Scientific and Technical Committee Report, 2003
Attachment 6

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FOR THE 8TH ANNUAL CONFERENCE OF THE PARTIES TO THE CONVENTION ON THE CONSERVATION AND MANAGEMENT OF POLLOCK RESOURCES IN THE CENTRAL BERING SEA

PORTLAND, OREGON, 15-18 SEPTEMBER 2003

Federal Committee on Fisheries of Russian Federation

HYDROACOUSTIC AND BOTTOM TRAWL SURVEYS OF THE BERING SEA WALLEYE POLLOCK IN OCTOBER-NOVEMBER 2002

(document submitted for VIII Bering Sea Pollock Conference, Portland, 2003)

By
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2003

The demersal component of the stock is usually assessed during bottom trawl surveys while pelagic component is studied using acoustic surveys (Karp and Wallers, 1994). It was stated by numerous surveys that usually demersal orientation is more common for older fish, and younger fish are more distributed in midwater. Simultaneously conducted bottom trawl and acoustic surveys could give new data to estimate the stock and to compare different ages vertical distribution.

The surveys were conducted simultaneously in the same area of the North-West part of Bering Sea near cape Navarin from October 28 to November 4, 2002. Acoustic data were collected in the whole water column using EY500 Simrad echosounder on the board of Japanese trawler KAYE-MARU №28.

The trackline consisted of 448 nautical miles (Fig.1).

The following a specialized complex of the equipment and the software was used for the echo survey:

- echo sounder EY500 Simrad (38 kHz) with single beam antenna in the towed body;
- PC, used as the block of management and monitor of echo sounder;
- GPS receiver of firm Trimble Navigation (USA), connected to the computer of the echo sounder and automatically determining coordinates of a vessel, which are registered together with acoustic data;
- magneto-optical drive Fujitsu FMO-1300WS2 for recording echo signals from the computer, which was used as the store of the information;
- echo processing system EP500 Simrad for reproducing and processing of the recorded echo signals.
- colour printer DeskJet HP850C (Hewlett Packard).

Complex allows to automate completely the collection of data during echo survey, providing record of primary data (as echo signal from an output of echo sounder) for their subsequent storage and processing. Other important peculiarity of a complex is an automatic determination of coordinates of a vessel with rather high precision of GPS system, registration of echo signals and coordinates simultaneously. It allows to calculate plots of distribution of measured parameters, to locate significant interesting records.

Nowadays advanced direction in hydroacoustics are methods and equipment of a quantitative estimation of fish schoolings. Created methods (Manual of hydroacoustic surveying, 1984) are well fulfilled and are widely used for biomass estimation of fish schooling and its distribution at realization echo survey in process of fishery researches with the use of echo sounders and echo integrators.

The method of realization of hydroacoustic surveys includes the following standard stages:

- installation of the equipment on a vessel and checking its functioning;
- calibration of the equipment with the use of standard copper sphere;
- choice of transects and parameters of echo survey (speed of a vessel, length of transect lines, place of control trawling, elementary sampling distance unit (ESDU) and etc.);
- choice of working parameters of the equipment during survey;
- directly registration and record of echo sign;
- data processing of survey, plotting of the echo integration results, estimation of the biomass with a confidence intervals.

The antenna of echo sounders was towed from the left board on a course of a vessel on depth about 2.5 m, in order to exclude influence of reflections of a echo sounder signals from the frame of a vessel and superficial of sound-scattering layers (air bubbles). Proceeding from the methodical recommendations of operation of the echo sounders and design peculiarities of a vessel, the speed of a movement was chosen 4.5 - 6 knots.

The choice of a transects was determined in view of results of the previous surveys, and also with necessity of more detailed surveying of chosen region. Transects of hydroacoustic survey crossed depths about 250 meters. The preliminary tests of echo sounder EY500 have show that the level of a signal-to-noise-ratio at duration of a pulse 1 msec (Medium) on such depthes has appeared unsufficient. Therefore duration of a pulse 3 msec (Long) with a narrow band was chosen. The record of echo signals was conducted during the day-and-night time with breaks, necessary for conduction control trawls.

Control trawls were carried out in places with high density of fish schooling and at change of character of their registration, where it was possible.

Biomass calculation W was computed according to a «Manual of hydroacoustic surveying» (1984) and instruction for use of echo processing system EP-500.

The technology of processing of acoustic data based on a principle of detailed stratification of region with the account length category of pollock stocks and another species. In a basis of such approach lay the following parcels:

- the acoustic image of a schooling rather adequately displays spatial distribution and behaviour of objects on a certain part of a way in a certain interval of time of days;
- the change of a kind of the acoustic image serves the indicator of change of behaviour and, probably, age-length characteristics of a fish and is subject to

check control trawling;

• in case there is record of object in various depth horizons, control trawlings are carried out for separate identification of each type of schooling.

• in accordance with receipt acoustic datas during survey the empirical analysis of echo signals, taking into account character of behaviour of object, type of distribution of target strength (TS, dB), results control trawling, experience of previous work in the certain region came true. In result of the conducted analysis of an acoustic situation parts of a way on transects of acoustic survey, schoolings appropriate to the characteristic acoustic description with certain length category, confirmed by results control trawlings on certain schooling. Were allocated, in the subsequent such part of a way and length-frequent line appropriate to a schooling were used for biomass calculation of an identified schooling on the given piece of acoustic transect.

Calculating of signals is made on echo processing system EP 500 Simrad by a echo-integration method. The values received as a result of surface back scattering strength *Sa* $(m^2/mile^2)$ were converted in area density values of fishes one-size group $_i$ $(ton/mile^2)$ using the following general formula:

where: ω_i - mean weight of *i -size* group of fish *(g)*,

$$\rho_i = S_a \cdot \frac{f_i}{\sum_1^n f_i \cdot \sigma_i} \cdot \omega_i \cdot 10^{-6};$$

σ_i - mean value of acoustic back-scattering cross section of *i-size* group of fish (m^2).

$$\sum_1^n f_i = 1$$

f_i - share of *i-size* group of fishes in control trawl,

n - amount of size groups by results of trawling.

Surface density values of fishes all size groups was computed as:

$$\rho = \sum_1^n \rho_i$$

In turn the acoustic back-scattering cross section was determined through target strength *(TSi, dB)* under the formula:

$$\sigma_i = 4\pi \cdot 10^{TS_i/10};$$

For recalculation *li (cm)* – fork length of pollock (biological characteristic) in the appropriate to it target strength of fish (the acoustic characteristic of reflective ability) fish was used the equation (Traynor, 1996):

$$TS_i = 20 \cdot Log_{10}[l_i] - 66;$$

During biomass estimation a method of selective processing of acoustic data was used. It is caused by that at the system, regular collection of acoustic data in a course echo sounding take place large variations of echo-intensity. The essence of a method is, that all echo-intensity (density), survey received in region, are distributed on "*n*" of numerical intervals *(j=1,2,3,..., n* - gradation*)*. Let, the area of region is equal "*S*", total of elementary sampling distance unit *(ESDU)* in region is equal "*N*", the amount of *ESDU* with echo-intensity in a numerical interval "*j*" is equal "*Nj*". It's suggested, that the area, occupied by echo-intensities in the interval "*j*", is equal:

$$S_j = \frac{N_j}{N} \cdot S$$

In this case dispersion and error at processing become less significant in comparison with classical ways of processing, also spatial influence of autocorrelation between acoustic measures decreases, as datas in each numerical interval "*j*" can get echo-intensities from different places of region.

The essential difficulties of detection and quantitative estimation arise during the work with semi-demersal of concentration in habit. By virtue of the various reasons they only are partially registered by echo sounders. To estimate such concentration can be possible only by a echo integration-trawl way (Yudanov, 1992). Taking into account, that vertical opening of bottom trawl was 4 m, it was made a decision to carry out echo-integration in a pelagic layer, excepting signals from bottom layer (4-0.5 m from the bottom). During result processing of area back scattering coefficient *Sa* $(m^2/mile^2)$ in the bottom layer was ignored.

To interpolate fish surface density values, the geostatistical gridding method of "Kriging", as recommended FAO a method of fields construction of biomass distribution by results of EIT surveys was used.

Biomass of fish aggregations is calculated as:

$$W = \sum_1^n W_j = \sum_j^n \rho_j \cdot S_j;$$

where: W_j – biomass in each gradation or on each part of region, (tons);

n – number of gradation or parts of region.

Dispersion of density values ([ton/mile^2]^2) in each gradation:

$$D_j^2 = \frac{\sum_1^{m_j} \left[\rho_j - \rho_i\right]^2}{m_j - 1};$$

where: p_j - mean value of density, appropriate *"j"-th* gradation,

$$\rho_j = \frac{\sum_1^{m_j} \rho_i}{m_j};$$

where: p_i - current value of density in *"j"-th* gradation, (tons/mile^2);

m_j - number of datas, appropriate *"j"-th* gradation.

Error of biomass estimation of fishes on all region was calculated under the formula:

$$\varepsilon_W = \pm t(m) \cdot \sqrt{\sum_1^n \frac{D_j^2 \cdot S_j^2}{m_j}};$$

$$m = \sum_1^n m_j;$$

where: $t(m)$ - value of Student *t*-distribution.

Fish on and near bottom were sampled with midwater trawl equipped with roller gear. Horizontal opening for the trawl averaged about 20.5 m. Vertical opening – 4 m. The trawl net had stretch mesh size to 1.0 cm in the codend. Vertical net opening and depth were monitored with a Koden wireless net sounder system attached to the headrope.

In places of the greatest concentration of fishes was carried out 18 control trawls, duration on 30 minutes each, on depthes from 90 meters up to 287 meters (Fig.1). For each haul were used to provide total weights and numbers of individuals by species. Pollock were further sampled to determine sex, fork length, body weight, age and maturity.

Surface density values of fishes (tons/mile^2) in a layer of trawling was computed as:

$$\rho = \frac{1852 \cdot W_t}{K_y \cdot S_t};$$

where: W_i - sample weight of trawl (tons);

S_t - fished area (mile^2);

K_y - coefficient catchability of trawl (K_y=0.4).

Fished area was computed as:

$$S_t = h_t \cdot v \cdot t;$$

where: h_t - horizontal opening of trawl (m^2);

v - speed of trawling (knots);

t - time of trawling (hour).

Software used at calculations (Excel, Surfer), and also the developed programs of thematic data processing (Biomass) provide calculation of errors of biomass estimations of fishes as on each gradation, and on the whole region. However it is necessary to mean, that the getting errors were calculated by the account only variations of integrals (density) of fish aggregations inside gradations and on region of surveying, i.e. are not complete errors, the calculation of which is impossible practically at the moment.

Acoustic data were collected using a Simrad EY 500 echo-sounding system operating at 38 kHz. Specifications of the acoustic system during the present servey were following:

- pulse duration - 3.0 ms (Long);
- band width - narrow (0.38 kHz);
- absorption loss coefficient - 10 dB/km;
- TVG function – 20 LogR;
- TS threshold = -60 dB;
- Sv threshold = -70 dB;
- sound velocity - 1490 m/s.

The echo sounder was calibrated using a 60 mm copper standard sphere with a TS of –33.6 dB using the technique described by Foote et al. (1987). The measurement of a noise level was carried out at various speeds of a movement of a vessel according to the methodical work instructions with echo sounder EY 500. Thus mean value of noise power on the antenna of echo sounder, recalculating to 1 W, at speed of a movement of 5 knots was - 139.9 db. During carry out of echo survey ESDU was choose 1.0 miles.

Echo recording of walley pollock were found in horizon from 70 up to 100 m, independently of time of day. In too time was present also insignificant bottom component distributions of fish, which conduct was determined by time of day: during day laid on a ground and practically was not registered by an echo-sounder, at the night - was diffused in a pelagic layer and was registered to within single fish.

Besides of pollock were registered shools of capelin and herring in horizon from 20 up to 70 m., which were are excluded from analysis at post-processing the received echograms.

Walleye pollock was the dominant species (up to 92%) captured in trawls. The size of a pollock varied from 11 up to 67 cm. Average length of a pollock was 30.6 cm. It the most significant aggregation were observed during conducting of transect №1 in coordinates 61°00N; 179°30W. The values of *Sa* on this part of transects was 3033 $m^2/mile^2$ (194,1 $tons/mile^2$).

Echo-integration of the other parts of transects has shown significant increase of density of registered shoolings – Sa values occasionally exceeded values in 1000 $m^2/mile^2$, at mean: 342 $m^2/mile^2$ (28,4 $tons/mile^2$).

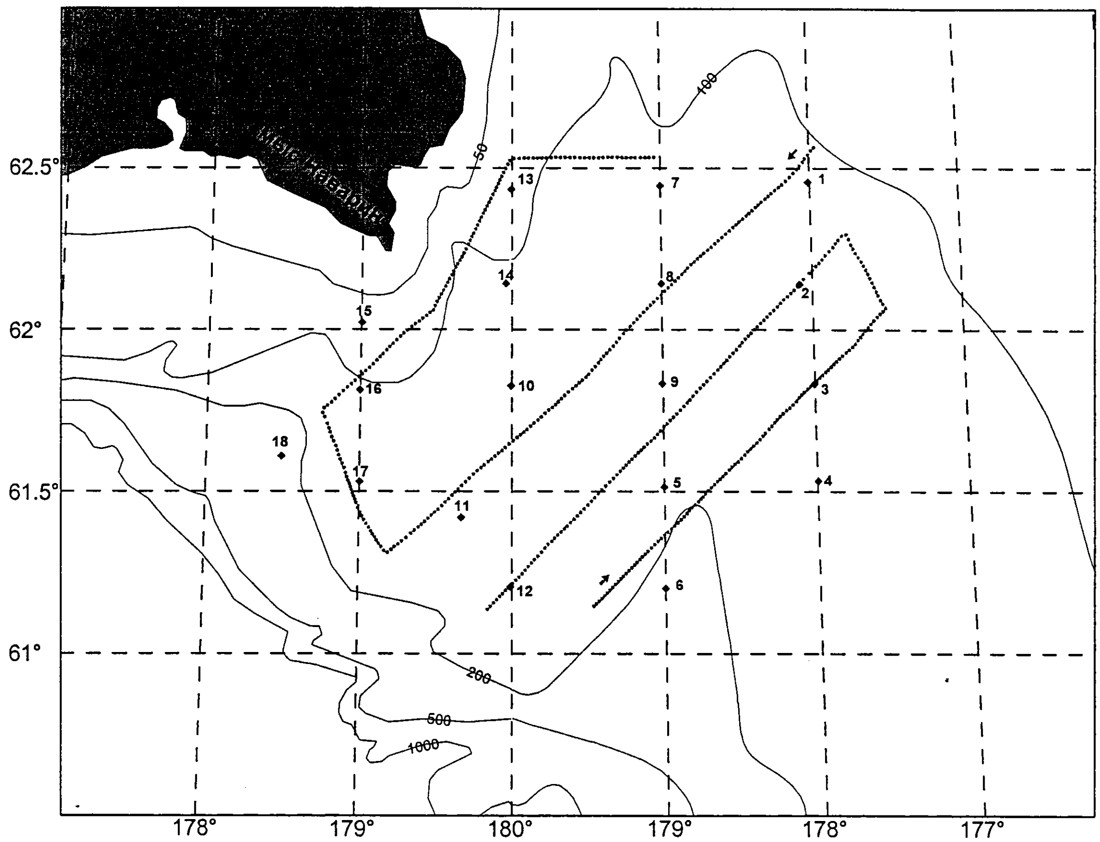

Fig. 1. Plot of hydroacoustic surveys and control trawls, carried out by a vessel "Kaye-Maru № 28 " from October 28 to November 4, 2002.

For biomass calculation the dependence of pollock weight versus length was computed from measurements of 1001 fish with length from 17.5 cm to 86 cm (Table 1), with correlation coefficient 0,97:

$$w = 6.5 \cdot 10^{-3} \cdot l^{3.04}$$

,where: w – weight of pollock *(g)*;

l – length of pollock in cm.

Table 1

Average and standard deviation of length and weight of Walleye pollock by results of cath data.

	Mean	St. deviation	Minimum	Maximum
Length(cm)	45,9	10,6	17,5	86,0
Weight(g)	889,9	637,1	60,0	5200,0

The dependence of weight on length, received by results of measurements of 1001 fish is introduced on Fig. 2.

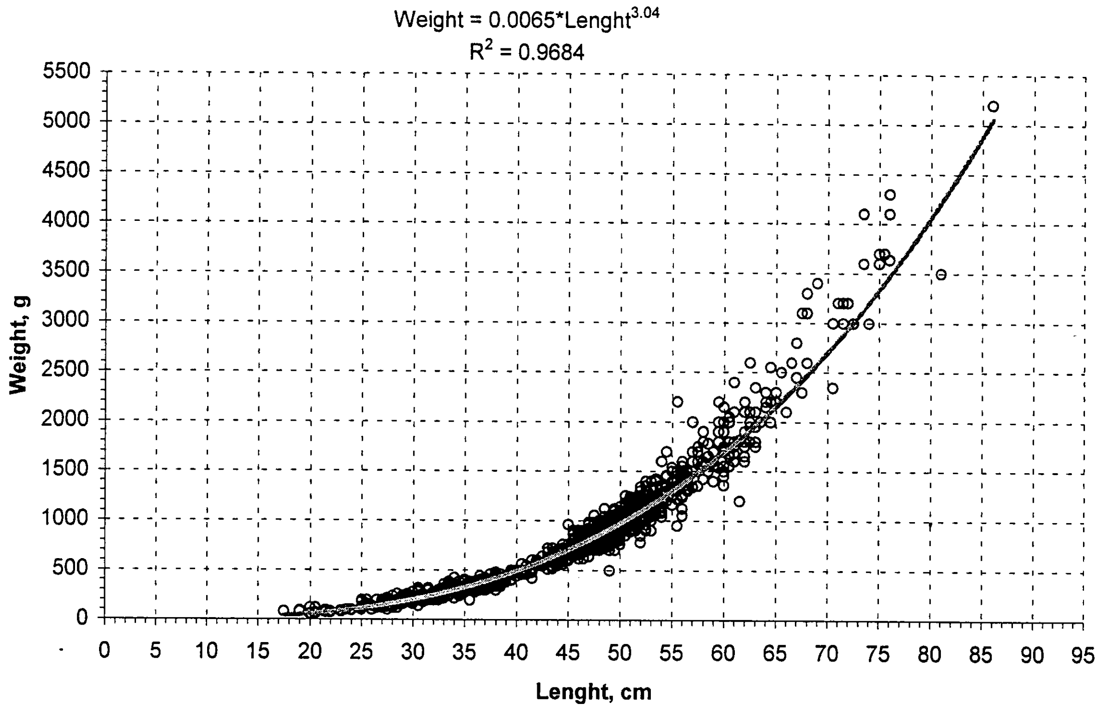

Fig. 2. Dependence of weight from length of Walleye pollock.

At plotting of area density distributions of pollock, for interpolation of area density values, display of a field of biomass distribution, its a quantitative estimation and calculation of each gradation area was used the "Surfer" software (Golden Software, USA) and "Biomass" software (VNIRO).

To study the spatial structure of pollock distribution, experimental omnidirectional standardised variograms were calculated on the respective estimated fish density. Variograms were fitted by visual inspection to exponential model. Software allows the user to monitor the goodness of fit resulting from the adoption of different choices for the parameters of the model, in order to find the best possible fit. The parameters of the exponential fit to the experimental variogram so obtained were then applied to implement Kriging interpolation method for biomass estimation and mapping purposes.

The parameters for calculating of density values in points of a regular grid were following:

- method of interpolation - Point Kriging;
- model of variogram - Exponential

(Scale = 1126; length = 13.739; anisotropy = 1.613, 119.1)

- scale of regular grid - 1 mile X 1 mile.

Area density of Walleye pollock by results of echo integration changed in limits from **0.04 up to 198.65 tons/mile2**
(mean = 28,44 tons/mile^2; st.dev = 33,34 tons/mile^2).

Table 2 represent the biomass calculations results of hydroacoustic survey on the area 10084 mile^2 in the whole water column of fish distribution.
The distribution of pollock area density (tons/mile^2) plotted on Fig. 3.

Table 2

Biomass calculations results of Walleye pollock in the whole water column.

Gradation [ton/nm2]	Area [nm2]	Density [ton/nm2]	Biomass [ton]	Confedence Interval[±ton]
0 - 9	1471	5,0	7285,7	184,5
9 - 18	1746	13,7	23881,8	208,1
18 - 27	2272	22,6	51379,0	240,3
27 - 38	2344	32,1	75319,3	293,3
38 - 45	681	41,1	28018,9	99,7
> 45	1570	72,4	113651,0	1864,8

Total Area = 10084[nm2]
Total Biomass = 299535,7 ± 1925,7[ton]

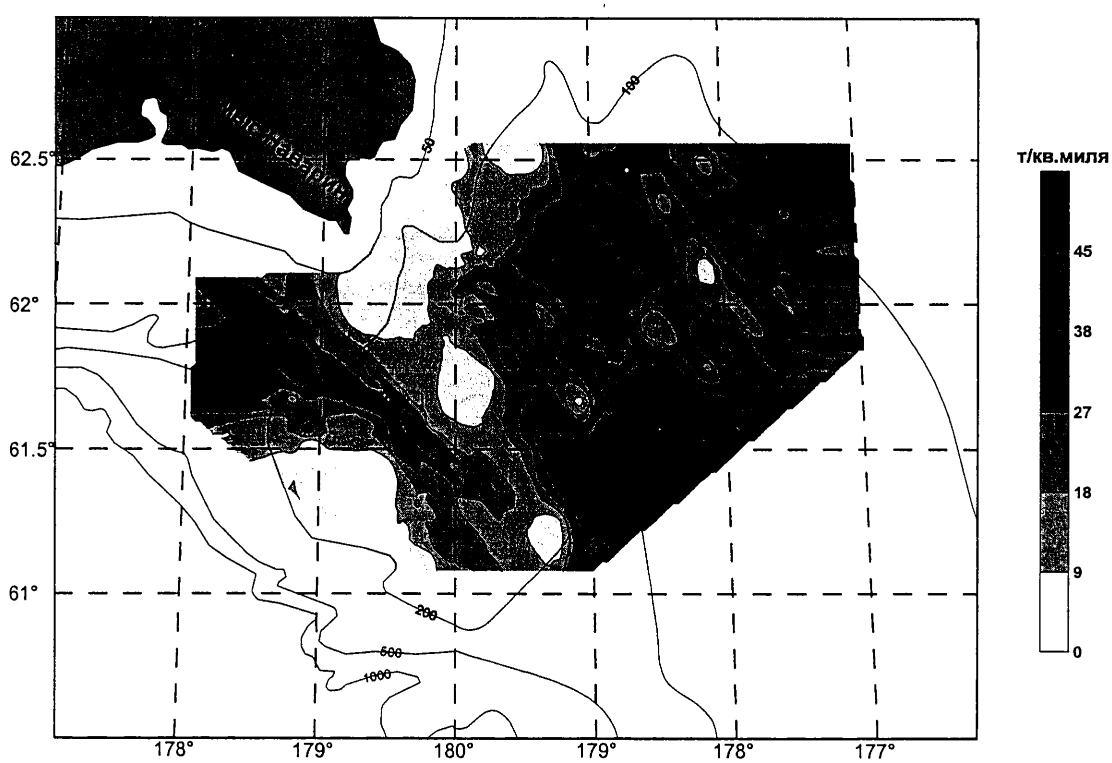

Fig. 3. The distribution of pollock area density (tons/mile^2) of hydroacoustic surveys, carried out by a vessel "Kaye-Maru № 28 " from October 28 to November 4, 2002

Table 3 represent the biomass calculations results of hydroacoustic survey of fish distribution for fish with length more then 35 cm. The conforming distribution of pollock area density (tons/mile^2) plotted on Fig. 4.

Table 3

Biomass calculations results of Walleye pollock in the whole water column. (length > 35 cm.)

Gradation [ton/nm2]	Area [nm2]	Density [ton/nm2]	Biomass [ton]	Confedence Interval[±ton]
0 - 9	2429	5,3	12772,2	238,7
9 - 18	4198	12,8	53587,5	316,6
18 - 27	1515	21,8	33075,5	192,2
27 - 38	961	32,0	30732,9	192,6
38 - 45	290	41,0	11897,6	65,8
> 45	691	70,6	48774,4	1059,6

Total Area = 10084[nm2]
Total Biomass = 190840,1 ± 1165,4[ton]

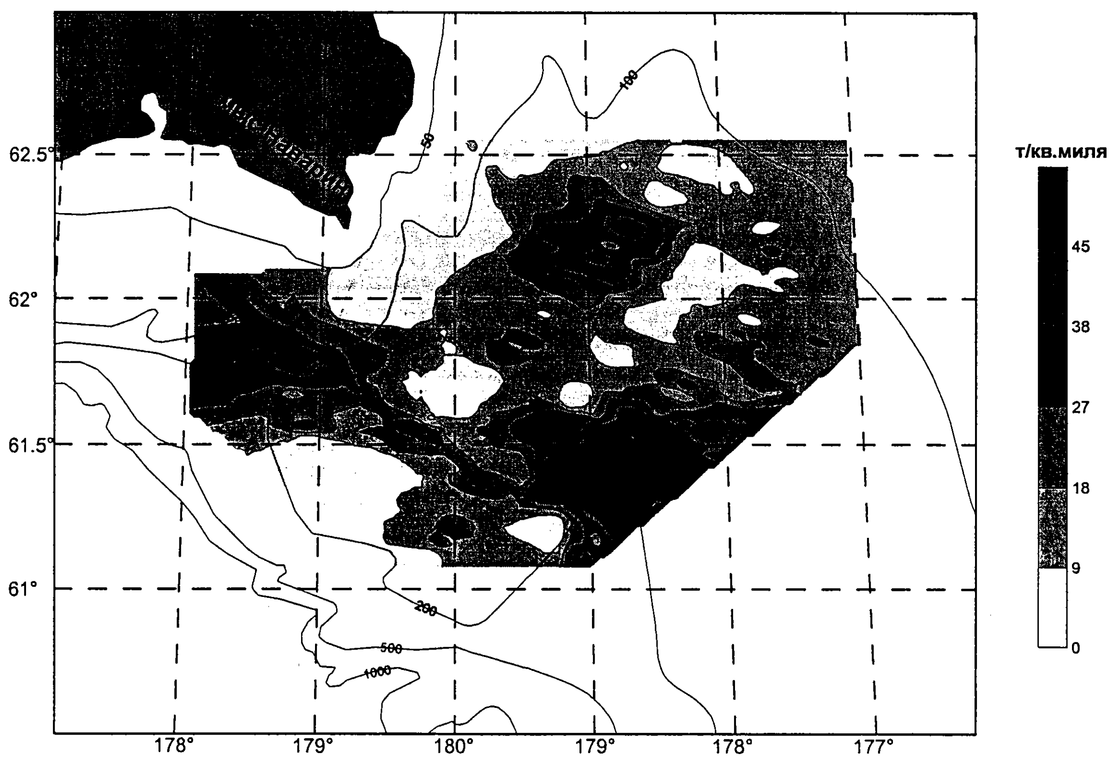

Fig. 4. The distribution of pollock area density (tons/mile^2) of hydroacoustic surveys for fish length more then 35 cm, carried out by a vessel "Kaye-Maru № 28 " from October 28 to November 4, 2002.

Table 4 represent the biomass calculations results of hydroacoustic survey of fish distribution for fish with length less then 35 cm. The conforming distribution of pollock area density (tons/mile^2) plotted on Fig. 5.

Table 4

Biomass calculations results of Walleye pollock in the whole water column. (length < 35 cm)

Gradation [ton/nm2]	Area [nm2]	Density [ton/nm2]	Biomass [ton]	Confedence Interval[±ton]
0 - 9	5677	3,2	17993,3	354,8
9 - 18	2142	13,0	27930,0	237,8
18 - 27	1586	22,1	34997,8	188,7
27 - 38	441	30,3	13348,8	114,1
38 - 45	53	41,3	2187,5	29,1
> 45	185	72,3	13375,9	622,4

Total Area = 10084[nm2]
Total Biomass = 109833,2 ± 786,9[ton]

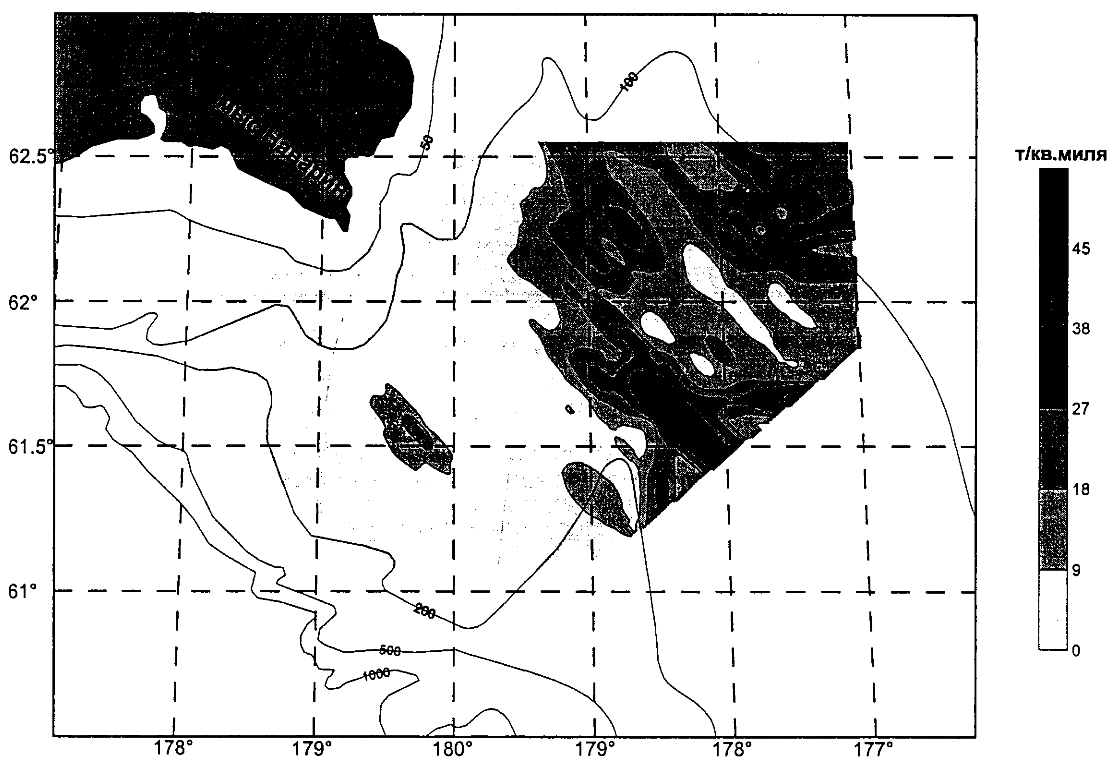

Fig. 5. The distribution of pollock area density (tons/mile^2) of hydroacoustic surveys for fish length less then 35 cm, carried out by a vessel "Kaye-Maru № 28 " from October 28 to November 4, 2002

For comparison (Fig. 6; Table 5) the distribution of pollock area density (tons/mile^2) of walley pollock by results of EIT surveys in October 2001 is represent.

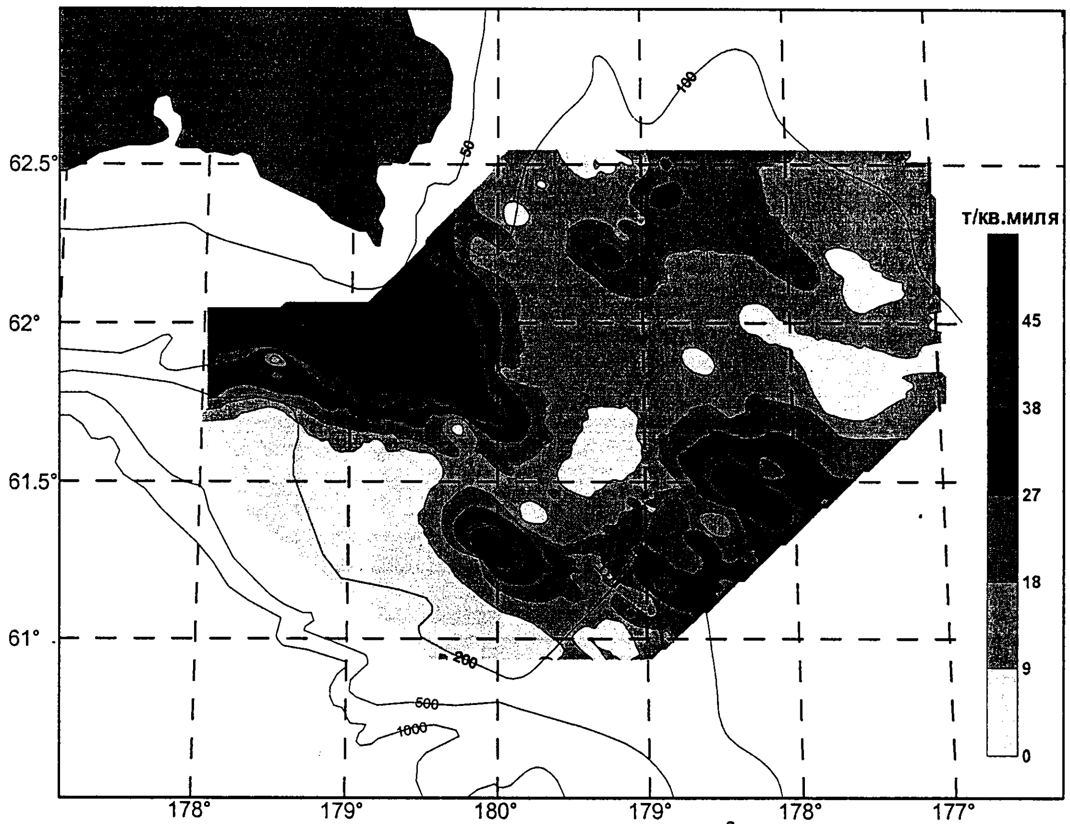

Fig. 7. The distribution of pollock area density (tons/mile^2) of hydroacoustic surveys, carried out by a vessel "Kaye-Maru № 28 " from October 25 to November 5, 2001

Table 6

Biomass calculations results of Walleye pollock in October 2001.

Gradation [ton/nm2]	Area [nm2]	Density [ton/nm2]	Biomass [ton]	Confedence Interval[±ton]
0 - 9	2351	4,5	10564,4	281,8
9 - 18	3995	13,2	52666,1	306,2
18 - 27	2015	21,8	43960,9	226,6
27 - 38	903	31,2	28170,8	182,4
38 - 45	277	41,3	11443,1	67,2
> 45	1025	73,4	75222,8	1466,5

Total Area = 10566[nm2]
Total Biomass = 222028,1 ± 1553,3[ton]

It is not difficult to notice, that there was a redistribution of shools of walley pollock: the part of "coastal pollock" was reduced. Biomass of walley pollock in October 2001 was 222 028.1 tons on the area 10 566 mile^2 (recalculation on area in 10 084 mile^2 is 211 899.6 tons). Increase of biomass has made 41.35%.

Total biomass of Walleye Pollock on data of EIT survey in region was:

299 535.7 tons on the area 10 084 mile^2.

The calculations carried out on the data of bottom trawl servey have shown, that on area of a Navarin polygon, which square compounded 10084 mile^2 biomass hardly less than **1 725 500 tons** (Fig 7; Table 6).

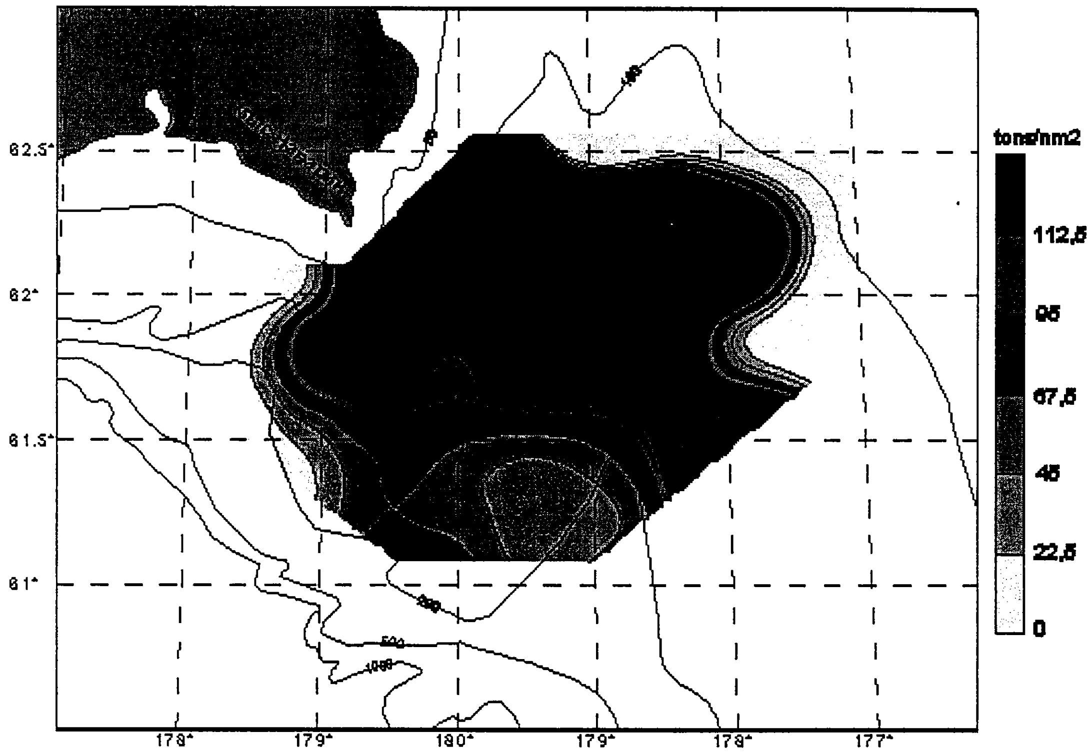

Fig. 7. The distribution of pollock area density (tons/mile^2) of bottom trawl servey, carried out by a vessel "Kaye-Maru № 28 " from October 28 to November 4, 2002

Table 6

Biomass calculations results of Walleye Pollock
by results of bottom trawl servey

Gradation [ton/nm^2]	Area [nm^2]	Density [ton/nm^2]	Biomass [ton]	Confedence Interval[$\pm$ton]
0-22,5	1869	2,5	4672,5	452,8
22,5-45	907	34,5	31291,5	365,3
45-67,5	1041	57	59337	421,0
67,5-95	990	78,5	77715	492,0
95-112,5	432	103,5	44712	202,8
>112,5	4845	311,2	1507764	21803,8

Total Area = 10084[nm^2]
Total Biomass = 1725492+21822[tons]

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Federal Committee on Fisheries of Russian Federation

DISTRIBUTION AND ABUNDANCE OF POLLOCK JUVENILES IN THE WESTERN BERING SEA IN SEPTEMBER-OCTOBER 2002

(document submitted for VIII Bering Sea Pollock Conference, Portland, 2003)

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2003

Research Institutes of the North Pacific Anadromous Fish Commission (NPAFC) countries – Russia, Canada, USA, Japan had conducted midwater trawl surveys (0-50 m) entire Bering Sea according to BASIS Program in September-October 2002. The surveys conducted by 4 research vessels in different Bering Sea regions at the same time.

The Russian R/V TINRO conducted midwater trawl survey in the northwestern and western Bering Sea (Russian EEZ), outside 12-miles coastal zone and R/V Korykskiy in coastal water and adjacent area of the western Bering Sea. The Japanese R/V Kaiyo Maru and US R/V Northwest Explorer conducted survey in US EEZ and central Bering Sea. The surveys was basically concerned salmon but another species - pollock, atka mackerel and squids juveniles also registered in upper layer by control tows. The R/V Kaiyo Maru registered relatively significant number of pollock juveniles in the Aleutian Basin.

The R/V TINRO found concentrations of pollock juveniles (M – 7.8cm) in the northwestern Bering Sea and most of them in Anadyr Bay and adjacent water (Fig.). Another concentration of smaller pollock juveniles (M - 6.3 cm) was registered in the western Bering Sea. It was speculated that juveniles was carried by currents from Olutorskiy and Karaginskiy Bays into Kommandor Basin and area placed offshore of Kommandor Islands (maximum catch – 637 specimen/1 hour tow).

Pollock juveniles distributed practically entire Anadyr Bay in 2002. The juveniles abundance in the northwestern Bering Sea estimated by midwater trawl survey data (K- 0.1) in 85.8 billion and biomass in 257.62 ths.t and in the western Bering Sea in 0.2 billion and 0.38 ths. t.

Pollock juveniles also registered in upper layer of Anadyr Bay and adjacent water during TINRO-center annual standard echointegration midwater trawl surveys (EI MWT). Juveniles abundance estimated in 8.8 billion in 1997, about 6.0 billion in 1999, 2.0 billion in 2000 and 3.0 billion specimen in 2001 by EI MWT surveys in the northwestern and western Bering Sea. In 1998 abundance of juveniles estimated just off bottom in the Anadyr Bay in 0.7-0.8 mln. specimen.

As regular pollock juveniles habits together with capelin and herring juveniles .in midwater and with mature capelin and pollock off bottom.

Size composition of pollock juveniles varies significantly from year to year in 1997-2002 - from 6.7 cm in 1999 and to 10.0 cm in 1997. Relatively high juveniles growth rate and bigger mean size in 1997 probably related with good habits condition in the Anadyr Bay. Water temperature in the northwestern Bering Sea in 1997 was highest for period 1997-2003. Distribution of water with positive temperature anomaly in the Anadyr Bay had maximum in 1997. Anomalous cold water occupied wide region adjacent to St. Lawrence Island and just limited area in the eastern Anadyr Bay in 1997 outside of juveniles distribution.

In 1999 anomalous cold water occupied most of Anadyr Bay. Growth rate of pollock juveniles was very low (mean size – 6.7 cm) in 1999. In 2000 and 2001 water temperature in the northwestern Bering Sea was higher compare 1999 and probably warm condition better for growth of juveniles. Mean size of pollock juveniles in 2000 and 2001 was 7.3 cm and 8.6 cm.

Biomass of zooplankton in the northwestern Bering Sea in cold year (1999) in 1.5-1.7 and euphausiids in 2.0 fold less as in relatively warm years (2000 and 2001). Survival of pollock juveniles quite possibly better in relatively warm years.

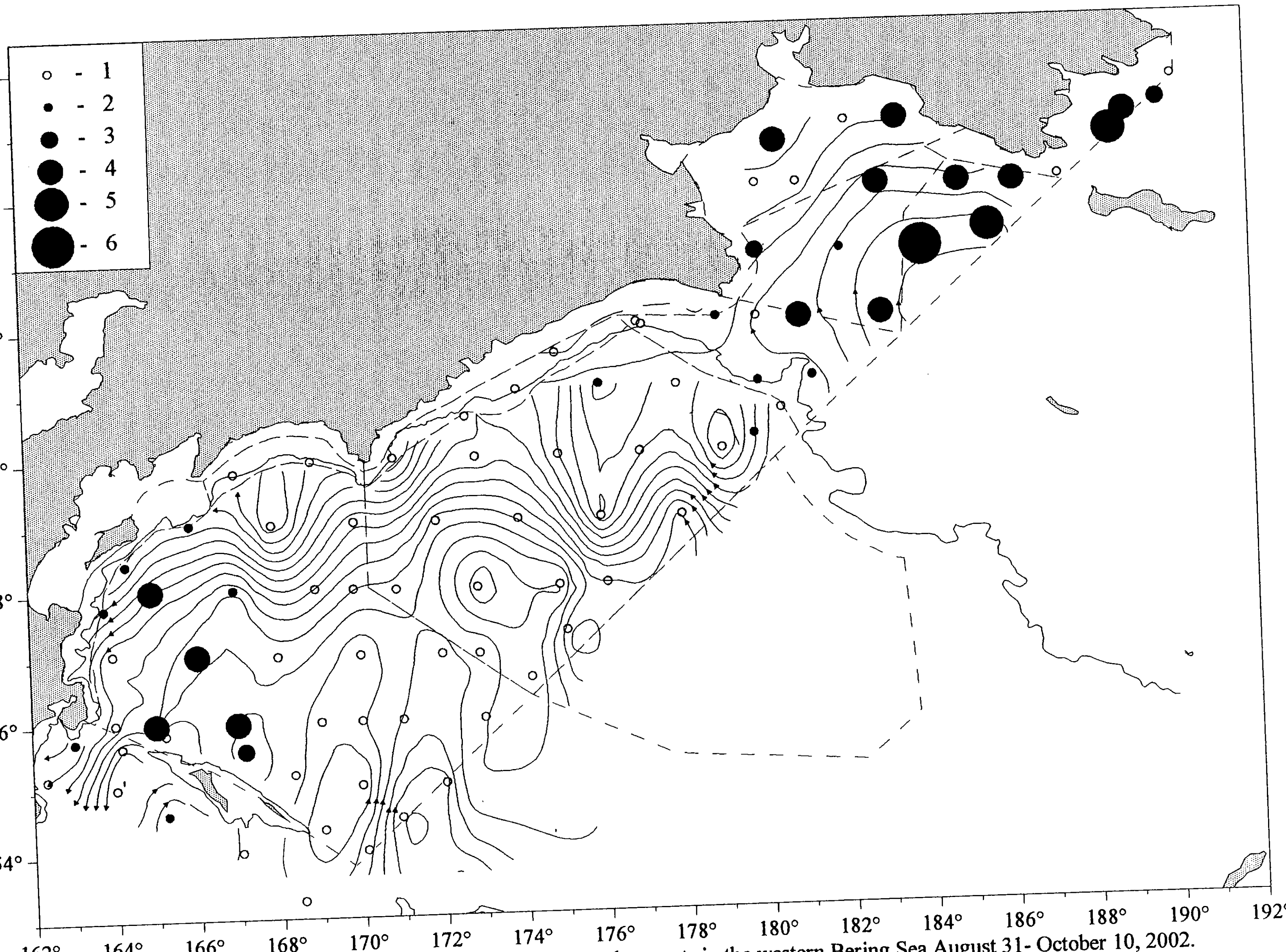

Fig. Distribution of pollock juveniles (n/sq.km) and general currents in the western Bering Sea August 31- October 10, 2002.
1 – no catch, 2 – 1 – 1000, 3 – 1001-10000, 4 – 10001-1000000, 5 – 1000001-10000000, 6 – more 10000000

Federal Committee on Fisheries of Russian Federation

SOME RESULTS OF POLLOCK BOTTOM TRAWL SURVEYS DURING *"KAIYO MARU 28"* CRUISE IN THE WESTERN BERING SEA IN AUGUST-SEPTEMBER 2002

(document submitted for VIII Bering Sea Pollock Conference, Portland, 2003)

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The results of trawler *"Kayio Maru 28"* cruise to the western Bering Sea in August-September 2002 conducted in frames of research program of Russian Federal Research Institute of Fisheries and Oceanography (VNIRO) in cooperation with Kamchatka Fisheries and Oceanography Research Institute (KamchatNIRO) and Pacific Fisheries Research Center (TINRO-Center) are represented. Two bottom trawl surveys (in the Cape Navarin area and in the Olutorskiy Bay and adjacent waters), and juvenile pollock trawl survey (in the Navarin area) were carried out.

A total of 19 families, 63 species of fish and 1 of commercial invertebrate were recorded in samples. Walleye pollock were the absolutely dominating component of trawl catches in the northwestern Bering Sea (90%), whereas in the Olutorskiy Bay and waters northeast of the Cape Olutorskiy Commander squid *Berryteuthis magister* prevailed.

The total biomass of near-bottom walleye pollock in early autumn in the Navarin area was estimated as 173.3 thousand tons on surveyed area of 7965 nmi^2 from 61^0 00 to 62^0 30 N and from 177^0 15 E to 177^0 00 W.

Abundance of young pollock in the Navarin area was determined by juvenile survey with small-mesh trawl (10 mm mesh in trawl codend). The most numerous age group of young pollock were 2 year old fish of 2000 year-class.

Russian Federal Research Institute of Fisheries and Oceanography (VNIRO) in cooperation with Kamchatka Fisheries and Oceanography Research Institute (KamchatNIRO) and Pacific Fisheries Research Center (TINRO-Center) has conducted a juvenile pollock trawl surveys and adult pollock bottom trawl surveys in the northwestern and southwestern Bering Sea annually since 1993 aboard Japanese vessel "*Kaiyo Maru 28*", operating in research regime, and partly as commercial fishing vessel. "*Kayio Maru 28*" is a stern trawler 52 meters long with maximal speed 14.2 knots.

In August-September 2002 "*Kaiyo Maru 28*" conducted two bottom trawl surveys (in the Cape Navarin area and in the Olutorskiy Bay), and a juvenile pollock trawl survey (in the Cape Navarin area). The primary objectives of the cruise were:

- To determine the spatial distribution of walleye pollock and other demersal fish in the western Bering Sea.
- To collect biological information on young walleye pollock from survey data, and assess the number and biomass of juveniles in the northwestern Bering Sea (the Navarin area).
- To obtain the preliminary assessment of near-bottom walleye pollock biomass in the Navarin area, Olutorskiy Bay and waters northeast off the Cape Olutorskiy by bottom trawl surveys.
- To collect the information on species composition in commercial catches on pollock and Commander squid trawl fishery.
- To collect biological information on walleye pollock and other demersal fish from commercial catches, including length, weight and sex composition, maturity, aging structure sampling.

In this report we represent only walleye pollock sampling information (spatial distribution, abundance, biological condition).

Area of cruise, material and methods

The research area was divided into three subareas: the Eastern Kamchatka zone (the Olutorskiy and Karaginskiy Bays); the shelf and upper slope between the Capes Olutorskiy and Navarin, waters adjacent to the Cape Navarin up to U.S. EEZ boundary (the Navarin area).

Biological surveys were conducted using bottom trawl with horizontal opening of 21.5 meters and vertical opening of 4 meters. Mesh size in trawl codend was 10 mm during the juvenile pollock survey.

Each tow catche was identified to species, and the total number and biomass of each species were counted and weighted on board. During vessel operating as a commercial fishing boat, when the control catches of fish were much higher compared to survey tows (up to 25-45 tons), the subsample of 300-400 kg was analyzed for species composition identification, and total number and weight of each species were back calculated on the basis of processed fish production.

From each catch a subsample of up to 300-500 specimens was selected randomly for length frequency analysis of pollock and species of bycatch. Additional samples of 50 or 100 specimens were analyzed for pollock length, weight, maturity determining. At the same time otoliths were removed for pollock aging. The number of fish sampled during the cruise is presented by species in Table 1. Total number of fish collected for size composition was 16293 specimens, biological analysis data including otolith collecting – 2468 specimens.

The accumulation and processing of biological data were made using personal computers. The spatial distribution of pollock and fishes of bycatch was mapped with software SURFER, abundance and biomass of juvenile and adult pollock were estimated in laboratory just after the end of cruise using software MAPDESIGNER 2.1 (Polyiakov, 1996).

Table 1. Biological data collected during *"Kayio Maru 28"* cruise.

Species (scientific name)	Length frequency.	Biological analysis
Fishes		
Theragra chalcogramma	9821	600
Gadus macrocephalus	1145	280
Clupea pallasi	362	50
Atheresthes evermanni	923	200
Atheresthes stomias	962	200
Reinchardtius h. matsuurae	723	30
Hippoglossus stenolepis	85	52
Sebastes borealis	243	50
Sebastes alutus	28	6
Hippoglossoides elassodon	1174	-
Lepidopsetta polyxystra	626	-
Pleuronectes quadrituberculatus	201	-
Squids		
Berrytheuthis magister	-	1000
Total:	16293	2468

Species composition by trawl survey data in the western Bering Sea

Table 2. Species composition of *"Kayio Maru 28"* combined of juvenile pollock trawl survey and bottom trawl survey data in the Navarin area, July 31 - August 6, 2002.

Species (scientific name)	Catch		Frequency of occurrence, %	Percent of total catch
	number/ hour	kg/ hour		
Rajidae				
Bathyraja aleutica	2.3	8.7	30	0.6
Bathyraja matsubarai	0.2	1.0	3	0.1

Bathyraja parmiphera	1.9	5.8	30	0.4
Gadidae				
Boreogadus saida	4.2	0.1	8	0.01
Gadus macrocephalus	9.6	17.0	57	1.2
Theragra chalcogramma	5254.7	1243.2	97	88.6
Sebastidae				
Sebastes alutus	0.4	0.04	5	+
Cottidae				
Gymnacantus galeatus	1.8	0.5	11	0.03
Hemilepidotus gilberti	23.5	5.2	51	0.4
Hemilepidotus jordani	74.2	9.9	32	0.7
Icelus spiniger	0.9	0.1	22	0.01
Myoxocephalus jaok	8.6	14.8	62	1.1
M polyacanthocephalus	15.9	6.7	22	0.5
M. verrucosus	0.4	0.2	11	0.01
Triglops scepticus	0.7	0.1	8	+
Triglops pingeli	0.5	0.04	8	+
Triglops macellus	0.4	0.03	8	+
Cyclopteridae				
Aptocyclus ventricosus	0.2	0.3	8	0.02
Eumicrotremus orbis	5.6	0.6	16	0.05
Psychrolutidae				
Dasycottus setiger	20.1	4.2	27	0.3
Malacocottus zonurus	38.3	5.9	22	0.4
Hemitripteridae				
Ulca bolini	4.0	5.8	38	0.4
Agonidae				
Percis japonicus	8.3	0.7	51	0.1
Sarritor frenatus	0.8	0.04	27	+
Pleuronectidae				
Hippoglossoides elassodon	131.9	17.3	87	1.2
Hippoglossus stenolepis	0.1	0.7	3	0.05
Lepidopsetta polyxystra	23.1	10.9	81	0.8
Pleuronectes quadrituberculatus	7.4	12.1	35	0.9
Atheresthes evermanni	2.3	2.9	24	0.2
Atheresthes stomias	1.3	2.5	14	0.2
Reinchardtius h.matsuurae	55.0	13.3	89	0.9
Zoarcidae				
Lycodes brevipes	0.1	0.03	3	+
Lycodes palearis	9.0	2.0	65	0.1
Lycodes raridens	0.6	0.05	3	+
Lycodes diapterus	0.2	0.02	3	+
Lycodes brevicaudus	0.1	0.01	3	+
Lycodes turneri	0.1	0.1	3	0.01
Liparidae				
Careproctus cypselurus	6.6	2.7	8	0.2
Careproctus furcellus	0.1	0.05	3	+
Careproctus scottae	0.5	0.4	8	0.03
Liparis sp.	2.7	3.0	22	0.2
Careproctus phasma	1.4	0.5	16	0.04
Careproctus sp.	2.0	0.8	3	0.1

Bathymasteridae				
Bathymaster signatus	3.0	0.5	27	0.04
Osmeridae				
Mallotus villosus catervarius	0.9	0.02	22	+
Clupeidae				
Clupea h. pallasi	8.8	1.9	46	0.1
Salmonidae				
Oncorhynchus nerka	0.2	0.6	8	0.04
Oncorhynchus keta	0.1	0.4	3	0.03
Stichaeidae				
Lumpenus saggita	0.2	+	3	+
SQUIDS				
cf. Berryteuthis magister	0.2	0.1	8	+

Table 3. Species composition of "Kayio Maru 28" bottom trawl survey in the Olutorskiy Bay and waters off the Navarin-Olutorskyi area, August 7-9, 2002.

Species (scientific name)	Catch		Frequency of occurrence, %	Percent in total catch
	number/hour	kg/ hour		
Squalidae				
Somniosus pacificus	0.6	18.4	14	0.5
Rajidae				
Bathyraja aleutica	5.4	15.6	50	0.5
Bathyraja matsubarae	0.6	2.5	7	0.1
Bathyraja parmiphera	14.6	18.6	50	0.6
Bathyraja interrupta	1.7	3.6	29	0.1
Gadidae				
Gadus macrocephalus	0.1	0.3	7	+
Theragra chalcogramma	670.1	568.1	86	16.9
Sebastidae				
Sebastes alutus	5.0	2.2	50	0.1
Sebastes borealis	32.1	128.6	57	3.8
Sebastolobus alascanus	2.3	1.4	29	0.04
Sebastolobus macrochir	0.3	0.4	14	0.01
Cottidae				
Icelus spiniger	24.1	1.8	21	0.1
Myoxocephalus jaok	0.3	0.9	14	0.03
Triglops scepticus	0.1	0.01	7	+
Psychrolutidae				
Dasycottus setiger	8.0	3.1	36	0.1
Malacocotus zonurus	235.1	53.2	93	1.6
Agonidae				
Percis japonicus	9.6	1.4	57	0.04
Sarritor frenatus	0.4	0.03	14	+
Pleuronectidae				
Hippoglossoides elassodon	13.7	8.8	57	0.3
Hipoglossus stenolepis	1.0	5.8	36	0.2
Atheresthes evermanni	21.1	35.0	57	1.0
Atheresthes stomias	15.0	26.3	50	0.8

Reinchardtius h.matsuurae	1.9	9.4	36	0.3
Zoarcidae				
Lycodes brevipes	14.4	12.1	64	0.4
Lycodes concolor	1.3	0.5	7	0.02
Lycodes palearis	0.6	0.3	7	0.01
Lycodes turneri	0.1	0.04	7	+
Bothrocara brunnea	1.1	1.7	21	0.1
Liparidae				
Careproctus cypselurus	22.9	9.7	43	0.3
Careproctus phasma	8.7	2.8	14	0.1
Careproctus sp.	6.6	2.5	14	0.1
Macrouridae				
Albatrossia pectoralis	137.1	469.1	57	13.9
Anoplopomatidae				
Anoplopoma fimbria	0.3	0.4	7	0.01
Cyclopteridae				
Aptocyclus ventricosus	0.1	0.2	7	0.01
SQUIDS				
cf. Berryteuthis magister	5203.1	1961.2	79	58.3

Total of 16 families and 49 species of fish were identified in samples collected during two surveys in the Navarin area (Table 2, 3). Walleye pollock were absolutely dominating species and accounted for 89.8% of the total fish weight. This species occurred in 36 from 37 trawl hauls with average catch 5255 specimens/hour and 1243 kg/hour. Proportion of other commercially important fishes was rather negligible: flathead sole, *Hippoglossoides elassodon* - 1.2%, Greenland turbot, *Reinchardtius h.matsuurae* (juveniles less than 30 cm) - 0.95%.

In the Olutorskiy Bay and area northeast of the Cape Olutorskiy species composition of research samples included 12 families and 34 species of fish and one commercial invertebrate. Commander squid *Berryteuthis magister* were the major component of bottom trawl catches (58.2% by weight), followed by pollock (16.9%) and grenadier *Albatrossia pectoralis (13.9%)*. Relatively high was also proportion of shortraker rockfish, *Sebastes borealis* - 3.8%.

With regard to *"Kaiyo Maru 28"* operating in regime of commercial fishing-processing, walleye pollock were target species in the Navarin area at the depths 150-420 meters. Total catches varied from 24 to 41 tons per trawl haul during 11-13 hours of towing. Pollock catches ranged from 1881 to 2805 kg/hour (2113 kg at average). In Olutorsky Bay pollock were not the goal of fishery and caught only as bycatch to Commander squid.

Spatial distribution and abundance of walleye pollock juveniles in the Navarin area

The pollock juvenile trawl survey was conducted in the Navarin area from August 31, 2002 till September 2, 2002 using trawl net with 10-mm mesh in codend. Total square were juvenile pollock were assessed was 7849 $nmi^{2.}$ Data on young pollock length frequency distribution are shown in Fig. 1.

Three size groups of pollock with length range 10-21 cm, 22-29 cm, and 30-37 cm could be distinctly observed. First two components of small pollock we identified as 2001 and 2002 year classes, pollock of length range 30-37 cm belongs to year class 1999, and, presumably, 1998. The year class 2000 pollock was the most numerous component of catches, providing 70 % of total amount with average catch per 1 hour of trawl haul 5640 fish. The maximum catch was 44085 fish/hour (Table 4). Spatial distribution of fry walley pollock is shown in the Fig. 2.

It should be noted that density of young pollock in the Navarin area in 2002 was much higher compared to the previous 2001. Especially this is true of the 2000 generation, whose abundance outnumbered the corresponding estimates from trawl survey in August 2001 by 2.5 times (Alexeev, Novikov. 2001).

Spatial distribution of all age groups of immature pollock in the Navarin area (Fig. 3) was generally similar: the catches gradually increased from southeast towards northwest reaching peak in coordinates 62^0 00 – 62^0 30 N, 180^0 00 – 170^0 00 W.

Table 4. Results of walleye pollock juvenile trawl survey in the Navarin area in August-September 2002.

Age (year class)	Surveyed area, nmi^2	Mean catch of fish per nmi^2	Catch (pollock/hour).		
			Min.	Mean	Max..
1+ (2001)	7849	5687	0	292	1659
2+(2000)	7849	150513	0	5640	44085
3+(1999)	7849	58629	0	1912	7347

Distribution and abundance of near-bottom walleye pollock

Navarin area

Bottom trawl survey for walleye pollock abundance estimation was conducted in the Navarin area on September 2-9 by standard scheme of stations from 61^0 00 to 62^0 30 N and from 177^0 15 E to 177^0 00 W. The total surveyed area was 7965 nmi^2. Pollock distributed rather smoothly, catches slightly increased southwards and ranged from 29 to 5712 kg/hour with average abundance of 954 kg/hour reaching highest values near the southwestern corner of surveyed region (Fig. 3).

Total biomass of pollock estimated during survey was 173.3 thousand tons.

Olutorskiy Bay

In the Olutorskiy Bay walleye pollock were less abundant than in the Navarin area, nevertheless, it occurred in nearly all samples of bottom trawl survey. Catches represented exceptionally with adult pollock larger than 40 cm fork length varied very widely: 2.3 – 4400 kg/hour. The maximum catches were recorded at station No. 47 (59^0 46 N, 167^0 54 E) (Fig. 4). Average catch was 728 kg/hour.

Total biomass of pollock surveyed in the Olutorskiy Bay was estimated at 10.1 thousand tons, with average density 20 tons/nmi^2.

Size composition and biological condition of walleye pollock in the Navarin area

Biological data collected during research surveys and commercial catches as well were analyzed to estimate walleye pollock size composition, sex ratio, and biological condition. Pollock length in the Navarin area ranged from 14 to 80 cm (Fig. 5), the average length for the whole period of sampling was 38.4 cm. The analysis of length frequency data shows three dominating size groups: 23-30, 31-40 and 41-50 cm with their proportion in total catch of 20.3, 33.8, and 34.1% respectively. Data on walleye pollock weight composition are represented in Fig. 6. The average weight was 497 g varying from 110 to 3400 g.

Table 5. Some biological characteristics of the Navarin area walleye pollock in August-September 2002 by dominating size groups.

Males	23-30 cm	31-40 cm	41-50 cm	Over 50 cm
Mean weight, g	174,5	330,1	700,1	1414,6
Sex ratio, %	37,7	48,3	40,9	29,6
Stomach fullness	1,30	1,39	1,76	1,64
Females				
Mean weight, g	165,0	330,1	712,6	1493,4
Sex ratio, %	62,3	51,7	59,1	70,4
Stomach fullness	1,39	0,85	1,46	1,89

Sex ratio varied significantly depending on size of fish from 30% of males among youngest pollock to 48% among largest fish (Table 5). Maximum proportion of females (more than 70%) was observed among the oldest pollock greater than 50 cm long.

Increasing of mature fish proportion by length for the Navarin area pollock, according to previous investigations is known to be rather rapid. Our data generally confirm this regularity (Fig. 7). Females were estimated to be 50% mature at 34 cm, while length of 50% mature males were 31-32 cm. Matured part of sampled fish was represented basically by pollock 41-50 cm long (50% of females and 51.6% of males) and 30-31 cm (31.5% and 34.8% respectively). Apparently, the latter pollock will form the core of spawning stock for the next year.

About 20% of male pollock sampled in the Navarin area were immature (stage II, Table 6). Among mature pollock most of fish were at early developing stages – II-III (27% males and 53% females) and III (46 and 23% respectively). It can be noticed that postspawning recovering processes were more intensive among males compared to females and among old-aged fish in relation to younger ones.

Table 6. Pollock gonads maturity stages in the Navarin area in August-September 2002

Males	23-30 cm	31-40 cm	41-50 cm	Over 50 cm	Mean
II	80,0	26,8			18,5
II-III	15,0	39,3	31,0	20,0	27,2
III	5,0	32,1	56,9	64,0	45,7
III-IV			8,2	4,0	3,8
IV		1,8	3,9	4,0	2,7
VI-II				8,0	2,1
Females					
II	97,0	41,7	4,9		20,1
II-III	3,0	53,3	67,9	57,1	53,4
III		5,0	25,0	36,1	22,6
III-IV			1,1	1,7	1,0
IV				4,2	1,7
IV-V				0,9	0,6
VI-V			1,1		0,6

Size composition and biological condition of walleye pollock in the Olutorskyi Bay

Biological data in the Olutorskiy Bay were collected both from research survey in early September and commercial trawl hauls in the end of the month. As a rule pollock in this region were the species of bycatch. Samples were represented exclusively by large-sized mature pollock with length range 40-69 cm (51.5 cm and 1100 g weight at average). Dominating group were 46-56 cm fish (Fig. 8), comprising 76% of total amount.

Prevailing of females in samples in this bay was even more obvious than in the Navarin area (mean sex ratio was 66 % females), likely that is linked with larger size of pollock here. Seasonal maturation of the major part of males, and females as well, was on early developing phase (proportion of gonad maturation stage II-III was 73% for males and 96% for females). Male gonads maturation developed more intensively (24 % at stage III), while proportion of females at this stage comprised only 2%.

SUMMARY

Scientific trawl surveys conducted on board of *"Kaiyo Maru 28"* in August-September 2002 appear to be important, providing us with the new information on species structure of bottom and near-bottom communities, spatial and bathymetric distribution of walleye pollock, Commander squid and other commercially valuable species of fish and invertebrates, their abundance and biomass at the outer shelf and upper slope of the Navarin area, Olutorskiy Bay and adjacent waters.

A total of 19 families, 63 species of fish and 1 of commercial invertebrate were recorded in samples.

The total biomass of near-bottom walleye pollock in the Navarin area was estimated as 173.3 thousand tons on surveyed area of 7965 nmi^2 from 61^0 00 to 62^0 30 N and from 177^0 15 E to 177^0 00 W.

Exploitable biomass of pollock surveyed in the Olutorskiy Bay was estimated at 10.1 thousand tons, with average density 20 tons/nmi^2.

Abundance of young pollock in the Navarin area was determined by juvenile survey with small-mesh trawl (10 mm mesh in trawl codend). The most numerous age group of young pollock were 2 year old fish of the 2000 year-class.

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Federal Committee on Fisheries of Russian Federation

RESULTS OF ECHO INTEGRATION-TRAWL SURVEY FOR WALLEYE POLLOCK (*THERAGRA CHALCOGRAMMA*) IN THE NORTHWESTERN BERING SEA IN JULY 2002

(document submitted for VIII Bering Sea Pollock Conference, Portland, 2003)

By

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2003

The results of echo integration-trawl (EIT) survey of walleye pollock (*Theragra chalcogramma*) in the northwestern Bering Sea, July, 2002 are represented. The survey was conducted by R/V "TINRO" from June 30 till July 19, 2002 in area placed from 174^0E long. up to $173^0$20'W long., including Anadyr Bay up to 64^0N lat. and adjacent of US water, 120 miles off Convention line.

The average relative density (nautical area backscattering coefficient) of pollock in the Navarin-Anadyr Bay region are 78 $m^2/n.mi.^2$ for pelagic fish and 11 $m^2/n.mi.^2$ for near-bottom pollock and in the St. Mattew area - 756 $m^2/n.mi.^2$ and 140 $m^2/n.mi.^2$.

The most numerous length-age group of pollock were 2 years old fish of 2000 year class (45.7%) in first part of July, 2002. The total abundance of pollock in the northwestern Bering sea estimated as 4800.6 million fish and total biomass - 1114.2 thousand tons (t), including 748.2 million fish (15.6%), 79.8 thousand t (7.2%) in Russian EEZ and 4052.4 million fish and 1034.5 thousand t in US EEZ.

INTRODUCTION

Since 1996 the TINRO-centre conducts annually echo integration-trawl surveys in the Navarin-Anadyr region of the Bering Sea. The age composition of pollock concentrations, it distribution and biomass in the northwestern Bering Sea significantly varies annually. The annual variability of pollock age composition especially increased last years, since 1998, and it connected with climate shift in the Bering Sea area.

The climate and oceanological shift had appeared especially strong in the northern and northwestern Bering Sea. In 1998-2002 extremely cold water with temperature below zero occupied northwestern Bering Sea and seasonal water warming were going slower as average in first part of the summers.

MATERIAL AND METHODS

Equipment And Software

The echosounder EK-500 (Simrad) with operational frequencies 38 and 120 kHz was used as hydroacoustic measuring system. The frequency 38 kHz was used for estimation of abundance and biomass of fish.

Standard sphere acoustic system calibration were made prior to the Bering Sea survey for measure 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. Results of sphere calibrations conducted before the summer 2002 pollock echo integration-trawl survey of the northwestern Bering Sea shelf and continental slope.

Date	Freq. (kHz)	Water temp. (^{0}C)		Distance from Transd. (m)	TS Gain (dB)	SV Gain (dB)	3 dB Beam Width (deg.)		Angle Offset	
		Transd.	Sphere				Along	Athwart	Along	Athwart
31.05.02	38	11.4	6.3	17.1*	27.39	27.01	6.93	6.75	0.05	0.16
31.05.02	120	11.4	6.8	14.4*	23.03	22.77	7.36	7.36	0.40	0.18

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

The accumulation and processing hydroacoustic, navigational and biological data were made using vessel's computers, integrated in a local network. The navigational support of an acoustic complex was carried out with use of a system of satellite positioning GPS.

The software FAMAS (Fishery Acoustic Monitoring and Analyses System) for registration and processing of acoustic data were used. 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 (bottom) layers. The obtained data (density of concentrations, abundance, biomass, distribution of fish etc.) are saved as files with a structure of data, accessible for consequent processing in Excel. The space distributions of a relative densities, abundance and biomass of fish were mapped with use of software Surfer-7 (Windows Version, Golden Software, Inc.).

Midwater and near-bottom fish schools was sampled using midwater trawl net RT/TM 57/360 with 10 mm mesh in codend and weight 450 kg on each side. The size headrope and footrope are 57m each. The vertical opening of trawl net as average 20-25 m used. The system FS 20/25 (Simrad) for control of tows was used.

Data Accumulation

Registration and accumulation of acoustic data on frequencies 38 and 120 кHz were executed continuously both in light and in dark time. The acoustic measurements were accompanied by registration in a data base of results control hauls, navigational and other data.

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).

The echo integration-trawl survey in the northwestern Bering Sea was conducted on a parallel transects east of 174^{0}E, distance between transects 20 miles. The transects from 7 to 0.3 were continued in U.S. EEZ approximately on 120 miles (Fig. 1).

The identification of fish echosign was made by control trawls. The place of trawl hauls was determined by necessity of monitoring of specific and dimensional structure of fish depends of change in echosign type appearance (see Fig. 1). The 37 control trawls was conducted during survey. All measured and designed parameters trawls were registered in a trawl-acoustic table (Table 2). The catch data presented in Table 3. The average tow speed was 3.7 knots. The results of control trawls were used for stratification of pollock by size in the survey area and for estimation of fish abundance. Target strength data were collected during control trawls when conditions were suitable.

Data Analysis

The technology of processing of acoustic data is based on a principle of detail stratification of survey area with allowance of length -frequent composition of pollock. The main procedures of processing is localization and selection echosign by certain groups (category) - SP_LFG (species/length frequency group), which corresponding pollock with similar biological parameters. The separate parts of survey area was selected in stratum - SP_LFS (species/length frequency stratum) and it length-frequent key describing mean weighted dimensional structure of fishes in survey area - SP_LFK (species/length frequency key) was appropriated. Stratum was determined geographically in a data base of distance ranges appropriate to the boundaries each strata.

The total surface scattering on square strata S_m (m^2) is calculated as:

$$S_{mi} = \sum_h \sum_{k=1}^{L_{ih}} S_{Aihk} T_h D_k,$$

where S_{Aihk} - nautical area backscattering coefficient (m^2/n.mi.^{2}) for strata **i** on transect **h** on interval **k** of an integration, D_k - length of an interval of an integration (miles), T_h – wide of transect (miles) and L_{ih} - number of intervals of an integration for stratum **i** on transect **h.** The number of fishes on strata **i** is evaluated by expression:

$$N_i = S_{mi} / <\sigma_i>.$$

The distribution of abundance on a fish length determined by using mean weighted length-frequent distribution of fishes in each stratum. The estimation of pollock biomass was made with use of length-weight coefficients, obtained by results of analysis control trawls data, length (L) and weight (W) of fish by dependence: $W = A * (L)^B$ ($A = 0.0058$ and $B = 3.0455$).

The pelagic (surface - 10 m above bottom) and bottom (10 m off bottom) layers was selected by processing echograms. In an results of sequential data processing the evaluations of the NASC, number and biomass pollock were formed within the limits of chosen stratums along transects of acoustic survey with a pitch (interval of an integration) 0.5 miles on a distance and with a pitch on depth 5 m - in pelagic layer and 1 m - in a bottom layer.

The pollock age-length key obtained in TINRO-centre on base of data sampled on board R/V Miller Freeman in the Bering Sea, July 2000 (U.S. EEZ) and charter vessel Borodino in the Navarin area-Anadyr Bay, August 2001 (Russian EEZ).

RESULTS AND DISCUSSION

The acoustic survey began on June 30 on Koryak shelf (transect 16) to east of 174^{0}E long. (Fig.1). Square of pelagic and bottom of registered pollock aggregations which used for processing and estimation of abundance and biomass are next:

	Pelagic aggregations	Bottom aggregations
Russian EEZ	14040 n.mi.^{2}	23920 n.mi.^{2}
USA EEZ	14260 n.mi.^{2}	18620 n.mi.^{2}
Russian – U.S. EEZ	28300 n.mi.^{2}	42540 n.mi.^{2}

The distribution of relative density of pollock (S_A) on survey's transects presented in Fig. 2. The estimation of pollock abundance and biomass are indicated in Table 4.

In the northwestern Bering Sea significant concentrations of pollock registered at shelf area placed between 174^{0}E and 177^{0}E long. (transects 12 – 16).

The average relative density (nautical area scattering coefficient S_A) of pelagic pollock in Navarin - Anadyr Bay area is 78 m^2/n.mi.^{2} and near-bottom aggregations is 11 m^2/n.mi.^{2}. The high density pollock concentrations were registered in area placed to northwest from St. Matthew I. in the first part of July (Fig. 2). The average relative density of pelagic pollock aggregations in this area is 756 m^2/n.mi.^{2} and near-bottom pollock is 140 m^2/n.mi.^{2}.

The pollock concentrations placed on the shelf west 177^{0}E and aggregations east 179^{0}W was widely separate spatially and almost didn't registered pollock in midwater at 8-12 transects (see Fig. 2, Table 4).

The 8 size strata with different size composition of fish was established in survey area by data of control tows (Fig. 3). The size-frequent keys (SP_LFK) were used in the program of processing for account of pollock abundance and biomass within each strata. The spatial distribution of strata presented on Fig. 4.

In area placed between 177^{0}E – 179^{0}W pollock was distributed basically in layer 50 m off bottom. In the St. Matthew I. area significant part of pollock, basically immature, was distributed in midwater in layer 10 - 50 m, and it was sometimes mixed with jellyfish. There is quite obvious interrelationships between pollock vertical distribution and water temperatures (Fig. 5, 6).

Pollock did not conduct active vertical migrations during day and night. In near-bottom region in night time pollock schools usually dispersed in water column and feeding actively. Midwater schools in the upper water column registered as dense pollock aggregations in dark and light time. At the same time, main concentrations of zooplankton were registered (120 KHz) near bottom. Therefore, in this time the upper layer probably occurred pollock accomplishing active horizontal migration to northwestern direction according to general direction of geostrophic currents.

The spatial distributions of pollock near bottom and in midwater region presented in Figs. 7 and 8. The high density of pollock concentration, basically 2 years old fish, was distributed in local area west of $177^0 30$'E long. The most dense pollock concentrations were found in survey area placed to southeast from Convention line in midwater (see Figs. 7, 8). Near-bottom pollock densities were lower but occupied more area and observed on Navarin shelf and Anadyr Bay.

Distribution of different age pollock at survey's transects is shown on Fig. 9. Proportion of mature pollock decreased to northeastern of transect 7 and increased density of immature pollock 1999-2000 year classes. The pollock of 2000 year class predominated on transect 5 and of 1999 year class on transect 4. The fish of 2000 year class absolutely predominated on transect 3. Proportion of mature pollock was relatively high on transects 1-2, especially off bottom layer.

The spatial distribution of different age pollock in the survey area northwestern Bering Sea demonstrates Figs. 10-13 At the same time, about 97 % of pollock in the St. Matthew I. area was registered at depth range 75-175 m.

Distribution of pollock in the northwestern Bering Sea depends on water temperature. Water temperature in region located north of $61^0 30$'-62^0N, including Anadyr Bay, was below or close to zero in first half of summer 2002 and it similar to temperature conditions of anomalous cold 1999.

The termoclyne was diffused and uniform lowering temperature observed from depth about 20 m to bottom on southeast of the survey area. Pollock was distributed both in midwater and close to bottom (see Figs. 5 and 6). The frontal boundary between area of warm waters with temperature 1-2^0C and cold water with temperature below 0^0C placed about 61^0–62^0N. Distribution of pollock was limited by boundary of cold water (Figs. 14, 15). The immature pollock was distributed basically in upper layer and fish apparently avoided water with temperature below 1^0C. The mature pollock was distributed in water with wider range of temperature but nevertheless mature fish avoided water with temperature below 0.5^0C.

The size-age composition, abundance and biomass of pollock shown on Figs. 16, 17 and Table. 5. The immature pollock of 2000 year class was most numerous in the northwestern Bering Sea in July 2002 (45.7%).

Proportion of 2000 year class pollock in Navarin area estimated as 82% by total abundance and 62.1% by total biomass. Most of them (97.9% off abundance) was registered in area placed to west of Cape Navarin (between 174^0E and 177^0E). Proportion of 1999 year class pollock estimated as 4.9% by total number and 8.0% by total biomass; 1995-1998 year classes (35-50 cm) about 2.5% by number and 11.1% by biomass; older pollock (65-82 cm) less than 1.0 % by number and 15.1% by biomass (Fig. 16, Table 5).

Proportion of the 2000 year class pollock in the St. Matthew I. area estimated in 39.0%, of 1999 year class in 23.5%, of 1998 year class in 17.6%, of 1997 year class in 9.6%, of 1996 year class in 4.5%, of 1995 year class in 2.5% by total abundance. The main portion of estimated biomass consisted 1995-2000 year classes pollock (94.5%). Pollock of 1998 year class predominated in total biomass (24%). The 1997 year class (19.1%) and 1999 year class (18.7%) pollock biomass estimation very similar. Proportion of the 2000 year class pollock estimated in 14.5% and of 1996 year class 11.1%; of 1995 year class - 7.3%. Biomass of 1995-1997 year classes pollock in near-bottom layer (10 m off bottom) estimated in 39.0% and older pollock in 32.0% (Fig. 17, Table 5).

Total abundance of pollock in the northwestern Bering Sea estimated in 4800.6 million fish and biomass in 1114.2 thousand tons for the total survey area, including 748.2 million fish and 79.7 thousand t in Russianin the Navarin-Anadyr Bay area and 4052.4 million fish and 1034.5 thousand t in the St. Matthew I area. (Table 5). Estimated pollock abundance in midwater (surface to 10 m off bottom) was 4176.2 million fish (87% of numbers) and 853.3 thousand t (76.6% of biomass). Numbers and biomass of pollock in bottom layer (10 m off bottom) estimated by results of EIT were 624.4 million fish (13% of numbers) and 261 thousand t (23.4% of biomass).

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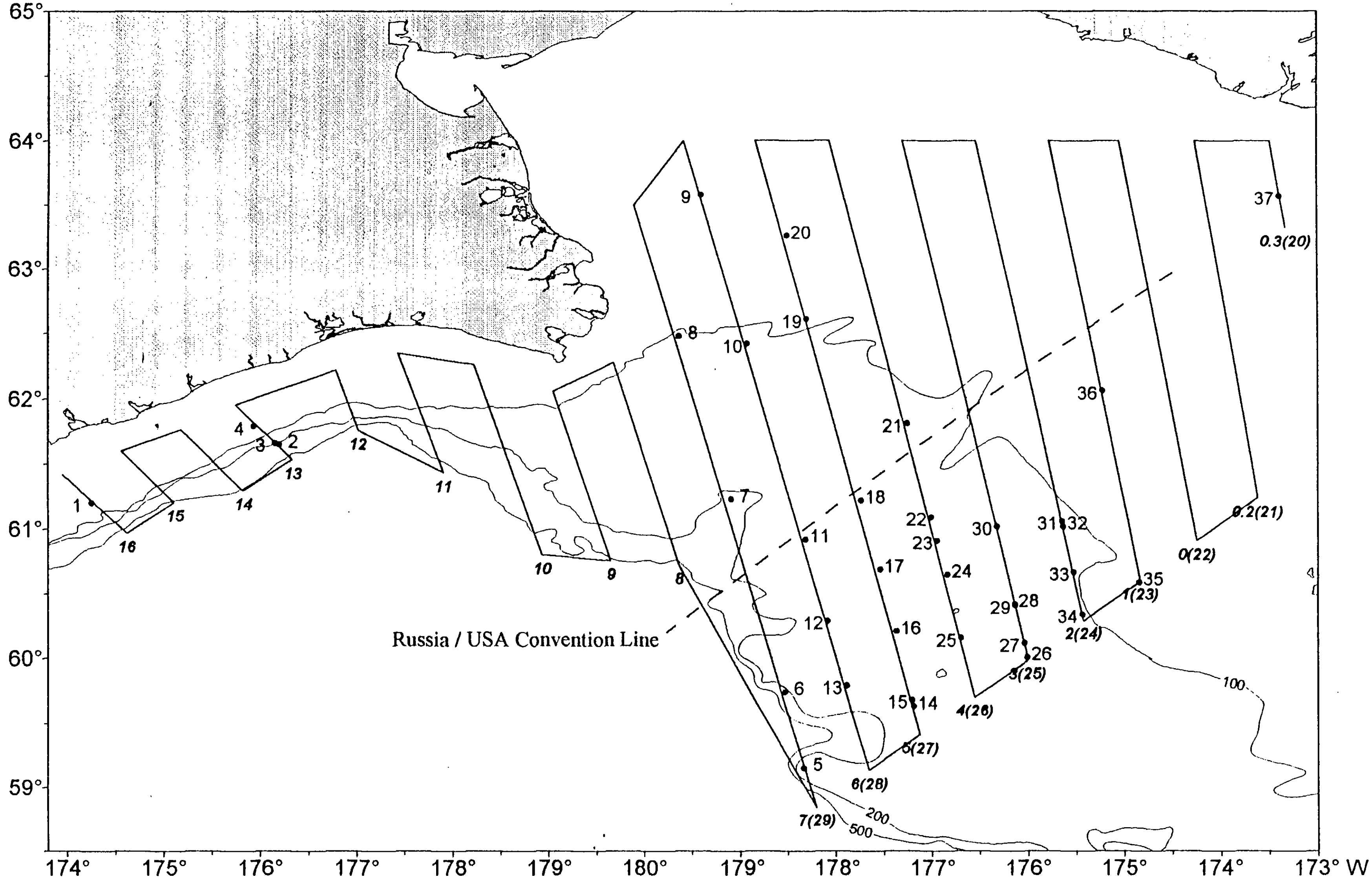

Figure 1. The scheme of transect lines and haul locations during the summer 2002 echo integration-trawl survey in the northwestern part of the Bering sea.

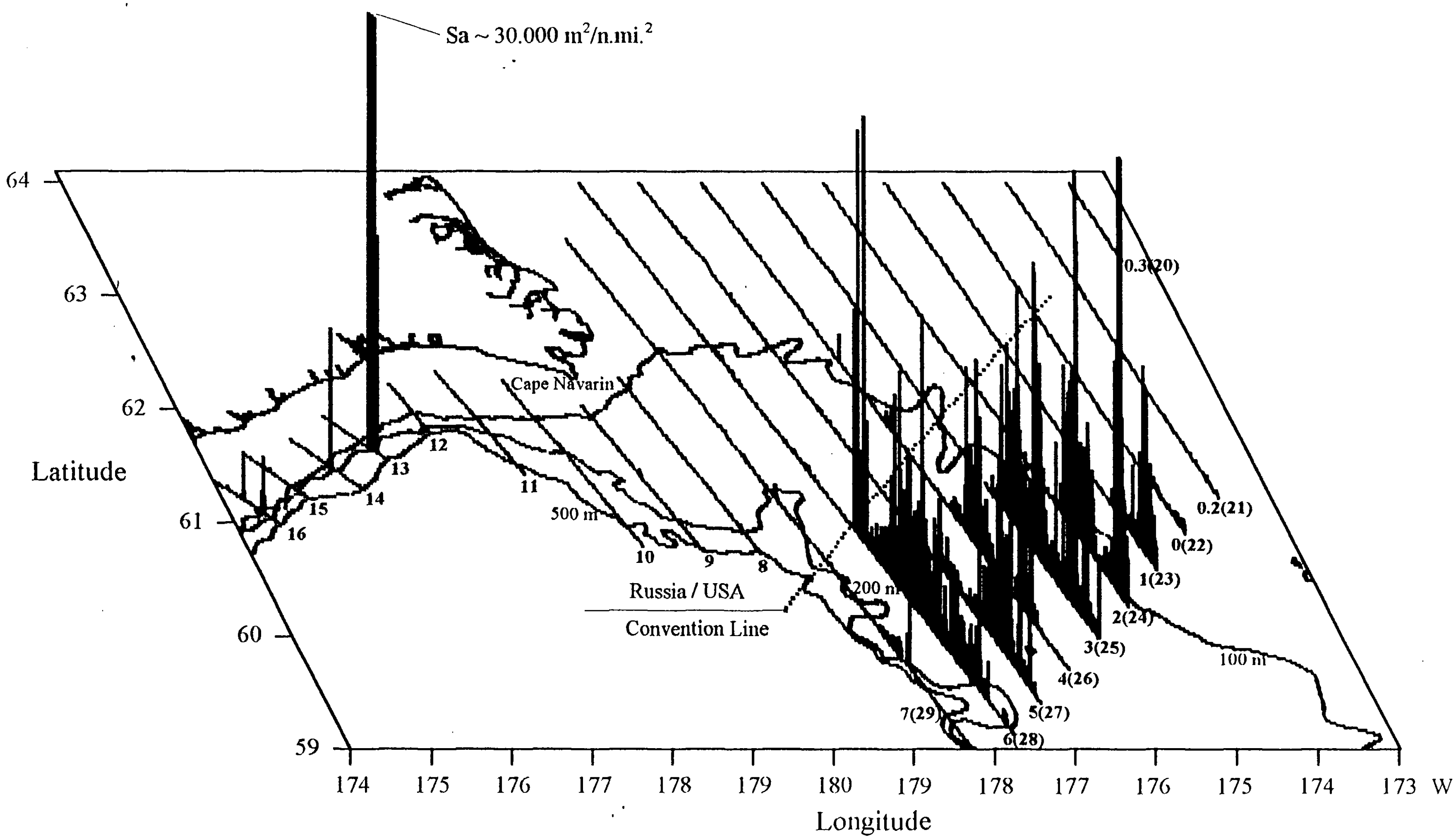

Figure 2. Relative density of pollock (S_A) along tracklines during the summer 2002 echo integration-trawl survey in the northwestern part of the Bering sea. Z axis = 10.000.

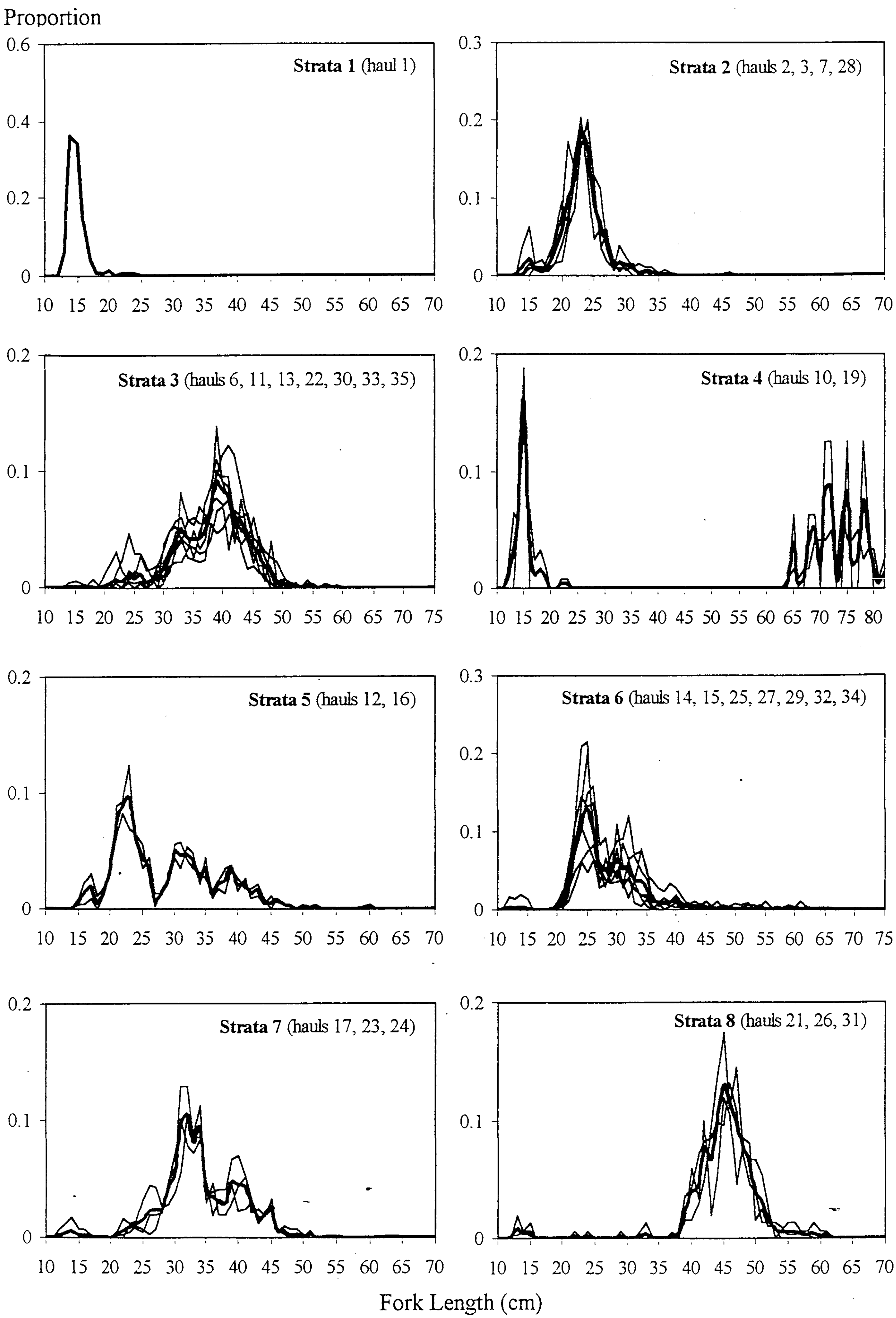

Figure 3. Pollock proportions by length from raw haul data and haul data averaged (heavy line) by stratum for the northwestern Bering sea shelf and slope.

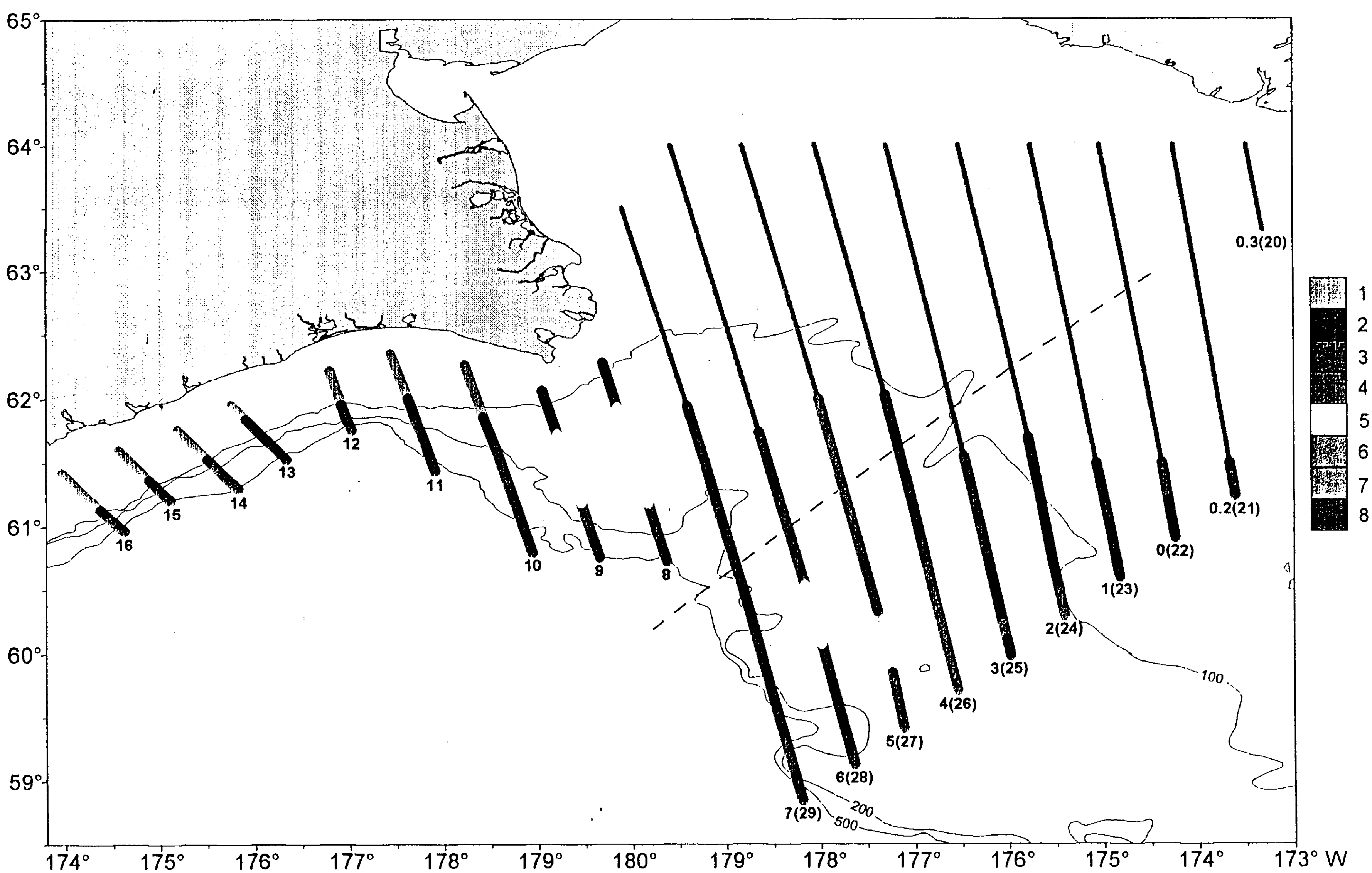

Figure 4. Spatial position of strata during the echo integration-trawl survey in the northwestern Bering sea in July 2002.

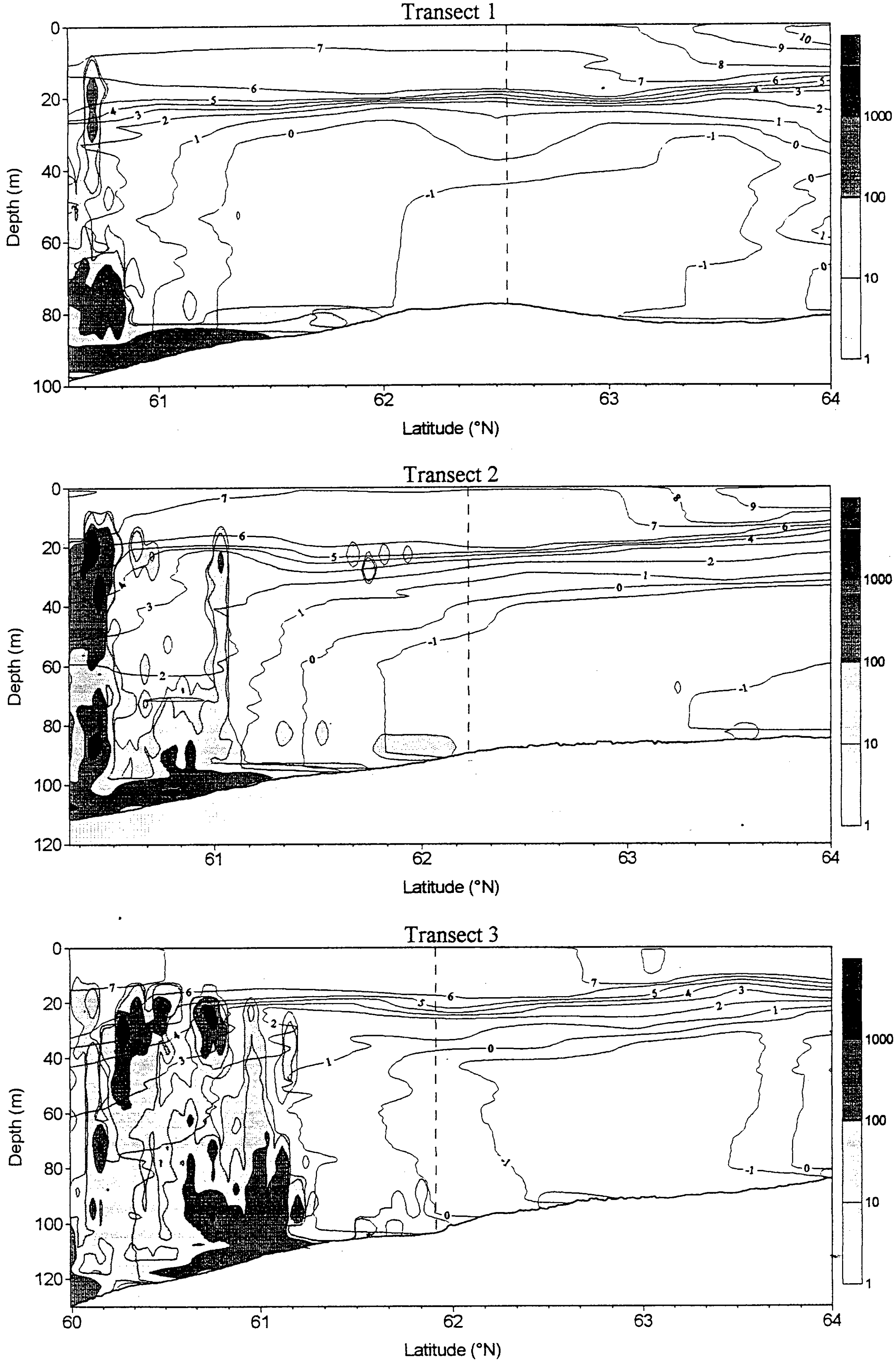

Figure 5. Vertical distribution of pollock acoustic backscatter (m^2/n.mi.^{2}) and water column temperature profile (^{0}C) along transects 1-3 during the echo integration-trawl survey of the northwestern Bering sea shelf in July 2002 (----- US/Russia Convention Line).

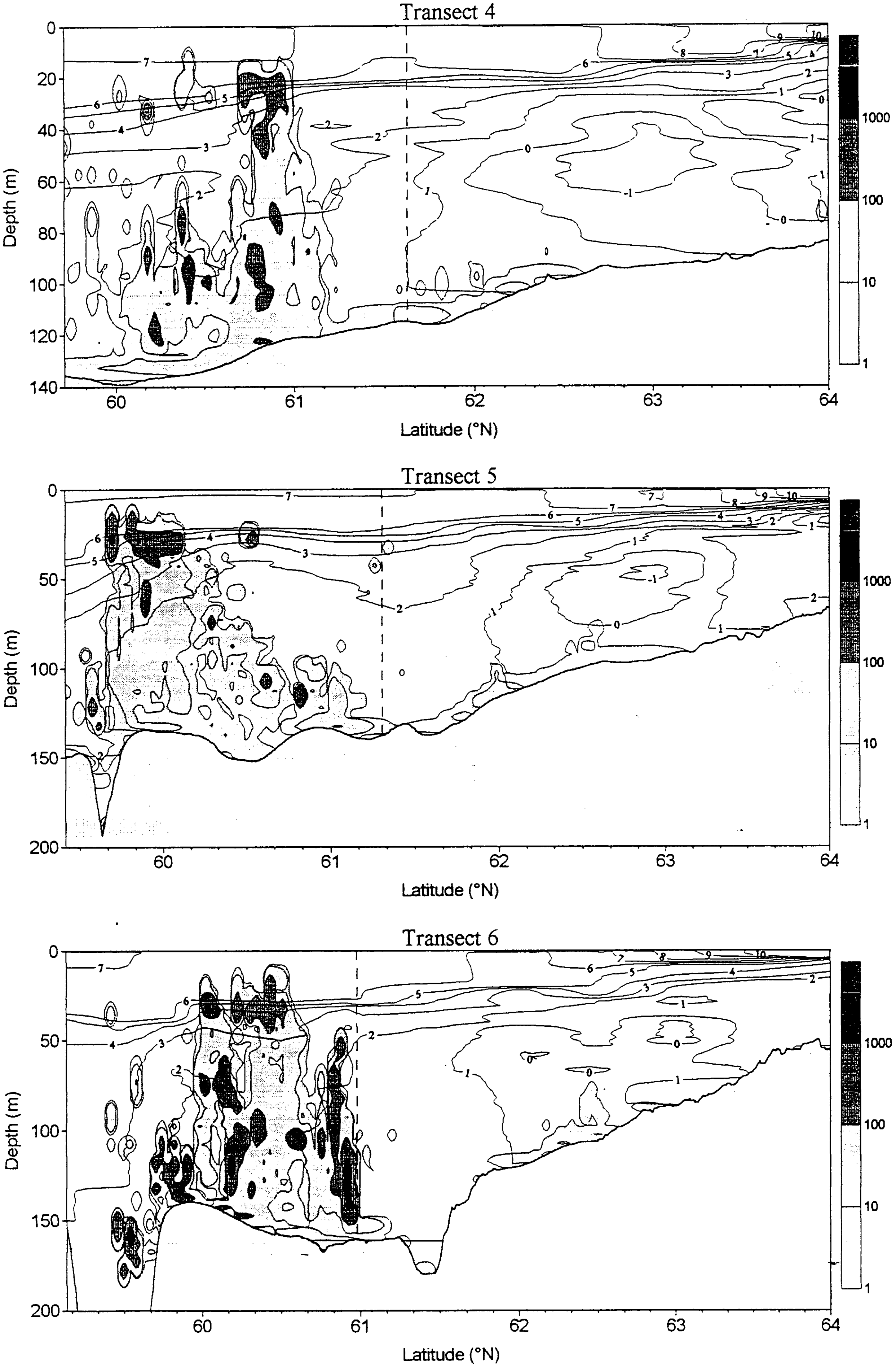

Figure 6. Vertical distribution of pollock acoustic backscatter ($m^2/n.mi.^2$) and water column temperature profile (^0C) along transects 4-6 during the echo integration-trawl survey of the northwestern Bering sea shelf in July 2002 (----- US/Russia Convention Line).

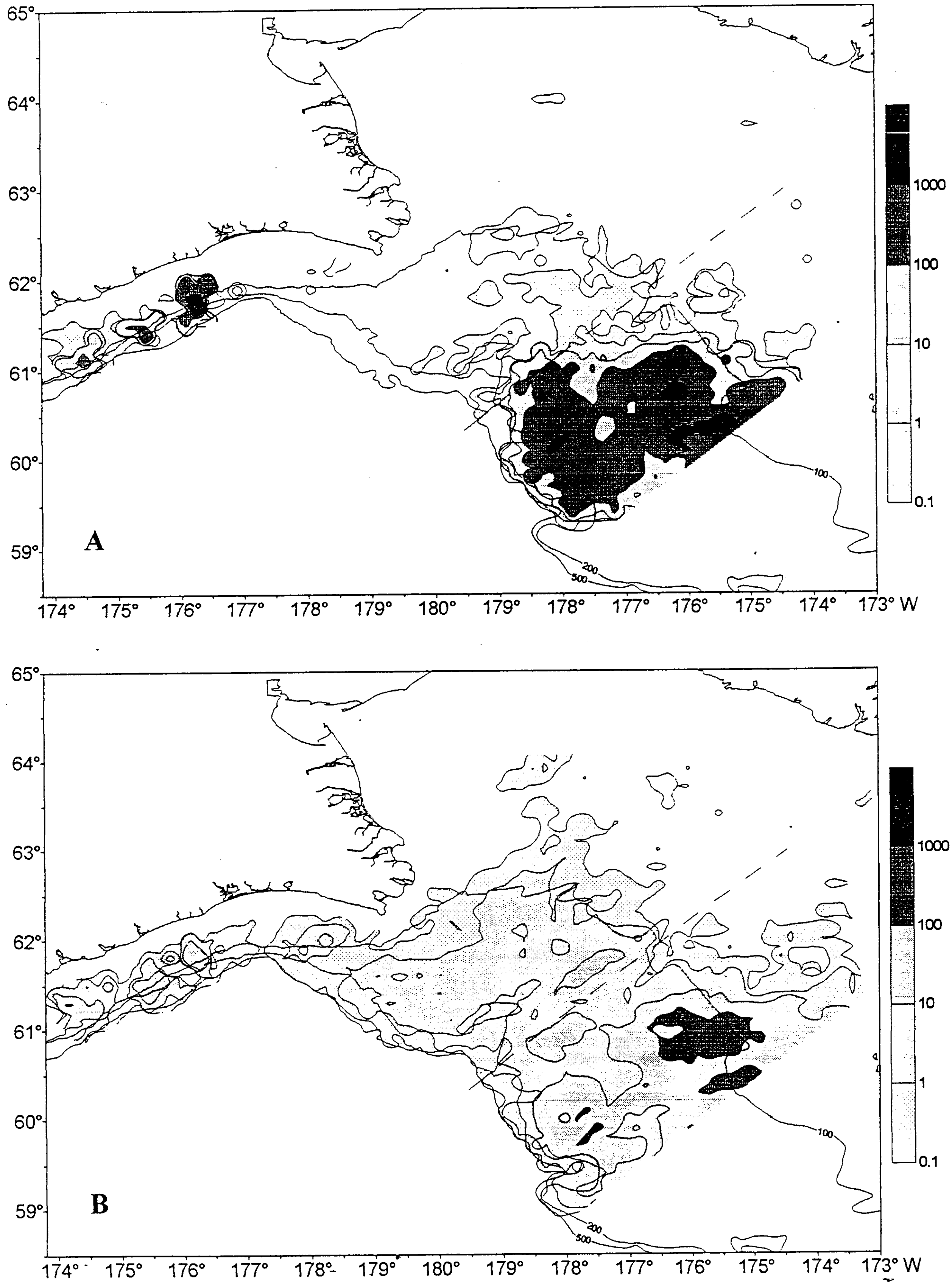

Figure 7. Distribution and density (ths. pcs./ n.mi.^{2}) of midwater (A) and near-bottom (B) pollock aggregations estimated during the summer 2002 echo integration-trawl survey of the northwestern Bering sea shelf and slope.

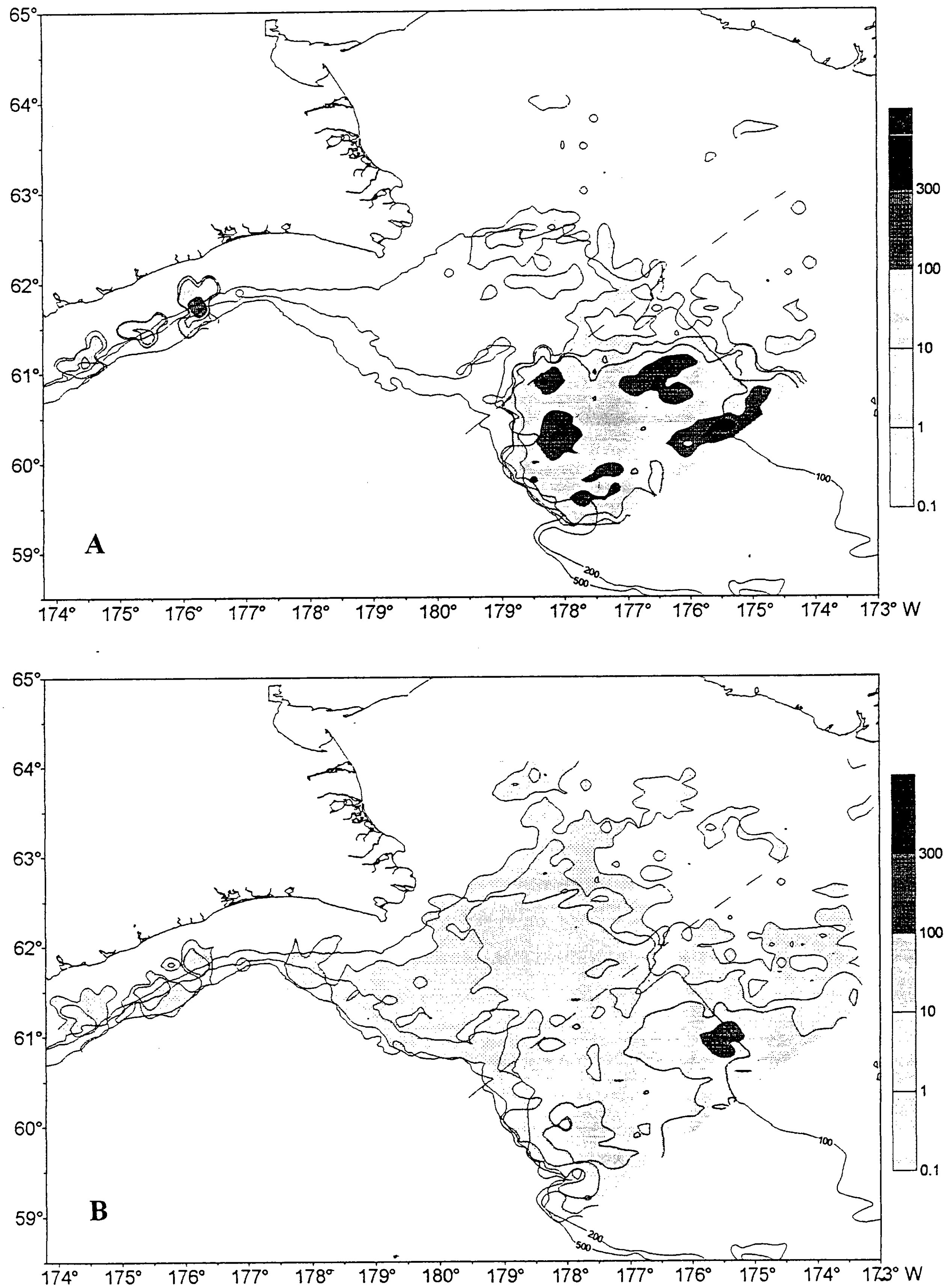

Figure 8. Distribution biomass (tons/ n.mi.^{2}) of midwater (A) and near bottom (B) pollock aggregations estimated during the summer 2002 echo integration-trawl survey of the northwestern Bering sea shelf and slope.

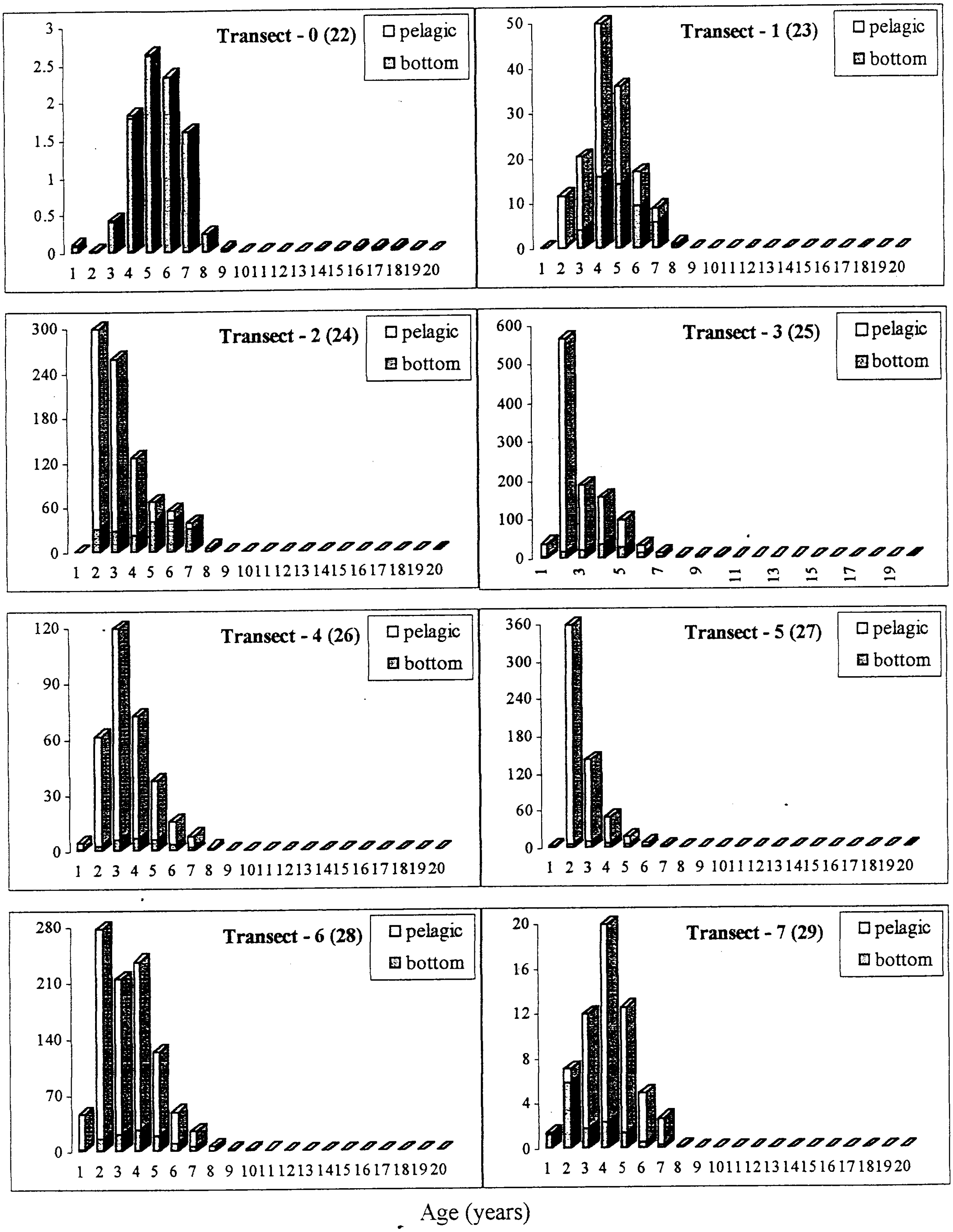

Figure 9. Estimated age composition for pollock by transects from the summer 2002 echo integration-trawl survey in the northwestern part of the Bering sea.

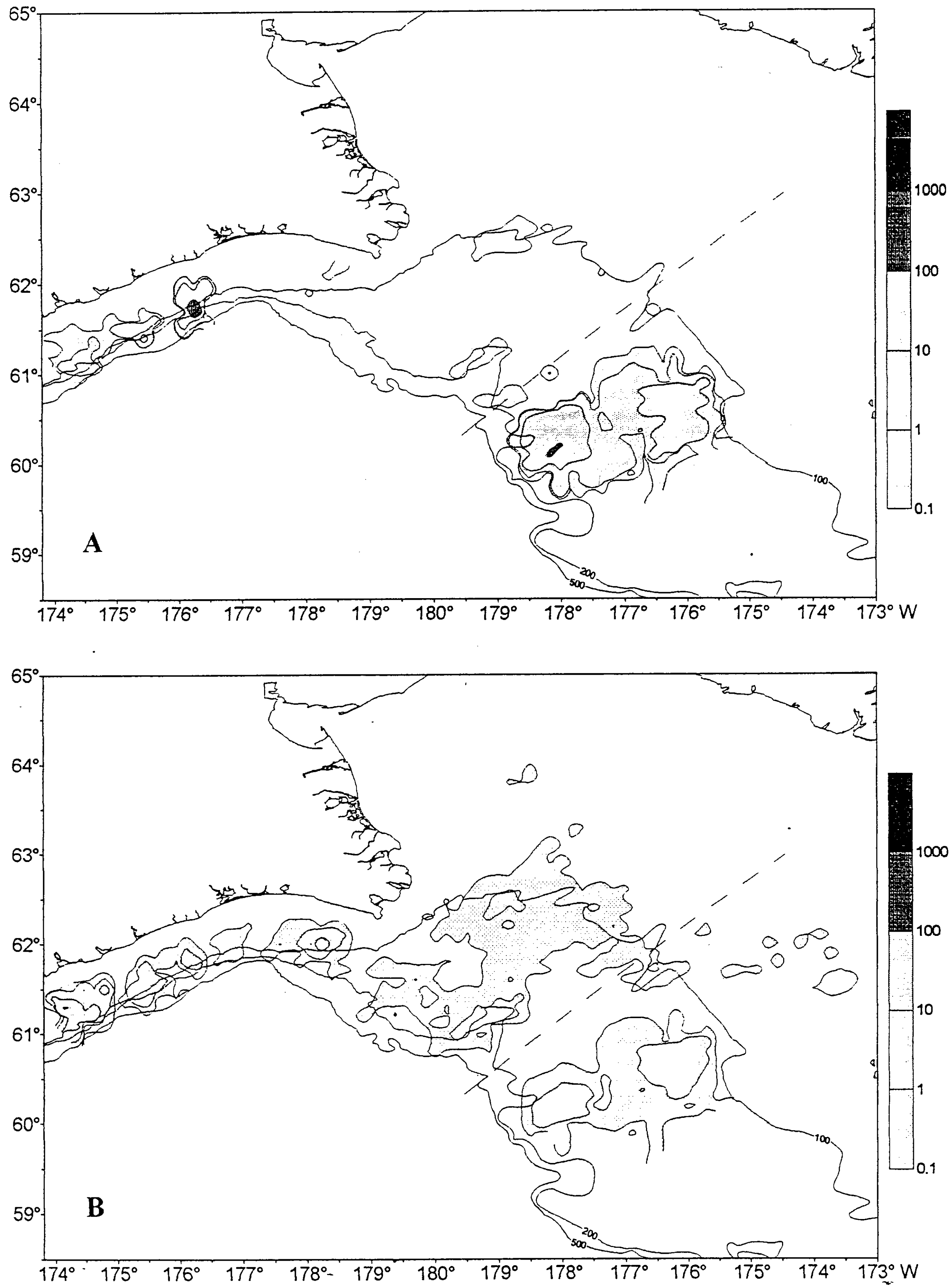

Figure 10. Distribution and density (ths. pcs./ n.mi.^{2}) of midwater (A) and near-bottom (B) **1-year old** pollock aggregations estimated during the summer 2002 echo integration-trawl survey of the northwestern Bering sea shelf and slope.

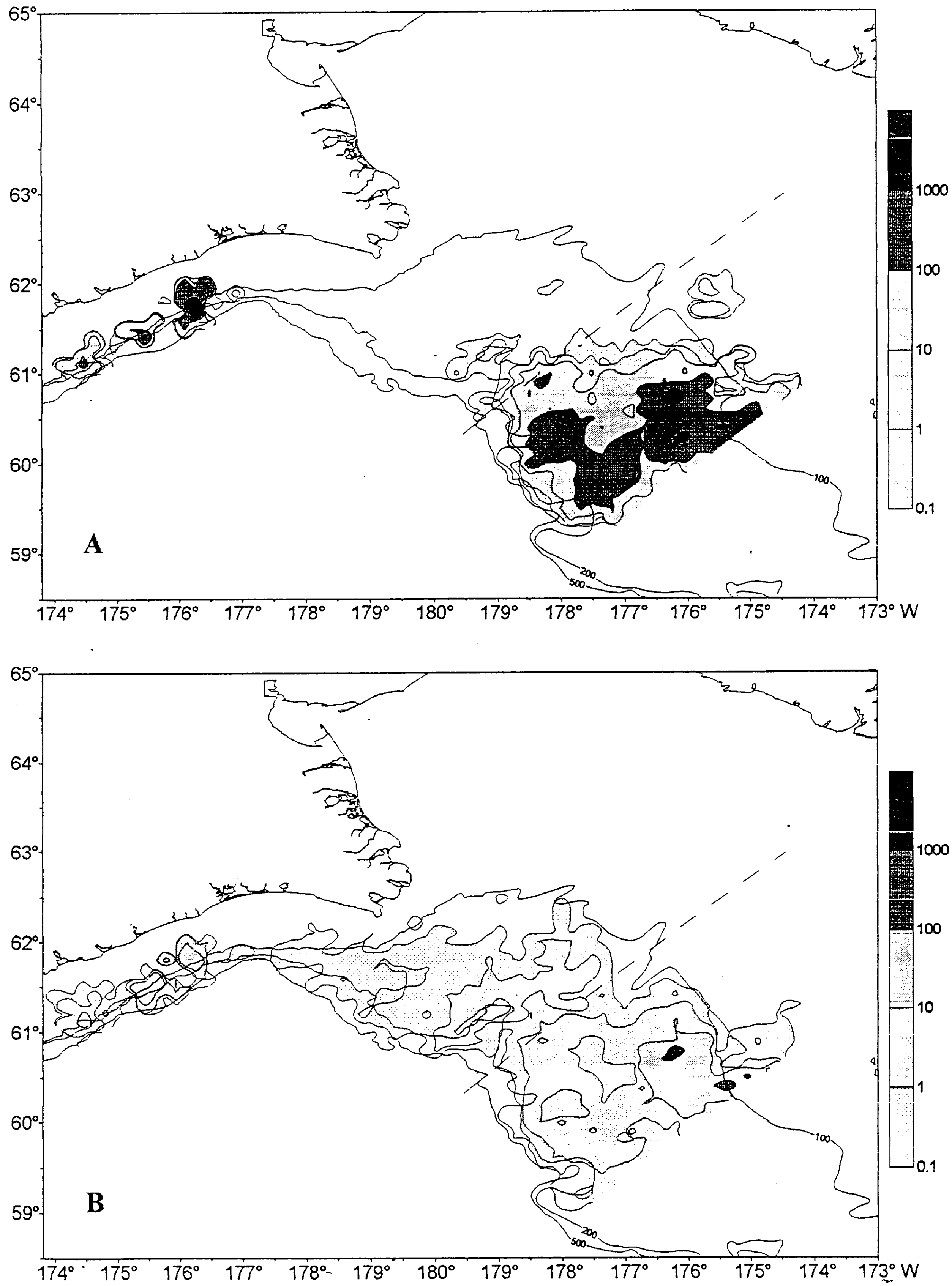

Figure 11. Distribution and density (ths. pcs./ n.mi.^{2}) of midwater (A) and near-bottom (B) **2-year old** pollock aggregations estimated during the summer 2002 echo integration-trawl survey of the northwestern Bering sea shelf and slope.

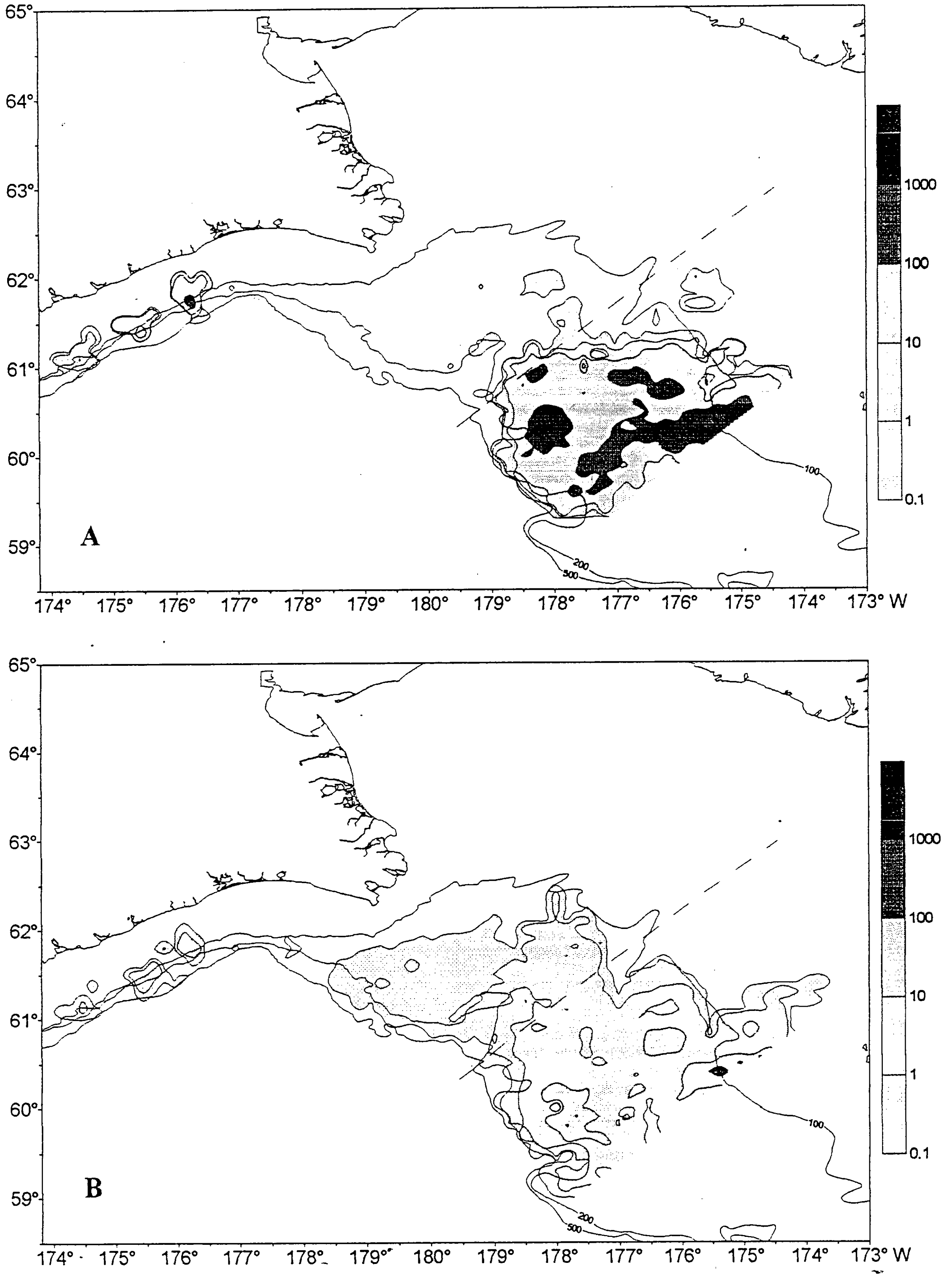

Figure 12. Distribution and density (ths. pcs./ n.mi.^{2}) of midwater (A) and near-bottom (B) **3-year old** pollock aggregations during the summer 2002 echo integration-trawl survey of the northwestern Bering sea shelf and slope.

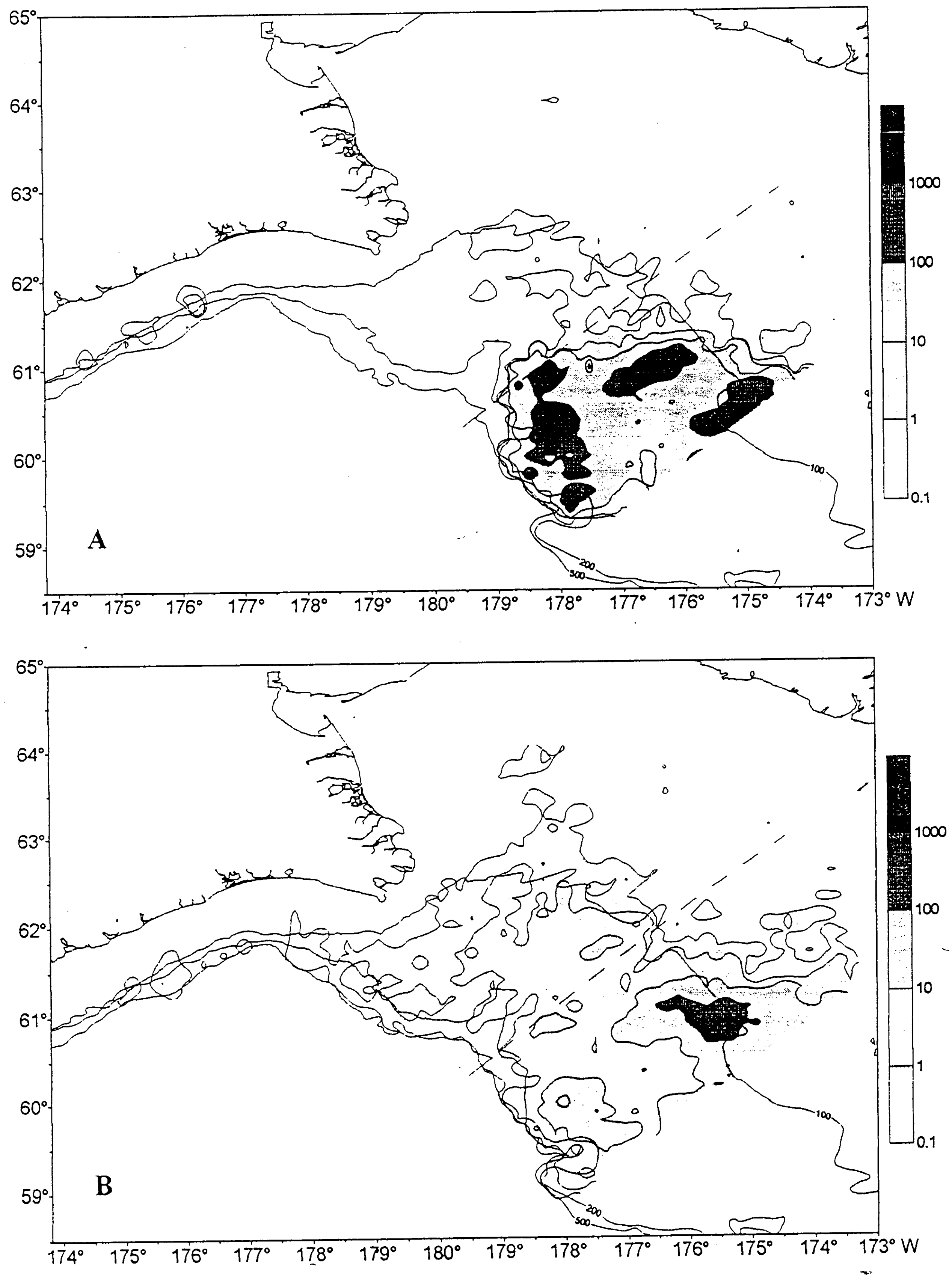

Figure 13. Distribution and density (ths. pcs./ n.mi.^{2}) of midwater (A) and near-bottom (B) aggregations of **mature** pollock (4-year-old and upwards) during the echo integration-trawl survey of the northwestern Bering sea shelf and slope in July, 2002.

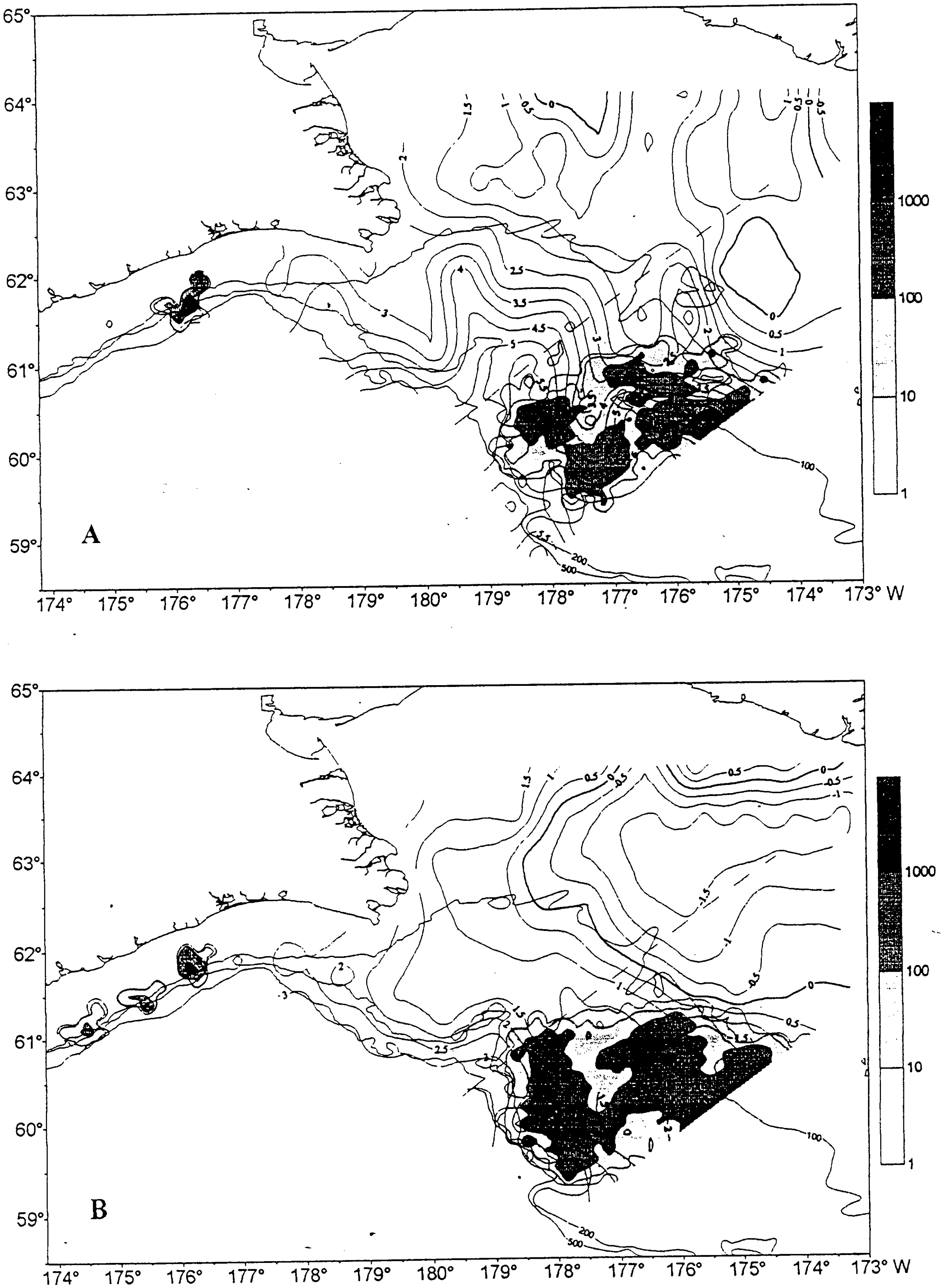

Figure 14. Contours of pollock density (ths. pcs./ n.mi.^{2}) and water temperature (^{0}C) in the layers of fishes location: A - in the upper water column (50 m off surface); B – in the lower part of midwater (layer 10-50 m off bottom). Northwestern part of the Bering sea, July, 2002.

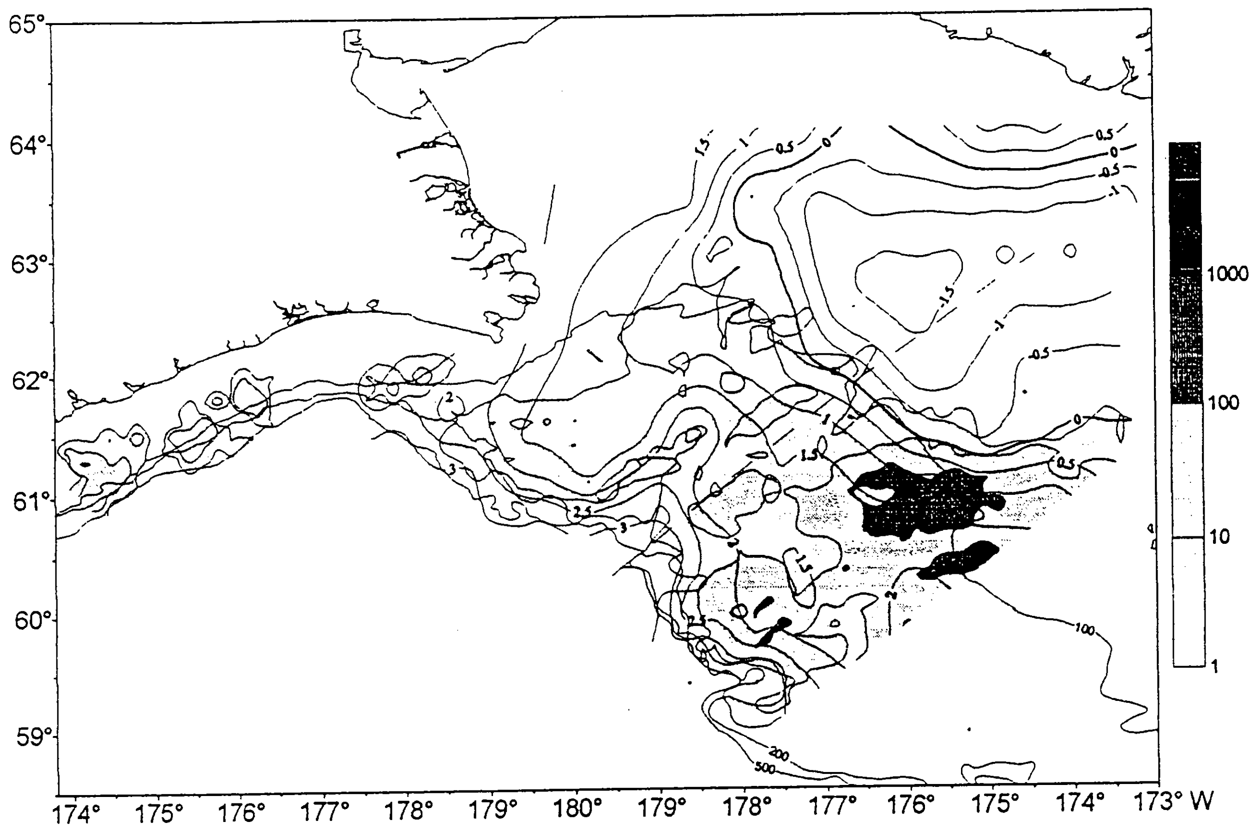

Figure 15. Contours of pollock density (ths. pcs./ n.mi.^{2}) and water temperature (^{0}C) in the near-bottom layer (10 m off bottom). Northwestern part of the Bering sea, July 2002.

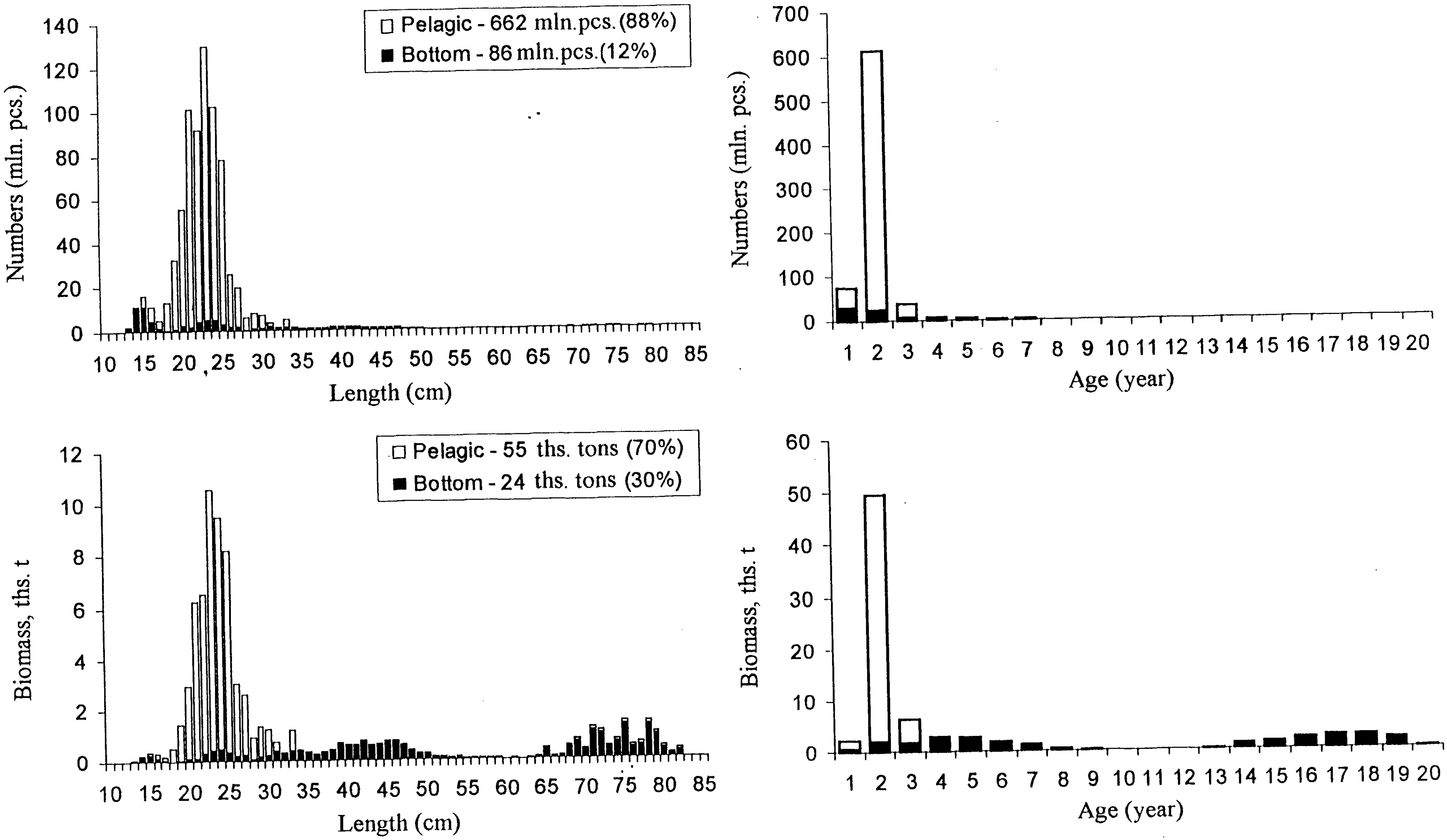

Figure 16. Estimated length-age composition of pelagic and near-bottom aggregations of walleye pollock in the northwestern Bering Sea in July, 2002 (Russian EEZ).

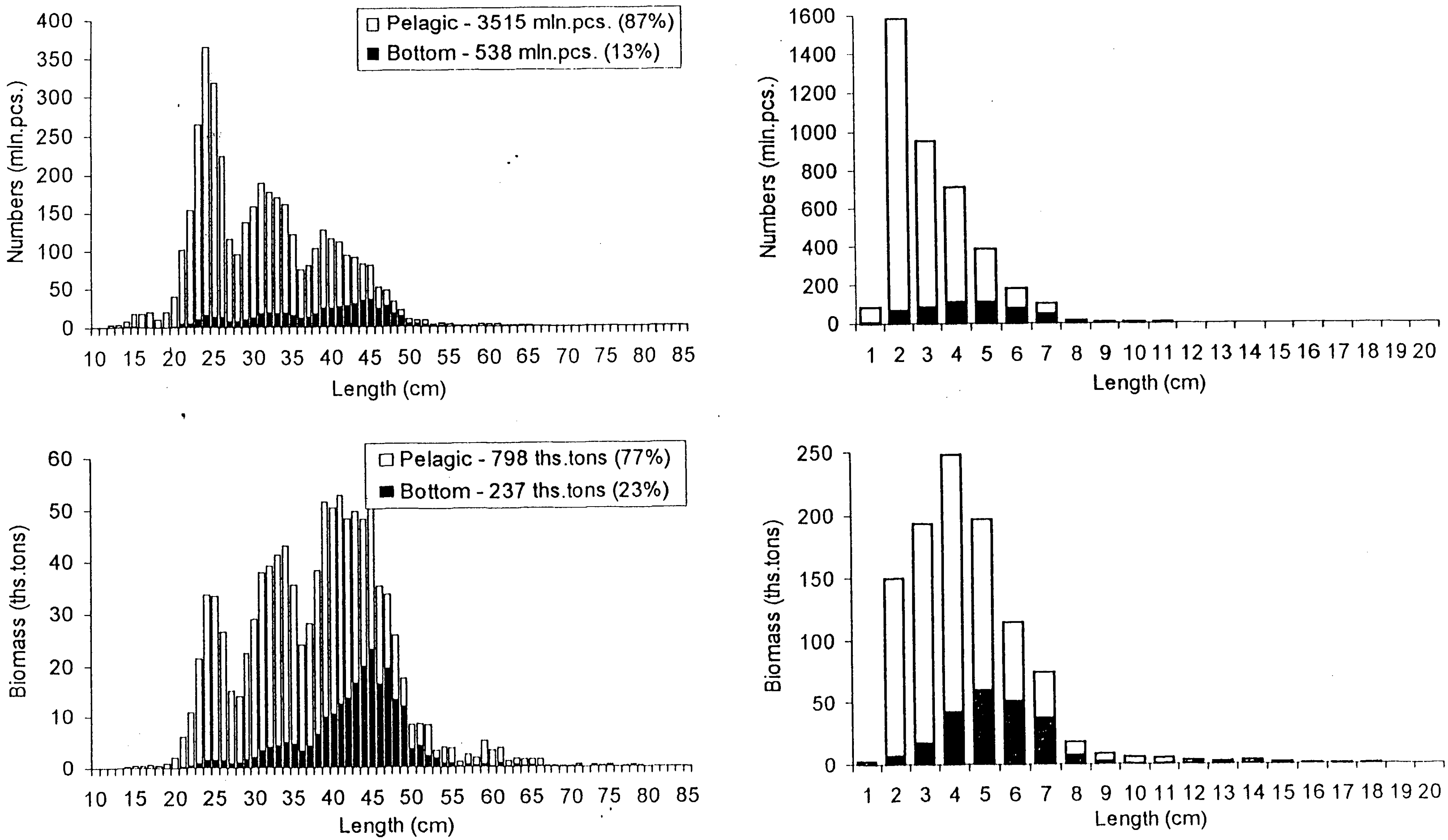

Figure 17. Estimated length-age composition of pelagic and near-bottom aggregations of walleye pollock in the northwestern Bering Sea in July, 2002 (USA EEZ).

Table 2. Trawl station and catch data summary from the summer 2002 echo integration-trawl survey of walleye pollock in the northwestern Bering sea shelf and slope.

Haul No.*	Date (GMT)	Time (GMT)	Duration (minutes)	Start Position		Speed (knots)	Depth (m)		Opening (m)	Temperature (C°)		Pollock Catch		Other Catch
				Latitude (N)	Longitude		Gear	Bottom		Surface	Gear	(kg)	number	(kg)
1	29.06.02	11:54	20	61.1223	174.1411 E	3.7	71	90	18	9.2	-	364.1	16222	4.7
2	30.06.02	6:09	10	61.3943	176.1106 E	3.8	29	183	24	7.3	-	2000.0	24365	1.4
3	30.06.02	7:33	30	61.3919	176.0776 E	3.4	113	156	18	7.8	-	830.0	6706	0.5
4	30.06.02	10:53	15	61.4765	175.5531 E	3.2	58	75	17	6.5	-	-	-	645.2
5	04.07.02	1:23	22	59.0941	178.2164 W	4.9	20	149	21	6.7	6.9	1.1	1	35.8
6	04.07.02	8:40	14	59.4513	178.3251 W	3.3	130	168	27	6.3	3.0	1100.0	2603	4.1
7	04.07.02	22:37	34	61.1369	179.0752 W	3.5	197	219	22	6.2	2.6	163.9	2278	18.2
8	05.07.02	10:25	15	62.2922	179.3826 W	3.3	75	104	26	7.0	0.9	-	-	12.5
9	06.07.02	1:17	15	63.3583	179.2459 W	3.7	39	61	20	11.2	1.7	0.0	1	3.9
10	06.07.02	11:17	60	62.2726	178.5617 W	3.6	85	107	23	7.1	0.9	194.0	123	5.0
11	07.07.02	8:09	15	60.5590	178.1910 W	3.7	127	161	23	6.4	1.7	1500.0	3904	3.8
12	07.07.02	13:07	17	60.1837	178.0527 W	3.5	73	153	26	6.5	2.2	469.0	2407	1.0
13	07.07.02	17:57	15	59.4754	177.5275 W	3.7	120	143	23	6.3	1.9	742.1	1750	1.6
14	08.07.02	7:12	60	59.3710	177.1090 W	3.3	75	179	23	7.1	2.2	237.4	1280	0.0
15	08.07.02	9:04	10	59.4168	177.1220 W	3.7	23	165	28	7.0	6.3	800.0	4420	1.3
16	08.07.02	13:47	14	60.1231	177.2168 W	3.3	78	137	22	6.9	1.5	45.1	226	3.9
17	08.07.02	17:58	32	60.4091	177.3197 W	3.7	110	143	26	7.2	1.5	356.0	1236	11.6
18	08.07.02	22:37	60	61.1171	177.4319 W	3.7	68	139	22	6.4	1.9	11.9	12	105.6
19	09.07.02	12:27	50	62.3563	178.1907 W	3.7	77	97	20	7.4	-0.1	31.0	16	8.1
20	09.07.02	17:58	32	63.1465	178.3052 W	4.0	61	86	23	8.6	0.5	0.0	3	4.5

Table 2. Continued.

Haul No.*	Date (GMT)	Time (GMT)	Duration (minutes)	Start Position		Speed (knots)	Depth (m)		Opening (m)	Temperature (C°)		Pollock Catch		Other Catch (kg)
				Latitude (N)	Longitude		Gear	Bottom		Surface	Gear	(kg)	number	
21	10.07.02	23:51	45	61.4778	177.1478 W	3.7	96	116	20	6.3	0.5	770.7	1239	8.6
22	11.07.02	9:55	36	61.0492	177.0000 W	3.5	90	121	19	6.5	1.7	518.3	1389	19.5
23	11.07.02	12:55	20	60.5416	176.5656 W	3.5	17	123	23	6.8	6.4	461.1	1507	24.5
24	11.07.02	16:13	30	60.3827	176.5018 W	3.5	95	130	24	6.4	2.0	758.5	2494	14.1
25	11.07.02	21:58	30	60.0892	176.4134 W	3.7	87	137	25	7.0	1.9	600.0	2908	10.3
26	12.07.02	6:15	15	60.0065	176.0017 W	3.6	104	129	24	7.1	2.3	97.9	151	72.0
27	12.07.02	8:48	5	60.0725	176.0181 W	3.4	63	127	24	7.1	2.9	1200.0	7985	19.7
28	12.07.02	11:31	15	60.2581	176.0835 W	4.4	20	122	26	6.9	5.9	613.6	5923	17.1
29	12.07.02	12:32	30	60.2400	176.0779 W	3.4	78	122	21	6.9	1.9	1484.1	6685	15.0
30	12.07.02	18:10	16	61.0119	176.1915 W	3.4	66	112	22	6.0	1.5	2430.0	5570	42.0
31	14.07.02	21:44	17	61.0352	175.3844 W	3.7	82	101	20	7.2	1.6	581.3	914	67.1
32	14.07.02	23:14	20	61.0215	175.3803 W	4.1	19	102	29	7.1	5.3	50.96	345	188.3
33	15.07.02	4:29	30	60.3982	175.3164 W	3.8	79	107	27	7.7	1.8	172.0	416	105.8
34	15.07.02	8:13	15	60.2010	175.2572 W	3.6	58	111	26	8.1	2.1	1300.0	6474	60.5
35	15.07.02	12:30	20	60.3530	174.5169 W	3.5	69	99	22	7.2	2.0	616.5	1472	354.66
36	16.07.02	0:49	25	62.0452	175.1394 W	3.8	62	80	18	6.9	-0.9	0.1	13	54.51
37	18.07.02	21:40	60	63.3272	173.2230 W	3.8	17	68	18	7.9	5.8	-	-	35.2

* Gear Type - RTPG 57/360

Table 3. Catch by species from trawl hauls conducted during the summer 2002 walleye pollock echo integration-trawl survey in the northwestern Bering sea shelf.

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
Walleye pollock	Theragra chalcogramma	20501.0	92.3	113038
Chrysaora jellyfish	Chrysaora melonaster	925.2	4.2	688
Shrimp	Pandalus sp.	665.9	3.0	218323
Pacific sleeper shark	Somniosus pacificus	55.0	0.25	1
Smooth Lumpsucker	Aptocyclus ventricosus	12.1	0.05	13
Greenland Turbot	Reinhardtius hippoglossoides	9.0	0.04	43
Aeginura (jellyfish)	Aeginura grimoldii	7.9	0.04	23
Capelin	Mallotus villosus	6.9	0.03	312
Rock Sole	Lepidopsetta bilineata	6.1	0.03	18
Pacific Cod	Gadus macrocephalus	5.2	0.02	2
Chum Salmon	Oncorhynchus keta	4.8	0.02	2
Majestic Squid	Berryteuthis magister	1.5	0.01	7
Pacific Spiny Lumpsucker	Eumicrotremus orbis	0.7	0.00	19
Phacellophora (jellyfish)	Phacellophora camtshchatica	0.5	0.00	1
Bering Flounder	Hippoglossoides robustus	0.4	0.00	2
Pacific three-toothed lamprey	Entosphenus tridentatus	0.3	0.00	1
Dragon Poacher	Percis japonicus	0.3	0.00	1
Liparis sp.	Liparis sp.	0.2	0.00	73
Variegated Snailfish	Liparis gibbus	0.2	0.00	1
Ptychogena (jellyfish)	Ptychogena lactea	0.2	0.00	21
Butterfly Sculpin	Melletes papilio	0.1	0.00	1
Wattled Eelpout	Lycodes palearis	0.1	0.00	1
Leptoclin	Leptoclinus m.diaphanocarus	0.1	0.00	4
Aurelia	Aurelia limbata	0.0	0.00	2
Northern lampfish	Stenobrachius leucopsarus	0.0	0.00	1
Irish lord	Hemilepidotus sp.	0.0	0.00	1
Light Dusky Rockfish	Sebastes sp.	0.0	0.00	1
	Итого	22203.5		332600

Table 4. Numbers and biomass of walleye pollock on the transects of echo integration-trawl survey in July 2002.

Pelagic layer (upper 10 m off bottom)											
Transect No.	Numbers (ths. pcs.)					Biomass (tons)					Sm (m2)
	Length (cm)				Sum	Length (cm)				Sum	
	10 - 20	21 - 30	31 - 40	> 40		10 - 20	21 - 30	31 - 40	> 40		
16	4138.8	15749.4	347.2	0.5	20235.9	177.5	1467.9	75.1	0.5	1720.9	34.4
15	158.4	32.3	1.4	9.3	201.3	3.6	3.0	0.4	6.5	13.6	0.2
14	2420.6	11232.7	255.9	5.5	13914.6	114.9	1047.0	56.3	3.2	1221.4	24.1
13	105481.0	514747.0	4199.2	3.0	624430.1	4836.2	44886.3	974.7	2.1	50699.2	1221.3
12	44.6	193.4	4.3	0	242.3	2.0	18.0	0.9	0	21.0	0.4
11	4.2	6.7	2.3	12.4	25.5	0.1	0.6	0.8	8.5	10.1	0.1
10	39.7	13.4	1.5	0.8	55.4	0.9	1.2	0.4	0.5	3.0	0.1
9	3.8	14.0	7.747	2.5	28.0	0.1	1.4	2.3	1.5	5.2	0.1
8	13.8	52.0	18.8	5.5	90.2	0.4	5.0	5.6	3.4	14.4	0.2
7 (29)	250.8	3416.9	27938.2	15650.9	47256.8	7.6	521.2	9205.0	9272.7	19006.6	429.6
6 (28)	67140.6	304829.9	355111.1	155621.2	882702.8	2619.0	32537.4	109571.5	97250.1	241978.1	3163.3
5 (27)	4991.5	431536.1	104003.9	20757.2	561288.8	221.4	46992.3	27776.0	14043.3	89032.9	1403.4
4 (26)	4533.1	97037.9	144921.0	48634.8	295126.8	151.7	12549.2	40275.2	29818.2	82794.3	1199.2
3 (25)	49936.2	629068.4	201516.2	103541.5	984062.3	1665.8	66272.6	61693.2	68301.6	197933.2	3327.6
2 (24)	5972.8	351396.5	250713.9	41434.2	649517.5	317.4	40568.4	66241.4	25373.9	132501.1	2968.2
1 (23)	8.6	16804.7	52744.4	27740.3	97298.0	0.1	2094.4	17939.6	16048.5	36082.6	428.2
0 (22)	21.4	3.8	71.8	84.9	181.9	0.4	0.5	24.7	144.0	169.6	1.3
0.2 (21)	6.5	0.1	0.8	34.7	42.1	0.1	0	0.3	50.7	51.2	0.4
0.3 (20)	0.1	0	0	0.2	0.4	0	0	0	0.8	0.8	0
SUM	*245166.4*	*2376135.4*	*1141859.6*	*413539.3*	*4176700.7*	*10119.5*	*248966.3*	*333843.4*	*260330.0*	*853259.2*	*14202.0*
Bottom layer (10 m off the bottom)											
Transect No.	Numbers (ths. pcs.)					Biomass (tons)					Sm (m2)
	Length (cm)				Sum	Length (cm)				Sum	
	10 - 20	21 - 30	31 - 40	> 40		10 - 20	21 - 30	31 - 40	> 40		
16	22170.5	2116.4	47.5	18.5	24352.8	497.0	193.8	11.1	17.1	719.1	26.5
15	1746.8	77.2	7.0	76.5	1907.4	38.7	6.9	2.7	53.8	102.0	1.9
14	2231.4	6530.9	222.6	112.9	9097.8	84.8	609.0	57.9	73.5	825.2	19.2
13	781.3	3250.8	72.3	8.6	4113.0	35.0	303.0	15.8	6.0	359.7	10.8
12	163.6	94.2	37.7	24.1	319.6	4.1	9.0	12.4	14.2	39.6	0.6
11	251.1	329.8	94.5	154.5	829.9	7.2	31.2	31.5	101.9	171.8	2.2
10	1934.6	338.2	557.6	446.6	3277.0	43.1	33.9	186.3	271.8	535.1	7.4
9	367.3	1402.2	1358.1	631.4	3759.0	13.8	144.1	423.1	384.5	965.5	12.7
8	498.7	1956.2	798.0	271.1	3524.0	16.6	187.7	244.5	165.0	613.8	8.9
7 (29)	1611.1	6203.3	3747.0	2357.1	13918.5	49.2	593.1	1215.9	1819.2	3677.4	60.2
6 (28)	3493.3	22172.2	43177.0	37195.4	106037.9	121.5	2683.9	13532.7	26294.4	42632.5	536.2
5 (27)	581.6	8705.976	15177.3	10456.1	34921.0	15.9	1143.1	4450.5	9293.1	14902.6	164.5
4 (26)	1366.1	4665.8	11071.3	12366.2	29469.3	36.9	574.3	3449.3	9786.2	13846.7	180.0
3 (25)	2923.6	21030.5	51198.5	43074.4	118226.9	56.6	2551.9	17272.4	27437.9	47318.8	642.4
2 (24)	819.0	42077.7	39503.4	125206.0	207606.2	41.6	4852.4	11362.3	83732.8	99989.0	1193.8
1 (23)	52.4	968.5	21342.3	29836.5	52199.7	1.1	143.7	7397.4	19187.0	26729.2	288.9
0 (22)	94.9	95.5	2198.8	7014.1	9403.2	2.0	14.0	771.5	5007.0	5794.4	57.8
0.2 (21)	185.1	4.5	34.3	1314.8	1538.7	4.0	0.3	14.1	1665.8	1684.3	12.9
0.3 (20)	9.3	0.2	0	18.4	27.9	0.2	0	0	51.7	51.9	0.4
SUM	*41281.7*	*122020.2*	*190645.0*	*270582.9*	*624529.9*	*1069.3*	*14075.2*	*60451.1*	*185362.9*	*260958.6*	*3227.2*
TOTAL	286448.1	2498155.6	1332504.7	684122.2	4801230.6	11188.8	263041.5	394294.5	445692.9	1114217.7	17429.2

Table 5. Estimated age composition (numbers and biomass) of pollock in the northwestern Bering se shelf and slope by results of echo integration-trawl survey in July 2002.

Russian EEZ

Age (years)	Numbers						Biomass					
	Pelagic*		Bottom**		Sum		Pelagic*		Bottom**		Sum	
	mln. pcs.	%	mln. pcs.	%	mln. pcs.	%	ths. tons	%	ths. tons	%	ths. tons	%
1	43.933	6.6	30.816	35.7	74.750	10.0	1.606	2.9	0.683	2.8	2.289	2.9
2	587.849	88.8	25.422	29.5	613.271	82.0	47.344	85.4	2.178	9.0	49.522	62.1
3	28.235	4.3	8.442	9.8	36.677	4.9	4.675	8.4	1.702	7.0	6.377	8.0
4	1.099	0.2	7.600	8.8	8.699	1.2	0.295	0.5	2.718	11.2	3.013	3.8
5	0.172	0.0	4.996	5.8	5.167	0.7	0.089	0.2	2.577	10.6	2.666	3.3
6	0.100	0.0	2.766	3.2	2.866	0.4	0.063	0.1	1.756	7.2	1.820	2.3
7	0.063	0.0	1.713	2.0	1.776	0.2	0.047	0.1	1.284	5.3	1.331	1.7
8	0.014	0.0	0.363	0.4	0.376	0.1	0.013	0.0	0.340	1.4	0.353	0.4
9	0.006	0.0	0.164	0.2	0.170	0.0	0.007	0.0	0.180	0.7	0.186	0.2
10	0.002	0.0	0.047	0.1	0.049	0.0	0.002	0.0	0.065	0.3	0.067	0.1
11	0.001	0.0	0.038	0.0	0.040	0.0	0.002	0.0	0.054	0.2	0.056	0.1
12	0.001	0.0	0.023	0.0	0.025	0.0	0.002	0.0	0.039	0.2	0.041	0.1
13	0.006	0.0	0.067	0.1	0.073	0.0	0.011	0.0	0.124	0.5	0.135	0.2
14	0.050	0.0	0.459	0.5	0.509	0.1	0.105	0.2	0.963	4.0	1.068	1.3
15	0.070	0.0	0.555	0.6	0.624	0.1	0.164	0.3	1.309	5.4	1.473	1.8
16	0.086	0.0	0.738	0.9	0.823	0.1	0.227	0.4	1.937	8.0	2.164	2.7
17	0.087	0.0	0.770	0.9	0.857	0.1	0.248	0.4	2.191	9.0	2.438	3.1
18	0.088	0.0	0.725	0.8	0.813	0.1	0.286	0.5	2.360	9.7	2.646	3.3
19	0.058	0.0	0.464	0.5	0.522	0.1	0.204	0.4	1.613	6.6	1.817	2.3
20	0.011	0.0	0.063	0.1	0.073	0.0	0.042	0.1	0.243	1.0	0.286	0.4
SUM	*661.929*	*100*	*86.232*	*100*	*748.161*	*100*	*55.434*	*100*	*24.315*	*100*	*79.749*	*100*

USA EEZ

Age (years)	Numbers						Biomass					
	Pelagic*		Bottom**		Sum		Pelagic*		Bottom**		Sum	
	mln. pcs.	%	mln. pcs.	%	mln. pcs.	%	ths. tons	%	ths. tons	%	ths. tons	%
1	82.677	2.4	5.278	1.0	87.954	2.2	2.430	0.3	0.123	0.1	2.553	0.2
2	1511.996	43.0	69.647	12.9	1581.643	39.0	142.982	17.9	6.870	2.9	149.851	14.5
3	866.341	24.7	86.066	16.0	952.407	23.5	174.961	21.9	18.095	7.6	193.056	18.7
4	596.022	17.0	116.056	21.6	712.077	17.6	204.733	25.7	43.116	18.2	247.849	24.0
5	275.282	7.8	114.543	21.3	389.825	9.6	135.903	17.0	61.294	25.9	197.197	19.1
6	102.834	2.9	80.357	14.9	183.190	4.5	63.120	7.9	51.700	21.8	114.820	11.1
7	49.790	1.4	51.488	9.6	101.278	2.5	36.891	4.6	38.256	16.2	75.147	7.3
8	11.307	0.3	8.584	1.6	19.891	0.5	10.793	1.4	7.773	3.3	18.566	1.8
9	5.579	0.2	2.658	0.5	8.238	0.2	6.248	0.8	2.774	1.2	9.023	0.9
10	3.819	0.1	0.723	0.1	4.543	0.1	5.465	0.7	1.014	0.4	6.479	0.6
11	3.147	0.1	0.614	0.1	3.761	0.1	4.568	0.6	0.886	0.4	5.454	0.5
12	1.870	0.1	0.472	0.1	2.342	0.1	2.993	0.4	0.767	0.3	3.760	0.4
13	1.403	0.0	0.395	0.1	1.798	0.0	2.386	0.3	0.669	0.3	3.055	0.3
14	1.543	0.0	0.427	0.1	1.970	0.0	2.943	0.4	0.829	0.4	3.772	0.4
15	0.420	0.0	0.207	0.0	0.627	0.0	0.877	0.1	0.458	0.2	1.335	0.1
16	0.117	0.0	0.209	0.0	0.326	0.0	0.304	0.0	0.555	0.2	0.859	0.1
17	0.048	0.0	0.170	0.0	0.218	0.0	0.127	0.0	0.486	0.2	0.613	0.1
18	0.017	0.0	0.173	0.0	0.190	0.0	0.056	0.0	0.564	0.2	0.621	0.1
19	0.011	0.0	0.110	0.0	0.121	0.0	0.038	0.0	0.381	0.2	0.419	0.0
20	0.001	0.0	0.008	0.0	0.009	0.0	0.003	0.0	0.032	0.0	0.035	0.0
SUM	*3514.224*	*100*	*538.187*	*100*	*4052.410*	*100*	*797.821*	*100*	*236.643*	*100*	*1034.464*	*100*
TOTAL	4176.153		624.419		4800.572		853.255		260.958		1114.213	

*Pelagic layer (upper 10 m off bottom)

**Bottom layer (10 m off the bottom)

Federal Committee on Fisheries of Russian Federation

PRELIMINARY NAVARIN WALLEYE POLLOCK STOCK ASSESMENT

(document submitted for VIII Bering Sea Pollock Conference, Portland, 2003)

By
D.A.Vasilyev

2003

Being limited in auxiliary information, stock assessment was undertaken by a special cohort model which gives possibility to get unique solution using catch-at-age data. The model belongs to ISVPA group (Vasilyev 2001, 2003). A group of separable cohort model, named ISVPA, may serve as an example of comparatively simple stochastic separable cohort models They are similar in many aspects to other separable cohort models and imply the existence of errors in catch-at-age data and in separable representation of fishing mortality coefficients. But their parameter estimation procedures is based on some principles of robust statistics what helps to diminish the influence of error (noise) in catch-at-age data on the results if the assessment. Besides, the solution is guaranteed to be unbiased in chosen statistical sense. Special parameterization of the model makes it unnecessary to use any preliminary assumptions about the age of unit selectivity and about the shape of selectivity pattern. This helps to get unique solution in cases when catch-at-age data are noisy and auxiliary information is too controversial or is not available.

In the assessment the so called catch-controlled version of the model was used. This version implies that errors in model approximation of catch-at-age data can be attributed to errors in separable representation of fishing mortality. Additional condition used in order to help to get unique solution in situations of strongly noisy data is that of unbiased separable representation of fishing mortality coefficient (*see manual*). The loss function of the model is the median of distribution of squared residuals in logarithmic catch-at-age data, which is more robust for noisy data in comparison to traditional sum of squared residuals.

The profile of the model loss function with respect to the value of the effort factor in the terminal year is given on Figure 1.

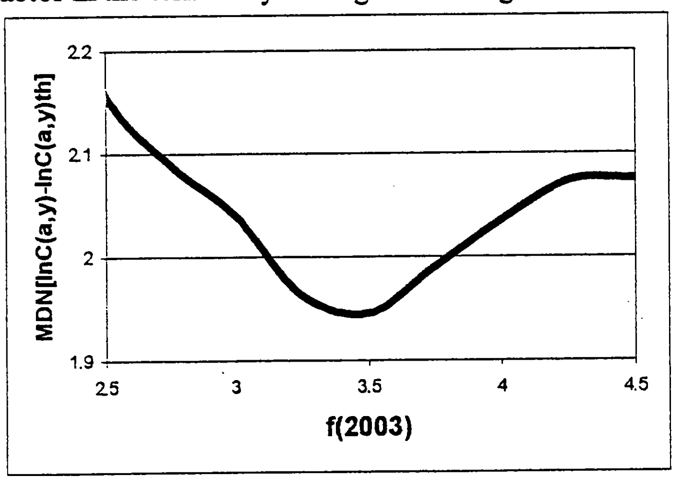

Fig.1 Profile of the ISVPA loss function with respect to value of effort factor in 2003

As it can be seen, profile of the loss function in the basic run reveals a rather distinct minimum, while there is also a slope to extremely high values of terminal effort factor.

Retrospective analysis (figures 2 and 3) undertaken with the same model options as in basic run, shows rather reasonable stability of results, bearing in mind that no tuning on auxiliary information was used. Final year of each curve on the graphs correspond to the year taken as terminal one in the assessment.

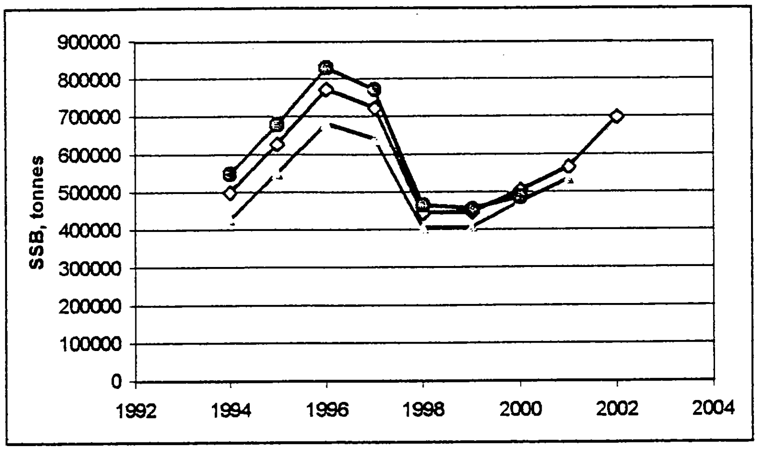

Fig.2 SSB estimates in ISVPA retrospective runs

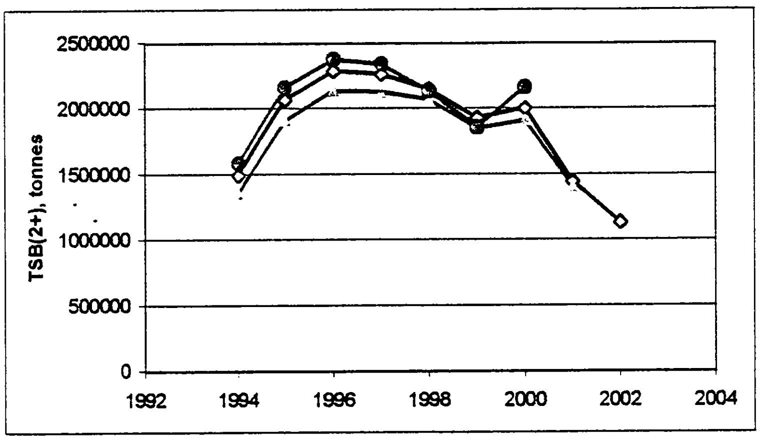

Fig.3 TSB(2+) estimates in ISVPA retrospective runs

Despite of good stability of retrospective runs, the results of bootstrap (conditional parametric, lognormal error distribution in catch-at-age residuals was assumed) indicate rather high uncertainty in the results (figures 4 and 5). This seems to be quite natural when using only catch-at-age data in analysis.

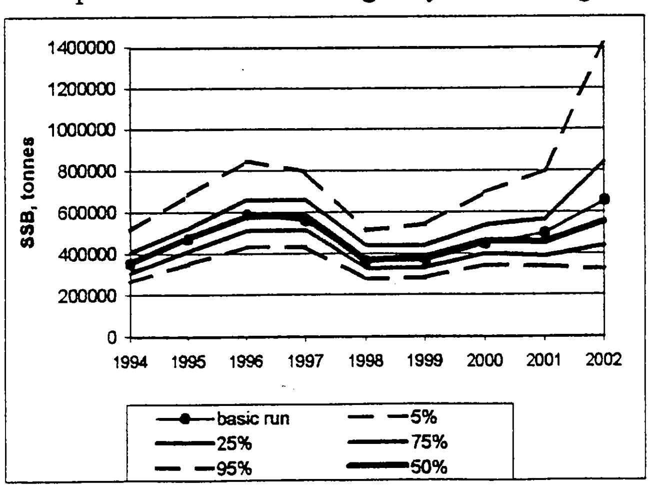

Fig.4 ISVPA bootstrap distribution for SSB

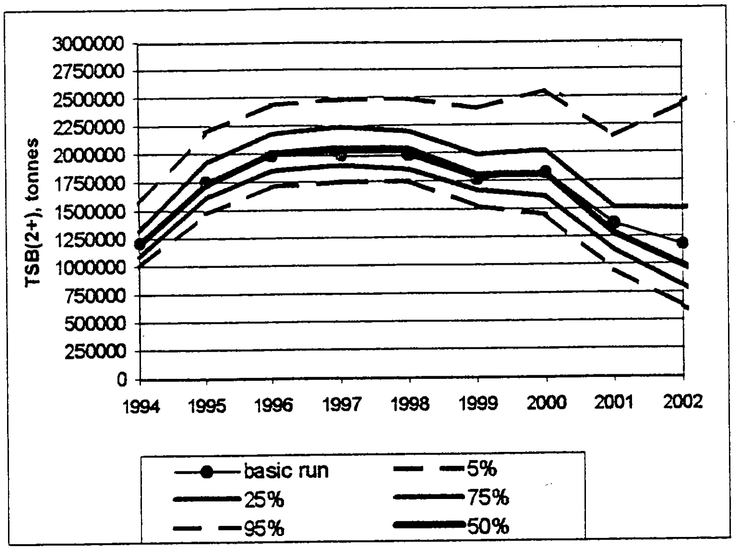

Fig.5 **ISVPA bootstrap distribution for TSB(2+)**

The estimates of abundance-at-age (basic run) are given in Table 1:

Year\age	2	3	4	5	6	7+
1994	2594.78	1597.87	680.39	270.72	149.65	104.88
1995	3811.61	1882.52	837.01	352.61	176.78	123.89
1996	3366.01	2788.65	1036.22	397.70	235.52	165.06
1997	4109.64	2348.99	1132.83	341.01	218.70	153.27
1998	5624.08	2829.78	1031.22	352.50	178.79	0.00
1999	4621.02	3812.57	1074.88	342.82	215.19	0.00
2000	2420.68	2837.55	1601.89	443.76	194.13	0.00
2001	6900*	1384.89	1397.51	904.28	301.15	0.00
2002	13451*	4099*	684.03	419.60	496.75	178.48

*) - corrected taking into account observed values

Table 1. Abundance-at-age estimates (thousands).

Direct observations indicate extremely strong 2000 and strong 2001 year classes. The recruitment estimates from surveys, being used in deterministic prognostic run (prognostic options are listed in figure 6), originate enhancement of SSB rise, starting from 2003.

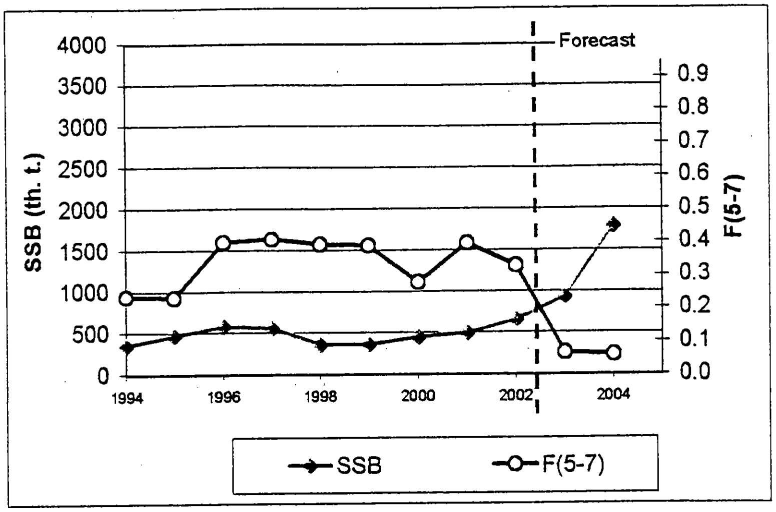

Figure 6. Restrospective and prognostic estimates of SSB and F(5-7)
In forecast: Catch(2003)=TAC=420 000 t.
selection-at-age - average(1994-2002)
recruitment - median(1994-2002)
weight-at-age - average(1994-2002)
maturity-at-age - average(1994-2002)

References

Vasilyev 2001. Cohort models and analysis of commercial bioresources at informational supply deficit. Moscow, VNIRO Publishing, 2001. 98 pp.

Vasilyev 2003. Description of the ISVPA. Working document to the ICES Working group on methods of stock assessment (Copenhagen, 29.01.2003- 5.02.2003).

Federal Committee on Fisheries of Russian Federation

COMPARATIVE POPULATION-GENETIC ANALYSIS OF POLLOCK *THERAGRA CHALCOGRAMMA* FROM THE BERING SEA AND WATER OFF THE NORTH KURIL ISLANDS BASED ON POLYMORPHIC MICROSATELLITE MARKERS. BRIEF RESULTS OF GENETIC RESEARCH DURING THE LAST TWO YEARS.

(document submitted for VIII Bering Sea Pollock Conference, Portland, 2003)

By
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2003

Given below are the results obtained from a comparative analysis of the Bering Sea and North Kuril concentrations of pollock using five microsatellite loci.

1. Assessment of genetic distances between the stocks after subsuming the sample into five conditional concentrations according to geographic coordinates of tows showed the presence of genetic overlapping between the Olutor and the isolated North Kuril concentrations, mostly by one locus Tch 15.

2. The genetic distance between the Navarin and Koryak concentrations does not allow us to regard those concentrations to be subdivided populations.

3. The genetic distance between the Olutor and Karagin concentrations is extremely low (smaller than the distance between the Navarin and Koryak concentrations) which makes it possible to refer them to the same population.

4. The genetic differences between the Olutor and Navarin concentrations agree with the commonly accepted distances obtained on the basis of empirical data for subdivided sea fish populations under a high level of gene migration.

5. Except the Olutor one, all the other concentrations examined are distinctly different from the North Kuril population.

6. The combination of the Olutor and Karagin, as well as of the Navarin and Koryak samples did not modify the results obtained from smaller and less fractioned samples.

Figure 1. Unrooted NPGMA tree constructed on the basis of genetic distances Nei. 1. Koryak concentration. 2. Olutor concentration. 3. North Kuril concentration. 4. Karagin concentration. 5. Navarin concentration.

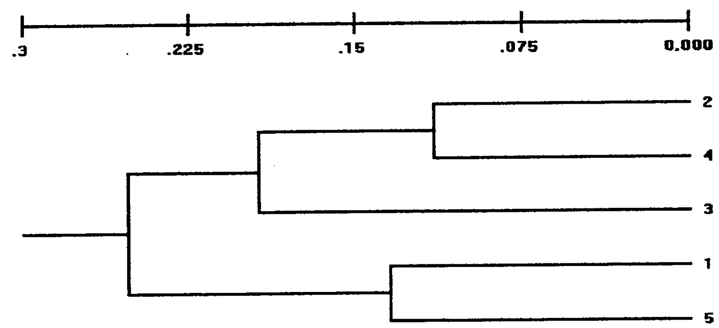
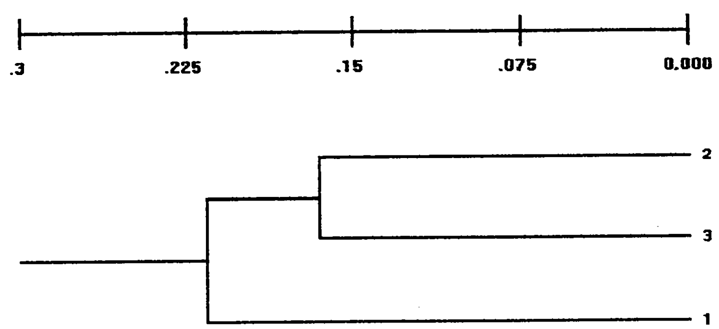


Figure 2. Unrooted UPGMA tree built on the basis of genetic distances Nei for the three groupings of pollock. 1. North Kuril 2.Olutor 3. Navarin



Federal Committee on Fisheries of Russian Federation

IDENTIFICATION, SPATIAL DISTRIBUTION OF THE BERING SEA POLLOCK SPAWNING STOCKS AND IT RESOURCE ASSESSMENT

(document submitted for 8 th Bering Sea Pollock Conference, Portland, 2003)

By

M.A. Stepanenko, Gritsay E.V.

2003

Spawning distribution depends on of mature pollock age composition because older pollock spawns basically at shelf adjacent Alaska peninsula and in deep water off eastern Aleutians but younger fish spawns at shelf off Pribilof Islands and in the northwestern Bering Sea. Pollock spawning activity could very high in deep water off eastern (Bogoslof I area) and central (Kanaga Sound) Aleutian Islands in some years. There are pollock spawning grounds off western Aleutian Islands and off Kommandor Islands.

At the same time there is possibility of big scale eggs drift according to direction of general currents.

Annual eastern Bering Sea pollock total catch in US, Russian and donut hole area reached 3.4-3.6 mln.t by the end of 1990-s (Table). Pollock fishing in the central part of Bering Sea (donut hole) had stopped early 1990-s and total catch varies between 1.6-2.0 mln.t last 10 years.

Direct pollock fishing in the western Bering Sea had stopped in 2002 and now available just trial fishing and it harvest as bycatch (10 ths. t a year).

There are a lot of unknown aspects of Bering Sea pollock biology present time including subpopulations status, interannual variability of. spawning stocks functioning, interrelationships between "shelf" and "basin" pollock, recruitment of "basin" pollock, identification of "basin" pollock recruits etc.

There are not only spatial but also temporal differentiations of pollock spawning stocks – most of older pollock spawns in deep water basically by the end of winter and early spring and younger fish at shelf mostly in middle spring. The older pollock (basically 6-12 years old) spawns in deep water and younger and first spawning fish (3-7 years old) at shelf.

Each spatially and temporarily isolated spawning stock usually compose by numbers of smaller pollock groups which differs by age composition, prespawning and spawning behaviour and time of active spawning. At the same time, pollock age composition on each spawning ground relatively stable every year.

As knowns older pollock basically spawns in deep water but all immature fish habits just at shelf.

Just recently had received some data about recruitment of "basin" pollock and interannual variability scale of pollock recruits migration from shelf area into Aleutian basin.

According to direct observation some 5-6 years old of first matured pollock migrates from outer shelf into adjacent continental slope, basically in area of big underwater canyons (Zhemchug, Pribilof, Bering canyons) annually by the end of winter. The 6 - years old mature pollock of 1995-1997 year classes represented significant part of prespawning fish (27-30 %) and 5-years old mature fish about 15-17% over continental slope in the canyons area in 2001-2003 according to observers data. This pollock represents of Bogoslof I area spawning stock recruitment. The migration of first maturing prespawning pollock from winter habits of outer shelf into adjacent continental slope take place very fast, during few days. As a rule, prespawning fish distributes by the end of winter over continental slope at depth 320 - 450 meters in area placed between Zhemchug canyon and

Eastern Aleutian Islands (Akutan I, Unalaska I). The pollock migrates to southeastern direction over bottom depth 500-550 meters.

Scale of mature pollock migration from shelf into continental slope in 2001-2003 was very limited. The recruits didn't compensate natural mortality of old pollock in spawning stocks off eastern Aleutian Islands in 2001-2003.

As preliminary concluded, scale of prespawning pollock migrations from shelf into deep water spawning grounds as well as distribution postspawning fish into Aleutian basin could depends on abundance and biomass of eastern Bering Sea pollock. For example, spawning stock off eastern Aleutian Islands and biomass of pollock in the Aleutian Basin significantly reduced by the end of 1980-s and 1990-s as result of decreasing abundance of numerous 1978, 1982, 1989, 1992 year classes in the eastern Bering Sea. Abundance and biomass of the eastern Bering Sea pollock increased by the end of 1990-s by recruits of numerous 1996 year class and relatively abundant 1995 and 1997 year classes. At the same time scale annual recruitments of spawning stock off eastern Aleutian Islands as well as pollock biomass in the Aleutian Basin didn't increased.

Recently some evidences have appeared that "shelf" and "basin" pollock differs not only by spatial and temporal gaps of reproduction and age composition but quite possibly it are completely independent reproductive stocks, perhaps genetically determined. The "shelf" and "basin" pollock also differs by some morphology signs of fish as well as eggs structure.

Sometimes observed some relationships between year classes abundance of the eastern Bering Sea pollock and scale of migration prespawning pollock from shelf into deep water (Bogoslof I) spawning ground. For example, the Bogoslof I spawning stock increased from 0.540 mln.t to 1.02 mln.t in 1995 by recruits of numerous 1989 year class.

Significant growth of spawning pollock stock biomass off eastern Aleutians was expectable also in 2001-2003 by recruits of numerous 1996 year class and relatively abundant 1995 and 1997 year classes. Unfortunately it's not happen. Spawning pollock biomass in Bogoslof I area in 2000-2003 stay at lowest level for last 15 years (0.270-0.198 mln.t) in spite of biomass of eastern Bering Sea pollock increased almost at 45% in second part of 1990-s. Possible reason of low recruitment pollock spawning stock off eastern Aleutians is fact that most of 1995-1996 year classes fish was born from shelf spawning pollock.

The pollock spawning stock off central Aleutian I (Kanaga Sound) is dependable part of eastern Aleutian I spawning stock.. Scale of pollock migration into Kanaga Sound spawning ground from eastern Aleutian usually increase at fish age 7-8 years old. Basically 8-12 years old pollock spawns in the Kanaga Sound.

Prespawning pollock observed annually off western Aleutian Islands and most density concentrations found in Kiska I and Attu I. areas. Quite possibly there are separate pollock spawning grounds off the western Aleutian Islands. Significant concentrations of pollock juveniles observed regular in Stailment bank area, off western Aleutian Islands.

There is separate pollock spawning stock in Kommandor Islands area. The trawl surveys usually registers immature and mature pollock in Kommandor Islands area.

There are stable spawning stocks of pollock at eastern Bering Sea shelf. Old pollock spawns annually in coastal water of Amak I and Pribilof Islands. The 7-12 years old pollock (basically 7-8 years old) spawns in coastal shelf of Amak I area. Pollock spawning in Amak I area take place much earler compare another shelf and deep water spawning groups, it starts by the end of January and peak spawning observed by the end of February. Postspawning pollock usually migrates from Amak I along Alaska peninsula and into central Bristol Bay.

The 9-12 years pollock spawns in coastal water of Pribilof Islands beginning middle March. Postspawning pollock of this stock migrates into northwestern Bering Sea and distributes in shallow water of inner shelf (depth 70-110 m) along of frontal zone of cold water with off bottom temperature below 0 C.

The one of the largest shelf spawning stock there is at shelf off Unimak I. The 6-7 years old pollock basically spawns off Unimak I in second part of March.

The first spawning and middle age pollock (3-7 years old) spawns at shelf off eastern Pribiloff Islands by the end of March and early April.

Spatial distribution of pollock reproduction connected with dynamics of plankton community because numerous zooplankton species serve as a food of pollock larvae and juvenile.

Functioning of pollock spawning grounds and spawning stocks depends on the eastern Bering Sea pollock abundance, it age composition and relative abundance of "shelf" and "basin" pollock.

At the same time, one of the main biological pattern of the Bering Sea pollock are big scale seasonal migrations. The big scale migrations determined by demands of special conditions for reproduction and limited food resource, basically zooplankton, in main reproduction areas. Eastern Bering Sea pollock concentrates in the southeastern Bering Sea in reproduction period and most of postspawning and immature fish distributes widely in summer and autumn period. The scale of distribution varied annually significantly depends on oceanological conditions, abundance and biomass of pollock.

The one year old pollock interannual variability of distribution also significant and as a rule corresponding distribution of juveniles in previous year. The old mature pollock (basically older 6 years old) distributes into Aleutians and Kommandor basins in summer-autumn period. The postspawning pollock of eastern Aleutian Isles spawning grounds (Bogoslof I area) predominates in the Aleutian basin in feeding period.

Unfortunately no direct assessment of pollock biomass in the Bering Sea deep water basins but spawning biomass in Bogoslof I area estimated at 2.4-2.1 mln.t and annual catch in donut hole area at 1.39-1.45 mln.t in 1988-1989. It's quite obviously that pollock biomass in the Aleutian basin was much higher of Bogoslof I spawning stock as well as there is evidence of postspawning pollock migration from eastern Bering Sea shelf by the end of 1980-s. The eastern Bering pollock biomass estimated as 10.0-12.0 mln.t that period.

Big scale postspawning pollock migration from Bogoslof I spawning grounds into the Aleutian basin begins by the end of February – early March. At the same time, postspawning pollock of Bogoslof I spawning stock also distributes in coastal water along Aleutian Islands and over continental slope. The postspawning pollock migration into Aleutian basin have a big scale in period existing of high biomass Bogoslof I pollock spawning stock. Most of postspawning pollock migrates from Bogoslof spawning ground to eastern direction basically by southern part of Aleutian basin. Some part of postspawning Bogoslof pollock migrating to northwestern direction.

Large, mature pollock distributes in the Aleutian basin in summer - autumn period for feeding. Feeding pollock begin concentrates at high density schools and slow migrates to eastern direction in October. Prespawning pollock migration into eastern Aleutians Islands water continues to early February. Some pollock migrates from northern Aleutian basin at first to nearest continental slope of the northwestern Bering Sea.

Scale of postspawning pollock distribution into Kommandor basin was significant in 1980-s. Biomass of the western Bering Sea pollock estimated at 2.0-2.5 mln.t this period. About 25-30% of total western Bering Sea pollock biomass usually distributed into Kommandor basin in postspawning period. Pollock of the eastern Bering Sea, western Bering Sea and Kommandor Isles populations mixed in the Kommandor basin in summer time. Most density pollock concentrations observed in the Shirshov ridge. Pollock begins slowly migrates into Olutorskiy and Karaginskiy Bays in October.

So, Bering Sea pollock subpopulation structure very complicated. There are some evidences that reproductively independent "shelf" and "basin" pollock exists. Reproduction of "basin" pollock take place off eastern Aleutian Islands and "shelf" pollock in the Bering Sea shelf.

Biomass of "shelf" pollock is relatively high (8.6 mln.t) and trend it increasing abundance and biomass stable in present time. At the same time, biomass of "basin" spawning pollock stay at low level (0.20 –0.23 mln.t) as well as annual recruitment in 2001-2002. Most of 1995-1997 year classes pollock spawns at shelf. Biomass of western Bering Sea pollock low(0.28 mln.t) and annual recruitment stay also at low level. Biomass of Northern Bering sea pollock average (1.726 mln.t).

Scale of distribution postspawning pollock into Aleutian and Kommandor basins last 10 years stay at low level.

Distribution pollock into northwestern Bering Sea shelf in summer-autumn time reduced significantly in 1999-2002.

Table. Historical catch of pollock from the Bering Sea, in metric tons, 1994-2003.

Year	Western Bering sea total	Navarin Region
1994	492900	288900
1995	506300	427300
1996	787000	753000
1997	765000	735000
1998	744000	719000
1999	685000	639000
2000	522000	507000
2001	551000	526000
2002	378000	370000
2003	265000[x]	

Data for 2003 is through August 31, 2003.

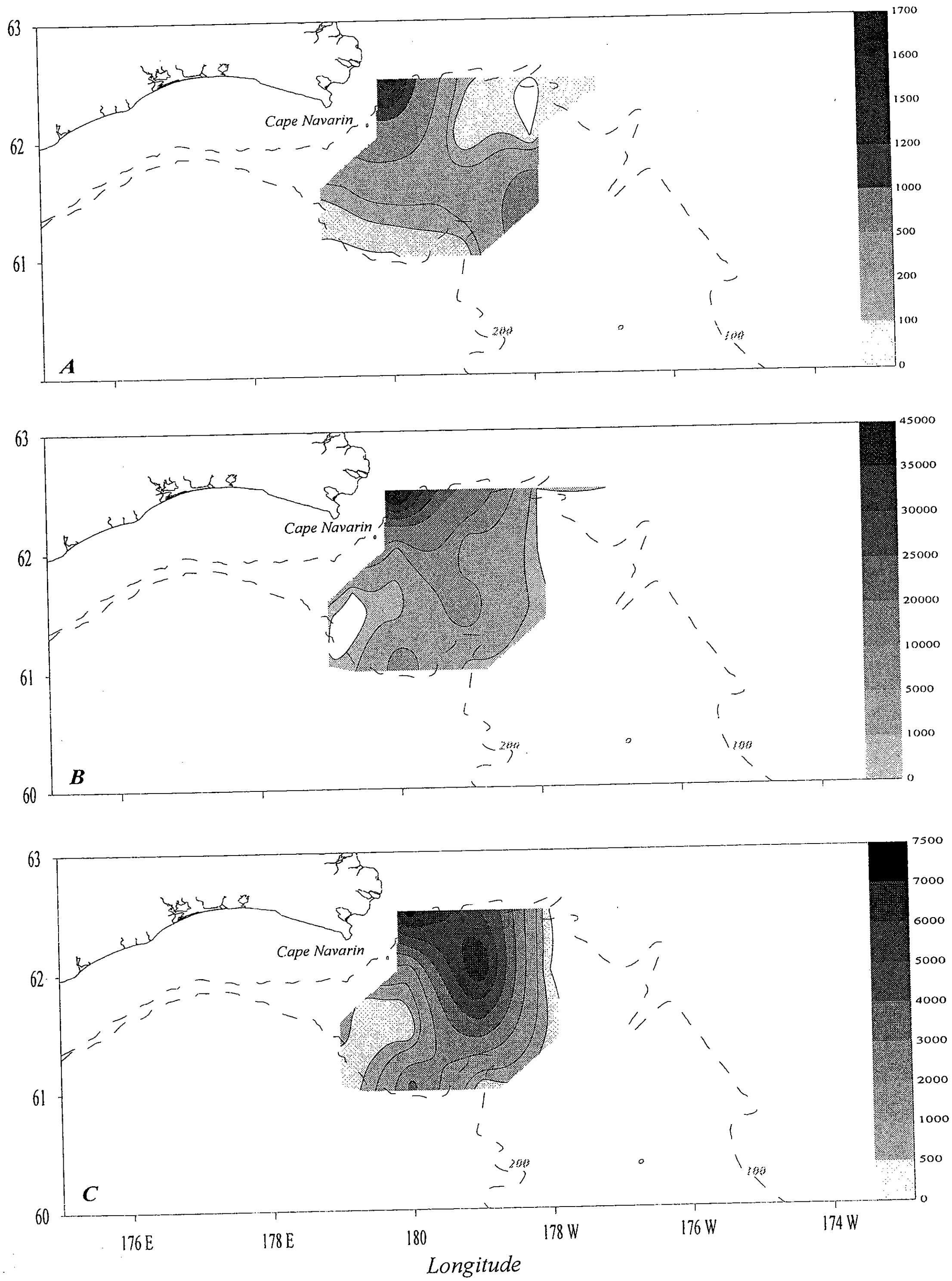


Fig. 2. Spatial distribution of young walleye pollock (fish/hour) in the Navarin area based on juvenile trawl survey in August-September 2002: A ,B,C – 2001, 2000, 1999 year-classes respectively.

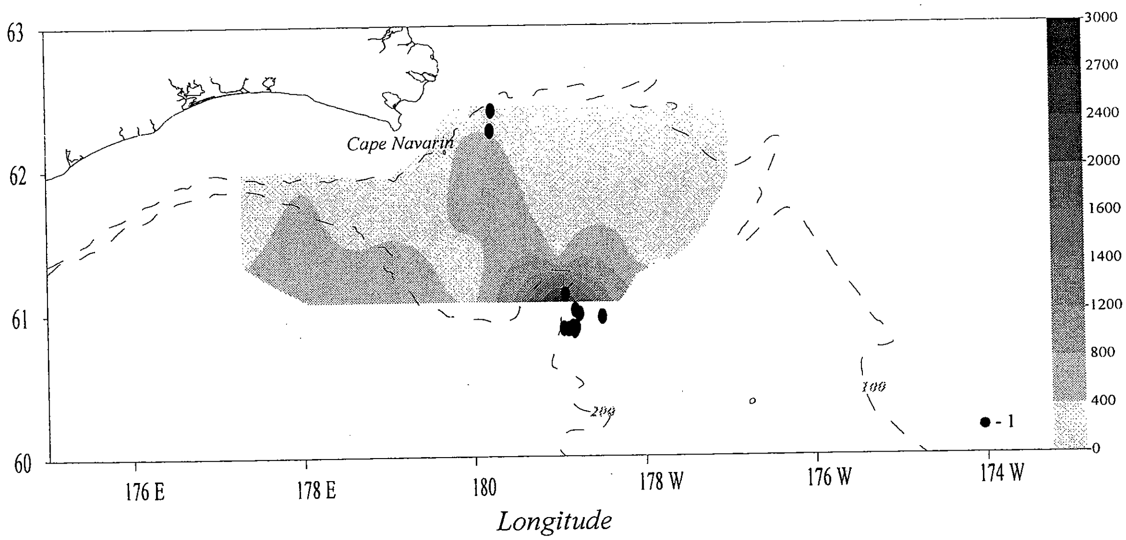


Fig. 3 ~~4~~. Spatial distribution of near-bottom walleye pollock in the Navarin area (fish/hour) by bottom trawl survey in September 2002: 1 – location of control trawl hauls of "*Kaiyo Maru 28*", during commercial fishing.

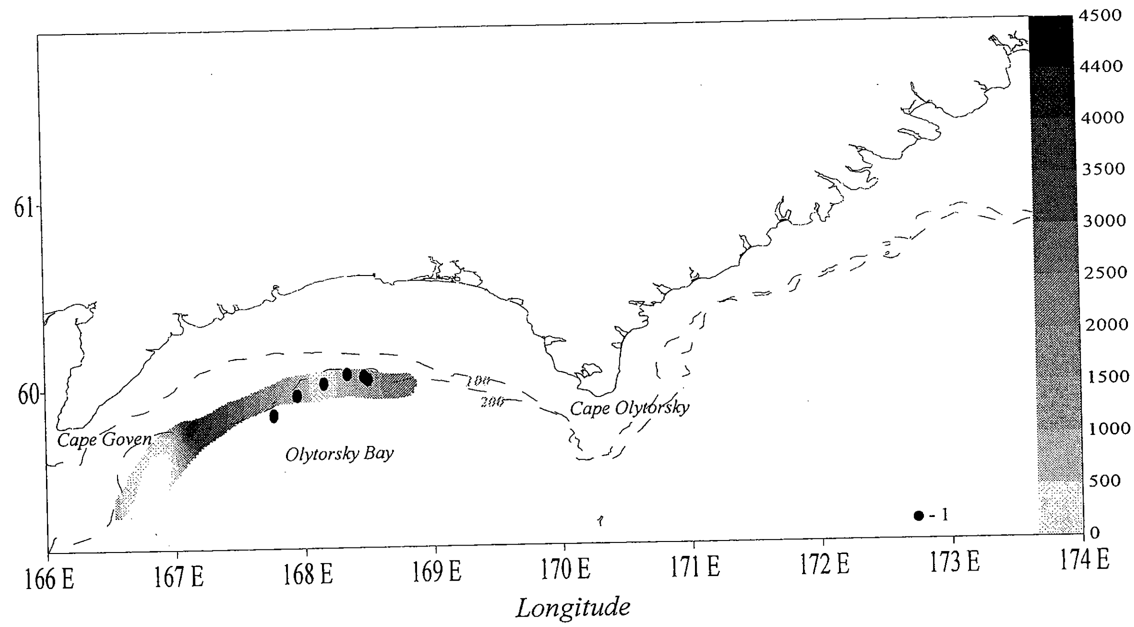


Fig. ~~5~~ 4. Spatial distribution of near-bottom walleye pollock in the Olutorskiy Bay (fish/hour) by bottom trawl survey in September 2002: 1 – location of control trawl hauls of "*Kaiyo Maru 28*", operating in commercial regime.

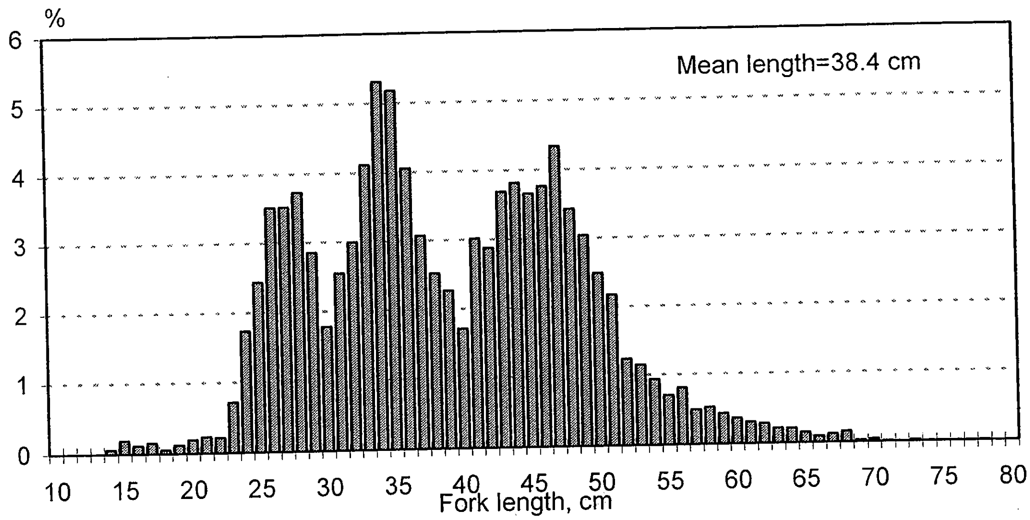


Fig. 5~~**6**~~. Length frequency composition of walleye pollock in *"Kaiyo Maru 28"* samples in the Navarin area in August-September 2002.

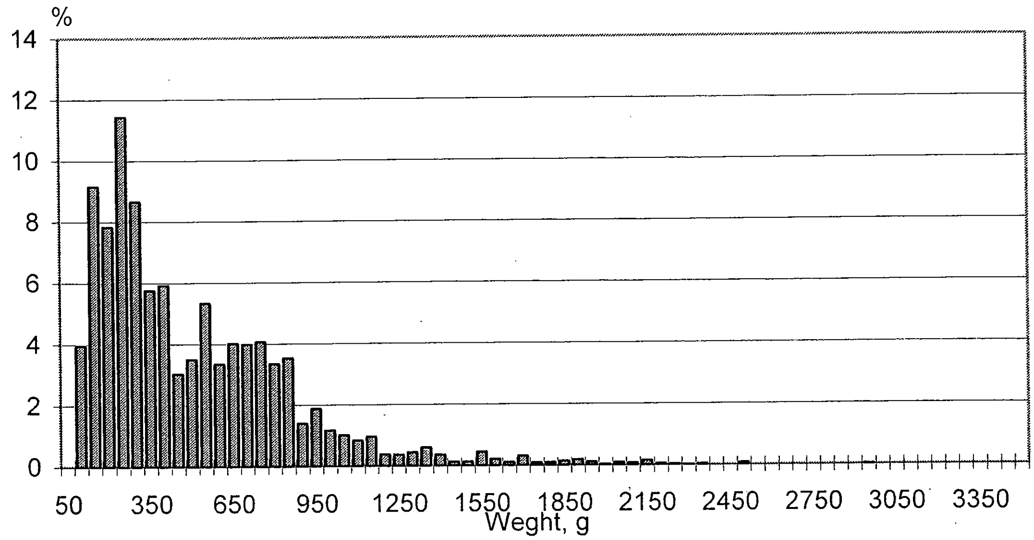


Fig. ~~7~~ 6. Weight composition of walleye pollock in *"Kaiyo Maru 28"* samples in the Navarin area in August-September 2002.

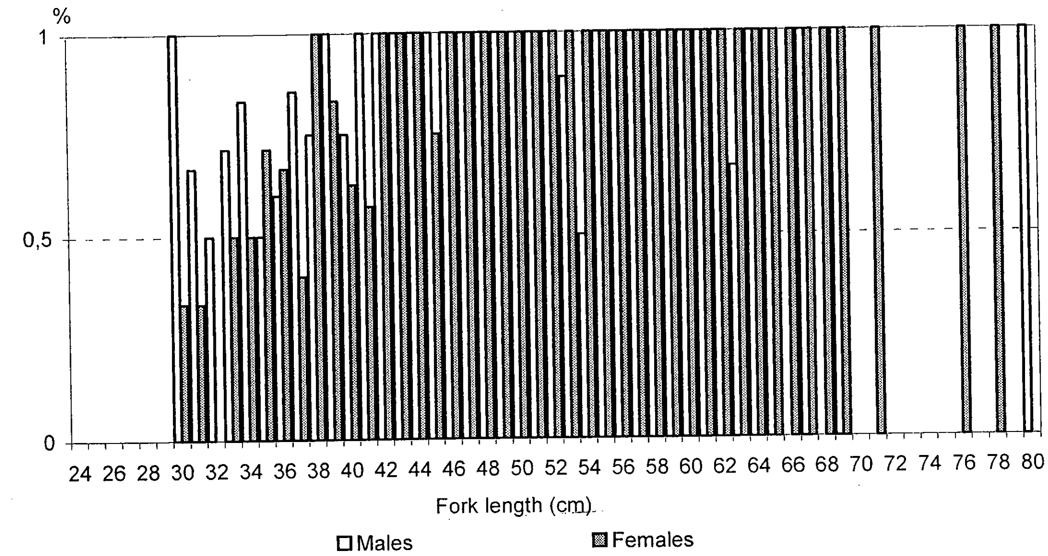


Fig. ~~**8**~~7. Proportion of matured walleye pollock by size in the Navarin area in August-September 2002.