RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 1632
(D. c. 2)

ICNAF Res. Doc. 66-24

ANNUAL MEETING - JUNE 1966

Increase in Growth of Labrador Cod

by A. W. May
Fisheries Research Board of Canada
Biological Station, St. John's, Nfld.

Abstract

Growth of Subarea 2 cod is examined in relation to area and time. Growth is slower in the north than in the south. During the period 1959-64 there was a slight increase in average length at age in Divisions 2G and 2H and a much greater increase in Division 2J, but only for those ages taken in quantity by the commercial gears. The increase in growth has occurred over a period of greatly increased fishing.

Introduction

Growth of cod appears to be readily modified by external factors, and may vary both in area and time (Kohler, 1964). Temporal variations in the northwest Atlantic have recently been described by Kohler (1964) and Williamson (MS, 1965). This study examines material collected from Labrador (Subarea 2) since 1948 for changes in growth of cod over the period. Each ICNAF Division is considered separately.

Material and Method

Inshore material from 1948 and 1950 was available from studies by Fleming (1960) and May (1959). More extensive material from the July-August inshore fishery has been collected annually (except 1961) since 1959. The collecting gears were cod trap and jigger. Occasional collections from offshore fishing by research vessels were available prior to 1959 (May, 1959), and larger and more widespread collections since 1959. Research vessels usually fished a series of depths across the offshore banks and used a small-meshed liner or cover for the otter-trawl codend.

Ages were determined from otoliths and growth expressed as average length at age. Length measurements were of fork length. Inshore and offshore data were considered separately because of differences in gear selectivity. The offshore collections were almost entirely from Division 2J, but sufficient inshore data were available to allow separate examination for Divisions 2G, 2H and 2J. All collections were random samples of the catch.

Since the data were collected at various times throughout the year the collections from one year to the next were not always directly comparable because of seasonal growth differences. However most of the collections were obtained in the July-September period, while none were obtained during January-March. For purposes of display and fitting mathematical functions the convention has been adopted of adding 1/4 to the otolith age for each quarter of the year beyond the January-March period. A 5-year-old fish would then be regarded as $5\frac{1}{4}$ years old in April-June, $5\frac{1}{2}$ in July-September and 5 3/4 in October-December.

The von Bertalanffy growth curve has been used to provide quantitative descriptions of growth. The curves were fitted using the "trial L_∞" approach suggested by Ricker (1958).

Changes in Growth

Changes in growth with time are best examined from the inshore data which were all collected at the same time each year (July-August). Plots of average size at age show no consistent trends between 1950 and 1959 in Division 2G (Fig. 1A), and between 1948 and 1959 in Divisions 2H and 2J (Fig. 2A and 4A). From 1959-64 the averages are variable, but generally show slight upward trends in Divisions 2G and 2H (Fig. 1A and 2A), and very pronounced upward trends from age 8 in Division 2J (Fig. 4A). The upward trend is less pronounced for ages 6 and 7, while the averages for ages 4 and 5 exhibit a decline over the period.

Trends in the averages for offshore data are shown in Fig. 4B. The material from 1950-54, 1960 and 1962 was collected in August and September. The 1963 data were from April-May and September; the 1964 data from April-May and October-November. For rough comparability with the earlier data unweighted averages were calculated from the two series in each year and these values plotted in Fig. 4B. These would undoubtedly be lower than true August-September averages in 1963, but possibly about the same in 1964. The general pattern (Fig. 4B) is the same as inshore (Fig. 4A) except that the averages for age 6 exhibit a downward trend.

Inshore growth curves (Fig. 1B, 2B and 3) also indicate slight increases in average size at age since 1959 in Divisions 2G and 2H, and a much greater increase for ages above 7 in Division 2J. Data for 1963, rather than 1964, were used in Divisions 2H and 2J since collections in these areas in 1964 were very small. It is obvious that in Division 2J (Fig. 3) a von Bertalanffy growth curve cannot adequately describe the whole of the 1963 data. The averages for ages 4-7 in 1963 are similar to those for 1959, though consistently below them, while growth is considerably greater beyond age 7. The fitted curves which are shown are as follows:

$$1963 \qquad l_t = 74\,(1-e^{-.21(t-.26)})$$

$$1959 \qquad l_t = 63\,(1-e^{-.36(t-1.85)})$$

The recent averages in Divisions 2G and 2H are very similar, and may be described by the following equation, based on combined 1963 and 1964 collections:

$$l_t = 65\,(1-e^{-.20(t-.35)}).$$

It is evident that for ages 7 and above growth has increased slightly in Divisions 2G and 2H, and very noticeably in Division 2J. Data were insufficient to examine the younger ages in the northern Divisions, but average sizes in Division 2J appear to have declined for ages below 7.

Discussion and Conclusions

Two aspects of the demonstrated increase in growth are of particular interest: first that it is very much less in the north than in the south, and second that it is not general for all ages. Ages below 7 in Division 2J seem to have declined in average size. Prior to 1963 growth in Division 2J was only slightly greater than in Division 2H (May et al, 1965), with L_∞ and k in the former area 65 cm and 0.31, and in the latter 64 cm and 0.24. In 1963-64 the values for Division 2J were 74 cm and 0.21, and for Divisions 2G and 2H 65 cm and 0.20. The fact that a slight cline in growth was previously evident, and that growth has increased so much in the south and so little in the north, is probably indicative of some stock separation between Division 2J and the northern Divisions.

Variations in cod growth with time in West Greenland have been associated with temperature (higher temperatures give higher mean lengths) by Hermann and Hansen (1965). The effect of temperature is usually considered to be indirect, through its influence on feeding, food assimilation and distribution of the predator and prey. Kohler (1964), from aquarium experiments, found correlations between temperature and food consumption and between food consumption and growth, though a direct temperature-growth correlation could not be demonstrated. Taylor (1958) suggests that if "temperature-dependent changes should occur, they might be mistakenly interpreted as effects of fishing."

It is most unlikely that the growth changes observed in Division 2J were due to temperature changes. The whole Labrador area is under the influence of the Labrador Current, and any growth changes due directly to temperature would have to be general throughout the area, and for all ages. The fact that the greatest changes in growth occurred only in the area heavily fished since 1959 (May, MS, 1966), and only for those ages taken in quantity by the fishery (see below), strongly suggests that the thinning out of the older ages through fishing was the responsible factor. Kohler (1964) attributes changes in cod growth in the western Gulf of St. Lawrence to actual changes in food supply plus changes in competition for food as a result of density changes due to fishing. Williamson (MS, 1965) considers that increased growth of cod from the southern Grand Bank is at least partly due to increased fishing.

Reported mesh sizes in use in the offshore fishery are of the order of 110-120 mm (ICNAF Sampling Yearbooks). Hodder and May (1965) report 50% retention lengths of about 40 cm in Division 2J for mesh sizes within this range. Full selection does not occur until 50 cm or above. No selection data for inshore gears are available, but Boulanger's (MS, 1961) value for 50% retention length of a cod trap with 4½-inch nylon back is 48 cm (the Labrador gear has 3- to 4-inch tarred cotton meshes). The average lengths of age 7 fish inshore and offshore in Division 2J during the 1959-64 period were about 55 cm (Fig. 3 and 4). It would thus appear that the greatest increase in growth has occurred for those ages in which most of the individuals are beyond the selection ranges of the various gears.

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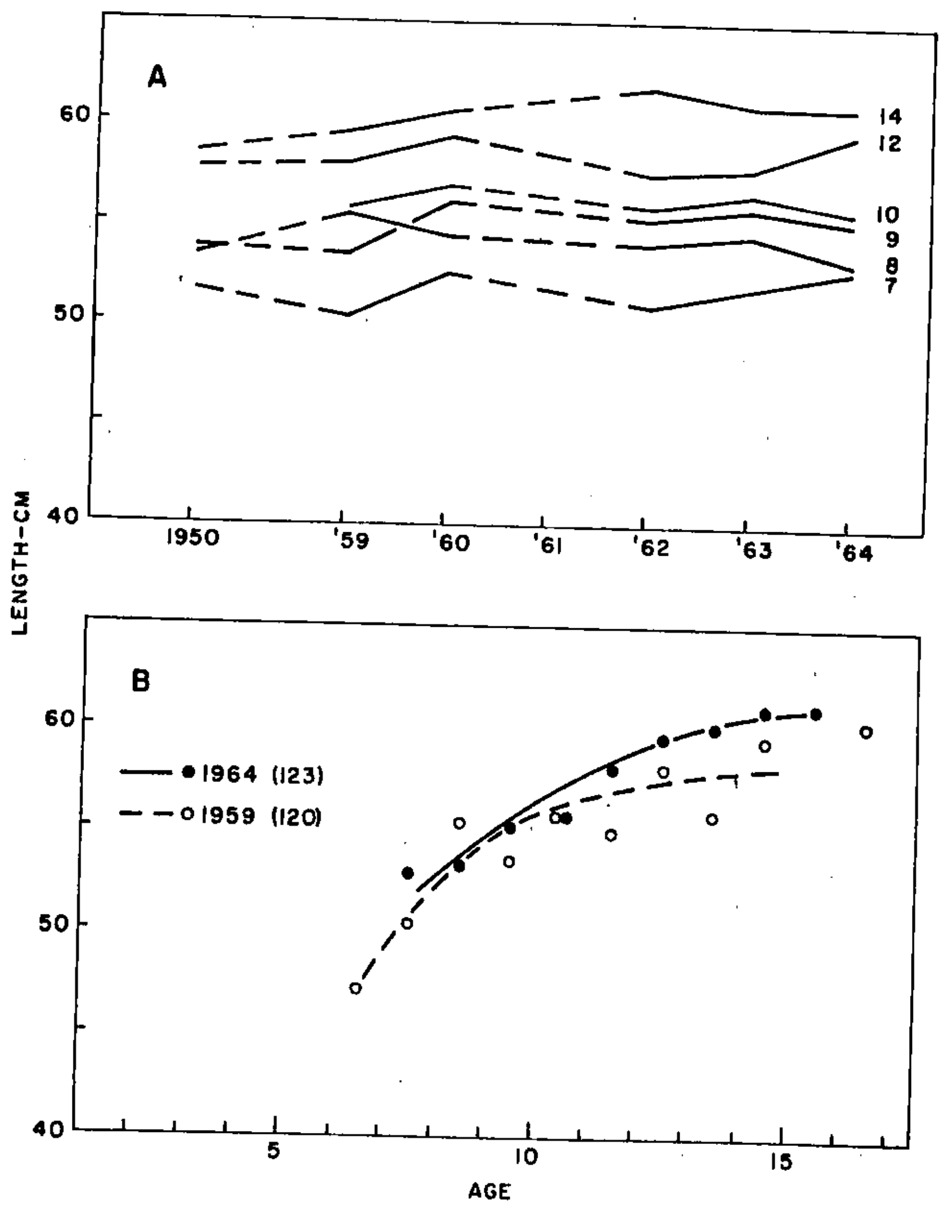

Fig. 1. A. Trends in average length at age, Division 2G (inshore data).
B. Growth curves for 1959 and 1964. Numbers of fish are in brackets.

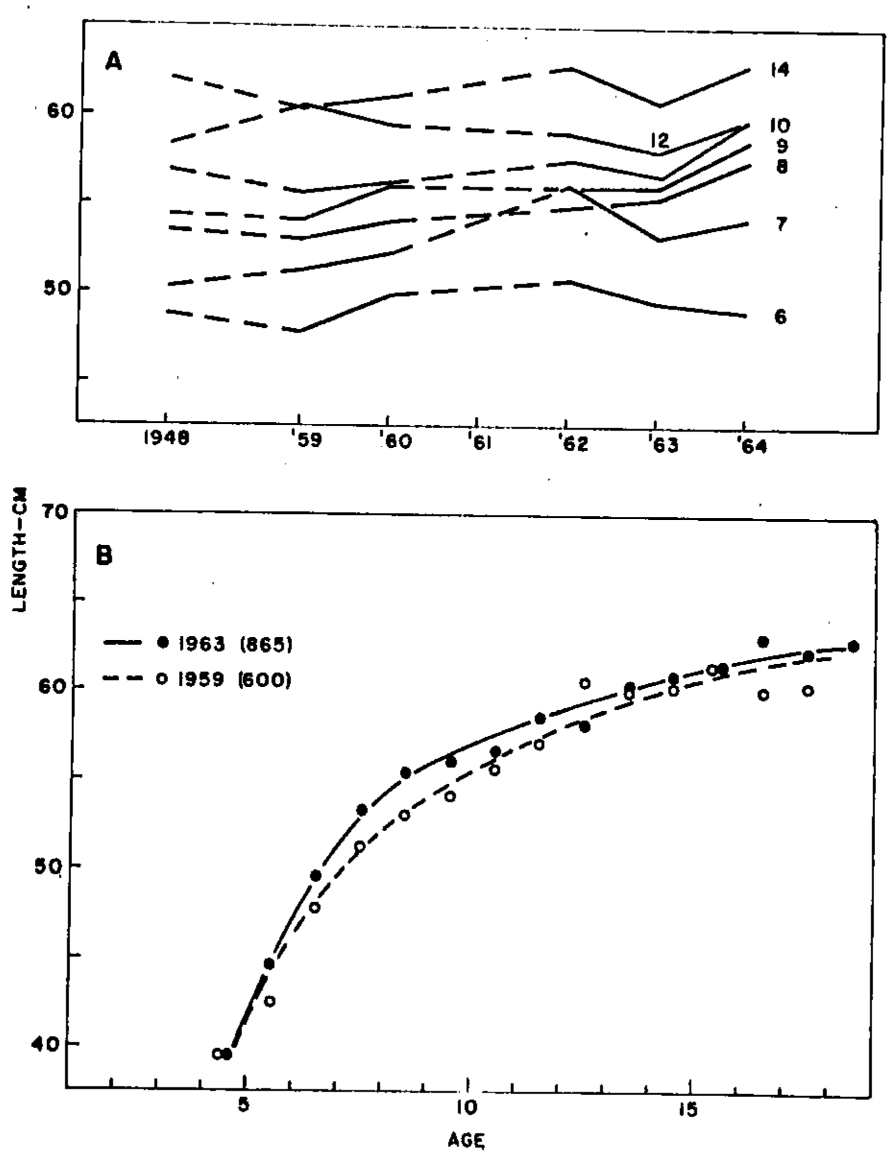

Fig. 2. A. Trends in average length at age, Division 2H (inshore data).
B. Growth curves for 1959 and 1963. Numbers of fish are in brackets.

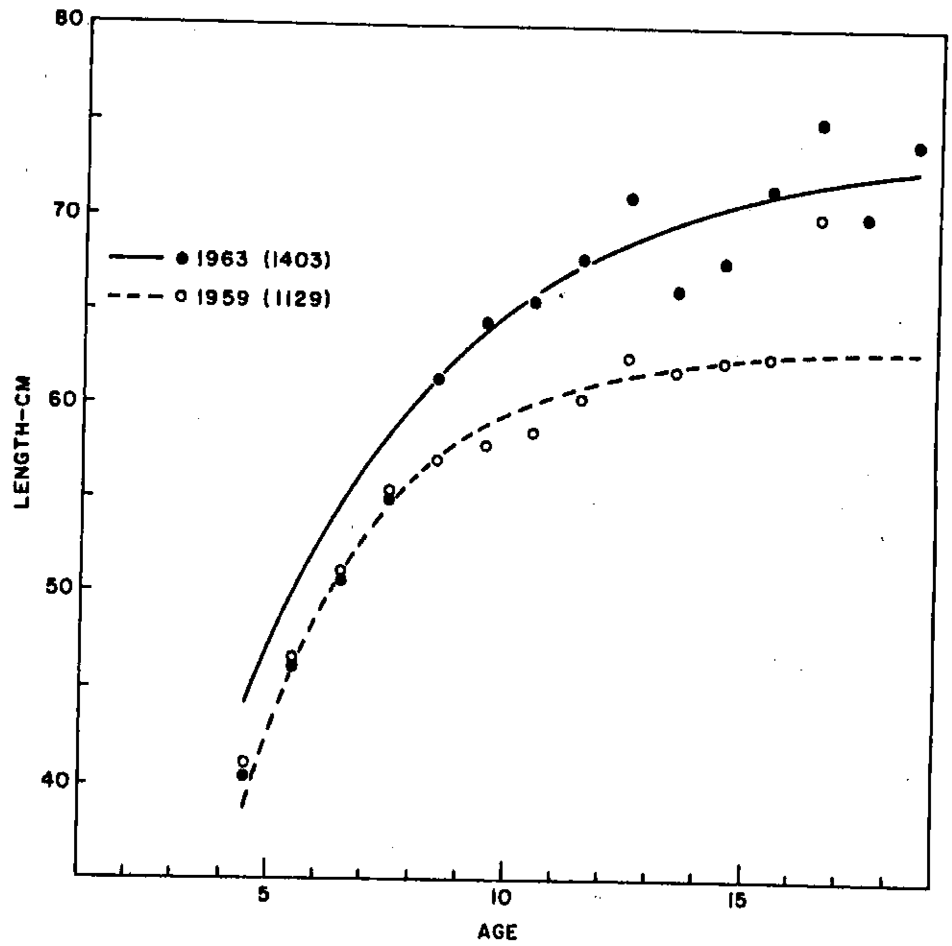

Fig. 3. Growth curves for Division 2J, 1959 and 1963 (inshore data). The 1963 curve is fitted only between ages 8 and 18. Numbers of fish are in brackets.

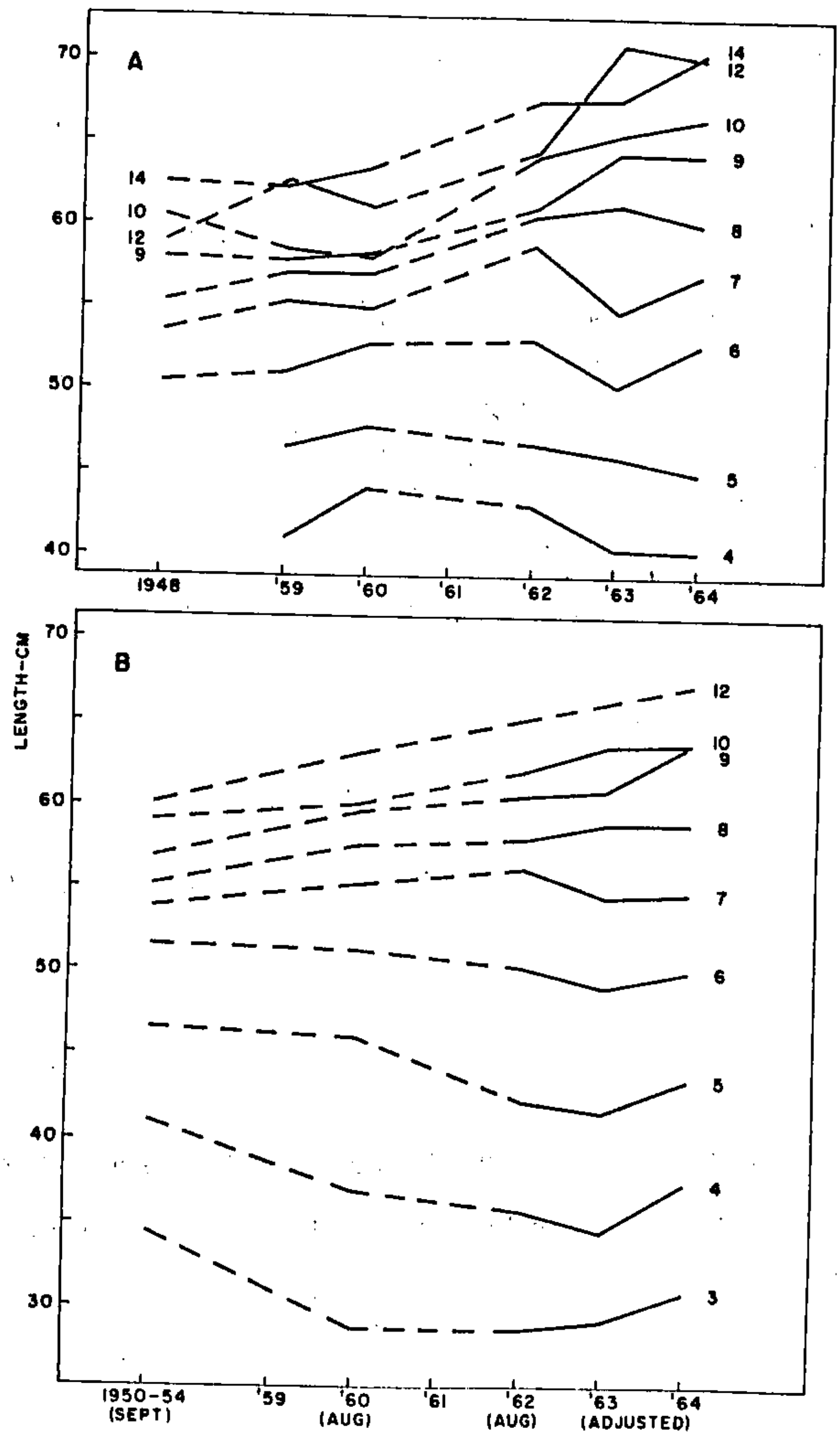

Fig. 4. Trends in average length at age in Division 2J. A - inshore, B - offshore.