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Distribution and abundance of yellowtail flounder populations on Georges Bank and off southern New England according to trawl survey data

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Abstract

Investigations carried out in 1967-1970 yielded the following results:

Georges Bank which is the habitat of yellowtail flounder underwent no changes during the period of studies; however, there was some tendency observed toward a decrease in areas of maximum species density. The boundaries of the habitat of the population from the southern part of New England were noticed to broaden up to 1970 and in 1970 the area occupied decreased markedly (from 15.02 thousand square miles in 1969 to 11.96 thousand square miles in 1970, that is by 20%).

Over the period of studies, the mean length of yellowtail flounder decreased on Georges Bank and increased in southern New England.

At present, the mean absolute abundance of the population on Georges Bank is 54.5×10^6 specimens, and its biomass is 16.1 thousand tons, and in southern New England 140.8×10^6 specimens and 30.6 tons respectively.

It is clear from these data that the abundance of the Georges Bank population is considerably lower than that of the southern New England population.

In addition, abundance decreased in the populations investigated by 40% from 1968 to 1970.

Introduction

In 1970 the absolute abundance of yellowtail flounder populations on Georges Bank and in southern New England was calculated by Brown (1970). He described the abundance of the 1958-1961 year-classes at the age of 2 years and older estimated by Gulland's model (1963) and also gave its evaluation for 1968 on the basis of the catch data.

This paper presents the determination of the abundance of two yellowtail stocks in 1967-1970 based on trawl survey data.

Materials and Methods

This study is based upon material obtained during the joint USSR-American trawl surveys conducted in the autumn of 1967-1970.

Charts of distribution and relative abundance were constructed in the following way: the data on a trawl survey were plotted on plane-tables and then interpolated, using zones of species density of 1-10 specimens, 11-25 specimens, 26-100 specimens, 101-200 specimens, 201 and more specimens per 30-minute haul and treating each separately. The areas inhabited by the species with a certain density were determined with the help of a planimeter.

Mean individual weights by sample sizes for the populations were calculated by the formula:

$$P = \frac{\Sigma n_1 P_1}{N}$$

where

P - mean individual weights by sample sizes,

nl - number of specimens of a certain size,

Pl - mean individual weight by fish sizes,

N - total number of specimens in the size frequency.

Since the populations from Georges Bank and southern New England come in contact in nature, calculation of the absolute abundance is made along the 70° meridian which is used as a conventional boundary between the above populations (Fig. 1). We have used the following formula:

$$No. = \frac{1}{k} \Sigma \frac{Si \times ni}{S}$$

where

No. - the abundance of the population in numbers,

S_i - the area of a certain density,

S - the tow area (0.016 square miles),

n_i - average abundance within the layer of a certain density,

k - general catchability coefficient by Edwards (1968) which is 0.39.

Distribution of Yellowtail Flounder

According to Scott (1954) there are three populations of yellowtail flounder in the area off New England (1), the population inhabiting the Cape Cod area, (2) the Georges Bank population, and (3) the population off southern New England. Later, tagging experiments and morphometric studies by Lux (1963) confirmed this suggestion.

The present paper deals with only two populations: one from southern New England and the other from Georges Bank.

The distribution of yellowtail flounder on Georges Bank is given in Fig. 3, 4, 5. These figures show that no substantial changes in habitat were observed during the period of 1968-1970. However, some change of areas of different density took place within the habitat, e.g. in 1968 concentrations of yellowtail flounder with a density of 101-200 specimens per 30-min. haul were observed over an area of 0.46 thousand square miles, the area decreased to 0.08 thousand square miles before 1970. The tendency to decrease is also observed over the areas with a density of 26-100 specimens; respectively, the areas with the least density of yellowtail flounder tended to increase (Table 1).

In southern New England (Fig. 2,3,4,5) an increase of the habitat areas due to the southerly extension of yellowtail flounder was noted up to 1970, e.g. in 1967 this species occurred over an area of 13.60 thousand square miles, while in 1968 it occupied 14.03 thousand square miles, and in 1969 - 15.02 thousand square miles (Table 1). In 1970 the habitat areas decreased abruptly and constituted only 11.96 thousand square miles. It should be noted that up to 1970, the areas with frequency of occurrence of 201 specimens and more increased substantially. In 1967 they occupied 0.08 thousand square miles, in 1968 - 0.51 thousand square miles, in 1969 - 1.15 thousand square miles, while in 1970 these areas decreased somewhat and were only 0.49 thousand square miles (0.6%, 4.3%, 7.6% and 4.0% of the total habitat area, respectively).

Size Composition

The results of mass measurements of yellowtail flounder are given in Fig. 6 and 7. These figures show that the areas under studies undergo some changes in size composition of the catches.

A decrease in mean length is observed on Georges Bank. The population is characterized by an increase of the young size groups and a decrease of the older ones.

The reverse is recorded in southern New England where the mean length of yellowtail flounder increases: the proportion of the young size groups decreases and that of the older ones increases from year to year.

The percentage recruitment of 12-28 cm specimens decreases in both populations. This can be explained by a lower abundance of 1967, 1968 and 1968 ? year-classes which was pointed out earlier by Brown (1970).

The decrease in mean size of yellowtail flounder from Georges Bank results in a decrease in mean weight. Mean weight of yellowtail flounder in southern New England increases (Table 2).

Studies of the Absolute Abundance of the Populations

The absolute abundance of the two populations was evaluated on the basis of the frequency of occurrence and the general catchability coefficient.

In 1968-1970 the average absolute abundance on Georges Bank was 54.5 x 10^6 specimens, but the abundance decreases from year to year (Table 3). In 1968 it was 66.8 x 10^6 specimens, but before 1970 it decreased to 40.2 x 10^6 specimens.

In the period 1967-1970 the average absolute abundance in southern New England was 140.8 x 10^6 specimens. Highest abundance was observed in 1968 (167.6 x 10^6 specimens). That year also had the highest catches per unit of effort (Graham, 1969). Later, the abundance began to decrease and by 1970 was 100.0 x 10^6 specimens (Table 3).

After estimating mean individual weights of yellowtail flounder by sample sizes, and its absolute abundance we calculated the biomass of the two populations (Table 4). Biomass in autumn 1968 was 55.7 thousand tons, in 1969 - 52.1 thousand tons, and in 1970 - 37.0 thousand tons. Thus, in 1971 the biomass of these two populations will be lower than in the previous years.

Conclusion

The following conclusion can be drawn from these investigations.

The habitat of the Georges Bank population showed no changes during the period of investigation, but showed some tendency toward a decrease in areas in which the maximum fish density was observed within the habitat.

The boundaries of the southern New England population expanded to 1970, the habitat areas increased (by 1.5 thousand square miles) from 13.51 thousand square miles in 1967 to 15.01 thousand square miles in 1969; in 1970 the area decreased sharply to 11.95 thousand square miles.

Mean length of yellowtail flounder from Georges Bank decreased and in southern New England tended to increase.

The absolute abundance of the Georges Bank population in 1968 was 66.8 x 10^6 specimens, in 1969 - 56.3 x 10^6 specimens and in 1970 - 40.2 x 10^6 specimens. It decreased in 1970 by 26.6 x 10^6 specimens (40%), as compared with 1968. Average biomass was about 16.1 thousand tons.

In southern New England the maximum abundance was recorded in 1968 - 167.6 x 10^6 specimens, the minimum abundance in 1970 (100.0 x 10^6 specimens).

The average biomass during the period in studies was 30.6 thousand tons.

Discussion

Our results differ slightly from the abundance data given by Brown (1970) who estimated abundance at 105,297 x 10^3 specimens based on catch data, and the yield at 32.6 thousand tons with an F = 0.8, or 31.2 thousand tons with an F = 1.15. Richter and Vinogradov (1969) determined the absolute abundance of the Georges Bank population at 11.148 thousand tons from 1968 trawl survey data.

The data on the absolute abundance and biomass of the populations from Georges Bank and southern New England obtained by using the general catchability coefficient of 0.39 proposed by Edwards, reflecting the state of the populations

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and the tendency of the abundance and biomass to decrease, are doubtful as absolute: the biomass is practically equal to the catches. The general catchability coefficient is, evidently, somewhat overestimated and, hence, the values of the absolute abundance and biomass should be considered as relative.

Summary

1. The abundance of the Georges Bank population is considerably lower than that of the population in southern New England.

2. In recent years, these two populations have tended to decrease in abundance.

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Table 1. Areas occupied by yellowtail flounder by density (in thousand square miles). Southern New England.

Years	Areas by fish density 1-10	11-25	26-10	101-200	201-max	Total area
			Southern New England			
1967	3.70	3.09	4.24	2.53	0.08	13.60
1968	3.91	2.24	4.96	2.41	0.51	14.03
1969	5.96	3.56	2.52	1.83	1.15	15.02
1970	5.18	2.36	2.98	0.95	0.49	11.96
average	4.96	2.80	3.65	1.93	0.56	13.63
			Georges Bank			
1968	3.79	2.49	3.61	0.46	-	10.35
1969	5.55	2.93	3.19	0,16	-	11.81
1970	7.07	2.07	2.09	0.08	-	11.31

Table 2. Mean weights by sample sizes based on the trawl surveys (g)

Years	Southern New England	Georges Bank
1967	190	-
1968	211	304
1969	224	287
1970	253	291

Table 3. Absolute abundance of the populations by densities (in pieces x 10^6).

Years	density					Total
	1-10	11-25	25-100	101-200	201-max	
			Southern New England			
1967	3.7	10.1	47.8	69.8	4.4	135.8
1968	3.9	7.4	57.3	66.3	32.7	167.6
1969	6.0	11.7	29.0	50.5	62.9	160.1
1970	5.2	7.8	34.4	26.1	26.5	100.0
average	4.7	9.2	42.1	53.2	31.6	140.8
			Georges Bank			
1968	3.8	8.2	42.1	12.7	-	66.8
1969	5.6	9.7	36.8	4.3	-	56.4
1970	7.1	6.9	24.1	2.1	-	40.2
average	5.5	8.3	34.3	6.4	-	54.5

Table 4. Biomass of the yellowtail flounder populations (in thousand tons).

Years	Southern New England	Georges Bank
1967	25.8	-
1968	35.4	20.3
1969	35.9	16.2
1970	25.3	11.7
average	30.6	16.1

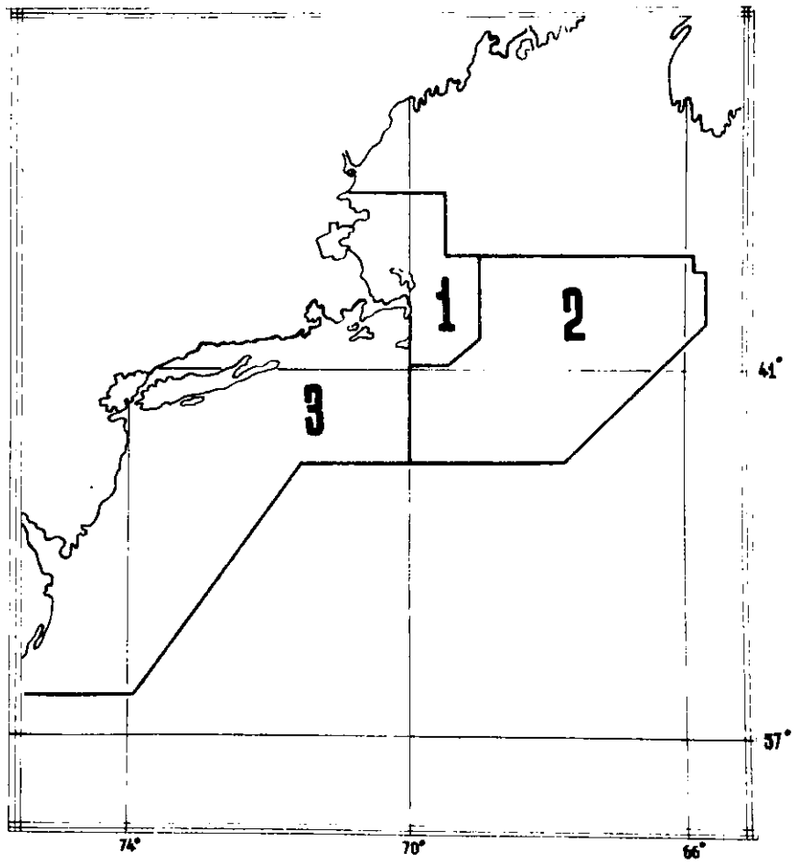

Fig. 1. Areas occupied by the three populations of yellowtail flounder off New England. (1) Cape Cod population; (2) Georges Bank population; (3) southern New England population.

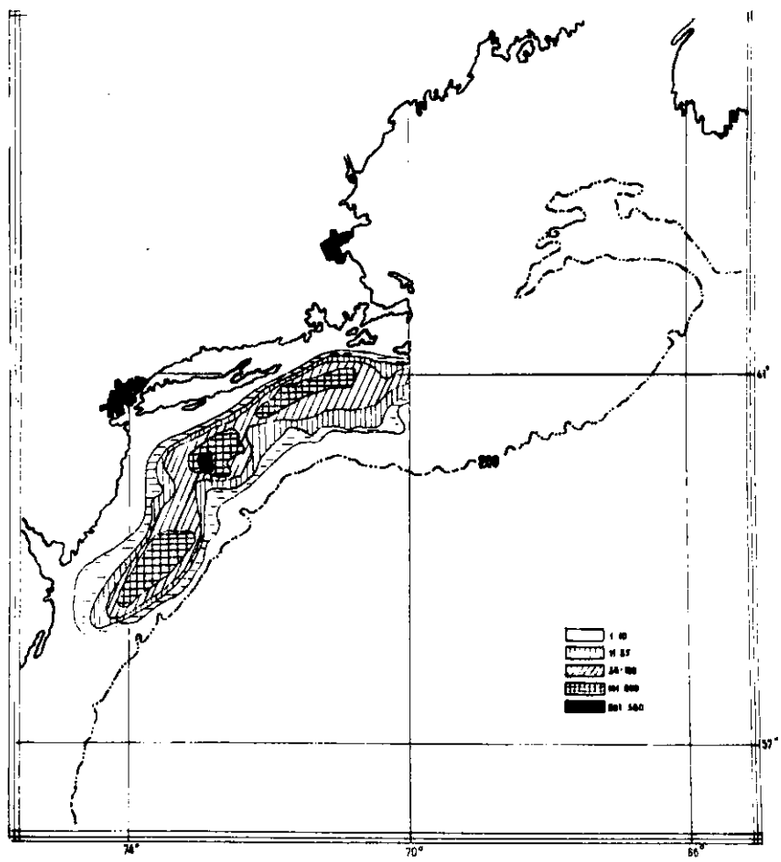

Fig. 2. Distribution and abundance of the Georges Bank and southern New England yellowtail flounder population in 1967.

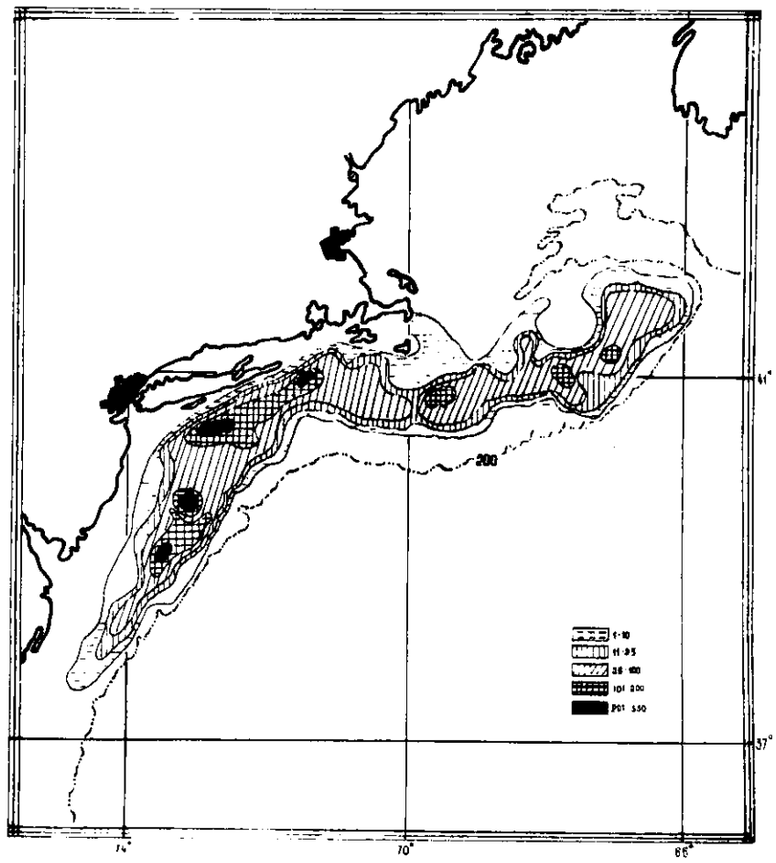

Fig. 3. Distribution and abundance of the Georges Bank and southern New England yellowtail flounder population in 1968.

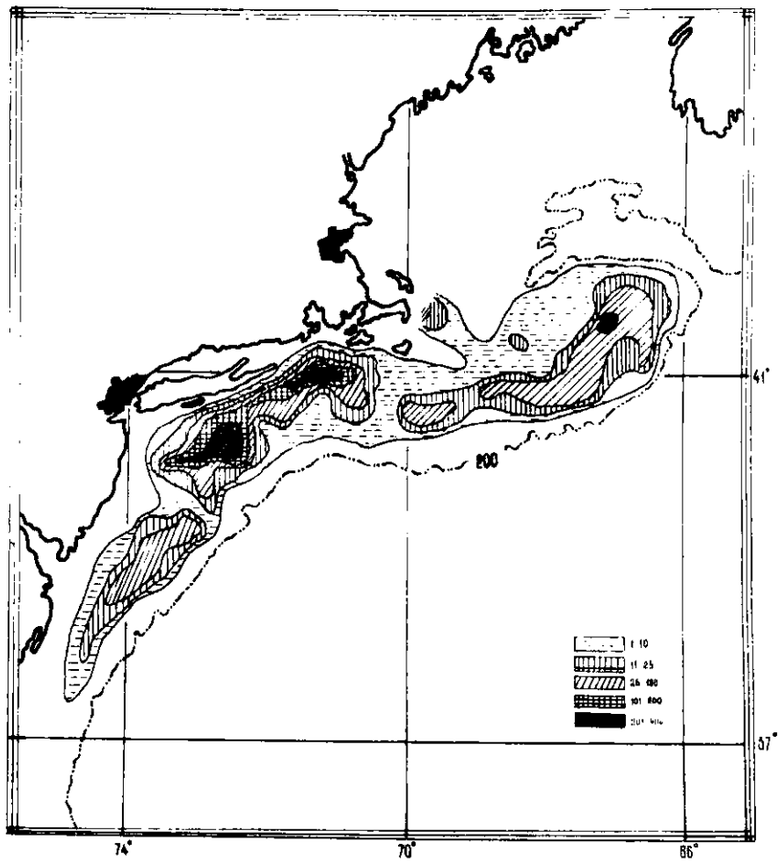

Fig. 4. Distribution and abundance of the Georges Bank and southern New England yellowtail flounder population in 1969.

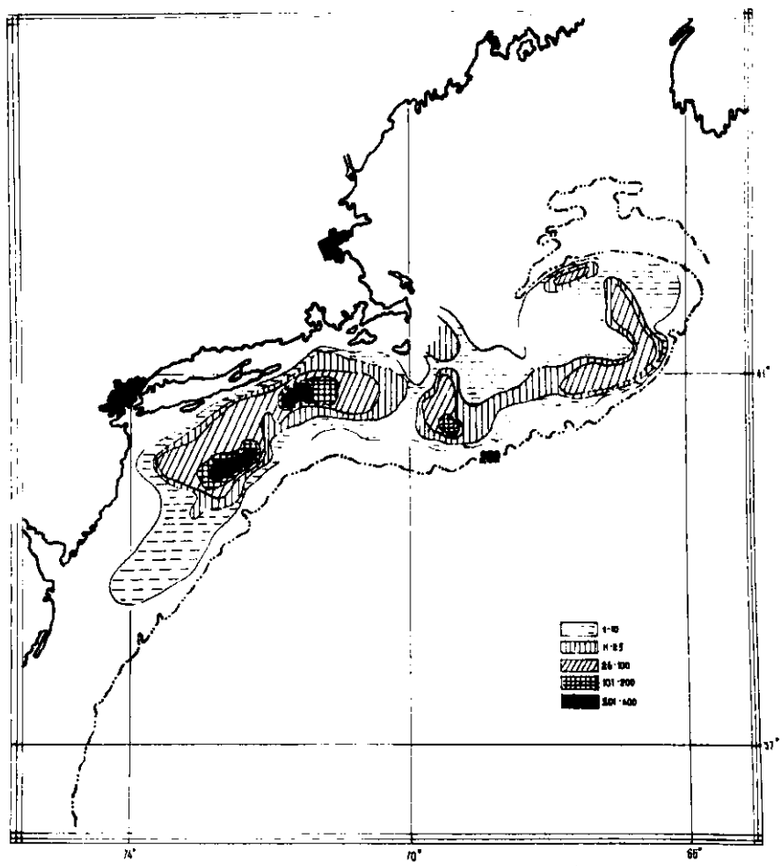

Fig. 5. Distribution and abundance of the Georges Bank and southern New England yellowtail flounder population in 1970.

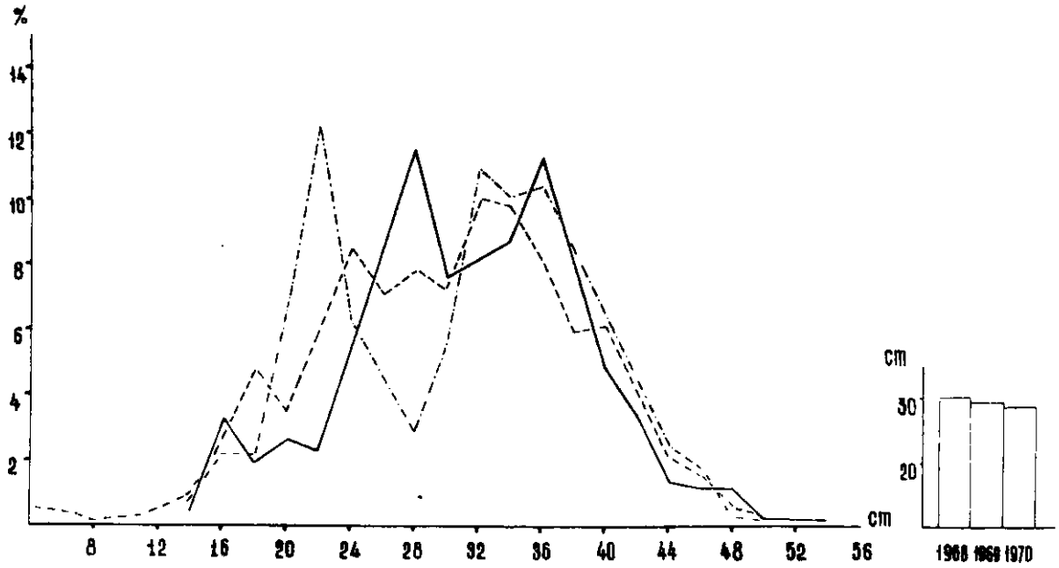

Fig. 6. Length frequency of Georges Bank yellowtail flounder for 1968–70.

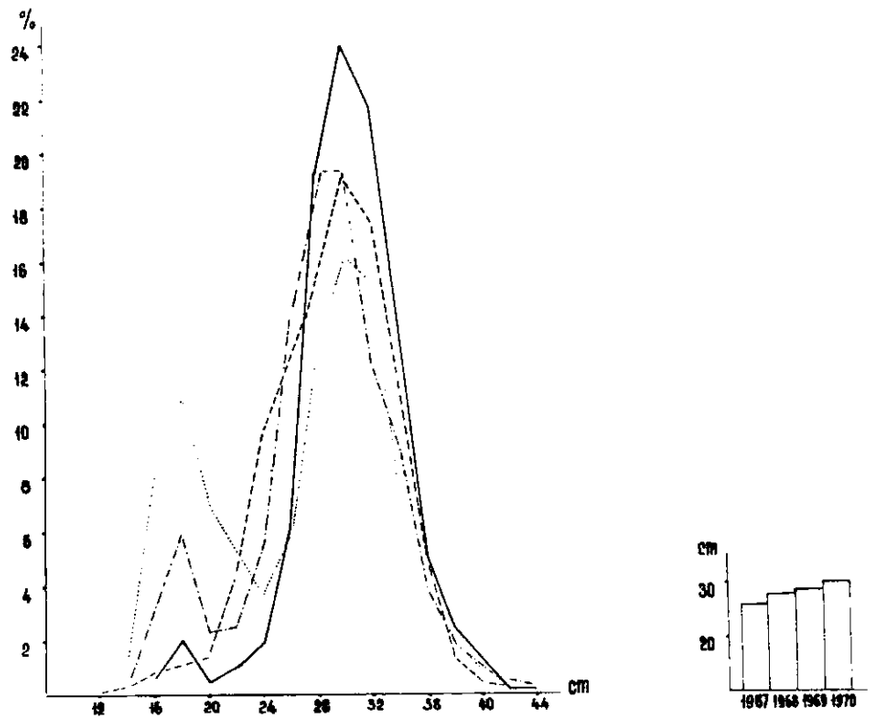

Fig. 7. Length frequency of southern New England yellowtail flounder for 1967-70.