

ANNUAL MEETING - JUNE 1967Mortality in Northeastern
Gulf of St. Lawrence Cod
during 1947-66

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Abstract

Collections for age and length frequencies from research vessels using small mesh otter trawl and from catches taken by line gears, indicated a decline in larger and older fish which commenced sometime during 1951-57 and increased by 1962-66. Catch curves plotted from the otter trawl data showed that total mortality (Z) of ages 5 or 6 and above increased from 0.39 to 0.65 during the period 1947-66. For line gears, during 1953-64 Z changed from 0.18 for ages 8-16 and 0.50 for ages 16-22 to 0.22 for ages 13-20 in 1966.

The above changes are provisionally attributed to the introduction of otter trawling in the mid 1950's in Divisions 4R and 4S, as observed by Wiles (MS, 1967b).

INTRODUCTION

Fishery assessments were not made for cod of ICNAF divisions 4R and 4S by the ICNAF working group on fishery assessments (see Beverton & Hodder, eds., 1962). For these divisions few data are published on age compositions of fish caught by the major gears in the cod fishery and no information is available on gear selectivity, ratio of fishing mortality to total mortality or natural mortality of fish within the selection ranges of the gears. Growth rates have recently been determined from research vessel small mesh trawl catches and inshore line gear samples by Wiles, (MS, 1967a), and shown to have increased in recent years for older fish and for all ages examined in 1966. This study of mortality was therefore undertaken to see if changes in growth rate were accompanied by increased total mortality.

Age distributions of research vessel and inshore line gear samples from Divisions 4R and 4S are here described, together with catch curves and estimates of total mortality derived from the age compositions.

MATERIALS AND METHODS

Offshore collections of otoliths and length frequencies were made on cruises of Canadian research vessels using No. 36 or 41-5 otter trawls having small-meshed cod-ends, in certain years during 1947-66. Line gear samples for length and age distributions were collected in some years during 1953-64 by research vessels working inshore and in 1966 from commercial landings at a fish plant on the west coast of Newfoundland. Details of all collections used in this study and a description of sampling procedures are given by Wiles, (MS, 1967a).

Age distributions for each year were obtained after adjustment of random, random plus "category" and "stratified" otolith subsamples to number measured or caught using age length keys based on otolith ages. The fish were caught at various depths between 38 and 293 m. Collections were made at different times of the year. To compensate for this and to prevent an error of one year being made in otolith ages in the September-December period, January 1st was used as the fishes' "birthday" and otolith edge deposits were recorded at the time of reading. Hyaline zones apparent in these months were regarded as the next annual hyaline zone and were not counted for ageing purposes until January 1st of the next year (see also otolith validity studies by Fleming (1960), Kohler (1964), Williamson (MS, 1965), May (1965) and Wiles (MS, 1967c).

In this study of age and length compositions, data were combined for several years to compensate for scarcity or lack of data in some years and to reduce effects of annual variations in recruitment. Offshore otter trawl samples were combined into three five year periods, 1947-51, 1957-61, and 1962-66. For inshore line gears, data were combined for 1953-55 and 1963-64 and compared with 1966 collections.

Estimates of total mortality in otter trawl and line gear samples were calculated from least squares regressions fitted to the descending limbs of catch curves based on percentage age distributions. For mortality estimates, offshore data were combined for 1947-61 and 1962-66 while those for line gears were combined for 1953-64 and compared with 1966 samples.

AGE AND LENGTH DISTRIBUTIONS

Composite age and length frequencies for offshore samples are shown in Fig. 1. During 1947-50 catches were composed of a wide range of age classes, fish 2-8 years old being dominant. Fish 9-13 years, and to a lesser extent those 14-17 years were relatively well represented. The wide range of ages is reflected in the length frequency for 1947-50 which had no well-defined mode and a large number of fish 25-70 cm. in length. In 1957-61 ages 2 and 4-7 were dominant but ages 8-14 were relatively reduced in comparison to the 1947-51 sample. There were no fish older than 14 in the more recent collection. The corresponding length frequency for 1957-61 had two distinct modes at 25 and 47 cm. but fish greater than 65 cm. were uncommon. The mode at 25 cm. was caused by a strong 1955 year class collected in 1957 (2 year-olds).

For 1962-66, collections from ICNAF Divisions 4R and 4S were kept separate. The age frequency for Division 4R had a relatively restricted range of ages composed largely of 4-7 year-olds. Cod less than 3 and greater than 9 were relatively poorly represented and there were virtually no fish older than 11 years in the sample. In the 4S sample, ages 3-7 were dominant and 8 and 9 year olds well represented, but there were few fish less than 3 or greater than 10 years old. In 1962-66, length frequencies for Divisions 4R and 4S had similar modes at 55 cm. but the frequency for 4S had a secondary mode at 40 cm. corresponding with the abundant 3 year-olds.

Age and length frequencies of line gear samples are shown in Fig. 2. During 1953-55 catches were composed of a wide range of ages. Ages 5-8 were dominant, followed in importance by ages 9-16 and to a lesser extent ages

17-22. The corresponding length frequency had a mode at 64 cm. but was skewed to the right by the relatively important larger and older fish in the sample.

In 1963-64 ages 5-11 were dominant but fish older than 12 years were poorly represented in comparison to the 1953-55 sample. The length frequency for 1963-64 had a mode at 61 cm. (cf 64 cm for 1953-55) and approached a normal distribution more closely that of 1953-55. In 1966, old fish were again predominant, with ages 12-14 forming the bulk of the sample. However, ages 15 and over were relatively reduced in comparison to 1953-55.

MORTALITY

Offshore catch curves are shown in Fig. 3. From 1947-61 to 1962-66 age at full recruitment rose from 4 to 6 years and Z increased from 0.39 (ages 5-16) to 0.65 (ages 7-15). In Fig. 4 are given the catch curves for line gears which indicate that age at full recruitment increased from 7 years in 1953-64 to 10 years in 1966 and that Z changed from 0.18 for ages 8-16 and 0.50 for ages 16-22 in the former period to 0.22 for ages 13-20 in 1966.

Thus, the descending limb of both offshore and the recent line gear catch curves were straight whereas that for line gears in 1953-55 was convex. The shape of the latter curve may indicate a decrease in line fishing from the 1940's to the early 1950's. Unfortunately, effort in the Newfoundland inshore fishery is not accurately known prior to 1956.

DISCUSSION

Age and Length Distributions

Assuming that an otter trawl with a small meshed codend provides a random sample of most of a fish population on the sea bed, the research vessel data indicate that prior to 1957 the cod stock in the northeastern Gulf

of St. Lawrence was composed of a wide range of ages and sizes, a good proportion of which were more than 10 years old and 70 cm. in length. A decline in older and larger fish occurred sometime during 1951-57. This may be related to the inception of otter trawl fishing in Divisions 4R and 4S in 1954 (Wiles, MS, 1967b). The decline became more marked by 1962-66 and so probably occurred in 1961 or 1962. This is consistent with the finding of Wiles (MS, 1967a) that an increase in growth rate of cod aged 10 or 11 and above was initiated in Divisions 4R and 4S in 1961-62, which is only one or two years after record trawler landings in these Divisions (Wiles, MS, 1967b). Thus, reduction of larger and older fish may have been due to the introduction and general increase of trawler fishing in this area.

The data for line gears show that although a decline of older and larger fish occurred sometime during 1956-62, by 1966 at least ages 12-14 were again well represented. However, the samples for the earlier period were from shallow (33-104 m) water and mostly at depths less than 90 m, whereas those for 1966 were from deeper (51-269 m) water usually below 90 m. Thus the two sets of data may indicate that proportionately more older and larger fish are found in deeper water. Furthermore, since no recent series of data is available for inshore commercial catches, it may be that 1966 was a year when large fish were unusually abundant.

Mortality

The increase in Z for the small mesh trawl samples, from 0.39 in 1947-61, to 0.65 in 1962-66, is a reflection of the decline in older and larger fish which occurred in recent years in offshore research vessel catches. The probable cause of increased total mortality was the introduction (in the mid 1950's) and continuance of otter trawl

fishing in Divisions 4R and 4S. For line gear samples Z only increased for younger ages (8-16 years), older fish having a lower value of Z in 1966 than in 1953-64. A convex descending limb on a catch curve such as was obtained for 1953-64 is indicative either of natural mortality simply increasing with age or of a period of low fishing intensity following one of greater fishing intensity (Ricker, 1958). An interesting result is that for the younger (8-16 years) fish caught by line gears, values of Z were almost identical in the early and recent periods, averaging 0.2 over the whole period of sampling. Thus there is an indication that the effort put into the line gear fishery has not changed appreciably during 1953-66.

Line gears select larger and older fish than otter trawl, which may explain the convexity of the curve for line gear samples in a period when trawl samples produced a straight catch curve. If this is correct, the catch curves for the earlier years in this study probably indicate a steady state where fishing was not at an intense level. The catch curves for recent data are also straight so it seems that the cod fishery in the Northeastern Gulf is not as yet exerting a strong effect on the stock since this should typically result in a concave curve (Ricker, 1958).

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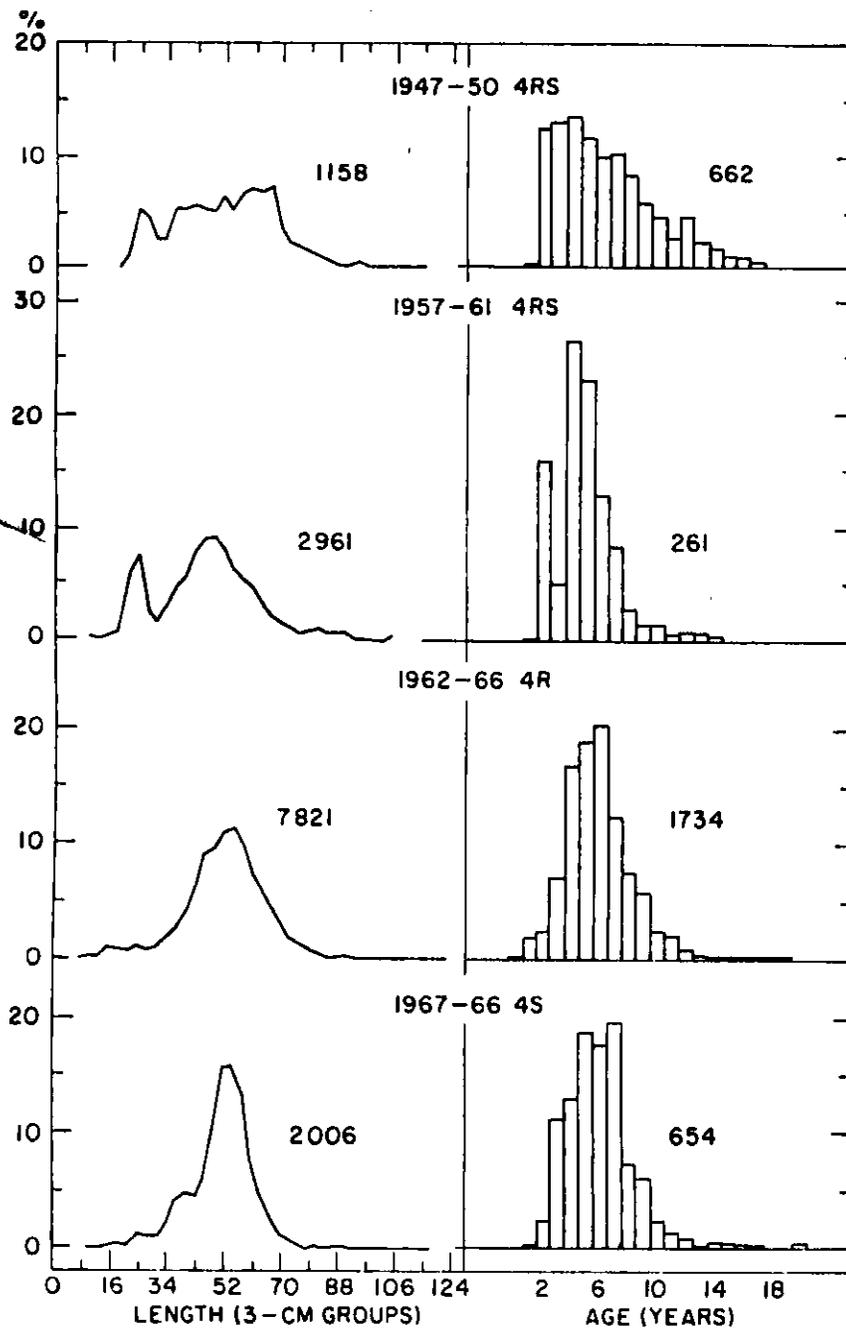


Fig. 1. Length and age compositions of cod taken by small mesh otter trawl in three five year periods in ICNAF Divisions 4R and 4S.

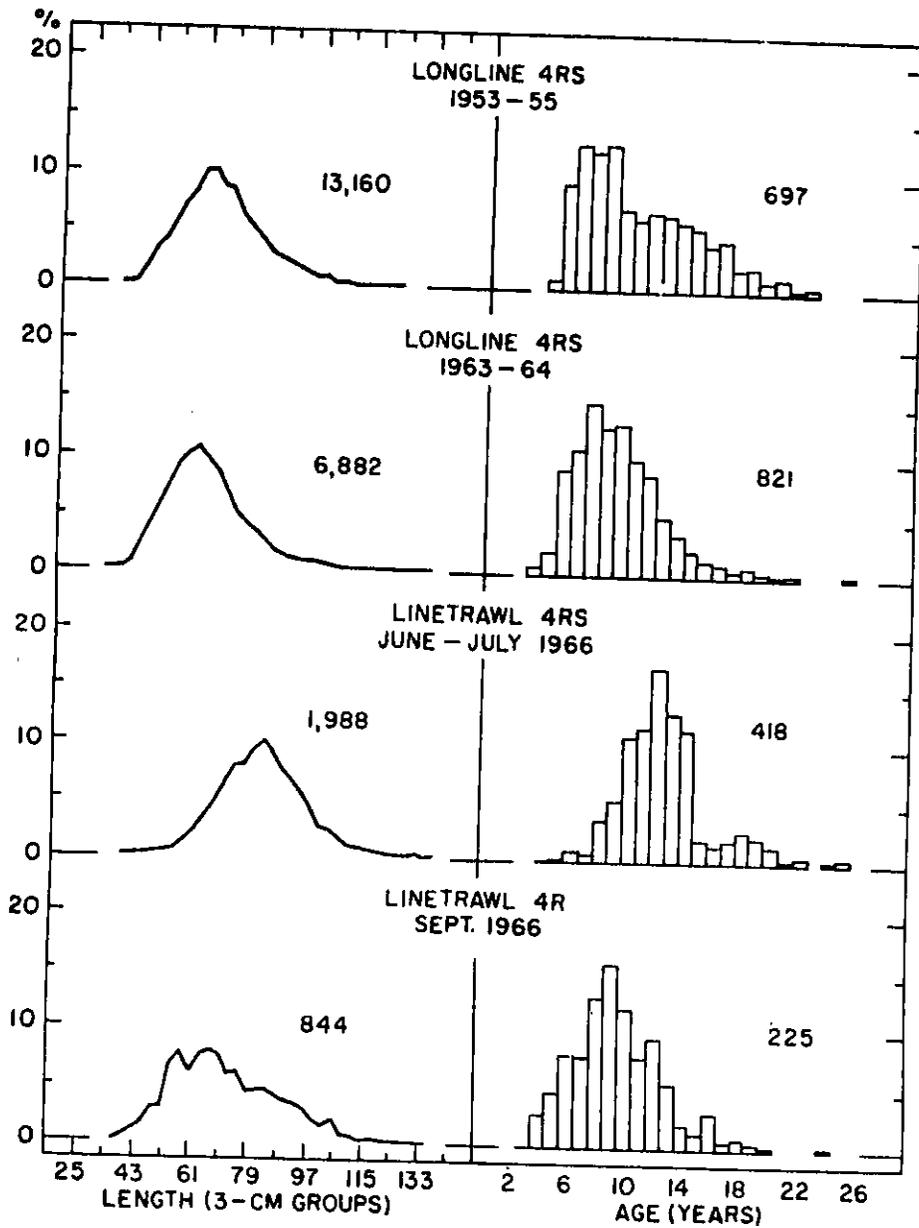


Fig. 2. Length and age compositions of cod taken in 1953-55 and 1963-64 by experimental longlining and in 1966 by commercial linetrawl in ICNAF Divisions 4R and 4S. Data for 1953 are revised from Templeman and Fleming (1956), the otoliths being read by the present author.

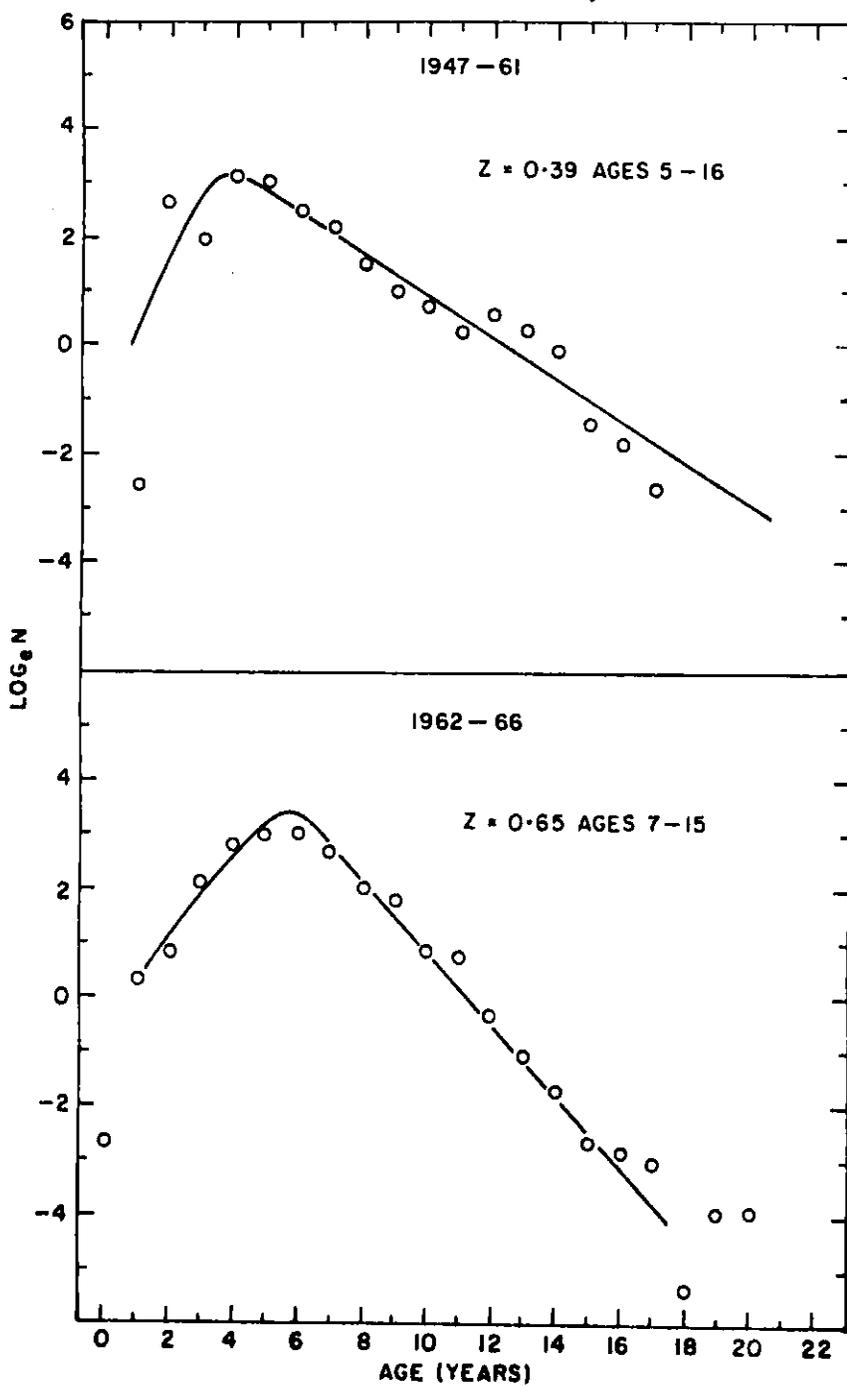


Fig. 3. Catch curves for combined age distributions of cod taken by small mesh otter trawl in ICNAF Divisions 4R and 4S.

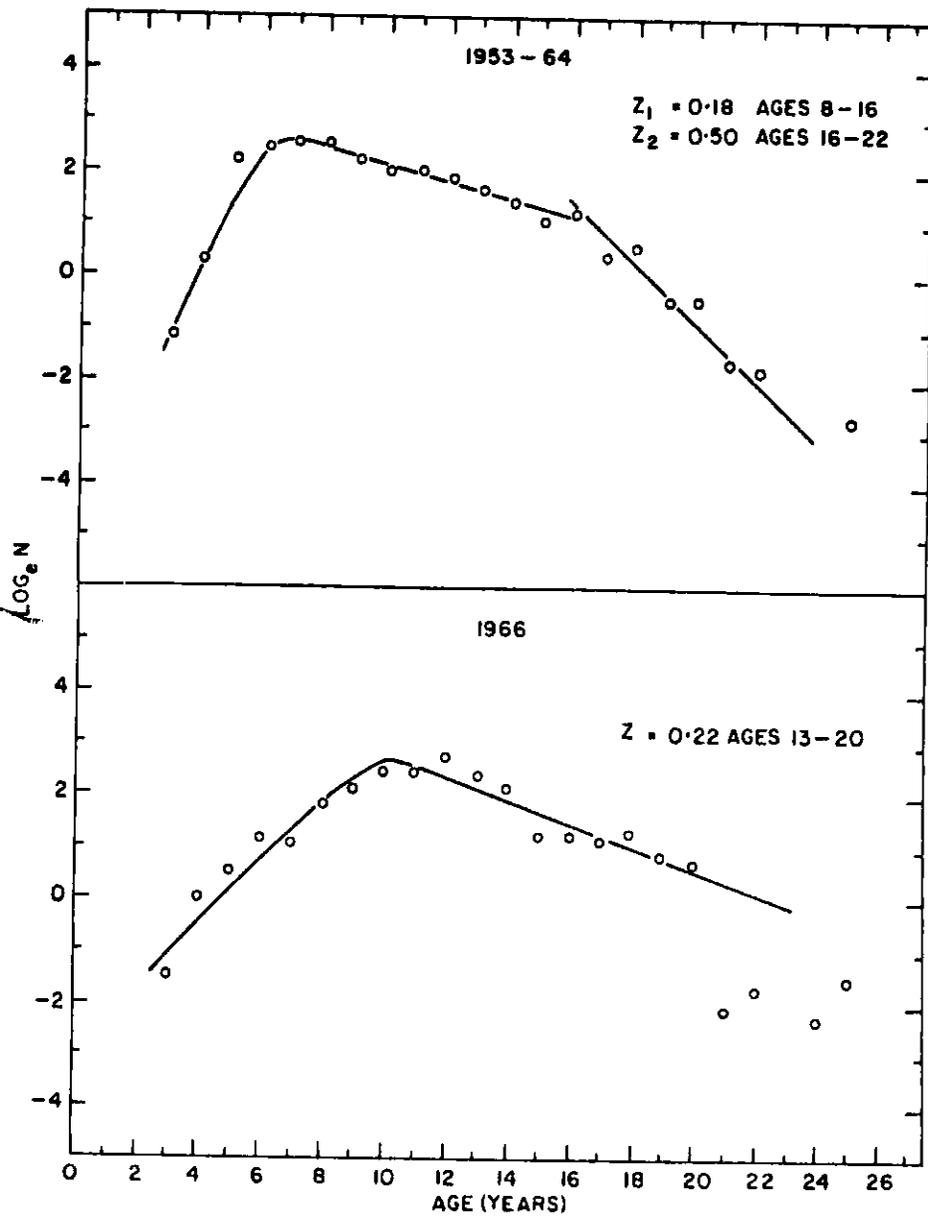


Fig. 4. Catch curves for combined age distributions of cod taken by line gears in ICNAF Divisions 4R and 4S.