

ANNUAL MEETING - JUNE 1964Trends in the Cod Fishery off the East Coast of Newfoundland and Labrador
(ICNAF Subarea 2 and Divisions 3K and 3L)

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Abstract

Statistics of landings for the period 1954-61 show that cod landings by trawlers from the stock complex of Subarea 2 and Divisions 3K and 3L have increased substantially since 1958, the greatest increase having been in the southern part of Subarea 2 (Division 2J) in 1960 and 1961. Coincidentally the landings from the offshore line fishery in 3L and from the inshore fishery in 3K and 3L have declined.

Starting in 1959 a very productive spring fishery developed in the northern divisions (particularly 2J and 3K) and this has resulted in an upward trend in the landing per unit effort in those regions, when the data are considered on an annual basis. However, when considered on a semi-annual basis, the trend in landing per unit effort has been slightly downward for the summer and autumn fishery by trawlers as the fishing effort has generally increased. More pronounced decreases in landing per unit effort are indicated for the offshore line fishery (dory vessels) in Division 3L and for the inshore fishery in all 3 regions.

Length and age composition data show that there is a tendency toward smaller and younger fish in the catches of trawlers and particularly so in the landings of the inshore fishery. The greatly decreased abundance of older fish in the inshore fishery and the trend toward smaller fish in the offshore trawl fishery is attributed to the greatly increased effort by trawlers in recent years, particularly since 1958.

1. Landings

Examination of statistics of landings as reported in ICNAF Statistical Bulletins reveals that great changes have taken place in the fishery on the cod stock complex extending from off the Labrador coast

(Subarea 2) southward to the northern half of the Grand Bank (Division 3L) (see Fig. 1). In Table 1 the cod landings, expressed in thousands of metric tons, round fresh weight, for the years 1954-62 are given by countries and also by major gear components. Prior to 1954 statistics were not available by division and for all countries, and they could not be included in the Table. From 1954 to 1957 total cod landings for the stock complex were relatively stable at 265-305 thousand tons. A low value of 220 thousand tons occurred in 1958, due largely to unusually high temperature conditions in the Grand Bank region of Subarea 3 (Templeman, 1959). Starting in 1959 there was a rapid increase in total cod landings to just over 500 thousand tons in 1961 and 1962. While the Canadian fishery, largely inshore, showed a decline over the period, the fishery by other major cod-fishing countries increased substantially. This increase is reflected by a four-fold increase in the cod landings by trawlers between the 1954-59 period and 1961.

Except for some annual variation, there has been little change in the level of total cod landings or in the landings of the major gear components for Division 3L. In Division 3K, however, although total cod landings have not changed substantially, there has been a considerable increase in trawler landings coincident with a decrease in the landings of the inshore fishery. While there has been a slight decrease in trawl landings from 3K between 1959 and 1961, probably attributable to a shift in fishing effort, the decrease in inshore landings is attributed to decreased availability of cod in the coastal waters.

In Subarea 2 (mostly Division 2J) a very great offshore cod fishery developed between 1959 and 1961 when trawler landings reached a level of almost 250 thousand tons from less than 30 thousand tons annually in 1954 to 1958. The great changes occurred largely as a result of increased effort by trawler fleets of France, Portugal, Spain and USSR.

No significant developments have occurred in the offshore line fishery, carried on largely by Portuguese dory vessels; if anything the trend in landings has been downward. This offshore line fishery is closely parallel to the Newfoundland inshore fishery, in that both are seasonal in nature and both depend on the seasonal migration of cod from the deep water of the continental slope to shallow water where the fishing is carried on.

2. Trawl Effort and Landing per Unit Effort

It is obvious from the foregoing that the changes in landings, particularly by trawlers, are largely due to changes in the amount of effort expended, but changes in the landings per unit effort may also be a contributing factor. In order to distinguish between these causes, both annually and seasonally, estimates were made of the fishing effort (in standard units) expended in each of the 3 regions for the 1954-61 period. These estimates were calculated by dividing the cod landings of trawlers in each region by standard landing per unit effort (L/E) values, which were obtained from the landing and effort data of selected trawler fleets that fished primarily for cod. The initial calculations were carried out on a monthly basis in order to detect any seasonal trends that might be apparent in the data.

The standard unit of effort selected was the Portuguese otter trawler hour. In order to fill some gaps for months when little or no Portuguese effort was expended and to consolidate the landing per unit effort values in relation to the total landings of cod by trawlers, landing and effort data by Spanish otter trawlers were also used, but after conversion to the standard. For a few instances, i.e. months when neither Portuguese nor Spanish trawlers operated in an area, UK and USSR data (for >1800 ton trawlers) were used but only where necessary. These data were utilized without conversion, since the few landing per unit effort values available show those fleets as being directly comparable with the Portuguese fleet.

Before standardization the landings per unit effort were calculated on a monthly basis from the landing and effort data of Portuguese and Spanish otter trawlers. Only those landing per hour values, based on an expenditure by both fleets of 200 or more hours fishing in each region for each month, were used, since for smaller amounts of effort the corresponding landing per unit effort values were somewhat more variable, particularly if one fleet fished relatively very little and the other much more. The comparable landing per unit effort values are shown in Fig. 2. For all 3 regions the points are scattered linearly about a line passing through the origin, the slope of which was

arbitrarily chosen as 0.8. The next step was to combine both the Spanish and Portuguese trawl landings and effort for each month in each region, with the effort by Spanish trawlers adjusted by a factor of 0.8. The average landing per hour (standard) of both fleets in each month was then obtained by dividing the cod landing by the adjusted effort. The effort expended for cod by all trawlers was estimated by dividing the total trawl landings for the month by the standard L/E for that month. The estimation of trawl effort by months has an advantage over the more direct method of estimating the effort on an annual basis, as carried out by Keir (1959), since it provides the basis for an analysis of trends in the fishery on a seasonal basis, the importance of which will be seen below.

Subarea 2. Total landings of cod have increased greatly between 1959 and 1962 coincident with the increase in trawler landings and effort (Fig. 3). The L/E (standard) declined to about 1 ton per hour in 1958 but from 1959 to 1961 it increased to just over 2 tons per hour. When shown on a semi-annual basis, it is apparent that the great increase in landings occurred in the first half of 1960 and 1961, when the average L/E was about 3 tons per hour compared with just over 1 ton per hour for the second half of these years. Traditionally all of the cod taken in Subarea 2 were caught in the second half of the year, and the L/E has generally declined for this seasonal period from about 1.6 tons per hour in 1954-56 to 1.2 tons per hour in 1961.

Division 3K. On an annual basis total cod landings varied between 75 thousand and 140 thousand tons (Fig. 4), the peak in 1959 having been the result of increased fishing activity by trawlers. The L/E has been relatively stable throughout the period. Seasonally, however, fishing effort by trawlers up to 1958 occurred only in the second half of the year. As for Subarea 2, trawler exploitation of the spring concentrations of cod started in 1959 and continued in 1960, but there was a decrease in 1961, due probably to a shift in effort to the more productive spring concentrations in Subarea 2. The average L/E in this Division during the first half of the years 1959-61 was just over 2 tons per hour compared with a 1.2-1.5 range in L/E for the July-December period of the years 1954-61:

Division 3L. The trend in total cod landings has been generally downward with trawlers accounting for about one-third of the total annual yields (Fig. 5). The trend in L/E has also been downward from about 1.6 tons per hour in 1954-56 to 1.1 in 1960 with some improvement to 1.4 in 1961. Unlike the other 2 regions, trawlers have during the 8 years shown fished in Division 3L in both the January-June and July-December periods. The L/E for the first half of the years was more variable than for summer and autumn, in which the trend has been downward from about 1.5 tons per hour during 1954-57 to about 1 ton per hour in more recent years. During the 8 years shown the spring fishery by trawlers has generally been more productive (in terms of L/E) than the fishery in the second half of each year, although the effort was usually higher for the latter period.

3. Effort and Landing per Unit Effort for the Offshore Line Fishery

While the offshore fishery for cod in Subarea 2 and Division 3K is entirely by trawlers (Table 1), about one-quarter of the landings from the offshore cod fishery of Division 3L ¹⁵ are obtained by fishing with lines, mostly by a fleet of Portuguese dory vessels. The effort and L/E values plotted in Fig. 6 were obtained from the revised Portuguese dory vessel data for 1956-61 given in the Appendix to ICNAF Statistical Bulletin, Vol. 11. The 1954 and 1955 adjustments were made by applying a conversion factor, based on the revised effort data of 1956, to the previously published unweighted effort data for 1954 and 1955. The effort is expressed in terms of dory hours, i.e. the number of hours the dory fleet is absent from the mother vessel times the number of dories.

Fig. 6 shows that the trend in landings, L/E and effort for the offshore line fishery has been downward since 1956 with a particularly large decrease in 1958. Although there has been some increase in effort and landings since 1958, the level of L/E has levelled off at just over 40 tons of cod per 1000 dory hours fishing, a decline of about 30% below the 1954-57 level. Considering the data on a semi-annual basis, the line fishery in July-December has generally been slightly more productive than in the first half of the year and in recent years relatively more fishing occurred in the summer and early autumn than in the spring.

4. Effort and Landing per Unit Effort for the Inshore Fishery

The inshore fishery in the 3 regions under consideration is carried on exclusively by Canadian (Newfoundland) fishermen using a variety of gears (codtraps, handlines, longlines, jiggers, gillnets). Unfortunately, with such gear variety and the very widespread distribution of fishermen in hundreds of coastal villages, a good measure of total effort in the inshore fishery is not available. However, estimates of the number of fishermen engaged in the inshore cod fishery have been obtained by the Canadian Department of Fisheries field staff for a number of years. While it does not necessarily follow that changes in the number of fishermen throughout the period under consideration means corresponding changes in total inshore fishing effort, the data are useful as indicators of trends.

Although an upward trend in inshore cod landings for Subarea 2 is apparent, coincident with a gradual increase in the number of fishermen (Fig. 7), the cod yield per man since 1959 is about 25% lower than the average for 1954-57. In Division 3K the number of fishermen has been relatively steady at just over 4000, but the cod landings (and L/E) have decreased rapidly to a level about 40% below that for the mid-1950's. In Division 3L inshore cod landings are now about 20% lower than in the mid-1950's, despite a 30% increase in the number of fishermen engaged in the inshore cod fishery.

An interesting feature of the data for all 3 regions concerned in the inshore fishery is the decline in landings and L/E for the year 1958. This same feature is evident for the trawler fishery (Fig. 3-5) and particularly so for the offshore line fishery (Fig. 6). Templeman (1959, 1964) reports that temperature conditions throughout most of the area off the east coast of Newfoundland were somewhat higher than normal in 1958, and this factor probably had the effect of causing the cod to be less concentrated on the fishing grounds than normally.

5. Length and Age Composition of the Cod Catches

Length and age composition data have been published annually since 1955 in the ICNAF Sampling Yearbooks. While data from several countries with trawlers fishing in the areas under consideration are available, Portuguese and Spanish data make up the longest series and only these data have been utilized in the present analysis of the length and age composition of trawler

catches. Data are available for Division 2J from 1956 and for 3K and 3L from 1955. The trawl length frequencies for 2J were sufficiently different from those of the more southerly divisions that they are treated separately, while those of Divisions 3K and 3L were combined because of their consistent similarity in each year of the 1955-61 period. The length frequencies were initially analyzed on a quarterly basis, but differences between the quarterly frequencies within any one year were generally so slight that they were combined after weighting by the quarterly trawler landings. The age frequencies were considerably less in number and were simply combined after adjustment of each to the actual number of fish aged.

In Fig. 8 are shown the average length and age compositions of cod catches (based on Portuguese and Spanish sample data) in 2 periods for which data are available: 1956-58 data are compared with 1960-61 data for Division 2J and 1955-57 data with 1960-61 for Divisions 3K + 3L. Actually age frequencies were available only for 1961 in 3K + 3L, but there are no significant differences in the length frequencies between 1960 and 1961. How representative the 1961 age composition for 3K + 3L is of the corresponding length composition is not known, but the data indicate that the average length and age of cod have decreased both in 2J and 3K + 3L. The average lengths and ages for the data of Fig. 8 are as follows:

Division	Period	Average	Average
		length	age
		<u>cm</u>	<u>years</u>
2J	1956-58	57.5	9.4
	1960-61	56.3	8.5
3K + 3L	1955-57	62.1	9.7
	1960-61	60.3	7.3

Although length frequencies for the inshore cod fishery are not available for long enough a period from Divisions 2J and 3K, regular sampling of the landings have been carried out since 1955 at 2 or more fishing ports located in Division 3L, mainly Bonavista and St. John's.

Length frequency data for such gears as codtraps, longlines, handlines and jiggers are available in the Sampling Yearbooks, but, since the trap fishery in June-August accounts for 60-65% of the inshore landings, only data for this important gear ^{are} is considered here (Fig. 9). From 1955-57 the trap fishery consisted of cod whose average size was 59.3 cm, but in 1958 there was a predominance of smaller cod and this has continued to the present with the average length fluctuating between 53.5 cm and 55.6 cm between 1958 and 1962. Unpublished age composition data reveal that since 1958 the trap fishery has been largely maintained by fish of ages 4-6 years with a very rapid decrease in the numbers of older fish in the samples. Before 1958, however, fish of ages 7 and 8 were much more prevalent in the samples than at present. Templeman and Fleming (1956) have shown that the cod caught inshore are considerably smaller than those caught on the offshore banks and in deep water both during the summer and in other seasons, indicating that as cod grow older more of them tend to remain offshore and to be more available to the trawl fishery than to the inshore fishery. The decreased abundance of fish older than age 6 in the inshore trap fishery is attributed to the decreased abundance of these ages on the offshore fishing grounds as a result of increased effort by trawlers in all areas off the east coast of Newfoundland and southern Labrador between 1955 and the present time (see Fig. 1).

References

- Keir, R. 1959. Summary of the Fishery in the Convention Area, 1952-57. ICNAF Stat. Bull., Vol. 7: 7-13.
- Templeman, W. 1959. Canadian Research Report for 1958. ICNAF Ann. Proc., Vol. 9: 20-26.
1964. Anomalies of Sea Temperature at Station 27 off Cape Spear and of Air Temperatures at Torbay-St. John's. ICNAF Environmental Symposium, Rome, 27 January-1 February, 1964, Ser. No. 1247, Contr. No. H-2 (mimeographed).
- Templeman, W. and A. M. Fleming. 1956. The Bonavista Longlining Experiment, 1950-53. Bull. Fish. Res. Bd. Can., No. 109, 55 pp.

Table 1. Cod landings (thousands of metric tons) by countries and by major gear components for Subarea 2 and Divisions 3K and 3L during 1954-62.

	Landings by country										Total Landings	Landings by gear		
	Canada	France	Germany	Portugal	Spain	USSR	UK	Others	Trawl	Line		Inshore		
Subarea 2	1954	11.7	4.1	-	3.0	0.3	-	-	-	-	19.1	7.4	-	11.7
	1955	10.5	7.6	-	7.7	-	-	-	-	-	25.8	15.3	-	10.5
	1956	8.7	12.3	-	13.0	0.3	-	-	-	-	34.3	25.6	-	8.7
	1957	11.7	12.7	-	7.0	0.8	-	-	-	-	32.2	20.5	-	11.7
	1958	11.5	17.7	0.6	8.2	1.6	0.5	-	0.1	-	40.2	29.1	-	11.1
	1959	18.9	23.7	3.2	6.5	5.7	0.2	1.5	0.3	-	60.0	41.1	-	18.9
	1960	16.7	18.9	11.8	43.8	29.6	38.6	0.1	1.5	-	188.2	171.5	-	16.7
	1961	18.6	36.5	11.1	46.1	41.4	109.6	1.3	0.4	-	265.0	246.4	-	18.6
	1962	24.6	46.0	0.7	62.8	57.0	60.1	3.0	1.0	-	255.2	230.6	-	24.6
	Division 3K	1954	82.6	18.5	-	5.4	0.7	-	-	-	107.2	24.6	-	82.6
		1955	59.2	15.9	-	5.9	-	-	-	-	81.0	21.8	-	59.2
		1956	70.3	6.6	-	2.2	0.3	-	-	-	79.4	9.1	-	70.3
1957		67.5	13.6	-	2.1	0.1	-	-	-	83.4	15.4	0.5	67.5	
1958		33.7	22.2	-	7.2	9.3	0.7	-	0.4	73.5	39.8	-	33.7	
1959		56.3	21.5	-	28.2	24.4	6.4	0.6	1.9	139.3	83.0	-	56.3	
1960		47.7	14.5	-	16.0	12.4	26.0	0.9	0.6	118.1	70.4	-	47.7	
1961		31.2	18.1	2.3	18.9	11.8	8.6	0.3	0.5	91.7	60.4	0.2	31.2	
1962		42.8	8.7	0.4	13.1	9.8	11.3	1.1	1.2	88.4	60.4	-	42.8	
Division 3L		1954	106.5	19.7	-	41.5	9.9	-	-	-	178.5	65.9	19.5	93.1
		1955	100.3	15.9	-	36.6	5.0	-	-	-	157.8	43.0	29.7	85.1
		1956	104.3	17.4	-	50.1	15.0	-	-	0.2	187.0	62.6	31.1	93.3
	1957	84.1	19.4	-	45.2	10.2	1.6	0.7	-	161.2	60.7	20.2	80.3	
	1958	70.8	8.8	-	17.7	8.1	0.5	-	-	105.9	31.4	6.5	68.0	
	1959	90.2	10.1	0.7	20.4	8.1	2.3	0.7	0.8	133.3	36.5	11.1	85.7	
	1960	101.5	16.2	1.8	21.8	13.2	1.4	5.1	0.8	161.8	49.8	17.8	94.2	
	1961	75.3	13.9	0.6	25.6	21.4	4.5	2.9	1.5	145.7	60.0	15.0	70.7	
	1962	76.4	27.0	0.1	22.2	33.7	2.4	1.5	0.8	164.1	60.0	15.0	70.7	
	Total for Stock Complex	1954	200.8	42.3	-	49.9	10.9*	-	-	-	304.8	97.9	19.5	187.4
		1955	170.0	39.4	-	50.2	5.0	-	-	-	264.6	80.1	29.7	154.8
		1956	183.3	36.3	-	65.3	15.6	-	-	0.2	300.7	98.3	31.1	172.3
1957		163.3	45.7	-	54.3	11.1	1.6	0.7	0.1	276.8	96.6	20.7	159.5	
1958		116.0	48.7	0.6	33.1	19.0	1.7	-	0.5	219.6	100.3	6.5	112.8	
1959		165.4	55.3	3.9	55.1	38.2	8.9	2.8	3.0	332.6	160.6	11.1	160.9	
1960		165.9	76.8	13.6	81.6	55.2	66.0	4.1	2.9	468.1	291.7	17.8	158.8	
1961		125.1	68.5	14.0	90.6	74.6	122.7	6.5	2.4	502.4	366.8	15.2	120.4	
1962		143.8	81.7	1.2	98.1	100.5	73.8	5.6	3.0	507.7	366.8	15.2	120.4	

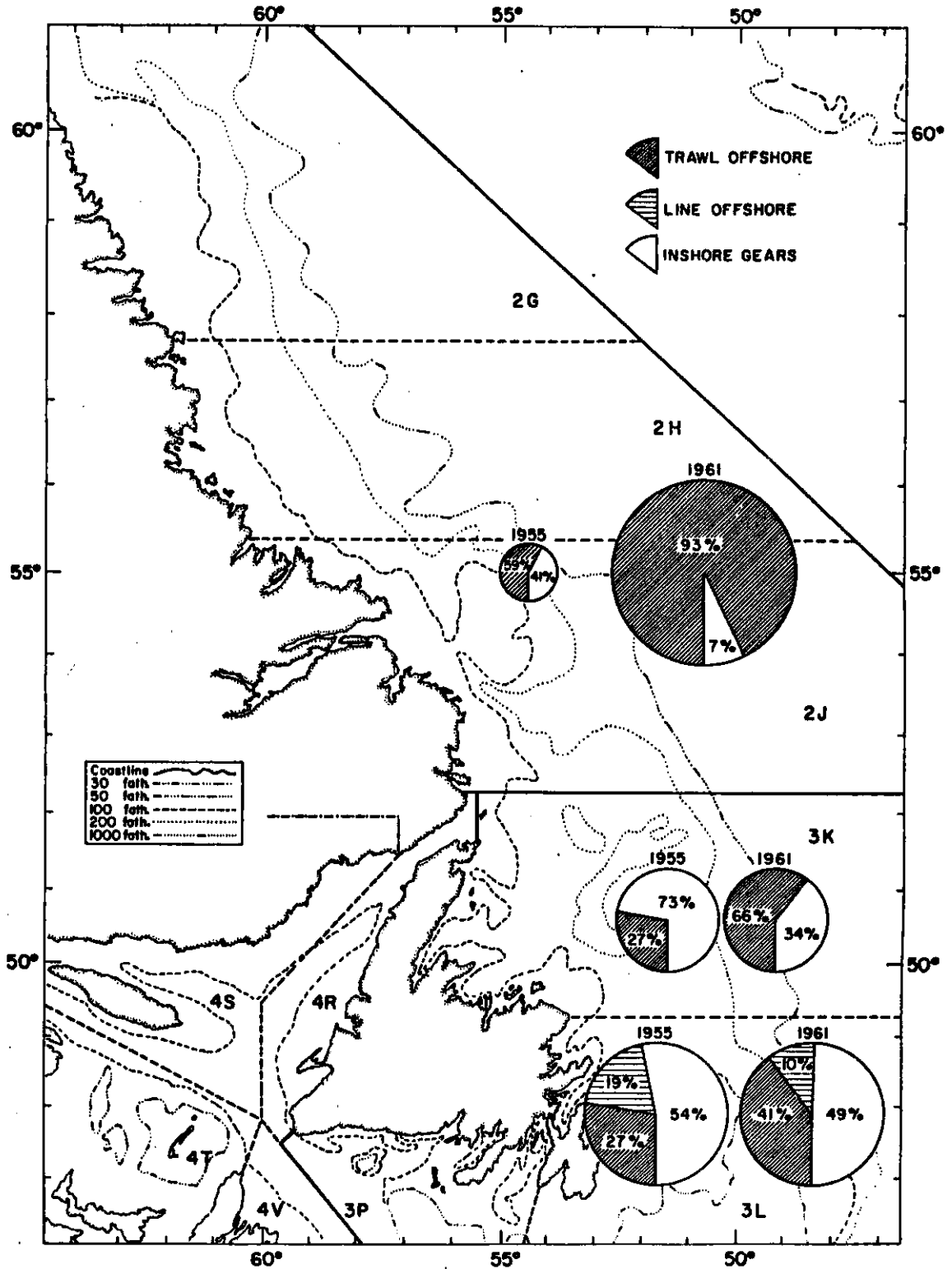


Fig. 1.. Map of Subarea 2 and Divisions 3K and 3L showing the distribution of landings by gears for 1955 and 1961.

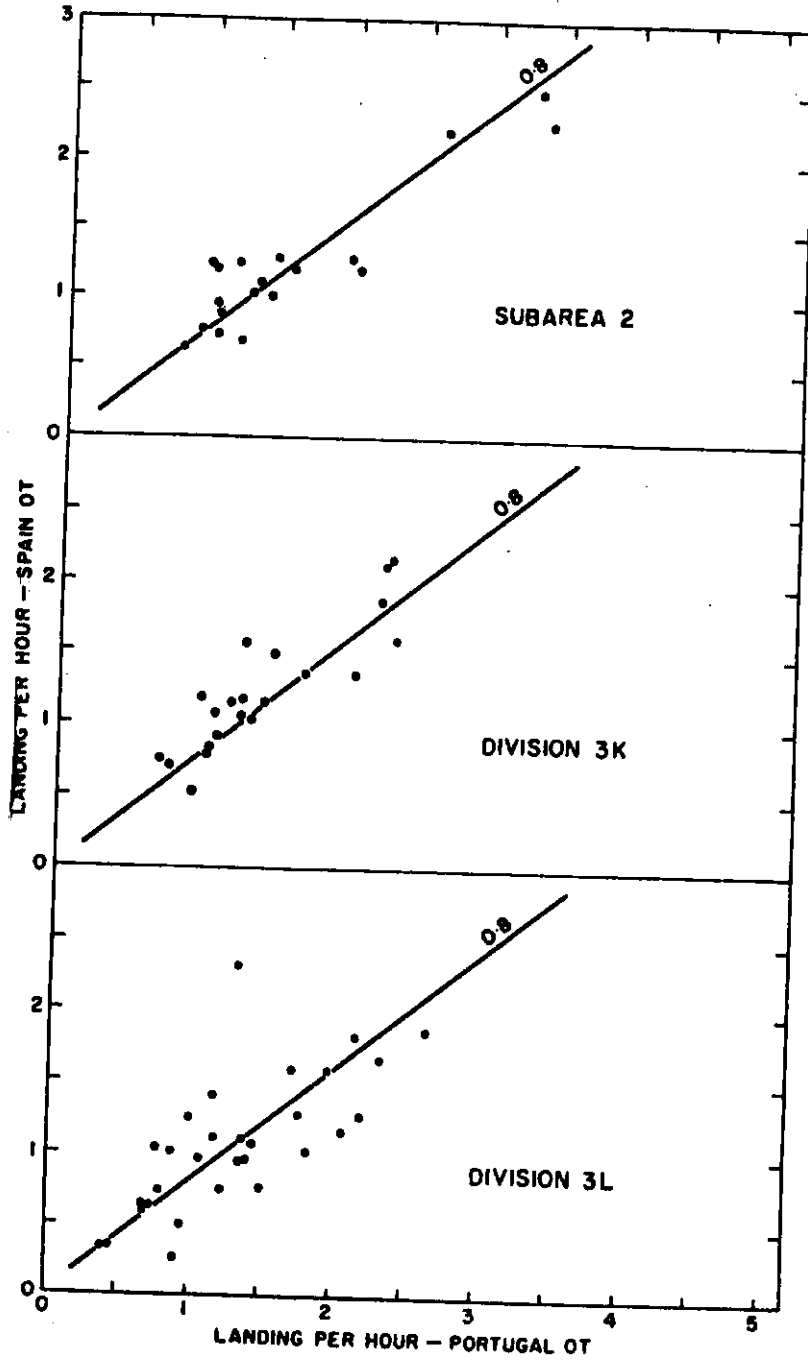


Fig. 2. Cod landings per hour fished (averaged on a monthly basis) for Spanish otter trawlers plotted against the corresponding landings per hour for Portuguese otter trawlers for the years 1955-61.

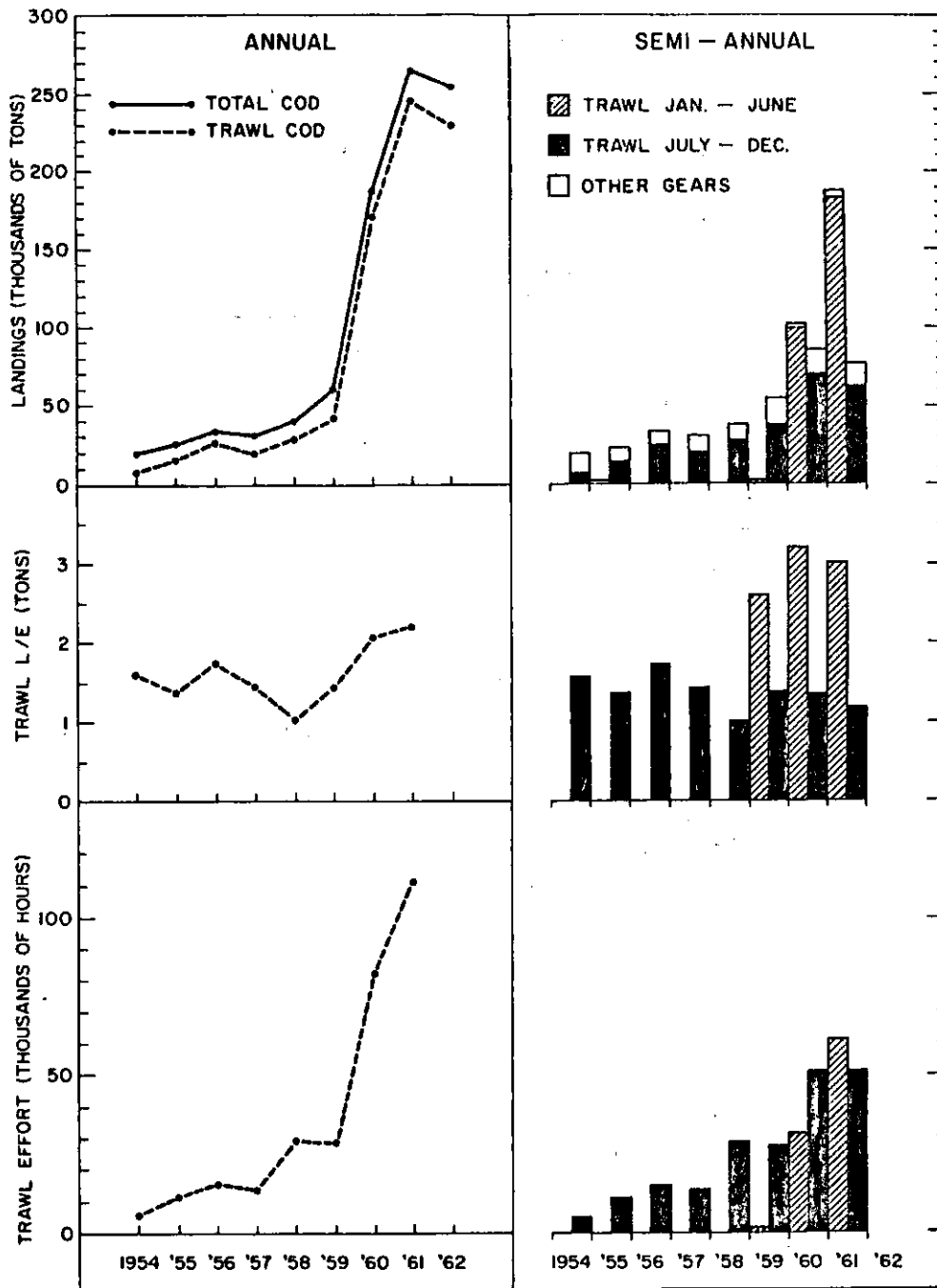


Fig. 3. Subarea 2 cod: landings, effort and landings per unit effort by trawlers, both annually and semi-annually, for the years 1954-61.

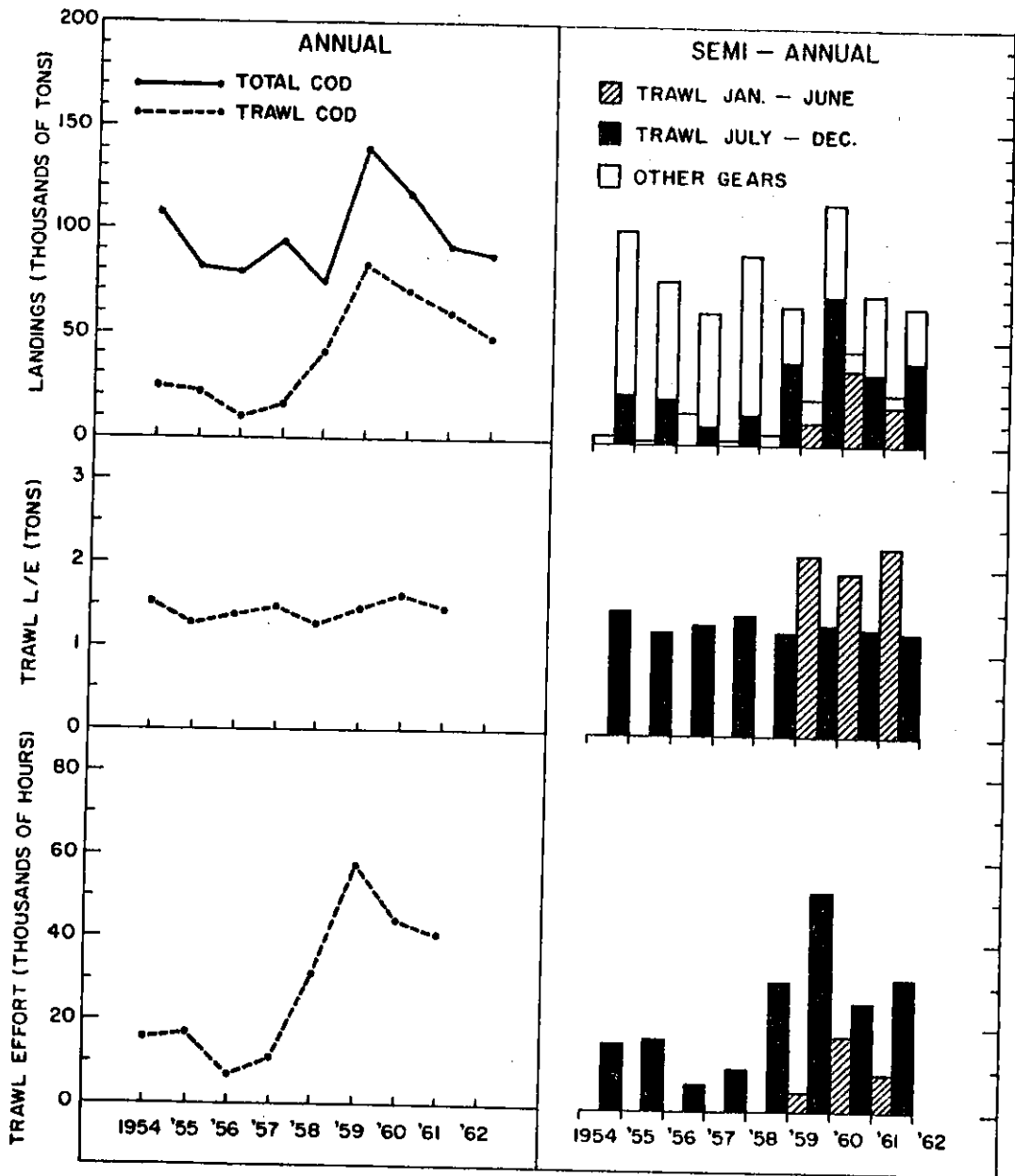


Fig. 4. Division 3K cod: landings, effort and landings per unit effort by trawlers, both annually and semi-annually, for the years 1954-61.

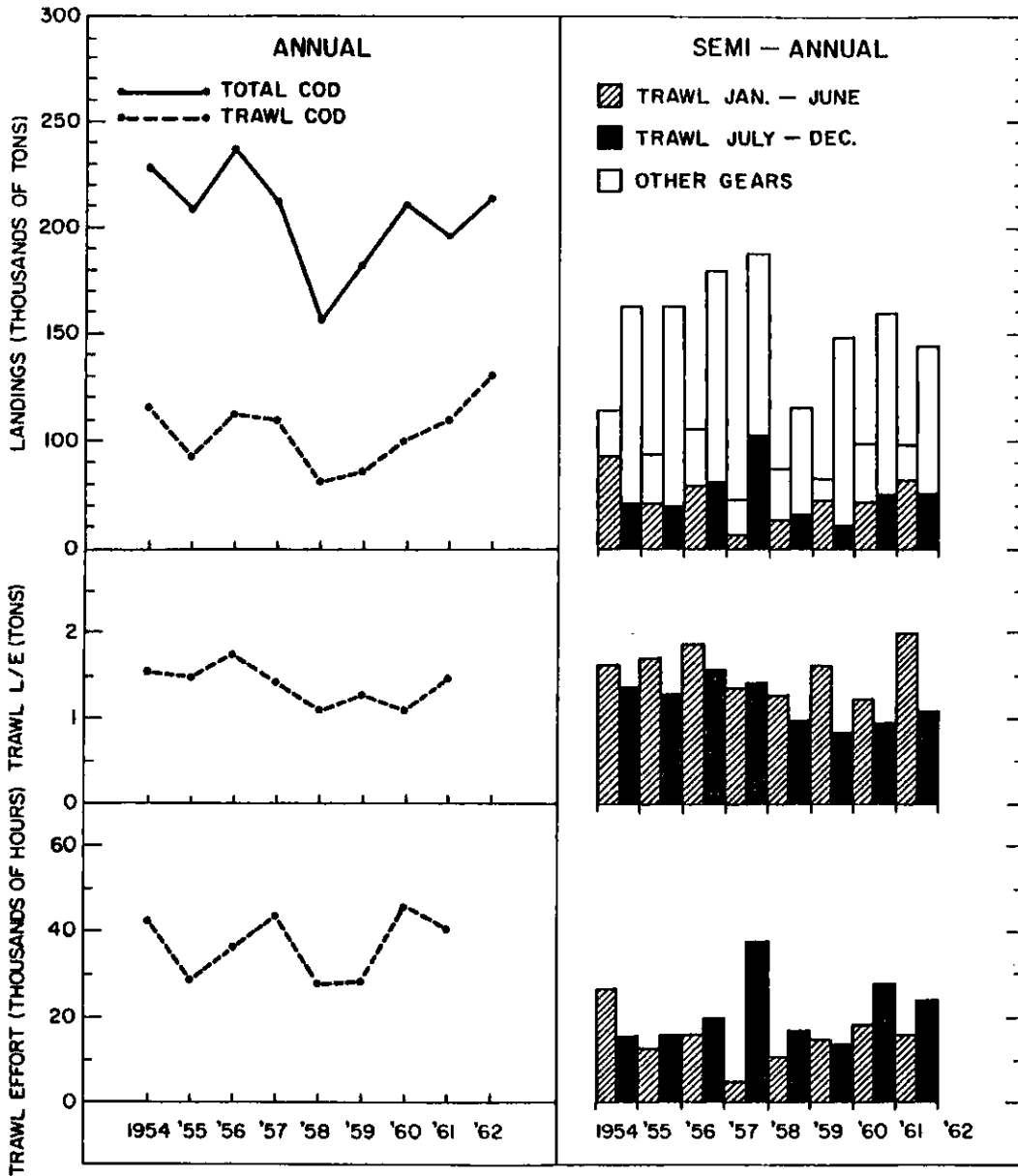


Fig. 5. Division 3L cod: landings, effort and landings per unit effort by trawlers, both annually and semi-annually, for the years 1954-61.

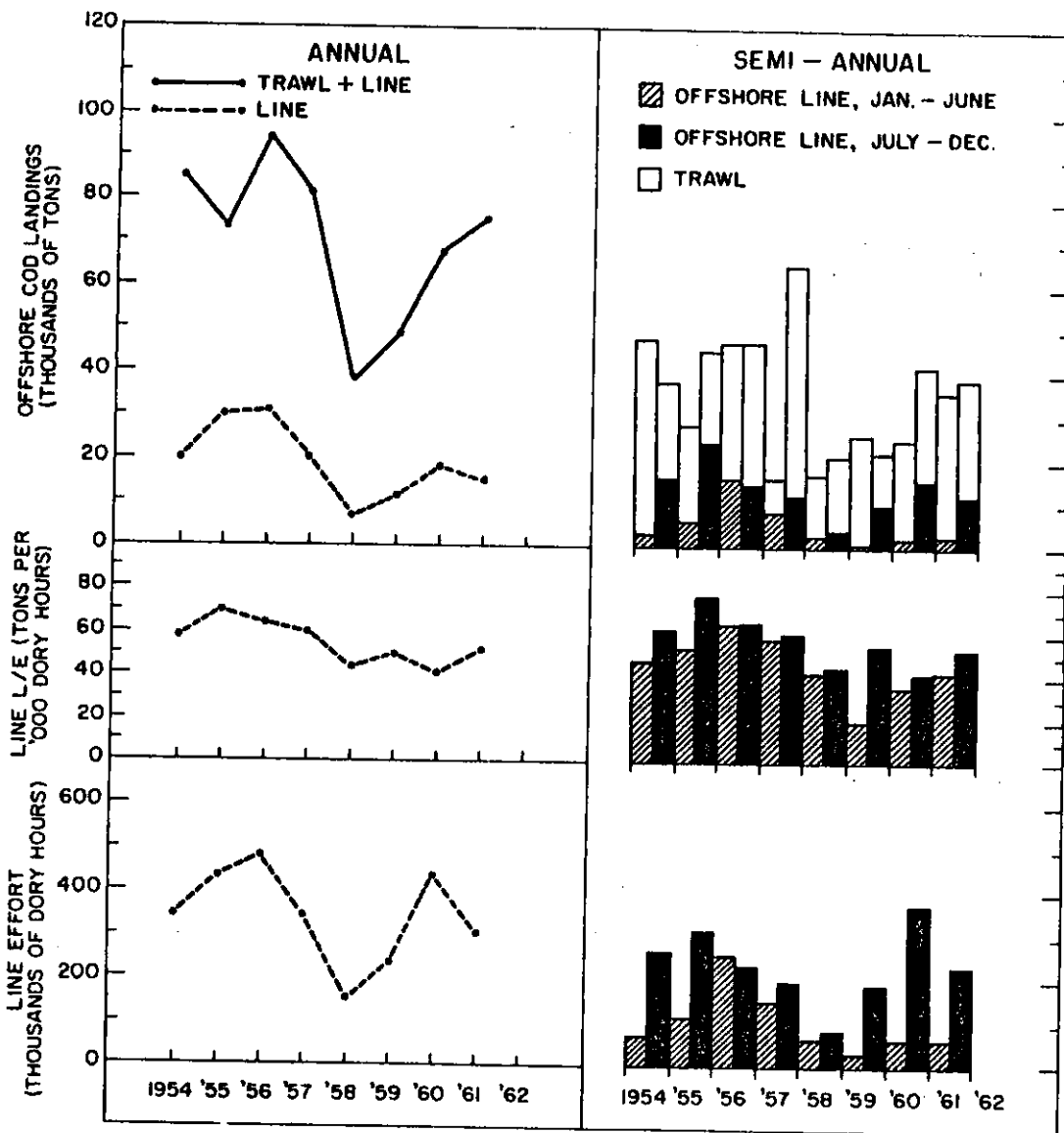


Fig. 6. Landings, effort and landings per unit effort for the offshore line fishery in Division 3L during the period 1954-61.

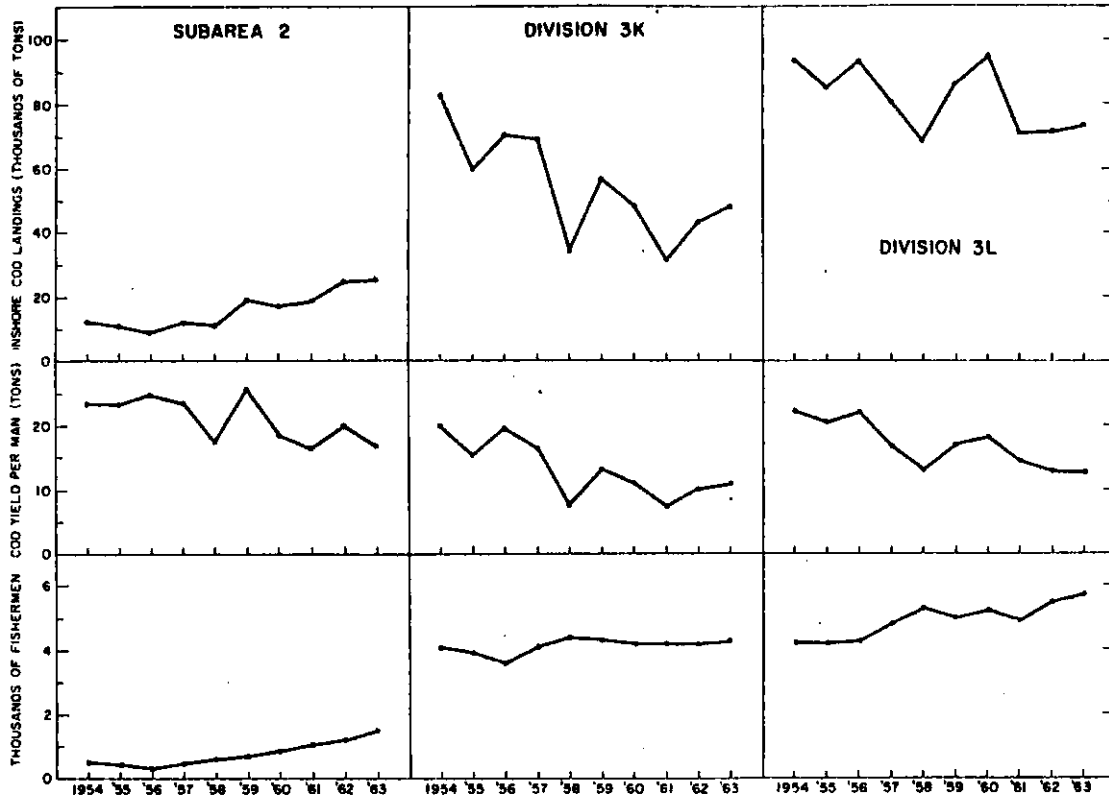


Fig. 7. Landings, effort and landings per unit effort for the inshore fishery in Subarea 2 and Divisions 3K and 3L during 1954-61.

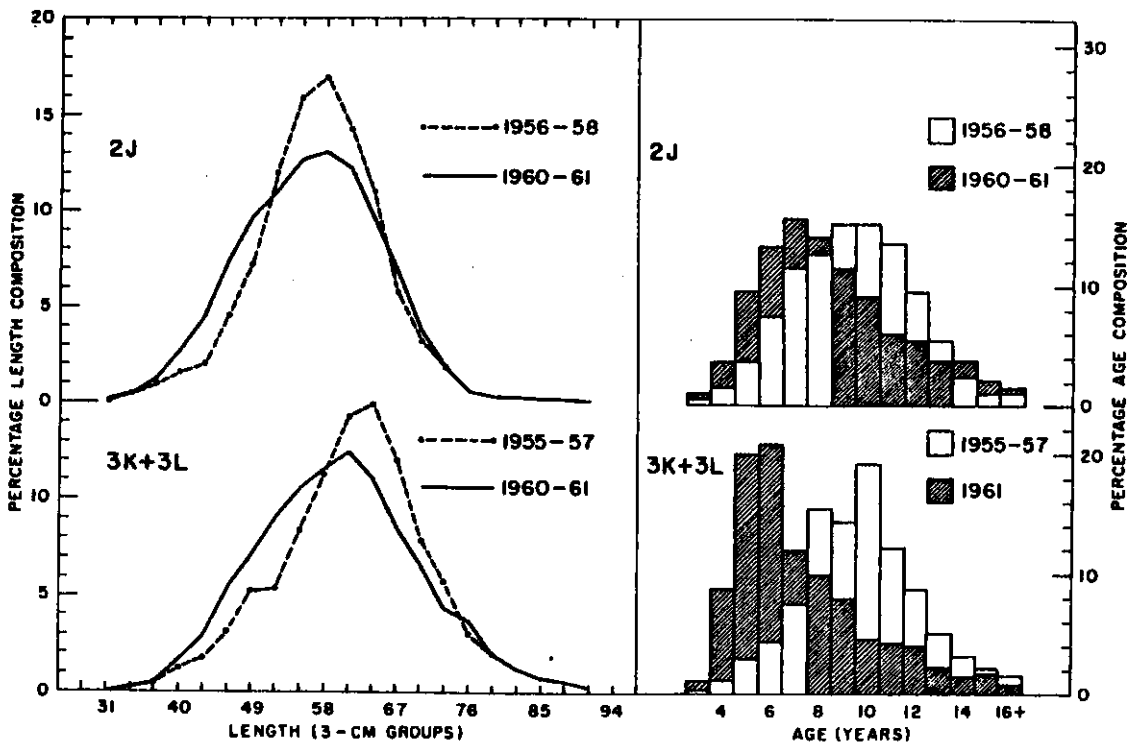


Fig. 8. Trends in length and age composition of cod in the offshore trawl fishery of Divisions 2J and 3K + 3L between 1955-58 and 1960-61.

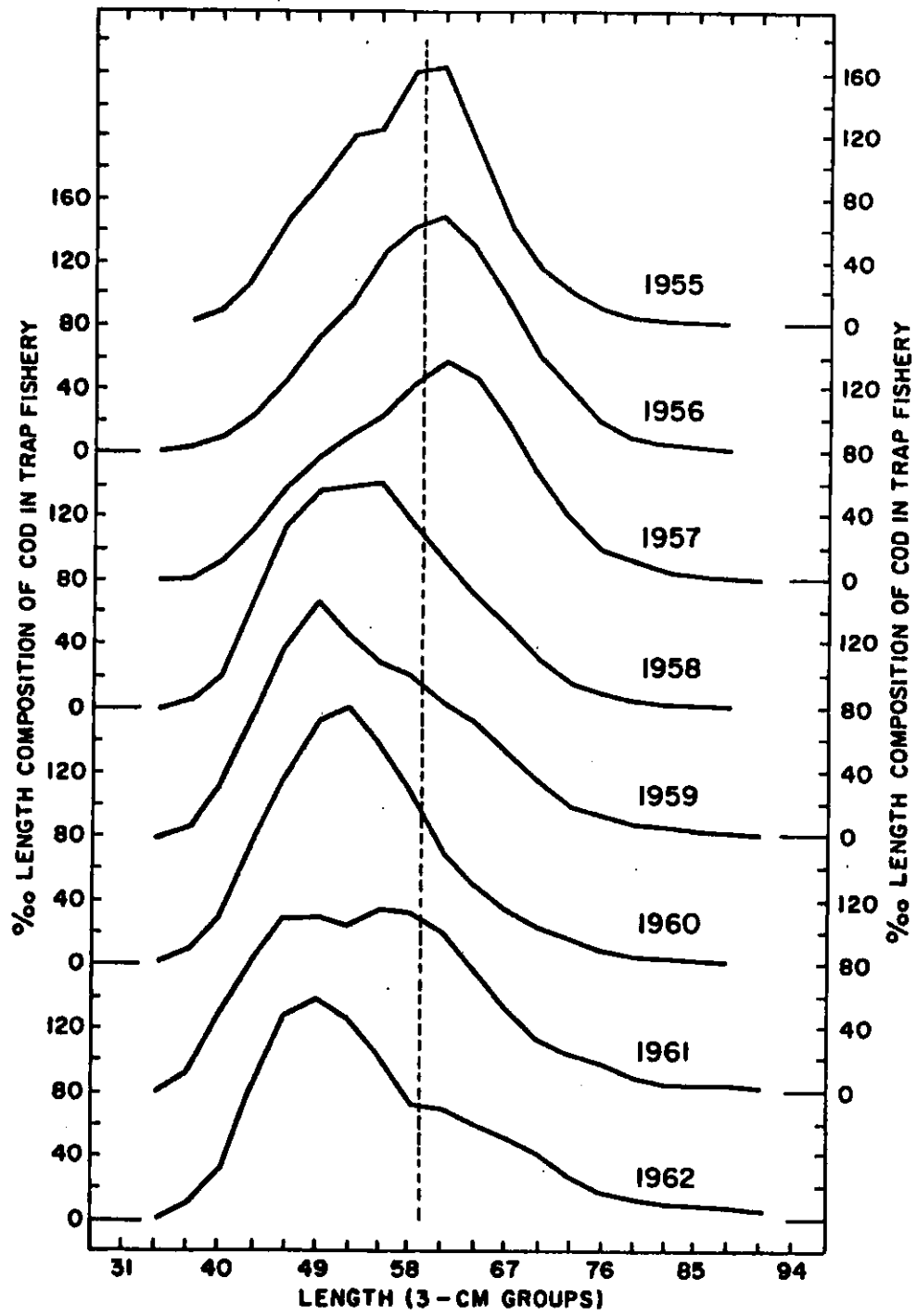


Fig. 9. Changes in length composition of cod landed by the inshore trap fishery in Division 3L between 1955 and 1962 (the vertical broken line represents the average length for 1955-57).