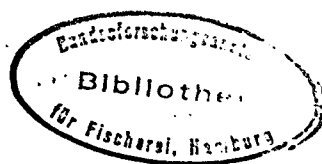


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THE STRUCTURE OF SPAWNING COD STOCK IN THE EASTERN BALTIC DURING 1972-1995

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Abstract

The cod spawning stock structure (age, sex composition, maturation, biological state of spawners), time of spawning and distribution of cod during pre-spawning and spawning periods are analyzed for 1972-1995.

In 1970s the cod spawning stock at the Gotland spawning ground consisted of age group 3-5, while in 1980s it was formed by age group 4-6. In 1978-86 the share of ripening fishes decreased in all age groups as compared with 1972-1977. Since 1981 the share of cod males was constantly decreasing in the spawning stock, reaching in 1990 only 40% from the level of 1972-1977.

In a pre-spawning period the growth of cod determines maturation of different age groups, age composition of the spawning stock and the time of spawning. An early cod maturation is observed in time of good feeding and favorable hydrological conditions. Ripening fishes start to move early to the slopes of the Gotland deep, nearer to their spawning grounds. Thus, already in January of 1976-1977 fishes on the third stage of gonad maturity concentrated within depths 60-80 m. In those years during spawning the whole adult part of cod population concentrated at spawning grounds, but fishes of younger age groups remained in the sea coastal areas. In the years of high cod stock abundance and poor feeding conditions an essential part of adult cod did not mature and missed their spawning: in spring of 1980-1982 and 1985-1986 fishes older than 4 years contributed 40-70% to catches in the coastal regions.

In 1980-1983 when spawning stock was large, but spawning grounds decreased in volume in eastern Baltic, the cod migrated to southern and western Baltic regions in spring. The intensity of migrations determined by two factors, i.e. by spawning volume near the Gotland deep and by the spawning stock size (density of population).

In the last 10 years cod reproduction is practically ineffective in eastern Baltic due to reduction of spawning volumes to the minimum in the end of 1980s, and very low number of cod spawning stock during 1991-1995.

(ei fado, mor lura 66)

Introduction

During recent 20 years the peculiarities of cod reproduction changed essentially in eastern Baltic. In 1980s long-time stagnation of deep waters caused a considerable decrease of spawning volume, practically to the minimum in 1985-90; conditions of cod eggs fecundation worsened, as well as the survival of eggs and larvae; time of cod spawning shortened; migration of cod spawning concentrations from eastern Baltic to southern and western Baltic was observed by Pliksh et al., 1993; Westin and Nissling, 1991; Baranova, 1986, 1989; Grauman and Jula, 1988; Lishev and Lablaika, 1989. In the beginning of 1990s the critical state of cod stock was already predicted basing on the analysis of long-term peculiarities of cod spawning, dynamics of hydrological conditions and intensive fishery (Uzars et al., 1991).

In south-western and western regions of the Baltic Sea the main factor determining the number of cod generations is the oxygen content in near-bottom water layers (Berner et al., 1989). The analysis of multi-annual data for eastern Baltic has revealed that the percentage of environmental influence is 40%, the same percentage is contributed by the parameters of cod spawning stock (Lishev et al., 1989; Lablaika et al., 1989). The most positive relation of recruitment with spawning cod abundance and the quality of spawners was observed in the periods of moderate hydrological conditions in spawning zones (Lablaika et al., 1989), but at unfavourable hydrological conditions the main limiting factor is the volume of water layer that is suitable for cod spawning (Pliksh et al., 1993).

Material and methods

Material from research catches of cod at the Gotland spawning ground in March-June was used for analysis, as well as that from Subdivisions 28 and 26 (in some years in Subdivisions 29, 32).

Cod age was determined by otoliths, i.e. by the surface of transversal break analyzed at falling light. The degree of gonads maturity was defined using the 6-stage scale (Powles 1958). During investigation period 1972-1995 cod age was determined for 25 000 individuals. For each Subdivision and month the age composition was calculated using length-age-key.

Results and discussion

Age composition of cod spawning stock

In 1970s the major part of cod spawning stock in eastern Baltic consisted of age groups 3-5. The mean age fluctuated from 4.1 to 4.5. Beginning with 1981 a shift toward older age groups occurred: age groups 4-6 dominated in spawning stock during the whole period of spawning from March till June. The share of cod older year groups (six year group and older) grew from 10-20% in 1972-1980 to 30-40% in 1981-1986 and 40-50% in 1989-1990 (Table 1.)

During 1980-1983 cod of two very abundant generations (1976 and 1977) dominated in the spawning stock. In 1980 age group 4 constitute about 50% of the spawning stock. In 1981-1982 those two generations contributed 60-70% to the spawning stock. Their relative abundance up to age groups 7 and 8 was 2-3 times more than average multi-annual data. In 1984-1986 fishes of abundant generation 1980 contributed 30-40% to the spawning stock. During 1987-1995 cod spawning stock was formed by fishes of poorly abundant generations.

In recent years the total cod stock decreased so drastically that spawning stock reached its critical minimum level. At the Gotland spawning ground cod spawning concentrations were

practically absent. In 1991-1995 the catch per an hour of trawling varied from few individuals to 60-100 kg being at an average 15-40 kg.

Cod sex ratio in a spawning stock

In the Baltic cod population the ratio of females and males is near to 1:1. In eastern Baltic during autumn-winter feeding period the share of cod males was 46-50% in 1970-1990. In the spawning stock of 1972-1977 the share of males was about 70%. The analogous domination of males in the spawning stock is characteristic both for the Gotland spawning ground and for spawning grounds in other Baltic regions (Berner and Vaske, 1981). Cod males mature earlier than females and come to spawning grounds earlier. In younger age groups the share of ripening males is considerably higher than that of females. For example, in the years of good feeding conditions generative processes for 30-40% of age group 3 males start already in January, but those processes are observed only for 10% of females. For age group 4 the share of ripening males is 1.5-2 times larger than that of females. In the beginning of spawning (March-April) the number of males is 1.5-2 times larger than the number of females. In the end of spawning the share of males lessens to 50%.

In the beginning of spawning cod of older age groups dominate in the spawning stock. They mature usually earlier. In May-June the mean age of males and females somewhat diminishes, but the share of younger fishes, mainly age group 3, grows. Their maturation becomes later and they come later to spawning grounds. In 1972-1977 the relative share of age group 3 was increasing 2 times from March till June. In 1981-1986 the share of age group 3 was small (5-10%) in the spawning stock and it did not increase by the end of spawning (Table 2).

Beginning with the period of high cod stock (1981-1983) a permanent decrease of males number is observed for cod spawning stock. In 1989-1990 the share of males decreased almost two times as compared with 1972-1977 and was about 40%. The decrease of males share took place for all age groups, but it was most sufficient for age groups 3 and 4. The decrease of males share at the Gotland spawning ground in 1980s explains the shortening of spawning time and the increase of unfecundated eggs number (Grauman 1988). The decrease of males number may be partly explained by migrations of ripening cod from eastern Baltic to spawning grounds in southern and western Baltic, noted in years of highly abundant stock and by worsening of hydrological condition at the Gotland spawning ground.

Maturation of spawners and time of spawning

In the years of good feeding conditions (1972-1973, 1976) generative processes start already in December. In January more than 50% of cod are on the III and IV stages of gonads maturity. At the Gotland spawning ground mainly mature fishes being on the IV-V stages of gonads maturity concentrated in those years. Spawning is early, it takes place in March-April. In time of medium stock size and moderate feeding conditions (e.g., 1985, 1986) about 30% of cod start to ripe in January. In those years spawning occurs later, in the end of April and in May. The share of immature cod is 10-15% at the spawning ground. In the period of large stock size and poor feeding conditions (1980-1982) cod maturation is slow: in January only 20% of fishes are on the III stage of maturity. The spawning is prolonged, it is going on from April till June, without a pronounced peak. Immature cod are noted to be in considerable number (20-40%) at the spawning ground (Baranova and Uzars, 1986; Baranova, 1989).

In pre-spawning period cod feeding conditions and their growth determine maturation of different age groups and their significance in the spawning stock. The growth and maturation of certain generations depend on their abundance and the stock size.

In the years of good feeding conditions about 20% of age group 3 and 40-60% of age group 4 begin to mature in January. For older age groups (age group 5 and older) generative processes start in the major part of cod (70-100%). When feeding conditions are moderate about 30% of age group 4 and 50-70% of age groups 5 and 6 begin to ripen in January. The share of ripening age group 3 is small, reaching only 7-8%. In the years of poor feeding conditions maturation is delayed for all age groups, only 20-50% of age groups 4-6 are on the III stage of maturity in January (Table 3.).

Ripening fishes have larger length, weight and a broader otolith growth zone formed during feeding period before spawning than immature ones (Baranova, 1992). In 1980-1982 at the Gotland spawning ground spawners of age groups 5-6 had low parameters of length and weight which were close to those of immature fishes. This is probably due to the fact that bigger cod that had ripened earlier migrated to spawning grounds in southern and western areas of the Baltic Sea, but cod worse prepared for spawning with low biologic parameters stayed on the Gotland spawning ground.

It should be noted that maturation of age group 3 worsened in 1980s. Even at good feeding conditions (1981-1987) and high parameters of length and weight (exceeding by 20-50% the multi-annual data) the share of ripening age group 3, especially cod males, not only increased, but it diminished. In those years in April the share of immature age group 3 made up 30-50% at the Gotland spawning ground (1.5-2 times more than the mean multi-annual data). Due to this reason the share of age group 3 decreased in the spawning stock, and the duration of spawning reduced as compared with 1970s, because just age group 3 matured later and took part in spawning later, i.e. in May-June.

Cod distribution in pre-spawning and spawning periods

In the years of good feeding conditions and early maturation ripening cod start to move nearer to spawning zones on the slopes of the Gotland deep already in January. For example, in January 1976 in Subdivision 28 (Ventspils area) the share of age group 5 and older grew in catches from 4.7% up to 22.4% with the increase of depth from 40-50 m to 70-80 m. At depth 40-50 m ripening cod made up about 30%. At depth 50-80 m 50-60% of cod were on the III stages of gonads maturity (Table 4). In April 1976 at the height of spawning the cod of younger age groups (age groups 1-3) dominated in Hiiumaa area (SD 28) at depth 30-50 m and in Ventspils area (SD 28) at depth 60-70 m. In Subdivision 26 age groups 2 and 3 concentrated mainly at depth 60 m, but age groups 3 and 4 at depth 80 m. The share of mature fishes was about 25%. At depth 90 m cod spawners dominated (age group 3 and older). Here 80% of fishes were mature, 64% of them being on the IV stage of maturity. Practically only spawning cod concentrated at depth more than 100 m. At depth 100 m age groups 3-5 prevailed, 60% of them being spawners, but at depth 120-130 m age groups 4-6 dominated, about 80% being spawners.

When cod maturation is poor a lot of adult immature fishes stay in the coastal zone during spawning time. Thus, in April 1980 a lot of cod stayed in the Gulf of Riga and in the Gulf of Finland. In the Gulf of Riga age groups 4-6 contributed about 40% to catches. In the Gulf of Finland about 75% of catches were made up by age groups 4-5, more than 60% being age group 4 of abundant generation of 1976. Quite a lot of age group 4 (more than 40%) were noted at depth 30-50 m in Subdivisions 28 and 29. In Ventspils area (SD 28) age groups 3-5, mainly immature individuals (about 80% were on the II stage of maturity), concentrated at depth 50-60 m and 70-80 m. In the zone of spawning at depth 100-110 m the cod spawning stock was mainly formed by age groups 3-5. Spawners made up only about 20%. Due to delay of maturation the major part of fishes were on the

IV stage of gonads maturity. The share of immature cod was also large at the spawning ground: more than 20% (Table 4).

In the period of good feeding conditions (1972-1977) practically all adult part of cod population ripened. In April even in coastal regions 70-90% of age groups 4-6 were mature (Baranova and Uzars, 1986). In the years of high stock abundance a considerable part of adult cod was immature due to poor feeding conditions and it missed spawning. During 1979-1983 in spring 40-75% of catches were made up by fishes older than 4 years. Bad maturation was also noted in 1985-1986. In spring there were more than 60% of age group 4 and older in the coastal catches (Baranova, 1989).

Density of spawning stock

During the years of high stock size and unfavorable hydrological conditions in eastern Baltic when the spawning volume decreased a part of cod migrated to southern and western Baltic (Lishev et al., 1989).

In the time of low stock size and favorable hydrological conditions on the Gotland spawning ground those migrations are not observed for eastern Baltic cod. Beginning with 1980 in Subdivisions 22 and 24 M. Berner (1985) noted an occurrence of fishes that were representatives of eastern Baltic cod by their morphometric features. They formed a local spawning stock not mixing with western cod which spawn later: in May-June.

Morphometric analysis of cod otoliths sampled in 1980-1982 in Subdivisions 22 and 24 and presented by M Berner evidently distinguished a group of otoliths with typical for eastern Baltic cod structural peculiarities, i.e. the width of opaque and hyaline zones and the character of their formation, especially for generations of 1976, 1977 and 1975.

During spawning in eastern Baltic there are clearly pronounced quantitative relationships of cod catches and their distribution with cod stock abundance and spawning zone volume. Lishev et al. (1989) showed that at the equal volumes of spawning zones the cod concentration and catches are determined by stock size, but different volumes of spawning zones correspond with equal catches at different stock abundances. With the reduction of spawning zones volume the cod concentrations and catches grow up to a certain value, but then they become stable on the level that is common for stocks of different values. This is explained by a definite populational behavior, i. e. relations within shoals, relations among the shoals and distances between them. In the years of intermediate hydrological characteristics stabilization of catches testifies to a certain maximum critical populational density in spawning zones of eastern Baltic. Cod population strives not to exceed this density and a part of fishes has to migrate. The value of cod migration from spawning zones is proportional to the reduction of spawning zones volume. A clear relation was revealed between cod maturity, length, weight, age and the spawning zone, i.e., the older is cod, the higher are its biological parameters, the earlier it reacts upon the change of sea hydrological conditions. The less is the spawning zones volume, the smaller and worse prepared for spawning cod stays in the spawning zone.

Figure 1 shows the dynamics of mean weight and mean age of spawning stock on the background of changes in spawning stock biomass (Anon., 1994), figure 2 - the dynamics of mean weight of spawning stock and spawning volume (Plikshs et al., 1993). Regularities of cod stock distribution and catches in eastern Baltic during spring of 1980s well agree with the conception that populational density has a decisive significance. In the years of high stock abundance and unfavorable hydrological conditions (for example 1980-1984) the spawning stock size fluctuated about a certain maximum value which was determined by the spawning volume and the maximum populational density in this volume. These two limiting factors are interrelated, but the influence of each of them obviously changes by years. Populational density also depends on cod individual sizes. In those years

biological parameters of spawning stock strongly varied, e.g., mean age fluctuated from 4.1 to 5.4, mean weight - from 820 g to 1370 g. The relationship "mean age - mean weight" for spawning stock is to a considerable extent determined by the factors of food supply.

Conclusion

The main factors determining the structure of eastern Baltic cod spawning stock are the following:

- the age composition of a population as a whole and the abundance of separate generations;
- the biological state of fishes in a pre-spawning period and maturation of different age groups;
- the mechanism acting in a population which regulates the ratio of females and males in a spawning stock.

The populational density is the factor regulating the distribution of mature part of cod population during pre-spawning and spawning periods, the abundance and composition of spawning concentrations. This factor is determined by the correlation of two indices, i.e., the spawning volume and the parameters of spawners.

References

- Anon., 1994: Report of the Working Group for Assessment of Demersal Stocks in the Baltic. - ICES, C.M. 1994/Assess:17.
- Baranova T., 1989. Some parameters of the eastern Baltic cod population in Subdivisions 26 and 28: growth and ripening in connection with abundance dynamics. Rap. P.-v. Reun. Cons. int. Explor. Mer., 190: 97-101.
- Baranova T., 1992. On the growth of eastern Baltic cod. ICES, C.M. 1992/J: 29.
- Baranova T. & D.Uzars, 1986. Growth and maturation of cod (*Gadus morhua callarias* L.) in the eastern Baltic. ICES, C.M. 1986/J: 7.
- Berner M., 1985. Die periodischen Veränderungen der Gonadenmasse und der Laichzyklus des "Ostsee- und Beltseedorsches", *G. morhua callarias*/*G. morhua morhua*, in verschiedenen regionen der Ostsee. Fisch.-Forsch., Rostock, 23.
- Berner M. & B.Vaske, 1981. Über das Geschlechterverhältnis und die Geschlechtsreife des Ostseedorsches (*Gadus morhua* L.) in den ICES-Gebieten SD 22,24 und 25 (Mecklenburger Bucht bis Bornholmsee). Fisch.-Forsch., Rostock, 19(1981)2.
- Berner M., H.Müller & D.Nehring, 1989. On the influence of environmental and stock parameters on the recruitment of cod stock to the East and West of Bornholm (SD 25-32 and 22-24) described by regression equations. ICES, 1988, Bal/7.
- Grauman G., & E.Jula, 1988. Early ontogenesis in cod and sprat in relation to abiotic and biotic factors. ICES, 1988, Bal/40.
- Lablaika I., S.Hoziosky & M.Kalejs, 1989. Abundance dynamics of eastern Baltic cod stocks and related factors. Rapp. P.-v. Reun. Cons. int. Explor. Mer., 190: 163-165.
- Lishev M. & I.Lablaika, 1989. Distribution of eastern-baltic cod stock. In: Main tendencies of ecosystem evolution. Projekt "Baltic" Problems of investigations and mathematical modelling on the Baltic sea ecosystem (ed. Davidan I., & O. Savchuk). Leningrad, Gidrometeoizdat: 222-228 (in Russ.).
- Nissling A. & L.Westin, 1991. Egg mortality and hatching rate of Baltic cod (*Gadus morhua*) in different salinities. Marine Biology, 111: 29-32.
- Plikshs M., Kalejs M., & G.Grauman, 1993. The influence of environmental conditions and spawning stock size on the year-class strength of the Eastern Baltic cod. ICES, C.M. 1993/J:22.
- Powles P.M., 1958. Studies of reproduction and feeding of Atlantic cod (*Gadus callarias* L.) in the southwestern Gulf of St. Lawrence. J. Fish. Res. Bd. Canada, 15(6).
- Uzars D., Plikshs M., Grauman G., Kalejs M., & T.Baranova, 1991. Cod distribution and spawning in the Gotland Basin in the 1980-ies. ICES, C.M. 1991/J:15.

Table 1. Age composition of cod spawning stock (%) in Eastern Baltic

Spawning ground	Year	Month	Age groups							Mean age
			2	3	4	5	6	7	>8	
Gotland spawning ground	1972-1975	March	1.7	11.2	45	23.7	13.8	3.6	1	4.5
		April	1.4	21.8	42.4	21.6	9.1	2.7	1	4.3
		May	1.6	20.4	37.9	22.8	13.5	2.5	1.3	4.4
	1976-1977	March		13.7	45	22.2	13.7	3	2.4	4.55
		April	0.3	8	42.4	30.3	15.4	3.5	0.1	4.6
		June	0.3	19.1	41.8	25.8	10.3	2.4	0.3	4.4
	1979	March	11.6	29	29.7	11	11.6	5.8	1.3	4.1
	1980	March		11.8	52.8	22.1	6.3	4.7	2.3	4.5
		April	0.8	11.5	42.6	32.8	10.7	0.8	0.8	4.5
	1981-1986	March	0.5	6.3	26.7	31.5	23.4	8.3	3.3	5.1
		April	0.1	7.1	20	33.3	27.5	9	3	5.2
		May	3.8	6.8	34.6	18.6	27.9	6	2.3	4.9
		June	1.2	4.2	17	33.8	27.1	8.1	8.6	5.4
	1987	March	10.3	37.4	15.9	22.4	12.1	1.9		3.9
		April	4.2	35.5	27.7	16.3	9.7	3.6	3	4.2
	1988	March	2.5	21.5	26.6	19	5.1	10.1	15.2	5
	1989	March	0.2	8.8	24	23.4	23.1	10.1	10.4	5.3
		April	2	9.9	26.7	25.8	16.8	7.9	10.9	5.1
	1990	March	0.7	3.5	11.6	26	34.9	18.5	4.8	5.7
		April	1.1	5.1	20.9	26	27	13	6.8	5.4
	1991	March	6.5	16.1	29	32.3	12.9	3.2		4.4
	1993	March-April	10.3	6.4	18	20.5	19.2	11.5	14.1	5.2
	1994	March-May	31.3	8.9	14.5	9.4	12.9	15.2	7.8	4.4
Gdansk spawning ground	1990	March	7.3	23.6	8.2	22.7	21.8	9.1	7.3	4.9
	1991	March	12.6	27.9	17.2	31.5	6.3	4.5		4.1
	1993	March-April	29.5	17.9	23.2	20.5	8	0.9		3.6
	1994	March-April	16.3	4.1	4.1	40.8	18.4	14.3	2	4.9

Table 2. Cod sex ratio in the spawning stock.
(A- Gotland spawning ground; B- Gdansk spawning ground)

Area	Year	Month	Share in %		Mean age			Share of males (%) in age groups in March-April			
			Females	Males	Females	Males	Total		4	5	6
A	1972-1977	March	32.6	67.4	5	4.3	4.5	86.5	79	61.1	49.7
		April	29.4	70.6	4.9	4.2	4.4				
		May	37.2	62.8	4.7	4	4.3				
		June	50.1	49.9	4.7	4	4.3				
	1980-1986	March	37.6	62.4	5.4	5	5.1	76.9	64.8	55.3	50
		April	46.2	53.8	5.4	5	5.2				
		May-June	52	48	5	4.9	5				
	1987	March	37.5	62.5	4.1	3.9	3.9	65.4	56	56	52.6
		April	49	51	4.4	4	4.2				
	1988	March	62	38	5.5	4.2	5	58.8	52.4	13.3	0
B	1989-1990	March	47.5	52.5	5.9	5.3	5.5	58.4	55.6	49.6	41.3
		April	63.7	36.3	5.5	5	5.3				
	1991	March	51.6	48.4	4.4	4.4	4.4	40	22.2	60	75
		April	41.4	58.6	4.8	3.5	4.1	80.7	52.6	37.1	51.1
	1993	March-April	52.6	47.4	5.9	4.5	50.2	100	57.1	18.8	46.7
		April	28.6	71.4	5	3.1	3.6	95	65.4	43.5	11.1
	1994	April	26.2	73.8	5.4	2.8	3.5	80	75	0	33.3
		May	28.9	61.1	7	6	6.3	100	80	79	61.3
		April	38.8	61.2	5.8	4.4	4.9	100	50	65	33.3

Table 3. Share of ripen cod (%) by age groups in Eastern Baltic in January (A-SD 26,28)
and in April on the Gotland spawning ground (B)

Fish growth in feeding period	Year	Month	Area	Age groups							
				3		4		5		6	
				Females	Males	Females	Males	Females	Males	Females	Males
Good	1976	January	A	10	33	50	64	78	100	87	70
	1976	April	B	100	98	95	100	100	100	100	100
	1984			60	70	80	90	100	90	90	100
	1989-90			95	100	93	100	96	98	100	100
Average	1985-86	January	A	7	8	25	34	61	33	75	80
	1985-86	April	B	50	60	70	75	80	90	90	97
	1991-94			50	70	87	50	90	100	100	100
Bad	1979-82	January	A	5	15	16	32	38	50	50	20
	1979-82	April	B	25	70	60	80	80	88	90	95

Table 4. Distribution of cod (%) in pre-spawning and spawning periods in 1976 and 1980

Year	Month	Area	Depth,m	Age groups								Mean age	Maturity stages				
				1	2	3	4	5	6	7	>8		II	III	IV	V	VI
1976	January	Ventspils	40-50	9	10	47.3	29	2.7	0.5	1	0.5	3.1	68.1	31.9			
			50-70	5.6	13.4	29.8	39.7	8	2.7	0.7		3.4	48.3	51.1	0.6		
			70-80	10.6	6.1	26.9	34	16.4	4.3	0.9	0.8	3.6	41.2	58.8			
	April	Hiiumaa	30-40		11.3	67.9	11.3	3.8	1.9	1.9	1.9	3.3	80.8	0	19.2		
			50	48.4	19.7	27.4	2.9	1.6				1.9					
		Liepaja	60-70	25.1	24.6	40.7	8.4	1.2				2.4	75.7	12.6	9	0	2.7
			60	5.9	27	50.9	8.1	4.9	1.4	0.4	1.4	2.9	73.6	12.5	13.9		
			80	5.7	7.2	57.9	20	4.8	2.4	0.3	1.7	3.3	74.6	5.4	20		
		Gotland	90			16	62.7	9.3	9.3	2.7		4.2	20	0	64	12	4
			100-130	1.6	1.6	13.8	37.1	28.7	13.4	3	0.8	4.5					
1980	April	Gulf of Finland	60		2.2	21.1	62.5	12	1.1	0.7	0.4	3.9	88.7	8.7	2.3	0	0.3
		Saaremaa	30		39	22	27	10	2			3.3					
			30-50		14.7	28.4	40	13.7	3.2			3.6	90	3.8	6.2		
		Hiiumaa	30		13.8	36.6	41.9	5.1	2	0.4	0.2	3.5	92.9	3.6	3.5		
		Ventspils	50-60		2.6	25.2	47.6	17.5	5.7	1	0.4	4					
			70-80		2	12.3	52.3	23.7	8	1	0.7	4.3	77.9	3.9	16.6	1.6	
			100		1	18	48	20	10	3		4.3					
		Gotland	110		2.6	24.6	39.6	20.1	10.8	1.3	1	4.2	21.9	12.3	45.2	20.6	

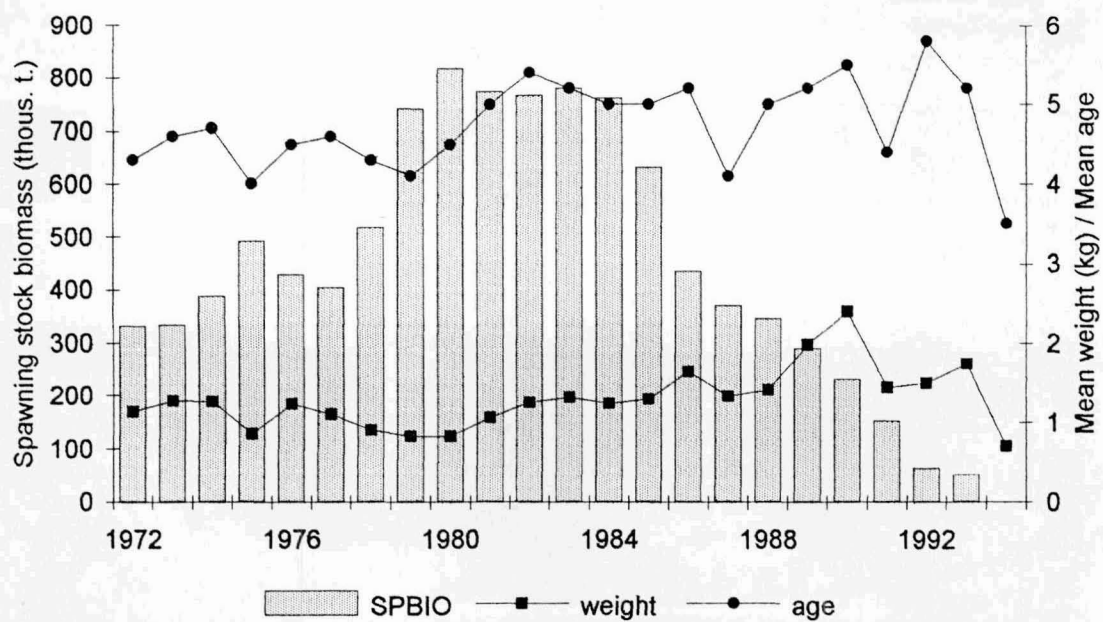


Figure 1. Dynamics of the cod spawning stock biomass, mean weight and mean age.

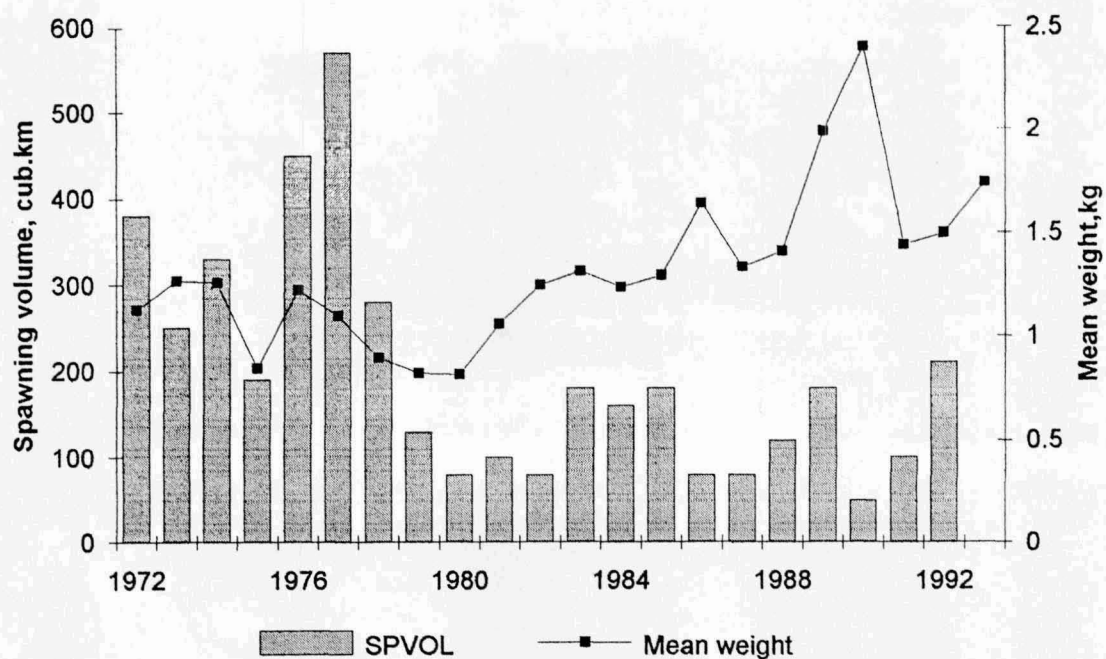


Figure 2. Dynamics of the mean weight of spawning stock and the spawning volume.