

ANNUAL MEETING - JUNE 1967SIZE, AGE, AND RECRUITMENT COMPARISONS FOR HADDOCK  
OF THE CENTRAL SCOTIAN SHELF

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Introduction

Haddock is one of the most important species of groundfish taken from the Scotian Shelf off central Nova Scotia (ICNAF Div. 4W). Landings between 1948 and 1965, the period considered in this paper, have ranged from about 13 thousand metric tons to 51 thousand metric tons (Fig. 1). In the early portion of the period, 1948-53, Canadian landings averaged about 10 thousand metric tons annually and made up about 60% of the total. Between 1954 and 1962 Canadian landings averaged about 17 thousand metric tons annually and were about 85% of the total. Since 1963 Canadian landings from Div. 4W have declined as effort was shifted elsewhere. At about 10 thousand metric tons annually they were about 50% of the total in 1963-64, and less than 15% in 1965 when the USSR landed over 45 thousand metric tons from Div. 4W.

In the period 1948-65 Canadian landings of haddock have been sampled systematically for size and age. Measurements of fish have provided information about sizes landed. Otolith collection and subsequent age interpretations have provided information about age composition of haddock taken by the Canadian fishery. In addition, calculations based on landings, sizes, and catch per unit effort have provided information about recruitment and strength of various year-classes in the fishery. Relatively little has been published about these results. This paper provides various

comparisons of sizes, ages, and year-class strengths of haddock in the stock fished in the period 1948 to 1965.

#### Material and methods

Since 1948 Canadian haddock landings have been sampled regularly and systematically for sizes and ages of fish. Usually haddock are landed graded into two categories, large and scrod. Fish lengths have been measured and otoliths taken from each category, and the final length and age composition derived by proportioning samples to the quantities of each category landed in the manner described by Kohler (1958). When other landing categories have occurred, such as when smaller fish have been landed round, these have also been sampled and their contribution to the total landings determined. Throughout this period haddock were measured to the nearest centimetre from the tip of the snout to the fork of the tail.

For presentation in this paper various calculations from the basic data have been made. During most of the period large (150-500 ton) trawlers have taken the largest proportion of the Canadian landings. These vessels also provided the best records of effort in terms of days and hours fished. Where quantities of sizes and ages landed have been calculated in terms of catch per effort these data have been used. Where age composition has been related to total Canadian landings, total numbers were derived from the total weight landed divided by the mean weight of haddock landed as calculated from our samples.

For one series of calculations, landings by all countries were used in determining total numbers of each year-class landed. It was assumed that size and age of haddock in landings by other countries were similar to those taken by Canadians. For the period considered in these calculations (1951-63) this is believed to be substantially correct.

Ages were determined by reading hyaline and opaque rings on haddock otoliths using a binocular microscope and reflected light in the manner described by Kohler (1958). Hyaline (winter) zones, separated by opaque (summer) zones, were counted to give the age of the fish.

### Results

#### Size-composition comparisons

Throughout the period considered (1948-65) haddock landed during February-April (Quarter I) have ranged from about 38 to 65 cm, most being between 45 and 55 cm (Fig. 2). A comparison of sizes landed by averaging number caught per hour trawled for three-year periods beginning in 1948 and continuing through 1965 shows no great changes. During the early part of this period (1948-53) there were somewhat greater numbers of haddock over 60 cm landed. More recently there has been a greater proportion of haddock landed between 40 and 45 cm.

Between 1948 and 1956 about half the fish landed were over 50 cm. Between 1957 and 1962 considerably more than half the fish landed were under 50 cm. However, in the most recent period (1963-65) the size composition was again more like the earlier years when about half the fish were above and half below 50 cm in length.

Comparisons between landings in the remainder of each year have been for data grouped for the period May through January (Quarters II, III, and IV) since landings have been less regular and varied considerably by seasons in different years. These landings show more variation in size composition of haddock than those landed in Quarter I (Fig. 1). Sizes landed have ranged between 35 and 60 cm and, in general, there has been a tendency to land fewer large fish than in Quarter I. Haddock landed in Quarters II-IV were mainly between 42 and 52 cm. However, in the middle

part of the series of years being considered (1954-59) most fish were between 40 and 50 cm. Size compositions in terms of numbers of fish caught per hour trawled for the two seasons are presented on an annual basis in Appendix Table I.

#### Age-composition comparisons

Haddock landed in the February-April period (Quarter I) from 1948 to 1965 have ranged between 3 to 14 years of age but were mainly from 5 to 9 years old (Fig. 3). There has also been considerable variation between periods. From 1948 to 1956 most haddock were landed as 6- to 8-year-old fish. From 1957 to 1962 a preponderance of the fish landed were from 4 to 6 years of age. In the most recent three-year period (1963-65) there were fewer younger fish, and landings were again dominated by fish from 6 to 8 years old.

In the remainder of the year, May through January (Quarters II, III, and IV), the haddock landed were generally younger than those of Quarter I. Haddock of 3 to 7 years of age predominated (Fig. 3), with considerable variation between periods. From 1954 to 1962 most haddock landed were between 3 and 5 years of age. Prior to 1954 and in the most recent three-year period (1963-65) a larger proportion of 5- to 7-year-old fish were being landed.

Data plotted in Fig. 3 show marked changes in numbers of haddock landed by Canada. Most haddock were landed in 1957-59 and from 1960-62. Smallest numbers of haddock were landed in the three-year period 1948-50 and in the most recent period 1963-65. Age compositions by seasons on an annual basis are presented in Appendix Table II.

### Recruitment variations

Estimates of haddock recruitment show wide fluctuations in year-class strength (Fig. 4). Mean number caught and landed per hour fished by large (150-500 ton) Canadian otter trawlers for year-classes 1942-59 as 5 and 6 year olds was 95.5. Maximum deviation above the mean was 189.5 for the 1952 year-class, and maximum deviation below the mean was 77.5 for the 1942 year-class. Based on average catch/hour fished, the 1952 year-class was about 16 times that of the 1942 year-class. (Less reliable estimates of abundance for the 1941, 1960, and 1961 year-classes are provided. These estimates rely on catch/effort figures for one year only. However, they do appear to be correct in the general order of year-class strength shown.)

A series of poor year-classes from 1941 to 1945 was followed by above average year-classes in 1946 and 1947. Below average year-classes in 1948-51 were followed by the most successful year-class of 1952 which dominated the fishery in the late 1950's. Better than average recruitment in 1955-57 was followed by below average year-classes in 1958, 1960, and 1961, with a better than average year-class in 1959.

Estimates of total numbers of each year-class caught by all gears and all countries follow closely the pattern shown by the Canadian catch/effort data (Fig. 4 and Table I). Average year-class strength, as landed, from 1943 to 1957 was about 16 million fish (Table I). The maximum difference between year-classes was 27 million fish (Table I).

Table I. Estimates of contributions of haddock year-classes to total landings, all countries, ICNAF Div. 4W.

<u>Year-class</u>	<u>Total numbers landed</u>
1959	9,673,172+
1958	6,768,619+
1957	23,174,479
1956	26,386,197
1955	22,788,547
1954	15,187,280
1953	14,317,131
1952	34,142,968
1951	6,943,783
1950	8,176,934
1949	17,762,024
1948	7,687,442
1947	18,458,393
1946	18,918,638
1945	9,916,319
1944	11,324,203
1943	11,332,329

Average year-class strength 1943-57: 16,400,000 fish  
 Maximum difference between successive year-classes = 27,000,000 fish  
 Average " " " " " = 7,500,000 fish  
 Max. divergence single year-class from long-term mean = 17,700,000 fish  
 Average divergence of year-classes from long-term mean = 6,200,000 fish

Calculations of year-class contributions from total landings show poor recruitment in the mid 1940's, better than average year-classes in 1946-47, poor recruitment in the early 1950's, an outstanding 1952 year-class, and good recruitment from 1955 to 1957 (Fig. 4).

#### Discussion

Variation in recruitment (year-class strength) has been the dominant feature of the stock of haddock from the central Scotian Shelf in the period considered. It appears that relative success of the fishery has been a direct result of year-class strengths. Thus poor year-classes in the mid 1940's resulted in poor landings in the late 1940's (Fig. 1). The dominant 1952 year-class and better than average year-classes in the late 1950's led to a build-up of Canadian otter-trawl effort in the 4V-W region. Similarly, the poor

year-classes of 1958, 1960, and 1961 probably contributed to decreased Canadian effort in the region from 1962 to date (Fig. 1).

That there has been relatively little change in size and age composition of haddock landed in the Canadian fishery between 1948 and 1965 is an interesting situation. It seems likely that the relative mobility of the fleet and the fact that haddock is a prime target of the fishery are both involved. Thus examination of landing statistics in the various ICNAF Statistical Bulletins shows a reduction in United States effort and landings in the area as the poor year-classes of the early 1950's began to contribute and United States effort was confined to more western regions. This gap was filled only slowly by the Canadian effort. As previously mentioned, the Canadian effort has also been shifted recently to the more western regions (4X and 5Z) as poor recruitment of the 1958, 1960, and 1961 year-classes apparently affected yield to the fishery.

For most of the period considered haddock were not being taken incidentally to other species and fishing mortality was not being imposed from such efforts. Only recently, about 1963-64, has mortality from other fisheries been important, as the USSR began to exploit silver hake in the same region. The most noticeable changes in size and age of haddock landed in the Canadian fishery have resulted from changes in recruitment, with lowering of sizes and ages landed as large year-classes entered the fishery and increasing of sizes and ages landed when poorer year-classes yielded fewer recruits. Reduction in acceptable size of fish appears to have played a minor part.

Such stability is in contrast to the changes in Gulf of St. Lawrence cod (4T) where increased effort by less

mobile Canadian fleet and additional fishing mortality produced by European vessels have resulted in much reduced landings of large cod and greater utilization of smaller fish (Kohler, 1965). The lack of change in haddock sizes and ages landed for the period 1948-64 suggests that fishing effort on this species has not built up. However, the very large catch by the USSR in 1965, taken mainly during July and August when smaller fish are known to be present may have changed markedly the current situation.

#### References

- Kohler, A. C. 1965. Changes in the southern Gulf of St. Lawrence cod fishery. Fish. Res. Bd. Canada, Biol. Sta., St. Andrews, N. B., Gen. Series Circular No. 46.
- Kohler, A. C. 1958. The validity of otolith age determinations for haddock (Melanogrammus aeglefinus L.) from the Lockeport, N. S. area. J. Fish. Res. Bd. Canada, 15(6).

Appendix Table I. Length frequency haddock landings (average number caught/hour trawled, Canadian otter trawlers 150-500 gross tons) from ICNAF Div. 4W, February-April period (Quarter I), by years, 1948 to 1965.

Year	1948*	1949*	1950*	1951*	1952*	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
36.5	-	-	0.3	0.4	1.6	-	0.3	0.4	0.2	1.9	0.9	0.7	1.5	1.4	0.8	-	1.6	-
38.5	2.1	2.3	3.3	5.5	1.2	0.8	2.7	2.1	1.7	7.5	0.5	5.1	4.9	6.6	5.4	6.1	4.6	0.2
40.5	4.3	4.2	11.9	21.7	6.2	3.2	10.9	4.9	9.3	16.0	13.0	18.7	21.9	27.0	19.0	18.6	17.5	1.8
42.5	13.2	13.3	20.5	46.4	19.0	10.2	26.7	11.6	23.7	45.5	51.0	25.7	40.2	34.3	33.3	30.6	30.0	2.4
44.5	23.3	23.3	15.5	45.4	38.4	23.2	39.2	16.3	28.5	83.1	78.9	28.9	52.2	55.0	51.0	27.8	37.6	6.0
46.5	8.4	17.1	17.5	41.6	38.7	30.1	50.1	3.7	24.0	69.6	106.1	33.2	46.7	80.0	49.1	54.2	51.7	6.0
48.5	12.0	23.3	16.5	33.8	36.0	44.0	37.1	21.8	34.7	53.0	96.2	49.2	37.8	77.4	43.4	54.7	50.2	14.5
50.5	8.9	21.6	22.4	24.0	36.0	42.8	35.5	29.8	30.6	32.5	72.4	42.2	37.7	66.7	36.9	51.2	42.3	21.2
52.5	11.9	19.6	25.0	19.6	28.4	38.8	25.4	29.8	33.3	28.3	53.5	35.6	33.4	51.3	23.0	41.0	36.6	21.2
54.5	10.5	20.2	25.5	19.6	20.3	30.4	35.2	33.7	33.3	24.4	32.7	30.8	27.9	31.9	17.7	36.0	34.0	24.4
56.5	11.3	17.5	19.7	15.4	15.7	20.2	15.5	27.6	25.1	17.5	26.2	26.8	23.9	29.1	13.6	25.1	29.0	23.0
58.5	17.0	17.5	19.1	10.7	12.6	14.3	7.9	17.5	19.2	17.1	16.4	17.9	17.9	22.2	11.3	17.0	18.0	16.9
60.5	7.4	13.2	13.8	13.6	11.5	9.7	5.6	11.8	11.7	10.7	11.1	12.0	15.7	15.7	10.9	11.1	10.7	14.9
62.5	10.2	9.9	12.0	10.1	8.1	6.1	3.7	9.7	12.2	7.1	7.8	9.3	6.8	11.4	8.0	7.4	7.2	10.6
64.5	8.8	5.2	3.8	7.7	6.8	4.1	2.1	9.8	6.4	3.8	3.9	6.0	5.1	6.8	4.7	4.3	3.8	6.5
66.5	6.0	4.6	4.7	6.2	5.5	1.0	1.7	4.4	3.2	2.8	3.0	4.0	2.5	3.9	3.4	2.0	2.5	4.7
68.5	4.1	9.6	3.2	5.0	1.5	0.8	0.6	1.6	0.8	1.6	1.6	3.4	2.8	3.3	2.7	1.1	1.2	1.8
70.5	1.7	1.9	2.1	3.0	0.9	0.2	-	1.0	0.5	0.8	0.3	0.6	0.5	1.9	2.0	0.3	0.4	1.1
72.5	1.7	1.5	1.5	-	0.9	-	-	0.2	0.2	0.2	0.3	0.8	0.1	2.2	1.0	-	-	0.5
74.5	0.8	4.2	1.8	0.6	0.4	-	-	0.2	-	0.2	0.2	0.4	-	1.0	0.3	0.1	-	0.2
76.5	0.5	0.3	0.6	-	-	-	-	-	-	0.2	-	0.2	-	1.0	0.1	-	-	-
78.5	0.4	0.1	0.3	0.6	0.2	-	-	-	-	0.2	-	0.1	-	1.0	-	-	-	-
80.5	0.4	0.1	0.3	0.6	0.2	-	-	-	-	0.2	-	0.1	-	-	0.1	-	-	-

\*includes 4W since landings not separated before 1953

continued

Appendix Table I (continued). Length frequency haddock landings (average number caught/hour trawled, Canadian otter trawlers (150-500 gross tons) from ICNAF Div. 4W, May-January period (Quarters II, III and IV), by years, 1948 to 1965.

Year	1948*	1949*	1950*	1951*	1952*	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
32.5	-	-	-	-	-	-	-	0.9	2.5	-	0.7	3.3	-	-	0.1	0.2	-	-
34.5	-	0.4	-	-	-	-	-	1.9	8.1	1.0	2.0	4.6	0.3	-	0.4	0.1	0.1	0.2
36.5	-	1.6	-	-	-	-	-	3.2	12.9	2.1	6.5	21.7	0.6	-	0.4	0.1	1.3	0.2
38.5	-	12.3	-	-	-	3.7	-	14.1	43.8	10.5	14.3	44.9	1.9	0.3	1.8	1.3	4.8	2.2
40.5	0.4	23.5	0.6	1.5	18.4	18.4	5.9	28.4	104.5	35.4	25.8	58.3	4.9	5.4	6.1	4.4	7.7	8.1
42.5	1.3	27.8	4.7	6.7	31.0	37.4	13.4	20.6	114.2	42.1	35.8	52.2	35.8	14.8	11.9	12.0	13.7	10.8
44.5	5.2	24.8	24.6	22.5	37.4	40.4	24.3	23.2	134.1	86.2	36.2	57.2	60.3	25.4	22.3	26.0	17.2	7.0
46.5	12.2	24.5	34.5	46.5	45.4	45.4	24.9	31.6	80.9	91.7	35.2	26.4	59.8	31.2	29.9	35.0	20.3	9.8
48.5	15.2	27.8	32.7	48.6	55.9	55.9	38.2	36.3	46.3	67.4	37.0	17.6	39.2	29.2	29.8	31.2	19.5	10.8
50.5	12.5	27.8	31.4	51.1	29.2	30.5	29.6	36.5	46.3	54.9	36.8	17.2	16.8	17.3	26.1	26.0	20.3	16.2
52.5	12.9	23.2	16.1	17.4	17.3	26.3	36.9	29.5	25.2	43.5	27.0	11.8	13.4	15.6	17.9	17.4	17.1	14.0
54.5	11.2	20.3	12.5	11.2	9.0	24.2	26.9	20.5	21.4	26.1	19.8	12.1	7.5	8.4	13.3	13.8	13.3	12.1
56.5	9.6	17.2	15.8	8.0	5.3	26.8	37.6	15.7	18.6	23.0	12.0	5.6	6.4	6.8	7.2	7.1	12.3	10.0
58.5	8.1	13.7	12.9	7.6	3.0	8.4	16.3	14.1	12.4	19.7	7.2	4.8	5.1	3.8	4.3	6.8	8.1	7.9
60.5	6.5	9.7	10.9	5.5	2.7	4.6	22.0	6.1	7.0	10.8	4.8	3.8	1.7	2.5	2.8	4.5	3.9	5.9
62.5	4.6	9.7	7.5	3.7	2.0	3.1	16.3	6.3	2.0	4.5	2.9	3.2	3.2	2.1	1.5	3.0	3.1	3.5
64.5	4.1	6.4	4.0	3.7	2.0	3.1	7.8	2.9	1.4	1.2	1.7	1.3	0.8	0.7	0.7	1.3	2.9	2.3
66.5	7.8	6.1	1.9	2.8	1.0	0.7	5.7	2.9	1.5	1.3	1.5	0.5	0.7	0.2	0.5	0.8	1.6	1.2
68.5	5.7	4.6	1.4	1.2	0.5	2.3	3.5	1.0	0.7	0.4	1.1	0.5	0.4	0.2	0.2	0.2	0.7	0.3
70.5	4.4	3.8	-	1.1	-	0.8	0.7	1.0	0.3	-	0.5	-	-	0.3	0.1	0.3	0.1	0.7
72.5	1.5	1.3	-	0.2	-	-	0.7	-	-	-	0.1	-	-	-	0.2	0.2	-	-
74.5	1.4	0.9	-	-	-	-	2.1	0.2	-	-	0.1	-	-	0.1	0.1	-	-	-
76.5	0.4	0.7	0.7	0.2	-	-	-	-	-	0.2	0.1	-	-	-	-	-	-	-
78.5	0.4	0.4	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-
80.5	0.5	0.2	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-

\*includes 4V since landings not separated until 1953

Appendix Table II. Age composition haddock landings in terms of catch/hour as landed by Canadian otter trawlers, 150-500 gross tons, ICNAF Div. 4W, February-April (Quarter I), by years, 1948 to 1965.

Year	1948*	1949*	1950*	1951*	1952*	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Age (yr)																		
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	3	55	1	1	13	16	54	2	45	3	41	89	6	25	1	-
4	19	17	32	168	7	30	80	45	41	48	78	48	41	211	6	25	22	15
5	40	87	48	36	95	65	34	90	41	48	78	79	142	211	100	41	162	28
6	21	74	76	41	101	103	54	33	51	73	305	68	76	115	124	170	60	62
7	21	14	55	41	43	40	74	44	68	60	42	153	68	49	48	88	81	25
8	13	11	6	25	20	27	20	21	26	38	42	23	54	26	30	28	36	34
9	5	9	7	-	11	11	20	7	46	10	42	12	17	29	15	7	9	6
10	6	7	2	2	4	2	-	7	12	10	15	10	9	9	10	1	2	2
11	2	3	6	1	2	1	-	-	4	4	10	5	6	3	2	1	5	1
12	3	6	3	1	4	-	-	-	1	1	3	2	6	5	2	-	1	-
13	1	1	1	1	1	1	-	-	1	-	2	2	2	3	1	-	-	-
14	2	1	1	-	1	1	-	-	1	-	-	-	1	1	-	-	-	-
15	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
16	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

11.

\*includes 4V since landings not separated prior to 1953

continued

Appendix Table II (continued). Age composition haddock landings in terms of catch/hour as landed by Canadian otter trawlers, 150-500 gross tons, ICNAF Div. 4W, May-January (Quarters II, III and IV), by years, 1948 to 1965.

Year	1948*	1949*	1950*	1951*	1952*	1953	1954	1955	1956	1957	1958-	1959-	1960	1961	1962	1963	1964	1965
2	1	38	19	-	3	-	4	10	3	-	1	-	6	2	5	-	7	1
3	7	31	56	3	44	27	28	110	74	9	63	121	92	2	11	67	9	27
4	48	91	31	71	50	120	80	38	420	86	79	127	82	28	82	31	61	20
5	36	91	31	110	96	63	104	40	80	315	40	33	57	73	57	62	21	17
6	8	68	64	45	37	86	30	45	38	49	97	19	20	38	16	27	37	30
7	9	56	40	23	10	38	77	18	41	23	10	40	18	6	6	3	25	11
8	7	56	3	8	5	13	40	26	11	29	7	-	19	10	1	1	6	13
9	5	6	10	4	2	5	21	5	12	5	8	3	4	4	1	1	1	3
10	2	4	3	2	-	3	-	3	3	4	1	1	-	1	-	-	1	1
11	4	2	6	1	-	4	8	1	1	1	2	-	-	-	-	-	-	-
12	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

\*includes 4V since landings not separated prior to 1953

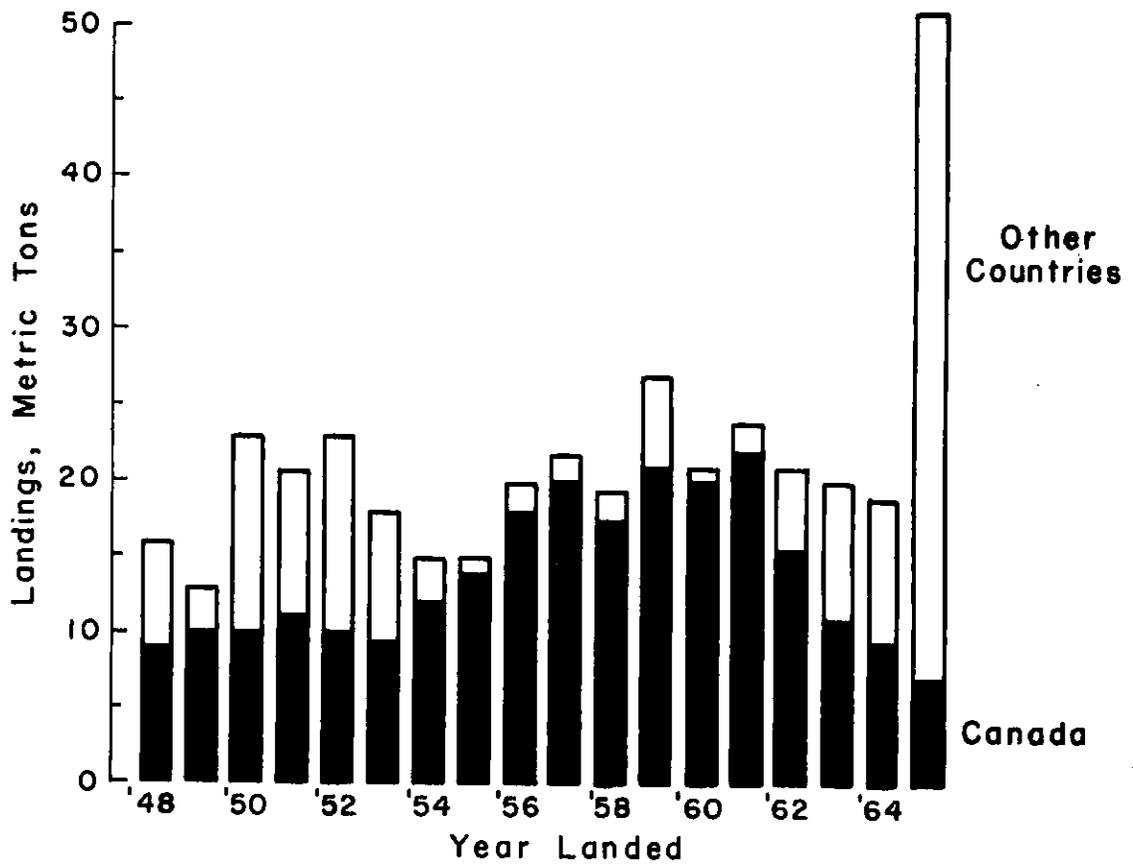


Fig. 1. Landings of haddock from central Scotian Shelf (Div. 4W), all gears, all countries, 1948-65. (Div. 4W portion of Div. 4V-W estimated for 1948-52.)

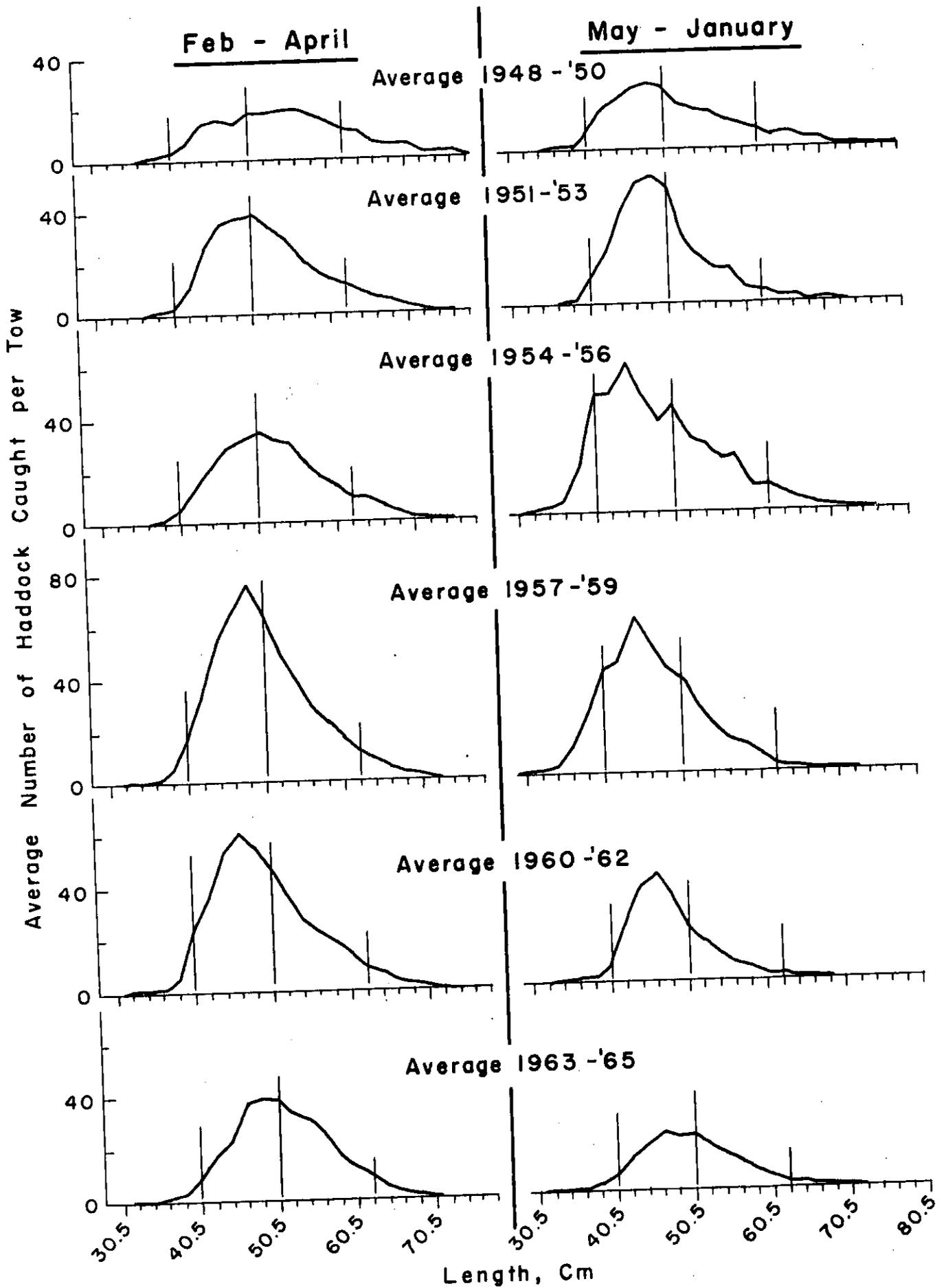


Fig. 2. Length composition of haddock landed from Div. 4W (Div. 4V-W for 1948-52) by Canadian otter trawlers of 150-500 gross tons, 1948-65; averages by three-year periods.

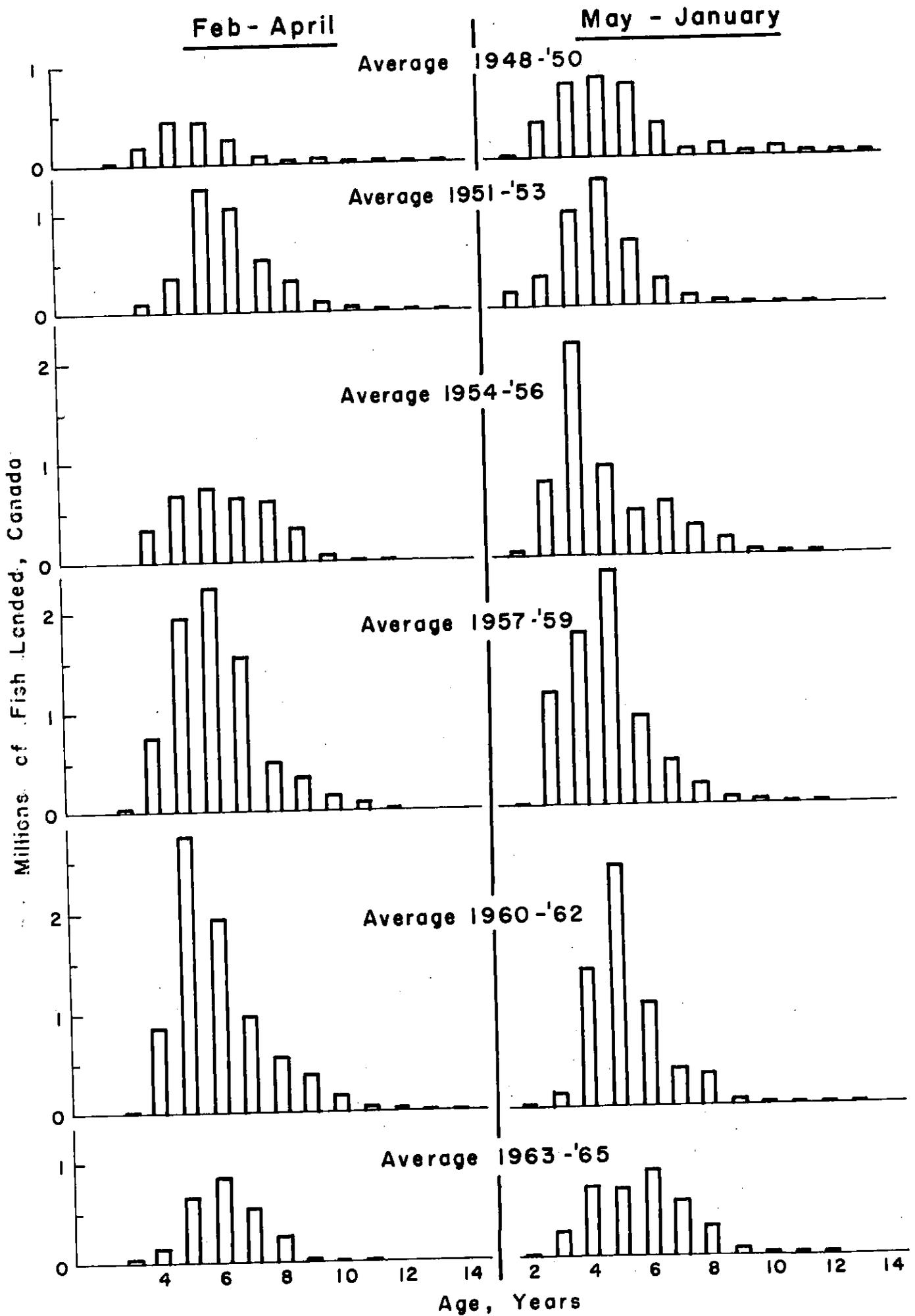


Fig. 3. Age composition of haddock landed from Div. 4W (Div. 4V-W for 1948-52) by all Canadian vessels; averages by three-year periods.

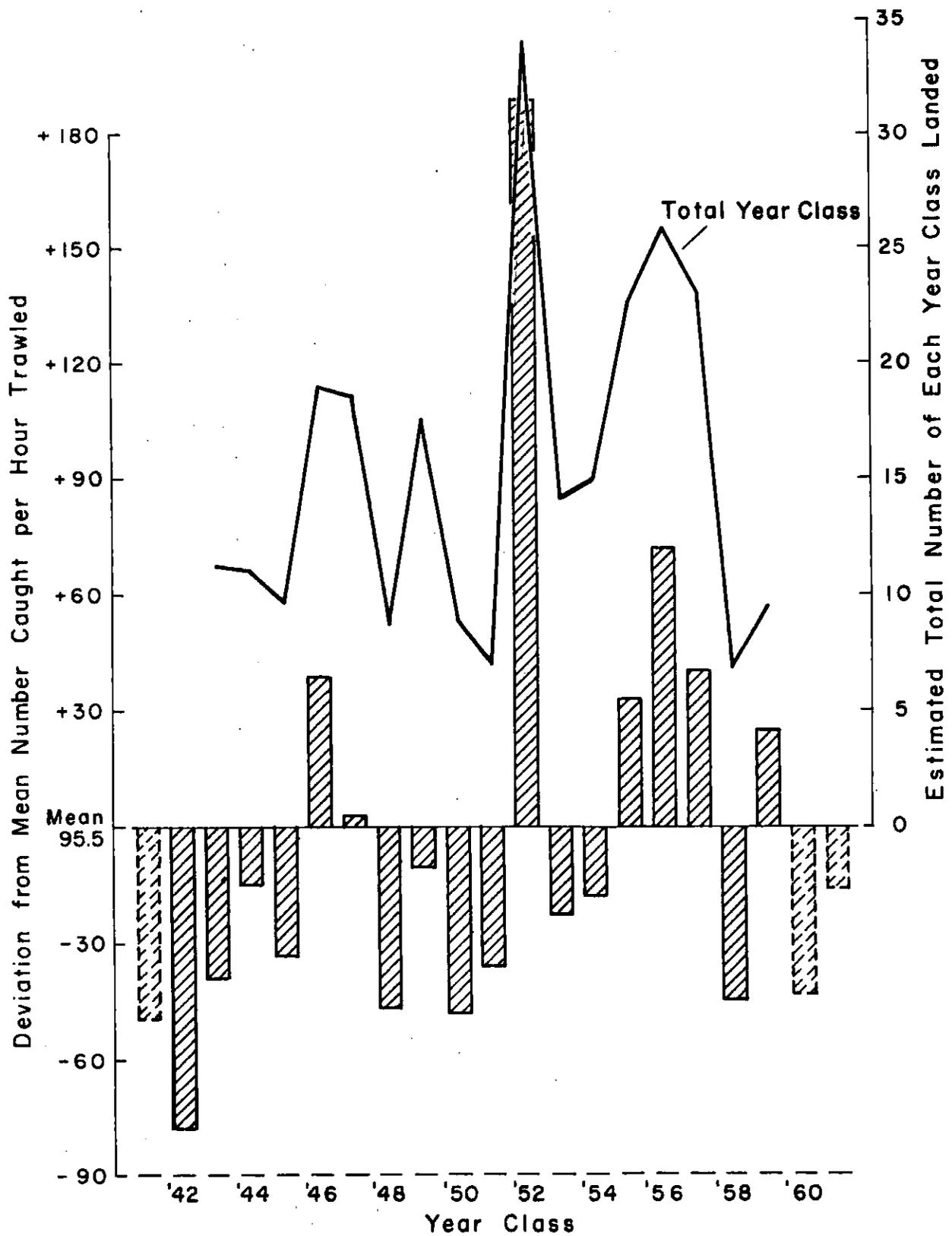


Fig. 4. Estimates of haddock year-class strength 1941-60 and contributions to total landings, all countries, by year-classes, 1943-58; year-class strengths 1942-59 estimates based on Canadian catch/effort figures.