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Results of the March 2012 Acoustic-Trawl Survey of Walleye Pollock (*Theragra chalcogramma*) Conducted in the Southeastern Aleutian Basin Near Bogoslof Island, Cruise DY2012-02

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Results of the March 2012 Acoustic-Trawl Survey of Walleye Pollock (*Theragra chalcogramma*) Conducted in the Southeastern Aleutian Basin Near Bogoslof Island, Cruise DY2012-02

by

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December 2012

INTRODUCTION

Scientists from the Midwater Assessment and Conservation Engineering (MACE) Program of the Alaska Fisheries Science Center (AFSC) regularly conduct acoustic-trawl (AT) surveys in late February and early March to estimate pre-spawning walleye pollock (*Theragra chalcogramma*) abundance in the southeastern Aleutian Basin near Bogoslof Island (Honkalehto et al. 2008a). These surveys were conducted annually between 1988 and 2007 (with the exception of 1990 and 2004), and biennially starting in 2009. Because of vessel mechanical and personnel issues, the planned 2011 survey was rescheduled for 2012. The biomass estimate for walleye pollock within the Central Bering Sea (CBS) Convention Specific Area obtained during these AT surveys provides an index of abundance for the Aleutian Basin walleye pollock stock[1].

In 2012, two AT survey tracks were completed. The first (primary) survey track covered the same area surveyed in 2009, and the second survey track was located just north of the primary survey track to observe whether walleye pollock were present in deeper waters, as they were in historical surveys (e.g., 1992). This report summarizes observed walleye pollock distribution and biological information from the winter 2012 AT survey, and provides an abundance estimate. It also summarizes physical oceanographic observations and acoustic system calibration results.

METHODS

MACE scientists conducted the acoustic-trawl survey between 7 and 15 March 2012 (Cruise DY2012-02) aboard the NOAA ship *Oscar Dyson*, a 64-m stern trawler equipped for fisheries and oceanographic research.

[1] Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea, Annex (Part 1), Treaty Doc. 103-27. 1994. Hearing before the Committee on Foreign Relations U.S. Senate, 103rd Congress, 2nd Session. Washington: U.S. Government Printing Office.

Acoustic Equipment, Calibration, and Data Collection

Acoustic measurements were collected with a Simrad ER60 scientific echosounding system using 18, 38, 70, 120, and 200 kHz split-beam transducers (Simrad 1997, 2004; Bodholt and Solli 1992). The transducers were installed on the bottom of a retractable centerboard extending 9 m below the water's surface. System electronics were housed inside the vessel in a permanent laboratory space dedicated to acoustics.

Standard sphere acoustic system calibrations were conducted on 14 February and 26 March to measure acoustic system performance. During calibrations, the *Oscar Dyson* was anchored at the bow and stern. Weather, sea state conditions, and acoustic system settings were recorded. A tungsten carbide sphere (38.1 mm diameter) was suspended below the centerboard-mounted transducers and used to calibrate the 38, 70, 120, and 200 kHz systems. The copper sphere (64 mm diameter) was then suspended and used to calibrate the 18 kHz system. After each sphere was centered on the acoustic axis, split-beam target-strength, and echo-integration measurements were collected to estimate transducer gains (Foote et al. 1987). Transducer beam characteristics were modeled by moving each sphere through a grid of angular coordinates and recording target-strength measurements using Simrad EKLOBES software (Simrad 2004). Acoustic system settings used during the survey were based on 38 kHz results obtained during the February calibration; however, for the analyses, gain and beam pattern parameters measured during the February and March calibrations were used to provide a final-analysis parameter set (Table 1).

Acoustic backscattering measurements were collected 24 hours a day between 16 m from the ocean surface to within 0.5 m of the bottom, unless the bottom exceeded 1,000 m, the lower limit of data collection. Acoustic telegram data from all frequencies were logged with Myriax EchoLog 500 (v. 4.70.1.14256) and raw data were logged using ER60 software (v. 2.2.0). Acoustic measurements were analyzed with the final-analysis parameter set using Myriax Echoview post-processing software (v. 5.1.41.20118). The sounder-detected bottom line used in analysis was a mean value derived from 3-5 frequency-dependent sounder-detected bottom lines (Jones et al. 2011). Results presented in this report were based on the 38 kHz echo-integration raw data with a post-processing S_v threshold of -70 decibels (dB).

Trawl Gear and Oceanographic Equipment

The *Oscar Dyson* was equipped with an Aleutian wing 30/26 trawl (AWT) to sample midwater organisms. 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, where it was fitted with a single 12 mm (0.5 in) codend liner for all trawl samples except trawl 4, which had a 0.25-inch codend liner. The AWT was fished with 82.3 m (270 ft) of 1.9-cm (0.75 in) diameter (8 H19 wire) non-rotational dandylines, 226.8-kg (500 lb) or 340.2-kg (750-lb) tom weights on each side, and 5 m^2 Fishbuster trawl doors [1,247 kg (2,750 lb) each]. Trawl depth was monitored using a Simrad ITI net mensuration system. Due to mechanical failure of the other net sounder equipment attached to the trawl headrope during fishing (i.e., Furuno CN-24 acoustic link and Simrad FS70 third-wire), the measurement for the vertical net opening was unavailable, but was estimated at 28 m using measurements from previous cruises.

Physical oceanographic measurements were collected throughout the cruise. Temperature-depth profiles were obtained at trawl sites with a Sea-Bird Electronics temperature-depth probe (SBE-39) attached to the trawl headrope. Surface temperature was measured continuously using the Furuno T-2000 external probe located mid-ship, approximately 1.4 m below the surface of the water. Other environmental measurements (e.g., surface salinity) were also recorded using the ship's sensors interfaced with the ship's Scientific Computing System (SCS). Surface temperatures were averaged to 0.5-nmi intervals for plotting purposes.

Survey Design

The survey occurred during 7-15 March and covered two survey tracks in the southeast Aleutian Basin. The primary survey was nearest to the Aleutian Islands and consisted of 35 north-south parallel transects spaced 3 nmi apart. The second survey track was located just north of the primary, in deeper water, and consisted of 12 north-south parallel transects spaced 9 nmi apart. These transects were essentially north-extensions of every third line of the primary survey track (Fig. 1). The survey began with the most easterly transect in the primary survey and proceeded westward from Unalaska Island at about 167°W longitude to the Islands of Four Mountains near 170°W (Fig. 1). A random start position was generated for the first transect. After the primary survey was complete, the ship surveyed the north-extension transects, proceeding from west to east. The survey covered 3,656 nmi^2 of the CBS Convention Specific Area, 1,455 nmi^2 in the primary region, and 2,201 nmi^2 in the north extension region. The average transecting speed was about 11 knots.

Trawl hauls were conducted to identify the species composition of observed acoustic scattering layers and to provide biological samples. Trawling speed averaged approximately 3.3 knots. Walleye pollock were sampled to determine sex, fork length (FL), body weight, age, gonad maturity, and ovary weight of selected females. Walleye pollock fork lengths were measured to the nearest millimeter (mm). Smaller forage fish such as lanternfishes (family Myctophidae) were measured to the nearest millimeter (mm) standard length (SL). An electronic motion-compensating scale (Marel M60) was used to weigh individual walleye pollock specimens to the nearest 2 g. Walleye pollock otoliths were collected and stored in 50% glycerin/thymol-water solution for age determinations. Gonad maturity was determined by visual inspection and categorized as immature, developing, pre-spawning, spawning, or post-spawning[2]. Gonado-somatic-indicies (GSI) were computed as ovary weight/body weight for pre-spawning mature female walleye pollock. Trawl station and biological measurements were electronically recorded and stored in the Catch Logger for Acoustic Midwater Surveys (CLAMS) relational database.

Data Analysis

Walleye pollock abundance was estimated by combining acoustic backscatter and trawl information. Acoustic backscatter identified as either walleye pollock, fish, or an undifferentiated mixture of primarily macrozooplankton was binned at 0.5 nmi horizontal by 20 m vertical resolution and stored in a database. Trawl information provided walleye pollock length and age compositions, and mean weight-at-length data necessary to scale acoustic measurements.

[2] ADP Codebook. 2012. Unpublished document. RACE Division, AFSC, NMFS, NOAA; 7600 Sand Point Way NE, Seattle, WA 98115. Available online http://www.afsc.noaa.gov/RACE/groundfish/adp_codebook.pdf

Walleye pollock length measurements from different hauls were combined into length strata based on geographic proximity and the similarity in size composition data. In the Bogoslof Island area, pre-spawning walleye pollock aggregations are often densely packed and vertically stratified by sex (Schabetsberger et al. 1999). Female walleye pollock are usually observed in the shallower layers, while males are abundant in deeper layers. This stratified layering makes sampling the deeper layers difficult without oversampling the shallower layer. Because female walleye pollock are longer than males after about 5 years of age, biased estimates of sex composition from hauls can result in biased estimates of population size and age composition. As in previous Bogoslof surveys, the sample sex ratio was assumed to be 50:50. Thus, to lessen the impact of any one haul's contribution of males or females, a male size composition was derived by averaging proportions-at-length for each haul in the length stratum and the same was done for female fish. The resultant male and female size compositions were then averaged to provide a sexes-combined size composition for each length stratum.

Mean fish weight-at-length was estimated using trawl catches. Weight-at-length measurements from individual walleye pollock were used to estimate mean fish weight-at-length for each length interval (to the nearest 1.0 cm) when there were more than five fish for that length interval; otherwise, weight at a given length interval was estimated from a linear regression of the natural logs of the length and weight data (De Robertis and Williams 2008).

Walleye pollock numbers and biomass for each length stratum were estimated as in Honkalehto et al. (2008b). Total biomass or numbers were estimated by summing the stratum estimates. Numbers and biomass at age were estimated by applying an age-length key from the trawl data to the numbers and biomass at length estimates.

Relative estimation errors associated with spatial structure observed in the acoustic data were derived using a one-dimensional (1D) geostatistical method (Petitgas 1993, Walline 2007, Williamson and Traynor 1996). Relative estimation error is defined as the ratio of the square root of the estimation variance to the estimate of biomass. Geostatistical methods were used for computation of error because they account for the observed spatial structure. These errors quantify only transect sampling variability. Other sources of error (e.g., target strength, trawl sampling) were not included.

Average walleye pollock depth was compared to the average bottom depth at each 0.5 nmi along the transects. Average walleye pollock depth was computed by multiplying the biomass in each 20 m vertical layer of water column by mean layer depth, then dividing by the sum of biomass for the corresponding 0.5 nmi. Average bottom depth was less straightforward to compute due to the extreme slopes at the shelf break. If the average walleye pollock depth was deeper than the average sounder-detected bottom depth, then the maximum depth of the walleye pollock backscatter was used in its place; otherwise, the average sounder-detected bottom depth was used.

RESULTS

Calibration

Pre- and post-survey calibration measurements of gain and transducer beam pattern were quite similar, confirming that the ER60 38-kHz acoustic system was stable throughout the survey (Table 1). The difference in integration gain (i.e., gain + Sa correction) measured before and after the survey was < 0.2 dB, so an averaged value was used in the final analysis. Transducer beam pattern measurments were also quite similar before and after the survey. Because the pre-calibration values were derived from the 64 mm copper sphere, only the results from the post-calibration were used.

Physical Oceanography

Water temperatures measured during the survey were cooler than temperatures measured in 2009. In 2012, mean surface temperatures ranged from 2.0 to 3.3 ºC, whereas in 2009, mean surface temperatures ranged from 2.8 to 4.0 ºC. In 2012, the coolest surface temperatures were observed in the easterly transects, which contrasts with the 2009 observations where the coolest surface waters were measured in the westerly transects. Water temperature profiles at trawl sites indicated colder water in the upper 200 m than what was observed in the previous eight surveys (Fig. 2). Temperatures measured in the water column between 300 and 600 m, where most of the walleye pollock were vertically distributed in the Bogoslof area in 2012, averaged between 3.4 and 3.7 ºC, which was similar to temperatures at this depth in 2009 (Fig. 2).

Trawl Samples

Biological data and specimens were collected from five trawl sites in the primary survey region (Tables 2-4; Fig. 1). By weight, walleye pollock represented 93.2% of the total catch (Table 4). However by number, pollock accounted for only 16.5% of the total catch, whereas *Leuroglossus schmidti* accounted for 43.7%, and myctophid species accounted for 35.7% of the total catch by number.

Walleye pollock length measurements ranging between 41 and 68 cm FL were collected from 842 fish (Table 3) and used to create two geographic length strata (Umnak and Samalga) for scaling the acoustic data and computing size-specific population estimates. Length measurements from hauls 2 and 4 were used to scale the Umnak stratum (transects 1-18, 107-112), and measurements from hauls 5 and 6 were used to scale the Samalga stratum (transects 19-35, 101-106). Length measurements collected in the two strata were similar in range (Umnak: 41-67 cm FL; Samalga: 43-68 cm FL) but had dissimilar modes (Umnak mode at 50 cm FL; Samalga mode at 60 cm FL). Trawl catch sex ratios among hauls ranged from 14% to 71% male. As observed in previous years, higher proportions of male walleye pollock were captured in deeper layers of the water column.

Individual maturity stages, lengths, and weights were collected from 328 walleye pollock specimens (Table 3). Most female walleye pollock were in the mature pre-spawning condition for both Umnak and Samalga strata (Fig. 3a), which was similar to previous years. Most male walleye pollock were in the mature spawning condition for the Umnak stratum but were in the mature pre-spawning condition for the Samalga stratum (Fig. 3a). The average GSI for pre-spawning mature female walleye pollock was 0.18 for both strata combined, 0.20 for Umnak, and 0.15 for Samalga (Fig. 3b). The combined average GSI estimate was similar to that observed during surveys between 2002 and 2007 (i.e., 0.17 – 0.18 for the entire area; Honkalehto et al. 2008a). The mean body weight-at-length for sexes combined was estimated using observed measurements for most of the fish lengths encountered (Fig.3c). Five weight-at-length intervals were estimated by using Weight

(g) = 0.007931 × Fork Length (cm) $^{2.9950}$ and corrected for a small bias due to back-transformation (Miller 1984).

<u>Distribution and Abundance</u>

Along the primary survey track, about 41% of the walleye pollock biomass was observed in the Umnak stratum and about 59% was observed in the Samalga stratum (Fig. 4). In the Umnak stratum, fish were concentrated (> 1,000 t/0.5 nmi) across fewer nautical miles than in the Samalga stratum. The main aggregations in Umnak were observed on transect 10, whereas in the Samalga strata, fish were observed across several transects (26-29) with no particularly dense aggregation. Walleye pollock were distributed in midwater between about 100 and 700 m (Fig. 5). With some exceptions, fish generally stayed close to the seafloor until bottom depths reached about 300-400 m. But as the seafloor descended, fish in the Umnak stratum were observed slightly shallower (350-500 m) than fish in the Samalga stratum 400-650 m. This trend was also observed where the bottom depths exceeded 900 m water depth. Note that bottom depth measurements were limited to 1,000 m.

The abundance estimate for walleye pollock in the primary survey area was 48.6 million fish weighing 67.1 thousand metric tons (t) (Tables 5-7; Fig. 6). The overall size composition was bimodal with major modes at 51 and 60 cm (Figs. 7-8) with a mean of 55.5 cm FL (Table 6). Based on the 1D geostatistical analysis, the relative estimation error of the abundance estimate was 9.7% (Table 5).

Along the north-extension survey track, minor acoustic backscatter observed on transect 103 was attributed to walleye pollock but no trawl sample was collected. Assuming these fish to be similar to those in the Samalga stratum, the backscatter amounted to another 20 t.

The estimated age composition and distribution for 2012 contrasts with what was observed in 2009 (Figs. 9-10). The 2012 age composition was bimodal, where 51% of the abundance was represented by 6-and 7-year-old fish (2006 and 2005 year classes) and 30% was represented by

11-and 12-year-old-fish (2001 and 2000 year classes; Tables 8-9; Fig. 9). Most of the younger fish (6-and 7-year-olds) were observed in the Umnak stratum, whereas most of the older fish were observed in the Samalga stratum (Fig. 10). The bimodal composition and bi-region distribution observed in 2012 contrasts with what was observed in 2009, when 67% of the population was composed of fish ages 8-and 9 (2001 and 2000 year classes), which were mostly distributed in the Samalga stratum (Fig. 10).

DISCUSSION

The 2012 acoustic-trawl survey estimate for walleye pollock was 49 million fish in the Bogoslof region. The 33% decrease from the 2009 estimate accentuates the overall downward trend in abundance (Fig. 8) (McKelvey, 2009). In 2009, there was a notable presence of fish greater than 50 cm, which were dominated by the 2001 and 2000 year classes (Fig. 8-9). But by 2012, these year classes represented only 30% of the population. The fish population in 2012, however, was buoyed by recruitment of the 2006 and 2005 year classes, which were also relatively strong year classes on the Bering Sea shelf (Ianelli et al. 2011). The average length-at-age for the 6 and 7 year olds in 2012 was observed at 50.2 and 52.2 cm FL, which contributed to the bimodal length distribution observed in Figure 7.

Because the backscatter attributed to walleye pollock has decreased over recent years, it has become more difficult to separate backscatter attributed to walleye pollock from backscatter attributed to other species. Where walleye pollock were densely distributed, the delineation was relatively straightforward but where walleye pollock were lightly distributed in an area, and trawl catch evidence suggested that other species were also in the area, then backscatter from walleye pollock was more difficult to separate. Using multifrequency backscatter data to help separate walleye pollock from other species was particularly useful for myctophids and euphausiids but the data were less useful for separating rockfish backscatter from walleye pollock backscatter (De Robertis et al., 2010). Of particular concern is backscatter often located along the shelf break, which can be difficult to sample. The first trawl of the survey sampled this type of backscatter off Unalaska Island (Fig. 1) and it captured small amounts of Pacific ocean perch and walleye pollock (Table 2).

This species combination is not unusual in this area (Honkalehto et al. 2006, 2005; McKelvey 2009). Sometimes weather precludes the ability to trawl sample the backscatter along the shelf break, and sometimes this backscatter is too weak to warrant the sample effort. In the future, it may prove productive to spend the extra time and effort to sample these difficult areas using trawl nets or optical sampling methods to help improve species identification.

The northern survey track contributed 2,201 nmi^2 to the surveyed area making the 2012 survey the largest area covered since 2001 (Table 5). The extended coverage allowed scientists to investigate whether walleye pollock were present in deeper waters, as they were in historical surveys (1988-1993; Honkalehto et al. 2005). Although the 2012 survey did not observe appreciable quantities of walleye pollock along the northern survey track, the effort will likely continue on an “every-other” survey basis.

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CITATIONS

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

De Robertis, A., D.R. McKelvey, and P.H Ressler. 2010. Development and application of an empirical multifrequency method for backscatter classification. Can. J. Fish. Aquat. Sci. 67: 1459-1474.

De Robertis, A., and K. Williams. 2008. Weight-length relationships in fisheries studies: the standard allometric model should be applied with caution. Trans. Am. Fish. Soc. 137:707–719.

Foote, K. G., H. P. Knudsen, G. Vestnes, D. N. MacLennan, and E. J. Simmonds. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. ICES Coop. Res. Rep., 144, 69 p.

Honkalehto, T., D. McKelvey, and N. Williamson. 2005. Results of the March echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) conducted in the southeastern Aleutian Basin near Bogoslof Island, cruise MF2005-03. AFSC Processed Rep. 2005-05, 37 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle WA 98115.

Honkalehto, T., D. McKelvey, and N. Williamson. 2006. Results of the March 2006 echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) conducted in the southeastern Aleutian Basin near Bogoslof Island, cruise MF2006-03. AFSC Processed Rep. 2006-14, 30 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle WA 98115.

Honkalehto, T., D. McKelvey, and K. Williams. 2008a. Results of the March 2007 echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) conducted in the southeastern Aleutian Basin near Bogoslof Island, cruise MF2007-03. AFSC Processed Rep. 2008-01, 37 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle WA 98115.

Honkalehto, T., N.Williamson, D.Jones, A.McCarthy, and D. McKelvey. 2008b. Results of the echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) on the U.S. and Russian Bering Sea shelf in June and July 2007. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-190, 53 p.

Ianelli, J.N., T. Honkalehto, S. Barbeaux, S. Kotwicki, K. Aydin, and N. Williamson. 2011. Assessment of walleye pollock stock in the Eastern Bering Sea. Section 1, p. 51-168. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. N. Pac. Fish. Mgmt. Council, 605 W. 4th Ave, Anchorage, AK 99501.

Jones, D. T., A. De Robertis, and N. J. Williamson. 2011. Statistical combination of multifrequency sounder-detected bottom lines reduces bottom integrations. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-219, 13 p.

McKelvey, D. 2009. Results of the March 2009 echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) conducted in the southeastern Aleutian Basin near Bogoslof Island, cruise DY2009-03. AFSC Processed Rep. 2009-03, 32 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle WA 98115.

Miller, D. M. 1984. Reducing transformation bias in curve fitting. The Am. Stat. 38:124-126.

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

Schabetsberger, R., R.D. Brodeur, T. Honkalehto, and K. L. Mier. 1999. Sex-biased cannibalism in spawning walleye pollock: the role of reproductive behavior. Environ. Biol. Fishes 54:175-190.

Simrad. 2004. Operator manual for Simrad ER60 Scientific echo sounder application. Simrad AS, Strandpromenenaden 50, Box 111, N-3191 Horten, Norway.

Simrad. 1997. Operator Manual for Simrad EK500 Scientific echo sounder – Base version. Simrad AS, Strandpromenenaden 50, Box 111, N-3191 Horten, Norway.

Walline, P. D. 2007. Geostatistical simulations of eastern Bering Sea walleye pollock spatial distributions, to estimate sampling precision. ICES J. Mar. Sci. 64:559-569.

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

Itinerary

Alaska Standard Time

4 March	Embark scientists in Kodiak, AK
5-7 March	Transit to southeast Aleutian Basin, Alaska
7-15 March	Acoustic-trawl survey of the Bogoslof Island area
15 March	End cruise, begin transit to Chirikof shelf break

Scientific Personnel

Name	Position	Organization
Denise McKelvey	Chief Scientist	AFSC
Taina Honkalehto	Fishery Biologist	AFSC
Scott Furnish	Info. Tech. Specialist	AFSC
Darin Jones	Fishery Biologist	AFSC
William Floering	Fishery Biologist	AFSC

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Table 1. -- Simrad ER60 38 kHz acoustic system description and settings used during the winter 2012 acoustic-trawl survey of walleye pollock in the Bogoslof Island area, results from standard sphere acoustic system calibrations conducted before and after the survey, and final values used to calculate biomass and abundance data.

	Bogoslof Survey system settings	14-Feb Ikatan Bay Alaska	26-Mar Malina Bay Alaska	Final system values
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):	23.09	23.09	22.91	23.00
S_a correction (dB):	-0.62	-0.62	-0.58	-0.60
Integration gain (dB):	22.47	22.47	22.33	22.40
3 dB beamwidth along:	6.68	6.68*	6.57	6.57
3 dB beamwidth athwart:	7.17	7.17*	7.13	7.13
Angle offset along:	-0.08	-0.08*	-0.09	-0.09
Angle offset athwart:	-0.11	-0.11*	-0.05	-0.05
Measured standard sphere TS (dB):	--	-41.56	-42.43	--
Sphere range from transducer (m):	--	19.34	19.82	--
Absorption coefficient (dB/m):	0.0099	0.0095	0.0099	0.0099
Sound velocity (m/s):	1466.0	1445.8	1454.3	1466.0
Water temp at transducer (ºC):	--	0.3	1.8	--

*Results derived using 64 mm copper sphere.

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.--Trawl station and catch data summary from the winter 2012 acoustic-trawl survey of walleye pollock in the Bogoslof Island area.

Haul		Date	Time	Duration	Start position		Depth (m)		Water temp. (°C)		Catch		
											Pollock		Other
No.	Stratum	(GMT)	(GMT)	(minutes)	Latitude (N)	Longitude (W)	Footrope	Bottom	Headrope	Surface[1]	(kg)	Number	(kg)
1	Umnak	8-Mar	12:55	8	53° 49.53'	167° 17.20'	317	382	3.8	2.7	4	4	32.0
2	Umnak	9-Mar	1:19	10	53° 34.59'	167° 48.01'	444	746	3.7	2.8	1,473	1,357	36.8
3[2]	Umnak	9-Mar	6:16	-	53° 33.27'	167° 45.98'	-	-	-	-	-	-	-
4	Umnak	10-Mar	1:05	4	53° 34.97'	167° 48.61'	601	701	3.4	2.9	2,352	2,145	96.6
5	Samalga	11-Mar	7:37	9	53° 2.63'	169° 12.57'	496	882	3.5	3.0	95	62	40.4
6	Samalga	11-Mar	16:50	19	52° 57.17'	167° 21.88'	399	567	3.6	2.7	157	96	91.8

[1]Temperature from hull-mounted Furuno T-2000, 1.4 m below surface
[2]Net torn on underwater pinnacle -no resulting catch

Table 3.--Numbers of fish measured and biological samples collected during the winter 2012 acoustic-trawl survey of walleye pollock in the Bogoslof Island area.

Haul	Walleye pollock				Pacific ocean perch
no.	Random lengths	Weights and maturities	Otoliths	Ovary weights	length weights
1	4	4	4	0	25
2	320	70	65	37	-
3	-	-	-	-	-
4	360	96	80	13	-
5	62	62	60	36	-
6	96	96	96	22	-
Totals	842	328	305	108	25

Table 4.--Catch by species from the five successful midwater trawl hauls during the winter 2012 acoustic-trawl survey of walleye pollock in the Bogoslof Island area.

Species name	Scientific name	Weight (kg)	%	Number	%
walleye pollock	*Theragra chalcogramma*	4,081.1	93.2	3,664	16.5
salmon shark	*Lamna ditropis*	90.0	2.1	1	<0.1
brokenline lampfish	*Lampanyctus jordani*	67.9	1.6	2,172	9.8
lanternfish unidentified	Myctophidae (family)	50.3	1.1	5,746	25.9
northern smoothtongue	*Leuroglossus schmidti*	43.4	1.0	9,698	43.7
Pacific ocean perch	*Sebastes alutus*	23.3	0.5	25	0.1
squid unidentified	Teuthoidea (order)	6.8	0.2	66	0.3
chinook salmon	*Oncorhynchus tshawytscha*	5.6	0.1	2	<0.1
lamprey unidentified	*Petromyzontidae*	5.3	0.1	10	<0.1
shrimp unidentified	Decapoda (order)	1.3	<0.1	512	2.3
crested bigscale	*Poromitra crassiceps*	0.8	<0.1	28	0.1
blackmouth eelpout	*Lycodapus fierasfer*	0.8	<0.1	216	1.0
sea nettle	*Chrysaora melanaster*	0.4	<0.1	1	<0.1
pinpoint lampfish	*Lampanyctus regalis*	0.4	<0.1	14	0.1
Pacific lamprey	*Lampetra tridentata*	0.4	<0.1	1	<0.1
jellyfish unidentified	*Scyphozoa (class)*	0.2	<0.1	4	<0.1
viperfish unidentified	*Chauliodontidae*	0.2	<0.1	4	<0.1
Pacific herring	*Clupea pallasi*	0.1	<0.1	2	<0.1
barracudina unidentified	*Paralepididae*	0.1	<0.1	4	<0.1
Total		4,378.6		22,170	

Table 5.--Walleye pollock biomass (metric tons (t)) estimated by survey area and management area from February-March acoustic-trawl surveys in the Bogoslof Island area between 1988 and 2012.

Bogoslof Survey Area				**Central Bering Sea Specific Area**	
Year	**Biomass (million t)**	**Area (nmi^2)**	**Relative estimation error (%)**	**Biomass (million t)**	**Relative estimation error (%)**
1988	2.396	--	--	2.396	--
1989	2.126	--	--	2.084	--
1990	--	No survey	--	--	--
1991	1.289	8,411	11.7	1.283	--
1992	0.940	8,794	20.4	0.888	--
1993	0.635	7,743	9.2	0.631	--
1994	0.490	6,412	11.6	0.490	--
1995	1.104	7,781	10.7	1.020	--
1996	0.682	7,898	19.6	0.582	--
1997	0.392	8,321	14.0	0.342	--
1998	0.492	8,796	19.0	0.432	19.0
1999	0.475	Conducted by Japan Fisheries Agency		0.393	--
2000	0.301	7,863	14.3	0.270	12.7
2001	0.232	5,573	10.2	0.208	11.8
2002	0.226	2,903	12.2	0.226	12.2
2003	0.198	2,993	21.5	0.198	21.5
2004	--	No survey	--	--	--
2005	0.253	3,112	16.7	0.253	16.7
2006	0.240	1,803	11.8	0.240	11.8
2007	0.292	1,871	11.5	0.292	11.5
2008	--	No survey	--	--	--
2009	0.110	1,803	19.2	0.110	19.2
2010	--	No survey	--	--	--
2011	--	No survey	--	--	--
2012	0.067	3,656	9.8[1]	0.067	9.8*

*The relative error for 2012 was computed for the primary survey area (1,455 nmi^2).

Table 6.--Numbers-at-length estimates (millions), and average fork length (cm) from February-March acoustic-trawl surveys of walleye pollock in the Bogoslof Island area. No surveys were conducted in 1990, 2004, 2008 or 2010-2011. The 1999 survey was conducted by the Japan Fisheries Agency.

Length (cm)	1988	1989	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006	2007	2009	2012
10	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	2	0	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0
24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0
31	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	<1	0	0	0	0	0	0	0	0	0	<1	<1	0	0	0	0	0
34	0	0	0	0	0	0	<1	<1	0	<1	0	0	0	<1	<1	0	0	0	0	0
35	0	0	0	0	0	0	<1	0	<1	0	0	0	0	<1	0	0	0	0	0	0
36	0	0	0	<1	0	0	<1	<1	<1	<1	0	0	0	1	0	0	0	0	0	0
37	9	3	<1	0	0	0	<1	<1	<1	<1	0	0	0	1	<1	<1	0	0	0	0
38	6	0	2	<1	1	0	1	1	<1	1	0	0	<1	1	<1	1	<1	0	0	0
39	16	4	5	0	2	<1	4	1	1	3	<1	<1	<1	2	<1	2	<1	<1	0	0
40	24	3	7	1	4	3	12	4	1	7	1	<1	1	3	<1	7	2	0	0	0
41	27	4	19	3	5	6	20	8	2	9	6	1	1	4	<1	11	5	1	<1	<1

Table 6.--Continued.

Length (cm)	1988	1989	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006	2007	2009	2012
42	48	23	23	7	7	9	40	14	3	11	8	1	1	2	<1	12	10	2	<1	<1
43	118	33	31	14	6	14	40	17	4	11	13	3	1	5	1	11	16	4	<1	<1
44	179	54	36	18	7	21	41	21	5	10	13	3	2	5	2	11	20	8	<1	<1
45	329	159	46	28	8	21	50	23	7	9	17	4	3	7	3	13	23	11	<1	1
46	488	177	55	32	13	21	53	31	10	11	19	5	4	5	5	11	23	17	<1	2
47	547	389	79	42	22	18	40	36	14	9	14	6	5	9	5	11	18	17	1	2
48	476	434	130	68	28	17	55	36	15	12	11	6	5	7	7	10	17	20	1	2
49	389	431	168	102	46	16	47	37	18	15	10	5	6	6	6	8	14	14	2	2
50	248	366	205	129	69	39	52	40	21	20	16	6	6	5	7	8	9	18	2	3
51	162	279	189	144	76	46	58	45	24	23	11	8	6	5	4	9	9	15	5	3
52	80	168	160	118	73	52	78	52	26	28	20	10	7	4	4	7	7	13	5	2
53	48	85	122	106	73	49	81	52	26	35	17	13	8	6	4	7	5	12	6	2
54	19	50	63	67	66	43	88	53	31	41	21	16	9	7	3	7	5	10	8	2
55	12	13	40	41	50	37	81	48	28	38	33	21	13	9	5	8	3	9	8	2
56	4	5	17	27	29	26	69	40	24	35	38	20	13	12	7	6	6	8	8	2
57	3	8	8	13	14	17	58	37	22	30	33	24	16	13	7	7	5	6	6	3
58	1	1	4	6	9	10	47	28	17	27	36	23	14	14	10	6	7	7	6	3
59	0	0	1	5	3	6	31	19	13	18	23	16	12	12	9	8	5	7	5	3
60	0	0	1	1	1	3	17	12	12	13	15	13	12	12	13	7	7	6	2	4
61	2	0	1	<1	1	2	7	6	6	8	18	10	10	8	9	9	5	8	2	2
62	0	0	<1	<1	<1	1	4	2	3	5	13	7	6	6	7	7	5	7	1	2
63	0	0	0	0	0	<1	2	1	1	3	4	4	4	4	5	7	4	4	2	3
64	0	0	0	1	<1	0	1	<1	1	1	3	2	3	3	5	5	2	4	1	2
65	0	0	<1	0	0	0	<1	<1	<1	1	1	1	1	1	3	4	2	3	<1	<1
66	0	0	0	0	0	0	<1	0	<1	1	<1	<1	<1	1	1	2	2	3	<1	1
67	0	0	0	0	0	0	0	0	0	0	1	<1	<1	<1	1	2	1	2	<1	1
68	0	0	0	0	0	0	1	0	0	<1	0	<1	<1	<1	<1	1	1	1	<1	<1
69	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	<1	<1	1	<1	0
70	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1	0	<1	<1	<1	<1	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1	<1	<1	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	<1	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	<1	0
Total	3,236	2,687	1,419	975	613	478	1,081	666	337	435	416	229	170	181	134	225	239	236	73	49
Average length	47.2	48.7	49.6	50.6	51.4	51.0	50.9	51.4	52.8	52.5	53.4	55.0	55.1	53.1	55.7	51.2	49.7	52.3	55.3	55.5

Table 7.--Biomass-at-length estimates (1,000 t) from February-March acoustic-trawl surveys of walleye pollock in the Bogoslof Island area. No surveys were conducted in 1990, 2004, 2008, or 2010-2011. The 1999 survey was conducted by the Japan Fisheries Agency. Lengths are in centimeters.

Length	1988	1989	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006	2007	2009	2012
10	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	<1	0	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0
24	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0
31	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	<1	0	0	0	0	0	0	0	0	0	<1	<1	0	0	0	0	0
34	0	0	0	0	0	0	<1	<1	0	<1	0	0	0	<1	<1	0	0	0	0	0
35	0	0	0	0	0	0	<1	0	<1	0	0	0	0	<1	0	0	0	0	0	0
36	0	0	0	<1	0	0	<1	<1	<1	<1	0	0	0	<1	0	0	0	0	0	0
37	3	1	<1	0	0	0	<1	<1	<1	<1	0	0	0	<1	<1	<1	0	0	0	0
38	2	0	1	<1	<1	0	<1	<1	<1	<1	0	0	<1	1	<1	<1	<1	0	0	0
39	6	1	2	0	1	<1	2	1	1	1	<1	<1	<1	1	<1	1	<1	<1	0	0
40	11	1	3	<1	2	1	6	2	1	3	1	<1	<1	2	<1	3	1	0	0	0
41	13	2	8	1	2	3	10	4	1	4	6	1	<1	2	<1	5	2	<1	<1	<1

Table 7.--Continued.

Length	1988	1989	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006	2007	2009	2012
42	24	11	11	3	4	5	21	7	1	6	7	1	<1	1	<1	6	5	1	<1	<1
43	64	17	16	7	3	8	22	9	2	6	12	2	1	3	<1	6	9	2	<1	<1
44	105	30	20	10	4	13	25	13	3	6	12	2	2	4	1	6	12	5	<1	<1
45	207	94	28	16	5	14	33	15	5	6	16	3	2	5	2	8	15	7	<1	1
46	329	113	36	21	9	15	37	22	7	8	18	3	3	4	4	8	17	12	<1	1
47	395	268	57	29	17	14	30	26	11	7	14	5	4	7	4	9	14	13	1	1
48	367	323	101	52	22	14	45	29	12	10	11	5	4	6	6	8	15	17	1	2
49	321	346	141	84	40	14	40	32	16	13	11	5	5	6	6	7	13	13	2	2
50	218	315	187	116	64	36	48	36	20	19	18	5	6	5	7	7	9	18	2	3
51	152	258	186	140	76	46	57	43	24	23	12	8	6	5	4	9	10	16	5	3
52	80	166	171	124	78	56	82	54	29	29	23	11	8	4	5	8	7	15	6	2
53	51	90	140	120	83	55	90	57	30	39	20	15	9	6	5	8	6	15	8	3
54	21	57	78	82	79	52	104	62	38	49	25	19	11	8	4	9	6	13	11	2
55	14	16	53	53	64	48	102	59	36	47	39	27	17	12	6	11	5	13	13	2
56	6	6	24	39	40	35	92	53	33	48	47	27	17	16	11	9	10	13	12	2
57	4	11	12	20	21	24	82	52	32	43	41	35	24	19	11	10	7	10	9	4
58	1	1	7	9	14	16	71	41	26	41	45	34	22	22	16	10	11	11	10	5
59	0	0	1	8	4	10	49	29	21	28	28	26	20	19	15	14	9	10	9	5
60	0	0	3	3	2	5	28	20	21	22	18	22	20	21	23	13	11	13	5	6
61	3	0	2	1	2	4	12	11	11	14	23	19	18	15	17	17	8	14	5	4
62	0	0	1	1	<1	2	8	4	6	10	15	13	12	12	15	13	10	15	2	4
63	0	0	0	0	0	<1	4	3	3	6	5	7	8	8	11	14	8	9	4	6
64	0	0	0	1	<1	0	1	1	1	2	3	4	6	6	11	10	6	9	2	4
65	0	0	1	0	0	0	<1	1	1	1	2	2	3	2	7	9	4	7	1	<1
66	0	0	0	0	0	0	<1	0	<1	1	<1	1	1	2	4	5	5	6	1	2
67	0	0	0	0	0	0	0	0	0	0	1	1	<1	1	2	5	3	5	<1	2
68	0	0	0	0	0	0	3	0	0	<1	0	<1	<1	1	1	2	2	3	<1	<1
69	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	1	1	3	<1	0
70	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1	0	<1	<1	1	<1	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1	1	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0	0
Total	2,396	2,126	1,289	940	635	490	1,104	682	392	492	475	301	232	226	198	253	240	292	110	67

Table 8.--Numbers-at-age estimates (millions) from February-March acoustic-trawl surveys of walleye pollock in the Bogoslof Island area. No surveys were conducted in 1990, 2004, 2008, or 2010-2011. The 1999 survey was conducted by the Japan Fisheries Agency. Ages are in years.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0	0	--	0	0	0	--	0	--	--	0
1	0	0	--	0	0	0	0	1	0	0	0	0	0	0	0	0	--	0	0	0	--	0	--	--	0
2	0	0	--	4	0	0	0	0	0	0	0	0	0	0	<1	0	--	0	0	0	--	0	--	--	0
3	0	0	--	0	1	1	0	2	0	0	0	0	0	0	9	<1	--	0	0	0	--	0	--	--	0
4	0	6	--	2	2	33	21	6	<1	<1	<1	2	1	1	5	8	--	5	4	1	--	0	--	--	<1
5	28	15	--	12	27	17	86	75	6	4	11	5	6	14	3	6	--	81	55	8	--	1	--	--	1
6	327	58	--	46	54	44	26	278	96	16	61	29	4	12	41	7	--	31	104	92	--	1	--	--	15
7	247	363	--	213	97	46	38	105	187	55	34	77	14	10	11	25	--	13	18	70	--	7	--	--	10
8	164	147	--	93	74	48	36	68	85	88	70	34	30	10	8	11	--	11	6	17	--	23	--	--	2
9	350	194	--	160	71	42	36	80	40	38	77	50	16	14	6	4	--	22	6	3	--	26	--	--	1
10	1,201	91	--	44	55	28	17	53	37	28	32	75	28	12	7	5	--	7	9	3	--	8	--	--	2
11	288	1,105	--	92	57	51	27	54	24	16	25	29	45	18	8	4	--	3	3	8	--	1	--	--	7
12	287	222	--	60	33	25	23	19	24	16	21	27	21	31	14	10	--	5	2	4	--	1	--	--	8
13	202	223	--	373	34	27	13	59	12	13	19	25	16	13	30	8	--	4	4	1	--	1	--	--	1
14	89	82	--	119	142	42	9	32	36	7	18	16	11	7	9	26	--	5	5	5	--	<1	--	--	<1
15	27	90	--	41	164	92	45	12	18	13	9	12	11	9	7	6	--	11	8	5	--	<1	--	--	<1
16	17	30	--	38	59	47	36	31	4	5	15	10	9	8	9	5	--	12	5	3	--	1	--	--	<1
17	7	60	--	29	8	25	28	103	16	4	5	8	3	5	5	3	--	6	7	6	--	1	--	--	<1
18	3	0	--	32	15	11	16	60	35	12	8	6	6	1	4	5	--	4	2	4	--	<1	--	--	<1
19	0	0	--	56	22	11	4	18	26	12	10	3	3	3	2	1	--	3	1	3	--	1	--	--	<1
20	0	0	--	4	42	11	4	5	12	7	15	4	2	1	2	<1	--	1	2	1	--	<1	--	--	0
21	0	0	--	2	13	10	8	5	3	2	4	3	1	0	0	1	--	<1	<1	<1	--	<1	--	--	0
22	0	0	--	0	3	1	2	6	2	1	1	2	1	0	0	0	--	0	0	1	--	0	--	--	0
23	0	0	--	0	1	1	2	6	1	<1	0	<1	0	<1	<1	0	--	0	0	0	--	0	--	--	0
24	0	0	--	0	0	0	1	2	0	1	0	0	<1	<1	<1	0	--	<1	0	1	--	0	--	--	0
25	0	0	--	0	0	0	0	0	0	0	0	0	0	0	<1	0	--	0	0	0	--	0	--	--	0
Total	3,236	2,687	--	1,419	975	613	478	1,081	666	336	435	416	229	170	181	134	--	225	239	236	--	73	--	--	49

Table 9.--Biomass-at-age estimates (1,000 t) from February-March acoustic-trawl surveys of walleye pollock in the Bogoslof Island area. No surveys were conducted in 1990, 2004, 2008, or 2010-2011. The 1999 survey was conducted by the Japan Fisheries Agency. Ages are in years.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0	0	--	0	0	0	--	0	--	--	0
1	0	0	--	0	0	0	0	<1	0	0	0	0	0	0	0	0	--	0	0	0	--	0	--	--	0
2	0	0	--	<1	0	0	0	0	0	0	0	0	0	0	<1	0	--	0	0	0	--	0	--	--	0
3	0	0	--	0	<1	<1	0	1	0	0	0	0	0	0	5	<1	--	0	0	0	--	0	--	--	0
4	0	2	--	1	1	19	13	3	<1	<1	<1	2	<1	<1	3	7	--	3	2	1	--	0	--	--	<1
5	15	7	--	6	21	12	60	49	4	2	7	6	4	12	2	5	--	52	36	6	--	1	--	--	1
6	192	41	--	25	38	39	22	208	69	11	38	28	3	11	34	6	--	25	85	80	--	1	--	--	15
7	156	241	--	143	67	43	40	83	165	50	30	78	12	10	10	26	--	14	19	86	--	9	--	--	11
8	115	111	--	75	59	47	39	72	76	95	74	37	30	12	9	12	--	15	7	25	--	33	--	--	3
9	251	149	--	149	67	44	40	96	46	44	94	60	18	18	8	6	--	29	8	4	--	39	--	--	1
10	910	68	--	44	57	31	21	64	45	38	40	90	40	16	9	8	--	10	15	6	--	13	--	--	4
11	226	895	--	94	61	59	32	71	31	23	36	35	63	26	12	7	--	6	4	14	--	2	--	--	12
12	233	187	--	59	36	27	28	26	33	22	29	33	32	50	23	18	--	9	3	7	--	2	--	--	14
13	167	194	--	378	37	30	17	77	17	18	27	30	25	20	48	14	--	8	6	1	--	2	--	--	2
14	82	72	--	116	150	47	11	42	49	11	26	19	18	11	15	47	--	10	9	11	--	1	--	--	<1
15	23	81	--	39	169	107	53	17	24	20	13	14	16	14	12	11	--	21	15	12	--	1	--	--	1
16	16	24	--	38	63	54	43	38	6	7	22	13	15	14	15	8	--	25	9	6	--	2	--	--	<1
17	7	52	--	31	9	28	32	131	21	5	8	10	6	7	8	5	--	11	13	12	--	2	--	--	1
18	3	0	--	32	15	11	18	74	43	17	10	7	8	2	6	10	--	8	3	8	--	1	--	--	<1
19	0	0	--	55	23	14	5	22	32	17	13	3	5	5	3	2	--	5	2	6	--	1	--	--	<1
20	0	0	--	4	44	12	5	6	14	9	19	4	3	2	3	1	--	1	3	2	--	<1	--	--	0
21	0	0	--	1	15	10	9	5	4	2	5	4	2	0	0	2	--	<1	1	1	--	<1	--	--	0
22	0	0	--	0	3	1	2	8	2	1	1	3	2	0	0	0	--	0	0	2	--	0	--	--	0
23	0	0	--	0	1	1	2	7	1	<1	0	1	0	<1	<1	0	--	0	0	0	--	0	--	--	0
24	0	0	--	0	0	0	1	3	0	1	0	0	1	<1	1	0	--	<1	0	1	--	0	--	--	0
25	0	0	--	0	0	0	0	0	0	0	0	0	0	0	<1	0	--	0	0	0	--	0	--	--	0
Total	2,396	2,126	--	1,289	940	635	490	1,104	682	392	492	475	301	232	226	198	--	253	240	292	--	110	--	--	67

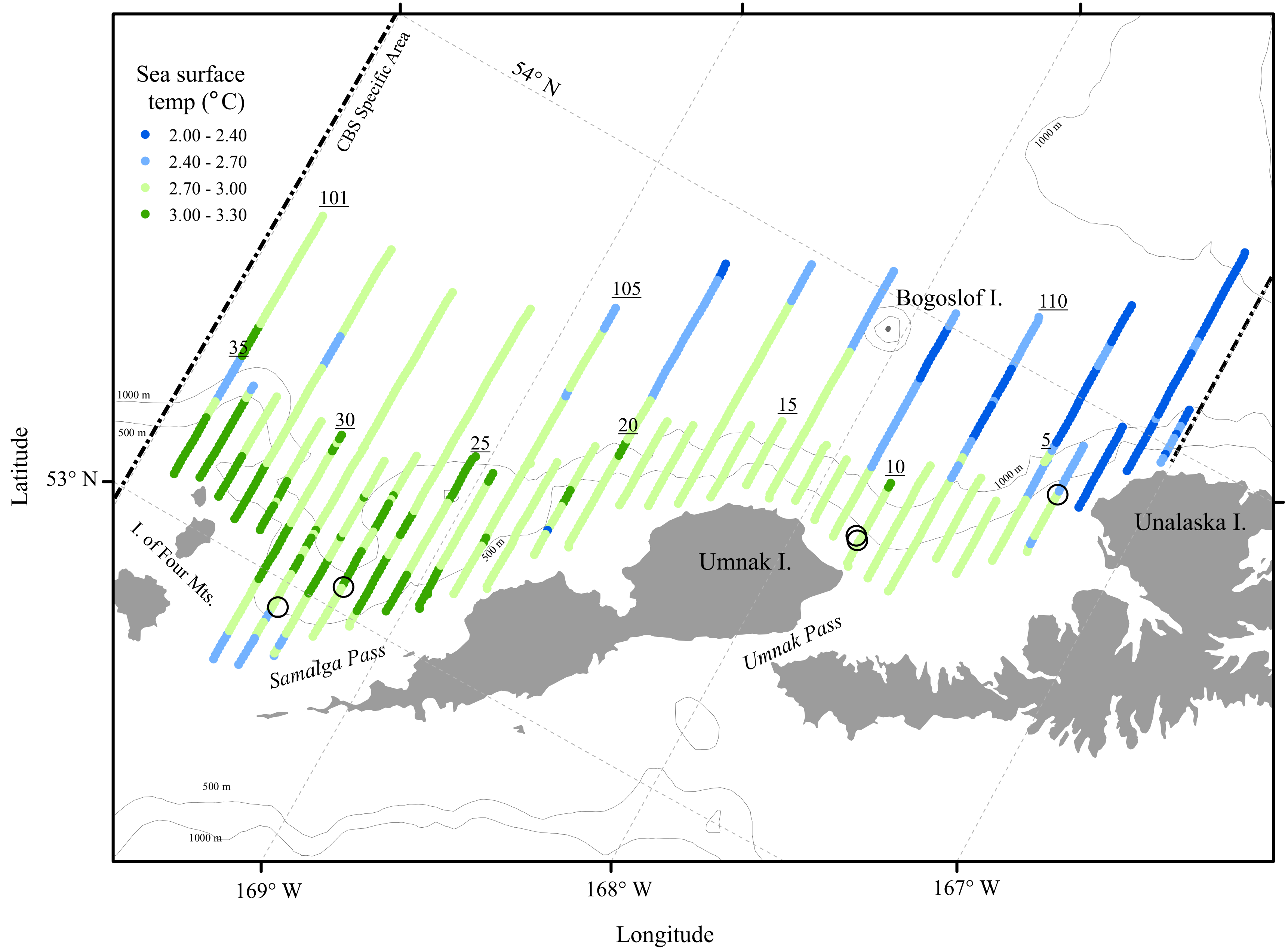

Figure 1.--Transects, haul locations (circles), and sea surface temperatures measured from the ship's hull sensor and recorded during the winter 2012 acoustic-trawl survey of walleye pollock in the southeast Aleutian Basin near Bogoslof Island. Transect numbers are underlined and the Central Bering Sea Specific area is indicated by a dash-dotted line.

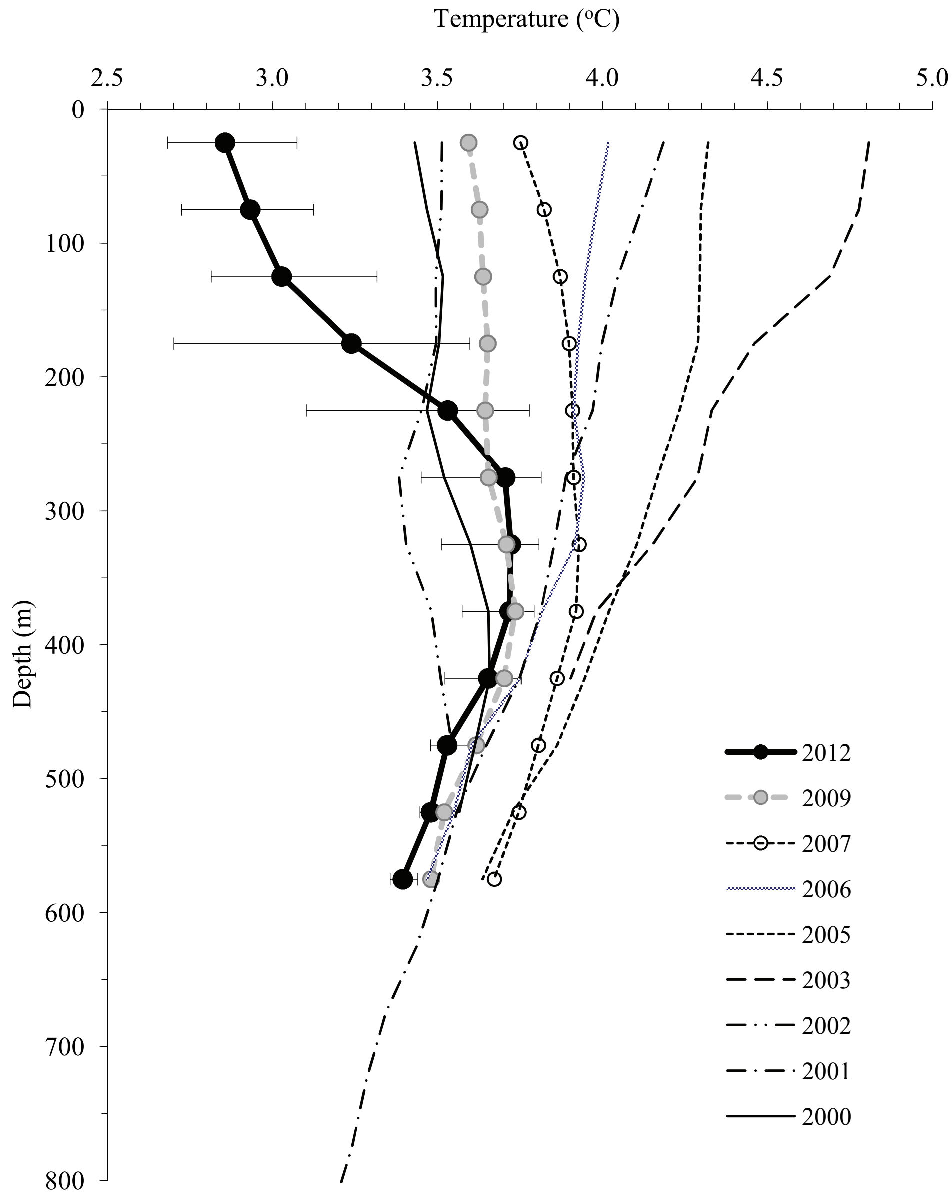

Figure 2.--Average temperature (°C) by 50-m depth intervals observed during hauls from the winter 2000-2003, 2005-2007, 2009, and 2012 acoustic-trawl surveys of walleye pollock in the Bogoslof Island area. The horizontal bars represent temperature ranges observed during the 2012 survey. Note: Temperature data from the 2003 survey were collected from only three locations.

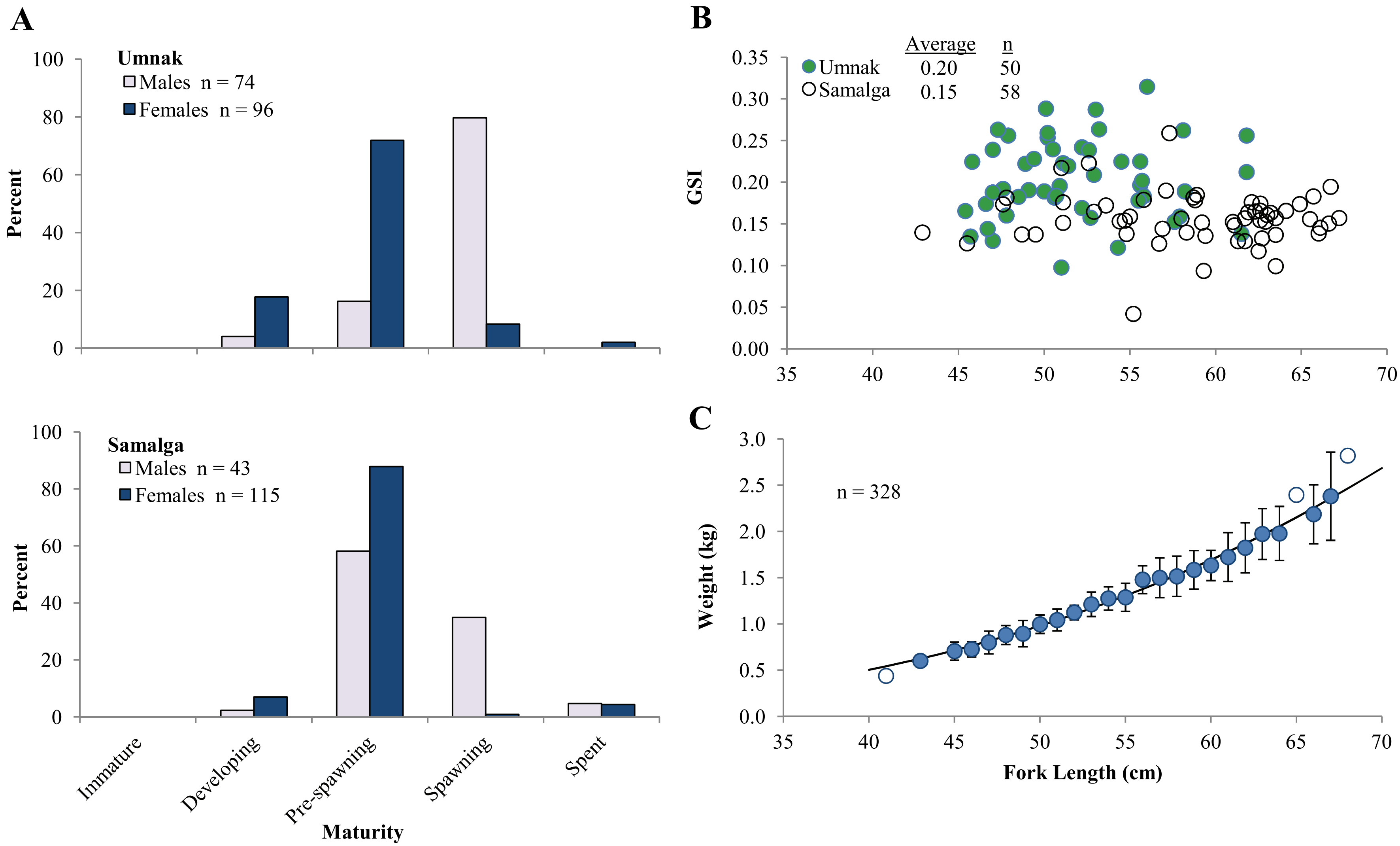

Figure 3.--Walleye pollock maturity stages by region and sex (A), gonado-somatic index (GSI) by region for pre-spawning females as a function of fork length (B), and observed mean weight-at-length with fitted regression line for combined regions and sexes (C), observed during the winter 2012 acoustic-trawl survey of the Bogoslof Island area. In panel C, hollow circles indicate fewer than five fish were measured and vertical bars indicate +/- one standard deviaion.

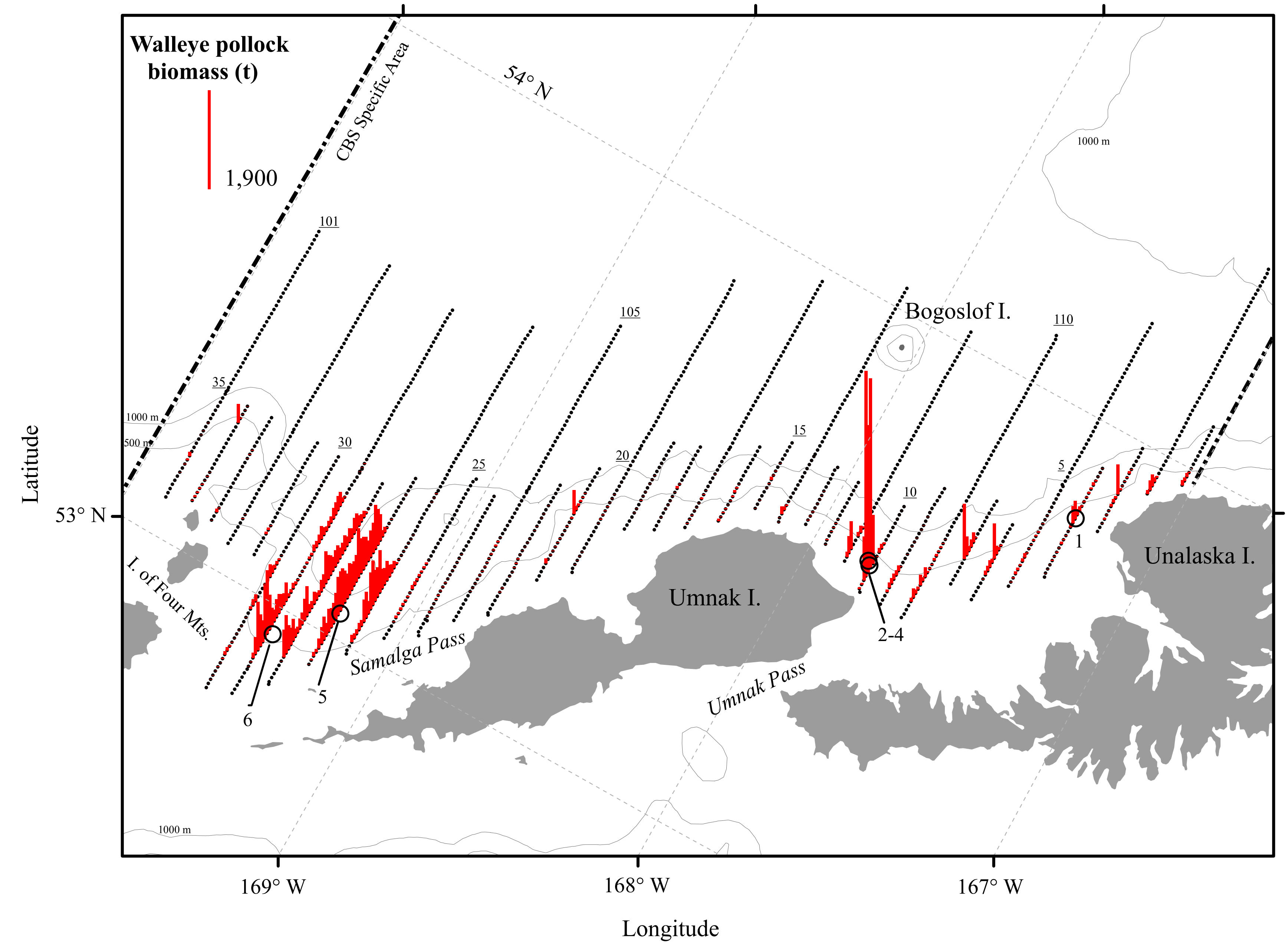

Figure 4.--Transects, haul locations, and walleye pollock biomass (in metric tons (t)) observed along primary and northern extension transects during the winter 2012 acoustic-trawl survey of walleye pollock in the southeast Aleutian Basin near Bogoslof Island. Transect numbers are underlined, trawl haul locations are indicated by circles, and the Central Bering Sea Specific area is indicated by a dash-dotted line. The Umnak stratum includes transects 1-18, and 107-112, and the Samalga stratum includes transects 19-35, and 101-106.

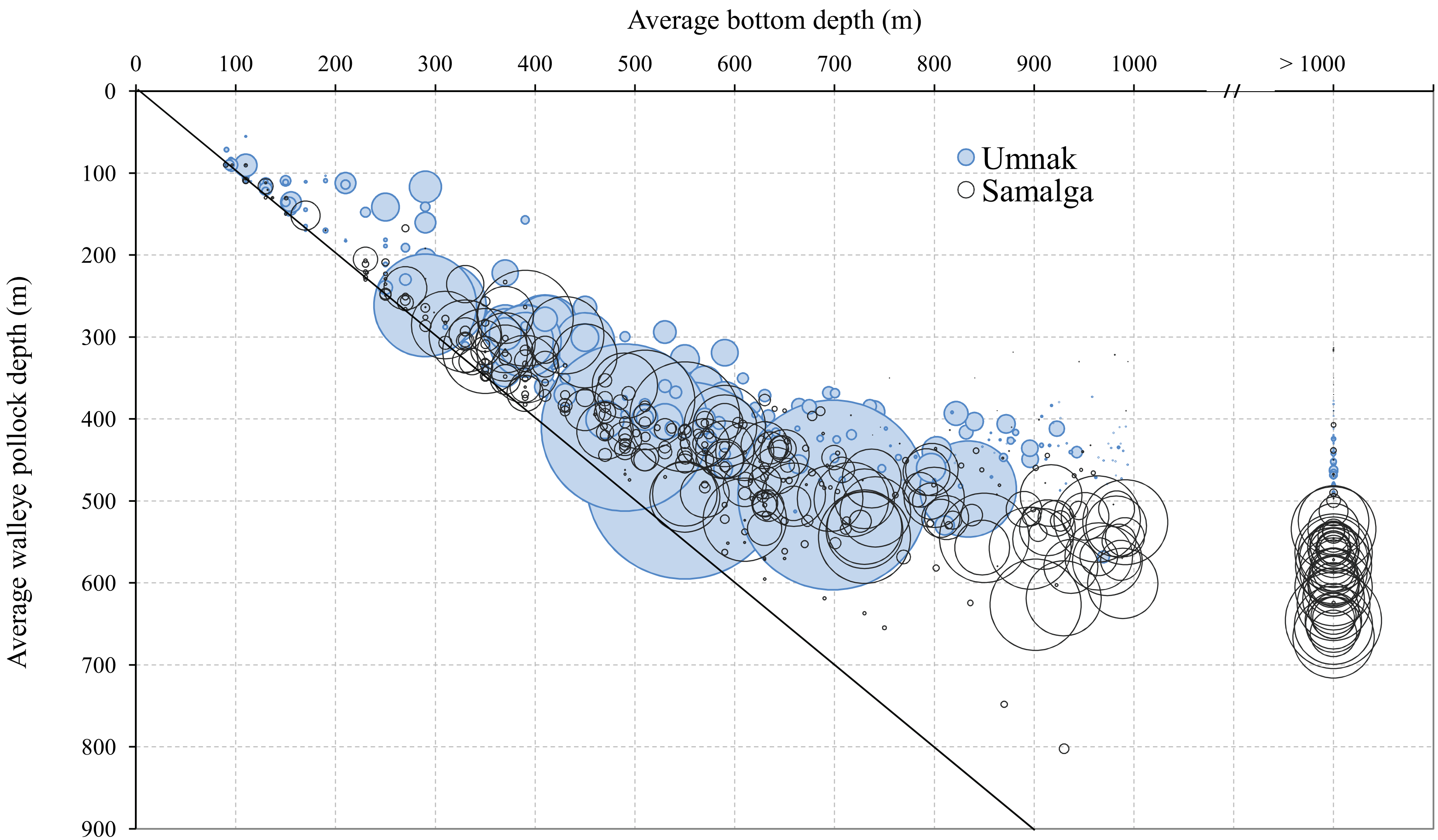

Figure 5.--Average walleye pollock depth (weighted by biomass) versus bottom depth (m), per 0.5 nmi sailed distance for the Umnak and Samalga strata during the winter 2012 acoustic-trawl survey of walleye pollock in the Bogoslof Island area. Bubble size was scaled to the maximum biomass/0.5 nmi interval (Umnak stratum 3,838 t) . The diagonal line indicates where the average pollock depth equals bottom depth.

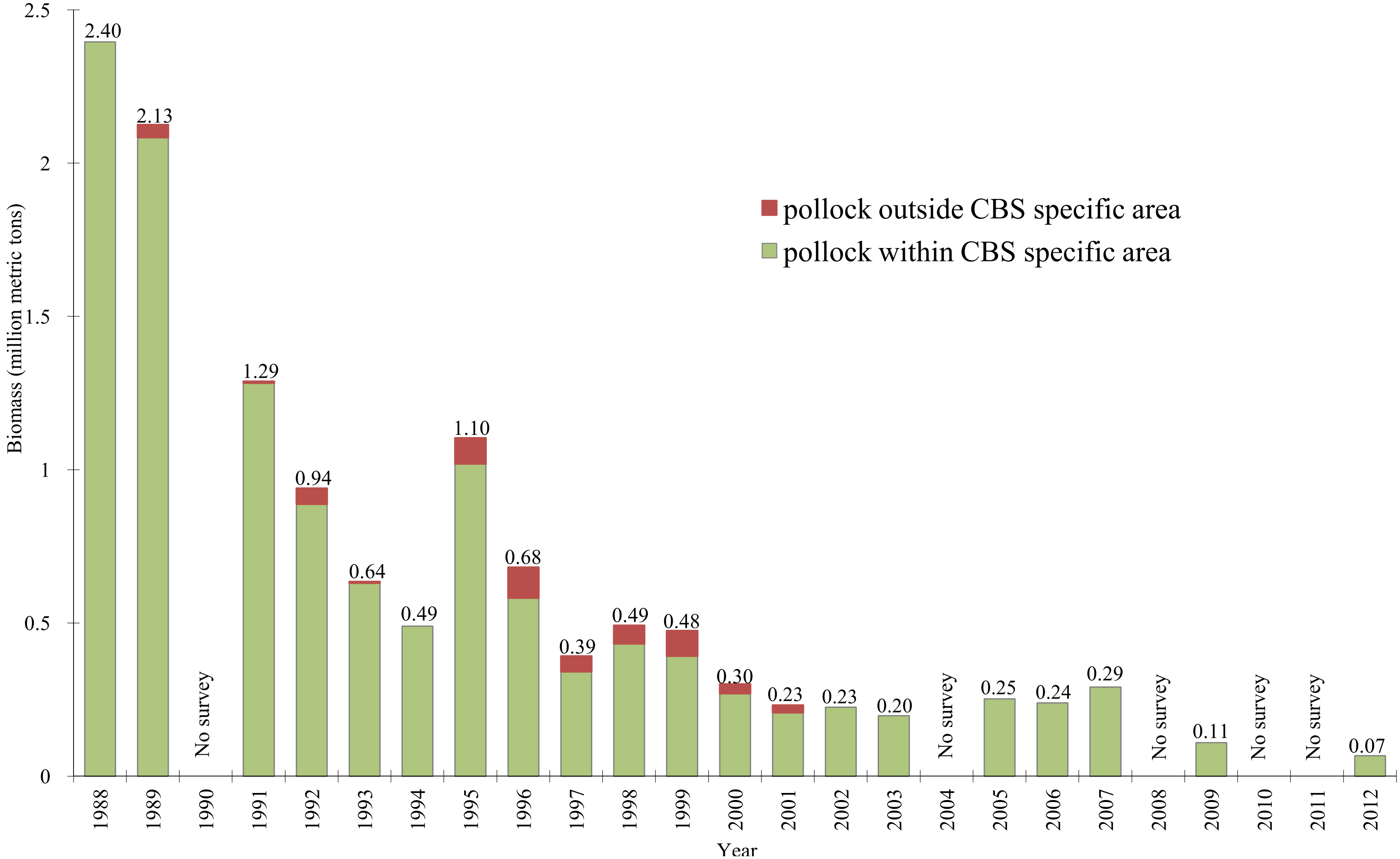

Figure 6.--Biomass estimates obtained during winter acoustic-trawl surveys for walleye pollock in the Bogoslof Island area, within and outside the Central Bering Sea (CBS) specific area,1988-2012. The United States conducted all but the 1999 survey, which was conducted by Japan. There were no surveys in 1990, 2004, 2008, or in 2010-2011. Total pollock biomass (million metric tons) for each survey year is indicated on top of each bar. Estimates in 2012 came from the primary survey.

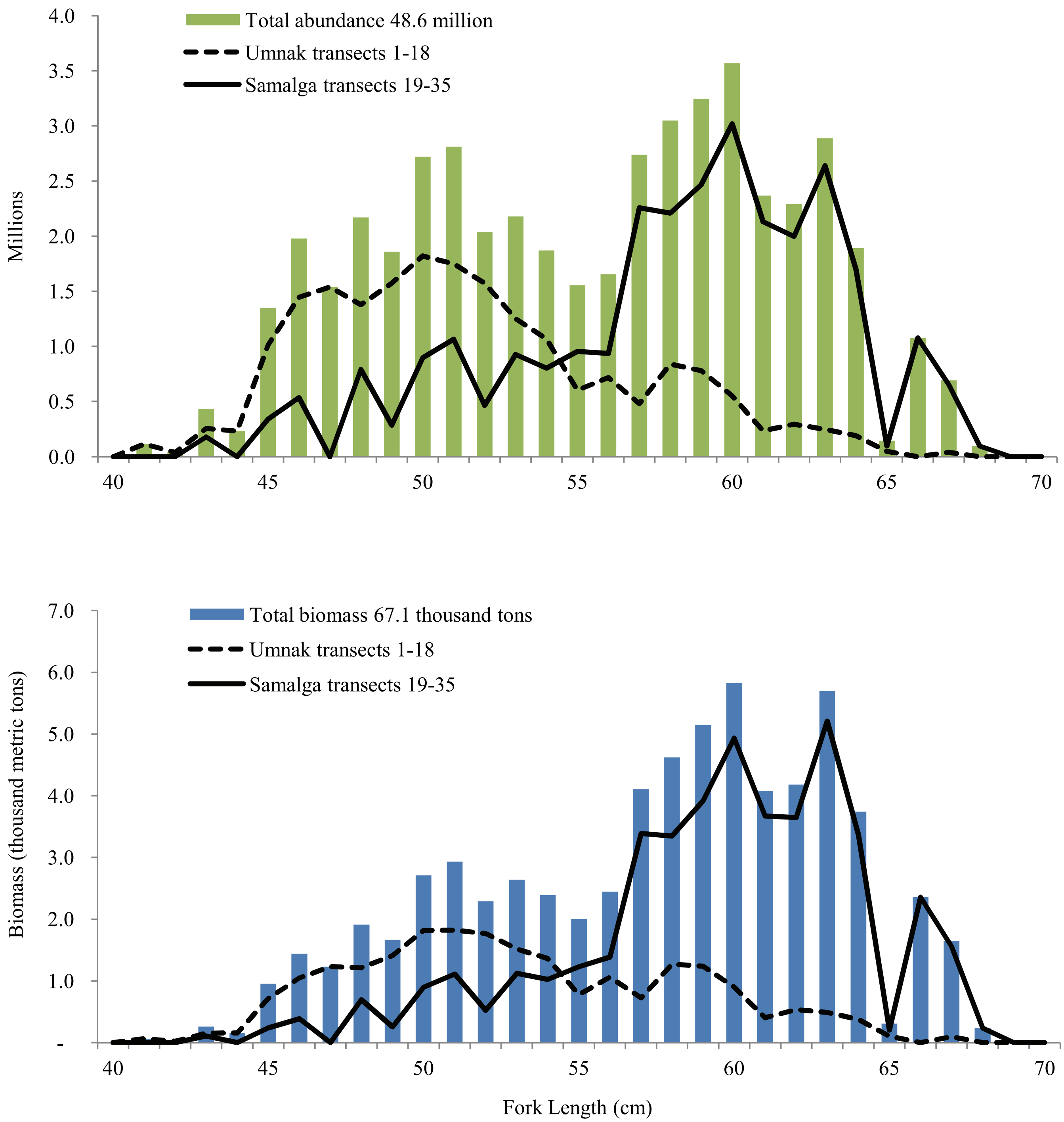

Figure 7. Numbers at length (top) and biomass at length (bottom) estimates by region and total from the winter 2012 acoustic-trawl primary survey of walleye pollock in the Bogoslof Island area.

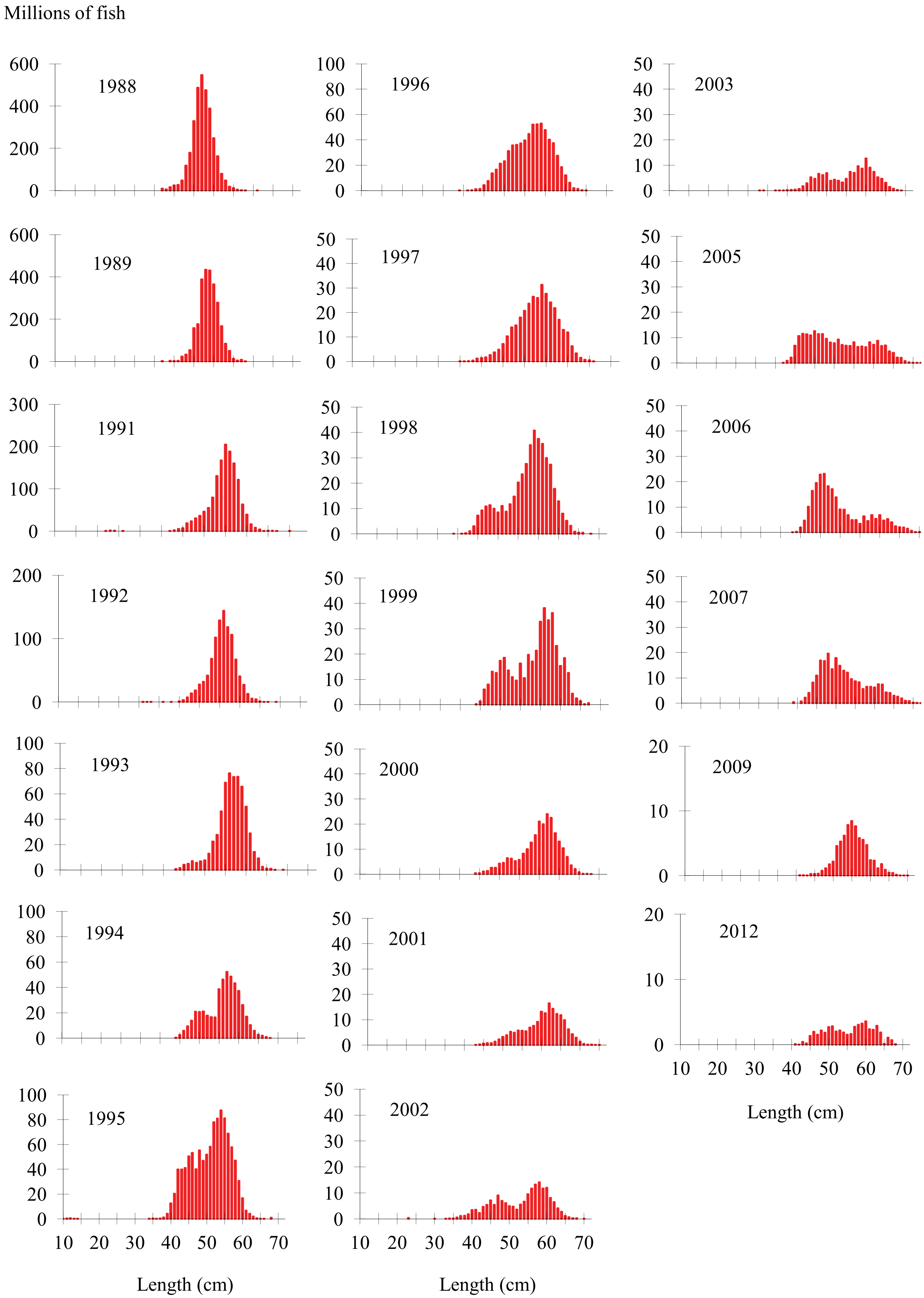

Figure 8.--Numbers-at-length estimates (millions) from winter acoustic-trawl surveys of spawning pollock near Bogoslof Island. No surveys were conducted in 1990, 2004, 2008, or 2010-2011. The 1999 survey was conducted by Japan.
Note: Y-axis scales differ.

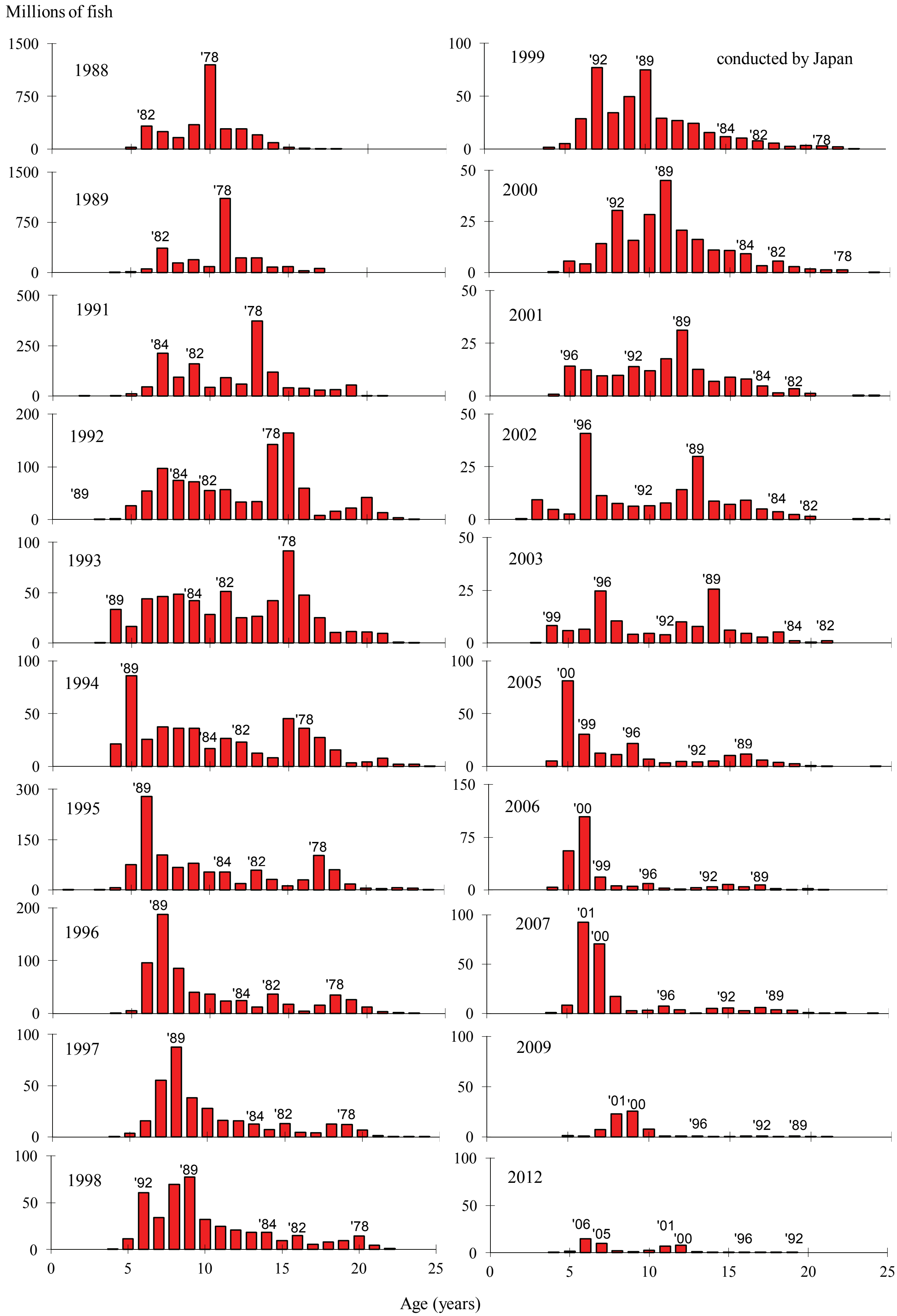

Figure 9.--Numbers-at-age estimates (millions) from acoustic-trawl surveys of pollock near Bogoslof Island. Major year classes on the Bering Sea shelf are indicated. No surveys were conducted in 1990, 2004, 2008 or 2010-2011.

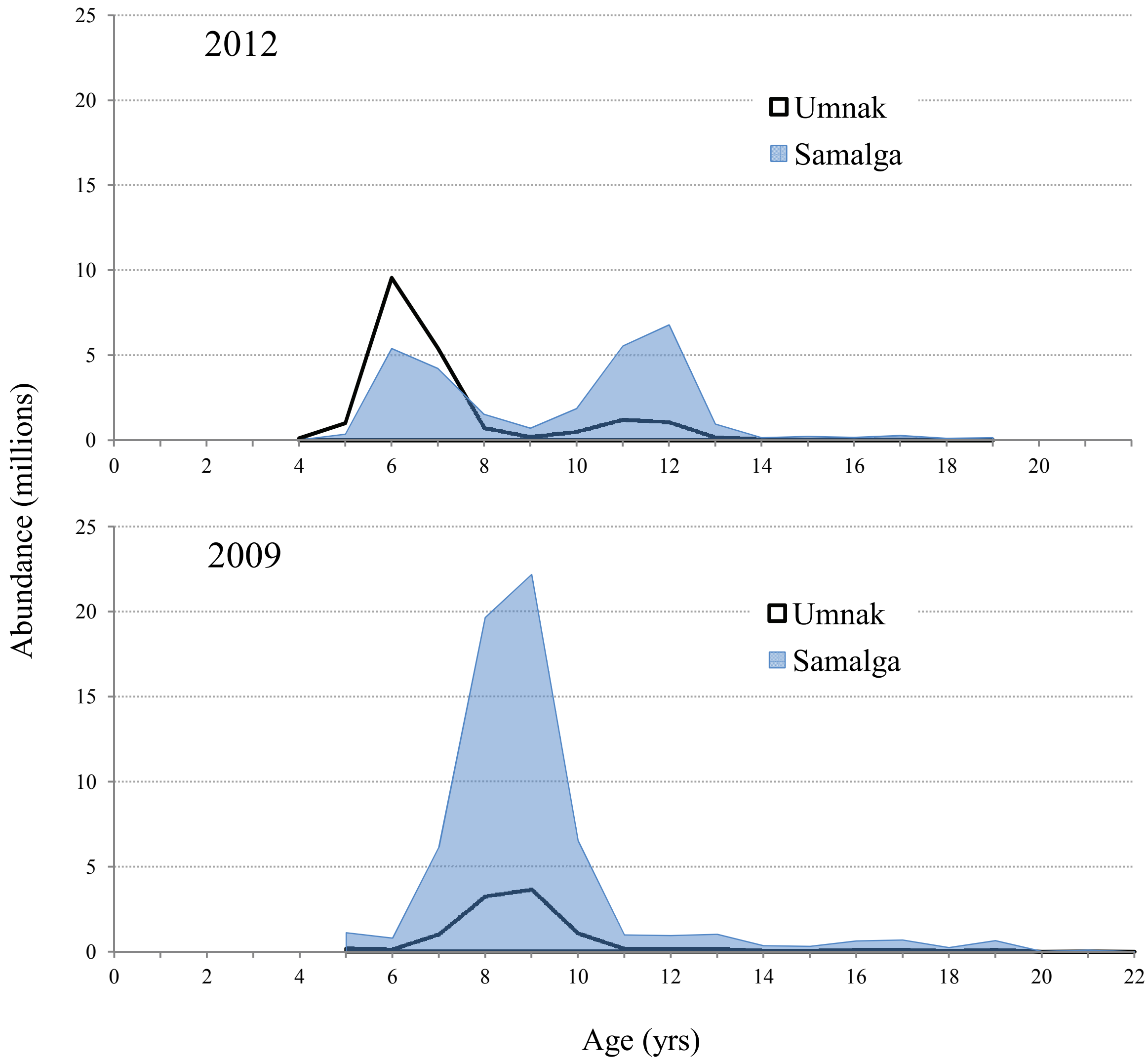

Figure 10.-- Abundance (millions) by age by stratum for walleye pollock observed during the acoustic-trawl surveys conducted in 2012 (top) and 2009 (bottom).