Federal Agency for Fisheries of the Russian Federation

DISTRIBUTION AND FEATURES OF BEHAVIOUR OF POLLOCK (*THERAGRA CHALCOGRAMMA*) IN THE NORTHWESTERN BERING SEA IN SUMMER – AUTUMN, 2003

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The results of hydroacoustic measurements and control tows in the northwestern Bering Sea in August-October, 2003 are presented. The measurements was conducted by R/V "TINRO" in August 12 - 23 and in October 15 - 27, 2003 in area placed between 176^0E - 170^0W, including Anadyr Bay (Russian EEZ).

The ratio of total values of pollock area backscattering - Sm (m^2) in August, 2003 to August, 2002 consisted **1.43** for pelagic layer and **1.34** for near-bottom layer. The ratio of Sm in October to August, 2003 consisted **1.68** for pelagic fishes and **1.24** for near-bottom layer.

Abundance of pollock in August, 2003 has been estimated in 2262 million fish, biomass 609 ths.t. in the Navarin-Anadyr area. Pollock abundance in October, 2003 estimated 3341 million fish, biomass in 932 ths. t. in same area The total abundance of age-0 pollock in the northwestern Bering Sea in October, 2003 estimated as 85 billions fishes and total biomass - 261 ths. t by hydroacoustic measurements.

The purpose of this work is study of seasonal variability of spatial distribution and an abundance of pollock in the northwestern Bering Sea in summer – autumn period.

MATERIAL AND METHODS

Hydrocoustic measurements were carried out in time of the R/V "TINRO" epipelagic survey in the northwestern Bering Sea in 2003 (Russian EEZ) (Fig. 1).

Registration and accumulation of acoustic data at frequencies 38 and 120 κHz were executed continuously both in light and in dark time by scientific echo sounder EK-500 (SIMRAD).

Standard sphere acoustic system calibration were made prior to the Bering Sea cruise for measuring acoustic system performance at each frequency. The calibration

echosounder were made according to a technique recommended «Operator Manual for SIMRAD EK-500 Scientific Echo Sounder» (1997) (Table 1).

Table 1. Summary of sphere calibrations EK-500 echo sounder conducted before the cruise of R/V "TINRO" in the Bering Sea in 2004.

Date	Freq. (kHz)	Distance From Sphere (m)	TS Gain (dB)	SV Gain (dB)	3 dB Beam Width (deg.)		Angle Offset	
					Along	Athwart	Along	Athwart
06.06.03	38	24.8*	27.54	27.39	6.91	6.78	-0.19	-0.09
06.06.03	120	20.1*	23.17	22.56	7.69	6.81	-0.34	0.15

* Transducer was located approximately 5.2 m below the water surface.

The navigational support of an acoustic complex was carried out using of a system of satellite positioning GPS. The software FAMAS (Fishery Acoustic Monitoring and Analyses System) for accumulation and postprocessing of acoustic data were used (Nikolaev, Ubarchuk, 2004). The typical structure of output data FAMAS is represented by outcomes of processing of fragments of acoustic images on elements of a grid with a size of a separate element of a grid of 0.5 miles and 5 m (1 m) on depth within the limits of chosen pelagic (or bottom) layers. The obtained data are saved as files with a structure of data, accessible for consequent processing in Excel. The space distributions of a relative densities of fish were mapped with use of software Surfer-8 (Windows Version, Golden Software, Inc.).

Acoustic measurements were carried out under the scheme of trawl stations accepted for complex survey. According to this scheme it was formed transects route of acoustic survey. Postprocessing of acoustic data was made according to a technology accepted of TINRO-centre (Kuznetsov, Nikolaev, 2000; Nikolaev et al., 2004).

The pelagic (surface - 10 m above bottom) and bottom (10 m off bottom) layers was selected by processing echograms. The threshold on a level of volumetric

scattering -70 dB, threshold of registration TS - 65 dB was installed. The echo integration values was estimated using a previously derived relationship between target strength and fish length (TS = 20 log FL – 66) (Traynor 1996).

In 2003 control tows was conducted only in upper surface layer, therefore pollock length data not available and for interannual comparison of pollock abundance in the northwestern Bering Sea in 2002-2003 used relative acoustic units of density (nautical area backscattering coefficient) Sa (m^2/n.mi.^{2}) and abundance (area backscattering) Sm – parameter, describing abundance of pollock stock on square of standart biostatistical regions (Volvenko, 2003) or total area of survey in relative units: Sm=(Sa*A)/1000 (m^2), where A – square of region (n.mi.^{2}). The abundance of fish is evaluated by expression: $N = Sm / \langle \sigma_i \rangle$.

Identification of pollock was carried out by the visual and algorithmic analysis of echogramms, and also on base of experience of previous surveys in this area.

RESULTS AND DISCUSSION

The main concentration of pelagic pollock aggregations have been indicated at shelf placed to east and southeast from cape Navarin (Sa> 10000 m^2/n.mi.^{2}) in August 2003 (Fig. 2)**.** The average density of pollock in the Navarin area due to a center of density consisted 269 m^2/n.mi.^{2} (Table 2). In August, 2003 midwater pollock aggregations have been distributed approximately in the same area as previous year, but density estimated basically more than 100 m^2/n.mi.^{2} (average density on area - 303 m^2/n.mi.^{2}). The near-bottom pollock distribution in the northwestern Anadyr Bay in August 2003 were less than in 2002. (Fig. 3). The density of near-bottom pollock concentration in the Navarin area in 2003 was comparable with 2002 data and just in the southeastern Anadyr Bay it was higher than in 2002.

Table 2. Relative density of pollock - Sa (m^2/n.mi.^{2}) and value of back scattering surface of fish (an acoustic index of abundance) - Sm (m^2) in biostatistical regions of the northwestern Bering sea by data of acoustic measurements in August, 2002 and 2003.

Year	Biostatistical regions								Total	
	2		3		4		5			
	Pelagic	Bottom	Pelagic	Bottom	Pelagic	Bottom	Pelagic	Bottom	Pelagic	Bottom
	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa
	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm
2002	2.4	4.4	35.5	30.5	0.3	1.6	269.3	161.6	307.5	198.1
	33.8	62.1	458.2	393.7	2.4	12.7	2914.5	1748.9	**3408.9**	**2217.4**
2003	-	-	122.7	131.2	0.9	7.1	303.0	112.3	426.6	250.6
	-	-	1583.7	1693.4	7.2	56.4	3279.2	1215.7	**4870.1**	**2965.5**

Scale of pollock distribution in northwestern Bering Sea depends of volume of cold waters pool. In August 2003 volume of cold water pool in the Anadyr Bay was less than in 2002 and pollock distribution in northwestern Bering Sea were wider (see Fig. 2, 3). The average density of pollock in a southern and southeastern Anadyr Bay in 2003 was much higher than in 2002 (Table 2).

The Sm in August, 2003 was higher than in 2002 in the Navarin area, except northwestern Anadyr Bay (Table 2). The ratio of total values Sm of 2003 to 2002 is 1.43 for pelagic and 1.34 for bottom layer.

The total pollock biomass estimated in 435 ths. t in August, 2002 and just 247 ths. t (57 % of a biomass) registered in midwater. The total pollock biomass in August, 2003 estimated on base the ratio Sm 2003/2002 as 605 ths. t (in midwater - 353 ths. t and 252 ths. t near-bottom).

The Navarin pollock stock length structure was reconstructed on base of observers data and it abundance estimated as 2262 million fish, biomass as 609 ths. t.

In second half of October, 2003 concentration of pelagic and near-bottom pollock have been registered in the southern Anadyr Bay and entire Navarin area, but scale of northwestern distribution was higher than in 2002 (Fig. 4, Table 3).

Table 3. Relative density and back scattering surface of pollock (an acoustic index of abundance) in the northwestern Bering sea in October, 2003 (0-year class fishes not included)

	Biostatistical regions					Total
	1	2	3	4	5	
	Midwater layer					
Sa (m^2/n.mi.^{2})	6.3	10.4	286.2	117.6	317.3	737.8
Sm (m^2)	20.0	96.1	3694.4	935.2	3433.7	**8179.5**
	Bottom layer (0-10 m)					
Sa (m^2/n.mi.^{2})	5.8	24.6	82.4	111.3	136.6	360.7
Sm (m^2)	18.4	227.8	1063.1	885.3	1478.4	**3673.0**

Pollock have been registered even in the Bering strait and in the northern Anadyr Bay in second part of October.

Value of Sm reflecting an acoustic estimation of an abundance of pollock, in October, 2003 was significantly higher as in August, 2003 (Table. 3). The ratio of total values of Sm in October/August estimated as 1.68 for midwater and 1.24 for a bottom layer. The total pollock biomass in the northwestern Bering Sea in October, 2003 estimated on base ratio Sm data as 905 ths. t, and proportion of midwater fish consisted 593 ths. t, near-bottom pollock - 312 ths. t.. From the specified length structure of fishes by hauls of fishing vessels and values of Sm, the total pollock abundance estimated on base reconstructed length frequency data in the Navarin-Anadyr region in October, 2003 is 3341 million fish and biomass 932 ths. t.

The pollock juveniles found everywhere in the Anadyr Bay in August, 2003 **(**Fig. 5). Pollock juveniles traditionally inhabited in upper layer above thermocline.

At night pollock juveniles were scattered and afternoon concentrated in small schools in layer 50 m – surface.

In October 2003 pollock juveniles were distributed entire northwestern Bering Sea until Chukchi Sea (Fig. 6A). The abundance of pollock juveniles and it distribution in the Navarin-Anadyr areas in autumn of 2003 most significant for last 6 years. Abundance and a biomass of pollock juveniles estimated, according to acoustic measurements in 85 billion specimen and 261 ths. t (Table 4).

Table 4. Abundance and biomass of pollock juveniles in the northwestern Bering Sea in October, 2003 (by acoustic measurements and tows data).

	Biostatistical regions					Total
	1	2	3	4	5	
Number, bln. pcs.	6.5	16.6	31.5	18.5	11.6	84.7
Biomass, ths. tons	25.8	66.3	87.4	41.1	40.2	260.8

The pollock juveniles length frequency very wide and demonstrates possibility of mixing different size and age juveniles in the northwestern Bering Sea (Fig. 7).

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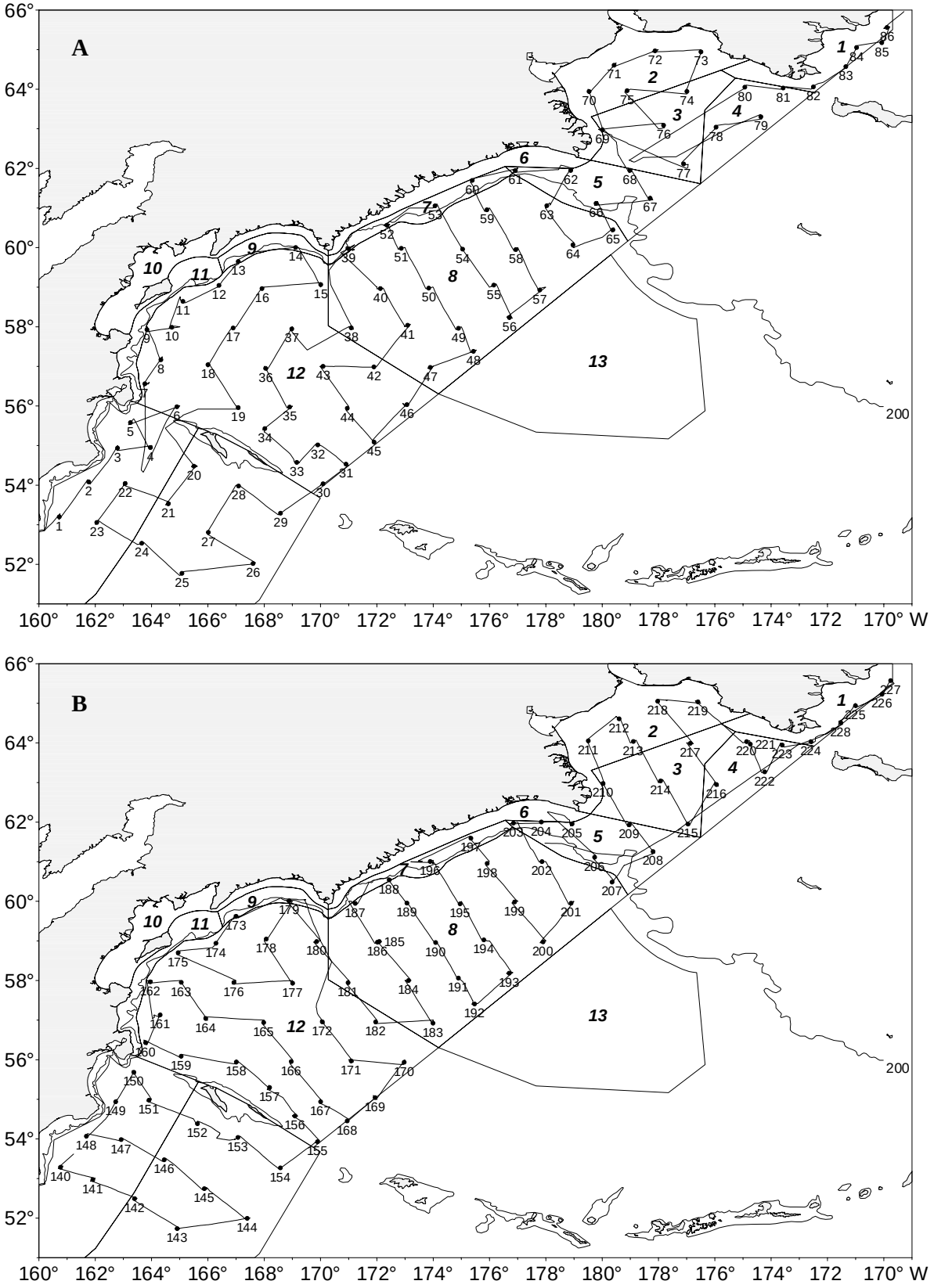

Fig. 1. The scheme of biostatistical regions, transect lines and haul locations in July - August (A) and September - October (B) 2003.

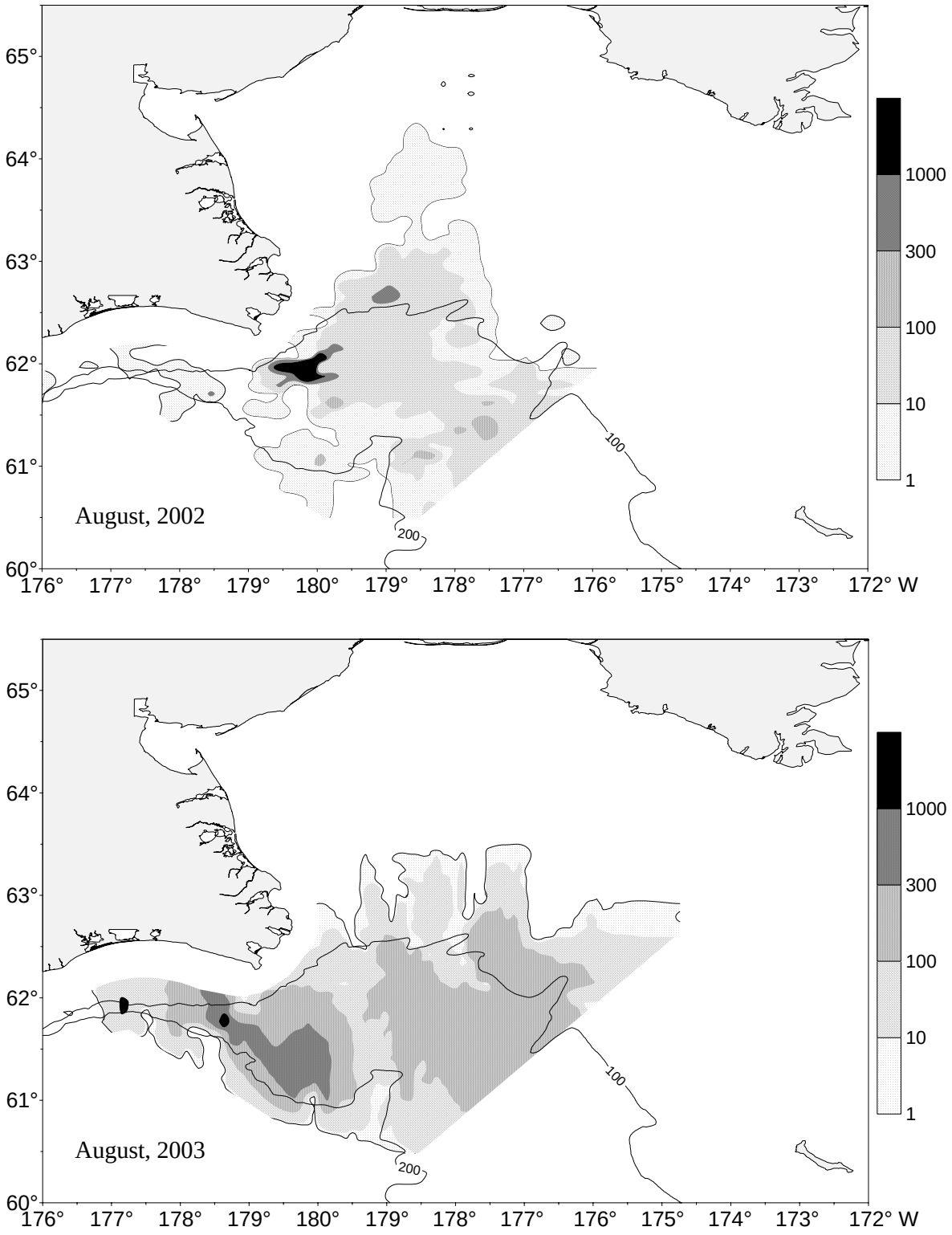

Fig. 2. Distribution of relative density Sa (m^2/n.mi.^{2}) of pelagic aggregations of walleye pollock in the northwestern Bering sea in August, 2002 and 2003.

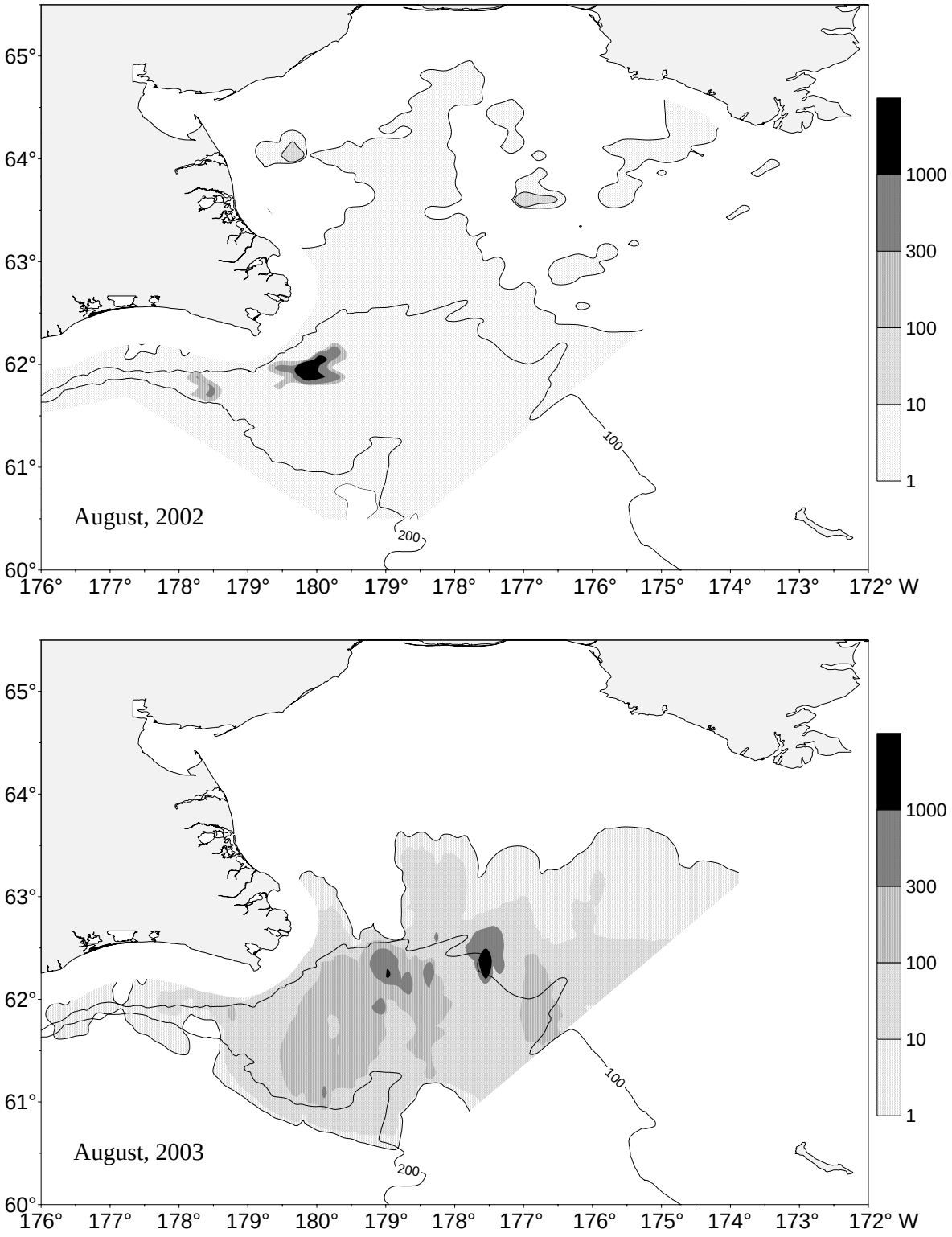

Fig. 3. Distribution of relative density Sa (m^2/n.mi.^{2}) of near-bottom pollock aggregations (layer 0-10 m) in August, 2002 and 2003.

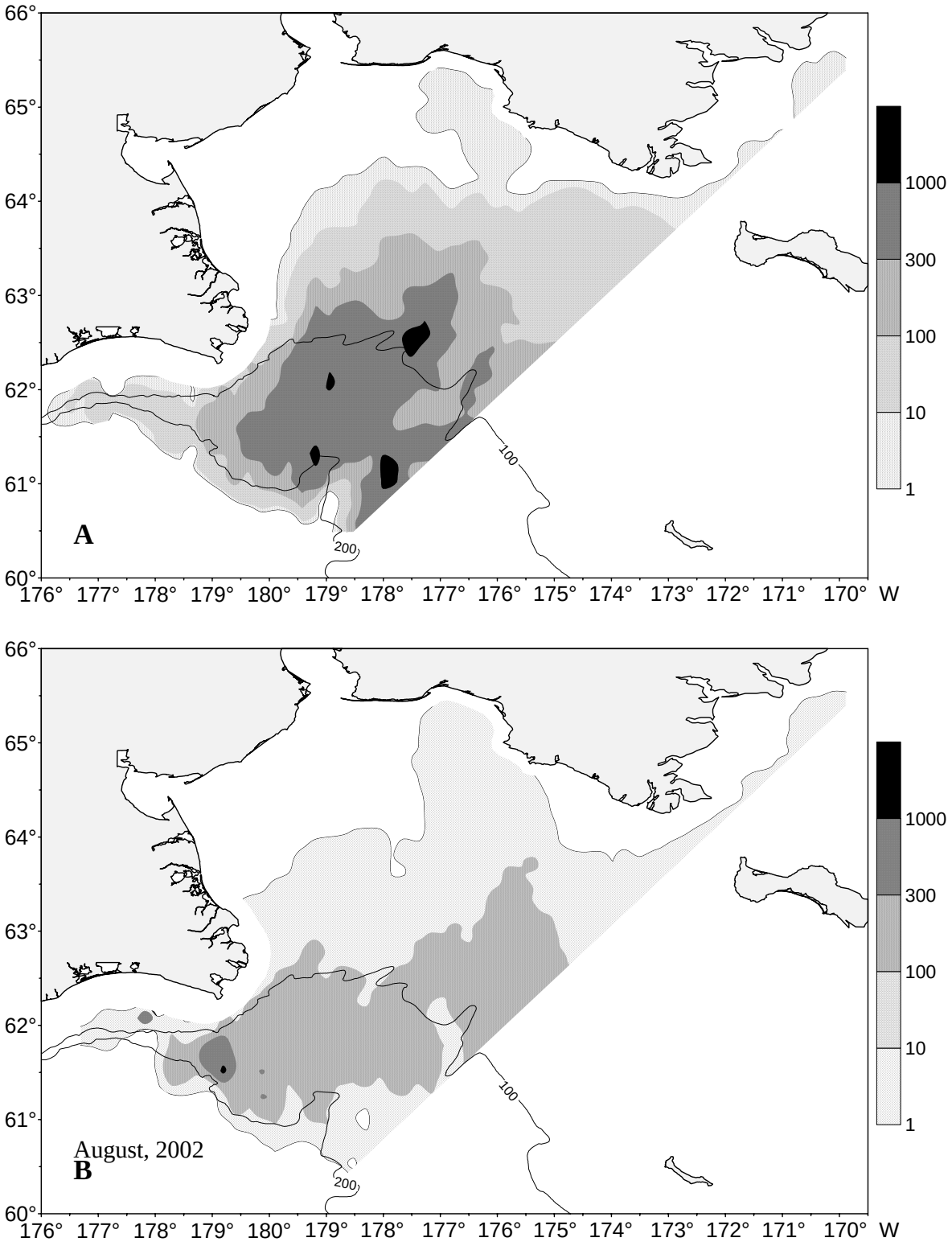

Fig. 4. Distribution of relative density Sa (m^2/n.mi.^{2}) of pelagic (**A**) and near-bottom (**B**) pollock aggregations in October, 2003.

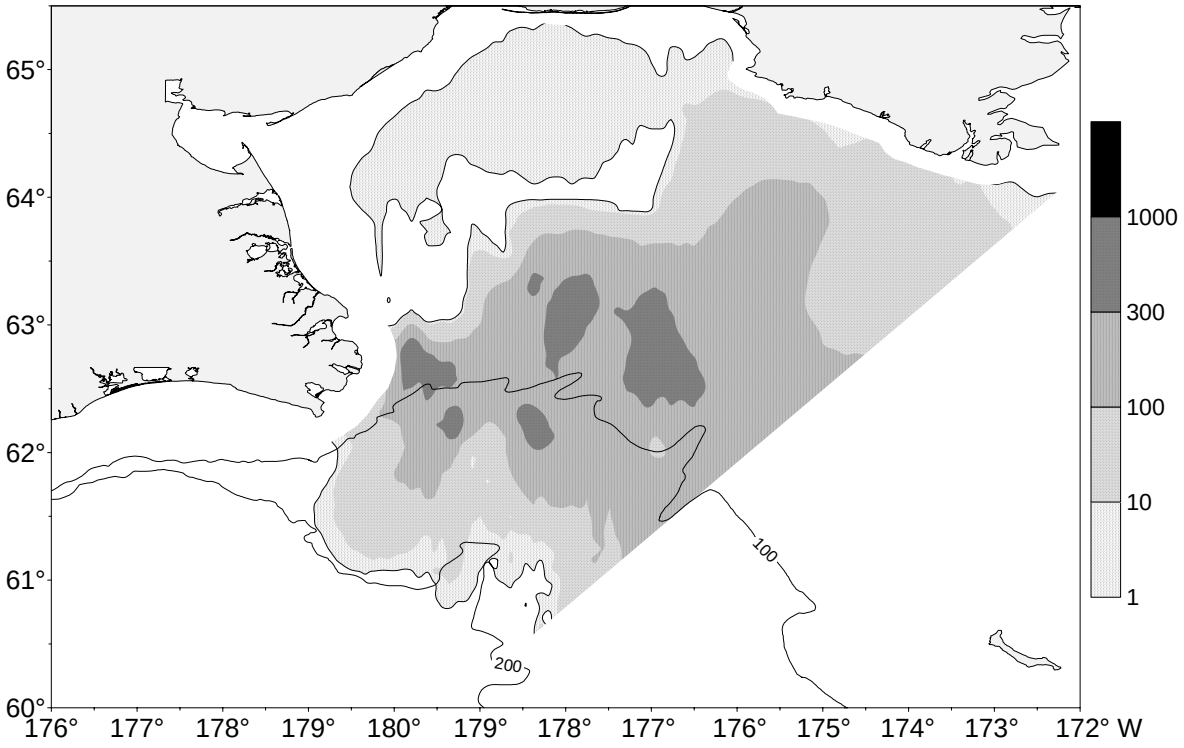

Fig. 5. Distribution of relative density Sa (m^2/n.mi.^{2}) of pelagic age-0 pollock aggregations by data of acoustic measurements in the northwestern Bering sea in August, 2003.

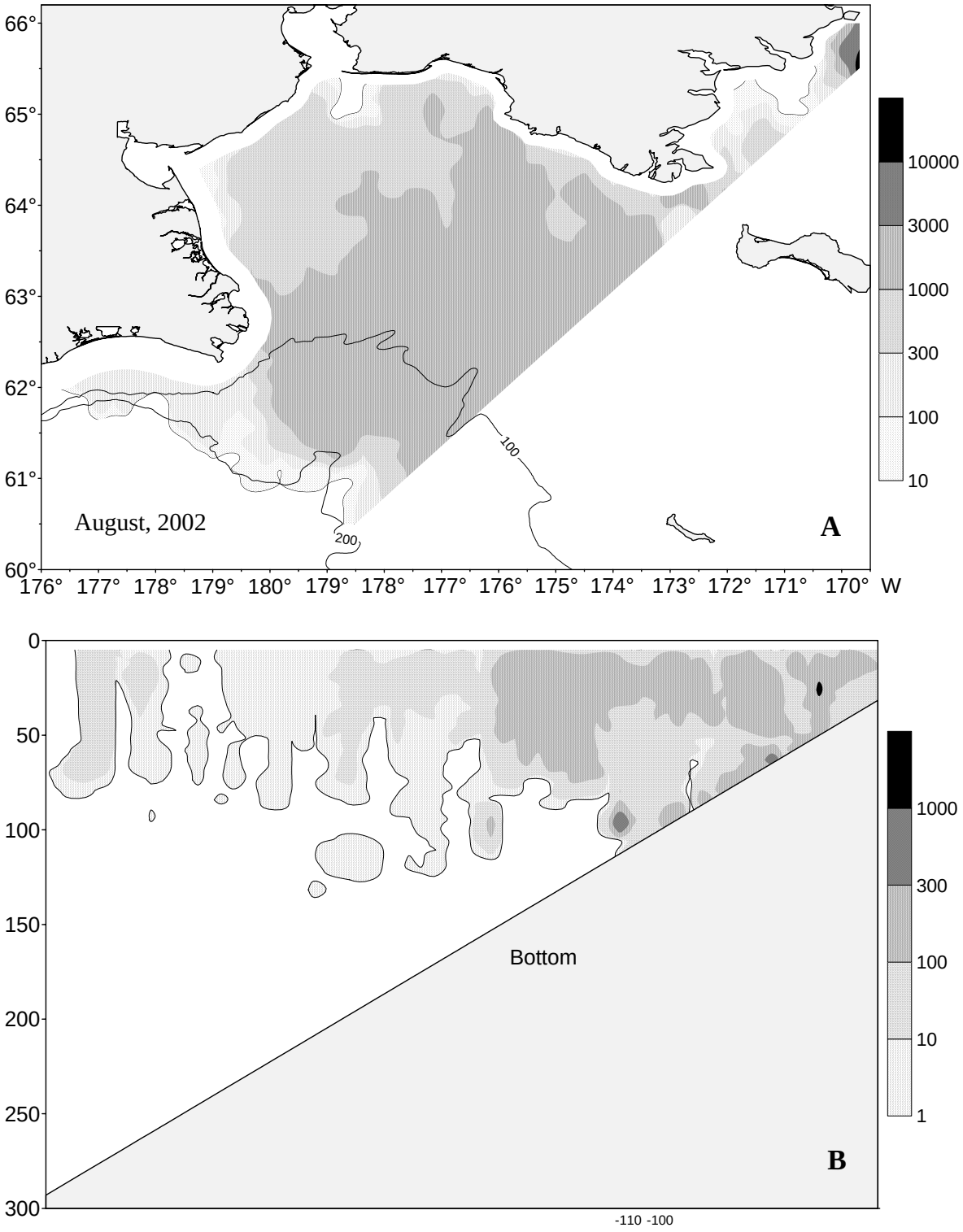

Fig. 6. Horizontal **(A)** and vertical **(B)** distribution of age-0 pollock (ths.pcs./n.mi.^{2}) on water area of Anadyr Bay in October, 2003.

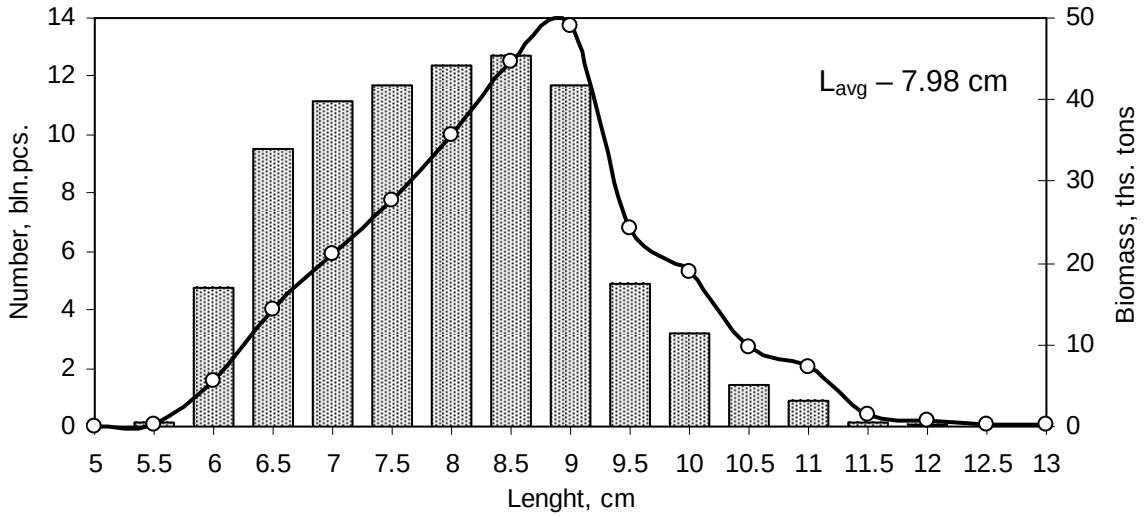

Fig. 7. Length composition of age-0 pollock in the northwestern Bering sea by results of acoustic measurements and trawl hauls 14-27.10.2003.