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Variation in Abundance of the Scotian Shelf Silver Hake and Some Other Gadidae in the Northwest Atlantic

by

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ABSTRACT

Probable correlation between the variations in abundance for silver hake in Div. 4VWX and some other Gadidae (pollock in Div. 4VWX + 5ZC and cod in Div. 2J3KL, 3NO, 4V_sW) was studied. No statistically significant correlation was found but during the 1980's inverse relationship between abundance of silver hake, cod and pollock year-classes dominated. Such variations in abundance can be explained by the influence of the oceanographic processes running in the Northwest Atlantic. This influence is a specific one for each species. In some cases synchronism of variations for estimates of catch-per-unit-effort was found and that fact should be interpreted from different points of view, i.e. dynamics of stocks and influence of the environmental factors on accessibility of the stocks for fishery should be taken into account. It is suggested that strong year-classes of the silver hake population inhabiting the nothern edge of its distributional area must appear in years when positive temperature anomalies of the water masses are recorded.

INTRODUCTION

Abundance of silver hake and other Gadidae in the Canadian waters is shown to be subjucted to strong year-to-year variations. Untill 1977 a sharp decrease of abundance could be explained in some cases by unlimited fishery. During the subsequent period rises and falls in abundance were, possibly, environmentally - dependent. Thus, it may be suggested that since 1977 a certain generality in abundance variations can be traced for some fish species, primarily related ones. Both direct and inverse relationships can be observed. An attempt to check the hypothesis is made in the present paper.

MATERIALS AND METHODS

Abundance indices obtained during the trawling surveys between 1977 and 1991, SPA-based estimates for the same period and standardized catch-per-unit-effort estimates for 1977-1991 were used as initial data. Cod from Div. 2J3KL (Baird et al., 1992a), 3NO (Baird et al., 1992b), 4V_sW (Mohn and MacEachern, 1992) and pollock (Annand and Beanlands, 1991) were taken to compare

them with silver hake (Waldron et al., 1992). Trawling survey indices and estimates obtained by SPA-method for the following age-groups were compared:

Unit of stock	Age, year	
	Indices of trawling surveys	Abundance estimates obtained by SPA-method
Silver hake, 4VWX	1	1
Cod, 2J3KL	2	3
Cod, 3NO	2	3
Cod, $4V_sW$	2	2
Pollock, 4VW+5ZC	3	2

Only total catch-per-unit-effort estimates were analysed.

RESULTS

Correlation coefficients were calculated both for one and the same year-classes of species under investigation and those with shift back one or two year-classes relative to silver hake. It concerned units of stock found in Subareas 2 and 3. The last was made to take into account later influence of the oceanographic processes originated in the Northern Scotian Shelf.

Coefficients of correlation between the trawling survey indices are given in Table 1. It can be seen that though statistically significant correlation is absent in all cases exclusion of the first three years from the analysis resulted in the noticeable increase of the coefficients discussed.

Thus, during the 1980's when according to the trawling survey data silver hake abundance variations were clearly pronounced they were in antiphase (qualitative correlation) to those of other species.

Correlation between the abundance estimates for silver hake and other fish species obtained by SPA method was practically absent in most cases (Table 2). We may speak about qualitative correlation only in respect of cod in Div. 3NO (shift back one year-class) and cod in Div. 4VsW (the same year-classes). When correlation coefficients were not less than 0.30 the trawling survey indices were presented graphically (Fig. 1-4). Variation of the curves confirms the above-mentioned supposition that inverse correlation between abundance of silver hake and other species prevailed during the 1980s.

It is too early to speak about prognostic significance of the results obtained. Further research is needed to draw a conclusion. Specifically attention must be paid to the relation between abundance indices of silver hake and cod from Div. 3NO (shift back two year-classes).

In Table 3 estimates of catch-per-unit-effort for the species under consideration are given. The data presented should be interpreted from different points of view, i.e. dynamics of stocks and influence of the environmental factors on accessibility of the stocks for fishery. Variation of the curves in Fig. 5 allows to suppose that relatively stable estimates of catch-per-unit-effort for cod and pollock as compared to those of silver hake can be explained both by more strong influence of the hydrometeorological conditions on accessibility of silver hake for fishery due to the restrictions introduced in 1977 and more clearly pronounced natural fluctuations in the species abundance.

The results obtained do not allow to accept or reject the hypothesis suggested but give ground to think about possible relationship between dynamics of the Scotian silver hake and some other Gadidae abundance influenced by the oceanographic processes running in the Northwest Atlantic.

DISCUSSION

The problem mentioned was analysed and discussed in many papers. Baltic herring may be used as a striking demonstration of winter temperature influence on the strength of the year-classes (Nikolaev, 1958). It being known that strong year-classes of autumn - and spring-spawning herring followed warm and cold winters, respectively. The relationship between periods of the strong year-classes of haddock, cod and Atlantic herring in the Northwest Atlantic between the Grand Banks in the west and the Barents Sea in the east was established by Templeman (1965). According to him the relationship found can be explained by the influence of the Gulf Stream and its variations. In another Templeman's paper (1972) the same relationship is marked for the populations of haddock and cod in the area between the Georges Bank in the west and the Barents Sea in the east. It is shown that strong year-classes of the species under discussion appear at the moderately low temperature. Lower temperature in the north

and more high temperature in the south must have an unfavourable influence on the strength of the year-classes. As far as haddock in the southern area of the Grand Banks is concerned its abundance is strongly dependent on the climatic changes. The aforesaid is possibly true for the Scotian silver hake and becomes apparent in the sharp fluctuations of its abundance over the whole period of observation since 1962. Silver hake belongs to the warm-loving species as compared to cod and haddock and is found on the northern edge of its distributional area. So the strong year-classes of the silver hake population under discussion must appear mainly during the years with positive temperature anomalies.

Between 1983 and 1988 when several strong year-classes of silver hake were recorded (Waldron et al., 1992) positive anomalies of the near-bottom temperature prevailed on the Scotian Shelf in contrast to the Georges Bank and Labrador areas (Borovkov and Tevs, 1991; Drinkwater et al., 1992; Sigaev, 1991).

REFERENCES

1. Annand C. and D.Beanlands. 1991. Assessment of pollock (Pollachius virens) in Divisions 4VWX and subdivision 5ZC for 1990. CAFSAC Res.Doc.91/35, 53p.

2. Baird J.W., C.A.Bishop, W.B.Brodie and E.F.Murphy. 1992 (a) An assessment of the cod stock in NAFO Division 2J3KL. NAFO SCR Doc.92/18, 69p.

3. Baird J.W., C.A.Bishop and E.F.Murphy. 1992(b). An assessment of the cod stock in NAFO Div.3NO. NAFO SCR Doc.92/75, 27p.

4. Borovkov V.A. and I.I.Tevs. 1991. Oceanographic conditions in NAFO Subareas 0, 1, 2 and 3 in 1990. NAFO SCR Doc. 91/11, 20p.

5. Drinkwater K.F., B.Petrie and S.Narayanan. 1992. Overview of environmental conditions in the Northwest Atlantic in 1991. NAFO SCR Doc. 91/73, 36p.

6. Mohn R. and W.J.MacEachern. 1992. Assessment of $4V_sW$ cod in 1992. 1992. CAFSAC Res.Doc. 91/54, 37p.

7. Nikolaev I.I. 1958. Some factors determining variations in abundance of Baltic and Atlanto-Scandinavian herring. Trudy VNIRO, vol. 34, p. 95.

8. Sigaev I.K. 1991. Review of hydrographic conditions in some areas of the Northwest Atlantic,1990,NAFO SCR, Doc. 91/4, 12p.

9. Templeman W. Relation of periods of successful year-classes of haddock on the Grand Bank to periods of success of year-classes for cod, haddock and herring in areas to the North and East. 1965. ICNAF Spec. Publication No. 6, p.523-533.

10. Templeman W. Year-class success in some North Atlantic stocks of cod and haddock. 1972. ICNAF spec., publ. No.8, p.223-238.

11. Waldron D.E., M.A.Showell and M.C.Bourbonnais. 1992. Status of the Scotian shelf silver hake (whiting) population in 1991 with prosections to 1993. NAFO SCR Doc.92/50, 22p.

Table 1 Correlation Between Abundance Indices for Silver Hake (Div. 4VWX) Cod (Div. 2J3KL, 3NO, 4VsW) and Pollock (Div. 4VWX+5ZC). (Data of trawling surveys)

Unit of stock	r		Note
	1977-1991 without any exclusion	1977, 1978 and 1979 are excluded	
Cod 2J3KL	-0.02	-0.30	The same year-classes
- " -	0.13	0.04	Shift back one year-class
- " -	-0.08	-0.25	Shift back two year-classes
Cod 3NO	-0.02	-0.18	The same year-classes
- " -	-0.09	-0.09	Shift back one year-class
- " -	-0.26	-0.36	Shift back two year-classes
Cod 4VsW	-0.22	-0.38	The same year-classes
Pollock 4VWX+5ZC	-0.22	-0.38	The same year-classes

Table 2 Correlation Between Abundance of Silver Hake (Div. 4VWX), Cod (Div. 2J3KL, 3NO, 4VsW) and Pollock (Div. 4VWX+5ZC) Year-Classes. (SPA calculation method was used)

Unit of stock	r 1977-1991	Note
Cod 2J3KL	0.12	The same year-classes
- " -	0.10	Shift back one year-class
- " -	0.10	Shift back two year-classes
Cod 3NO	-0.07	The same year-classes
- " -	-0.31	Shift back one year-class
- " -	-0.16	Shift back two year-classes
Cod 4VsW	-0.19	The same year-classes
Pollock 4VWX+5ZC	-0.14	The same year-classes

Table 3 Correlation Between Standardized Catch-Per-Unit-Effort Estimates for Silver Hake (2J3KL, 3NO, 4VsW) and Pollock (4VWX+5ZC)

Unit of stock	1977-1991 without any exclusion	1982, 1990 and 1991 are excluded
Cod	0.49	0.73
Cod	0.30	0.06
Cod	0.38	0.40
Pollock	0.23	0.29

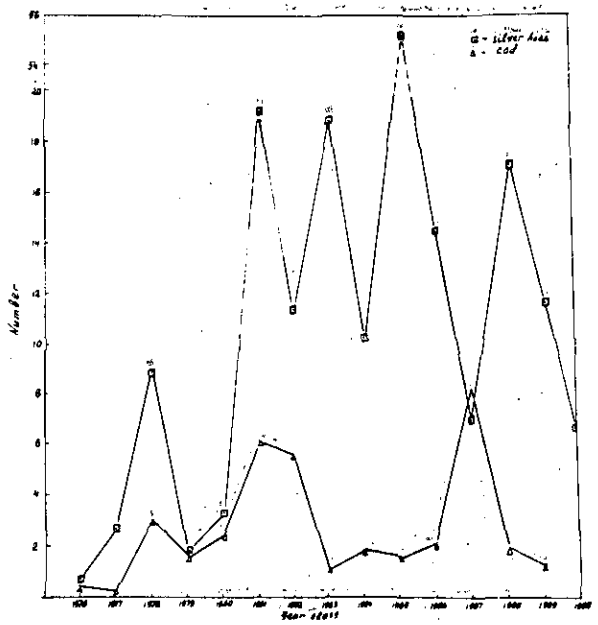

Fig. 1. Abundance indices for one and the same year-classes of silver hake (Div. 4VWX) and cod (Div. 2J3KL).

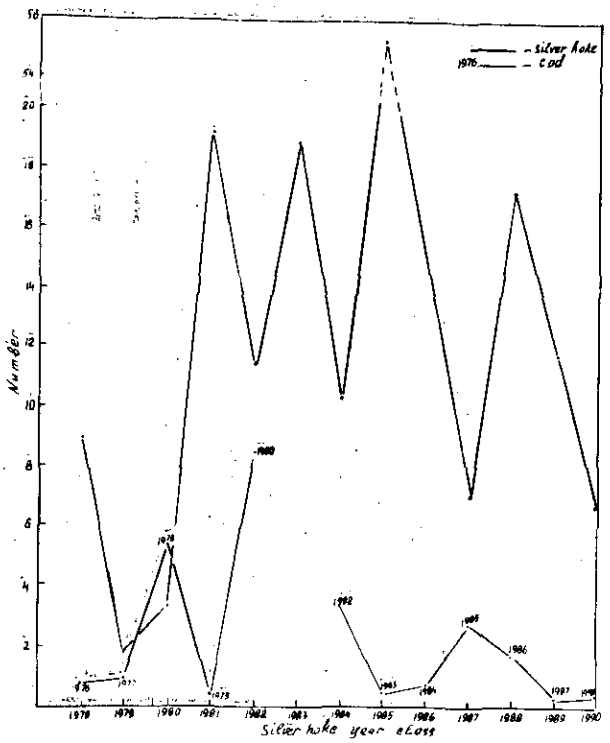

Fig. 2. Abundance indices for silver hake (Div. 4VWX) and cod (Div. 3NO) at shift back two year-classes.

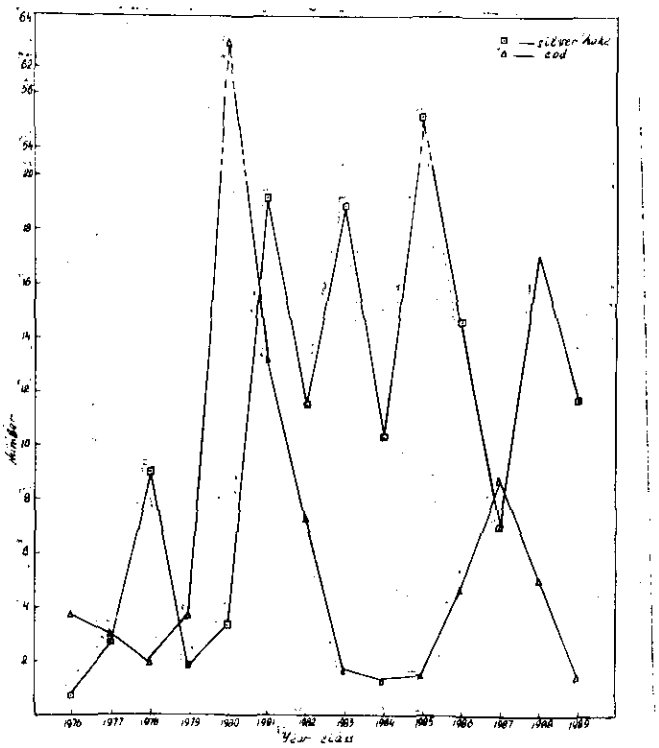

Fig. 3. Abundance indices for one and the same year-classes of silver hake (Div. 4VWX) and cod (Div. 4VsW).

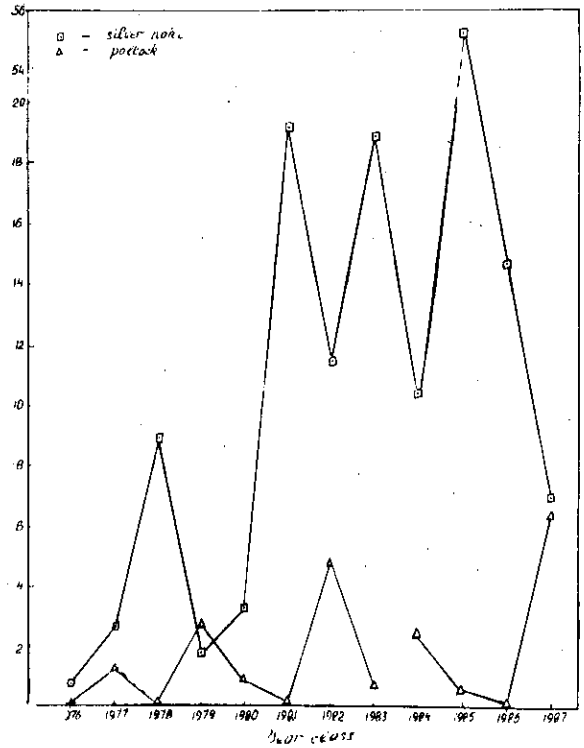

Fig. 4. Abundance indices for one and the same year-classes of silver hake (Div. 4VWX) and pollock (4VWX+5ZC).

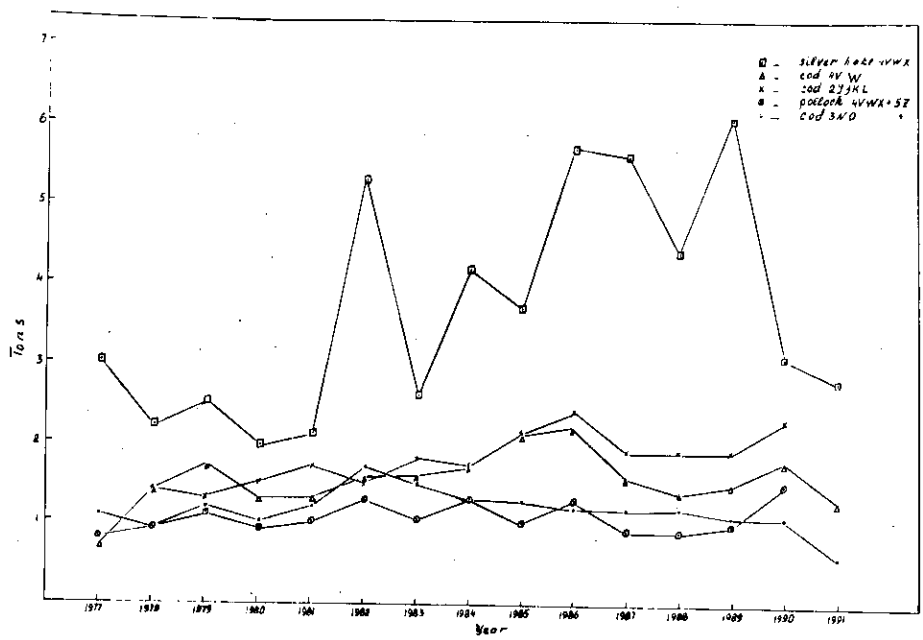

Fig. 5. Standardized catch-per-unit-effort estimates for silver hake, pollock and three units of cod stocks by years.