Alaska
Fisheries Science
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National Marine
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U.S DEPARTMENT OF COMMERCE

AFSC PROCESSED REPORT 2010-01

Results of the February-March 2009 Echo Integration-Trawl Surveys of Walleye Pollock (*Theragra chalcogramma*) Conducted in the Gulf of Alaska, Cruises DY2009-01 and DY2009-04

February 2010

This document should be cited as follows:

Guttormsen, M. A., A. McCarthy, and D. Jones. 2010. Results of the February-March 2009 echo integration-trawl surveys of walleye pollock (*Theragra chalcogramma*) conducted in the Gulf of Alaska, Cruises DY2009-01 and DY2009-04. AFSC Processed Rep. 2010-01, 67 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.

Results of the February-March 2009 Echo Integration-Trawl Surveys of Walleye Pollock (*Theragra chalcogramma*) Conducted in the Gulf of Alaska, Cruises DY2009-01 and DY2009-04

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February 2010

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INTRODUCTION

Scientists from the Midwater Assessment and Conservation Engineering (MACE) Program of the Alaska Fisheries Science Center's (AFSC) Resource Assessment and Conservation Engineering (RACE) Division routinely conduct echo integration-trawl (EIT) stock assessment surveys in the Gulf of Alaska (GOA) during late winter and early spring to estimate the distribution and abundance of walleye pollock (*Theragra chalcogramma*). Most of these efforts have been focused on the Shelikof Strait area, which has been surveyed annually since 1980, except in 1982 and 1999. Surveys have also been conducted in the Shumagin Islands area in 1994-1996, 2001-2003, and 2005-2008 and along the GOA continental shelf break east of Chirikof Island to Barnabas Trough in 2002-2008. This report presents the distribution and abundance of walleye pollock for surveys conducted in the GOA during February and March 2009.

METHODS

MACE scientists conducted surveys in the western GOA in the Shumagin Islands (comprising of Shumagin Trough, Stepovak Bay, Renshaw Point, Unga Strait, and West Nagai Strait), Sanak Trough, along the continental shelf break from Sanak Island to Unalaska Island between 13 and 22 February (Cruise DY2009-01), and in the central GOA in the Shelikof Strait area and Marmot Bay between 20 and 31 March (Cruise DY2009-04). The surveys were conducted aboard the NOAA ship *Oscar Dyson*, a 64-m stern trawler equipped for fisheries and oceanographic research. The surveys were conducted following established EIT methods as specified in NOAA protocols for fisheries acoustics surveys and related sampling[1].

[1] National Marine Fisheries Service (NMFS) 2004. NOAA protocols for fisheries acoustics surveys and related sampling (Alaska Fisheries Science Center), NOAA Policy Directive 04-105-05, 24 p. Prepared by Midwater Assessment and Conservation Engineering Program, Alaska Fish. Sci. Center, Natl. Mar. Fish. Serv., NOAA. Available online http://reefshark.nmfs.noaa.gov/f/pds/publicsite/documents/supplements/04-105-05-01-AKC.pdf.

Acoustic Equipment

System electronics were housed inside the vessel in permanent laboratory space dedicated to acoustics. Echosounding was conducted with a Simrad EK60 using 18-, 38-, 70-, 120-, and 200-kHz split-beam transducers (Simrad 1997, 2004; Bodholt and Solli 1992). The transducers were mounted on the bottom of a retractable centerboard, positioning the transducers 9 m below the surface when fully extended. Data were logged to files using ER60 software (version 2.2.0) and Myriax EchoLog 500 (version 4.1).

Standard sphere acoustic system calibrations were conducted to measure acoustic system performance (Table 1). During calibrations, the ship 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 transducers. The tungsten carbide sphere was used to calibrate the 38-, 70-, 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 collecting target-strength data using EKLOBES software (Simrad 2004).

The Myriax Echoview (version 4.60.49.13299) PC-based application was used for all post-processing and analyses of the acoustic data, which were collected from 16 m below the surface to within 0.5 m of the bottom. Results presented in this report are based on 38-kHz echo integration telegram data with a post-processing S_v threshold of -70 dB.

Trawl Gear

The vessel was equipped with an Aleutian Wing 30/26 trawl (AWT). This trawl 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 1.3-cm (0.5-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, 113.4 kg (250 lb) or 226.8 kg (500 lb) tom weights on each side, and 5 m^2 Fishbuster trawl doors [1,247 kg (2,750 lb) each]. Vertical net opening and depth were monitored using a Simrad FS70 third wire system attached to the headrope. The vertical net opening for the AWT ranged from 18 to 30 m (59 to 98 ft) and averaged 24 m (79 ft) while fishing.

The vessel was also equipped with a poly Nor'eastern bottom trawl (PNE). The PNE is a high-opening trawl equipped with roller gear and constructed with stretch mesh sizes that range from 13 cm (5 in) in the forward portion of the net to 8.9 cm (3.5 in) in the codend. The codend was fitted with a 3.2-cm (1.25 in) nylon mesh liner. The 27.2-m (89.1 ft) headrope held 21 floats [30-cm (12 in) diameter]. A 24.7-m (81 ft) chain fishing line was attached to a 24.9-m (81.6 ft) footrope constructed of 1-cm (0.4 in) 6 × 19 wire rope wrapped with polypropylene rope. The trawl was also rigged with triple 54.9-m (180 ft) galvanized wire rope dandylines. The rollergear was attached to the fishing line using chain toggles [2.9 kg (6.5 lb) each] comprising five links and one ring. 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 some of 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 net was fished with the Fishbuster trawl doors. The vertical net opening and depth were monitored with a Furuno CN-24 netsounder system attached to the headrope. The PNE vertical mouth opening ranged from 8 to 10 m (26-32 ft) and averaged 8 m (20 ft) while fishing.

Oceanographic Equipment

Physical oceanographic data collected during the cruises included temperature 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 during the special studies. Sea surface temperature data were measured using the ships' Furuno T-2000 sea surface temperature system located mid-ship, approximately

1.4 m below the surface. These and other environmental data were recorded using the ship Scientific Computing Systems.

Survey Design

The survey design consisted of a series of parallel line transects, except where it was necessary to reorient tracklines to maintain a perpendicular alignment to the isobaths. A random start position was generated for the first transect for all surveys. The Shumagin Islands survey was conducted from 15 to 18 February using transects spaced 9.3 km (5.0 nautical miles (nmi)) apart within Shumagin Trough, 4.6 km (2.5 nmi) apart in Stepovak Bay, West Nagai Strait, and Unga Strait, and 1.9 or 3.2 km (1.0 and 1.75 nmi) apart east of Renshaw Point and elsewhere (Fig. 1). Bottom depths did not exceed 225 m along any transect, and transects generally did not extend into waters less than about 60 m depth. The Sanak Trough survey was conducted from 18 to19 February using transects spaced between 3.7 and 5.5 km (2 and 3 nmi) apart (Fig. 1). Bottom depths did not exceed 165 m along any transect, and transects generally did not extend into waters less than about 50 m depth. The GOA shelf break was surveyed from 19 to 20 February from southwest of Sanak Island to Unalaska Island between the 200 and 1,500 m depth contours along transects spaced 11.1 km (6 nmi) apart, with zigzag transects placed prior to and following the parallel transects to increase the distance surveyed (Fig. 2). The GOA shelf break was surveyed from 20 to 22 March from south of Barnabas Trough to southwest of Chirikof Island between the 200 and 1,500 m depth contours along transects spaced 11.1 km (6 nmi) apart (Fig. 3). The Shelikof Strait sea valley was surveyed from 22 to 28 March using 13.9 km (7.5 nmi) transect spacing (Fig. 3). Bottom depths did not exceed 315 m along any transect, and transects generally did not extend into waters less than about 60 m depth. Marmot Bay was surveyed from 29-31 March along transects spaced 1.9 km (1.0 nmi) and 3.8 km (2.0 nmi) apart for the inner and outer portions of the Bay, respectively. Bottom depths ranged from 75 to 310 m depth. All surveys were conducted 24 hours per day.

Trawl hauls (Figs. 1-3) were conducted to collect specimens of walleye pollock and to classify observed backscatter layers to species and size composition. Average trawling speed was

approximately 1.5 m/sec (3 knots). Walleye pollock were sampled to determine sex, fork length (FL), body weight, age, maturity, and ovary weight of selected females. Walleye pollock were measured to the nearest 1 cm using an electronic measuring board (Williams and Towler in prep). 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 a 50% ethanol-water solution. Maturity was determined by visual inspection and was categorized as immature, developing, pre-spawning, spawning, or post-spawning[2]. All data were electronically recorded using the Fisheries Scientific Computing System, and stored in an Oracle database.

Data Analysis

Walleye pollock abundance was estimated by combining echo integration and trawl information. The detected bottom was calculated using the mean of sounder-detected bottom lines for all five frequencies (Jones in prep.). Acoustic backscatter, identified as walleye pollock, rockfish, and an undifferentiated mixture of primarily macrozooplankton, was recorded between depths of 16 m below the surface to 0.5 m above the detected bottom (except where the bottom exceeded the 1,000 m lower limit of data collection). All acoustic backscatter data were binned at 0.5 nmi horizontal by 10 m vertical resolution using an s_V threshold of –70 decibels (dB) and stored in a database. Mean fish weight-at-length for each length interval (cm) was estimated from the trawl information when there were six or more 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 (De Robertis and Williams 2008). Abundance for each length stratum was estimated as described below:

The echosounder measures nautical area scattering coefficient s_A, which is proportional to fish abundance (MacLennan et al. 2002). The acoustic return from an individual fish is referred to as its backscattering cross-section (σ_{bs}), or in more familiar (logarithmic) terms as its target

[2] ADP Codebook. 2005. Unpublished document. RACE Division, Alaska Fisheries Science Center, NMFS, NOAA; 7600 Sand Point Way NE, Seattle, WA 98115.

strength (TS), where

$$TS = 10 \log \sigma_{bs}.$$

The estimated TS-to-length relationship for walleye pollock (Traynor 1996) is

$$TS = 20 \log_{10} L - 66.$$

Biological information available from the trawl hauls includes

length composition, where P_i is the proportion at length L_i,
mean weight-at-length, $\overline{W}_i$,
and an age-length key, where $Q_{i,j}$ is the proportion of j-aged fish of length L_i.

For a given geographic length stratum area (A), backscatter attributed to walleye pollock is scaled to abundance using a weighted mean backscattering cross-section along with the biological information as follows:

$\overline{\sigma}_{bs} = \Sigma_i (P_i \times \sigma_{bsi})$, where $\sigma_{bsi} = 10^{((20 \log Li - 66)/10)}$
Numbers at length $L_i = N_i = P_i \times \bar{s}_A \times A / 4\pi\overline{\sigma}_{bs}$
Biomass at length $L_i = B_i = \overline{W}_i \times N_i$
Numbers at age $j = N_j = \Sigma_i Q_{i,j} \times N_i$
Biomass at age $j = B_j = \Sigma_i Q_{i,j} \times B_i$.

Total abundance was estimated by summing the stratum estimates.

Relative errors for the acoustic-based estimates 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 in the fish distribution. These errors quantify only transect sampling variability. Information is not yet available to assess contributions from other sources of error (e.g., target strength, trawl sampling).

RESULTS and DISCUSSION

Calibration

The 38-kHz collection system showed no significant differences in gain parameters or transducer beam pattern characteristics between calibrations, confirming that the acoustic system was stable throughout the surveys (Table 1).

Shumagin Islands

Physical Oceanography

Surface water temperatures ranged from 2.3° to 2.8° C with a mean of 2.6° C (Fig. 4). Mean surface temperatures for the 2001-2003 and 2005-2007 surveys ranged from 2.4° to 5.6° C. Mean temperatures at the depths where most adult walleye pollock biomass occurred ranged from 3.6° to 4.0° C off Renshaw Point (120-160 m) and from 4.0° to 4.2° C in Shumagin Trough (130-190 m).

Trawl Samples

Biological data and specimens were collected in the Shumagin Islands from seven AWT hauls (Tables 2-3; Fig. 1). Walleye pollock was the most abundant species, contributing 89.3% by weight and 50.7% by numbers to the total catch (Table 4). Walleye pollock ranged in length from 9 to 74 cm FL. Age-1 fish[3] dominated catches in Shumagin Trough and in the mouth of Stepovak Bay. Elsewhere, age-2 and age-3 fish dominated, although older fish also contributed significant amounts off Renshaw Point and in Unga Strait (Fig. 5). By numbers, eulachon

[3] Based on results of the Shelikof Strait ages, which are the only otoliths to have been read at the time of this report.

(*Thaleichthys pacificus*) was the second most abundant species, contributing 48.3% of the catch (Table 4). Most of the eulachon catch occurred in Shumagin Trough.

The unweighted maturity composition for males longer than 40 cm FL (n = 93) was 0% immature, 33% developing, 48% pre-spawning, 16% spawning, and 2% spent (Fig. 6a). The maturity composition of females longer than 40 cm FL (n = 249) was 0% immature, 50% developing, 48% pre-spawning, 1% spawning, and 1% spent (Fig. 6b). The low percentage of spawning and spent female fish suggests that the survey timing was appropriate. A logistic model fit to the female maturity-at-length data predicted that 50% of females (L_{50}) were mature at 46 cm FL (Fig. 6c), which was similar to results from other recent Shumagin Islands surveys (42 to 49 cm FL). The average GSI (gonadosomatic index: ovary weight/(ovary weight+body weight)) of pre-spawning females, although based on only 18 samples, was 0.09 (Fig. 6d), which was similar to last year's Shumagin Island survey value of 0.08, although lower than that of previous years (0.10 to 0.19).

Distribution and Abundance

Acoustic backscatter was measured along 603 km (326 nmi) of tracklines. The densest walleye pollock aggregations were located in the eastern part of the Shumagin Trough. High densities were also found in West Nagai Strait and off Renshaw Point (Fig. 7), although, as in 2007 and 2008, the densities off Renshaw Point were relatively low compared with earlier surveys. Walleye pollock were distributed near bottom as well as in dense, midwater schools. Most of the biomass was deeper than 120 m and was within 40 m of the bottom (Fig. 8).

Age-1 walleye pollock were the dominant age group by numbers in Shumagin Trough and in the mouth of Stepovak Bay (Fig. 5). Age-2, and, to a lesser extent, age-3 fish, were numerically dominant elsewhere.

The 2009 biomass estimate was 63,300 metric tons (t). The relative estimation error of the biomass based on the one-dimensional geostatistical analysis was 10.8%. The 2009 biomass was

more than double the 2008 estimate (30,600 t) and three times the 2007 estimate of 20,000 t, which was the lowest in survey history (Table 5, Fig. 9). The 2009 biomass estimate was still much lower, however, than the 1995 and 2001-2002 estimates. In contrast to surveys conducted prior to 2007, most of the biomass for the 2007-2009 surveys consisted of juvenile fish (Fig. 10).

Inference about abundance trends based on the entire Shumagin time series is confounded for several reasons. Previous to 2001, only the 1995 survey covered the entire Shumagin Islands area. It is also unknown whether changes in abundance reflect variation in the timing of peak spawning or actual changes in the population. With the exception of the 1994 survey, which occurred in March well after peak spawning, the dates of the Shumagin Island survey have been similar between years, but the timing of peak spawning has varied. For example, 45% of the females in 2001 (third largest Shumagin Islands biomass estimate to date) were either spawning or spent, suggesting that the peak of spawning had already occurred and that some fish might have already left the area.

The Shumagin Islands surveys also may not provide reliable predictions of future walleye pollock abundance. For example, over 50% of the Shumagin Islands adult walleye pollock in 2001 consisted of fish from the 1993, 1994, and 1995 year classes; however, these year classes were either detected in low numbers or were absent entirely as juveniles during the 1994, 1995, and 1996 Shumagin Islands surveys (Fig. 10), so these might have immigrated from another area.

Sanak Trough

Physical Oceanography

Surface water temperatures averaged 2.3° C from the two trawl locations in this area (Fig. 11). Mean surface water temperatures were slightly cooler than in previous years, which ranged from 2.5° C in 2007 to 5.1° C in 2003. Temperatures at the depths where most of the walleye pollock biomass occurred (>75 m) ranged from 2.7° to 3.0° C, with a mean of 2.8° C, which was cooler than in 2007 (3.0° C), and much cooler than in 2004 (5.3° C) and 2005 (4.4° C).

Trawl Samples

Biological data and specimens were collected in Sanak Trough from one AWT haul and one PNE haul (Tables 2-3, Fig. 1). Walleye pollock was the most abundant species caught, contributing 99.4% by weight and 97.6% by numbers to the AWT haul (Table 6), and 96.2% by weight and 91.7% by numbers to the PNE haul (Table 7). Most of the walleye pollock that were captured ranged in length from 45 to 72 cm FL (Fig. 5a) with a mode of 61 cm FL.

The unweighted maturity composition for males longer than 40 cm FL (n = 39) was 0% immature, 15% developing, 51% pre-spawning, 23% spawning, and 10% spent (Fig. 12a). The unweighted maturity composition for females longer than 40 cm FL (n = 48) was 0% immature, 13% developing, 54% pre-spawning, 10% spawning, and 23% spent (Fig. 12b). The high percentage of spawning or spent females suggests that the survey timing was late. Previous Sanak Trough surveys have also found relatively high numbers of spawning and spent females, which suggests that Sanak Trough should be surveyed earlier in the season to be consistent with the timing of other winter GOA surveys. Because no fish were shorter than 40 cm FL, a logistic model could not be fitted to the female maturity-at-length data (Fig. 12c). The average GSI of pre-spawning females was 0.16 (Fig. 12d), which was similar to that in previous surveys in this area.

Distribution and Abundance

Acoustic backscatter was measured along 168 km (91 nmi) of tracklines. Most of the backscatter was distributed in the western part of the Trough close to the seafloor and on the shelf to the west of the Trough in dense, on-bottom schools (Figs. 7 and 13). Walleye pollock were sparse in the centers of the northern transects, where much of the biomass was located during previous Sanak Trough surveys.

The 2009 abundance estimate of 31,400 t reverses the dramatic biomass decline seen from 2006 (127,200 t) to 2008 (19,800 t) (Table 6), although the 2009 estimate is still about one-half the

2007 estimate. The relative estimation error for 2009 based on the one-dimensional geostatistical analysis of the acoustic backscattering was 17.4%.

Shelf Break from Sanak Island to Unalaska Island

Physical Oceanography

The mean surface water temperature was 3.5° C (Fig. 14), warming to 5.2° C at the maximum depth sampled (200 m).

Trawl Samples

Biological data and specimens were collected from a single AWT haul (Tables 2 and 4, Fig. 2). Pacific ocean perch (POP; *Sebastes alutus*) was the most abundant species by weight (93.4%) and numbers (95.4%), with other rockfish species making up the remainder of the catch (Table 9).

Distribution and Abundance

Acoustic backscatter was measured along 215 km (134 nmi) of tracklines. No walleye pollock were observed during this survey. POP, however, were found in low concentrations over bottom depths of 200-300 m from W163°20′′ to W164°00′′.

Shelikof Strait

Physical Oceanography

Surface water temperatures in 2009 ranged from 0.6° to 2.8° C with a mean of 2.0° C (Fig. 15), much colder than in 2008 (3.6° C) and other recent years with the exception of 2007 (2.4° C). Temperatures increased with depth down to approximately 250 m, rising to an average of 4.5° C, which was cooler than for 2008 (5.5° C) but warmer than for 2004-2006, where the average at depth was roughly 4.0° C.

Trawl Samples

Biological data and specimens were collected in the Shelikof Strait area from 9 AWT hauls and 3 PNE hauls (Tables 10-12; Fig. 3). Walleye pollock and eulachon were the most abundant species by weight in midwater trawl hauls, contributing 81.1% and 17.4%, respectively, to the total catch (Table 11). By numbers, walleye pollock and eulachon were also the most abundant caught, accounting for 56.1% and 40.8% of the catch, respectively. Walleye pollock and eulachon also accounted for 70.7% and 26.4%, respectively, of the number of fish caught in the PNE hauls (Table 12).

Trawl hauls conducted within Shelikof Strait proper contained a mixture of age groups, with age-1 and -2 fish dominating most catches by number (Fig. 16a). Between the mouth of the Strait and the Semidi Islands, catches were distributed between age 1, age 2, and older fish (Fig. 16b). Older fish heavily dominated catches at the southernmost end of the survey area between the Semidi Islands and Chirikof Island (Fig. 16c). This result differed from previous surveys, where juvenile walleye pollock dominated the catches.

The unweighted maturity composition in the Shelikof Strait area for males longer than 40 cm FL (n = 188) was 0% immature, 45% developing, 44% mature pre-spawning, 10% spawning, and 1% spent (Fig. 17a). The maturity composition of females longer than 40 cm FL (n = 231) was 0% immature, 52% developing, 39% pre-spawning, 6% spawning, and 3% spent (Fig. 17b). These results are similar to previous surveys, which suggests that the survey timing was consistent with previous surveys. The female L_{50} of 47 cm FL (Fig. 17c) was similar to most estimates since 1985. The average GSI for pre-spawning females of 0.13 (Fig. 17d) was similar to GSI values for 2008 (0.12), 2002 (0.12), and 2003 (0.11), but slightly lower than 2004-2007, where the mean GSI ranged from 0.14 to 0.16. The current mean is also lower than the mean GSIs (0.14-0.19) reported for the 1992-2001 surveys.

Distribution and Abundance

Acoustic backscatter was measured along 1,280 km (692 nmi) of tracklines. The densest walleye pollock aggregations were detected within the Strait proper between Cape Kuliak and Wide Bay (Fig. 18). Last year, in contrast, most of the backscatter was located on the eastern ends of transects near Chirikof Island. Most walleye pollock were generally located within 50 m of the seafloor over bottom depths exceeding 200 m, except for scattered aggregations of age-2 fish about 150 m below the surface over bottom depths of about 250 m (Fig. 19).

The biomass estimate for Shelikof Strait of 265,971 t was 28% larger than that for 2008 (208,032 t), and 47% larger than for 2007 (180,881 t), the lowest in the time series (Fig. 20). The relative estimation error of the biomass based on the one-dimensional geostatistical analysis was 5.9% (Table 5). An estimated 1.2 billion 2-year-old walleye pollock indicate that the 2007 year class is still strong, and the estimated 330 million 1-year-old fish suggest an average to above-average 2008 year class. The 1999 year class, the second largest contributor of 1-year-old walleye pollock (4.5 billion fish) in the history of the Shelikof Strait area surveys, has virtually disappeared (Tables 13-16; Fig. 21).

Shelf Break from Chirikof Island to Barnabas Trough

Physical Oceanography

Surface water temperatures ranged from 2.8° to 3.6° C with a mean of 3.2° C (Fig. 22). This is similar to 2008 (3.2° C) and 2007 (3.5° C) but cooler than in 2004 (4.8° C), 2005 (4.4° C), and 2006 (4.3° C). The temperatures at the depths where most walleye pollock biomass occurred (200-400 m) ranged from 4.5° to 5.2° C with a mean of 4.8° C and was similar to the mean temperatures of previous years: 2004 (4.7° C), 2005 (4.8° C), 2006 (4.8° C), 2007 (4.9° C), and 2008 (4.8° C).

Trawl Samples

Biological data and specimens were collected along the GOA shelf break near Chirikof Island from three AWT hauls and three PNE hauls (Tables 17-18; Fig. 3). In the AWT hauls, POP was the most abundant species by weight, making up 93.3% of the catch (Table 17). Giant grenadier (*Albatrossia pectoralis*) and walleye pollock contributed an additional 2.2% and 1.9% to the catch by weight, respectively. By number, POP, unidentified shrimp, and myctophids contributed 35.0%, 27.8%, and 26.9% of the catch, respectively. In the PNE hauls, giant grenadier were the most abundant species by weight (49.6%), followed by sablefish (9.2%; *Anoplopoma fimbria*), rougheye rockfish (9.0%; *S. aleutianus*), and shortspine thornyhead (8.4%; *Sebastolobus alascanus*, Table 18). By numbers, shortspine thornyhead and giant grenadier dominated the catch with 19.6% and 15.2%. The 19 walleye pollock captured in the AWT hauls ranged from 35 to 60 cm FL with a mode of 43 cm FL (Fig. 23a). None of the walleye pollock were in a spawning or spent condition. The small sample size (n = 19), however, prevented any further analysis of these data. As is typical for this survey, no juvenile walleye pollock were captured.

Distribution and Abundance

Acoustic backscatter was measured along 268 km (145 nmi) of tracklines (Fig. 5). Very few walleye pollock were located along the shelf break between Chirikof Island and Barnabas Trough (Fig. 5). Most of the walleye pollock echosign occurred in midwater layers between 250 and 300 m depth over bottom depths of 200-400 m (Fig. 24). Substantial acoustic backscattering, attributed to myctophids and other micronekton species, occurred offshore at about 200-300 m depth. This myctophid scattering layer, which occurred mostly over bottom depths from 800 m to deeper than 1,500 m, may have obscured low densities of walleye pollock.

The biomass estimate for the Chirikof Island survey of 396 t was far lower than for any previous surveys, with the next lowest being the 2008 estimate of 22,100 t (Table 5). The relative estimation error of the biomass based on the one-dimensional geostatistical analysis was 32.3%.

Marmot Bay

Physical Oceanography

Surface water temperatures ranged from 2.4° to 2.9° C with a mean of 2.6° C (Fig. 25). The mean surface temperature was warmer than temperatures in Shelikof Strait (2.0° C), and cooler than on the shelf between Chirikof Island and Barnabas Trough (3.3° C). Temperatures at the depths where most adult walleye pollock biomass occurred (50-250 m) ranged from 2.6° to 3.4° C with a mean of 3.0° C.

Trawl Samples

Biological data and specimens were collected in Marmot Bay from three AWT hauls and one PNE haul (Tables 19-20; Fig. 3). In the AWT catches, walleye pollock and eulachon were the most abundant species, accounting for 96.6% and 3.2% of the catch by weight, respectively, and 45.3% and 52.5% of the catch by numbers, respectively (Table 19). In the single PNE haul, walleye pollock made up 88.1% of the catch by weight and 57.4% of the catch by numbers, with eulachon making up 1.5% of the catch by weight and 23.1% of the catch by numbers (Table 20). Walleye pollock ranged from 11 to 73 cm FL with a mode of 39 cm FL (Fig. 23b).

The unweighted maturity composition in Marmot Bay for males longer than 40 cm FL (n = 176) was 0% immature, 11% developing, 27% mature pre-spawning, 61% spawning, and 1% spent (Fig. 26a). The maturity composition of females longer than 40 cm FL (n = 49) was 0% immature, 33% developing, 59% pre-spawning, 8% spawning, and 0% spent (Fig. 26b). The high percentage of pre-spawning females indicates that peak spawning had not occurred. The female L_{50} was 42 cm FL, shorter than in Marmot Bay (47 cm FL; Fig. 26c). The average GSI for pre-spawning females of 0.14 (Fig. 26d) was similar to that in the Shelikof Strait area (0.14).

Distribution and Abundance

Acoustic backscatter was measured along 268 km (145 nmi) of tracklines (Fig. 18). Most of the walleye pollock echosign occurred northwest of Spruce Island in midwater layers between 50 m and 75 m in depth over bottom depths of 100-175 m (Fig. 27), with most fish ranging in length from 33 to 42 cm. A similar distribution was observed during a survey conducted here in 2007, when most fish were age 1 (10-15 cm FL) and age 2 (19-25 cm) fish. Fish caught near-bottom in this area as well as in the gully north of Spruce Island mostly exceeded 45 cm.

The biomass estimate for the Marmot Bay survey was 19,759 t, which was substantially higher than the 2007 estimate of 3,600 t.

MACE Special Projects

Following the February surveys, a lowered acoustic system was tested during one deployment to a depth of 100 m and a second deployment to 450 m. The acoustic communication link worked well during both casts. Sphere calibration data were collected during the second deployment at depths of 50, 75, 100, 200, 300, 400, and 450 m. A total of 10 deployments were conducted during the March surveys to determine the cause of a strong, anomalous reverberation that was associated with the transmit pulse of the lowered system. It was found that back-radiation from the transducer caused this unwanted signal, which was diminished when a foam pad was placed between the top of the transducer and the transducer mounting plate.

Successful calibrations of a Simrad ME70 multi-beam echosounder were completed for two instrument configurations: a 21-beam configuration used over juvenile walleye pollock during summer 2008 EBS survey, and a 31-beam configuration used during winter 2009 field season. With the ME70 slaved to the ER60, data were collected during all February surveys and along the Chirikof shelf break and in the Shelikof Strait area. Analyses of these data are in progress.

Net selectivity work during February included outfitting the AWT near the codend with one pocket net, a Didson acoustic camera, and a 'pea-pod' stereo camera device. Successful image collection from these devices will allow for development of non-lethal fish identification, quantification, and measurement procedures, as well as catch composition within the codend, Although age-1 pollock were often captured in the pocket net, difficulties were encountered in positioning and operating the Didson and stereo camera on the AWT.

Following the Marmot Bay survey, two deployments were made using MACE's acoustically controlled multiple opening and closing codend (MOCC) device installed in place of the standard AWT codend. The MOCC is controlled by an acoustic link to the ship and contains three codends providing up to three discrete samples during a single trawl haul. During the first deployment, the intention was to fish codend net 1 in a dense pollock layer at 50 m depth, fish net 2 in a sparser aggregation at 80-100 m, and not use net 3. However, upon retrieval, net 3 had inadvertently opened. All three nets caught fish, and the breakout panels in nets 1 and 3 had split open, as designed. No damage occurred to the MOCC frame because of the large catches in all nets. Possibilities for the tripped net 3 are that the MOCC had either been mis-armed prior to deployment or that one of the nets had inadvertently triggered. During the second deployment, the MOCC was lowered into the deeper aggregation where net 1 was fished, then raised into the shallow, dense schools to fish net 2. Net 2 was closed prematurely, resulting in zero catch. Net 3 also fished these dense schools and caught 5 t of pollock (visual estimate). The breakout panel of net 3 again operated as designed, and spilled much of the catch as the codend was pulled onto the stern ramp. Several hundred kilograms of the catch remained in the aft portion of the net for sample processing.

ACKNOWLEDGMENTS

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

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ITINERARY

Shumagins/Sanak

(DY0901)

12-13 Feb.	Depart Kodiak, AK, acoustic sphere calibration in Three Saints Bay, Kodiak Island, AK.
14 Feb.	Transit to first survey transect.
15-18 Feb.	Echo integration-trawl survey of Shumagin Islands.
18-19 Feb.	Echo integration-trawl survey of Sanak Trough.
19-20 Feb.	Echo integration-trawl survey of shelf break from Sanak Island to Unalaska Island.
21-22 Feb.	Lowered transducer data collection
22 Feb.	Transit to Dutch Harbor, AK.

Shelikof/Chirikof Shelf Break

(DY0904)

19 March	Depart Kodiak, AK. Transit to first survey transect.
20-22 March	Echo integration-trawl survey of the Chirikof shelf break.
23-28 March	Echo integration-trawl survey of Shelikof Strait.
29 March	Acoustic sphere calibration in Kizhuyak Bay, Kodiak Island, AK.
29-30 March	Echo integration-trawl survey of Marmot Bay.
31 March	Lowered transducer data collection and MOCC testing
1 April	Transit to Kodiak, AK.

SCIENTIFIC PERSONNEL

Shumagin Islands, Sanak Trough, and GOA Shelf Break (DY2009-01)

Name	Position	Organization
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Shelikof Strait and Chirikof Shelf Break (DY2009-04)

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Table 1. -- Simrad ER60 38 kHz acoustic system description and settings used during the late winter/early spring 2009 echo integration-trawl surveys of walleye pollock in the Gulf of Alaska and results from standard sphere acoustic system calibrations conducted in association with the surveys.

	Survey system settings	12 Feb Three Saints Bay Alaska	8 Mar Broad Bay, Alaska	29 Mar Kizhuyak Bay, Alaska
Echosounder	Simrad ER60	--	--	--
Transducer	ES38B	--	--	--
Frequency (kHz)	38	--	--	--
Transducer depth (m)	9.15	--	--	--
Pulse length (ms)	1.024	--	--	--
Transmitted power (W)	2000	--	--	--
Angle sensitivity along	22.83	--	--	--
Angle sensitivity athwart	21.43	--	--	--
2-way beam angle (dB)	-20.77	--	--	--
Gain (dB)	22.95	22.95	22.98	23.07
s_A correction (dB)	-0.60	-0.60	-0.63	-0.69
3 dB beamwidth along	6.84	6.84	6.73	6.78
3 dB beamwidth athwart	7.28	7.28	7.18	7.11
Angle offset along	-0.08	-0.08	-0.06	-0.06
Angle offset athwart	-0.11	-0.11	-0.10	-0.09
Post-processing sv threshold (dB)	-70	--	--	--
Standard sphere TS (dB)	--	-42.20	-42.09	-41.86
Sphere range from transducer (m)	--	19.25	19.25	24.35
Absorption coefficient (dB/m)	0.0099	0.0100	0.0100	0.0099
Sound velocity (m/s)	1456.9	1456.9	1461.5	1454.5
Water temp at transducer (ºC)	--	2.9	3.0	2.8

Note: Gain and beam pattern terms are defined in the Operator Manual for Simrad ER60 Scientific echo sounder application, which is available from Simrad Strandpromenaden 50, Box 111, N-3191 Horten, Norway.

Table 2. -- Summary of trawl and catch data from the 2009 walleye pollock echo integration-trawl surveys of the Shumagin Islands (hauls 1-7), Sanak Trough (hauls 8-9), and along the Gulf of Alaska shelf break west of Sanak Island (haul 10).

Haul	Gear[1]	Date	Time	Duration	Start position		Depth (m)		Temp. (deg. C)		Walleye pollock		Other
no.	type	(GMT)	(GMT)	(minutes)	Lat. (N)	Long. (W)	footrope	bottom	headrope	surface[2]	(kg)	number	(kg)
1	AWT	15-Feb	3:43	8	55° 22.18'	158° 37.08'	165	175	4.9	2.8	251.0	2,414	486.9
2	AWT	15-Feb	20:09	22	55° 14.29'	159° 05.05'	170	200	4.4	2.7	17.7	2,413	63.2
3	AWT	16-Feb	14:09	4	55° 32.23'	159° 49.93'	153	166	3.3	2.5	227.3	3,236	8.0
4	AWT	16-Feb	23:19	3	55° 07.26'	160° 20.48'	167	214	3.0	2.5	719.2	6,062	2.0
5	AWT	17-Feb	14:47	6	55° 27.56'	160° 26.68'	129	154	3.6	2.3	1,639.8	5,367	31.2
6	AWT	18-Feb	3:45	33	55° 34.69'	160° 19.08'	137	190	3.5	2.2	1,234.3	7,374	17.3
7	AWT	18-Feb	7:05	7	55° 34.52'	160° 14.69'	178	188	4.2	2.3	1,247.4	2,802	30.6
8	PNE	18-Feb	23:07	4	54° 40.25'	162° 42.32'	72	75	2.8	2.0	55.7	33	2.2
9	AWT	19-Feb	8:34	2	54° 34.52'	162° 40.19'	125	137	2.9	2.4	973.3	526	6.1
10	AWT	19-Feb	20:39	<1	53° 53.68'	163° 27.06'	224	326	5.2	3.5	0.0	0	3,496.0

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

[2]Temperature from hull-mounted Furuno T-2000, 1.25 m below surface

Table 3. -- Summary of trawl and catch data from the 2009 walleye pollock echo integration-trawl surveys of the Gulf of Alaska shelf break near Chirikof Island (hauls 1-6), the Shelikof Strait area (hauls 7-18), Marmot Bay (haul 19-22), and experimental net studies (hauls 101-106).

Haul	Gear[1]	Date	Time	Duration	Start position		Depth (m)		Temp. (deg. C)		Walleye pollock		Other
no.	type	(GMT)	(GMT)	(minutes)	Lat. (N)	Long. (W)	Footrope	Bottom	Headrope	Surface[2]	(kg)	Number	(kg)
1	AWT	20-Mar	11:44	16	56 20.79	152 36.69	272	804	5.1	-	0.0	0	751.7
2	PNE	21-Mar	17:00	12	55 59.11	154 33.60	466	466	4.2	3.0	0.0	0	68.6
3	AWT	21-Mar	21:41	14	56 00.19	154 34.77	370	372	4.7	3.0	11.7	17	6.9
4	PNE	22-Mar	5:48	7	55 57.14	153 57.68	349	349	4.5	3.3	0.0	0	28.2
5	AWT	22-Mar	16:41	33	55 55.62	154 21.25	353	523	4.8	3.1	3.7	2	32.2
6	PNE	22-Mar	23:05	15	55 37.06	155 16.25	689	689	3.7	2.7	0.0	0	98.5
7	AWT	23-Mar	21:53	22	56 14.81	156 01.90	218	228	5.1	2.1	913.2	1,585	111.3
8	AWT	24-Mar	20:45	4	56 42.35	155 39.17	243	253	5.0	2.2	198.4	532	23.9
9	AWT	25-Mar	6:08	15	57 00.98	155 54.79	267	290	5.0	2.0	556.8	1,625	60.6
10	AWT	25-Mar	14:27	5	57 02.87	155 29.48	254	268	5.2	2.1	78.4	691	66.2
11	AWT	26-Mar	8:10	8	57 15.60	155 04.60	217	230	5.2	2.5	323.5	2,848	264.7
12	AWT	26-Mar	15:49	3	57 19.43	155 26.77	112	263	3.4	2.7	322.3	4,256	0.0
13	AWT	26-Mar	21:59	13	57 33.39	155 23.48	261	315	4.8	1.2	407.3	4,373	8.6
14	PNE	27-Mar	0:47	8	57 34.77	155 26.89	285	285	4.0	1.5	268.6	431	4.4
15	AWT	27-Mar	6:52	8	57 35.34	154 42.77	197	231	4.8	2.5	224.3	3,310	225.0
16	PNE	27-Mar	11:19	2	57 43.97	155 01.97	257	286	5.0	1.3	75.3	358	7.3
17	PNE	27-Mar	19:02	3	57 52.49	154 38.92	258	258	5.2	0.8	1,767.5	1,872	130.5
18	AWT	27-Mar	22:22	8	57 52.64	154 15.00	194	209	4.7	1.1	1,648.7	21,962	326.3
19	AWT	29-Mar	10:22	5	57 57.10	152 39.72	91	111	2.7	2.4	3,984.7	10,486	9.3
20	PNE	29-Mar	17:39	8	58 00.14	152 33.06	195	195	3.1	2.5	294.2	251	39.7
21	AWT	30-Mar	4:12	10	58 01.90	152 22.25	217	242	3.2	2.8	2,735.9	4,107	214.7
22	AWT	30-Mar	7:04	20	58 00.14	152 20.31	206	253	3.2	2.7	1,388.2	1,416	60.7
101	AWT-MOCC	31-Mar	13:42	1	57 56.32	152 41.64	87	137	2.5	2.4	390.2	1,033	0.1
102	AWT-MOCC	31-Mar	13:49	6	57 56.54	152 41.07	125	136	2.5	2.4	552.5	1,435	4.2
103	AWT-MOCC	31-Mar	13:54	<1	57 54.89	152 43.97	125	125	2.5	2.4	55.7	144	0.0
104	AWT-MOCC	31-Mar	18:24	9	57 56.41	152 41.49	130	136	2.5	2.4	558.1	1,300	2.3
105	AWT-MOCC	31-Mar	18:38	4	57 56.92	152 40.18	65	107	2.5	2.4	0.0	0	0.0
106	AWT-MOCC	31-Mar	18:48	5	57 57.31	152 39.24	53	131	2.4	2.3	5,000.0	13,361	0.0

[1]AWT = Aleutian wing trawl, AWT-MOCC = Aleutian wing trawl with multiple-opening and closing codend, PNE = poly-Nor'eastern bottom trawl

[2]Temperature from hull-mounted Furuno T-2000, 1.25 m below surface

Table 4. -- Number of biological samples and measurements collected during the winter 2009 walleye pollock echo integration-trawl surveys of the Shumagin Islands area (hauls 1-7), Sanak Trough (hauls 8-9), and along the shelf break west of Sanak Island (haul 10).

Haul	Walleye pollock				Eulachon	POP
no.	Lengths	Weights	Otoliths	Maturity	lengths	lengths
1	264	89	55	89	71	0
2	89	49	17	49	84	0
3	412	125	66	125	0	0
4	362	85	50	85	0	0
5	451	77	26	77	2	0
6	430	43	33	43	51	0
7	500	57	46	57	122	0
8	33	33	33	33	0	0
9	320	54	54	54	0	0
10	0	0	0	0	0	101
Total	2,861	612	380	612	330	101

Table 5. -- Summary of catch by species in seven Aleutian wing trawls conducted during the 2009 walleye pollock echo integration-trawl survey of the Shumagin Islands area.

Common name	Scientific name	Weight		Numbers	
		kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	5,336.7	89.3	29,668	50.7
eulachon	*Thaleichthys pacificus*	560.1	9.4	28,268	48.3
Pacific cod	*Gadus macrocephalus*	60.4	1.0	15	< 0.1
arrowtooth flounder	*Atheresthes stomias*	5.3	< 0.1	13	< 0.1
smooth lumpsucker	*Aptocyclus ventricosus*	4.5	< 0.1	3	< 0.1
chinook salmon	*Oncorhynchus tshawytscha*	2.8	< 0.1	1	< 0.1
flathead sole	*Hippoglossoides elassodon*	2.5	< 0.1	6	< 0.1
northern shrimp	*Pandalus borealis*	1.8	< 0.1	390	0.7
rock sole	*Lepidopsetta* sp.	0.8	< 0.1	2	< 0.1
squid unident.	Teuthida (Order)	0.8	< 0.1	28	< 0.1
capelin	*Mallotus villosus*	0.3	< 0.1	69	< 0.1
shrimp unident.	Decapoda (Order)	< 0.1	< 0.1	4	< 0.1
Pacific herring	*Clupea pallasi*	< 0.1	< 0.1	1	< 0.1
Total		5,975.9		58,468	

Table 6. -- Estimates of walleye pollock biomass (in metric tons) and relative estimation error for the Shelikof Strait area, Shumagin Islands, Chirikof Island shelf break, and Sanak Trough echo integration-trawl surveys.

Year	Shelikof Strait		Shumagin Islands		Chirikof shelf break		Sanak Trough	
	Biomass	Est. error	Biomass	Est. error	Biomass	Est. error	Biomass	Est. error
1981	2,785,756							
1982	no survey							
1983	2,278,175							
1984	1,757,169							
1985	1,175,282							
1986	585,754							
1987	no estimate [1]							
1988	301,708							
1989	290,457							
1990	374,735							
1991	380,331							
1992	713,430	3.6%						
1993	435,755	4.6%						
1994	492,589	4.5%	112,000 [2]					
1995	763,612	4.5%	290,100					
1996	777,174	3.7%	117,700 [3]					
1997	583,017	3.7%	no survey					
1998	504,775	3.8%	no survey					
1999	no survey		no survey					
2000	448,639	4.6%	no survey					
2001	432,752	4.5%	119,600					
2002	256,745	6.9%	135,600	27.1%	82,100	12.2%		
2003	316,463	5.2%	67,692	17.2%	30,900	20.7%	80,503	21.6%
2004	326,799	9.2%	no survey		30,424	20.4%	no survey	
2005	356,117	4.1%	51,970	11.4%	77,037	20.7%	65,548	7.4%
2006	293,608	4.0%	37,338	10.1%	69,012	11.0%	127,214	10.4%
2007	180,881	5.8%	20,009	8.6%	36,621	6.7%	60,289	5.7%
2008	208,032	5.6%	30,582	9.8%	22,055	9.6%	19,750	6.7%
2009	265,971	5.9%	63,337	10.8%	396	32.3%	31,435	17.4%

[1]Shelikof Strait was surveyed in 1987, but no estimate was made due to an equipment malfunction.

[2]Survey was conducted after peak spawning had occurred.

[3]Partial survey.

Table 7. -- Summary of catch by species in one Aleutian wing trawl conducted during the 2009 walleye pollock echo integration-trawl survey of Sanak Trough.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	973.3	99.4	526	97.6
Pacific cod	*Gadus macrocephalus*	3.3	0.3	1	< 0.1
rock sole	*Lepidopsetta* sp.	2.8	0.3	7	1.3
northern shrimp	*Pandalus borealis*	< 0.1	< 0.1	5	< 0.1
Total		979.4		539	

Table 8. -- Summary of catch by species in one poly-Nor'eastern bottom trawl conducted during the 2009 walleye pollock echo integration-trawl survey of Sanak Trough.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	55.7	96.2	33	91.7
southern rock sole	*Lepidopsetta bilineata*	2.1	3.7	2	5.6
hermit crab unident.	Paguridae (Family)	0.1	0.1	1	2.8
Total		57.9		36	

Table 9. -- Summary of catch by species in one Aleutian wing trawl conducted during the 2009 walleye pollock echo integration-trawl survey of the shelf break west of Sanak Island.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
Pacific ocean perch	*Sebastes alutus*	3,265.4	93.4	2,735	95.4
shortraker rockfish	*Sebastes borealis*	118.9	3.4	17	0.6
northern rockfish	*Sebastes polyspinis*	62.0	1.8	33	1.2
sharpchin rockfish	*Sebastes zacentrus*	38.1	1.1	66	2.3
harlequin rockfish	*Sebastes variegatus*	11.6	0.3	17	0.6
Total		3,496.0		2,868	

Table 10. -- Number of biological samples and measurements collected during the winter 2009 echo integration-trawl survey of walleye pollock of the Gulf of Alaska shelf break near Chirikof Island (hauls 1-6), the Shelikof Strait area (hauls 7-18), Marmot Bay (haul 19-22), and experimental net studies (hauls 101-106).

Haul	Walleye pollock				Eulachon	Rockfish	Sablefish
no.	Lengths	Weights	Otoliths	Maturity	lengths	lengths	lengths
1	0	0	0	0	0	75	0
2	0	0	0	0	0	0	0
3	17	17	16	17	0	0	0
4	0	0	0	0	0	6	0
5	2	2	2	2	0	0	0
6	0	0	0	0	0	2	6
7	318	73	73	73	75	0	0
8	269	70	47	70	50	0	0
9	735	136	99	135	153	0	0
10	271	77	50	77	132	0	0
11	399	59	53	59	101	0	0
12	75	0	0	0	0	0	0
13	320	46	36	46	0	0	0
14	385	100	49	101	0	0	0
15	213	100	21	100	102	0	0
16	201	58	39	58	50	0	0
17	453	62	62	62	70	0	0
18	286	79	40	79	47	0	0
19	624	153	50	153	42	0	0
20	225	59	48	59	0	0	0
21	378	43	43	43	85	0	0
22	296	120	0	120	53	0	0
101	265	0	0	0	0	0	0
102	246	0	0	0	0	0	0
103	144	0	0	0	0	0	0
104	204	0	0	0	0	0	0
106	149	0	0	0	0	0	0
Totals	6,475	1,254	728	1,254	960	83	6

Table 11. -- Summary of catch by species in nine Aleutian wing trawls conducted during the 2009 walleye pollock echo integration-trawl survey of the Shelikof Strait area.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	4,672.8	81.1	41,182	56.1
eulachon	*Thaleichthys pacificus*	1,002.1	17.4	29,934	40.8
squid unident.	Teuthida (Order)	42.5	0.7	471	0.6
chinook salmon	*Oncorhynchus tshawytscha*	16.9	0.3	13	< 0.1
northern smoothtongue	*Leuroglossus schmidti*	9.9	0.2	836	1.1
smooth lumpsucker	*Aptocyclus ventricosus*	5.1	0.1	4	< 0.1
arrowtooth flounder	*Atheresthes stomias*	4.9	0.1	17	< 0.1
shrimp unident.	Decapoda (Order)	1.5	< 0.1	786	1.1
flathead sole	*Hippoglossoides elassodon*	1.4	< 0.1	4	< 0.1
northern sea nettle	*Chrysaora melanaster*	1.4	< 0.1	4	< 0.1
capelin	*Mallotus villosus*	0.7	< 0.1	100	0.1
Pacific herring	*Clupea pallasi*	0.2	< 0.1	6	< 0.1
Pacific lamprey	*Lampetra tridentata*	0.1	< 0.1	2	< 0.1
fish larvae unident.	Actinopterygii (Class)	< 0.1	< 0.1	16	< 0.1
lanternfish unident.	Myctophidae (Family)	< 0.1	< 0.1	9	< 0.1
Total		5,759.6		73,384	

Table 12. -- Summary of catch by species in three poly-Nor'eastern bottom trawl conducted during the 2009 walleye pollock echo integration-trawl survey of the Shelikof Strait area.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	2,111.5	93.7	2,661	70.7
eulachon	*Thaleichthys pacificus*	66.8	3.0	994	26.4
arrowtooth flounder	*Atheresthes stomias*	28.6	1.3	49	1.3
magistrate armhook squid	*Berryteuthis magister*	15.2	0.7	15	0.4
Aleutian skate	*Bathyraja aleutica*	14.1	0.6	2	0.1
Pacific halibut	*Hippoglossus stenolepis*	9.2	0.4	2	0.1
squid unident.	Teuthida (Order)	3.9	0.2	10	0.3
Kamchatka flounder	*Atheresthes evermanni*	2.5	0.1	4	0.1
northern sea nettle	*Chrysaora melanaster*	1.6	0.1	2	0.1
flathead sole	*Hippoglossoides elassodon*	0.2	< 0.1	1	< 0.1
shrimp unident.	Decapoda (Order)	0.1	< 0.1	13	0.3
mollusk unident.	Mollusca (Phylum)	0.1	< 0.1	2	0.1
starfish unident.	Asteroidea (Class)	< 0.1	< 0.1	8	0.2
capelin	*Mallotus villosus*	< 0.1	< 0.1	1	< 0.1
Total		2,253.6		3,764	

Table 13. -- Numbers-at-age estimates (millions) from echo integration-trawl surveys of walleye pollock in the Shelikof Strait area. No surveys were conducted in 1982 or 1999, and no estimate was produced for 1987 due to mechanical problems.

Age	1981	1983	1984	1985	1986	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	78	1	62	2,092	575	17	399	49	22	228	63	186	10,690	56	70	395	4,484	289	8	48	53	1,626	162	54	1,368	332
2	3,481	902	58	544	2,115	110	90	1,210	174	34	76	36	510	3,307	183	89	755	4,104	163	94	94	157	836	232	391	1,205
3	1,511	380	324	123	184	694	90	72	550	74	37	49	79	119	1,247	126	217	352	1,107	205	58	56	41	175	250	110
4	769	1,297	142	315	46	322	216	63	48	188	72	32	78	25	80	474	16	61	97	800	159	35	12	30	53	99
5	2,786	1,171	635	181	75	78	249	116	65	368	233	155	103	54	18	136	67	42	16	56	357	173	17	10	12	60
6	1,052	698	988	347	49	17	43	180	70	84	126	84	245	71	44	14	132	23	16	8	48	162	56	17	2	10
7	210	599	450	439	86	6	14	46	116	85	27	42	122	201	52	32	17	35	8	4	3	36	75	34	4	3
8	129	132	224	167	149	6	4	22	24	171	36	27	54	119	98	36	13	13	7	2	3	4	32	21	11	1
9	79	14	41	43	60	4	2	8	29	33	39	44	17	40	53	74	10	6	1	1	3	2	7	2	7	5
10	25	12	3	6	11	9	1	8	2	56	16	48	11	13	14	26	8	3	1	< 1	< 1	0	< 1	1	2	6
11	2	4	0	2	1	2	10	1	4	2	8	15	15	11	2	14	14	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1
12	0	2	1	1	0	2	1	3	1	15	3	7	6	5	3	7	7	2	< 1	0	0	0	< 1	0	0	< 1
13	0	0	0	0	0	< 1	< 1	2	4	1	2	1	2	3	1	< 1	2	1	< 1	< 1	< 1	0	0	0	0	0
14	0	0	0	0	0	0	0	1	0	< 1	< 1	2	< 1	< 1	< 1	1	1	< 1	< 1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	< 1	0	0	1	< 1	0	0	0	1	0	< 1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	< 1	0	0	1	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	< 1	< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	10,122	5,212	2,928	4,260	3,351	1,267	1,119	1,781	1,109	1,339	740	728	11,932	4,024	1,865	1,425	5,743	4,932	1,424	1,220	777	2,252	1,240	576	2,100	1,832

Table 14. -- Biomass-at-age estimates (thousands of metric tons) from echo integration-trawl surveys of walleye pollock in the Shelikof Strait area. No surveys were conducted in 1982 or 1999, and no estimate was produced for 1987 due to mechanical problems.

Age	1981	1983	1984	1985	1986	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	1	< 1	1	24	4	< 1	4	< 1	< 1	3	1	2	114	1	1	4	57	2	< 1	< 1	< 1	18	1	< 1	19	4
2	309	71	6	54	139	8	8	67	12	3	6	3	46	180	15	8	63	214	13	8	8	13	55	15	39	94
3	342	117	83	41	40	130	21	15	85	16	11	14	23	24	195	28	60	60	164	42	14	17	11	39	67	29
4	255	529	78	159	17	91	86	23	13	60	34	20	41	12	28	153	9	25	29	222	77	19	5	13	26	51
5	1,068	650	373	109	56	31	111	61	33	144	136	127	83	50	13	53	54	27	12	25	179	132	14	9	10	44
6	496	455	684	253	41	9	27	120	54	68	90	75	220	73	53	12	107	24	16	7	35	119	63	22	3	11
7	133	332	331	353	76	6	12	36	106	92	28	48	116	212	61	39	17	40	9	5	4	29	87	47	8	5
8	92	94	161	138	140	6	4	24	23	194	43	34	55	132	120	47	17	18	8	2	3	4	43	30	20	2
9	68	11	36	35	58	5	3	9	36	36	46	64	19	48	67	95	15	8	2	2	4	3	10	3	13	11
10	19	12	3	6	11	11	1	11	3	71	21	68	15	17	20	33	11	5	1	1	< 1	0	1	2	4	13
11	1	5	0	2	2	2	12	1	6	3	10	21	20	16	3	21	22	2	1	< 1	< 1	1	2	1	< 1	3
12	0	1	1	1	0	3	1	4	1	21	4	10	7	7	5	10	11	3	1	0	0	0	1	0	0	< 1
13	0	0	0	0	0	< 1	< 1	2	7	1	3	2	3	4	1	< 1	4	1	< 1	< 1	< 1	0	0	0	0	0
14	0	0	0	0	0	0	0	1	0	1	1	4	1	< 1	1	1	2	1	< 1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	< 1	0	0	1	< 1	0	0	0	1	0	< 1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	< 1	0	0	1	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	< 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,786	2,278	1,757	1,175	586	302	290	375	380	713	436	493	764	777	583	505	449	433	257	316	327	356	294	181	208	266

Table 15. -- Numbers-at-length estimates (millions) from echo integration-trawl surveys of walleye pollock in the Shelikof Strait area. No surveys were conducted in 1982 or 1999, and no estimate was produced for 1987 due to mechanical problems.

Length	1981	1983	1984	1985	1986	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	< 1	0	0	0	< 1	0	0	0	0	0
9	0	0	0	21	60	0	4	1	1	< 1	< 1	4	163	0	3	4	29	4	0	0	< 1	6	4	< 1	7	1
10	0	0	0	310	175	0	47	5	0	4	3	32	1,120	3	3	16	372	33	0	1	10	106	36	4	25	16
11	2	0	1	581	206	4	133	16	4	27	16	51	3,906	12	20	70	1,162	87	0	8	15	476	61	14	161	74
12	10	1	60	810	102	8	153	16	9	74	26	60	3,779	20	21	140	1,565	87	5	14	24	621	39	20	407	134
13	26	1	0	278	32	4	50	9	4	79	13	33	1,538	18	15	104	999	52	2	20	3	296	13	11	412	74
14	31	0	1	79	1	1	9	1	4	36	3	6	157	4	7	49	320	24	1	8	1	98	5	4	265	30
15	5	0	0	13	0	< 1	3	< 1	< 1	6	1	< 1	25	< 1	1	10	30	2	1	1	< 1	19	2	1	77	2
16	5	0	0	1	3	0	< 1	0	< 1	1	0	< 1	1	5	< 1	2	7	2	0	< 1	< 1	4	1	0	11	1
17	1	1	0	< 1	7	0	0	4	< 1	0	0	0	1	51	< 1	< 1	1	20	0	< 1	< 1	< 1	7	2	2	0
18	5	1	0	1	41	1	< 1	36	1	0	< 1	1	4	249	1	< 1	10	185	< 1	0	< 1	1	23	8	0	6
19	12	8	0	2	187	2	1	165	7	< 1	< 1	< 1	16	634	1	1	32	808	3	1	1	2	75	24	5	7
20	70	70	0	6	444	8	2	341	12	1	4	2	39	945	8	3	81	1,407	15	3	4	8	141	54	5	77
21	280	177	< 1	20	535	26	7	362	33	2	8	5	68	772	23	10	147	1,043	36	11	10	20	203	60	20	179
22	733	221	1	75	431	32	17	198	48	5	17	7	92	441	50	16	196	460	29	15	20	29	161	42	38	347
23	952	198	7	152	267	29	23	75	41	8	20	6	93	131	48	20	176	107	43	17	23	38	107	20	83	293
24	695	142	15	151	136	9	19	21	23	10	14	5	73	54	48	21	68	20	56	16	18	30	66	9	117	181
25	389	37	21	75	46	4	11	7	23	6	7	4	53	18	89	10	30	22	128	11	12	16	27	6	76	80
26	219	28	12	36	23	11	5	1	59	5	5	2	36	9	208	8	11	31	239	8	9	7	14	7	36	20
27	90	6	5	16	11	40	3	6	108	3	1	3	27	9	275	6	6	60	250	9	4	2	6	11	30	9
28	70	6	6	6	9	107	3	3	142	3	1	1	17	11	268	5	10	85	210	23	2	3	3	15	19	14
29	83	3	9	3	15	158	6	9	123	8	1	1	5	22	205	10	13	91	124	52	3	1	5	23	13	6
30	235	7	26	5	31	191	12	16	72	19	1	3	2	23	104	25	18	50	74	107	4	8	6	30	11	6
31	420	3	48	6	34	129	23	19	32	25	2	6	6	15	59	42	32	37	42	153	7	8	6	23	27	9
32	492	24	67	4	38	92	27	17	22	37	3	7	4	15	31	78	37	15	25	185	16	2	6	23	38	13
33	490	65	68	11	29	85	24	11	8	48	5	11	8	13	21	102	34	14	29	145	25	10	6	19	42	24
34	499	141	53	22	18	89	28	10	8	67	6	6	6	6	16	99	28	7	20	122	41	3	8	16	31	24
35	592	195	27	27	12	63	37	8	7	85	10	7	11	4	11	103	22	6	17	77	56	10	5	12	32	19
36	665	258	21	41	9	41	53	12	8	83	9	6	15	4	10	84	13	8	7	57	59	4	4	8	17	17
37	541	339	20	44	7	28	62	19	9	84	17	3	14	3	10	66	9	9	5	38	54	18	3	5	19	8
38	403	368	35	53	3	24	66	23	8	65	26	3	20	2	9	45	8	9	6	28	47	10	2	4	7	12
39	352	341	87	64	4	12	57	21	6	36	40	2	9	2	5	26	7	11	6	23	39	11	1	4	3	16

Table 15.--Continued.

Length	1981	1983	1984	1985	1986	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
40	339	343	138	77	3	13	52	33	10	30	53	3	15	2	8	15	11	9	2	14	35	23	2	4	8	10
41	231	290	170	82	8	8	46	34	9	22	57	5	5	2	4	16	13	12	2	13	35	22	2	3	7	14
42	224	326	219	96	8	5	36	37	13	15	57	9	7	2	5	6	19	8	3	7	38	32	2	2	4	16
43	178	311	271	106	12	5	22	32	14	14	48	16	17	4	4	7	19	7	2	6	32	33	4	3	4	15
44	145	304	309	113	22	3	16	37	19	14	37	23	18	6	5	5	18	7	2	5	27	41	5	2	3	14
45	116	256	316	119	35	2	12	34	21	17	33	36	35	7	3	2	19	8	3	3	24	39	7	3	4	12
46	84	201	283	148	39	2	6	25	24	22	23	39	53	13	4	2	22	5	2	3	18	33	9	2	3	9
47	113	171	213	140	50	2	6	23	22	21	19	46	62	25	4	3	19	5	3	3	17	37	11	3	1	6
48	62	116	158	139	57	2	4	20	26	32	17	37	74	37	6	4	17	6	4	2	11	33	14	3	1	5
49	75	91	104	117	52	3	5	16	20	38	16	33	73	53	13	6	13	9	3	2	8	22	15	4	1	3
50	58	52	68	83	51	4	5	15	19	46	17	29	66	64	20	13	16	8	3	2	7	28	18	6	<1	3
51	50	49	40	52	42	4	4	8	20	40	15	24	51	69	30	18	10	5	4	2	5	14	19	8	<1	3
52	25	23	25	28	21	3	4	8	14	38	14	21	40	64	36	24	11	9	4	2	4	7	19	6	1	4
53	12	17	13	23	18	3	5	7	13	35	14	24	30	53	37	26	10	6	3	2	2	6	16	9	1	2
54	9	7	4	9	6	2	4	5	9	35	13	18	22	39	34	23	9	4	3	1	3	4	12	7	2	2
55	15	9	3	4	11	2	2	7	10	30	11	18	16	29	28	20	9	5	2	1	3	3	13	8	2	2
56	5	2	2	2	2	2	1	2	6	15	9	18	14	19	24	19	8	5	1	< 1	2	2	7	6	4	3
57	7	2	1	2	< 1	1	1	2	3	18	7	13	7	13	12	12	9	3	1	< 1	1	1	5	5	1	2
58	3	1	1	1	1	< 1	1	1	5	14	7	11	6	10	8	9	6	2	1	< 1	1	1	3	4	2	1
59	1	1	< 1	1	< 1	< 1	1	1	2	4	4	9	3	6	5	8	5	3	1	1	1	1	3	3	3	1
60	0	1	< 1	2	1	0	1	1	2	2	3	7	2	5	3	4	2	3	< 1	1	< 1	1	2	2	2	1
61	0	1	< 1	< 1	1	< 1	< 1	< 1	1	2	2	5	1	3	2	2	1	1	< 1	1	< 1	< 1	2	2	3	1
62	0	0	1	1	< 1	< 1	< 1	< 1	< 1	3	1	2	2	2	1	2	2	< 1	< 1	< 1	< 1	0	1	1	1	1
63	0	0	1	1	< 1	0	< 1	< 1	1	1	1	1	< 1	1	1	2	1	1	< 1	< 1	< 1	1	1	1	1	1
64	0	0	< 1	0	< 1	0	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1	1
65	0	0	0	0	< 1	0	0	< 1	1	0	< 1	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0	< 1	< 1	< 1	< 1	<1	< 1
66	0	0	0	< 1	< 1	0	< 1	< 1	0	< 1	< 1	< 1	0	< 1	< 1	< 1	< 1	1	0	0	0	< 1	< 1	< 1	1	1
67	0	0	0	0	< 1	< 1	0	< 1	< 1	< 1	< 1	< 1	0	< 1	< 1	0	< 1	0	< 1	< 1	0	0	< 1	< 1	<1	1
68	0	0	0	0	0	0	0	< 1	0	0	< 1	0	0	< 1	< 1	< 1	0	< 1	< 1	0	< 1	0	< 1	< 1	<1	< 1
69	0	0	0	0	0	0	0	< 1	1	0	< 1	< 1	0	< 1	< 1	0	0	0	0	0	0	0	0	< 1	<1	< 1
70	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 1
71	0	0	0	0	0	0	0	< 1	0	0	0	< 1	0	0	0	0	0	0	< 1	0	0	0	0	< 1	0	< 1
72	0	0	0	0	0	0	0	0	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 1
Total	10,121	5,211	2,928	4,259	3,352	1,266	1,119	1,782	1,109	1,339	740	729	11,931	4,024	1,866	1,425	5,742	4,931	1,424	1,224	780	2,252	1,240	575	2,100	1,832

Table 16. -- Biomass-at-length estimates (thousands of metric tons) from echo integration-trawl surveys of walleye pollock in the Shelikof Strait area. No surveys were conducted in 1982 or 1999, and no estimate was produced for 1987 due to mechanical problems.

Length	1981	1983	1984	1985	1986	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	< 1	0	0	0	0	0	0	0	< 1	0	0	0	0	0
9	0	0	0	< 1	< 1	0	< 1	< 1	< 1	< 1	< 1	< 1	1	0	< 1	< 1	< 1	< 1	0	0	< 1	< 1	< 1	< 1	<1	<1
10	0	0	0	2	1	0	< 1	< 1	0	< 1	< 1	< 1	7	< 1	< 1	< 1	3	< 1	0	< 1	< 1	1	< 1	< 1	<1	<1
11	< 1	0	< 1	6	2	< 1	1	< 1	< 1	< 1	< 1	< 1	35	< 1	< 1	1	11	1	0	< 1	< 1	4	< 1	< 1	2	1
12	< 1	< 1	1	10	1	< 1	2	< 1	< 1	1	< 1	1	44	< 1	< 1	1	20	1	< 1	< 1	< 1	7	< 1	< 1	4	1
13	< 1	< 1	0	4	< 1	< 1	1	< 1	< 1	1	< 1	< 1	23	< 1	< 1	1	16	1	< 1	< 1	< 1	4	< 1	< 1	6	1
14	1	0	< 1	2	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1	3	< 1	< 1	1	7	< 1	< 1	< 1	< 1	2	< 1	< 1	5	1
15	< 1	0	0	< 1	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	<1
16	< 1	0	0	< 1	< 1	0	< 1	0	< 1	< 1	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0	< 1	< 1	< 1	< 1	< 1	<1	<1
17	< 1	< 1	0	< 1	< 1	0	0	< 1	< 1	0	0	0	< 1	2	< 1	< 1	< 1	1	0	< 1	< 1	< 1	< 1	< 1	<1	0
18	< 1	< 1	0	< 1	2	< 1	< 1	1	< 1	0	< 1	< 1	< 1	9	< 1	< 1	< 1	6	< 1	0	< 1	< 1	< 1	< 1	<1	<1
19	1	< 1	0	< 1	8	< 1	< 1	7	< 1	< 1	< 1	< 1	1	27	< 1	< 1	2	33	< 1	< 1	< 1	< 1	3	1	<1	<1
20	4	4	0	< 1	23	< 1	< 1	16	1	< 1	< 1	< 1	2	48	< 1	< 1	5	68	1	< 1	< 1	< 1	7	3	<1	4
21	18	11	< 1	1	33	1	< 1	21	2	< 1	< 1	< 1	4	46	1	1	10	59	2	1	1	1	12	4	1	11
22	53	16	< 1	6	31	2	1	13	3	< 1	1	1	7	30	4	1	16	31	2	1	1	2	11	3	3	25
23	78	16	1	14	22	2	2	6	3	1	2	1	8	10	4	2	17	8	4	1	2	3	8	2	7	23
24	65	13	2	15	13	1	2	2	2	1	1	1	7	5	5	2	7	2	5	2	2	3	6	1	11	16
25	41	4	2	9	5	< 1	1	1	2	1	1	< 1	6	2	10	1	4	2	14	1	1	2	3	1	8	8
26	26	3	2	5	3	1	1	< 1	7	1	1	< 1	5	1	25	1	1	4	29	1	1	1	2	1	5	2
27	12	1	1	2	2	5	< 1	1	14	< 1	< 1	< 1	4	1	38	1	1	8	35	1	< 1	< 1	< 1	1	4	1
28	11	1	1	1	1	16	< 1	< 1	21	< 1	< 1	< 1	3	2	42	1	2	13	33	3	< 1	< 1	< 1	2	3	2
29	14	1	2	1	3	26	1	1	20	1	< 1	< 1	1	4	36	2	2	15	22	9	1	< 1	< 1	4	2	1
30	44	1	5	1	6	35	2	3	13	4	< 1	1	< 1	4	20	5	4	9	15	20	1	2	1	5	2	1
31	86	1	10	1	7	27	5	4	7	5	< 1	1	1	3	13	9	8	8	9	32	1	2	1	5	6	2
32	111	5	16	1	9	21	6	4	5	9	1	2	1	3	7	19	10	3	6	43	4	1	1	5	10	3
33	122	16	18	3	7	22	6	3	2	12	1	3	2	3	5	26	10	4	8	37	7	3	2	5	12	6
34	136	39	15	6	5	25	8	3	2	19	2	2	2	2	5	28	9	2	6	34	12	1	2	5	10	7
35	176	59	9	9	4	19	11	2	2	27	3	2	4	1	4	33	8	2	6	24	18	3	2	4	11	6
36	216	84	7	14	3	14	18	4	3	29	3	2	5	1	3	29	5	3	2	19	20	1	1	3	6	6
37	191	121	7	17	2	11	23	7	3	32	6	1	5	1	4	25	4	3	2	14	21	7	1	2	8	3
38	154	142	14	21	1	10	26	9	3	26	11	1	8	1	4	19	4	4	2	11	20	4	< 1	2	3	5
39	146	143	38	28	2	5	25	9	3	16	18	1	4	1	2	12	3	5	3	10	18	5	< 1	2	2	7

Table 16.-- Continued.

Length	1981	1983	1984	1985	1986	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
40	152	155	66	37	1	6	24	15	5	15	26	2	7	1	4	7	6	4	1	7	17	12	1	2	4	5
41	112	142	87	42	4	4	23	17	4	11	30	3	3	1	2	8	7	6	1	7	19	13	1	2	4	8
42	117	172	121	53	4	3	20	20	7	9	32	5	4	1	3	3	11	5	2	4	22	19	1	1	3	9
43	100	176	161	63	7	3	13	19	9	9	29	10	10	2	2	4	13	5	1	4	20	21	2	2	3	9
44	87	185	197	72	14	2	10	24	12	9	24	16	12	4	3	3	13	5	1	3	19	27	4	2	2	10
45	75	167	215	81	24	2	8	23	15	12	23	26	24	5	2	2	15	6	2	2	17	27	5	2	3	9
46	58	140	206	107	29	2	4	19	18	17	18	31	39	10	3	1	17	4	2	3	15	24	7	2	2	7
47	83	127	166	108	40	1	5	18	18	17	16	39	49	20	3	3	16	4	2	3	14	29	10	3	1	5
48	49	92	131	115	49	2	3	17	22	29	15	34	63	32	6	4	15	6	3	2	10	28	12	3	1	4
49	63	77	92	102	47	2	4	15	19	36	15	32	66	48	13	6	13	8	3	2	8	19	15	4	1	3
50	51	46	63	78	49	4	4	15	19	47	17	30	63	62	20	13	16	8	3	2	8	28	18	6	<1	3
51	47	47	40	52	43	4	4	8	21	43	16	26	52	71	32	20	12	6	4	2	5	14	22	9	<1	3
52	25	23	26	29	24	3	4	8	15	44	15	24	43	70	41	27	13	10	5	2	5	8	23	7	2	5
53	13	19	15	26	21	4	5	8	15	43	17	29	34	62	45	32	12	8	4	2	3	7	20	11	1	3
54	11	8	5	10	7	3	5	6	12	45	17	23	26	48	44	30	13	6	4	1	4	5	16	10	3	4
55	18	11	4	5	14	3	2	9	14	41	15	24	20	38	38	27	12	7	3	2	4	4	19	11	3	3
56	6	2	2	3	3	2	2	3	9	22	13	27	19	27	35	28	12	8	2	< 1	3	3	10	9	6	4
57	10	3	2	3	< 1	1	2	4	5	28	11	21	10	20	19	18	13	5	2	< 1	1	1	8	8	2	3
58	4	1	1	1	2	1	1	2	7	24	12	19	10	15	13	15	11	4	2	1	2	2	6	8	4	2
59	1	1	< 1	2	1	1	1	2	3	8	7	16	4	11	8	13	8	6	2	2	1	1	6	5	5	3
60	0	1	< 1	3	1	0	1	2	4	4	5	13	3	9	5	8	4	6	1	1	< 1	1	4	4	4	2
61	0	1	1	< 1	1	< 1	1	1	1	4	3	9	3	5	4	4	2	3	1	1	< 1	< 1	4	3	6	3
62	0	0	2	1	1	1	< 1	< 1	1	5	2	4	3	3	2	3	3	1	1	< 1	< 1	0	2	2	3	2
63	0	0	2	2	< 1	0	< 1	< 1	1	3	1	3	< 1	2	2	4	1	3	< 1	< 1	1	1	2	2	3	2
64	0	0	1	0	< 1	0	< 1	< 1	< 1	1	< 1	2	1	1	< 1	1	1	1	< 1	1	< 1	< 1	1	1	4	2
65	0	0	0	0	< 1	0	0	< 1	3	0	< 1	2	< 1	1	< 1	1	< 1	< 1	< 1	0	< 1	< 1	< 1	1	1	1
66	0	0	0	< 1	1	0	< 1	< 1	0	1	< 1	< 1	0	< 1	< 1	1	< 1	3	0	0	0	1	< 1	< 1	2	3
67	0	0	0	0	1	1	0	< 1	< 1	1	< 1	1	0	< 1	< 1	0	< 1	0	< 1	< 1	0	0	< 1	< 1	1	2
68	0	0	0	0	0	0	0	< 1	0	0	< 1	0	0	< 1	1	< 1	0	1	< 1	0	< 1	0	< 1	< 1	<1	1
69	0	0	0	0	0	0	0	< 1	2	0	< 1	< 1	0	< 1	< 1	0	0	0	0	0	0	0	0	< 1	<1	1
70	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
71	0	0	0	0	0	0	0	< 1	0	0	0	< 1	0	0	0	0	0	0	< 1	0	0	0	0	< 1	0	1
72	0	0	0	0	0	0	0	0	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 1	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Total	2,786	2,278	1,757	1,175	586	302	290	375	380	713	436	493	764	777	583	505	449	433	257	317	331	356	294	181	208	266

Table 17. -- Summary of catch by species in three Aleutian wing trawls conducted during the 2009 walleye pollock echo integration-trawl survey of the Chirikof shelf break.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
Pacific ocean perch	*Sebastes alutus*	751.9	93.3	826	35.0
giant grenadier	*Albatrossia pectoralis*	18.0	2.2	5	0.2
walleye pollock	*Theragra chalcogramma*	15.4	1.9	19	0.8
shortraker rockfish	*Sebastes borealis*	8.5	1.0	3	0.1
lanternfish unident.	Myctophidae (Family)	5.7	0.7	635	26.9
arrowtooth flounder	*Atheresthes stomias*	2.4	0.3	2	0.1
rougheye rockfish	*Sebastes aleutianus*	2.3	0.3	1	0.0
eulachon	*Thaleichthys pacificus*	0.6	0.1	11	0.5
squid unident.	Teuthida (Order)	0.5	0.1	95	4.0
California headlightfish	*Diaphus theta*	0.4	0.1	73	3.1
shrimp unident.	Decapoda (Order)	0.4	0.1	657	27.8
northern smoothtongue	*Leuroglossus schmidti*	< 0.1	< 0.1	2	0.1
salps unident.	Thaliacea (Class)	< 0.1	< 0.1	24	1.0
viperfish unident.	Chauliodontidae (Family)	< 0.1	< 0.1	7	0.3
Total		806.2		2,360	

Table 18.-- Summary of catch by species in three poly-Nor'eastern bottom trawls conducted during the 2009 walleye pollock echo integration-trawl survey of the Chirikof shelf break.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
giant grenadier	*Albatrossia pectoralis*	96.9	49.6	38	15.2
sablefish	*Anoplopoma fimbria*	18.0	9.2	6	2.4
rougheye rockfish	*Sebastes aleutianus*	17.6	9.0	10	4.0
shortspine thornyhead	*Sebastolobus alascanus*	16.4	8.4	49	19.6
Dover sole	*Microstomus pacificus*	6.7	3.4	9	3.6
rougheye rockfish	*Sebastes aleutianus*	6.6	3.4	3	1.2
popeye grenadier	*Coryphaenoides cinereus*	5.6	2.9	31	12.4
giant grenadier	*Albatrossia pectoralis*	5.4	2.8	2	0.8
arrowtooth flounder	*Atheresthes stomias*	4.2	2.1	2	0.8
Pacific grenadier	*Coryphaenoides acrolepis*	3.2	1.6	24	9.6
blackspotted rockfish	*Sebastes melanostictus*	3.2	1.6	2	0.8
golden king crab	*Lithodes aequispina*	3.1	1.6	2	0.8
Kamchatka flounder	*Atheresthes evermanni*	2.5	1.3	1	0.4
Pacific ocean perch	*Sebastes alutus*	2.0	1.0	2	0.8
sea anemone unident.	Actiniaria (Order)	1.2	0.6	24	9.6
smooth lumpsucker	*Aptocyclus ventricosus*	0.9	0.5	1	0.4
sponge unident.	Porifera (Phylum)	0.8	0.4	1	0.4
Pacific flatnose	*Antimora microlepis*	0.3	0.2	1	0.4
wattled eelpout	*Lycodes palearis*	0.2	0.1	3	1.2
squid unident.	Teuthida (Order)	0.1	0.1	1	0.4
brittlestarfish unident.	Ophiuroidea (Class)	0.1	0.1	16	6.4
Stenobrachius lampfish	*Stenobrachius* sp.	0.1	0.1	11	4.4
snail unident.	Gastropoda (Class)	0.1	0.1	6	2.4
starfish unident.	Asteroidea (Class)	< 0.1	< 0.1	2	0.8
sea pen or sea whip unident.	Pennatulacea (Order)	< 0.1	< 0.1	3	1.2
Total		195.3		250	

Table 19. -- Summary of catch by species in three Aleutian wing trawls conducted during the 2009 walleye pollock echo integration-trawl survey of the Marmot Bay area. Catches from experimental hauls are not included.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	8,108.8	96.6	16,009	45.4
eulachon	*Thaleichthys pacificus*	269.6	3.2	18,489	52.5
Pacific cod	*Gadus macrocephalus*	5.4	0.1	1	< 0.1
squid unident.	Teuthida (Order)	4.5	0.1	11	< 0.1
shrimp unident.	Decapoda (Order)	2.8	< 0.1	698	2.0
flathead sole	*Hippoglossoides elassodon*	1.2	< 0.1	7	< 0.1
southern rock sole	*Lepidopsetta bilineata*	0.7	< 0.1	1	< 0.1
Pacific herring	*Clupea pallasi*	0.3	< 0.1	10	< 0.1
arrowtooth flounder	*Atheresthes stomias*	0.1	< 0.1	1	< 0.1
slender eelblenny	*Lumpenus fabricii*	0.1	< 0.1	10	< 0.1
Total		8,393.5		35,237	

Table 20. -- Summary of catch by species in one poly-Nor'eastern bottom trawl conducted during the 2009 walleye pollock echo integration-trawl survey of Marmot Bay.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	294.2	88.1	251	57.4
arrowtooth flounder	*Atheresthes stomias*	15.2	4.6	16	3.7
flathead sole	*Hippoglossoides elassodon*	10.7	3.2	20	4.6
eulachon	*Thaleichthys pacificus*	5.0	1.5	101	23.1
Pacific cod	*Gadus macrocephalus*	4.6	1.4	1	0.2
rex sole	*Glyptocephalus zachirus*	2.1	0.6	5	1.1
Alaska plaice	*Pleuronectes quadrituberculatus*	0.8	0.2	1	0.2
slender eelblenny	*Lumpenus fabricii*	0.7	0.2	6	1.4
jellyfish unident.	Scyphozoa (Class)	0.3	0.1	1	0.2
shrimp unident.	Decapoda (Order)	0.3	0.1	34	7.8
spinyhead sculpin	*Dasycottus setiger*	0.1	< 0.1	1	0.2
Total		333.9		437	

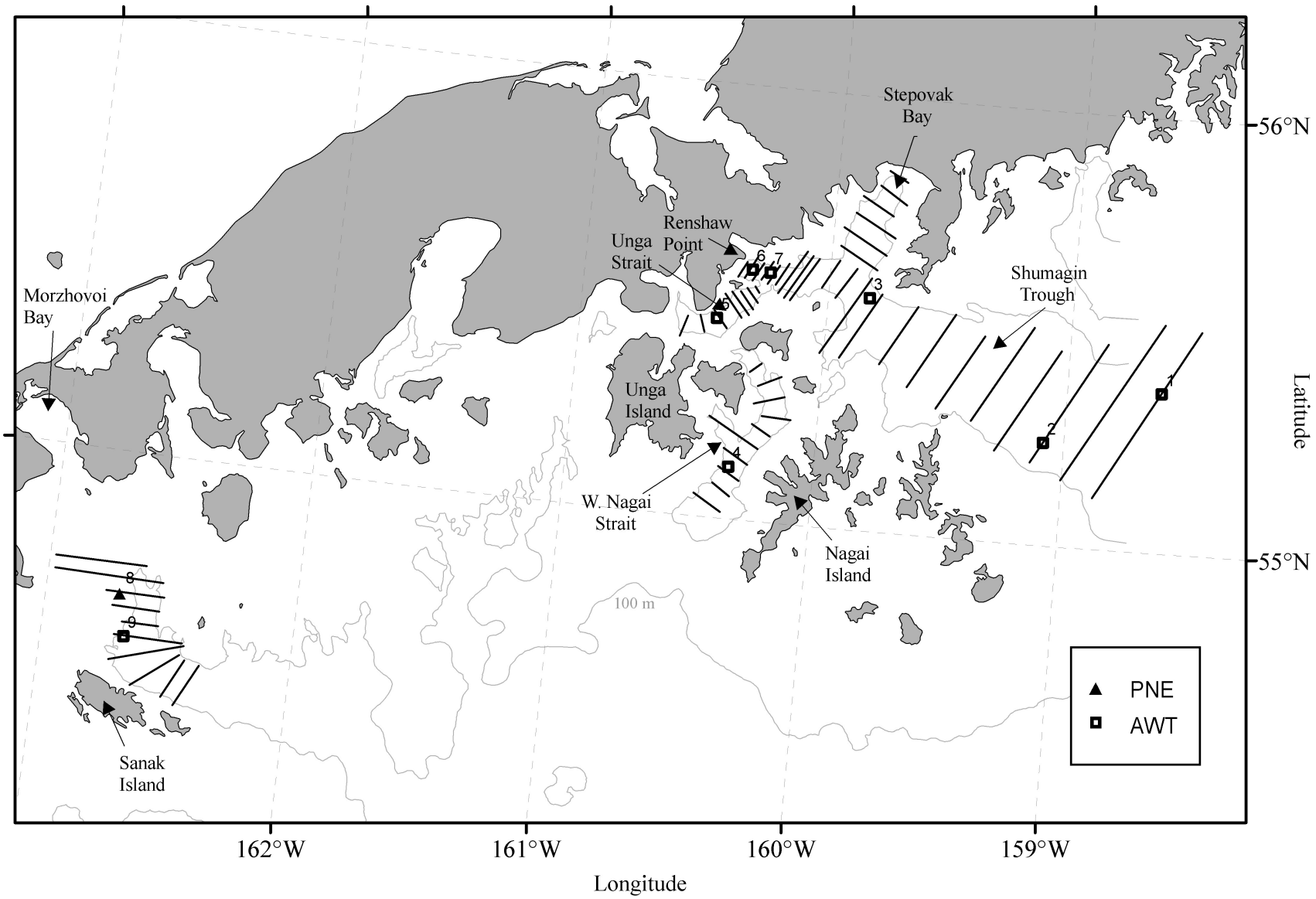

Figure 1. -- Transect lines and locations of Aleutian-wing trawl (AWT) and poly-Nor'eastern trawl (PNE) hauls during the winter 2009 echo integration-trawl survey of walleye pollock in the Shumagin Islands and Sanak Trough.

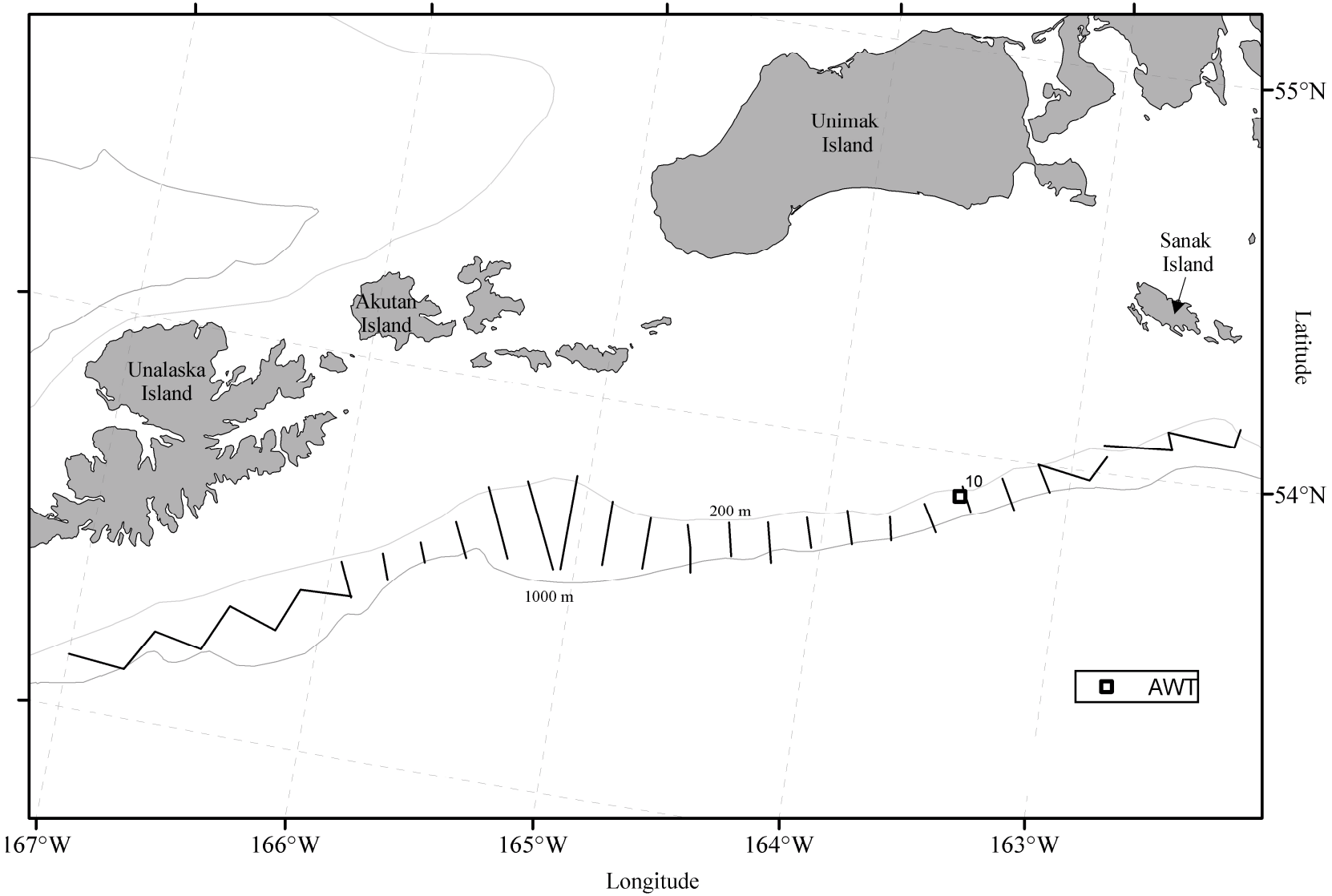

Figure 2. -- Transect lines and location of the Aleutian-wing trawl (AWT) haul during the winter 2009 echo integration-trawl survey along the Gulf of Alaska shelf break from Sanak Island to Unalaska Island.

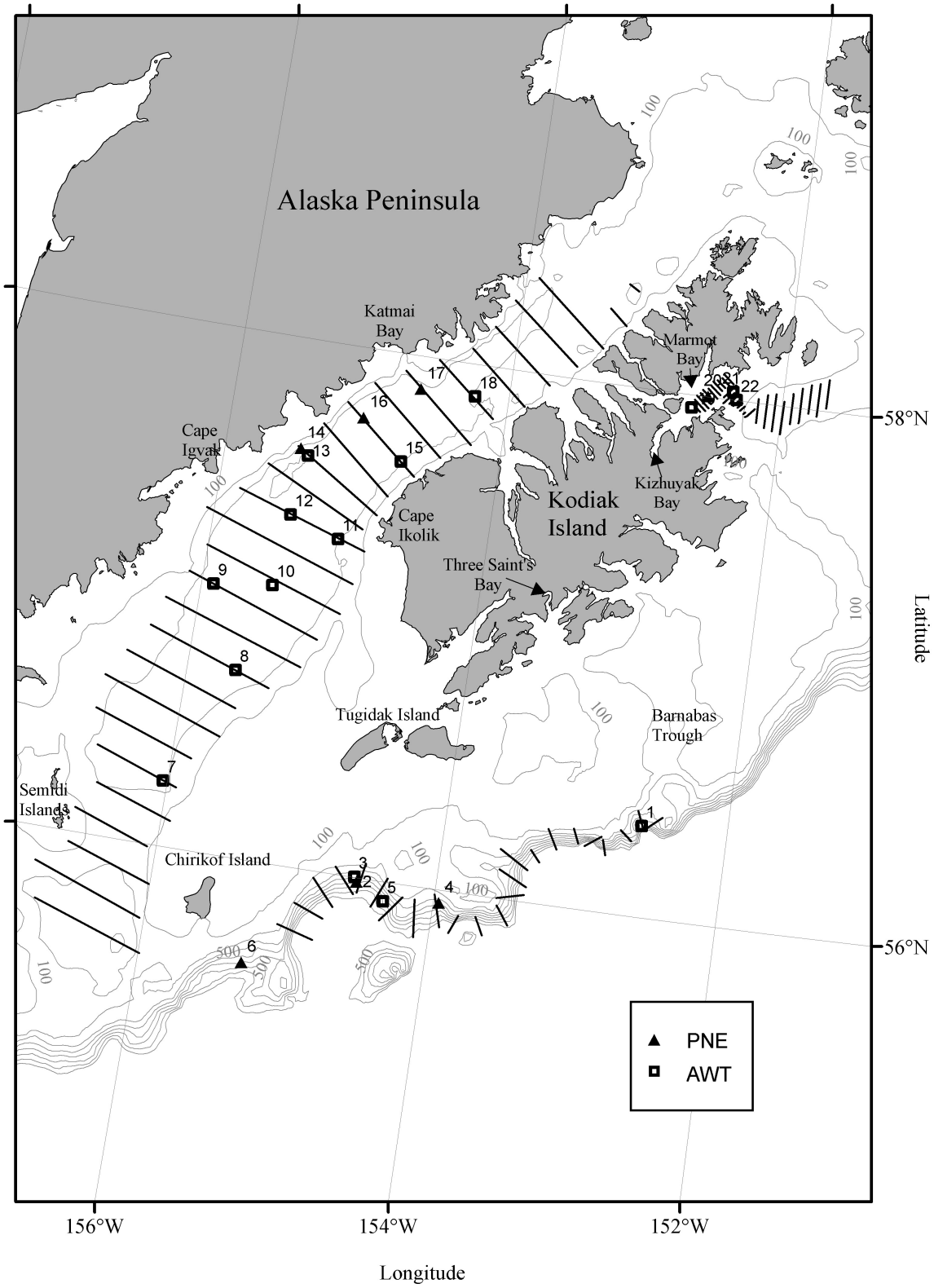

Figure 3. -- Transect lines and locations of Aleutian-wing trawl (AWT) and poly-Nor'eastern trawl (PNE) hauls during the winter 2009 echo integration-trawl survey of walleye pollock in the Shelikof Strait area, Marmot Bay, and along the Gulf of Alaska shelf break from Chirikof Island to Barnabas Trough.

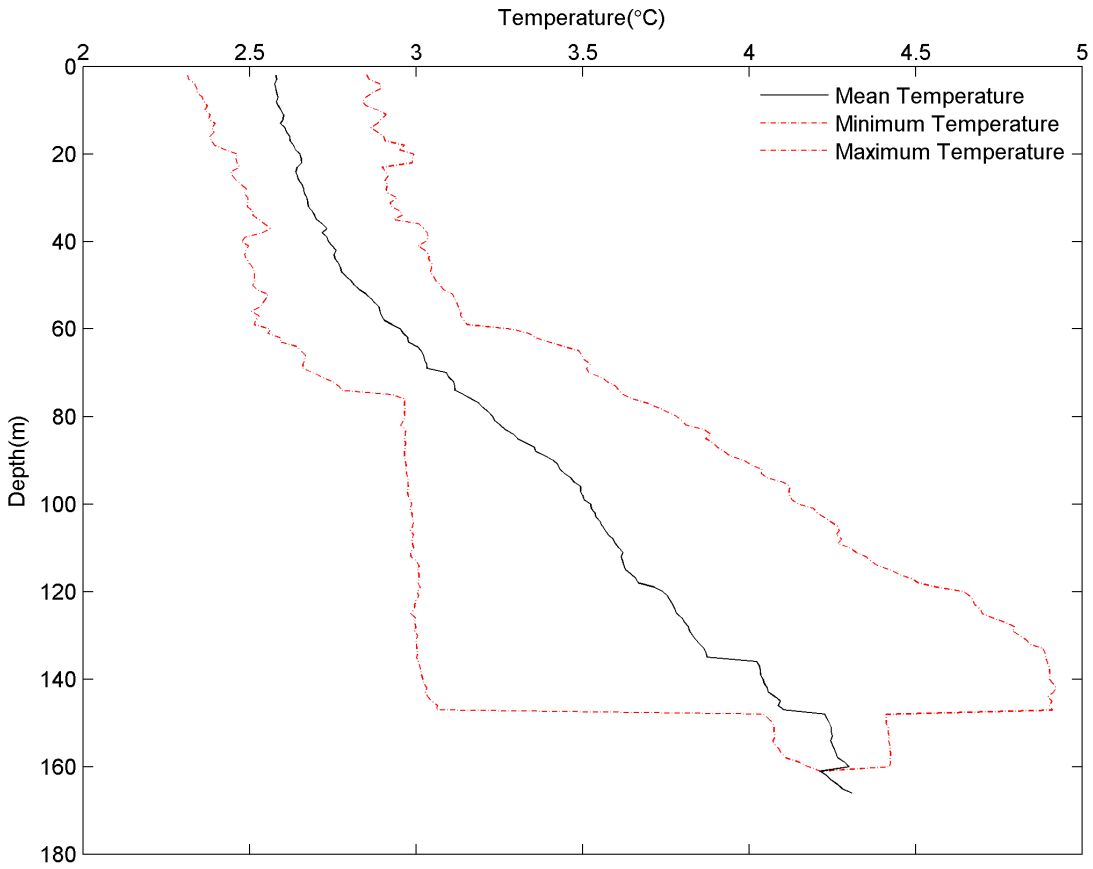

Figure 4. -- Mean water temperature (°C) (solid line) by 1-m depth intervals observed during the winter 2009 echo integration-trawl survey of walleye pollock in the Shumagin Islands area. Dashed lines represent minimum and maximum temperatures observed during the survey. Data were collected at 7 trawl locations.

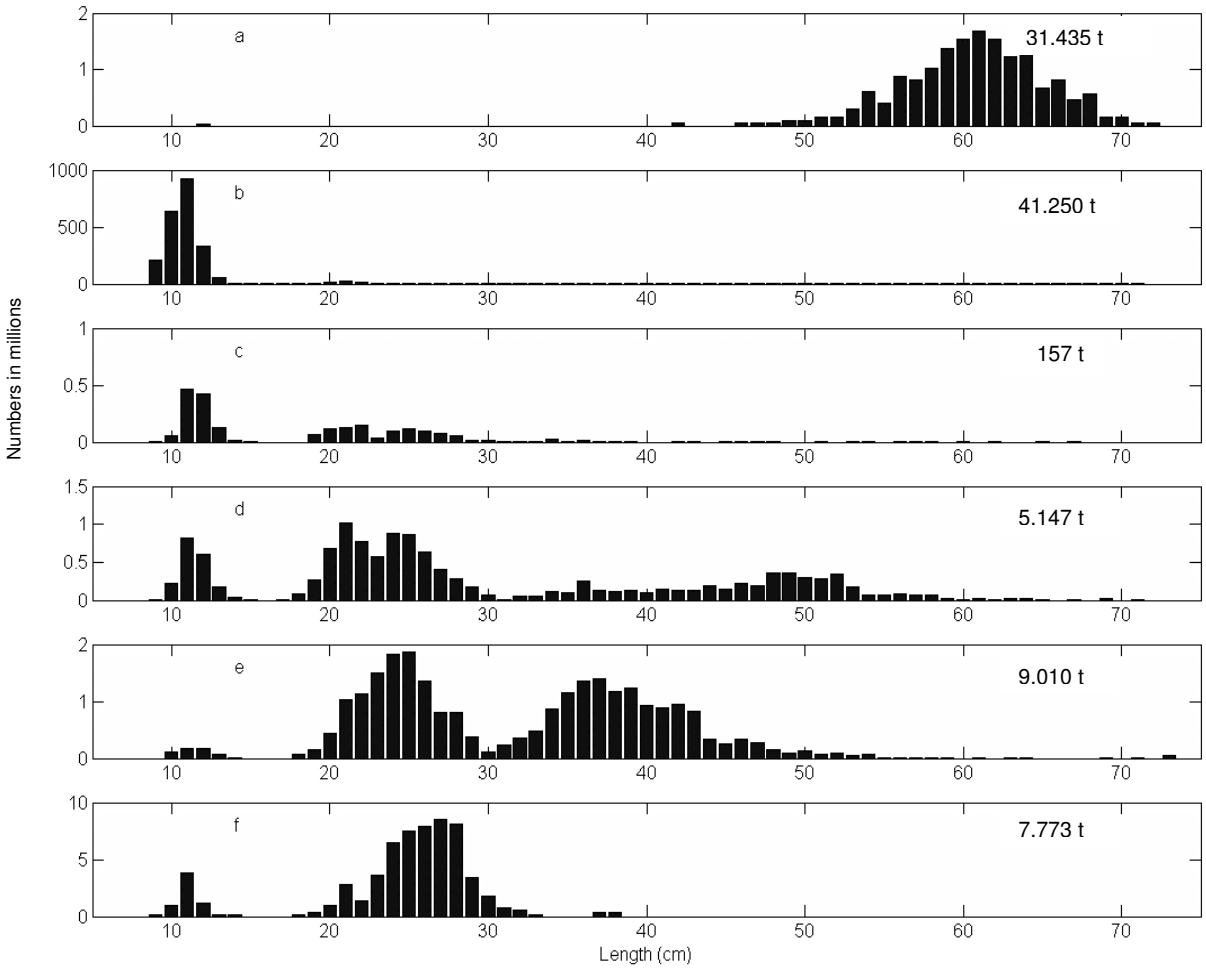

Figure 5. -- Length distribution of walleye pollock (numbers) for the 2009 echo integration-trawl survey of a) Sanak Trough, b) Shumagin Trough, c) Stepovak Bay, d) Renshaw Point, e) Unga Strait, and f) West Nagai Strait.

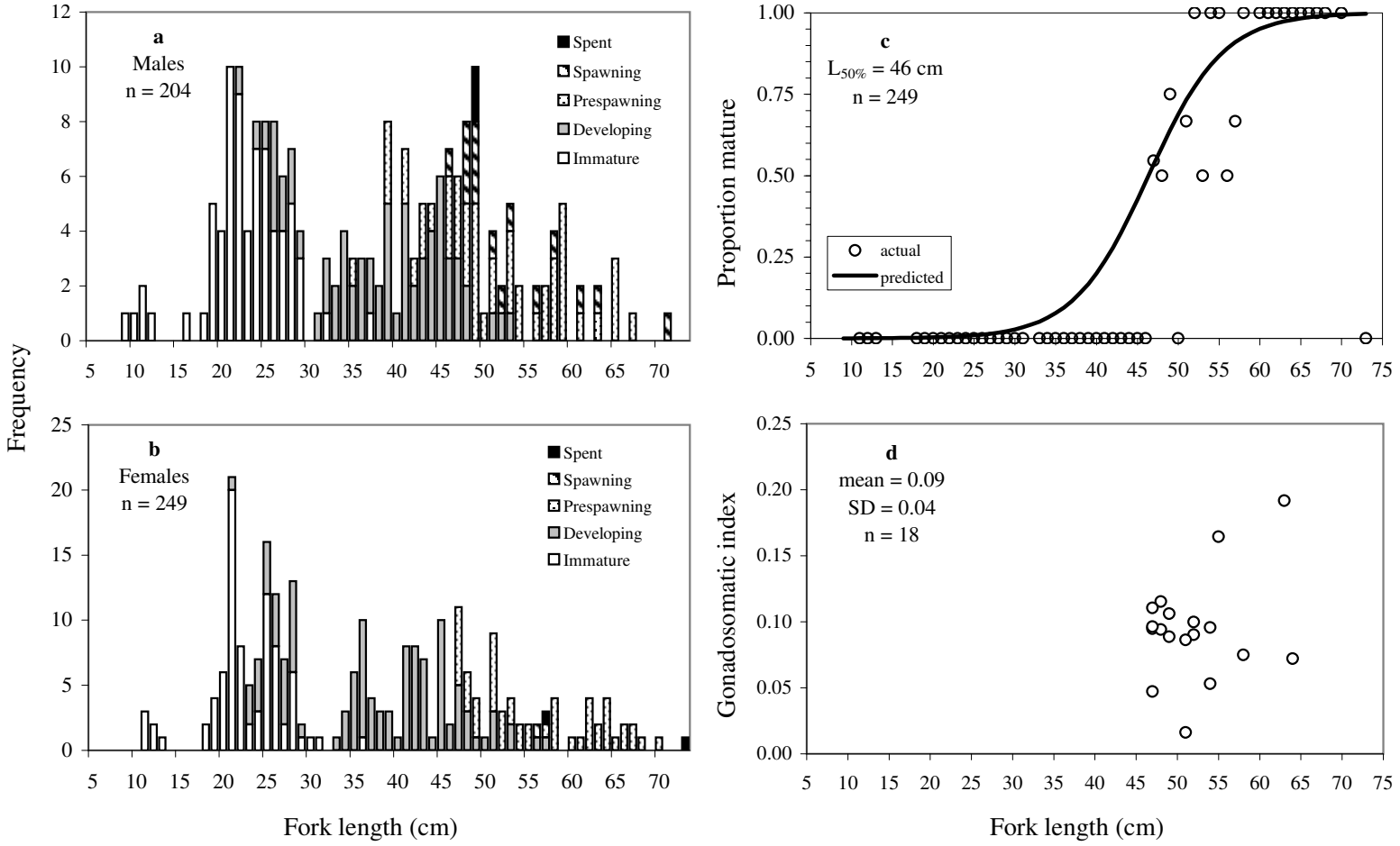

Figure 6. -- Maturity stages for (a) male and (b) female walleye pollock, (c) proportion mature by 1-cm size group for female walleye pollock and (d) gonadosomatic index for pre-spawning females examined during the 2009 echo integration-trawl survey of the Shumagin Islands.

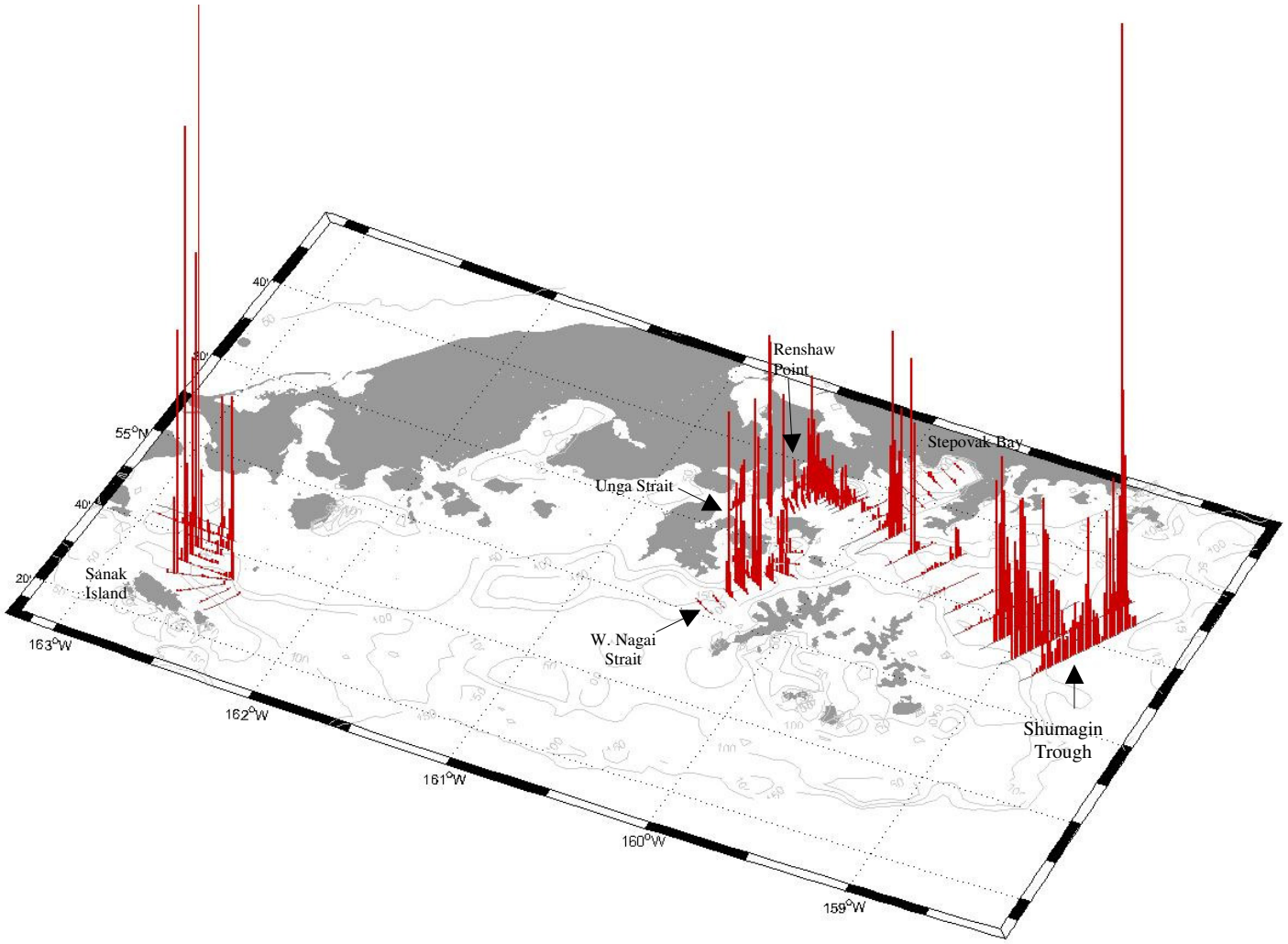

Figure 7. -- Acoustic backscattering (s_A) attributed primarily to walleye pollock (vertical lines) along tracklines surveyed during the winter 2009 echo integration-trawl survey of the Shumagin Islands and Sanak Trough.

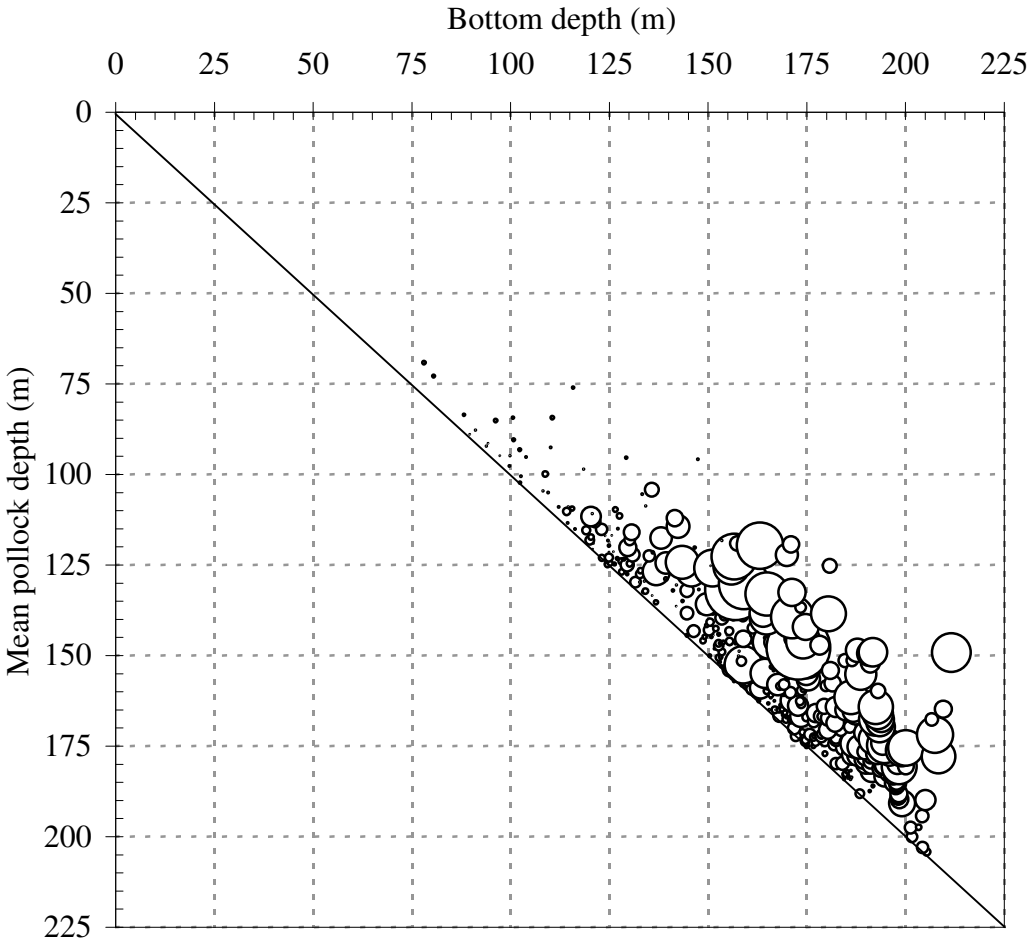

Figure 8. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for walleye pollock observed during the winter 2009 echo integration-trawl survey of walleye pollock in the Shumagin Islands area. Circle size is scaled to the maximum biomass.

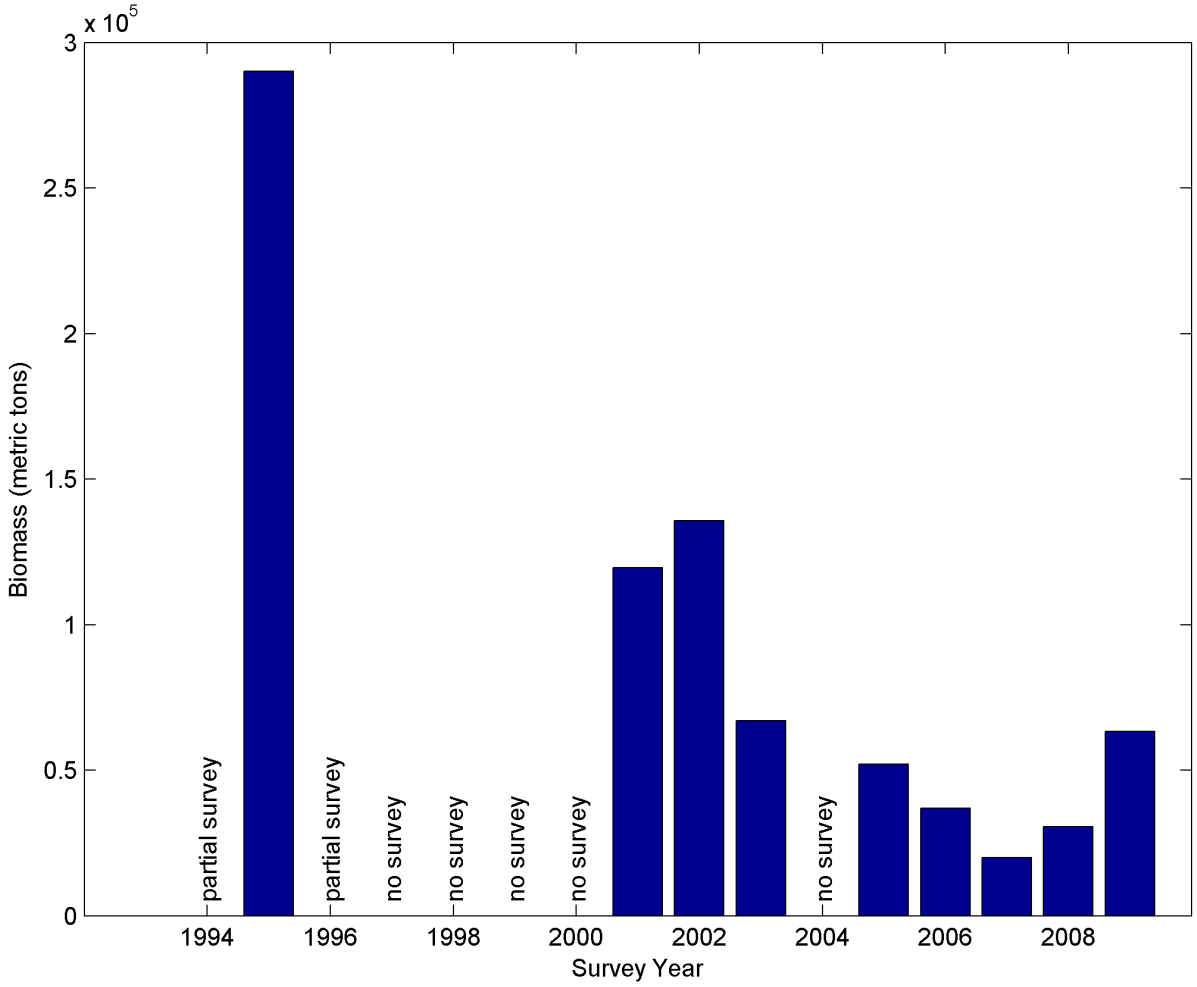

Figure 9. -- Summary of Shumagin Islands area walleye pollock biomass estimates based on echo integration-trawl surveys.

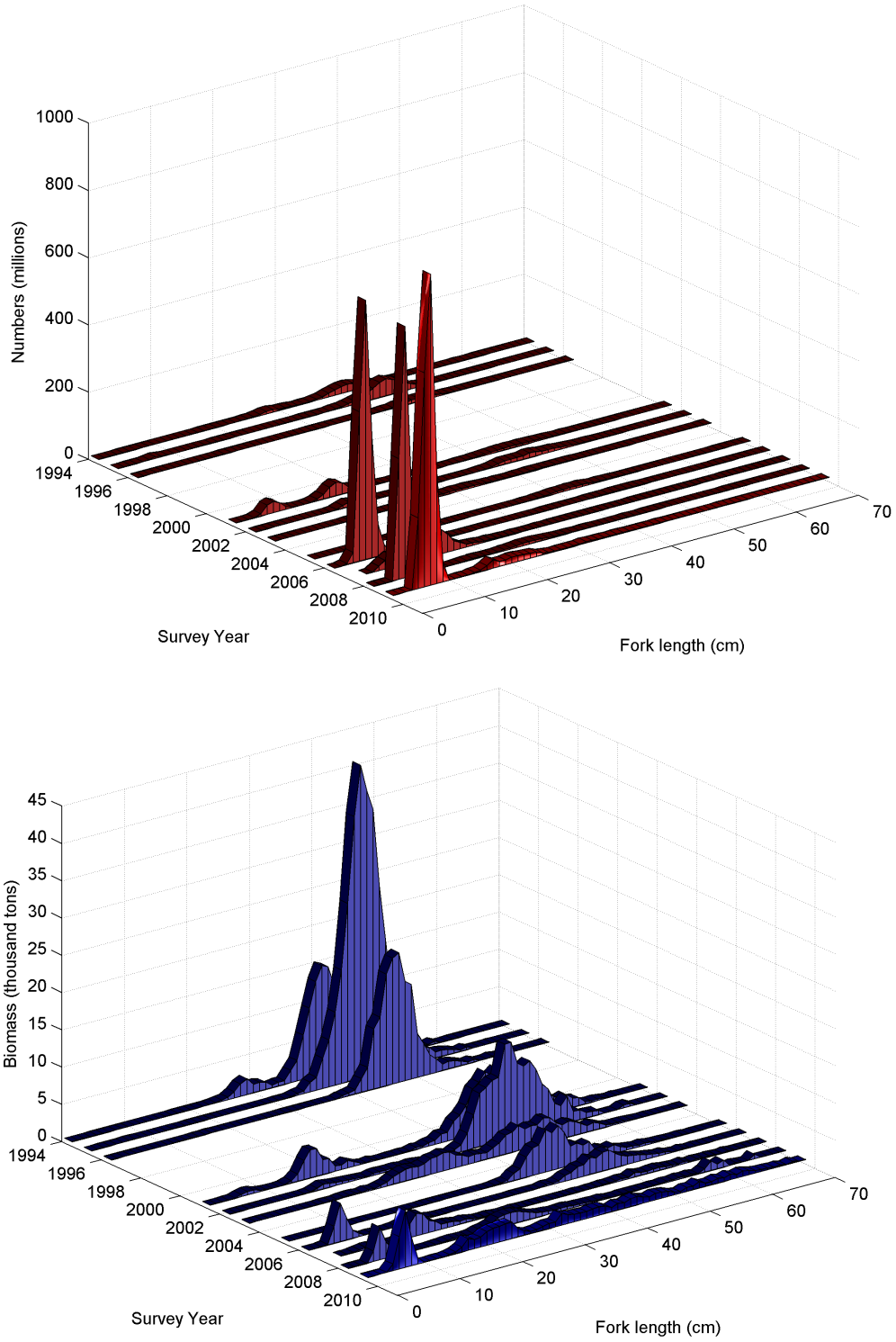

Figure 10. -- Walleye pollock biomass in thousands of metric tons and numbers in millions at length from the Shumagin Islands echo integration-trawl surveys since 1994. No survey was conducted in 1997-2000 or in 2004.

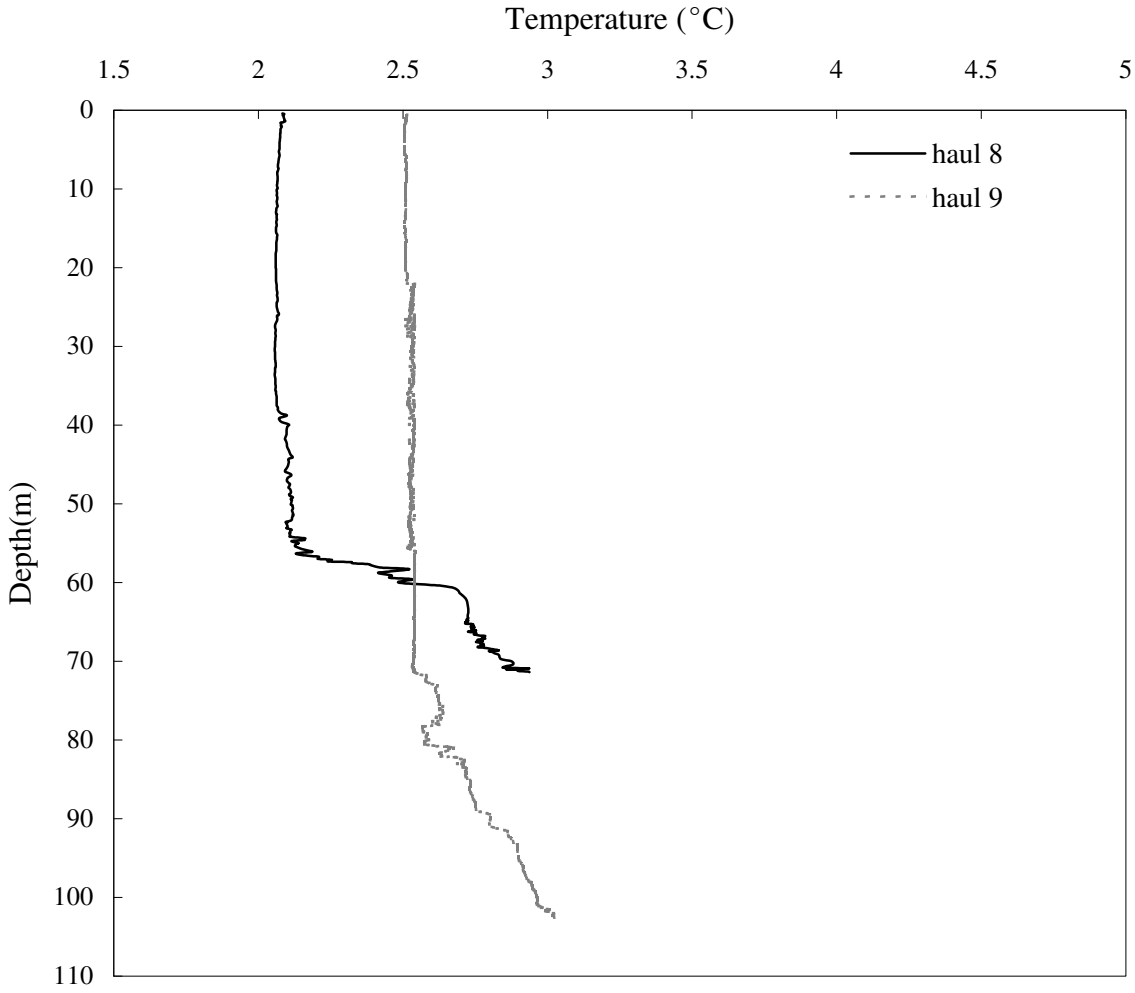

Figure 11. -- Water temperature (°C) (solid line) by 1-m depth intervals observed during the winter 2009 echo integration-trawl survey of walleye pollock in the Sanak Trough area. Data were collected at 2 trawl locations.

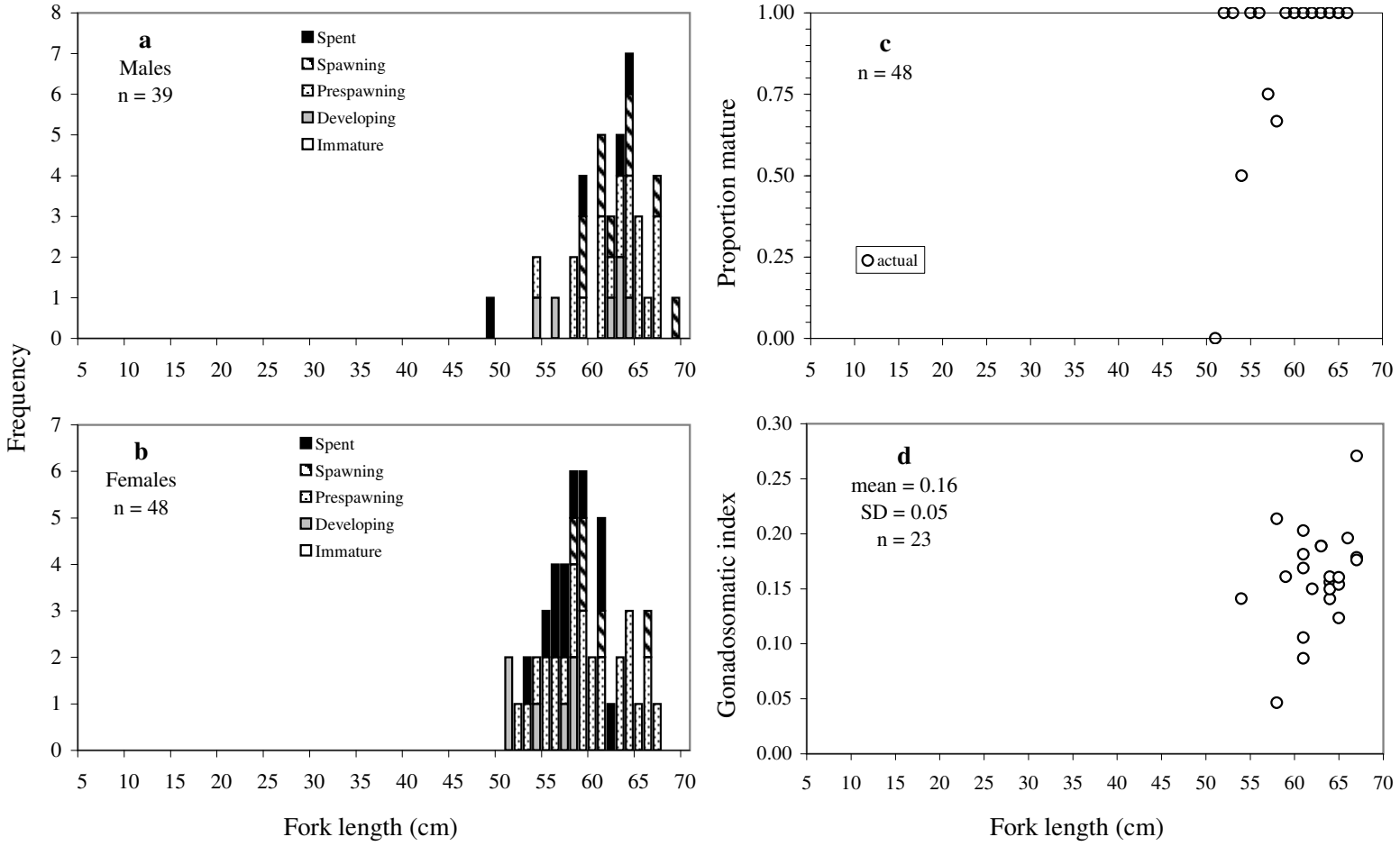

Figure 12. -- Maturity stages for (a) male and (b) female walleye pollock, (c) proportion mature by 1-cm size group for female walleye pollock, and (d) gonadosomatic index for pre-spawning females examined during the 2009 echo integration-trawl survey of Sanak Trough.

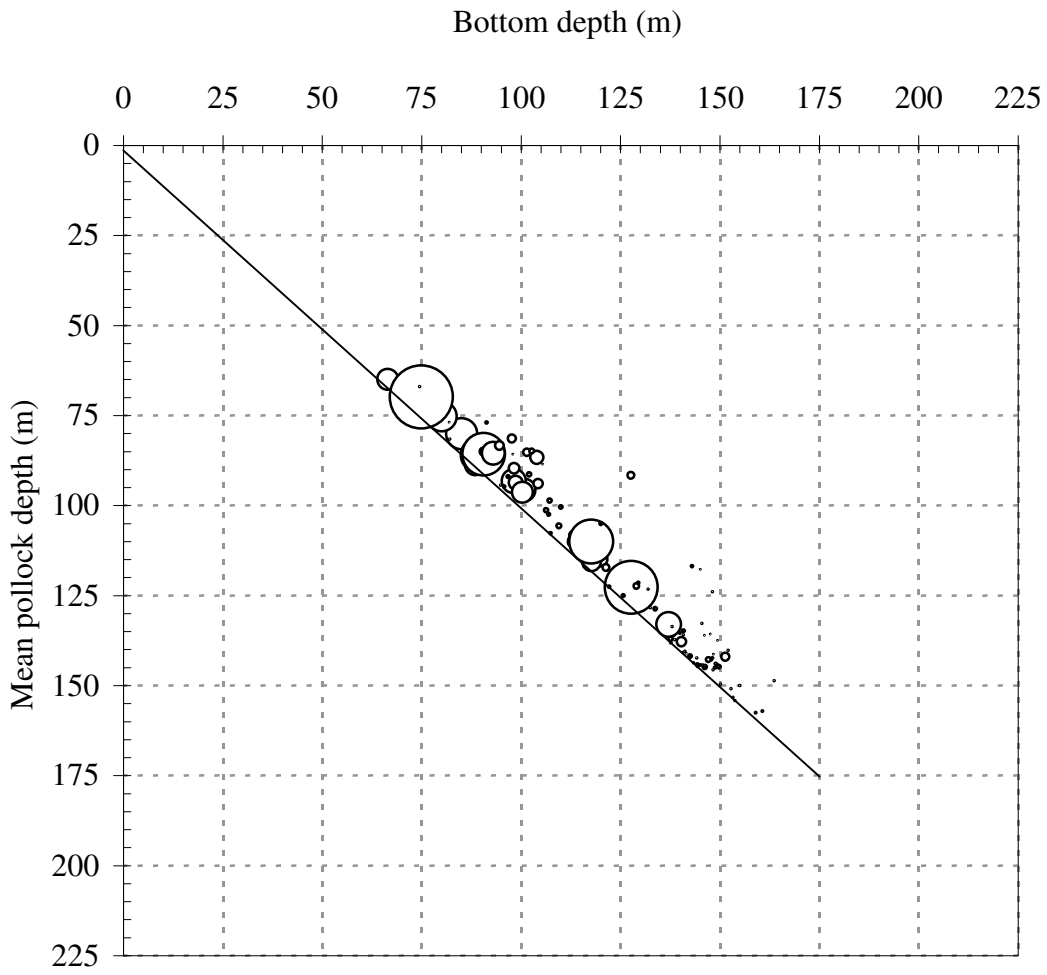

Figure 13. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for pollock observed during the winter 2009 echo integration-trawl survey of walleye pollock in Sanak Trough. Circle size is scaled to the maximum biomass.

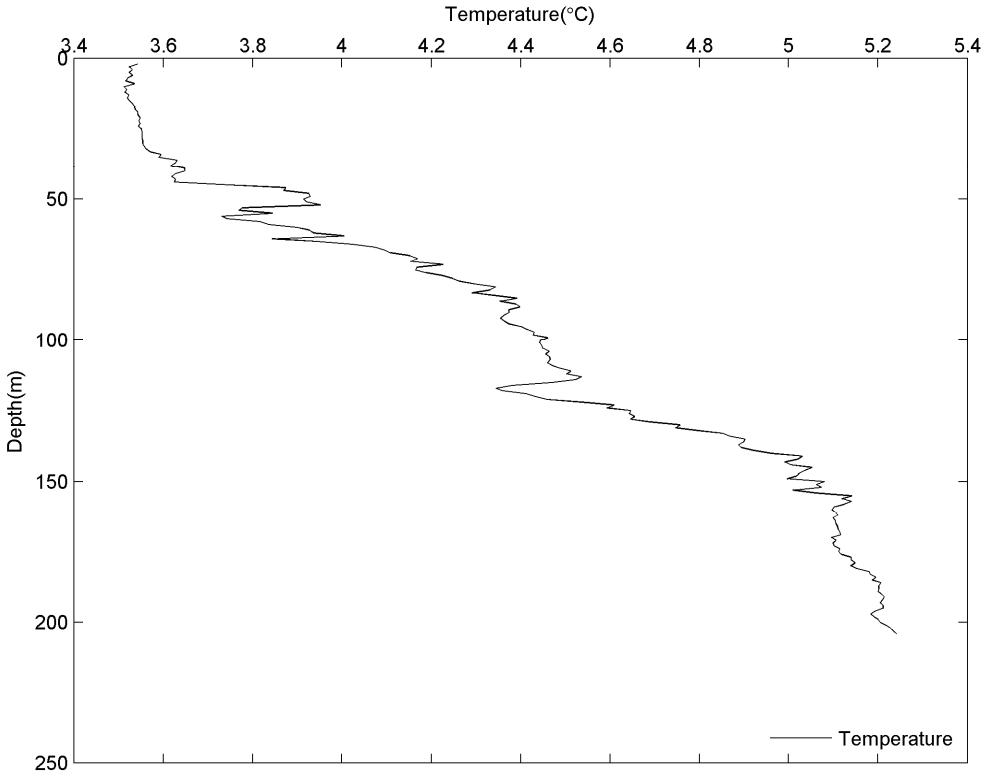

Figure 14. -- Water temperature (°C) by 1-m depth intervals observed during the winter 2009 echo integration-trawl survey along the shelf break west of Sanak Island. Data were collected at 1 trawl location.

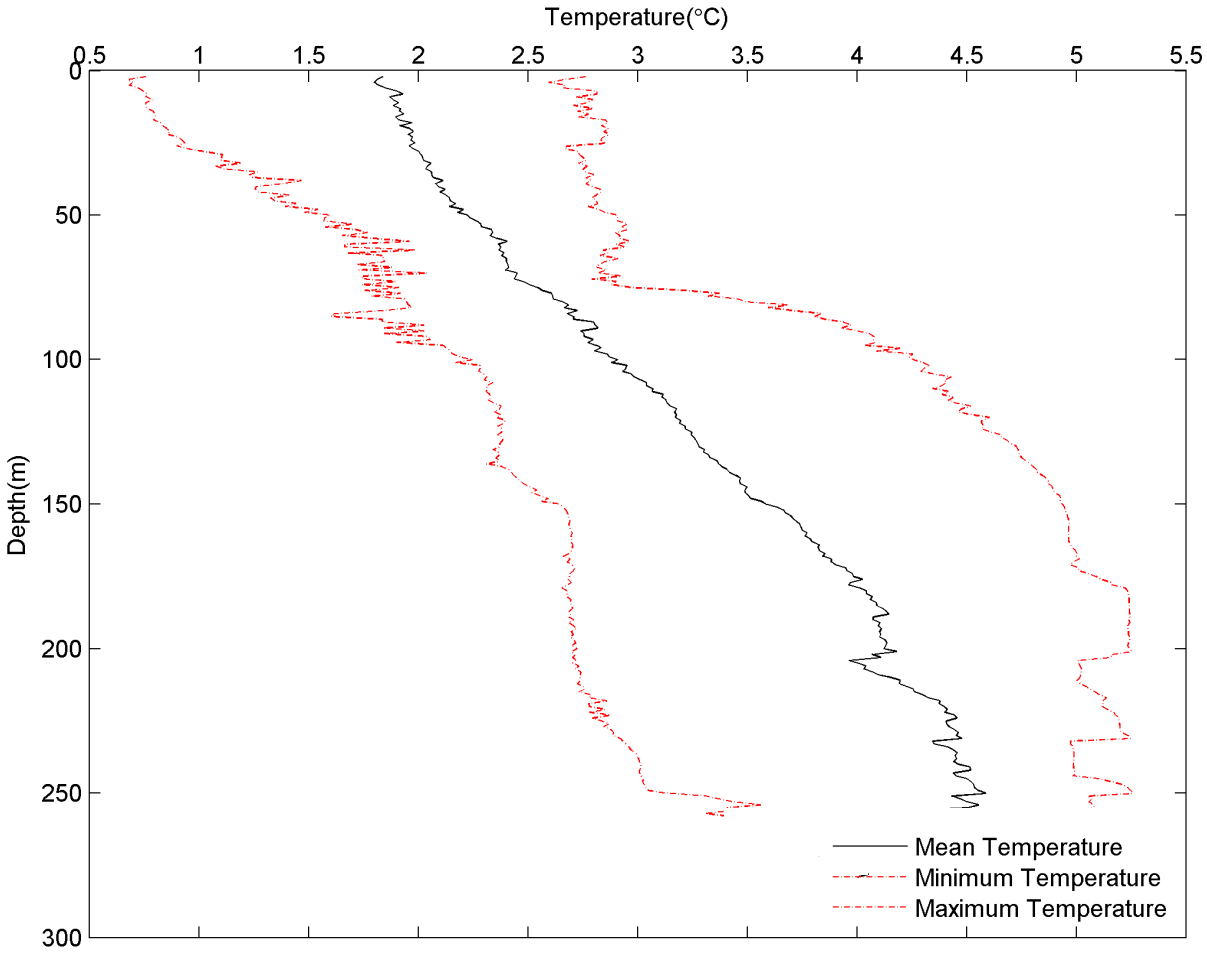

Figure 15. -- Mean water temperature (°C) (solid line) by 1-m depth intervals observed during the winter 2009 echo integration-trawl survey of walleye pollock in the Shelikof Strait. Dashed lines represent minimum and maximum temperatures observed during the survey. Data were collected at 12 trawl locations.

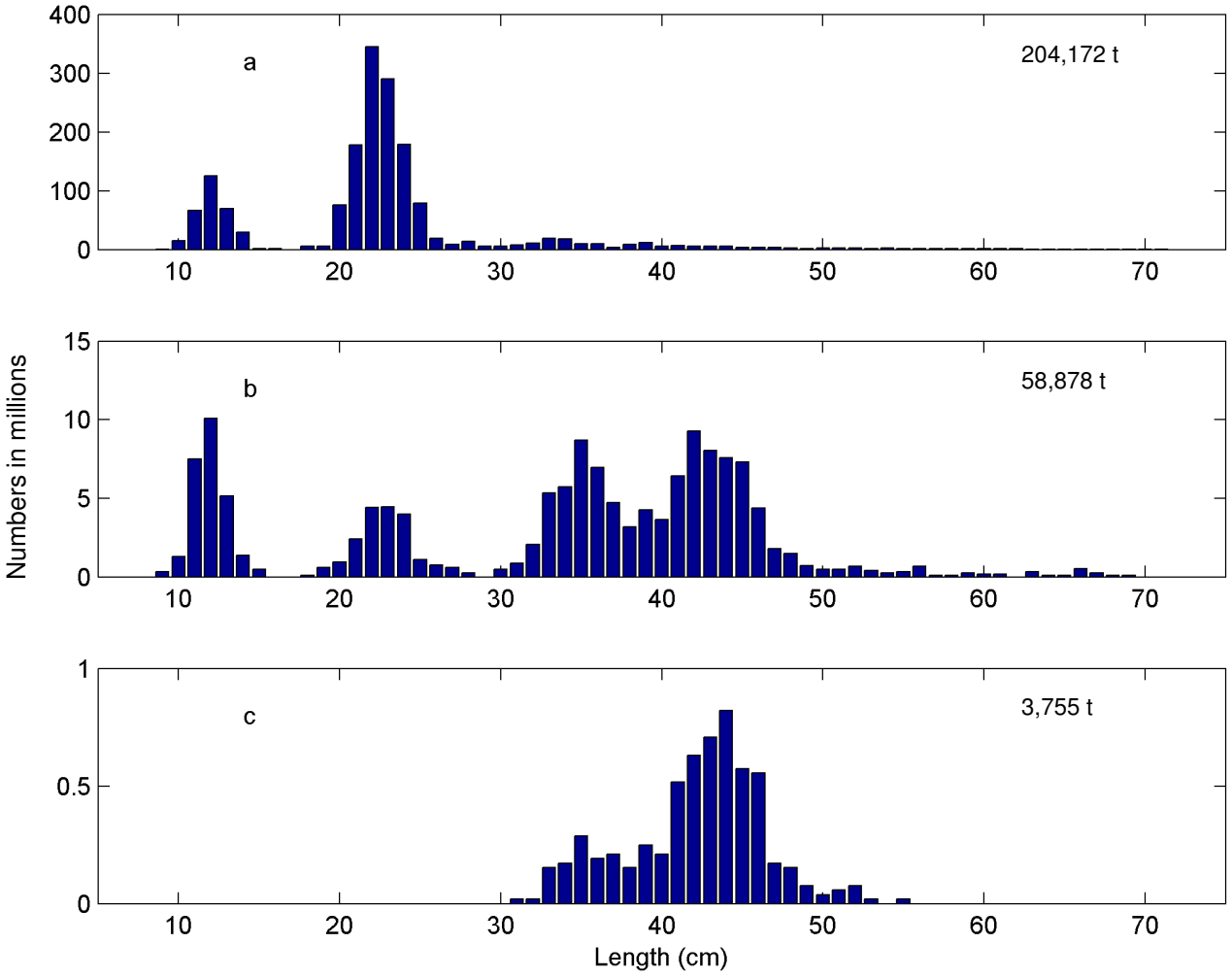

Figure 16. -- Length distribution of walleye pollock (numbers) for the 2009 echo integration-trawl survey of a) Shelikof Strait proper, b) south of Kodiak Island to the Semidi Islands, and c) between the Semidi Islands and Chirikof Island.

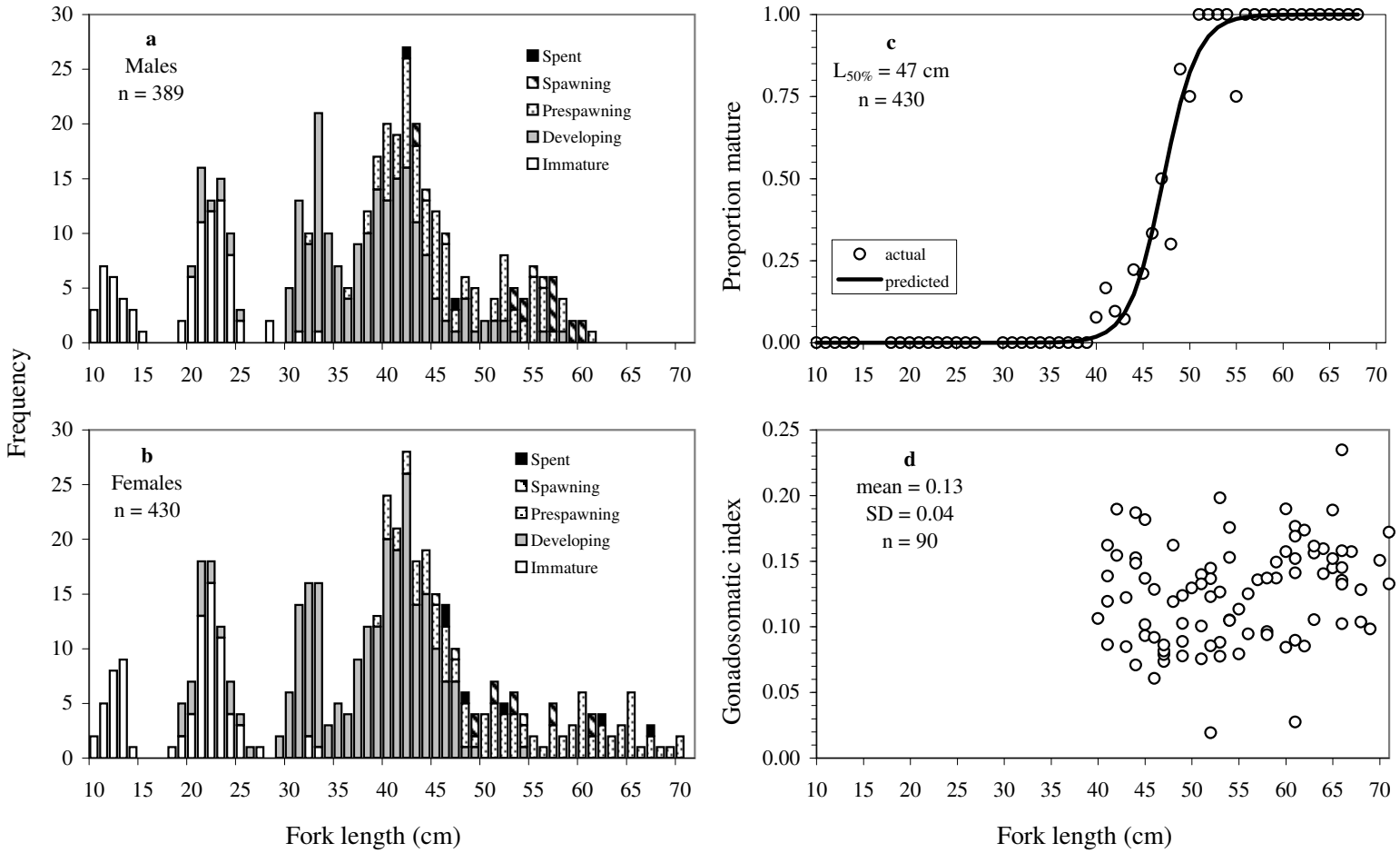

Figure 17. -- Maturity stages for (a) male and (b) female walleye pollock, (c) proportion mature by 1-cm size group for female walleye pollock and (d) gonadosomatic index for pre-spawning females examined during the 2009 echo integration-trawl survey of the Shelikof Strait area.

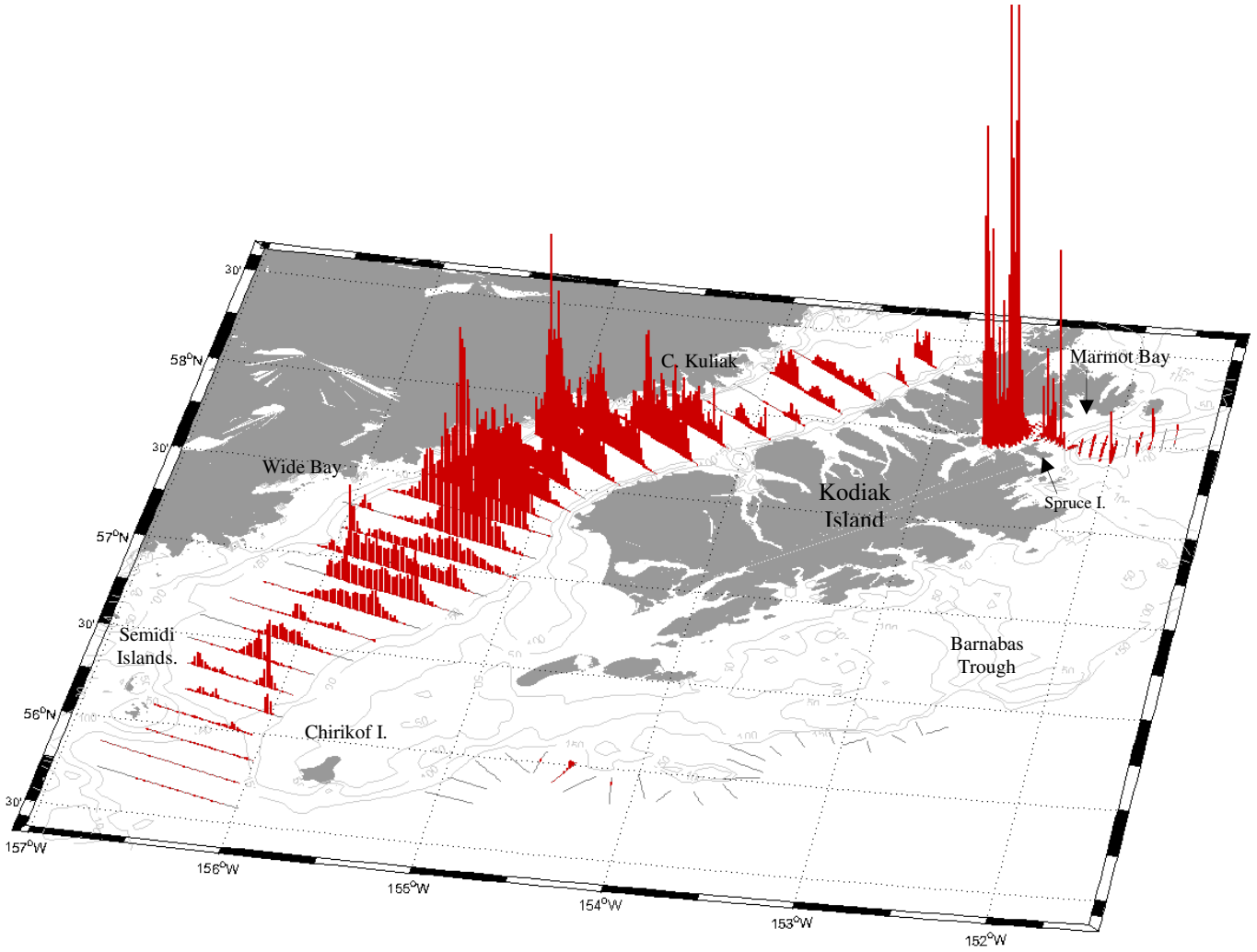

Figure 18. -- Acoustic backscattering (s_A) attributed primarily to walleye pollock (vertical lines) along tracklines surveyed during the winter 2009 echo integration-trawl survey of the Shelikof Strait area, Marmot Bay, and along the Gulf of Alaska shelf break from Chirikof Island to Barnabas Trough.

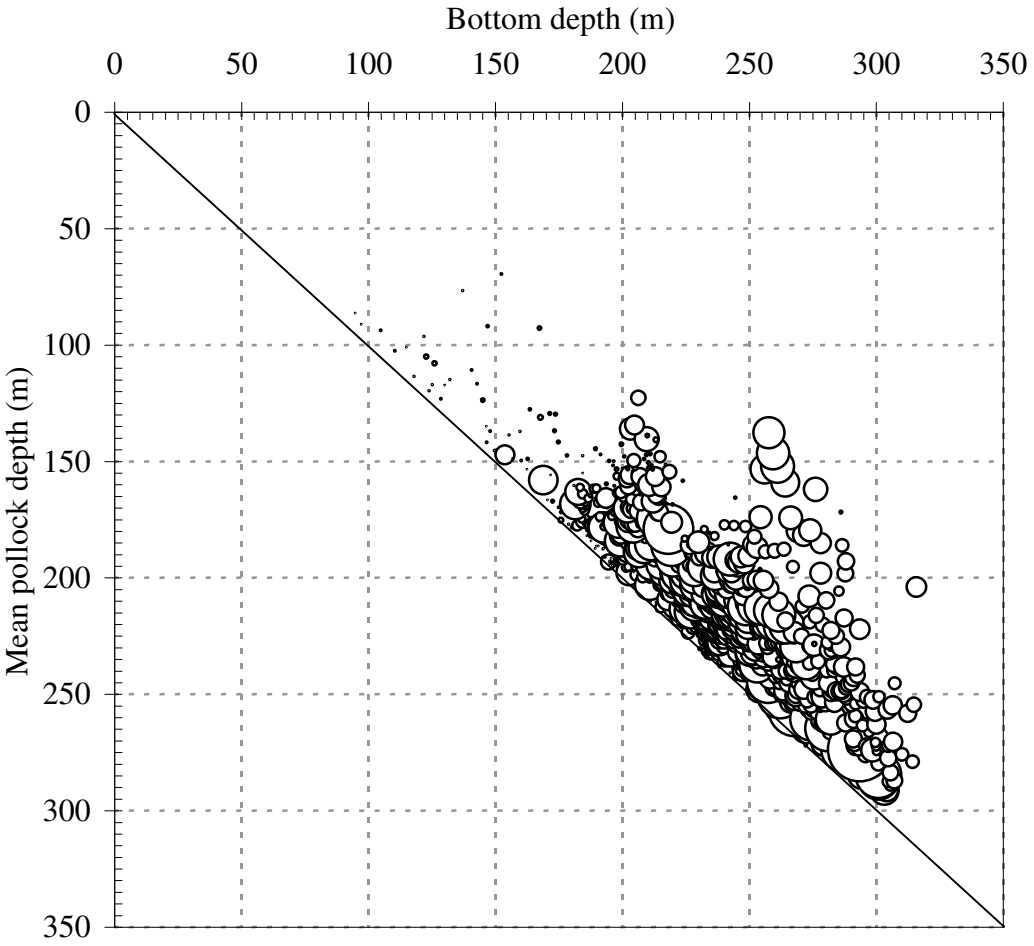

Figure 19. -- Average walleye pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for walleye pollock observed during the winter 2009 echo integration-trawl survey of the Shelikof Strait area. Circle size is scaled to the maximum biomass.

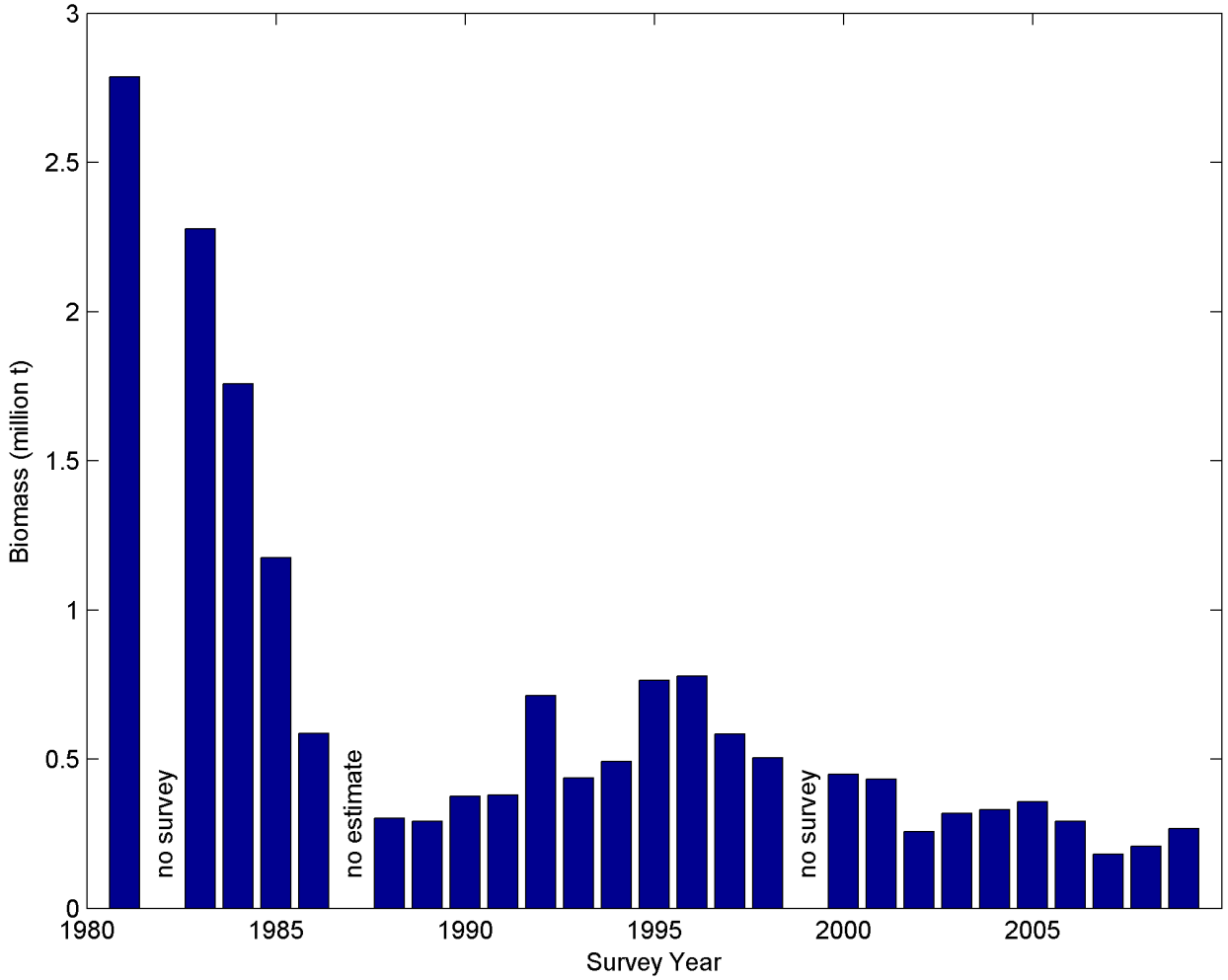

Figure 20. -- Summary of annual pollock biomass estimates based on echo integration-trawl surveys of the Shelikof Strait area.

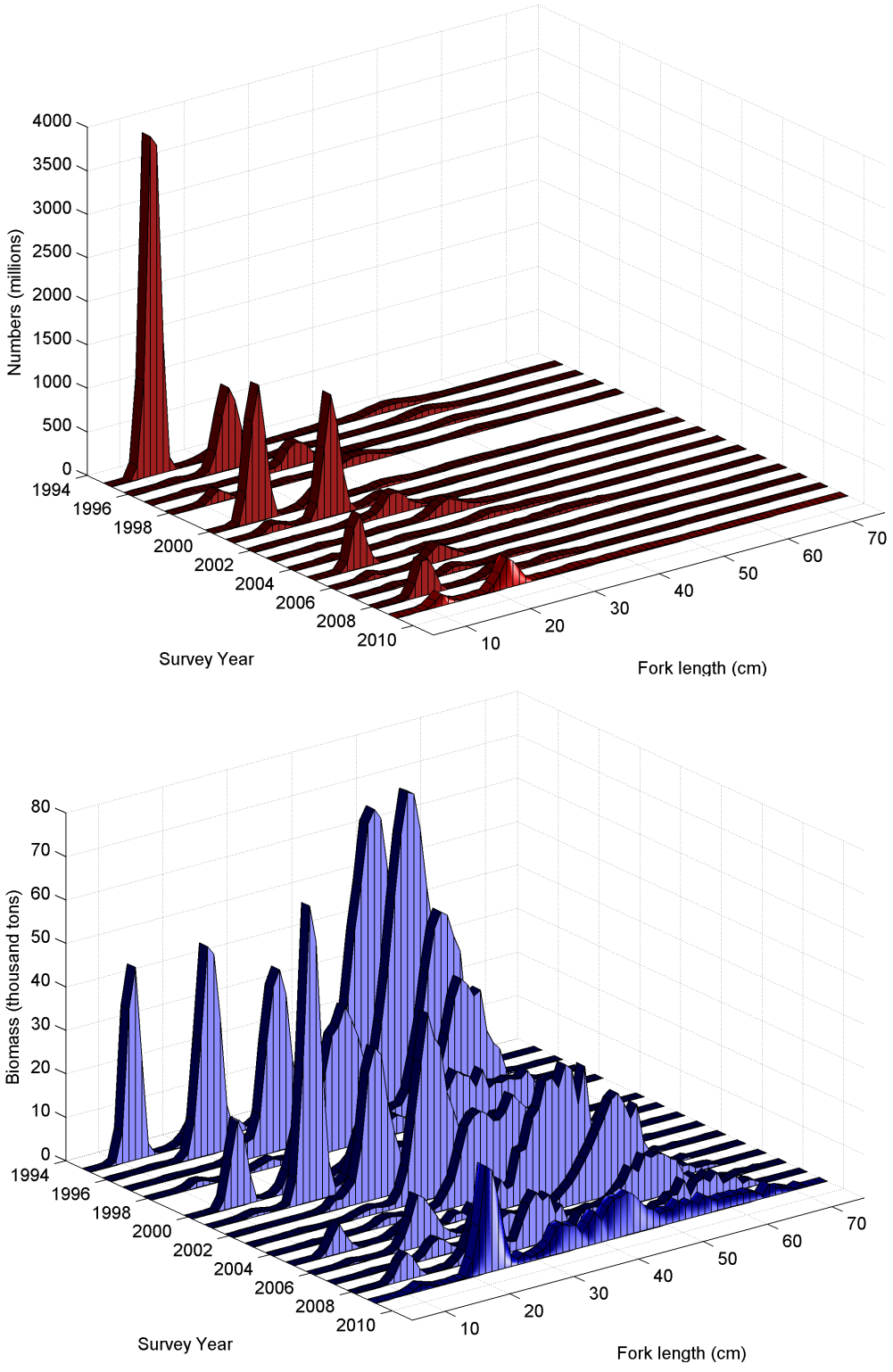

Figure 21. -- Walleye pollock biomass in thousands of metric tons and numbers in millions at length from the Shelikof Strait echo integration-trawl surveys since 1995. No survey was conducted in 1999.

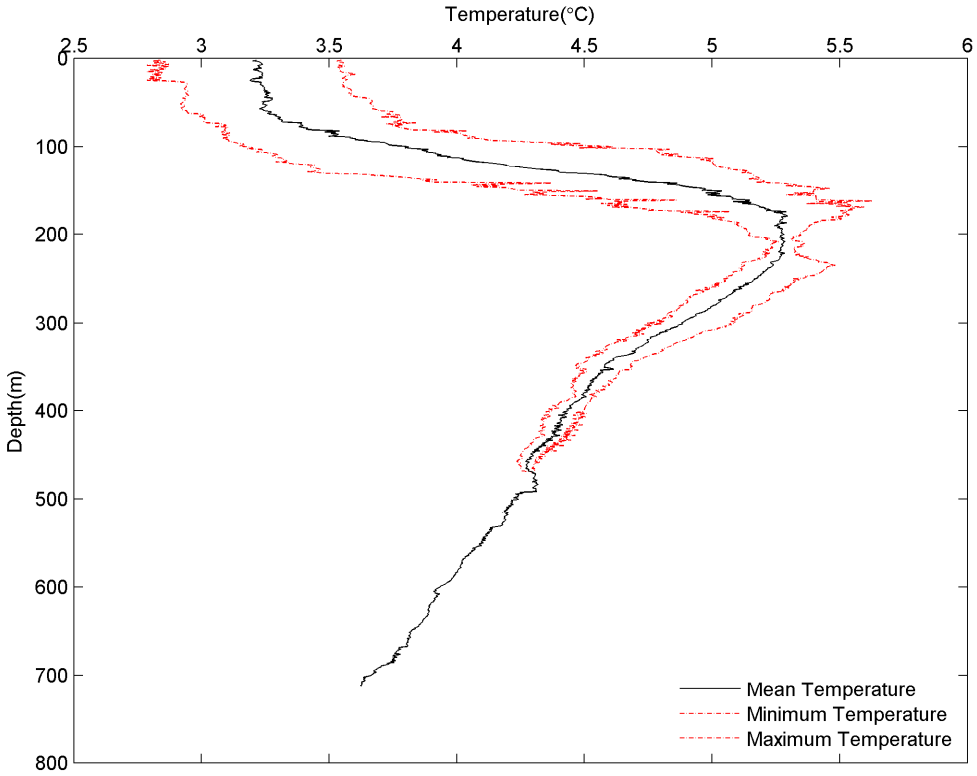

Figure 22. -- Mean water temperature (°C) (solid line) by 1-m depth intervals observed during the winter 2009 echo integration-trawl survey of walleye pollock along the Chirikof shelf break. Dashed lines represent minimum and maximum temperatures observed during the survey. Data were collected at 6 trawl locations.

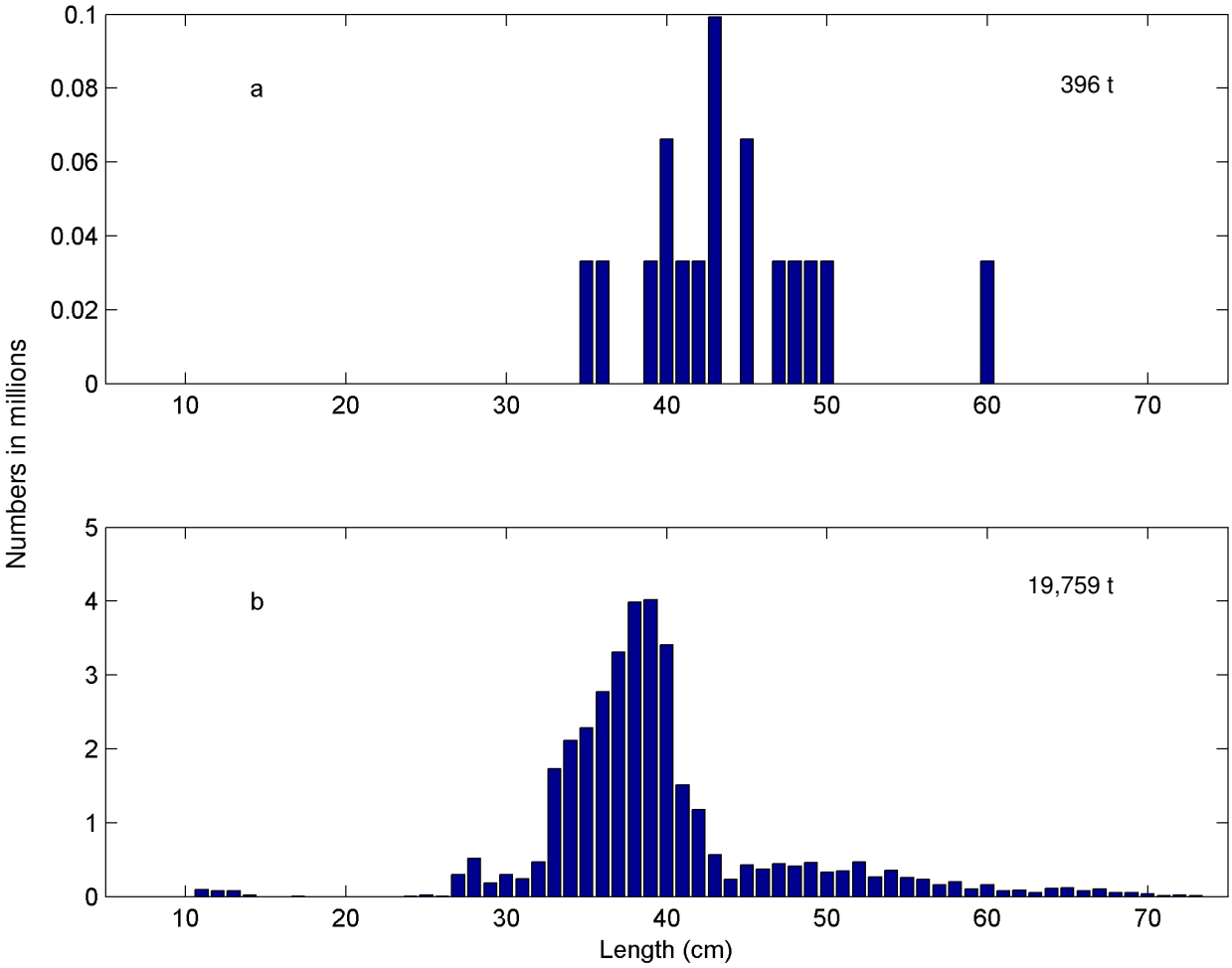

Figure 23. -- Length distribution of walleye pollock (numbers) for the 2009 echo integration-trawl survey of a) the GOA shelfbreak from Chirikof Island to Barnabas Trough and b) Marmot Bay.

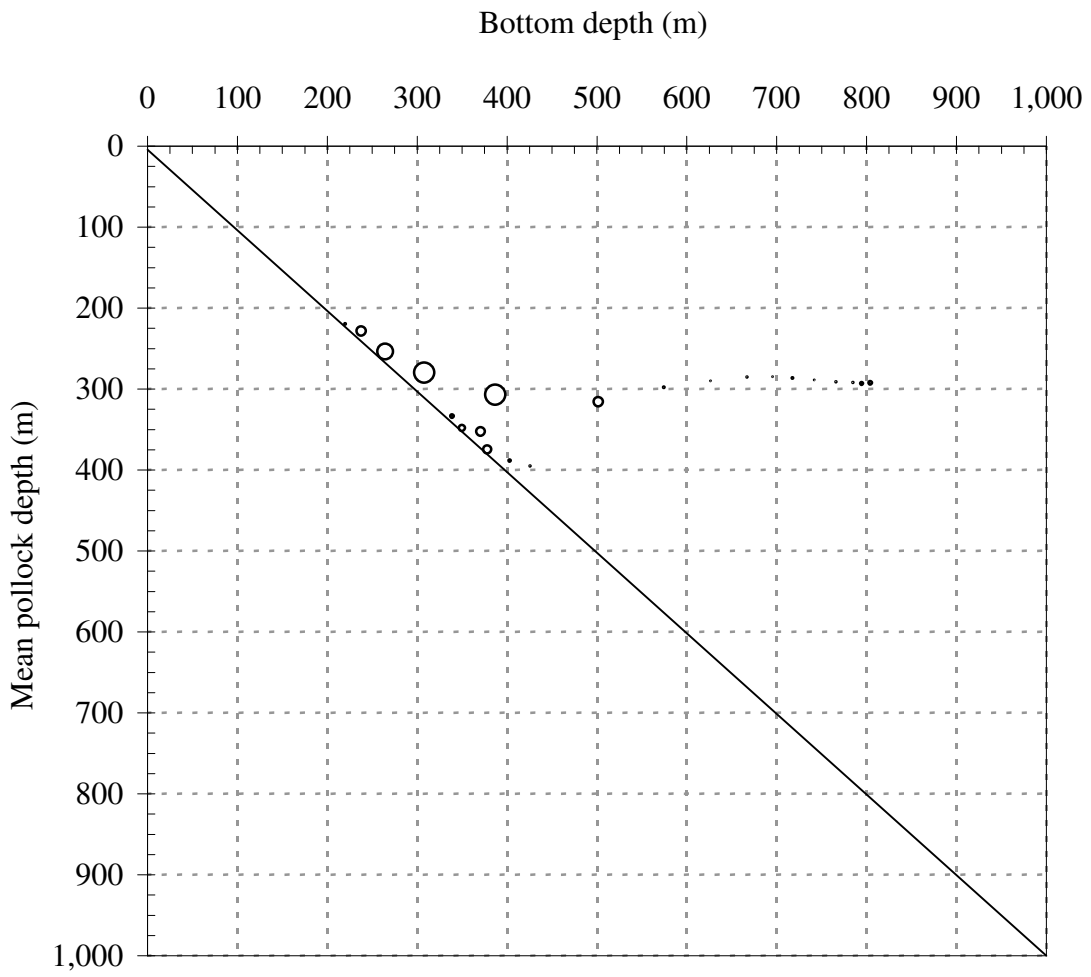

Figure 24. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for walleye pollock observed during the winter 2009 echo integration-trawl survey of the Chirikof Island area. Circle size is scaled to the maximum biomass.

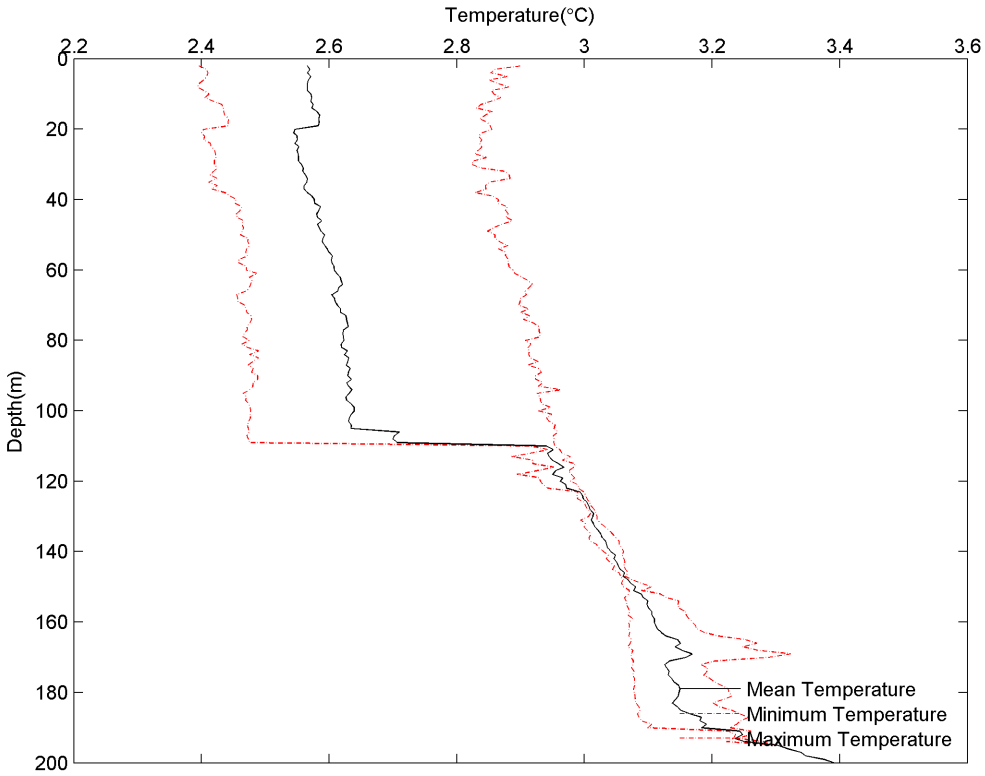

Figure 25. -- Mean water temperature (°C) (solid line) by 1-m depth intervals observed during the winter 2009 echo integration-trawl survey of walleye pollock in Marmot Bay. Dashed lines represent minimum and maximum temperatures observed during the survey. Data were collected at 7 trawl locations.

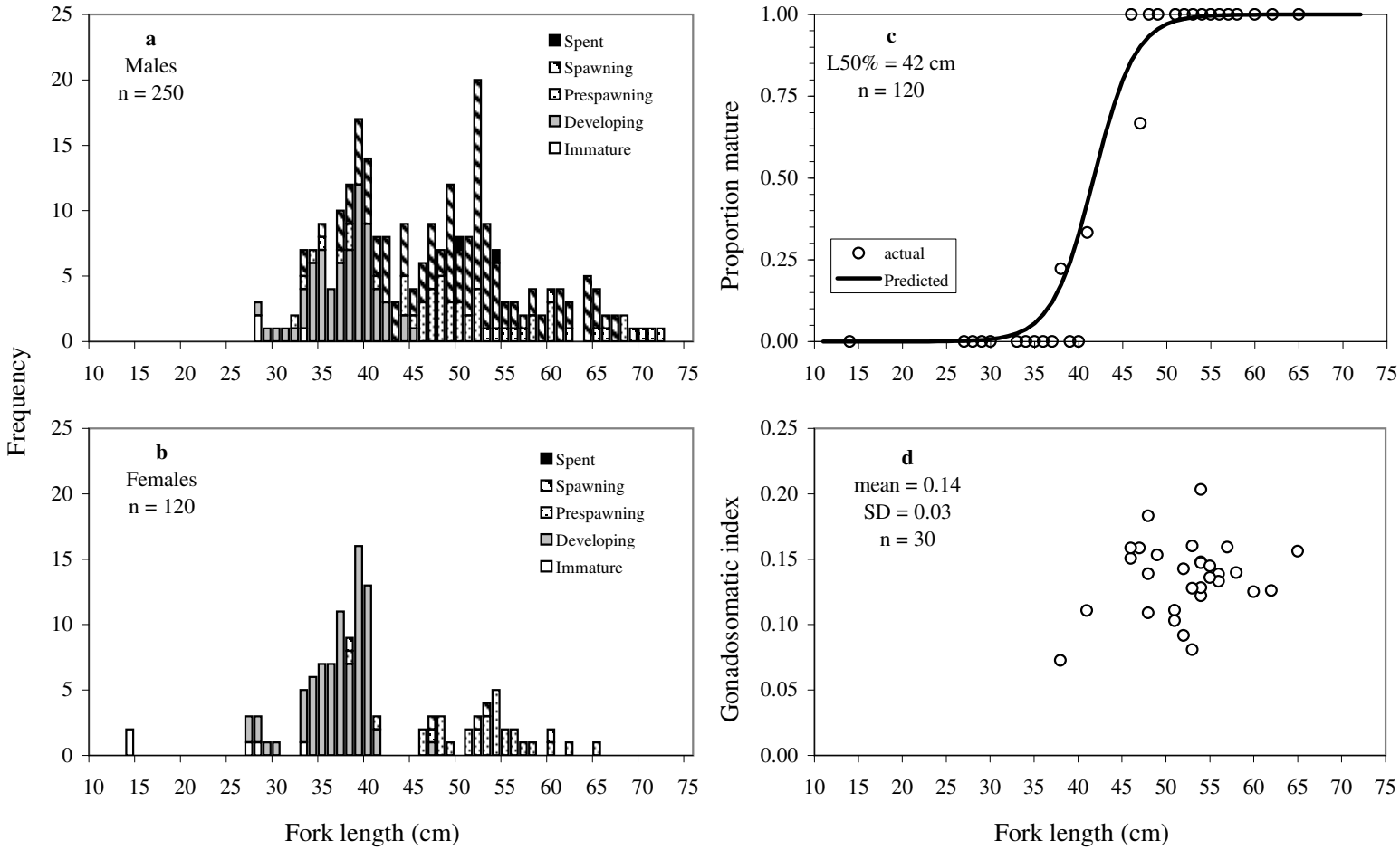

Figure 26. -- Maturity stages for (a) male and (b) female walleye pollock, (c) proportion mature by 1-cm size group for female walleye pollock, and (d) gonadosomatic index for pre-spawning females examined during the 2009 echo integration-trawl survey of Marmot Bay.

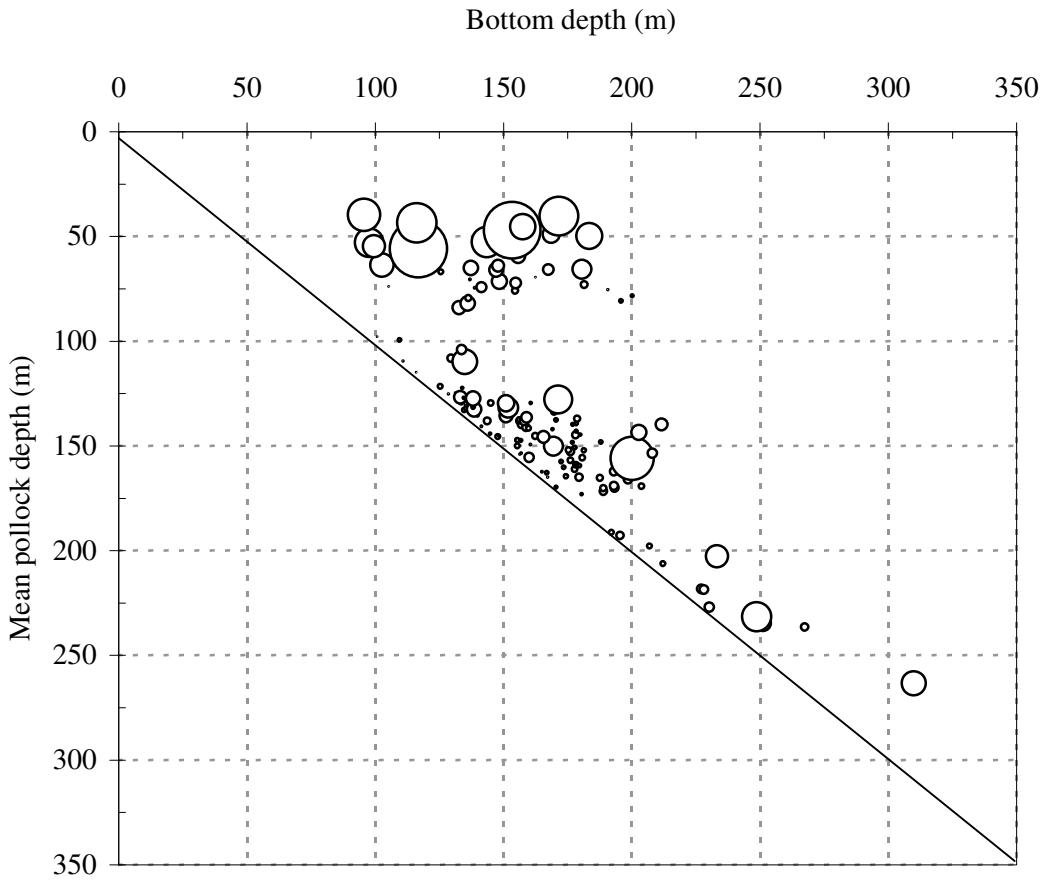

Figure 27. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for walleye pollock observed during the winter 2009 echo integration-trawl survey of Marmot Bay. Bubble size is scaled to the maximum biomass.