International Council for the
Exploration of the Sea

C.M. 1963

Symposium on the Measurement
of Abundance of Fish Stocks

No. 27

Some Remarks on the Estimation of Abundance of Herring and Mackerel from Data on the Catches of the Netherlands' Trawler Fleet

by

K. H. Postuma & J. J. Zijlstra
Rijksinstituut voor Visserijonderzoek
IJmuiden

1. Introduction

The Dutch fleet of large trawlers is fishing nearly exclusively for herring and mackerel the whole year round. Only during the winter months other fish, e.g., haddock, whiting, coalfish, may form a more important part of the by-catch. All species are caught by the same ships, with about the same gear and often during the same fishing trips. It is not possible, therefore, to separate the data by ship or fishing trip into those of a herring fishery, a mackerel fishery and a roundfish fishery.

From all ships data are collected on catch, fishing hours and fishing area. From these statistics the catch per unit effort is calculated by species, month and statistical rectangle. The data referring to herring and mackerel are published annually in the Statistical Newsletters.

It appears from the data on catch per unit of effort that the figures for roundfish do not depend on the abundance of roundfish only, but are greatly influenced by the possibility to make good herring catches. It has, therefore, been found that no reliable estimates of the abundance of roundfish can be obtained from the statistics of the Netherlands' trawler fleet.

The data on herring and mackerel show some of the problems which are encountered when trying to estimate the abundance of two fish species which are caught by the same fishery in varying proportions in the course of the year.

This paper describes the magnitude of these difficulties and the methods used in the Netherlands' herring and mackerel investigations to eliminate, at least partly, the sources of error arising from them.

2. The Distribution of the Fishing Effort

It appears from the data that practically the whole North Sea is fished for herring and mackerel in the course of the year, with the exception of the German Bight. However, there exists practically no place in the North Sea where fishing for herring and mackerel is going on during the whole year. If the monthly distribution of the fishing effort in the North Sea is compared for a number of successive years, it appears that every year practically the same areas are fished in the same months, with peaks of the effort at corresponding times.

The fishery has a seasonal character, and follows every year more or less the same pattern.

For our present purpose the North Sea has been divided into four areas, in each of which in particular the abundance of herring shows a different seasonal aspect. These areas are shown in Figure 1. In Figure 2 the monthly figures of the fishing effort are given for each of the areas separately.

The graphs show clearly the seasonal fluctuations in fishing effort within each area. In the beginning of the year the areas "North" and "Northeast" are fished, until April-May when most of the fishing shifts to area "Northwest", with a peak of fishing in June-July. The area "Central" is fished mainly in August, September and October. Towards the end of the year the trawlers are returning to the areas "North" and "Northeast".

This seasonal distribution of the effort can be understood if we turn to the distribution of the herring and mackerel.

3. The Distribution of Herring and Mackerel

Apart from the fluctuations in fishing effort in the four areas in the course of the year, Figure 2 also shows the catch per unit effort per month for herring and mackerel in those areas. It is clear from these graphs that the season of the greatest catches is different in each area, for both species.

When comparing the graphs of the fishing effort with those of the catch per unit effort it can be seen that in many cases the graphs coincide. However, in other cases there is no relation at all.

In the fisheries in the areas "North-west" and "Central", the peaks of the catch per unit effort of herring and those of the effort correspond rather closely, whereas the peaks of the catch per unit effort of mackerel and those of the effort do not show any relation. It is clear that in these areas the main fishery is concentrated on herring and that the mackerel can be considered as a by-catch. When fishing for the herring, the ships may accidentally catch a good quantity of mackerel in one year, and miss the mackerel concentrations in other years. For this reason the catch per unit effort of mackerel may vary considerably from year to year, without these variations having any relation with the real variation in abundance of mackerel. Estimates of abundance of mackerel based on catch per unit effort in these areas will, therefore, not be reliable.

In the areas "North" and "North-east" the situation is more complicated. The catch per unit effort of mackerel shows a peak in the months April-May, and the curves of fishing effort also, whereas the catch per unit effort of herring is low in these months. Thus, in these areas, the period April-May can be considered as the mackerel season in which fishing will be concentrated on this species (see also Figure 3). During the remaining of the year the fleet is searching for herring, and peaks in the catches of herring are observed in February-March and in September and October in both areas. In winter, the catches of herring too may be low, and in that season the fishery may also be influenced by the possibility to obtain a reasonable by-catch of roundfish.

It can be concluded that the distribution of the fishing effort of the Netherlands' fleet of large trawlers in time and space is mainly determined by the distribution and abundance of the herring. Only in the months April-May, in the areas "North" and "North-east" the fishery is mainly directed towards mackerel.

4. The Estimation of the Abundance of Herring and Mackerel

As can be expected from the description given above on the distribution of fishing effort and of the catches of herring and mackerel, the annual figures of catch per unit effort of mackerel show wide variations in successive years. The figures per year-class fluctuate so much that it is impossible to obtain any reliable estimate of mortality from them. Only the mortality estimates of mackerel based upon data on catch per unit of effort by year-class obtained from the areas "North" and "North-west" in the months April-May proved to be reasonably consistent. This indicates that the catch per unit effort gives a reliable estimate of the abundance of mackerel in this area and period.

Because, as concluded above, the fishing effort of the fleet is mainly directed towards the herring, it is probable that the catch per unit effort per month really gives a measure of the abundance of herring, except in the mackerel season and area.

The seasonal fluctuations in both the fishing effort and the herring catches gave rise to the question in which way the average annual catch per unit effort should be calculated in order to obtain the best estimate of the abundance of the herring stocks. If for each area the average catches per unit effort for each of the twelve months of the year are averaged, the figures of the months with low catches, and also those of the herring catches during the mackerel season, have the same weight in the annual figure as the values of the months of high catches.

If the total yearly landings are divided by the total effort in each area, the catches per unit effort in the months of the highest fishing effort have much more influence on the annual figure than those of the months of low fishing intensity. This is still more so if the abundance of the herring in each area and year is determined from the catches in the three top months of the season only (averaging the data of the three monthly means).

Each of these three methods has its own advantages and disadvantages and may lead to different results. Table 1 gives the figures obtained for each area by applying each of the three methods to the data of the years 1958-62. The results show that in the areas "North-west" and "Central" the three methods of calculation give about the same estimate of the trends in the catch per unit effort from year to year (the actual figure being, of course, at a different level), although the rate of the fluctuations is different. In the areas "North" and "North-east", however, the three methods of calculation give very different results. Because the age-composition of the catch is often different from month to month, the various ways of calculation also lead to different weighing of the successive age-groups.

These results can be understood from the biology of the herring and the seasonal distribution of the fishery. The herring populations within each of the areas are of a heterogeneous nature, and are greatly changing in the course of the year. The fisheries in the areas "North-west" and "Central" are more or less restricted to one main season. It cannot be expected that with such a seasonal fishery the three methods of calculation give very different results. The fisheries in the areas "North" and "North-east", however, are carried on throughout the whole year. In this case it can be expected that more or less independent changes in the abundance of the various parts of the herring stock do affect the estimate of the annual figure of catch per unit effort differently for each of the three methods of calculation.

For these reasons another method of estimating abundance has been adopted in the Netherlands' herring investigations. On the hypothesis that the herring in the North Sea consists of various groups each with their own spawning area, for which hypothesis many arguments have been brought forward in the course of the years, the abundance estimates are determined from the catch per unit effort of spawning herring within the spawning area. These data are used for calculations of mortality etc.

The monthly data on catch per unit effort in the four areas described above are considered to give a reasonable estimate of the abundance of herring in each month. These data, together with the data on stock composition, meristic and other racial characters in comparison with those obtained from the investigations on spawning fish can be used for studies on migration and mixing.

Summary

The Netherlands' fleet of large trawlers is fishing for both herring and mackerel. The fishing effort varies greatly between areas and seasons in the course of the year. This is mainly related with the distribution of the herring. The data on catch per unit effort of mackerel give a reasonable estimate of the abundance of mackerel in part of the North Sea and in the months April-May only.

The annual figures of catch per unit effort of herring by area give different results for the changes in abundance in successive years, dependent on whether the annual figures are based on total catch and total effort, or on the monthly data of catch per unit effort. For more reliable estimates of abundance of herring, in the Netherlands' herring investigations the catch per unit effort is determined from spawning herring in the spawning areas. The monthly data on catch per unit effort by area of the North Sea outside the spawning season can be used for studies on migration and mixing.

References

Postuma, K. H., Zijlstra, J. J. & Beukema	1960	"Mackerel fishery in the Netherlands in 1958". Ann.Biol., XV, pp.195-97.
Zijlstra, J. J. & Postuma, K. H.	1961	"Mackerel fishery in the Netherlands in 1959". Ann.Biol., XVI, pp.232-34.
Schubert, K.	1959	"Survey of the German commercial herring fisheries and the biological conditions of the stocks". Ann.Biol., XIV, pp.169-74.
Schubert, K.	1960	"Survey of the German commercial herring fisheries and the biological conditions of the stocks". Ann.Biol., XV, pp.141-56.

Schubert, K. 1961 "Survey of the German commercial herring fisheries and the biological conditions of the stocks". Ann.Biol., XVI, pp.192-2o6.

Schubert, K. 1962 "Survey of the German commercial herring fisheries in 196o". Ann.Biol., XVII, pp.188-2o5.

Table 1. Catch in tons of herring per loo hours' fishing of a trawler of 5oo H.P.

Year	Central			North-east			
	a	b	c	a	b	c	d
1958	44,9	2o,5	47,8	14,2	lo,2	5,o	17,9
1959	5o,2	3o,2	62,1	8,8	8,4	4,7	14,9
196o	27,6	18,4	28,9	lo,5	9,4	13,8	13,1
1961	34,1	25,5	41,3	6,o	5,1	6,3	7,7
1962	2o,o	14,2	28,9	6,6	5,5	2,9	13,o

Year	North-west			North			
	a	b	c	a	b	c	d
1958	2o,4	21,8	38,1	17,6	lo,4	15,7	5,8
1959	43,6	26,7	53,1	12,7	14,o	5,5	9,9
196o	28,8	21,4	28,4	13,1	12,6	16,1	lo,3
1961	15,7	11,4	22,6	7,3	lo,2	7,9	6,4
1962	13,3	1,8	11,7	8,o	12,5	29,3	6,6

a. $\frac{\text{total catch}}{\text{total effort}} \times$ loo

b. Mean catch per year as a mean of the monthly means.

c. and d. Mean catch of the three top months of a season.

Central c: August, September, October.

NW : July, August, September.

NE & N (c : January, February, March.

NE & N (d : September, October, November.

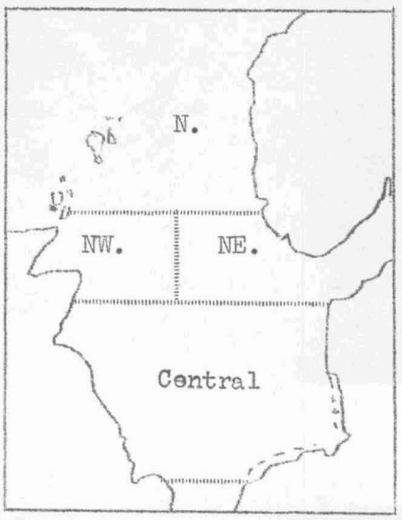

Figure 1.

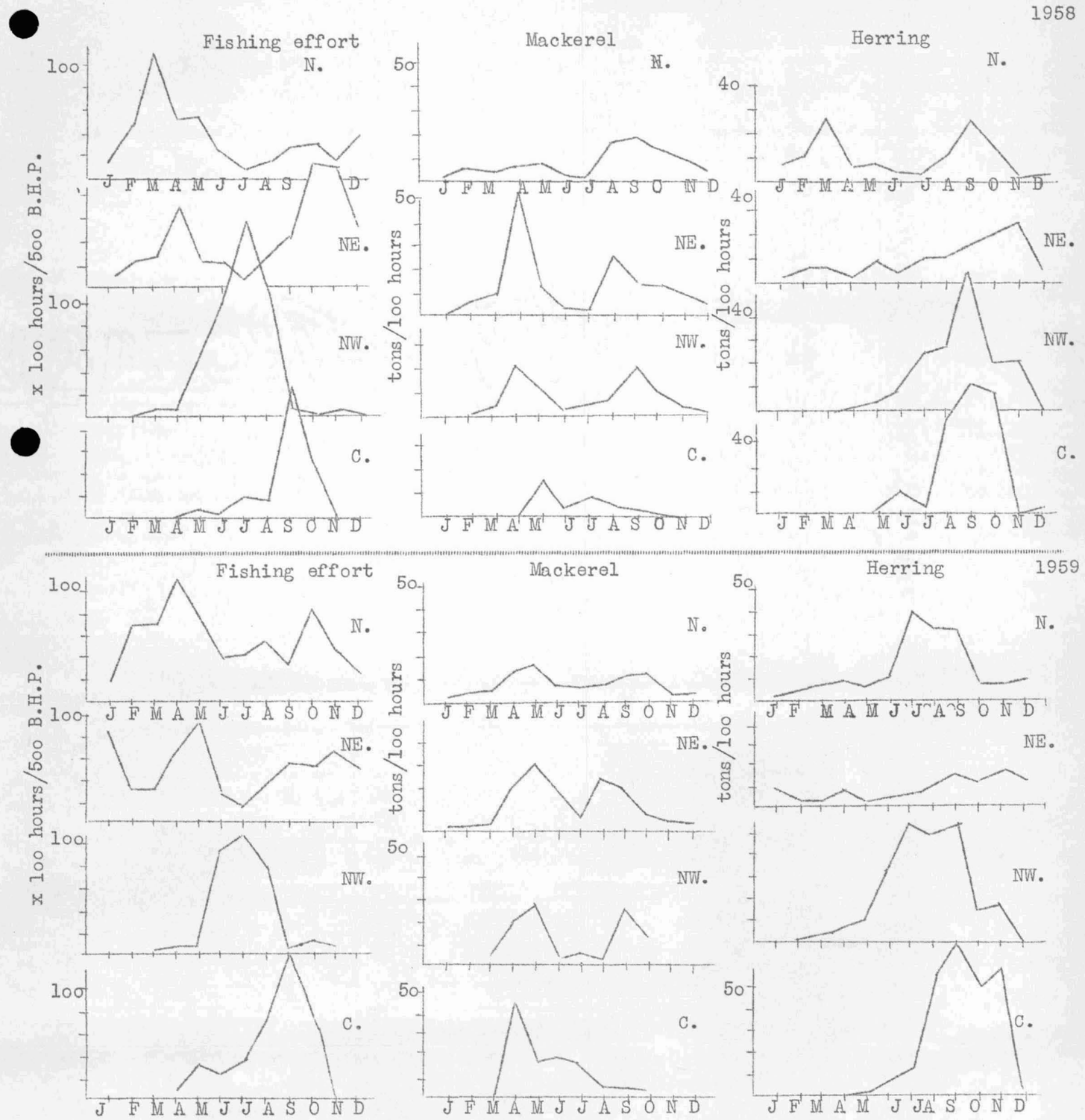

Figure 2. The catch per 100 hours fishing of herring and mackerel of a trawler of 500 B.H.P. and the effort expressed in numbers of hours fishing of a trawler of 500 B.H.P.

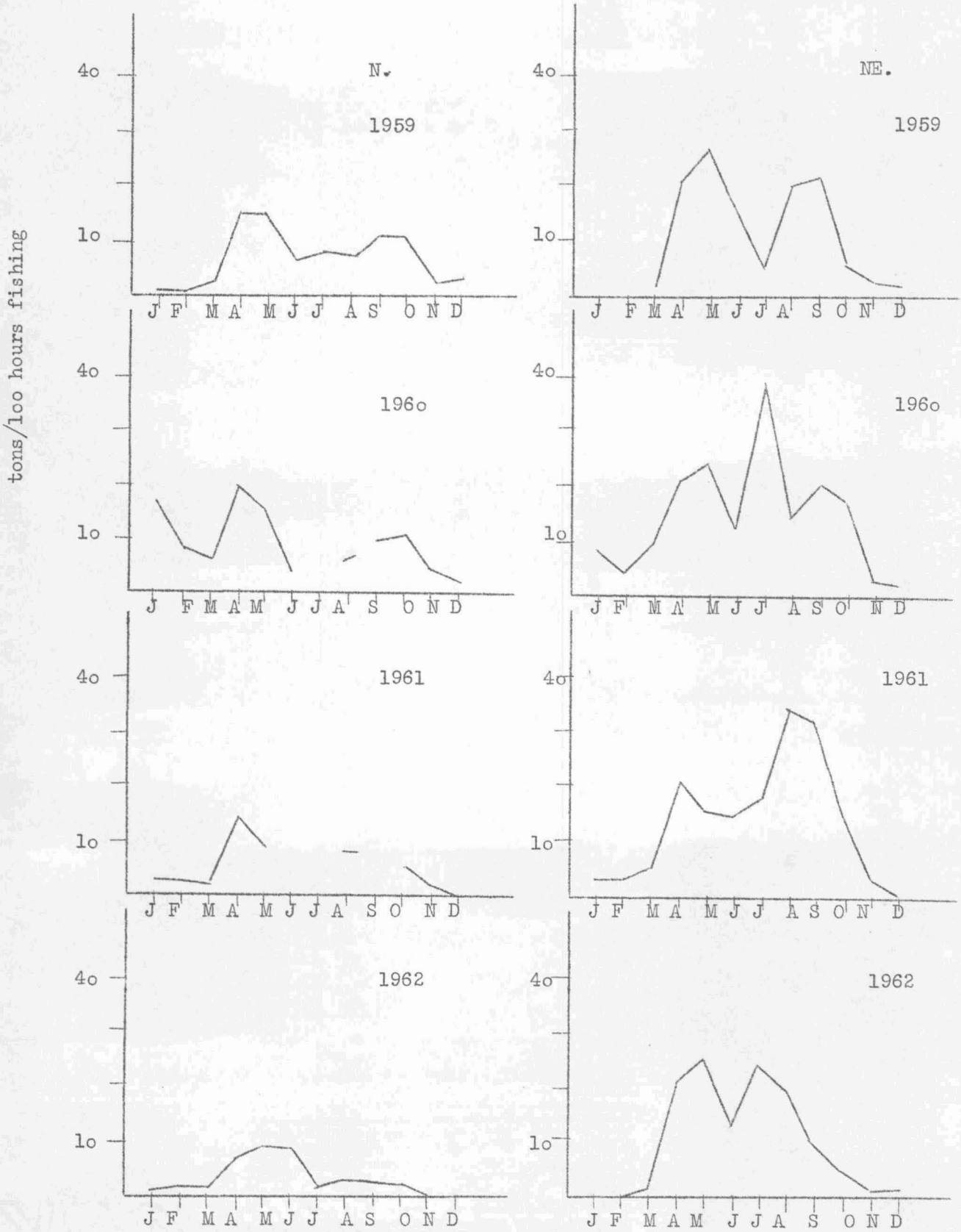

Figure 3. Catch per 1oo hours fishing of mackerel of a trawler of 5oo B.H.P. in the areas N. and NE. in the period 1959-1962.