**Contents**

**Federal Agency of Fisheries Russian Federation**

**Pacific Research Fisheries Centre (TINRO-centre)**

# STATUS OF STOCKS AND REPRODUCTION OF THE EASTERN BERING SEA POLLOCK (*Theragra chalcogramma*) IN 2003-2005

(document submitted for Workshop on the Determination of allowable Harvest Levels and Genetics Research on Pollock Resources in the Central Bering Sea, Seattle)

By

Stepanenko M.A. and A.V. Nikolaev

2005

The trend of Eastern Bering Sea pollock biomass increasing were stable by the end of 1990-s and early 2000-s as result of annual recruitment by average 1995, 1997-1999 and numerous 1996, 2000 year classes. Pollock biomass had increased for 61% in period 1996-2002.

The oceanology condition and pollock spatial distribution were close to average at first part of 1990-s. Some signs of cooling had appears in the Bering Sea by the end of 1997 and it have maximum in 1999. At the same time, cold period in the Bering Sea was short and new warming process began in 2001-2002. The high positive water temperature anomaly observed in the Bering Sea in 2003-2004.

There is direct interrelationship between distribution of pollock and variability of oceanology condition, basically of water temperature, in summer-autumn time. Distribution of pollock in the northwestern Bering Sea have big scale interannual variability depends of changing water temperature. Scale of pollock distribution into northwestern Bering Sea much higher in period warm oceanology condition.

Indicated interrelationships between interannual variability of the Eastern Bering Sea pollock spatial distribution, biomass (5.0 - 9.0 mln.t) and changing oceanology condition were observed in period between middle 1990-s and early 2000-s.

Spatial distribution of the Bering Sea pollock in feeding period depends on it abundance and biomass, age composition and environmental condition. The eastern Bering Sea pollock usually distributed very widely at shelf and deep water Aleutian and Commandor basin in periods of it high abundance (12.0-15.0 mln.t).

The eastern Bering Sea pollock biomass decreased to about 5.5-6.0 mln.t in middle 1990-s but by the end of 1990-s it increased again on behalf of new relatively abundant year classes.

Interannual variation of pollock abundance and biomass in the Navarin area also very significant as indicated by bottom trawl and echointegration survey data (Table 1).

Table 1

Estimated of walleye pollock abundance and biomass in the Navarin area in 1996-2002 (by EI MWT and BT surveys data)

| Year | Bottom ** | | | Midwater | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | S ($mile^2$) | N (mln.fish) | B (ths.t) | S ($miles^2$) | N (mln. fish) | B (ths.t) | N (mln.fish.) | B (ths.t) |
| 1996 | 18500 | 1158 | 390 | 17520 | 769 | 259 | 1927 | 649 |
| 1997 | 24050 | 1004 | 333 | 27036 | 1323 | 250 | 2327 | 583 |
| 1998 | 15820 | 962 | 390 | 13640 | 234 | 71 | 1196 | 461 |
| 1999 | 32663 | 532 | 250 | 12688 | 291 | 70 | 823 | 320 |
| 2000 | 22400 | 203 | 64 | 15420 | 365 | 54 | 568 | 118 |
| 2001 | 38027 | 1642 | 384 | 22380 | 218 | 32 | 1860 | 416 |
| 2002 | 42146 | 938 | 215 | 14040 | 672 | 58 | 1610 | 273 |

** Estimates of biomass off bottom in 1997-1999, 2001- 2002 by BT surveys (K=1.0), in 2000 by EI MWT survey

As a rule, pollock abundance and biomass have high long term and short term interannual variability everywhere in the North Pacific. By the end of 1980-s and early 1990-s had appeared stable trend decreasing of most pollock populations abundance . Biomass of the eastern Bering Sea pollock decreased to 5.5-6.0 mln.t in middle 1990-s. The Eastern Bering Sea pollock stock is neither overfished and it biomass increased (8.0-9.0 mln. t) by the end of 1990-s and early 2000-s (Table 2).

The AFSC pollock biomass estimate by bottom-trawl (BT) survey for 2003 is very high – 8.51 mln. tons, an increase of 77 % from the 2002 estimate of 4.82 mln. tons. The echo-integration trawl (EIT MWT) survey biomass for 2002 is 3.6 mln. tons.

The time series of survey estimates suggest an increasing trend of pollock biomass in the southeastern Bering Sea by the end of 1990-s and early 2000-s.. Interannual variability of biomass estimates is due to the effect of year class variability. (NPFMC Bering Sea/ Aleutian Islands SAFE document, 2003).

The annual catch of pollock in the Bering Sea have varies depends of pollock abundance and biomass and recently have stable trend for increasing (Table 3).

The annual eastern Bering Sea pollock recruitment and spatial distribution of mature and immature fish also variates significantly

Table 2

Biomass of the eastern Bering Sea pollock in 1979-2004, mln.t (according to AFSC data)

| ***Year*** | ***Survey data*** | | | |
|---|---|---|---|---|
| | ***BT,shelf*** | ***EI, shelf*** | ***EI, Bogoslof*** | ***Total*** |
| 1979 | 2.00 | 1.550 | - | 3.55 |
| 1980 | 0.99 | - | - | - |
| 1981 | 2.27 | - | - | - |
| 1982 | 3.54 | 4.640 | - | 8.18 |
| 1983 | 4.81 | - | - | - |
| 1984 | 3.96 | - | - | - |
| 1985 | 4.36 | 5.450 | - | 9.82 |
| 1986 | 4.31 | - | - | - |
| 1987 | 5.03 | - | - | - |
| 1988 | 5.94 | 4.160 | 2.400 | 12.50 |
| 1989 | 4.78 | - | 2.100 | - |
| 1990 | 7.70 | - | - | - |
| 1991 | 5.10 | 1.400 | 1.300 | 7.80 |
| 1992 | 4.30 | - | 0.980 | - |
| 1993 | 5.50 | - | 0.680 | - |
| 1994 | 4.98 | 2.760 | 0.540 | 8.28 |
| 1995 | 5.41 | - | 1.020 | - |
| 1996 | 3.20 | 2.239 | 0.682 | 6.12 |
| 1997 | 3.03 | 2.590 | 0.390 | 6.01 |
| 1998 | 2.21 | - | 0.490 | - |
| 1999 | 3.57 | 3.290 | 0.480 | 7.34 |
| 2000 | 5.13 | 3.05 | 0.301 | 8.48 |
| 2001 | 4.1 | - | 0.232 | - |
| 2002 | 4.81 | 3.60 | 0.227 | 8.63 |
| 2003 | 8.5 | - | 0.198 | - |
| 2004 | 3.75 | 3.31 | - | 7.06 |

Table 3

Catch of the Bering Sea pollock in 1984-2004, ths. m.t. (according to AFSC and TINRO data)

| **Year** | ***EBS shelf*** | ***Bogoslof I.*** | ***WBS shelf*** | ***Aleutian Basin*** | ***Aleutian Islands*** | ***Total*** |
|---|---|---|---|---|---|---|
| 1984 | 1092.05 | - | 503.0 | 181.20 | 81.80 | 1858.0 |
| 1985 | 1139.67 | - | 488.0 | 363.40 | 58.70 | 2049.8 |
| 1986 | 1141.99 | - | 570.0 | 1039.00 | 46.60 | 2797.6 |
| 1987 | 859.41 | 377.40 | 463.0 | 1326.30 | 28.70 | 3054.8 |
| 1988 | 1228.72 | 87.80 | 852.0 | 1395.90 | 30.00 | 3594.4 |
| 1989 | 1229.60 | 36.00 | 684.0 | 1447.60 | 15.50 | 3412.7 |
| 1990 | 1455.19 | 151.60 | 232.0 | 917.40 | 79.00 | 2835.2 |
| 1991 | 1217.30 | 264.70 | 178.0 | 293.40 | 78.60 | 2037.3 |
| 1992 | 1164.44 | 0.160 | 315.0 | 10.00 | 48.70 | 1538.3 |
| 1993 | 1326.60 | 0.886 | 389.0 | 1.95 | 57.10 | 1775.4 |
| 1994 | 1363.45 | 0.566 | 178.0 | - | 58.60 | 1600.6 |
| 1995 | 1262.76 | 0.264 | 320.0 | - | 64.40 | 1647.4 |
| 1996 | 1192.77 | 0.387 | 700.8 | - | 29.06 | 1922.2 |
| 1997 | 1124.59 | 0.168 | 680.0 | - | 25.94 | 1830.6 |
| 1998 | 1101.16 | 0.080 | 643.6 | - | 23.82 | 1768.7 |
| 1999 | 992.00 | 0.029 | 632.7 | - | 1.00 | 1625.8 |
| 2000 | 1112.5 | 0.028 | 378.0 | - | 1.24 | 1490.5 |
| 2001 | 1381.6 | 0.029 | 526.1 | - | 0.80 | 1908.5 |
| 2002 | 1485.0 | 0.001 | 383.4 | - | 1.04 | 1869.4 |
| 2003 | 1489.4 | 0.002 | 415.6 | - | 1.64 | 1906.6 |
| 2004 | 1492.0 | - | 455.1 | - | 1.14 | 1948.2 |

The annual eastern Bering Sea pollock spatial distribution varies especially significantly in periods of anomalous environmental condition.

In summer, 1999 most of pollock were distributed at shelf placed between Pribilof Isles and $177^{0}00$ W. Relatively intensive northwestern migrations indicated just by the end of August. Distribution pollock in the Bering Sea in 1999 quite different compare the 1994-1997 pattern.

Scale of pollock distribution in the northwestern Bering Sea was less as average also in 2000, especially in first part of summer, because that area was occupied by extremely cold water.

In 2003-2004 water temperature was much higher entire Bering Sea and pollock distribution in the northwestern area had increased.

The some trend of increasing of pollock recruitment in the Bering Sea, including southeastern shelf indicated in 1998 - 2000.

The immature pollock of 2000 year class were really abundant in 2002 both in the northwestern and southeastern Bering Sea.

At the same time, summer 2004 survey data indicated that spatial distribution pollock significantly differs from 2000-2003 data and abundance of 2001-2003 year classes much less as 2000 year class.

In summer 2004 most of immature pollock and fish of numerous 2000 year class were distributed in the northwestern shelf. Older pollock of 1998-1999 year classes predominated in the southeastern Bering Sea (23.8% and 36.6%) and fish of 2000 year class consisted just 16.2% of abundance (Fig. 1). Biomass of pollock in the southeastern Bering Sea estimated in 2.05 mln.t by EI MWT survey data.

The pollock of 2000, 1999 and 2001 year classes predominated in the northwestern Bering Sea in the U.S. EEZ – 31.4%, 21.6% and 19.6% consequently and abundance of 2003 year class pollock very low (Fig. 2). Biomass pollock in the northwestern shelf estimated in 2.93 mln.t.

The pollock biomass in the Bering Sea (0.5 m off bottom-surface, AFSC EI MWT survey data) estimated in 4.98 mln.t in 2004 (in 2002 – 4.63 mln.t, in 2000 - 3.74 mln.t, in 1999 – 4.04 mln.t.) (Table 4). The pollock of 2000 and 1999 year classes predominated in the eastern Bering Sea by numbers – 31.4% and 21.6% consequently (Fig. 3).

Table 4

Biomass and abundance pollock in the Bering Sea in 1996-2004 (by EI MWT survey data).

| | ***Biomass, mln.t*** | | | ***Abundance, mln.specimen.*** | | |
|---|---|---|---|---|---|---|
| Год | Surface-3м off bottom | 3-0.5м off bottom | Surface-0.5м off bottom | Surface-3м off bottom | 3-0.5м off bottom | Surface-0.5м off bottom |
| ***1996*** | 2370.7 | 681.0 | **2991.7** | 6525.3 | 1311.5 | **7836.7** |
| ***1997*** | 2631.7 | 961.9 | **3593.6** | 18554.9 | 2016.4 | **20571.3** |
| ***1999*** | 3202.2 | 842.3 | **4044.4** | 8833.7 | 2046.9 | **10880.5** |
| ***2000*** | 3050.3 | 690.0 | **3740.3** | 7629.1 | 1311.4 | **8940.6** |
| ***2002*** | 3707.2 | 930.4 | **4637.6** | 11877.8 | 1673.7 | **13551.5** |
| ***2004**** | 4115.2 | 871.6 | **4986.8** | 8595.8 | 1313.7 | **9909.5** |
| ***2004*** | 3846.0 | 814.6 | **4660.6** | 7521.7 | 1149.6 | **8671.3** |

* - including biomass estimated in the Navarin area

The 2001 and 2002 year classes abundance much less compare abundance of 2000 year class. Abundance of 1-year old pollock of 2003 year class very low by 2004 EI MWT survey data, in spite of extremely high abundance of pollock juveniles registered both

in the northwestern and southeastern Bering Sea shelf in 2003. It's demonstrates that natural mortality of 0+ year old pollock were very high in winter 2003-2004 but reason of it unknown.

Relative abundance of immature 1-3 years old pollock in the Bering Sea in 2004 much less compare 1999, 2000 and 2002 by EI MWT survey data (Fig. 4).

Aleutian Basin pollock spawning stock in the Bogoslof Island area have been surveyed regular since 1988. The last years surveys data demonstrates low pollock spawning biomass in the area (NPFMC Bering Sea/ Aleutian Islands SAFE document, 2003).

The originally shelf and deep water pollock habits in the eastern Bering Sea shelf before first maturing. Identification of origin immature pollock at shelf unpossibly by present methods. At the same time, there are a lot of observations of distinct differentiation of immature pollock at the Bering Sea shelf by growth rate, length, body morphology as well as it behaviour and distribution.

The survey data of 2000 indicated possibility high abundance Bogoslof I origin of 2000 year class pollock on base of distribution pollock juveniles. A lot number of pollock juveniles were distributed close to shelf edge in area placed from Unimak Pass to eastern side of Pribilof canyon in 2000 and were speculated that the juveniles originally from Bogoslof reproduction area. Another big concentration of pollock juveniles in summer 2000 was found at shelf off eastern side of Pribilof Islands.

The age of first maturing Bogoslof I spawning stock pollock is 4+-5+.Quite possibly that by the end winter and early March some prespawning 4+ - 5+ pollock migrates from outer shelf into adjacent continental slope basically inside the canyons. Most solid concentrations of prespawning fish observed in the Pribylof and Zhemchug canyons in first part of February each year in 1990-2000-s. The recruits of 2005 represent basically pollock of abundant 2000 year class.

Prespawning pollock begin migrate from big canyons area to southeast along direction continental slope, into Bogoslof I spawning ground by the end of February and early March. Big concentrations of prespawning pollock observed in deep water (about 400-500 m) of the Bering canyon, in area placed to north from Akutan I during second part February or early March almost annually.

Interannual data of prespawning pollock maturity dynamics in the Bogoslof I reproduction area (Yanagimoto et al., 2002) indicated that active spawning, especially younger fish, start basically in second part of March (1992-1993, 1995-1996, 1998-1999).

Quite possibly that spawning of abundant 2000 year class recruits in 2005 taken place basically later the regular EI survey time (March 4-11), - in second part of March.

The high density concentrations of mature pollock were observed at shelf and adjacent continental slope off eastern Aleutian Islands (Akun I.– Akutan I. – northern Unalaska I) in summer 2002 and 2004. This pollock differs sharply from fish distributed at shelf by length-age composition and gonads maturity. In 2002 the pollock

of 1995-1996 year classes (42-50 cm) and in 2004 of 1998-1999 year classes (42-48 cm) predominated off eastern Aleutian Islands. Apart from, in 2004 pollock of 1995-1997 year classes also was relatively abundant in that area. The gonads of pollock males have not any remains of sperm and females resorbing eggs of previous generation. It shows that active spawning period of this fish was long time ago and much earler as spawning of pollock at shelf.

Quite possibly that feeding pollock distributed off eastern Aleutian Islands is a part Bogoslof Island spawning stock and mature fish of 1998-1999 year classes represent a recruits of it spawning stock in 2004.

## References

1. Schuntov V..P., Volkov A.F., Temnykh O.S., Dulepova E.P. Pollock in ecosystem of fareastern seas.- Vladivostok: TINRO.-1993.- 426 p.

2. Bakkala R.G. Structure and historical changes in the groundfish complex of the eastern Bering Sea // NOAA Tech. Rept. NMFS. –1993.-Vol. 114.- P. 91.

3. Dawson P. Walleye pollock stock structure implications from age composition length-at age, and morphometric data from the central and eastern Bering Sea// Proc. Intern. Symp. Biol. Managm. Walleye Pollock. Anchorage, 1989, Fairbanks, Alaska.- P. 433-456.

4. Stepanenko M.A. The state of stocks and distribution of pollock in the Bering Sea // Proc. Int. Symp. Biol. Mgmt. Walleye pollock. Fairbanks, Univ. Alaska Sea Grant AK – SG – 89-01.- 1989.- P. 537-547.

5. Gritsay E.V., Stepanenko M.A. Interannual variability of spatial distribution and functioning of the eastern Bering Sea pollock.- Izv. TINRO.- 2003.- vol. 133, pp. 80-93.

6. Stepanenko M.A. The pollock spawning group in the eastern Bering Sea.- Izv. TINRO.- 2003.- vol. 133.- pp. 67-79.

7. Yanagimoto T., Nishimura A., Mito K., Takao Y., Williamson N. Interannual changes of biological properties of walleye pollock Theragra chalcogramma in the central Bering Sea.- Prog. Oceanography.- 2002.- vol 55.- pp. 195-208.