

# **REPORT**

**On the Russian Scientific Observation in the Cruise Onboard of the  
Russian BATM #K - 2176 "Leader" in the South-East Pacific  
(SEPO), March-May 2011**

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## 1. Introduction

The following tasks must be carried out onboard of the fishing vessels during the Russian studies for long-term sustainable use of stocks of jack mackerel fishing in the SPRFMO Convention Area:

- to ensure the observance by Russia the Interim control measures, apply to fisheries for *Trachurus* species in respect of the direction of scientific observers on 10% of Russian vessels engaged in fishing in SP;
- to continue the gathering of samples for genotypic analysis of population structure of Pacific jack mackerel;
- to spend a relative estimation of the stock's condition of jack mackerel using the catches by the standard effort;
- to investigate the spatial distribution of jack mackerel in the fishing season;
- to investigate the size-age composition of jack mackerel's catches in order to identify the structure of clusters and abundant generations;
- to carry out the morphophysiological studies of jack mackerel;
- to collect fishery and biostatistical data.

The works in 2011 were carried out onboard the Russian BATM "Leader" in the area between parallels 42°00' and 45°58' of the southern hemisphere and between meridians 83°00' and 94°59' of the western hemisphere.

One Russian scientific observer D.V.Pelenev worked onboard of the BATM "Leader". His duties included the performance of works according to the trip task.

## 2. Characteristics of the vessel, technical equipment and instruments

The general length of the vessel is 125.22 m; the general width is – 16.02 m; depth – 10.2 m; maximum speed – 16.1 knots. Engine power – 5146 kW; emergency power diesel generators – 1750 kW.

The fishing of hydroids were made with mid-water trawl with the horizontal opening of 120 m and vertical – 80-100 m, general length of trawl – 690 m, mesh size in codend – 110 mm.

The ichthyologic researches were carried out by measuring board (division value of 1 mm), electronic scales of firm «Ishida» with compensated pump (maximum weight 20 kg, accuracy – 1 g), mechanical scales (maximum weight – 6 kg) and the cup weights (accuracy 10 mg).

### **3. Research technique, the volume of collected material**

At each trawling the trawling card including the characterization of trawling and the species composition of target species was filled. The following trawling parameters were registered: the coordinates where the dragrope was taking to the stopper, the depth of the trawling and the catch's volume (t). The fishing-statistical parameters, such as catch per hour of trawling, 24 hours' catch, average daily catch for the ten days, general catch for 10 days were calculated during the fishing.

Samples for mass measurements of length, individual weight and biological analysis of the most abundant species of fish (jack mackerel and chub mackerel) were selected from each catch.

The biological analysis of fish included:

- measurement of the Smith's length (from the end of mug to the end of medium rays of caudal fin), up to 1 mm;
- determination of total body weight, up to 1 g;
- determination of body weight without viscera, up to 1 g;
- definition of sex and maturity stage of gonads;
- definition of filling the stomach to 5-point scale (0-4);
- determination of food composition in the stomach content.

The main bodies of hydrobionts – gonads and liver were weighted for the morphophysiological study. Then the indexes of each of the organs (the ratio of organ mass to body weight without viscera, expressed as a percentage) and the condition factor by Clark were calculated.

Data of trawling cards, biological analyses and data of morphophysiological studies, were brought in program Microsoft Excel. The maps of hydrobionts'

distribution were built with use of software Chartmaster, on a method a 2D-spline, which was developed in VNIRO (Russia). The following characteristics and factors were accepted for calculations:

- horizontal opening of a trawl is 120 m;
- trawling speed is 5 knots;
- catchability coefficient is 1.0;
- spline smoothing parameters is 0;
- coefficient of influence of the depth is 0.

During the work 68 trawlings were carried out; 11131 mass measurements of jack mackerel and 266 of chub mackerel were made; 1850 and 50 biological analyses of jack mackerel and chub mackerel were done respectively; for age determination 327 jack mackerel's otoliths were taken; 200 jack mackerel's genetic samples (the fragment of right pectoral fin) were collected.

#### **4. Chronology of scientific observation**

The beginning of fisheries	March 21, 2011
The end of the scientific observation	May 21, 2011

#### **5. Common characteristics of the catch, catch statistics**

In 2011 from March to May the total catch of the main fishing objects (jack mackerel, chub mackerel) was 1913.78 tons, of them jack mackerel – 1912.47 t, chub mackerel – 1.31 t. The catches per one trawling ranged from 0.318 to 78.413 t, per hour of trawling – from 0.212 to 8,023 t. The largest catch was recorded in April – 1306 t (Fig. 1). Trawlings were carried out at depth layers of 20-46 t. In 2008, 2009 and 2011 the largest catches of pacific jack mackerel occurred in 2009, from May to July, while the lowest were in October 2008. It should be borne in mind that the diagram for 2011 presents data, based on the work of a single ship; while at the same time another Russian vessel worked in the SEPO.

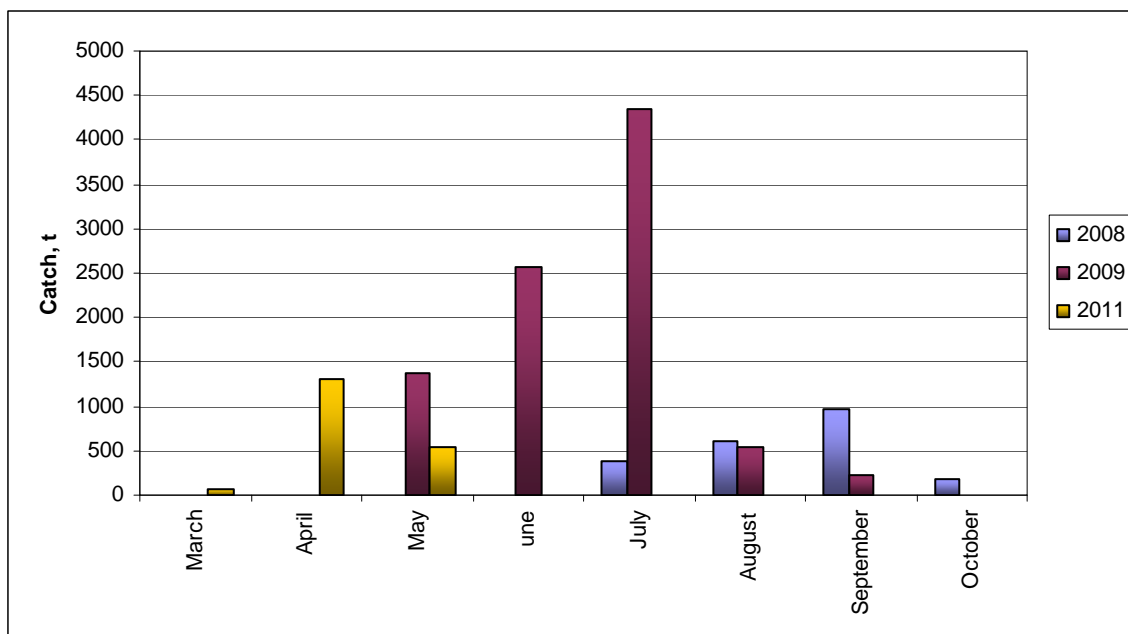


Figure 1. Monthly catches of the Pacific jack mackerel by Russian fleet for 2008, 2009 and 2011.

The catches of the chub mackerel also were highest in July 2009 – more than 280 t. Nearly uniform monthly catch was recorded in 2008 from July to September and was about 50 tons, the minimum catches were observed in September 2009 and April 2011 (Fig. 2.)

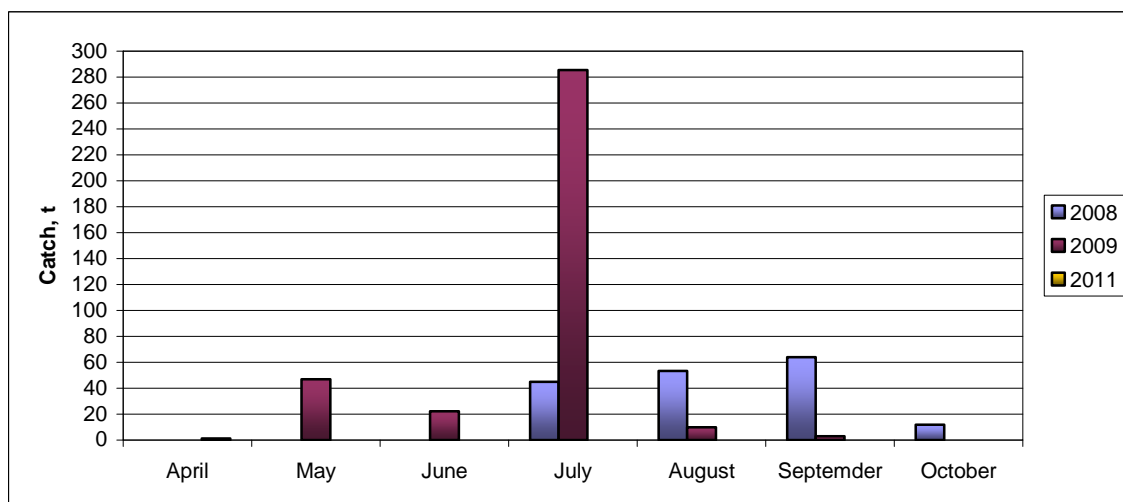


Figure 2. Monthly catches of the chub mackerel for 2008, 2009 and 2011.

The largest catches of the pacific jack mackerel per hour trawling were made in the third decade of July either in 2008 or in 2009 (Fig.3). During research in 2011 from March to May decadal catches ranged from 1.75 to 6.23 t per hour of trawling (there was the maximum catch in the second half of April).

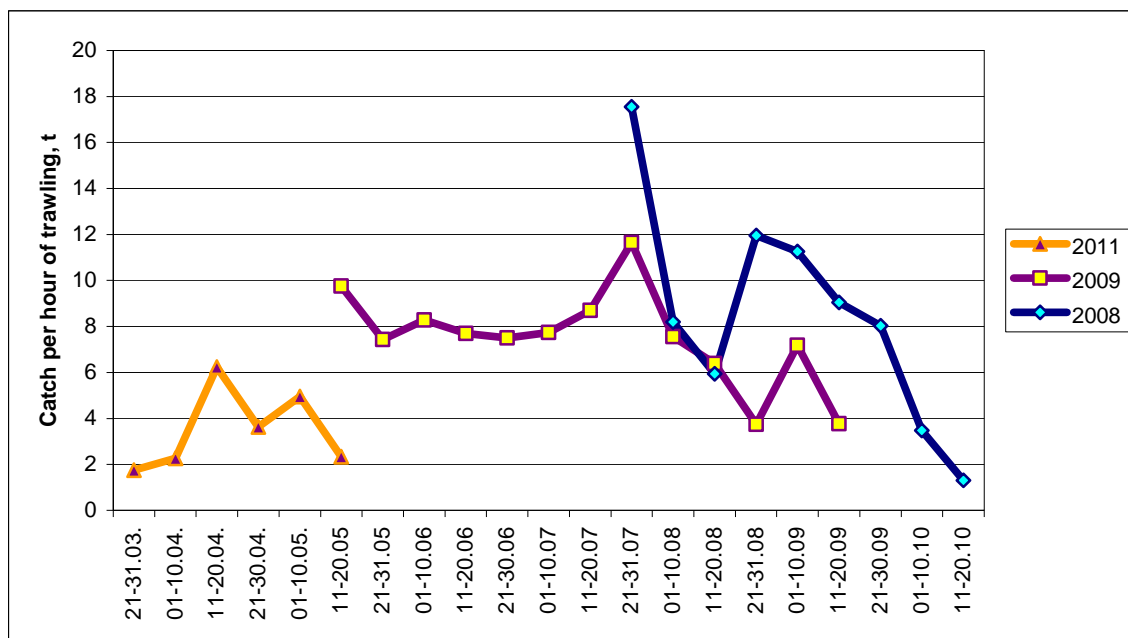


Figure 3. Decadal catches per effort of the pacific jack mackerel in 2008, 2009 and 2011 (Russian fleet).

In general, catches by the standard effort in 2011 was minimal for all the compared period. At the same time the annual decline in catch per unit effort in a number of years 2008-2009-2011 was pointed out (Table 1). This is an indirect indication of the deterioration of the pacific jack mackerel's stocks in the high seas of SEPO.

Table 1. Russian catches per hour of trawling of the pacific jack mackerel and chub mackerel by years.

year	jack mackerel	chub mackerel
2008	10.06	0.84
2009	7.94	0.57
2011	3.75	0.19

In general, fishing situation during the period of research can be described as unsatisfactory.

Also the frequent adverse weather conditions complicated the fishing, because of which the vessels lost from one to three days of work.

### 6. The characteristic of the pacific jack mackerel – *Trachurus murphyi*

Catches of the pacific jack mackerel per trawling ranged from 0.318 to 78.413 t, averaging 28.125 t. Maximum catch was recorded at coordinates 43°18' S 87°35' W. Catch per hour of trawling ranged from 0.212 to 8.023 t, averaging 3.750 t.

The main core of the pacific jack mackerel's aggregations was observed in the north of fishing area of BATM "Leader" at the end of March - May 2011

The fishery aggregations of the pacific jack mackerel shifted to the north (Fig. 4), following the cooling of water from March to May (Fig. 5). The jack mackerel's most preferred temperature was 11-12° C in March-May.

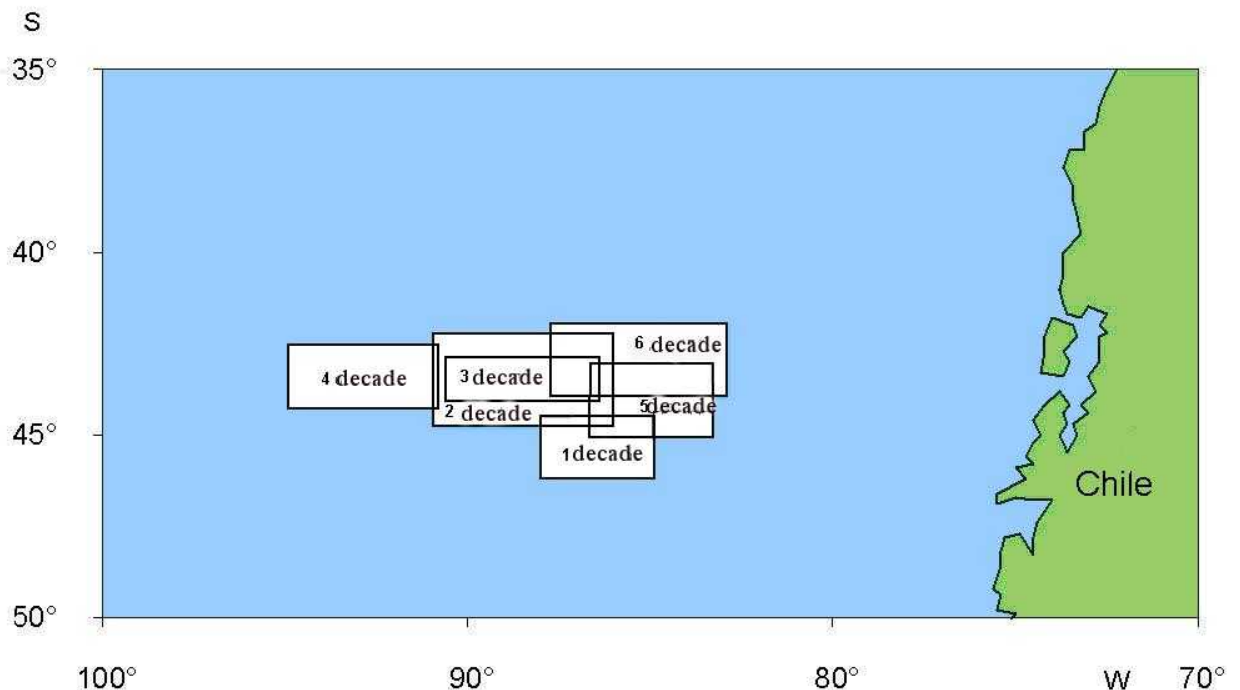


Figure 4. Map of movements of the vessel "Leader" in 2011 during the fishery in the SEPO by ten days (1 decade – 21.03.-31.03., 2 decade – 01.04.-



10.04., 3 decade – 11.04.-20.04., 4 decade – 21.04.-30.04., 5 decade – 01.05.-10.05., 6 decade – 11.05.-20.05.).

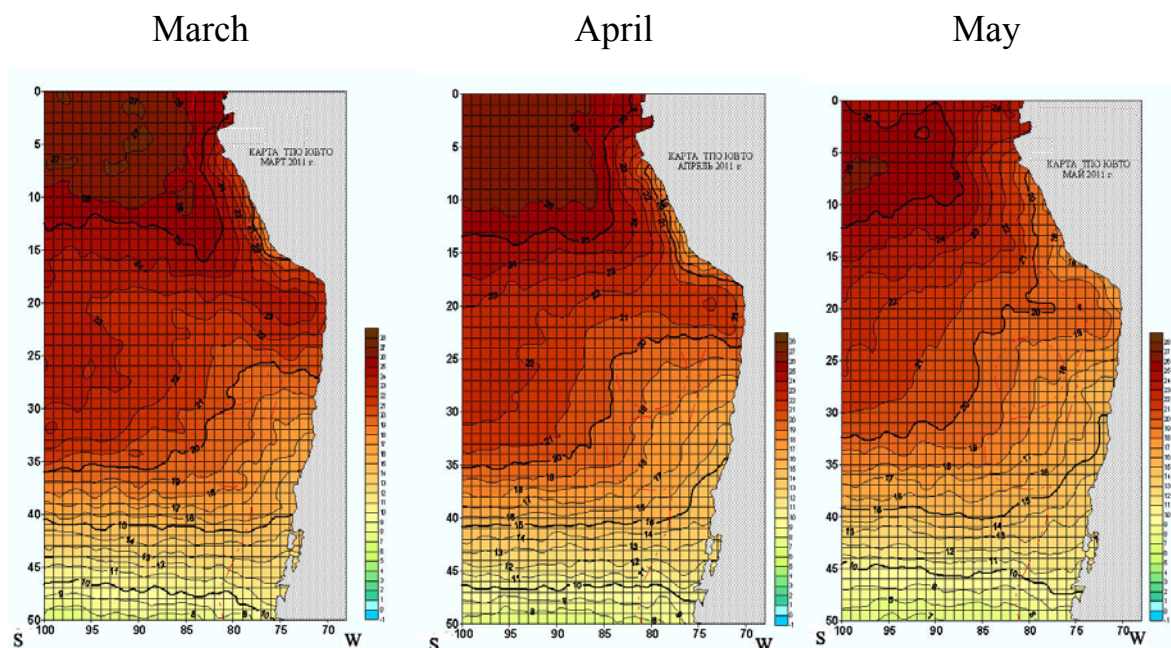


Figure 5. Maps of SST in the SEPO in the period from March to May 2011.

The jack mackerel with length from 22 to 55 cm (mean length 37.97 cm) were met in catches. Two modal groups dominated in the size range: of 32 - 35 cm, which accounted for 23.46% of the catch, and of 40-43 cm – 23.83% (Fig. 6).

The jack mackerel's length composition, similar to the 2011, was noted in 2007: the first dominated group had a modal length from 33 to 38 cm, the second – from 41 to 45 cm (Fig. 7). In 2008 and 2009 the length composition of the jack mackerel was unimodal with a mode of 34 to 39 cm. In addition, the catch in 2009 was attended by a large number of young generations, 2007-2008.

According to our data in 2008-2011 the occurrence of juveniles in the catches increased in advancing from the east to the west, causing a decrease in the average sizes of fish in the catches (Fig. 8).

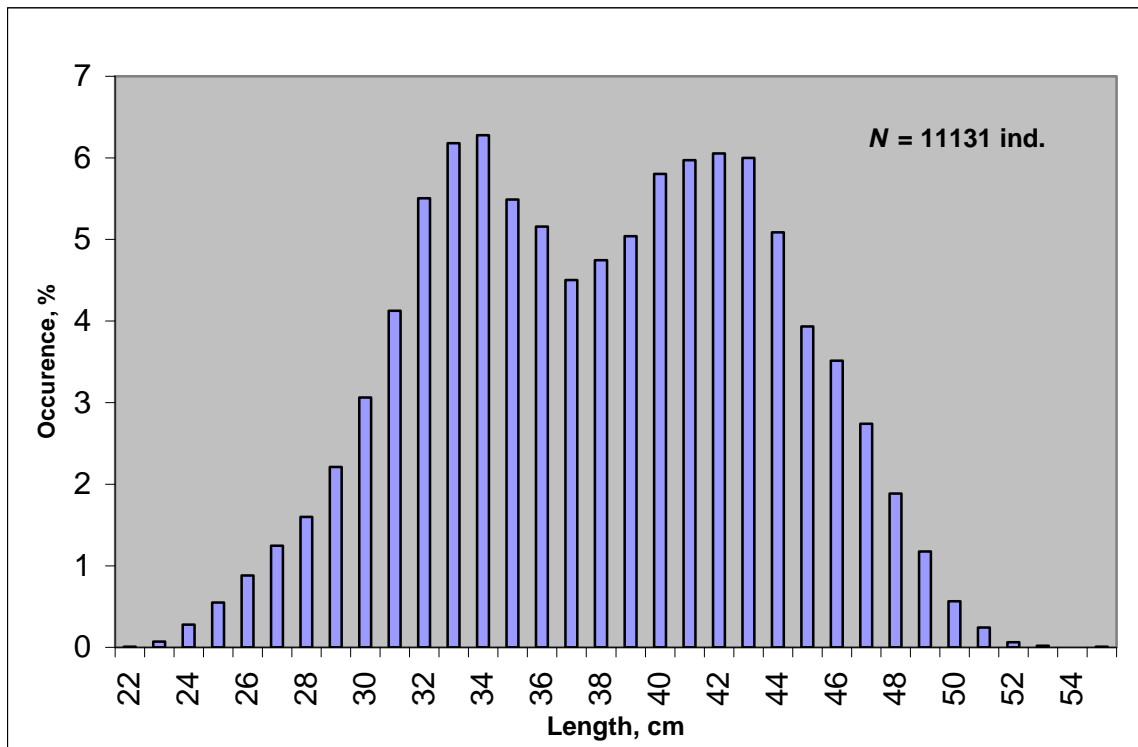


Figure 6. Length composition of the Pacific jack mackerel in the SEPO in March-May 2011, according to trawlings of BATM "Leader".

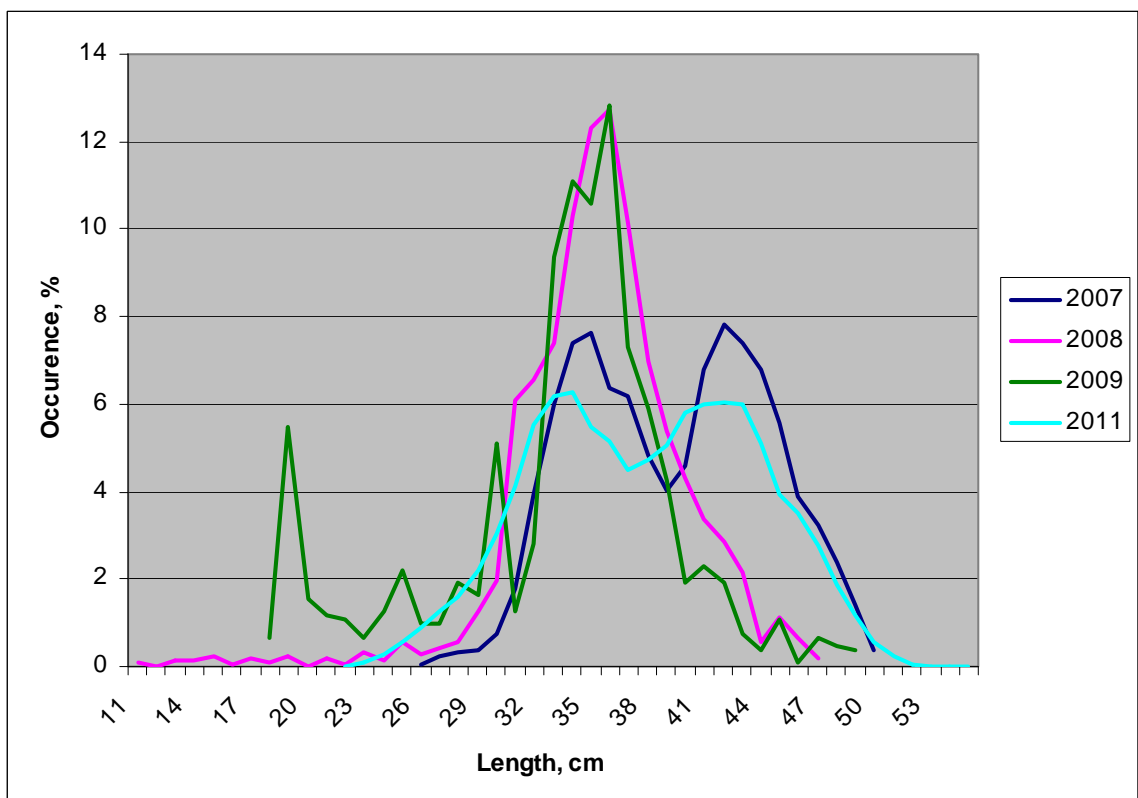


Figure 7. Length composition of the Pacific jack mackerel from commercial catches in the SEPO 2007-2011.

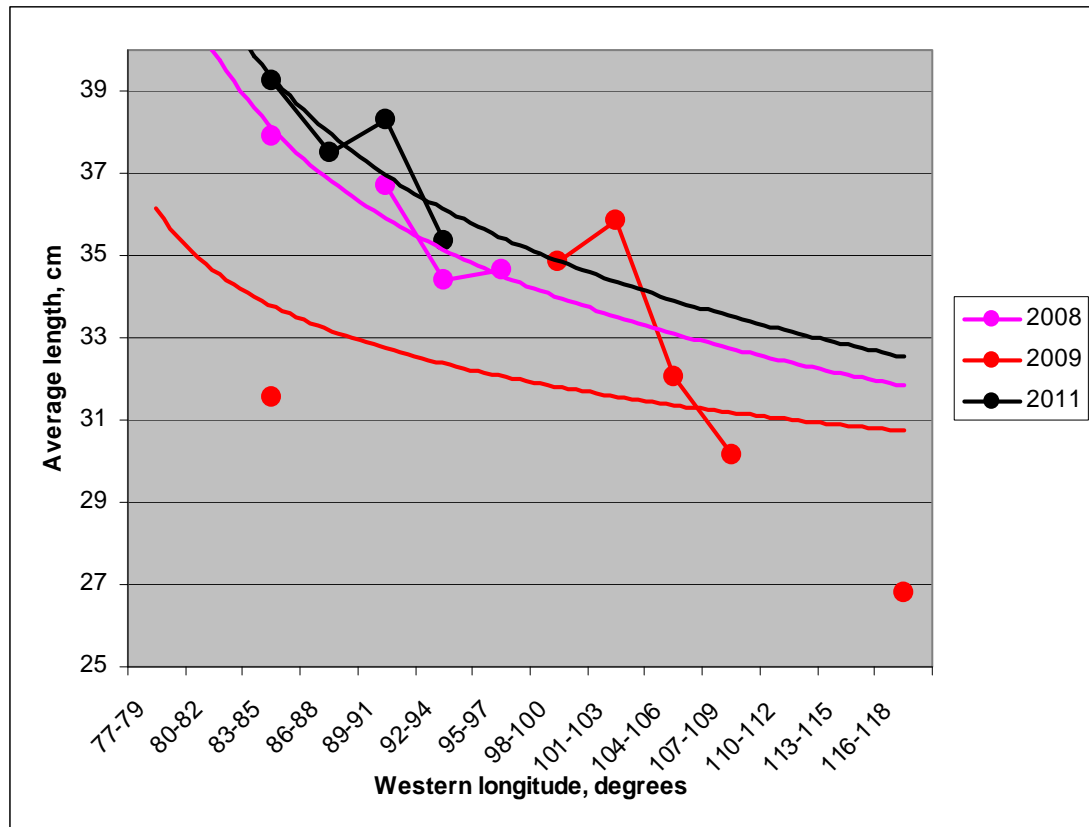


Figure 8. The average length of the pacific jack mackerel in the Russian catches on different meridians in 2008-2011.

According to the Russian data in 1979-2002 the average length of the pacific jack mackerel, on the contrary, decreased in a direction from the west to the east, that is, off the coast of the South America the smallest jack mackerel was caught. According to the data, collected in the cruise of R/V "Atlantida" in 2009 the average length of a jack mackerel in catches increased at advancement in east direction on area from 126° W to 74° W (Sushin, 2009).

Thus, since 2008 the number of the juvenile jack mackerel, which was found in the coastal waters, was essentially reduced in comparison with the period from 1979 to 2002.

In 2011, the jack mackerel in age from 3 to 5 years (generations of 2008-2006) dominated in the catches. Individuals of the same age classes dominated in the catches in 2007 (Fig. 9). There were practically no individuals older than 4 years in catches in 2008 and 2009. Attention is drawn to the appearance of the

immature fish with age 2 + in the catches of 2009 and 2011. Despite the emergence in the last 3 years of the young fish, the proportion of fish in the next age class (3 +) reduced during 2008-2011. In the same period the increased the share of old fish (6 +), which may develop high speed and for whom it is easy to avoid the gear. This may be indirect evidence of excessive catches of juveniles in recent years.

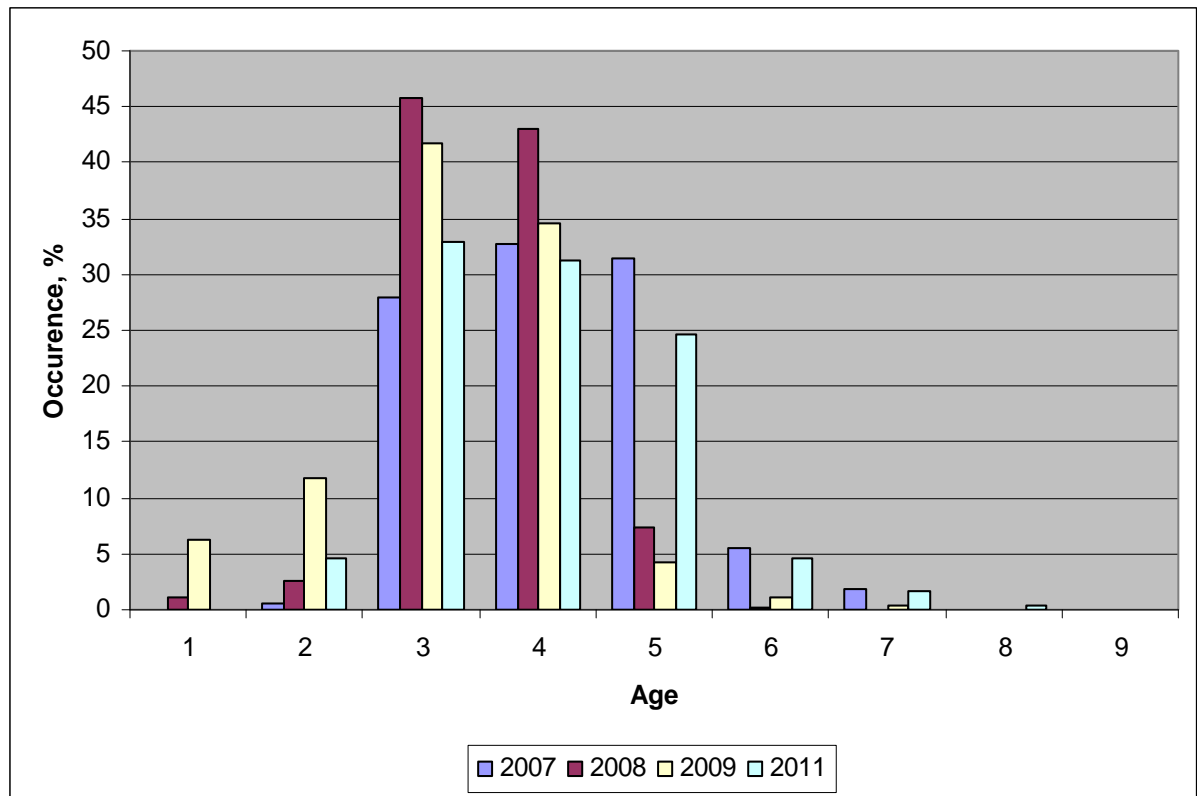


Figure 9. Age composition of jack mackerel's catches in the open sea of SEP according to fishing trawls 2007-2011.

Female jack mackerel dominated in the South-East Pacific in March-May 2011. They accounted for 70.78% and males – 22.15%, 7.07% – the juvenile. The stage of maturity of gonads of male and female jack mackerel were a similar during the study. The females with gonads at II - 17.14%, III - 58.49% and VI-II - 24.37% stages of maturity dominated in March-May 2011 (Table 2, Figure 10).

Table 2. The biological characteristic of the pacific jack mackerel according to trawlings of BATM "Leader".

average length, cm/number of measurements		37.97/11131
minimum – maximum length, cm		20.7-62.5
average weight, g	females	685
	males	717
minimum - maximum weight, g	females	170-2014
	males	193-2382
share of males, %		22.15
dominated stages of maturity, %	females	II – 17.14%; III – 58.49%; VI-II – 24.37%
	males	II – 16.08%; III – 58.29%; VI-II – 25.63%
stomach fullness, point		2.46
share of empty stomach, %		88.16
cubic condition factor		0.89
gonadosomatic index, %	females	0.879
	males	0.886
hepatosomatic index, %	females	0.905
	males	0.965
number of individuals: bioanalysis/morphophysiology		1850/1850

Note: the average length is given by results of mass measurements, the rest is based on the results of the full biological analysis.

Among males dominated fish with gonads at II – 16.08%, III – 58.29% и VI-II – 25.63% stages of maturity.

A significant change in the ratio of individuals with different stages of maturity of the gonads were not observed during 60 days of research from March 21 till May 21 (Fig. 11, 12). During the period of scientific observation onboard of the BATM "Leader", the jack mackerel was in the middle of its feeding period of the annual cycle, which suggests the prevalence of individuals with III stage of the gonads' maturity.

Females were slightly smaller than males. Length of the first ranged from 23.0 to 58.8 cm, averaging 40.9 cm. Males' length range was from 26.0 to 62.5 cm, mean length – 41.4 cm. Difference in body weight among the females also was a

bit smaller: 170 - 2014 (average 685 g) and 193 - 2382 g (mean 717 g), males and females in accordance. The relationship between length and body mass had a well-pronounced exponential character (Fig. 13, 14) that were highly accurate approximation for both sexes ( $R^2 = 0.94$  and  $0.96$  for females and males in accordance). The values of linear and power coefficients depending on the males and females were similar.

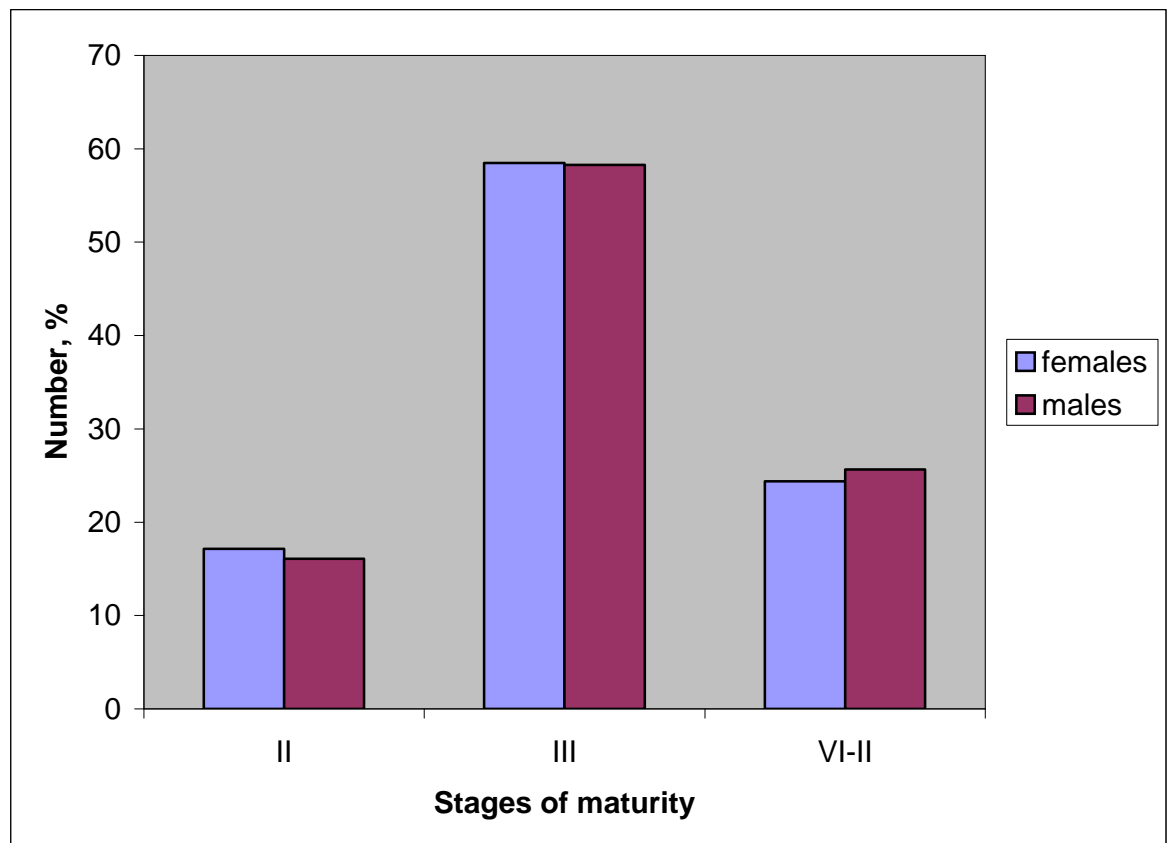


Figure 10. Ratio (%) of females (N = 1272) and males (N = 398) of jack mackerel with the gonads at different maturity stages in SEPO in March-May 2011.

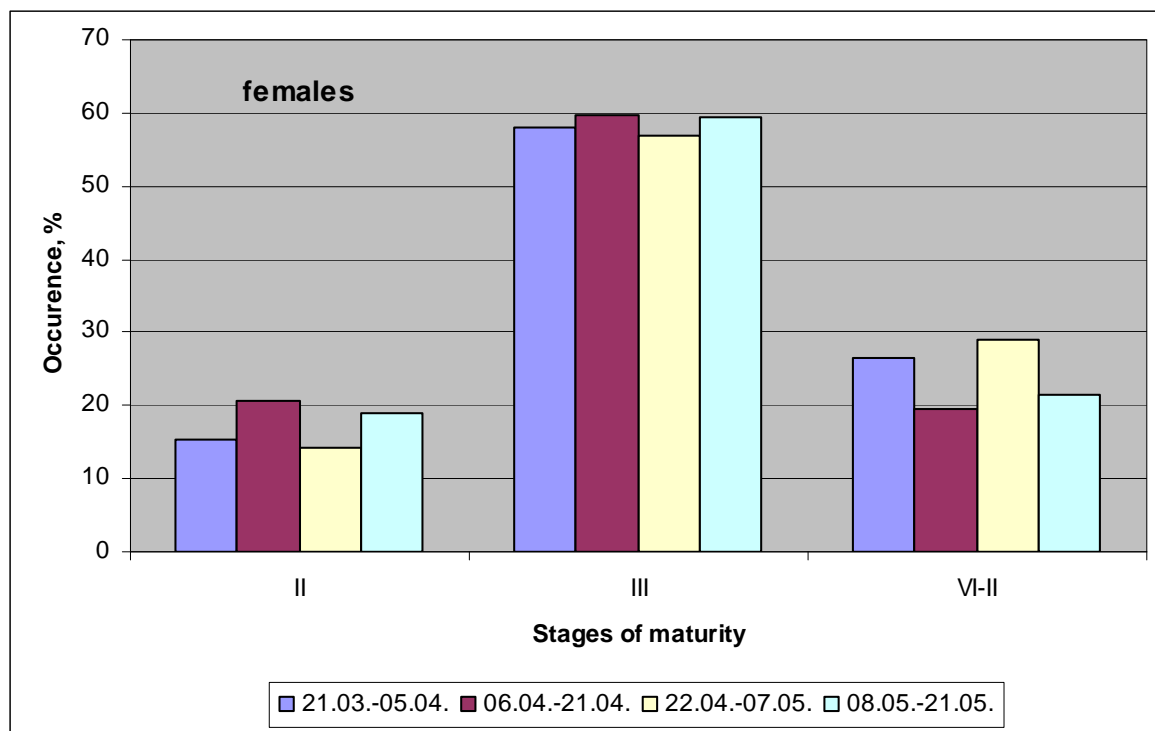


Figure 11. The ratio of females by stages of the gonads' maturity by 15 days in March-May 2011 in the SEPO.

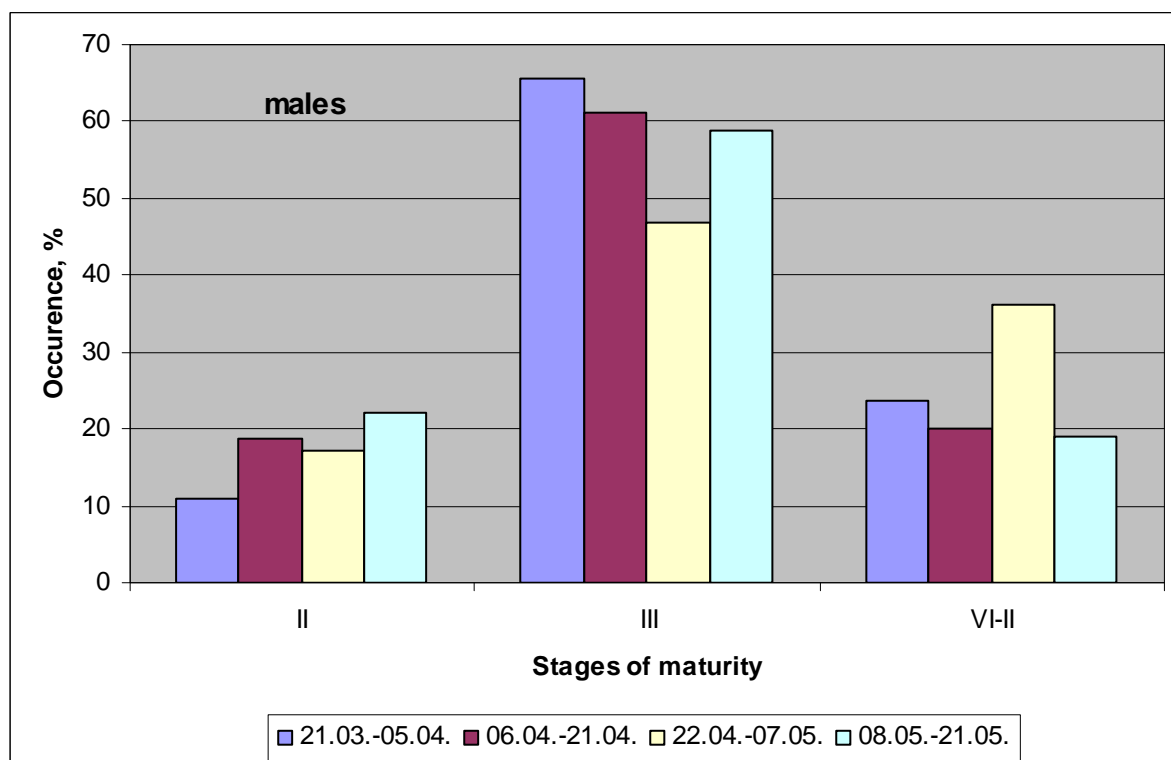


Figure 12. The ratio of males by stages of the gonads' maturity by 15 days in March-May 2011 in the SEPO.

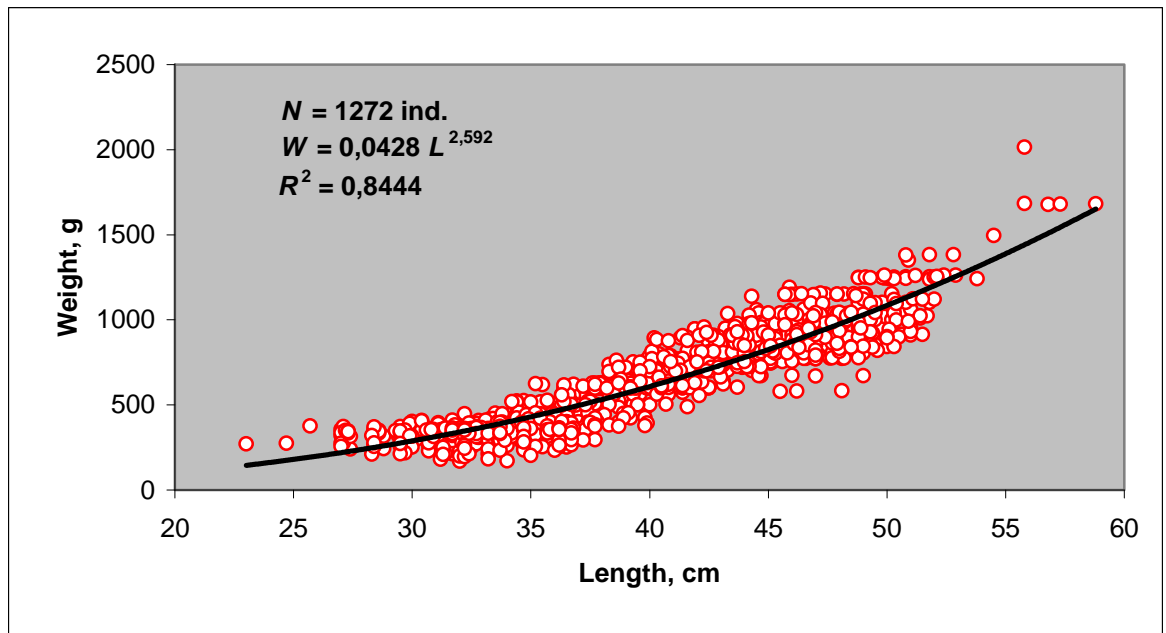


Figure 13. The relationship between length and weight of females of the Pacific jack mackerel in the SEPO in March-May 2011.

The gonadosomatic index (GSI) of jack mackerel's females was lower than males' and was equal (an average) to 0.879 (Table 2). The males' gonadosomatic index was equal (an average) to 0.879 (Table 2).

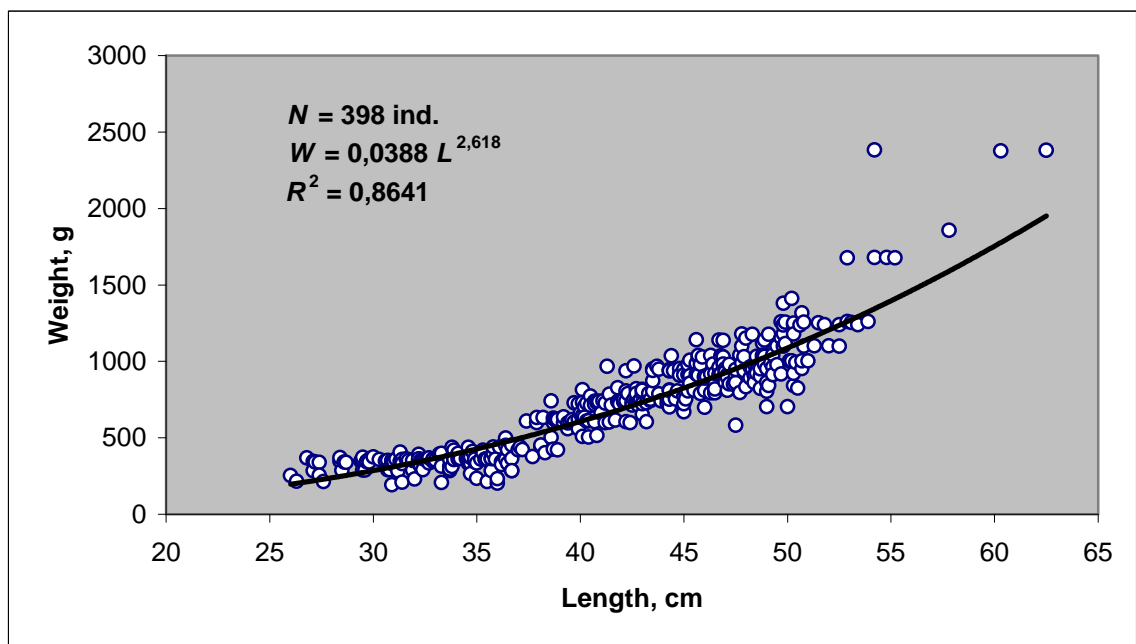


Figure 14. The relationship between length and weight of males of the Pacific jack mackerel in the SEPO in March-May 2011.



A significant correlation between the GSI and length of specimens were not found (Fig. 15, 16).

In the period of study the highest rates of GSI were in the third decade of March (Fig. 17) both in males and females, probably due to the recent completion of spawning. Subsequently, the GSI was approximately at the same level.

Compared with 2007 (Fig. 18), GSI of females and males was higher in 2011; this fact probably indicates a low number of pacific jack mackerel in 2011 in comparison with 2007.

The females' hepatosomatic index (HSI) was also slightly lower than in males during the period of study, and was equal to (an average) 0.905 (Table 2). Males' HSI was equal to (an average) 0.965 (Table 2). The relative weight of the jack mackerel's somewhat decreased with increasing length of the specimens. This trend is more pronounced in males (Fig. 19, 20).

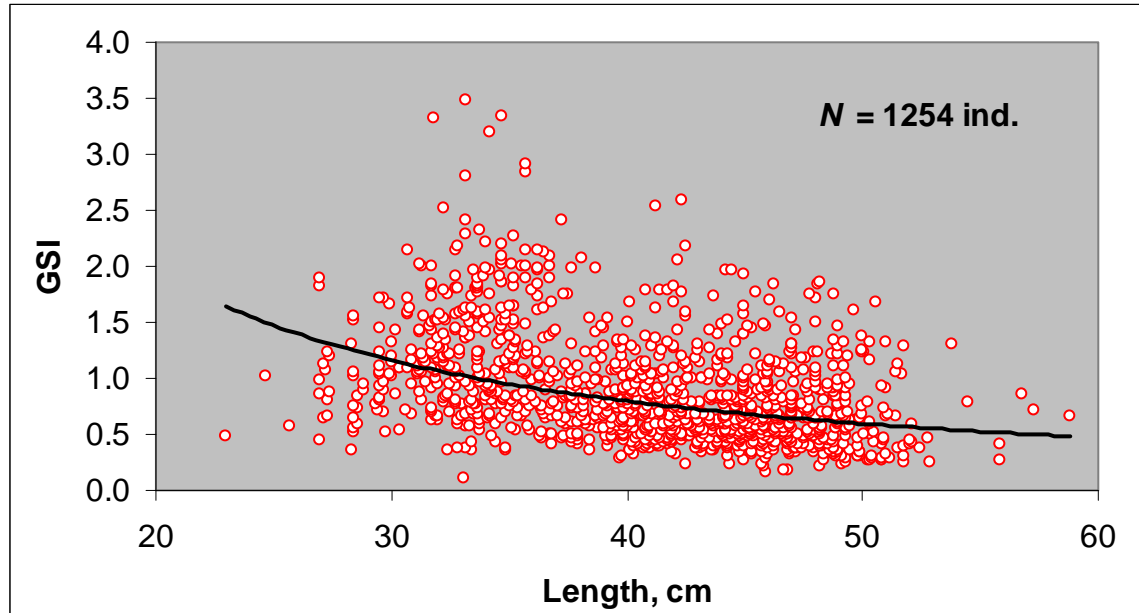


Figure 15. Gonadosomatic index (GSI) of jack mackerel's females, depending on the length in the SEPO in March-May 2011.

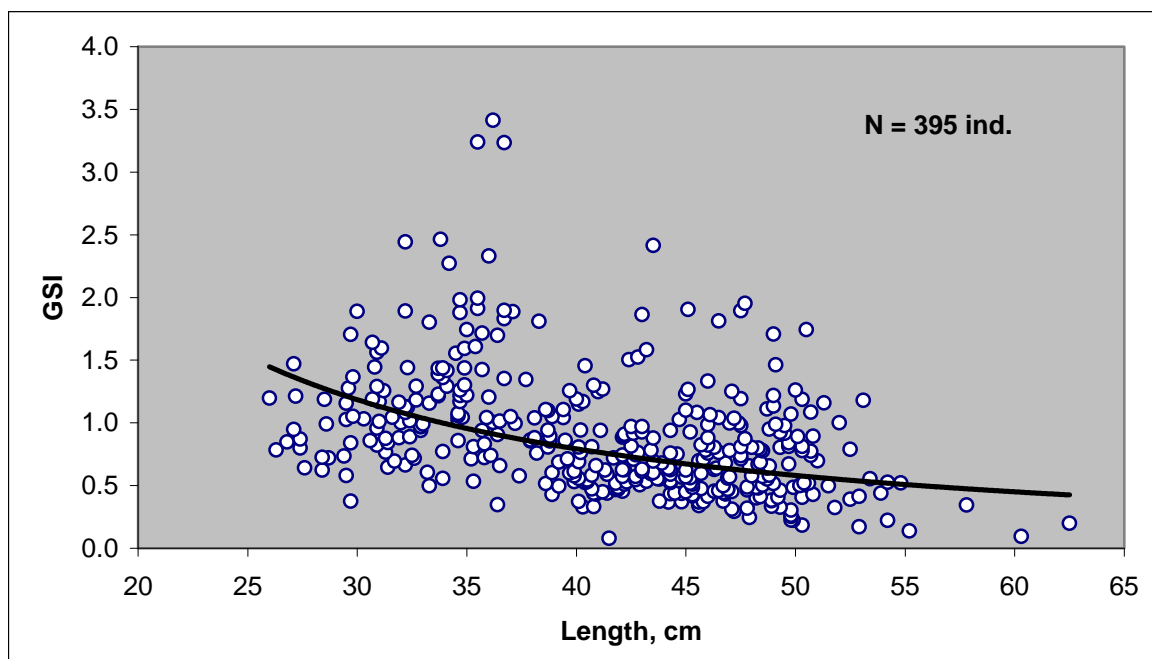


Figure 16. Gonadosomatic index (GSI) of jack mackerel's males, depending on the length in the SEPO in March-May 2011.

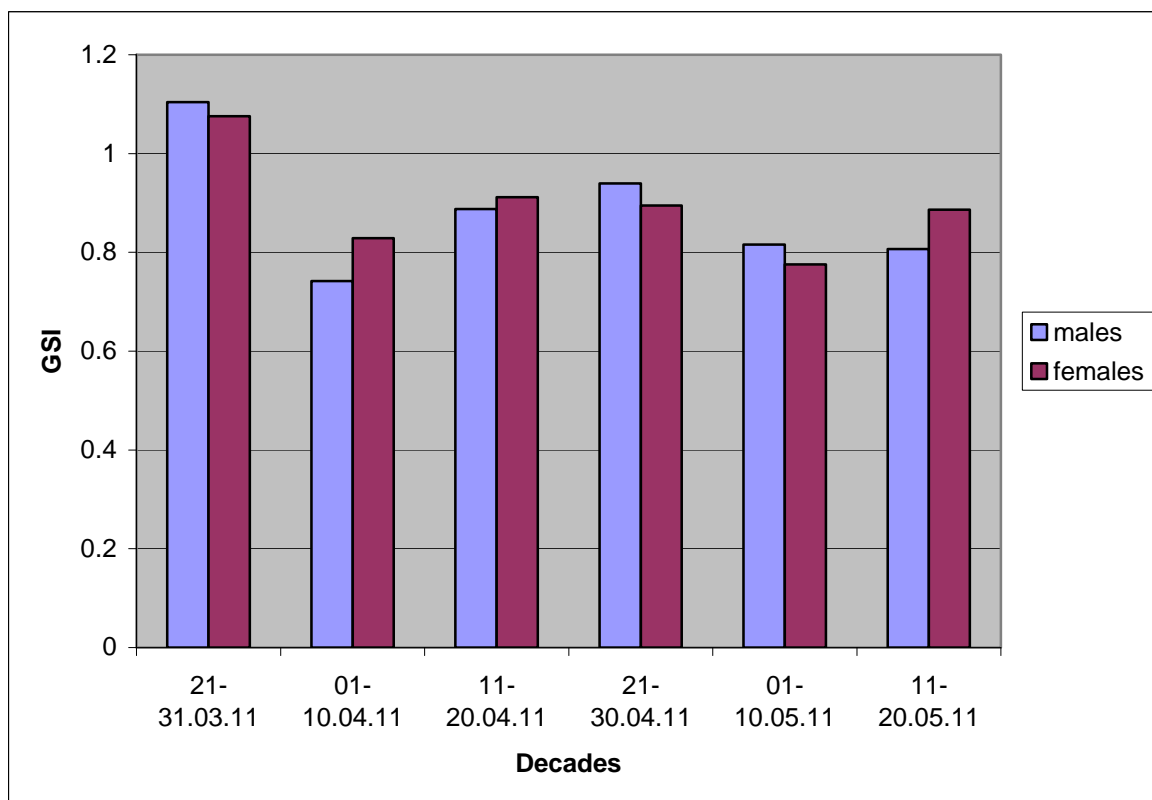


Figure 17. Gonadosomatic index of the pacific jack mackerel by ten days in March-May 2011.

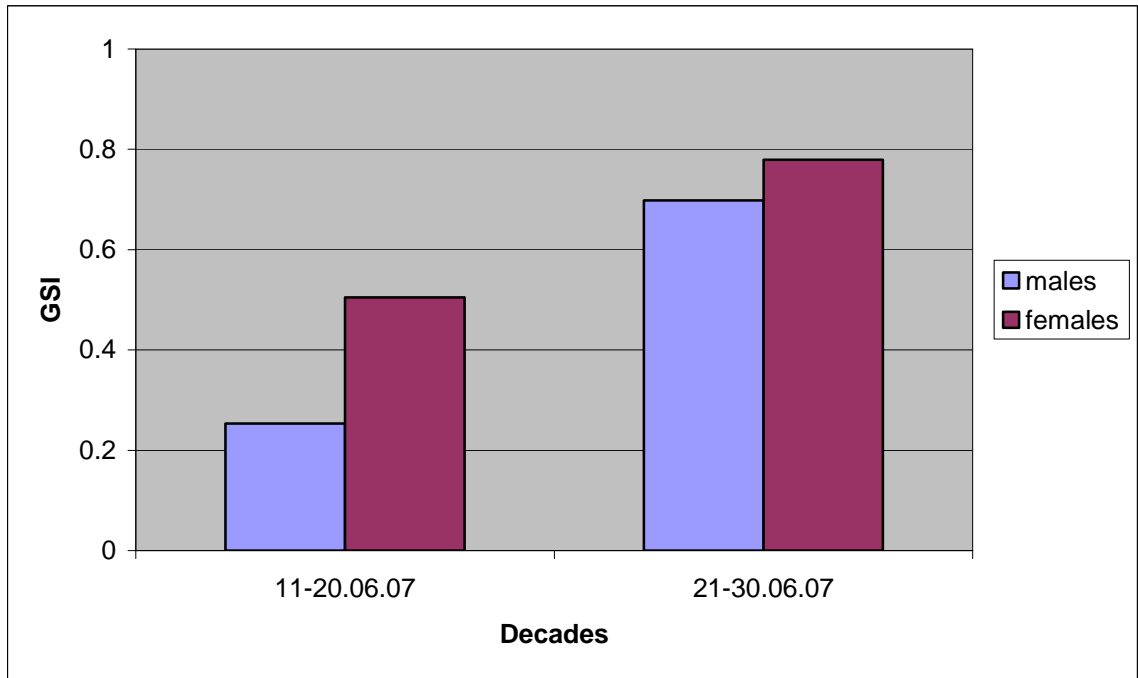


Figure 18. Gonadosomatic index of the pacific jack mackerel by ten days in June 2007.

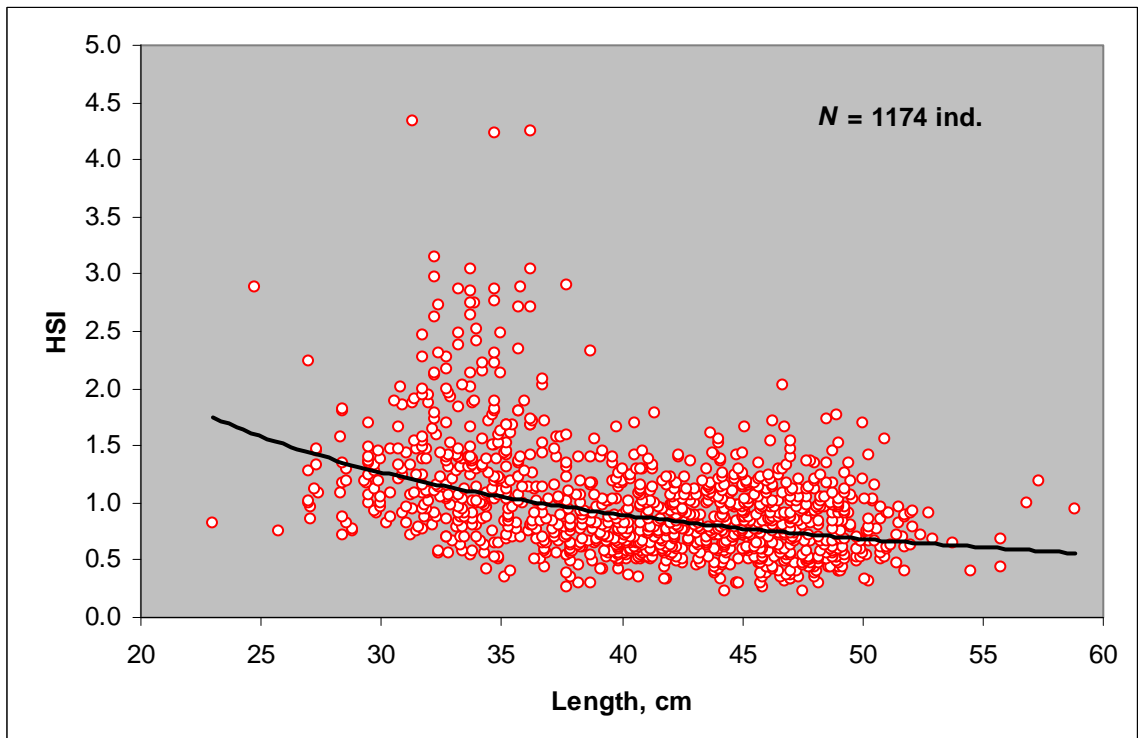


Figure 19. Hepatosomatic index of jack mackerel's females, depending on the length in the SEPO in March-May 2011.

The highest rate of HSI was recorded in females in the first decade of observation (Fig.21). Later it was about the same level. In males, the entire period of observation HSI was on one level. Either HSI or GSI was higher in 2011 than in 2007 (Fig.22), which indirectly reflects the low number of jack mackerel in 2011.

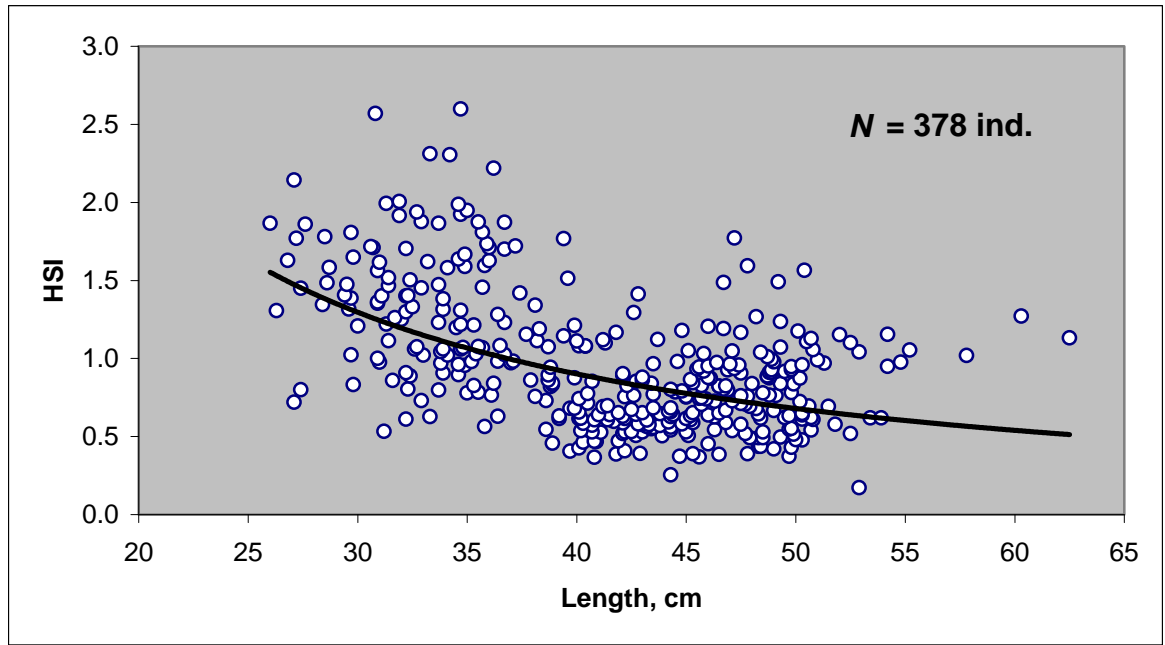


Figure 20. Hepatosomatic index of jack mackerel's males, depending on the length in the SEPO in March-May 2011.

The cubic condition factor as in females and males of the jack mackerel was similar and amounted to an average of 0,868 relative units for females and 0.865 for males (Table 2).

Value of the cubic condition factor does not depend on the length (Fig.23, 24).

The average stomach fullness (without scales) of the jack mackerel was 2.46, the percentage of empty stomachs reached 88.16%. As in most stomachs we found scales, it was not include in food items and excluded from the analysis (presumably fish swallowing it directly into the trawl). The main food objects of jack mackerel were euphausiids (54.33%) (mainly in fish length from 20 to 30 cm), hyperiids (25.80%) and shrimp (17.32%), in the rest the stomachs were digested food (12.70%) (Fig. 25).

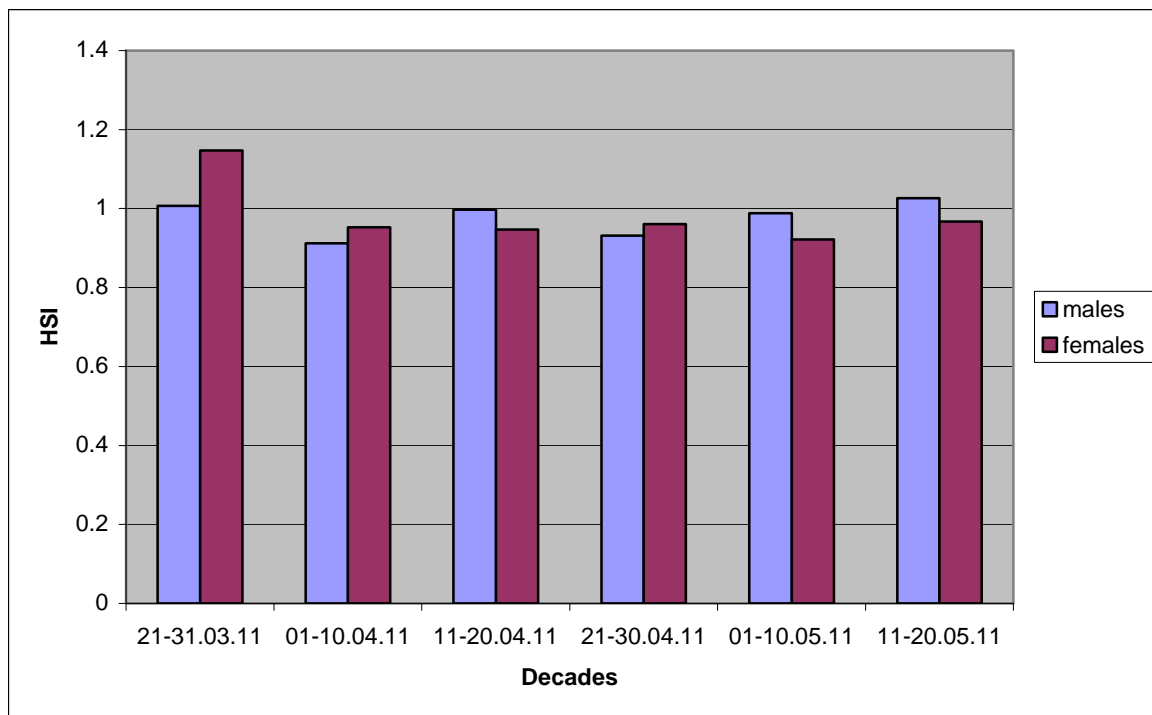


Figure 21. Hepatosomatic index of the pacific jack mackerel by ten days in March-May 2011.

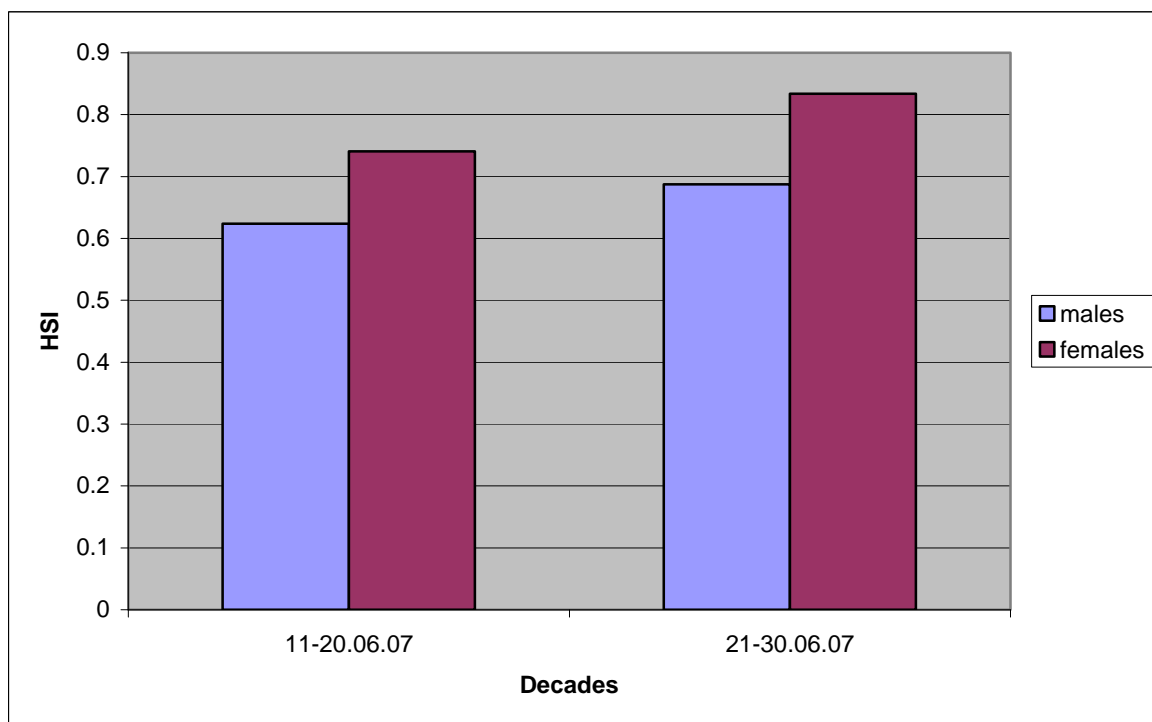


Figure 22. Hepatosomatic index of the pacific jack mackerel by ten days in June 2007.

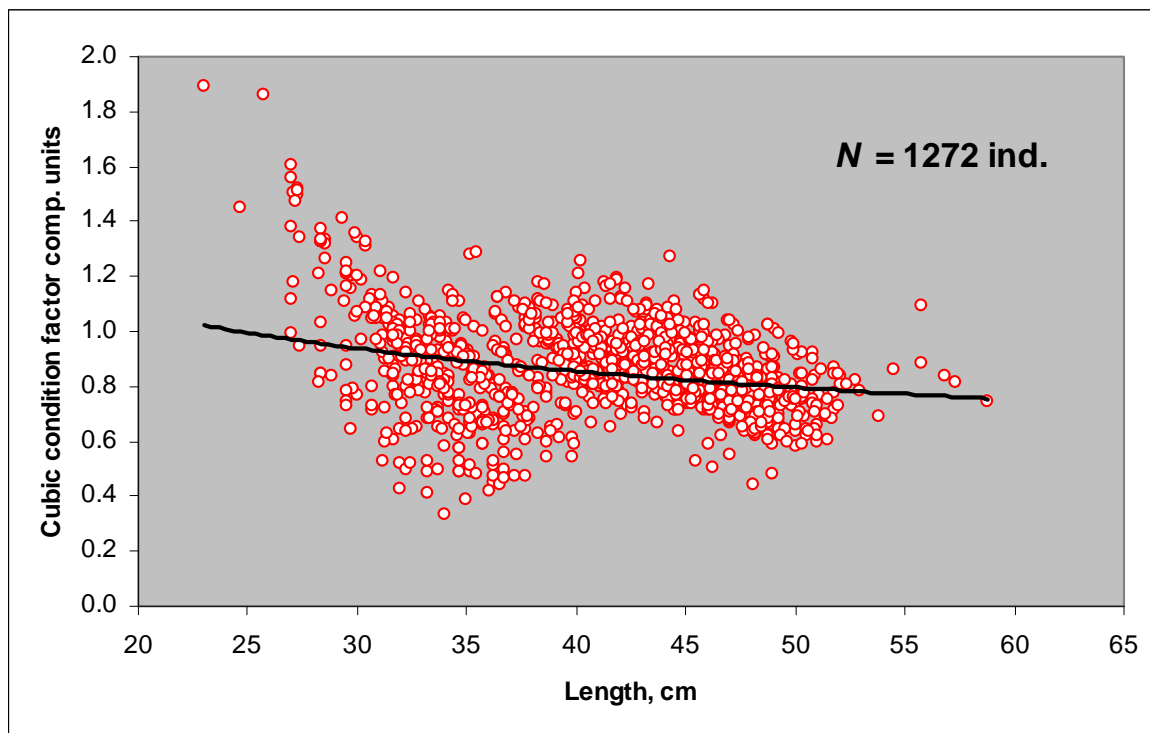


Figure 23. The cubic condition factor by Clark of jack mackerel's females, depending on the length in the SEPO in March-May 2011.

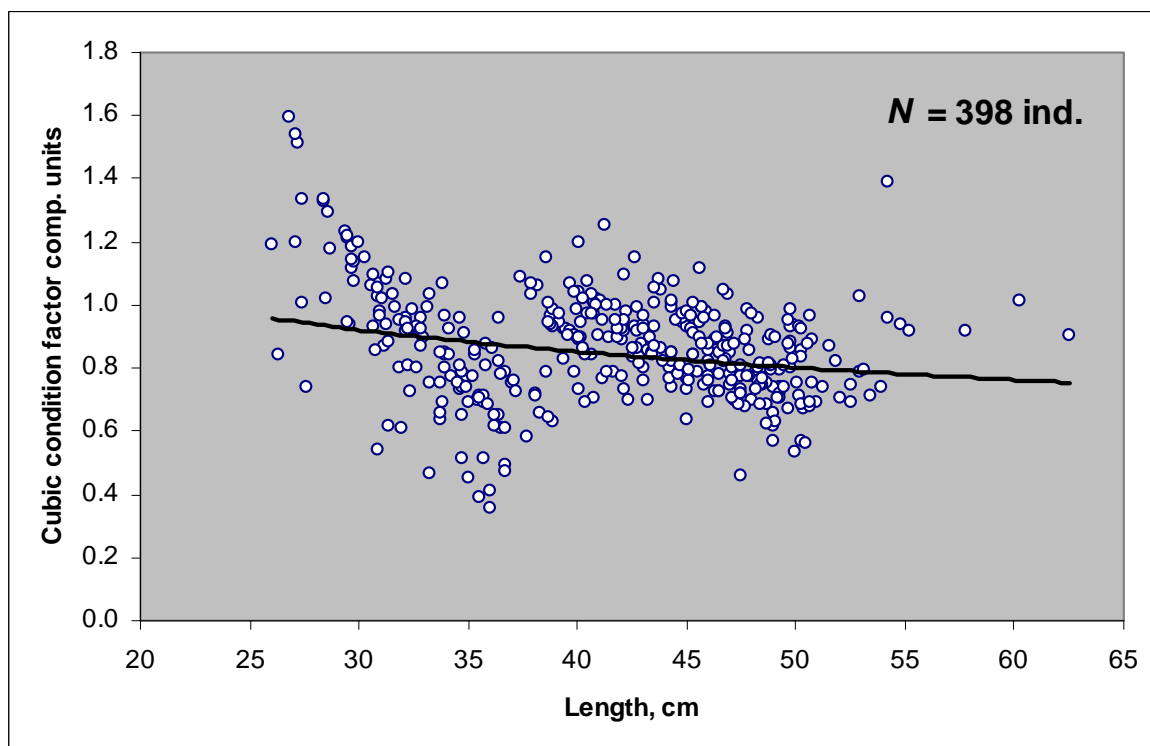


Figure 24. The cubic condition factor by Clark of jack mackerel's males, depending on the length in the SEPO in March-May 2011.

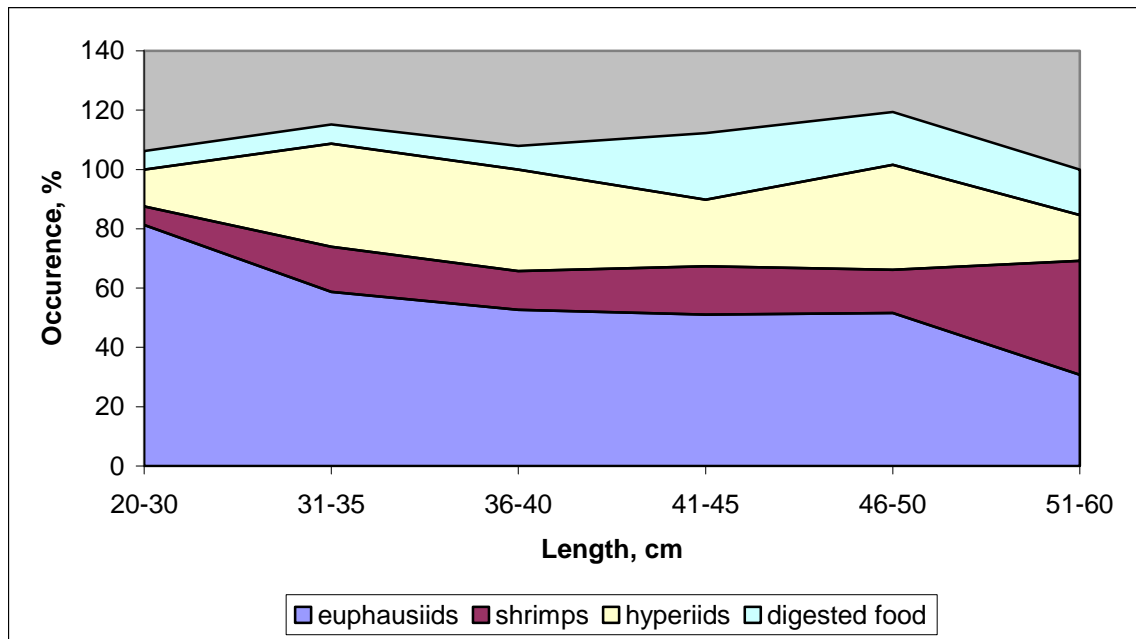


Figure 25. Pacific jack mackerel's food composition depending on the length in the SEPO in March-May 2011.

### 7. Characteristic of the chub mackerel – *Scomber japonicus*

In catches in the South-East Pacific during March-May 2011, chub mackerel was noted only once – on April 14 in the coordinates 44°34' S 86°47' W. The value of the catch amounted to 1.311 t per trawl, 0.187 t per hour of trawling.

The length of chub mackerel ranged from 30 to 42 cm, mode was 33-37 cm. 51.88% of catch consisted of the fish with such length (Fig.26).

Females dominated in the catch (62.0%). Males accounted for 38.0%. The weight of females varied in the range from 232 to 772 g, males – 272-820 g, averaging 561.84 g and 623.89 g in accordance (Table 3).

Average stomach fullness of chub mackerel was 0.8, the proportion of empty stomachs reached 76.0% (without scales). The cubic condition factor by Clark was equal to 1.124.

The females' GSI was significantly higher than males'. The average value of females' GSI in the catches was equal to 1.0; the GSI of males was equal to an average of 0,713.

The females' HSI increased with the increasing of their length. The females' index of the liver was on average slightly smaller than males': 1.147 and 1.206 in accordance.

Table 3. The biological characteristic of the chub mackerel.

average length, cm/number of measurements		35.23/266
minimum – maximum length, cm		32.2-39.0
average weight, g	females	561.84
	males	623.89
minimum - maximum weight, g	females	232-772
	самцы	272-820
share of males, %		38.0
dominated stages of gonads maturity, %	females	II – 12.90%; III – 80.65%; VI-II – 6.50%
	males	II – 21.05%; III – 78.95%
stomach fullness, point		3.2
share of empty stomach, %		76.0
cubic condition factor		1.124
gonadosomatic index, %	females	1.000
	males	0.713
hepatosomatic index, %	females	1.147
	males	1.206
number of individuals: bioanalysis/morphophysiology		50/50

Note: the average length is given by results of mass measurements, the rest is based on the results of the full biological analysis.

The females with gonads at II – 12.90%, III – 80.65%, VI-II – 6.5% stages of maturity dominated in catches at the middle of April. The males' gonads were at II – 21.05% and III – 78.95% stages of maturity (Fig. 27).



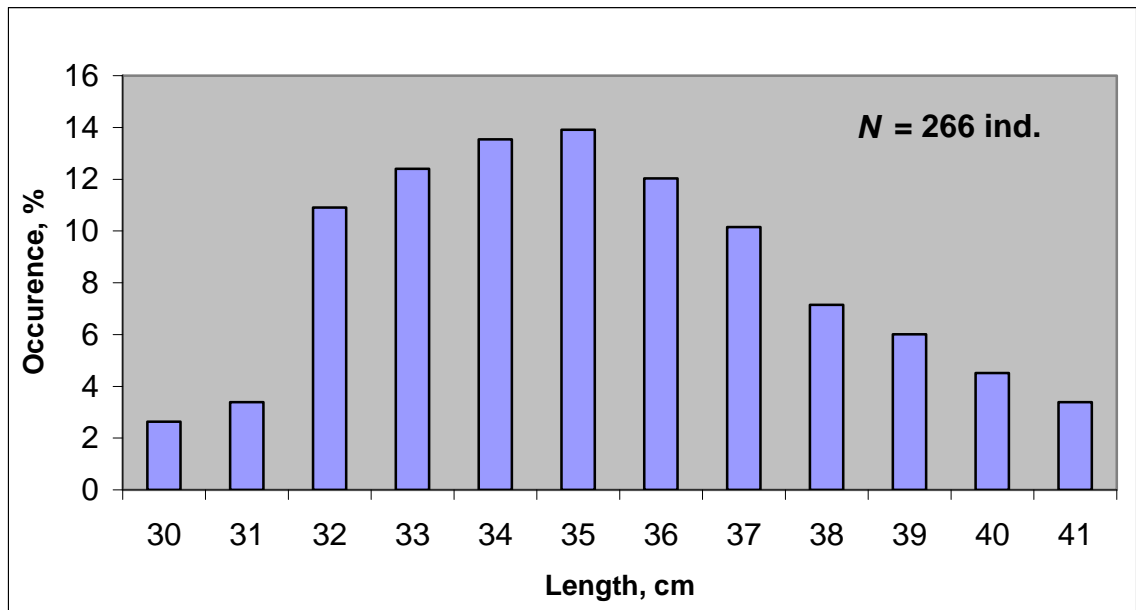


Figure 26. Length composition of the chub mackerel in the SEPO in March-May 2011.

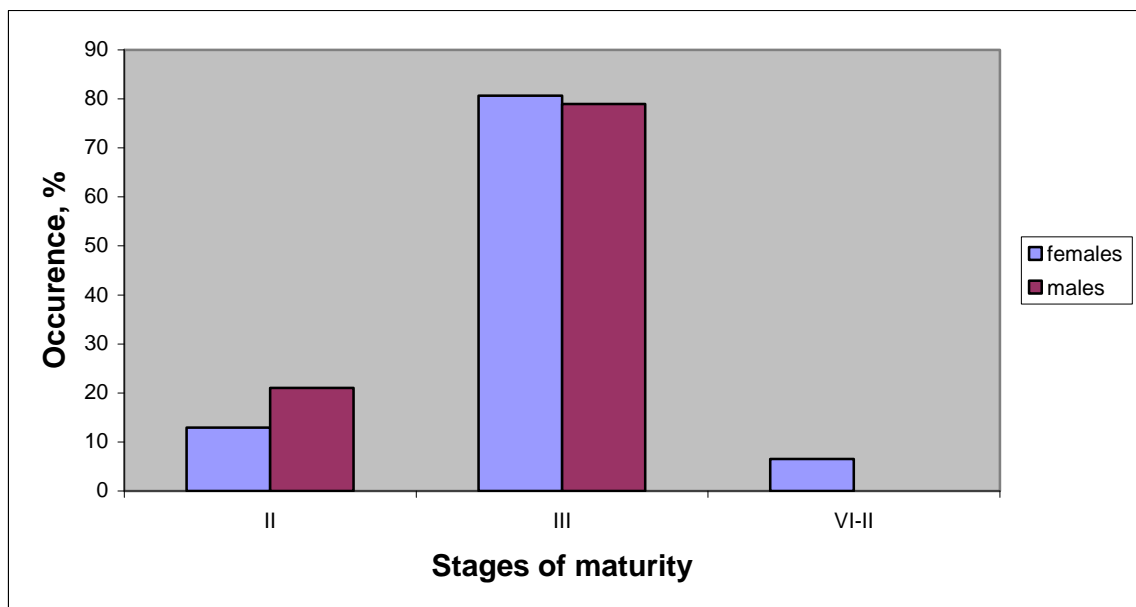


Figure 27. Ratio (%) of females (N = 31) and males (N = 19) of chub mackerel with gonads at different stages of maturity in SEPO in April 2011.

### 8. Conclusion and recommendations

The results of analysis of scientific data collected aboard the Russian fishing vessel the "Leader" in the March-May 2011, allows us to do the following conclusion.

The stocks conditions of pacific jack mackerel and chub mackerel in the high seas of SEPO to deteriorate in a number of years 2008-2009-2011. This is evidenced by reduced catches on the standard effort: in 2.7 times of the first species, in 4.4 times in the second species. Indirect evidence of a decrease in the number of jack mackerel is the increasing of liver and gonad indices in 2011, despite the long-term average climate conditions (lack of temperature anomalies) (Fig. 28) (with a smaller number of jack mackerel in 2011 compared with 2007 and equal to the feed base food supply is obtained above a year low abundance, which leads to better conditions of feeding and increase the relative size of the depot spare nutrients - the liver).

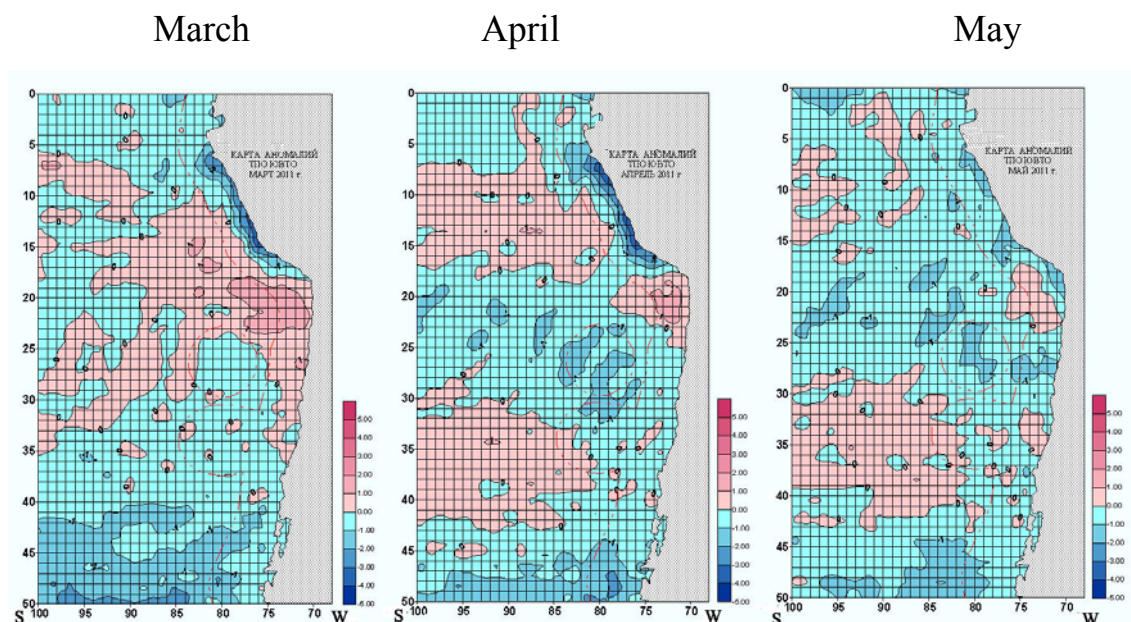


Figure 28. Maps of SST anomalies in the SEPO in the period from March to May 2011.

The main commercial concentrations of the jack mackerel were confined to the SST isotherms of 11-12° C in March-May 2011. The seasonal cooling of water marked shift of jack mackerel to the north following the displacement of the best temperature conditions for it.

In the last 4 years the smallest jack mackerel was met in the catches from the western part of SEPO. In eastern areas the average length of the jack mackerel in

the catch is much bigger than in the western fishery areas. This is due to the fact that there are no immature fish in the catches approximately to 90° W. Apparently, juveniles are absent near the Chilean EEZ due to its catches.

In 2009 abundance of jack mackerel at the age of 2+ was highest during last couple years. Nevertheless, in 2011 catches the abundance of this generation in age 4+ was lower than the same age generations in previous years. Such a picture is the indirect evidence that as early as age 2+ jack mackerel is under the greatest fishing press, which resulted in that there is average abundant generation in age 2+ had no average numbers after two years.

During the preparation of the annual stock assessment in September 2011 by the Science Working Group of the Convention on the Conservation and Management of the High Seas Fishery Resources in the South Pacific Ocean, it should take into account the deterioration of the pelagic fish stocks status in the high seas of the South Pacific.

Significant fishing pressure on the younger age classes of jack mackerel requires to establish the minimum fishery length of the jack mackerel and the minimum allowed mesh size of fishing gear by the regional fisheries management organization in the South Pacific and to monitor the compliance with these control measures of fishing.

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