Alaska
Fisheries Science
Center

National Marine
Fisheries Service

U.S DEPARTMENT OF COMMERCE

AFSC PROCESSED REPORT 2002-02

Results of the Echo Integration-trawl Survey of Walleye Pollock (*Theragra chalcogramma*) Conducted on the Southeastern Bering Sea Shelf and in the Southeastern Aleutian Basin Near Bogoslof Island in February and March 2002

September 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 of Walleye Pollock (*Theragra chalcogramma*) Conducted on the Southeastern Bering Sea Shelf and in the Southeastern Aleutian Basin Near Bogoslof Island in February and March 2002

by Taina Honkalehto, Neal Williamson, Dale Hanson, Denise McKelvey, and Steve de Blois

September 2002

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 in this report are from the echo integration-trawl (EIT) survey carried out between 18 February and 11 March 2002 on the southeastern Bering Sea continental shelf and in the southeastern Aleutian Basin near Bogoslof Island (the Bogoslof Island area) aboard the NOAA ship *Miller Freeman*. The primary objective of the Bering Sea shelf portion of the survey was to assess the abundance and distribution of pollock inhabiting the Steller sea lion Conservation Area (SCA) east of 168°W. The primary objective of the Bogoslof portion was to assess the abundance and distribution of pre-spawning pollock in the southeastern Aleutian Basin. The biomass estimate for pollock inside the North Pacific Fishery Management Council's (NPFMC) Statistical Reporting Area 518 (Area 518; the same as the Central Bering Sea (CBS) Convention Specific Area[1]) obtained during this survey provides an index of abundance for Aleutian Basin pollock. The Japan Fisheries Agency also conducted an EIT survey of pollock in the southeastern Aleutian Basin between 9 February and 5 March 2002. This survey was conducted aboard the R/V *Kaiyo Maru* in cooperation with the United States in order to estimate

---

[1] The "specific area" is defined in the Annex to the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea as "the area south of a straight line between a point at 55° 46' N lat. and 170° W long. and a point at 54° 30' N lat., 167° W long. and between the meridian 167° W long. and the meridian 170° W long. and the north of the Aleutian Islands and straight lines between the islands connecting the following coordinates in the order listed: 52° 49.2 N 169° 40.4 W, 52° 49.8 N 169° 06.3 W, 53° 23.8 N 167° 50.1 W, 53° 18.7 N 167° 51.4 W."

distribution and abundance of pre-spawning pollock. In addition to surveying the Bogoslof Island area, they surveyed basin and slope waters north of the Aleutian Islands west of 170°W to about 176°W. Prior to the start of the U.S. survey in February, the two vessels conducted an intership calibration to compare acoustic systems. Intership calibration results will be presented in a different report. This report summarizes the U.S. EIT survey results on observed pollock distribution and biological composition, and provides abundance estimates. It also summarizes oceanographic observations and acoustic system calibration results.

METHODS

Itinerary

18 Feb	Embark scientists in Dutch Harbor, AK; calibration of acoustic systems in Captains Bay.
19-20 Feb	Intership calibration of the NOAA ship *Miller Freeman* with the Japan Fisheries Agency R/V *Kaiyo Maru* in the Islands of Four Mountains area (Samalga Pass).
20 Feb-1 Mar	Transit to Bering Sea shelf. Retrieval of two temperature sensor moorings in Bristol Bay. EIT survey of the southeastern Bering Sea shelf (Transects 98-114).
1 Mar	Exchange scientists and obtain fuel in Dutch Harbor.
1-10 Mar	EIT survey of the southeastern Bering Sea shelf (Transects 115-122) and southeastern Aleutian Basin (Transects 199-220). Acoustic system calibration in Captains Bay.
11 Mar	Inport Dutch Harbor.

Acoustic Equipment

Acoustic data were collected with a Simrad[2] EK500 quantitative echo sounding system (Bodholt et al. 1989, Bodholt and Solli 1992) on the NOAA ship *Miller Freeman*, a 66-m (216-foot) stern trawler equipped for fisheries and oceanographic research. Two split-beam transducers (38 kHz

[2] Reference to trade names or commercial firms does not constitute U.S. government endorsement.

and 120 kHz frequencies) 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 at both frequencies. The depth limit of acoustic data collection was 1,000 m. Scientists scrutinized these 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 pollock, non-pollock fish, myctophid scattering layers, and an undifferentiated invertebrate/fish mixture, and stored them in a relational database. Results presented here are based on the 38-kHz data. Acoustic data were also collected at 38 kHz and 120 kHz with a new acoustic system (Simrad EK60 quantitative echosounding system and Sonardata Echolog) run in parallel to the EK500 acoustic system for testing. Comparison of the performance of the EK500 and EK60 38 and 120 kHz transceivers was facilitated by the use of a custom-designed multiplexer. The multiplexer generated master trigger pulses and switched transducers between transceivers on an alternate ping basis; this device also ensured that the 38 and 120 kHz transceivers were properly synchronized. For each frequency (38 or 120 kHz), the transducer was connected by the multiplexer to one transceiver for a complete trigger-transmit-receive cycle and was then connected to the other transceiver for the next trigger-transmit-receive cycle. The multiplexer ping interval was adjustable between 1 and 3 seconds, therefore the ping interval for one transceiver could be varied between 2 and 6 seconds.

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 (AWT). This trawl was constructed with full-mesh nylon wings with 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 32-mm (1.25-in) codend liner. The AWT was fished with 82.3 m (270 ft) of 1.9-cm (0.75-in) diameter (8x19 wire) non-rotational dandylines. On the continental shelf, the AWT

was fished with 113.6-kg (250-lb) or 226.8-kg (500-lb) tom weights on each side; in the basin, 340.2-kg (750-lb) tom weights were used. A polyethylene Nor'eastern high-opening bottom trawl (PNE) was used in the Bering Sea shelf area to sample echosign on or near bottom, and on a few occasions, to sample echosign observed in the upper 50 m (due to difficulty deploying the AWT in water shallower than about 60 m). The bottom trawl was equipped with roller gear and was constructed with stretch mesh sizes that ranged from 13 cm (5 in) in the forward portion of the net to 89 mm (3.5 in) in the codend. It was fitted with a nylon codend liner with a mesh size of 32 mm. The 27.2-m (89.1-ft) headrope had 21 floats [30-cm (12-in) diameter]. A 24.7-m (81-ft) chain fishing line was attached to the 24.9-m (81.6-ft) footrope which was constructed of 1-cm (0.4-in) 6 x 19 wire rope wrapped with polypropylene rope. The 24.2-m (79.5-ft) roller gear was constructed with 36-cm (14-in) rubber bobbins spaced 1.5 to 2.1 m (5 to 7 ft) apart. A solid string of 10-cm (4-in) rubber disks separated the bobbins in the center section of the roller gear. Two 5.9-m (19.5-ft) wire rope extensions with 10-cm (4-in) and 20-cm (8-in) rubber disks were used to span the two lower flying wing sections and were attached to the roller gear. The roller gear was attached to the fishing line using chain toggles [2.9 kg (6.5 lb.) each] which comprised five links and one ring. The trawl was rigged with triple 54.9-m (180-ft) galvanized wire rope dandylines. Both nets were fished with 5-m^2 Fishbuster trawl doors [1,247 kg (2,750 lb) each].

The vertical net opening and headrope depth were monitored during all hauls using a WESMAR third wire or a Furuno acoustic link netsounder system attached to the trawl headrope. Net opening varied depending on the trawl type and tom weights. For bottom trawl hauls, the net opening ranged from 5 to 9 m and averaged 7 m. For midwater trawl hauls that were fished with 113.6-kg tom weights, the net opening ranged from 16 to 21 m and averaged 18 m. When the midwater trawl was fished with the 226.8-kg tom weights, the net opening ranged from 21 to 28 m and averaged 23 m. In the Bogoslof Island area, where the midwater trawl was fished with 340.2-kg tom weights, the net opening ranged from 20 to 29 m and averaged 26 m.

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) observations collected with a Sea-Bird CTD system at calibration sites and mooring locations. Sea surface temperature, 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

Survey design differed slightly between the two areas covered during this cruise. The Bering Sea shelf survey began on 23 February 2002 north of the Alaskan Peninsula at about 162° 30'W long. and proceeded west across the shelf to about 168°W, ending on 4 March. The 25 north-south transects were spaced 8 nautical miles (nmi) apart and covered a 12,784 nmi^2 area. The Bogoslof Island area survey began 5 March 2002 north of Unalaska Island at about 167°W long., and proceeded west towards the Islands of Four Mountains near 170°W, concluding on 8 March. The 22 north-south transects were spaced 5 nmi apart and covered a 2,903 nmi^2 area (Fig. 1).

Echo integration and trawl data were collected 24 hours a day. Acoustic system settings used during the collection (Table 1) were based on results from acoustic system calibrations and on experience from prior winter Bering Sea shelf surveys. Trawl hauls were conducted to identify echosign and to provide biological samples. Average trawling speed for both nets was approximately 3 knots. Standard catch sorting and biological sampling procedures were used to provide weight and number by species for each haul (MACE Sampling Manual)[3]. Pollock were sampled to determine sex, fork length, body weight, maturity, and ovary weight of selected females. For age determinations, pollock otoliths were collected and stored in a 50% ethanol-water solution. An electronic motion-compensating scale was used to weigh individual pollock specimens. Fork lengths were measured to the nearest centimeter (i.e., a fish measuring between

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

49.5 cm and 50.5 cm was recorded as 50 cm). Lengths were recorded with a Polycorder measuring device (a hand-held computer connected to a bar coded length reader, Sigler 1994) and downloaded to a desktop computer. Pollock maturity was determined by visual inspection and categorized as immature, developing, pre-spawning, spawning, or post-spawning. Additional samples of pollock tissue, stomach contents, ovaries, and gametes were collected for ongoing research by AFSC scientists. Whole fish were retained for a calorimetric prey study and for the AFSC's Observer Program training specimens.

Pollock target strength (TS) data collections were made when conditions were suitable (i.e., low fish density, single species aggregations, unimodal size distribution, and calm seas). Repeated passes were made over fish aggregations at speeds of less than 3 knots. Biological data were obtained from trawl hauls made in conjunction with the acoustic data collection using the methods described above.

Standard sphere acoustic system calibrations were made prior to the Bering Sea shelf survey and at the end of the Bogoslof Island area survey to measure acoustic system performance for both the echosounders at each frequency. During calibrations, the *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, were suspended at about 25 m and 30 m, respectively, below the centerboard-mounted transducers. After each sphere was centered on the acoustic axis, split-beam target strength and echo integration data were collected to determine acoustic system gain parameters. The average on-axis target strength and on-axis integration values were measured and recorded. Transducer beam characteristics were measured using a Simrad software program (EKLOBES). Each sphere was pulled through its corresponding transducer beam, TS data were collected on a grid of angle coordinates, and beam shape was estimated (Foote et al. 1987).

U.S./Japan Acoustic Systems Comparison

An intership calibration of acoustic systems between the NOAA ship *Miller Freeman* and the Japan Fisheries Agency R/V *Kaiyo Maru* was conducted 19 to 20 February in the Islands of Four Mountains area (Fig 1). Intership calibration results will be presented in a subsequent document.

Data Analysis

The abundance of pollock was estimated by combining echo integration and trawl data. Echo integration data collected between 14 m from the surface (5 m below the centerboard-mounted transducer) and 0.5 m off the bottom were scrutinized and echosign identified as pollock was stored in a database. Pollock length data from 37 hauls were aggregated into 10 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 echo integration values were then summed and 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 on the eastern shelf and one for the Bogoslof Island area. Age data for winter 2002 were not available when this analysis was completed. However, age data from the winter 2001 EIT survey were available, and age-specific numbers and biomass were estimated for that year using age-length keys developed from the trawl data.

In the Bogoslof Island area, pre-spawning pollock aggregations are often densely packed and vertically and/or horizontally stratified by sex. Therefore it is sometimes difficult to obtain a random sample of lengths from these aggregations to estimate population size composition. At ages older than about 5 years, female pollock have longer lengths at age than male pollock, thus the sex composition of the trawl hauls directly affects the estimates of population size composition. Although we caught more females than males in the Bogoslof area, we assumed

that the sex ratio in the spawning aggregations we sampled was 50:50, and estimated population size composition under this assumption.

Numbers and biomass at length were estimated for pollock between 14 m from the surface and 0.5 m from the bottom for the entire area surveyed. This area was divided into two regions, the eastern shelf, and the Bogoslof area. Estimates were also made for the CBS specific area and the SCA. Estimates for the CBS specific area were the same as for the Bogoslof area minus the number of pollock estimated from a small area outside the CBS border. Estimates for the SCA were made by adding the shelf area and Bogoslof area abundance estimates and removing abundances estimated for transect area outside the SCA borders.

Relative estimation errors for 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". Geostatistical methods were used for computation of error because they account for the observed spatial structure. The method was applied separately to the shelf and Bogoslof Island areas because transect spacing differed (8 and 5 nmi, respectively). 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

Calibration

Acoustic system calibrations were conducted before, between, and after the winter EIT surveys in the Bering Sea and Gulf of Alaska (Table 1). The EK500 38-kHz frequency collection system (used for data analysis) showed no significant differences in gain parameters or transducer beam pattern characteristics in either of the Captains Bay, AK calibrations before and after the Bering Sea shelf and Bogoslof Island area survey. Calibration results for the EK500 120-kHz system indicated that there were some changes in gain parameters and beam pattern characteristics

during the winter field season. Calibration results from the EK60 acoustic system will be reported elsewhere.

Target Strength

Two pollock target strength collections were made on the Bering Sea shelf. The first collection occurred during the day on 28 February and the second collection occurred on 10 March. Results will be reported elsewhere.

Oceanographic Data

Oceanographic data were collected from trawl-mounted SBE 39s at 38 sites (Table 2), CTDs at 4 sites, and continuous surface thermosalinograph readings. In the southeastern shelf region surveyed, bottom depths ranged between about 40 to 50 m in the east and along the Alaska Peninsula, deepening gradually to 200 m in the west at the shelf break. Water temperature varied with depth and location. The upper 50 m of the water column was well mixed and usually colder than the deeper layers. Temperatures varied between 0.9° and 3.5°C and averaged 2.3°C (Fig. 2). Between 50 and 100 m the water column was more stratified with temperatures increasing rapidly with depth to greater than 4.5°C in some areas. Temperatures between 50 and 100 m ranged from 0.9° to 4.7°C and averaged 3.1°C. Water deeper than 100 m ranged from 3.2° to 4.4°C and averaged about 3.9°C. In contrast, temperature profiles from the basin region indicated well mixed water columns with little variation in temperature between the surface and deeper waters. Temperatures in the upper 500 m of the water column ranged from 2.8° to 3.9°C and averaged 3.5°C.

Surface temperatures ranged from -0.9° to 3.8°C. The coldest surface temperatures (colder than 0°C) were observed on the shelf at the beginning of the survey (east of Transect 101), near the Alaska Peninsula (Fig. 3). Surface temperatures progressively warmed from east to west. The warmest waters (greater than about 3.5°C) occurred near the Aleutian Chain in basin waters west of about 167° W.

Biological sampling

Biological data and specimens were collected from 38 trawl hauls, 27 using the midwater trawl and 11 using the bottom trawl (Table 2, Fig. 1). All bottom trawl hauls were conducted on the southeastern Bering Sea shelf; four were hard on bottom and seven were with the bottom trawl slightly off bottom or in midwater. Length frequency data were collected from more than 12,000 pollock specimens (Table 3) for scaling the acoustic data to produce population estimates. Biological data and specimens for other research projects (e.g., fecundity studies, trophic investigations, pollock early life history studies) were also collected at many of the trawl haul locations (Table 4). On the Bering Sea shelf and in the Bogoslof Island area, pollock dominated the midwater trawl catches in both weight and numbers (Tables 5 and 6). Jellyfish and rock sole (*Lepidopsetta* sp.) were next most abundant on the shelf, and together accounted for about 6% of midwater catches by weight. In the Bogoslof area, lanternfish (Myctophidae) and Pacific lamprey (*Lampetra tridentata*) were the next most abundant in midwater catches by weight, but comprised only 0.2% of the total catch. Pollock accounted for more than 95% of bottom trawl hauls catches on the shelf by weight, with Pacific cod (*Gadus macrocephalus*) and rock sole together accounting for about 3.1% (Table 7).

Bering Sea Shelf

Twenty seven trawl hauls were conducted in the southeastern shelf area (Hauls 1 to 26, and 38: Fig. 1). Pollock fork lengths ranged from 18 to 66 cm. Modal lengths decreased from 49 cm in the east along the Aleutian Islands to 23 cm in the western part of the shelf survey area (Fig. 4). Catch sex ratios for all hauls and fish sizes ranged from 23% to 78% male (Fig. 5). Among pollock larger than 29 cm fork length (approximately age 3 and older), 66% of the females and 51% of the males were pre-spawning (Fig. 6a). Twenty seven percent of females and 23% of males were developing. One percent of females and about 20% of males were actively spawning. For pollock 29 cm and smaller (approximately ages 1 and 2, sexes combined), 13% were immature and 87% were developing. Female pollock were estimated to be 50% mature at 41 cm (Fig. 6c). The mean gonadosomatic index (GSI) for pre-spawning females on the shelf was 0.12 (Fig. 7a). GSI was higher between 162°W and 164°W and also between 166°W and 168°W than in the middle portion of the shelf survey area (Fig. 7c). As GSI appears to be

related to length (Fig. 7a) the differences may be partly due to slight differences in mean length. The regression of total body weight to length for sexes combined used in population analysis was $W=0.004\times FL^{3.1498}$ where FL is fork length and W is weight (Fig. 8a).

Pollock were observed on all transects (Fig. 9a). They were most abundant north of the Alaska Peninsula and Aleutian Chain between Amak Island and the west edge of Unimak Pass (Transects 101-111, see Fig. 1). The highest pollock concentrations were observed on or near-bottom in waters adjacent to Amak Island at about the 50-60 m isobath, and north of the center of Unimak Island between about the 95 and 110 m isobaths. Pollock were usually off-bottom and not as densely aggregated at night as during the day. South of 55°N and west of 165°W (just north of Unimak Pass) pollock aggregations were more pelagic. West of Akutan Island, pollock were observed near bottom on the slope in deeper water (between the 200 and 500 m isobaths) close to the Aleutian Chain. Pollock were present in very low densities or absent between about 166°W and 167°W except for one patch of juveniles (mostly age 2) observed between the north ends of Transects 115 and 116. Between 167°W and 168°W, along the 200-m isobath and inshore to 150 m, pollock occasionally formed isolated 1 to 2 nmi long patches of dense pelagic schools consisting mainly of 2-year-old juveniles. In 2002, the easternmost transects had lower densities of fish (Fig. 9a) than the easternmost transects in the 2001 survey (Fig. 9b), and transects north of the center of Unimak Island had higher densities in 2002 than in 2001.

The abundance estimate for pollock on the Bering Sea shelf between 14 m below the surface and 0.5 m off bottom is 2.329 billion fish (1.355 million metric tons (t)) (Table 8, Fig.10). The relative estimation error of the shelf biomass based on the 1D geostatistical analysis is 6.2%. Twenty-two percent of the estimated number of pollock (3% of the total biomass) were smaller than 30 cm (the smallest was 18 cm), and of those, the average fork length was 23.1 cm. Eleven percent by numbers were 30 to 40 cm (6% of the biomass) with an average length of 35.9 cm. Pollock greater than 40 cm comprised 67% by numbers (91% of the biomass) with an average length of 47.7 cm.

Age data from the winter 2001 southeastern Bering Sea shelf survey show that the average length at age for fish older than age 4 was slightly greater for females than males on the shelf (Fig. 11). Population estimates by age for eastern Bering Sea shelf pollock indicate that in 2001 the 1996 and 1995 year classes made up about 30% and 24% of the population by numbers, respectively. The 2000 year class was next most numerous, at about 18% of the population (Fig. 12).

Bogoslof Area

In the Bogoslof area, the fork lengths of pollock sampled in trawl hauls (Hauls 27 to 37) ranged from 23 to 70 cm. Length compositions were bimodal; 47 cm and 52 cm modes were dominant in the region at the northeast corner of Umnak Island (Fig. 4), while 56 to 60 cm modes were dominant in the Islands of Four Mountains area. In one trawl haul sample of an aggregation north of the center of Unalaska Island (Transect 200, Haul 27), pollock had a narrow length range (30 to 46 cm) and a mode of 40 cm. Catch sex ratios ranged from 13% to 69% male (Fig. 5). Eighty-four percent of the female and 40% of the male pollock were in pre-spawning condition (Fig. 6b). Most developing stage pollock were observed in Haul 27 on Transect 200. Three percent of females and about 46% of males were actively spawning. The average GSI for pre-spawning females was 0.18 (Fig. 7b), comparable to Bogoslof in winters 2000 and 2001 (0.17 in both of those years), indicating that survey timing was similar in relation to peak spawning. The average Bogoslof GSI was higher than the average shelf GSI (Fig. 7c), suggesting that spawning was more spread out in time, or occurred later on the Bering Sea shelf, or both. The regression equation of total body weight to length for sexes combined used in population analysis for the Bogoslof Island area was $W=0.007\times FL^{3.0458}$ where FL is fork length and W is weight (Fig. 8b).

The spatial distribution of pollock in the Bogoslof/Aleutian Basin area (Fig. 9a) was similar to that observed in 2001 (Fig. 9b). Pollock were concentrated along the north slopes of the Aleutian Chain, either at the northeast end of Umnak Island, or between the west end of Umnak and the Islands of Four Mountains, just north of Samalga Pass. In 2002 more pollock were observed in the Umnak Island aggregation than in 2001.

The abundance estimate for pollock in the Bogoslof area between 14 m below the surface and 1,000 m is 181 million fish (0.227 million t) (Table 8, Fig. 10). The relative estimation error of the Bogoslof pollock biomass estimate based on the 1D analysis is 12.2%. The abundance estimates and relative estimation error for pollock inside the CBS Specific Area/Area 518 are the same as for the total area. Thirty-six percent of the pollock by numbers (21% of the biomass) were 50 cm or smaller in length, and of those, the average fork length was 44.9 cm. The smallest pollock were 23 cm in length. The remaining 64% of the estimated pollock numbers (79% of the biomass) were larger than 50 cm, and of those, the average fork length was 57.7 cm. The largest pollock observed was 70 cm in length.

The abundance estimate for the SCA is 2.497 billion pollock (1.574 million t) (Table 8). The relative estimation error of the SCA pollock biomass estimate based on the 1D analysis is 5.7%. The population estimate for the entire area surveyed on the southeastern shelf and Bogoslof area combined is 2.510 billion pollock (1.582 million t). The relative estimation error of the pollock biomass estimate for the entire area surveyed based on the 1D analysis is 5.6%.

Age composition data from the winter 2001 Bogoslof Island area survey show that average length at age was higher for females than males at all ages (Fig. 11). Population estimates by age indicate that the 1989 year class was dominant, comprising about 18% of the population in numbers, the 1990 year class was next most important, comprising about 10% in numbers, and the 1992 and 1996 year classes each contributed about 8% of the population by numbers (Fig. 12).

DISCUSSION

The 2002 southeastern Bering Sea shelf survey was the third winter EIT pollock survey in a series that began in 2000. The survey designs for the 2001 and 2002 winter surveys were similar although two transects were added east of the eastern edge of the SCA in 2002. Few pollock were observed east of the eastern border of the SCA in 2002, in contrast to 2001 when they were concentrated on the eastern border of the SCA (Fig. 9). Although the modal lengths of adult

pollock sampled in the SCA in 2001 and 2002 were similar (46 cm), the underlying length compositions were different. In 2002 more smaller and younger fish were present. Pollock from a size class of 2-year-old juveniles were present in 2002 near the 200-m isobath in the northwestern part of the SCA. They were observed as one year-olds in 2001. No pollock of one-year-old size were observed in 2002, and relatively few adults were observed in the northwest part of the SCA in either year compared to numbers of adults in the eastern part of the SCA north of Unimak Island. Maturity composition was similar for both sexes between years. However, the length at 50% maturity for females was estimated to be 41 cm in 2002 while it was estimated at 43 cm in 2001. This was due to the presence of greater numbers of pollock in the 30 to 40 cm length range in 2002 than in 2001, and to the proportion of mature fish. In winter 2002, estimated pollock abundance on the eastern shelf (1.355 million t) was higher than in 2001 (0.825 million t)(Table 8).

In the second part of the winter 2002 EIT survey, pollock in the Bogoslof Island area were surveyed for the 13th time in 14 years. Pre-spawning pollock aggregate in this area in February and March each year (Honkalehto and Williamson 1995, 1996), and spawn between the end of February and mid-March. During the earliest survey years (1989-92), Bogoslof pre-spawning pollock occupied a large area of the southeast Aleutian Basin extending from east of Bogoslof Island westward to the Islands of Four Mountains and Samalga Pass, with highest concentrations surrounding Bogoslof Island. At that time they were subject to a large commercial fishing effort. Fishing in this region was terminated in 1992.

In 2002, as in recent years (2000 and 2001), pollock were highly concentrated in Samalga Pass (74% of biomass in 2002, 76% in 2001, and 72% in 2000), and were otherwise sparsely distributed within the Bogoslof area. There has been little change in population biomass since prior to 2000 (Table 8). However, Bogoslof population estimates from EIT surveys indicate that biomass is decreasing with time (Fig. 13). There has been little recruitment to the spawning population since the 1989 year class began appearing in about 1994 (Tables 9, 10, 11, and 12, Figs.14 and 15). Estimated numbers at age of dominant Bogoslof year classes (Figs. 15 and 16) showed that the 1989 year class became the main component of the population at age 5,

replacing the 16-year-old 1978 year class in 1994. The 1992 year class first became important in the population at age 6 in 1998, but appeared to peak in numbers in 1999. There was evidence of increased numbers of the 1996 year class in 2001 (Fig. 15).

ACKNOWLEDGMENTS

The authors would like to thank the officers and crew of the NOAA ship *Miller Freeman* for their contribution to the successful completion of this work.

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. and N. Williamson. 1995. Echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) in the southeast Aleutian Basin during February and March, 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-52, 39 p.

Honkalehto, T. and N. Williamson. 1996. Echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) in the southeastern Aleutian Basin during February and March, 1995. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-65, 57 p.

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

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.

Sigler, M. 1994. An electronic measuring board with bar codes. Trans. Amer. Fish. Soc. 123:115-117.

Simrad. 1993. Simrad BI500 post-processing system reference manuals V5.20. 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
Taina Honkalehto	F/USA	Chief Scientist	MACE
Neal Williamson	M/USA	Chief Scientist	MACE (2/18-3/1)
John Horne	M/Canada	Fish. Biologist	UW (3/1-3/11)
Denise McKelvey	F/USA	Fish. Biologist	MACE
Mike Brown	M/USA	Computer Specialist	MACE (2/18-3/1)
Dale Hanson	M/USA	Fish. Biologist	MACE
Steve Porter	M/USA	Fish. Biologist	FOCI (3/1-3/11)
William Floering	M/USA	Fish. Biologist	MACE/PMEL
Hyun-Su Jo	M/Korea	Fish. Biologist	NFRDI (3/1-311)

MACE - Midwater Assessment and Conservation Engineering Program, Alaska Fisheries Science Center, Seattle, WA

FOCI - Fisheries Oceanographic Coordinated Investigations, AFSC, Seattle, WA

NFRDI – National Fisheries Research and Development Institute, Pusan, Republic of Korea

PMEL - Pacific Marine Environmental Laboratory, Seattle, WA.

UW - University of Washington, Seattle, WA.

Table 1. Results from standard sphere acoustic system calibrations conducted before, during, and after the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island area.

Date	Location	Frequency (kHz)	Water Temp (°C) at Transducer[1]	Water Temp (°C) at Sphere	Sphere Range from Transducer (m)	TS Gain[2] (dB)	S_v Gain[2] (dB)	3-dB Beam Width (deg) Along	3-dB Beam Width (deg) Athwart	Angle Offset (deg) Along	Angle Offset (deg) Athwart
17-Jan	Port Susan, WA	38	9.3	9.3	32.1	25.6	25.4	6.92	6.83	-0.10	0.01
		120	9.3	9.3	27.3	27.1	27.6	6.67	6.50	-0.19	0.09
10-Feb	Sanborn Harbor, AK	38	2.5	3.1	-	-	-	6.90	6.78	-0.10	-0.02
		120	2.5	3.1	-	-	-	6.76	6.71	-0.26	0.19
18-Feb	Captains Bay, AK	38	1.8	3.7	28.2	26.1	25.8	6.90	6.79	-0.11	-0.01
		120	-	-	-	-	-	-	-	-	-
10-Mar	Captains Bay, AK	38	3.2	3.2	29.1	26.1	25.6	6.94	6.82	-0.10	0.00
		120	3.2	3.2	23.6	26.0	26.2	7.01	6.93	0.14	0.04
25-Mar	Ugak Bay, AK	38	3.3	3.4	26.6	26.0	25.6	6.94	6.79	-0.09	0.01
		120	3.3	3.4	-	-	-	6.86	6.84	-0.08	0.09
Feb 18-Mar 10	System settings during surveys	38	-	-	-	26.0	25.7	6.90	6.80	-0.08	0.03
		120	-	-	-	27.1	27.1	6.70	6.70	-0.23	-0.14
	S_v threshold used for post-processing = -69 dB										

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

[2]Gain terms are defined in MacLennan et al. (2002).

Note: 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. Trawl station and catch data summary from the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island area.

Haul	Gear		Time	Duration	Start Position				Depth (m)		Temp. (deg. C)		SBE 39 Profiler	Pollock Catch		Other Catch
No.	Type[1]	Date	(GMT)	(minutes)	Latitude (N)		Longitude (W)		Footrope	Bottom	Gear[2]	Surface	No.	(kg)	number	(kg)
1	PNE	22-Feb	4:38	24	55	33.76	163	12.34	59	64	1.3	1.1	301	1,341.0	1,466	424.6
2	AWT	23-Feb	7:50	10	55	53.46	162	24.69	62	65	1.7	1.7	306	469.3	526	32.9
3	PNE	23-Feb	21:46	10	55	34.09	163	7.13	61	61	0.9	1.1	307	801.6	916	65.1
4	AWT	24-Feb	4:48	17	55	33.30	163	20.89	52	70	2.3	1.9	308	810.7	925	169.3
5	PNE	24-Feb	10:22	11	55	24.52	163	35.13	37	70	2.0	1.9	309	713.1	842	57.7
6	PNE	24-Feb	14:33	11	55	53.62	163	35.60	84	92	2.8	2.5	310	208.2	282	51.5
7	PNE	24-Feb	20:43	8	55	14.40	163	49.13	57	58	2.1	2.3	311	1,312.9	1,407	2.1
8	PNE	25-Feb	2:20	5	55	33.43	164	3.47	97	97	3.8	2.6	312	8,804.1	12,567	275.9
9	AWT	25-Feb	8:14	3	55	57.03	164	18.53	75	92	2.0	2.2	313	536.4	2,262	13.1
10	PNE	25-Feb	14:08	46	55	7.05	164	17.41	50	62	2.2	1.8	314	345.4	520	17.8
11	PNE	25-Feb	19:21	12	55	18.78	164	31.36	94	103	4.2	2.5	315	924.9	1,168	12.8
12	AWT	26-Feb	2:58	40	55	39.81	164	47.06	91	99	2.8	2.2	316	1,405.7	2,241	316.3
13	AWT	26-Feb	15:32	9	55	19.04	164	59.08	94	111	2.3	2.5	317	1,050.2	2,666	10.3
14	PNE	27-Feb	1:13	8	55	32.93	165	14.04	112	112	4.4	2.4	318	2,500.6	3,803	64.4
15	AWT	27-Feb	9:15	20	54	26.98	165	9.92	115	140	3.1	2.8	319	1,051.8	1,349	9.2
16	AWT	27-Feb	15:36	15	54	48.30	165	25.79	148	175	4.2	2.7	320	521.7	1,149	0.4
17	PNE	27-Feb	23:15	6	55	55.64	165	30.06	102	102	4.7	2.1	321	6,855.7	13,797	414.3
18	AWT	28-Feb	6:53	20	55	10.88	165	41.32	113	122	3.2	2.6	322	404.3	656	8.9
19	PNE	28-Feb	13:48	30	54	37.89	165	38.91	332	338	3.9	2.7	323	231.5	316	20.4
20	AWT	1-Mar	9:41	26	54	14.13	166	4.50	264	367	3.3	2.9	324	1,240.6	1,606	30.8
21	AWT	2-Mar	9:06	19	55	30.62	166	33.23	102	133	3.5	2.4	325	291.3	2,756	6.1
22	AWT	3-Mar	10:36	12	55	2.01	167	4.31	148	158	4.1	2.7	326	215.0	2,547	1.0
23	AWT	3-Mar	12:18	14	54	59.20	167	4.51	75	PNE	2.8	2.7	327	754.6	8,852	1.6
24	AWT	3-Mar	20:00	15	55	1.10	167	18.18	140	209	4.0	2.6	328	422.9	4,943	2.4
25	AWT	4-Mar	3:03	43	55	8.01	167	32.64	138	198	3.5	3.1	329	18.0	212	2.2

Table 2. continued

Haul No.	Gear Type[1]	Date	Time (GMT)	Duration (minutes)	Start Position Latitude (N)		Start Position Longitude (W)		Depth (m) Footrope	Depth (m) Bottom	Temp. (deg. C) Gear[2]	Temp. (deg. C) Surface	SBE 39 Profiler No.	Pollock Catch (kg)	Pollock Catch number	Other Catch (kg)
26	AWT	4-Mar	13:29	8	55	29.23	168	3.88	111	151	3.0	2.4	330	286.4	2,910	0.3
27	AWT	5-Mar	6:08	13	53	55.77	167	10.18	404	541	3.8	3.6	331	3,623.7	7,667	34.2
28	AWT	5-Mar	18:37	43	53	40.70	167	37.51	440	822	3.8	3.5	332	226.9	185	20.3
29	AWT	5-Mar	23:08	9	53	35.57	167	44.32	495	719	3.7	3.4	333	860.8	773	25.7
30	AWT	7-Mar	19:04	14	53	1.66	169	15.32	435	965	3.4	3.5	334	331.6	209	1.0
31	AWT	8-Mar	8:16	12	53	7.51	169	25.47	469	898	3.6	3.6	335	1,527.1	1,104	3.9
32	AWT	8-Mar	11:31	4	53	5.17	169	25.03	419	854	3.5	3.5	336	611.9	427	0.1
33	AWT	9-Mar	1:51	10	53	8.51	169	19.67	502	1273	3.6	3.7	337	2,699.6	2,175	0.4
34	AWT	9-Mar	5:16	14	53	5.07	169	15.52	439	973	3.5	3.7	338	291.5	179	2.2
35	AWT	9-Mar	7:37	3	53	5.20	169	10.48	441	859	3.5	3.7	339	3,822.2	2,213	1.8
36	AWT	9-Mar	14:38	5	53	8.85	169	7.43	477	1,075	3.5	3.7	340	237.3	184	1.2
37	AWT	9-Mar	17:20	10	53	8.86	169	5.58	474	966	3.5	3.7	341	6,780.5	4,236	0.7
38	AWT	10-Mar	10:42	21	54	56.95	167	4.50	113	196	3.1	3.3	--	23.0	50	1.1

[1] Gear type: AWT = Aleutian wing trawl, PNE = Poly Nor'eastern bottom trawl

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

Table 3. Numbers of walleye pollock biological samples and measurements collected during the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island areas.

Haul	Lengths	Maturity	Otoliths	Fish weights	Ovary weights
1	326	78	57	78	24
2	332	62	62	62	40
3	310	80	80	80	42
4	338	59	56	59	14
5	302	55	55	55	26
6	282	60	60	60	32
7	389	64	62	64	24
8	305	51	51	51	24
9	389	104	104	104	0
10	366	57	57	57	36
11	407	60	60	60	26
12	390	63	63	63	18
13	445	74	74	74	11
14	363	45	45	45	18
15	344	43	41	43	13
16	401	58	58	58	10
17	439	46	46	46	15
18	338	41	41	41	17
19	316	49	49	49	19
20	354	52	52	52	31
21	288	68	68	68	2
22	234	48	20	48	0
23	238	62	32	62	0
24	332	135	84	135	17
25	212	0	0	0	0
26	340	143	111	143	15
27	368	87	78	87	2
28	185	82	82	82	46
29	366	78	78	78	24
30	209	84	84	84	46
31	389	87	87	87	28
32	343	84	84	84	38
33	345	113	113	113	38
34	179	85	85	85	64
35	379	103	103	103	88
36	184	101	101	101	0
37	329	100	100	100	50
38	50	49	0	50	0
Totals	12,106	2,710	2,483	2,711	898

Table 4. Numbers of biological samples collected for fisheries research projects at the Alaska Fisheries Science Center during the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island areas.

	Pollock				Whole Fish Collections	
Haul	Ovaries[1]	Stomachs[2]	Gametes[3,4]	fin clips[5]	A[4,6]	B[4,7]
1	9	-	-	-	X	X
2	11	4	-	-	-	X
3	6	10	-	-	X	X
4	3	15	-	-	-	X
5	3	15	-	-	-	X
6	7	2	-	-	-	-
7	2	15	-	-	-	-
8	2	15	-	-	-	X
9	-	15	-	-	-	X
10	-	15	-	100	X	-
11	1	18	-	-	X	-
12	-	15	-	-	X	X
13	1	9	-	-	X	-
14	-	-	-	-	X	X
15	1	3	-	-	X	X
16	-	15	-	-	-	X
17	1	15	-	-	-	X
18	-	8	-	-	-	-
19	4	-	-	-	-	-
20	6	-	-	-	-	X
21	-	15	-	-	-	X
22	-	15	-	-	-	-
23	-	-	-	-	-	X
24	-	1	-	-	-	X
25	-	-	-	-	-	-
26	-	5	-	-	-	-
27	-	-	-	-	-	X
28	12	-	-	-	-	-
29	11	1	-	-	-	X
30	26	-	X	84	-	-
31	1	-	-	-	-	-
32	2	1	-	16	-	-
33	3	-	-	-	-	-
34	-	-	-	-	-	-
35	-	-	X	-	-	-
36	-	-	-	-	-	X
37	1	-	-	-	-	-
Totals	112	227	2 sites	200	8 sites	19 sites

[1] Pollock ovaries sampled for a fecundity study (B. Megrey)

[2] Pollock stomach content collections for trophic investigations (P. Livingston)

[3] Pollock gametes propagated for early life history investigations (S. Porter)

[4] "X" indicates a collection was made, but numbers were not specified.

[5] Pollock genetic samples collected for stock identification work (M. Canino)

[6] Whole fish retained for identification training (S. Corey)

[7] Whole fish collected for calorimetric investigations (L. Logerwell)

Table 5. Catch by species from 22 midwater trawl hauls (includes 15 Aleutian wing trawls and 7 Poly nor'eastern bottom trawls fished in midwater habitats) during the winter 2002 echo integration-trawl survey of walleye pollock on the southeastern Bering Sea shelf.

Species Name	Scientific Name	Weight (kg)	Percent by Weight	Numbers
walleye pollock	*Theragra chalcogramma*	14,555.9	92.4	41,601
jellyfish	Scyphozoa (class)	849.6	5.4	--
rock sole sp.	*Lepidopsetta* sp.	120.4	0.8	529
Pacific cod	*Gadus macrocephalus*	68.9	0.4	35
yellowfin sole	*Limanda aspera*	60.3	0.4	246
Pacific ocean perch	*Sebastes alutus*	24.0	0.2	21
smooth lumpsucker	*Aptocyclus ventricosus*	23.5	0.1	12
flathead sole	*Hippoglossoides elassodon*	13.0	0.1	31
arrowtooth flounder	*Atheresthes stomias*	10.4	0.1	24
starfish	Asteroidea (class)	5.3	< 0.1	49
Pacific lamprey	*Lampetra tridentata*	4.1	< 0.1	10
yellow Irish lord	*Hemilepidotus jordani*	2.5	< 0.1	9
coho salmon	*Oncorhynchus kisutch*	2.4	< 0.1	1
starry flounder	*Platichthys stellatus*	1.0	< 0.1	2
sea anemone	Actiniaria (order)	0.9	< 0.1	2
horsehair crab	*Erimacrus isenbeckii*	0.9	< 0.1	2
Pacific halibut	*Hippoglossus stenolepis*	0.8	< 0.1	3
squid unidentified	Teuthoidea (order)	0.7	< 0.1	20
Pacific herring	*Clupea pallasi*	0.5	< 0.1	4
Alaska plaice	*Pleuronectes quadrituberculatus*	0.5	< 0.1	1
pandalid shrimp	Pandalidae	0.5	< 0.1	7
sponge hermit crab	*Pagurus brandti*	0.4	< 0.1	3
eulachon	*Thaleichthys pacificus*	0.3	< 0.1	12
hermit crab unidentified	Paguridae	0.2	< 0.1	3
chinook salmon	*Oncorhynchus tshawytscha*	0.2	< 0.1	1
Pacific sandfish	*Trichodon trichodon*	0.1	< 0.1	1
sturgeon poacher	*Podothecus acipenserinus*	0.1	< 0.1	1
snail	Gastropoda (class)	0.1	< 0.1	1
lanternfish unidentified	Myctophidae	0.1	< 0.1	4
Pacific sand lance	*Ammodytes hexapterus*	< 0.1	< 0.1	2
Totals		15,747.5		42,637

Table 6. Catch by species from 11 Aleutian wing trawl hauls conducted during the winter 2002 echo integration-trawl survey of walleye pollock in the Bogoslof Island area.

Species Name	Scientific Name	Weight (kg)	Percent by Weight	Numbers
walleye pollock	*Theragra chalcogramma*	21,013.1	99.6	19,352
lanternfish	Myctophidae	18.2	0.1	1,769
Pacific lamprey	*Lampetra tridentata*	11.5	0.1	20
squid unidentified	Teuthoidea (order)	10.8	0.1	109
Pacific sleeper shark	*Somniosus pacificus*	9.9	< 0.1	1
longnose lancetfish	*Alepisaurus ferox*	9.6	< 0.1	1
Bathyscaphoid squid unidentified	Cranchiidae	7.6	< 0.1	2
chinook salmon	*Oncorhynchus tshawytscha*	5.6	< 0.1	4
Pacific ocean perch	*Sebastes alutus*	4.7	< 0.1	4
northern smoothtongue	*Leuroglossus schmidti*	3.5	< 0.1	513
magistrate armhook squid	*Berryteuthis magister*	2.6	< 0.1	11
jellyfish	Scyphozoa (class)	2.3	< 0.1	2
smooth lumpsucker	*Aptocyclus ventricosus*	2.0	< 0.1	2
California headlightfish	*Diaphus theta*	1.4	< 0.1	54
emarginate snailfish	*Careproctus furcellus*	0.7	< 0.1	1
salps	Thaliacea (class)	0.3	< 0.1	28
longfin dragonfish	*Tactostoma macropus*	0.2	< 0.1	10
shrimp unidentified	Decapoda (order)	0.2	< 0.1	92
slender barracudina	*Lestidiops ringens*	0.2	< 0.1	6
eulachon	*Thaleichthys pacificus*	0.2	< 0.1	2
Atka mackerel	*Pleurogrammus*	0.1	< 0.1	1
fish unidentified	Teleostei	0.1	< 0.1	1
Pacific viperfish	*Chauliodus macouni*	< 0.1	< 0.1	1
blackmouth eelpout	*Lycodapus fierasfer*	< 0.1	< 0.1	1
Totals		21,104.6		21,987

Table 7. Catch by species from 4 Poly nor'eastern bottom trawl hauls conducted during the winter 2002 echo integration-trawl survey of walleye pollock on the southeastern Bering Sea shelf.

Species Name	Scientific Name	Weight (kg)	Percent by weight	Numbers
walleye pollock	*Theragra chalcogramma*	18,962.0	95.9	31,083
Pacific cod	*Gadus macrocephalus*	415.4	2.1	192
rock sole sp.	*Lepidopsetta* sp.	189.6	1.0	666
sablefish	*Anoplopoma fimbria*	85.3	0.4	85
flathead sole	*Hippoglossoides elassodon*	59.0	0.3	191
jellyfish	Scyphozoa (class)	33.6	0.2	--
Pacific halibut	*Hippoglossus stenolepis*	16.8	0.1	28
arrowtooth flounder	*Atheresthes stomias*	12.3	0.1	37
yellowfin sole	*Limanda aspera*	2.6	< 0.1	12
red king crab	*Paralithodes camtschaticus*	2.5	< 0.1	1
rex sole	*Glyptocephalus zachirus*	1.3	< 0.1	1
yellow Irish lord	*Hemilepidotus jordani*	0.9	< 0.1	1
starfish	Asteroidea (class)	0.5	< 0.1	11
Totals		19,781.7		32,308

Table 8. Estimates of walleye pollock biomass (in metric tons (t)) by survey area and management area from February-March echo integration-trawl surveys on the southeastern Bering Sea shelf and in the Bogoslof Island area between 1988

Shelf Survey Area				Steller sea lion Conservation Area (SCA)[1]	
Year	Biomass (million t)	Area	Relative estimation error (%)	Biomass (million t)	Relative estimation error (%)
2000	0.816	4,956	13.2	1.117	11.0
2001	0.825	11,612	8.1	0.968	7.1
2002	1.355	12,784	6.2	1.574	5.7
Bogoslof Survey Area				**Central Bering Sea Specific Area/Area 518**	
Year	Biomass (million t)	Area	Relative estimation error (%)	Biomass (million t)	Relative estimation error (%)
1988	2.396	--	--	2.396	--
1989	2.126	--	--	2.084	--
1990	--	No survey	--	--	--
1991	1.289	8,411	11.7	1.283	--
1992	0.940	8,794	20.4	0.888	--
1993	0.635	7,743	9.2	0.631	--
1994	0.490	6,412	11.6	0.490	--
1995	1.104	7,781	10.7	1.020	--
1996	0.682	7,898	19.6	0.582	--
1997	0.392	8,321	14.0	0.342	--
1998	0.492	8,796	19.0	0.432	19.0
1999	0.475	Conducted by Japan Fisheries Agency		0.393	--
2000	0.301	7,863	14.3	0.270	12.7
2001	0.232	5,573	10.2	0.208	11.8
2002	0.227	2,903	12.2	0.227	12.2

[1] SCA includes CBS Specific area/ Area 518

Table 9. Estimates of population at length (million fish) from February-March echo integration-trawl surveys of walleye pollock in the Bogoslof Island area. No survey was conducted in 1990. The 1999 survey was conducted by the Japan Fisheries Agency.

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10	0	0	–	0	0	0	0	<1	0	0	0	0	0	0	0
11	0	0	–	0	0	0	0	<1	0	0	0	0	0	0	0
12	0	0	–	0	0	0	0	1	0	0	0	0	0	0	0
13	0	0	–	0	0	0	0	<1	0	0	0	0	0	0	0
14	0	0	–	0	0	0	0	<1	0	0	0	0	0	0	0
15	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	–	0	0	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
22	0	0	–	<1	0	0	0	0	0	0	0	0	0	0	0
23	0	0	–	2	0	0	0	0	0	0	0	0	0	0	<1
24	0	0	–	1	0	0	0	0	0	0	0	0	0	0	0
25	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	–	<1	0	0	0	0	0	0	0	0	0	0	0
27	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	–	0	0	0	0	0	0	0	0	0	0	0	<1
31	0	0	–	0	<1	0	0	0	0	0	0	0	0	0	0
32	0	0	–	0	<1	0	0	0	0	0	0	0	0	0	0
33	0	0	–	0	<1	0	0	0	0	0	0	0	0	0	<1
34	0	0	–	0	0	0	0	<1	<1	0	<1	0	0	0	<1
35	0	0	–	0	0	0	0	<1	0	<1	0	0	0	0	<1
36	0	0	–	0	<1	0	0	<1	<1	<1	<1	0	0	0	1
37	9	3	–	<1	0	0	0	<1	<1	<1	<1	0	0	0	1
38	6	0	–	2	<1	1	0	1	1	<1	1	0	0	<1	1
39	16	4	–	5	0	2	<1	4	1	1	3	<1	<1	<1	2
40	24	3	–	7	1	4	3	12	4	1	7	1	<1	1	3
41	27	4	–	19	3	5	6	20	8	2	9	6	1	1	4
42	48	23	–	23	7	7	9	40	14	3	11	8	1	1	2
43	118	33	–	31	14	6	14	40	17	4	11	13	3	1	5
44	179	54	–	36	18	7	21	41	21	5	10	13	3	2	5
45	329	159	–	46	28	8	21	50	23	7	9	17	4	4	7
46	488	177	–	55	32	13	21	53	31	10	11	19	5	4	5
47	547	389	–	79	42	22	18	40	36	14	9	14	6	5	9
48	476	434	–	130	68	28	17	55	36	15	12	11	6	5	7
49	389	431	–	168	102	46	16	47	37	18	15	10	5	6	6
50	248	366	–	205	129	69	39	52	40	21	20	16	6	7	5
51	162	279	–	189	144	76	46	58	45	24	23	11	8	6	5
52	80	168	–	160	118	73	52	78	52	26	28	20	10	7	4

Table 9. Continued.

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
53	48	85	–	122	106	73	49	81	52	26	35	17	13	7	6
54	19	50	–	63	67	66	43	88	53	31	41	21	16	8	7
55	12	13	–	40	41	50	37	81	48	28	38	33	21	12	9
56	4	5	–	17	27	29	26	69	40	24	35	38	20	13	12
57	3	8	–	8	13	14	17	58	37	22	30	33	24	17	13
58	1	1	–	4	6	9	10	47	28	17	27	36	23	15	14
59	0	0	–	1	5	3	6	31	19	13	18	23	16	13	12
60	0	0	–	1	1	1	3	17	12	12	13	15	13	11	12
61	2	0	–	1	<1	1	2	7	6	6	8	18	10	9	8
62	0	0	–	<1	<1	<1	1	4	2	3	5	13	7	6	6
63	0	0	–	0	0	0	<1	2	1	1	3	4	4	4	4
64	0	0	–	0	1	<1	0	1	<1	1	1	3	2	3	3
65	0	0	–	<1	0	0	0	<1	<1	<1	1	1	1	1	1
66	0	0	–	0	0	0	0	<1	0	<1	1	<1	<1	1	1
67	0	0	–	0	0	0	0	0	0	0	0	1	<1	<1	<1
68	0	0	–	0	0	0	0	1	0	0	<1	0	<1	<1	<1
69	0	0	–	0	0	0	0	0	0	0	0	0	0	<1	0
70	0	0	--	0	0	0	0	0	0	0	0	0	0	<1	<1
Totals	3,236	2,687	–	1,419	975	613	478	1,081	666	337	435	416	229	171	181

Table 10. Estimates of biomass at length (metric tons) from February-March echo integration-trawl surveys of walleye pollock in the Bogoslof Island area. No survey was conducted in 1990. The 1999 survey was conducted by the Japan Fisheries Agency.

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10	0	0	--	0	0	0	0	<1	0	0	0	0	0	0	0
11	0	0	--	0	0	0	0	2	0	0	0	0	0	0	0
12	0	0	--	0	0	0	0	5	0	0	0	0	0	0	0
13	0	0	--	0	0	0	0	2	0	0	0	0	0	0	0
14	0	0	--	0	0	0	0	1	0	0	0	0	0	0	0
15	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	--	0	0	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
22	0	0	--	13	0	0	0	0	0	0	0	0	0	0	0
23	0	0	--	70	0	0	0	0	0	0	0	0	0	0	38
24	0	0	--	61	0	0	0	0	0	0	0	0	0	0	0
25	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	--	26	0	0	0	0	0	0	0	0	0	0	0
27	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	--	0	0	0	0	0	0	0	0	0	0	0	7
31	0	0	--	0	37	0	0	0	0	0	0	0	0	0	0
32	0	0	--	0	42	0	0	0	0	0	0	0	0	0	0
33	0	0	--	0	48	0	0	0	0	0	0	0	0	0	9
34	0	0	--	0	0	0	0	53	35	0	29	0	0	0	48
35	0	0	--	0	0	0	0	93	0	29	0	0	0	0	73
36	0	0	--	0	68	0	0	42	96	18	32	0	0	0	204
37	3,199	846	--	115	0	0	0	113	109	84	92	0	0	0	456
38	2,304	0	--	768	84	260	0	435	465	173	395	0	0	19	508
39	6,365	1,461	--	1,843	0	634	202	1,697	562	507	1,250	258	168	149	823
40	10,573	1,116	--	2,801	451	1,776	1,190	5,510	1,857	634	3,208	1,242	195	315	1,716
41	12,697	1,532	--	7,940	1,235	2,276	2,855	9,777	3,637	851	4,484	5,598	575	403	1,919

Table 10. Continued

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2,002
42	24,360	10,704	--	10,812	3,316	3,571	4,990	20,730	7,012	1,387	5,652	7,223	674	464	1,307
43	64,253	16,516	--	15,540	6,760	3,089	8,021	22,332	9,190	2,158	6,407	12,079	1,511	770	2,885
44	104,733	29,588	--	20,103	9,877	4,006	12,963	24,863	12,735	3,018	6,048	11,877	1,622	1,562	3,642
45	206,586	93,899	--	28,059	16,329	4,818	13,823	32,817	14,927	4,824	5,592	16,278	2,848	2,966	5,117
46	328,735	113,092	--	36,235	20,645	8,835	15,081	37,303	21,637	7,399	7,774	17,678	3,289	3,218	4,174
47	394,741	268,496	--	56,880	29,146	16,669	13,565	30,184	26,425	10,786	6,653	13,933	5,002	4,095	7,420
48	367,368	323,170	--	101,488	51,983	22,214	13,658	44,572	28,658	12,233	9,528	11,280	5,191	4,548	6,062
49	320,630	345,632	--	141,399	84,329	39,811	14,414	40,477	31,599	15,951	12,766	10,698	4,659	5,654	5,646
50	217,890	314,778	--	187,006	115,614	63,571	36,256	47,785	35,907	19,593	18,837	18,373	5,466	6,794	4,904
51	152,084	258,067	--	186,358	140,004	75,524	46,297	57,291	43,272	23,896	23,203	12,204	8,364	6,361	5,004
52	79,654	166,322	--	170,855	124,034	77,721	55,851	81,793	53,696	28,549	29,109	23,427	10,816	7,605	3,992
53	50,739	89,721	--	139,671	120,309	83,189	55,151	90,342	57,294	29,783	39,234	20,486	14,509	8,203	6,504
54	21,211	56,681	--	77,905	82,110	79,461	52,329	104,021	61,504	38,168	48,567	25,270	19,059	10,064	8,249
55	14,191	16,270	--	52,506	53,286	64,342	47,770	102,318	59,033	35,853	47,461	39,463	27,179	16,246	12,509
56	5,580	6,059	--	23,541	38,564	39,556	35,451	91,962	52,765	33,144	47,627	46,764	27,212	17,977	16,277
57	3,886	10,681	--	12,470	19,710	20,781	24,453	81,885	52,000	31,736	42,594	40,641	34,562	24,987	19,422
58	1,395	1,220	--	6,603	9,188	14,391	15,826	70,522	40,581	26,309	41,160	44,788	34,255	23,153	21,834
59	0	0	--	1,284	7,872	4,376	9,546	48,878	28,918	21,031	28,241	28,362	26,252	20,390	19,158
60	0	0	--	2,743	2,631	1,989	4,716	28,240	19,749	20,509	21,604	18,174	22,075	19,263	20,581
61	2,561	0	--	2,195	562	1,756	3,644	11,855	10,762	11,428	14,301	22,618	18,519	16,883	14,659
62	0	0	--	780	600	372	1,826	7,951	3,578	6,439	9,748	15,120	12,972	11,334	12,296
63	0	0	--	0	0	0	200	3,978	2,835	2,999	6,344	5,181	7,033	7,722	8,207
64	0	0	--	0	1,363	415	0	1,074	863	1,489	1,777	3,198	4,277	5,489	5,719
65	0	0	--	938	0	0	0	495	578	1,096	1,156	1,833	1,660	2,730	2,463
66	0	0	--	0	0	0	0	163	0	329	1,251	403	534	1,132	1,515
67	0	0	--	0	0	0	0	0	0	0	0	863	520	715	583
68	0	0	--	0	0	0	0	2,570	0	0	276	0	403	426	777
69	0	0	--	0	0	0	0	0	0	0	0	0	0	55	0
70	0	0	--	0	0	0	0	0	0	0	0	0	0	100	61
Totals	2,395,735	2,125,851	--	1,289,008	940,197	635,403	490,078	1,104,118	682,279	392,403	492,398	475,311	301,402	231,795	226,548

Table 11. Estimates of population at age (million fish) from February-March echo integration-trawl surveys of walleye pollock in the Bogoslof Island area. No survey was conducted in 1990. The 1999 survey was conducted by the Japan Fisheries Agency.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0	0	--	0	0	0	0	0	0	0	0	0	0	0
1	0	0	--	0	0	0	0	1	0	0	0	0	0	0
2	0	0	--	4	0	0	0	0	0	0	0	0	0	0
3	0	0	--	0	1	1	0	2	0	0	0	0	0	0
4	0	6	--	2	2	33	21	6	<1	<1	<1	2	1	1
5	28	15	--	12	27	17	86	75	6	4	11	5	6	14
6	327	58	--	46	54	44	26	278	96	16	61	29	4	12
7	247	363	--	213	97	46	38	105	187	55	34	77	14	10
8	164	147	--	93	74	48	36	68	85	88	70	34	30	10
9	350	194	--	160	71	42	36	80	40	38	77	50	16	14
10	1,201	91	--	44	55	28	17	53	37	28	32	75	28	12
11	288	1,105	--	92	57	51	27	54	24	16	25	29	45	18
12	287	222	--	60	33	25	23	19	24	16	21	27	21	31
13	202	223	--	373	34	27	13	59	12	13	19	25	16	13
14	89	82	--	119	142	42	9	32	36	7	18	16	11	7
15	27	90	--	41	164	92	45	12	18	13	9	12	11	9
16	17	30	--	38	59	47	36	31	4	5	15	10	9	8
17	7	60	--	29	8	25	28	103	16	4	5	8	3	5
18	3	0	--	32	15	11	16	60	35	12	8	6	6	1
19	0	0	--	56	22	11	4	18	26	12	10	3	3	3
20	0	0	--	4	42	11	4	5	12	7	15	4	2	1
21	0	0	--	2	13	10	8	5	3	2	4	3	1	0
22	0	0	--	0	3	1	2	6	2	1	1	2	1	0
23	0	0	--	0	1	1	2	6	1	<1	0	<1	0	<1
24	0	0	--	0	0	0	1	2	0	1	0	0	<1	<1
25	0	0	--	0	0	0	0	0	0	0	0	0	0	0
Totals	3,236	2,687	--	1,419	975	613	478	1,081	666	336	435	416	229	171

Table 12. Estimates of biomass at age (metric tons) from February-March echo integration-trawl surveys of walleye pollock in the Bogoslof Island area. No survey was conducted in 1990. The 1999 survey was conducted by the Japan Fisheries Agency.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0	0	--	0	0	0	0	0	0	0	0	0	0	0
1	0	0	--	0	0	0	0	10	0	0	0	0	0	0
2	0	0	--	170	0	0	0	0	0	0	0	0	0	0
3	0	0	--	0	162	284	0	681	0	0	0	0	0	0
4	0	2,184	--	715	782	18,809	13,028	3,411	322	87	78	1,809	324	437
5	14,997	7,275	--	6,067	21,455	11,939	59,938	48,690	3,668	2,083	6,771	5,688	4,060	11,581
6	192,324	41,140	--	24,911	38,081	39,100	21,530	208,409	69,106	10,598	37,697	28,096	2,884	11,166
7	155,569	241,301	--	143,024	67,027	43,049	39,768	82,680	165,354	49,598	29,637	77,751	12,065	9,698
8	114,725	111,156	--	74,575	59,445	46,874	39,107	72,294	75,658	94,580	73,714	37,210	30,361	11,576
9	251,417	149,143	--	149,035	67,358	43,976	39,539	96,260	45,732	44,076	94,394	59,688	17,797	18,033
10	910,016	68,495	--	43,519	56,969	30,688	20,520	64,202	45,360	37,822	40,417	90,284	39,852	16,273
11	226,380	894,895	--	94,020	61,394	59,294	31,589	70,646	31,116	22,942	35,706	35,240	63,335	26,491
12	232,810	187,280	--	59,273	36,293	27,008	27,506	26,482	33,262	22,497	29,180	32,724	31,891	49,843
13	167,054	193,548	--	377,521	37,218	29,947	17,038	77,225	16,950	18,074	26,690	29,864	24,979	20,032
14	81,596	71,920	--	116,171	150,237	46,997	10,896	42,417	48,990	10,713	26,304	18,915	17,620	11,025
15	22,969	81,447	--	38,750	168,966	107,062	52,899	16,595	24,443	19,768	13,230	14,207	16,150	14,340
16	16,336	24,342	--	37,870	63,304	54,401	42,771	37,907	5,538	6,659	21,631	12,723	14,740	13,925
17	6,681	51,725	--	30,696	9,342	27,577	32,128	131,396	20,782	5,470	8,218	9,635	5,637	7,351
18	2,863	0	--	32,392	15,467	10,736	17,911	74,010	43,092	16,894	10,212	7,020	8,460	2,106
19	0	0	--	55,116	23,380	13,607	4,768	22,292	31,760	17,174	13,047	3,357	4,798	5,264
20	0	0	--	3,840	43,605	11,963	5,081	5,902	14,486	9,228	19,016	4,343	2,547	2,043
21	0	0	--	1,341	15,240	10,167	8,866	5,433	4,023	1,885	5,376	3,574	1,566	0
22	0	0	--	0	3,186	1,329	2,011	7,728	1,974	947	1,078	2,668	1,810	0
23	0	0	--	0	1,287	598	2,323	6,696	661	419	0	514	0	493
24	0	0	--	0	0	0	860	2,758	0	888	0	0	526	493
25	0	0	--	0	0	0	0	0	0	0	0	0	0	0
Totals	2,395,737	2,125,851	--	1,289,006	940,198	635,405	490,077	1,104,124	682,277	392,402	492,396	475,311	301,402	232,170

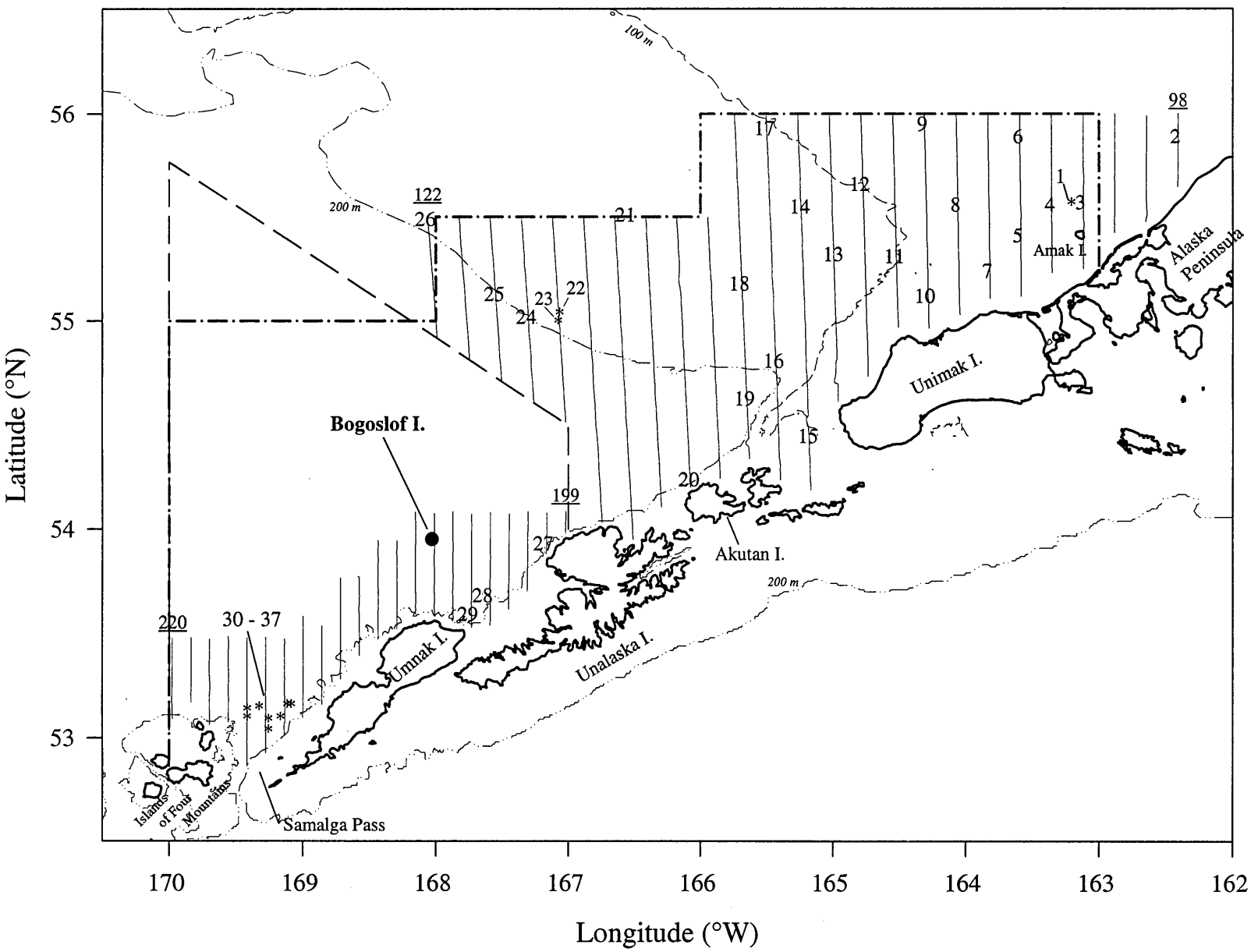


Figure 1. Trackline and haul locations from the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island areas. Hauls close together are indicated with asterisks and numbers. Transect numbers are underlined. Dash-dotted line indicates boundary of the Steller sea lion Conservation Area (SCA), and long-dashed line outlines NPFMC Area 518/Central Bering Sea Specific Area.

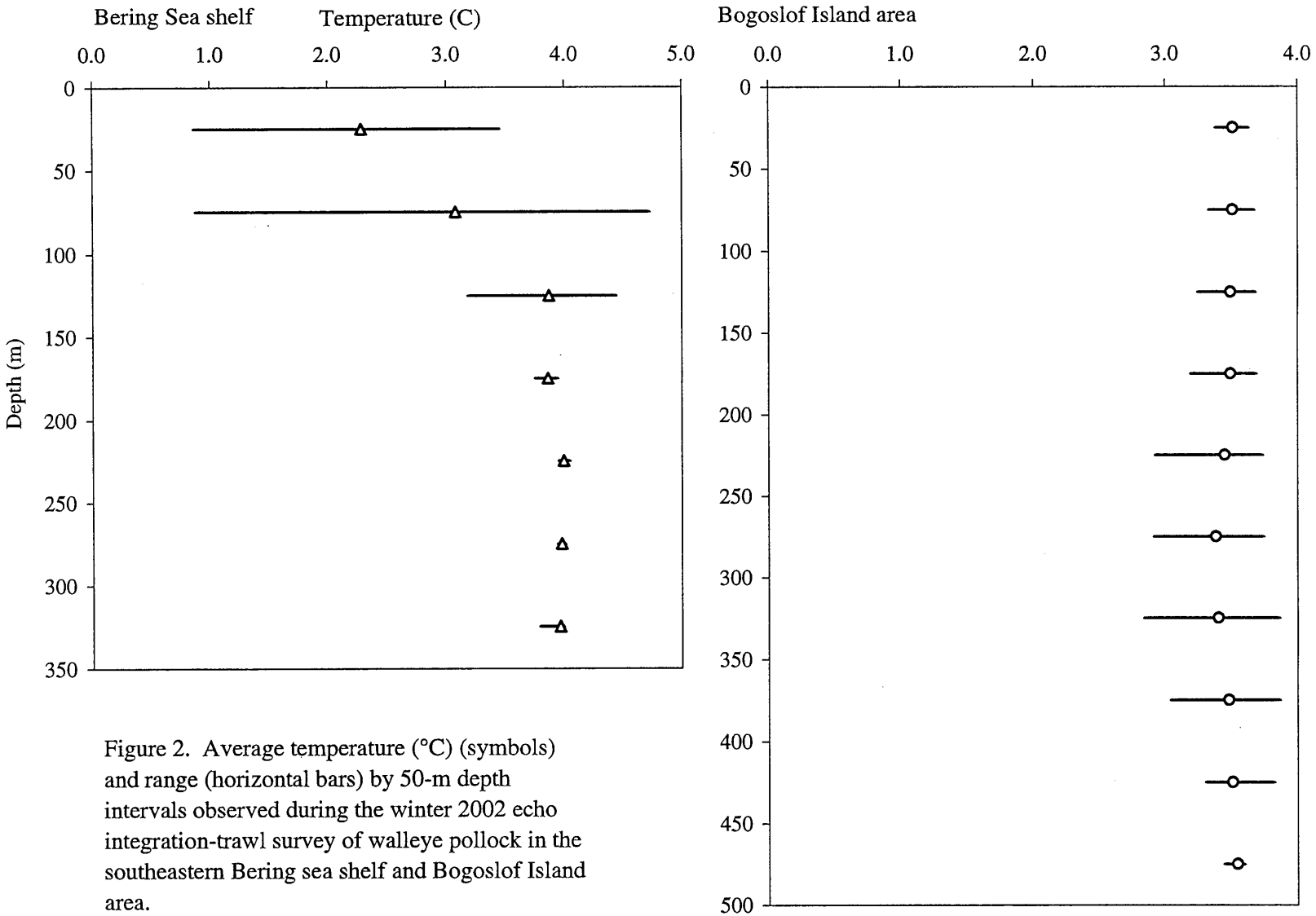


Figure 2. Average temperature (°C) (symbols) and range (horizontal bars) by 50-m depth intervals observed during the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering sea shelf and Bogoslof Island area.

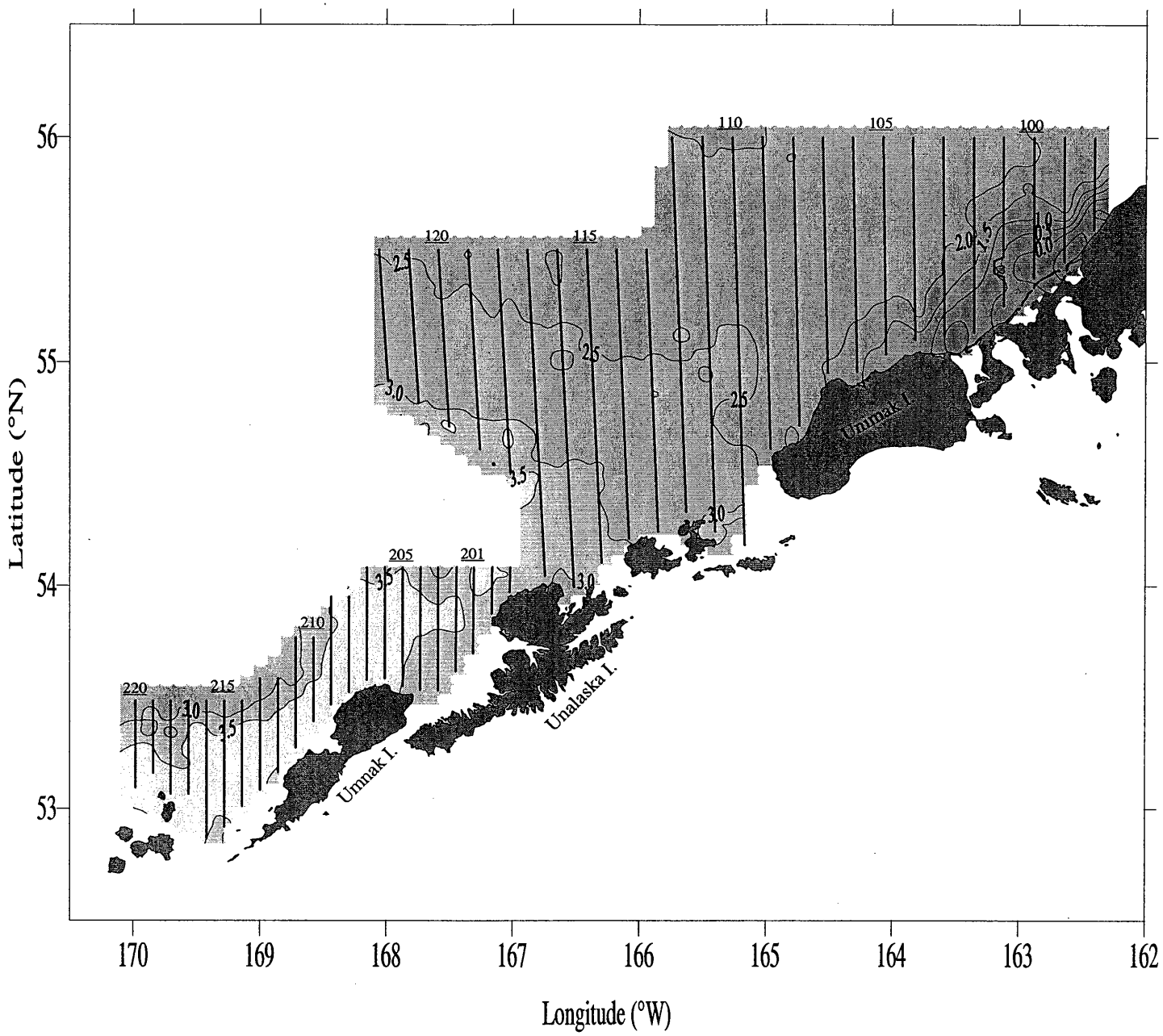


Figure 3. Transect lines with surface temperature contours (in °C) during the winter 2002 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island area. Transect numbers are underlined.

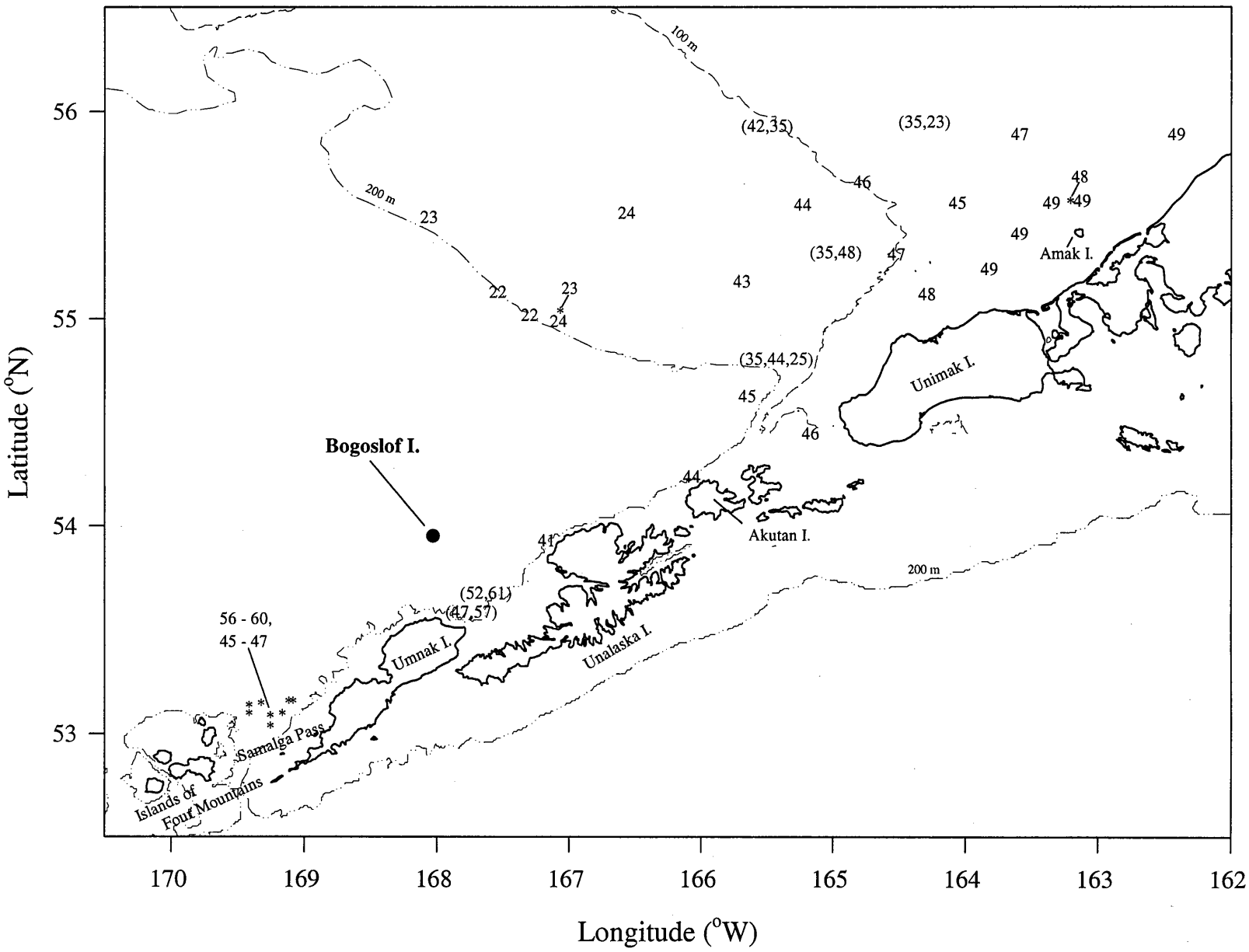


Figure 4. Haul locations with pollock modal lengths (cm) from the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island areas. Hauls with more than one mode have modes listed in parentheses in order of importance. Hauls west of Umnak Island in Samalga Pass are labeled with asterisks and dominant mode ranges.

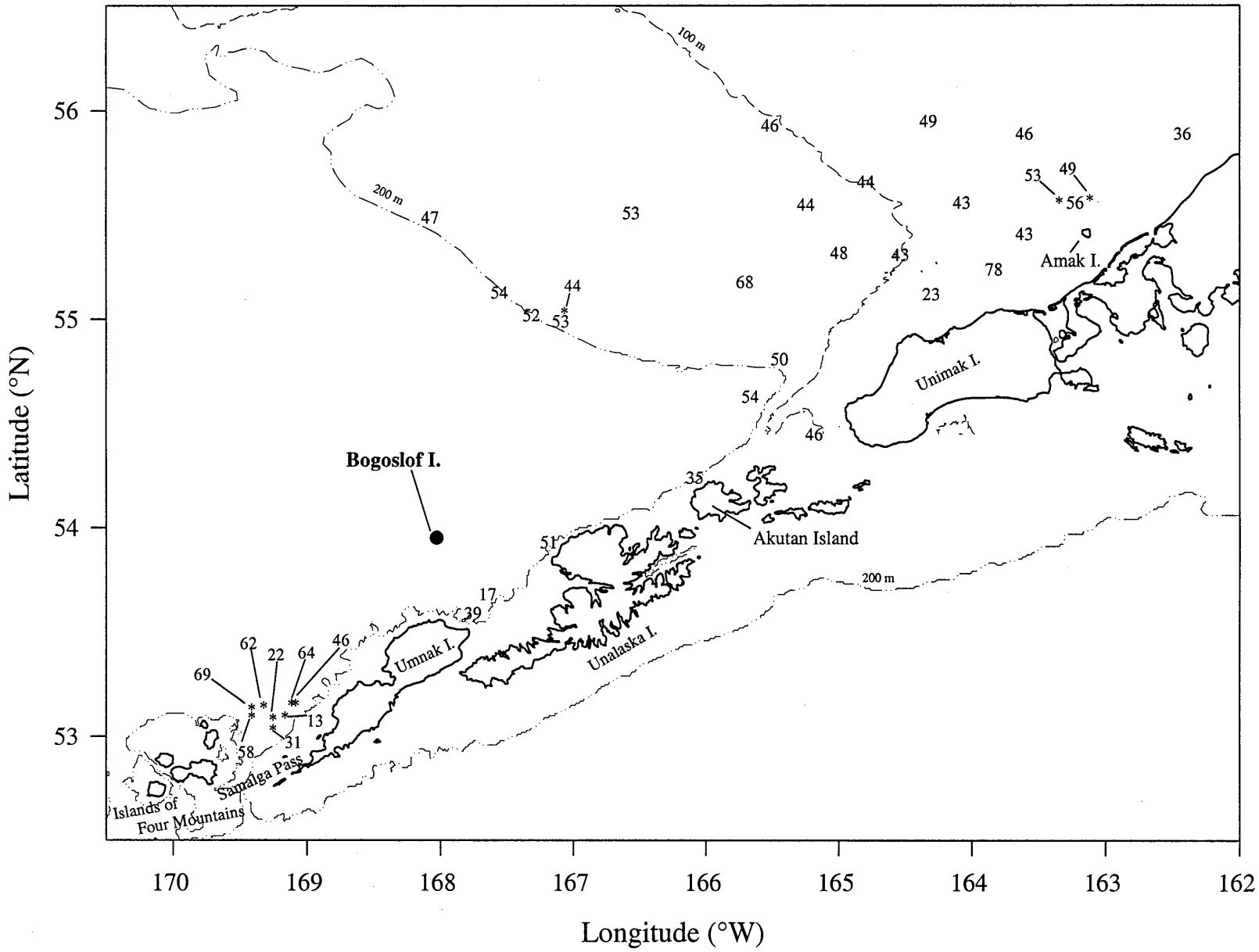
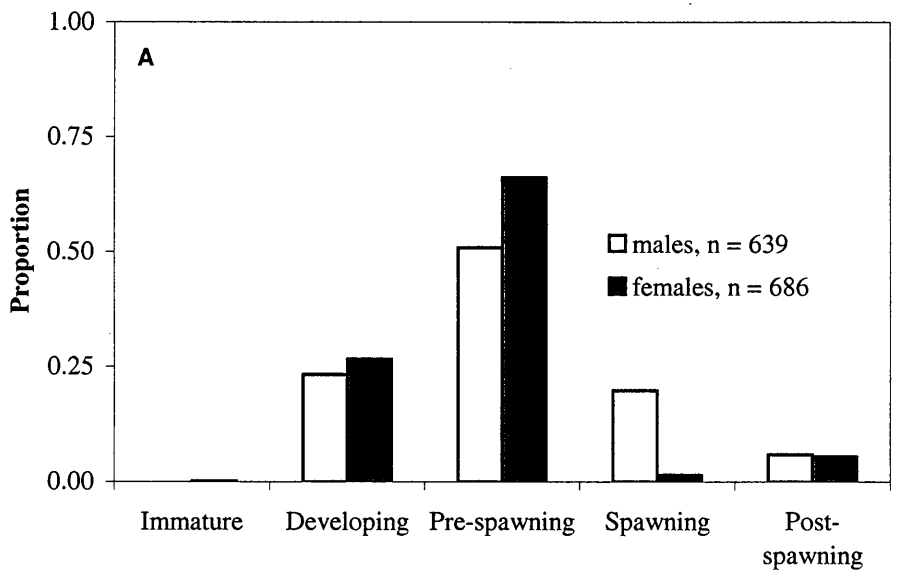
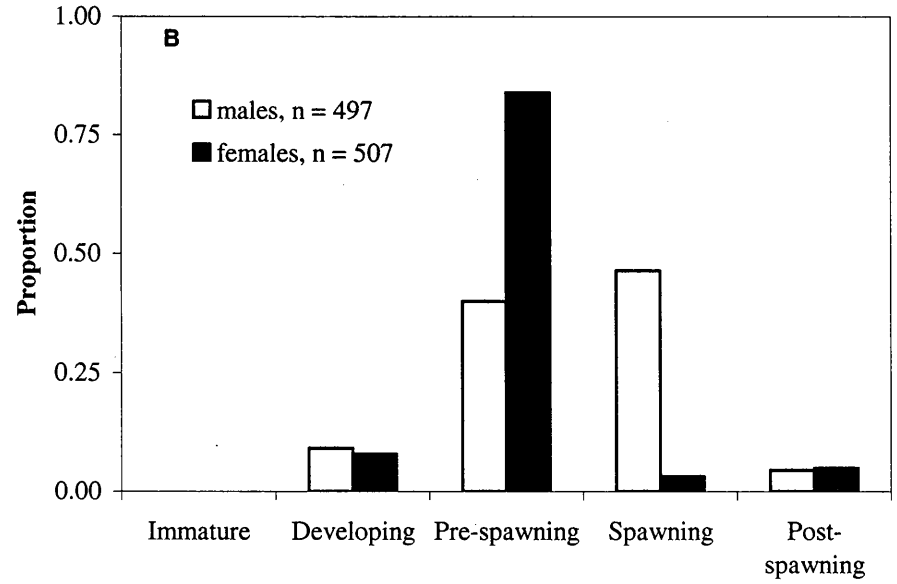


Figure 5. Haul locations with percent male pollock (N > 50) from the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island areas. Hauls close together are shown as asterisks with the percent male label adjacent to the haul location.





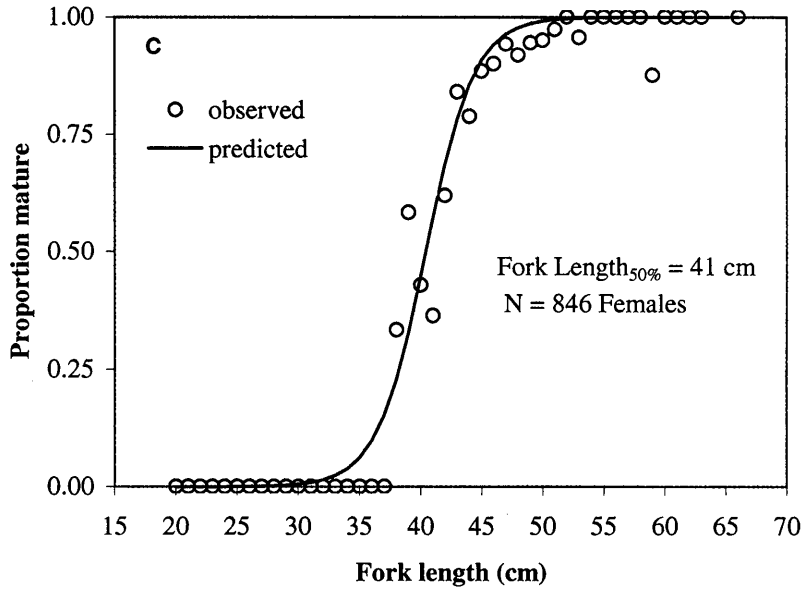


Figure 6. Pollock (>29 cm fork length) maturity stages observed during the winter 2002 echo integration-trawl survey of the southeastern Bering Sea shelf (A) and southeastern Aleutian Basin near Bogoslof Island (B). Fitted logistic function and proportion mature at each size class for female pollock observed in the southeastern Bering Sea shelf region (C). Fork length$_{50\%}$ is the predicted fork length of fish that are 50% mature.

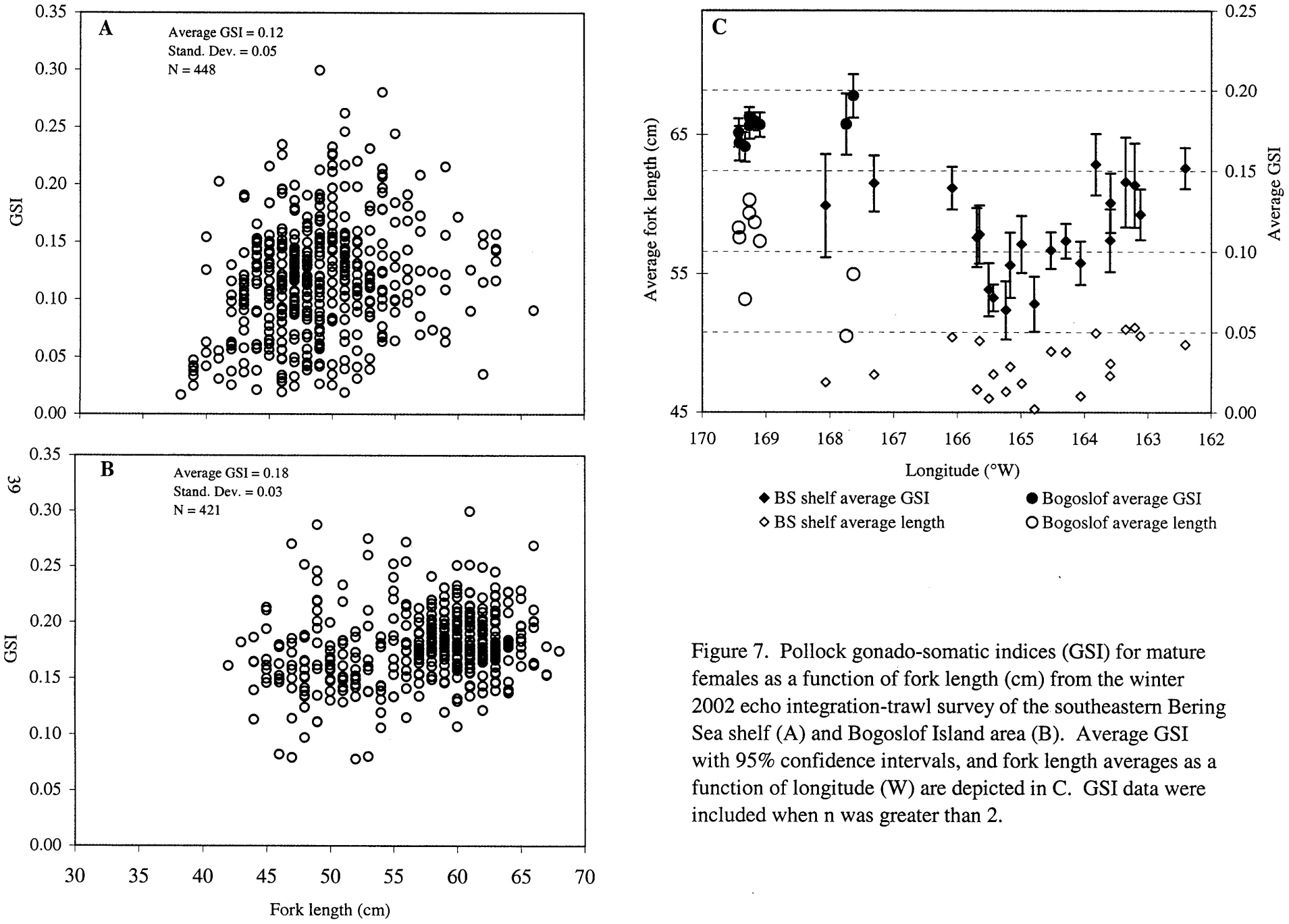


Figure 7. Pollock gonado-somatic indices (GSI) for mature females as a function of fork length (cm) from the winter 2002 echo integration-trawl survey of the southeastern Bering Sea shelf (A) and Bogoslof Island area (B). Average GSI with 95% confidence intervals, and fork length averages as a function of longitude (W) are depicted in C. GSI data were included when n was greater than 2.

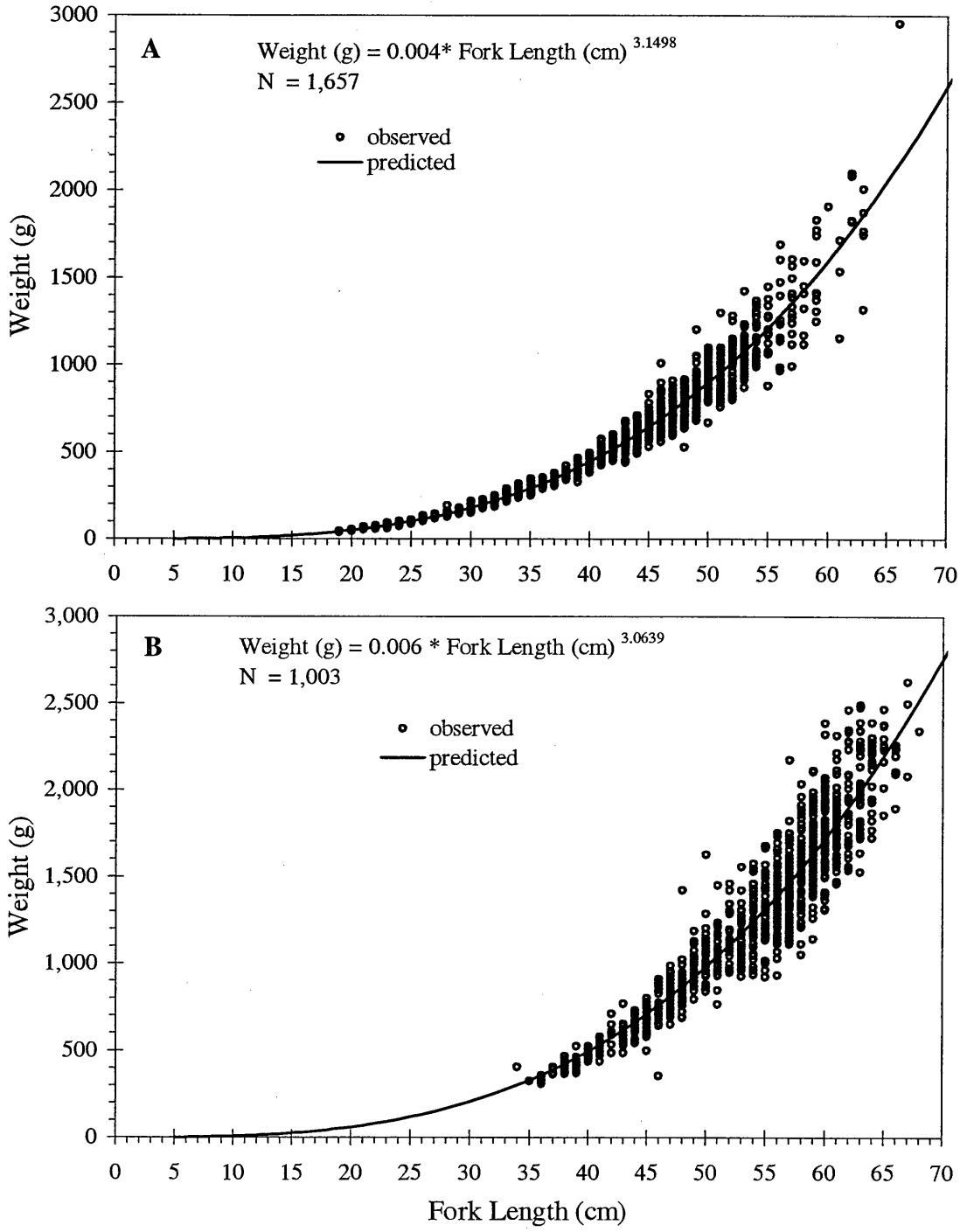


Figure 8. Pollock length-weight relationships (sexes combined) observed during the winter 2002 echo integration-trawl survey of the southeastern Bering Sea shelf (A) and Bogoslof Island region (B).

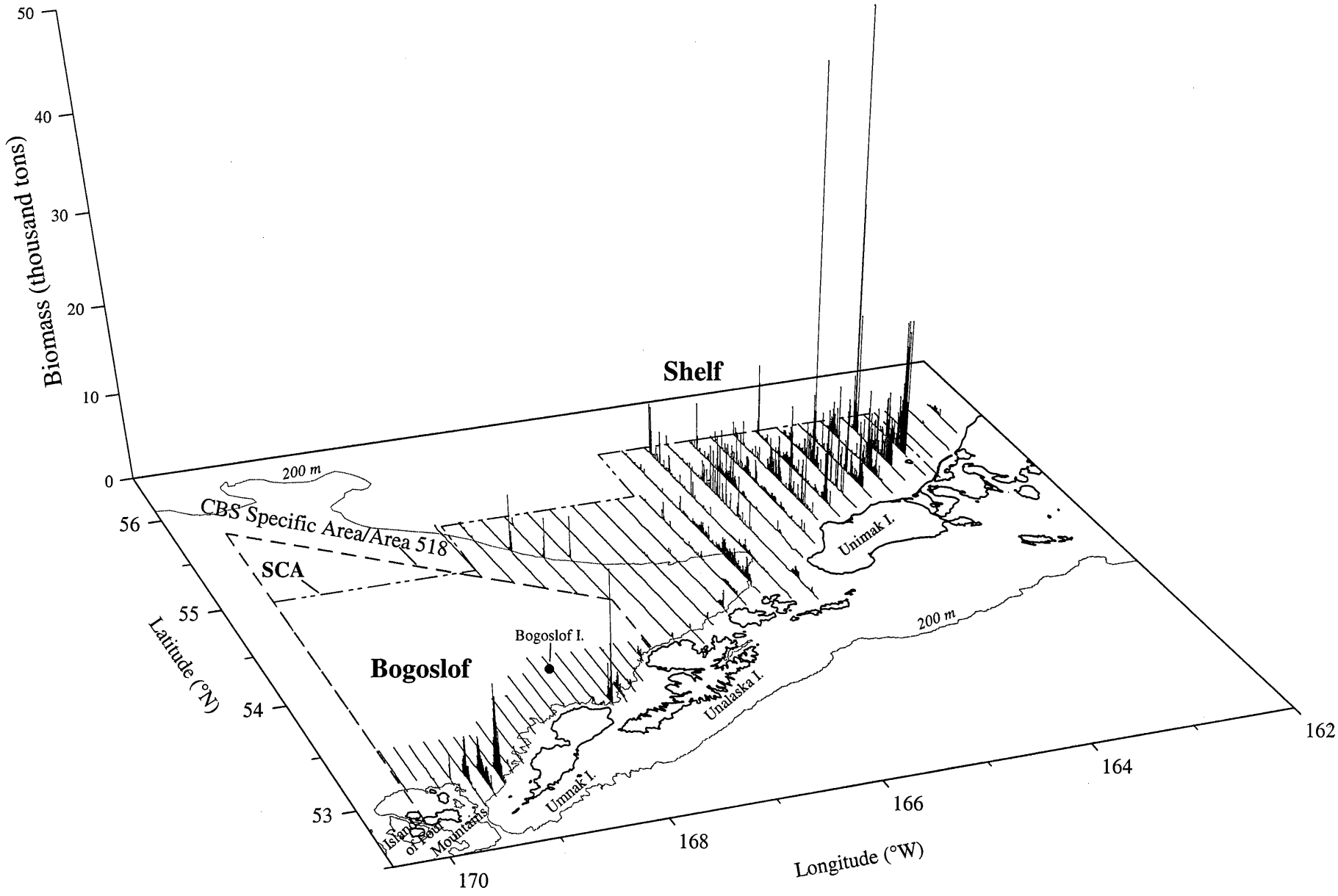


Figure 9a. Pollock biomass (1000 metric tons) along tracklines from the winter 2002 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island areas. Steller sea lion Conservation Area (SCA) and CBS Specific Area/Area 518 are indicated.

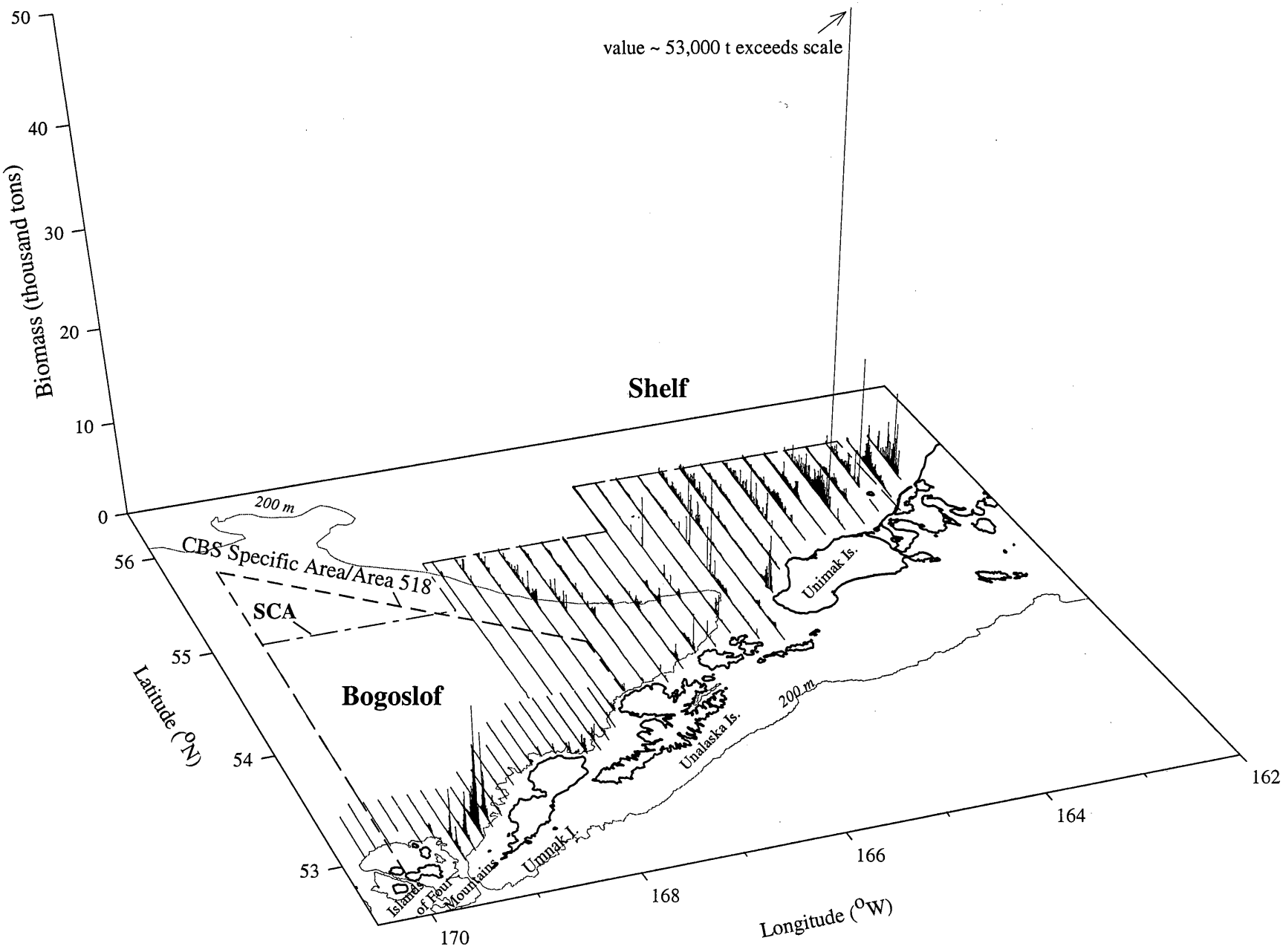


Figure 9b. Pollock biomass (1000 metric tons) along tracklines from the winter 2001 echo integration-trawl survey of walleye pollock in the the southeastern Bering Sea shelf and Bogoslof Island areas. Steller sea lion Conservation Area (SCA) and CBS Specific Area/Area 518 are indicated.

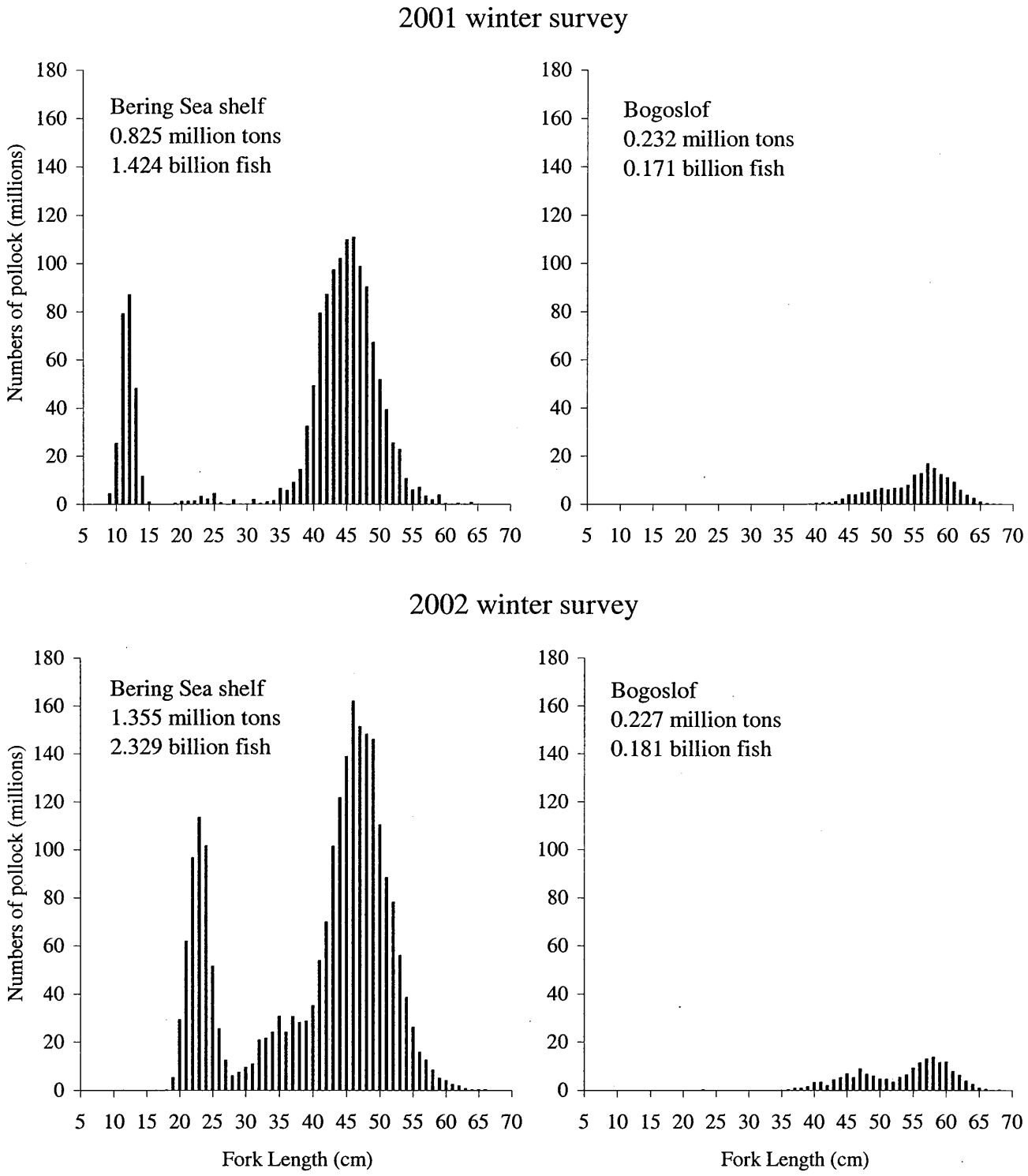


Figure 10. Population-at-length estimates from the winter 2001 (top) and winter 2002 (bottom) echo integration-trawl surveys of walleye pollock on the southeastern Bering Sea shelf (left) and in the Bogoslof Island area (right).

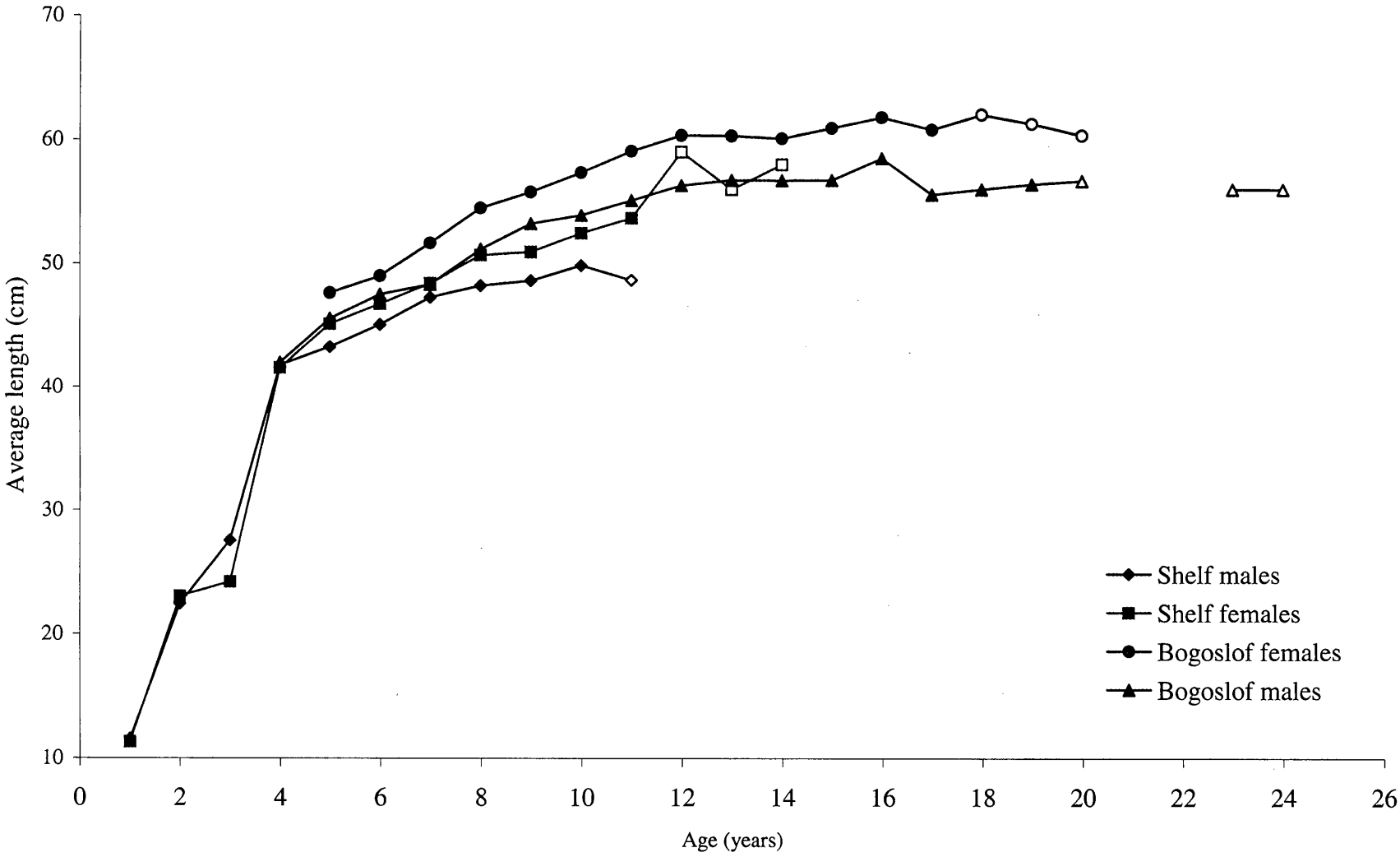


Figure 11. Average lengths at age for pollock from the winter 2001 echo integration-trawl survey of the Bering Sea shelf and Bogoslof Island area. Samples based on fewer than five individual pollock have hollow symbols.

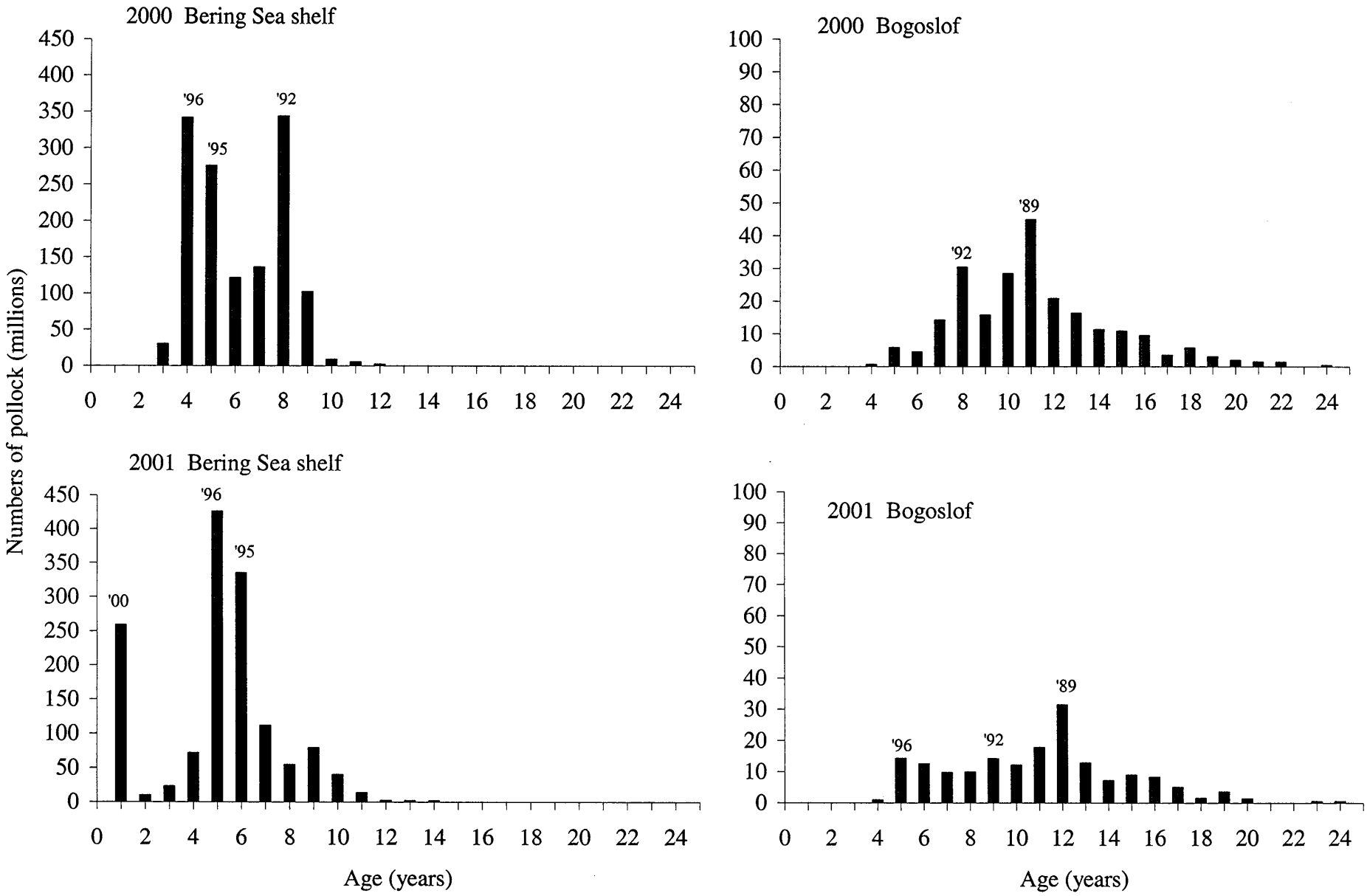


Figure 12. Population-at-age estimates from the winter 2000 (top) and 2001 (bottom) echo integration-trawl survey of walleye pollock on the southeastern Bering Sea shelf (left) and in the Bogoslof Island area (right). Major year classes are indicated. Note Y-axis scales differ.

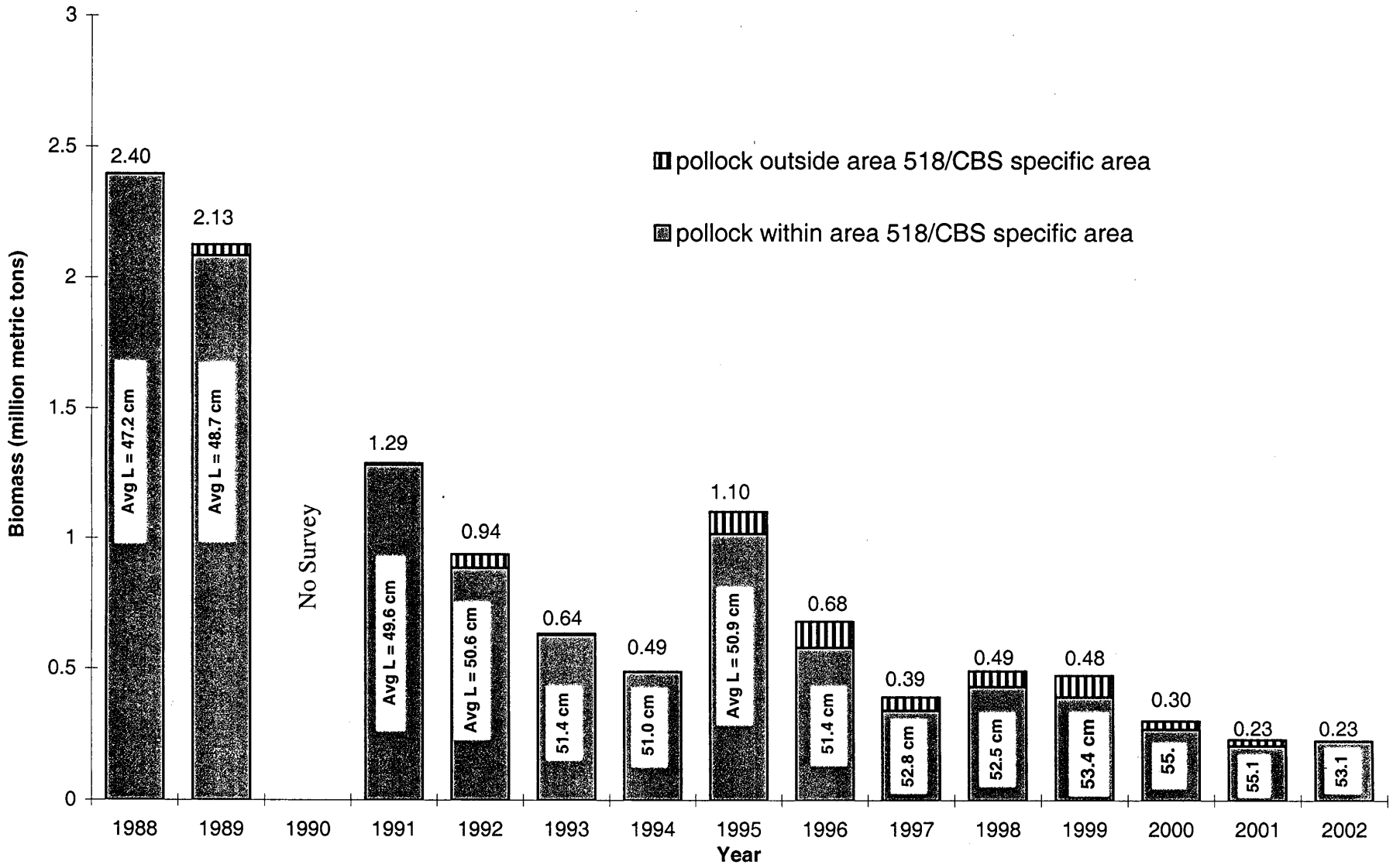


Figure 13. Biomass estimates and average fork lengths obtained during winter echo integration-trawl surveys for walleye pollock in the Bogoslof Island area, 1988-2002. The United States conducted all but the 1999 survey, which was conducted by Japan. Total estimated pollock biomass for each survey year is indicated on top of each bar.

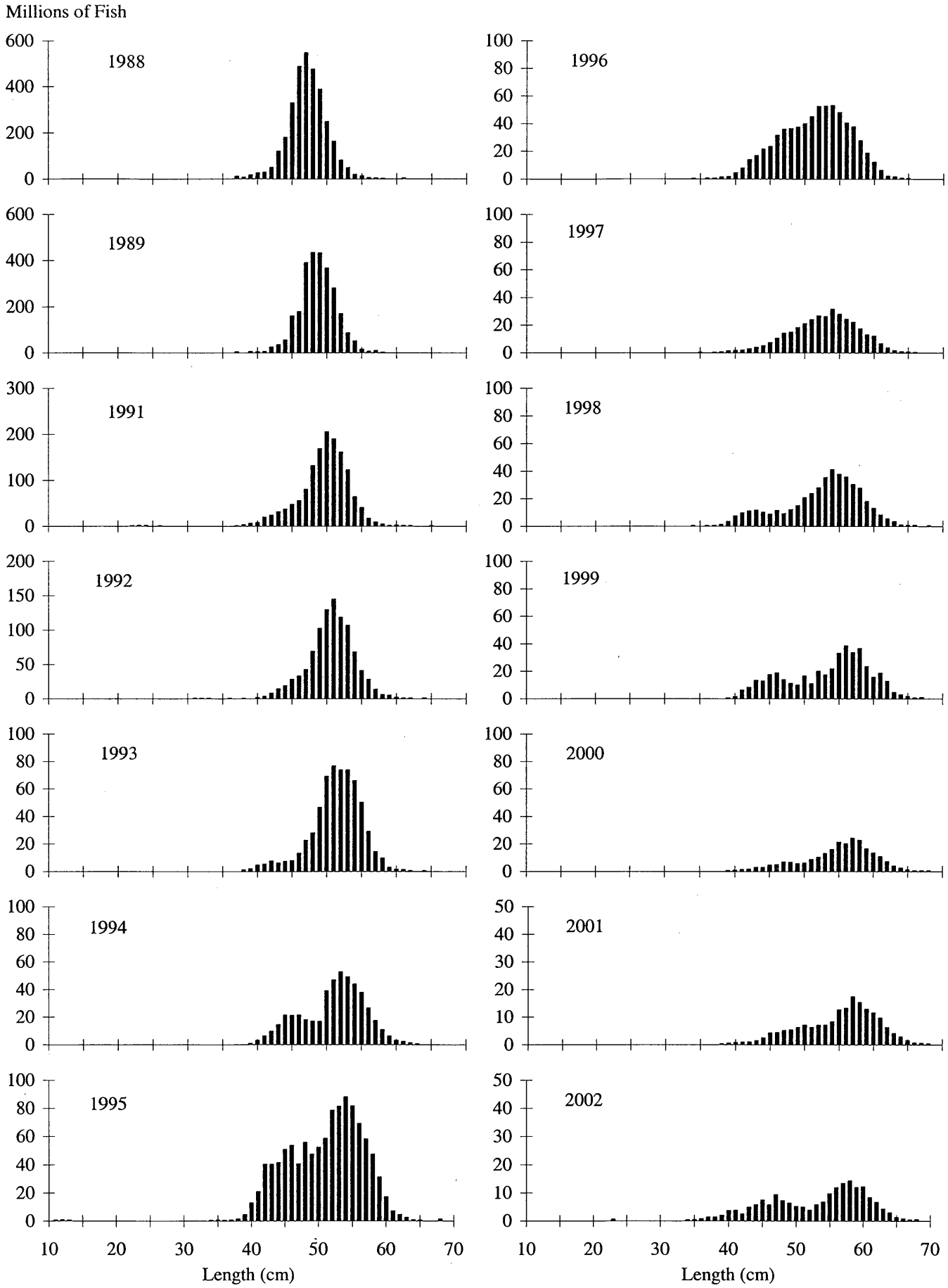


Figure 14. Population-at-length estimates from echo integration-trawl surveys of spawning pollock near Bogoslof Island in winter 1988-2001. The United States conducted all but the 1999 survey, which was conducted by Japan. There was no survey in 1990. Note y-axis scales differ.

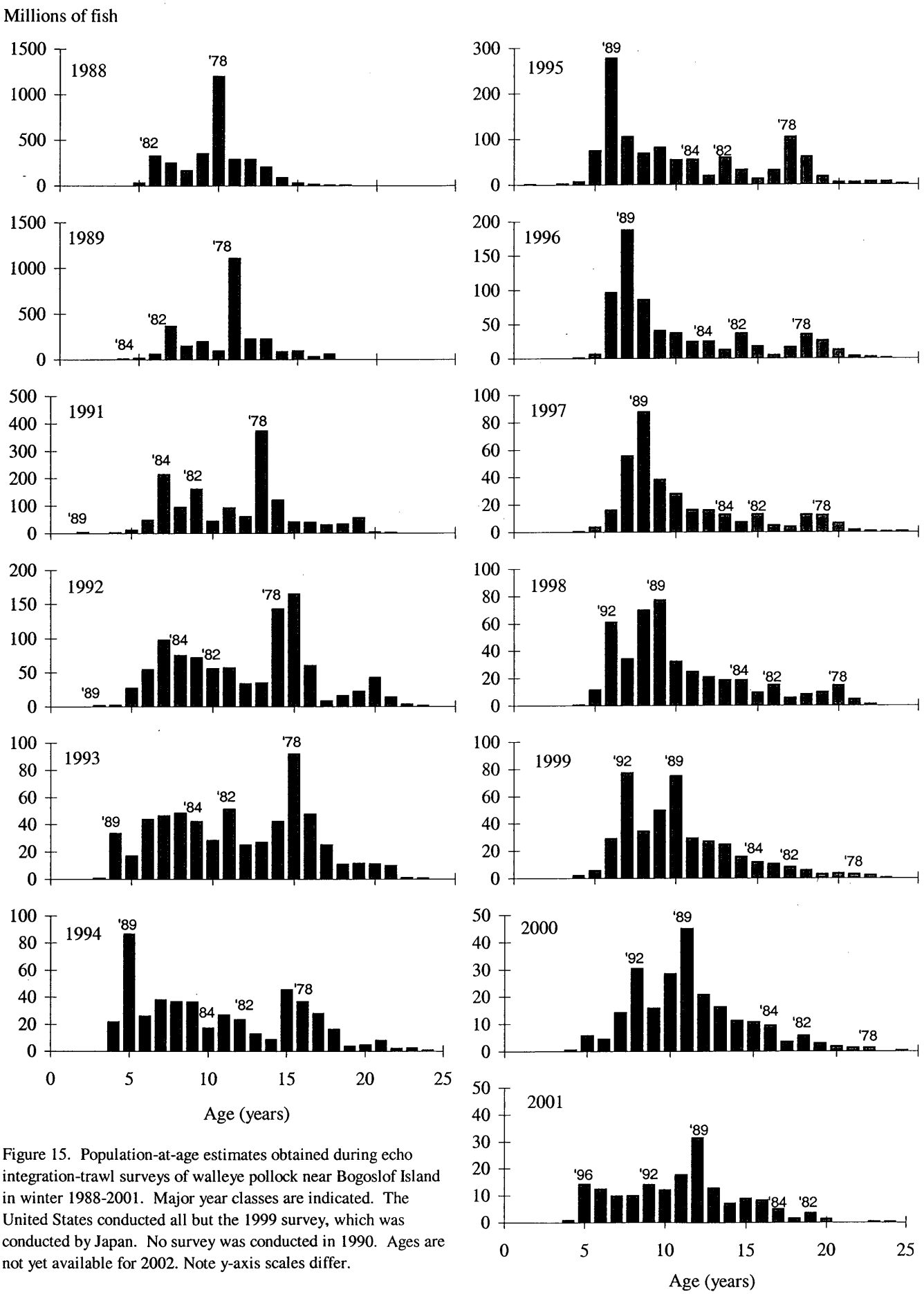


Figure 15. Population-at-age estimates obtained during echo integration-trawl surveys of walleye pollock near Bogoslof Island in winter 1988-2001. Major year classes are indicated. The United States conducted all but the 1999 survey, which was conducted by Japan. No survey was conducted in 1990. Ages are not yet available for 2002. Note y-axis scales differ.

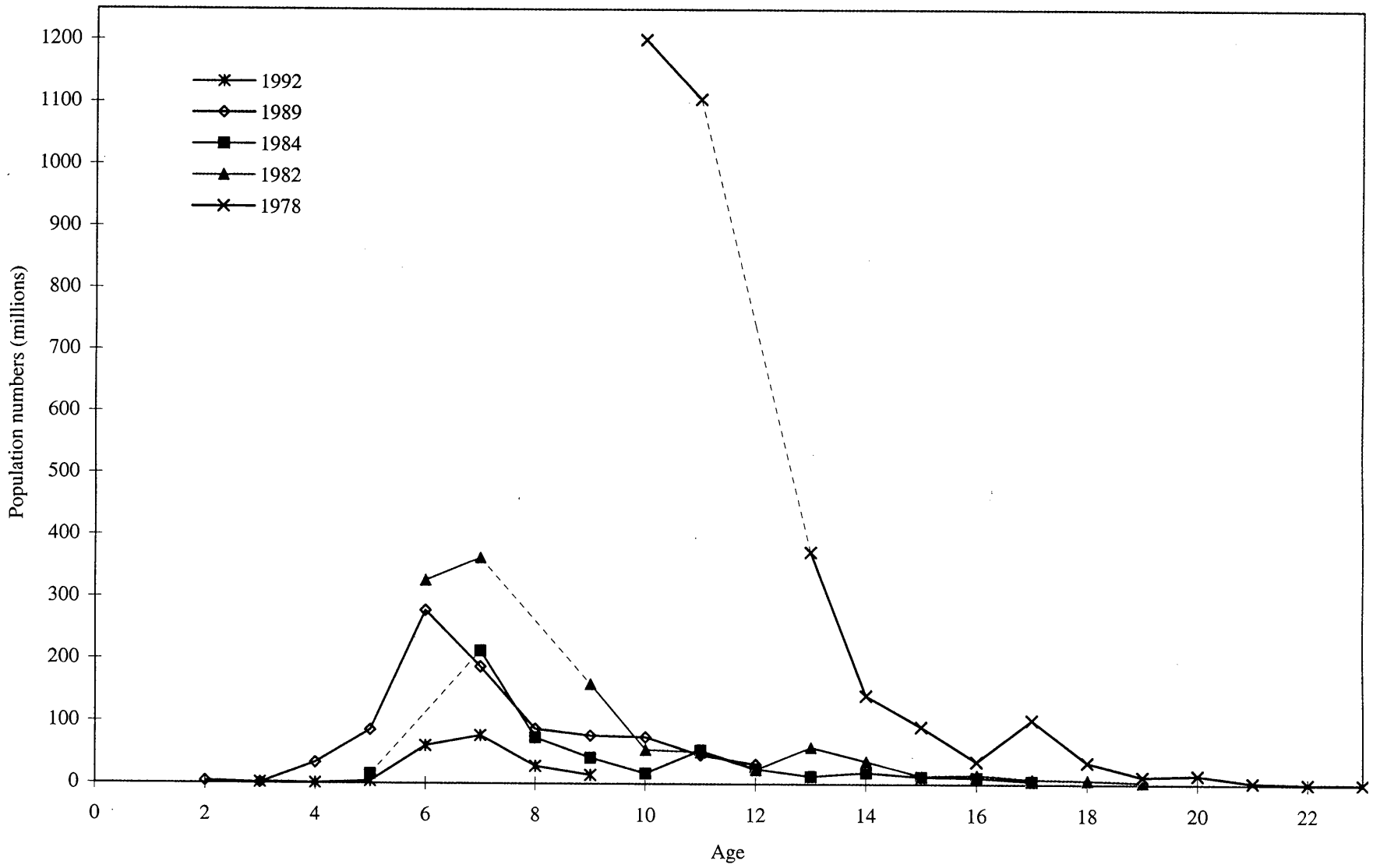


Figure 16. Estimated population numbers at age for dominant year classes observed in winter echo integration-trawl surveys of Bogoslof Island area spawning pollock. Data are from surveys conducted in 1988-2001. The United States conducted all but the 1999 survey, which was conducted by Japan. No survey was conducted in 1990 (dashed lines).