



Serial No. 2823
(D.c.5)

ICNAF Res.Doc. 72/96

ANNUAL MEETING - JUNE 1972

Some biological characteristics of the Fortune Bay,
Newfoundland, herring stock, 1966-1971

L.S. Parsons and V.M. Hodder¹
Fisheries Research Board of Canada
Biological Station, St. John's, Newfoundland

Introduction

Since its inception in 1964-65 the Newfoundland purse seine fishery for herring has been primarily concentrated along southwestern Newfoundland in areas J1 and J2 (Fig. 1) with lesser quantities being caught in Fortune Bay and along western Newfoundland (Hodder, 1971). Traditionally up to the early 1950's, Fortune Bay (area I) on the southeast coast was one of the main centres of the Newfoundland herring fishery, with a catch of 6440 metric tons in 1953 (the earliest year for which catch data are available by area). Annual catches in Fortune Bay declined to less than 700 metric tons during the period 1956 to 1964 when the demand for herring as food was very low (Hourston and Chaulk, MS, 1968). With the advent of the purse seine fishery during the mid-1960's, catches in Fortune Bay by purse seiners and bar seiners increased to 5400 metric tons in 1967 and fluctuated between 6400 and 14,700 metric tons during 1968 to 1971 with peak catches of 14,218 and 14,748 metric tons in 1968 and 1971 respectively (Table 1). Bar seiners generally account for between 10 and 25% of the combined total. The bulk of the fish caught by the mobile fleet is taken in the January-May period.

Tibbo (1956, 1957), initially at the Newfoundland Fisheries Research Station and later as a member of the Canadian Atlantic Herring Investigations Committee, conducted studies of the Fortune Bay herring population in 1943-44 and again in 1946-48. This report presents more recent information on the size and age composition and selected biological characteristics of the Fortune Bay herring concentrations during the 1966-71 period.

¹Present address: ICNAF, P.O. Box 638, Dartmouth, N.S., Canada.

Materials and methods

Length, weight, sex and maturity data were collected from more than 6600 fish landed by purse seiners at Harbour Breton during the years 1967-71. Most of the samples were examined in the fresh condition immediately after capture but some, particularly in 1969, 1970 and 1971, were thawed and examined after being kept in frozen storage for several weeks. In 1971 the specimens were also examined to determine the incidence and intensity of infestation with larval nematodes of the genus *Anisakis*. The examination for nematodes was restricted to the body cavity and viscera.

During two cruises to Fortune Bay in March and May 1966 by the Fisheries Research Board of Canada vessel *Investigator II* samples were obtained from herring catches in anchored gillnets set in coastal waters over depths of 10-30 fathoms. Each set consisted of a string of five nylon herring nets of different mesh sizes (2 inch, 2¼ inch, 2½ inch, 2¾ inch, 3 inch). Size and age data for 340 specimens from these catches are included in Figs. 2 and 3 for comparison with commercial catches.

The length used is the greatest total length (to the nearest millimeter) measured from the tip of the lower jaw to the end of the longest lobe of the caudal fin with the lobe extending posteriorly in line with the body. Thawed lengths were adjusted to the fresh condition by applying a conversion factor of 1.02 (Hodder and Parsons, in preparation). Whole weights were determined to the nearest gram.

The age was recorded as the number of completed summer (opaque) growth zones on the otolith with January 1 as the arbitrary birthdate; a fish is considered to be age 1 on January 1 following completion of the first summer's growth.

Results

Maturity and spawning

Percentages of immature fish in the samples ranged from 2 to 8% during 1966 to 1968 but increased to 31-32% in 1969 and 1970 and decreased to 20% in 1971. The vast majority of the mature fish were definite spring spawners with well-developed gonads (Stage 4); with the exception of the 1966 research vessel samples, recovering spents (autumn spawners) comprised less than 9% of the total fish sampled. Most of the immature herring were also assigned to the spring-spawning group since an examination of the otolith structure of these herring revealed that spring spawners could generally be separated from autumn spawners on the basis of certain otolith characteristics (L.S. Parsons, in preparation).

Reports from Fishery Officers of the Canadian Fisheries Service, Department of the Environment, over the past several years indicate that spring spawning in Fortune Bay usually occurs sometime between mid-April and mid-May, mostly in early May, which is earlier than in most other Newfoundland areas.

Size and age composition

Figure 2 depicts the percentage length composition (greatest total length to the cm below) of Fortune Bay herring by spawning group from 1966 to 1971. In all years autumn spawners were larger than spring spawners and exhibited a fairly dispersed length distribution. The length-frequency patterns for spring spawners differed considerably among years. In the 1966

research vessel samples there were distinct modes at 27 and 33 cm. In 1967 there was a very distinct mode at 29 cm and the appearance of a few herring 8-14 cm in length. The 33 cm mode of the previous year had virtually disappeared. The length frequency for 1968 spring spawners was sharply peaked at 31 cm and there was a small proportion of 21-22 cm herring. By 1969 the length frequency was again distinctly bimodal with peaks at 26 and 32 cm and a slight trace of 19-22 cm herring. In 1970 the length distribution was markedly trimodal with modes at 23, 29 and 33 cm. There were also three modes in 1971 but the third mode was greatly reduced in comparison with the previous year. The dominant modes were at 27 and 31 cm.

The progression and succession of several modes in the length distribution of Fortune Bay spring spawners during the 1966-71 period indicates the occurrence of several dominant year-classes (Fig. 3). The 1963 year-class of spring spawners, which was dominant in 1966, maintained its dominance during 1967 and 1968 but by 1969 was slightly less abundant than the 1966 year-class which first appeared in the catches during 1967 as 1-year-olds. During 1970 the 1968 year-class first appeared in abundance as 2-year-olds with the catch in numbers being derived in approximately equal proportions from the 1963, 1966 and 1968 year-classes. By 1971 the 1963 year-class was greatly reduced in abundance and the fishery was supported primarily by the 1966 year-class as 5-year-olds and the 1968 year-class as 3-year-olds. Preliminary age composition data for the 1972 season indicate that the 1966 and 1968 year-classes were again dominant as 6- and 4-year-olds respectively.

The size and age trends for Fortune Bay spring spawners during the 1966-71 period are in sharp contrast to those exhibited by the southwest Newfoundland herring stock complex which overwinters in areas J1 and J2 from late November to early April. There was a gradual increase in the average size of both spring and autumn spawners taken along southwestern Newfoundland from the beginning of the purse seine fishery in 1965 up to the 1969-70 season (Fig. 4). The average size of autumn spawners continued to increase during the 1970-71 season but that of spring spawners decreased from 33.4 cm in 1969-70 to 32.8 cm in 1970-71. It is evident from Fig. 4 that the southwest Newfoundland winter fishery has been largely dependent on a very abundant 1958 year-class of autumn spawners and a smaller 1959 year-class of spring spawners. Basically there has been a lack of substantial recruitment to the spring-spawning as well as the autumn-spawning component of the stock. However, the 1968 year-class of spring spawners appears to be relatively strong in comparison with other year-classes of the 1960's (Fig. 4; Winters and Parsons, this meeting).

Growth

Fig. 5 depicts mean lengths-at-age for Fortune Bay spring spawners based on data from the 1968 season during which sampling was most intensive and the 1963 year-class as it passed through the fishery. Mean lengths-at-age based on the 1968 season (pooled year-classes) and the 1963 year-class (at ages 3-8) are very similar. Lengths-at-age for Fortune Bay herring during the 1943-44 period derived from Tibbo (1956) differ somewhat from those of the more recent period. Our mean lengths-at-age are less than Tibbo's for the younger fish and greater for the older fish. At ages 5 and 6 we found mean lengths of 31.4 and 32.5 cm respectively compared with 32.8 and 33.7 cm for these ages during 1943-44. Our data indicate a mean length at age 10 1.7 cm greater than that reported by Tibbo (1956) for the same age.

It should be noted that Tibbo used scales for ageing whereas our age estimates are based on otoliths. This may partially account for these differences between investigators in the average lengths of herring at various ages.

Length-weight relation

Length-weight curves for spring spawners during January, February and April 1970 (Fig. 6) were derived by using the equation $W = cL^b$ in which W = weight, L = total length and c and b are constants. The least squares regression of the logarithmic transformation

$$Y = a + bX$$

in which $Y = \log_e W$, $a = \log_e C$, and $X = \log_e L$ was used for estimating values of c and b .

The equations relating whole weight to total length are as follows:

$$\text{January} \quad W = 4.993 \times 10^{-7} L^{3.4731}$$

$$\text{February} \quad W = 5.862 \times 10^{-7} L^{3.4486}$$

$$\text{April} \quad W = 2.160 \times 10^{-6} L^{3.2216}$$

Whole weight increases with length at a rate faster than would be expected from the cube relation of weight to length. At all sizes there was a slight increase (approximately 2%) in average weight from January to February. Between January and April there was an overall increase (approx. 3%) in average weight at sizes less than 33 cm and an overall decrease (approx. 3%) at the larger sizes (> 33 cm).

Nematode incidence and intensity

Nematode incidence (percentage of fish infested) and intensity (average number of nematodes per fish) in Fortune Bay spring spawners during January to April 1971 were compared with nematode abundance in southwest Newfoundland spring spawners during the same period (Fig. 7). Nematode incidence and intensity increase with fish size and age in both areas. However, at any particular size values were generally higher for Fortune Bay than for southwest Newfoundland spring spawners. There are considerable differences in the nematode incidence-fish age relationship between these areas. Nematodes were fairly abundant in Fortune Bay fish of ages 3, 4 and 5 (26-38% infested) but absent in southwest Newfoundland fish of these age groups. At ages 6 to > 10 differences between Fortune Bay and southwest Newfoundland spring spawners in percentages of fish infested ranged between 18 and 48% (Fig. 7).

Discussion

The size and age composition of Fortune Bay herring has changed considerably since Tibbo's investigations during 1943-44 and 1946-48. In 1943 and 1944 Fortune Bay herring had an average size of 34.90 cm and an average age of 9.42 years. In 1946 to 1948 the mean length and age had increased to 35.63 cm and 11.79 years respectively (Tibbo 1956, 1957). In both periods a relatively large number of year-classes were well represented. During the recent period of exploitation by a mobile purse seiner fleet, the catches have contained a high proportion of relatively small young fish (less than 8 years old), a large proportion of the catch in numbers being derived from immature fish and fish maturing to spawn for the first time.

Tag recaptures (Winters, 1970; MS, 1971; Beckett, MS, 1971) and comparisons of various biological characteristics (Hodder and Parsons, 1971a, b; Parsons and Hodder, 1971a) have shown a seasonal migration of herring eastward from the southern Gulf of St. Lawrence in the autumn to overwintering areas along southwestern Newfoundland and westward again into the Gulf in the spring. These herring concentrations, which are fished by purse seiners in the fjords and bays along the southwest coast in Areas J1 and J2 (Fig. 1) from late November to April consist of two intermixed spawning groups, autumn spawners comprising 70% of the population, spring spawners the remainder (Hodder, 1971; Parsons and Hodder, 1971b). The small Fortune Bay fishery based almost exclusively on spring spawners also occurs during winter and spring and could involve fish which are related to the southern Gulf-southwest Newfoundland stock complex.

Parsons (this meeting), in a study of the meristic characteristics of herring inhabiting Newfoundland and adjacent waters, reports that Fortune Bay spring spawners differ significantly in mean numbers of vertebrae and pectoral fin rays from those in adjoining areas. Fortune Bay spring spawners have the highest vertebral average and the lowest pectoral fin ray average among spring spawners of the Newfoundland area. Tibbo (1956, 1957) reported that Fortune Bay herring had the highest mean vertebral number in the Newfoundland area during 1943-44 and 1946-48 (55.877 and 55.772 respectively). On the basis of these differences Parsons (MS, 1972) concludes that Fortune Bay herring probably do not intermix to any great extent with those in adjoining areas.

The present study indicates that Fortune Bay spring spawners, which have had a succession of several dominant year-classes (those of 1963, 1966 and 1968) from 1966 to 1971, have differed considerably in size and age composition from southwest Newfoundland spring spawners, which were dominated by the 1959 year-class from 1965-66 to 1969-70. They also differ considerably in nematode incidence, Fortune Bay spring spawners having significantly higher percentages of fish infested with nematodes at any particular age than those from southwest Newfoundland.

These differences in meristic characteristics, year-class dominance and nematode abundance suggest that Fortune Bay spring spawners do not intermingle to any great extent with the herring stock complex which overwinters along southwestern Newfoundland but rather constitute a relatively discrete spring-spawning stock. However, virtually nothing is known of the biology and distribution of Fortune Bay herring during the summer and autumn (July-December). Herring concentrations appear in abundance in Fortune Bay during January and disappear again in May or early June after spawning in shallow coastal waters (0-5 fathoms). The location of their summer feeding grounds is presently unknown. Recent taggings (April, 1972) will probably shed further light on the seasonal migrations of this stock and the degree of intermixing with the southern Gulf-southwestern Newfoundland stock complex and herring concentrations in adjoining Placentia and St. Mary's bays.

Acknowledgements

The 1967 and 1968 Fortune Bay samples were collected under the direction of Dr. A. S. Hourston and the sampling data for these seasons have been published previously in a series of Technical Reports (Hourston et al., MS, 1968). The present authors have re-examined the otoliths from herring samples taken during these seasons and assigned ages in accordance with current age-reading techniques at the St. John's Biological Station.

References

- Beckett, J.S. MS 1971. Interim report of herring tagging in the Gulf of St. Lawrence, 1970. Int. Comm. Northw. Atl. Fish. Annu. Meet., June 1971, Res. Doc. No. 71/95, Ser. No. 2565, 4 p.

Hodder, V.M. 1971. Status of the southwest Newfoundland herring stocks, 1965-70. Int. Comm. Northw. Atl. Fish., Redbook 1971, Part III: 105-114.

Hodder, V.M., and L.S. Parsons. 1971a. Comparison of certain biological characteristics of herring from Magdalen Islands and southwestern Newfoundland. Int. Comm. Northw. Atl. Fish. Res. Bull. 8: 59-65.

1971b. Some biological features of southwest Newfoundland and northern Scotian Shelf herring stocks. Int. Comm. Northw. Atl. Fish. Res. Bull. 8: 67-73.

Hourston, A.S., and R. Chaulk. MS 1968. Herring landings and catches in Newfoundland and their implications concerning the distribution and abundance of the stocks. Fish. Res. Bd. Canada, Tech. Rep., No. 58, 77 p.

Hourston, A.S., R. Chaulk, and J.A. Thomson. MS 1968. Herring sampling data and summary tabulations for Newfoundland, 1966-67. Fish. Res. Bd. Canada, Tech. Rep., No. 96.

Hourston, A.S., R. Chaulk, S. Parsons, and J.A. Thomson. MS 1968. Herring sampling data and summary tabulations for Newfoundland, 1967-68. Fish. Res. Bd. Canada, Tech. Rep., No. 97.

Parsons, L.S. MS 1972. Meristic characteristics of Atlantic herring (*Clupea harengus harengus* L.) stocks in Newfoundland and adjacent waters. Int. Comm. Northw. Atl. Fish., Annu. Meet., June 1972, Res. Doc. No.

Parsons, L.S., and V.M. Hodder. 1971a. Variation in the incidence of larval nematodes in herring from Canadian Atlantic waters. Int. Comm. Northw. Atl. Fish. Res. Bull. 8: 5-14.

1971b. Meristic differences between spring- and autumn-spawning Atlantic herring (*Clupea harengus harengus*) from southwestern Newfoundland. J. Fish. Res. Bd. Canada 28: 553-558.

Tibbo, S.N. 1956. Populations of herring (*Clupea harengus* L.) in Newfoundland waters. J. Fish. Res. Bd. Canada 13: 449-466.

1957. Herring populations on the south and west coasts of Newfoundland. Fish. Res. Bd. Canada Bull. 111: 153-164.

Winters, G.H. 1970. Preliminary results of herring tagging in southwest Newfoundland coastal waters, 1970. Fish. Res. Bd. Canada Biol. Sta., St. John's, Nfld., Circ. 18: 20-24.

MS 1971. Migrations of the southwest Newfoundland stock of herring as indicated by tag recaptures. Int. Comm. Northw. Atl. Fish. Annu. Meet., June 1971, Res. Doc. No. 71/108, Ser. No. 2591, 6 p.

Winters, G.H., and L.S. Parsons. MS 1972. Present status of the southwest Newfoundland herring stocks. Int. Comm. Northw. Atl. Fish., Annu. Meet., June 1972, Res. Doc. No.

Table 1. Purse seiner and bar seiner catches (metric tons) in Fortune Bay, 1965-71.

Month	1965	1966	1967	1968	1969	1970	1971
Jan					3368	4382	5260
Feb				5269	1129	1342	3439
Mar				4073 241	166	2180 228	5043
Apr			4109 263	1778 945	303	67 236	806 200
May	19		432 245	1651	1248	579	
June			- 372	- 73	- 36		
Dec				188	163		
Total (P.S.)	19		4541	11308	4826	7971	14548
(B.S.)	-		880	2910	1587	1043	200
Total	19		5421	14218	6413	9014	14748

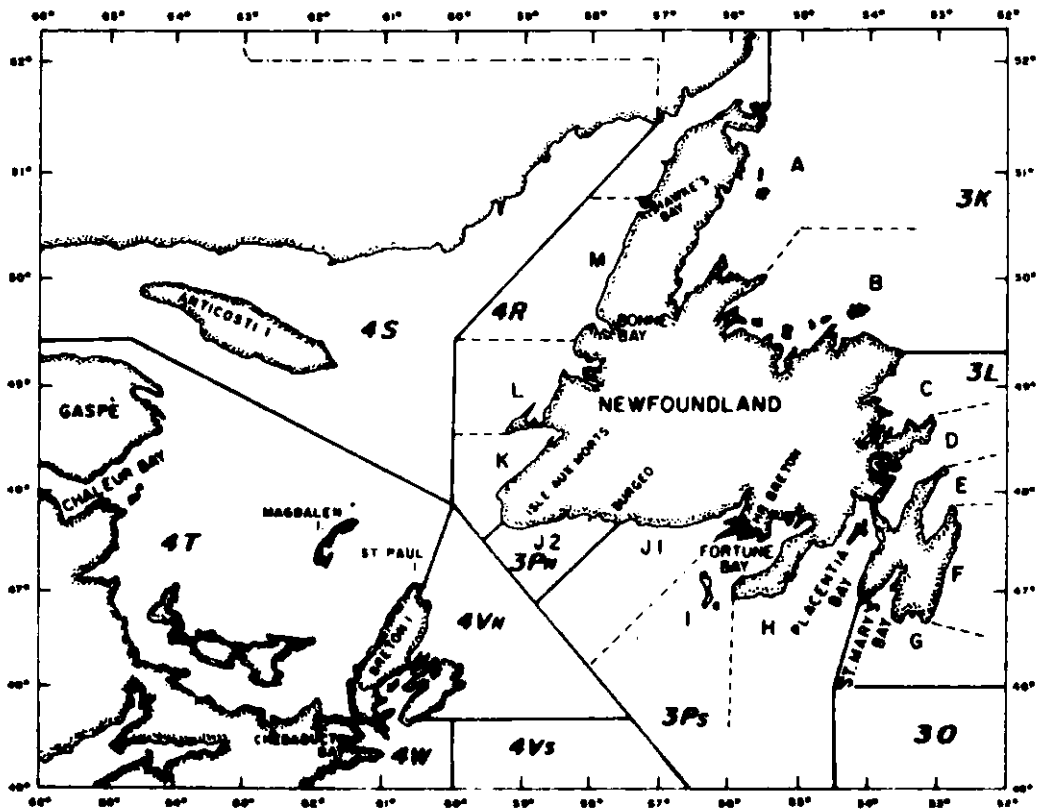


Fig. 1. Map of the Gulf of St. Lawrence-Newfoundland area with place names and statistical areas mentioned in the text.

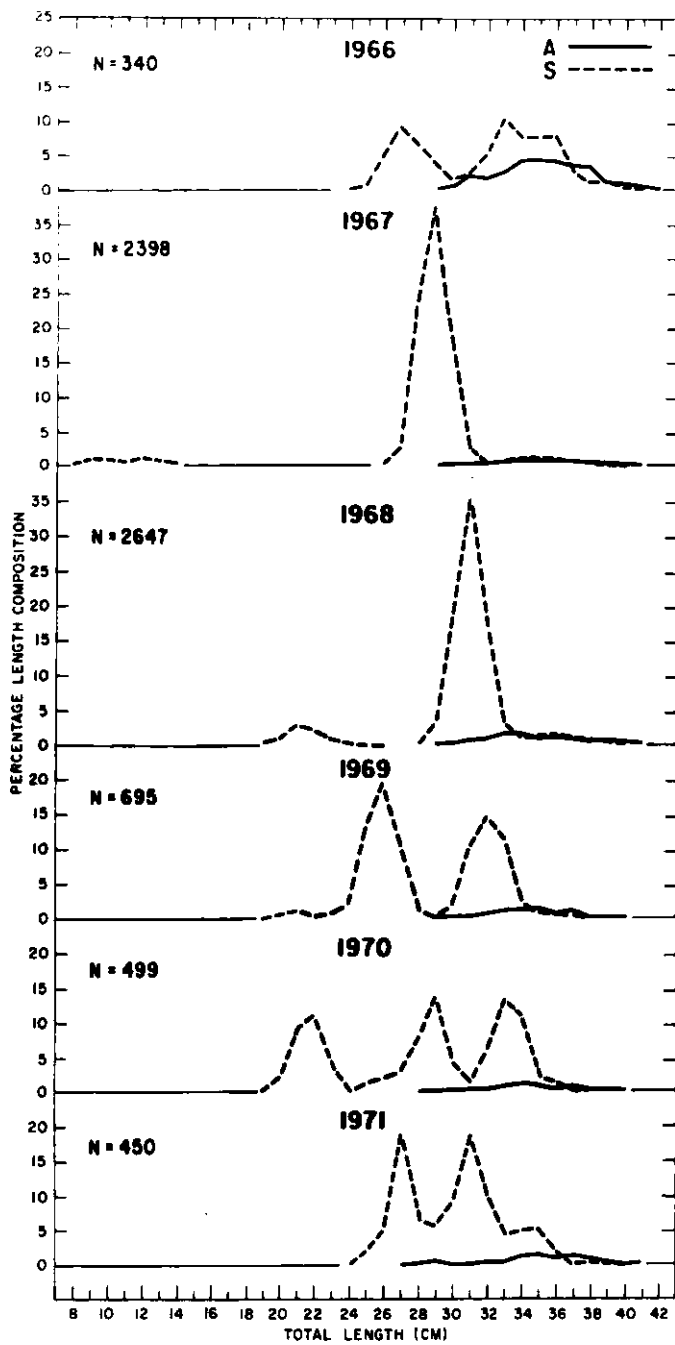


Fig. 2. Length composition of Fortune Bay herring by spawning group during the 1966 to 1971 seasons.

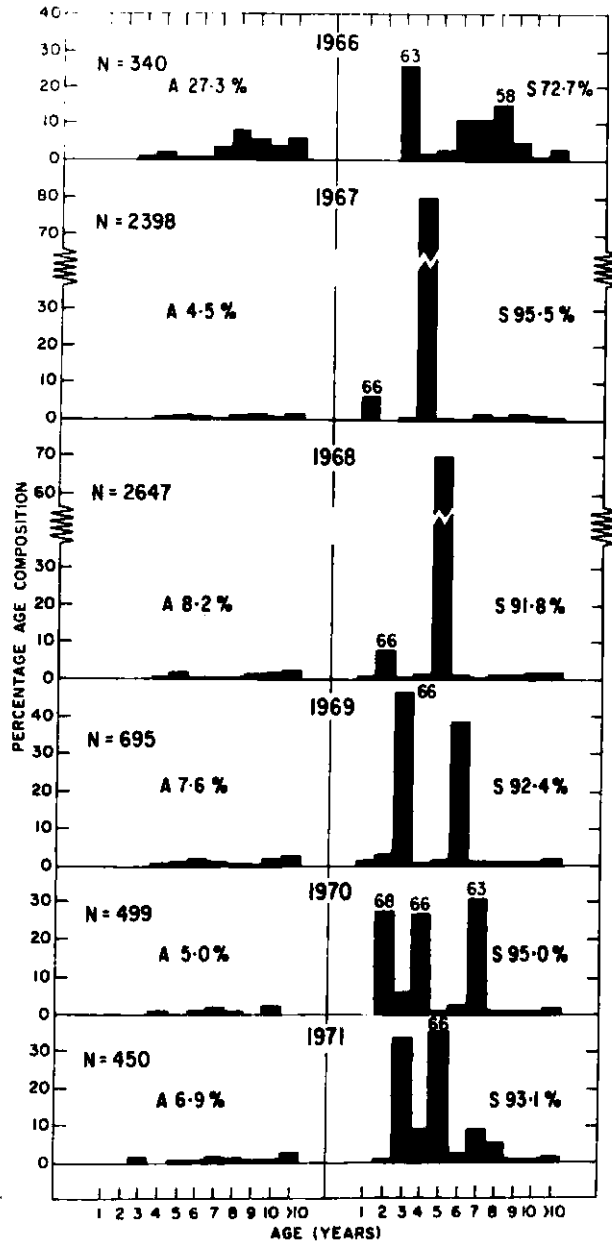


Fig. 3. Age composition of Fortune Bay herring by spawning group during the 1966 to 1971 seasons.

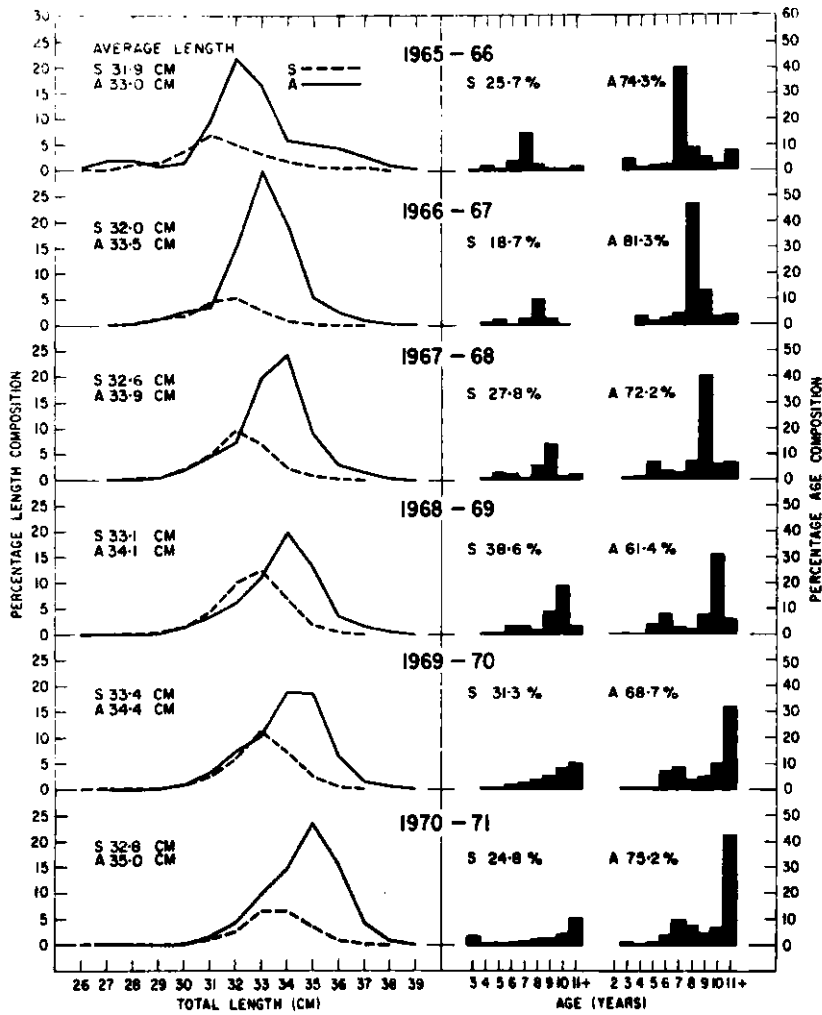


Fig. 4. Length and age composition of spring and autumn spawners in the southwest Newfoundland herring fishery during the 1965-66 to 1970-71 seasons (11+ = > 10).

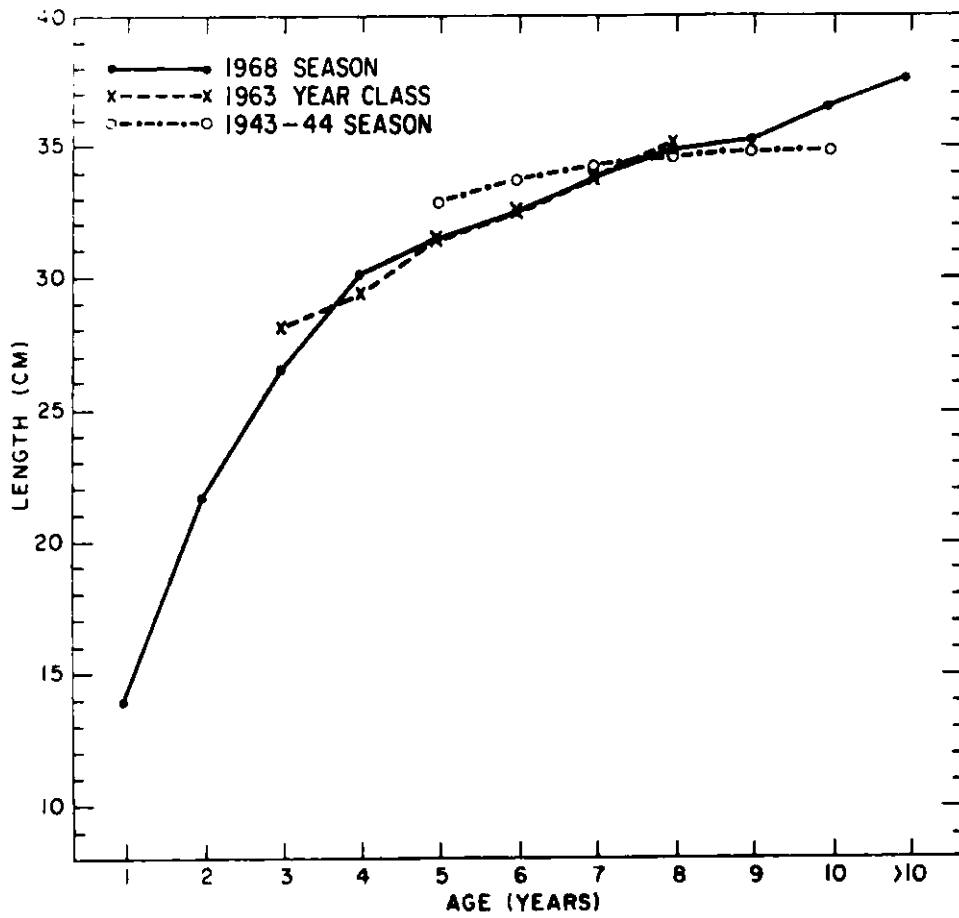


Fig. 5. Mean lengths-at-age for Fortune Bay spring-spawning herring.

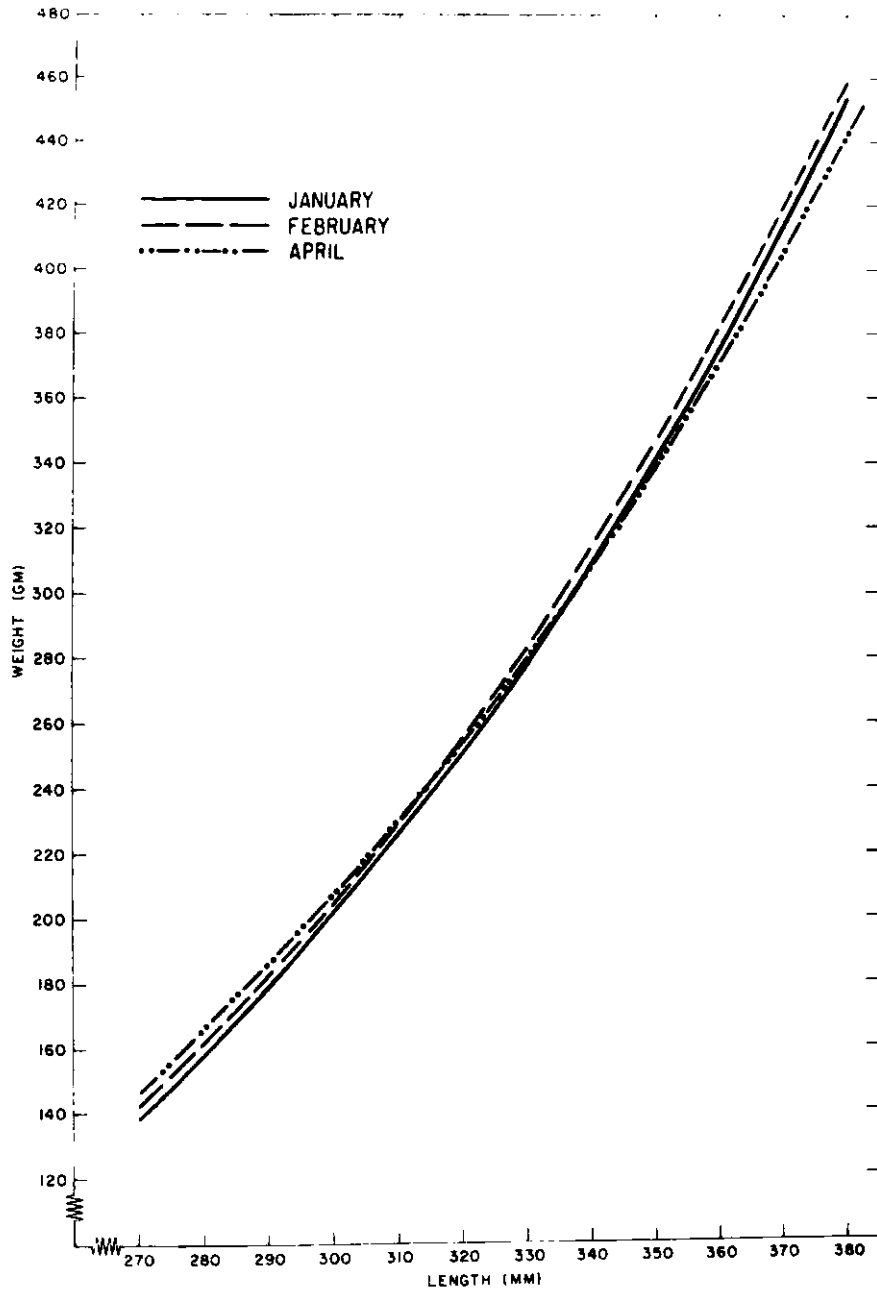


Fig. 6. Length-weight curves for Fortune Bay spring spawners during the 1970 season (see text for equations).

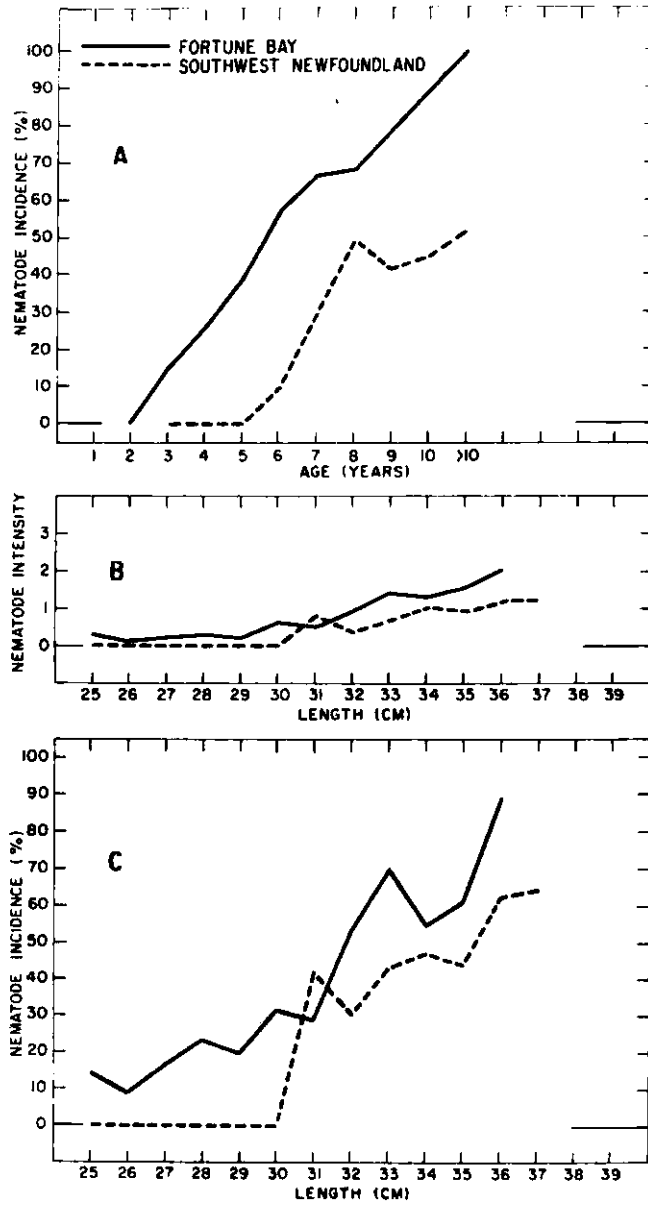


Fig. 7. Nematode incidence (percentage of fish infested) and intensity (average number of nematodes per fish) in relation to fish length and age for Fortune Bay and southwest Newfoundland spring spawners during the winter of 1971.