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Results of the echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) on the Bering Sea shelf in June and July 2006

by

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INTRODUCTION

Scientists from the Alaska Fisheries Science Center's (AFSC) Midwater Assessment and Conservation Engineering (MACE) Program conduct biennial echo integration-trawl (EIT) surveys (e.g., Honkalehto et al., 2002) along the eastern Bering Sea shelf during the summer to estimate the abundance and distribution of walleye pollock (*Theragra chalcogramma*). This report summarizes observed walleye pollock distribution, and provides walleye pollock biomass and abundance estimates by size and age for the EIT survey conducted in June-July 2006 within the U.S. Exclusive Economic Zone (EEZ). An inter-vessel acoustic comparison between the NOAA ships *Miller Freeman* and *Oscar Dyson* was also conducted during the cruise and results will be presented elsewhere (De Robertis *et al*., in press).

METHODS

MACE scientists conducted the EIT survey (Cruise MF2006-08) between 3 June and 25 July 2006 (Table 1) aboard the NOAA ship *Miller Freeman*, a 66-m stern trawler equipped for fisheries and oceanographic research.

Acoustic Equipment and Calibration

Multi-frequency acoustic measurements were collected with a Simrad ER60 quantitative echosounding system (Simrad 2004, Bodholt and Solli 1992). Four split-beam transducers (18, 38, 120, and 200 kHz) were installed on the vessel's retractable centerboard, which extended 9 m below the water surface. System electronics were housed inside the vessel in a permanent laboratory space dedicated to acoustics.

Standard sphere acoustic system calibrations (Simrad 2004) were conducted to measure acoustic system performance at the start of Legs 1, 2, and 3, and at the end of the Bering Sea shelf survey (Table 2). During calibrations, the *Miller Freeman* was anchored at the bow and stern; a tungsten carbide sphere (38.1 mm diameter) and a copper sphere (64 mm diameter) were suspended below the centerboard-mounted transducers. The tungsten carbide sphere was used to calibrate the 38, 120 and 200 kHz systems and the copper sphere was used to calibrate the 18 kHz system. After each sphere was centered on the acoustic axis, split beam target strength and echo integration measurements were collected to estimate transducer gains (Foote et al. 1987). Transducer beam characteristics were modeled by moving each sphere through a grid of angular coordinates and recording target-strength measurements using Simrad EKLOBES software (Simrad 2004).

During the survey, acoustic data were logged at all four frequencies using SonarData EchoLog 500 (v. 3.50) and ER60 software (v. 2.1.2). Acoustic system settings during the collection were based on results from acoustic system calibrations and on experience from prior surveys (Table 2). Acoustic data were collected from 12 m below the surface (3 m below the centerboard-mounted transducer) to within 0.5 m of the bottom and were analyzed using SonarData Echoview post-processing software (Version 3.5). The depth limit of data collection was 500 m. Results presented in this report are based on 38 kHz echo integration backscatter measurements between 12 m from the surface and 3 m off the bottom.

Trawl Gear

The vessel was equipped with an Aleutian wing 30/26 trawl (AWT), an 83/112 bottom trawl, and a Methot trawl. The vertical net opening and depth for all trawls were monitored while fishing with either a WESMAR third wire netsounder system or a Furuno acoustic link netsounder system attached to the headrope or frame.

The AWT was constructed with full-mesh nylon wings and polyethylene mesh in the codend and aft section of the body. 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. The net was fitted with a 3.2 cm (1.25 in) nylon mesh codend liner. The AWT was fished with 82.3 m (270 ft) of 1.9 cm (0.75 in) diameter (8 × 19 wire) non-rotational dandylines, 5 m^2 Fishbuster trawl doors [1,247 kg (2,750 lb) each], and usually with tom weights attached to the lower wing on each side. Depending on the targeted fishing depth, tom weights varied between 113.4 kg (250 lb), 226.8 kg (500 lb), or 340.9 kg (750 lb) on each side. The vertical net opening for the AWT ranged from 9 to 28 m, and averaged 21 m while fishing with tom weights, and averaged 15 m when fishing depths were shallow and tom weights were not used.

The 83/112 bottom trawl was fished without roller gear. 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 lenths 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 trawl was fished with 54.9 m (180 ft) double dandylines, and 5 m^2 Fishbuster trawl doors. The vertical net opening was 2 to 3 m.

A Methot trawl has a rigid square frame measuring 2.3 m on each side forming the mouth of the net. Mesh sizes were 2 by 3 mm in the body of the net and 1 mm in the codend. A 1.8-m dihedral depressor was used to generate additional downward force. A calibrated General Oceanics flow meter was attached to the mouth of the trawl to estimate the volume of water filtered during hauling. The trawl was attached to a single cable fed through a stern-mounted A-frame.

Trawl gear testing and experiments were conducted separately from survey operations during Legs 2 and 3. The AWT was tested while it was equipped with a multiple opening-closing codend (MOCC) device that allowed three layers to be sampled discretely with catches retained in separate codends. Net selectivity experiments were conducted by equipping the AWT with pocket nets. On some occasions during the net-selectivity experiments, a dual frequency identification sonar (DIDSON) or a video camera was also used to record escapement. Gear test results were not used in the walleye pollock abundance analyses.

Oceanographic Equipment

Physical oceanographic data were collected throughout the cruise. Temperature-depth profiles were obtained at trawl sites with a Sea-Bird Electronics temperature-depth probe (SBE-39) attached to the trawl headrope, and expendable bathythermographs (XBTs) were deployed at a few additional locations. Conductivity-temperature-depth (CTD) observations were collected with a Sea-Bird CTD system at various locations during the survey, and at the calibration sites. Sea surface temperature and salinity data were measured continuously using the *Miller Freeman's* Sea-Bird Electronics SBE-21 probe located mid-ship, approximately 5 m below the water line. These and other environmental data were recorded using the ship's Scientific Computing System (SCS). Sea surface temperature data were averaged across 10 nautical mile (nmi) intervals for graphical representation.

Survey Design

The survey design consisted of 28 north-south transects spaced 20 nmi apart over the Bering Sea shelf from Port Moller, Alaska, to the U.S.-Russian Convention Line (Fig. 1). Echo integration survey data were collected during daylight hours (typically between 0600 and 2400, depending on calendar date and location). Nighttime operations included target-strength data collection, acoustic-system testing, inter-vessel calibration work (Leg 2), and trawl-gear testing (AWT-MOCC field tests, selectivity experiments; Legs 2 and 3).

Trawl hauls were conducted to classify the observed backscatter layers to species and to collect walleye pollock specimens. Typical trawling speed was approximately 1.5 m/s (3 knots). Walleye pollock were sampled to determine sex, fork length (FL), body weight, age, and maturity. Walleye pollock were measured to the nearest centimeter, except for age-0 fish, which were measured to the nearest millimeter (standard length). An electronic motion-compensating scale (Marel M60) was used to weigh individual walleye pollock to the nearest 2 g. For age determinations, walleye pollock otoliths were collected and stored in individually marked vials containing a 50% ethanol-water solution. Maturity was determined by visual inspection and fish were categorized as immature, developing, pre-spawning, spawning, or post-spawning*. All data were recorded using a Fisheries Scientific Computer System (FSCS). The FSCS system was designed and developed by NOAA's Office of Marine and Aviation Operations to digitally collect data aboard research vessels. Biological data and associated trawl information were stored in an Oracle database.

Data Analysis

Walleye pollock abundance and distribution were estimated by combining echo integration and trawl data. Values of mean area backscattering from layers identified as walleye pollock, non-pollock fish, and an undifferentiated mixture (primarily jellyfish, other macrozooplankton, and fish) were binned at 0.5 nmi horizontal by 10 m vertical resolution, and stored in the Oracle database. Estimates of walleye pollock backscattering strength were calculated using an S_v threshold of –70 decibels (dB). Walleye pollock length data from 64 hauls were combined into 8 length strata based on geographic proximity, similarity of length composition, and aggregation patterns. For each stratum, the echo integration backscatter values were summed and scaled using a previously derived relationship between TS and fish lengths (TS = 20 Log L – 66, where L is fork length (cm); Traynor 1996) and the length composition data to produce estimates of walleye pollock numbers by length. Two average weight-at-length relationships were used to compute walleye pollock biomass: east of 170°W and west of 170°W. For each relationship, mean fish weight-at-length for each length interval (cm) was estimated from the trawl data when there were more than five walleye pollock for that length interval; otherwise weight at a given length interval was estimated from a linear regression of the natural logs of all the length and weight data. These weight-at-length estimates were combined with numbers-at-length estimates to provide biomass-

* ADP Codebook. 2005. Unpublished document. Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, NMFS, NOAA; 7600 Sand Point Way NE, Seattle, WA 98115.

at-length. Total biomass or numbers were estimated by summing the strata estimates. Estimated walleye pollock distribution and abundance were then summarized into two areas: east and west of 170°W. Length-at-age data were also stratified into east and west of 170°W areas and used to scale abundance estimates to numbers and biomass-at-age. The average walleye pollock depth (weighted by biomass) was computed for each 0.5 nmi interval across the shelf by multiplying the middle depth of each 10 m vertical layer of water column by the biomass in the layer, then dividing by the sum of biomass for the corresponding 0.5 nmi interval.

Relative estimation errors associated with spatial structure observed in the acoustic data were derived using a one-dimensional (1D) geostatistical method (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 biomass. 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) were not addressed.

A relative condition factor (K_n; Anderson and Neumann 1996) was calculated for age-1 walleye pollock captured in midwater within the U.S. EEZ west of 170°W. Few age-1 walleye pollock were captured east of 170°W, so these were not used in analyses. For each fish, $K_n = (W/W')$, where W is the weight (g) of an individual age-1 in 2006, and W′ is the length-specific (cm) weight (g) as predicted from a linear regression of the natural logs of all the length and weight data from age-1 walleye pollock from the summer 1999, 2000, 2002, 2004, and 2006 EIT surveys. For an average size age-1 walleye pollock, the relative condition factor would be 1.0.

RESULTS and DISCUSSION

Calibration

Four acoustic system calibrations were conducted during the summer 2006 field season (Table 2). No significant differences in gain parameters or transducer beam characteristics were observed for the Simrad ER 60 38 kHz system. However, the average S_v gain from the calibrations was slightly less than the S_v gain setting used during the survey. Therefore, a scalar correction of 1.0459 was applied to echo integration backscatter values attributed to walleye pollock.

Oceanographic Conditions

With a few exceptions, ocean surface temperatures were lower inshore (Fig. 2). The coldest surface water (2.8°C) was near the Pribilof Islands on transect 16 and the warmest surface water (9.6°C) was measured offshore on transect 28 (Fig. 2a). In contrast to the surface waters, the average temperatures at 60 m (representing the water column below the thermocline) decreased as the survey progressed northwest, where the temperatures at the northern end of transect 23, northwest of St. Matthew Island measured only -1.7°C (Fig. 2b). While interpreting these results, the reader should keep in mind that these temperature results are a collection of data over a 2-month time period rather than a snapshot time period.

Biological Sampling

Biological data and specimens were collected from 104 trawl hauls (Table 3, Fig. 1), which included 75 with the AWT midwater trawl, 16 with the AWT-MOCC, 8 with a bottom trawl, and 5 with a Methot trawl. By weight, walleye pollock and jellyfish (Cnidaria) were the most abundant taxon captured in midwater trawl hauls (Tables 4 and 5). Walleye pollock was also the most abundant species group by weight and number in bottom trawls (Table 6). Jellyfish was the most abundant species group by weight for the Methot trawls followed by euphausiids (Table 7).

During the cruise, 28,178 walleye pollock lengths were measured and 2,711 pairs of otoliths were collected from walleye pollock captured in trawl hauls (Table 8). Inspection of gonads showed less than 1% of the walleye pollock larger than 29 cm FL were actively spawning. Most walleye pollock were either in the developing or post-spawning maturity stage (Figs. 3a-b). Walleye pollock 38 to 50 cm FL caught in trawl hauls east of 170°W were on average 5% heavier than those caught west of 170°W (Fig. 3c).

Distribution and Abundance

Acoustic data were collected along 8,292 km (4,478 nmi) of tracklines. Backscatter measurements across the shelf were attributed primarily to walleye pollock. Significant walleye pollock aggregations were observed northwest of Unimak Island (inside the Steller sea lion Conservation Area (SCA), near the Pribilof Islands, and west of St. Matthew Island (Fig. 4). Across the shelf, where walleye pollock biomass was at least one metric ton (t) per 0.5 nmi, the average walleye pollock depth (weighted by biomass) ranged between 20 and 582 m (Fig. 5). Highly aggregated walleye pollock (at least 2,000 t per 0.5 nmi) were primarily found near bottom except for an area off Unimak Island, (Fig. 5). Walleye pollock aggregations that were at least 500 t per 0.5 nmi and located near CTD or SBE temperature samples east of 170°W tended to be in temperatures ranging between 2.7° and 4.2°C, while walleye pollock aggregations west of 170°W tended to be in cooler waters ranging between 0.3° and 3.1°C (Figs. 2 and 5).

Estimated walleye pollock abundance for 2006 along the U.S. Bering Sea shelf was 3.40 billion fish weighing 1.56 million t. This estimate was less than half of what was observed in 2004 (Tables 9-11; Figs. 6a-b), and nearly the lowest abundance observed since 1979, when the survey time series began. The lowest estimate of 1.45 million t was in observed in 1991. Only about 14% of the 2006 population numbers was east of 170°W and although a few juveniles were present, most of these walleye pollock ranged between 40 and 61 cm FL with a mode at 48 cm FL (Fig. 6a); approximately one-third of the eastern population was found inside the SCA (Fig. 6c). West of 170°W, where 86% of the estimated population numbers were observed, the walleye pollock length composition ranged between 11 and 79 cm FL with major modes at 13 cm and 44 cm FL and a minor mode at 23 cm FL (Fig. 6a). Based on the 1D analysis, the relative estimation error of the total biomass estimate was 0.039, which was similar to what was observed in 2004 (Table 11).

Population numbers-at-age estimates indicated that walleye pollock from the 2000-2002, and 2005 year classes made up most of the population (Table 12, Fig. 7). Five-year-old walleye pollock (2001 year class) were estimated to number 695.3 million and weigh 366.4 thousand t, contributing about 20.5% and 23.5% of the total estimated numbers and biomass, respectively. Walleye pollock average-length-at-age observed east and west of 170°W during the 2006 EIT survey was similar to averages observed for walleye pollock measured during the four previous summer Bering Sea summer EIT surveys occurring within June-July in the years 1999, 2000, 2002, and 2004 (Fig. 8).

The age-1 walleye pollock estimate of 455.6 million was significantly higher than the estimate in 2004 (15.8 million) and contributed 13.4% of the total estimated population numbers. Most all of the age-1 fish were distributed west of 170°W. The average relative condition factor for age-1 walleye pollock measured west of 170°W was 1.02, indicating a typical condition (Fig. 9).

In 2006 the EIT survey found an unusually low level of non-pollock 38-kHz backscatter in the water column compared to previous EIT surveys conducted in June-July (Fig. 10). The non-pollock backscatter in 2006 was primarily distributed in the upper 25 m of the water column across the shelf, and contributed less to the total backscatter than did walleye pollock. For the 1999, 2000 and 2002 surveys, backscatter was measured between 14 m from the surface and 0.5 m off the bottom; in 2004 and 2006, it was measured between 12 m from the surface and 0.5 m off the bottom. These data should be interpreted with care because the exact biological composition of the other scatterers is unknown. Additionally, classification of non-pollock backscatter was not always performed as rigorously as classification of walleye pollock, and so may contain small amounts of non-biological scatter. Trawl data suggest that the biological components of non-pollock backscatter include macrozooplankton (e.g., jellyfish, euphausiids), age-0 walleye pollock, and other fishes. Some scatterers, such as fish with swimbladders and large medusae, are more easily detected at 38 kHz than small and poorly reflective organisms such as copepods and euphausiids. Because these scatterers all reflect sound at different target strengths, comparison of backscatter both within and between years is not strictly possible. Still it appears from the data presented that the contribution from non-pollock scatterers in 2006 was quite a bit lower than that of preceding years. The impact of this is unknown but should be closely monitored.

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Table 1.--Itinerary and scientific personnel for the summer 2006 walleye pollock echo integration-trawl (EIT) survey of the Bering Sea shelf.

Leg 1

3 June	Depart Kodiak, AK
4 June	Acoustic sphere calibration in Three Saints Bay, Kodiak Island, AK
4-6 June	Transit to Bering Sea
6-20 June	EIT survey of the Bering Sea shelf through transect 15.
21 June	Inport Dutch Harbor, AK

Scientific Personnel	Position	Organization*	Nation
Michael Guttormsen	Chief Scientist	AFSC	USA
Paul Walline	Fishery Biologist	AFSC	USA
Scott Furnish	Info. Tech. Specialist	AFSC	USA
Tyler Yasenak	Fishery Biologist	AFSC	USA
Robert L. Self	Fishery Biologist	AFSC	USA
William Floering	Fishery Biologist	AFSC	USA
Alexander Nikolayev	Acoustician	TINRO	Russia
Mikhail Stepanenko	Fishery Biologist	TINRO	Russia
Jacob Tanenbaum	Teacher at Sea	NOAA	USA
Tamara Mills	Seabird Observer	US Fish & Wildlife	USA
Becky Howard	Seabird Observer	US Fish & Wildlife	USA

Leg 2

22 June	Acoustic sphere calibration in Captains Bay, Unalaska Island, AK
22-23 June	Transit to transect 16.0 waypoint
23 June-12 July	EIT survey of the Bering Sea shelf (transects 16-24); inter vessel-comparison of scientific acoustic systems with the NOAA ship *Oscar Dyson*
12-13 July	Transit to Unalaska Island, AK
13-14 July	Acoustic sphere calibration in Captains Bay, Unalaska, AK
14 July	Overnight Dutch Harbor, AK

Table 1.—Continued

Scientific Personnel	Position	Organization	Nation
Neal Williamson	Chief Scientist	AFSC	USA
Scott Furnish	Info. Tech. Specialist	AFSC	USA
Patrick Ressler	Fishery Biologist	AFSC	USA
Kresimir Williams	Fishery Biologist	AFSC	USA
William Floering	Fishery Biologist	AFSC	USA
Tess Brandon	Student Intern	Colorado Univ.	USA
Mikhail Stepanenko	Fishery Biologist	TINRO	Russia
Alexander Nikolayev	Acoustician	TINRO	Russia
Tamara Mills	Seabird Observer	US Fish & Wildlife	USA
Paul Suchanek	Seabird Observer	US Fish & Wildlife	USA

Leg 3

15-17 July	Transit to transect 25.0 waypoint
17-21 July	EIT survey of the Bering Sea shelf (transects 25-28)
21-23 July	Gear testing
23-25 July	Transit to Unalaska Island, AK
25 July	Acoustic sphere calibration in Captains Bay, Unalaska, AK, end of cruise

Scientific Personnel	Position	Organization	Nation
Taina Honkalehto	Chief Scientist	AFSC	USA
Sarah Stienessen	Fishery Biologist	AFSC	USA
Rick Towler	Info. Tech. Specialist	AFSC	USA
Robert L. Self	Fishery Biologist	AFSC	USA
Carwyn Hammond	Fishery Biologist	AFSC	USA
Sandi Neidetcher	Fishery Biologist	AFSC	USA
Alexander Nikolayev	Acoustician	TINRO	Russia
Mikhail Stepanenko	Fishery Biologist	TINRO	Russia
Dennis Starkey	Teacher at Sea	NOAA	USA
Tamara Mills	Seabird Observer	US Fish & Wildlife	USA

* TINRO — Pacific Research Institute of Fisheries and Oceanography, Vladivostok, Russia

Table 2.--Simrad ER60 38 kHz acoustic system description and settings during the summer 2006 walleye pollock echo integration-trawl survey of the Bering Sea shelf, and results from standard sphere acoustic system calibrations conducted before, during, and after the survey.

		Calibrations			
	Survey system settings	4-Jun Three Saints Bay, Alaska	23-Jun Captain's Bay, Alaska	14-Jul Captain's Bay, Alaska	25-Jul Captain's Bay, Alaska
Echosounder:	Simrad ER 60	--	--	--	--
Transducer:	ES38B	--	--	--	--
Frequency (kHz):	38	--	--	--	--
Transducer depth (m):	9.15	--	--	--	--
Pulse length (ms):	1.024	--	--	--	--
Transmitted power (W):	2000	--	--	--	--
Angle sensitivity:	21.9	--	--	--	--
2-Way beam angle (dB):	-21.0	--	--	--	--
Gain (dB)	26.44	26.35	26.34	26.36	26.35
Sa correction (dB)	-0.57	-0.58	-0.57	-0.60	-0.56
S_v gain (dB)	25.87	25.77	25.77	25.76	25.79
3 dB beamwidth (deg)					
Along:	7.01	7.03	6.94	6.97	7.13
Athwart:	7.01	7.04	6.92	6.91	6.92
Angle offset (deg)					
Along:	0.03	0.03	0.03	0.00	0.00
Athwart:	0.02	0.00	0.05	0.01	0.04
Post-processing S_v threshold (dB):	-70	--	--	--	--
Standard sphere TS (dB)	--	-42.22	-42.23	-42.22	-42.24
Sphere range from transducer (m):	--	19.90	20.27	22.77	18.41
Absorption coefficient (dB/m):	0.009978	0.009760	0.009899	0.009914	0.009860
Sound velocity (m/s)	1470.0	1468.3	1471.5	1470.8	1472.8
Water temp at transducer (°C):	--	7.3	6.7	6.7	7.3

Note: Gain and Beam pattern terms are defined in the "Operator Manual for Simrad ER60 Scientific echo sounder application (2004)" available from Simrad AS, Strandpromenaden 50, Box 111, N-3191 Horten, Norway.

Table 3.--Trawl stations and catch data summary from the summer 2006 Bering Sea shelf walleye pollock echo integration-trawl survey, MF2006-08.

Haul	Gear[1]	Date	Time	Duration	Start position		Depth (m)		Temp. (deg. C)		Pollock		Other
no.	type	(GMT)	(GMT)	(minutes)	Lat. (N)	Long. (W)	footrope	bottom	headrope	surface[2]	(kg)	number	(kg)
1	AWT	9-Jun	4:23	25	55 23.23	163 38.08	59	71	3.5	6.6	123	137	431
2	AWT	9-Jun	12:05	40	55 15.67	164 13.75	81	89	4.0	6.5	223	267	25
3	AWT	10-Jun	8:36	45	55 58.56	164 49.80	79	95	3.2	5.8	101	89	92
4	AWT	10-Jun	17:58	24	55 26.10	164 48.09	97	104	4.5	5.9	920	1,274	2
5	AWT	11-Jun	4:56	35	54 46.50	165 21.46	169	184	3.8	5.7	21	30	8
6	AWT	11-Jun	8:39	40	55 00.49	165 22.74	108	120	4.2	5.7	142	198	1
7	AWT	12-Jun	8:25	60	56 13.74	166 01.17	53	103	3.8	6.4	120	168	45
8	AWT	12-Jun	23:01	31	54 35.44	165 56.31	384	429	3.8	6.1	127	170	33
9	83-112	13-Jun	5:59	1	54 19.17	166 00.59	215	538	6.5	6.0	--	--	18
10	AWT	13-Jun	8:44	30	54 19.76	165 53.98	239	252	4.4	5.7	215	246	73
11	AWT	13-Jun	14:37	30	54 10.70	166 18.14	177	182	3.9	6.5	11	11	32
12	AWT	14-Jun	3:33	30	55 58.94	166 37.08	102	129	4.3	7.8	92	112	6
13	83-112	14-Jun	23:39	17	56 53.26	167 17.37	77	78	2.6	5.7	1,007	1,123	54
14	AWT	15-Jun	8:38	30	55 27.47	167 10.37	35	138	3.8	7.4	238	336	< 1
15	AWT	15-Jun	11:37	5	55 46.73	167 12.33	42	136	5.8	7.0	123	5,991	1
16	AWT	16-Jun	3:47	40	56 26.91	167 51.45	45	121	4.3	6.7	1	2	20
17	AWT	16-Jun	8:33	10	56 58.06	167 54.43	32	82	3.0	5.6	21	26	19
18	AWT	16-Jun	9:54	20	56 57.73	167 53.83	61	82	2.7	5.5	231	327	6
19	AWT	17-Jun	0:34	40	57 22.82	168 33.97	57	73	2.1	4.6	621	590	7
20	AWT	17-Jun	11:34	10	55 49.43	168 24.25	115	142	3.9	6.9	211	304	2
21	AWT	17-Jun	17:40	14	55 34.35	168 22.84	143	154	3.7	6.7	852	1,541	2
22	83-112	18-Jun	3:27	12	56 37.39	169 05.54	65	65	3.1	6.1	3,228	4,570	1,001
23	AWT	18-Jun	9:06	8	57 15.97	169 10.75	59	76	2.7	5.5	439	626	8
24	AWT	18-Jun	11:39	45	57 01.77	169 08.98	69	78	2.4	6.0	317	409	8
25	83-112	19-Jun	3:55	12	57 19.82	169 48.92	56	61	-0.2	4.5	161	182	166
26	AWT	19-Jun	9:48	12	56 41.15	169 43.11	65	78	4.1	4.3	79	111	8
27	AWT	19-Jun	16:02	15	56 26.99	169 39.77	79	87	4.0	5.0	57	75	2
28	AWT	24-Jun	2:39	43	56 52.44	170 18.93	89	95	3.2	7.1	903	1,488	23
29	AWT	24-Jun	17:07	15	57 29.29	170 25.39	69	71	2.6	4.8	921	1,276	16
30	Methot	24-Jun	23:13	23	58 18.78	170 35.08	63	77	-0.8	5.3	0	1	8
31	AWT	26-Jun	17:01	45	58 03.37	171 12.80	80	92	0.3	4.6	495	655	20
32	AWT	27-Jun	1:08	10	57 15.25	171 01.94	40	90	5.6	5.6	--	--	122
33	83-112	27-Jun	3:37	25	57 10.99	171 01.52	94	94	2.9	5.8	1,640	2,265	83
34	AWT	27-Jun	16:14	40	56 24.47	170 54.21	118	125	3.9	7.1	116	165	1
35	AWT	28-Jun	1:52	45	56 46.66	171 33.07	108	117	3.8	6.0	180	228	9

Table 3.--Continued.

Haul no.	Gear[1] type	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Lat. (N)		Long. (W)		Depth (m) footrope	bottom	Temp. (deg. C) headrope	surface[2]	Pollock (kg)	number	Other (kg)
36	AWT	28-Jun	5:50	31	57	06.17	171	37.44	48	110	4.5	6.1	2	2	10
37	AWT	28-Jun	14:40	49	57	25.44	171	40.78	78	105	5.9	5.9	264	422	1
38	AWT	28-Jun	22:39	52	58	25.34	171	52.29	90	98	1.1	5.1	336	513	7
39	AWT	29-Jun	21:14	30	58	54.42	172	35.89	94	103	1.0	5.0	496	775	8
40	83-112	30-Jun	2:13	31	58	20.04	172	29.95	103	104	1.9	6.1	178	251	7
41	AWT	30-Jun	7:30	10	57	47.14	172	23.13	95	110	2.5	6.4	305	458	26
42	83-112	30-Jun	21:16	31	56	38.35	172	09.64	135	138	3.9	7.3	373	416	25
43	AWT-MOCC	1-Jul	10:14	25	57	25.20	174	07.09	808	15	3.3	6.9	--	--	3
44	AWT	1-Jul	19:07	35	58	01.27	173	02.36	75	111	2.5	6.3	472	803	--
45	AWT	2-Jul	0:28	26	58	35.62	173	11.10	85	116	2.2	6.7	302	454	--
46	AWT	2-Jul	5:06	11	58	59.09	173	17.22	72	111	1.6	5.6	120	184	32
47	AWT-MOCC	2-Jul	11:31	10	59	34.76	173	26.38	87	102	0.3	5.5	32	51	1
48	AWT-MOCC	2-Jul	11:58	10	59	33.52	173	28.11	64	103	0.3	5.5	78	123	--
49	AWT-MOCC	2-Jul	12:22	18	59	32.33	173	29.84	49	103	1.1	5.5	8	13	--
50	AWT	3-Jul	4:21	17	60	23.57	174	16.55	85	95	-0.7	5.6	126	142	14
51	AWT-MOCC	3-Jul	10:13	15	59	42.18	174	05.93	98	109	0.5	6.0	116	257	11
52	AWT	3-Jul	16:32	26	59	25.65	174	05.18	96	114	1.4	6.9	636	1,214	5
53	AWT	4-Jul	7:05	31	57	11.70	173	29.87	121	133	3.1	6.5	66	91	1
54	AWT	4-Jul	10:13	22	57	06.65	173	28.25	212	210	--	7.6	2	3	23
55	AWT	4-Jul	12:20	26	57	06.66	173	28.65	201	196	3.7	7.5	12	16	59
56	AWT	5-Jul	9:55	36	58	53.00	174	36.79	123	134	2.2	7.0	75	116	1
57	AWT	6-Jul	11:46	20	59	45.96	174	52.75	103	120	1.5	6.6	726	1,423	3
58	AWT	6-Jul	23:24	35	60	27.94	175	10.79	99	108	0.5	6.2	519	1,143	40
59	Methot	7-Jul	7:33	30	61	17.76	175	14.37	44	94	-1.7	6.2	--	--	35
60	AWT-MOCC	7-Jul	10:42	15	61	22.00	175	59.15	94	104	-0.4	6.3	19	18	3
61	AWT	8-Jul	10:53	20	60	26.21	175	42.42	107	116	1.7	6.4	571	1,229	6
62	AWT	9-Jul	1:05	13	60	00.49	175	32.24	108	122	1.6	6.9	719	1,500	7
63	AWT	9-Jul	11:53	21	59	31.98	175	23.47	52	136	3.6	7.5	20	38	3
64	AWT	9-Jul	13:35	10	59	30.99	175	23.62	126	136	2.1	7.4	577	1,130	< 1
65	AWT	9-Jul	17:11	43	59	06.64	175	16.42	124	134	2.2	7.6	154	271	3
66	AWT	10-Jul	11:52	10	59	29.82	176	03.00	120	138	1.8	6.6	1,030	4,452	2
67	AWT	10-Jul	13:43	15	59	29.59	176	03.08	60	138	1.2	6.6	376	719	2
68	AWT	10-Jul	23:32	16	59	43.97	176	12.62	118	139	1.6	7.2	410	1,366	< 1
69	AWT	11-Jul	10:30	13	60	05.26	176	18.36	117	136	1.9	7.8	725	2,780	--
70	AWT	11-Jul	12:16	18	60	05.17	176	18.40	50	136	0.9	7.8	588	1,151	18
71	AWT	11-Jul	18:59	21	60	47.53	176	28.33	110	121	--	7.0	528	1,408	22

Table 3.--Continued.

Haul no.	Gear[1] type	Date (GMT)	Time (GMT)	Duration (minutes)	Start position Lat. (N)	Start position Long. (W)	Depth (m) footrope	Depth (m) bottom	Temp. (deg. C) headrope	Temp. (deg. C) surface[2]	Pollock (kg)	Pollock number	Other (kg)
72	AWT	11-Jul	23:58	30	61 15.70	176 37.68	101	113	0.0	7.4	1,345	2,176	187
73	Methot	17-Jul	19:05	15	58 44.74	176 26.17	117	129	--	9.6	--	--	8
74	AWT	18-Jul	1:12	13	59 32.82	176 42.64	131	145	1.9	8.8	1,045	1,863	--
75	AWT	18-Jul	5:57	10	60 02.33	176 52.91	115	143	1.2	8.5	1,138	2,935	--
76	AWT-MOCC	18-Jul	11:24	17	60 24.44	176 59.92	107	145	--	8.7	431	1,309	< 1
77	AWT	18-Jul	17:41	15	60 48.43	177 09.37	90	130	--	7.5	976	5,493	3
78	AWT	18-Jul	21:24	11	61 12.06	177 17.76	111	127	1.1	7.7	805	2,504	9
79	AWT	19-Jul	4:36	14	60 43.34	177 49.31	131	154	1.7	8.5	556	6,431	2
80	AWT-MOCC	19-Jul	10:12	10	60 06.29	177 35.58	161	141	1.3	17.0	311	1,205	< 1
81	AWT	19-Jul	17:51	6	59 58.20	177 32.30	122	138	1.5	8.6	1,086	2,897	< 1
82	AWT	19-Jul	20:24	10	60 08.28	177 36.03	120	140	1.5	8.1	678	5,427	< 1
83	AWT	20-Jul	0:26	20	59 43.96	177 26.96	161	175	2.4	8.9	18	37	1
84	Methot	20-Jul	7:48	16	58 46.69	177 06.25	118	130	2.2	9.5	--	--	3
85	Methot	20-Jul	16:42	15	58 38.29	177 03.16	109	145	2.6	7.9	--	--	5
86	83-112	21-Jul	2:55	16	59 46.74	178 06.97	146	147	2.2	8.8	2,713	5,379	43
87	AWT	21-Jul	5:36	6	59 49.65	178 08.14	142	146	2.0	8.7	1,048	3,082	--
88	AWT-MOCC	21-Jul	10:08	3	59 59.88	178 12.79	137	144	2.1	10.6	193	724	--
89	AWT-MOCC	21-Jul	10:20	3	59 59.39	178 13.85	107	144	1.9	8.4	123	3,148	--
90	AWT-MOCC	21-Jul	10:32	15	59 58.99	178 14.81	106	143	2.1	10.6	2	114	< 1
91	AWT	21-Jul	18:30	15	60 43.29	178 30.15	161	175	2.4	10.4	1,086	1,977	1
92	AWT	21-Jul	22:56	23	60 40.62	178 51.17	208	236	2.7	8.5	1,682	2,872	2
93	AWT	22-Jul	5:37	13	59 54.98	178 51.81	186	197	2.4	9.6	3	5	13
94	AWT	22-Jul	11:54	10	59 59.37	178 14.78	120	144	2.0	8.0	546	4,202	< 1
95	AWT	22-Jul	13:39	5	59 59.40	178 14.78	110	143	1.9	8.6	858	7,046	1
96	AWT	22-Jul	19:01	10	60 02.71	178 15.35	126	143	2.1	8.6	885	5,981	< 1
97	AWT	22-Jul	22:44	2	60 06.47	177 44.81	113	142	1.4	8.4	765	2,688	10
98	AWT	23-Jul	1:33	20	60 05.22	177 55.85	128	145	2.0	8.8	490	3,076	6
99	AWT	23-Jul	3:39	20	60 05.20	177 55.67	129	145	1.9	8.8	1,454	5,499	6
100	AWT-MOCC	23-Jul	10:19	19	60 01.86	178 20.64	119	143	2.0	8.3	205	1,261	4
101	AWT-MOCC	23-Jul	13:40	18	60 02.82	178 22.78	123	143	2.0	10.0	41	290	2
102	AWT-MOCC	23-Jul	18:03	0	60 04.34	178 13.12	118	144	1.7	8.6	--	--	--
103	AWT-MOCC	23-Jul	18:11	11	60 04.20	178 12.36	124	144	1.9	8.3	444	2,191	--
104	AWT-MOCC	23-Jul	20:57	13	60 03.86	178 10.58	125	144	1.9	8.5	--	--	1

[1]AWT = Aleutian wing trawl, AWT-MOCC = Aleutian wing trawl with multiple opening closing codend, 83-112 = bottom trawl, Methot = Methot trawl

[2]Sea-Bird Electronics (SBE) temperature measured at 1 m.

Table 4.--Catch by species from 75 Aleutian wing trawl hauls conducted during the summer 2006 walleye pollock echo integration-trawl survey of the Bering Sea shelf, MF2006-08. Catches from the Aleutian wing trawl with the modified codend were not included.

Species name	Scientific name	Weight (kg)	Weight (%)	Number
walleye pollock	*Theragra chalcogramma*	34,520.1	95.8	106,846
northern sea nettle	*Chrysaora melanaster*	715.8	2.0	645
jellyfish	*Chrysaora* sp.	451.2	1.3	301
Pacific ocean perch	*Sebastes alutus*	88.6	0.2	109
jellyfish	Scyphozoa	42.3	0.1	56
chum salmon	*Oncorhynchus keta*	27.0	0.1	10
northern smoothtongue	*Leuroglossus schmidti*	25.9	0.1	3,913
rock sole	*Lepidopsetta* sp.	24.2	0.1	55
Pacific cod	*Gadus macrocephalus*	22.7	0.1	9
flathead sole	*Hippoglossoides elassodon*	22.0	0.1	58
lumpsucker	Cyclopterinae	21.9	0.1	13
chinook salmon	*Oncorhynchus tshawytscha*	8.1	< 0.1	3
yellow Irish lord	*Hemilepidotus jordani*	4.9	< 0.1	4
smooth lumpsucker	*Aptocyclus ventricosus*	4.6	< 0.1	2
lanternfish	Myctophidae	4.2	< 0.1	290
yellowfin sole	*Limanda aspera*	4.1	< 0.1	9
hydroid	*Aequorea* sp.	4.1	< 0.1	20
eulachon	*Thaleichthys pacificus*	4.0	< 0.1	70
magistrate armhook squid	*Berryteuthis magister*	3.6	< 0.1	12
Alaska skate	*Bathyraja parmifera*	3.3	< 0.1	1
Alaska plaice	*Pleuronectes quadrituberculatus*	3.2	< 0.1	2
lamprey	Petromyzontidae	2.9	< 0.1	7
arrowtooth flounder	*Atheresthes stomias*	2.8	< 0.1	5
egg yolk jellyfish	*Phacellophora camtschatica*	2.7	< 0.1	1
squid	Teuthoidea	2.5	< 0.1	78
pink salmon	*Oncorhynchus gorbuscha*	1.9	< 0.1	2
Pacific lamprey	*Lampetra tridentata*	1.0	< 0.1	3
sturgeon poacher	*Podothecus accipenserinus*	0.6	< 0.1	8
Pacific herring	*Clupea pallasi*	0.6	< 0.1	2
shrimp	Decapoda	0.3	< 0.1	74
Pacific sandfish	*Trichodon trichodon*	0.3	< 0.1	1
salp	Thaliacea	0.2	< 0.1	47
sawback poacher	*Leptagonus frenatus*	0.0	< 0.1	2
daubed shanny	*Lumpenus maculatus*	0.0	< 0.1	1
Totals		36,021.7		112,659

Table 5.--Catch by species from 16 Aleutian wing trawl-modified codend hauls conducted during the summer 2006 walleye pollock echo integration-trawl survey of the Bering Sea shelf, MF2006-08.

Species name	Scientific name	Weight (kg)	Weight (%)	Number
walleye pollock	*Theragra chalcogramma*	2,003.4	99.0	10,704
northern sea nettle	*Chrysaora melanaster*	5.9	0.3	3
rock sole unident.	*Lepidopsetta* sp.	3.9	0.2	9
flathead sole	*Hippoglossoides elassodon*	3.8	0.2	11
lumpsucker	Cyclopterinae	2.6	0.1	2
blacksmelt	*Bathylagus* sp.	1.5	0.1	43
giant grenadier	*Albatrossia pectoralis*	0.9	< 0.1	1
jellyfish	Scyphozoa	0.6	< 0.1	15
squid	Teuthoidea	0.4	< 0.1	4
lanternfish	Myctophidae	0.3	< 0.1	53
helmet jelly	*Periphylla periphylla*	0.2	< 0.1	7
shrimp	Decapoda	0.1	< 0.1	29
northern smoothtongue	*Leuroglossus schmidti*	0.1	< 0.1	9
smooth lumpsucker	*Aptocyclus ventricosus*	0.0	< 0.1	1
Totals		2,023.8		10,891

Table 6.--Catch by species from eight 83-112 bottom trawl hauls conducted during the summer 2006 walleye pollock echo integration-trawl survey of the Bering Sea shelf, MF2006-08.

Species name	Scientific name	Weight (kg)	Weight (%)	Number
walleye pollock	*Theragra chalcogramma*	9,298.9	79.7	14,186
Irish lord	*Hemilepidotus* sp.	759.6	6.5	991
sea cucumber	Holothuroidea	732.4	6.3	685
Pacific cod	*Gadus macrocephalus*	210.4	1.8	57
rock sole	*Lepidopsetta* sp.	157.2	1.3	422
sculpin	*Myoxocephalus* sp.	145.9	1.3	20
bigmouth sculpin	*Hemitripterus bolini*	62.3	0.5	11
sea anemone	Actiniaria	61.4	0.5	614
flathead sole	*Hippoglossoides elassodon*	52.4	0.4	138
arrowtooth flounder	*Atheresthes stomias*	50.8	0.4	79
Alaska skate	*Bathyraja parmifera*	32.4	0.3	4
basketstar	*Gorgonocephalus eucnemis*	17.9	0.2	85
yellowfin sole	*Limanda aspera*	15.1	0.1	54
hermit crab	Paguridae	9.3	0.1	135
Greenland turbot	*Reinhardtius hippoglossoides*	9.0	0.1	1
starfish	Asteroidea	8.2	0.1	116
Pacific ocean perch	*Sebastes alutus*	7.7	0.1	11
sea urchin	Echinacea	7.0	0.1	94
northern sea nettle	*Chrysaora melanaster*	4.9	< 0.1	5
yellow Irish lord	*Hemilepidotus jordani*	2.7	< 0.1	5
Alaska plaice	*Pleuronectes quadrituberculatus*	2.6	< 0.1	2
empty gastropod shells		2.6	< 0.1	34
Tanner crab	*Chionoecetes bairdi*	2.3	< 0.1	15
crinoids	Crinoidea	2.1	< 0.1	7
jellyfish	*Chrysaora* sp.	1.8	< 0.1	9
rex sole	*Glyptocephalus zachirus*	1.7	< 0.1	3
snail	Gastropod	1.3	< 0.1	15
whelk	Buccinidae	1.0	< 0.1	9
Pacific lyre crab	*Hyas lyratus*	1.0	< 0.1	18
snow crab	*Chionoecetes opilio*	0.7	< 0.1	2
northern ronquil	*Ronquilus jordani*	0.7	< 0.1	2
Oregon triton	*Fusitriton oregonensis*	0.6	< 0.1	12
sturgeon poacher	*Podothecus accipenserinus*	0.6	< 0.1	9
searcher	*Bathymaster signatus*	0.6	< 0.1	2
scale worm	Polynoidae	0.4	< 0.1	11
darkfin sculpin	*Malacocottus zonurus*	0.4	< 0.1	1
Aleutian skate	*Bathyraja aleutica*	0.3	< 0.1	1
crab	Decapoda	0.3	< 0.1	2
sculpin	*Triglops* sp.	0.2	< 0.1	10
horsehair crab	*Erimacrus isenbeckii*	0.2	< 0.1	1
sponge	Porifera	0.2	< 0.1	2
Totals		11,667.0		17,880

Table 7.--Catch by species from five Methot trawl hauls conducted during the summer 2006 walleye pollock echo integration-trawl survey of the Bering Sea Shelf, MF2006-08.

Species name	Scientific name	Weight (kg)	Weight (%)	Number
northern sea nettle	*Chrysaora melanaster*	32.2	54.8	30
euphausiid	Euphausiacea	23.0	39.2	381,481
hydroid	*Aequorea* sp.	2.0	3.5	5
salp	Thaliacea	0.8	1.3	42
jellyfish	Scyphozoa	0.7	1.1	2
isopod	Isopoda	0.0	< 0.1	83
squid	Teuthoidea	0.0	< 0.1	2
fish	Teleostei	0.0	< 0.1	2
walleye pollock	*Theragra chalcogramma*	0.0	< 0.1	1
coral	Anthozoa	0.0	< 0.1	2
Totals		58.7		381,650

Table 8.--Numbers of biological samples observed or collected during the summer 2006 walleye pollock echo integration-trawl survey of the Bering Sea shelf, MF2006-08.

Haul	Pollock				Other species measurements				TINRO	Seabird
No.	Lengths	Maturity	Weight	Otoliths	Species	Lengths	Weight	Bell diameter	collection*	observations
1	137	55	55	40	Eulachon	11			-	x
2	267	56	56	42					-	x
3	89	42	42	34	Eulachon	6			-	x
4	358	63	63	41	Eulachon	13	13		50	x
5	30	30	30	30					-	x
6	198	41	41	37					-	x
7	168	35	35	35	Eulachon	26			-	x
8	170	42	42	35					50	x
9	-	-	-	-					-	x
10	191	35	35	35					-	x
11	11	11	11	11	Rockfish	18			-	x
12	112	35	35	35					50	x
13	312	35	35	35					-	x
14	318	42	42	34	Eulachon	5			50	x
15	94	26	26	26	Eulachon	5	5		-	x
16	2	-	-	-					-	x
17	26	-	-	-					-	x
18	327	37	35	35					-	x
19	174	35	35	34					50	x
20	304	67	67	28					-	x
21	404	41	41	41					-	x
22	300	38	38	38					50	x
23	269	35	35	35					-	-
24	310	72	72	32					-	x
25	182	34	34	34					-	x
26	111	39	39	39	Pac. herring	1			-	x
27	75	36	36	36					-	x
28	321	41	41	35					50	x
29	343	40	40	35					-	x
30	-	-	-	-	Jellyfish			6	-	-
31	349	39	39	35					50	x
32	-	-	-	-	Jellyfish			15	-	x
33	382	51	51	35					50	x
34	165	40	40	35					-	x
35	228	38	38	35					-	x
36	2	-	-	-	Jellyfish			3	-	x
37	283	43	43	36					-	x
38	354	47	47	35					50	x
39	350	42	42	35					-	x
40	461	41	41	36					50	x
41	624	46	46	35					-	x
42	335	40	40	36					-	x
43	-	-	-	-					-	-
44	387	48	48	35					50	x
45	366	39	39	35					50	x
46	184	40	40	35					-	-
47	51	-	-	-					-	-
48	123	-	-	-					-	-
49	13	-	-	-					-	-
50	142	55	55	35					-	x
51	257	-	-	-					-	-
52	475	48	48	35					-	x
53	91	37	37	35					-	x

Table 8.--Continued.

Haul	Pollock				Other species measurements				TINRO	Seabird
No.	Lengths	Maturity	Weight	Otoliths	Species	Lengths	Weight	Bell diameter	collection*	observations
54	3	-	-	-	Rockfish	11			-	-
55	16	-	-	-	Rockfish	32			-	x
56	116	41	41	35					-	-
57	367	53	53	35					50	-
58	470	58	58	34					50	x
59	-	-	-	-	Jellyfish			24	-	-
60	18	18	18	18					-	x
61	459	42	42	38					50	-
62	503	62	62	35					-	-
63	38	-	-	-					-	-
64	437	48	48	40					50	-
65	271	48	48	35					-	x
66	472	81	81	67					-	-
67	379	44	44	33					-	-
68	557	76	76	35					50	x
69	458	75	75	75					-	-
70	321	23	23	21					-	-
71	443	56	56	39					50	x
72	373	46	46	35					50	x
73	-	-	-	-	Jellyfish			5	-	-
74	370	35	35	35					50	x
75	376	35	35	35					-	x
76	566	-	-	-					-	-
77	811	89	89	65					50	x
78	513	65	65	42					-	x
79	455	62	62	62					-	x
80	422	53	53	50					-	x
81	469	71	71	46					-	x
82	568	49	49	48					-	x
83	37	-	-	-					-	x
84	-	-	-	-	Jellyfish			2	-	x
85	-	-	-	-					-	-
86	342	35	35	35					50	x
87	433	61	61	61					-	x
88	397	58	58	58					-	-
89	300	67	67	67					-	-
90	114	14	14	14					-	-
91	291	46	46	34					50	x
92	222	29	29	29					50	x
93	5	-	-	-					-	x
94	717	-	-	-					-	x
95	731	-	-	-					-	x
96	621	-	-	-					-	x
97	494	-	-	-					50	x
98	678	-	-	-					-	x
99	317	-	-	-					-	x
100	358	-	-	-					-	x
101	188	-	-	-					-	-
102	-	-	-	-					-	-
103	457	-	-	-					-	-
104	-	-	-	-					-	-
Totals	28,178	3,297	3,295	2,711		128	18	55	1,300	74 sites

*TINRO center biological sampling included pollock length, weight, sex, maturity, stomach contents, scales, and otoliths.

Table 9.--Numbers-at-length estimates (millions) of walleye pollock between near surface and 3 m off bottom from the Bering Sea shelf echo integration-trawl surveys, 1994-2006.

Length cm	**1994**	**1996**	**1997**	**1999**	**2000**	**2002**	**2004**	**2006**
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	0.03	0	0	0
9	0	0	0	0.01	0.03	0	0	0
10	0	0	2.04	0.12	0.76	0.01	0.24	0
11	0.40	0	0.19	4.78	2.30	0.77	0.20	5.29
12	5.44	0.47	30.13	14.43	5.50	4.70	2.56	59.83
13	44.79	5.44	238.10	22.71	19.26	21.36	2.38	144.42
14	94.23	38.20	1416.21	22.35	36.70	100.48	4.08	117.62
15	179.82	131.29	2949.25	16.20	56.69	194.98	1.84	84.56
16	166.05	227.77	3364.00	5.20	79.57	178.72	1.80	27.81
17	105.16	317.31	2207.83	5.20	50.81	99.74	1.76	10.15
18	129.71	215.26	1309.13	12.92	22.39	33.47	1.12	2.90
19	212.54	115.39	569.51	44.60	30.27	40.07	4.34	4.73
20	381.96	64.79	181.06	152.57	47.16	61.90	8.40	10.85
21	589.69	37.20	74.90	251.49	92.37	162.63	23.15	17.43
22	794.28	64.41	81.07	314.31	136.41	289.69	34.90	31.71
23	788.35	60.24	150.80	288.90	185.76	485.72	47.06	37.50
24	772.58	70.32	255.93	220.31	186.04	734.73	48.21	33.77
25	581.45	47.68	408.07	164.37	207.95	859.82	39.35	30.25
26	372.26	38.32	458.83	188.58	186.91	832.36	32.49	24.95
27	198.97	33.63	519.67	256.04	187.68	718.04	25.99	21.77
28	122.07	60.16	422.68	302.47	168.93	516.42	29.43	25.52
29	135.90	85.07	296.50	419.16	164.76	491.26	69.82	29.78
30	138.25	122.81	175.36	435.28	167.17	507.57	90.09	35.24
31	178.83	183.98	115.83	417.13	169.72	592.86	148.82	42.19
32	234.80	240.98	79.12	410.19	167.23	539.68	151.19	45.36
33	239.39	341.56	69.15	372.65	188.70	533.40	180.25	51.47
34	291.50	408.41	68.83	393.58	221.59	421.17	185.43	68.74
35	296.57	458.38	89.48	415.94	332.90	291.90	237.90	82.66
36	326.66	477.95	146.28	433.11	360.41	239.36	302.68	111.93
37	343.99	400.98	220.62	393.54	414.22	218.57	430.24	118.70
38	305.79	333.42	321.35	403.47	369.24	222.31	476.40	124.99
39	294.82	253.70	397.12	359.07	344.63	218.51	539.43	118.56
40	311.31	214.24	397.83	304.48	297.14	209.21	499.73	126.41

Table 9.--Continued.

Length cm	**1994**	**1996**	**1997**	**1999**	**2000**	**2002**	**2004**	**2006**
41	271.09	168.18	350.37	243.06	331.55	200.43	511.11	140.54
42	289.53	154.99	292.97	240.38	316.41	179.46	475.59	154.29
43	273.09	149.27	222.05	265.33	331.24	186.32	453.93	163.58
44	243.93	133.46	172.49	321.32	302.44	185.26	388.07	178.01
45	256.58	117.96	125.08	328.57	290.08	197.15	339.54	170.87
46	216.09	103.48	93.20	304.97	249.82	183.59	247.30	158.64
47	177.93	98.39	74.75	238.84	235.52	182.87	196.13	146.34
48	148.15	94.29	59.37	182.91	176.81	168.36	150.84	130.84
49	73.11	83.67	45.51	122.90	143.24	154.43	113.57	105.90
50	66.74	79.87	40.23	88.16	106.27	133.48	78.29	88.25
51	33.15	72.52	33.10	60.42	78.54	117.74	64.53	73.93
52	30.35	60.21	31.72	42.15	48.15	91.92	56.33	62.45
53	18.15	50.89	29.59	33.02	35.75	88.43	41.08	45.82
54	15.68	38.44	23.91	26.90	22.09	62.98	30.20	35.31
55	18.57	25.63	19.77	16.14	16.58	44.34	19.12	23.01
56	11.05	14.07	14.58	9.26	12.58	40.16	14.43	19.33
57	9.52	7.65	10.61	9.40	8.92	24.16	8.83	14.93
58	4.85	7.68	8.60	5.68	6.41	18.77	5.83	10.63
59	2.96	3.02	5.98	3.24	5.13	11.26	6.16	8.11
60	3.47	4.71	3.45	3.04	1.87	10.58	4.00	5.39
61	6.63	2.88	4.58	2.40	2.30	7.11	2.89	4.60
62	1.39	1.79	1.55	2.12	1.72	3.92	1.95	2.07
63	0.71	0.28	2.01	0.62	1.57	2.18	2.07	1.17
64	0.49	0.59	0.47	0.57	0.98	1.74	0.08	1.98
65	1.86	0.85	0.81	0.93	0.64	1.74	0.30	0.73
66	0.77	0.35	0.32	1.42	0.70	1.16	0.55	0.85
67	0.97	0.66	1.27	0.48	0.03	0.27	0.35	0.27
68	1.46	0	0.19	0.30	0.27	0.17	0.19	0.02
69	0	0	0.59	0.29	0.59	0	0	0.00
70	1.93	0	0.10	0	0	0.43	0	0.02
71	0.49	0.11	0	<0.01	0	0.01	0	0.14
72	0.97	0	0	0.11	0.15	0	0	0.46
73	0.49	0	0.05	0.16	0	0	0	0.02
74	0	0	0	0	0.14	0	0	0
75	0	0	0	0.04	0	0	0	0
76	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0
78	0.49	0	0	0	0	0	0	0
79	0	0	0	0.39	0	0	0	0.08
80	0	0	0	0	0	0	0	0
Total	10,821	6,525	18,686	9,601	7,630	12,122	6,835	3,396

Table 10.--Biomass-at-length estimates (metric tons) of walleye pollock between near surface and 3 m off bottom from the Bering Sea shelf echo integration-trawl surveys, 1994-2006.

Length cm	**1994**	**1996**	**1997**	**1999**	**2000**	**2002**	**2004**	**2006**
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	<1	0	0	0
9	0	0	0	<1	<1	0	0	0
10	0	0	14	1	8	0	2	0
11	4	0	2	59	30	9	2	54
12	71	6	394	227	88	75	30	762
13	744	92	4,148	445	370	428	36	2,366
14	1,937	804	31,282	538	859	2,488	81	2,176
15	4,520	3,384	81,544	472	1,613	5,841	48	1,997
16	5,040	7,098	111,182	181	2,713	6,393	57	815
17	3,817	11,818	84,460	214	2,055	4,231	67	365
18	5,553	9,485	58,223	623	1,064	1,664	50	123
19	10,655	5,960	28,768	2,499	1,677	2,284	210	235
20	22,244	3,892	10,677	9,852	3,017	4,072	498	626
21	39,601	2,579	4,900	18,587	6,782	12,242	1,595	1,133
22	61,100	5,121	6,101	26,421	11,419	24,828	2,730	2,413
23	69,048	5,458	12,962	27,464	17,629	47,351	4,265	3,277
24	76,622	7,221	24,999	23,562	19,911	81,309	4,887	3,259
25	64,967	5,520	45,081	19,681	24,970	107,760	4,475	3,176
26	46,652	4,979	56,998	25,168	25,070	117,666	4,347	3,107
27	27,847	4,884	72,339	37,933	28,002	113,478	3,876	2,946
28	19,028	9,721	65,700	49,557	27,927	89,827	4,813	3,917
29	23,550	15,240	51,328	75,679	30,072	92,941	12,745	5,050
30	26,437	24,307	33,691	86,321	33,574	104,158	17,942	6,561
31	37,756	40,104	24,685	90,579	37,396	132,640	32,663	9,236
32	54,180	57,669	18,522	97,251	40,301	131,538	36,257	10,767
33	60,378	89,480	17,709	96,204	49,614	141,718	48,265	13,252
34	80,001	116,812	19,201	110,357	63,403	122,045	53,459	19,248
35	88,546	142,771	27,148	126,368	103,387	92,414	74,135	25,252
36	105,903	161,724	48,272	142,256	121,237	82,291	103,401	36,989
37	120,806	147,067	79,075	139,441	150,552	81,503	156,813	41,377
38	116,110	132,264	124,841	153,908	144,826	88,680	188,084	47,836
39	121,143	108,629	166,999	147,178	145,465	93,405	229,225	49,056
40	137,651	98,825	180,668	133,859	135,080	95,675	230,733	55,427

Table 10.--Continued.

Length cm	**1994**	**1996**	**1997**	**1999**	**2000**	**2002**	**2004**	**2006**
41	129,335	83,422	171,750	114,415	161,884	98,165	252,339	65,790
42	149,294	82,523	154,670	120,957	165,982	94,168	253,443	78,528
43	152,526	85,177	125,886	142,492	185,961	104,975	261,967	87,505
44	147,017	81,478	104,750	183,897	181,482	110,994	239,860	102,839
45	166,444	76,937	81,320	200,114	185,345	125,772	222,131	103,984
46	149,720	71,999	64,736	197,389	169,854	124,740	171,216	102,312
47	131,130	72,930	55,323	164,067	170,024	132,267	142,845	100,258
48	115,921	74,352	46,750	133,183	135,575	129,623	115,709	94,693
49	60,566	70,102	38,100	94,742	116,332	126,481	92,215	81,175
50	58,531	71,016	35,728	71,872	91,389	115,778	67,512	73,481
51	30,462	68,346	31,145	52,026	71,352	108,641	58,478	63,585
52	29,789	60,080	31,560	38,303	46,186	89,753	53,394	56,209
53	18,463	53,710	31,087	31,630	36,163	91,552	41,489	44,479
54	16,856	42,859	26,500	27,130	23,496	68,832	31,998	36,086
55	21,296	30,163	23,075	17,129	18,562	51,122	21,285	25,029
56	13,207	17,456	17,914	10,327	14,788	48,961	17,136	21,089
57	11,943	9,998	13,712	11,013	11,004	30,986	11,453	17,519
58	6,368	10,573	11,671	6,984	8,300	25,335	7,517	13,507
59	4,167	4,365	8,530	4,174	6,962	15,953	8,825	10,892
60	5,001	7,163	5,155	4,104	2,656	15,550	6,038	7,784
61	10,199	4,591	7,172	3,394	3,421	11,003	4,574	6,869
62	2,285	2,998	2,550	3,135	2,679	6,415	3,214	3,241
63	1,196	498	3,448	953	2,551	3,683	3,585	1,937
64	844	1,084	843	925	1,660	3,109	139	3,360
65	3,382	1,637	1,531	1,562	1,122	3,223	562	1,314
66	1,467	704	617	2,497	1,296	2,202	1,097	1,587
67	1,929	1,386	2,622	876	52	505	717	519
68	3,021	0	413	567	551	352	406	46
69	0	0	1,351	585	1,244	0	0	0
70	4,349	0	230	0	0	945	0	51
71	1,142	267	0	3	0	33	0	322
72	2,380	0	0	238	351	0	0	1,084
73	1,239	0	126	362	0	0	0	57
74	0	0	0	0	362	0	0	0
75	1,340	0	0	90	0	0	0	0
76	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0
78	1,503	0	0	0	0	0	0	0
79	0	0	0	1,118	0	0	0	253
80	0	0	0	0	0	0	0	0
Total	2,886,223	2,310,728	2,592,178	3,285,138	3,048,697	3,622,072	3,306,935	1,560,182

Table 11.--Walleye pollock abundance by area from summer echo integration-trawl surveys on the U.S. EEZ portion of the Bering Sea shelf, 1994-2006. Data are estimated pollock biomass between near surface and 3 m off bottom. Relative estimation error for the biomass 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
1994	9 Jul-19 Aug	78,251	0.312 10.8	0.399 13.8	2.176 75.4	2.886	0.047
1996	20 Jul-30 Aug	93,810	0.215 9.3	0.269 11.7	1.826 79.0	2.311	0.039
1997	17 Jul-4 Sept	102,770	0.246 9.5	0.527 20.3	1.818 70.2	2.591	0.037
1999	7 Jun-5 Aug	103,670	0.299 9.1	0.579 17.6	2.408 73.2	3.290	0.055
2000	7 Jun-2 Aug	106,140	0.393 12.9	0.498 16.3	2.158 70.8	3.049	0.032
2002	4 Jun -30 Jul	99,526	0.647 17.9	0.797 22.0	2.178 60.1	3.622	0.031
2004	4 Jun -29 Jul	99,659	0.498 15.1	0.516 15.6	2.293 69.3	3.307	0.037
2006	3 Jun -25 Jul	89,550	0.131 8.4	0.254 16.3	1.175 75.3	1.560	0.039

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

Table 12. Estimated numbers-at-age (millions, top) and biomass-at-age (thousand metric tons, bottom) for walleye pollock observed between near surface and 3 m off bottom from summer Bering Sea shelf echo integration-trawl surveys 1994-2006.

Age	1994	1996	1997	1999	2000	2002	2004	2006
1	610.2	972.3	12,360.0	111.9	257.9	634.8	15.8	455.6
2	4,781.1	446.4	2,745.2	1,587.6	1,272.3	4,850.4	275.1	208.6
3	1,336.0	520.4	386.2	3,597.0	1,184.9	3,295.1	1,189.3	282.0
4	1,655.7	2,686.5	490.9	1,683.6	2,480.0	1,155.0	2,933.9	610.1
5	1,898.1	820.7	1,921.5	582.6	899.7	507.2	1,442.1	695.3
6	296.1	509.3	384.4	273.9	243.9	756.8	416.6	551.8
7	71.2	434.4	205.2	1,169.1	234.0	436.7	199.2	319.7
8	65.2	84.9	142.5	400.2	725.1	91.4	194.0	110.1
9	31.9	16.7	32.7	104.6	190.4	110.3	68.3	53.0
10	23.2	6.3	3.9	66.9	84.7	205.4	33.5	40.3
11	8.5	5.7	4.9	14.5	35.6	52.1	24.8	23.3
12	19.3	12.1	2.0	6.5	18.1	17.9	19.8	16.2
13	4.8	1.3	2.2	1.7	1.2	3.1	12.1	8.6
14	5.7	4.8	2.3	0.0	1.4	5.9	5.8	9.9
15	1.2	2.4	2.0	0.1	0.1	0.0	4.3	5.0
16	7.9	0.5	0.0	0.1	0.3	0.0	0.0	3.8
17	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.2
18	0.0	0.5	0.0	0.4	0.1	0.0	0.0	0.1
19	0.7	0.0	0.0	0.0	0.0	0.0	0.0	2.1
20	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
21+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	10,821	6,525	18,686	9,601	7,630	12,122	6,834	3,396

Age	1994	1996	1997	1999	2000	2002	2004	2006
1	17.1	36.7	417.8	3.3	8.1	21.2	0.4	8.8
2	425.3	35.3	369.9	156.6	144.0	645.1	31.6	21.2
3	312.4	118.7	99.5	847.4	284.6	843.7	329.3	68.8
4	641.3	888.8	188.6	640.2	974.4	458.2	1349.4	230.7
5	1,067.2	396.0	921.0	271.7	488.6	286.0	820.9	366.4
6	187.2	341.8	235.0	164.3	156.0	514.5	288.7	359.8
7	50.1	359.9	161.3	751.5	166.6	351.6	153.0	244.1
8	55.3	72.5	139.5	278.9	540.8	85.6	166.3	93.2
9	30.9	16.3	34.2	84.6	149.0	111.0	62.4	49.5
10	26.4	6.6	4.4	62.5	76.3	212.5	33.1	39.2
11	10.5	6.9	6.1	14.2	39.0	59.6	25.3	23.3
12	27.9	17.1	3.4	7.2	16.7	19.7	21.9	18.7
13	6.7	1.5	4.5	1.5	1.3	4.6	12.7	10.4
14	7.7	7.0	3.8	0.0	2.6	8.5	6.2	12.7
15	2.1	3.8	2.9	0.2	0.1	0.0	5.7	5.9
16	12.5	0.9	0.0	0.2	0.3	0.0	0.0	4.3
17	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.4
18	0.0	0.9	0.0	0.7	0.3	0.0	0.0	0.3
19	0.8	0.0	0.0	0.0	0.0	0.0	0.0	2.5
20	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
21+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	2,886	2,311	2,592	3,285	3,049	3,622	3,307	1,560

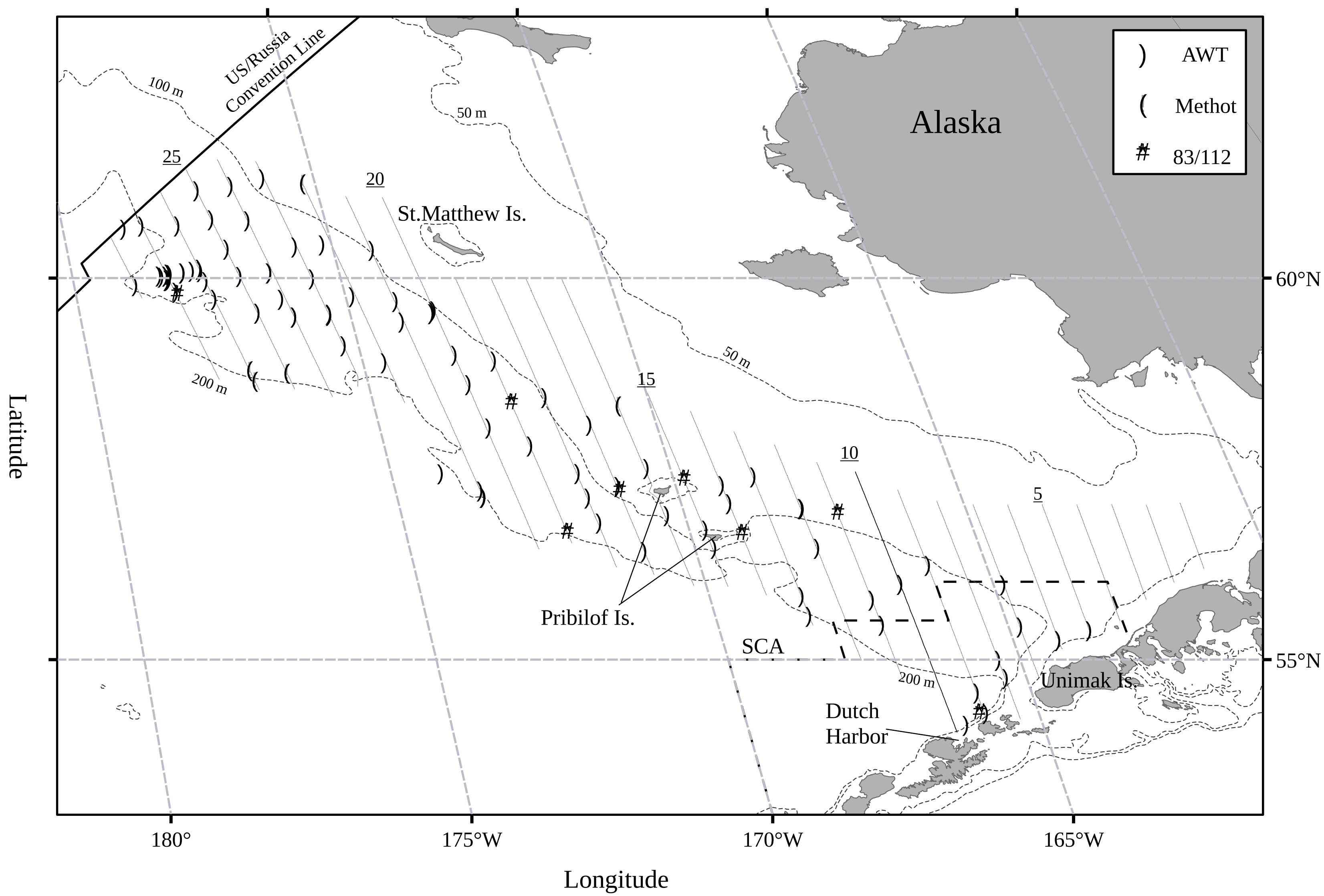


Figure 1. -- Transect lines with locations of midwater (Aleutian wing (AWT) and Methot trawls) and bottom trawl (83/112) hauls during the summer 2006 echo integration-trawl survey of walleye pollock in the Bering Sea shelf. Transect numbers are underlined and the Steller sea lion Conservation Area (SCA) is outlined (---).

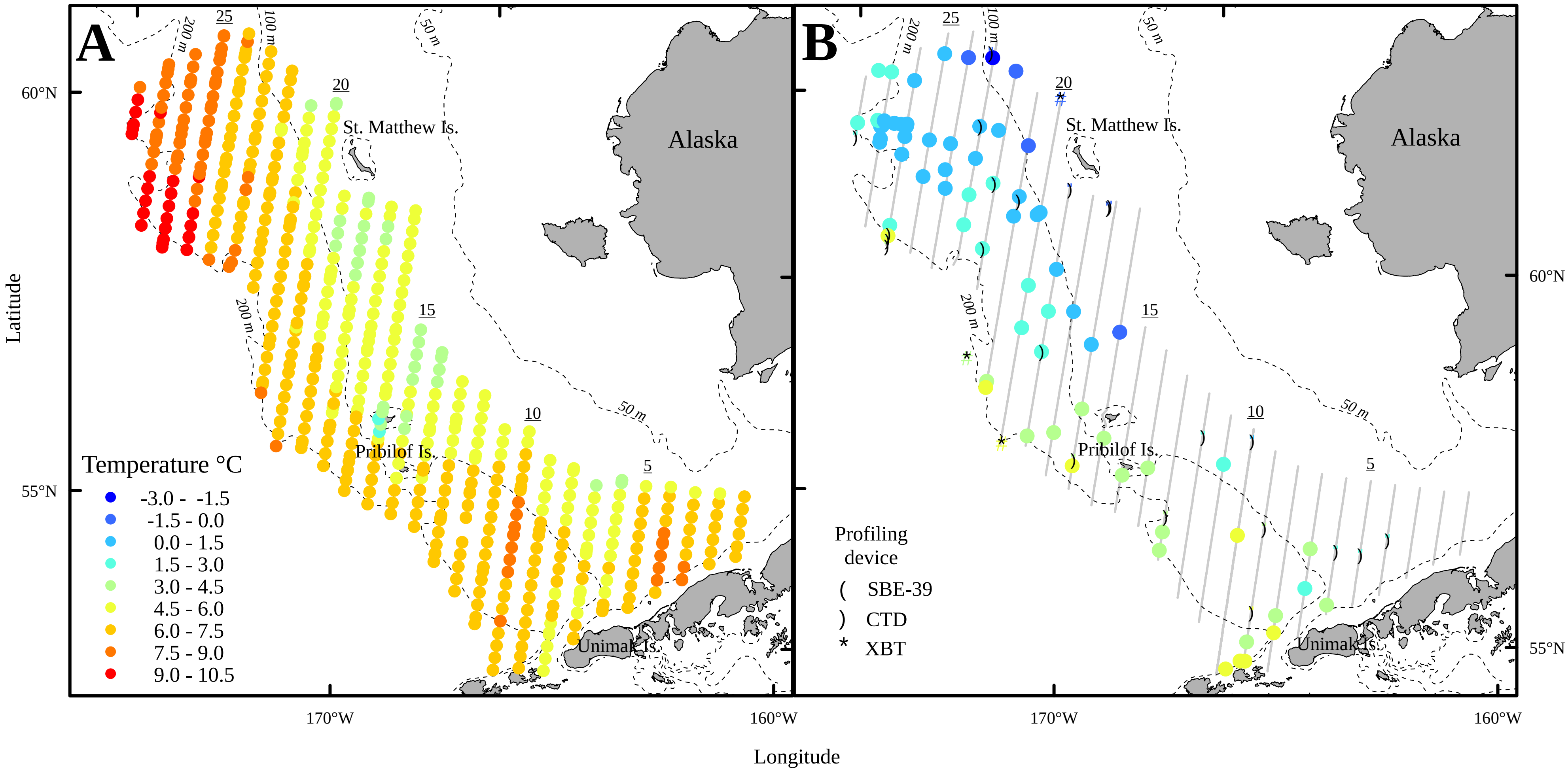


Figure 2.--Temperature (°C) measured at the sea surface (A) and at 60 m depth (B) measured using SBE-39s at trawl locations, XBTs, and CTDs during the summer 2006 echo integration-trawl survey of walleye pollock in the Bering Sea shelf.

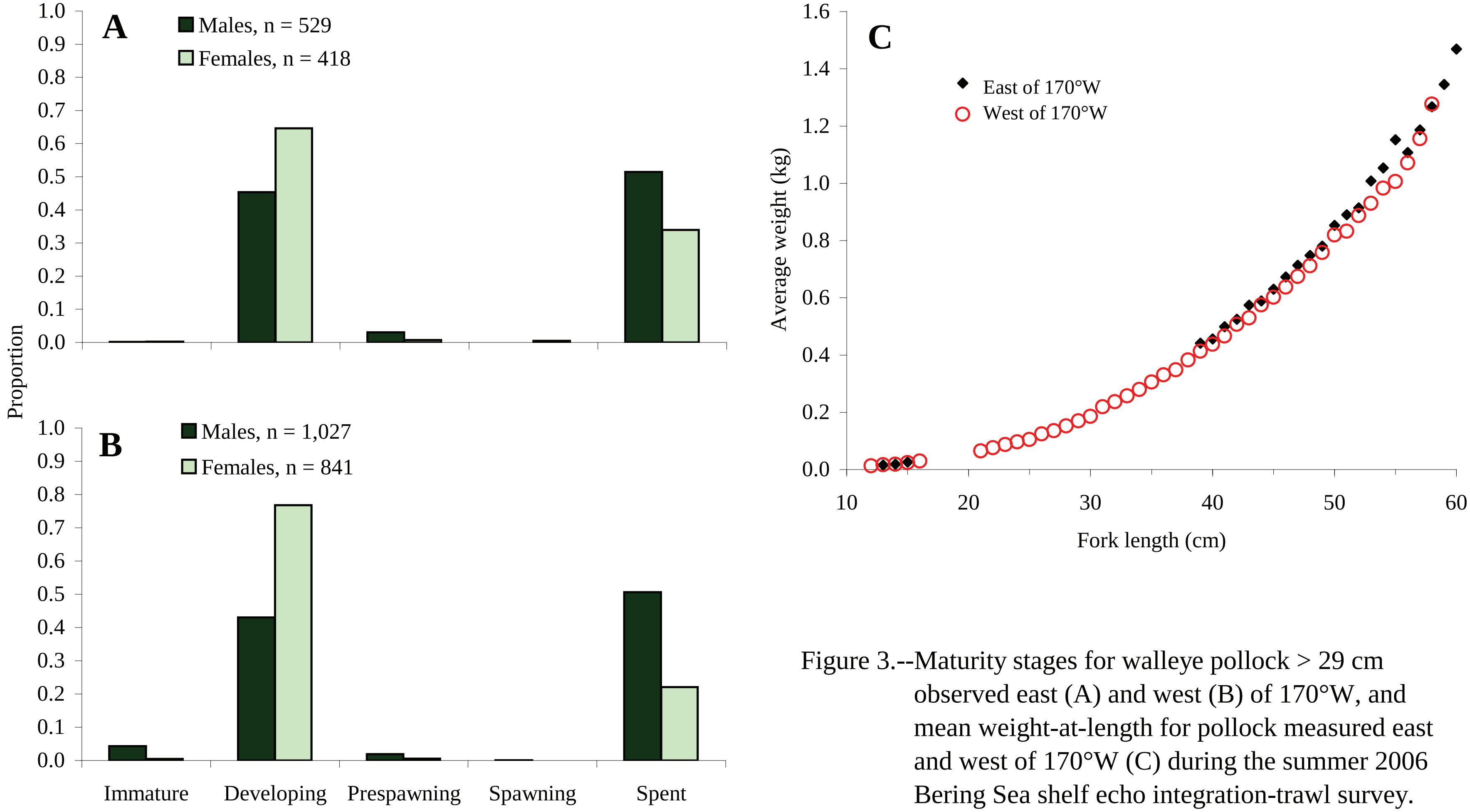


Figure 3.--Maturity stages for walleye pollock > 29 cm observed east (A) and west (B) of 170°W, and mean weight-at-length for pollock measured east and west of 170°W (C) during the summer 2006 Bering Sea shelf echo integration-trawl survey. Average weights (kg) were computed when > 5 fish were measured at any given length (cm).

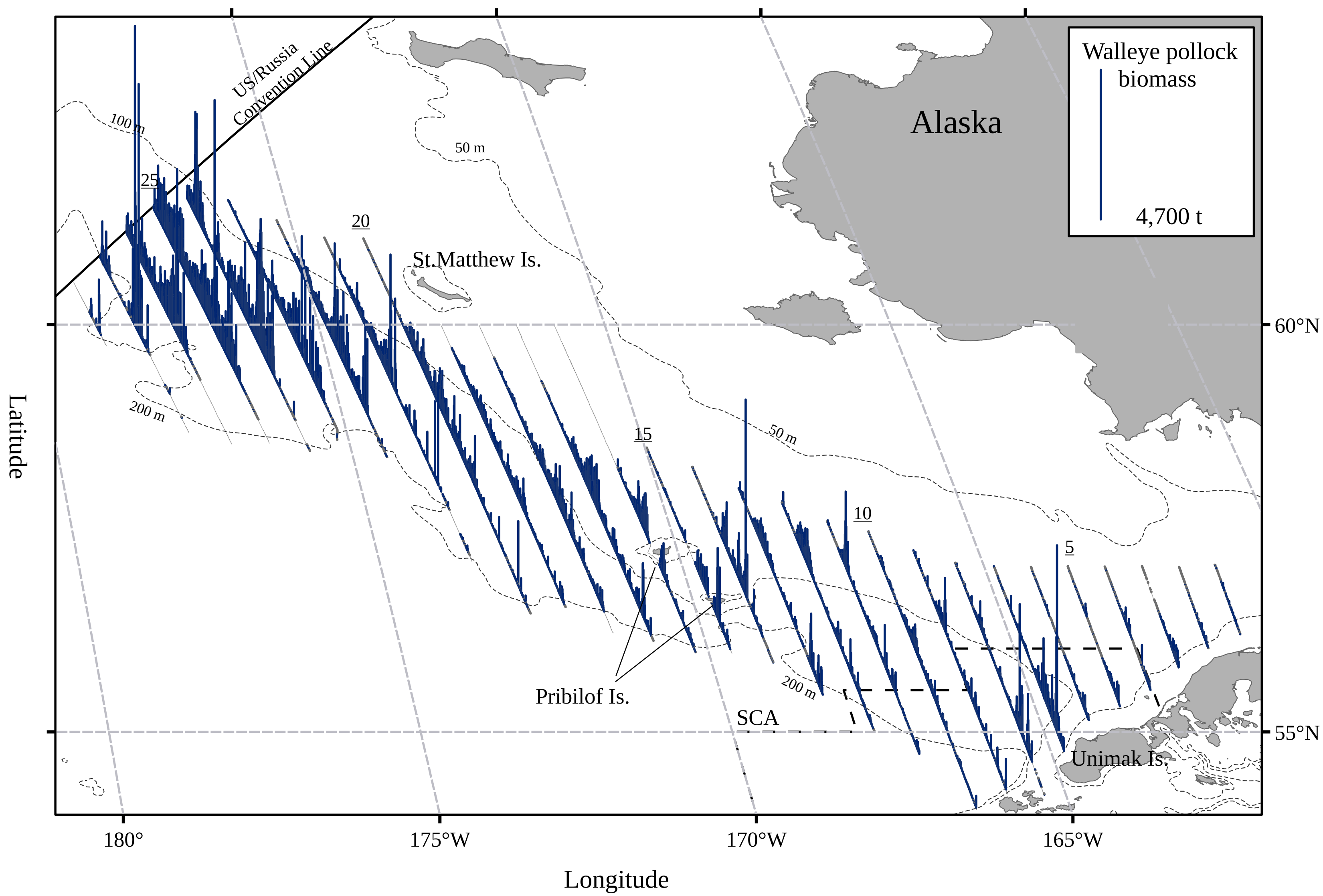


Figure 4. -- Estimated walleye pollock biomass (t) along tracklines surveyed during the summer 2006 echo integration-trawl survey of the Bering Sea shelf. Transect numbers are underlined, and the Steller sea lion Conservation Area (SCA) is outlined (---).

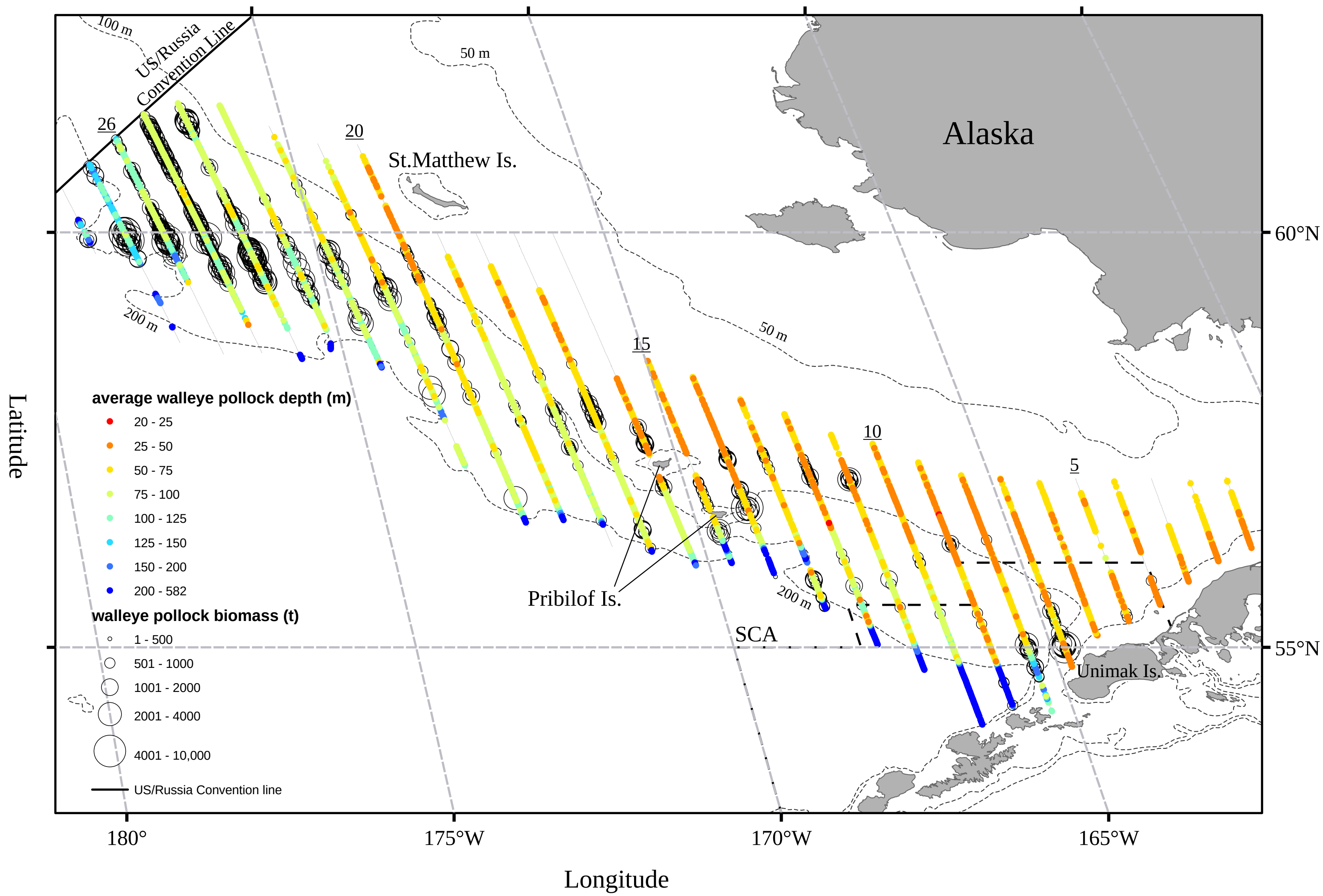
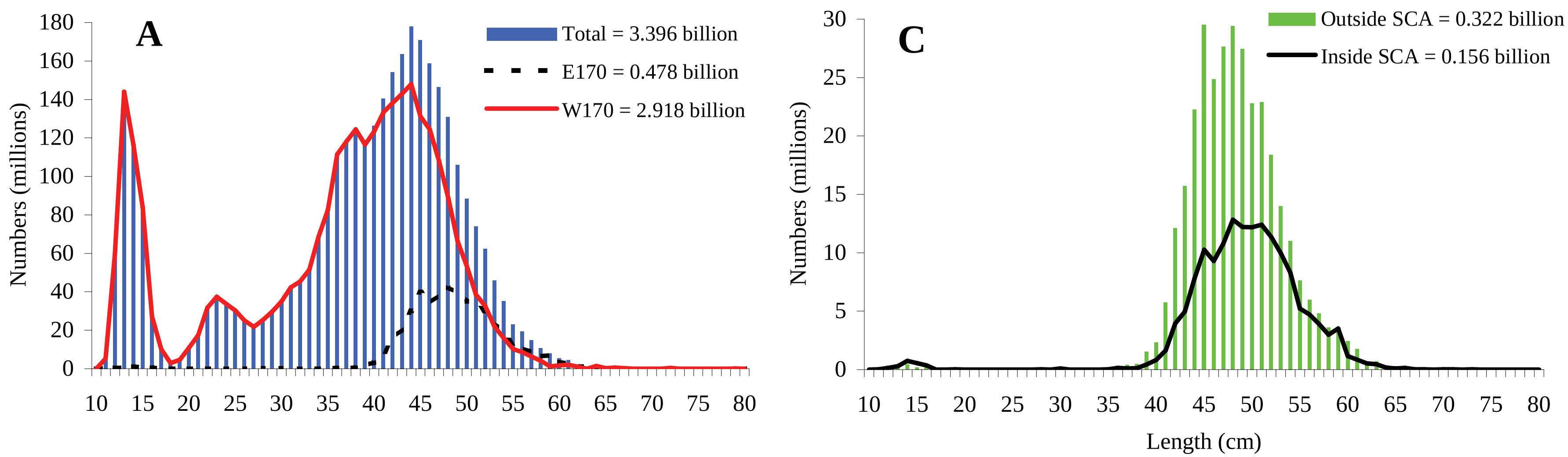


Figure 5. -- Estimated midwater walleye pollock biomass (t) (> 1 metric ton) and average pollock depth (m) observed along tracklines during the summer 2006 echo integration-trawl survey of the Bering Sea shelf. Transect numbers are underlined, and the Steller sea lion Conservation Area (SCA) is outlined (---).



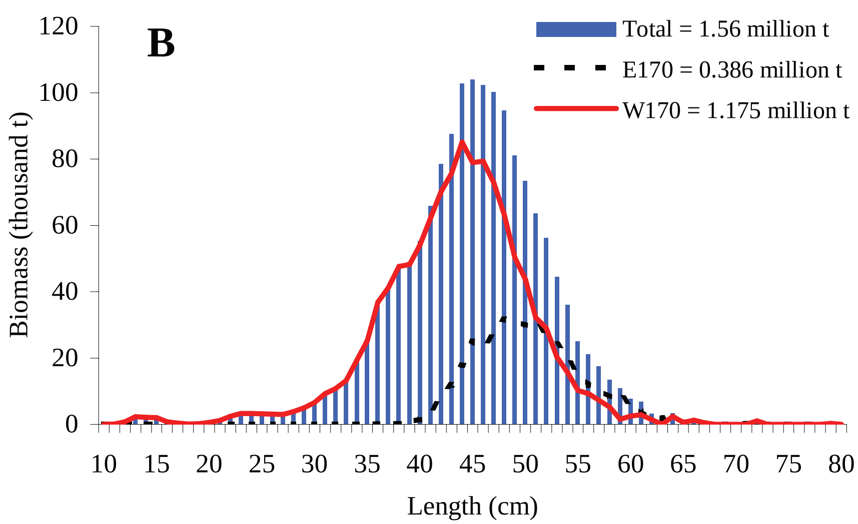


Figure 6.--Population- and biomass-at-length estimates for walleye pollock between 12 m from the surface and 3 m off bottom during the summer 2006 echo integration-trawl survey along the Bering Sea shelf. Population-at-length estimates (A) and biomass-at-length estimates (B) include areas east and west of 170°W. East of 170°W population-at-length estimates are illustrated for inside-outside the Steller sea lion Conservation Area (SCA) (C). Note Y-axes differ.

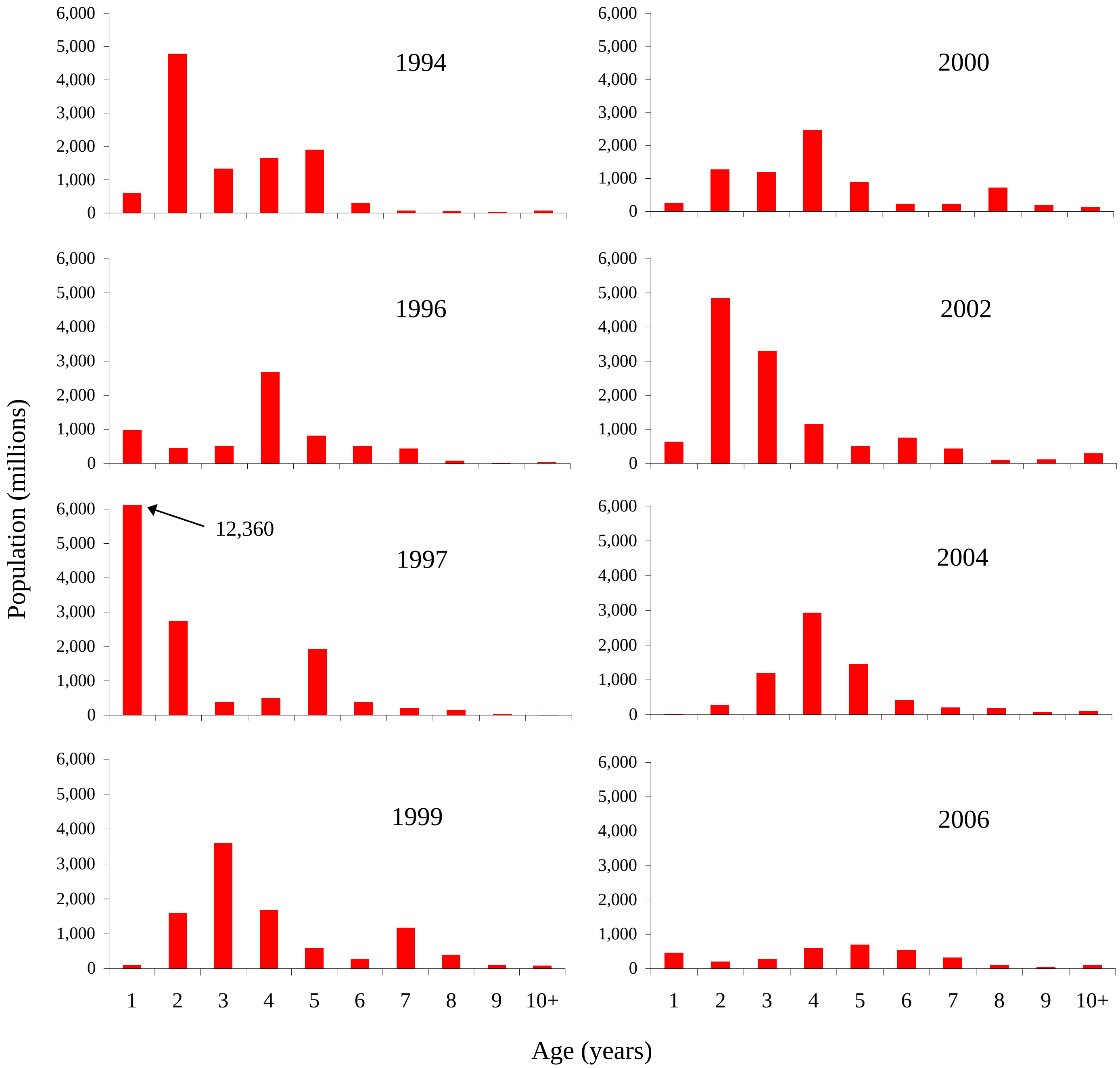


Figure 7.--Estimated numbers-at-age for walleye pollock observed between near surface and 3 m off bottom from summer Bering Sea shelf echo integration-trawl surveys 1994-2006.

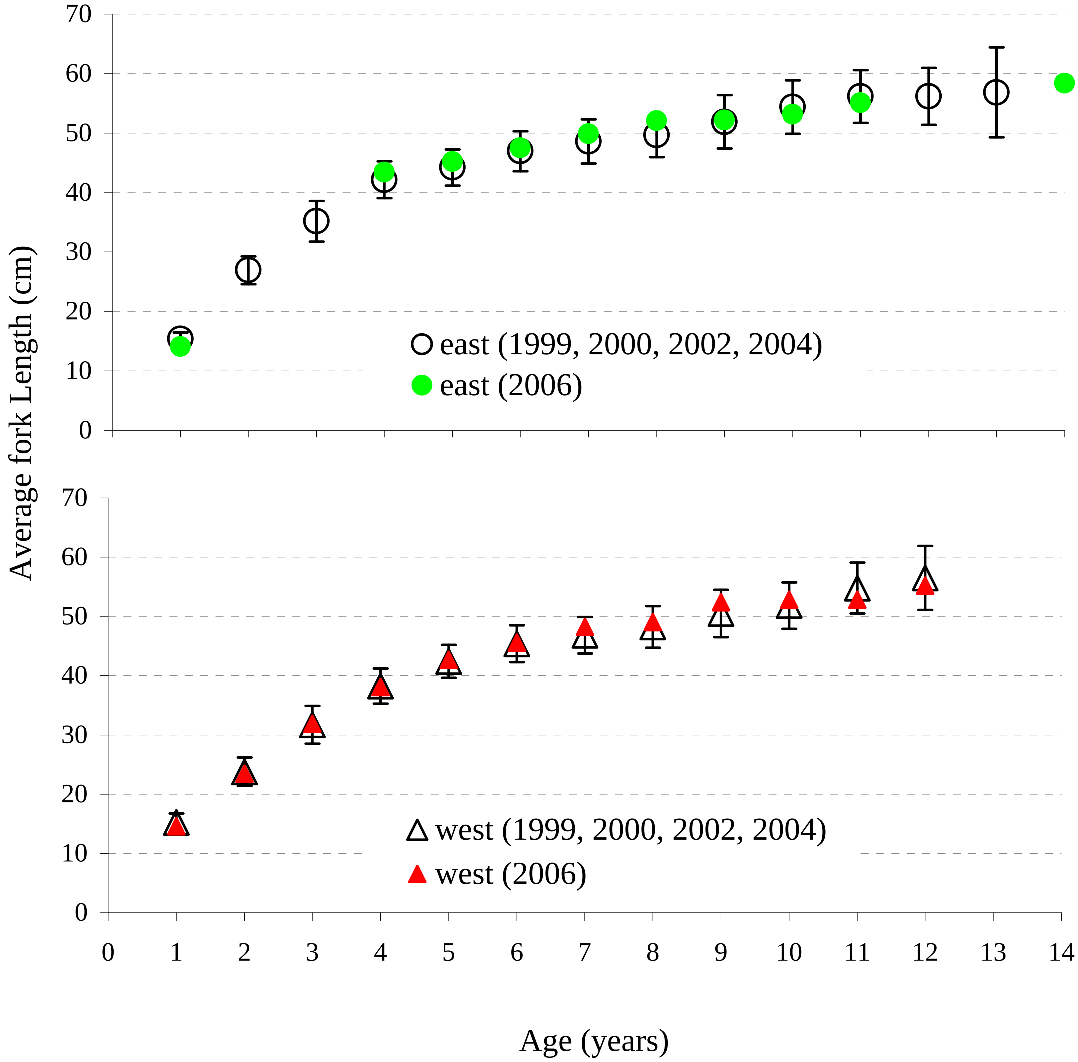


Figure 8.--Comparison between walleye pollock average-length-at-age observed during the summer 2006 and the four previous summer echo integration-trawl surveys occuring in June-July 1999, 2000, 2002, and 2004 within the U.S. Exclusive Economic Zone east (upper) and west (lower) of 170°W. Results are from midwater tows only. Averages and standard deviations were computed for those ages where at least 10 pollock were measured. Vertical bars indicate one standard deviation.

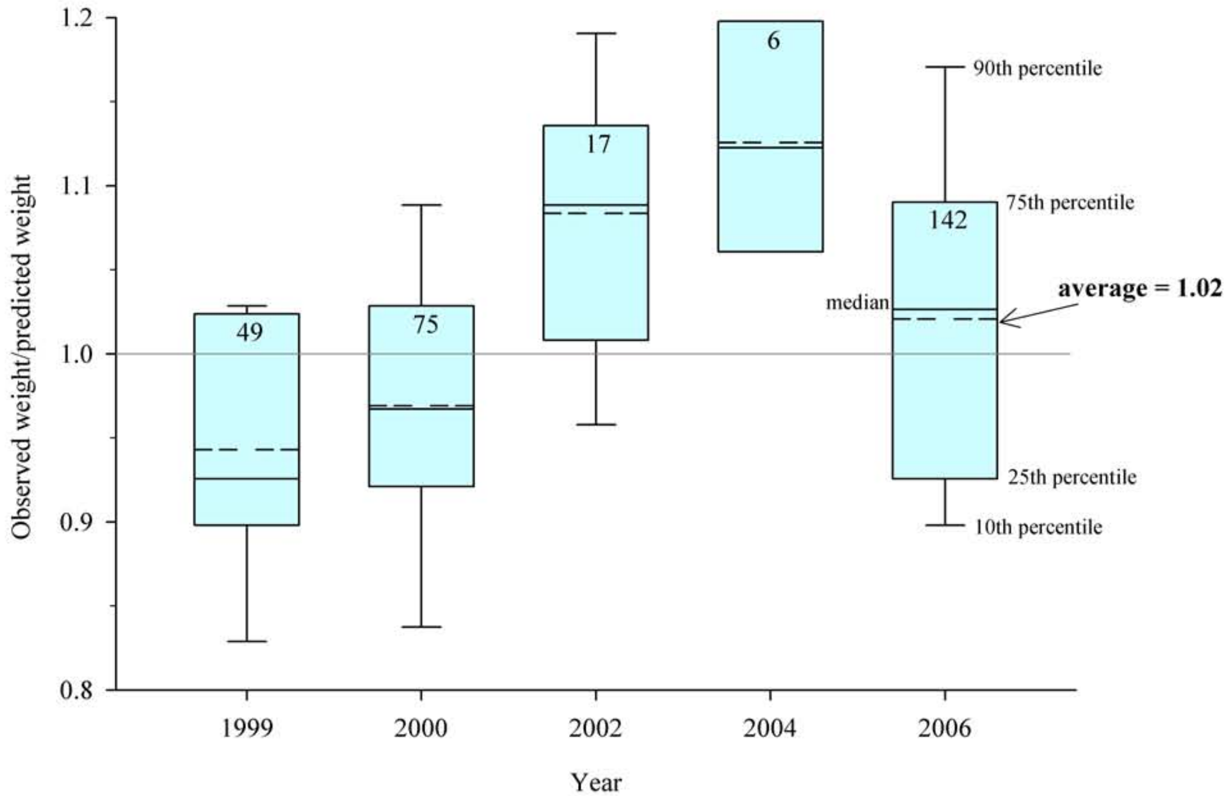


Figure 9.--Average condition factor (dashed line) for age-1 walleye pollock captured in midwater during the summer 1999, 2000, 2002, 2004 and 2006 echo integration-trawl surveys occuring within the U.S. Exclusive Economic Zone west of 170°W. Numbers inside the box indicate how many fish were measured.

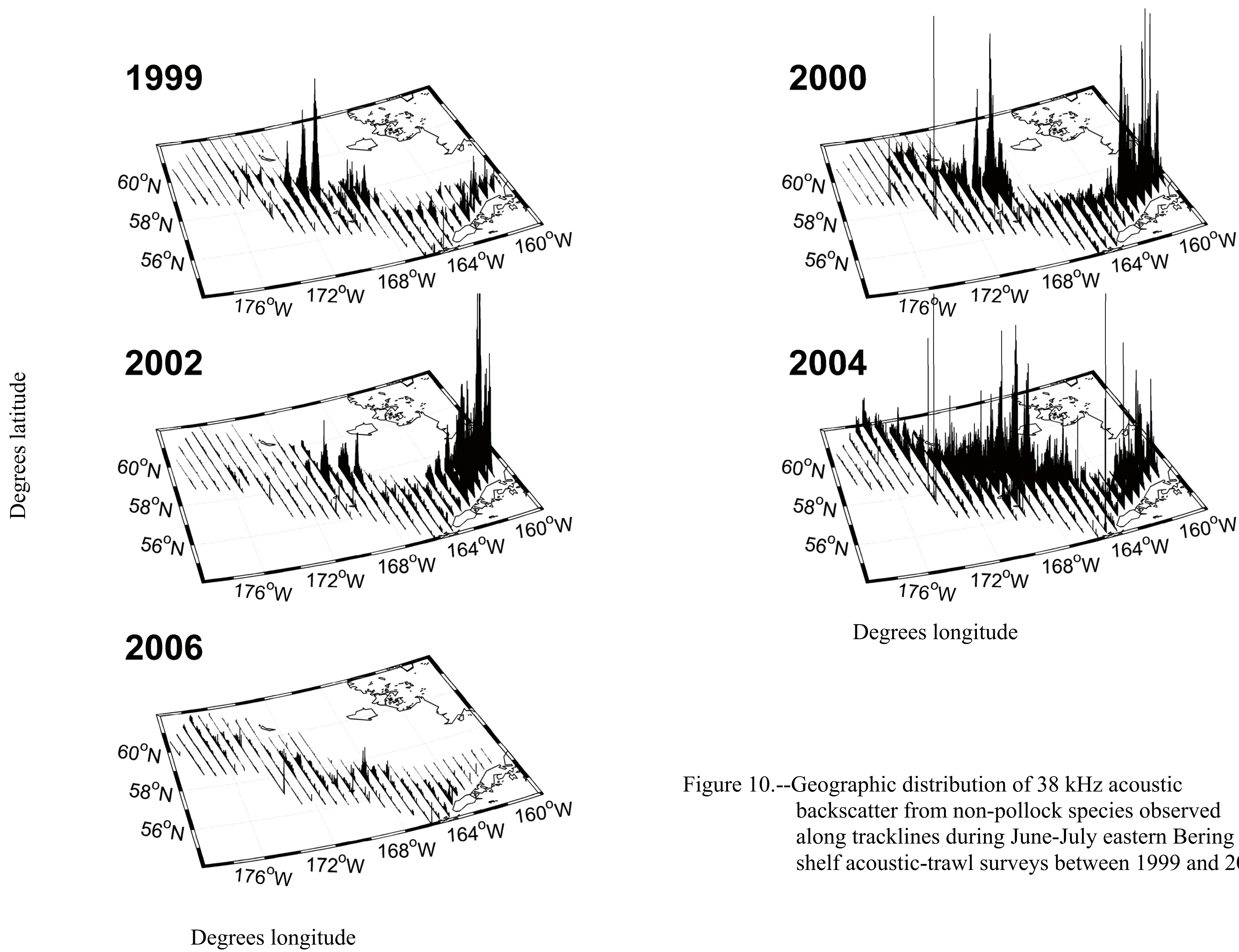


Figure 10.--Geographic distribution of 38 kHz acoustic backscatter from non-pollock species observed along tracklines during June-July eastern Bering Sea shelf acoustic-trawl surveys between 1999 and 2006.