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Age-related Temporal and Seasonal Changes in Distribution of

Cod on the Eastern Scotian Shelf

by

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Introduction

By 1984 Canada had carried out 15 years of annual summer groundfish trawling surveys and 5 years of seasonal spring (March) and fall (September-October) surveys covering the whole of the Scotian Shelf and Bay of Fundy. A standard, well-documented methodology was used (Halliday and Kohler, 1981) based on a depth stratified random selection of fishing stations. The results of the surveys have been used emtensively in stock assessment exercises and general ecological and distributional studies (e.g. Scott, 1976; Mahon et al., 1984), but not in relation to detailed changes in distribution and density of fish species which may have occurred in the period of the surveys.

Age-related changes in distribution of fishes are a generally accepted, if not demonstrated, feature of several species, for instance, where increasing fish length with depth of capture occurs. It was suspected that cod on the Scotian Shelf showed changes in distribution both in relation to age and to season. To examine this possibility and to check the consistency of distributions derived from research surveys, the distributions of cod catches from the surveys on the eastern Scotian Shelf (NAFO Divisions (4VsW) were examined.

The observations in the selected area from a single year of surveys (approximately 80 stations) would not be sufficient to determine distributional patterns, therefore it wass considered necessary to aggregate the data. Previous distributional studies (Scott, 1981) have examined year to year variations and have found that aggregations of 5-year periods provided useful summaries. It was recognized that the resultant distributional patterns, based on 5-year periods, could not be used to examine the short-term annual variations.

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Since this study was concerned with distributional patterns, it was considered necessary to remove the effect of changes in abundance, thus rendering all observations on an equal footing with respect to the objective. This was accomplished by dividing each observation by the mean number per tow from the respective survey, thereby empressing the data as normalized or relative densities. The resultant quantity has no units and has an expected value of 1.

Age groups were treated separately as 2-, 3-, 4- and 5-12-year olds. The behaviour of adult fish was considered similar enough to warrant aggregations of 5-12's. One-year-old cod were not included as comparative estimates of year class strength suggest that the catches of 1-year olds are not representative of the year class.

The 4VsW cod stock appears to be well-delinated by physical oceanographic features. It is bounded by the Scotian Gulf to the west, the Laurentian Channel to the east, and by the Nova Scotia coast and the Shelf breaks to the north and south, respectively. The only connection with another stock may be in the northeast where there is the possibility of limited interchange with cod in Divisions 4Vn and 4T.

Comparison of the three periods of summer distributions (Fig. la,b,c) shows that there was a common pattern of increasing relative densities in the northeast with age. Two-year olds were particularly low and tended to be well away from the deeper water of the Laurentian Channel, whereas later age groups showed progressively expanding distributions and increasing densities towards the edge of the Laurentian Channel. Inshore densities off Cape Breton appeared to increase with age, possibly indicating a movement of larger fish to coastal waters.

A difference between the 1975-79 period and the other 2 periods appears in the 5-12-year-old group. In 1970-74 and 1980-84 the fish were strongly localized in the northeast at all ages, but in 1975-79 relative densities were lower in the northeast and the cod were more widely distributed over most of the area, particularly on west Sable Island, Western and Emerald Banks.

The results of the 15-year series show that there has been no significant change in the overall distribution of the 4VsW cod stock and that changes of distribution between age-groups follows a consistent

## pattern.

Seasonal changes in cod distribution are evident in comparing the figures for spring (Fig. 2), summer (Fig. 1c) and fall (Fig. 3). The progressive increase in concentrations of fish with increase in age in the northeast is still evident, but much less noticeable in spring and fall than in summer. Relative densities in summer were more moderate than in spring and fall but were more widely distributed over the whole area. This was particularly noticeable in the northeast, and moreso in spring where the cod tended to be off the top of the banks with high concentrations in the gully, in the Sable Island and Western Banks area and in the coastal waters off Cape Breton.

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The concentrations of cod to the west and northwest of Sable Island in fall are interesting as this follows the spawning migration of silver hake into the area. It is possible that the cod prey on the various stages of silver hake then. In spring the 2- and 3-year-old fish also appeared in the Scotian Gulf area, possibly a result of a retreat to the deeper (warmer) waters in winter and slow warming in spring, whereas the fall distributions are closer to the summer distributions as the water temperatures on the Banks were still high enough to permit the fish to range widely.

Changes in relative density and distribution in relation to age were very evident in spring. The 2-year-old fish showed high relative densities in coastal waters, were well represented in the edges of Sable Island and Western Banks, but were absent from the northeast. The 3-year olds tended to be further offshore, along the edge of the Laurentian Channel and the edges of the Banks, with increased representation in the gully. In the 4and 5-12-year olds this trend developed with particularly high concentrations around Western Bank and in the gully. The concentration of older, mature fish in the gully is peculiar to spring and may be related to spawning activity.

In spring and fall the relative densities were more extreme with fewer moderate catches than in summer and, particularly in spring, concentrations of the cod were highly localised, as mentioned above. This could have important implications for survey design where abundance estimates for stock assessment is the major consideration. Intensive surveys in specific areas of high concentration of target species could be more rewarding and economical than general multi-species surveys covering wide areas. For instance, a possible survey design for cod could be more intensive in the Sable Island-Western Bank area and the gully; for haddock in areas of abundance in the Browns and Emerald Bank areas, and so on. Conversely, areas such as the Bay of Fundy, the Scotian Gulf and less important areas of bad bottom, or of great uniformity but poor in target species could be sampled less intensively.

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## References

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