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On the Question of Relationship of Growth Rate of Gonads, Abundance and Timing of Silver Hake Migration from the Scotian Shelf Slopes in Summer

by

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Abstract

A relationship of mean values of maturity stages, abundance indices and timing of spawning migration of silver hake from the Scotian Shelf slopes is analysed. The results of the studies suggest the existence of inverse correlation between growth rate of gonads and abundance, and the influence of differences in growth rates of gonads on timing of massive spawning of silver hake northward of the SMGL, provided that hydrographic conditions favour this movement.

Introduction

A relatively lengthy series of observations on the timing of silver hake migration northward of the SMGL has been accumulated since introduction of the 200-mile zone. Considerable fluctuations of the dates of closure of the fishery in some years were undoubtedly connected with the above-mentioned timing. At the same time, the observed year-to-year variations of gonad maturity rates are indicative of differing rates of growth of gonads. In the present paper an attempt is made to cast light on the question of possible relationship of maturity rate, abundance and the timing of silver hake migration northward of the SMGL in summer-time.

Materials and methods

Biological data were collected by the Soviet observers on commercial ships during the 1977 to 1984 period. A six-grade scale was used to determine gonad maturity stages with regard for

partial spawning peculiar to silver hake. To obtain mean values all intermediate stages corresponding to one or another phase of spawning condition of females were regarded as stage V. Calculations were made by sex, and only mature specimens were involved. The amount of data by year, month and sex is given in table1. The data on the possible timing of silver hake migration from the shelf slopes are contained in some NAFO Research Documents (Rikhter et al., 1980; 1981; 1982; 1983; Rikhter, Turok, 1984; Rikhter, Grinkov, 1984). The data from the commercial ships which were intended for detection of short-finned squid aggregations in 1982 and 1984 were also used. Silver hake abundance indices (commercial and survey data) were adopted in Waldron and Harris

Results and discussion

Mean values of maturity stages by year, month and sex are given in table 1. As is evident from the data, the variations of mean values by year were considerable at times. In particular, very large variations were observed in 1982-84. It would have been reasonable to suggest that these variations might bear a relation to the stock abundance. Mean values of maturity stages for May and June (later data may hardly be useful as the migration of silver hake began at that time) and abundance indices for corresponding years are given in table 2.

Unfortunately, likewise abundance indices are not available for 1984. Nevertheless, the data reported in the paper, which is also submitted to the 1985 June Session (Rikhter, Turok, 1985), are suggestive that in 1984 the commercial index appeared to be at least at the 1982 level. For calculations, it was conditionally set at 16.00. Based on the abundance indices originating from commercial and survey data (table 2), the periods of relatively low (1977-1980) and high (1981-1984) silver hake abundance can be distinguished, although no obvious correlation can be observed between them. Results of estimating correlation factors are presented in table 3.

According to the data, preference should be given to mean values of maturity stages for females. A possible explanation

may lay in the fact that maturity stages can be better defined in females, thus reducing the probability of error. In one case (June, females) a correlation factor appeared to be high and statistically reliable. Hence it can be admitted that a relationship between growth rate of gonads and abundance does exist. It is understood that after introduction of the 200-mile zone commercial indices for some years are not representative of the population size on the shelf on the whole, however, they certainly are comprehensive enough to reflect the silver hake abundance in the fishing area, i.e. southward of the SMGL. Correlation between mean values of maturity stages and survey indices appeared to be weak and unreliable in terms of statistics. Correlation between survey and commercial indices ($r = 0.42$) in the period under consideration was moderate. It should be remembered that a very short observation series, which is the case, with a statistically unreliable correlation factor is not a reason to deny any relationship between varying characteristics.

Now let's consider a possible correlation between the growth rate of gonads and the timing of silver hake migration northward of the SMGL. The dates of migration stated in the paper by Rikhter and Grinkov (1984) had to be adjusted with regard for specified and new information. So, in 1979, the majority of silver hake migrated in July, not August, for in August, with permission of the Canadian authorities, the fishery was carried out chiefly northward of the SMGL. The catches taken on the shelf slopes at that time were insignificant (Rikhter et al., 1980). In 1982 the fishery terminated in July as the allocation had been caught by that time. However, according to the data from the commercial ships which were in search of and fishing squids, dense silver hake aggregations south of the SMGL persisted through August. A fairly curious situation was observed in 1984. Dense silver hake aggregations stayed on the shelf slopes for as long time as can be, with the gonads being far from mature even in August (table 1). The only possible explanation can be that in 1984 maturation of silver hake in mass was slackened. The specimens that lagged behind the mature fish stayed on the shelf slopes. Spawning migration northward of the SMGL seems to be per-

formed by small groups and extended in time. According to the data of observers (Rikhter, Turok, 1985, the paper submitted to the June Session), in the first ten-day period of August the area of commercial silver hake aggregations slightly reduced compared to July. However the data from the commercial ship intended for detection of the squids indicated that a dense silver hake aggregation represented by specimens with slackened maturation rate was still observed in early September, in the eastern part of the area open for foreign fishery. Evidently, gradual migration of maturing silver hake to the north of the SMGL began in the end of June and continued through August.

Table 2 presents adjusted approximate dates of silver hake migration northward of the SMGL and mean values of maturity stages for May and June of the corresponding years.
These data do not display an obvious correlation between the growth rate of gonads and dates of spawning migration of silver hake except for the last two years. A more detailed analysis is required (preferably on a daily basis), which will be probably done in the future. However a detailed analysis can be complicated by a problem of determination of the beginning of silver hake migration more or less accurately.

Based on the available data some preliminary conclusions can be made. So, during the 1977 to 1981 period the timing of migration was similar except for maybe 1979. The situation in 1982 is still obscure. However a good agreement with the growth rate of gonads in 1983 and 1984 raise hopes that such indices as mean values of maturity stages will be useful for forecasting the dates of massive movement of silver hake to the north of the SMGL. At that, it also should be taken into account that the endurance of silver hake on the shelf slopes and stability of its aggregations in the fishing area may be largerly influenced by hydrographic conditions. The migration of silver hake to the spawning area (shallow waters of Sable Island) is known to be timed to the period of summer heating of the waters (Vialov, Karasiov, 1967). Hence, the low temperatures of the water in the near bottom layer around Sable Island or on the way to this area will prevent silver hake from northward migration notwithstan-

ding the readiness of the fish to spawn. Therefore only a combined analysis of the growth rate of gonads and hydrometeorological conditions during the fishery will allow to confidently forecast the timing of silver hake migration from the shelf slopes to the spawning ground.

Summary

Results of the studies are suggestive of the existence of inverse correlation between the growth rate of gonads and abundance of silver hake on the Scotian Shelf. In its turn, a considerable difference between growth rates of gonads may influence the timing of silver hake massive migration northward of the SMGL for spawning provided that hydrographic conditions are favourable. It follows from this that mean values of maturity stages can be used to forecast the timing of silver hake migration from the shelf slopes.

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Table 1 Mean maturity stages of silver hake from Divisions 4VWX by sex, year and month (brackets involve observation number)

Years	Males					Females				
	April	May	June	July	August	April	May	June	July	August
1977	-	-	3.7 (735)	4.3 (3 217)	4.3 (424)	-	-	4.0 (690)	4.6 (3 149)	5.0 (319)
1978	3.9 (400)	3.8 (1 902)	4.2 (1 289)	4.4 (341)	4.1 (385)	3.0 (419)	3.4 (1 312)	3.9 (1 141)	4.2 (538)	4.5 (440)
1979	3.2 (114)	3.9 (1 066)	4.0 (1 278)	-	3.8 (186)	3.1 (103)	3.9 (884)	4.0 (998)	-	4.3 (301)
1980	-	3.4 (463)	4.0 (396)	4.2 (294)	4.2 (162)	-	3.5 (592)	4.0 (493)	4.3 (378)	4.5 (405)
1981	-	3.4 (152)	3.8 (707)	4.1 (761)	4.1 (130)	-	3.3 (144)	3.5 (711)	4.7 (827)	4.8 (224)
1982	-	3.7 (559)	3.9 (643)	4.0 (1 024)	-	-	3.1 (389)	3.1 (673)	3.3 (1 281)	-
1983	3.2 (555)	4.1 (1 932)	4.5 (1 351)	4.3 (170)	-	3.3 (399)	3.9 (1 630)	4.2 (2 194)	4.3 (200)	-
1984	-	3.2 (1 895)	3.0 (784)	3.1 (1 124)	3.1 (234)	-	3.0 (1 406)	3.1 (1 462)	3.3 (2 050)	3.2 (594)

Table 2 Mean values of maturity stages, abundance indices and timing of silver hake migration northward of SMGL

Years	May		June		Abundance indices		Timing of migration
	males	females	males	females	commercial	survey (ooo)	
1977	-	-	3.7	4.0	8.293	33 387	August
1978	3.8	3.4	4.2	3.9	8.880	44 992	August
1979	3.9	3.9	4.0	4.0	7.600	177 390	July
1980	3.4	3.5	4.0	4.0	5.437	43 184	August
1981	3.4	3.3	3.8	3.5	6.505	171 934	August
1982	3.7	3.1	3.9	3.1	15.833	166 625	August
1983	4.1	3.9	4.5	4.2	10.514	148 514	June
1984	3.2	3.0	3.0	3.1			August

Table 3 Correlation between mean values of maturity stages and abundance indices

Month	Sex	Commercial		Survey	
		$r \pm m_r$	Critical values of r at P= 0.05	$r \pm m_r$	Critical values of r at P= 0.05
May	Males	$-0,11 \pm 0,33$	0,75	$0,15 \pm 0,33$	0,81
	Females	$-0,57 \pm 0,22$	0,75	$0,25 \pm 0,31$	0,81
June	Males	$-0,44 \pm 0,27$	0,71	$0,12 \pm 0,33$	0,75
	Females	$-0,73 \pm 0,15$	0,71	$0,10 \pm 0,33$	0,75