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Results of the February-March 2008 Echo Integration-trawl Surveys of Walleye Pollock (*Theragra chalcogramma*) Conducted in the Gulf of Alaska, Cruises MF2008-01 and OD2008-03

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Results of the February-March 2008 Echo Integration-Trawl Surveys of Walleye Pollock (*Theragra chalcogramma*) Conducted in the Gulf of Alaska, Cruises MF2008-01 and OD2008-03

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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 were also conducted in the Shumagin Islands area in 1994-96, 2001-03, and 2005-07 and along the GOA continental shelf break east of Chirikof Island to Barnabas Trench in 2002-07. This report presents the distribution and abundance of walleye pollock for surveys conducted in the GOA during February and March 2008.

METHODS

MACE scientists conducted surveys in the western GOA between 4 and 15 February in the Shumagin Islands and Sanak Trough (Cruise MF2008-01, DY2008-01) and in the central GOA in the Shelikof Strait area and along the GOA shelf break from Chirikof Island to Middleton Island between 13 and 31 March (Cruise DY2008-03).

Acoustic Equipment

The February survey was conducted aboard the NOAA ship *Miller Freeman*, a 66-m stern trawler, and the March survey was conducted aboard the NOAA ship *Oscar Dyson*, a 64-m stern trawler. Both vessels were equipped for fisheries and oceanographic research. The surveys were conducted following established EIT methods (NOAA Protocols for Fisheries Acoustics Surveys and Related Sampling 2003).

System electronics were housed inside the vessels in permanent laboratory spaces dedicated to acoustics. Echosounding was conducted with a Simrad EK60 using 18, 38, 120, and 200 kHz split-beam transducers; the *Oscar Dyson* also is outfitted with a 70-kHz transducer (Simrad 1997, 2004; Bodholt and Solli 1992). For each vessel, 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 2.1.2) and SonarData EchoLog 500 (version 4.1).

Standard sphere acoustic system calibrations were conducted to measure acoustic system performance (Table 1). During calibrations, the ships were 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 SonarData Echoview (version 4.30.53) PC-based application was used for all post-processing and analyses of the acoustic data. The 38-kHz echo sounder was the primary source for the quantitative walleye pollock backscatter measurements presented here.

Trawl Gear

Both vessels were 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 either a 1.3 cm (0.5 in) or 3.2 cm (1.25 in) nylon mesh codend liner. The AWT was fished with 82.3 m (270 ft) of 1.9 cm (0.75 in) diameter (8×19 wire) non-rotational dandylines, 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 WESMAR (*Miller Freeman*) or Simrad FS70 (*Oscar Dyson*) third wire system attached to the headrope. The vertical net opening for the AWT ranged from 22 to 37 m (72-121 ft) and averaged 27 m (89 ft) while fishing.

The vessels were also equipped with a poly Nor'eastern bottom trawl (PNE) with roller gear. 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] comprised of 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. On each vessel, the vertical net opening and depth were monitored with a Furuno netsounder system attached to the headrope. The PNE vertical mouth opening ranged from 6 to 8 m (20-26 ft) and averaged 6 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. Sea surface temperature and salinity data were measured using the ships' Sea-Bird Electronics SBE-21 probes located mid-ship, approximately 5 m below the water line. These and other environmental data were recorded using the ships' 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 using transects spaced 9.3 km (5.0 nautical miles (nmi)) apart within Shumagin Trough, 1.9 km (1 nmi) apart east of Renshaw Point, and 4.6 km (2.5 nmi) apart elsewhere (Fig. 1). Bottom depths did not exceed 220 m along any transect, and transects generally did not extend into waters less than about 75 m depth. The Sanak Trough survey was conducted using transects spaced 3.7 km (2 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 Shelikof Strait sea valley was surveyed from Malina Bay to just south of Chirikof Island using 13.9 km (7.5 nmi) transect spacing (Fig. 2). Bottom depths did not exceed 340 m along any transect, and transects generally did not extend into waters less than about 100 m depth. The GOA shelf break was surveyed from southeast of Chirikof Island to east of Middleton Island between the 200 and 1,000 m depth contours along transects spaced 11.1 km (6 nmi) apart. The traditionally surveyed 'Chirikof' section is included in Figure 2. The shelfbreak east of this area was formally surveyed for the first time, with the exception of the Middleton Island area, which was also surveyed in 2003 (Fig. 3). All surveys were conducted 24 hours per day.

Trawl hauls (Figs. 1-3) were used to collect specimens of walleye pollock (Tables 2-3) and to classify observed backscatter layers (Figs. 4-6) 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

(Tables 4-5). Walleye pollock were measured to the nearest centimeter. 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[1]. 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. Acoustic backscatter identified as walleye pollock, rockfish, and an undifferentiated mixture of primarily macro-zooplankton between depths from 16 m of the surface to 0.5 m above the detected bottom, except where the bottom exceeded 1,000 m (the lower limit of data collection) was 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 were estimated as follows:

The echo sounder 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 strength (TS), where

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

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

MACE uses the following TS to length relationship for walleye pollock (Traynor 1996)

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

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:

$$\overline{\sigma}_{bs} = \Sigma_i (P_i \times \sigma_{bsi}), \text{ where } \sigma_{bsi} = 10^{((20 \log L_i - 66)/10)}$$

$$\text{Numbers at length } L_i = N_i = P_i \times \overline{s}_A \times A / 4\pi\overline{\sigma}_{bs}$$

$$\text{Biomass at length } L_i = B_i = \overline{W}_i \times N_i$$

$$\text{Numbers at age } j = N_j = \Sigma_i Q_{i,,j} \times N_i$$

$$\text{Biomass at age } j = B_j = \Sigma_i Q_{i,,j} \times B_I .$$

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. Other sources of error (e.g., target strength, trawl sampling) were not addressed.

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 2.4° to 3.1°C with a mean of 2.8°C (Fig. 7). Mean surface temperatures for the 2001-2003 and 2005-2007 surveys ranged from 3.0º to 5.6ºC. Temperatures at the depths where most adult walleye pollock biomass occurred ranged from 3.3° to 4.8°C off Renshaw Point (120-190 m) and from 2.7° to 4.4°C in Shumagin Trough (120-180 m).

Trawl Samples

Biological data and specimens were collected in the Shumagin Islands from seven AWT hauls and two PNE hauls (Table 2; Fig. 1). Walleye pollock was the most abundant species, comprising 95.8% and 86.2% by weight and 52.4% and 71.3% by numbers in AWT and PNE hauls, respectively (Tables 6 and 7). Walleye pollock ranged in length from 9 to 71 cm FL

(Fig. 8) with modes of 10 cm FL in Shumagin trough, 29 cm FL at Renshaw Point, and 12 cm FL and 11 cm FL at Unga Strait and West Nagai Strait, respectively. By numbers, capelin (*Mallotus villosus*) and sand lance (*Ammodytes hexapterus*) contributed 26.9% and 12.3% of the catch, respectively (Table 6). The capelin occurred primarily in Shumagin Trough, and the sand lance occurred in Unga Strait. In the two bottom hauls, walleye pollock, flathead sole (*Hippoglossoides elassodon*), Pacific cod (*Gadus macrocephalus*), and arrowtooth flounder (*Atheresthes stomias*) were the most abundant species by weight, comprising 86.2%, 5.0%, 3.7%, and 3.0%, respectively (Table 7).

The unweighted maturity composition for males longer than 40 cm FL (n = 172) was 23% immature, 35% developing, 42% pre-spawning, 0% spawning, and 0% spent (Fig. 9a). The maturity composition of females longer than 40 cm FL (n = 221) was 12% immature, 23% developing, 61% pre-spawning, 0% spawning, and 4% spent (Fig. 9b). 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 49 cm FL (Fig. 9c), which was slightly larger than other recent Shumagin Islands surveys (42 to 45 cm FL). The average GSI (gonadosomatic index: ovary weight/(ovary weight+body weight)) of pre-spawning females was 0.08 (Fig. 9d), which was lower than previous Shumagin Island surveys, which ranged from 0.10 to 0.19.

<u>Distribution and Abundance</u>

Acoustic backscatter was measured along 542 km (293 nmi) of tracklines. The densest walleye pollock aggregations were located in Shumagin Trough and off Renshaw Point (Fig. 4). Walleye pollock were distributed demersally 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. 10).

Age-1 walleye pollock[2] were the dominant age group by numbers in Shumagin Trough, Unga Strait, and West Nagai Strait (Fig. 8). Age-3, and to a lesser extent age-2, fish dominated the catch by numbers off of Renshaw Point. This trend follows the 2007 survey, when juvenile fish dominated the abundance off Renshaw Point for the first time in survey history.

The 2008 estimate of 30,600 metric tons (t) suggests an increase in biomass from the 2007 estimate of 20,000 t, which was the lowest in survey history and only 7% of the peak 1995 estimate of 290,100 t (Table 8, Fig. 11). The relative estimation error of the biomass based on the one-dimensional geostatistical analysis was 9.8%.

Based on our surveys, walleye pollock in the Shumagin Islands have declined in abundance since the mid-1990s (Fig. 11). Inference about this abundance trend, however, is confounded for several reasons. Previous to 2001, only the 1995 survey covered the entire Shumagin Islands area. Also, it is 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 had occurred, 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 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 in the Gulf of Alaska. For example, over 50% of the 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 surveys (Fig. 12).

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[2] Because walleye pollock age data are not yet available, length ranges were used as a proxy for age using length-at-age data from previous surveys. Fish between 9 and 16 cm FL are considered 1-year-olds, most fish between 17 and 25 cm FL are considered 2-year-olds, most fish from 26 to 33 cm FL are considered 3-year-olds, and most fish >33 cm FL are adults.

Sanak Trough

Physical Oceanography

Surface water temperatures averaged 2.5°C. Mean surface water temperatures were slightly cooler than in previous years, which ranged from 2.8°C in 2006 to 5.1°C in 2003. Temperatures at the depths where most of the walleye pollock biomass occurred (110-150) ranged from 2.5° to 3.4°C, with a mean of 3.0°C, which was similar to 2006 and 2007 but cooler than in 2003 (5.3°C) and 2005 (4.4°C) (Fig. 13).

Trawl Samples

Biological data and specimens were collected in Sanak Trough from one AWT haul and one PNE haul (Tables 9 and 10; Fig. 1). Walleye pollock was the most abundant species caught, comprising 99.7% and 66.7% by weight and 91.5% and 63.2% by numbers in AWT and PNE hauls, respectively (Tables 9 and 10). Walleye pollock that were captured ranged in length from 24 to 69 cm FL (Fig. 8) with a mode of 58 cm FL.

The unweighted maturity composition for males longer than 40 cm FL (n = 96) was 0% immature, 11% developing, 71% pre-spawning, 12% spawning, and 6% spent (Fig. 14a). The unweighted maturity composition for females longer than 40 cm FL (n = 54) was 0% immature, 4% developing, 71% pre-spawning, 0% spawning, and 25% spent (Fig. 14b). The percentage of spawning or spent females was lower than in 2007 (66% total) suggesting that the survey timing was more appropriate in 2008. However, a large percentage of the females had already spawned indicating that the timing of this year's survey was still somewhat 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. Because few fish were shorter than 40 cm FL, a logistic model could not be fitted to the female maturity at length data (Fig. 14c). The average GSI of pre-spawning females was 0.14 (Fig. 14d), which was similar to the previous surveys.

Distribution and Abundance

Acoustic backscatter was measured along 221 km (120 nmi) of tracklines. Most of the backscatter was distributed in the eastern and central portion part of Sanak Trough both demersally as well as in dense, midwater schools within 40 m of the seafloor over bottom depths between 80 and 160 m (Fig. 15). Walleye pollock were sparse in the northwestern part of the Trough, where about half of the 2006 biomass was detected over bottom depths shallower than 100 m. Little backscattering was seen in the southernmost part of the Trough as well.

The 2008 abundance estimate of 19,800 t continues the biomass decline seen over the past 3 years. In 2007, the estimate was 60,300 t whereas 2006 estimate was 127,200 t (Table 8). The relative estimation error for 2008 based on the one-dimensional geostatistical analysis of the acoustic backscattering was 6.7%.

Shelikof Strait

Physical Oceanography

Surface water temperatures ranged from 3.0° to 4.7°C with a mean of 3.6°C (Fig. 16), which were warmer than 2007 (2.4°C) but similar to previous years - 2004 (3.8°C), 2005 (4.0°C), and 2006 (3.5°C). Temperatures increased with depth down to approximately 250 m, rising to an average of 5.5°C at 250 m. This temperature distribution is warmer than that observed during 2004-06 where the maximum at depth was roughly 4.0°C.

Trawl Samples

Biological data and specimens were collected in Shelikof Strait from 10 AWT hauls and 1 PNE haul (Table 3; Fig. 2). Walleye pollock and eulachon (*Thaleichthys pacificus*) were the most abundant species by weight in midwater trawl hauls, comprising 49.4% and 46.6%, respectively, of the total catch (Table 11). By numbers, eulachon and walleye pollock were most abundant, accounting for 66.4% and 31.6%, respectively. Excluding one sleeper shark (*Somniosus pacificus)* that dominated the weight caught in the PNE haul, walleye pollock and eulachon accounted for 57.8% and 38.8%, respectively, of the number of fish caught in the PNE hauls (Table 12).

Trawl hauls conducted within Shelikof Strait proper revealed a mixture of age groups of walleye pollock, with age-1 fish dominating most catches by number (Fig. 17a). South of the Strait proper between Kodiak Island and the Semidi Islands, catches were dominated by both age-1 and age-2 fish (Fig. 17b). Age-1 fish heavily dominated catches at the extreme southern end of the Shelikof Strait survey area between the Semidi Islands and Chirikof Island (Fig. 17c).

The unweighted maturity composition in the Shelikof Strait area for males longer than 40 cm FL (n = 358) was 7% immature, 44% developing, 28% mature pre-spawning, 21% spawning, and 0% spent (Fig. 18a). The maturity composition of females longer than 40 cm FL (n = 426) was 0% immature, 48% developing, 51% pre-spawning, 1% spawning, and 0% spent (Fig. 18b). These results are similar to previous survey results in terms of low numbers of spawning and spent female fish, which suggests that the survey timing was appropriate. The female L_{50} of 47 cm FL (Fig. 18c) was similar to most estimates since 1985. The average GSI for pre-spawning females of 0.12 (Fig. 18d) was similar to GSI values for 2002 (0.12) and 2003 (0.11) but slightly lower than previous years (2004-2007), where the mean GSI has ranged from 0.14 to 0.16. The current mean is also slightly lower than the mean GSIs (0.14-0.19) reported for the 1992-2001 surveys.

<u>Distribution and Abundance</u>

Acoustic backscatter was measured along 1,239 km (669 nmi) of tracklines. The densest walleye pollock aggregations were detected just south of the Strait proper northeast of the Semidi Islands

(Fig. 5). Walleye pollock abundance was sparse along on the north side of the Strait, where historically the highest abundance of mature, pre-spawning walleye pollock was located. Most walleye pollock were generally located within 50 m of the seafloor over bottom depths exceeding 150 m (Fig. 19).

The biomass estimate for Shelikof Strait of 208,000 t was slightly larger than that for 2007 (180,900 t), which was the lowest in the time series (Fig. 20). The relative estimation error of the biomass based on the one-dimensional geostatistical analysis was 5.6% (Table 8). An estimated 1.3 billion 1-year-old walleye pollock in 2008 suggests a strong 2007 year class in Shelikof Strait, representing the fifth largest year class in survey history. 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, appears to have virtually disappeared (Tables 13-16; Fig. 21).

Shelf Break from Chirikof Island to Barnabas Trough

Physical Oceanography

Surface water temperatures ranged from 3.1° to 3.9°C with a mean of 3.5ºC (Fig. 22). The mean surface temperature was similar to 2007 (3.5º C) but cooler than in 2004 (4.8ºC), 2005 (4.4ºC), and 2006 (4.3ºC). Temperatures at the depths where most adult walleye pollock biomass occurred (300-450 m) ranged from 4.5º to 5.0ºC with a mean of 4.8ºC and was similar to the mean temperatures of previous years: 2004 (4.7ºC), 2005 (4.8ºC), 2006 (4.8ºC), and 2007 (4.9ºC).

Trawl Samples

Biological data and specimens were collected along the Gulf of Alaska shelf break near Chirikof Island from two AWT hauls (Table 3; Fig. 2). No PNE hauls were conducted in this area. Walleye pollock was the most abundant species by weight, comprising 96.3% of the catch

(Table 13). Rougheye and shortraker rockfish (*Sebastes aleutianus* and *S. borealis*, respectively) contributed an additional 3.5% to the catch by weight. By number, walleye pollock and myctophids contributed 83.6% and 13.1% of the catch, respectively.

Walleye pollock ranged from 33 to 69 cm FL with a mode of 57 cm FL (Fig. 23a). As is typical for this survey, no juvenile walleye pollock were captured.

The unweighted maturity composition in the Chirikof Island area for males longer than 40 cm FL (n = 47) was 0% immature, 17% developing, 57% mature pre-spawning, 26% spawning, and 0% spent (Fig. 24a). The maturity composition of females longer than 40 cm FL (n = 126) was 0% immature, 3% developing, 97% pre-spawning, 0% spawning, and 0% spent (Fig. 24b). The high percentage of pre-spawning females indicates that peak spawning had not occurred. The female L_{50} of 47 cm FL was similar to previous surveys (Fig. 24c). The average GSI for pre-spawning females of 0.16 (Fig. 24d) was also similar to previous surveys (0.14 to 0.18).

<u>Distribution and Abundance</u>

Acoustic backscatter was measured along 268 km (145 nmi) of tracklines (Fig. 3). Relatively few walleye pollock were located along the shelfbreak between Chirikof Island and Barnabas Trough (Fig. 5). Most of the walleye pollock echosign occurred in midwater layers between 275 and 330 m depth over bottom depths of 300-600 m (Fig. 25). 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 22,100 t was less than any in previous surveys with the next lowest being in 2004 (30,000 t) and 2003 (31,000 t) estimates (Table 8). The relative estimation error of the biomass based on the one-dimensional geostatistical analysis was 9.6%.

Shelf Break from Barnabas Trough to Middleton Island

Physical Oceanography

Surface water temperatures ranged from 4.4º to 4.8ºC with a mean of 4.6ºC (Fig. 26). Temperatures at the depths where most adult walleye pollock biomass occurred (300-450 m) ranged from 4.7º to 5.2ºC with a mean of 5.0ºC.

Trawl Samples

Biological data and specimens were collected from six AWT hauls and one PNE haul (Table 3; Fig. 3). Pacific ocean perch (POP) and walleye pollock were the most abundant species by weight in the AWT hauls, comprising 55.9% and 33.2% of the catches, respectively (Table 14). By numbers capelin, myctophids, POP, and walleye pollock contributed 44.1%, 25.8%, 12.9%, and 8.8% of the catch, respectively. POP comprised 94% by weight and numbers of the bottom haul while shortraker rockfish made up 2.6% of the haul weight and myctophids comprised 3.6% of the haul by number (Table 15). No walleye pollock were caught in the bottom haul.

Walleye pollock ranged from 22 to 66 cm FL with a mode of 34 cm FL (Fig. 23b), which was substantially shorter than walleye pollock caught along the shelfbreak between Chirikof Island and Barnabas Trough (Fig. 23a). Similar to that area, however, few juvenile walleye pollock were captured.

The unweighted maturity composition for males longer than 40 cm FL (n = 65) was 0% immature, 2% developing, 12% mature pre-spawning, 86% spawning, and 0% spent (Fig. 27a). The maturity composition of females longer than 40 cm FL (n = 49) was 0% immature, 18% developing, 79% pre-spawning, 3% spawning, and 0% spent (Fig. 27b). The low percentage of spawning and spent females indicates that peak spawning had not occurred. Because of an insufficient maturity-at-length dataset, a logistic model could not be fitted (Fig. 27c). The average GSI for pre-spawning females was 0.18 (Fig. 27d).

Distribution and Abundance

Acoustic backscatter was measured along 760 km (410 nmi) of tracklines. Minimal walleye pollock acoustic backscatter was seen in this area (Fig. 6). Similar to the Chirikof area, most acoustic backscattering occurred in midwater layers between 300 and 450 m over bottom depths of 325 to 1,000 m (Fig. 28). Dense POP acoustic backscattering was detected along the shelfbreak, particularly near the mouth of Amatuli Trench area (Fig. 29).

The walleye pollock biomass estimate for the Gulf of Alaska shelfbreak between Barnabas Trough and Middleton Island was 4,200 t. Of this amount, 3,500 t was observed in the vicinity of Middleton Island. For the 2003 survey, 6,000 t were observed in this same area. The relative estimation error of the biomass based on the one-dimensional geostatistical analysis was 87.4%, indicating a very patchy distribution along the shelfbreak.

Vessel Comparison

MACE scientists continued vessel-comparison work to determine whether walleye pollock differentially avoid the NOAA ships *Miller Freeman* and *Oscar Dyson*. This latest vessel-comparison work was conducted during the 2008 Shumagin Island and Sanak Trough surveys. Previous studies were conducted during a portion of the summer 2006 eastern Bering shelf survey and the entire 2007 Shelikof Strait area survey. Additional vessel-comparison work with these two ships was conducted during the summer 2008 eastern Bering shelf EIT survey. The vessel-comparison work is needed because the *Oscar Dyson* was designed to meet the ICES specification for underwater radiated noise to minimize vessel avoidance during fish abundance surveys, whereas the older *Miller Freeman* is a conventionally built vessel which exceeds this specification. Thus, fish could potentially respond differently to the vessels due to the different auditory stimuli produced by each vessel. If this were the case, differential vessel avoidance reactions could influence biomass estimates derived from standard survey methods with the two ships. Results of the vessel comparison work will be important as the *Oscar Dyson* has become the primary vessel used for walleye pollock acoustic-trawl surveys, which have been conducted with the *Miller Freeman* in the past.

Both vessels continuously collected acoustic backscatter at 18, 38, 120 and 200 kHz while traveling in close proximity to one another, as described for earlier vessel comparison work (De Robertis et al. 2008). The two-part experimental design consisted of a side-by-side vessel configuration, where the ships traveled beside one another at a distance of 0.5 nmi along survey tracklines, and a follow-the-leader vessel configuration where one vessel followed the other at a distance of 1 nmi. The side-by-side configuration allowed for standard survey operations without compromising biomass estimates for stock assessment purposes. Acoustic data from both vessels were collected over a wide range of densities of adult walleye pollock and conditions typical of acoustic surveys in these areas. Analyses of these data are underway.

Gear Testing

Research projects addressing selectivity of the midwater trawl used during the MACE EIT surveys were conducted during the Shelikof Strait survey. Eight trawl hauls were conducted with the trawl outfitted with small recapture bags, or pocket nets attached to the outside of the trawl to sample escaping fish (Table 3). The pocket net catches will be compared with the size and species composition of the catch retained in the codend. Fish behavior in the trawl was observed using an underwater stereo-camera. The stereo-camera images are also used to determine fish length. These observations will aid in the understanding of size-dependent behavior of walleye pollock in the trawl. Additionally, six AWT hauls were conducted as part of a codend comparison experiment comparing the retention of juvenile and small adult fish using 0.5” compared to 1.25” codend mesh liner. Analyses of these data are underway.

ACKNOWLEDGMENTS

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

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ITINERARY

Shumagins/Sanak

Miller Freeman/Oscar Dyson Intervessel comparison (MF0801/DY0801)

6 Feb.	Depart Kodiak, AK, acoustic sphere calibration in Three Saints Bay, Kodiak Island, AK.
7 Feb.	Transit to first survey transect.
8 - 12 Feb.	Echo integration-trawl survey of Shumagin Islands, side-by-side dedicated survey transects, and buoy pass operations.
12-14 Feb.	Echo integration-trawl survey of Sanak Trough and continuation of side-by-side dedicated survey transects.
14 Feb.	Transit to Unalaska Island, AK.
15 Feb.	Acoustic sphere calibration in Captains Bay, Unalaska Island, AK. In port Dutch Harbor.

Shelikof/Shelfbreak

(DY0803)

13 March	Depart Kodiak, AK. Transit to first survey transect.
13-21 March	Echo integration-trawl survey of the Shelikof Strait, Chirikof shelfbreak, and Gulf of Alaska shelfbreak (through transect 218).
22 March	Acoustic sphere calibration in Kizhuyak Bay, Kodiak Island, AK.
23 March	Weather delay.
24-26 March	Gear selectivity and codend comparison experimental gear trials.
27 March	Transit to Gulf of Alaska shelfbreak at Middleton Island.
28-31 March	Echo integration-trawl survey of the Gulf of Alaska shelfbreak area (transects 219-251).
31 March	In port Kodiak, AK.

SCIENTIFIC PERSONNEL

Shumagin Islands and Sanak Trough (MF2008-01)

Name	Position	Organization
Michael Guttormsen	Chief Scientist	AFSC
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Abigail McCarthy	Fishery Biologist	AFSC
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Shumagin Islands and Sanak Trough (DY2008-01)

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AFSC – Alaska Fisheries Science Center, Seattle, WA

USFWS – U.S. Fish and Wildlife Service, Juneau, AK

Table 1. -- Simrad ER60 38 kHz acoustic system description and settings used during the late winter/early spring 2008 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.

	Miller Freeman			*Oscar Dyson*			
	Survey system settings	6-Feb Three Saints Bay Alaska	15-Feb Captains Bay, Alaska	Survey system settings	6-Feb Three Saints Bay Alaska	15-Feb Captains Bay, Alaska	22-Mar Kizhuyak Bay, Alaska
Echosounder:	Simrad ER60	--	--	Simrad ER60	--	--	--
Transducer:	ES38B	--	--	ES38B	--	--	--
Frequency (kHz):	38	--	--	38	--	--	--
Transducer depth (m):	9.15	--	--	9.15	--	--	--
Pulse length (ms):	1.024	--	--	1.024	--	--	--
Transmitted power (W):	2000	--	--	2000	--	--	--
Angle sensitivity along:	23.77	--	--	22.83	--	--	--
Angle sensitivity athwart:	23.83	--	--	21.43	--	--	--
2-way beam angle (dB):	-21.11	--	--	-20.77	--	--	--
Gain (dB)	26.37	26.37	26.45	22.95	22.99	22.95	22.96
s_a correction (dB)	-0.57	-0.57	-0.55	-0.61	-0.66	-0.61	-0.63
3 dB beamwidth along	6.42	6.42	6.51	6.79	6.66	6.79	6.69
3 dB beamwidth athwart	6.38	6.38	6.45	7.21	7.20	7.21	7.14
Angle offset along	0.04	0.04	0.03	-0.08	-0.08	-0.08	0.07
Angle offset athwart	0.01	0.01	0.01	-0.12	-0.10	-0.10	-0.11
Post-processing s_v threshold (dB):	-70	--	--	-70	--	--	--
Standard sphere TS (dB)	--	-42.21	-41.96	--	-42.25	-42.14	-42.13
Sphere range from transducer (m):	--	19.44	19.75	--	20.10	22.00	18.90
Absorption coefficient (dB/m):	0.0099	0.0100	0.0099	0.0099	0.0100	0.0099	0.0099
Sound velocity (m/s)	1466.0	1457.4	1458.6	1466.0	1457.4	1458.6	1458.7
Water temp at transducer (^{o}C):	--	2.2	2.7	--	2.5	2.7	3.0

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

Table 2. -- Summary of trawl and catch data from the 2008 walleye pollock echo integration-trawl surveys of the Shumagin Trough area (hauls 1-3), Renshaw Point (hauls 4-7), Unga Strait (haul 8), Nagai Strait (haul 9), and Sanak Trough (hauls 10-11).

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	8-Feb	2:07	1	55 18.79	-158 51.20	168	188	4.4	3.0	388.2	1,621	0.0
2	AWT	10-Feb	2:14	8	55 18.02	-159 20.78	188	203	3.4	3.0	2.7	401	0.3
3	AWT	10-Feb	7:44	6	55 22.56	-159 37.34	119	129	2.7	2.7	35.8	2,363	65.2
4*	PNE	10-Feb	21:12	9	55 34.05	-160 20.23	180	183	4.8	2.4	265.4	825	58.4
5	AWT	10-Feb	23:22	4	55 34.82	-160 12.13	163	191	3.0	2.8	349.2	1,999	0.0
6*	PNE	11-Feb	19:23	11	55 33.70	-160 14.09	170	182	3.8	2.8	157.6	216	9.3
7	AWT	11-Feb	22:12	3	55 33.91	-160 04.89	122	171	2.9	2.8	559.5	3,390	0.0
8	AWT	12-Feb	4:21	20	55 27.76	-160 33.31	127	134	3.0	2.7	147.5	1,717	11.3
9	AWT	12-Feb	13:08	14	55 08.72	-160 19.30	125	209	3.1	3.1	503.5	3,627	9.4
10*	PNE	13-Feb	1:41	14	54 31.84	-162 36.92	148	156	3.4	2.5	754.2	493	377.3
11	AWT	13-Feb	17:30	6	54 35.33	-162 33.49	111	152	2.5	2.5	273.2	182	0.9

[1] AWT = Aleutian Wing Trawl, PNE = poly-Nor'eastern bottom trawl

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

* Hauls conducted using 1.25" liner, otherwise a 0.5" liner was used

Table 3. -- Summary of trawl and catch data from the 2008 walleye pollock echo integration-trawl surveys of the Shelikof Strait area (hauls 1-12), the Gulf of Alaska shelf break near Chirikof Island (hauls 13-14), Marmot Bay (haul 15), net selectivity studies (hauls 16-30), and the Gulf of Alaska shelf break from Barnabas Trough to Middleton Island (hauls 31-37).

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	14-Mar	16:57	7	58 04.73	-153 35.85	224	233	4.5	4.0	912.1	3,348	218.0
2*	AWT	14-Mar	22:53	12	57 53.49	-153 55.66	183	212	4.5	4.0	200.6	4,767	246.5
3*	AWT	15-Mar	7:02	12	57 40.24	-154 33.19	205	215	4.5	3.8	128.4	1,551	383.6
4*	AWT	15-Mar	15:20	8	57 32.34	-154 58.39	120	231	4.5	3.8	146.6	3,688	571.2
5*	AWT	15-Mar	22:24	12	57 30.54	-155 14.68	238	256	4.5	4.0	354.0	2,855	327.2
6*	AWT	16-Mar	8:23	25	57 15.98	-155 02.87	213	225	4.4	3.5	223.9	2,432	798.4
7*	PNE	16-Mar	16:36	16	57 07.81	-155 49.95	275	280	4.6	3.4	28.0	235	262.8
8*	AWT	17-Mar	1:12	15	56 52.89	-155 11.51	192	203	2.5	3.7	246.8	970	143.9
9*	AWT	17-Mar	11:31	2	56 46.38	-155 19.22	195	203	4.6	3.7	295.1	3,024	623.3
10*	AWT	17-Mar	20:58	7	56 35.44	-155 43.47	200	232	4.7	3.7	1,118.8	7,690	969.3
11*	PNE	18-Mar	20:28	9	56 00.61	-156 11.12	167	209	4.0	3.7	10.7	428	3.7
12*	AWT	19-Mar	4:35	7	55 48.92	-156 31.81	232	248	4.7	3.7	599.4	18,775	40.3
13*	AWT	20-Mar	2:28	29	55 55.24	-154 15.76	361	417	4.7	3.8	1,310.5	893	3.5
14*	AWT	20-Mar	18:04	21	56 15.13	-153 13.24	346	538	4.8	3.5	1,003.5	657	85.4
15	AWT-exp	22-Mar	5:36	6	57 55.11	-152 40.97	81	110	3.6	3.1	1,770.3	9,441	2.7
16	AWT-exp	23-Mar	9:34	16	57 49.56	-153 31.40	124	189	3.5	3.4	831.8	2,392	6.0
17	AWT-exp	24-Mar	7:02	5	57 45.31	-154 58.75	222	288	4.5	3.2	444.0	3,876	61.5
18	AWT-exp	24-Mar	10:53	13	57 44.98	-154 57.51	225	281	4.5	3.6	314.0	1,670	191.6
19	AWT-exp	24-Mar	15:37	20	57 45.18	-154 58.46	230	294	4.5	3.7	480.6	3,276	85.9
20	AWT-exp	24-Mar	19:26	20	57 44.91	-154 58.88	246	278	4.5	3.5	626.1	5,258	349.8
21	AWT-exp	25-Mar	0:21	15	57 44.85	-154 58.49	248	274	4.5	3.6	143.7	1,639	161.9
22	AWT-exp	25-Mar	7:45	25	57 40.05	-155 04.81	245	261	4.5	3.6	1,071.2	7,929	516.8
23	AWT-exp	25-Mar	11:24	20	57 40.34	-155 04.50	246	262	4.5	3.5	366.1	2,699	283.8
24	AWT-exp	25-Mar	15:15	31	57 38.45	-155 04.00	220	250	4.5	3.5	1,107.5	6,972	462.5
25*	AWT-exp	25-Mar	23:55	6	57 30.43	-154 54.15	217	228	3.8	4.5	968.4	4,675	531.6
26	AWT-exp	26-Mar	3:51	10	57 30.49	-154 54.46	209	230	4.5	3.9	646.0	5,141	823.0
27	AWT-exp	26-Mar	6:39	5	57 29.73	-154 52.77	200	238	4.5	3.9	306.3	3,890	815.7
28*	AWT-exp	26-Mar	9:01	6	57 29.83	-154 52.89	203	243	4.5	3.7	586.4	3,633	725.6
29*	AWT-exp	26-Mar	11:24	12	57 29.78	-154 52.84	176	244	4.5	3.7	125.4	1,423	259.8
30	AWT-exp	26-Mar	16:55	23	57 43.26	-154 44.67	115	227	4.5	3.7	263.8	2,613	1,143.2
31	AWT	28-Mar	14:25	27	59 15.26	-146 15.30	307	383	5.4	4.8	<0.1	1	226.4
32*	PNE	28-Mar	23:39	12	59 15.89	-146 16.02	321	365	5.2	4.6	0.0	0	156.5
33	AWT	29-Mar	5:46	45	59 12.72	-146 49.35	365	609	5.0	4.7	430.1	337	193.6
34	AWT	29-Mar	18:06	33	58 57.76	-148 36.69	235	245	5.5	4.6	92.4	298	76.7
35	AWT	30-Mar	2:39	9	58 42.24	-148 13.42	208	289	5.3	4.6	0.0	0	7.2
36	AWT	30-Mar	5:55	5	58 44.56	-148 34.22	283	267	5.7	4.5	0.0	0	455.7
37	AWT	30-Mar	22:43	10	57 54.25	-149 24.13	333	482	4.9	4.5	158.8	406	411.3

[1]AWT = Aleutian Wing Trawl, AWT-exp = Aleutian Wing Trawl experimental trawl, PNE = poly-Nor'eastern bottom trawl

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

* Hauls conducted using 1.25" liner, otherwise a 0.5" liner was used

Table 4. -- Number of biological samples and measurements collected during the winter 2008 echo integration-trawl survey of walleye pollock of the Shumagin Trough area (hauls 1-3), Renshaw Point (hauls 4-7), Unga Strait (haul 8), West Nagai Strait (haul 9), and Sanak Trough (hauls 10-11).

Haul No.	Lengths	Weights	Otoliths	Maturity
1	505	118	50	118
2	70	20	5	20
3	73	29	13	29
4	480	92	92	92
5	392	43	26	43
6	196	43	43	43
7	210	0	0	0
8	150	48	38	48
9	320	0	0	0
10	166	61	51	61
11	182	89	88	89
Totals	2,744	543	406	543

Table 5. -- Number of biological samples and measurements collected during the winter 2008 echo integration-trawl survey of walleye pollock of the Shelikof Strait area (hauls 1-12), the Gulf of Alaska shelf break near Chirikof Island (hauls 13-14), Marmot Bay (haul 15), net selectivity studies (hauls 16-30), and the Gulf of Alaska shelf break from Barnabas Trough to Middleton Island (hauls 31-37).

Haul No.	Lengths	Weights	Otoliths	Maturity
1	469	97	55	98
2	457	57	39	57
3	159	44	44	44
4	292	68	31	59
5	388	115	61	115
6	298	128	56	128
7	82	22	22	22
8	341	77	28	77
9	147	27	8	27
10	176	75	52	75
11	106	1	1	1
12	564	82	30	82
13	255	86	43	86
14	279	89	49	87
15	558	89	29	89
16	397	0	0	0
17	442	0	0	0
18	369	0	0	0
19	333	0	0	0
20	318	0	0	0
21	298	0	0	0
22	322	0	0	0
23	280	0	0	0
24	252	0	0	0
25	294	0	0	0
26	306	0	0	0
27	319	0	0	0
28	300	0	0	0
29	255	0	0	0
30	256	0	0	0
33	244	80	40	80
34	159	34	0	34
37	241	0	0	0
Totals	9,956	1,171	588	1,161

Table 6. -- Summary of catch by species in seven Aleutian wing trawls conducted during the 2008 walleye pollock echo integration-trawl survey of the Shumagin Islands area.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	1,986.3	95.8	15,118	52.4
capelin	*Mallotus villosus*	31.0	1.5	7,753	26.9
arrowtooth flounder	*Atheresthes stomias*	23.9	1.2	23	0.1
eulachon	*Thaleichthys pacificus*	16.3	0.8	791	2.7
Pacific cod	*Gadus macrocephalus*	3.9	0.2	2	< 0.1
Pacific sand lance	*Ammodytes hexapterus*	3.6	0.2	3,537	12.3
shrimp unident.	Decapoda (order)	3.1	0.1	1,576	5.5
smooth lumpsucker	*Aptocyclus ventricosus*	1.7	0.1	1	< 0.1
rock sole	Lepidopsetta sp.	1.1	0.1	2	< 0.1
flathead sole	*Hippoglossoides elassodon*	0.9	< 0.1	9	< 0.1
Pacific herring	*Clupea pallasi*	0.3	< 0.1	5	< 0.1
jellyfish unident.	Scyphozoa (class)	0.3	< 0.1		
Gonatopsis sp.	Gonatopsis sp.	0.1	< 0.1	10	< 0.1
sturgeon poacher	*Podothecus acipenserinus*	0.1	< 0.1	2	< 0.1
squid unident.	Teuthoidea (order)	0.1	< 0.1	16	0.1
antlered sculpin	*Enophrys diceraus*	< 0.1	< 0.1	5	< 0.1
scissortail sculpin	*Triglops forficata*	< 0.1	< 0.1	5	< 0.1
rex sole	*Glyptocephalus zachirus*	< 0.1	< 0.1	1	< 0.1
smelt unident.	Osmeridae (family)	< 0.1	< 0.1	2	< 0.1
Total		2,072.8		28,858	

Table 7. -- Summary of catch by species in two poly-Nor'easter bottom trawls conducted during the 2008 walleye pollock echo integration-trawl survey of the Shumagin Islands area.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	423.0	86.2	1,041	71.3
Bairdi crab	*Chionoecetes bairdi*	1.1	0.2	3	0.2
squid unident.	Teuthoidea (order)	0.2	< 0.1	2	0.1
shrimp unident.	Decapoda (order)	1.6	0.3	207	14.2
rex sole	*Glyptocephalus zachirus*	2.5	0.5	8	0.5
Pacific cod	*Gadus macrocephalus*	18.1	3.7	9	0.6
flathead sole	*Hippoglossoides elassodon*	24.3	5.0	55	3.8
eulachon	*Thaleichthys pacificus*	5.4	1.1	128	8.8
arrowtooth flounder	*Atheresthes stomias*	14.6	3.0	8	0.5
Total		490.7		1,461	

Table 8.-- 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	2,785,800							
1982	no survey							
1983	2,278,200							
1984	1,757,200							
1985	1,175,300							
1986	585,800							
1987	no estimate [1]							
1988	301,700							
1989	290,500							
1990	374,800							
1991	380,300							
1992	713,400	3.6%						
1993	435,800	4.6%						
1994	492,600	4.5%	112,000 [2]					
1995	763,600	4.5%	290,100					
1996	777,200	3.7%	117,700 [3]					
1997	583,000	3.7%	no survey					
1998	504,800	3.8%	no survey					
1999	no survey		no survey					
2000	448,600	4.6%	no survey					
2001	432,700	4.5%	119,600					
2002	256,700	6.9%	135,600	27.1%	82,100	12.2%		
2003	317,300	5.2%	67,300	17.2%	30,900	20.7%	81,500	21.6%
2004	330,800	9.2%	no survey		30,400	20.4%	no survey	
2005	356,100	4.1%	52,000	11.4%	77,000	20.7%	67,800	7.4%
2006	293,600	4.0%	37,300	10.1%	69,000	11.0%	127,200	10.4%
2007	180,900	5.8%	20,000	8.6%	36,600	6.7%	60,300	5.7%
2008	208,032	5.6%	30,582	9.8%	22,055	9.6%	19,750	6.7%

[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 9. -- Summary of catch by species in one Aleutian wing trawl conducted during the 2008 walleye pollock echo integration-trawl survey of Sanak Trough.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	273.2	99.7	182	91.5
rock sole	Lepidopsetta sp.	0.8	0.3	1	0.5
capelin	*Mallotus villosus*	0.1	< 0.1	16	8.0
Total		274.1		199	

Table 10. -- Summary of catch by species in one poly-Nor'easter bottom trawl conducted during the 2008 walleye pollock echo integration-trawl survey of Sanak Trough.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	754.2	66.7	493	63.2
Pacific sleeper shark	*Somniosus pacificus*	267.3*	23.6	1	0.1
arrowtooth flounder	*Atheresthes stomias*	77.9	6.9	175	22.4
flathead sole	*Hippoglossoides elassodon*	17.3	1.5	92	11.8
Pacific halibut	*Hippoglossus stenolepis*	12.7	1.1	4	0.5
rex sole	*Glyptocephalus zachirus*	1.5	0.1	8	1.0
Dover sole	*Microstomus pacificus*	0.4	< 0.1	2	0.3
spinyhead sculpin	*Dasycottus setiger*	0.1	< 0.1	1	0.1
Oregon triton	*Fusitriton oregonensis*	0.1	< 0.1	1	0.1
sea cucumber unident.	Holothuroidea (class)	< 0.1	< 0.1	1	0.1
sunflower sea star	*Pycnopodia helianthoides*	< 0.1	< 0.1	1	0.1
common mud star	*Ctenodiscus crispatus*	< 0.1	< 0.1	1	0.1
Total		1,131.5		780	

*weight was estimated

Table 11.-- Summary of catch by species in ten Aleutian wing trawls conducted during the 2008 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*	4,225.8	49.4	49,100	31.6
eulachon	*Thaleichthys pacificus*	3,979.1	46.6	103,111	66.4
salmon shark	*Lamna ditropis*	236.0*	2.8	2	< 0.1
chinook salmon	*Oncorhynchus tshawytscha*	38.0	0.4	23	< 0.1
squid unident.	Teuthoidea (order)	21.7	0.3	739	0.5
big skate	*Raja binoculata*	15.2	0.2	1	< 0.1
northern smoothtongue	*Leuroglossus schmidti*	11.5	0.1	601	0.4
shrimp unident.	Decapoda (order)	6.0	0.1	1,503	1.0
arrowtooth flounder	*Atheresthes stomias*	4.7	0.1	89	0.1
Pacific cod	*Gadus macrocephalus*	2.3	< 0.1	1	< 0.1
magistrate armhook squid	*Berryteuthis magister*	1.7	< 0.1	8	< 0.1
Pacific ocean perch	*Sebastes alutus*	1.2	< 0.1	5	< 0.1
coho salmon	*Oncorhynchus kisutch*	1.2	< 0.1	1	< 0.1
smooth lumpsucker	*Aptocyclus ventricosus*	1.1	< 0.1	1	< 0.1
flathead sole	*Hippoglossoides elassodon*	0.9	< 0.1	3	< 0.1
capelin	*Mallotus villosus*	0.8	< 0.1	205	0.1
Pacific herring	*Clupea pallasi*	0.3	< 0.1	4	< 0.1
Pacific lamprey	*Lampetra tridentata*	< 0.1	< 0.1	1	< 0.1
comb jelly unident.	Ctenophora (phylum)	< 0.1	< 0.1	2	< 0.1
lanternfish unident.	Myctophidae (family)	< 0.1	< 0.1	2	< 0.1
Total		8,547.3		155,402	

Table 12.-- Summary of catch by species in two poly-Nor'eastern bottom trawls conducted during the 2008 walleye pollock echo integration-trawl survey of the Shelikof Strait area.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
Pacific sleeper shark	*Somniosus pacificus*	225.0*	73.7	1	0.1
walleye pollock	*Theragra chalcogramma*	38.7	12.7	663	57.8
eulachon	*Thaleichthys pacificus*	30.3	9.9	445	38.8
arrowtooth flounder	*Atheresthes stomias*	7.2	2.4	11	1.0
chinook salmon	*Oncorhynchus tshawytscha*	1.5	0.5	1	0.1
squid unident.	Teuthoidea (order)	1.1	0.4	3	0.3
Pacific ocean perch	*Sebastes alutus*	0.9	0.3	4	0.3
shrimp unident.	Decapoda (order)	0.2	0.1	17	1.5
starfish unident.	Asteroidea (class)	0.2	0.1	1	0.1
capelin	*Mallotus villosus*	< 0.1	< 0.1	1	0.1
Total		305.2		1,147	

* weight estimated

Table 13. -- Summary of catch by species in two Aleutian wing trawls conducted during the 2008 walleye pollock echo integration-trawl survey of Chirikof shelfbreak.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
walleye pollock	*Theragra chalcogramma*	2314.1	96.3	1,550	83.6
rougheye rockfish	*Sebastes aleutianus*	63.7	2.7	32	1.7
shortraker rockfish	*Sebastes borealis*	19.6	0.8	1	0.1
lanternfish unident.	Myctophidae (family)	2.2	0.1	242	13.1
dusky rockfish	*Sebastes variabilis*	1.7	0.1	1	0.1
arrowtooth flounder	*Atheresthes stomias*	0.7	< 0.1	1	0.1
Pacific ocean perch	*Sebastes alutus*	0.6	< 0.1	1	0.1
squid unident.	Teuthoidea (order)	0.3	< 0.1	18	1.0
eulachon	*Thaleichthys pacificus*	0.1	< 0.1	1	0.1
shrimp unident.	Decapoda (order)	< 0.1	< 0.1	7	0.4
Total		2,402.9		1,854	

Table 14. -- Summary of catch by species in six Aleutian wing trawls conducted during the 2008 walleye pollock echo integration-trawl survey of the Gulf of Alaska shelfbreak between Middleton Island and Barnabas Trough.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
Pacific ocean perch	*Sebastes alutus*	1147.0	55.9	1,527	12.9
walleye pollock	*Theragra chalcogramma*	681.3	33.2	1,042	8.8
giant grenadier	*Albatrossia pectoralis*	71.6	3.5	27	0.2
capelin	*Mallotus villosus*	40.9	2.0	5,214	44.1
Pacific halibut	*Hippoglossus stenolepis*	35.0	1.7	5	0.0
eulachon	*Thaleichthys pacificus*	19.4	0.9	422	3.6
lanternfish unident.	Myctophidae (family)	19.1	0.9	3,048	25.8
chinook salmon	*Oncorhynchus tshawytscha*	14.7	0.7	4	< 0.1
rougheye rockfish	*Sebastes aleutianus*	10.9	0.5	8	0.1
arrowtooth flounder	*Atheresthes stomias*	8.8	0.4	9	0.1
northern smoothtongue	*Leuroglossus schmidti*	1.2	0.1	64	0.5
squid unident.	Teuthoidea (order)	1.0	< 0.1	142	1.2
Pacific cod	*Gadus macrocephalus*	0.7	< 0.1	1	< 0.1
shrimp unident.	Decapoda (order)	0.4	< 0.1	255	2.2
eelpout unident.	Zoarcidae (family)	0.1	< 0.1	23	0.2
salps unident.	Thaliacea (class)	< 0.1	< 0.1	4	< 0.1
Pacific viperfish	*Chauliodus macouni*	< 0.1	< 0.1	3	< 0.1
jellyfish unident.	Scyphozoa (class)	< 0.1	< 0.1	23	0.2
northern pearleye	*Benthalbella dentata*	< 0.1	< 0.1	3	< 0.1
Total		2,052.2		11,824	

Table 15. -- Summary of catch by species in one poly-Nor'eastern bottom trawl conducted during the 2008 walleye pollock echo integration-trawl survey of the Gulf of Alaska shelfbreak between Middleton Island and Barnabas Trough.

		Weight		Numbers	
Common name	Scientific name	kg	Percent	Nos.	Percent
Pacific ocean perch	*Sebastes alutus*	147.1	94.0	186	94.4
shortraker rockfish	*Sebastes borealis*	4.0	2.6	1	0.5
rougheye rockfish	*Sebastes aleutianus*	2.7	1.7	1	0.5
spiny dogfish	*Squalus acanthias*	2.2	1.4	1	0.5
magistrate armhook squid	*Berryteuthis magister*	0.4	0.3	1	0.5
lanternfish unident.	Myctophidae (family)	0.1	< 0.1	7	3.6
Total		156.5		197	

Table 16. -- 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 because of mechanical problems. Note: 2008 age estimates are not yet available.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	78	--	1	62	2,092	575	--	17	399	49	22	228	63	186	10,690	56	70	395	--	4,484	289	8	51	53	1,626	162	53
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	90	94	157	836	232
3	1,511	--	380	324	123	184	--	694	90	72	550	74	37	49	79	119	1,247	126	--	217	352	1,107	208	58	56	41	175
4	769	--	1,297	142	315	46	--	322	216	63	48	188	72	32	78	25	80	474	--	16	61	97	802	160	35	12	30
5	2,786	--	1,171	635	181	75	--	78	249	116	65	368	233	155	103	54	18	136	--	67	42	16	57	356	173	17	10
6	1,052	--	698	988	347	49	--	17	43	180	70	84	126	84	245	71	44	14	--	132	23	16	8	49	162	56	17
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
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
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
10	25	--	12	3	6	11	--	9	1	8	2	56	16	48	11	13	14	26	--	8	3	1	1	1	--	1	1
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
12	0	--	2	1	1	0	--	2	1	3	1	15	3	7	6	5	3	7	--	7	2	< 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	--	--	--
14	0	--	0	0	0	0	--	0	0	1	0	< 1	< 1	2	< 1	< 1	< 1	1	--	1	< 1	< 1	0	0	--	--	--
15	0	--	0	0	0	0	--	0	0	< 1	0	0	1	< 1	0	0	0	1	--	0	< 1	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	--	--	--
17	0	--	0	0	0	0	--	0	0	0	0	0	< 1	< 1	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	--	--	--
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	1,224	781	2,252	1,240	576

Table 17. -- 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 because of mechanical problems. Note: 2008 age estimates are not yet available.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
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
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
3	342	--	117	83	41	40	--	130	21	15	85	16	11	14	23	24	195	28	--	60	60	164	43	14	17	11	39
4	255	--	529	78	159	17	--	91	86	23	13	60	34	20	41	12	28	153	--	9	25	29	222	78	19	5	13
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
6	496	--	455	684	253	41	--	9	27	120	54	68	90	75	220	73	53	12	--	107	24	16	7	37	119	63	22
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	92	--	94	161	138	140	--	6	4	24	23	194	43	34	55	132	120	47	--	17	18	8	2	5	4	43	30
9	68	--	11	36	35	58	--	5	3	9	36	36	46	64	19	48	67	95	--	15	8	2	3	5	3	10	3
10	19	--	12	3	6	11	--	11	1	11	3	71	21	68	15	17	20	33	--	11	5	1	1	1	--	1	2
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
12	0	--	1	1	1	0	--	3	1	4	1	21	4	10	7	7	5	10	--	11	3	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	--	--	--
14	0	--	0	0	0	0	--	0	0	1	0	1	1	4	1	< 1	1	1	--	2	1	< 1	0	0	--	--	--
15	0	--	0	0	0	0	--	0	0	< 1	0	0	1	< 1	0	0	0	1	--	0	< 1	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	--	--	--
17	0	--	0	0	0	0	--	0	0	0	0	0	< 1	1	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	--	--	--
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

Table 18. -- 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 because of mechanical problems.

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 18.--Continued.

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 19. -- 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 because of mechanical problems.

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 19.-- Continued.

Length	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

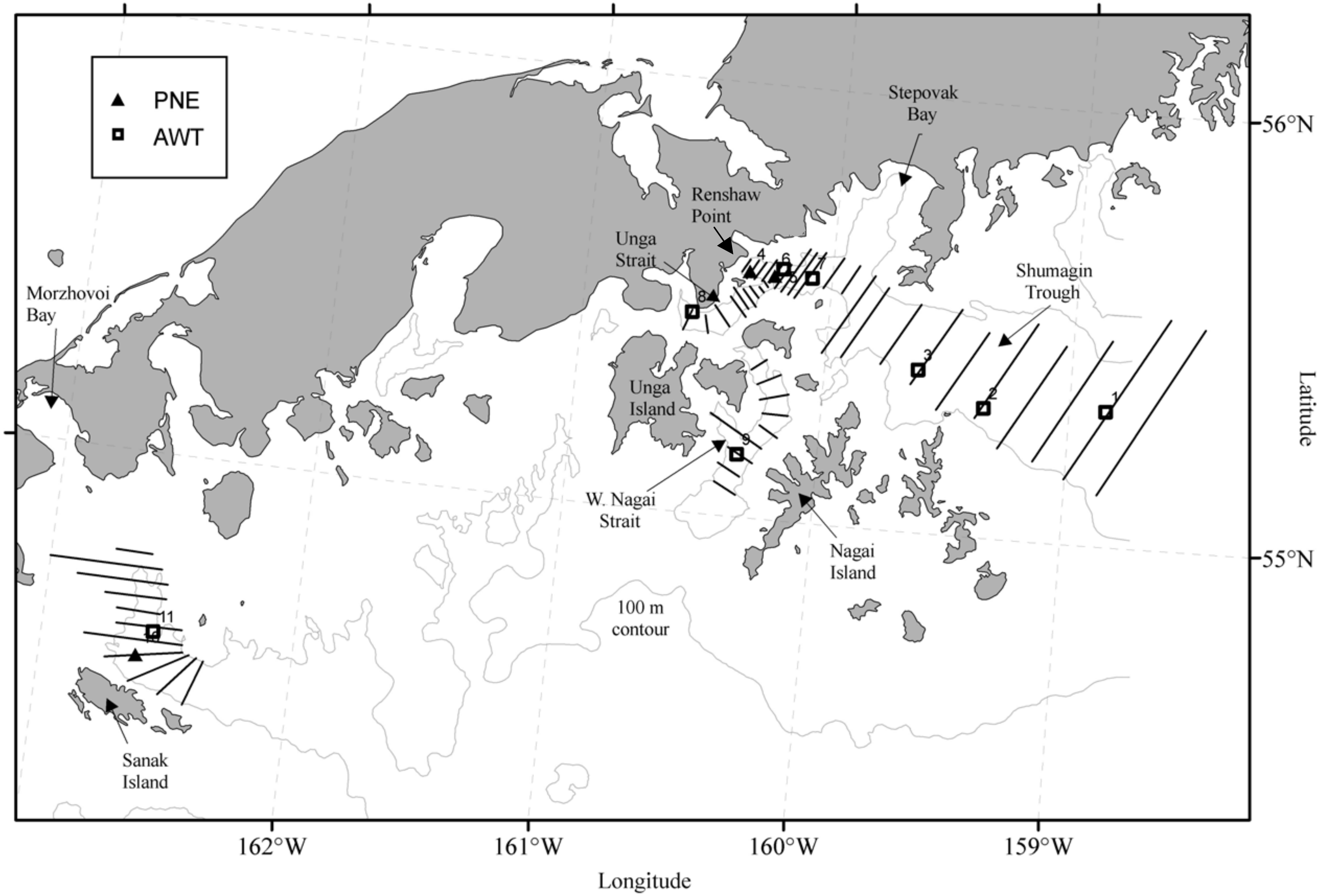

Figure 1.-- Transect lines and locations of Aleutian-wing trawl (AWT) and poly-Nor'eastern trawl (PNE) hauls during the winter 2008 echo integration-trawl survey of pollock in the Shumagin Islands and Sanak Trough.

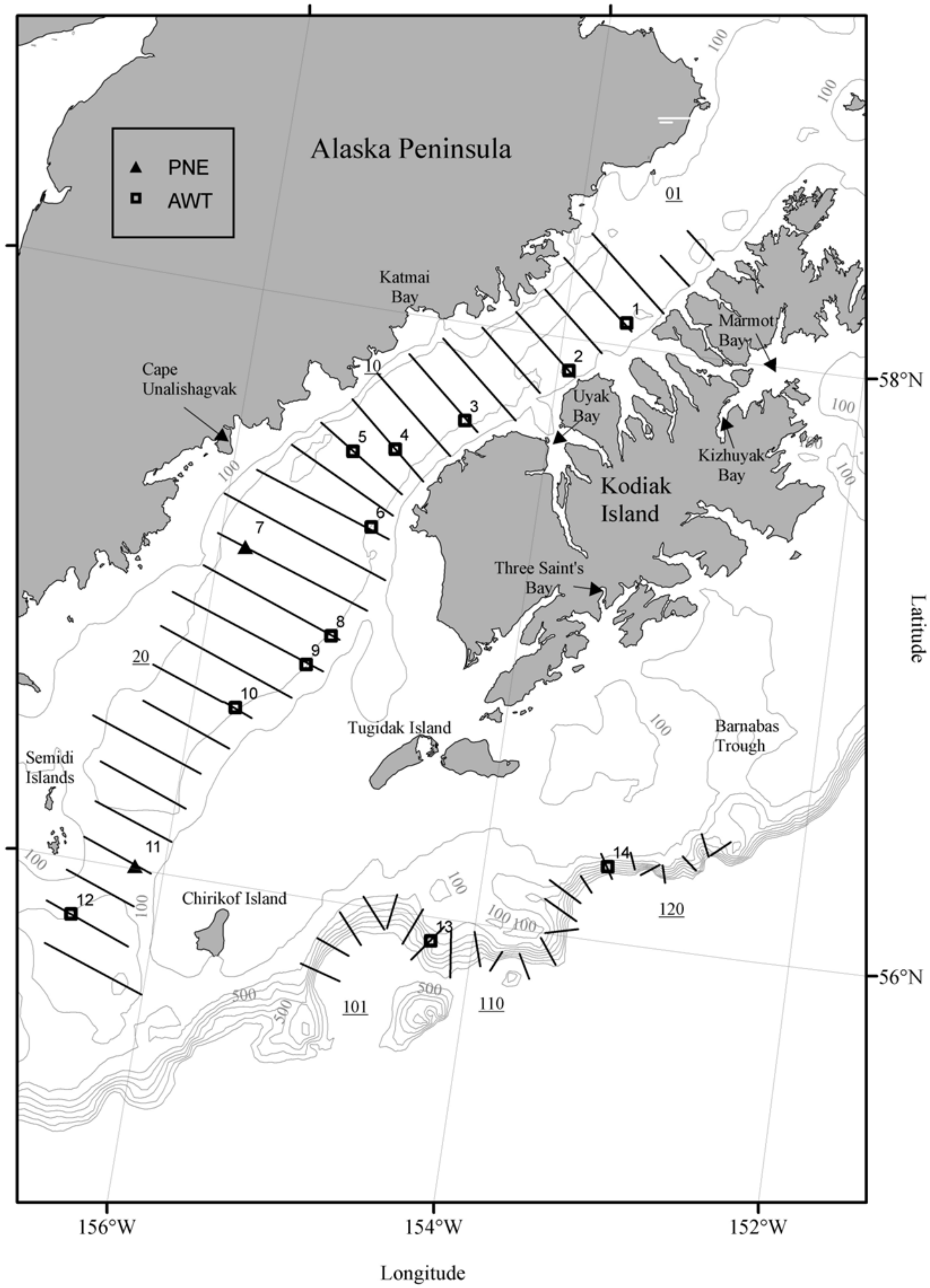

Figure 2. -- Transect lines and locations of Aleutian-wing trawl (AWT) and poly-Nor'eastern trawl (PNE) hauls during the winter 2008 echo integration-trawl survey of pollock in the Shelikof Strait and Gulf of Alaska shelfbreak from Chirikof Island to Barnabas Trough. Transect numbers are underlined.

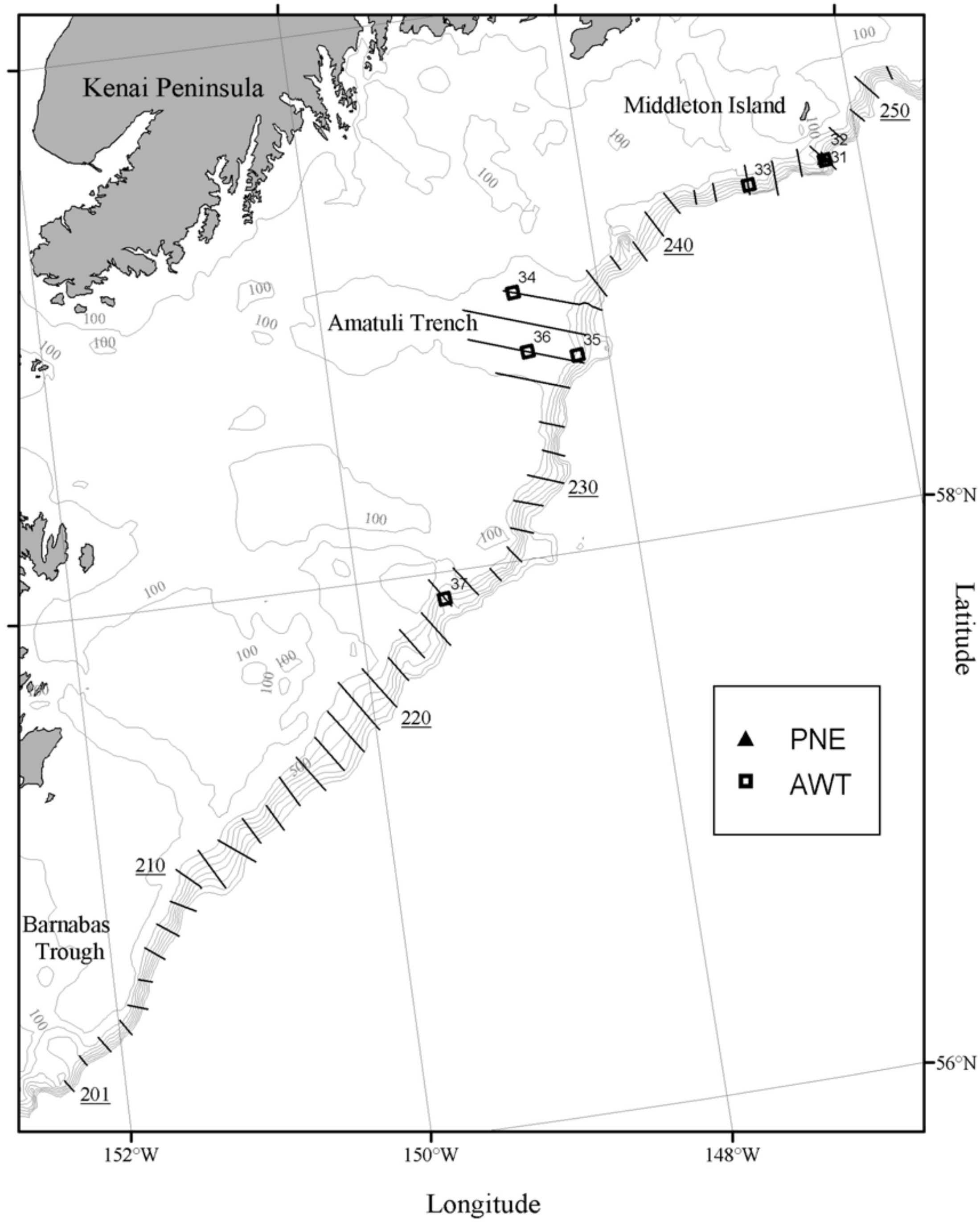

Figure 3. -- Transect lines and locations of Aleutian-wing trawl (AWT) and poly-Nor'eastern trawl (PNE) hauls during the winter 2008 echo integration-trawl survey of pollock on the Gulf of Alaska shelfbreak from Barnabas Trough to Middleton Island. Transect numbers are underlined.

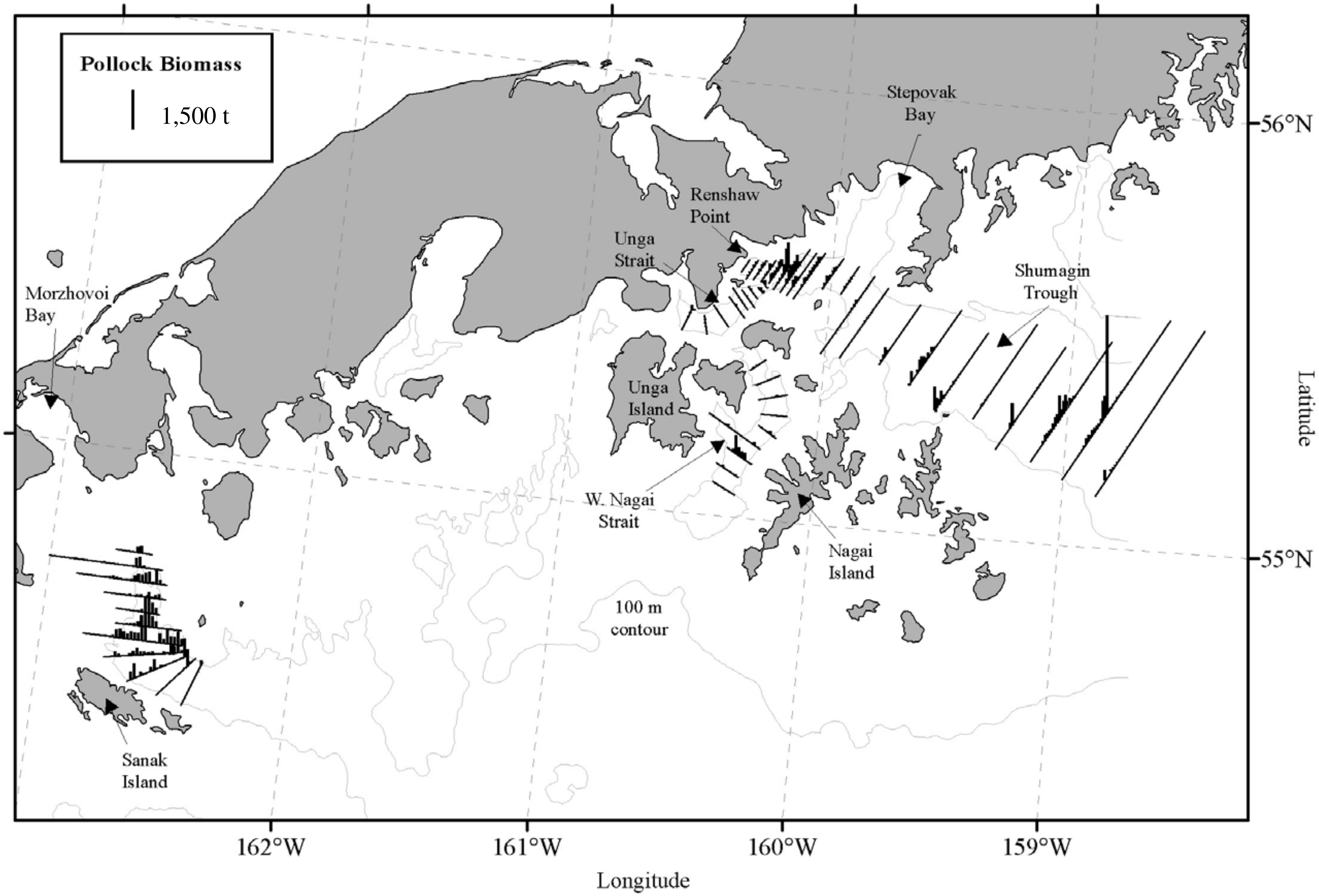

Figure 4. -- Estimated walleye pollock biomass in metric tons (t) along tracklines surveyed during the winter 2008 echo integration-trawl survey of the Shumagin Islands and Sanak Trough.

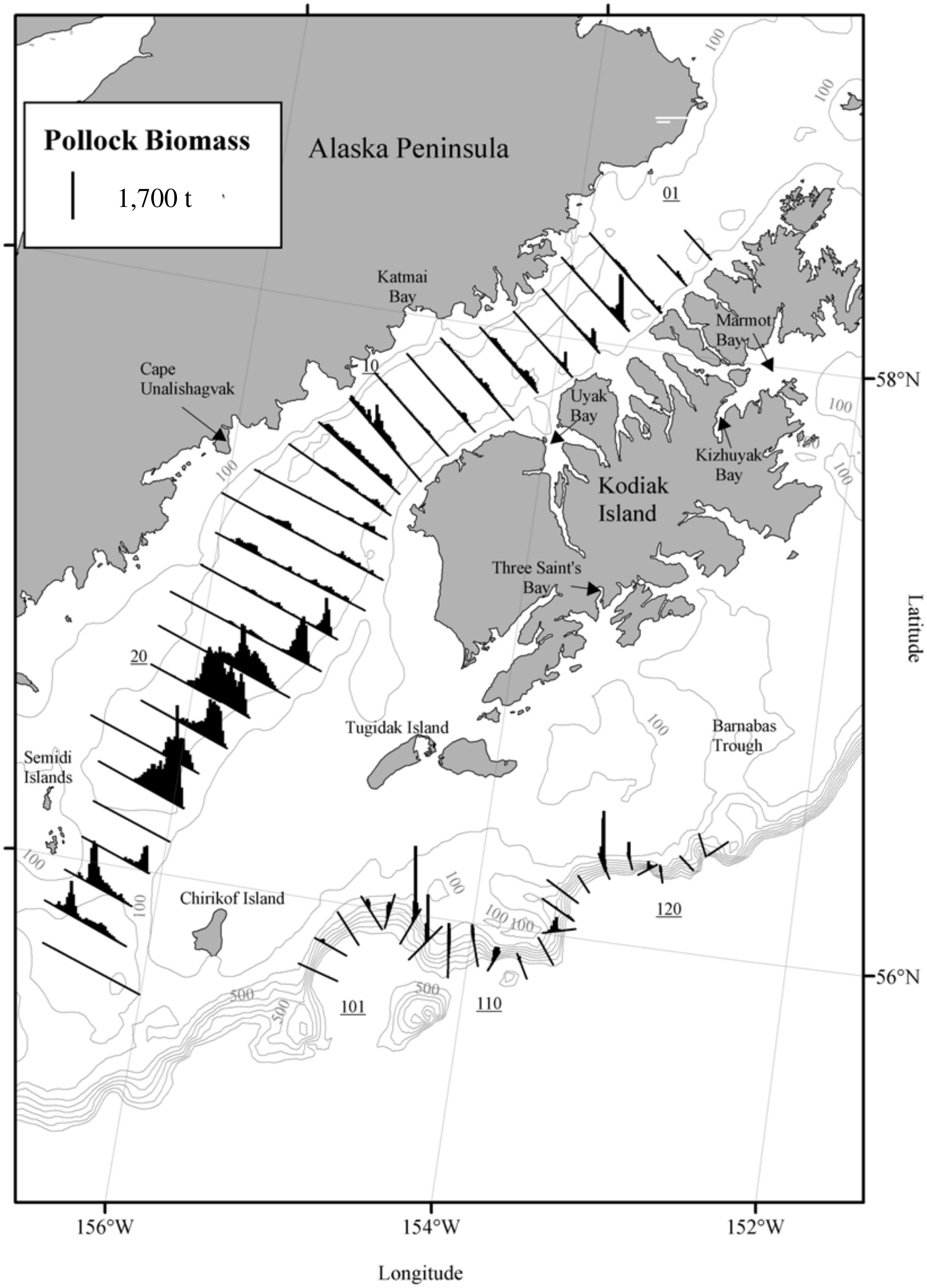

Figure 5. -- Estimated walleye pollock biomass in metric tons (t) along track lines surveyed during the winter 2008 echo integration-trawl survey of Shelikof Strait and the Gulf of Alaska shelfbreak from Chirikof Island to Barnabas Trough. Transect numbers are underlined.

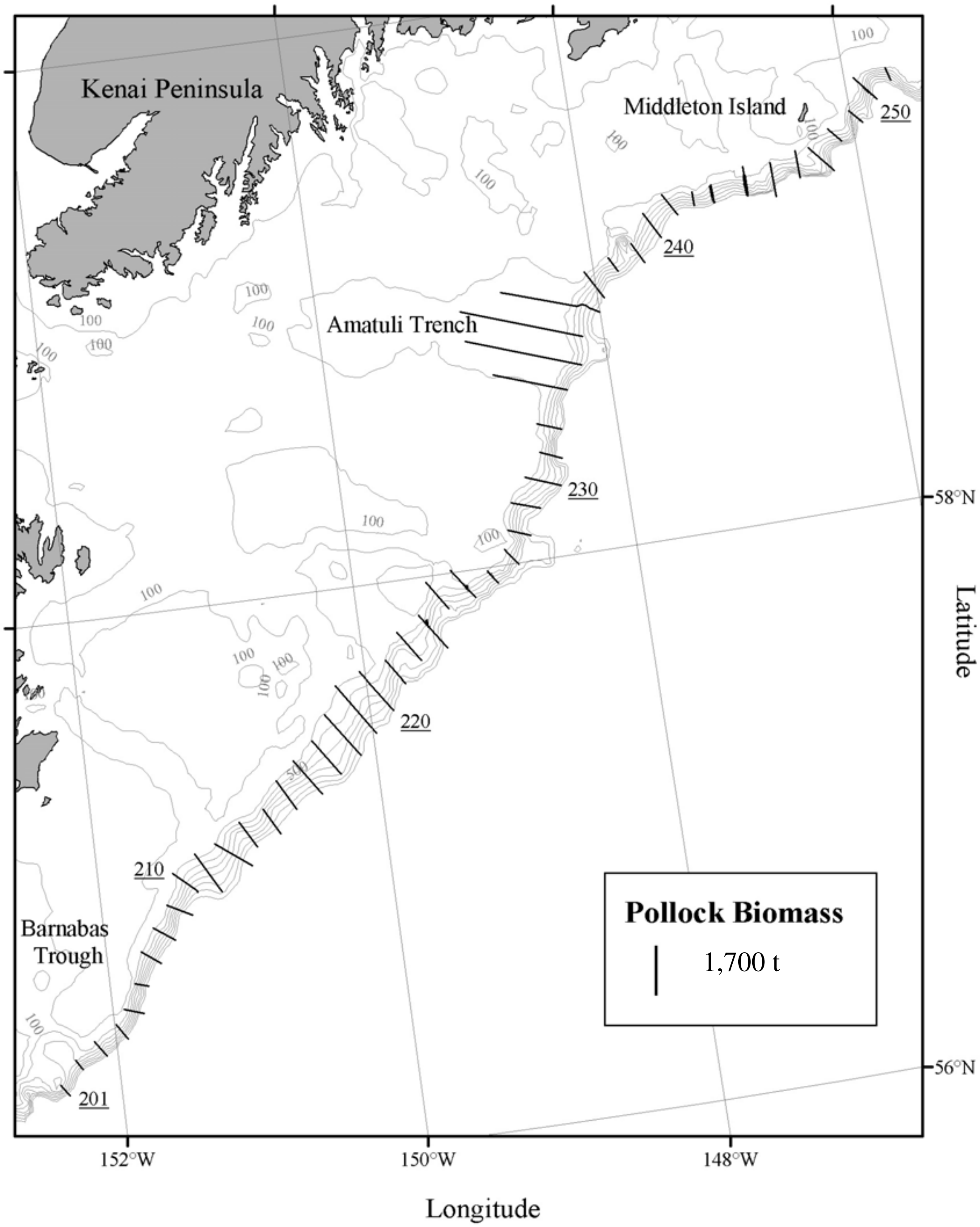

Figure 6. -- Estimated walleye pollock biomass in metric tons (t) along track lines surveyed during the winter 2008 echo integration-trawl survey of the Gulf of Alaska shelfbreak from Barnabas Trough to Middleton Island. Transect numbers are underlined.

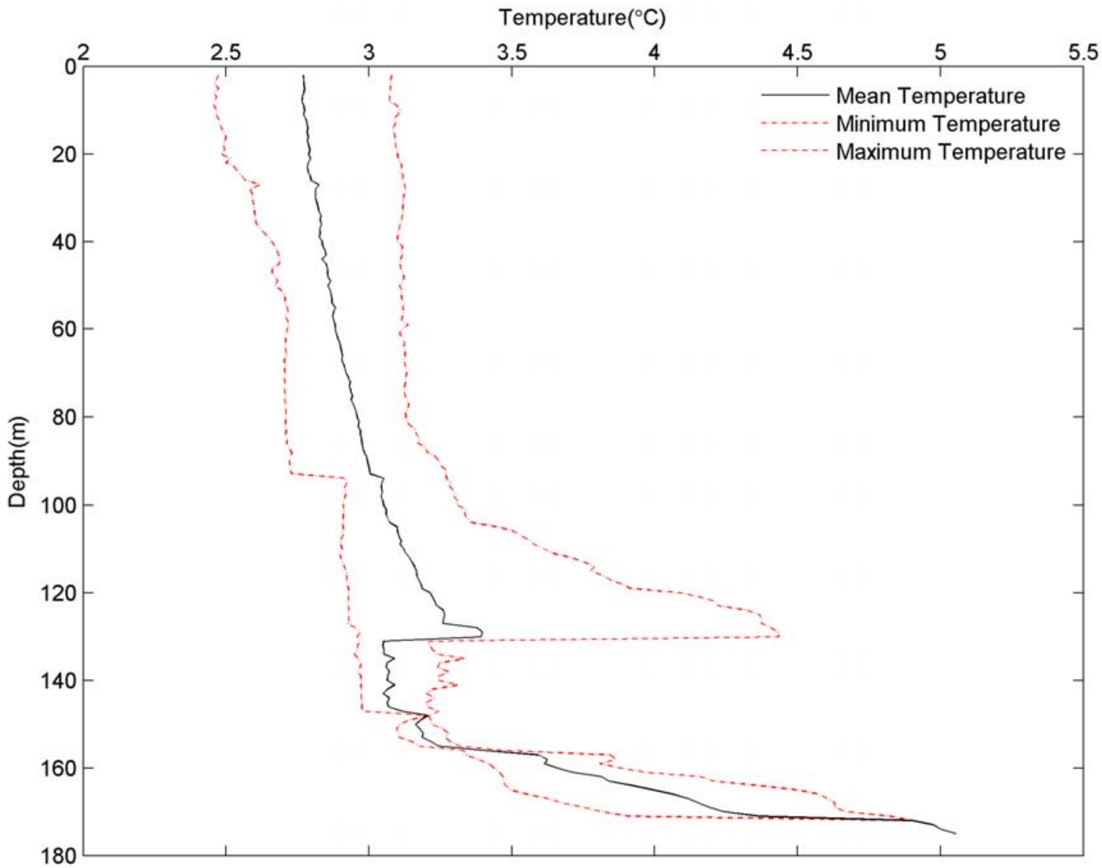

Figure 7. -- Average temperature (°C) (black line) by 1-m depth intervals observed during the winter 2008 echo integration-trawl survey of walleye pollock in the Shumagin Islands area. The dashed lines represent temperature ranges observed during the survey. Data were collected at 10 trawl locations.

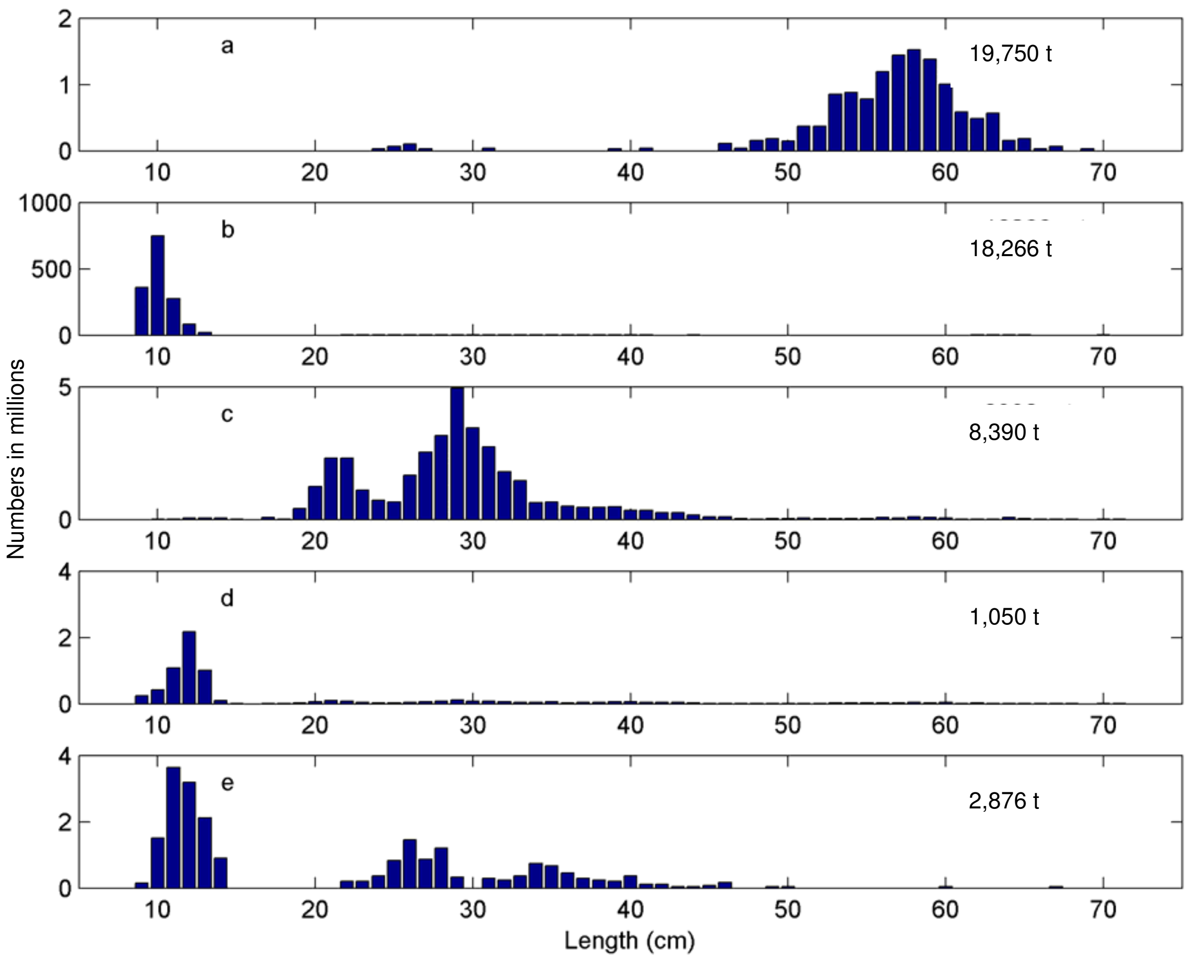

Figure 8. -- Length distribution of walleye pollock (numbers) for the 2008 echo integration-trawl survey of a) Sanak Trough, b) Shumagin Trough, c) Renshaw Point, d) Unga Strait, and e) West Nagai Strait.

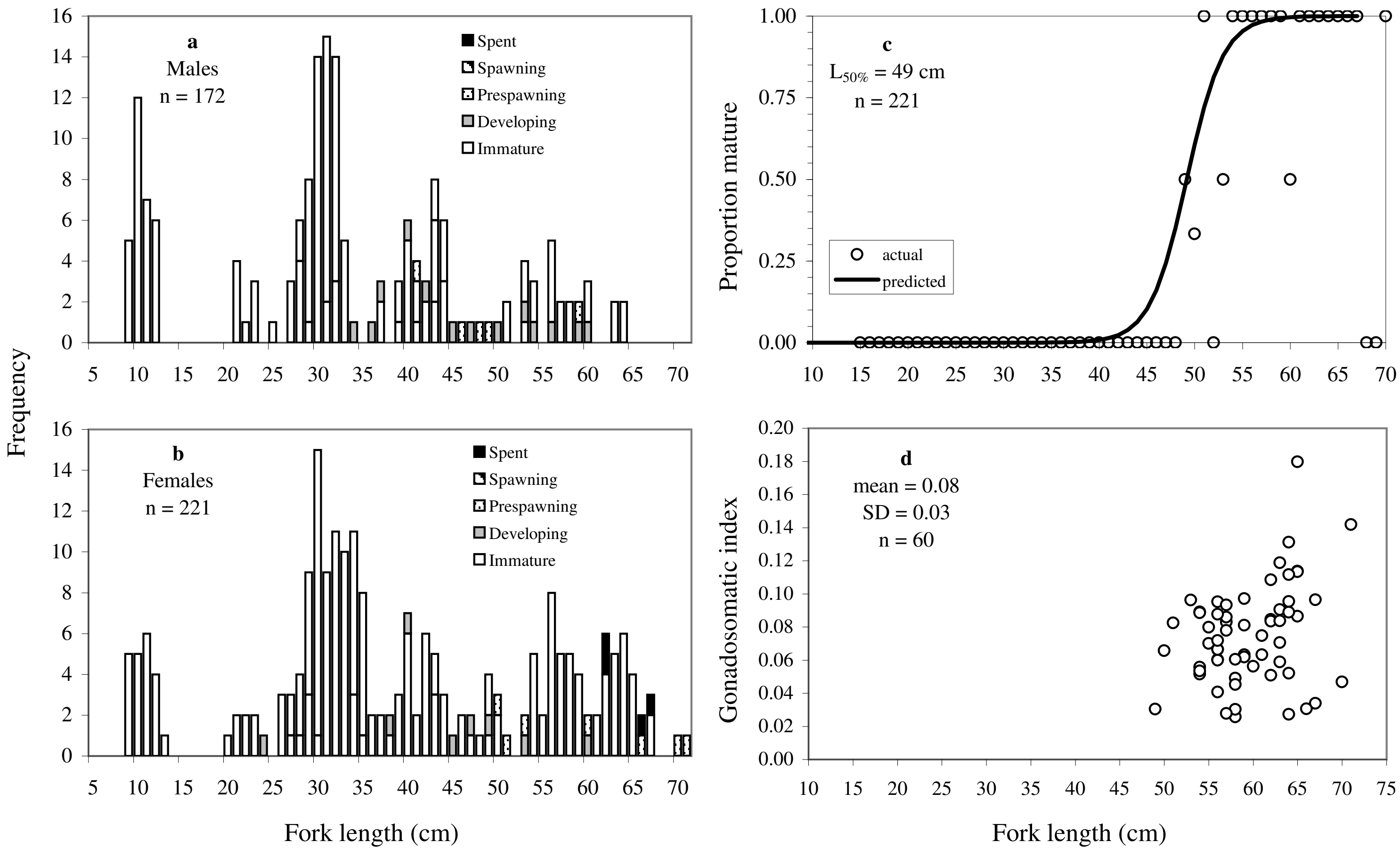

Figure 9. -- Maturity stages for (a) male and (b) female pollock, (c) proportion mature by 1-cm size group for female walleye pollock and (d) gonadosomatic index for pre-spawning females examined during the 2008 echo integration-trawl survey of Shumagin Islands.

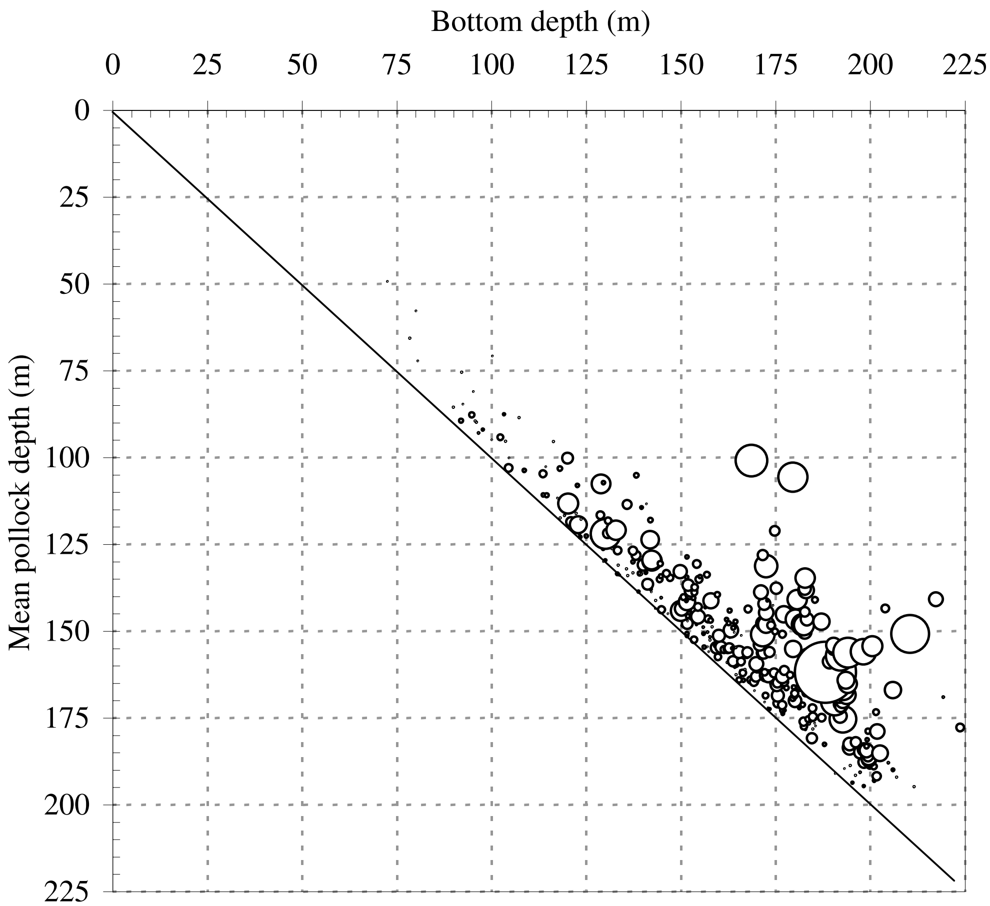

Figure 10. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for pollock observed during the winter 2008 echo integration-trawl survey of walleye pollock in the Shumagin Islands area. Circle size is scaled to the maximum biomass.

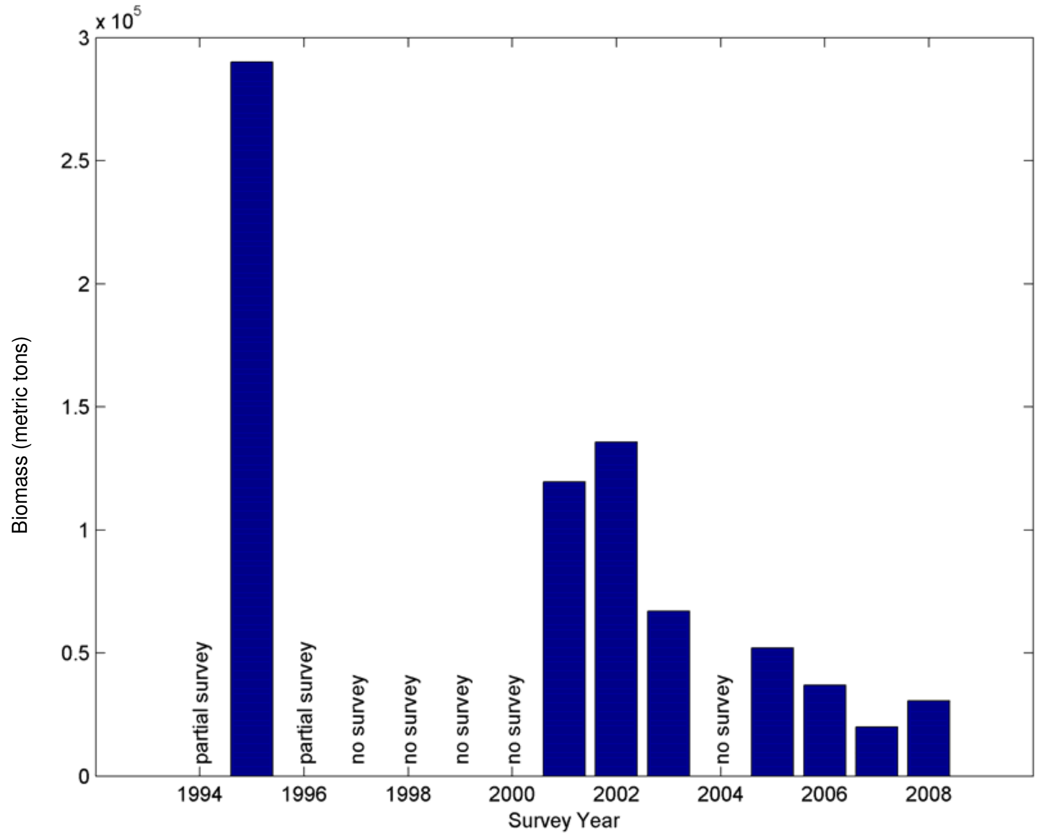

Figure 11. -- Summary of annual walleye pollock biomass estimates based on echo integration-trawl surveys of the Shumagin Islands area.

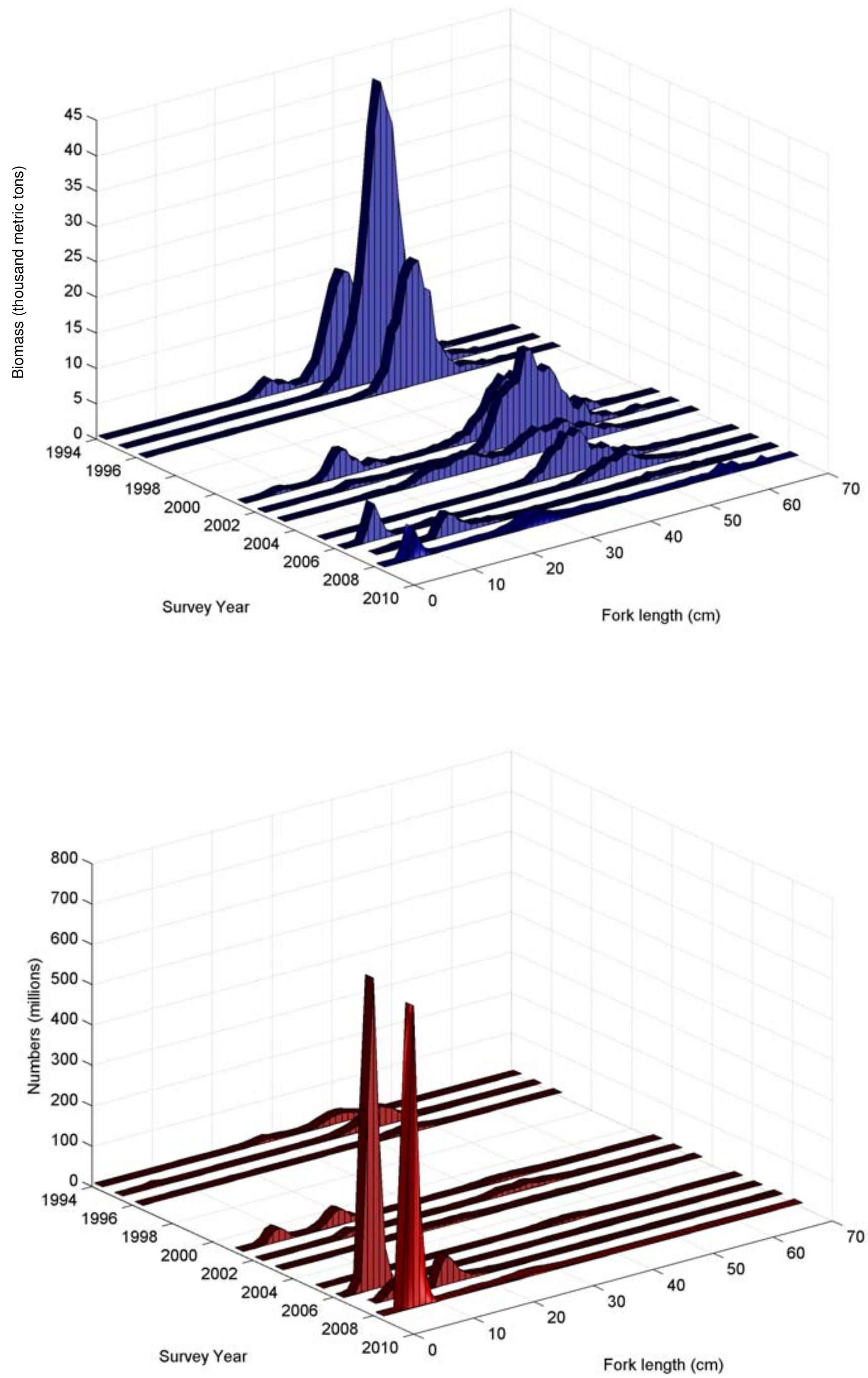

Figure 12. -- Historical walleye pollock biomass in thousands of metric tons (top) and numbers in millions (bottom) at length from the Shumagin Islands echo integration-trawl surveys since 1995. No survey was conducted in 1997-2000 or in 2004.

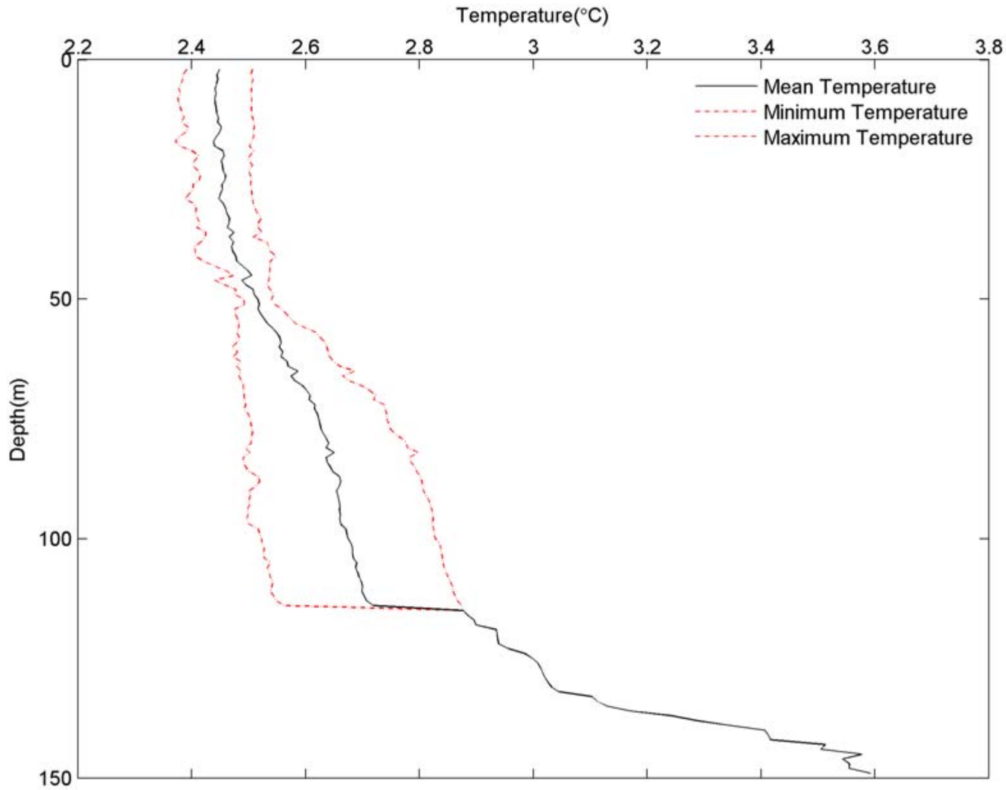

Figure 13. -- Average temperature (°C) (black line) by 1-m depth intervals observed during the winter 2008 echo integration-trawl survey of walleye pollock in the Sanak Trough area. The dashed lines represent temperature ranges observed during the survey. Data were collected at two trawl locations.

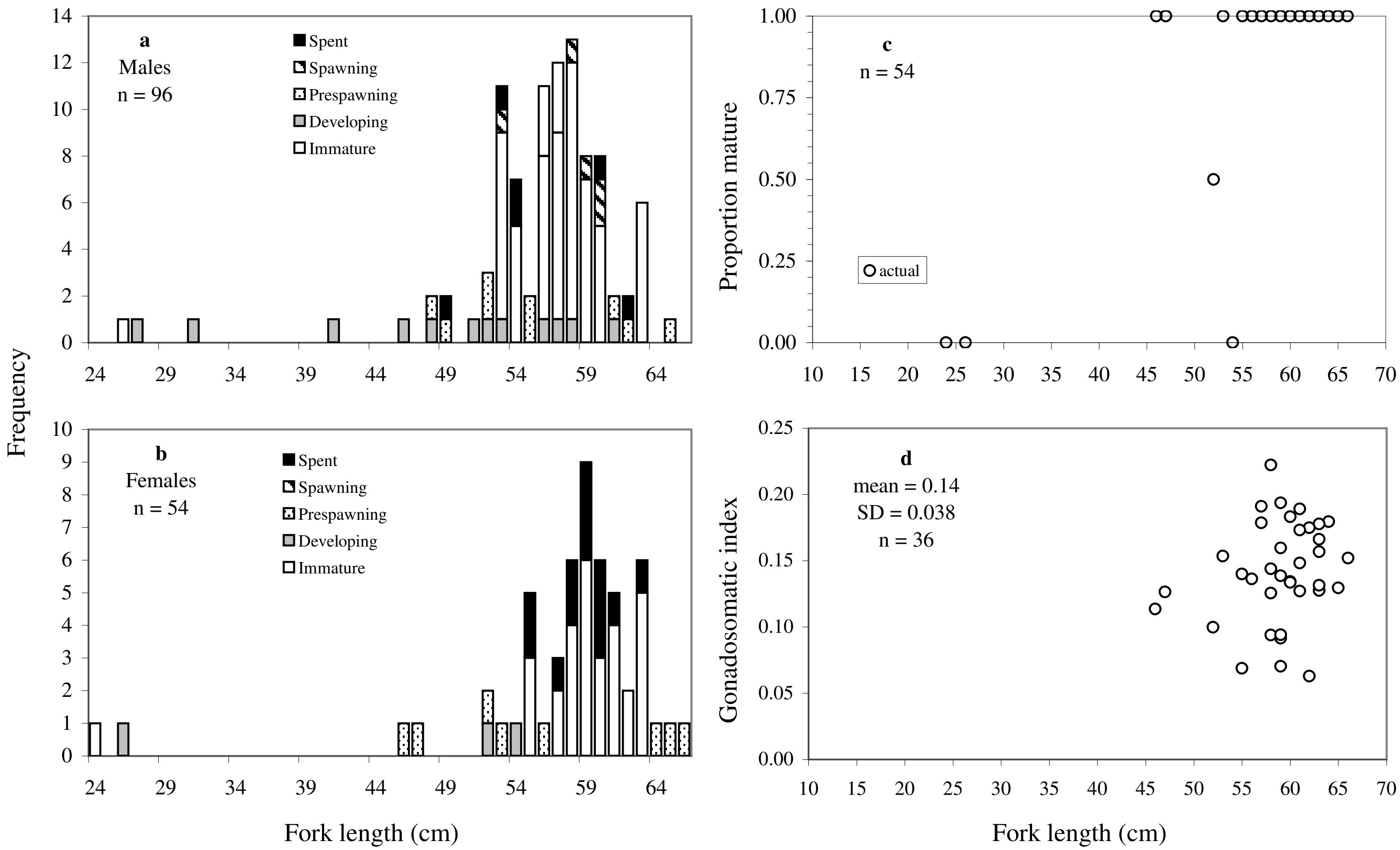

Figure 14. -- Maturity stages for (a) male and (b) female pollock, (c) proportion mature by 1-cm size group for female walleye pollock, and (d) gonadosomatic index for pre-spawning females examined during the 2008 echo integration-trawl survey of Sanak Trough.

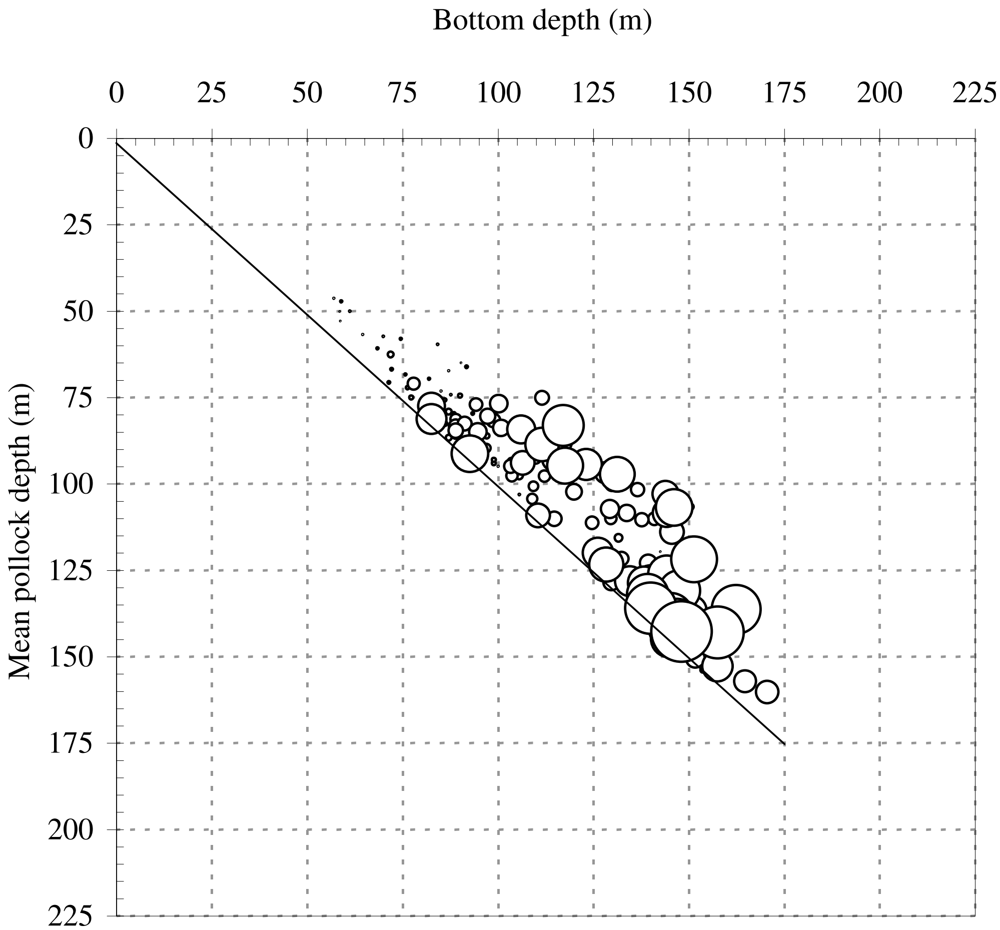

Figure 15. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for pollock observed during the winter 2007 echo integration-trawl survey of walleye pollock in Sanak Trough. Circle size is scaled to the maximum biomass.

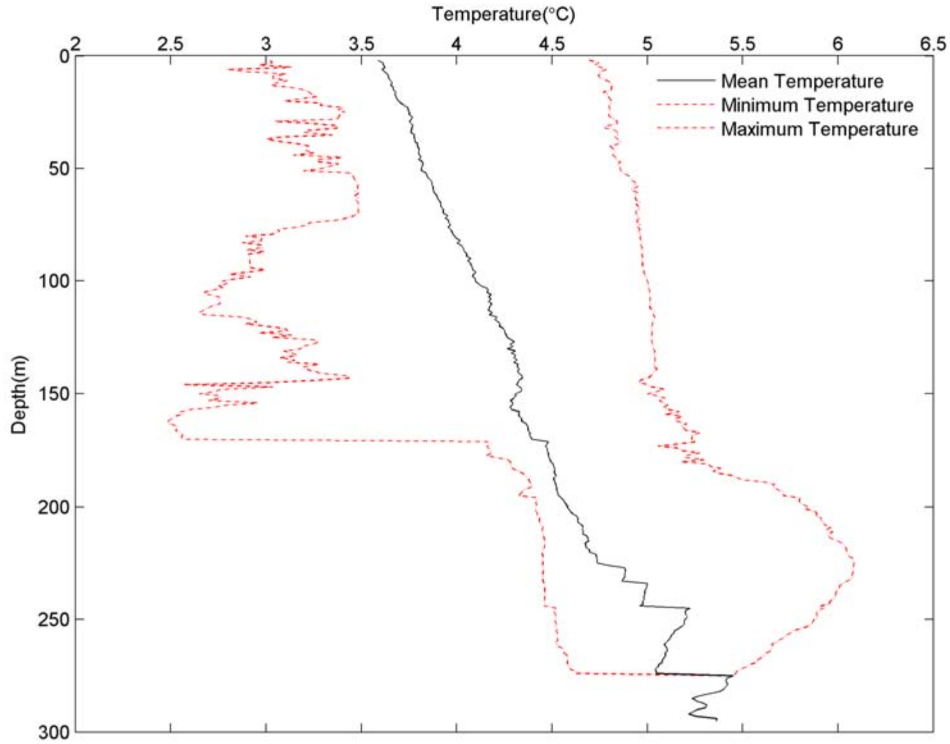

Figure 16. -- Average temperature (°C) (black line) by 1-m depth intervals observed during the winter 2008 echo integration-trawl survey of walleye pollock in the Shelikof Strait area. The dashed lines represent temperature ranges observed during the survey. Data were collected at 14 locations.

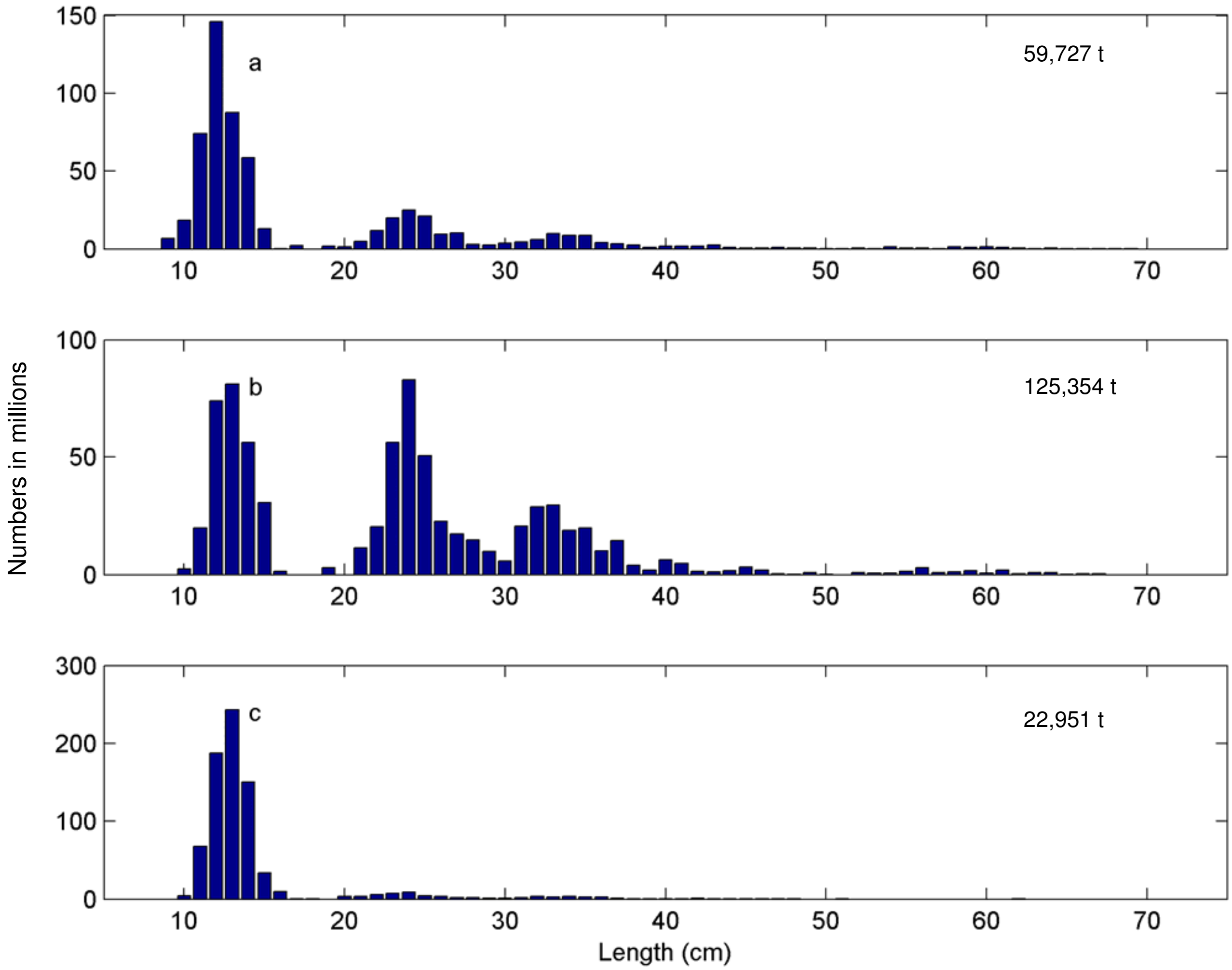

Figure 17. -- Length distribution of walleye pollock (numbers) for the 2008 echo integration-trawl survey of a) Shelikof Strait proper b) south of Kodiak Island to the Semidi Islands, and c) between the Semidi Islands and Chirikof Island.

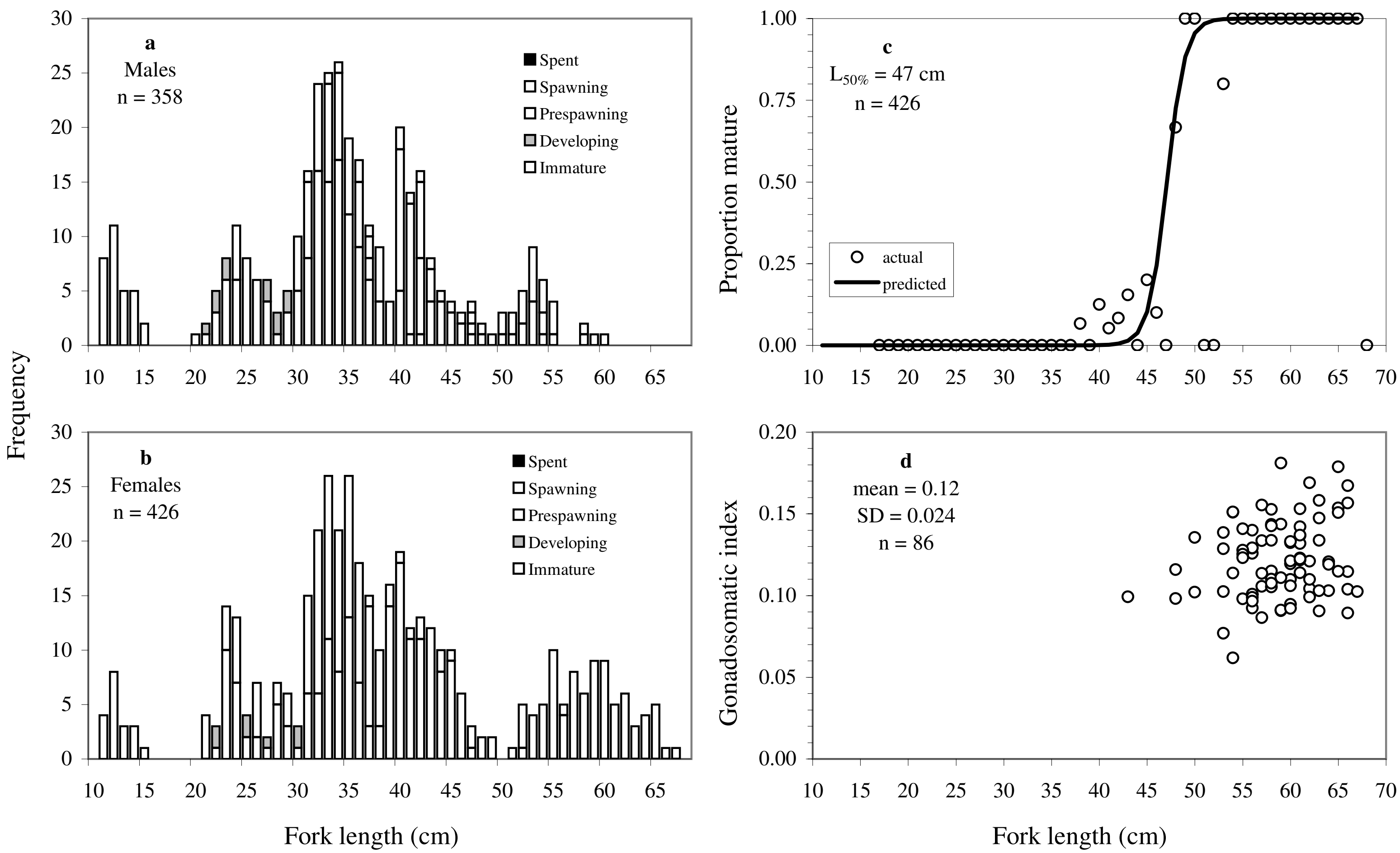

Figure 18.— Maturity stages for (a) male and (b) female pollock, (c) proportion mature by 1-cm size group for female walleye pollock and (d) gonadosomatic-index for pre-spawning females examined during the 2008 echo integration-trawl survey of Shelikof Strait.

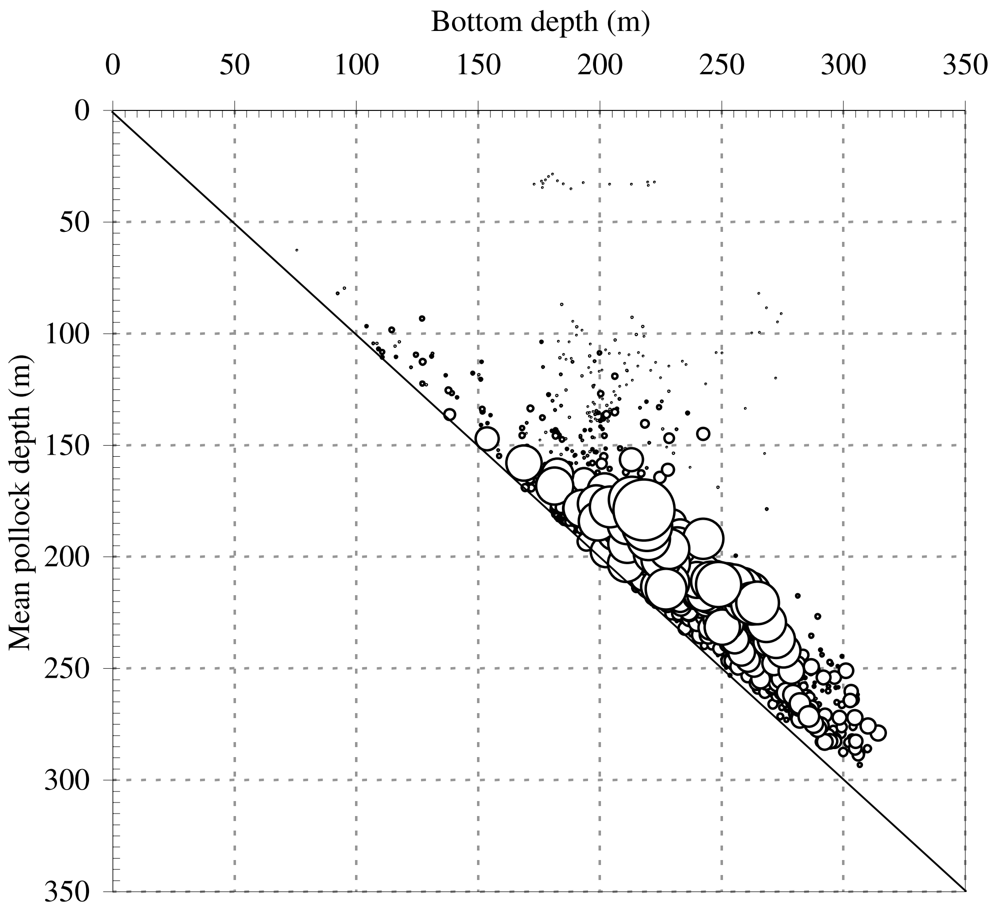

Figure 19. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for walleye pollock observed during the winter 2008 echo integration-trawl survey of the the Shelikof Strait area. Circle size is scaled to the maximum biomass.

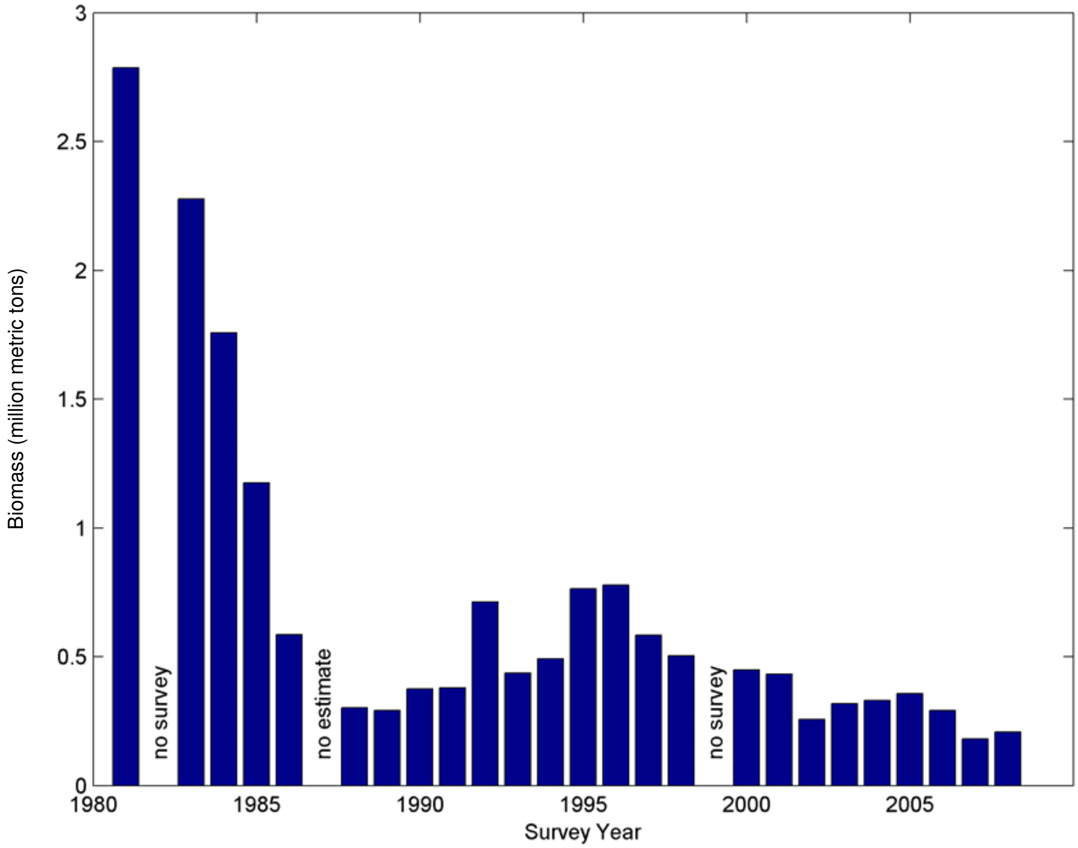

Figure 20. -- Summary of annual walleye pollock biomass estimates based on echo integration-trawl surveys of the Shelikof Strait area.

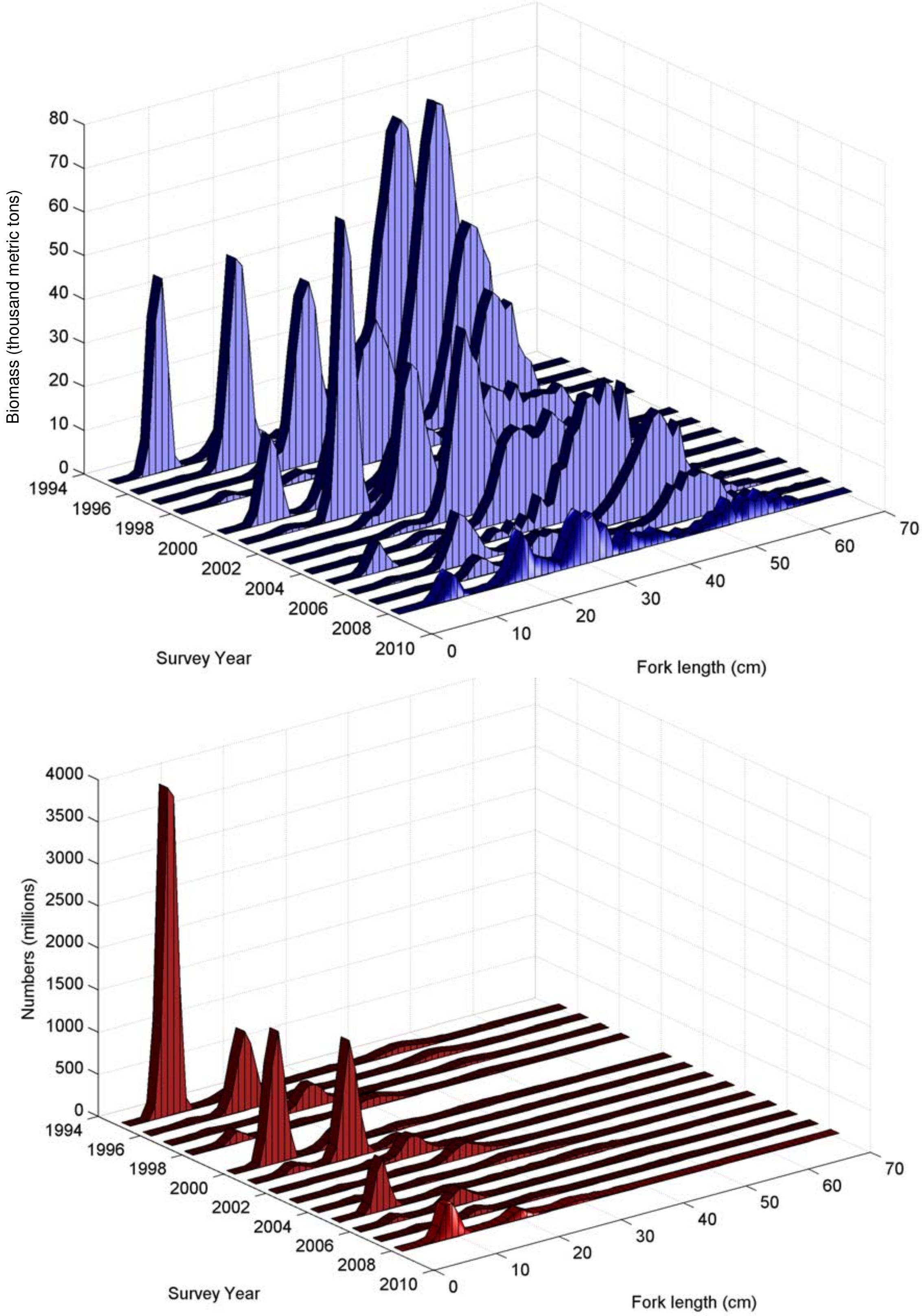

Figure 21. -- Historical walleye pollock biomass in thousands of metric tons (top) and numbers in millions (bottom) at length from the Shelikof Strait echo integration-trawl surveys since 1995. No survey was conducted in 1999.

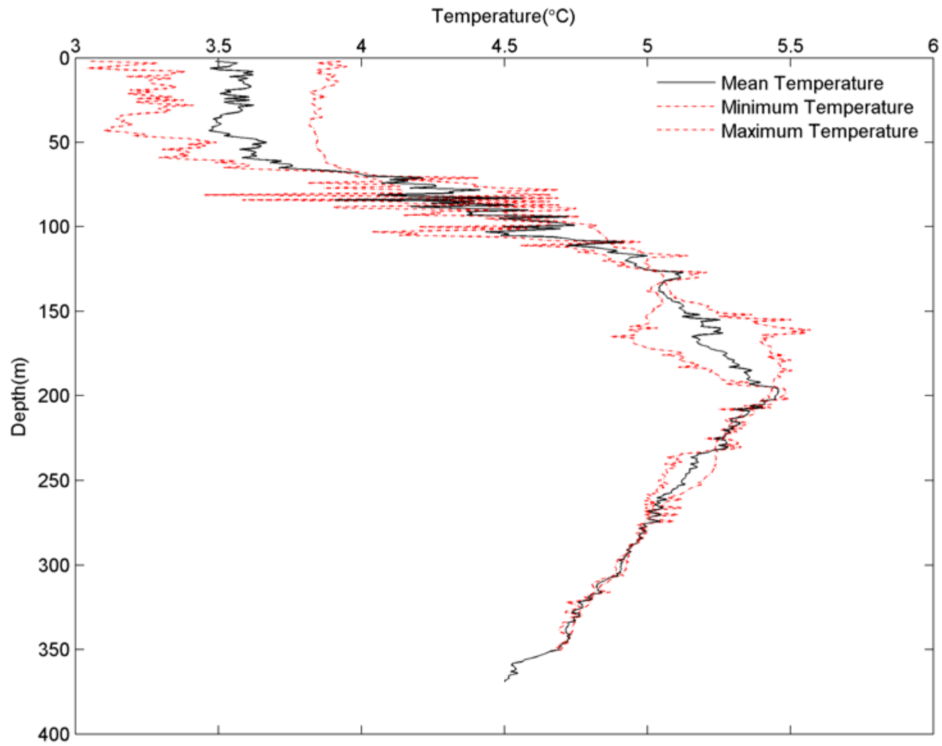

Figure 22. -- Average temperature (°C) (black line) by 1-m depth intervals observed during the winter 2008 echo integration-trawl survey of walleye pollock in the GOA shelfbreak from Chirikof Island to Barnabas Trough. The dashed lines represent temperature ranges observed during the survey. Data were collected at two trawl locations.

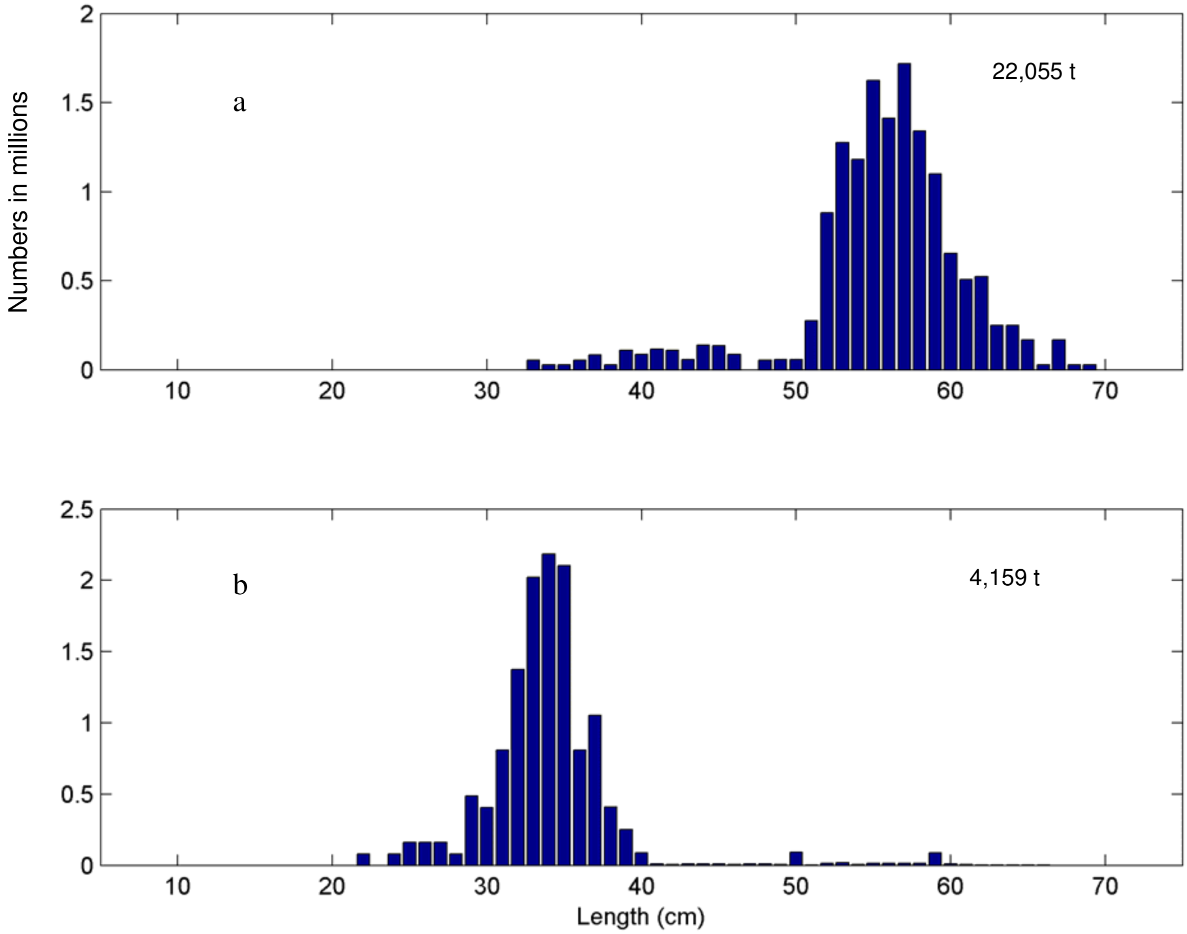

Figure 23. -- Length distribution of walleye pollock (numbers) for the 2008 echo integration-trawl survey of a) the GOA shelfbreak from Chirikof Island to Barnabas Trough and b) the GOA shelfbreak from Barnabas Trough to Middleton Island.

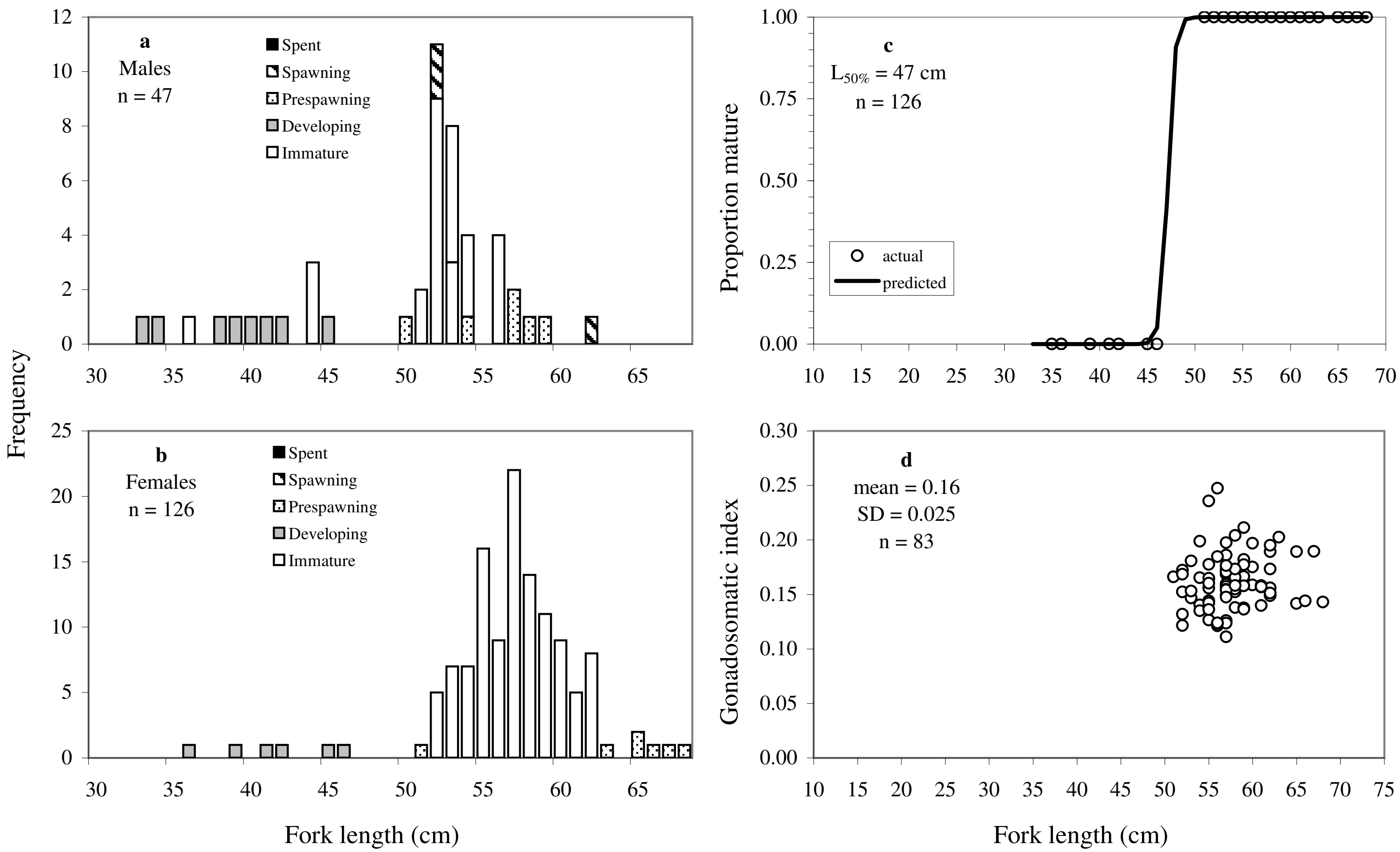

Figure 24. -- Maturity stages for (a) male and (b) female pollock, (c) proportion mature by 1-cm size group for female walleye pollock, and (d) gonadosomatic index for pre-spawning females examined during the 2008 echo integration-trawl survey of the Gulf of Alaska shelfbreak from Chirikof Island to Barnabas Trough.

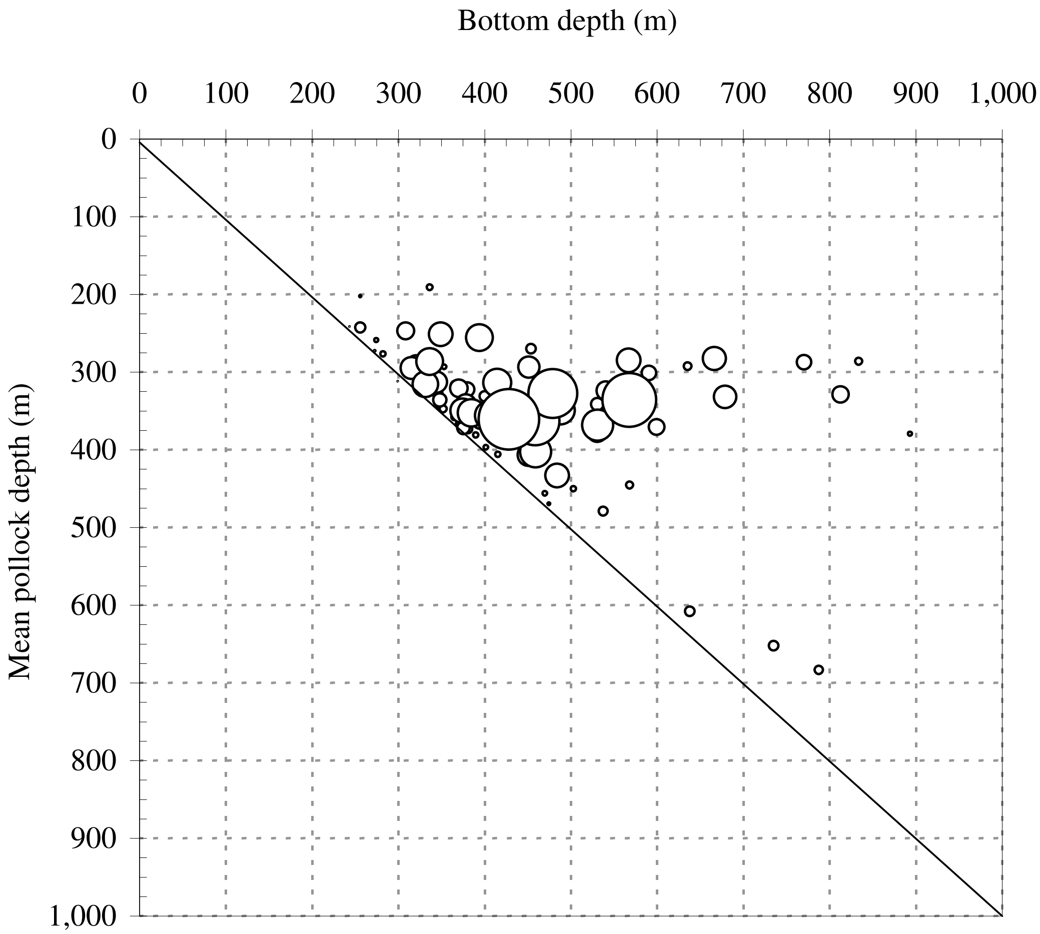

Figure 25. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for walleye pollock observed during the winter 2008 echo integration-trawl survey of the Chirikof Island area. Circle size is scaled to the maximum biomass.

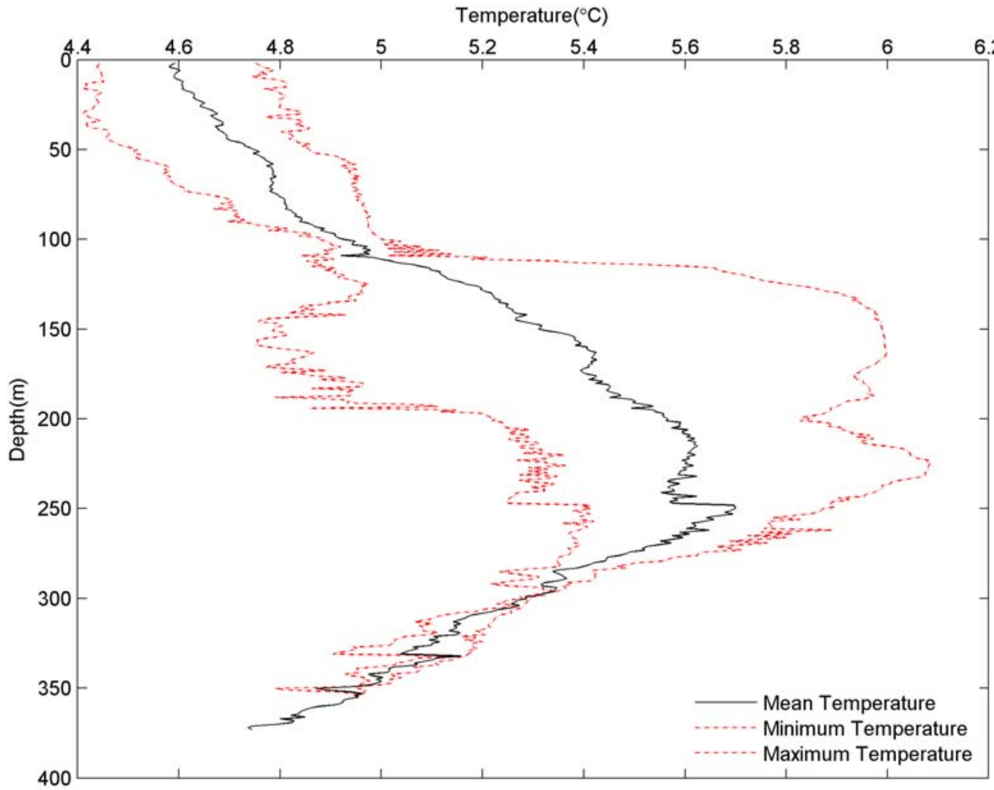

Figure 26. -- Average temperature (°C) (black line) by 1-m depth intervals observed during the winter 2008 echo integration-trawl survey of walleye pollock along the GOA shelfbreak from Barnabas Trough to Middleton Island. The dashed lines represent temperature ranges observed during the survey. Data were collected at seven trawl locations.

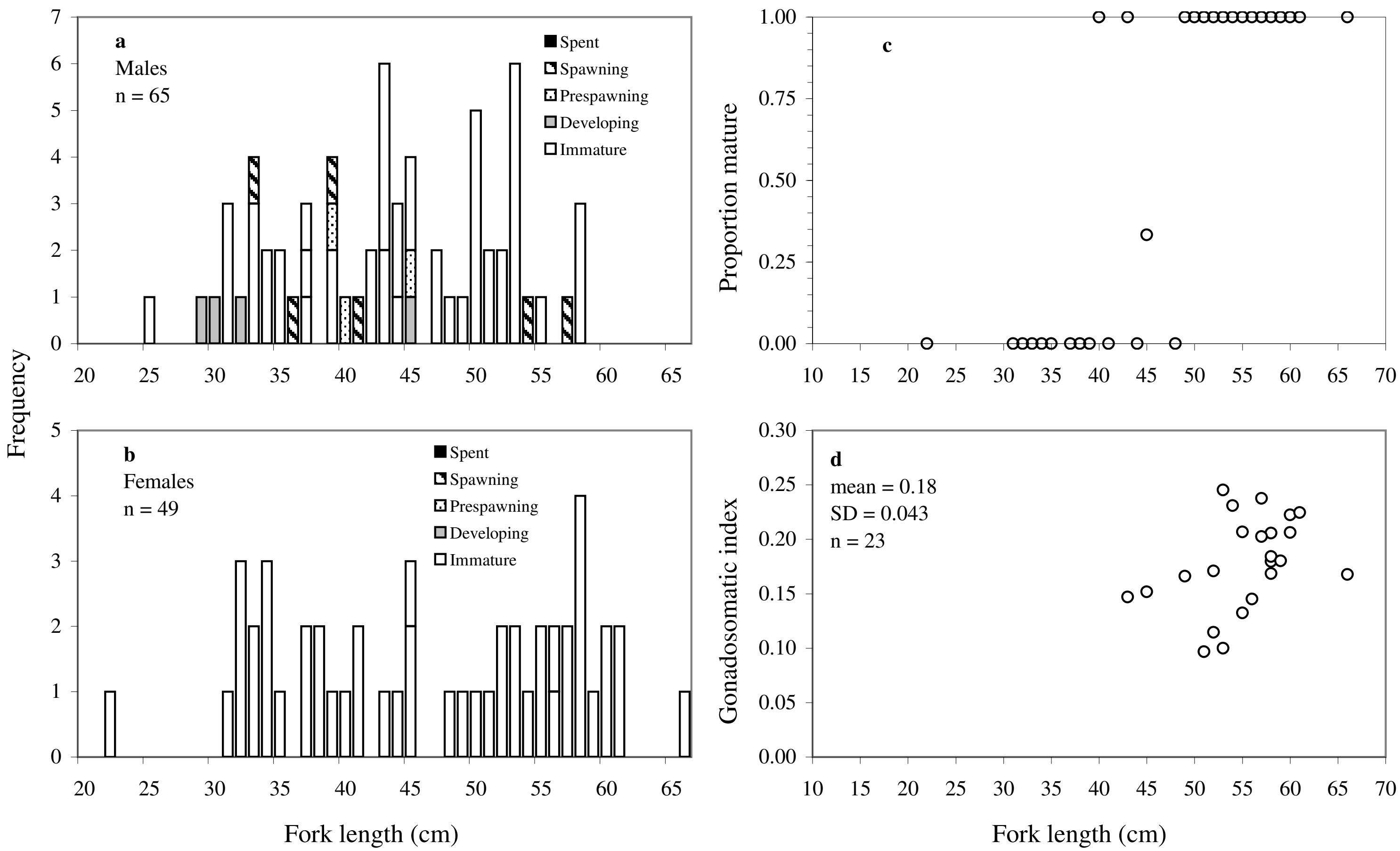

Figure 27. -- Maturity stages for (a) male and (b) female pollock, (c) proportion mature by 1-cm size group for female walleye pollock and (d) gonadosomatic index for pre-spawning females examined during the 2008 echo integration-trawl survey of the Gulf of Alaska shelfbreak from Barnabas Trough to Middleton Island.

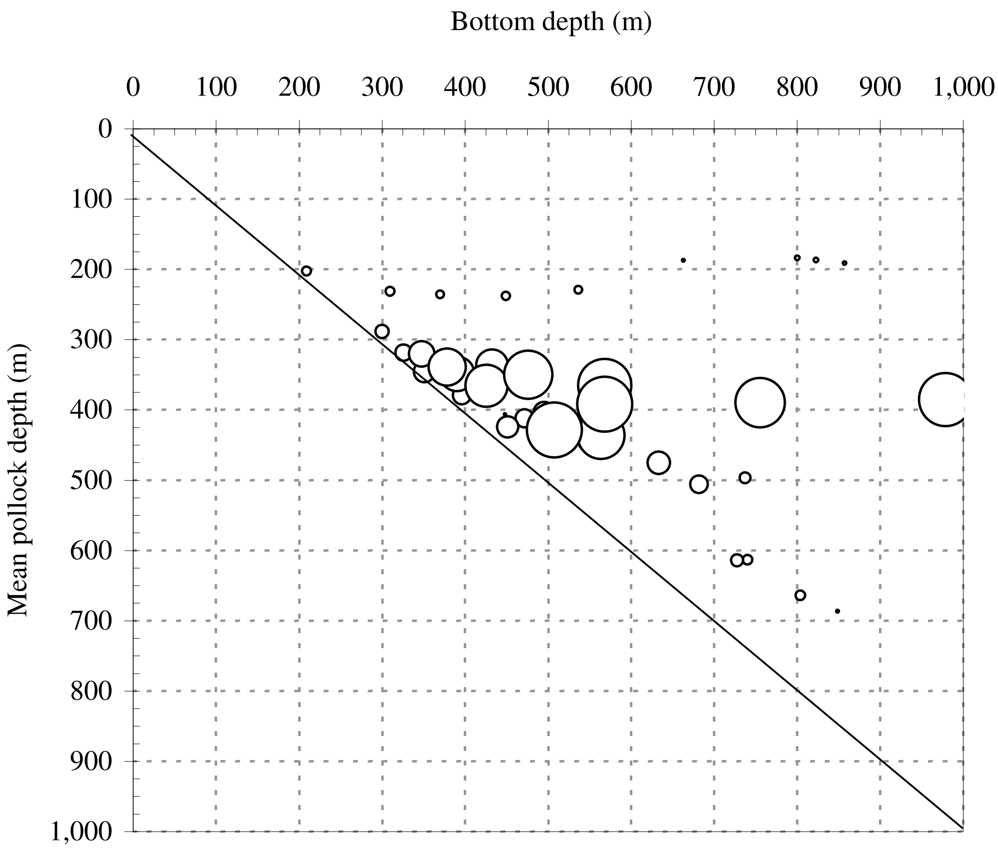

Figure 28. -- Average pollock depth (weighted by biomass) versus bottom depth (m) by 0.5 nautical mile for walleye pollock observed during the winter 2008 echo integration-trawl survey of the Gulf of Alaska shelfbreak from Barnabas Trough to Middleton Island. Bubble size is scaled to the maximum biomass.

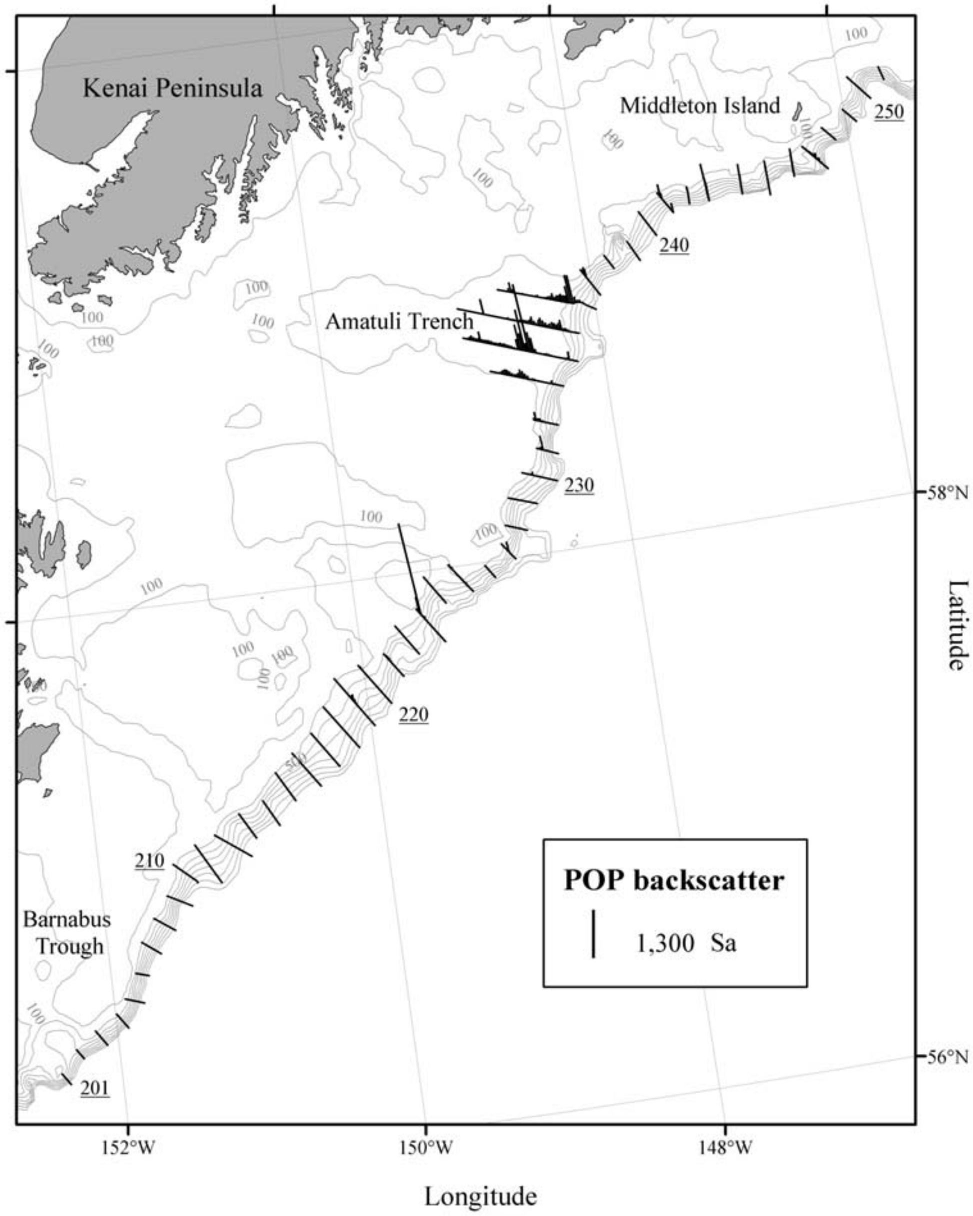

Figure 29. -- Acoustic backscattering attributed to Pacific ocean perch during the winter 2008 echo integration-trawl survey of the Gulf of Alaska shelfbreak from Barnabas Trough to Middleton Island. Transect numbers are underlined.