**Pollock Stock Assessment Documents**

Submitted by

**the Russian Party**

for the

**Meeting of the Science and Technical Committee**

**Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea**

November 8-12, 1999

Pusan, Republic of Korea

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**Documents**

Introduction.

The retrospective analysis of the state of Bering Sea pollock stock shows that it is characterized by the alternation of periods with the high- and low abundance. Over the last century the duration of each period ranges from one to several decades. The 1990s are marked by the low abundance that determines the state of pollock stock in the western Bering Sea. Transitions between periods of high and low abundance follow shifts in climatic regimes.

## 1. Stock assessment of western Bering Sea pollock for 2000.

V. K. Babayan, T. I. Bulgakova (VNIRO), P. A. Balykin, O. G. Zolotov (KamchatNIRO)

The assessment of the stock state and prospects of fishery on western Bering Sea pollock stock was based on the use of methodology of precautionary approach (Babayan, 1999). The following methods and models were used in calculations:

- extended Thompson-Bell analysis used to determine the relationship between catch per recruit and spawning stock per recruit for balance state of exploited stock;
- parametric analysis of relationship "stock-recruitment", R(S), (with the use of Ricker's parameterization which takes into account cannibalism as one of the factors of density regulation of pollock abundance);
- non-parametric analysis on the plane "stock-recruitment" to assess $F_{low}$, $F_{med}$ and $F_{high}$;
- age-structured production model, ASPM;
- instantaneous separable VPA, ISVPA (Kizner and Vasilyev, 1997; Vasilyev, 1999);
- methods of statistical modeling including Monte-Carlo method and bootstrap.

The initial information available from KamchatNIRO included age composition of catches (1970-1998), average weight - at - age values (1980-1994, 1996-1998; for 1970-1979 the mean long-term values were accepted), total catches (1970-1998), portion of matured fish by age, statistical data by year – the 5-year averaged data were given (1976-1980, 1981-1985, 1986-1990, 1991-1998).

Biological characteristics of western Bering Sea pollock according to results of surveys conducted in 1999 are given in Document 2, Tables 2.3-2.5.

Due to a lack of reliable data on fishing effort and catch per unit effort (CPUE) for the last years, the retrospective estimations are based on the use of instantaneous separable VPA model (ISVPA) which does not require data on fishing efforts. The estimation of coefficients of natural mortality by age is also obtained on the basis of evaluation of model parameters. The results of retrospective analysis show that a sharp decline of stock biomass occurred in 1993-1995, slows down essentially now (Fig.1.1).

Because the current assessment of spawning stock biomass is the lowest for the whole period since 1970, precautionary approach dictates a ceasing of large-scale fishery and transition to control fishery.

The consequences of establishment of control fishery equal to 40,000 tons for the future are presented in Fig.1.2. The mean long-term value of recruitment R(2) over the 1990-1998 period (period with a low recruitment) was used in forecasting calculations. As seen from Fig. 1.2, even in case of weak year classes the control fishery equal to 40,000 tons will not result in further deterioration of the stock state and will be accompanied by its gradual recovery.

## 2. Assessment of Navarin pollock stock for 2000.

M. A. Stepanenko (TINRO-Centre), P. A. Balykin, A. I. Varkentin (KamchatNIRO), A. I. Glubokov, B. N. Kotenev (VNIRO)

The analysis of the state of Navarin pollock stock presented at the Meeting held in Seattle in the last year was based on data for the 1971-1997 period and partly for 1998.

The present analysis was supplemented with data for 1997 which were not included in the previous analysis, results of expeditions in the northwestern Bering Sea aboard R/V "Professor Kaganovsky" (TINRO-Center with participation of VNIRO scientists, August-October, 1998), Japanese trawlers "Kaiyo-maru 28" and "Tenyo-maru 78" (VNIRO, TINRO-Center, KamchatNIRO, June, 1998- August, 1999), and fishery data.

Over the last four years the total value of Navarin pollock stock in summer period decreased steadily in accordance with a total drop of the species abundance (Table 2.1). Thus, according to results of echo-integration and bottom trawl surveys the total biomass of Navarin pollock in 1996 was about 2.0 mln tons, in 1997- 1.3 mln tons, in 1998- 0.9 mln tons, and in 1999- 0.4 mln tons. If until the mid-1990s the dense pollock concentrations were observed over the whole aquatory of the Navarin area including the Anadyr and eastern Koryak shelves, since 1996 the discontinuities in concentrations appeared. Then these concentrations disintegrated to separate patches and in 1998-1999 the only dense pollock concentration off Navarin cape was noted in the Navarin area (Fig. 2.1-2.3).

As in previous years, the individuals of all age groups, from 2+ (data of fry survey) to the older age, were registered in the concentration (Fig. 2.4-2.6).

Fry survey conducted in the Navarin area in June , 1999, showed that on the aquatory with the total area of 11,028 square miles the abundance of the 1998 year class was 147.72 mln, 1997 year class – 1037.39 mln, 1996 year class – 247.59 mln individuals. The biological characteristics of fry of the above year classes is presented in Table 2.2.

Proceeding from data for previous years and this year, it may be concluded that over the last 5 years in the northern Bering Sea the abundance of 1995 (up to 50% in catches of R/V in 1998), 1996 (up to 31% in catches of R/V 1999), and 1997 (34-38%) year classes was higher than mean long-term level. According to data of fry survey, the 1998 year class may be considered as weak.

Concurrently with appearance of the weak year class, the following changes in the rate of sexual maturation of northwestern Bering Sea pollock occurred. In 1996-1997 (years of strong year classes) the first mature females were 24-25 cm long and males were 23 cm long. Most of females matured at length of 40 cm and males at length less than 35 cm. In 1999 the maturation of 50% of females occurred only at length 45-46 cm and matured males were 40-41 cm long (Fig. 2.7). Among the other reasons, the earlier pollock maturation in previous years resulted in increase of spawning part of population and appearance of a number of strong year classes. Shift of maturation to the later dates leads to reverse processes and may cause the appearance of some weak year classes in the northwestern Bering Sea in the nearest future.

Due to the total decline of pollock abundance in the Navarin area and other areas the competition for food and space decreased. Pollock concentrations remained only in places with the maximal zooplankton content, i.e. ("that is") within the quasistationary eddies typical for this

aquatory. As a result, in the 1990s in the northwestern Bering Sea the spatial distribution of pollock acquired a patchy character.

The earlier studies showed that individuals of pollock from separate concentrations differed essentially by a number of morphologic characteristics (Pollock stock assessment, 1998). Physiologic investigations also revealed differences among pollock individuals from different aquatories of the northwestern Bering Sea (Table 2.3-2.5; Fig. 2.8-2.10). In summer period gonadsomatic indices of Navarin pollock were high, and cubic condition coefficients and hepatsomatic indices were minimal among all individuals of the northwestern Bering Sea (Table 2.3-2.5; Fig. 2.9-2.10). This is associated with hydrological conditions. The given aquatory is the coldest within the area from the Olutorsky Bay to the Russian EEZ boundary, and pollock spawns in the latest dates there. The beginning of feeding period also delays compared with the warmer southwestern regions.

To assess genetic status of existing differences Drs. E. A. Shubina and B. M. Mednikov (Biological Faculty of Moscow State University) and Institute of Marine Biology (Far East Branch of Russian Academy of Science) jointly with VNIRO and TINRO-Centre investigated molecules of nuclear and mitochondrial DNA, and polymorphysm of esterases and transferrins. Construction of tree based on genetic distances between objects showed an absence of differences of population rank among pollock individuals on the aquatory from the western Koryak shelf to Anadyr shelf and Navarin area (Fig. 2.11). Possibly, this is explained by intensive drift of genes occurring as result of regular exchange by individuals between different pollock concentrations during the period of high abundance of the species. According to decisions of the Meeting on Pollock

Stock structure, September 7-9, 1999, Yokohama, Japan, in 2000 genetic studies of pollock will be conducted by Russian scientists with the purpose to search for variable DNA parts (mithochondrial and genomic molecules) suitable for identifying the population structure of pollock. Only the samples obtained during the spawning period will be used for the analysis.

Fishery data of the last years show that due to decline of Navarin pollock stock biomass the catches per unit effort (CPUE) decreased from year to year. At the same time, for the first time during the last 4 years in 1999 the intensity of fishery on Navarin pollock stock was essentially reduced. Thus, the total pollock catch in the Navarin area in 1996 was 797,600 tons, in 1997 – 757,300 tons, in 1998 – 719,700 tons, and by November 1, 1999, the total catch was only 416,220 tons.

The analysis of fishery situation in the Navarin area during the current year showed the following. In the first quarter 31,500 tons of pollock was caught. In April, as in the 1$^{st}$ quarter, the fishery situation was good. The average daily catches of large-tonnage trawlers made up 65-140 tons per vessel. However, in May the fishery situation became worse- the average daily catches dropped down to 20-30 tons per vessel. In late August the average daily catches per vessel rose and ranged from 37 to 73 tons until mid-October.

Thus, in 1999 the whole period of pollock fishery may be divided into 3 stages. At the first stage lasted from the beginning of fishery (January) to mid-May, the fishery situation on wintering and pre-spawning grounds was good. At the second stage (late May – late August) the fishery situation was weak. At the third stage, the fishery situation became better.

One of the reasons for deterioration of fishery conditions in the Navarin area in May can be associated with feeding migrations of

pollock outside the area ,and improvement of fishery situation in late August is connected to its gradual returning to wintering grounds.

Thus, the present state of Navarin pollock stock shows that in 2000 its biomass will be at a low level, and pollock will not migrate to the deepwater Aleutian basin.

**References**

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Table. 2.1. Biomass of Navarin pollock 1996-1999.

| | | date | S, miles'2 | Biomass,ths.t |
|---|---|---|---|---|
| | | 1996 | | |
| 1 | EIT | July-August | 23298 | 1018 |
| 2* | bottom trawl | July-August | 23119 | 2425 |
| 3 | survey | Sept-Octob | 26178 | 1098 |
| 4 | (BTS) | Nov-Decemb | 19002 | 804 |
| | | 1997 | | |
| 5 | EIT | June-July | 19931 | 259 |
| 6 | EIT | September | 17000 | 410 |
| 7 | BTS | June-July | 24522 | 1030 |
| 8 | BTS | September | 17000 | 80 |
| | | 1998 | | |
| 9 | EIT | November | 5000 | 100 |
| 10 | BTS | November | 25000 | 400 |
| | | 1999 | | |
| 11 | BTS | June | 7329 | 181 |

* Bottom trawl survey was carried out by 4 vessels with different characteristics of trawls.

Table. 2.2. Characteristics of Navarin pollock fry, june 1999.

| | | generation 1998 | generation 1997 | generation 1996 |
|---|---|---|---|---|
| Average | length,cm | 12.79 | 17.72 | 28.93 |
| Maximum - | minimum | 10-15 | 16-24 | 25-33 |
| Average | weight,g | 11.90±0.74 | 17.05±2.69 | 154.67±4.58 |
| Male portion | % | - | 40.00 | 43.66 |
| Portion of unmaturity specimen | female | - | 100.0 | 100.0 |
| | male | - | 100.0 | 40.0 |
| Cubic condition index | female | - | 0.610±0.014 | 0.656±0.016 |
| | male | - | 0.600±0.007 | 0.631±0.019 |
| Hepatsomatic index,% | female | - | 3.11±0.32 | 2.32±0.12 |
| | male | - | 3.43±0.30 | 3.52±0.38 |

Table. 2.3. Characteristics of North-Western Bering sea pollock, June-July 1998.

| | <170 E | 170-172'45 E | 173-175'45 E | 176-178 E | 178'15< |
|---|---|---|---|---|---|
| Linear coef. In length-weight relationship (LC) | 0.0195 | 0.0275 | 0.0170 | 0.0149 | 0.0056 |
| Degree coef.(DC) | 2.71 | 2.63 | 2.76 | 2.78 | 3.02 |
| Aver.length, cm | 48.88±0.12 | 51.83±0.17 | 54.92±0.24 | 46.46±0.15 | 48.70±0.13 |
| Mode length,cm | 49-55,31-33, 23-24 | 54-56 | 54-56 | 45-47 | 45-48,33-35 |
| Aver.weight, g | 992±11 | 902±23 | 1057±26 | 686±13 | 918±20 |
| Male portion,% | 27.52 | 42.97 | 11.33 | 32.50 | 33.13 |
| Predom. stage oogenesis(%) (PSO) | 6(74.6), 6-3(13.3) | 6(64.6), 2-3(16.0) | 6-3(54.1), 3(12.0) | 6-3(34.8), 6(32.3) | 6(54.8), 6-3(26.1) |
| Predom.stage spermatogenesis (%) (PSS) | 6(86.4) | 6(97.3) | 6(64.7), 6-3(35.3) | 6(89.7) | 6(98.1) |
| Predom.food object(%) (PFO) | euph(40.8), copep(30.3) | euph(61.0), copep(25.8) | euph(70.4), copep(13.2) | copep(45.0) euph(31.0) | euph(54.5), copep(20.8) pollock(10.1) |
| Aver.stomach filling(SF) | 1.54 | 2.06 | 1.01 | 2.18 | 1.15 |
| Female gonadsomat. Ind.,%(FGSI) | 2.29±0.16 | 2.34±0.18 | 2.35±0.35 | 1.64±0.14 | 1.82±0.06 |
| Male gonad-somat.ind.,% (MGSI) | 1.86±0.11 | 1.43±0.12 | 1.10±0.27 | 1.00±0.11 | 1.31±0.07 |
| Female hepatsomat. Ind.,%(FHSI) | 7.12±0.08 | 7.96±0.16 | 7.37±0.17 | 6.56±0.16 | 5.76±0.12 |
| Male hepat-somat.ind.,% (MHSI) | 5.80±0.11 | 6.83±0.17 | 5.85±0.63 | 5.88±0.23 | 4.39±0.15 |
| Cubic condition ind.(CCI) | 0.53 | 0.56 | 0.59 | 0.55 | 0.55 |

Table. 2.4. Characteristics of North-Western Bering sea pollock, August-October, 1998

| | <170 E August | 170 E October | 170-172'45 E August | 173-175'45 E Septemb | 173-175'45 E October | 176-178 E Setemb | 178'15 E< Septemb |
|---|---|---|---|---|---|---|---|
| LC | 0.0386 | 0.0336 | 0.0216 | 0.0140 | 0.0464 | 0.0146 | 0.0075 |
| DC | 2.55 | 2.59 | 2.70 | 2.82 | 2.54 | 2.80 | 2.98 |
| Aver.length,cm | 49.62 ±0.13 | 55.48 ±0.19 | 51.31 ±0.10 | 50.10 ±0.20 | 52.24 ±0.21 | 44.80 ±0.70 | 45.50 ±0.20 |
| Mode length,cm | 47-53 | 52-54,57 | 49-53 | 47-50 | 49,51,53 | 52-53, 25,27-28 | 45-47, 24-26,33-36 |
| Aver. Weight,g | 866±13 | 1125±17 | 921±11 | 932±24 | 1108±18 | 1027±28 | 862±17 |
| Male portion,% | 44.70 | 20.65 | 44.10 | 31.70 | 63.27 | 25.00 | 30.00 |
| PSO | 3(88.1) | 3(100.0) | 3(85.5) | 3(96.3) | 3(100.0) | 3(93.3) | 3(98.0) |
| PSS | 3(62.2), 6-3(26.6) | 3(100.0) | 3(50.3), 6-3(43.8) | 3(81.6), 6-3(15.8) | 3(88.4) | 3(86.7) | 3(93.3) |
| PFO | copep39.4, euph26.3 | myct31.8 euph28.2 | euph39.2 hyper28.3 | euph48.7 prawn33. | myct51.1 euph28.6 | prawn55.1 euph25.6 | prawn88.4 |
| SF | 0.54 | 1.66 | 0.67 | 0.90 | 1.52 | 1.05 | 0.93 |
| FGSI | 1.87±0.08 | 2.51±0.05 | 2.00±0.08 | 1.79±0.10 | 2.54±0.23 | 2.43±0.28 | 1.98±0.16 |
| MGSI | 1.04±0.08 | 2.05±0.14 | 0.99±0.06 | 1.02±0.07 | 3.20±0.14 | 2.03±0.48 | 1.89±0.30 |
| FHSI | 9.71±0.16 | 8.69±0.15 | 8.99±0.12 | 9.88±0.22 | 11.02±0.24 | 7.03±0.25 | 9.82±0.23 |
| MHSI | 8.83±0.16 | 8.26±0.21 | 8.26±0.10 | 8.91±0.33 | 10.94±0.17 | 6.64±0.43 | 8.36±0.32 |

Table. 2.5. Characteristics of North-Western Bering sea pollock, June 1999.

| | | Olutor bay | Western Koryak shelf | Eastern Koryak shelf | Navarin region |
|---|---|---|---|---|---|
| Catch/effort | kg | 38-598 | 52-132 | 24-4900 | 88-6874 |
| Average | catch,kg | 318 | 94 | 1299 | 1412 |
| Average | length,kg | 50.3±0.3 | 46.4±0.6 | 46.7±0.5 | 55.6±0.4 |
| Mode length | cm | 53-58,40-41, 36-37 | 39-43,45-47 | 37-39,52-53, 59-62 | 65-69,58-60, 36-39 |
| Average | weight,kg | 996±32 | 958±56 | 971±43 | 1509±42 |
| LC | | 0.0051 | 0.0057 | 0.109 | 0.0079 |
| DC | | 3.06 | 3.04 | 2.86 | 2.94 |
| Male portion | % | 23.60 | 22.22 | 26.67 | 32.01 |
| PSO | | VI-II(76.7) II(15.8) | VI-II(68.1) II(21.7) | VI-II(85.1) II(11.5) | VI-II(85.8) |
| PSS | | VI-II(46.0) II(39.7) | VI-II(65.0) II(35.0) | VI-II(59.4) II(28.1) | VI-II(83.5) |
| PFO | | prawn(33.6) euphaus(33.4) | euphaus(44.6) prawn(22.6) | prawn(43.8) myctoph(20.9) | prawn(55.5) euph(25.8) |
| SF | | 1.94 | 1.42 | 1.94 | 1.44 |
| CCI | female | 0.666±0.005 | 0.687±0.011 | 0.669±0.008 | 0.651±0.004 |
| CCI | male | 0.670±0.017 | 0.732±0.025 | 0.718±0.020 | 0.698±0.008 |
| FGSI | | 2.66±0.19 | 3.74±0.71 | 2.43±0.24 | 3.83±0.22 |
| MGSI | | 2.07±0.46 | 2.62±0.70 | 1.50±0.38 | 2.29±0.23 |
| FHSI | | 6.00±0.15 | 6.50±0.24 | 5.73±0.21 | 5.49±0.22 |
| MHSI | | 4.60±0.24 | 5.08±0.55 | 4.67±0.47 | 3.67±0.13 |
| Heart index,% | female | 0.316±0.005 | 0.290±0.012 | 0.301±0.006 | 0.334±0.005 |
| | male | 0.318±0.018 | 0.261±0.011 | 0.268±0.014 | 0.299±0.009 |
| Spleen index,% | female | 0.190±0.006 | 0.190±0.013 | 0.183±0.009 | 0.179±0.006 |
| | male | 0.235±0.023 | 0.149±0.020 | 0.187±0.033 | 0.198±0.009 |
| Gall-bladder index,% | female | 0.165±0.007 | 0.231±0.022 | 0.213±0.011 | 0.251±0.010 |
| | male | 0.137±0.011 | 0.228±0.012 | 0.180±0.018 | 0.195±0.008 |

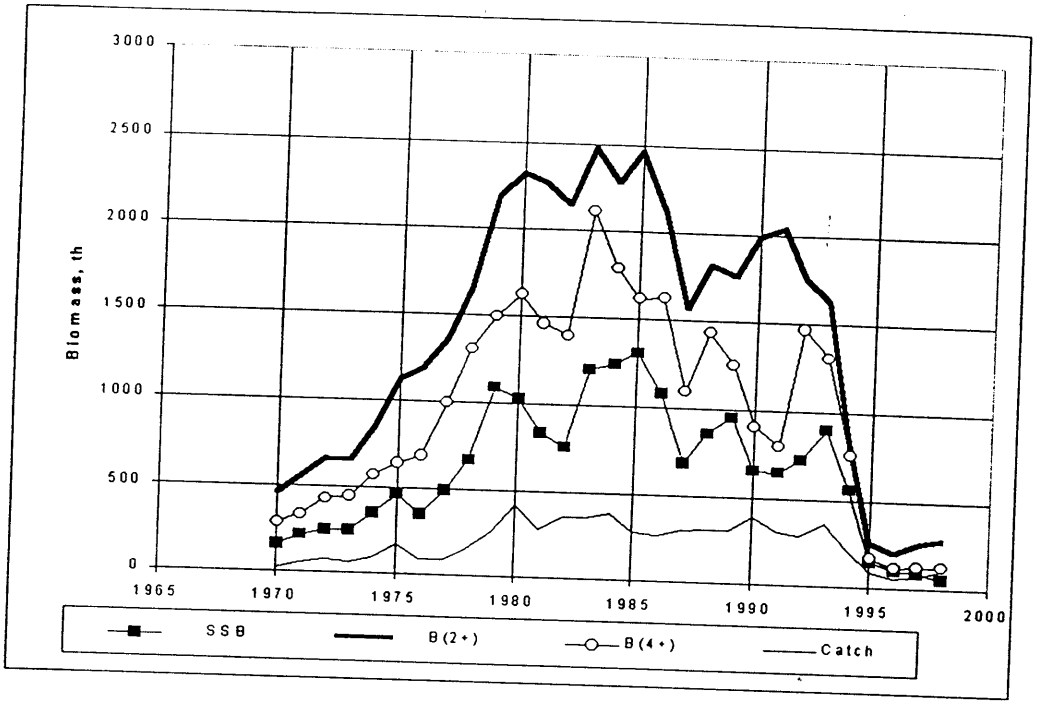


Fig.1.1 Western Bering Sea pollock. Results of retrospective analysis.

Table. 2.5. Characteristics of North-Western Bering sea pollock, June 1999.

| | | Olutor bay | Western Koryak shelf | Eastern Koryak shelf | Navarin region |
|---|---|---|---|---|---|
| Catch/effort | kg | 38-598 | 52-132 | 24-4900 | 88-6874 |
| Average | catch,kg | 318 | 94 | 1299 | 1412 |
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| Average | weight,kg | 996±32 | 958±56 | 971±43 | 1509±42 |
| LC | | 0.0051 | 0.0057 | 0.109 | 0.0079 |
| DC | | 3.06 | 3.04 | 2.86 | 2.94 |
| Male portion | % | 23.60 | 22.22 | 26.67 | 32.01 |
| PSO | | VI-II(76.7) II(15.8) | VI-II(68.1) II(21.7) | VI-II(85.1) II(11.5) | VI-II(85.8) |
| PSS | | VI-II(46.0) II(39.7) | VI-II(65.0) II(35.0) | VI-II(59.4) II(28.1) | VI-II(83.5) |
| PFO | | prawn(33.6) euphaus(33.4) | euphaus(44.6) prawn(22.6) | prawn(43.8) myctoph(20.9) | prawn(55.5) euph(25.8) |
| SF | | 1.94 | 1.42 | 1.94 | 1.44 |
| CCI | female | 0.666±0.005 | 0.687±0.011 | 0.669±0.008 | 0.651±0.004 |
| CCI | male | 0.670±0.017 | 0.732±0.025 | 0.718±0.020 | 0.698±0.008 |
| FGSI | | 2.66±0.19 | 3.74±0.71 | 2.43±0.24 | 3.83±0.22 |
| MGSI | | 2.07±0.46 | 2.62±0.70 | 1.50±0.38 | 2.29±0.23 |
| FHSI | | 6.00±0.15 | 6.50±0.24 | 5.73±0.21 | 5.49±0.22 |
| MHSI | | 4.60±0.24 | 5.08±0.55 | 4.67±0.47 | 3.67±0.13 |
| Heart index,% | female | 0.316±0.005 | 0.290±0.012 | 0.301±0.006 | 0.334±0.005 |
| | male | 0.318±0.018 | 0.261±0.011 | 0.268±0.014 | 0.299±0.009 |
| Spleen index,% | female | 0.190±0.006 | 0.190±0.013 | 0.183±0.009 | 0.179±0.006 |
| | male | 0.235±0.023 | 0.149±0.020 | 0.187±0.033 | 0.198±0.009 |
| Gall-bladder index,% | female | 0.165±0.007 | 0.231±0.022 | 0.213±0.011 | 0.251±0.010 |
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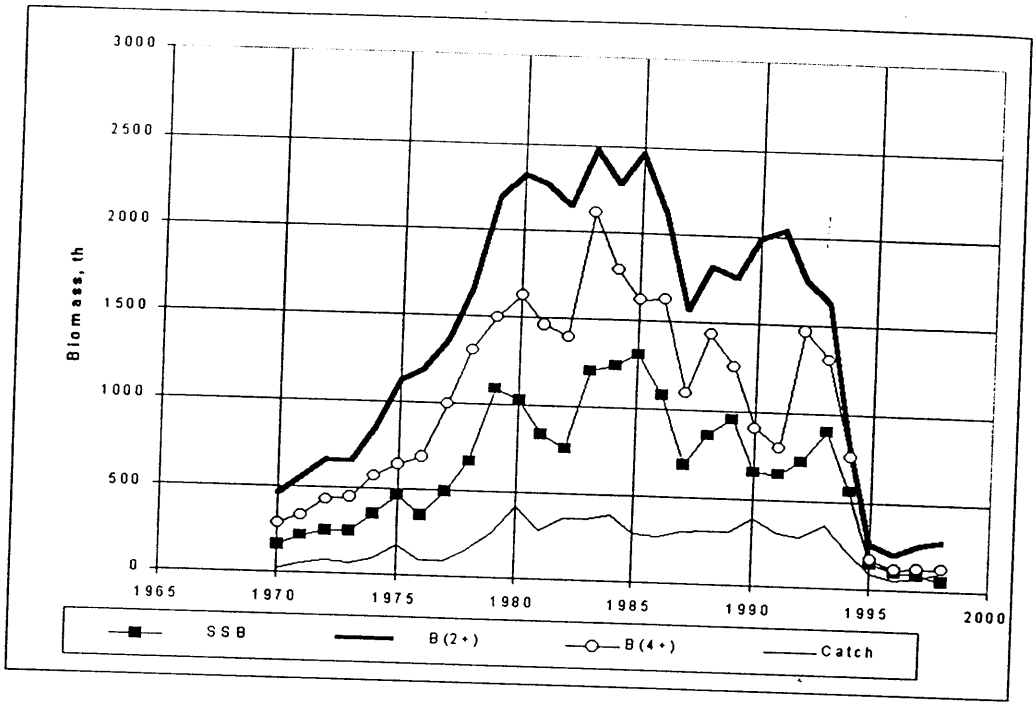



Fig.1.1 Western Bering Sea pollock. Results of retrospective analysis.

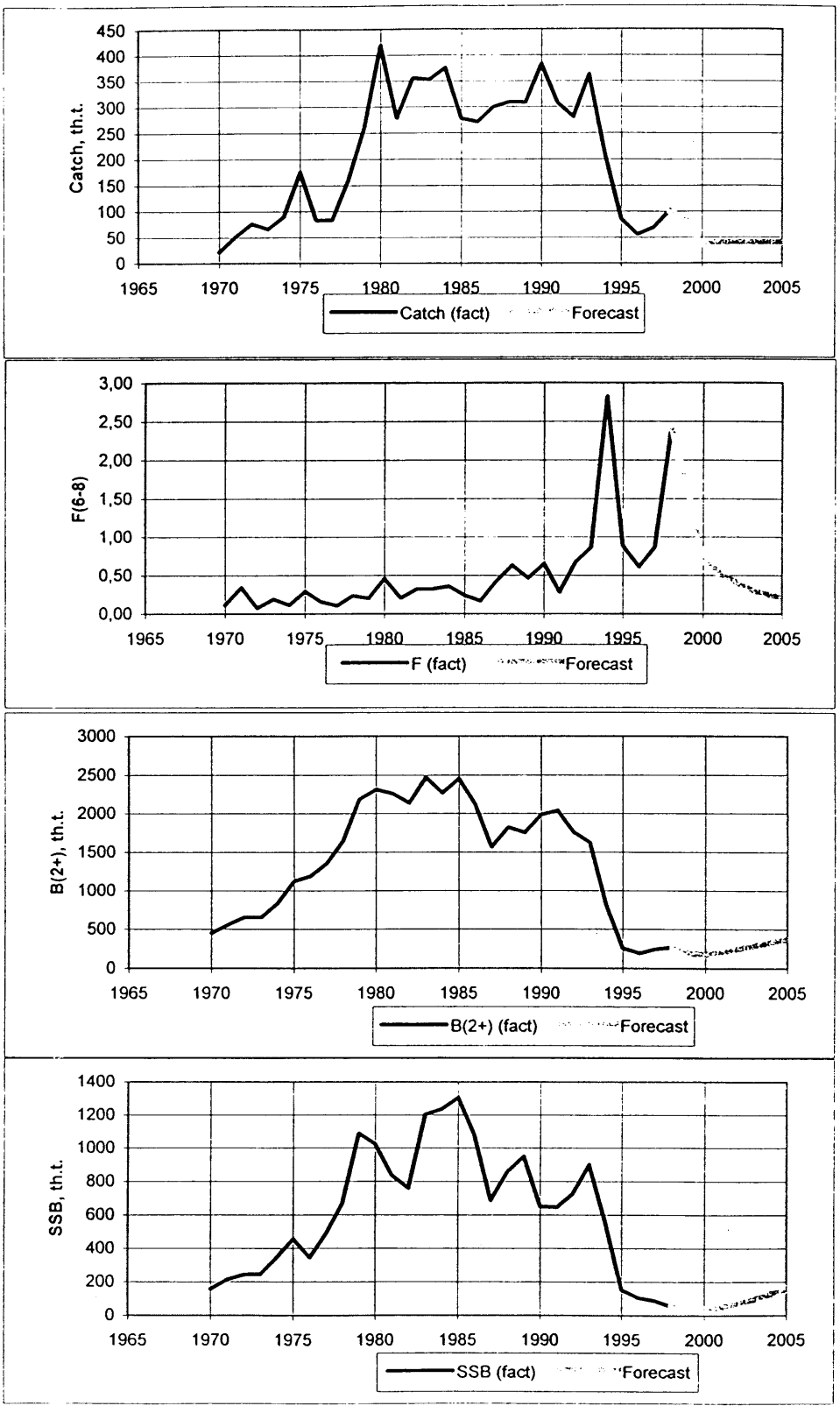



Fig.1.2. West Bering Sea pollock. Forecast for scenario of control catch = 40 th.t.

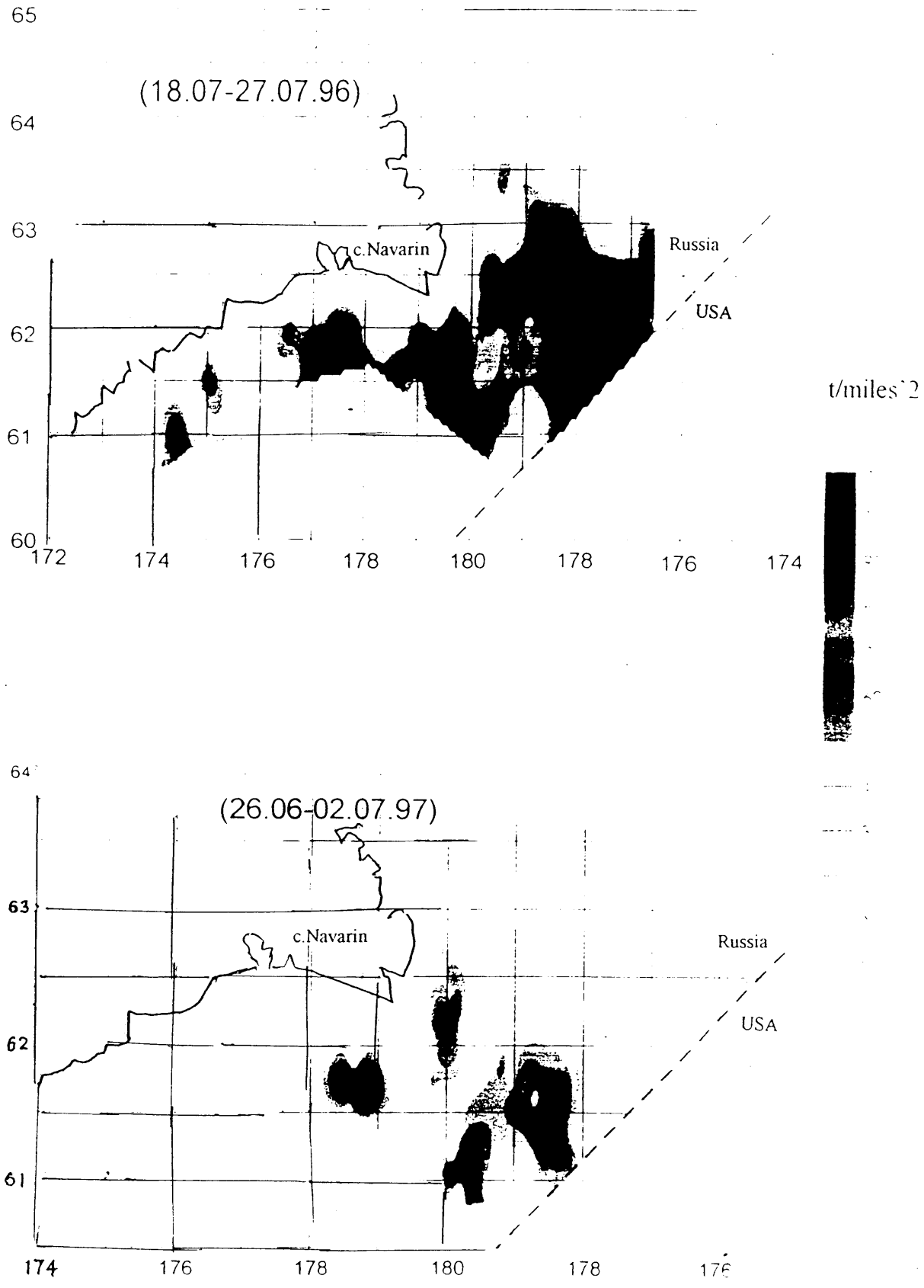



Fig. 2.1. Distribution of pollock bottom trawl survey.

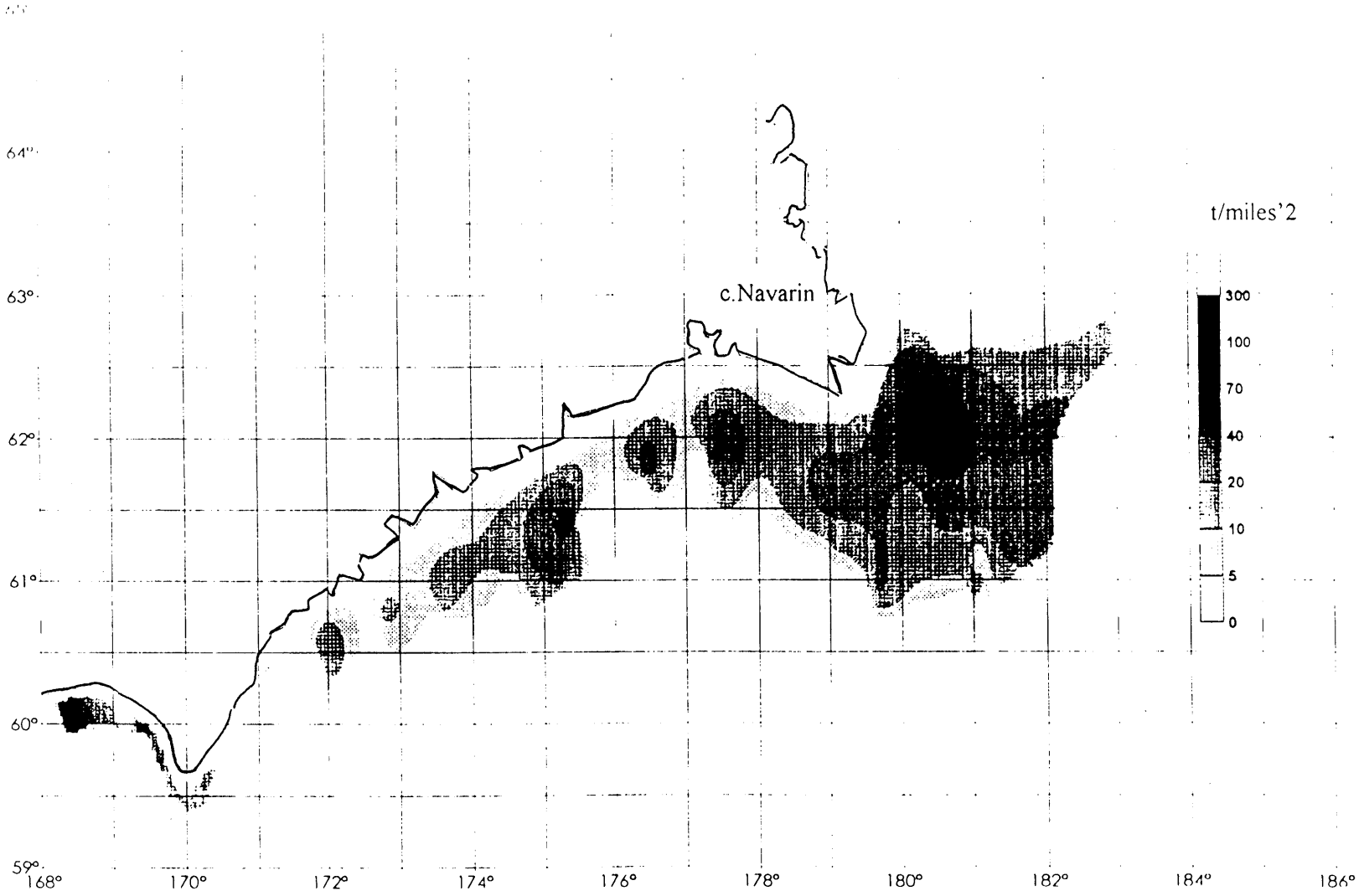



Fig.2.2 Distribution of pollock, bottom trawl survey, November 03-11, 1998.

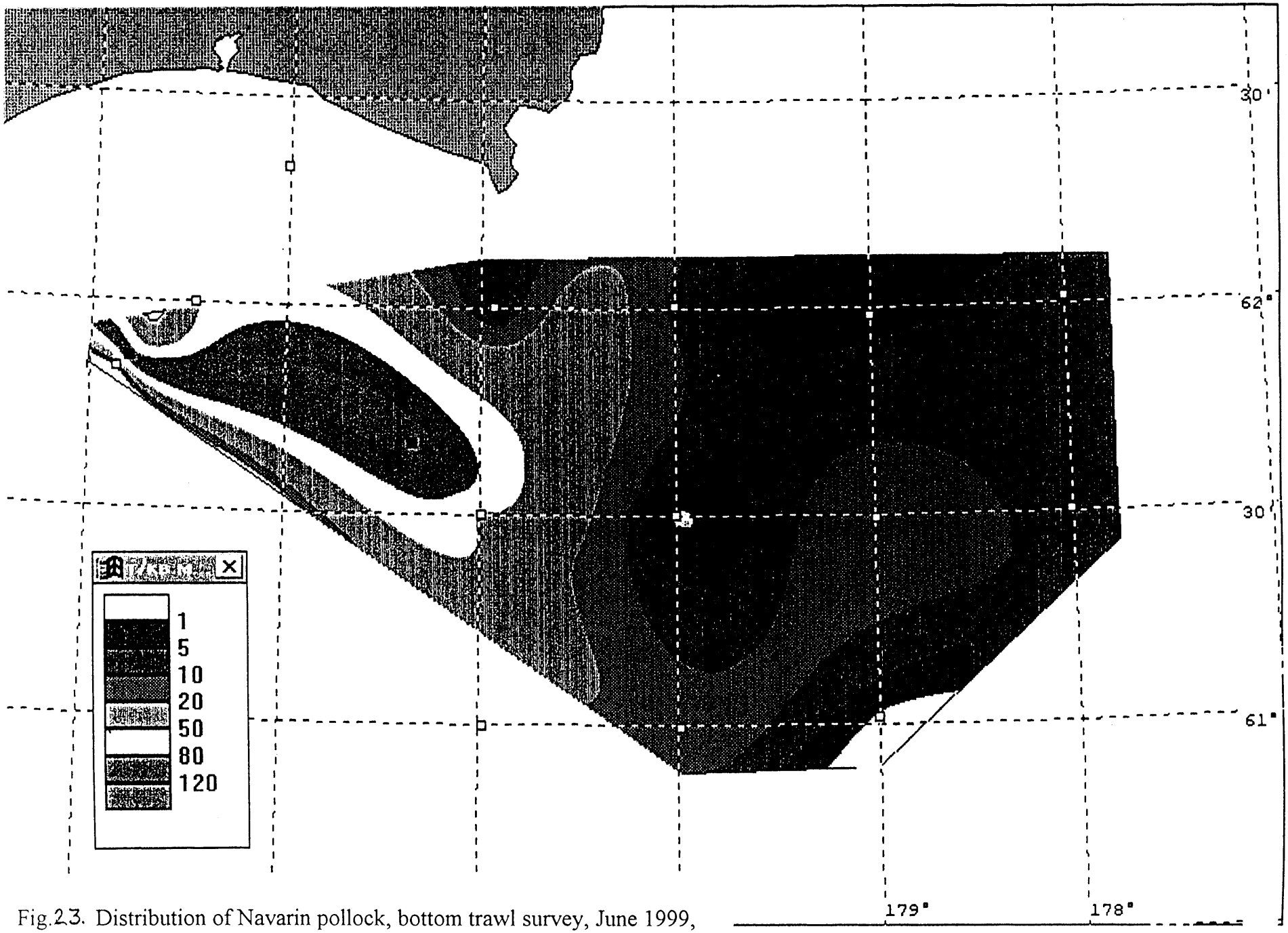



Fig.23. Distribution of Navarin pollock, bottom trawl survey, June 1999, t/miles'2.

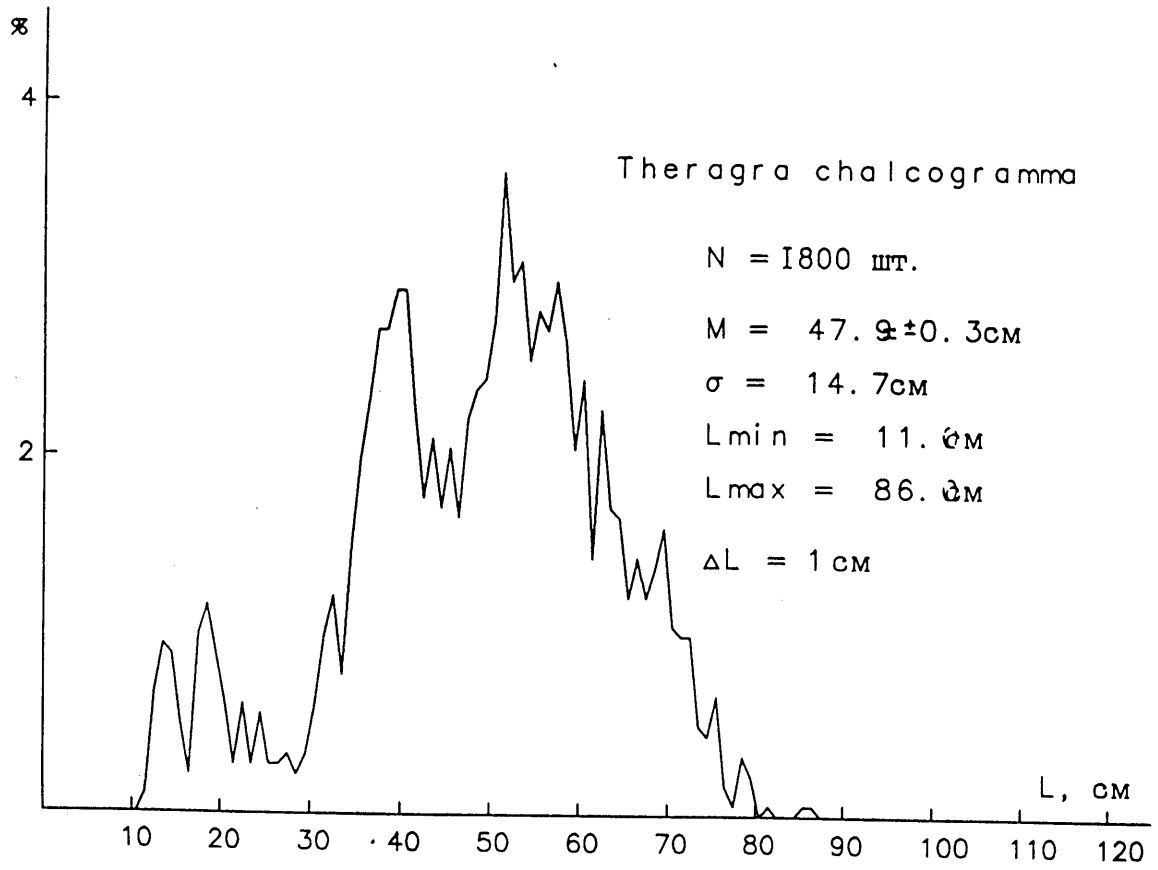



Fig.2.4 Length composition of Navarin pollock, bottom trawl survey, June 1999

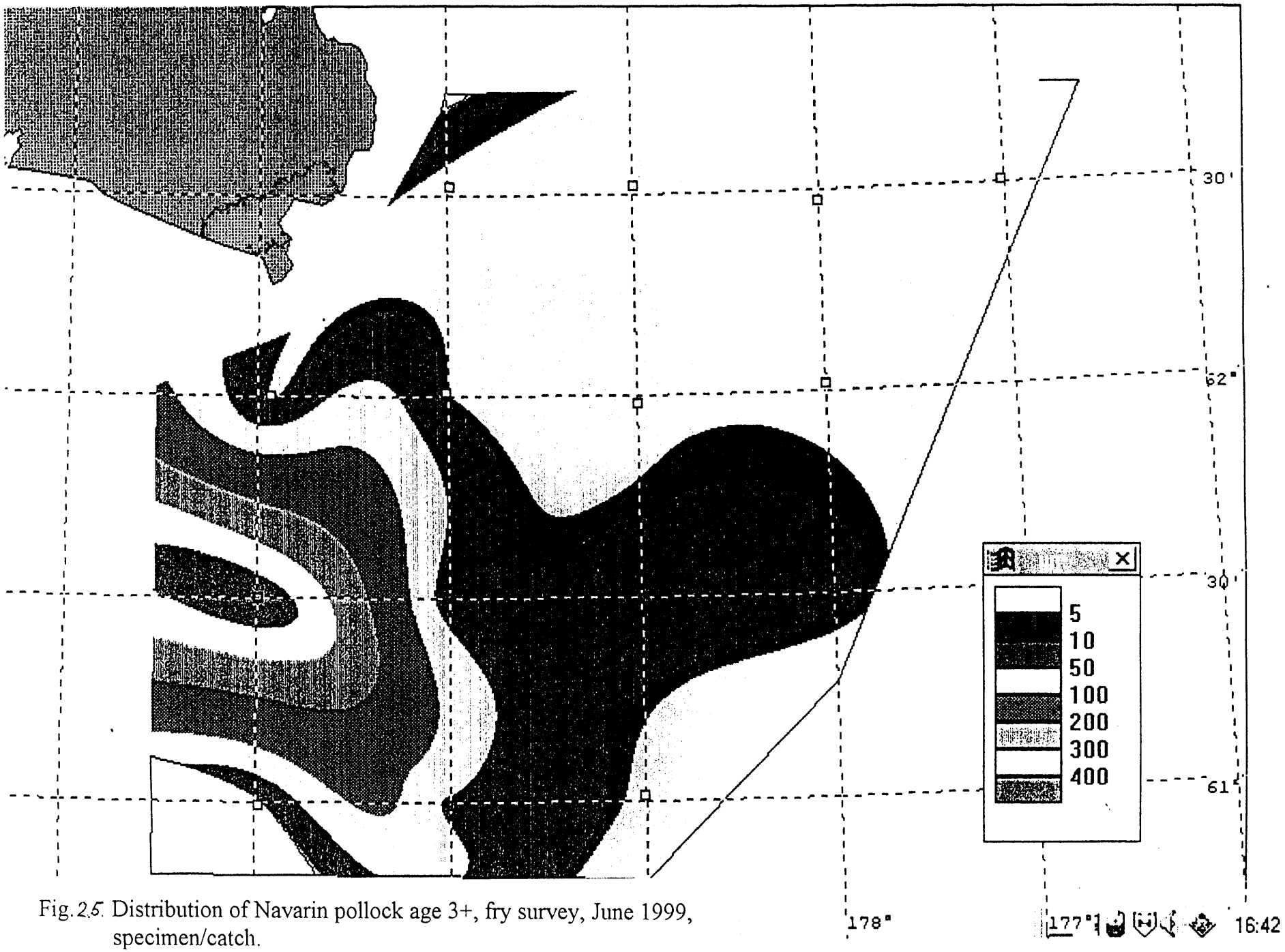



Fig. 2.5. Distribution of Navarin pollock age 3+, fry survey, June 1999, specimen/catch.

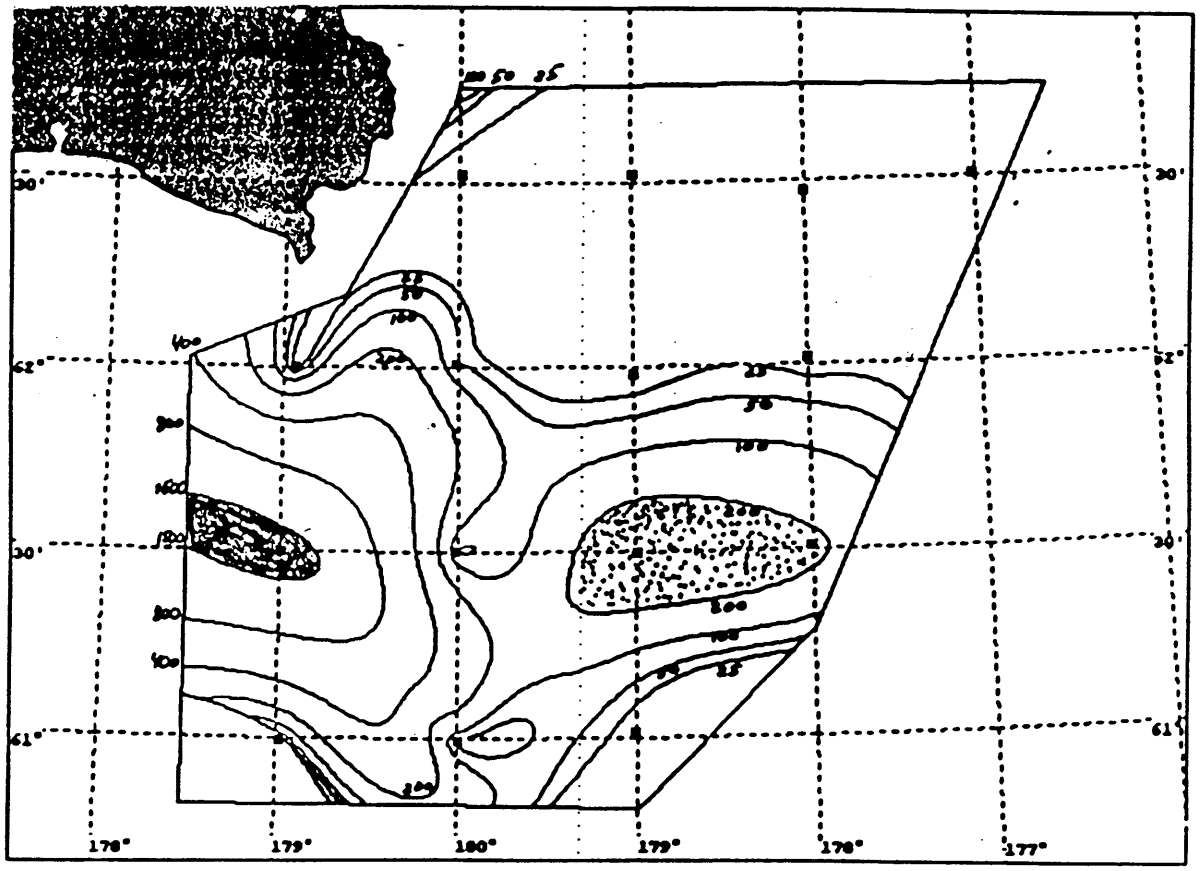



Fig.2.6. Distribution of Navarin pollock age 2+, fry survey, June 1999, specimen/catch.

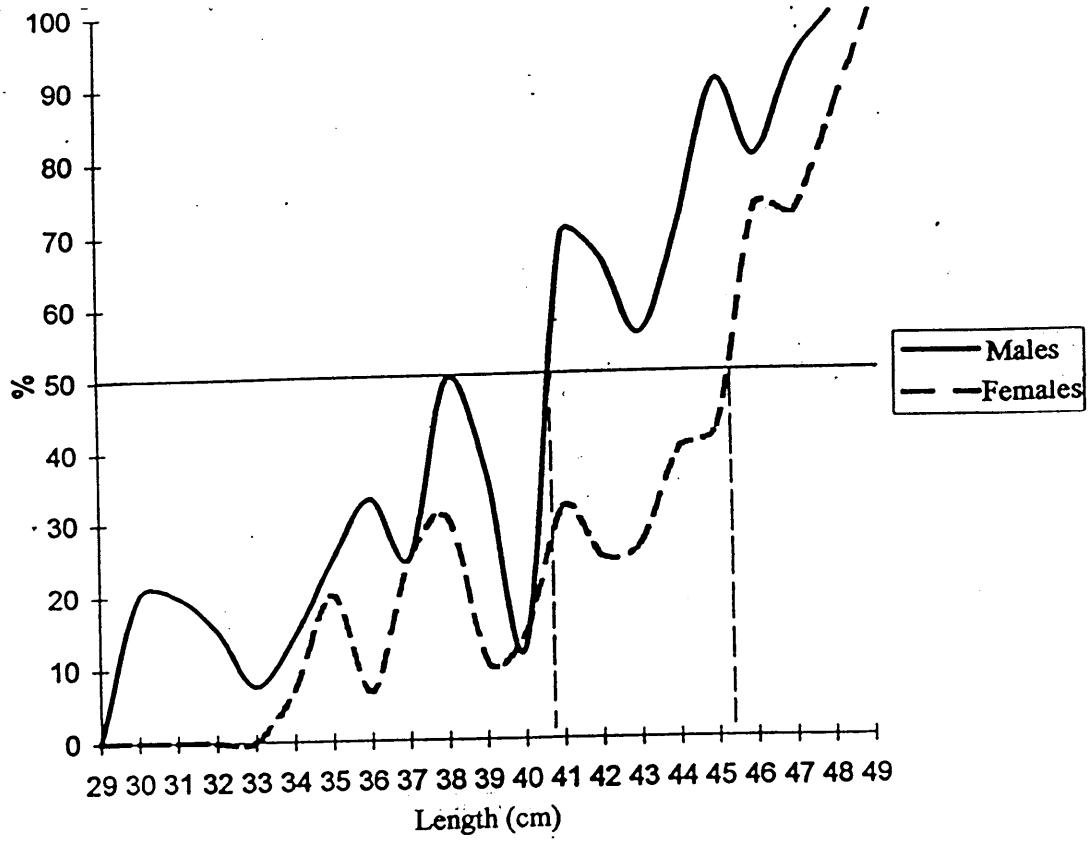



Fig 2.7. Maturation curve of North-Western Bering sea pollock, June 1999.

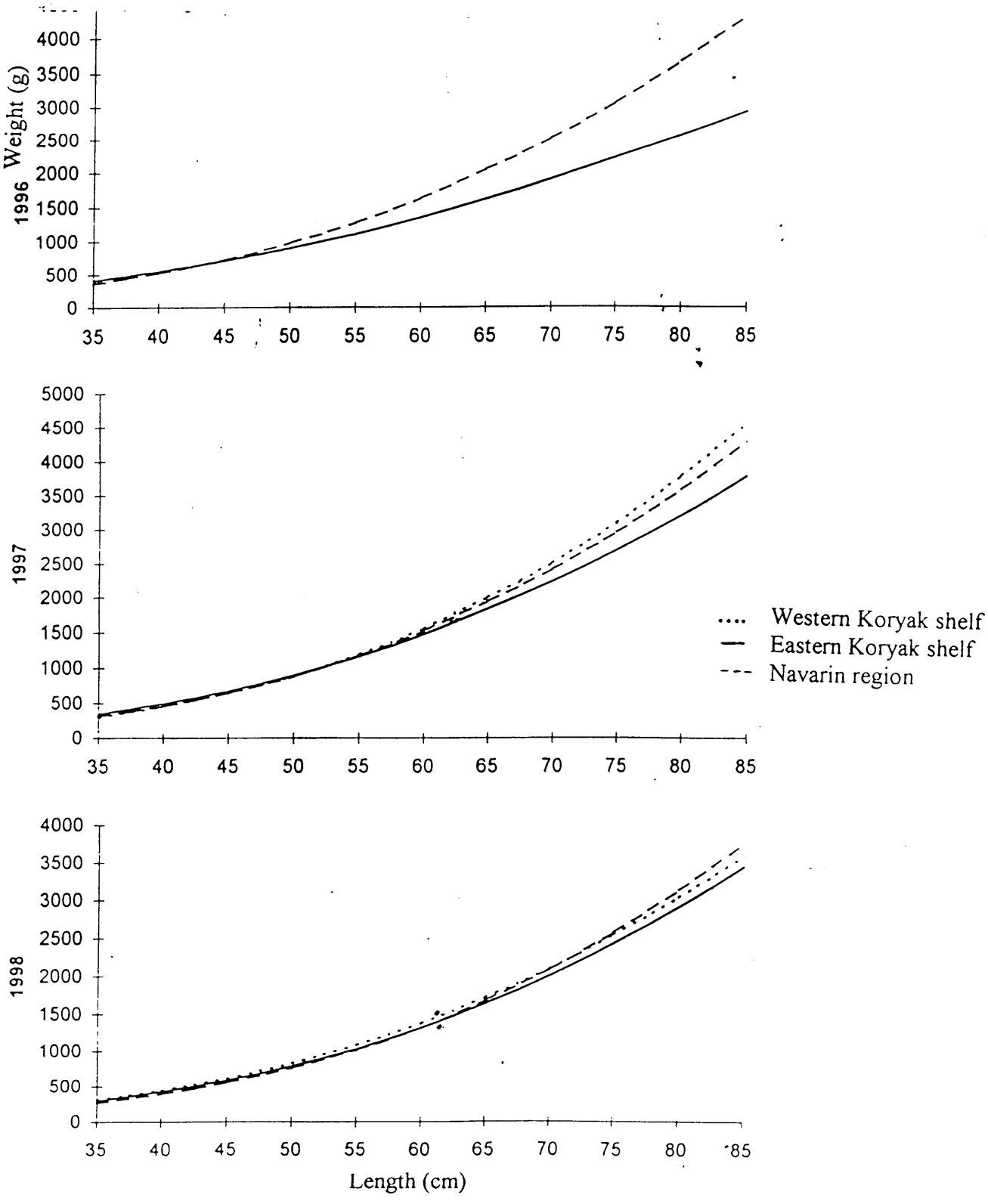
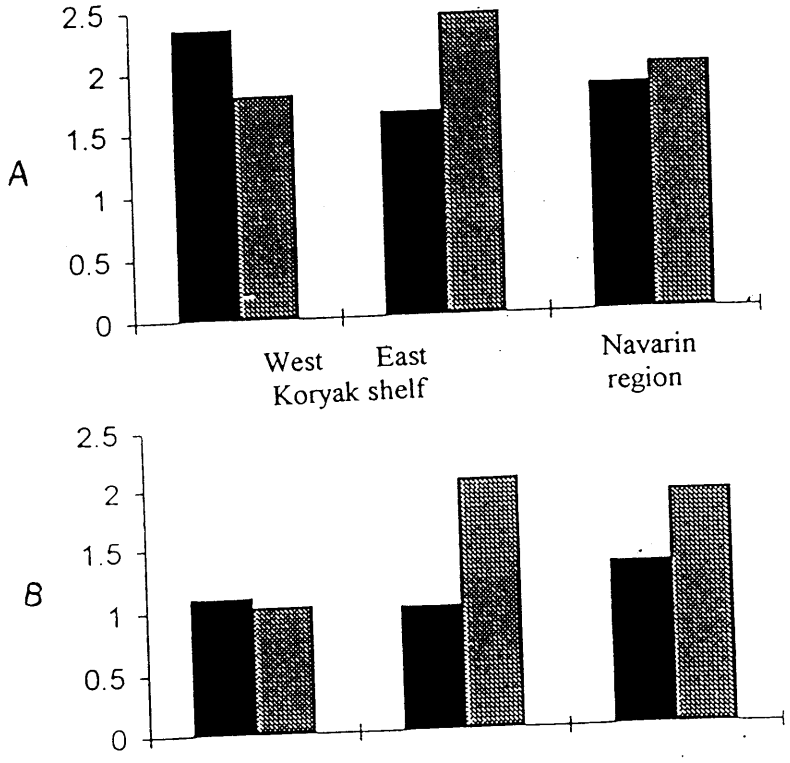



Fig 2.8. Length-weight relationships for North-Western Bering sea pollock, July-August

1998




Black – July, grey – September.

Fig. 29. Seasonal changes in gonadsomatic index of North-Western Bering sea pollock (A) for females, (B) for males, %.

1998

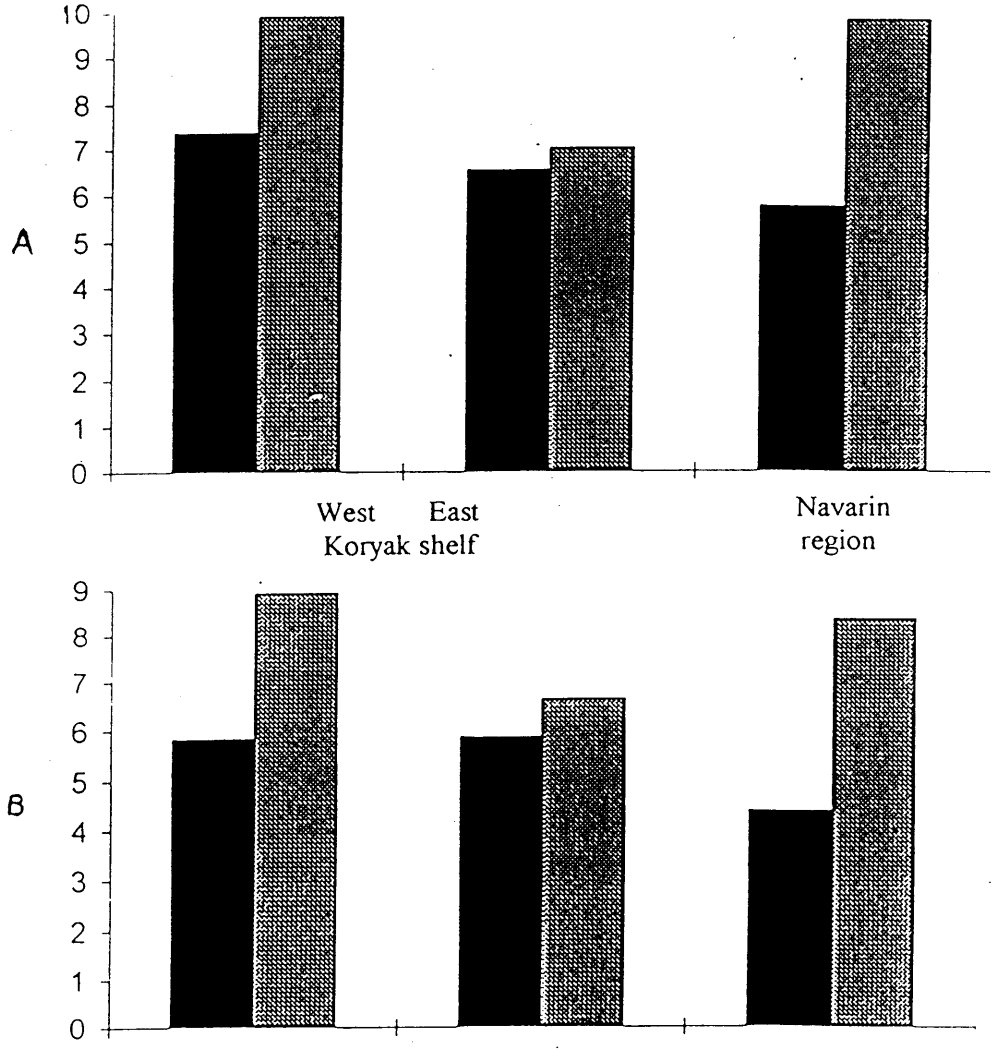



Fig.2.10 Seasonal changes in hepatsomatic index of North-Western Bering sea pollock (A) for females, (B) for males, %. Black – July, grey – September.

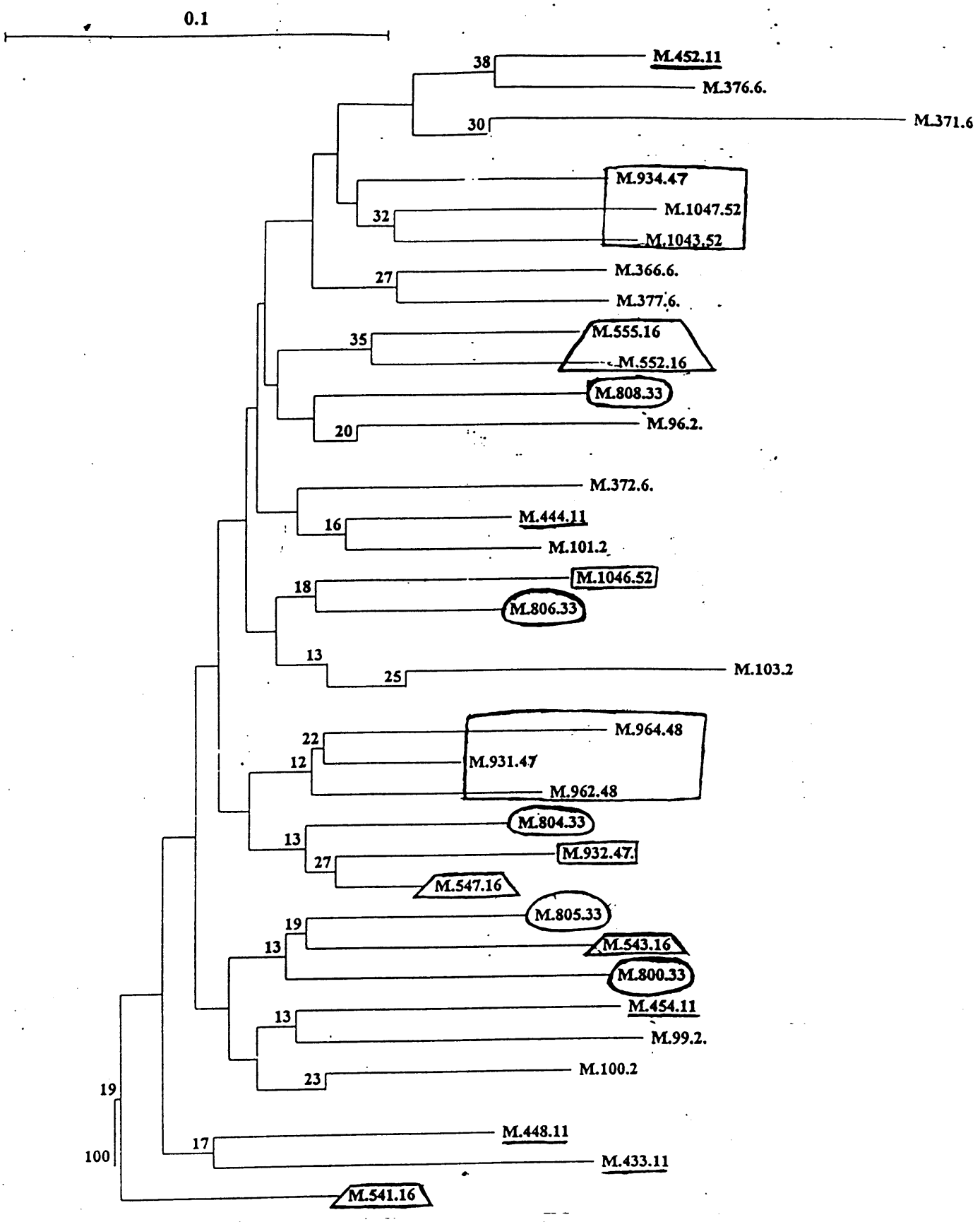



Fig 2.11 Genetic tree on the base of differences between DNA molecules of North-Western Bering sea mature pollock males.

- Western Koryak shelf
- Eastern Koryak shelf
- Navarin region
- Western Anadyr shelf
- Eastern Anadyr shelf