278	48,272	433.114	142,256	360.412	121,237	239.361	82,291
37	343.989	120,806	400.982	147,067	220.621	79,075	393.544	139,441	414.223	150,552	218.569	81,503
38	305.794	116,110	333.419	132,264	321.354	124,841	403.472	153,908	369.243	144,826	222.313	88,680
39	294.823	121,143	253.698	108,629	397.122	166,999	359.069	147,178	344.626	145,465	218.506	93,405
40	311.312	137,651	214.240	98,825	397.831	180,668	304.476	133,859	297.136	135,080	209.209	95,675
41	271.091	129,335	168.180	83,422	350.373	171,750	243.059	114,415	331.554	161,884	200.428	98,165
42	289.526	149,294	154.985	82,523	292.974	154,670	240.382	120,957	316.410	165,982	179.46	94,168
43	273.093	152,526	149.274	85,177	222.045	125,886	265.326	142,492	331.240	185,961	186.316	104,975
44	243.930	147,017	133.456	81,478	172.494	104,750	321.315	183,897	302.442	181,482	185.259	110,994
45	256.581	166,444	117.959	76,937	125.076	81,320	328.569	200,114	290.085	185,345	197.146	125,772
46	216.089	149,720	103.478	71,999	93.202	64,736	304.971	197,389	249.821	169,854	183.59	124,740
47	177.931	131,130	98.392	72,930	74.746	55,323	238.840	164,067	235.521	170,024	182.869	132,267
48	148.148	115,921	94.287	74,352	59.370	46,750	182.908	133,183	176.807	135,575	168.361	129,623
49	73.110	60,566	83.667	70,102	45.506	38,100	122.899	94,742	143.241	116,332	154.429	126,481
50	66.743	58,531	79.869	71,016	40.226	35,728	88.163	71,872	106.266	91,389	133.478	115,778
51	33.152	30,462	72.517	68,346	33.097	31,145	60.415	52,026	78.542	71,352	117.739	108,641
52	30.347	29,789	60.209	60,080	31.717	31,560	42.152	38,303	48.154	46,186	91.921	89,753
53	18.153	18,463	50.892	53,710	29.587	31,087	33.020	31,630	35.747	36,163	88.428	91,552
54	15.676	16,856	38.439	42,859	23.912	26,500	26.896	27,130	22.093	23,496	62.983	68,832
55	18.573	21,296	25.630	30,163	19.766	23,075	16.141	17,129	16.578	18,562	44.337	51,122
56	11.047	13,207	14.068	17,456	14.583	17,914	9.258	10,327	12.576	14,788	40.16	48,961
57	9.523	11,943	7.649	9,998	10.615	13,712	9.401	11,013	8.923	11,004	24.156	30,986
58	4.849	6,368	7.685	10,573	8.599	11,671	5.681	6,984	6.412	8,300	18.765	25,335
59	2.955	4,167	3.017	4,365	5.981	8,530	3.239	4,174	5.132	6,962	11.263	15,953
60	3.473	5,001	4.713	7,163	3.450	5,155	3.039	4,104	1.869	2,656	10.576	15,550
61	6.625	10,199	2.877	4,591	4.580	7,172	2.401	3,394	2.302	3,421	7.114	11,003
62	1.395	2,285	1.791	2,998	1.555	2,550	2.121	3,135	1.725	2,679	3.915	6,415
63	0.710	1,196	0.284	498	2.010	3,448	0.617	953	1.571	2,551	2.18	3,683
64	0.485	844	0.590	1,084	0.470	843	0.574	925	0.979	1,660	1.743	3,109

Table 9. Continued.

Length (cm)	1994 numbers (millions)	1994 biomass (tons)	1996 numbers (millions)	1996 biomass (tons)	1997 numbers (millions)	1997 biomass (tons)	1999 numbers (millions)	1999 biomass (tons)	2000 numbers (millions)	2000 biomass (tons)	2002 numbers (millions)	2002 biomass (tons)
65	1.859	3,382	0.851	1,637	0.811	1,531	0.927	1,562	0.636	1,122	1.741	3,223
66	0.771	1,467	0.350	704	0.315	617	1.421	2,497	0.702	1,296	1.159	2,202
67	0.970	1,929	0.659	1,386	1.269	2,622	0.478	876	0.027	52	0.267	505
68	1.455	3,021	0	0	0.194	413	0.297	567	0.273	551	0.165	352
69	0.0	0	0	0	0.586	1,351	0.294	585	0.591	1,244	0	0
70	1.925	4,349	0	0	0.099	230	0	0	0	0	0.429	945
71	0.485	1,142	0.107	267	0	0	0.001	3	0	0	0.014	33
72	0.970	2,380	0	0	0	0	0.107	238	0.148	351	0	0
73	0.485	1,239	0	0	0.048	126	0.156	362	0	0	0	0
74	0	0	0	0	0	0	0	0	0.141	362	0	0
75	0.485	1,340	0	0	0	0	0.036	90	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0	0	0
78	0.485	1,503	0	0	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0.387	1,118	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0
Total	10,820.683	2,888,217	6,525.240	2,312,724	18,686.153	2,594,175	9,600.647	3,287,137	7,629.756	3,050,697	12,121.763	3,622,072

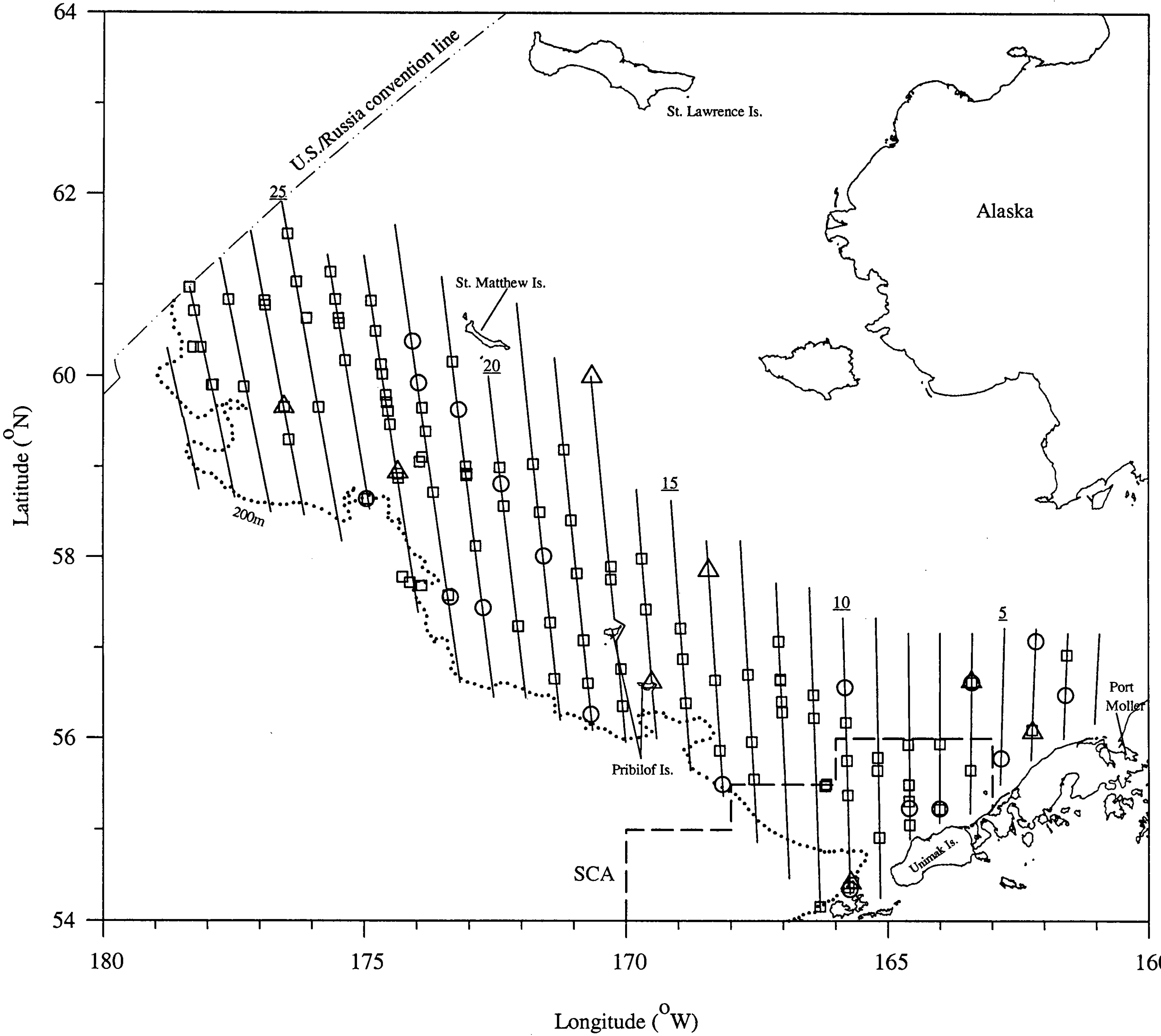

Figure 1. Transect lines with locations of midwater (square), bottom (circle), and Methot (triangle) trawl hauls during the summer 2002 pollock echo integration-trawl survey of the eastern Bering Sea shelf and slope, MF2002-08. Underlined numbers indicate transect sequence, and the Steller sea lion Conservation Area (SCA) is outlined.

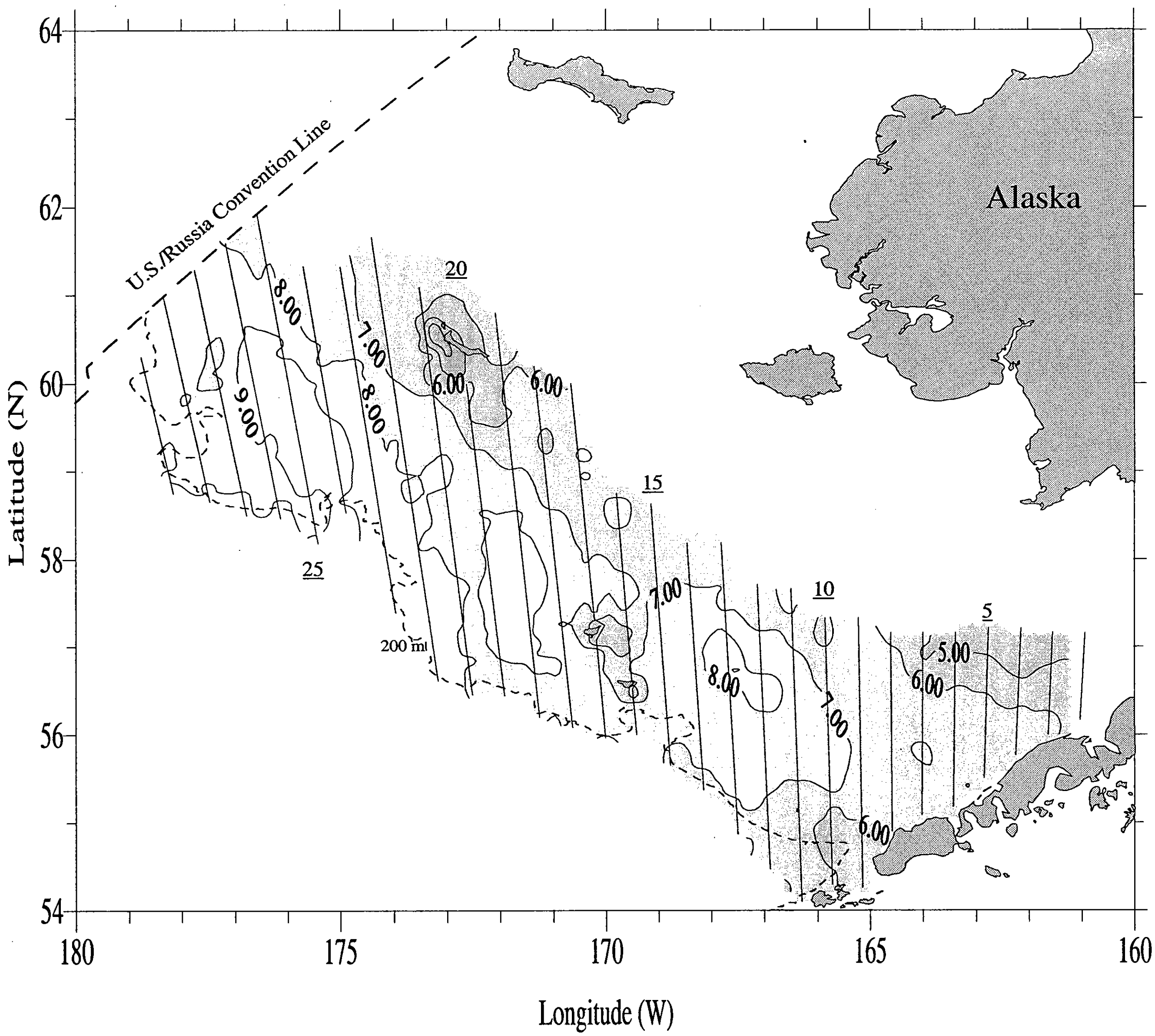

Figure 2. Transect lines with surface temperature contours (in degrees C) during the summer 2000 echo integration-trawl survey of the eastern Bering Sea shelf. Underlined numbers indicate transect sequence.

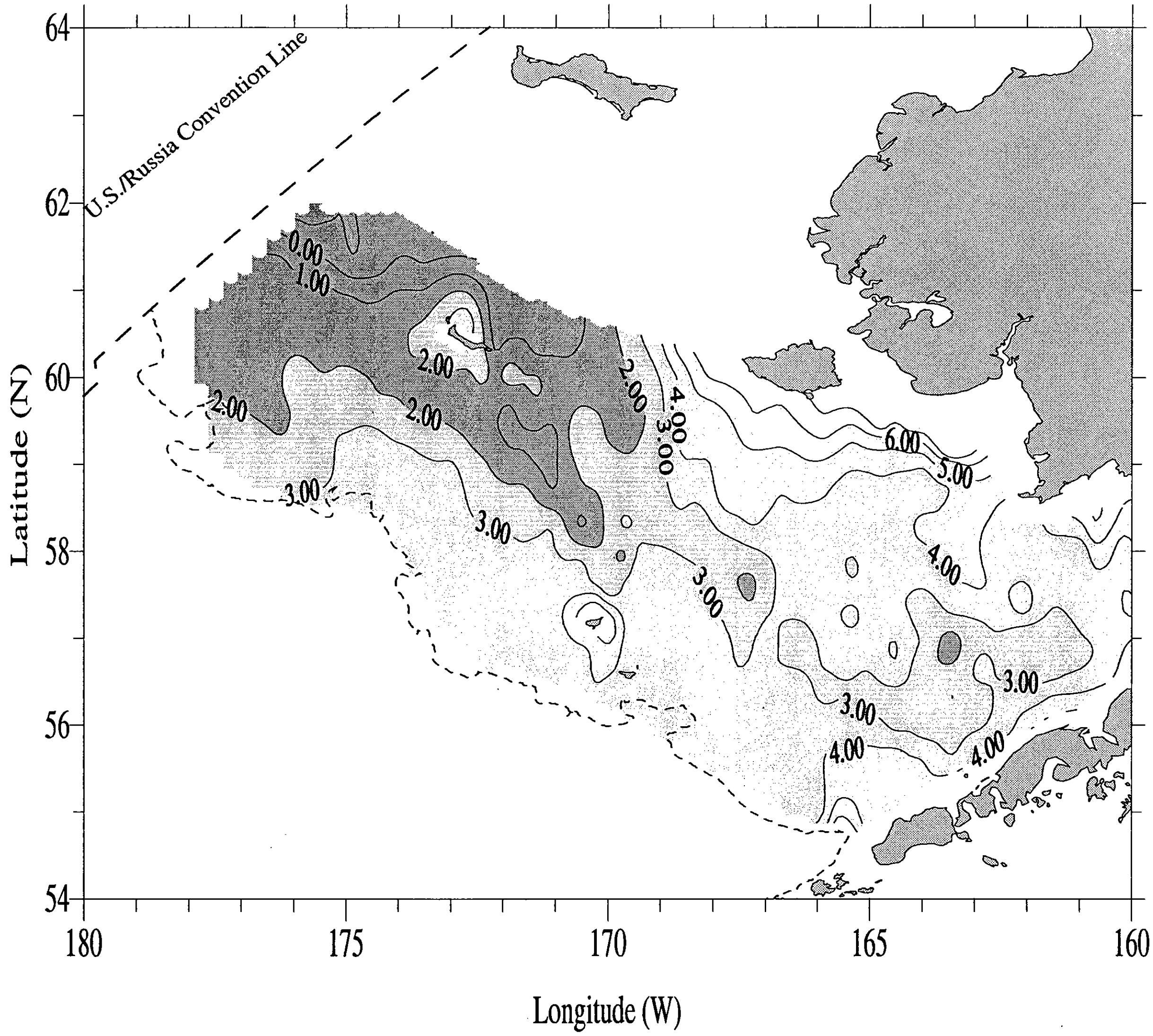

Figure 3. Bottom temperature contours (in degrees C) during the summer 2002 eastern Bering Sea bottom trawl survey. Data from T. Sample (AFSC, RACE).

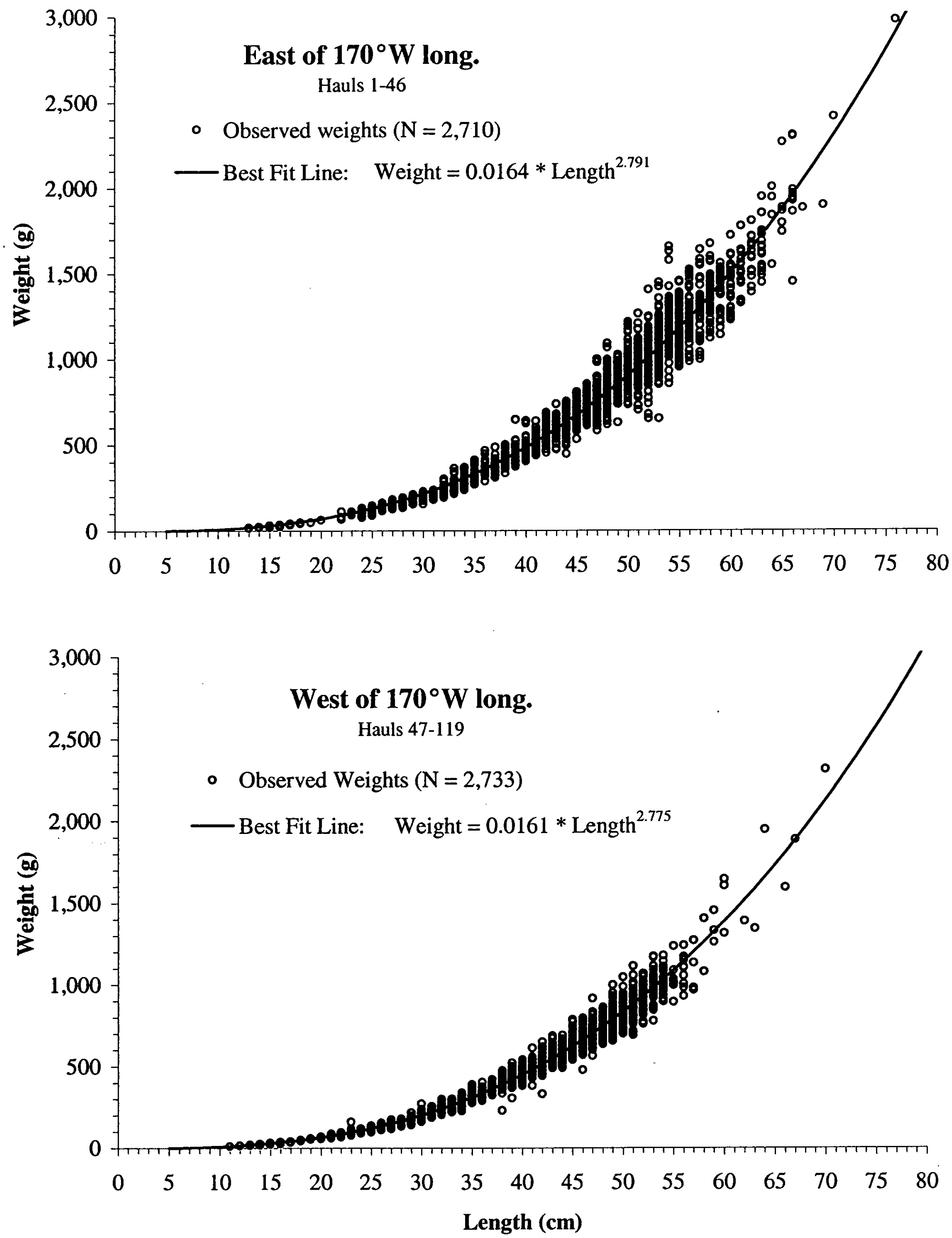

Figure 4. Length-weight regression curves for pollock sampled east (upper) and west (lower) of 170°W longitude during the summer 2002 echo integration-trawl survey of the eastern Bering Sea shelf and slope, MF2002-08.

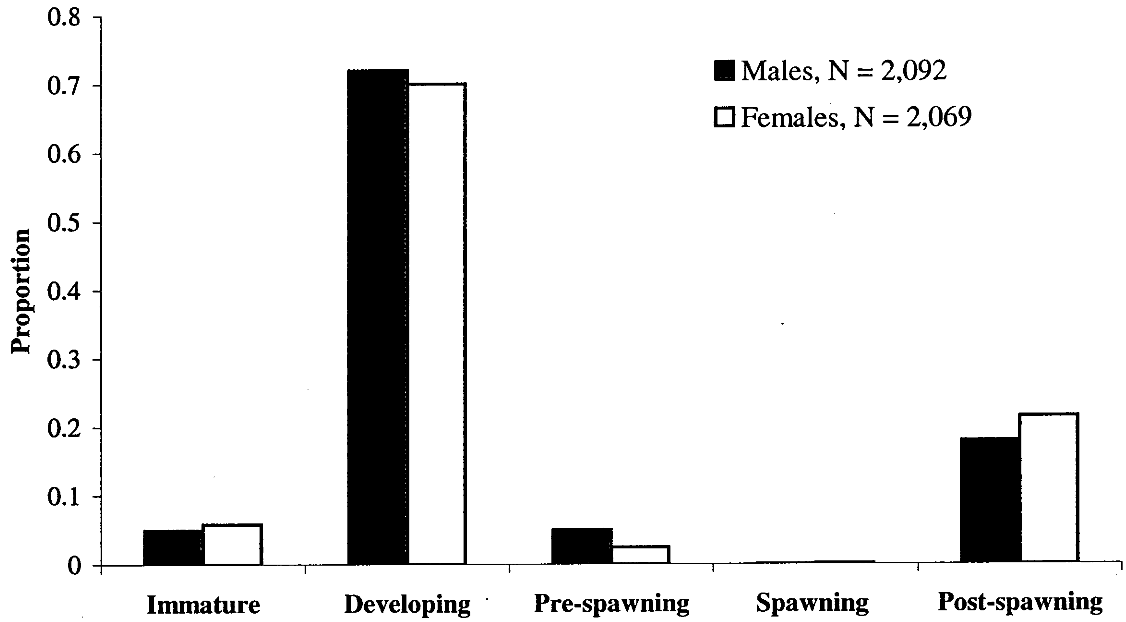

Figure 5. Maturity stage (by sex) for pollock greater than 29 cm in length observed in the 2002 echo integration-trawl survey of the eastern Bering Sea shelf and slope, MF2002-08.

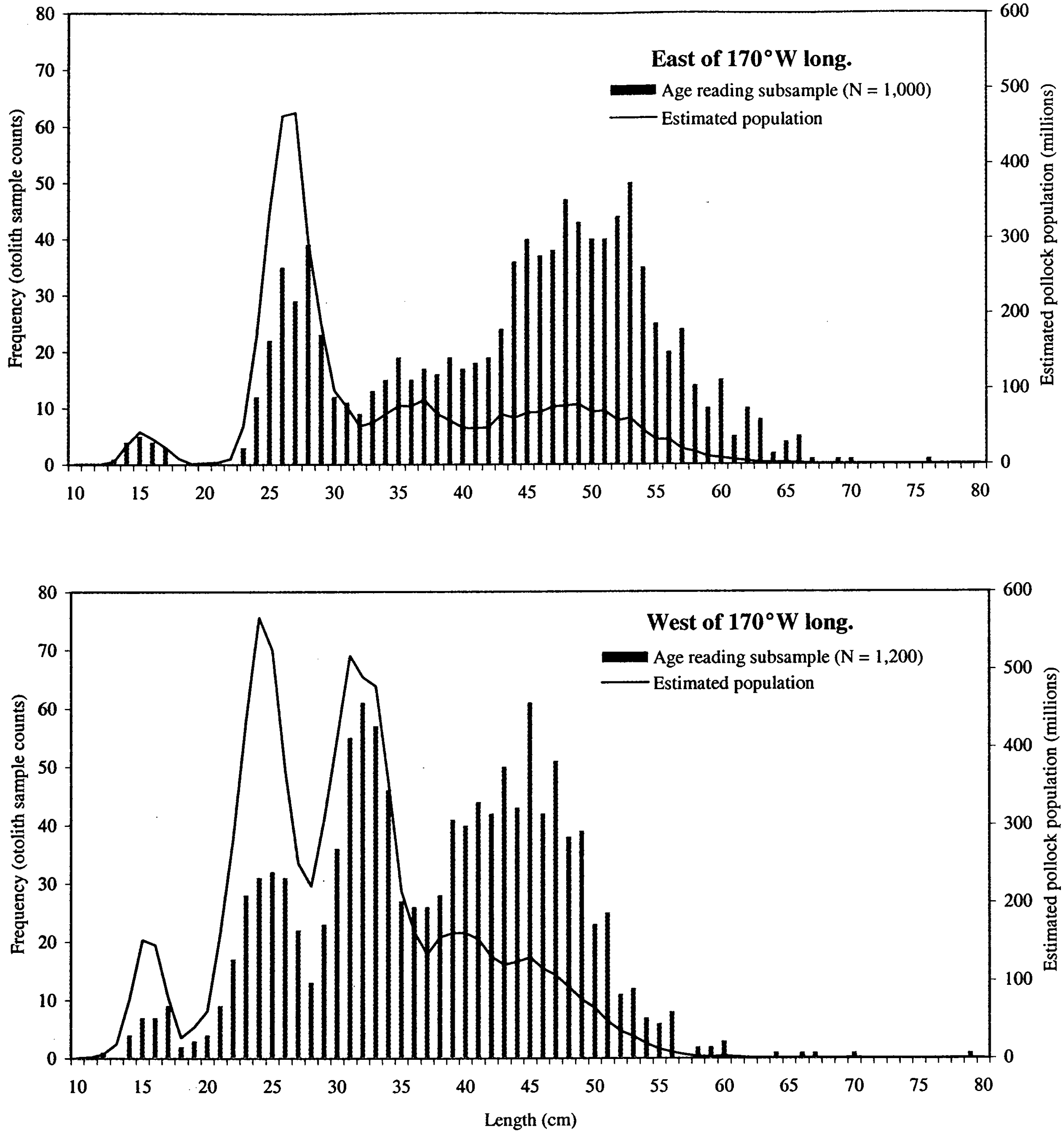

Figure 6. Length frequency distribution of pollock from which otolith specimens were subsampled for age reading (bars, left Y-axis), and estimated population at length (solid line, right Y-axis) east (upper) and west (lower) of 170°W longitude during the summer 2002 echo integration-trawl survey of the eastern Bering Sea shelf and slope, MF2002-08.

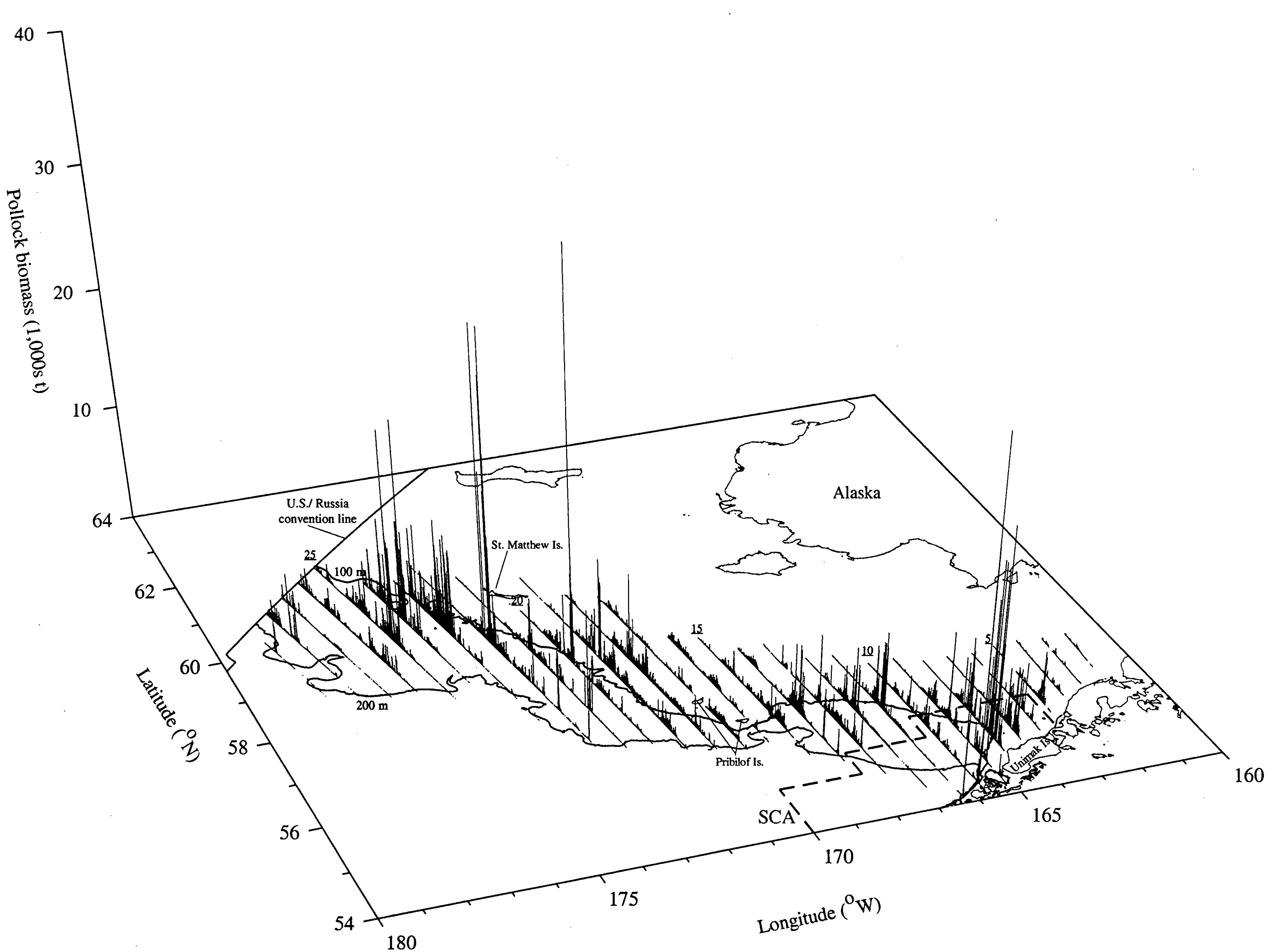

Figure 7. Estimated pollock biomass (in thousands of metric tons (t)) between 3 m off bottom and 14 m from the surface along tracklines surveyed during the summer 2002 echo integration-trawl survey of the eastern Bering Sea shelf and slope, MF2002-08. Transect numbers are underlined, and the Steller sea lion Conservation Area (SCA) is outlined.

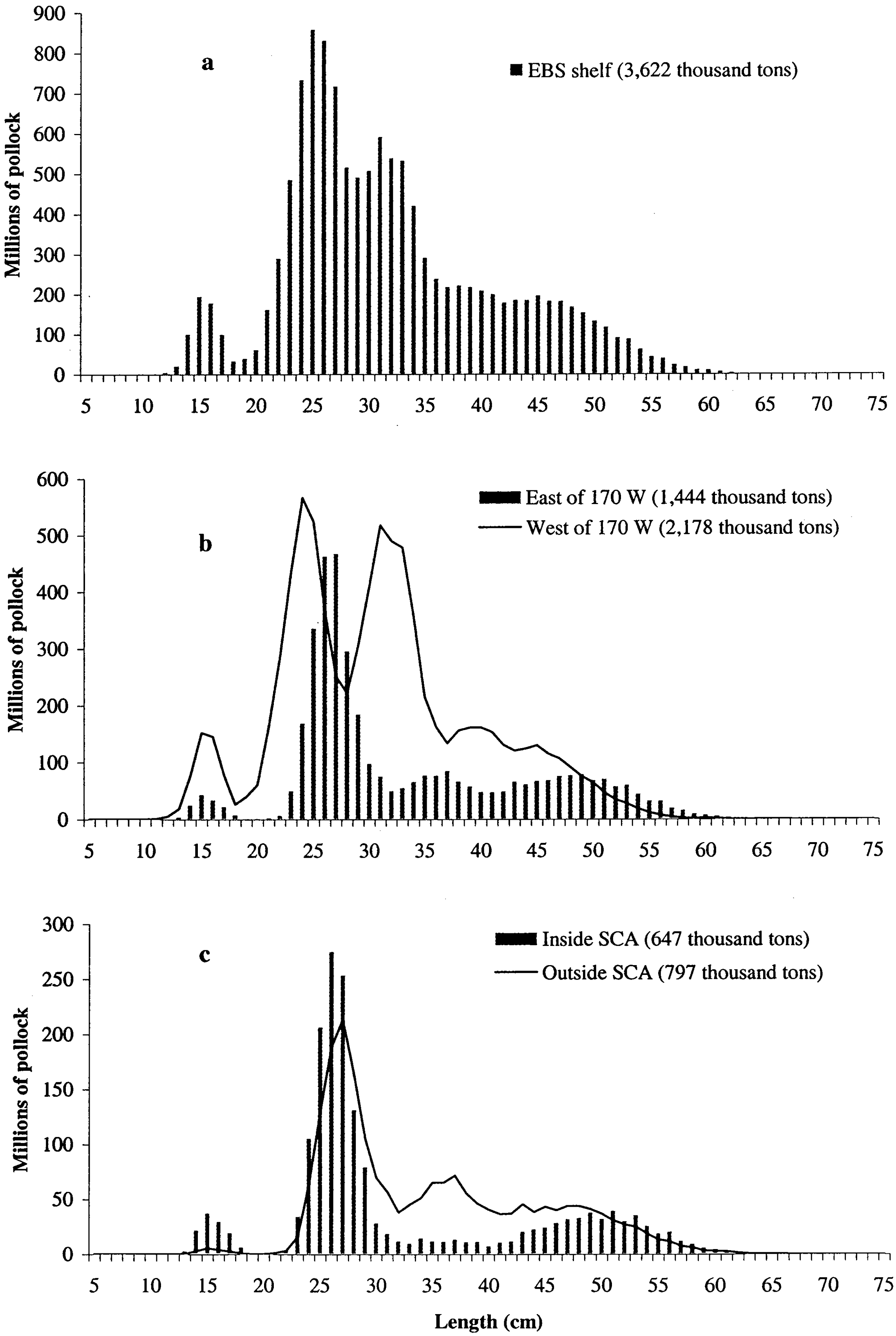

Figure 8. Estimated pollock length composition between 14 m from the surface and 3 m off bottom a) on the entire eastern Bering Sea shelf, b) east and west of 170°W long., and c) east of 170°W long., inside and outside the sea lion conservation area (SCA) during the summer 2002 echo integration-trawl survey of the eastern Bering Sea shelf and slope, MF2002-08. Estimated biomass in each sub-area is indicated. Note the y-axis differences.