Federal Agency for Fisheries of the Russian Federation

**SOME RESULTS OF ECHOINTEGRATION AND BOTTOM TRAWL
SURVEYS OF WALLEYE POLLOCK (*THERAGRA CHALCOGRAMMA*)
IN THE NORTHWESTERN PART OF THE BERING SEA
ABOARD THE SHIP "PIONER NIKOLAYEVA"
IN OCTOBER-NOVEMBER 2003**

(document is submitted for IX Bering Sea Pollock Conference, Kushiro, Japan, 2004)

By

A.I.Glubokov, S.B.Popov

2004

This cruise was a continuation of a multiannual study of the northwest Bering Sea pollock conducted under the "Program of comprehensive study of the population structure, status of stocks of the northwest Bering Sea pollock, and its role for the current ecosystems in 2001-2005".

The major cruise objectives were:

1.   Biological and biostatistical data collection and machining;

2.   Study of walleye pollock population-genetic stocks structure in the northern and central parts of the Bering sea;

3.   Monitoring of walleye pollock size - weighting structure, biological state;

4.   Walleye pollock distribution data gathering. Estimation of stocks state.

Hydrobionts studies included the following surveys:

- the bottom-trawl survey which consist of 45 trawlings in Navarin 16240 nm^2 polygon area (Fig. 1), was conducted strictly in the daytime, trawlings duration was 30-60 min;

- echo-integration trawl survey in Navarin region and general tracklines expansion of 458.6 nm, were held at no more than 3 balls sea motions.
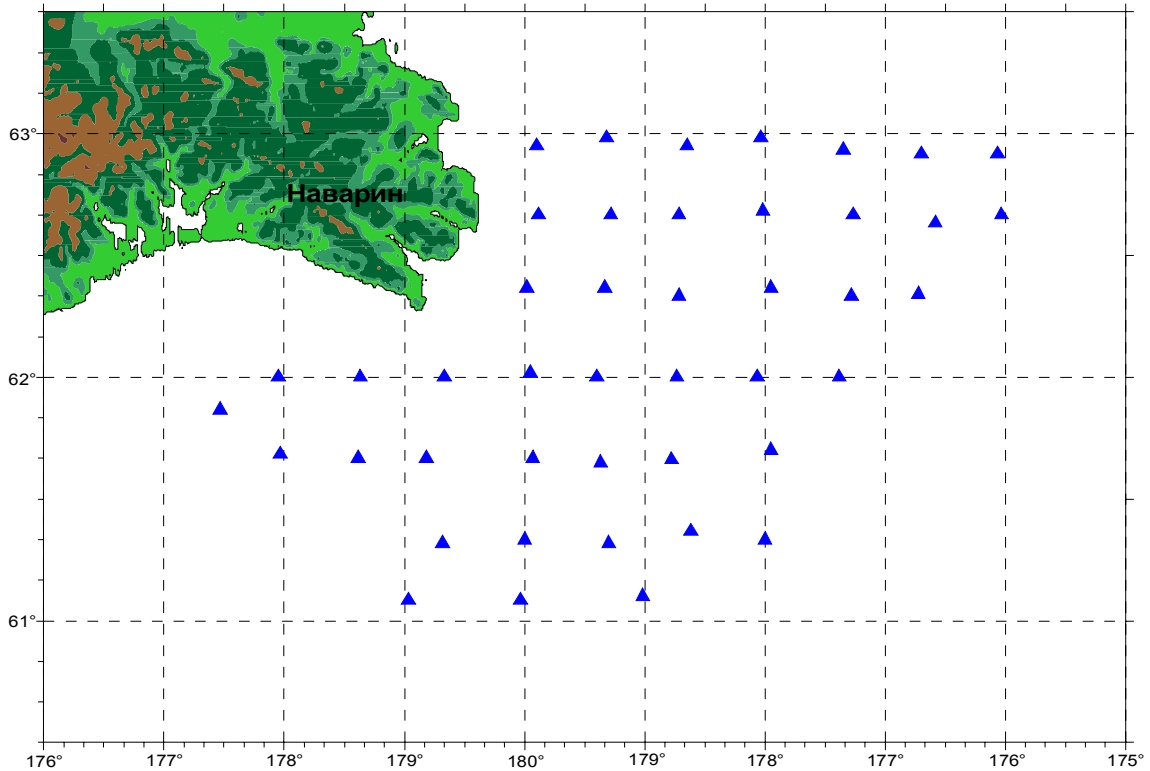
Figure 1. Plot of trawlings places which were made during bottom trawl survey.

For echo integration trawl survey was used specialized complex which included the following software and equipment:

• echo sounder EY500 Simrad (38 kHz) with single beam antenna in the towed body;

• PC, used as management and monitor block of echo sounder;

• GPS receiver produced by Trimble Navigation (USA), connected to echo sounder, which automatically determine vessel coordinates and they are registered together with acoustic data;

• post-processing system EP500 Simrad for echo signals processing.

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

measured distribution plots parameters and to locate significant interesting records.

Hydroacoustic surveys holding methods includes the following standard stages:

• equipment installation on a vessel and checking its functioning;

• equipment calibration using standard copper sphere;

• transects choice and echo survey parameters (vessel speed, transect lines length, control trawling place, elementary sampling distance unit (ESDU) and etc.);

• equipment working parameters choice during survey;

• echo sign directly registration and record;

• survey data processing, echo integration results plotting;

• biomass with a confidence intervals estimation.

Echo sounder antenna was towed from the left board in accordance with the vessel course (depth about 2 m). According to echo sounder methodical recommendations for operation and vessel constructive peculiarities had been chosen 4.5 - 6 knots movement speed.

The choice of transects was determined in accordance with the previouse surveys results, and also with necessity of more detailed surveying in chosen region. Hydroacoustic survey transects have crossed depths about 250 m. Echo sounder EY500 preliminary tests have shown that the signal-to-noise-ratio level at 1 msec pulse (Medium) duration on such depthes has appeared unsufficient. Therefore 3 msec pulse (Long) duration with a narrow band had been chosen. Echo signals record was was held all day and night long with breaks, necessary for control trawls conducting.

Taking into account, that bottom trawl vertical opening was 6 m, it had been made a decision to carry out echo-integration in a pelagic layer, excepting signals from benthonic objects which were estimated at bottom-trawling servey.

Biomass calculation W was made according to a «Hydroacoustic

Surveying Manual» (VNIRO) and with the help of echo processing system EP-500 instruction.

The acoustic data processing technology was based on detailed region stratification principle, taking into account pollock and catch abundance.

Signals calculating was made on EP500 Simrad echo processing system by a echo-integration method. The meanings received as a result of surface back scattering strength Sa (m^2/nm^2) were converted in surface density meanings of one-size group fishes ρ_i (ton/nm^2) using the following general formula:

$$\rho_i = S_a \cdot \frac{f_i}{\sum\limits_1^n f_i \cdot \sigma_i} \cdot \omega_i \cdot 10^{-6};$$

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

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

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

$$\sum\limits_1^n f_i = 1$$

n - size groups amount according to trawling results.

Surface density meanings of all size groups fishes were determined as follows:

$$\rho = \sum\limits_1^n \rho_i$$

In return the acoustic back-scattering cross section was determined through target strength (TS_i, dB) according to the following formula:

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

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

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

During biomass estimation was used selective processing method of acoustic data. The crux of the method is, that all echo-intensity (density),

received in servey region, are distributed on «n» of numerical intervals *(j=1,2,3,..., n - gradation)*. If region area is equal «S», total quantity 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.

For the areas and positions estimation were used cartographical projection formulas of Mercator equiangular cylindrical projection in cylindrical projection with metric coordinates according to referentc-ellipsoid of Krasovsky:

$$X = \frac{111134.86 \cdot \varphi - 16036.48 \cdot \sin\left(\frac{2 \cdot \pi \cdot \varphi}{180}\right) + 16.78 \cdot \sin\left(\frac{4 \cdot \pi \cdot \varphi}{180}\right)}{1852};$$

$$Y = \frac{\left[111508.36 - 187.15 \cdot \cos\left(\frac{2 \cdot \pi \cdot \varphi}{180}\right) + 0{,}19 \cdot \cos\left(\frac{4 \cdot \pi \cdot \varphi}{180}\right)\right] \cdot \cos\left(\frac{\pi \cdot \varphi}{180}\right) \cdot [\lambda - \lambda_0]}{1852}$$

Where: X - meridian arc length (latitude) from equator up to the given parallels (nm);

Y - parallels arc length (longitude) up to the given meridian (nm);

φ - latitude (degrees);

λ - longitude (degrees).

During construction of fish distribution and estimation plane-table, was used «Kriging» geostatistical gridding method recommended by *FAO* called construction of biomass fields distribution by results of EIT surveys.

Fish biomass aggregations can be presented as:

$$W = \sum_{1}^{n} W_j = \sum_{j}^{n} \rho_j \cdot S_j;$$

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

n – gradation or region parts number.

Dispersion of density meaning $([ton/nm^2]^2)$ in each gradation:

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

where: ρ_j - density meaning, appropriate «j»-*th* gradation,

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

where: ρ_i - current density meaning in «j»-*th* gradation, *(tons/nm²);*

      m_j - counting out numbers, appropriate «j»-*th* gradation.

Fish biomass estimation error in all region was calculated according to the following 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.

Acoustic data were collected using Simrad EY500 echo-sounding system operating at 38 kHz. Acoustic system specifications during the present servey were the following:

- output power – 250 W;
- pulse duration - 3.0 ms (Long);
- band width - narrow (0.38 kHz);
- absorption loss coefficient - 10 dB/km;
- TVG function - 20LogR;
- TS threshold = -60 dB;
- Sv threshold = -70 dB;
- sound velocity - 1490 m/s.

The echo sounder was calibrated using 60 mm copper standard sphere with a TS of –33.6 dB using the technique described by Foote et al. (1987). Measurement

of noise level during various vessel movement speeds was made according to echo sounder EY500 methodical work instructions. It has been chosen 1.0 nm integration interval.

The information concerning fishes specific and size - mass structure was taken from control pelagic trawlings data and bottom trawl survey data.

The general walleye pollock biological characteristic.

In 2003 year walleye pollock was located on depths up to 300 m, which is traditional for this area and season.
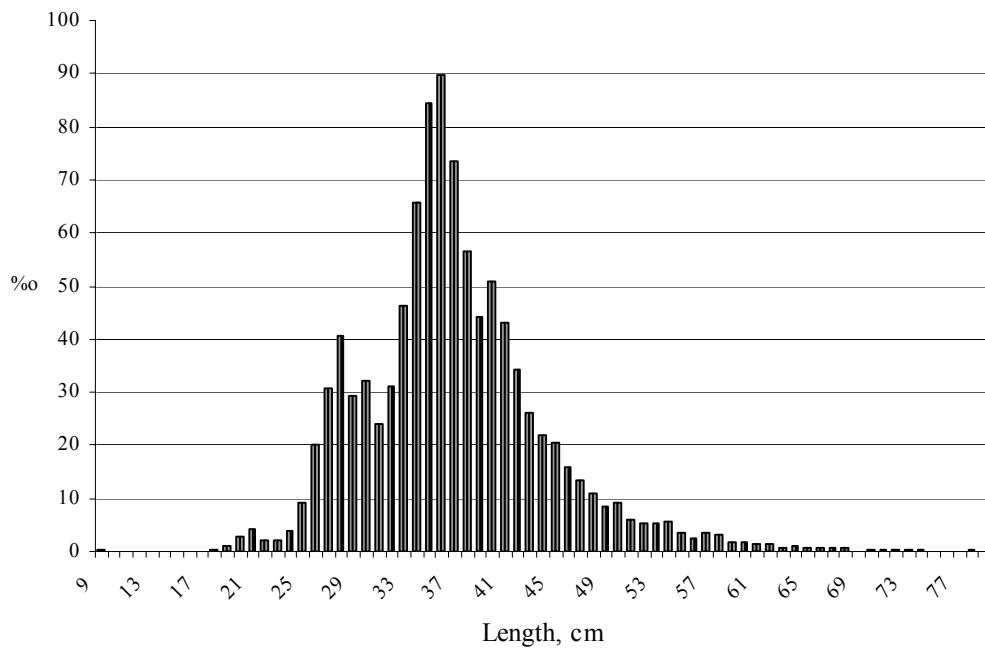

Figure 2.   Length frequency of walleye pollock based on bottom trawl survey data, October 27 – November 09, 2003.

During the bottom trawl survey, which was carring out from the end of October – till the first decade of November, were caught walleye pollock fork

length from 9 up to 79 cm. The greatest modal group has been introduced by 2000 year generation walleye pollock (35-37 cm).

Also in catch was numerous walleye pollock of 2001 year generation (27-30 cm). In size series 2002 year generation was noticeable (20-21 cm) and 1999 year generation was insignificantly outlined (40-41 cm) (Fig. 2). According to 2002 year summer-autumn surveys 2000 year generation has maximal number among 1997-2001 years generations. 2001 year generation has second place.

Walleye pollock mass varied from 3.2 up to 3650 g limits, averaging 1149. Body mass dependence on a length is well approximated by equation: $W=0.00323 \times L^{3.206}$, where: W - weight (g); L - fork length (cm). The correlation coefficient is equal 0.977 (Fig. 3).
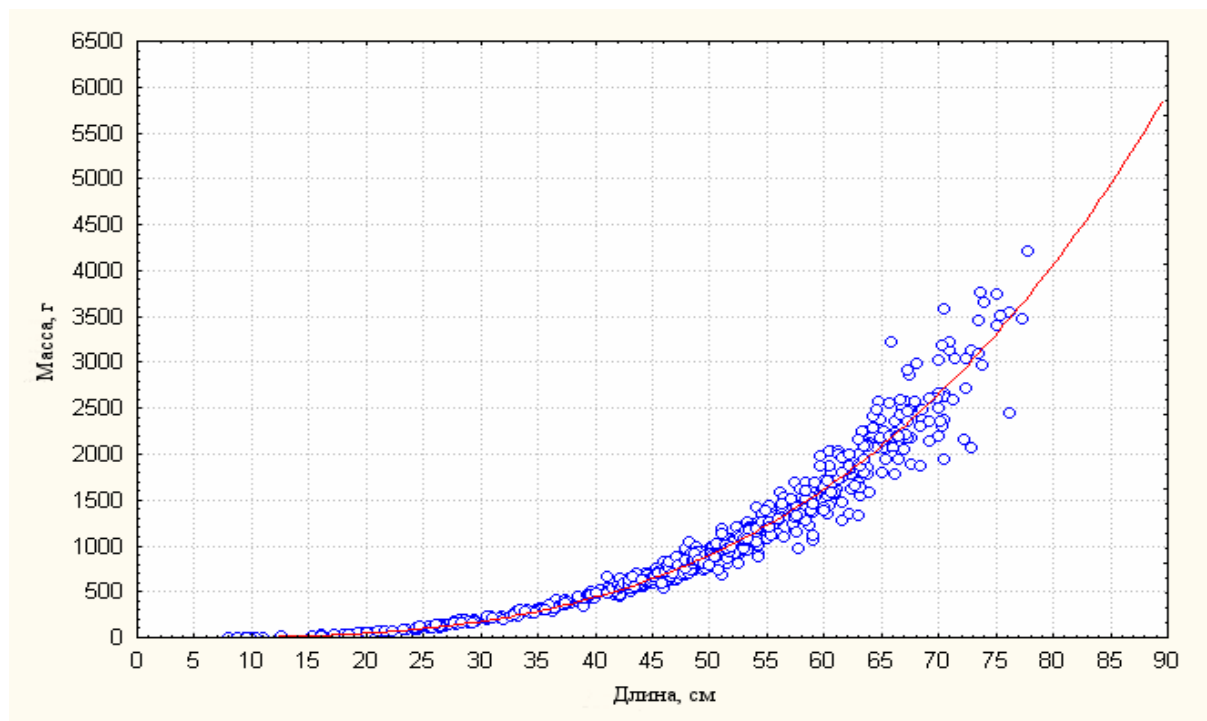

Figure 3.   Walleye pollock weight dependence from length.

During survey females and males ratio in bottom trawl catch was 635:365, accordingly.

Among mature females prevails gonads of III - 41.1, II-III - 19.2 and IV - 18.3 % maturity stages. Males surpass females on gonadogenesis velocity. Among them prevails the following gonads of - IV - 35.4, III - 24.6 and III-IV - 18.5% maturity stages.

Table. 1. Walleye pollock biological characteristics based on the bottom trawl survey data, October 27 – November 2003.

Average length, cm/number of measurements		37.03/11326
min – max		9 - 79
Mode		20-21, 27-30, 35-37
Average weight, g		1149
min – max		3.2 - 3650
Portion of males, %		36.54
Prevailing stages of maturity, %	females	II-III – 19.2; III – 41.1; IV – 18.3
	males	III - 24.6; III-IV – 18.5; IV - 35.4
Relative stomach fulness index, ball		0.74
Portion of empty stomaches, %		62.66
Prevailing food organisms, %		pollock – 55.7; shrimps – 35.1
Morfophysiological parameters of mature fishes		
Cubic condition factor		0.613±0.003
GSI, %	females	3.79±0.17
	males	4.84±0.29
Index of liver, %	females	7.43±0.17
	males	6.41±0.22
Index of heart, %	females	0.238±0.003
	males	0.233±0.004
Index of spleen, %	females	0.190±0.005
	males	0.207±0.007
Numbers		367

Note: the average length is specified according to the mass measurements results , average weight - in accordance with biological analysis results.

At the end of October – in the beginning of November walleye pollock gonadosomathic index (GSI) was 3.79 and 4.84% among females and males, accordingly.

Females liver index was higher, than males, it was 7.43 firstly and 6.41% secondly. Males and females heart index had similar magnitudes, and males spleen index was higher (Table. 1).

In the autumn 2003 walleye pollock feeding intensity was low. In the middle of autumn relative stomach fulness index average score was 0.78. In connection with the fact that in October - November in Navarin region were forming young fishes of walleye pollock abundance, during this period among mature individuals is hardly developed cannibalism. Individuals of the same kind reoccurrence in walleye pollock stomaches was 55.7 %. Body length of preys varied from 7 up to 32 cm. Shrimp was the second entity that was dominanted in feeding. It is marked in 35.1 % of the charged stomaches.

Walleye pollock benthic biomass abundance according to the results of the bottom trawl survey.

Walleye pollock benthic estimated value in harbour area of 16240 nm^2 has been 589 000 tons (coefficient of catchability 1.0). This meaning is consider to be the greatest starting from 1997 year. However in comparison with identical 2002 and 2003 region, in the current year will be received 12% decrease of biomass.

Spatial distribution of benthic walleye pollock on survey area.

Walleye pollock distribution in the northwestern part of the Bering sea has irregular character. According to longstanding complex researches data the basic abundance of walleye pollock population from the northwestern part of the Bering sea is centred in Navarin region where during the year were conducted multiple surveys. Basic walleye pollack abundance is formed in quasistationary eddies area to the east from Navarin cape. This fact is connected with favourable hydrological conditions for zooplankton and other walleye pollock feed development and concentration in this place. Also here are the

favourable conditions for spawning and an early ontogenesis. In October - November, 2003 during survey maximum sustainable catches (from 11.4 till 16.3 tons per one hour trawlings) have been marked in the northen parallel 62^020 area between 178^040 W - 179^020 W. And in the places with the following coordinates 62^000 N, 179^020 W, - 61^005 N, 179^000 W (Fig. 4). Due to warm weather and as the result the retained water warmup and feed availability, walleye pollock was stocker in the central – northen part of Navarin region. During survey walley pollock abundance began to displaced at great depths to a wintering area (Fig. 4).
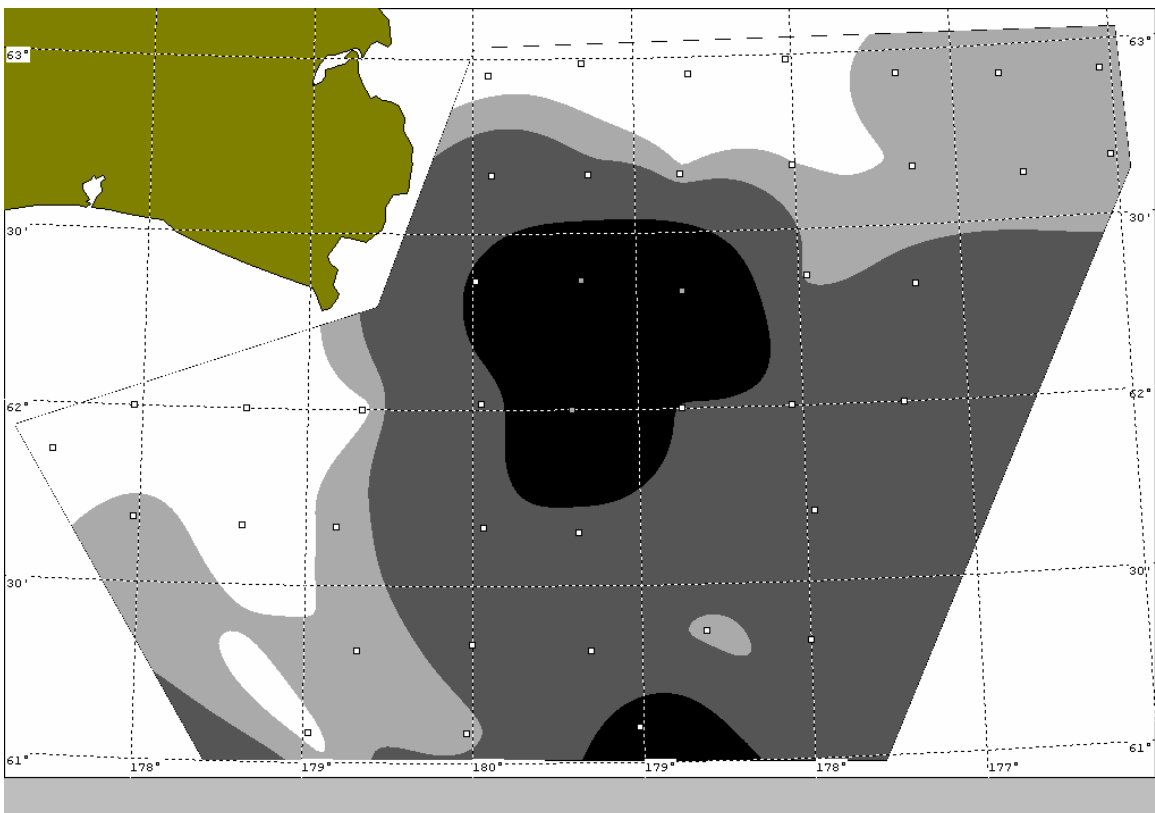

Figure 4.   Plot of walleye pollock distribution in Navarin region of the Bering sea in accordance with bottom trawl survey data, October 27 – November 09, 2003.

In 2003 walleye pollock catches were distributed uniformly in survey area: in 76 % of events catches exceeded one ton during an hour trawlings. Low catches are marked in the north-eastern region part on 62-th parallels and in a

central part of the most northen section which was located on 63-th parallels, between 180^0 and 178^0 W.

Pollock pelagic biomass and it's distribution (spatial, bathymetric) according to echo integration trawl survey data.

The most dense abundance of pollock have been fixed in coordinates 61º40´N, 179º01´E; 62º20´N, 178º04´W and 61º14´ N, 179 º16´W (Fig. 5). Surface back scattering strength on these sites was about 2868.1 m^2/nm^2 (290.3 tons/nm^2), 3077.6 m^2/nm^2 (273.7 tons/nm^2) and 4113.1 m^2/nm^2 (412.5 tons/nm^2), accordingly. These abundance density exceeded the similar 2002 year parameters.

Echo integration in other polygon's part also has shown density growth of registered abundance in comparison with the last year. Surface back scattering strength values were limited by 500-1000 m^2/nm^2, average value - 866.4 m^2/nm^2 (79.5 tons/nm^2). The average surface back scattering strength meaning which was received as the result of 2002 year echo integration of survey was 342 m^2/nm^2 (28.4 tons/nm^2).

Bathymetric pollock distribution was strongly depended on day time. Pollock echo records have been marked in horizon 70 - 300 m. During light time pollock was concentrated and registered in a benthic layer. However pelagic abundance was not pressed to the ground, and were registered in layer 10 - 20 meters above bottom. The abundance was about 40 m vertical size. During dark time pollock abundance dispersed, rising above to pelageal where was mixed up with herrings (*Clupea pallasi*). The basic pollock part did not rise above 50 m from sea level, and dispersed herring abundance did not fall below this horizon. This fact allowed to execute specific night records selection with the least mistakes. Besides pollock and a herring abundance in 20 - 70 m horizon have been marked capelin and jellyfishes abundance which have been excluded from the analysis during received echogramm post processing.

During pollock superficial density estimation has been used weight on length depences equation (Fig. 3). Received variogramm is presented in figure 5. Changes limits of superficial pollock density accoording to the echointegration results were the following: from 2.5 up to 412.5 tons/nm^2 (average: 79.5 tons/nm^2; standard deviation was 65.8 tons/nm^2).
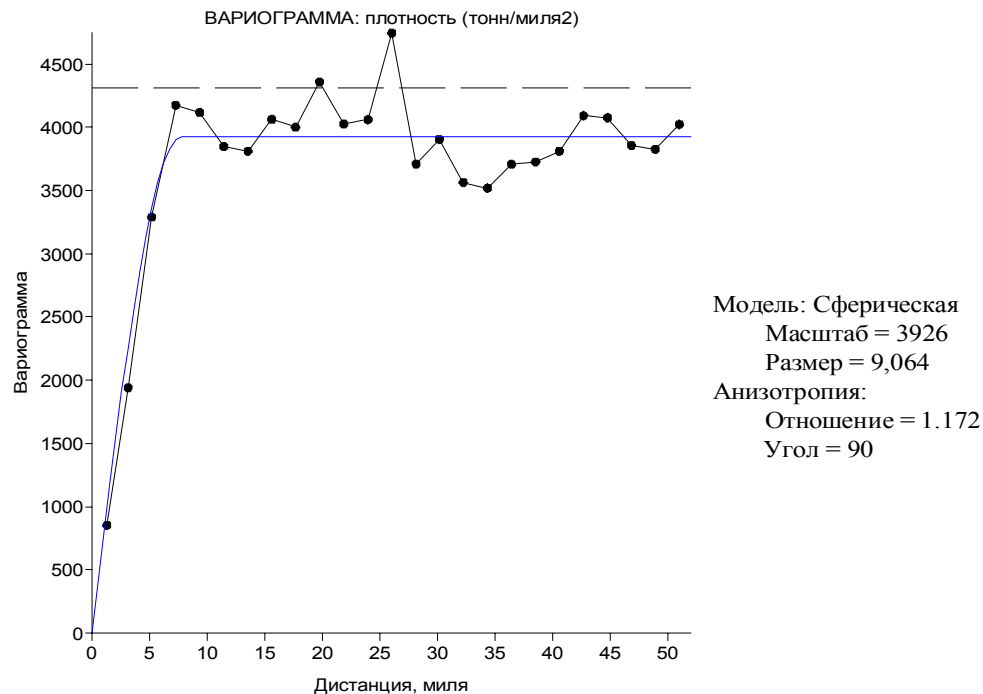

Figure 5.   Variogramm of meanings of pollock superficial density.

In Figure 6 are presented plot of pollock biomass distribution in mid water layers according to the results of hydroacoustic survey and biomass calculation.

Pollock biomass based on echointegration trawl survey on 8897 nm^2 area was: 667000 tons.

In October, 2001 estimated pollock biomass was 187000 tons on 8897 nm^2 area.

In October, 2002 on the same testing area pollock biomass according to hydroacoustic survey was 264000 tons. Thus, the biomass estimation in

comformity with 2003 year hydroacoustic survey results exeeded the previous results in 3.57 and 2.52 times, accordingly.

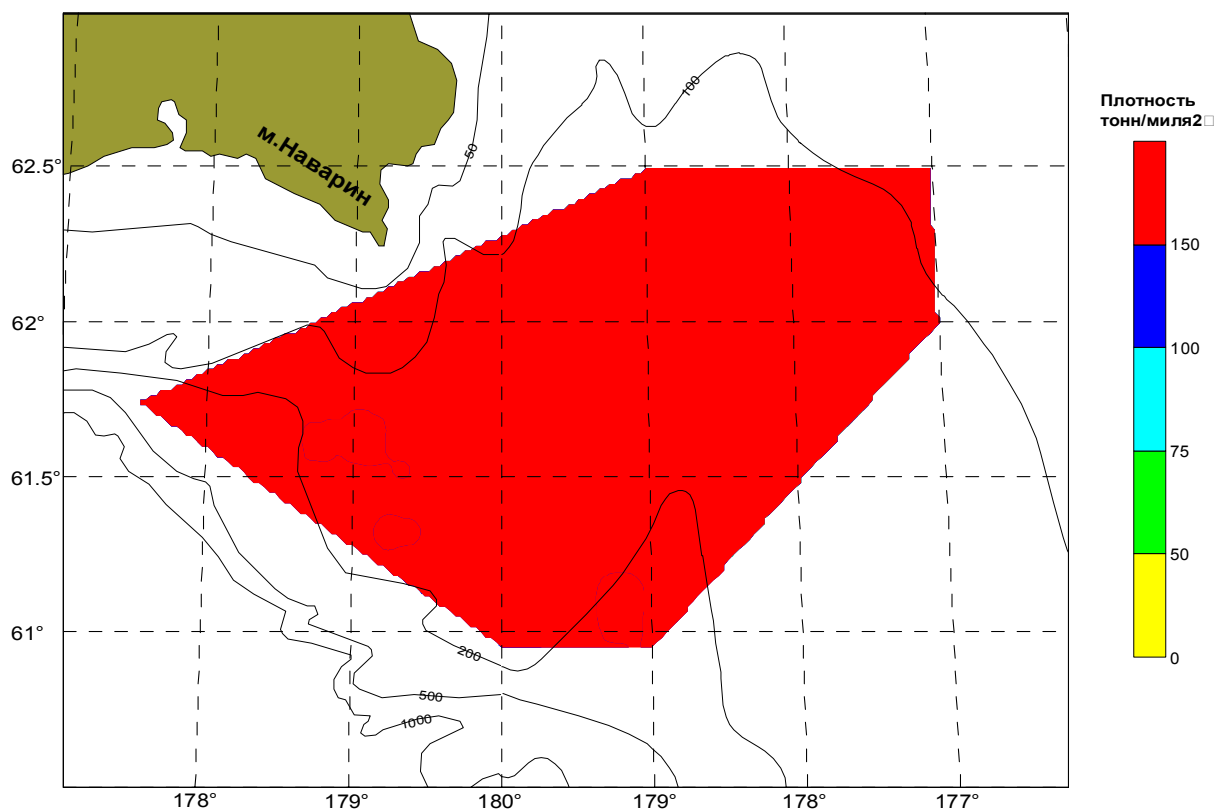The total ground and pelagic pollock biomass during the last 3 years annually has been increasing on 54-49%.

Figure 6.   Plot of distribution of pollock area density (tons/nm^2) of hydroacoustic surveys, carried out in Navarin region, October 27 – November 01, 2003.

Juvenile pollock characteristic from Navarin region.

According to the results of fry pollock measuremments which have been caught during survey, length frequency of walleye pollock were constructed (Fig. 2). Modal groups comparison with cameral definition data of juvenile pollock has allowed to reveal individual lengths fluctuation limits of different age groups.

The maximum 0-year class pollock quantity (2003 year generation) has been marked in the central part of Navarin region in the place with the following coordinates: 62º40 N, 178º00 W. At the end of October - the first decade of November, 2003 the length of 0-year class pollock varied within 8-13 cm limits, averaging 9.73 cm. Weight - from 3.2 up to 10.8 g, on the average - 6.1 g. All 2003 year generation individuals were nonmature. Females and males ratio was equal.

Liver index was low - 3.44 % ,which is typical for early ontogenesis as during this period basic feed power resources go on organism proteins growth without formation of significant power resources in depot organs (liver). In feed prevailed Calanidae and fine Euphausiidae.

Individuals of the 2002 year class maximal catch was marked in a point nearest to the southwestern coast of Anadyr bay, in coordinates 62º40 N, 179º53 W. The second quantity of two years old individuals catch has been marked in the central part of the most northern transect which was located on 63º00 N.

During autumn period 1-year class individuals had length from 15 up to 23 cm at 21.01 cm average value and mode 20-21 cm. 1-year class females average weight was 50.4 g, males - 55.0 g (Table. 2). This was the only generation where males prevailed. Their share was 64.00%. Among both sex dominated individuals with gonads of II maturity stage, among this generation mature individuals were not marked.

In connection with gradual growth delay among 1-year class individuals in comparison with 0-year class fish, have increased cubic condition and liver indices. This fact testifies to the beginning of power resources reserve formation.

Among 1-year class individuals feed as well as among 0-year class fishes prevailed Euphausiidae. 2002 generation was the youngest among which was fixed cannibalism. 10% two years old pollock fed at 7 cm length juvenile fishes of the same kind.

Table. 2. Walleye pollock generation 1999-2003 biological characteristics, October – November 2003.

Generation		1999	2000	2001	2002	2003
Average length, cm/number of measurements		41.06/2496	35.35/5064	28.26/2159	21.01/151	9.73/22
min – max		39 - 44	32 – 38	24 – 31	15 - 23	8 – 13
Mode		40	35 – 37	27 – 30	20 – 21	9
Average weight, g	Female	558.2	314.8	146.4	50.4	6.1
	Male	538.0	312.5	152.1	55.0	
min – max	Female	343 - 705	199 – 354	93 – 232	23.4 – 75.0	3.2 – 10.8
	Male	385 - 660	202 – 414	82 – 222	34.0 – 83.0	
Portion of males, %		42.00	50.00	40.00	64.00	50.00
Prevailing stages of maturity, %	Female	II-III – 44.7 III – 40.4	II – 81.0	II – 96.7	II – 88.9	I-II – 100.0
	Male	II-III – 20.6 III – 50.0 III-IV – 17.6	II – 61.9; II-III – 28.6	II – 90.0	II – 75.0	I-II – 100.0
The relative stomach fulness index, ball		0.75	0.43	0.84	0.60	0.67
Portion of empty stomaches, %		51.20	73.81	46.00	60.00	50.00
Prevailing food organisms, %		pollock-55.0 (7-12 cm); shrimps-32.5	Euph.-54.5; pollock-45.5 (6-12 cm)	Euph.-63.0; pollock-11.1 (9-11 cm)	Euph.-60.0; pollock-10.0 (7 cm)	Calanids-66.7; Euph.-33.3
Cubic condition index		0.628±0.005	0.633±0.006	0.635±0.007	0.593±0.009	0.554±0.014
GSI, %	Female	1.90±0.13	0.68±0.09	0.38±0.02	0.37±0.04	-
	Male	2.89±0.39	0.80±0.28	0.40±0.27	-	-
Index of liver, %	Female	8.75±0.31	8.51±0.35	8.11±0.52	5.32±0.65	3.44±0.34
	Male	7.36±0.27	8.61±0.54	7.91±0.40	5.55±0.41	
Index of heart, %	Female	0.230±0.006	0.249±0.010	0.236±0.007	0.220±0.011	-
	Male	0.229±0.008	0.237±0.010	0.236±0.008	0.236±0.019	-
Index of spleen, %	Female	0.173±0.006	0.156±0.009	0.135±0.007	0.150±0.019	-
	Male	0.177±0.009	0.168±0.011	0.138±0.009	0.108±0.021	-
Numbers		81	42	50	25	15

Note: the average length is specified according to the mass measurements results , average weight - in accordance with biological analysis results.

2-year class individuals (2001 year generation) according to survey in the 2002 year had number above average. They were presented in appreciable

quantities in scientific - trade catches, which testifies that quantity of this generation individuals continued to remain on the high level.

During studing period 2-year class individuals had length from 24 up to 31 cm at 28.26 cm average value and 27-30 cm mode. The average weights were the following: females - 146.4, males - 152.1 g. Among 2-year class individuals insignificantly prevailed females - their share was 60%. Both sex individuals were unmature. In autumn 2-year class individuals cubic condition index in accordance with Clark has reached values which is characteristic for an adult pollock (Table. 2). This fact confirms that proportion achievement between growth lengthways and in width is the same as for mature fishes have (Table. 1, 2). 1-year class and 2-year class individuals grow mainly lengthways.

In connection with absence of mature fishes among 2001 year generation, gonadosomatic index continued to remain low: 0.38-0.40%. Liver index, as well as cubic condition index, had values close to mature fishes average indices.

In feed of 2-year class fishes the share of the same kind individuals continued to increase. Thus, as well as 1-year class fishes, 2001 year generation individuals ate 0-year class fishes.

In autumn, 2003 3-year class pollock individuals (2000 year generation) constitutes pollock abundance basis in Navarin region. First of all, this generation has provided pelagic pollock biomass growth: 2-year class individuals weight grows in 2.05 - 2.15 times a year (Table. 2). According to fry survey which was held in 2002 year this generation had the maximal number for the 5-years study period. In connection with high number of 3-year class individuals their spatial distribution determined the general pollock distribution in Navarin region.

In October - November 3-year class individuals had length from 32 up to 38 cm at 35.35 cm average value. For the first time from the moment of birth the average females weight has exceeded average males weight which is typical for mature fishes. This age class males share in catches was 50%. Prevailing

gonad maturity stage among both sexes remained II. At the same time some individuals of this generation have started to mature, due to that, average gonadosomatic index has increased. However the share of the first time maturing males of this age class was insignificant, and females was insignificant small.

3-year class individuals cannibalism intensity has achieved parameters close to mature fishes - 45.5%. The size of body preys has been 6-12 cm. This generation individuals feed activity as a whole was minimal (stomaches filling average score - 0.43) among other generations juvenile fishes. This fact confirms the high number presence of 2000 year generation individuals, due to that the feed competition is the highest.

In Navarin region population of 1999 year generation had average number. This generation individuals have been concentrated in the central part of survey polygon and in its southeast part on 140-150 m depths in area 61º20-61º40 N, 178º00 W - 178º40 W.

In autumn average length of this generation pollock was 41.06 cm, modal group - 40 cm. Share of this generation males was lower than females: 42.0%. 40.4% females had mature gonades at III stage, 50% males had gonades of the same maturity stage. Feed activity in comparison with the previous age class has increased. Pollock occurance in stomaches was 55%.

The conclusion.

In 2003 in the North Bering sea was proceeded biomass growth of walley pollock population. For the first time since 1996 the total biomass size on the survey polygon has exceeded one million tons.

The biomass increase is consider to be the consequence of the following reason:

1. Since 2000 in Navarin region supertrawlers has not been working.

2. Since June 1998 has been established the minimal allowed size of mesh during walley pollock trawling trade - 100 mm; for West Bering sea zones is established the pollock trade measure - 35 cm; since 2000 in the Western Bering sea zone special pollock fishing during spawning period is prohibited; also has been introduced minimal daily catch estimates for a vessel day of fishing by the type of boat, fishing gear and areas.

3. Now in the northern and eastern parts of Bering sea climate-oceanologic conditions are very favorable for pollock. Therefore in 1999, 2000 and 2001 years very enomerous generations appeared.

In 2003 year filling of ground pollock ecotope was resulted in increase of its biomass in pelagic layers.