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REPORT



P81

ON THE

GRIMSBY STEAM TRAWLER RECORDS

1904-1907.

BY

ROSA M. LEE, M.A.

WITH FIGURES 1-98 ; TABLES I.-XXXIII. ; APPENDIX I. AND II. AND ONE CHART.

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INTRODUCTION.

THE MATERIAL.

These statistics are the reduction of the material obtained from the masters of certain of the Grimsby Steam Trawlers. They were supplied by the Marine Biological Association with Record Books, containing the same forms as those used by the Lowestoft Skippers,* and these, giving the date, duration, position and quantity of fish caught in each haul, have been continuously filled up by them since May, 1904.

The number of men engaged in supplying the information is as follows:—1904, seven; 1905, nine; 1906, six; 1907, three; and of these, two in 1904, two in 1905, two in 1906, only continued their records for a few voyages, extending over one or two months. In the ordinary course they fill in from 30 to 45 record forms in a voyage of eight or nine days, so that from them we have obtained detailed particulars of a very large number of hauls.

The total number of hauls and of hours fishing up to the end of 1907 are given in the following table:—

TABLE I.—Showing for the Grimsby Trawlers, the total number of hauls and hours fishing, 1904–1907.

| Year. | | | | | No. of hauls. | No. of hours. |
|--------------|-----|-----|-----|-----|---------------|----------------------|
| 1904 | ... | ... | ... | ... | 2,669 | 10,144 $\frac{3}{4}$ |
| 1905 | ... | ... | ... | ... | 5,111 | 18,953 $\frac{3}{4}$ |
| 1906 | ... | ... | ... | ... | 3,312 | 11,704 |
| 1907 | ... | ... | ... | ... | 2,154 | 8,222 $\frac{1}{4}$ |
| 1904–1907... | ... | ... | ... | ... | 13,246 | 49,024 $\frac{3}{4}$ |

The men who keep these records were chosen with special reference to their ability to do so, and in working through their books I have been exceedingly struck by their clearness, neatness and reliability, as well as by their readiness to make note of any unusual features and to give any information which they might think valuable. I should like to acknowledge the interest they have shown in this way, and the help it has been to me in dealing with their work.

The records may be taken as a very representative sample of the work of the Grimsby fisheries, as far as the North Sea is concerned. The skippers employ the ordinary commercial steam trawler and extend their fishing operations over the whole of the central part of the North Sea.

* LEE.—Report on the Lowestoft Sailing Trawler Records, 1903–1906. *Internat. Invest. Mar. Biol. Ass. Report II., Part II., Cd. 4641.* Appendix, p. 111.

In examining the results of my statistical analysis of these records I have been greatly helped by some valuable hints from my colleague, Mr. G. T. Atkinson, whose practical knowledge of the fisheries served to elucidate and explain many points suggested by the figures. I take this opportunity of expressing my indebtedness to him. My thanks are also due to Mr. J. Potter for his careful preparation of my figures and charts accompanying this report.

THE REGION INVESTIGATED.

These Grimsby fishermen work mainly in the belt of the North Sea lying between Lat. $52^{\circ} 30'$ and Lat. 57° . No hauls are recorded from further north than Lat. $57^{\circ} 25'$. They generally avoid the deepest parts of this region (over 40 fathoms) and confine their fishing principally to the central and eastern grounds in depths of from 10 to 30 fathoms.

Nearly all the skippers give their positions according to the latitude and longitude of the place where the trawl is shot, and there is no reason to think that there is any error in their determinations, for they were generally found to be consistent with the depths and the nature of the bottom, the name of the ground, and also with their subsequent positions. The only cases where there was any doubt were those in which the position was given by the bearings and distance from Spurn. In long distances there would be some doubt as to the exact position, and as sometimes the name of the ground was not given, the depth of the water had to be taken as the best guide to the position. Even in some of the nearer grounds there would be some uncertainty as to the position, as there is reason to believe that the bearings given were not quite correct. All the hauls for each year have been plotted out on charts in their appropriate positions and these have been very useful, by showing the difference of distribution in the different years, in the interpretation of the statistics and the explanation of the somewhat anomalous features of some of the curves.

This whole region contains fishing grounds of exceedingly diverse characters—diverse as regards depths, bottom, and nearness to the coast—and the catches of fish on these different grounds are just as diverse. For instance, enormous catches of small plaice and soles are made on the eastern grounds, while at the same time the yield of these fish on the western or central areas is many times smaller.

DIVISION INTO AREAS.*

The whole region is divided into a number of "areas," the sub-division being based primarily on the areas adopted by Professor Garstang in his Report as Convener of Committee B†. But these areas proved to be too many and too small for our purpose, and so several areas were combined (*e.g.* the Dogger Bank is made into one area); in other areas the bounding lines were slightly shifted, so as to coincide with the 20-fathom line instead of the 40-metre line. The final arrangement is given in the appended chart. The areas themselves are as follows, and they fall naturally into certain groups.

NORTH-EASTERN AREAS.

Area A. This ground lies off the western coast of northern Denmark. It contains the Jutland Bank, and is bounded on the south by the Ringkjøbing Ground. It ranges in depth from 13–22 fathoms. This ground was not much fished by these men. The August hauls of 1904 were made in the extreme north of the area, and the July hauls of 1905 on the west, outside the 20-fathom line.

Area B contains the West Bank and part of the Little Fisher Bank. It lies offshore and north-west from A. In depth it ranges from 20 to 40 fathoms.

Area C lies adjacent to B, but still further offshore. It has a bottom of fine sand and an average depth of 35 fathoms.

Area E.—This is a small area lying next to and west of area A. It contains two well-known fishing banks, the Tarbot Bank and the Monkey Bank. Most of the fishing here is confined to these banks (depths less than 20 fathoms), and but a small proportion takes place in the deeper water (about 24 fathoms) between them.

* NOTE.—The depths given in these areas are generally taken from the fishermen's soundings, but the limiting values are from charts.

† GARSTANG.—The Distribution of the Plaice in the North Sea, Skagerak and Kattegat. Chart II. *Rapports et Procès-Verbaux*. Vol. XI., 1907–1908.

Area G is situated west of F and south of B and C. On its eastern side it is just under 30 fathoms, but over the greater part of the area it is between 30 and 40 fathoms. The fishing in this area comes more in the eastern than in the western half.

None of these areas were fished to any great extent. The statistics we have are the result of a few occasional and intermittent voyages. In character and depths the offshore areas are much alike and show in the resulting statistics much similarity in their catches.

The more offshore areas of this group coincide with Garstang's Fisher Bank group of areas.

EASTERN AREAS.

Area H.—This lies directly south of area A and includes the grounds from the western coast of Denmark to the 20-fathom line. It contains Ringkjøbing ground and the Horn Reef North ground, but we find that the majority of the hauls are clustered together in the central part of this area (the Horn Reef North ground) within a radius of ten miles from Lat. $55^{\circ} 55'$ N., Long. $7^{\circ} 24'$ E. The depths in this part are from 12-16 fathoms and the bottom is of sand and shells, although there are patches of rough gravel in other parts of the area. This ground was much fished in 1905 throughout the year, but in the other years most of the fishing took place from October to December.

Area M.—This area, situated directly south of area H, contains the Horn Reef South grounds, Sylt Rough, Sylt Outer and Inner and Amrum grounds. Most of the fishing, but not quite all, took place outside the 10-fathom line, and between it and the 20-fathom line in depths of 10-13 fathoms. The majority of the summer hauls were made slightly more inshore, in less depths—from 8 to 11 fathoms. The rough ground in this area is mostly in the western half, and we find that with a few exceptions the hauls were taken over a bottom of fine sand. The April to June hauls are very numerous and these months constitute what the fishermen call "the season."

Area Q.—This area includes the strip of sea between the 10 and 20-fathom lines, running parallel to the German coast. It extends in a southwesterly direction from Heligoland to Vlieland, and embraces Heligoland Rough, Heligoland ground, Norderney, Borkum, Ameland and Terschelling grounds. There is an area of deeper water coming into this area about the north-eastern part as far as Heligoland, but for the most part the depths are under 20 fathoms. We find that in the Terschelling grounds the men fish a good deal on the edge of the 20-fathom line which does not here form a natural barrier to the fishing ground, so that the outer part of Q and inner part of the adjacent area N, are very much alike. The bottoms in this area are composed of sand and mud, and in some places stones and gravel are abundant, as in Borkum Rough.

Area W.—A few hauls were made on the Texel and Vlieland grounds, and to include them, area W, a continuation of area Q was formed. The majority of the soundings are 15 and 16 fathoms.

These "Eastern grounds" all lie about the same distance from the continental coast, and in regard to depth and bottom are very similar. Three of them are regularly fished by the Grimsby Skippers, and the resulting statistics are on the whole fairly complete and satisfactory. Areas H and M together correspond to Garstang's Eastern offshore and inshore grounds, and the rest to the Terschelling and Borkum grounds.

CENTRAL AREAS.

Area J.—This area is roughly triangular in shape, the apex being at the Tail end of the Dogger and the base the 20-fathom line bordering on the outer part of areas H and M, *i.e.*, the Horn Reef and Sylt grounds. It contains no well-defined fishing grounds—the greater part of it being known by the fishermen as "The Mud" or "Outside the Mud." It also borders on the White Bank, Oyster Ground and Lower Scruff whose outer limits are somewhat variable. The most inshore part of the area has a bottom of fine sand; further out it is of mud. The depth on an average is about 26 fathoms. This is comparable with Garstang's Eastern Deep ground.

Area N.—This is an offshore area running parallel to area Q and divided from it by the 20-fathom line (except near Heligoland, where the deep water penetrates into area Q). It contains the White Bank in the north-eastern part, the Oyster ground, Terschelling Mud and parts of Clay Deep and Upper Scruff. The depth varies between 20 and 27 fathoms and is generally about 24 and 25 fathoms. In most parts the bottom is a mixture of sand and mud. The area has been well fished over all parts and throughout the year.

Area I.—This ground is enclosed between area N and area O (the Dogger Bank). Except for the south-east side of the Dogger where hauls were made in 20-21 fathoms the

prevailing depths are 24-27 fathoms. The grounds included are "Above the Dogger," Clay Deep and The Scruff. The hauls made are scattered over the whole area. Very few were taken in the spring months.

Area O.—This includes the whole of the Dogger Bank lying within the 20-fathom contour line.

NORTHERN AREAS, "BELOW THE DOGGER."

Area D.—This comprises the deep water (greater than 40 fathoms) west of Long. 3° E. and extending from the 40-fathom line north of the Dogger to about Lat. 57° 20' N.

Most of the hauls were made in depths between 40 and 50 fathoms in the southern and eastern parts. The bottom is of fine sand.

Area K.—This lies between G and O. All the depths in it are greater than 20 fathoms and less than 40 fathoms.

Area L.—This lies between D (Deep water) and the Dogger, and is continued southwards and ranges in depth from 20 to 40 fathoms. For the most part the bottom is of sand but there are some rough patches of ground in it.

In all these areas a great deal of the fishing took place in the first three months of the year. Areas D and L are the south-eastern parts of the "Middle Deep."

SOUTHERN GROUNDS.

Area S.—This is the most southern ground of our region and it includes the ground situated about half way between the Norfolk and Lincolnshire and the northern Dutch coasts. It includes the "northern areas" of the Lowestoft Sailing Trawler Statistics, *i.e.* The Leman ground, Brown Bank, and the Brown Ridges, as well as some grounds lying to the north of these, such as Botney ground and New Zealand ground. The hauls are made mostly in depths of 15-18 fathoms and in sandy ground.

This area is much frequented in the summer time.

Area T.—This is a small area lying north of area S and south-east of the Silver Pits. It includes Markam's Hole and the shallower ground just around it, and the deeper water over 20 fathoms, wherein are the Western Mud Hole (greater than 20 fathoms) and the Botney Gut (greater than 30 fathoms).

Area V.—This small area includes all the Silver Pits. It is bounded on the north by the Dogger Bank and on the south by the Well Bank Flat and area T, from all of which it is separated by the 20-fathom line. In the Pits themselves the depths reach to over 40 fathoms, but a good many of the hauls were made on the borders of this area, *i.e.*, just over the 20-fathom line separating it from Well Bank.

WESTERN AREAS.

Area E.—This is an inshore ground off the Norfolk and Lincolnshire coast. A few hauls were made here during the course of 1906, most of them at a distance of 20 or 30 miles from Cromer and the Norfolk coast, the depths in which they were made being about 9-11 fathoms.

Area R.—This area includes the Well Bank Flat and grounds, the shallower parts of the "Off Grounds," the Dowsing grounds and the Haddock Bank, all of which are shallow water, generally from 11-14 fathoms. But there are also in it small deep holes, where the soundings are often over 30 and sometimes more than 40 fathoms.

These are known as the Sole Pit, and the Coal Pit or N.E. Hole, and are especially visited by the fishermen for the large catches of soles that are to be made there. In 1906 this area was well fished by one or two fishermen who came constantly here throughout the year. In the other years this was very little worked.

Area X.—Is formed by the Deep Water (between 20 and 30 fathoms) west of the Dogger and Silver Pits. Its southern boundary is the 20-fathom line which divides it from area R. The Dogger Bight, Flamborough Off and Eastermost grounds are in this area.

There was hardly any fishing in the western part of this area. It is rather a rough ground, and is worked by a special class of Grimsby steam trawlers.

Area P.—This is an area of very deep water situated north of area X and abreast of the Yorkshire coast. There are very few hauls here, nearly all of them are in the south-eastern region of it where the bottom is of fine sand and the depths about 35-38 fathoms.

These grounds correspond, roughly, to the Western Deep and Flamborough Off Grounds of Garstang's chart.

TABLE II., showing the total number of hours fishing in each area in each year.

| — | 1904. | 1905. | 1906. | 1907. | 1904-07. |
|--------------|----------------------|----------------------|---------------------|---------------------|----------------------|
| A | 22 | 44 $\frac{1}{2}$ | — | — | 66 $\frac{1}{2}$ |
| B | 287 $\frac{3}{4}$ | 226 | — | 152 $\frac{1}{4}$ | 666 |
| C | — | 16 $\frac{1}{2}$ | — | — | 16 $\frac{1}{2}$ |
| F | 334 | 318 $\frac{1}{2}$ | 37 $\frac{1}{2}$ | — | 690 |
| G | 198 $\frac{3}{4}$ | 140 | 98 $\frac{1}{2}$ | 96 $\frac{1}{2}$ | 533 $\frac{3}{4}$ |
| H | 733 $\frac{1}{4}$ | 1,624 | 16 | 70 $\frac{1}{2}$ | 2,443 $\frac{3}{4}$ |
| M | 860 | 2,318 $\frac{1}{4}$ | 1,833 $\frac{3}{4}$ | 1,177 | 6,252 |
| Q | 336 | 996 $\frac{1}{4}$ | 29 $\frac{1}{4}$ | 729 $\frac{1}{2}$ | 2,356 $\frac{1}{4}$ |
| W | 77 | 6 | 12 | 16 | 111 |
| J | 767 | 451 $\frac{3}{4}$ | 769 | 151 $\frac{3}{4}$ | 2,139 $\frac{1}{2}$ |
| N | 944 $\frac{3}{4}$ | 1,610 $\frac{3}{4}$ | 1,907 $\frac{1}{2}$ | 2,084 | 6,547 |
| I | 1,431 $\frac{1}{4}$ | 1,379 $\frac{1}{2}$ | 261 | 258 $\frac{1}{2}$ | 3,330 $\frac{1}{4}$ |
| O | 1,461 | 2,829 $\frac{3}{4}$ | 64 $\frac{1}{2}$ | 429 | 4,784 $\frac{1}{4}$ |
| D | 37 $\frac{1}{2}$ | 1,563 | 497 $\frac{1}{4}$ | 28 | 2,125 $\frac{3}{4}$ |
| K | 209 $\frac{1}{2}$ | 559 $\frac{1}{4}$ | 119 $\frac{1}{2}$ | 540 | 1,428 $\frac{1}{4}$ |
| L | 379 | 1,263 $\frac{1}{4}$ | 1,329 $\frac{1}{4}$ | 73 | 3,044 $\frac{1}{2}$ |
| S | 1,218 | 1,437 | 647 $\frac{1}{4}$ | 1,095 $\frac{3}{4}$ | 4,398 |
| T | 85 $\frac{1}{2}$ | 1,143 | 1,017 $\frac{1}{2}$ | 625 | 2,871 |
| V | 277 | 189 $\frac{1}{4}$ | 368 $\frac{1}{4}$ | 238 $\frac{1}{2}$ | 1,073 $\frac{1}{2}$ |
| E | — | — | 45 $\frac{1}{4}$ | — | 45 $\frac{1}{4}$ |
| R | 13 $\frac{1}{2}$ | 487 $\frac{1}{2}$ | 1,693 $\frac{3}{4}$ | 66 | 2,260 $\frac{3}{4}$ |
| X | 250 $\frac{1}{2}$ | 269 $\frac{3}{4}$ | 659 $\frac{1}{4}$ | 391 | 1,570 $\frac{1}{2}$ |
| P | 221 $\frac{1}{2}$ | 16 | 33 | — | 270 $\frac{1}{2}$ |
| Total | 10,144 $\frac{3}{4}$ | 18,953 $\frac{1}{4}$ | 11,704 | 8,222 $\frac{1}{4}$ | 49,024 $\frac{3}{4}$ |

This table shows the distribution of the fishing operations. The grounds most favoured by these men are N and M, including the most important of the "small fish" grounds off the Danish and Dutch coasts. Next in importance are the Dogger Bank, which was very extensively fished in 1905, and the southern ground S, which includes the Leman and Botney Ground, &c. I and L come next, with over 3,000 hours fishing, and T, H, Q, R, J, D have all between two and three thousand hours fishing. The grounds least frequented are the north-eastern areas and E and P. In 1906 some of the men who worked regularly on the Dogger Bank ceased sending in records.

TREATMENT OF THE RECORDS.

Tabulation.—The Grimsby records have been treated in the same way as the Lowestoft statistics*, *i.e.*, the hauls have been grouped according to areas and months and a series of monthly totals and averages calculated for each area. The results for seven of the most important species, *viz.*, plaice, soles, turbot, brill, cod, haddock and whiting, are discussed in the present report.

Conversion of measurements into weight.—For four of these species, plaice, cod, haddock and whiting, which are measured by the skippers in baskets, it has been necessary to calculate a scale whereby the amount in a basket may be converted into weight. The methods adopted to determine this are given in detail for each species later in the report. It might be objected that I have used a single value for each species, when it is clearly shown by the tables that there is distinctly a bias on the part of some of the skippers, and that it might have been better to convert their amounts by using different ratios for different men, or different ratios for different years.

My answer to this objection is, that very little accuracy would be gained to balance the additional labour this would entail, for in the monthly catches the actual ratio for any one man is likely to vary about as much from *his* yearly ratio as does the actual ratio chosen, and furthermore, as the men's catches are combined, the use of the single average ratio is a close enough approximation to the true weights, for material measured in as rough a way as this is. I have tested the difference caused by using varying ratios in one or two areas and find that it is quite unimportant. The curves thus derived show the *same* trend and facts as the ones obtained in the ordinary way, *i.e.*, by using a constant ratio, and differ only slightly in the heights of a few ordinates, and I conclude that any error introduced by this method is but a small proportion of the errors due to roughness of material or any other causes, and has no significant effect on the conclusions drawn from the curves.

Investigation of the yearly fluctuations.—The method employed in my report on the Lowestoft Trawler Records to determine the variations in the yearly abundance, was in the case of the Grimsby Records not admissible. That method was the simple one of combining all the catches from the whole region for the year, and determining the average catch for each year by dividing by the number of hours fishing.

The range of variation over the whole region was far too great, and the catches from the different areas so diverse, while at the same time the distribution of the fishing differed exceedingly year by year, that a combined average over the whole sea would be greatly affected by the distribution, and so would be valueless for comparing one year with another. Nor was it feasible to work out the yearly averages for each area separately, for there were too many gaps in the statistics and it seldom happened that there was a complete series of monthly averages for any area.

It therefore became necessary to use several methods in studying this question, so that each, though inadequate and uncertain in itself, becomes more decisive when its results are corroborated by those of other methods. These have been chiefly:—a comparison of the monthly averages in the same area, to determine whether they more generally show an increase or decrease throughout the period when comparing the averages with the corresponding months in the later years; secondly, a comparison of the mean values of the monthly averages in each year, excluding those which are untrustworthy, and including only the same months in each year of comparison; and thirdly, where groups of areas showing some similarity in their total yield could be formed, the method of lumping together all the catches from these areas was employed.

Investigation of the quantitative Distribution in Time and Space.

The only way in which the fish population from a certain area can be compared with that from another, or with itself at different times, by such statistics as these, is to assume that the average catch per uniform time, represents proportionally the population of that area. This of course involves certain assumptions, the chief being that there is a considerable homogeneity of conditions over the area chosen, and that the fishing is well distributed in time and space. We find, generally speaking, that the method is justified by experience, and that it is only where the fishing has been very limited in amount or space that the deductions drawn from such figures reach such a measure of unreliability as to become worthless. By studying the figures giving the amount of fishing, which the average represents, the reader will be able to judge how approximate the averages may be.

There are several ways of representing the quantitative distribution according to time and space. The simplest is to plot out the monthly averages as a continuous series of points varying with time, but we find that the material is too incomplete, rough and variable, for this to be done without a certain amount of interpolation and smoothing. The smoothed curves given in the diagrams are obtained by averaging the average of each month with the one before and after it, the averages of the first and last month in the series being left as they are. These diagrams are rendered more complete by gaps in the curves being joined by a thin line following the general trend of the thick continuous line. This method, although not representing the actual averages, gives a general picture of the seasonal trend, which when combined with a study of the actual figures enables us to determine more or less approximately the real nature of the fluctuations. The index figures given in the tables represent the number of hours fishing in each month, and by these we can judge of the reliability of the average.

When further statistics are to hand we can arrive at a closer approximation of the actual abundance and investigate in more detail the periods of maximum and minimum abundance. Another method, which I also use to smooth the figures and obtain a general measure of the comparative abundance, is to calculate "general averages" for each month, that is, the combined catches of all the years in any particular month, divided by the total number of hours fishing. This method too has its drawbacks, owing to the varying amount of fishing in the different years, but I regard it as the most reliable average obtainable from these figures, to represent the catch in the particular months of the year. It is for this reason that I have used these "general" monthly averages in calculating the *mean values* for the different areas. In this case, it is assumed that the general monthly averages represent, as closely as such figures can, the actual population of the area, and in taking the arithmetic mean of the monthly averages we are not biased in our estimate of the abundance by taking into account the number of hours fishing in the different months, for this might be especially large or small in the month of greatest abundance.

Size distinctions.—The size distinctions have been retained in all cases. It is true that the groups of large, medium and small fish have a very wide range of length and overlap each other to some extent, and that they may be somewhat differently classed by the several men. But we are taking *average* values in all cases so this error is minimised. The proportions in each area are obtained from the mean monthly value, *i.e.*, the average of the monthly general averages. Here we assume that the general average is the nearest we can get to the true state of things, and the method is equivalent to taking samples, as nearly as possible of equal value, during each month of the year, and finding by totalling up for the whole year, what are the proportions of large and small in the long run. This method gives a better picture of the conditions than would be obtained by calculating the percentage proportions from the total catch, or by taking the averages of the percentages in each month.

The results thus obtained are found to be in close agreement with the statistics of the Board of Agriculture and Fisheries, where they are comparable with these. Wherever a definite bias has been found in the classification of the size-groups, attention has been called to it in the discussion of the statistics.

In speaking of the seasons, I have used the terms "winter" for the months December to February, "spring" for the months March to May; "summer," June to August; and "Autumn," September to November.

The average duration of a haul is between three and four hours. All averages are calculated on ten hours fishing, as being the most convenient unit to take.

II.—ACCOUNT OF SEPARATE SPECIES.

A.—PLAICE.

Introduction.—Some of the most important fishing grounds for plaice are to be found in this region. This species is to be taken in all areas but in exceedingly varying amounts, some grounds yielding several hundredweights of fish in a haul and others only three or four fish.

The catch is grouped by the fishermen into three classes large, medium and small, and it is according to their classification that they are discussed in the report. The market group "large" varies about a modal value of 17–18 ins.; medium fish vary about a mean of 13 inches, and small about a mean of 10 inches.

The Conversion of the Different Measures into Weight.

The first consideration that presented itself in the reduction of the plaice statistics was the conversion of the quantities measured by different methods to the same unit. In the record forms, either the number of fish of each size-group or the number of baskets was given, generally the latter. In grounds where few fish were caught and then only large ones, their numbers were mostly given.

Their weight was estimated by the following average scale:—

One large plaice weighs .02 cwt.

One medium plaice weighs .007 cwt.

One small plaice weighs .003 cwt.

With regard to the conversion of the baskets into weight there was more uncertainty. It was found that the Grimsby "baskets" were larger than those in use at Lowestoft, which had been ascertained to contain an average amount of half a hundredweight of fish.

Enquiries at Grimsby elicited the information that one "basket" of plaice, irrespective of size, weighs about six stone, with a considerable range of weight due to packing. A "box" averages eight stone* and a "basket" may therefore be estimated at .75 cwt. or .75 of a box.

This relation was confirmed by the skippers own records. By summing up the total quantities of the individual hauls, for each skipper throughout each year, and also the sum of the numbers of boxes of plaice given in the summaries of the voyages, and comparing these two measures of the same quantity, we have a means of obtaining a ratio between a basket and a box.

* The recently published report of the Board of Agriculture and Fisheries on the Plaice fisheries of the North Sea, Cd. 4,738 (p. 53), shows that the weight of a "box" is slightly greater than eight stone, averaging 54.8 kilos at Grimsby. This is equivalent to 1.02 cwts.

These ratios have been calculated in each case and are given in the following table :—

TABLE III.—Showing for each skipper in each year, the ratio of a BASKET to a BOX, as estimated from the total number of baskets in the hauls, compared with the total number of boxes in the summaries.

| | Skipper. | 1904. | 1905. | 1906. | 1907. | Average. |
|---------|----------|-------|-------|-------|-------|----------|
| i | ... | .77 | .77 | (.83) | — | .77 |
| ii | ... | — | .80 | — | — | .80 |
| iii | ... | .67 | .76 | .75 | .81 | .75 |
| iv | ... | — | .64 | .68 | — | .66 |
| v | ... | .76 | .74 | .78 | .73 | .75 |
| vi | ... | (.64) | .73 | .73 | .67 | .71 |
| vii | ... | .72 | .68 | — | — | .70 |
| viii | ... | .65 | (.51) | — | — | .65 |
| Average | ... | .71 | .73 | .75 | .74 | .73 |

The ratios in brackets are calculated on the summaries from but a few voyages. These are omitted in calculating the averages.

The last column in this table gives a good measure of each man's bias, and the last line shows whether the tendency in each year has been to estimate above or below the average. Omitting the doubtful averages in brackets, we find that these figures have a very small deviation from the average .73.

This figure (.73 cwt.) has been chosen as the average weight of a basket for this set of statistics. The choice is further confirmed by measurements made on board the s.s. "Huxley," when the contents of a Grimsby basket were found to weigh 82 lbs. (or .73 cwt.).

Total Quantities of Plaice and the Proportions formed by the Three Trade Categories.

Using the above determined scale for conversion into weight and putting together the catches from all areas, we find that the total catches by these men during the years 1904 to 1907 are as follows :—

TABLE IV.—Showing the total weight of PLAICE in cwts., and the percentage formed by each of the three trade groups.

| Year. | Total weight in cwts. | | | | Percentage of Total. | | |
|-------|-----------------------|----------|-----------|------------|----------------------|---------|--------|
| | Large. | Medium. | Small. | All sizes. | Large. | Medium. | Small. |
| 1904 | 354.73 | 1,046.99 | 3,351.20 | 4,752.92 | 7.5 | 22 | 70.5 |
| 1905 | 739.09 | 3,127.76 | 6,233.66 | 10,098.51 | 7 | 31 | 62 |
| 1906 | 534.70 | 1,236.58 | 1,290.07 | 3,061.35 | 17.5 | 40.5 | 42 |
| 1907 | 298.77 | 697.98 | 1,383.49 | 2,380.24 | 13 | 29 | 58 |
| Total | 1,925.29 | 6,109.31 | 12,258.42 | 20,293.02 | 9.5 | 30 | 60.5 |

The average catch per ten hours fishing for the whole time is 4.14 cwts., of which only 9.5 per cent. by weight are large fish. Over nine-tenths of the total are medium and small fish, and as but very few of the medium fish can be mature, this table shows the enormous destruction of immature fish. But if we consider the proportions by *numbers*, which we roughly estimate as 2 per cent. large, 17 per cent. medium, and 81 per cent. small, this feature becomes still more striking.

The proportions of "small" in each year are really not comparable with one another. It is necessary to bear in mind that in 1904 there was no fishing before May, and it is in the first four months of the year that the small fish are least abundant. Thus there is an unduly high proportion of small in that year. Moreover in 1906 and 1907 a smaller proportion of fishing took place on the eastern small plaice grounds than in the other years. Further detailed analysis of these figures for the "Eastern grounds," shows that although the proportion of "small" was greatest in 1904, yet in the next three years it did not vary significantly from 80 per cent. In at least one area, N, the proportion is greatest in 1907 and least in 1905.

B 4

TABLE V. (continued)—SHOWING for each area the Monthly Average Weight of PLAICE in cwts. per 10 hours' fishing; large (L.), medium (M.), and small (S.) being distinguished. The monthly total number of hours' fishing in each area, to the nearest hour, is given as an index number.

| Group. | Area. | Year. | January. | | | | February. | | | | March. | | | | April. | | | | May. | | | | June. | | | | July. | | | | August. | | | | September. | | | | October. | | | | November. | | | | December. | | | | Area. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|-------|--------|----------|------|------|--------------------|-----------|------|------|-------------------|--------|------|------|--------------------|--------|------|------|--------------------|------|------|------|---------------------|-------|------|---------------------|---------------------|-------|------|---------------------|---------------------|---------|------|---------------------|----------------------|------------|------|---------------------|----------------------|----------|------|---------------------|---------------------|-----------|------|---------------------|---------------------|-----------|------|---------------------|---------------------|-------|------|---------------------|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| | | | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SOUTHERN AREAS. | S | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.43 | 3.12 | 1.46 | 5.01 ²¹⁶ | 0.21 | 2.77 | 3.30 | 6.28 ³⁴⁵ | 0.02 | 2.26 | 6.74 | 9.63 ⁴⁵⁴ | 0.00 | 2.56 | 2.15 | 4.71 ¹⁰⁰ | 0.51 | 1.83 | 1.67 | 4.00 ¹⁰³ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | S | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.20 | 4.07 | 3.04 | 7.30 ⁶¹⁷ | 0.57 | 4.70 | 2.61 | 7.88 ⁷⁴⁹ | 0.81 | 3.08 | 3.65 | 7.54 ⁴⁵ | 0.45 | 0.93 | 0.45 | 1.83 ⁴ | 0.65 | 0.65 | 0.86 | 2.15 ⁵ | 0.86 | 0.29 | 0.00 | 1.15 ¹³ | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 1.65 | 2.33 | 3.98 ⁵ | 1.11 | 1.61 | 0.82 | 3.54 ⁹² | 0.51 | 0.81 | 0.89 | 2.21 ²² | 0.16 | 1.47 | 0.49 | 2.12 ⁷ | 0.33 | 1.56 | 1.44 | 3.33 ⁵⁵ | 0.20 | 1.76 | 1.51 | 3.46 ⁸³ | 0.06 | 1.51 | 1.55 | 3.12 ¹⁰⁶ | 0.04 | 1.24 | 2.56 | 3.84 ²²⁰ | 0.03 | 1.55 | 2.36 | 3.94 ⁵⁶ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.17 | 1.68 | 1.29 | 3.14 ⁴⁶¹ | 0.80 | 1.59 | 2.01 | 4.41 ³⁴⁸ | 0.34 | 1.41 | 1.74 | 3.49 ²⁷¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.78 | 1.14 | 0.23 | 2.15 ¹⁶ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 1.65 | 2.33 | 3.98 ⁵ | 1.11 | 1.61 | 0.82 | 3.54 ⁹² | 0.51 | 0.81 | 0.89 | 2.21 ²² | 0.17 | 1.68 | 1.28 | 3.12 ⁴⁶³ | 0.63 | 2.12 | 1.77 | 4.52 ⁶¹⁹ | 0.23 | 3.04 | 2.74 | 6.01 ¹³¹⁶ | 0.34 | 3.59 | 3.96 | 7.90 ¹³⁰⁹ | 0.12 | 1.83 | 2.59 | 4.54 ²⁶⁵ | 0.35 | 1.71 | 1.88 | 3.93 ¹⁵³ | 0.73 | 0.97 | 0.45 | 2.15 ²⁴ | 0.86 | 0.29 | 0.00 | 1.15 ¹³ | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | T | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.98 | 0.00 | 0.98 ¹³ | 0.46 | 2.28 | 1.14 | 3.88 ²⁴ | 0.00 | 1.64 | 0.91 | 2.55 ¹⁰ | 0.00 | 1.38 | 1.38 | 2.75 ⁵ | ... | ... | ... | ... | ... | ... | ... | ... | 1.14 | 0.57 | 0.08 | 1.79 ²² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | T | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.80 | 1.15 | 0.06 | 2.01 ⁵⁵ | ... | ... | ... | ... | 0.45 | 2.75 | 1.32 | 4.52 ⁴⁵ | 0.05 | 0.70 | 1.09 | 1.84 ⁷⁹ | 1.41 | 1.39 | 0.93 | 3.73 ¹⁰⁰ | 1.07 | 1.24 | 1.28 | 3.59 ¹⁷⁷ | 1.05 | 0.67 | 1.66 | 3.38 ²⁴³ | 0.83 | 0.23 | 0.17 | 1.23 ³⁴⁰ | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | 0.84 | 1.27 | 0.23 | 2.33 ⁹⁶ | 0.71 | 0.63 | 0.28 | 1.63 ³² | 1.31 | 0.84 | 0.11 | 2.27 ¹¹² | 0.10 | 1.45 | 0.46 | 2.02 ⁵³ | 0.45 | 1.67 | 0.68 | 2.81 ⁹⁷ | 0.41 | 2.04 | 0.53 | 2.98 ¹⁸¹ | 0.19 | 1.33 | 0.87 | 2.39 ⁹⁰ | 0.78 | 1.03 | 0.95 | 2.76 ⁸³ | 0.59 | 0.85 | 0.55 | 1.99 ²²⁵ | 0.27 | 0.60 | 0.00 | 0.86 ²⁷ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.78 | 0.62 | 0.21 | 1.61 ²⁹ | 0.09 | 0.66 | 0.48 | 1.22 ²⁵ | 0.27 | 0.83 | 2.14 | 3.25 ¹⁴³ | 1.16 | 1.68 | 0.35 | 3.20 ⁶¹ | ... | ... | ... | ... | 0.22 | 1.55 | 0.28 | 2.04 ⁷⁰ | 0.52 | 1.22 | 0.39 | 2.14 ⁵⁴ | 1.35 | 1.02 | 0.24 | 2.61 ²¹² | 0.22 | 1.53 | 0.38 | 2.13 ¹² | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | ... | ... | 0.84 | 1.27 | 0.23 | 2.33 ⁹⁶ | 0.71 | 0.63 | 0.28 | 1.63 ³² | 1.18 | 0.79 | 0.14 | 2.10 ¹⁵¹ | 0.35 | 1.16 | 0.27 | 1.78 ¹⁴⁶ | 0.36 | 1.27 | 1.52 | 3.14 ²⁶⁴ | 0.61 | 2.03 | 0.61 | 3.25 ³³⁰ | 0.12 | 1.05 | 0.99 | 2.16 ¹⁷⁷ | 1.00 | 1.26 | 0.89 | 3.15 ²¹¹ | 0.75 | 1.06 | 0.79 | 2.66 ⁴⁵⁶ | 1.12 | 0.78 | 1.03 | 2.93 ⁵⁰⁴ | 0.81 | 0.28 | 0.17 | 1.26 ³³² | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | V | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.08 | 1.62 | 0.00 | 1.71 ¹³¹ | 0.19 | 1.77 | 0.00 | 1.96 ⁸⁶ | 1.03 | 1.76 | 0.00 | 2.80 ⁴⁵ | ... | ... | ... | ... | ... | ... | ... | ... | 1.49 | 0.00 | 0.00 | 1.49 ¹³ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | V | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1906 | 0.05 | 0.22 | 0.72 | 1.00 ³⁸ | 0.40 | 0.00 | 0.00 | 0.40 ⁴ | 0.41 | 0.24 | 0.01 | 0.66 ⁵⁰ | 0.64 | 0.29 | 0.00 | 0.94 ²⁵ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.44 | 0.82 | 0.00 | 3.27 ⁴ | 1.14 | 0.46 | 0.00 | 1.60 ⁶⁵ | 0.99 | 0.45 | 0.00 | 1.44 ⁵⁵ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ...</ |

Discussion of the Seasonal Fluctuations in each Area.

Table V. gives the average monthly catch of plaice in each area, together with the combined monthly averages.

North-Eastern Areas.

Area A.—Only two months' catches are represented, giving averages 0.45 cwt., and 0.50 cwt. of large and medium fish, in July and August respectively.

Area B.—The stock of plaice seems to be fairly good, the averages reaching a maximum of 1.88 cwts. and comparing favourably with those of a more southern area J. Large fish form the chief stock, a very small proportion of the catch being medium. Only six months averages are present, so we cannot compare the winter and summer catches, but there is a great similarity in the shape of the curve as far as it goes, to that of F, where there are indications of at least an autumn maximum. It was noticeable in October in tabulation that the fish were more plentiful on the "West Bank" than in the deeper water.

Area C.—The three or four hauls that were made in this area show a very small yield of plaice. The October average is higher than the March one, while in December there were no fish caught. Large fish only were taken.

Area F.—There is a small catch in March. From June the averages increase till September or October and then fall away to December. Small fish are almost entirely absent. Both large and medium plaice are present, the medium predominating and forming 72 per cent. of the catch.

Area G.—The winter averages are low, compared with those of the autumn, when there appears to be a distinct maximum, culminating about October. Large and medium fish are present, being about 64 per cent. and 34 per cent. of the total catch respectively. Small fish are seldom found.

Although there has been very little fishing in these areas, and the curves are very incomplete and disconnected, yet we have indications that these north-eastern areas are very much alike in their total yield of plaice. B, F, and G have similar curves of very much the same direction, shape and height, reaching a maximum of just over 1.5 cwts. They are combined into the smoothed curve of Fig. 1.

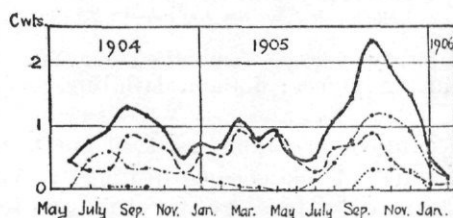


FIG. 1.—PLAICE. North-Eastern areas combined. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

The winter averages and the early summer averages, when present, are considerably lower than the autumn ones. September and October are months of maximum. In B and C which are the most offshore areas, large fish are entirely predominant. In G the population is more mixed, but large still preponderate. In F which is nearer inshore and where there are banks, medium fish predominate.

Eastern Areas.

Area H.—This ground is characterised by enormous catches of plaice at certain seasons of the year. These occur in the early autumn, and by contrast, the spring and early summer catches are so low as to be almost inappreciable. The maximum catches on these grounds far exceed those of any other area, the highest average reached in any month being 49.88 cwts. per ten hours fishing (September 1905). The October and November averages too, are extraordinarily high, the lowest catches are made in May, when only 0.25 cwts. are taken. The February and June averages are missing. The curve (Fig. 2) illustrates the comparatively low catches made in the beginning of the year, the minimum in spring, and the sudden and enormous influx of fish in the autumn with a fall almost as sudden to December and January.

The curve (Fig. 2) shows also the constitution of the fish population in this area. Large plaice are generally absent altogether or are caught in very rare instances. In one case (November, 1904) a skipper records a fish 2 ft. 3 ins. long, 1 ft. 2½ ins. wide, but this is very exceptional, though again in November, 1905 one *very* large fish is noticed.*

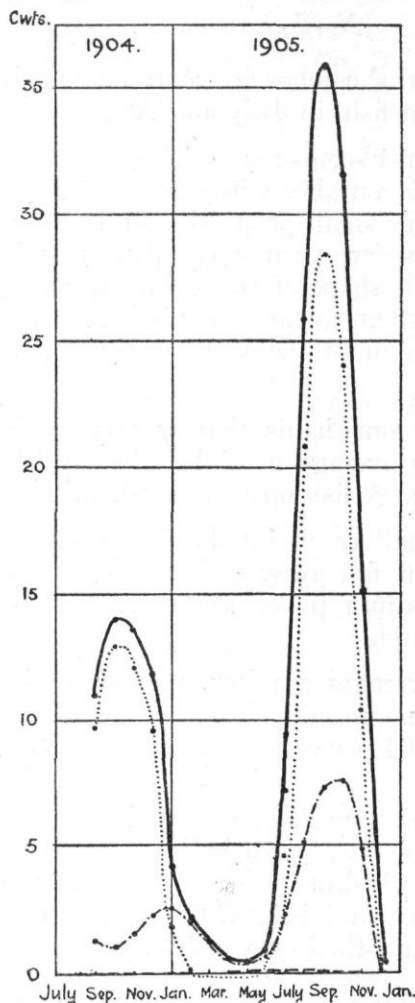


FIG. 2.—PLAICE. Area H. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

From January to May the catches are composed of medium and small plaice, medium preponderating. With the influx of plaice beginning in August, the character of the population appears to be changed. Here by far the greater portion are *small* fish; medium fish become fairly numerous, but the really large catches are formed by the enormous quantities of small fish. We find that these catches fluctuate very much and that for a few days the fishermen will take about 20 baskets or more in each haul, and then suddenly the quantity caught drops to one basket or less. It is remarkable that these small fish disappear entirely in the winter months and do not seem to be caught anywhere.

In November medium fish appear in the catch of one man only after the middle of the month (November, 1904). The small fish at this time become exceedingly numerous for several days. In 1905 these large shoals appeared earlier, as September and October both had very large catches of small fish. By December we find that the medium fish are more numerous relatively to the small than in the previous months, showing that though they are disappearing they do not do so as rapidly as the small fish. The stock of small fish in this ground is affected both by immigration during August and September of fish from the very shallow coastal grounds near Esbjerg to the S.E., and by a still further offshore movement of the stock of plaice already present. For comparison of the catches year by year, we have really only two years to go upon. Comparing the averages of the months from September to December we find that the largest catches are made in 1905 in the first two of these months, but 1904 exceeds 1905 in the latter two. The

* Johansen (Contributions to the Biology of the Plaice, No. 1., p. 41) has found that the large plaice used formerly to be very numerous on the Horn Reef grounds and have diminished exceedingly in recent years.

autumn catches of 1906 and 1907 are considerably less than those of the corresponding months of 1904 and 1905.

Area M.—A skipper who fishes regularly in these grounds from year to year remarks—"Plenty of plaice and no soles up to March, then the soles occupy the ground till the end of May." Later in the year in July he says—"Fish is getting very scarce here now. The majority of the plaice are very small, averaging from 4-8 ins. The season generally extends from the latter part of March till the end of June, then it is done." In comparing this statement with the facts brought out by observation we see that they correspond. The curve for area M (Fig. 3) is incomplete from January to March as there are no February records, but the figures show that there are considerable

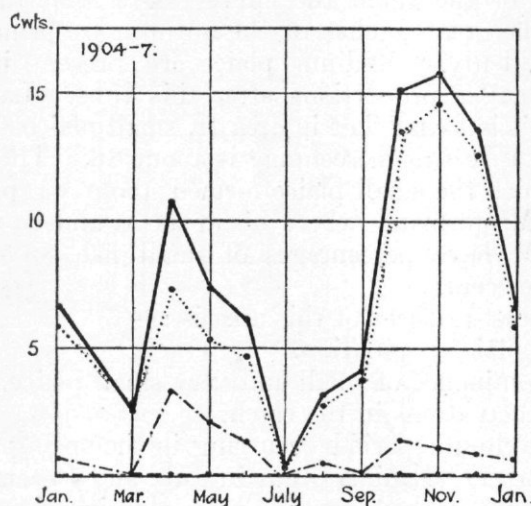


FIG. 3.—PLAICE. Area M. Monthly averages. 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

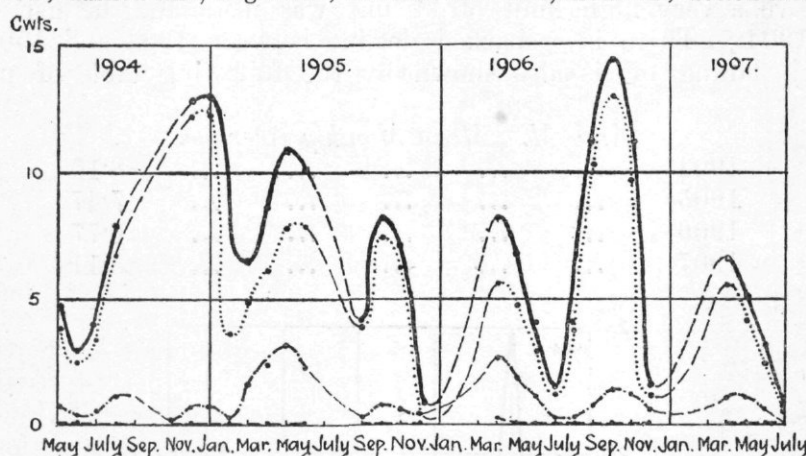


FIG. 4.—PLAICE. Area M. Monthly averages, smoothed curves. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

quantities of plaice reaching a maximum of 10.76 cwts. in April, and the catches afterwards, though good, fall off till, in July, the average is 0.36 cwts., showing that "plaice are getting very scarce." Of the fishery here in the autumn and winter he says nothing, but the averages and the curve show that plaice are increasing after July in the same way as they do in the adjacent area H. There is a sudden and great rise to November (15.78 cwts.) and then a sudden fall. Except for the large catches (30.34 cwts.) in December, 1904, all the December averages are very low and indicate the sudden and almost complete disappearance of the fish. It seems probable that the exceptional case of December 1904 may be a continuation of the phenomenon exhibited in November 1904 in area H, when especially large catches were made. Perhaps some of these great shoals migrated southwards and made their appearance in area M in the following month. Further confirmation of this hypothesis is present in the fact that the high averages of September and October, 1905, in H are followed by a very high average in November, 1905 in M. These large shoals, some of them yielding 40 or 50 baskets in a haul last till about the 22nd of the month and then disappear.

Large quantities of small plaice are thrown away on this ground. In May, June and July of 1904, a skipper reports that he throws away all small plaice under 11 ins. The total quantity disposed of in this way varies considerably. Sometimes there are none, and sometimes as many as 20 baskets or so in a haul. In July he finds that there

are very few plaice except tiny ones of 4 to 8 ins., which are thrown away. This fact has made the 1904 averages for these months less than they would otherwise have been. In April, 1905, this same skipper remarks :—"There are less small plaice over here than I have known for the last 15 years. I think it is owing to the cold weather."

The trend of the curves (Figs. 3 and 4) is also shown in the trend of the figures throughout the course of each month. In 1906 and 1907 we notice that throughout June the catches are appreciably decreasing on the Sylt Inner grounds, and after the 20th the fish disappear altogether. In July there is a continued absence of plaice and it is not till after the beginning of August that they appear even in small quantities.

In the composition of the catch the curves show that the small plaice form the dominant population. The great catches of the autumn are principally of small fish, and these disappear very suddenly. Medium plaice are present in large quantities from March to June, but in smaller proportions after this time. Large plaice are practically absent. On the average it is found that in area H, small plaice form about 76 per cent. of the total catch, in area M this percentage is about 86. The two areas together then would yield catches of which the small plaice formed about 81 per cent., a result which confirms that found by Masterman* where his areas A₃ and B₄ which together cover the same grounds as H and M have percentages of small fish 83.5 and 76.6 respectively, i.e., on the average, 80 per cent.

A summary of the chief features of this area is :—

- i. A very large plaice population.
- ii. A great predominance of small and very small plaice.
- iii. Very great fluctuations in the catch.
- iv. A double maximum period occurring in the spring and autumn about April and November. Minima occur in July and December.

The yearly fluctuations are best studied by comparing the averages in each year for the months April to August. May and June are less in 1904 than in 1905, but, as pointed out above, a very high limit of 11 ins. was made for the fish to be thrown overboard in 1904. There is a marked decline between 1904 and 1907. That the average catch is falling off is also shown by the following table of mean monthly averages †:—

| | Area M. Mean Monthly Average. | | | | |
|------|-------------------------------|-----|-----|-----|------|
| 1904 | ... | ... | ... | ... | 8.10 |
| 1905 | ... | ... | ... | ... | 7.47 |
| 1906 | ... | ... | ... | ... | 6.77 |
| 1907 | ... | ... | ... | ... | 3.11 |

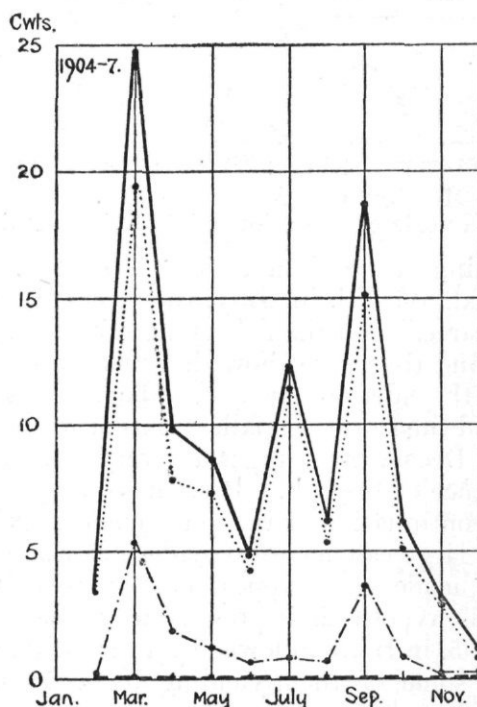


FIG. 5.—PLAICE. Area Q. Monthly averages, 1904-07. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted, small.

* Report of Research work of the Board of Agriculture and Fisheries. Vol. I. Special Statistics.

† Compare also the yield of the Sylt ground in March, 1895; 275 and 230 boxes of plaice from two voyages, thus averaging 20 cwts. per 10 hours. CUNNINGHAM. North Sea Investigations. *Journ. Mar. Biol. Assoc. Vol. IV. 1895. p. 13.*

Area Q.—This ground with regard to plaice is very similar in its characteristics to area M. Good catches of plaice are to be made here at nearly all times, the average only once falls below 3.12 cwts. But extraordinary large catches are taken in some months, as in March and July of 1905, and in September, 1904 (33.1 cwts.). Without these exceptional catches the trend of the figures appears to be a gradual rise from the beginning of the year to March or April, a fall to May, a rise to August or September, after which as far as we can tell from the incomplete figures there is a decided falling off.

In March, 1907, we notice a sudden appearance of shoals of small plaice on the Borkum Inner ground, as many as ten baskets being sometimes taken in one haul. But these hauls, though large, are nothing like those of the same month in 1905, when about seven times the quantity was caught. Most of the large catches were made on the Borkum Inner ground. Other parts of the same area did not show such a large population. The average of 25.8 cwts. in July, 1905, is obtained from hauls made by a skipper on the Heligoland ground. His catches in August on the same place are also greater than those of the other skippers who fished about Borkum and Terschelling. It is probable that the fish have come here out of the shallower waters off the Danish coast (area M). The large hauls of September, 1904, were made on the Norderney and Borkum grounds.

Like the other eastern areas the plaice population is essentially a small fish one. This class forms 84 per cent. of the total. Medium plaice are present in large quantities in the exceptionally large catches (March, July and September), but they are in smaller proportions of the whole than in the other months. The number of large fish in this area is negligible.

A comparison of the monthly averages year by year shows on the whole a decline in the average catch, between 1905 and 1907, and also between 1904 and 1907 sometimes, although it is very seldom that the 1904 averages are reliable enough for comparison. This decline is noticeable in March, April, May, and July. In August, 1907 is the best year. The last four months of the year do not give figures sufficient for comparison of the yearly catches. 1907 was, on the whole, a somewhat better year than 1906, but the mean averages of these two years are considerably less than those of 1904 and 1905.

Area W.—The averages of hauls in this area show the presence of a large quantity of plaice, all medium and small, the small being about 69 per cent. of the catch. We cannot ascertain the seasonal fluctuations from these figures as very little fishing took place. The highest average obtained is 7.39 cwts. in June, about which time of the year a large quantity of unmarketable plaice was thrown overboard.

All these eastern areas are very well stocked with plaice, and exceptionally large catches are sometimes made. The catches fluctuate exceedingly, the maximum quantities in the autumn being very large and the minimum very low, sometimes amounting to almost complete absence. Two maximum periods are evident in areas M and Q, and one in area H, where the spring maximum is not marked. The summer minimum in M is probably due to an offshore migration of all sizes of fish present, the larger ones not returning again when the small ones appear to form the autumn maximum. The predominant population is of small fish, but the character of the catch changes in the course of the year.

In the winter and early part of the year, the small fish seem to disappear as in H, or be less abundant in proportion; medium fish are more plentiful than they are in the autumn when the small fish are exceedingly numerous. Large fish are generally absent, but their appearance in the spring is probably due to an immigration of these fish towards the coasts after the spawning season. A large number of small plaice are thrown overboard and lost count of in the total. There is no doubt that some men retain much smaller fish than others, and their catches are thereby considerably augmented. One of the men states that he keeps none under 11 ins., and that it pays him to throw them away.

Where it has been possible to make comparisons between one year's catch and another, we find that the averages decline between 1904 and 1907 on the whole.

Central Areas.

Area J.—The amount of plaice in this area is very small compared with that obtained from the shallower water between it and the coast; indeed, the catches are quite of a different order. Whereas enormous quantities of plaice are taken on the inshore grounds, sometimes amounting to 20 or 30 cwts. in 10 hours fishing, no average catch in area J exceeds 2.17 cwts., while most of the general averages are below 1 cwt.

This is possibly partly caused by the enormous destruction of plaice on the inshore grounds. Marked fish experiments (Danish) show that sometimes the intensity of fishing is about 70 per cent.

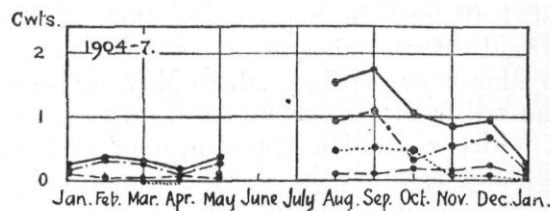


FIG. 6.—PLAICE. Area J. Monthly averages, 1904-07. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

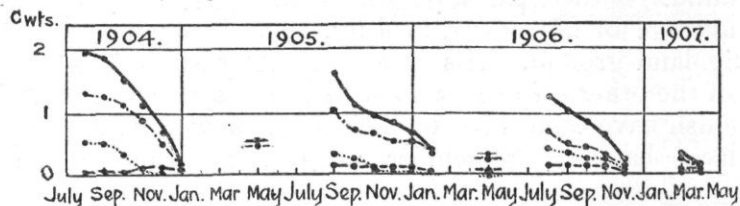


FIG. 7.—PLAICE. Area J. Monthly averages (smoothed curve). Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

The monthly catches year by year are very comparable with one another and show much the same trend from August to January (Fig. 7), the records of February to April are those of only one year, and the June and July records are wanting.

We may conclude from Fig. 6 that the catches from January to May are very low (less than 4 cwt.) compared with those in the summer and autumn. August and September are the months of maximum abundance, and then the fish depart gradually and decrease till January or February. We presume that June and July would not have higher averages than August, by comparing the trend of the curve with those of N and I, which are very similar in respect to depth and distance from the shore, and are likely to be affected at about the same time by immigration from the inshore waters.

The average proportions formed by the large, medium, and small fish are 14 per cent., 64 per cent., and 22 per cent. respectively. We see, therefore, that the predominant population is of medium fish. Small fish are generally absent, and it is only in the months of August, September, and October, when the whole catches are larger, that they appear in any numbers and exceed in bulk the quantity of large fish.

The yearly fluctuations in area J are best studied by comparing the averages in each year of the months from August to December. With the exception of October the averages become smaller between 1904 and 1906 (there are no figures for 1907, except in November, which is unreliable).

The chief features of this area are :—

- i. A small population of plaice, with medium sized fish predominating.
- ii. An annual wave of immigration, the late summer catches being higher than those of the winter and spring. In this immigration a number of *small* fish partake.
- iii. A decline in the average catch between 1904 and 1906.

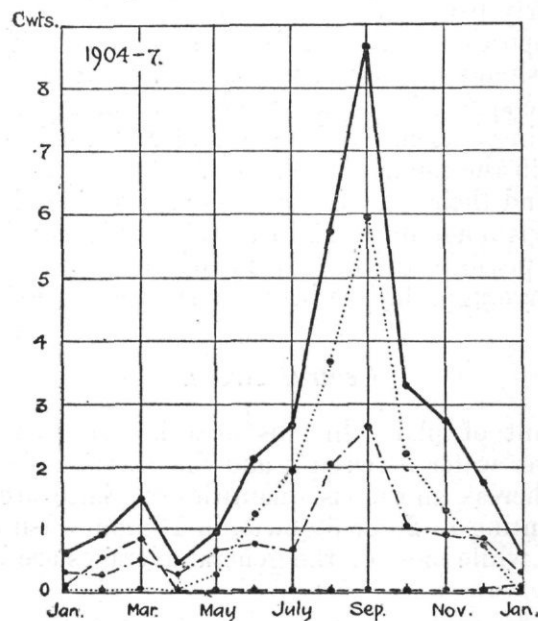


FIG. 8.—PLAICE. Area N. Monthly averages, 1904-07. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

Area N.—The curve, Fig. 8, illustrating the fluctuations of the general monthly averages in this area is complete and fairly smooth. It is a very good plaice ground and shows, for the seasonal fluctuations, two cusps giving maxima in March and September, but the autumn maximum is far larger than that of the spring, the difference being 7.12 cwts. The averages increase from 0.53 cwts. in January to 1.50 cwts. for the March maximum. After the minimum in April the amounts increase steadily and rapidly to an average of 8.62 cwts. in September and then fall off to the January minimum at about the same rate. The smoothed curve in Fig. 9 shows the seasonal fluctuations of each group year by year.

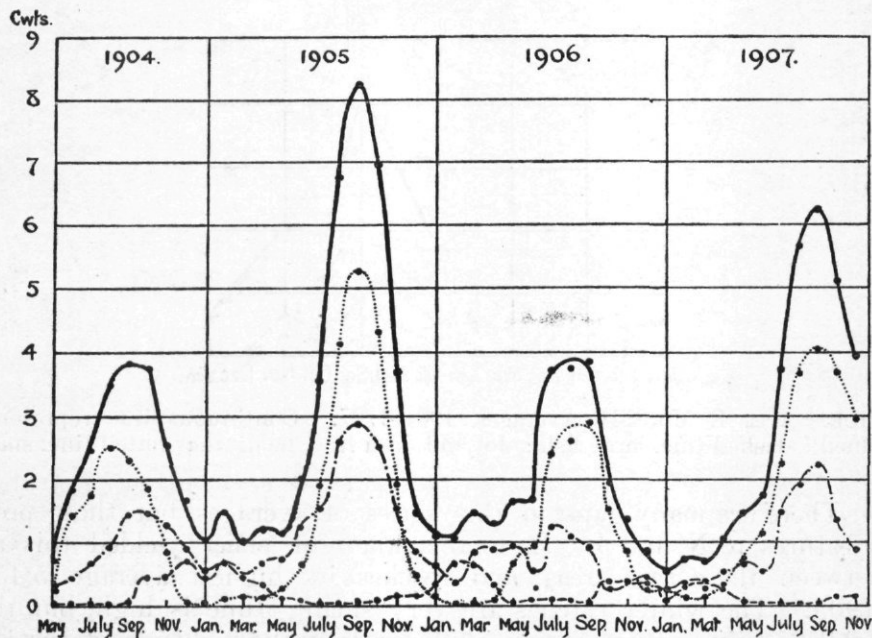


FIG. 9.—PLAICE. Area N. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

The features of the curve of combined averages are all present in each year on this curve, namely, a large wave culminating in a maximum in the late summer and early autumn, and a minimum in January, with a very much smaller wave of increase in February or March. This secondary maximum is formed entirely by the increase in large fish alone, for these are found in their greatest numbers in winter and spring. But this curve (Fig. 9.) also brings out the differences in the four years. 1904 and 1906 are very similar from June to December, though in the latter the high values begin earlier and fall off a month earlier. 1905 and 1907, especially the former, have larger maxima in the autumn than 1904 and 1906. The spring values of 1907 are considerably lower than those of 1905 and 1906. From this curve, 1905 is undoubtedly the best year, 1907 comes next and 1906 is the worst. The comparison is also shown by the following table, giving the quarterly and monthly averages for each year.

| Months. | | | 1904. | 1905. | 1906. | 1907. |
|-----------------------|-----|-----|-------|--------|-------|-------|
| January-March | ... | ... | — | (1.47) | 1.06 | 0.76 |
| April-June | ... | ... | 1.04 | 1.13 | 1.62 | 1.42 |
| July-September | ... | ... | 3.49 | 6.79 | 3.77 | 5.66 |
| October-December | ... | ... | 2.58 | 3.55 | 1.38 | 3.99 |
| Average of all months | | | 2.53 | 3.24 | 1.96 | 2.96 |

Small fish are found to be 56 per cent. of the total catch in the mean monthly average, but there is a distinct change in the composition of the catch during the course of the year. Large fish predominate up to March, and they are closely followed in amount by medium fish, while small are hardly present at all (*see* Fig. 8). During the summer and throughout the autumn, the large fish disappear and their place is taken by a small fish population, medium fish being also fairly plentiful. The following figures show this change very clearly.

| | | | | Average Percentage of Total. | | |
|---------------|-----|-----|-----|------------------------------|---------|--------|
| | | | | Large. | Medium. | Small. |
| January-March | ... | ... | ... | 55 | 39 | 6 |
| June-October | ... | ... | ... | 1 | 32 | 67 |

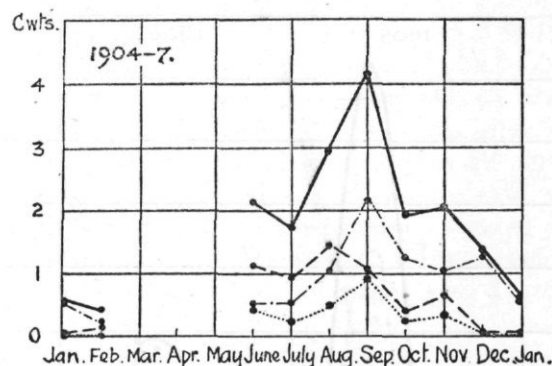


FIG. 10.—PLAICE. Area I. Monthly Averages, 1904-1907. Continuous line represents all sizes combined ; dashed line, large fish ; dot and dash line, medium ; dotted line, small.

Area I.—There are many gaps in this series of averages, but those present show very similar features to N and J. In total amount of plaice yielded this area comes some way between these two areas, and reaches its highest average 5.45 cwts. in September, 1905. The winter catches are very small ; June is high, but there is no evidence of a fall to July as this average is lowered by the inclusion of the 1906 figure, which is absent in June. August and September are both high and then the curve falls straight to January (November is higher than October in only one year).

In the first two months of the year large and medium fish only are present, medium fish preponderating, but the proportion of "large" increases between January and February. During the summer small fish appear. The large fish preponderate at first but they begin to disappear earlier than the medium and small fish, and from September medium fish have the first place. The average proportions of the three classes are as follows :—Large 34 per cent., medium 50 per cent., small 16 per cent.

We have seven months at our disposal for comparison of the yearly fluctuations, but the figures are so incomplete, and many months are missing, while several of those that are present are based on an amount of fishing too small for purposes of a yearly comparison, so that we cannot venture to draw many definite conclusions. 1905 has the highest average in the months of January, June, August, and September. In July there is a fall between 1904 and 1906, and in September between 1905 and 1907.

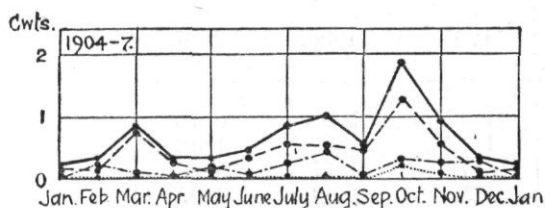


FIG. 11.—PLAICE. Area O. Monthly Averages, 1904-1907. Continuous line represents all sizes combined ; dashed line, large fish ; dot and dash line, medium ; dotted line, small.

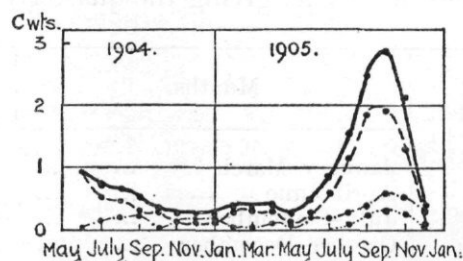


FIG. 12.—PLAICE. Area O. Monthly Averages, (smoothed curves). Continuous line represents all sizes combined ; dashed line, large fish ; dot and dash line, medium ; dotted line, small.

Area O.—This curve, Fig. 11, is mainly derived from the 1905 figures when there was a great deal of fishing on the Dogger Bank. In 1906 and 1907 there were very few records, for some of the men ceased recording their catches in those years.

The curve (Fig. 11) shows that plaice are appearing on the Dogger between January and March, when there is a very small maximum. There is a minimum about May or June, and then the curve rises till the secondary and much greater maximum in October. The fall in September on the curve of combined averages (Fig. 11) is probably a chance

occurrence as the average is based on the fishing of 1904, when very small quantities were taken in all months of the year. The catches decline in amount after October throughout the succeeding months to January or February. A sudden appearance of large plaice on the Bank is noted in March, 1907, when, about the 21st of the month, the catches increased from four fish to about $1\frac{3}{4}$ baskets in a haul.

The total amount of fish taken from this area is not large. The greatest average catch obtained is that of 3.68 cwts. in October 1905, and the smallest that of 0.20 cwts. in January 1907.

Although this is a shallow area (less than 20 fathoms) it is divided from the coastal ground by surrounding deep water, and for this reason and also because of the intense fishing between the small fish grounds and the Bank, very few small fish find their way on to the Bank. The majority of the fish are large. Small fish seem to have appeared in appreciable quantities only in October and November of 1905. Large fish form 68 per cent., medium 28 per cent. and small 4 per cent. of the total. Compare this result with the $69\frac{1}{2}$ per cent. large, 24 per cent. medium, 3 per cent. small and $3\frac{1}{2}$ per cent. not distinguished, obtained by Masterman* in his area B₁.

The only two years we can compare are 1904 and 1905, and the latter year yielded undoubtedly the best catches (see Fig. 12). 1904 has uniformly very low averages, and, by contrast, those of 1905 are very large.

These four central areas show together by comparison that the quantity of fish decreases as we move offshore and the size increases, for we have found that in regard to the yield of plaice, N comes first with very good catches, I a very good second, but the areas J and O seldom yield more than an average of 1 cwt. (per 10 hours), while in N the predominant size of the fish is small, in I and J it is medium, and in O it is large.

An early autumn or late summer maximum is apparent in all areas, and where the figures are sufficient to show it, there is another maximum but one of much smaller extent, which occurs about March.

It is a fact worthy of notice that the stock of fish on these grounds begins to increase in May and June, at the time when on the adjacent grounds M and Q, the stock is decreasing. It has been noticed how the constitution of the population in some of these areas changes about April. It is probable that the two maxima on the curve are caused by two quite different sets of fish, the spring one by an immigration of large and medium fish about the time of the spawning season (these being less numerous than the small fish would only cause a small maximum), and the summer increase by an offshore movement of the stock of all sizes of fish including small fish, from the coastal areas M, Q and W.† The majority of the fish probably move in a westerly direction from the Danish and Dutch coasts, while in N and the grounds to south-west they are found in great quantities in the summer. The maximum in O and I is formed mainly by large fish, the small plaice not generally migrating so far. Perhaps the larger fish and some of the medium remain offshore and ultimately make their way northwards to the Dogger Bank and the grounds beyond it, while the small fish remain abundant on the central grounds till August or September and on the inshore grounds till October and November, after which they seem to disappear altogether during the winter. They are supposed at this time to hibernate and so escape capture. The yearly variations in these central areas have on the whole a downward trend from 1905, (also from 1904 in area J) but in some months this is not apparent. 1905 is generally the best year, but we are somewhat hampered in drawing conclusions as to the state of the fishing in 1904, as the records are on the whole very few. 1907 has often higher averages than 1906.

Northern Areas.—“Below the Dogger.”

Area D.—In this area we have very deep water (greater than 40 fathoms) and here only large fish are found, and those in very small quantities. There is a downward trend in the averages from 0.38 cwts. in January to 0.0 in April. There are no records in May, June and July. In August, the catch is really very large, 2.87 cwts., but this is based in the fishing in the year 1906 which took place on the Edge of the Deep water, just over the line dividing it from area L. The large catches made here in this month as well as in September are a reflection of the phenomenon observed in areas L and K at the same

* Report on the Research work of the Board of Agriculture and Fisheries, Vol. I, Table IV.

† Note.—The detailed tables of the report on plaice investigations published by the Board of Agriculture and Fisheries confirm the fact that it is during the summer and autumn maximum period that the proportion of small fish is the greatest. See Report on Research work of Board of Agriculture and Fisheries on Plaice Fisheries of the North Sea, Vol. II, 1906–07, 1907–08. p. 65.

time when the summer averages are exceptionally high compared with those of the other years. The November and December catches are very low.

Area K.—This again is another area where plaice are very scarce, the averages being generally about 0·3 or 0·4 cwts. There is a continuous fall from September 1904 to February and March 1905, but it is of one small extent. The averages do not change much, either month by month in the same year or in the same month of different years, and they only show any great increase in the month of September, when, especially in 1906 the catches become large. There are many gaps in this series of figures, so much cannot be said about the seasonal or yearly changes. The population is formed almost entirely by large fish, the only important exception being that of September 1906, when medium fish appeared.

Area L.—A first glance at the averages makes it appear that the catches from May to October are comparatively large (greater than 1·0 cwt.) while those from November to April are very small (less than 0·40 cwts.). But to some extent this appearance is perhaps exaggerated, as the averages are affected by the predominance of the 1906 figures. We find that the summer catches of 1906 are exceptionally large compared with those of 1904 and 1905. (For 1907 we have no figures in the summer.) It is however probable that the trend indicated by these figures is correct and that the summer catches, beginning in May, are higher than the winter ones, but not generally to such a great extent as is indicated by the general averages. The main bulk of the catch is of large fish.

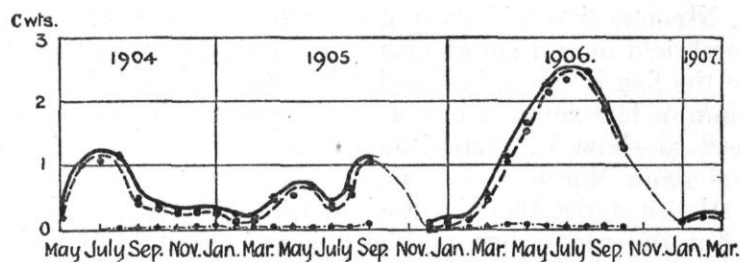


FIG. 13.—PLAICE. Northern Areas D, K and L combined. Monthly Averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium fish.

These three areas (see Fig. 13 for a representation of the averages of the combined catches of the areas) are frequented mainly by large plaice which are never numerous, most often only three or four fish being taken in a haul. The catches do not fluctuate much, but are somewhat greater in the spring and summer than in the winter. 1906 seems to have been an exceptional year with regard to its summer hauls, which gave many more plaice than usual in this region (averaging between two and three cwts.).

Had the averages been more complete for the surrounding areas than they are, we might have been able to trace the course of these extra abundant fish towards these areas. A point which suggests itself, but wants confirmation, is that in 1906 the plaice penetrated the deep water and further north to a greater extent than usual, because of the exceptionally fine and hot summer that was experienced in that year.* It is noticeable, too, that in the more coastal areas, at least on the eastern side, 1906 was a very poor year.

Southern Areas.

Area S.—This area corresponds in position to a part of the northern areas discussed in my paper on the Lowestoft trawlers.† As far as concerns the seasonal fluctuations, the curve (Fig. 14) may be said to corroborate the conclusions there found. There is an annual immigration into this area giving maximum catches in the summer, and the curve falls away smoothly on either side of this maximum, showing that the fish are leaving this ground in the autumn and winter. We found in the Lowestoft trawling statistics that the fish migrated into this area and formed a maximum in the summer, and left it after this season, some of them to migrate southwards in the winter towards the spawning grounds. With regard to the February and March values, which are higher than April, it should be explained that neither of these are reliable, as the February average is based on two hauls only, and nearly all the March hauls were made on the "Well Bank" on the borders of areas S and R, and might even belong to R rather than S (see p. 8). The hauls made away from this border line give a much lower average (about 0·8 cwt.).

* See p. 25.

† Loc. cit.

The bulk of the fish that migrate on to these grounds in the summer probably come both from the southern grounds of the Flemish Bight (after the spawning season) and also from the Dutch coasts (areas W and Q), where we find a summer minimum.

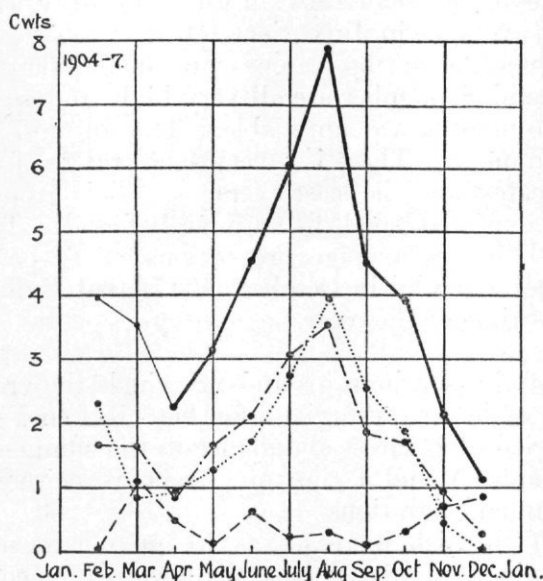


FIG. 14.—PLAICE. Area S. Monthly averages, 1904–1907. Continuous line represents all sizes combined ; dashed line, large fish ; dot and dash line, medium ; dotted line, small.

Fish of all sizes are found in this area, but large fish form but a small proportion of the total. The hauls in April, November and December are made by one man, who is evidently biased in his judgment of size. Neglecting these months and the averages of February and March, we obtain from the average of the remaining six months the following proportions during the summer :—Large, 6 per cent., medium, 47 per cent., small, 47 per cent., so that the bulk of the population is seen to consist of medium and small fish in equal proportions.

A comparison of the catches in the different years made of the averages of June to October, which are the most reliable, shows that there is sensibly a decline in the average catch between 1904 and 1906. 1904 is always better than 1906, and it has larger catches than 1905 in two of the four months July to October. The few 1907 averages present compare favourably with those of 1906.

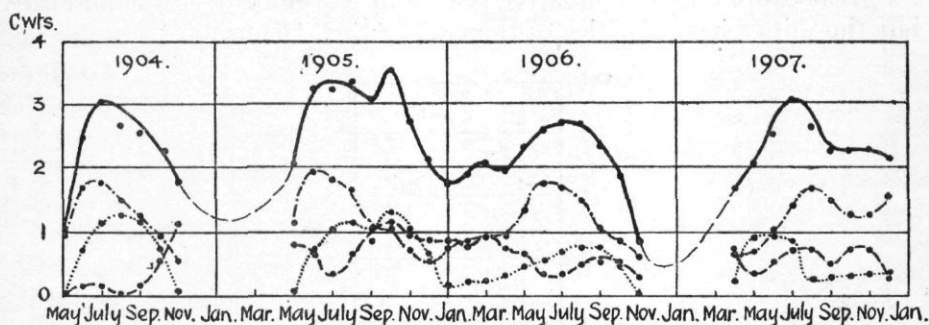


FIG. 15.—PLAICE. Area T. Monthly averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, large fish ; dot and dash line, medium ; dotted line, small.

Area T.—The somewhat irregular fluctuations of the general monthly averages for this area are eliminated in the smoothed curve of Fig. 15, which shows that the stock of plaice fluctuates between one and three and a half cwt. (per 10 hours) and maintains a higher level in the summer than in the spring and winter. There is a minimum about January, 1906, and the trend of the curve points to the existence of similar minima at about the same time in the other winters.

The plaice population is very mixed in character, all sizes being found, and in the general averages they appear to fluctuate irregularly and independently of one another. How far this may be due to the fact that the groups of fish migrate through this area from the surrounding areas at very different times, or to personal errors on the part of the fishermen in classifying the fish, it is impossible to say. Most probably the latter reason has a good deal to do with this irregular appearance. The average proportions are as follows :—Large, 30 per cent., medium, 44 per cent., small, 26 per cent.

There is no evidence of any great increase or decrease throughout the period, but the smoothed curve suggests that 1905 was the best of the three years, 1905-1907 (we leave 1904 out of account, as all the averages are based on too few hours' fishing to be reliable). In April and May, 1906 is higher than 1907, in June and July, 1907 is better than 1906, but 1905 had the highest averages in July, September, October and November.

Area V.—In this area the spring catches are small compared with those of the summer. July, August and September are all very high, and so are May and June, but the averages for these two months are unreliable. The autumn and winter averages are lower than those of the summer. There is a very small range of difference (a little over one cwt.) between the greatest and the least averages. This ground has in it some very deep pits, and, as may be expected, small fish are rarely found. The catch mostly consists of large and medium fish in the average proportions of 62 per cent. and 33 per cent. respectively. One skipper remarks in October, 1907, that "the plaice we get in the Pits are very large at this time of the year."

The most shallow of the southern grounds, S, yields the greatest amount of plaice. T comes next, and V gives the smallest yield, for here is found the deepest water. All three areas have their period of greatest abundance in the summer and their least in the winter and spring. In areas V and T the total stock is neither greatly increased nor much decreased by the annual migrations.

The average size of the fish increases as we go northwards through these areas. Medium and small predominate in area S (the shallow area), medium in T, followed by large, and the large fish in V (the deepest).

These proportions are not, however, by any means constant. The variation may be caused by different stocks of fish migrating into these areas from the Flemish Bight and the eastern and western coastal areas at different times.

In one of these areas we have found the annual average yield is declining, in the other two the evidence is by no means conclusive.

Western Areas.

Area E.—The few averages present are not really representative of this area. Apparently exceedingly small quantities are found in the early months of the year. Eight hauls in June give very good quantities, but out of four in July only one yielded any fish. Only small and medium fish were found.

Area R.—This ground gives a fairly good yield of plaice, the general averages for the first eight months of the year fluctuating between $3\frac{1}{2}$ and $4\frac{1}{2}$ cwts. There is a downward trend from the maximum in June to an autumn or winter minimum of about 2 cwts., which is not a great drop. The cumulative rise from November to June and July is quite significant, but the minor irregularities of the curve (Fig. 16) are not so.

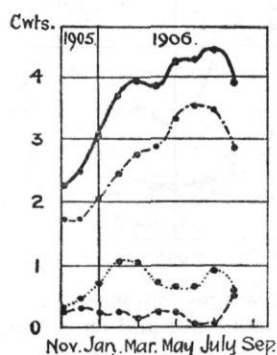


FIG. 16.—PLAICE. Area R. Monthly averages, smoothed curves. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

The majority of the fish are medium sized, but both large and small are present. It can safely be said that the peculiar appearance of the curves, where the maxima and minima of the large fish appear to alternate with those of the small fish, is an unnatural one. It is brought about by the fact that nearly all the hauls in this area were made by two men who were biased in opposite directions, one to classify the greater part of his catch as "large" and the other, to have but few "large" and many more small. When the hauls of the former preponderate, as they do in September and October, we have a maximum of large fish. When the hauls of the latter preponderate as in February, March, June, July and August we have a maximum for small fish.

We cannot say much about the yearly fluctuations. In the month of May, when it is possible to compare three years, we find a distinct decline in the average catch between 1904 and 1907.

Area X.—The December to March averages are all based on the result of very little fishing, and we do not know that they are really representative. From April to July the quantities maintain a fairly high level, after which there is a slight decrease. On the whole a fairly steady level of population seems to be maintained throughout the greater part of the year. The stock consists almost entirely of large and medium fish, small fish seldom averaging more than 0.03 cwts. Large fish are considerably in excess of the medium and form 60 per cent. of the total. Medium are 39 per cent. and small 1 per cent.

Area P.—The few odd hauls made in this area yield averages which are nearly equal to those of the adjacent area X in the same month. Large fish preponderate even more than they do in that area. Small fish are altogether wanting.

In investigating the western areas we are much hampered by the many gaps in the series of monthly averages, and any attempt to draw conclusions from such figures as are present must be regarded as merely provisional. However, the following ideas suggest themselves and await corroboration. The stock of plaice is *very* much smaller than on the eastern grounds off the continental coast and by contrast with these is subject to a very small range of variation. Areas X and P give an average yield of under 2 cwts. R is the best ground, and, like X, keeps up a high level for a considerable number of months. The proportion of large fish increases and that of the small decreases as we move outwards from E to R and thence into the deeper waters of X and P.

Spawning.

We have observations on the maturation and spawning of plaice for the three spawning seasons 1904-5, 1905-6 and 1906-7. These were recorded by the skippers on the ordinary record forms, and were kept very consistently during the first two seasons. But a few of the skippers failed to give any spawning records at all, and some of those who made observations in the first season omitted in the others to note the spawning fish at the same place and time. For this reason it was found impossible to summarise the results numerically, more than has been done in the table (Table VI.). In this, for each area, the total number of hauls where spawning or maturing plaice were recorded, are given as the numerator of a fraction, whose denominator is the total number of hauls made in that month in the area, by the skippers who record spawning fish. In addition to these, there are notes made by one particular skipper in his summary of the voyages, that the fish are maturing or nearly ripe, without specifying the number of hauls in which they occur. These observations are entered in the table at the appropriate areas by significant signs.

TABLE VI.—Showing the number of hauls in each area in which maturing or spawning plaice are recorded.

| — | B. | C. | D. | F. | G. | H. | I. | J. | K. | L. | M. | N. | O. | Q. | R. | T. | X. |
|----------------|-----------------|---------------|--------------------|----------------|-----------------|----------------|-----------------|-----------------|-------------------|--------------------|---------------|-----------------|------------------|----------------|----|----------------|---------------|
| September 1904 | — | — | — | — | — | — | — | — | — | — | — | — | $\frac{1}{29}$ | — | — | — | — |
| November " | — | — | — | — | — | — | * | — | — | — | — | * | $\frac{4}{25}$ | — | — | — | $\frac{5}{8}$ |
| December " | — | — | — | — | — | — | $\frac{35}{33}$ | $\frac{8}{6}$ | — | — | — | — | — | — | — | — | — |
| January 1905 | — | — | † | — | $\frac{11}{26}$ | — | $\frac{5}{9}$ | $\frac{2}{25}$ | $\frac{20}{30}$ † | — | — | — | $\frac{18}{25}$ | — | — | — | — |
| February " | — | — | $\frac{52}{132}$ † | — | $\frac{2}{2}$ | — | — | — | $\frac{20}{38}$ † | $\frac{35}{146}$ † | — | † | $\frac{2}{14}$ | — | — | — | — |
| March " | — | — | $\frac{21}{152}$ | — | — | — | — | — | — | $\frac{24}{47}$ | — | — | $\frac{10}{37}$ | $\frac{5}{21}$ | — | — | $\frac{2}{6}$ |
| September 1905 | $\frac{13}{22}$ | — | — | $\frac{7}{24}$ | — | — | $\frac{2}{2}$ | $\frac{2}{11}$ | $\frac{5}{21}$ | $\frac{11}{17}$ | — | — | — | — | — | — | — |
| October " | $\frac{5}{5}$ | $\frac{1}{1}$ | — | $\frac{4}{10}$ | $\frac{2}{3}$ | $\frac{2}{17}$ | — | $\frac{18}{18}$ | — | — | $\frac{2}{3}$ | — | $\frac{8}{8}$ | — | — | $\frac{1}{42}$ | — |
| November " | — | — | — | — | — | — | $\frac{7}{9}$ | $\frac{1}{1}$ | — | — | — | $\frac{15}{17}$ | — | — | — | — | — |
| December " | — | — | — | $\frac{2}{2}$ | $\frac{1}{1}$ | — | $\frac{4}{5}$ * | $\frac{14}{14}$ | — | $\frac{5}{7}$ | — | $\frac{2}{2}$ * | $\frac{28}{119}$ | — | † | — | $\frac{7}{8}$ |
| January 1906 | — | — | — | — | — | — | — | † | — | — | — | — | — | — | — | — | — |
| February " | — | — | — | — | — | — | — | † | — | — | — | — | — | — | — | — | — |
| March " | — | — | — | — | — | — | — | — | — | — | — | — | — | † | — | — | — |
| January 1907 | — | — | — | — | — | — | — | — | — | — | — | $\frac{28}{74}$ | — | — | — | — | — |
| February " | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

Maturing plaice are present in hauls from areas marked thus,* and plaice which are described as full of roes or spawn are present in hauls in areas marked thus†. The number of hauls is not specified. The numerator of the fractions denotes the number of hauls when records of the presence of spawning or maturing plaice were made and the denominator, which is given as a means of comparison, is the total number of hauls in the area for each month which are made by those men who record the spawning fish.

The season of maturation begins in September. In this month and the following the fish are described as "beginning to have roes in them" and "spawn forming." In November and December they are full or "getting ripe," and in many cases actually spawning. In March they are generally spawning, and then the season seems to end.

With regard to the distribution, the table shows that they are present in a greater or less degree in most of the areas, the occurrences being greatest in the deep water areas. They are hardly ever present on the shallow eastern areas H, M, Q and W, nor in the southern areas S, T and V, although we cannot speak with any certainty about these last two areas, as the hauls of January to March were made by men who seldom record spawning fish at all. However, the large fish are never numerous in this region at this time. In area R there were some plaice mentioned as being heavy with spawn at the end of December 1905, but there are no records of spawning fish. Of the other western areas, X, Flamborough Off, &c., seems to be a spawning area, for large numbers of spawning fish are recorded there in a few hauls taken during the spawning season. In the north-eastern areas, A, C, B and also area P, there is either none, or very little, fishing at the spawning time. On the Dogger Bank both maturing and spawning fish were present in the first season. In the second season only full fish were found, none actually spawning, and in the third, when there was a good amount of fishing on the Bank, none were recorded. It was the same case on the adjacent grounds lying to the north of the Bank. In January and February maturing fish were present, and in March a considerable proportion were spawning. In the second season fish "with spawn forming" were present in September and December. After that, and in the next season, none were noticed, although these grounds were well sampled during the winter months. Both maturing and spawning fish are present regularly on the central areas J, N and I. In these the depths are all over 20 fathoms.

These records are generally entered as "few large spawning," and it is only in the deep water areas (over 30 fathoms) that they form any large proportion of the catch. Only in a very few cases do they mention medium plaice as being "full of spawn."

One of the most important of the spawning areas of plaice in the North Sea, that in the southern region*, lies altogether outside the region fished by these Grimsby trawlers, and this shows a more definite accumulation of spawning plaice than any of the areas in the central region.

Summary.—Plaice.

a. Distribution—The distribution of the plaice over the central part of the North Sea, according to the abundance in the average catches, is shown in Fig. 17.

Exceedingly great amounts of plaice are taken on the eastern grounds, off the coasts of Denmark, Germany and Holland (areas H, M, Q and W), and the grounds adjacent to these give also a fairly good yield. The western grounds off the English coast are much more poorly supplied than the eastern inshore grounds, and here we find the conditions are very different. The shallow coastal waters are not of such a large extent, as the deep water off Flamborough Head comes almost to the coast. The ground is very much rougher and is unfit for trawling in some places, and these conditions are probably more unsuitable for the growth of the young plaice. The off-shore grounds have a less abundance, the quantities decreasing as we move off-shore, in a northerly direction and into deeper water. Thus S, I, J, K, G and C form a rough series, as do also S, R, T, V, L and D, in a descending scale.

The Dogger Bank (area O) is unique. It is a shallow area lying in a central position offshore, and quite surrounded by deep water. Its yield corresponds more to that of the offshore areas J or L than to that of any of the shallow waters.

In some of the northern grounds plaice are very scarce, and are often absent in many hauls.

These figures also show the known law of distribution according to size. The average size increases in the more offshore and deeper waters. The areas with very large catches have a predominant small plaice population. The central areas with the intermediate quantities have a mixed population. The northern areas with deep water, and also the Dogger Bank, have almost entirely only large fish.

The proportion of "small" is much greater on the eastern than on the western side of the North Sea.

* LEE.—Report on the Lowestoft Sailing Trawler Records 1903–06. *Internat. Inves. Mar. Biol. Assoc. Report II.*, Part V., Cd. 4641, p. 104.

cf. also REDEKE and VAN BREEMEN. Distribution of eggs and larvae in the southerly N. Sea, *Verhandelingen uit het Rijksinstituut voor het Onderzoek der Zee*, p. 34 and Chart III.

"Small" form the largest bulk of the fish landed and with "medium" are 90 per cent. of the total. Thus a small proportion only of the plaice captured in the central part of the North Sea have attained maturity.

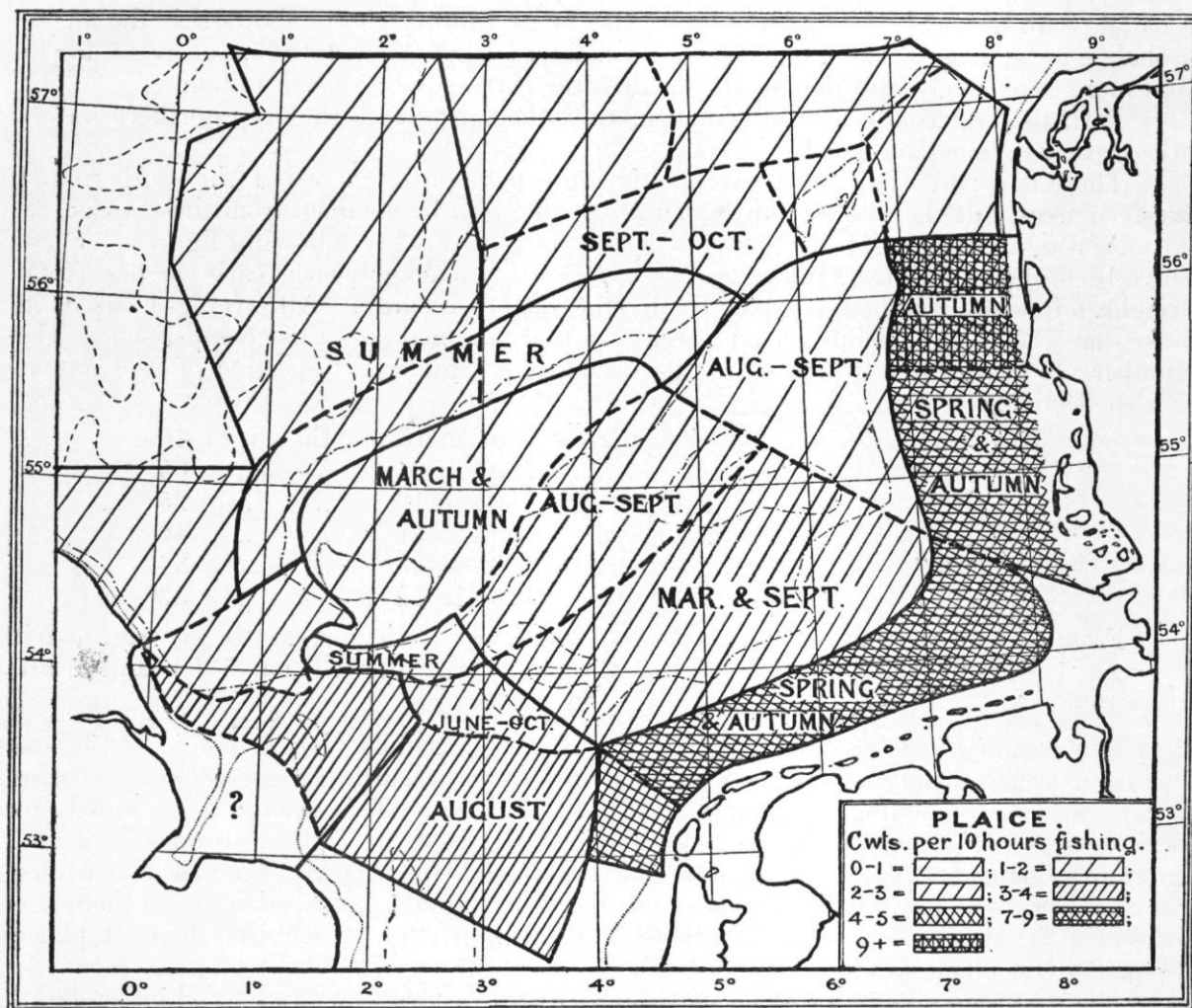


FIG. 17.—CHART showing the distribution of PLAICE according to the mean monthly average catch in various areas, and the periods of maximum abundance in the different regions.

b. Yearly variations.—These have been studied as far as possible by a comparison of the average catches in the corresponding months of each year, but the resulting variations are by no means uniform over the whole of the region investigated. In many cases it was impossible to draw conclusions owing to lack of data.

On the eastern grounds we find a decline in the average catch between 1904 and 1907; sometimes 1905 was the best year. In most of the central areas we have a downward trend from 1905 and sometimes from 1904, but there is evidence in some of a recovery to larger catches in 1907 after minimum quantities in 1906.*

About the north-eastern areas we are not able to draw any conclusions as to the yearly fluctuations.

In the grounds north of the Dogger there is a marked increase in the summer of 1906, the catches being two and a-half times those of the two previous years. This may, perhaps, be explained by the somewhat unusual conditions of temperature and salinity. A study of the temperature and salinity charts of the Quarterly Bulletins of the International Council shows that on the whole the surface temperature of the sea was somewhat higher in 1906 than in the other years of this period,† and on p. 32 of No. 1,

* Cf. The Dutch Statistics. Jaarverslag omtrent het beheer vande Visscherhaven te IJmuiden, 1908 (Table IV.). The trend shown by the average catch of plaice for these years is the same as this.

† See also *Conseil Perm. Internat. pour l'Explor. de la Mer*. Bulletin Trimestriel. 1906-7. Partie Supplémentaire, p. 64.

NOTE.—Since the writing of this paper, more detailed and summarised information as to the surface temperatures of the North Sea is to hand in a paper by Mr. F. G. Young, B.Sc., in the Fourth Report (Northern Area) of the North Sea Fisheries Investigation Committee. He shows that in 1907 the mean surface temperature was much lower than in 1906, this fact being attributable mainly to the severe winter experienced over Western Europe in 1907 (p. 76) and that the yearly differences were greater and more extreme in the southerly parts of the North Sea.

1906–1907, August 1906, we have the following remark :—"Salinity is remarkably low in the eastern and southern parts of the North Sea. The $34^{\circ}/_{\infty}$ line has an extraordinary westerly position. The $35^{\circ}/_{\infty}$ water in the north-west part of the North Sea is not smaller than usual. A comparison with the mean salinity charts shows that the $35^{\circ}/_{\infty}$ isohaline as well as that of the $35.25^{\circ}/_{\infty}$ isohaline, during August 1906, penetrate deeper and more extensively into the North Sea than the corresponding mean isohaline."

Perhaps these conditions influenced more of the fish to seek the deep northern waters to a greater extent than usual.

There is apparently a yearly decline during some months in two of the southern and western areas, but there is very little definite evidence to be obtained from these areas.

A rough measure of the general decline is given by the following figures. These have been obtained thus. Taking each set of monthly averages, each year's catches (total weight, all sizes) have been compared with the ones preceding. All averages based on less than 30 hours fishing have been omitted in making this comparison. The number of averages in which a decline occurred are given, irrespective of the extent of that decline.

| | | | | | | |
|---|---|---|---|------------|---|----|
| The 1905 average is less than that of 1904 in 13 months out of 40 | | | | | | |
| " 1906 | " | " | " | 1904 in 24 | " | 35 |
| " 1907 | " | " | " | 1904 in 13 | " | 25 |
| " 1906 | " | " | " | 1905 in 31 | " | 46 |
| " 1907 | " | " | " | 1905 in 23 | " | 34 |
| " 1907 | " | " | " | 1906 in 12 | " | 33 |

From this we see that generally speaking there was a decline in the average catch between 1904 and 1907, but that 1905 was somewhat better than 1904 and 1907 than 1906.

c. Seasonal Fluctuations and Migrations.—The curves show that a definite periodical variation occurs in the stock of plaice in most of the areas, resulting in one or two maximum periods and corresponding minimum periods of abundance. This change is due mostly to periodic seasonal migrations of the fish. For instance on the "Eastern grounds" we find enormous quantities in the late summer and autumn, but in early summer and winter they are very scarce. These grounds and those offshore grounds adjacent to them are subject to far greater variations than those on the English side, where the stock of plaice is smaller but much steadier.

Many of the areas, such as the north-eastern and eastern areas and the Dogger Bank have a maximum in September or October. The central areas have increasing quantities in the summer; the southern and northern areas throughout the greater part of the summer maintain their highest level. Some of the eastern grounds have a spring maximum as well. The most obvious migration observed is that of a spring and summer offshore movement from the Danish and Dutch coasts, commencing about April or May when the central, southern and offshore grounds begin to increase their stock.

A change is found to take place in the constitution of the catch during the course of the year. Large and medium fish are in greater proportions in the spring than in the summer and autumn, and this is probably due to two definite migrations of different sets of fish. Large and medium fish are present in the shallow grounds about April, just after the winter spawning season. They are scattered all over the offshore grounds during the summer, some probably remaining and ultimately making their way to the more distant grounds, while the smaller ones migrate back towards the coast for the autumn, reinforced by the growing small plaice population of the Dutch and Danish nursery grounds which have been hitherto too small for capture or have migrated from still shallower waters more inshore. In most areas (except R and X) the winter catches are low. Small fish do not seem to be caught at all, and they are probably hibernating at this time,* and we know that for some of the large fish there is a definite southward migration for the purposes of spawning which takes them altogether out of this region. In the western areas the winter maximum is probably also connected with the spawning habits. There is some evidence of a southward or south-eastward movement through the eastern areas at the approach of winter, October to December, especially of the great shoals of small plaice before they settle for their winter rest.

d. Spawning.—There is no direct evidence of any accumulations of plaice in this region for spawning purposes, but a good deal of material is lacking in the winter spawning months in those areas (such as X) which are known from other sources† to be spawning

* HEINCKE & HENKING. Schollen and Schollenfischerei, p. 17.

† WALLACE. Maturity of Plaice. *Internat. Invest. Mar. Biol. Ass., Report II., Part II.* Cd. 4641.

areas. They are found maturing in all the deep water areas and offshore grounds in the months of December and January. Spawning fish are found in most of the same areas and are observed in the months of December to March, most of them being in January to February. Most of the fish recorded as spawning are large, and these form a very small proportion of the total.

B.—SOLES.

Introduction.

The numbers of soles caught are recorded in pairs on the record forms supplied to the fishermen, who always keep the size distinctions of "large," "medium," and "slips" or "small." These were tabulated according to the areas on the chart corresponding to their place of capture, and totals and averages calculated for each area for each month, the numbers of fish (not pairs) in each size group and in the total catch being given.

Although the total yield of soles never amounts in bulk to anything like that found for plaice, for they are always few enough to be counted individually, while plaice are caught in basketfuls numbering hundreds, yet there is as much variation proportionally in the yield of the different grounds as there is for the more abundant plaice. For instance, the highest average obtained is 311 per ten hours fishing, in July, 1906, in area M, while on the Dogger and some of the northern grounds we get as a maximum two or three fish in the same time. Therefore, when we speak of "very large catches" or "abundant shoals," it must be understood that these are but comparative terms used in relation to other more normal catches of soles on the same ground.

In some areas soles seem to become very localised and will congregate in some parts of them in large numbers, leaving the rest of the area very sparsely populated. We find this in areas where there are deep pits, or ground specially suited to them. Moreover, they are limited in this region, as they are never found very far north and their limits of relatively great abundance are readily definable.

The total quantities of Soles and proportions of Large, Medium and Small.

TABLE VII.—Showing the total numbers of large, medium and small SOLES, taken by certain skippers in each year, and the percentage of the total formed by each category.

| Year. | Total Number of Soles. | | | | Percentage of Total. | | |
|-----------|------------------------|---------|--------|------------|----------------------|---------|--------|
| | Large. | Medium. | Small. | All sizes. | Large. | Medium. | Small. |
| 1904 ... | 2,178 | 12,703 | 9,916 | 24,797 | 9 | 51 | 40 |
| 1905 ... | 12,589 | 23,992 | 16,693 | 53,274 | 24 | 45 | 31 |
| 1906 ... | 9,728 | 34,651 | 11,872 | 56,251 | 17 | 62 | 21 |
| 1907 ... | 6,052 | 16,468 | 9,492 | 32,012 | 19 | 51 | 30 |
| Total ... | 30,547 | 87,814 | 47,973 | 166,334 | 18 | 53 | 29 |

This table shows that the greatest proportion by number are medium sized soles, which are over one-half of the total number caught. The large fish are not quite so numerous as the small fish, but their bulk in weight would be considerably greater.

The monthly averages are arranged in the same way as for plaice, and are discussed in the manner employed for that species, each area being taken separately and then afterwards discussed in its relation to other areas of the same group.

Yearly Fluctuations.

For the reasons set forth in the first section, we cannot obtain a single yearly average for each year of the period, but by the same methods of comparison used for plaice we have discovered no evidence of a general decline. Where it has been possible to discuss this question in the single areas it has been done, and also a general idea of the yearly changes, is obtained from the following table, which has been prepared in the same way as the

corresponding one in the section on plaice, all averages based on less than 30 hours fishing being omitted :—

1905 is 16 times less than, and 19 times greater than, 1904 out of 40 months.
 1906 is 16 times less than, and 16 times greater than, 1904 out of 35 months.
 1907 is 13 times less than, and 10 times greater than, 1904 out of 25 months.
 1906 is 17 times less than, and 24 times greater than, 1905 out of 46 months.
 1907 is 20 times less than, and 12 times greater than, 1905 out of 34 months.
 1907 is 16 times less than, and 15 times greater than, 1906 out of 33 months.

Nothing very definite can be concluded from this table as the number of excesses and defects are nearly equal. But this takes no account of the extent of the difference nor of the years when observations were lacking in some months. The year 1906 is more often greater than 1905, than less than it, and is in some areas at any rate, rather exceptional for its catches of soles. Apparently, however, there is no continued decline or increase in the catch over the whole area. Variations of considerable extent are noticeable in certain areas.

The fluctuations in each area.

The monthly average catch of soles is given in Table VIII, and the variations in these averages are shown in the following discussion.

North-Eastern Areas.

Areas A, B, and C.—No soles are recorded in any of the months in which we have records of fishing in these areas. We may therefore conclude, that if not entirely absent, they must be very rare on these grounds.

Area F.—Most of the hauls in this area were taken on the Tarbot Bank (16–20 fathoms). Soles were found, but only occasionally, and in very small quantities. One large fish was found in March, 1905. The records of June, July and August show complete absence. From September to December they were found in small numbers, the argest catch being made in December, 1904, when they were taken at the rate of 3·17 per 10 hours.

Area G.—There are records of fishing in eight months of the year. January is the only one of these in which any soles were caught. This was in 1905, when one man reported four soles in 61 hours, and another three soles in 32½ hours fishing. None were caught in the following January.

The quantity of soles found in these areas is almost inappreciable. They are taken occasionally in the autumn and winter, but never in the summer.

Eastern Areas.

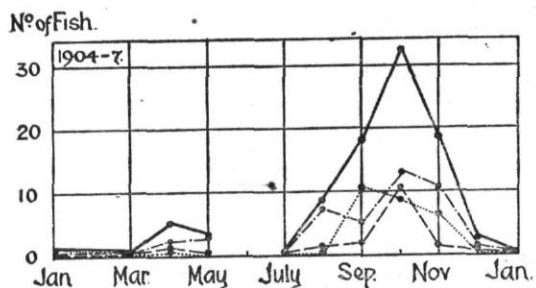


FIG. 18.—SOLES. Area H. Monthly Averages, 1904–1907. Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

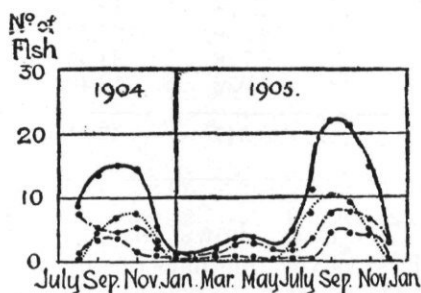


FIG. 19.—SOLES. Area H. Monthly Averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

Area H.—In this area soles are extremely scarce or altogether absent in the winter and spring; in the summer their numbers are considerably increased and they become comparatively numerous in the autumn. The quantities caught from January to March are almost negligible. There appears to be a small maximum in April (averaging 5·3 soles (Fig. 18)). After July there is a sharp, regular and definite increase to a maximum in October in which month the averages are as much as 32. There is a decided drop to November and December, although in one instance (1907) the November catch is very high (82). Most of these figures are based on the fishing of 1904 and 1905, and in some

[illegible]

TABLE VIII. (continued)—SHOWING for each area the Monthly Average Number of SOLES caught per 10 hours' fishing; large (L.), medium (M.), and small (S.) being distinguished. The monthly total number of hours' fishing in each area, to the nearest hour, is given as an index number.

| Group. | Area. | Year. | January. | | | | February. | | | | March. | | | | April. | | | | May. | | | | June. | | | | July. | | | | August. | | | | September. | | | | October. | | | | November. | | | | December. | | | | Area. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|----------------|--------|----------|------|------|--------------------|-------------------|------|------|---------------------|--------|------|------|---------------------|--------------------|-----|-----|--------------------|------|------|------------------|---------------------|-------|---------------------|------------------|---------------------|---------------------|---------------------|-------------------|----------------------|---------------------|---------------------|------|----------------------|--------------------|---------------------|------|---------------------|--------------------|---------------------|--------------------|---------------------|-------------------|-------------------|--------------------|----------------------|--------------------|------|--------------------|----------------------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| | | | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | L. | M. | S. | All Sizes. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SOUTHERN AREAS. | S | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1·9 | 17·0 | 22·2 | 41·1 ²¹⁶ | 4·6 | 15·0 | 16·3 | 35·9 ³⁴⁵ | 0·1 | 21·1 | 20·3 | 41·5 ⁴⁵⁴ | 0·0 | 38·4 | 29·2 | 67·6 ¹⁰⁰ | 0·0 | 43·3 | 25·4 | 68·7 ¹⁰³ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | S | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2·6 | 5·7 | 6·0 | 14·3 ⁶¹⁷ | 1·5 | 8·2 | 3·6 | 13·4 ⁷⁴⁹ | 0·0 | 54·4 | 7·1 | 61·6 ⁴⁵ | 30·0 | 5·0 | 0·0 | 35·3 ⁰⁴ | 4·7 | 4·7 | 2·4 | 11·8 ⁸ | 19·3 | 7·4 | 0·0 | 26·7 ¹³ | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1906 | ... | ... | ... | ... | 0·0 | 32·7 | 18·2 | 50·9 ⁵ | 5·7 | 2·8 | 1·1 | 19·6 ⁹² | 0·9 | 3·6 | 1·8 | 6·2 ²² | 0·0 | 0·0 | 0·0 | 0·0 ⁷ | 5·8 | 2·7 | 0·4 | 8·9 ⁵⁵ | 1·0 | 4·1 | 0·2 | 5·3 ⁵³ | 7·0 | 7·2 | 1·1 | 15·4 ¹⁰⁶ | 0·0 | 12·2 | 5·1 | 17·3 ²²⁰ | 3·2 | 9·0 | 2·1 | 14·3 ³⁶ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1·1 | 17·7 | 11·3 | 30·1 ⁴⁶¹ | 1·5 | 7·6 | 6·0 | 15·1 ³⁴⁸ | 0·0 | 7·7 | 4·5 | 12·1 ²⁷¹ | ... | ... | ... | ... | ... | ... | ... | ... | 16·3 | 8·8 | 5·0 | 30·0 ¹⁶ | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1904-7 | ... | ... | ... | ... | [0·0 | 32·7 | 18·2 | 50·9 ⁵] | 5·7 | 2·8 | 1·1 | 19·6 ⁹² | 0·9 | 3·6 | 1·8 | 6·2 ²² | 1·1 | 17·4 | 11·1 | 29·6 ⁴⁶⁸ | 2·0 | 10·4 | 11·1 | 23·6 ⁶¹⁹ | 2·5 | 8·4 | 8·0 | 19·0 ¹³¹⁶ | 1·5 | 12·6 | 9·2 | 23·3 ¹³⁰³ | 0·0 | 24·6 | 12·0 | 36·5 ³⁶⁵ | 1·8 | 30·5 | 16·8 | 49·1 ¹⁶³ | 12·2 | 7·3 | 4·1 | 23·7 ²⁴ | 19·3 | 7·4 | 0·0 | 26·7 ¹³ | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | T | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1·5 | 0·0 | 10·8 | 12·8 ¹³ | 0·0 | 10·0 | 3·3 | 13·3 ⁸⁴ | 10·0 | 10·0 | 0·0 | 20·0 ¹⁰ | 0·0 | 15·0 | 10·0 | 25·0 ⁸ | 0·0 | 72·5 | 42·5 | 115·0 ⁸ | ... | ... | ... | ... | 8·0 | 16·0 | 1·8 | 25·8 ²² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | T | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2·2 | 2·5 | 0·4 | 5·0 ⁵⁵ | ... | ... | ... | ... | 0·0 | 3·7 | 4·9 | 8·7 ⁴⁸ | 0·0 | 38·6 | 1·8 | 40·4 ²⁹ | 34·2 | 13·0 | 0·0 | 47·2 ¹⁰⁰ | 27·8 | 7·8 | 0·6 | 36·2 ¹⁷⁷ | 24·5 | 8·9 | 2·0 | 35·4 ³⁴³ | 33·0 | 11·8 | 3·2 | 48·0 ³⁴⁰ | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1906 | | ... | ... | ... | ... | 10·8 | 6·2 | 1·9 | 18·9 ⁹⁶ | 4·4 | 4·2 | 0·8 | 19·4 ⁵² | 2·3 | 1·7 | 0·2 | 4·2 ¹¹² | 1·9 | 1·9 | 0·4 | 4·2 ⁵³ | 7·0 | 1·9 | 0·6 | 9·5 ⁹⁷ | 9·8 | 1·3 | 0·2 | 11·4 ¹⁸¹ | 16·1 | 3·8 | 1·5 | 21·4 ⁹⁰ | 15·9 | 5·3 | 0·5 | 21·7 ³³ | 22·3 | 6·1 | 0·2 | 28·6 ²³⁵ | (10·2 | 0·0 | 0·0 | 10·2 ²⁷) | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1907 | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4·7 | 1·6 | 2·6 | 8·8 ³⁹ | 0·8 | 1·6 | 2·4 | 4·8 ²⁵ | 5·9 | 0·7 | 3·5 | 10·1 ¹⁴³ | 3·5 | 0·0 | 1·1 | 4·6 ⁹¹ | ... | ... | ... | ... | 11·0 | 7·0 | 5·0 | 23·0 ²⁰ | 13·2 | 0·0 | 3·8 | 22·0 ⁶⁴ | 27·9 | 7·5 | 8·9 | 44·3 ²¹² | (13·3 | 8·3 | 6·7 | 23·3 ¹²) | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1904-7 | | ... | ... | ... | ... | 10·8 | 6·2 | 1·9 | 18·9 ⁹⁶ | 4·4 | 4·2 | 0·8 | 19·4 ⁵² | 2·9 | 1·7 | 0·8 | 5·4 ¹⁵¹ | 1·8 | 1·9 | 1·6 | 5·3 ¹⁴⁵ | 5·8 | 2·0 | 2·4 | 10·2 ²⁶⁴ | 6·7 | 1·6 | 1·1 | 9·4 ³³⁰ | 8·2 | 19·8 | 2·0 | 30·0 ¹⁷⁷ | 23·5 | 11·7 | 2·3 | 37·4 ²¹¹ | 23·6 | 5·7 | 0·9 | 30·2 ⁴⁵⁵ | 24·4 | 8·3 | 4·3 | 37·0 ⁶⁰⁴ | 32·3 | 11·6 | 3·4 | 47·3 ³⁵² | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | V | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1·7 | 3·1 | 0·3 | 5·2 ¹³¹ | 1·7 | 4·4 | 0·1 | 6·2 ⁸⁶ | 34·9 | 2·6 | 0·0 | 37·6 ⁴⁵ | ... | ... | ... | ... | 7·4 | 0·0 | 0·0 | 7·4 ¹³ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | V | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | 9·6 | 0·0 | 3·2 | 12·8 ²⁵ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1·5 | 0·2 | 0·0 | 1·7 ¹⁰⁸ | 12·5 | 14·6 | 0·0 | 27·1 ²⁹ | ... | ... | ... | ... | 0·7 | 0·0 | 0·0 | 0·7 ²⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1906 | 1·5 | 9·4 | 6·0 | 16·9 ⁵⁹ | 4·4 | 0·0 | 0·0 | 4·4 ⁴ | 2·5 | 7·3 | 3·5 | 13·3 ³⁵⁰ | 1·6 | 2·9 | 1·1 | 5·6 ³⁸ | ... | ... | ... | ... | 0·0 | 1·7 | 0·0 | 1·7 ¹² | 1·1 | 1·3 | 0·0 | 2·5 ⁵³ | 19·8 | 0·4 | 0·0 | 20·2 ⁴⁹ | 22·8 | 0·9 | 0·0 | 23·7 ⁴⁷ | 6·1 | 0·0 | 0·0 | 6·1 ¹⁶ | 7·0 | 0·0 | 0·0 | 7·0 ¹² | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·0 | 0·0 | 0·0 | 0·0 ⁴ | 5·0 | 2·5 | 0·0 | 7·5 ⁵ | 3·6 | 0·3 | 0·0 | 4·0 ⁵⁵ | ... | ... | ... | ... | ... | ... | ... | ... | 27·9 | 1·9 | 0·6 | 30·4 ⁹⁴ | 19·3 | 0·7 | 0·0 | 20·0 ⁸⁵ | 9·1 | 1·6 | 0·0 | 10·7 ⁴⁵ | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1904-7 | 1·5 | 9·4 | 6·0 | 16·9 ⁵⁹ | 4·4 | 0·0 | 0·0 | 4·4 ⁴ | 4·2 | 5·5 | 3·4 | 13·2 ¹⁰³ | 1·6 | 2·9 | 1·1 | 5·6 ³⁸ | 0·0 | 0·0 | 0·0 | 0·0 ⁴ | 2·0 | 2·0 | 0·0 | 4·0 ²⁰ | 1·9 | 1·5 | 0·1 | 3·5 ³⁴⁷ | 9·0 | 5·0 | 0·1 | 14·0 ¹⁶⁴ | 23·8 | 1·7 | 0·0 | 30·5 ⁹² | 19·8 | 1·3 | 0·4 | 21·5 ¹³⁵ | 13·6 | 0·4 | 0·0 | 14·0 ⁵³ | 9·1 | 1·6 | 0·0 | 10·7 ⁴⁵ | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | WESTERN AREAS. | E | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 1906 | 0·0 | 12·9 | 33·5 | 46·5 ⁸ | ... | ... | ... | ... | 0·0 | 53·3 | 66·7 | 120·0 ⁷ | ... | ... | ... | ... | ... | ... | ... | ... | 0·0 | 45·4 | 8·6 | 54·1 ¹⁸ | 0·0 | 17·4 | 115·7 | 133·0 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1907 | | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1904-7 | | | 0·0 | 12·9 | 33·5 | 46·5 ⁸ | ... | ... | ... | ... | 0·0 | 53·3 | 66·7 | 120·0 ⁷ | ... | ... | ... | ... | ... | ... | ... | ... | 0·0 | 45·4 | 8·6 | 54·1 ¹⁸ | 0·0 | 17·4 | 115·7 | 133·0 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| R | | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |

months of 1905 alone (Fig. 19). The average catch per month is 1.77 large, 4.36 medium, and 2.85 small, whence we see that medium fish form the largest proportion, or 48 per cent. of the total, while small form 32 per cent., and large, 20 per cent. of the whole.

During tabulation, some points were noticed which either confirm the general features of the curve or help to explain anomalous ones. In December, 1904, and January, 1905, there were scarcely any soles. In April there were few, but they were more numerous in the shallower parts (about ten fathoms) of this area. This probably explains the small maximum on the curve.

In October, 1904, there were large numbers (from 8 to 10 pairs in each haul) which decreased regularly and steadily throughout November to one or two in each haul. This decrease continued till the 8th December, after which, scarcely any were taken. In October, 1905, they appeared in good numbers in the beginning of the month, and about the middle of the month became much more numerous, and very large catches were made.

Area M.—The grounds contained in this area (Sylt, Amrum, Horn Reef South, &c.) are pre-eminently sole-fishing grounds in the summer and stand first and foremost amongst the areas in this region for their yield of soles. The large catches of soles made here, together with an abundance of plaice no doubt well justify the large proportion of the fishing time that is spent here by some fishermen, including the time spent in voyaging across the North Sea from Grimsby to the distant eastern fishing grounds. The catches are so large that the curves for this area, Figs. 20 and 21, are drawn on a much smaller scale than the others. The average of the 11 months is 68.8.

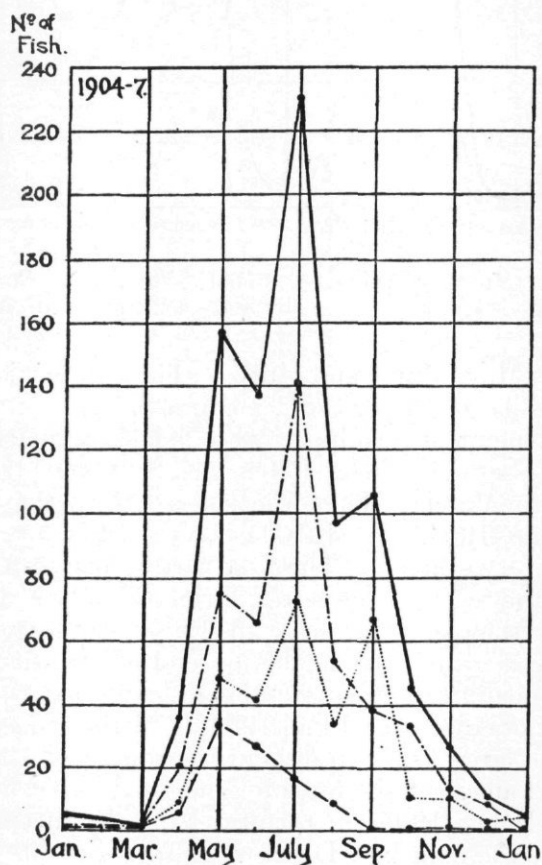


FIG. 20.—SOLES. Area M. Monthly Averages, 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line, small.

This area is characterised by the great difference that exists between the abundance at the maximum and minimum periods. In the early months of the year the catches are exceedingly small—being little more than one in ten hours fishing—then after March a great influx of soles occurs suddenly and this continues till July, when the total catch of all sizes reaches 230, a number which is not exceeded at any other time or in any other area. This sudden rise is checked by a slight fall from May to June, which occurs in each year though it is of but a small extent. After July there is an extremely sudden fall to August and then the curve descends gradually to December, after which the catches, as stated above, become insignificantly small.

Large fish are not comparatively abundant in this area. They are absent from September to March. They reach their greatest number in May, when there are 33 large

out of a total of 158. At this period a large number of soles are spawning on this very ground and it is the height of the season. They then decline steadily till September. For the rest, small soles considerably exceed the large, and medium are still more

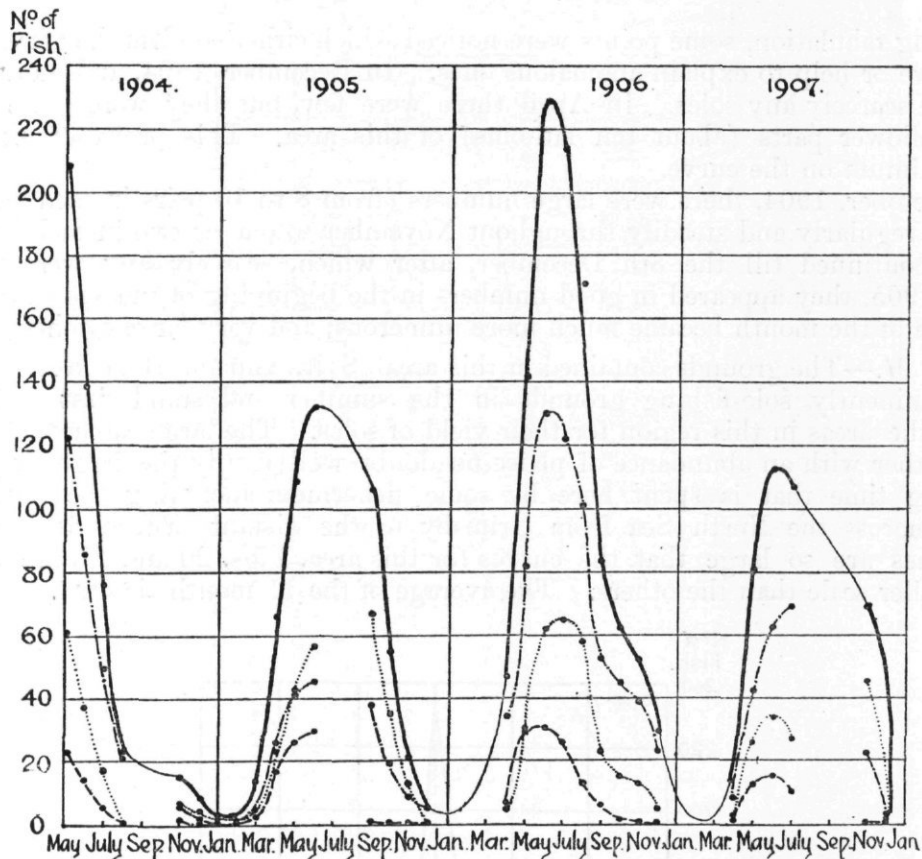


FIG. 21.—SOLES. Area M. Monthly Averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, large fish ; dot and dash line, medium ; dotted line small.

numerous, especially in May, June and July. The proportions calculated from the averages are as follows :—large 13 per cent., medium 47 per cent., and small 40 per cent. The following is the statement of a skipper who fished regularly on this ground each year, and for many years previously :—“ On the Sylt and Horn Reef grounds there are no soles there up to March. Then the soles occupy the ground until the end of May.” This was in June, 1904. In July he says : “ Fish are getting very scarce here now. Soles are getting very scarce.” The first part of his statement is correct but his own figures tell against the truth of the latter, for most of the July records are those of this particular man and they show, at least in 1906, *very* large catches. Probably the statement referred to a scarcity of soles in the more off-shore parts of this area.

Large numbers of medium and large soles are recorded as spawning in April, May and June. There was noticeable in June, 1904, a distinct decrease in the number of soles, mostly amongst the large fish, throughout the course of the month. In July, this trend was not maintained amongst the medium and small sized fish.

During the course of May, 1905, the quantities of soles increased enormously between the beginning and end of the month. There was also noticeable in another set of records a difference in the catches from various depths. On the Horn Reef South ground where the depths are 14–17 fathoms, few soles were found and these were mostly medium, but in 9–12 fathoms a little later on, all sizes of fish were present in great numbers, and of these, the large and medium ones were spawning. Exactly the same phenomenon was observed in another man's records of fishing at the same time. In June, 1905, the number of soles had increased and again it was especially in the shallower water (10–11 fathoms), that there was a large number of spawning fish. In all depths the numbers decreased in the latter part of the month. In several hauls in July, 1907, and in a few in June, a skipper took a large number of “ very small soles.” There would be about 15 or 20 pairs in each haul, and these have not been included in the figures, as there is a great probability of their being, not small soles, but solenettes (*Solea lutea*).

To judge of the fluctuations in the catch year by year, we have a very good number of months for comparison. A first glance at Figure 21 and at the corresponding averages shows us that 1906 has very much larger catches than most of the other years, and the following

figures are also telling. 1906 is greater than 1904, four times out of five ; than 1905, five times out of five ; and than 1907, six times out of six. 1907 is less than 1904 and also less than 1905 in three times out of five.

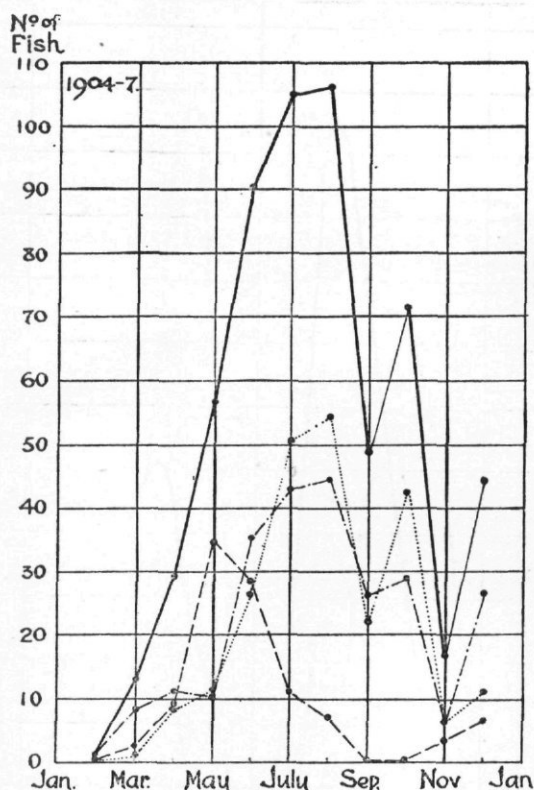


FIG. 22.—SOLES. Area Q. Monthly averages, 1904-1907. Continuous line represents all sizes combined ; dashed line, large fish ; dash and dot line, medium ; dotted line, small.

Area Q.—It presents in regard to the catches of soles, many similar features to the area M, to which it is also comparable in respect to its depth and relation to the coast. The main feature of the curve (Fig. 22) as in the previous area, is a single annual ebb and flow in the stock of soles with the maximum abundance occurring somewhat later in the summer.

The numbers caught, though large, by no means equal those of M, the average of the five months May to September, being a little over one-half that of the corresponding months in M. The average of the 11 months is 53.1. The rise from 1.3 in February to 106.1 in August is very steady and regular. After this month the curve descends to the winter minimum irregularly, the amount of fishing in the last three months being very small and the averages therefore unreliable.

Medium and small soles are of about equal frequency (41.6 per cent., and 40.3 per cent., respectively) and their fluctuations agree with each other and with those of the general curve, but large soles (18.1 per cent. of the total) behave differently. In common with the other sizes, they partake of the general movement into this area until May, when their numbers form the largest part of the catch ; then, instead of continuing in the general rise till August, they diminish in numbers by degrees till, in September, they are absent altogether. In May, 1907 this departure is particularly noticed to take place just at the beginning of the month. In August, 1905, a series of hauls was made on the Eider ground. The catches here were large, but consisted entirely of medium and small soles.

The numbers increased considerably between July and August 1905 on the Heligoland ground. Most of the 1907 fishing took place on the Terschelling ground, as did also the fishing during October, 1906, which as well as October, 1907, yields a high average.

In a comparison of the yearly averages we find that 1907 is perhaps the worst year of the four.

Area W.—The few hauls made during the spring and summer in this area can show us no more than that very fair numbers of soles were to be taken on this ground and that large fish are present during the spring months only, decreasing from May onwards ; the catch in the later months consisted entirely of small and medium. The highest number in any month is 26 in one haul in September. The other averages are under 50 per ten hours.

These areas are characterised by one large wave of immigration of soles during the year, culminating in very large catches, in summer for two of them, and in October for

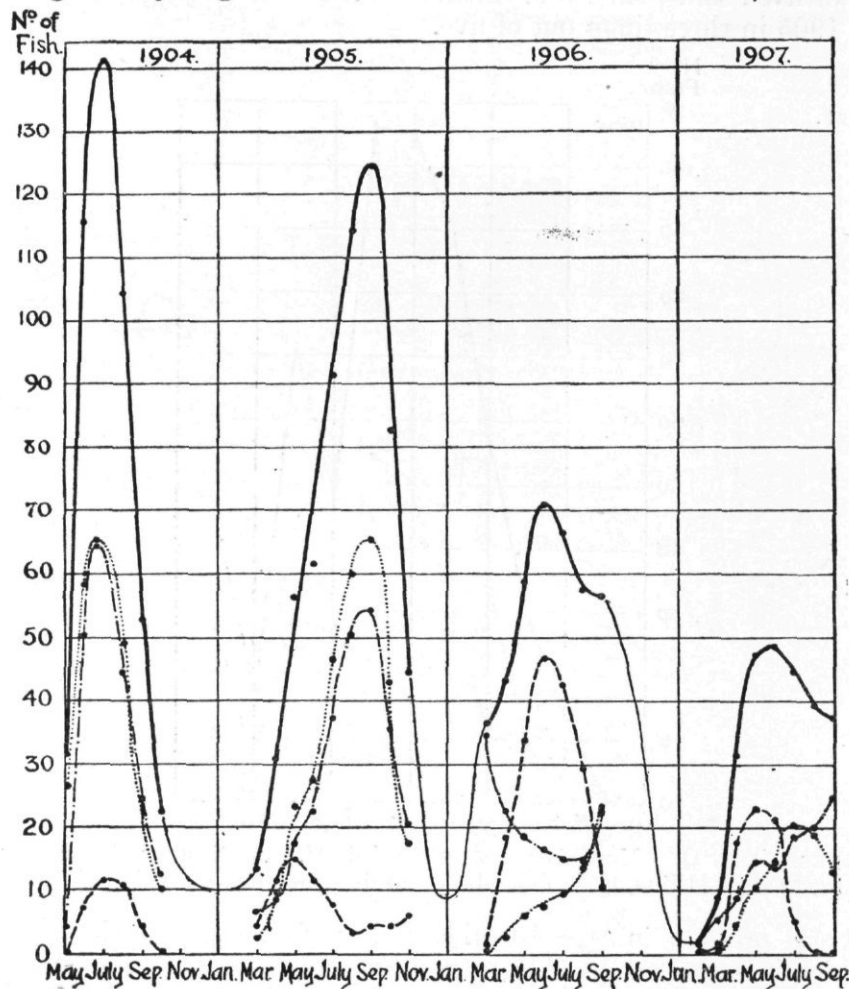


FIG. 23.—SOLES. Area Q. Monthly averages (smoothed curves). Continuous line represents all sizes; dashed line, large fish; dash and dot line, medium; dotted line, small.

the third (Horn Reef North). In order of importance M comes first, then Q and then W and H. In the winter, soles are practically absent from these grounds. Medium and

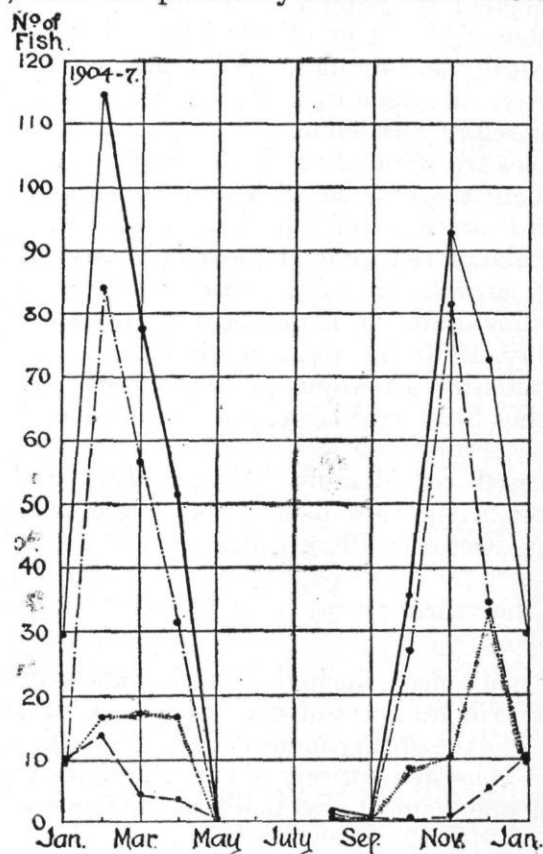


FIG. 24.—SOLES. Area J. Monthly Averages, 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

small fish predominate in the catches. Large fish appear more during the spring spawning season and their departure commences earlier, about June, just after the spawning period. Where we could make reliable comparisons it was found that 1906 had much larger catches than the other years—1904 and 1905 were fairly alike—and 1907 was the worst.

Central Areas.

Area J.—Soles are very plentiful here at certain times of the year and absent at others, and like the adjacent inshore areas, H and M, the area is characterised by the great difference in its maximum and minimum catches, and by the annual ebb and flow in its stock of fish. The average catches of May, August and September are all very low, and presumably too, those of June and July also, though there are no records in these two months. But we might expect it to be so, as the coastal areas are at this time so well stocked with fish, and the trend of the curve (Fig. 24) points to absence in the summer. The curve ascends rapidly from October onwards, showing that soles are quickly appearing in these waters as the cold weather approaches. They probably come from M through area H, for the maximum in H comes later than in M and about November they begin to disappear rapidly in H and to appear quickly in J. December should be the maximum month and not November, as one would suppose from the curve (Fig. 24). These irregularities are smoothed out in the smoothed curve (Fig. 25).

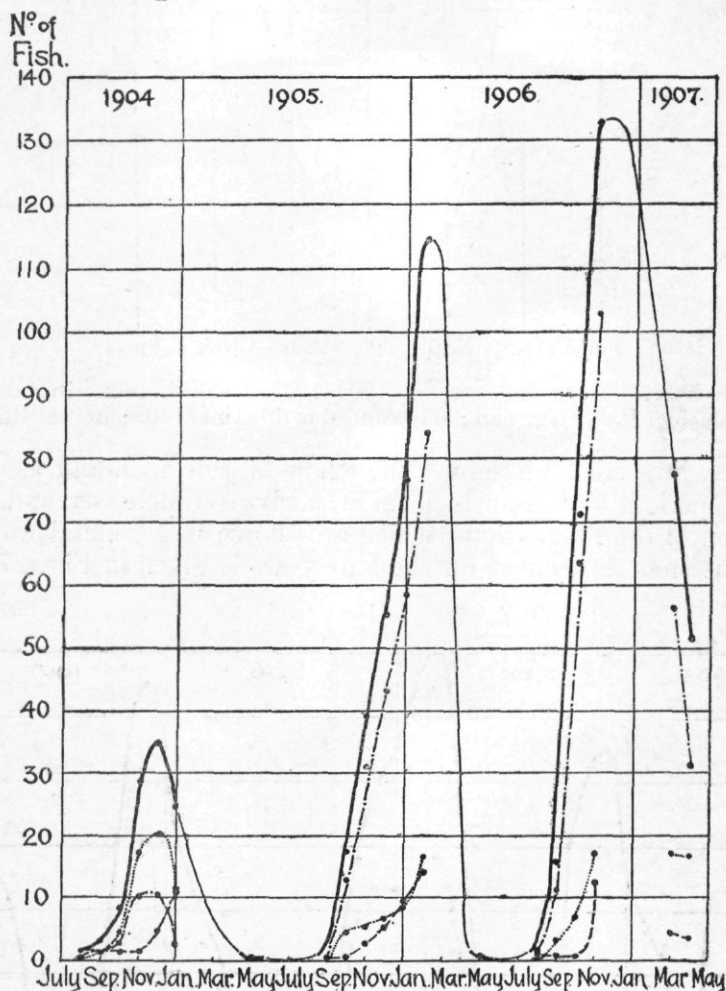


FIG. 25.—SOLES. Area J. Monthly averages (smoothed curves.) Continuous line represents all sizes combined ; dashed line, large fish ; dash and dot line, medium ; dotted line, small.

Following the course of the figures for each year separately, one finds that December is really greater than November, while the fact that there was a greater amount of fishing in November, 1906, and less in December, 1906, compared with the other years, and the catches in this year were extraordinarily large, makes the November general average appear considerably higher than that of December.

The January catches are low, but they are based on the fishing in only two years and may not be altogether representative. The very high value for February represents the average catch of ten hauls in February, 1906, on the edge of the Oyster ground. The averages in the succeeding months show that soles leave these grounds at the approach of spring and summer, so that, when May arrives, they are almost all gone.

Soles of a medium size predominate in the catches and form 68·1 per cent. of the total. Large soles (8·4 per cent.) are numerically less than slips (23·5 per cent.).

In December, 1904, we find from the individual records that soles appear relatively numerous about the 21st of the month, "Outside the Mud." The shoals include large soles, which were absent in hauls made "In the Mud." In December, 1905, we notice the same feature in another set of records.

We have only three years for a comparison of the yearly fluctuations. The 1905 monthly averages are a little greater than those of 1904. 1906 had much higher averages than the other two years, and was by far the best of the three. The ground was not fished much in 1907, so this year cannot be compared with the others.

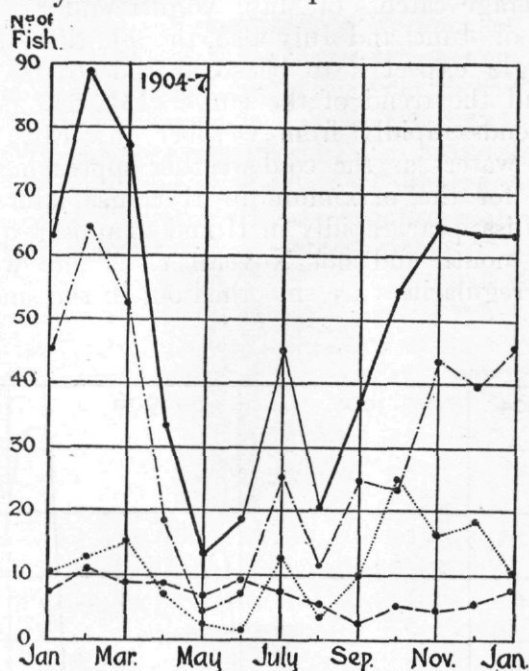


FIG. 26.—SOLES. Area N. Monthly averages 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

Area N.—Trawling takes place over the whole of this area, and as it has been well fished during this period, the records form a fairly complete set and allow of a very detailed examination of the fluctuations, which are shown in a general way in Fig. 26.

The continuous smoothed curve for the four years is given in Fig. 27.

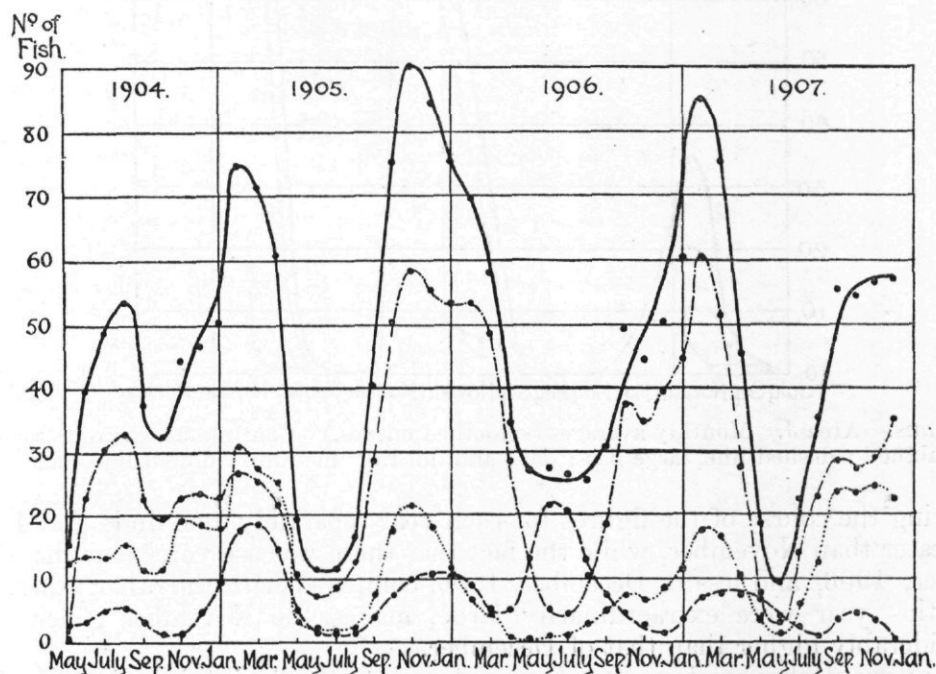


FIG. 27.—SOLES. Area N. Monthly averages (smoothed curves.) Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

At a glance we gather that with the exception of 1904, the summer averages in each year are very low while the winter and autumn averages are high. In fact the phenomena

are very similar to those described for area J, with the difference that the averages never get quite so large, nor do they decrease to such a great extent as do those of that area.

The June, July and August catches are generally small in the greater part of this area, but in July 1904 there is a high average of 86.6 based on 205 hours fishing. An examination of the individual records shows that most of this took place in the Terschelling Mud ground, just over the 20-fathom line. This is during the period of greatest abundance in area Q, and this ground which is but a continuation of that in area Q into slightly deeper water (20–21 fathoms), partakes of this abundance.

The August hauls of 1904 and 1907 were also made in the same place, so that the fact that these are so high compared with the other years is thus explained. Hauls made further out in this area at the same time yield very few soles. Now the July catches of 1904 predominate in the general average and thus form the apparent maximum and the cusp that appears on the general curve (Fig. 26). And also some of the hauls in July, 1906, were made in Terschelling Mud, a fact which helps to bring about the same result.

The maximum periods come late in 1904–5 (March, 1905) and early in winter 1905–6 (November, 1905), and late in the winter of 1906–7 (February, 1907). There is a slight fall between the November and December values and a secondary rise in February. The catches begin to decline after February and March and there is a rapid fall to the minimum in May or June.

The number of large soles is small and remains fairly constant throughout the year. The monthly general averages vary between 2 and 11 (per 10 hours). Slips are slightly more numerous, the averages fluctuating between 2 in June and 25 in October. Medium soles, as in area J, form the chief population, but they are not so numerous proportionally as they are in that area.

The question of yearly variations is somewhat complicated by the presence of hauls in grounds (*e.g.*, Terschelling Mud) which do not partake of the general character of the whole, and show decrease in the stock in the summer. The curves in Fig. 27 do not show any evidence of a distinct change in the stock of fish between each year. 1907 seems to have had larger catches in the early months of the year than either 1905 or 1906. This may be because the movement into deeper water was retarded till this time as we find that the October to December averages of 1906 were comparatively low.

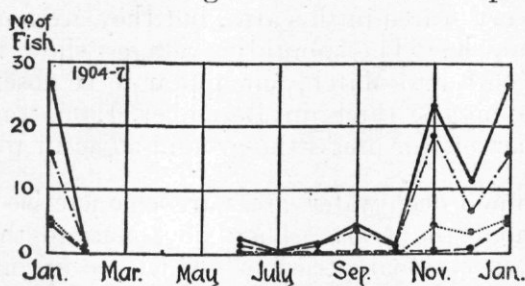


FIG. 28.—SOLES. Area I. Monthly averages 1904–1907. Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

Area I.—Soles do not seem to penetrate much further offshore than the outer boundary of N, for we find a striking difference in the abundance in these two adjacent areas. The quantities found in I are *very* small, and it is only in the winter that appreciable catches are made (Fig. 28). Unfortunately we have no records from March to May, but we may presume that the catches are small, as at this time the shoals are moving rapidly out of N towards the inshore spawning areas (M and Q).

Soles approach this area and are found more plentifully in the winter when they appear to become localised and not distributed at all evenly over the whole area. The large catches in December, 1905, and the next month (January, 1906) were all made in the Clay Deep. The December hauls of 1904 sometimes contain very few soles, and at other times a very fair number. They seem to avoid the Lower Scruff in this month, and also the “Hard ground at the east end of the Pits.” They are generally absent in the summer, but in September, 1907, several pairs were taken in each haul in the Lower Scruff. In each year they become comparatively abundant in November.

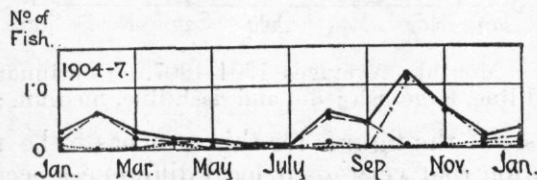


FIG. 29.—SOLES. Area O. Monthly averages, 1904–1907. Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

The relative abundance of large, medium, and small fish is very similar to that of N, *i.e.*, medium come first—then small, and then large.

Area O.—The occurrence of soles on the Dogger Bank is very rare. From the table (Table VIII.) we see that 2·3 per ten hours in October, 1905, is the highest average catch obtained. More often they are wholly absent or almost so. They appear in greater numbers in 1905 than in 1904, and also than in 1906 and 1907 in the months in which we can compare them. Evidence as to seasonal fluctuations can be obtained from the 1905 averages. There is a direct fall from January to June and July, and increasing quantities till October, after which they diminish again, see Fig. 29. Small fish occur only as exceptions. Most of the fish present are classed as medium.

Of these central areas those lying next to the coastal grounds have large quantities of soles, sometimes averaging over ten per hour. In contrast to these, the more central grounds, I and O, are very ill-stocked, especially O. All areas show a definite seasonal fluctuation—broadly speaking, it is that of absence in summer and abundance in winter, with decreasing and increasing quantities in the spring and autumn respectively. The minor fluctuations on the curves, due to some extent to local differences in each area, are not sufficient to hide the main features of these areas in respect of the movement of soles. The summer minimum lasts a shorter time in N, nearest the coastal grounds, than in the other areas, and the complementary period of greater abundance lasts much longer in this area, showing that the fish do not stay in the more offshore areas for any length of time.

Northern Areas.—Below the Dogger.

Area D.—Soles are practically absent from this ground, the only records being of a few isolated ones caught in the early months of the year (January to March). These are mostly large fish, and are so few, numbering only 10 fish caught during over 1,800 hours' fishing, that they may be regarded as exceptions to the general rule that soles are not to be found in this region of deep water.

Area K.—This area too is devoid of soles. One fish only was caught, and that in March, 1905.

Area L.—Soles are very scarce in this area, but they are found more frequently than in the adjacent areas D and K. The monthly averages show that they are present in small quantities from December to March, but appear to be absent during the remaining months of the year. The biggest catch, in December, 1905, was derived from fishing in the extreme south-west part of this area—the ground adjacent to areas P and O.

These three northern and deep-water areas are characterised by an almost complete absence of soles throughout the year. They do penetrate this region, however, and are found on rare and exceptional occasions, which occur only in the winter. The greatest proportion of these instances occur in the ground L, which is in proximity to the Dogger Bank, and the nearest of the three to the English coast.

Southern Areas.

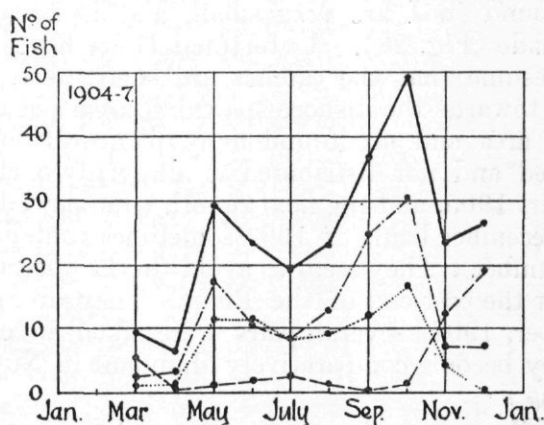


FIG. 30. SOLES. Area S. Monthly Averages 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dot and dash line, medium; dotted line small.

Area S.—The analysis of the figures for this area has to be made with especial care, for it was found in tabulation that very great local differences occur in the abundance of soles.

The general curve (Fig. 30) for the whole area shows maxima in May and October, the latter being the greatest, and the summer depression being only slight. This area as a whole gives only a moderate yield of soles which consists for the most part of medium and small fish.

Since considerable difference exists in the nature of the catches from the northern part of this area (New Zealand Ground and Tea Kettle Hole) and the south-eastern part (Brown Bank and Brown Ridges) it became advisable to retabulate the hauls from this area and group them according to the actual fishing grounds. Accordingly the area was subdivided into four regions, viz., (a) The Leman ground and the banks to the west of it, (b) The Botney Ground, New Zealand ground and Tea Kettle Hole, (c) The Brown Bank and Brown Ridges, (d) Winterton Twenties and Smith's Knoll. The monthly averages for these areas are given in table IX. From this we see that in 1904

TABLE IX.—Showing the monthly average number of SOLES per 10 hours fishing in the different fishing grounds of Area S. Large (L.), medium (M.), and small fish (S.), are distinguished. The number of hours fishing is given as an index number.

| Years. | Leman Ground. | | | | Botney, New Zealand Ground, Tea Kettle Hole. | | | | Brown Bank, Brown Ridges. | | | | Smith's Knoll, Winterton Twenties. | | | |
|--------------|---------------|------|------|---------------------|--|------|------|---------------------|---------------------------|------|------|---------------------|------------------------------------|------|------|---------------------|
| | L. | M. | S. | All. | L. | M. | S. | All. | L. | M. | S. | All. | L. | M. | S. | All. |
| 1904. | | | | | | | | | | | | | | | | |
| June... | 1.3 | 8.2 | 5.2 | 14.7 ⁴⁶ | 2.0 | 22.2 | 29.1 | 53.3 ¹²⁹ | 2.5 | 10.5 | 19.5 | 32.5 ⁴⁰ | — | — | — | — |
| July... | 7.5 | 15.5 | 18.5 | 41.5 ⁵⁰ | 2.7 | 19.2 | 30.2 | 52.1 ⁹⁰ | 4.3 | 12.7 | 8.8 | 25.2 ¹⁷⁵ | — | — | — | — |
| August... | 0.0 | 15.0 | 7.5 | 22.5 ⁸ | 0.2 | 29.2 | 38.2 | 67.6 ²⁰⁰ | 0.0 | 14.3 | 5.5 | 19.8 ¹⁷⁷ | 0.0 | 15.7 | 7.8 | 23.5 ⁶⁹ |
| September... | — | — | — | — | 0.0 | 46.9 | 35.3 | 82.2 ⁷² | (0.0 | 30.0 | 30.0 | 60.0 ⁴) | 0.0 | 14.2 | 10.8 | 25.0 ²⁴ |
| October... | (0.0 | 20.0 | 15.0 | 35.0 ⁴) | 0.0 | 44.2 | 25.9 | 70.1 ⁹⁹ | — | — | — | — | — | — | — | — |
| 1905. | | | | | | | | | | | | | | | | |
| July... | 2.0 | 6.5 | 5.7 | 14.3 ¹⁶⁸ | 0.6 | 14.4 | 17.8 | 32.8 ¹⁰⁰ | 3.5 | 2.7 | 2.8 | 9.0 ³⁰⁹ | 3.5 | 3.0 | 2.5 | 8.9 ⁴⁰ |
| August... | 2.7 | 9.0 | 2.7 | 14.5 ¹⁹⁷ | 0.0 | 13.5 | 22.8 | 36.3 ³³ | 1.0 | 8.8 | 2.4 | 12.3 ³⁴⁷ | 1.5 | 5.1 | 3.5 | 10.1 ¹⁷² |
| September... | — | — | — | — | 0.0 | 54.4 | 7.1 | 61.5 ⁴⁵ | — | — | — | — | — | — | — | — |
| 1906. | | | | | | | | | | | | | | | | |
| March... | 5.7 | 2.8 | 1.1 | 9.6 ⁹² | — | — | — | — | — | — | — | — | — | — | — | — |
| April... | 0.9 | 3.6 | 1.1 | 6.2 ²² | — | — | — | — | — | — | — | — | — | — | — | — |
| May... | 0.0 | 0.0 | 0.0 | 0.0 ⁷ | — | — | — | — | — | — | — | — | — | — | — | — |
| June... | 1.5 | 0.0 | 3.0 | 4.4 ¹⁴ | 7.2 | 3.4 | 0.0 | 10.6 ⁴¹ | — | — | — | — | — | — | — | — |
| July... | 0.0 | 3.7 | 0.3 | 4.0 ⁷⁵ | 10.0 | 8.0 | 0.0 | 18.0 ⁸ | — | — | — | — | — | — | — | — |
| August... | 6.9 | 7.3 | 1.2 | 15.4 ¹⁰² | (10.0 | 5.0 | 0.0 | 15.0 ⁴) | — | — | — | — | — | — | — | — |
| September... | 0.0 | 15.3 | 3.5 | 18.8 ¹²⁰ | 0.0 | 11.7 | 27.1 | 38.8 ²⁴ | (0.0 | 10.0 | 0.0 | 10.0 ⁴) | 0.0 | 7.4 | 0.8 | 8.3 ⁷² |
| October... | 21.2 | 18.8 | 4.7 | 44.7 ⁸ | 0.0 | 8.4 | 1.3 | 9.7 ³² | 0.0 | 5.0 | 2.5 | 7.5 ¹⁶ | — | — | — | — |
| 1907. | | | | | | | | | | | | | | | | |
| May... | — | — | — | — | 1.2 | 1.2 | 2.4 | 4.8 ¹⁷ | 0.3 | 12.2 | 9.9 | 22.3 ³⁸⁸ | 2.6 | 29.6 | 14.7 | 47.0 ¹⁵⁶ |
| June... | 5.0 | 2.5 | 2.5 | 10.0 ⁸ | 8.6 | 0.4 | 5.0 | 13.9 ⁵⁶ | 0.0 | 8.2 | 9.9 | 18.1 ¹⁷⁹ | 0.0 | 11.0 | 0.0 | 11.0 ¹⁰⁵ |
| July... | 0.0 | 8.2 | 5.1 | 13.2 ¹⁹¹ | 0.0 | 7.5 | 0.0 | 7.5 ¹² | 0.0 | 4.4 | 6.7 | 11.1 ³⁶ | 0.0 | 8.4 | 0.0 | 8.4 ³² |
| November... | 16.2 | 8.8 | 5.0 | 30.0 ¹⁶ | — | — | — | — | — | — | — | — | — | — | — | — |

and 1905, quite large numbers were taken in the north-eastern part of this area, the mean of the numbers in the five months June to October, 1904, being 65.1, of the 3 months July to September, 1905, being 43.5, while none of the other grounds yielded even half this amount. The differences between the other three sub-regions are not so significant, but when we compare the averages of corresponding months, we find that those of the Leman Ground are the highest. Between the Brown Bank region and Winterton Ground there is very little difference.

The differences in the catch of the corresponding months year by year are significant. In all cases those of 1904 are the highest, but there are too many gaps in the observations for us to be able to measure the decline, and to determine whether the catches for the whole year would show the same trend throughout the period as do those for the corresponding months.

The seasonal fluctuations are determinable only from the spring to autumn, as there is no winter fishing. In the Leman Ground, the spring and early summer catches (1906) are very low, but increased quantities are found in the summer and there is a maximum in the autumn. In 1904 there is a considerable increase between June and July. In the region consisting of the Botney Ground, New Zealand Ground and Tea Kettle Hole there is a maximum in September in three out of the four years, but the trend in the spring is not determinate. On the Brown Bank and Brown Ridges there is a decline from June to August in 1904, and from May to July in 1907. This May maximum is also shown in the averages in the adjacent southern sub-area, Winterton

Twenties, etc., where an average of 47.0 is attained, while the June and July averages are much lower. The statistics of the Lowestoft sailing trawlers show the fluctuations in the neighbourhood of the Brown Ridges, much more fully.* There we find a summer minimum, as is also indicated by these figures, and an autumn or early winter maximum.

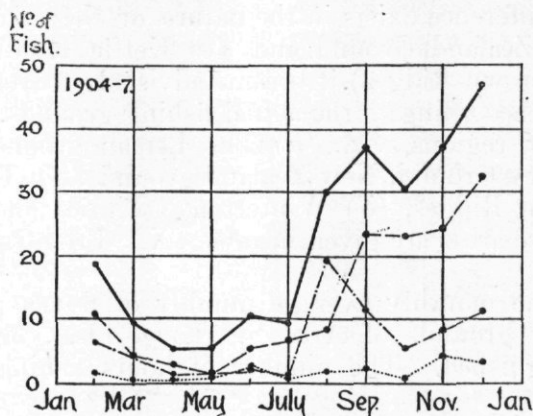


FIG. 31.—SOLES. Area T. Monthly averages 1904-1907.

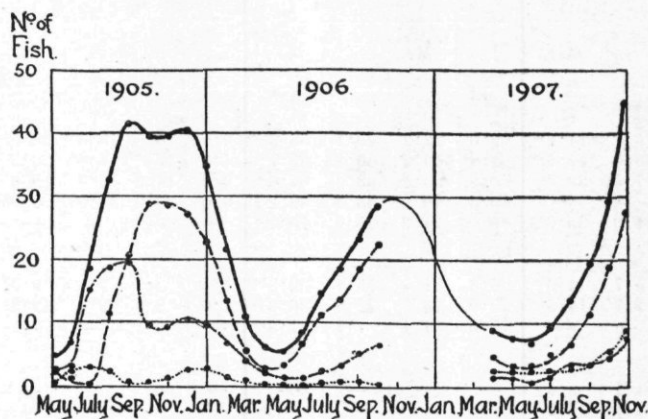


FIG. 32.—SOLES. Area T. Monthly averages (smoothed curve.)

Continuous line represents all sizes combined; dashed line, large fish; dash and dot line, medium; dotted line, small.

Area *T*.—Although in this area the depths are not uniform, the catches from the various localities are very comparable with one another. The monthly averages show a close resemblance in trend in all the years. (Fig. 32.)

The number of soles caught are of the same order as those of area *S*, i.e., they rise at their greatest to a maximum of about 40 or 50, and at the minimum they are 5.3 per 10 hours. The curve resulting from the combined averages (Fig. 31) is fairly smooth, and shows distinctly that there is a definite immigration into and emigration from this area, the immigration taking place in the summer and autumn, and the emigration in the spring. There is a regular decline in the average catch from February to April and May. The increase begins in June, is slow at first, but is very sudden between July and August, after which the curve continues to ascend till December. The months, September to December, are all high, the month of maximum not being exactly determined, but the trend of the smoothed curve in Fig. 32 indicates that it occurs in November or December. In this area large soles are apparently the most numerous class, especially after the time when the summer immigration begins. In the autumn and winter they form a large proportion of the catch. The number of small soles is quite insignificant. We have reason to suppose that this appearance on the curve, as well as that in area *V*, is to be explained to some extent by there being a personal bias in the judgment of the size. Most of the hauls are made by a certain skipper, who calls the majority of his soles large, while at the same time other skippers fishing in this area find a much smaller proportion of large soles, and many more medium and small. The figures for August, 1904 and 1905, are those in which this man's records do not appear, nor do the large soles. The number of times in which any of the other skippers fish in this area is very small,

* LEE.—Report on Lowestoft Sailing Trawler Records. *Internat. Inves. Mar. Biol. Ass. Report II., Part II.* Cd. 4641. p. 107.

so that the averages, especially those of the later months of the year, are based on his returns, and are influenced in regard to the relative proportions of the sizes by his judgment. For this reason we cannot arrive even at the approximate proportions of the three groups.

With regard to the yearly fluctuations we find 1906 to be a little less than 1907, while both years are on the whole somewhat less than 1905. 1904 cannot be compared with them.

Area V.—This area, including chiefly the Silver Pits, is not at present a good ground for soles when compared with the eastern areas, although some years ago it had the reputation of being well populated with this fish.* Only for two months in the year does the average exceed 15 (per ten hours).

The trend of the averages throughout the year, shows that there is a gradual decline from January to about July. There appears to be a great influx in August and a still greater one in September, but the fishing is very unrepresentative. The decline apparently begins in October, but it is doubtful whether this is the case as in 1907 a skipper made a few hauls in that month and got large catches about which he stated: "Soles are extra large in the Pits, their market value is not so good." His catches for November too are better than those of 1904 and 1906, but the number of hauls is so few that the averages for the last three months are most uncertain.

These southern grounds yield fairly good catches of soles. There are far more fish than in the northern grounds, but at their best they are only about half as productive as the eastern grounds. All three areas show seasonal fluctuations. A period of maximum abundance occurs in the autumn and winter with a corresponding depression in the spring and early summer. Area S has also a smaller secondary maximum about May or June, but here the phenomena are rather ill defined as great local differences are found to exist. Probably there is a northward movement of the soles from midsummer throughout area S, which is continued into T, for here the maximum comes somewhat later (about V we have no certain information for the winter). There is a considerable difference between the catches in the maximum and the minimum months (about 40 per 10 hours). Of the proportion of large, medium and small we have no reliable knowledge.

Western Areas.

Areas E.—The averages of hauls in this area, few as they are, show that very large catches of soles are to be found here. They approximate somewhat to the numbers caught on the continental side of the North Sea. The inshore parts of this ground are known to be one of the English nursery grounds for soles. No large fish were taken, all being medium and small. It is a curious fact that these hauls were all made by the same man, yet his proportions of medium and small vary greatly.

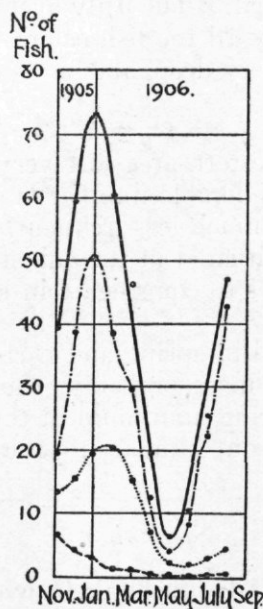


FIG. 33.—SOLES. Area R. Monthly Averages (smoothed curves). Continuous line represents all sizes; dashed line, large fish; dash and dot line, medium; dotted line, small.

Area R.—Seeing that this area is adjacent to an English nursery ground for soles, it

* Cf. Cunningham's Investigations in 1895, when from 3 to 10 boxes of soles was the usual quantity landed from the Silver Pits.

is not surprising to learn from the curves that it gives a good yield of soles. The catches are sometimes very high, the highest being over 80 in December and February, and the lowest about 3 (per 10 hours). There is indeed a period of comparative scarcity in April, May and June, but this minimum is of short duration. The September and October averages too are low, but they are calculated from so few records that they are probably more chance occurrences than representatives of the actual stock. This is very likely to be the case as they were taken in the extreme north-east part of this area, the Well Bank Flat. If we omit these two months' averages, the quantities would seem to rise till December. The course of the curve relies almost entirely upon the figures for 1906, when this area in particular was fished regularly by a single fisherman (Fig. 33). But the November and December averages are based on those of 1904 and 1905 (the latter mainly), and they call for more examination. Many hauls were made in and around the deep holes (Coal Pit and Sole Pit, &c.) which are to be found in this area, and the soles were found to be exceptionally numerous in them. In the deep pits from 40 to 50 pairs would sometimes be taken in one haul, while in the shallower water the number caught is generally under 10 pairs per haul. These very large catches appeared oftener in December than in November.

The same great variation is noticeable in the January and February catches of 1906. By April the numbers had diminished greatly, and in several hauls no soles were found. In May they were fewer still. Throughout June they increase slightly. In July and August still more.

The main features of the curve are the spring minimum of short duration and the winter maximum.

Area X.—The average catches of soles from January to June and July are comparatively low (< 9 per 10 hours). They increase rapidly to a very high maximum in October (50 per 10 hours). In this area as in some others there are considerable local differences, and it is difficult to determine the true course of the curve after October, for in November and December some averages are high and some low. The December average of 1905 is the average of hauls made in the Dogger Bight, where there are apparently few fish at this time of year. The relatively small catches of October and November, 1906, were also mostly from the Dogger Bight. On the January and February averages no reliance can be placed. One other fact is noticeable. In October, 1905, there were some exceptionally large catches. After getting an ordinary number of about 10 or 12 pairs in one haul, the skipper suddenly came across a large number, of say 40 pairs in one haul. These extraordinary catches which were all made on the Eastermost and Off grounds have raised the average for this month considerably. Large fish predominate in the catches except in April, May and June, the spawning season, but this may be explained by the fact that the greater number of these hauls were recorded by the fisherman, who as was mentioned above, seemed to be biased.

Area P.—Here we have very few hauls. One pair of soles was present in each of the single hauls taken in March and April. The July average is very low; that of September relatively much higher. Apparently all the fish caught were large. This is very likely to be the case as the water is here very deep, and as several skippers participated in the hauls there is probably no bias.

The records in some of these western areas are very incomplete, but they indicate as far as they go the presence of a considerable number of soles on the inshore and shallow grounds. In deeper water they are much less frequent, with the exception of those very deep holes, such as the N.E. Hole, situated in the midst of comparatively shallow water. The tendency is shown for the soles to congregate in large numbers in these deep holes, especially in the winter.

The minimum catches are found in spring and early summer in two of these areas (R and X), and the autumn and, most probably, the winter catches are high. It is possible and probable that the spring minimum in these areas is caused by a migration shorewards for the spawning season, similar to the one that occurs on the eastern grounds.

Spawning.

From the table showing the number of hauls in which spawning soles were recorded we obtain some very definite information (Table X). Obviously, the period April, May and June is the real spawning season, the maximum proportion of occurrences coming in May. The season in 1906 and 1907 may have been a little later than in 1904 and 1905, as we have in both years "Large and Medium Soles beginning to have roes" in April, and

* CUNNINGHAM. North Sea Investigations. *Journ. Mar. Biol. Ass.*, Vol. IV., 1895, p. 13.

in May the "Large and Medium Soles are full and nearly ripe for spawning." Occasionally, but rarely, a few slips are recorded as spawning.

TABLE X.—Showing number of hauls in which spawning SOLES are recorded.

| Area. | | | | I. | J. | L. | M. | N. | O. | Q. | X. |
|----------|------|-----|-----|----------------|---------------|----------------|-------------------|----------------|-----------------|----------------|---------------|
| May | 1904 | ... | ... | — | — | — | $\frac{10}{18}$ | — | — | — | — |
| June | " | ... | ... | — | — | — | $\frac{2}{71}$ | — | — | — | — |
| December | " | ... | ... | $\frac{7}{53}$ | — | — | — | — | — | — | — |
| January | 1905 | ... | ... | $\frac{1}{5}$ | $\frac{3}{4}$ | — | — | — | — | — | — |
| February | " | ... | ... | — | — | $\frac{3}{13}$ | — | — | — | — | — |
| March | " | ... | ... | — | — | $\frac{2}{5}$ | — | — | — | $\frac{2}{21}$ | $\frac{1}{2}$ |
| April | " | ... | ... | — | — | — | $\frac{44}{51}$ | $\frac{1}{14}$ | $\frac{2}{105}$ | — | — |
| May | " | ... | ... | — | — | — | $\frac{177}{208}$ | — | — | — | — |
| June | " | ... | ... | — | — | — | $\frac{66}{81}$ | — | — | — | — |
| April | 1906 | ... | ... | — | — | — | * | — | — | — | — |
| May | " | ... | ... | — | — | — | § | — | — | — | — |
| June | " | ... | ... | — | — | — | $\frac{15}{22}$ | $\frac{1}{19}$ | — | $\frac{7}{26}$ | — |
| April | 1907 | ... | ... | — | — | — | * | — | — | — | — |
| May | " | ... | ... | — | — | — | § | — | — | — | — |
| June | " | ... | ... | — | — | — | $\frac{3}{9}$ | — | — | — | — |

* "Large and medium soles beginning to have roes."

§ "Very full of spawn."

The number of hauls in which spawning soles are recorded is given as the numerator of a fraction of which the denominator is the total number of hauls in the area during the month.

Undoubtedly the most important spawning grounds of the soles are found in area M, where not only are most of the hauls with spawning soles made, but also the fish are here very numerous and a great portion of the catch, at least of the large and medium fish, are recorded as spawning. A few are also found in area Q. The soles are thus found to seek shallow water at their spawning season.

These figures yield no information as to the spawning grounds on the English coast, as hardly any fishing took place in the shallow waters off the Lincolnshire coast, but we know that spawning soles are found in large numbers in the shallow flats off Lowestoft.*

We have in 1905 a few instances of spawning fish in some of the more offshore areas. These cases are in January to April and are in all probability of fish not spawning but "maturing" and making their way towards the shallow water for the purpose of spawning.

Summary.—Soles.

a. Distribution.—The general comparative abundance of soles is displayed by the chart in Fig. 34, which also shows in what season the fish were most abundant in the various areas.

This shows that the inshore grounds off the coasts of Denmark and Germany are very well stocked with soles and supply much the greatest average catch. With the exception of area J, which has in some parts, more especially in the south-east, much larger catches than its adjacent inshore area H, though less than M to which it is also adjacent, the quantities diminish as we proceed further and further offshore into deeper water. On the western side there are indications of large quantities in the shallow grounds off the English coast, but the material does not supply us with sufficient information to enable us to examine the conditions of distribution in that part very precisely. However, area R is found to compare well with N on the eastern side in regard to its maximum yield. The coastal waters off the north-east coast of England are not investigated, so they are not included in the following statement.

An imaginary line drawn from the north-west corner of area H to the end of the line dividing I and N, and continued along this line through areas V and X to Flamborough Head, affords a rough boundary for the occurrence of soles. South of this line, generally speaking, they are plentiful, north of it they are very scarce and almost entirely absent in the summer. The further offshore we proceed the scarcer they get, and they do so, so rapidly, that they are only found on rare occasions on the Dogger Bank and in the grounds north of it. In the southern central grounds they are not so numerous as nearer

*cf. LEE.—Report on Lowestoft Sailing Trawler Records 1903–1906. *Internat. Invest. Mar. Biol. Assoc. Report II., Part II.* Cd. 4641, p. 109.

the coasts, and in the most southern part of this region investigated, in the neighbourhood of the Brown Ridges, they are comparatively scarce.

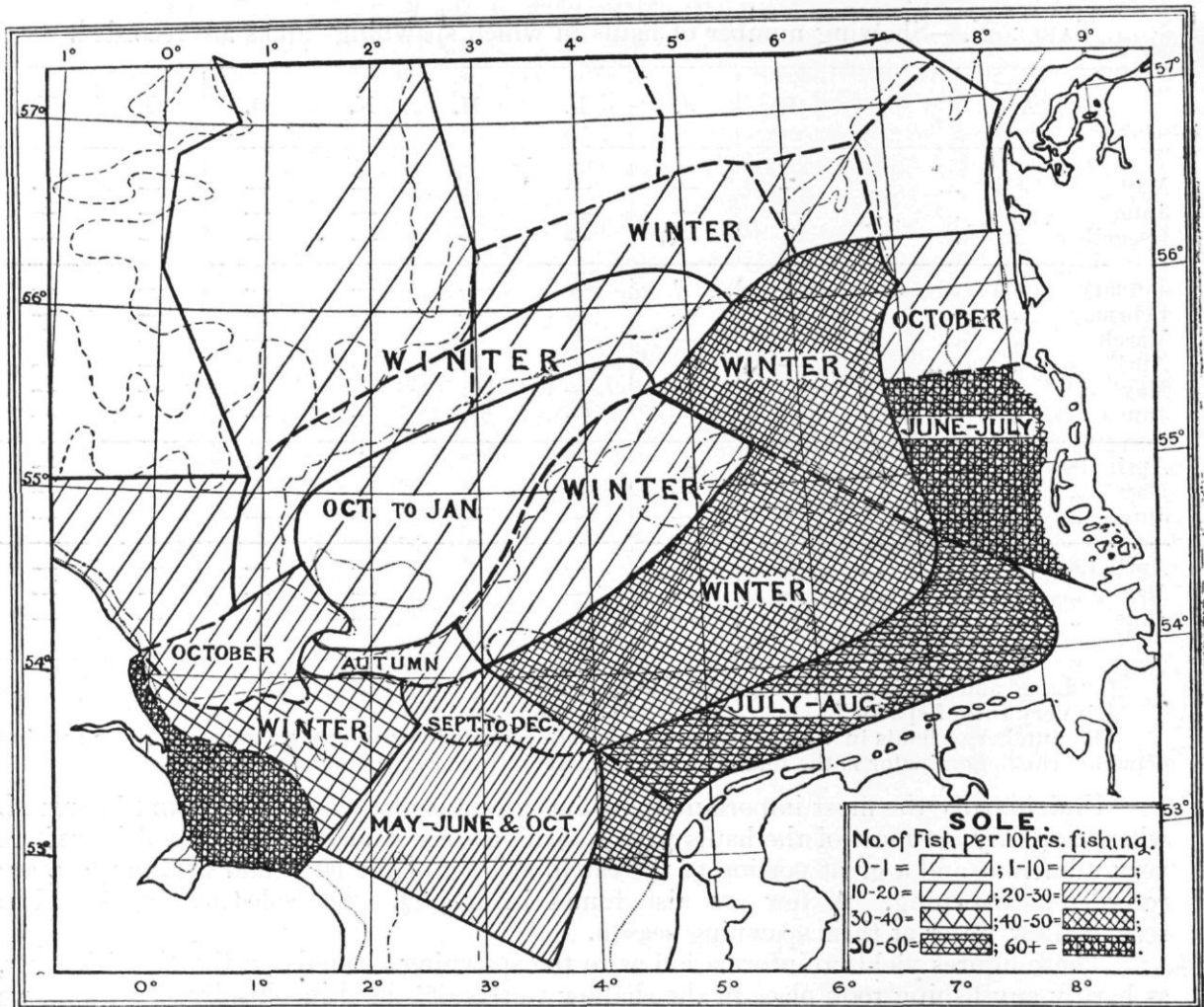


FIG. 34.—Chart showing the distribution of SOLES according to the mean monthly catch in each area, and the periods of maximum abundance in the different regions.

With regard to size, we find that over one-half of the total number caught are classed as medium. Small fish do not appear in the northern grounds, or on the Dogger, but they are found to be relatively numerous and nearly equal to the medium on the eastern grounds and in area S. They become relatively less numerous in the central grounds adjacent to these. Large fish generally form under 20 per cent. of the total, but in the deep-water areas and the western areas they appear to predominate. However, the proportions in these latter areas are somewhat unreliable.

b. Yearly variations.—There does not appear to be any regular decrease or increase in the average catch over the whole region. 1906 seems to have been in some respects an exceptional year. In the eastern and some of the central areas it had much larger catches than the other years. 1904 and 1905 were fairly alike, and 1907 was the worst year.

The conditions of salinity and temperature were also somewhat unusual this year (1906). In August, 1906, in the waters off the Danish coast, the salinity was much lower than usual,* while the sea temperatures were somewhat higher than normal. In 1907 they were lower.

Complementary fluctuations appear in the more offshore and the southern areas, when 1906 appears to be a very poor year relatively to the others, and 1907 a little better than it. These facts give great support to a theory that soles are influenced greatly by changes of temperature, and that they seek the shallow water in hot weather, and to a greater extent than usual in hot years. Similarly in 1893 an improvement in the Terschelling sole fishery was attributed to the warm summer.†

c. Seasonal Fluctuations and Migrations.—There appears to be a definite seasonal migration between the inshore and offshore areas, and this may be described as an inshore immigration in the spring, culminating in a maximum stock on the shallow inshore waters in the summer. The offshore migration takes place in the autumn and winter,

* Cf. p. 25 of present report.

† HOLT. North Sea Investigations. *Jour. Mar. Biol. Ass.* Vol. 3, p. 127.

and leaves the shallow waters entirely devoid of soles. This fact is suggested, more than proved, for the western areas by the spring and early summer minima that occur on the curves, followed by an influx in the latter part of the year. On the eastern side the figures are much more conclusive. That the fish move into deeper water after the summer is apparent from the curves illustrating the offshore areas N, I and J, &c., where the complementary fluctuations to those in M and Q, *i.e.*, a minimum in spring and summer followed by a maximum in autumn and winter, are clearly to be seen. Moreover the few fish that do migrate farther north than the majority, and reach the Dogger Bank and the grounds beyond, are found there only in the winter. We can also suppose, after a comparison of the curves for the central areas, that the migration of the general mass of soles from the eastern coasts is not of a very great extent, and that the outer limit of migration of the majority stops short some considerable distance from the Dogger Bank. Such an area as R, where, though the grounds on the whole are shallow, there are a number of small but deep holes, where soles are found in large numbers, still more supports the theory that soles have a tendency to seek the deep pits in the winter.

Probably these movements are connected directly with the change of temperature. A study of the temperature charts issued in the Bulletin Trimestriel shows phenomena which vary in much the same way as the stock of fish on these eastern grounds. In October to December, 1905, there was a sudden cooling of the surface waters and at the same time the fish are found to disappear quickly from area M. The winter maximum comes very early in the season in area N—*i.e.*, in November—on the smoothed curve. In the winter of 1906 to 1907, the sea temperatures continued higher than usual up to December and then fell suddenly in the early months of 1907 to very low values. Simultaneously, we find that the migration from area M is delayed in 1906, the averages being fairly high up to December, while the winter maximum in N is late and is protracted beyond the usual time.

All sizes of fish participate in the migrations. Large fish leave the shallow coastal waters earlier than the medium and small, in fact directly after the spawning season.

d. Spawning.—Soles are found to spawn always in shallow water under 20 fathoms. The season for spawning occurs in spring and early summer, April, May and June being the months when most of the spawning fish are found. Nearly all the large fish and many of the medium ones are recorded as spawning. On the western side we have no fishing in the spawning grounds, but on the eastern side we find that area M (Sylt, Amrum, &c.) is the chief ground on which the spawning soles congregate. A few occur in area Q, but none so far north as area H.

C.—TURBOT.

Introduction.

These fish are found sparsely scattered over the whole of this region. The numbers of large and small fish caught are recorded by the fishermen, but they seldom amount to more than two or three fish per haul, and it often happens that none are taken at all. The grounds in the south and eastern parts are the most prolific in this fish, and there is definite evidence of regular seasonal fluctuations in these areas. Many of the curves however, especially for the grounds north and west of the Dogger bank, are of a most irregular character, and for this reason several have not been reproduced. The figures need to be studied with especial caution and many reservations in drawing conclusions. The numbers of fish taken are so very small that a difference of one or two makes a great difference in the average, and the variations in these are therefore very great.

The total numbers caught are given in the following table, together with the proportions formed by the large and small fish.

TABLE XI.—Showing the total numbers of TURBOT caught by certain skippers in each year, and the percentage of the total formed by the two categories "large" and "small."

| | | | Total number of Turbot. | | | Percentage of total. | |
|-------|-----|-----|-------------------------|--------|------------|----------------------|--------|
| | | | Large. | Small. | All sizes. | Large. | Small. |
| 1904 | ... | ... | 2,438 | 6,873 | 9,311 | 26 | 74 |
| 1905 | ... | ... | 3,662 | 6,570 | 10,232 | 36 | 64 |
| 1906 | ... | ... | 2,200 | 4,209 | 6,409 | 34 | 66 |
| 1907 | ... | ... | 1,717 | 3,299 | 5,016 | 34 | 66 |
| Total | ... | ... | 10,017 | 20,951 | 30,968 | 32 | 68 |

Here we see that in 1904 a large number of *small* fish were taken. In the other three years the proportions were fairly constant; the large fish forming about one-half the number of small. We find in corroboration of this fact that the catches in the small fish grounds (the eastern areas chiefly) were exceptionally large in 1904.

A study of the curves reveals the fact that turbot have a much more even distribution than we found for either plaice or soles. There are, of course, local differences, and we find much the same law of bathymetric distribution, *i.e.* a decrease in the quantities as we proceed off-shore and northwards into deeper water, but there is nothing like the contrast in numbers, such as was found for soles between the different areas such as M or Q and I or O; they are present even in the most northern grounds of this region in quite appreciable numbers compared with the eastern grounds.

Yearly fluctuations.

In studying the curves of monthly averages, we find in some that there is a distinct downward trend, indicating continuously decreasing catches. Those areas where this is not shown, are mostly those which have not a sufficient number of reliable monthly averages to determine the yearly trend with anything like a close approximation. The trend of the yearly variation is also shown by the following figures obtained by comparing the averages in the corresponding months of the successive years. (All averages based on less than 30 hours' fishing are omitted.)

The 1905 average is 22 times less than that of 1904 out of 40 months.

The 1906 average is 25 times less than that of 1904 out of 35 months.

The 1907 average is 20 times less than that of 1904 out of 25 months.

The 1906 average is 26 times less than that of 1905 out of 46 months.

The 1907 average is 23 times less than that of 1905 out of 34 months.

The 1907 average is 19 times less than that of 1906 out of 33 months.

From this it appears that there is, on the whole, a decline throughout the period in the average catch, for each year was more often less than the preceding ones than greater than them. Moreover, the proportion increases as time goes on, for 1907 is less than 1904 in a greater proportion of the total months of comparison, than are either 1906 or 1905. In the same way it is greater than 1905, more often proportionally than is 1906. And further, not only is 1904 the best year in the greatest number of time, but there is often a great difference between its averages and those of the subsequent years.*

The Fluctuations in each Area.

The monthly average catch of turbot for each area is given in Table XII., and the nature of the variations are described below.

North-eastern Areas.

Area A.—The averages 4.72 and 8.64 for July and August indicate the presence of appreciable numbers of turbot, at least in the summer.

Area B.—The averages fluctuate between 0 and 4 per 10 hours. It is impossible to determine the seasonal fluctuations from these averages as the trend is not the same in each of the years.

Area C.—Only one fish was taken in the few hauls made in this area.

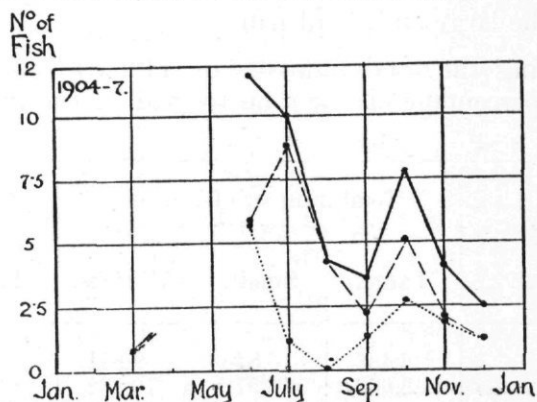


FIG. 35.—TURBOT. Area F. Monthly averages, 1904-1907. Continuous line represents all sizes; dashed line, large fish; dotted line, small.

* With this continued decline we may compare the same phenomenon evidenced by the Dutch statistics. *Jaarverslag omtrent het beheer van de Vissershaven te IJmuiden*. 1908. Table IV., p. 72.

TABLE XII.—SHOWING for each area the Monthly Average Number of TURBOT caught per 10 hours' fishing; large (L.) and small (S.) being distinguished. The monthly total number of hours' fishing in each area, to the nearest hour, is given as an index number.

| Group. | Area. | Year. | January. | | | February. | | | March. | | | April. | | | May. | | | June. | | | July. | | | August. | | | September. | | | October. | | | November. | | | December. | | | Area. | | |
|----------------------|--------|--------|----------|---------------------|---------------------|-----------|--------------------|------------|--------|------|-------------------|--------------------|------|---------------------|------|------|---------------------|-------|--------------------|---------------------|---------------------|------|--------------------|---------------------|---------------------|--------------------|---------------------|--------------------|---------------------|---------------------|---------------------|---------------------|--------------------|--------------------|---------------------|--------------------|-------------------|---------------------|---------------------|-------------------|-----|
| | | | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | | | | | | |
| NORTH-EASTERN AREAS. | A | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.27 | 6.36 | 8.64 ²² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | A | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.72 | 0.00 | 4.72 ⁴⁴ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.72 | 0.00 | 4.72 ⁴⁴ | 2.27 | 6.36 | 8.64 ²² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | |
| | B | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.67 | 1.67 | 3.33 ¹⁸ | 3.62 | 0.00 | 3.62 ⁸⁸ | 0.26 | 0.34 | 0.60 ¹¹⁷ | 0.00 | 0.00 | 0.00 ⁶⁴ | ... | ... | ... | ... | B | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.67 | 0.00 | 0.67 ³⁰ | 1.60 | 0.00 | 1.60 ¹² | ... | ... | ... | ... | ... | ... | ... | 0.31 | 0.38 | 0.69 ¹⁶⁰ | 3.00 | 0.00 | 3.00 ²⁰ | 5.00 | 0.00 | 5.00 ⁴ | ... | ... | ... | ... | ... | | | |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.09 | 0.00 | 0.09 ¹¹³ | 0.26 | 0.00 | 0.26 ²⁰ | ... | ... | ... | ... | ... | | | |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.67 | 0.00 | 0.67 ³⁰ | 1.60 | 0.00 | 1.60 ¹² | ... | ... | ... | ... | ... | ... | 1.67 | 1.67 | 3.33 ¹⁸ | 1.49 | 0.24 | 1.73 ²⁴⁸ | 0.40 | 0.16 | 0.56 ²⁵⁰ | 0.28 | 0.00 | 0.28 ¹⁰⁷ | ... | ... | ... | ... | ... | |
| | C | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | C | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | 1.25 | 0.00 | 1.25 ⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁴ | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁴ | ... | | | |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | ... | 1.25 | 0.00 | 1.25 ⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁴ | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁴ | ... | | | |
| | F | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 5.99 | 5.69 | 11.68 ⁶⁸ | 7.50 | 1.25 | 8.75 ⁸ | 2.50 | 0.00 | 2.50 ⁸ | 2.14 | 0.00 | 2.14 ⁶⁸ | ... | ... | ... | 1.72 | 2.19 | 3.91 ⁶⁴ | 1.25 | 1.33 | 2.58 ¹²⁰ | ... | F | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | 0.80 | 0.00 | 0.80 ¹² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 9.04 | 1.15 | 10.19 ⁶² | 8.73 | 0.00 | 8.73 ³⁵ | 2.30 | 2.12 | 4.42 ¹⁸⁰ | 5.11 | 2.77 | 7.87 ⁹⁴ | 5.00 | 0.00 | 5.00 ⁸ | 1.25 | 0.00 | 1.25 ⁸ | ... |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | ... | 0.80 | 0.00 | 0.80 ¹² | ... | ... | ... | ... | ... | ... | 5.99 | 5.69 | 11.68 ⁶⁸ | 8.83 | 1.17 | 10.00 ⁶⁰ | 4.32 | 0.00 | 4.32 ⁸¹ | 2.24 | 1.32 | 3.56 ¹⁷⁴ | 5.11 | 2.77 | 7.87 ⁹⁴ | 2.08 | 1.94 | 4.02 ⁷² | 1.25 | 1.25 | 2.50 ¹²⁸ | ... | |
| G | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.41 | 2.37 | 6.78 ²⁰ | ... | ... | ... | 0.31 | 1.54 | 1.85 ³² | 0.56 | 1.36 | 1.92 ⁸⁸ | 1.36 | 1.36 | 2.71 ⁴⁴ | 0.00 | 0.00 | 0.00 ⁴ | ... | ... | ... | ... | G | | |
| | 1905 | 0.28 | 0.92 | 1.20 ¹⁰⁸ | 0.00 | 0.00 | 0.00 ⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁴ | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 2.00 | 2.00 ⁵ | ... | | | | |
| | 1906 | 0.49 | 0.00 | 0.49 ²¹ | 0.13 | 0.00 | 0.13 ⁷⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | |
| | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | |
| | 1904-7 | 0.31 | 0.78 | 1.09 ¹²⁰ | 0.12 | 0.00 | 0.12 ⁸⁰ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.41 | 2.37 | 6.78 ²⁰ | ... | ... | ... | 0.27 | 1.37 | 1.64 ³⁶ | 0.56 | 1.36 | 1.92 ⁸⁸ | 1.02 | 1.36 | 2.38 ⁶⁰ | 0.20 | 0.00 | 0.20 ¹⁰⁰ | 0.00 | 2.00 | 2.00 ⁵ | ... | | |
| EASTERN AREAS. | H | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.08 | 2.31 | 5.38 ⁸² | ... | ... | ... | ... | ... | ... | 1.25 | 1.25 | 2.50 ¹⁶ | 3.33 | 5.33 | 8.67 ¹⁸ | 0.82 | 3.13 | 3.95 ⁷⁸ | 1.04 | 1.17 | 2.21 ³⁸⁵ | 0.63 | 0.68 | 1.31 ¹⁹¹ | ... | H | |
| | | 1905 | 0.09 | 0.14 | 0.23 ³⁴⁷ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁰ | 0.30 | 0.15 | 0.44 ¹⁸⁵ | 3.46 | 0.65 | 4.11 ¹⁷⁰ | ... | ... | ... | 2.50 | 2.50 | 5.00 ¹⁶ | ... | ... | ... | 0.25 | 0.00 | 0.25 ⁴⁰ | 0.97 | 0.74 | 1.72 ²⁵⁷ | 0.00 | 0.71 | 0.71 ⁸⁴ | ... | ... | | | | |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1904-7 | 0.09 | 0.14 | 0.23 ³⁴⁷ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁰ | 0.30 | 0.15 | 0.44 ¹⁸⁵ | 3.37 | 1.03 | 4.40 ²²² | ... | ... | ... | 2.50 | 2.50 | 5.00 ¹⁶ | 1.25 | 1.25 | 2.50 ¹⁶ | 1.08 | 1.44 | 2.52 ²⁵ | 0.93 | 1.02 | 1.96 ⁶⁵⁴ | 0.80 | 1.74 | 2.54 ⁷¹² | 0.44 | 0.69 | 1.12 ²⁷⁵ | ... | | |
| | M | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

TABLE XII. (continued)—SHOWING for each area the Monthly Average number of TURBOT caught per 10 hours' fishing ; large (L.) and small (S.) being distinguished. The monthly total number of hours' fishing in each area, to the nearest hour, is given as an index number.

| Group. | Area. | Year. | January. | | | February. | | | March. | | | April. | | | May. | | | June. | | | July. | | | August. | | | September. | | | October. | | | November. | | | December. | | | Area. | |
|-----------------|-------|--------|----------|------|---------------------|-----------|------|---------------------|--------|------|---------------------|--------|------|---------------------|------|-------|----------------------|-------|----------------------|----------------------|-------|----------------------|----------------------|---------|----------------------|----------------------|------------|----------------------|----------------------|----------|----------------------|----------------------|---------------------|--------------------|---------------------|--------------------|--------------------|---------------------|--------------------|--|
| | | | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | | | | | |
| SOUTHERN AREAS. | S | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.97 | 9.84 | 12.81 ²¹⁶ | 2.78 | 12.90 | 15.68 ³⁴⁵ | 1.52 | 10.25 | 11.77 ⁴⁵⁴ | 2.70 | 16.40 | 19.10 ¹⁰⁰ | 2.91 | 17.96 | 20.87 ¹⁰³ | ... | ... | ... | ... | ... | ... | S | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.75 | 6.06 | 7.81 ⁶¹⁷ | 1.66 | 2.32 | 3.98 ⁷⁴⁹ | 8.00 | 15.78 | 23.78 ⁴⁵ | 5.00 | 10.00 | 15.00 ⁴ | 0.00 | 2.35 | 2.35 ⁸ | 1.48 | 4.44 | 5.93 ¹³ | | | |
| | | 1906 | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁵ | 1.20 | 1.09 | 2.29 ⁸² | 0.00 | 0.00 | 0.00 ²² | 0.00 | 6.67 | 6.67 ⁷ | 2.55 | 2.36 | 4.91 ¹⁵⁵ | 4.70 | 1.69 | 6.39 ⁸³ | 0.85 | 3.03 | 3.89 ¹⁰⁶ | 1.36 | 3.27 | 4.64 ²²⁰ | 1.06 | 2.30 | 3.36 ⁵⁶ | ... | ... | ... | ... | ... | ... | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.58 | 2.19 | 4.78 ⁴⁶¹ | 3.24 | 4.25 | 7.49 ³⁴⁵ | 1.85 | 3.39 | 5.24 ²⁷¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.75 | 3.75 | 7.50 ¹⁶ | ... | ... | ... | | |
| | | 1904-7 | ... | ... | ... | [0.00 | 0.00 | 0.00 ⁵ | 1.20 | 1.09 | 2.29 ⁸² | 0.00 | 0.00 | 0.00 ²² | 2.54 | 2.26 | 4.81 ⁴⁶⁸ | 3.09 | 6.03 | 9.12 ⁶¹⁰ | 2.23 | 7.03 | 9.25 ¹³¹⁶ | 1.54 | 5.13 | 6.68 ¹³⁰⁹ | 2.55 | 8.41 | 10.96 ³⁶⁵ | 2.32 | 12.35 | 14.68 ¹⁶³ | 2.45 | 3.27 | 5.71 ²⁴ | 1.48 | 4.44 | 5.93 ¹³ | | |
| | T | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.62 | 10.77 | 15.38 ¹³ | 1.67 | 15.83 | 17.50 ²⁴ | 11.00 | 17.00 | 28.00 ¹⁰ | 11.25 | 17.50 | 28.75 ⁸ | 5.00 | 23.75 | 28.75 ⁸ | ... | ... | ... | 0.89 | 6.22 | 7.11 ²² | ... | ... | ... | T | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.88 | 7.57 | 10.45 ⁵⁵ | ... | ... | ... | 1.44 | 6.60 | 8.04 ⁴⁸ | 7.34 | 14.56 | 21.90 ⁷⁹ | 0.40 | 6.10 | 6.50 ¹⁰⁰ | 0.68 | 6.48 | 7.15 ¹⁷⁷ | 1.49 | 8.41 | 9.90 ³⁴³ | 1.59 | 7.29 | 8.88 ³⁴⁰ | | |
| | | 1906 | ... | ... | ... | 0.31 | 4.36 | 4.68 ⁹⁶ | 0.58 | 0.96 | 1.54 ⁴² | 0.53 | 1.60 | 2.13 ¹¹² | 3.02 | 6.98 | 10.00 ⁴³ | 2.58 | 6.20 | 8.79 ⁹⁷ | 2.82 | 4.53 | 7.35 ¹⁸¹ | 2.32 | 2.65 | 4.97 ⁹⁰ | 1.45 | 3.61 | 5.06 ⁸³ | 2.40 | 6.04 | 8.44 ²²⁵ | 1.45 | 0.73 | 2.18 ²⁷ | ... | ... | ... | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.26 | 4.16 | 4.42 ⁸⁹ | 2.80 | 5.60 | 8.40 ⁵⁵ | 4.76 | 8.81 | 13.57 ¹⁴³ | 1.54 | 4.95 | 6.48 ⁹¹ | ... | ... | ... | 2.00 | 5.50 | 7.50 ⁹⁰ | 1.80 | 3.47 | 5.27 ⁸⁴ | 2.83 | 6.42 | 9.25 ²¹² | 0.83 | 1.67 | 2.50 ¹² | | |
| | | 1904-7 | ... | ... | ... | 0.31 | 4.36 | 4.68 ⁹⁶ | 0.58 | 0.96 | 1.54 ⁴² | 0.46 | 2.25 | 2.72 ¹⁵¹ | 3.07 | 7.30 | 10.38 ¹⁴⁶ | 3.68 | 8.49 | 12.17 ²⁶⁴ | 2.51 | 5.33 | 7.84 ²³⁰ | 4.96 | 8.62 | 13.58 ¹⁷⁷ | 1.14 | 5.73 | 6.87 ²¹¹ | 1.67 | 5.76 | 7.43 ⁴⁵⁶ | 1.94 | 7.28 | 9.21 ⁶⁰⁴ | 1.56 | 7.10 | 8.66 ³⁵² | | |
| | V | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.90 | 1.44 | 3.35 ¹³¹ | 1.27 | 3.12 | 4.39 ⁸⁶ | 3.52 | 0.88 | 4.40 ⁴⁵ | ... | ... | ... | 1.48 | 1.48 | 2.96 ¹³ | ... | ... | ... | V | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0.80 | 1.20 | 2.00 ²⁵ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.31 | 3.70 | 6.02 ¹⁰⁸ | 2.43 | 0.35 | 2.78 ²⁹ | ... | ... | ... | 0.71 | 5.71 | 6.43 ²⁸ | ... | ... | ... | ... | ... | ... | | |
| | | 1906 | 0.85 | 3.23 | 4.09 ⁹⁹ | 2.22 | 4.44 | 6.67 ⁴ | 0.25 | 1.76 | 2.01 ⁸⁰ | 0.53 | 0.79 | 1.32 ³⁸ | ... | ... | ... | 1.67 | 0.83 | 2.50 ¹² | 0.38 | 0.76 | 1.14 ⁵³ | 1.03 | 0.82 | 1.86 ⁴⁹ | 2.15 | 1.94 | 4.09 ⁴⁷ | 1.21 | 0.00 | 1.21 ¹⁶ | 0.87 | 0.00 | 0.87 ¹² | ... | ... | ... | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 2.22 | 2.22 ⁴ | 1.25 | 0.00 | 1.25 ⁸ | 0.36 | 0.00 | 0.36 ⁵⁵ | ... | ... | ... | ... | ... | ... | 2.77 | 0.43 | 3.19 ⁹⁴ | 2.50 | 1.79 | 4.29 ²⁸ | 1.03 | 0.21 | 1.24 ⁴⁸ | | |
| | | 1904-7 | 0.85 | 3.23 | 4.09 ⁹⁹ | [2.22 | 4.44 | 6.67 ⁴ | 0.38 | 1.62 | 2.00 ¹⁰⁵ | 0.53 | 0.79 | 1.32 ³⁸ | 0.00 | 2.22 | 2.22 ⁴ | 1.50 | 0.50 | 2.00 ²⁰ | 1.55 | 1.81 | 3.37 ³⁴⁷ | 1.40 | 1.95 | 3.36 ¹⁶⁴ | 2.83 | 1.41 | 4.24 ⁹² | 2.17 | 1.44 | 3.61 ¹³⁸ | 1.89 | 1.32 | 3.21 ⁶³ | 1.03 | 0.21 | 1.24 ⁴⁸ | | |
| WESTERN AREAS. | E | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1906 | 0.00 | 0.00 | 0.00 ⁸ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁷ | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ¹⁸ | 0.87 | 0.00 | 0.87 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1904-7 | 0.00 | 0.00 | 0.00 ⁸ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁷ | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ¹⁸ | 0.87 | 0.00 | 0.87 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | |
| | R | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 3.33 | 3.33 ⁹ | 0.00 | 2.22 | 2.22 ⁴ | ... | R | |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0.00 | 0.71 | 0.71 ¹⁴ | ... | ... | ... | 0.66 | 1.19 | 1.85 ⁷⁶ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.56 | 0.56 | 1.11 ¹⁸ | ... | ... | ... | 0.48 | 1.43 | 1.91 ¹⁶⁸ | 0.61 | 0.94 | 1.56 ²¹² | | |
| | | 1906 | 0.43 | 0.58 | 1.01 ¹³⁹ | 0.42 | 0.80 | 1.23 ²³⁶ | 0.18 | 0.61 | 0.79 ²⁵⁰ | 0.15 | 0.86 | 1.02 ²⁶⁶ | 0.68 | 1.53 | 2.21 ¹⁷⁶ | 0.29 | 1.39 | 1.68 ²⁸⁸ | 0.49 | 0.90 | 1.39 ²²² | 0.18 | 0.97 | 1.15 ¹¹³ | 0.00 | 1.33 | 1.33 ⁷ | 0.69 | 3.45 | 4.14 ¹⁴ | ... | ... | ... | ... | ... | ... | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 3.08 | 3.08 ⁸ | 0.43 | 0.43 | 0.85 ²³ | 0.31 | 0.00 | 0.31 ³² | 0.00 | 0.00 | 0.00 ⁴ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | |
| | | 1904-7 | 0.43 | 0.58 | 1.01 ¹³⁹ | 0.42 | 0.80 | 1.23 ²³⁶ | 0.17 | 0.61 | 0.78 ²⁹⁴ | 0.15 | 0.92 | 1.06 ²⁷² | 0.65 | 1.34 | 2.06 ²⁷⁵ | 0.30 | 1.22 | 1.52 ²⁷⁰ | 0.49 | 0.88 | 1.37 ²²⁶ | 0.18 | 0.97 | 1.15 ¹¹³ | 0.39 | 0.78 | 1.18 ²⁵ | 0.69 | 3.45 | 4.14 ¹⁴ | 0.45 | 1.53 | 1.92 ¹⁷⁷ | 0.60 | 0.97 | 1.57 ²¹⁶ | | |
| | X | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.30 | 1.49 | 1.79 ³³ | 1.71 | 2.86 | 4.57 ¹⁷ | ... | X | |
| | | 1905 | 0.00 | 0.00 | 0.00 ⁴ | 0.00 | 0.00 | 0.00 ³ | 0.19 | 0.93 | 1.12 ²³ | 3.33 | 0.00 | 3.33 ¹² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.47 | 1.58 | 2.05 ¹⁰⁷ | 0.00 | 1.36 | 1.36 ¹⁵ | 1.36 | 0.91 | 2.27 ⁴⁴ | |
| | | 1906 | ... | ... | ... | 0.00 | 1.11 | 1.11 ⁹ | 0.67 | 0.50 | 1.18 ⁸⁰ | 1.17 | 1.29 | 2.46 ⁷⁷ | 0.38 | 1.14 | 1.52 ³² | 1.67 | 0.32 | 1.99 ¹⁵⁶ | 0.62 | 0.71 | 1.34 ¹¹² | 0.32 | 0.75 | 1.08 ⁹³ | 0.94 | 0. | | | | | | | | | | | | |

Area F.—This includes the "Tarbot" or "Turbot" Bank and gives a fairly good yield. The March average is low (.8 per 10 hours), but June and July are high. There is a distinct downward trend in the curve (Fig. 35) till September. In October there is a recovery, showing a probable second maximum period. The November and December averages are lower than those of the summer. Large fish predominate.

Area G.—The maximum average obtained is 6.78 in June, 1904. The autumn catches are lower, but there is a slight increase between August and October. The winter averages are low, being only 0.12 in February.

Of these north-eastern areas F (or A) gives the best yield, though the quantities taken are never very large (numbering at the most four or five fish per haul). The greater proportion of the fish are large.

The seasonal fluctuations cannot be very well determined, but from areas F and G we have indications that the summer catches are higher than the winter ones.

Eastern Areas.

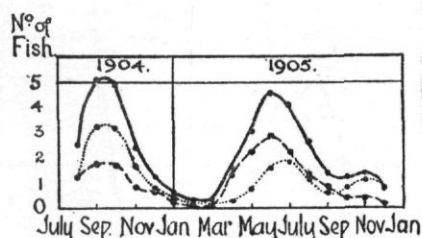


FIG. 36.—TURBOT. Area H. Monthly averages, (smoothed curves). Continuous line represents all sizes; dashed line, large fish; dotted line, small.

Area H.—This area, the most northern of this set, seems to have a very poor yield of turbot compared with the others. The maximum average is about five (per 10 hours). Hardly any fish are caught at the beginning of the year and up to April; in May there is a sudden increase. The summer catches are comparatively large, and then there is a gradual decrease till the winter minimum. (See Fig. 36.)

In 1904 we notice the decline in the course of the months October to December by the increasing number of hauls when no turbot were present. They were caught less and less frequently, and after the 8th of December none were taken. In 1905 they were practically absent in the months of January to April. Several were present in each haul in May, and a good many of them were spawning. In October, 1905, very few were caught, and this month was not anything if at all better than November. In one man's records we find none caught up to the 8th of the month, after which they occurred more frequently.

Large and small fish are found in nearly equal numbers, though in May, when the greatest number of fish are taken, large fish predominate; this is at their spawning time.

The 1905 averages are generally lower than those of the corresponding months in 1904.

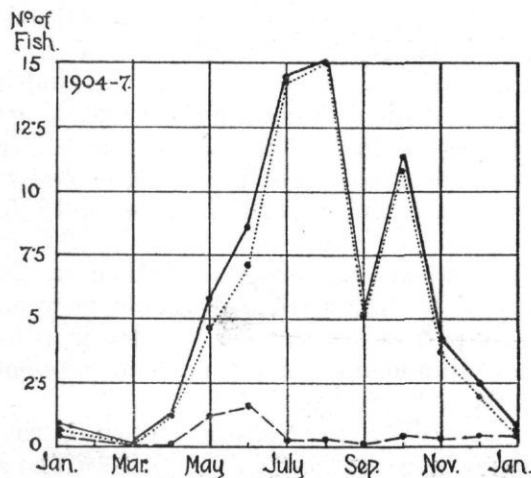


FIG. 37.—TURBOT. Area M. Monthly averages, (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area M.—This is a small fish ground, and it yields a fairly large number of fish, but it does not hold its pre-eminent position amongst the areas, in regard to quantity, that was found for it for plaice and soles.

The maximum averages are from 15 to 20 per 10 hours. The main features of the curves (Fig. 37 and Fig. 38) are the winter and spring minimum and the summer and autumn maximum, showing a considerable migration into this area in the middle of the

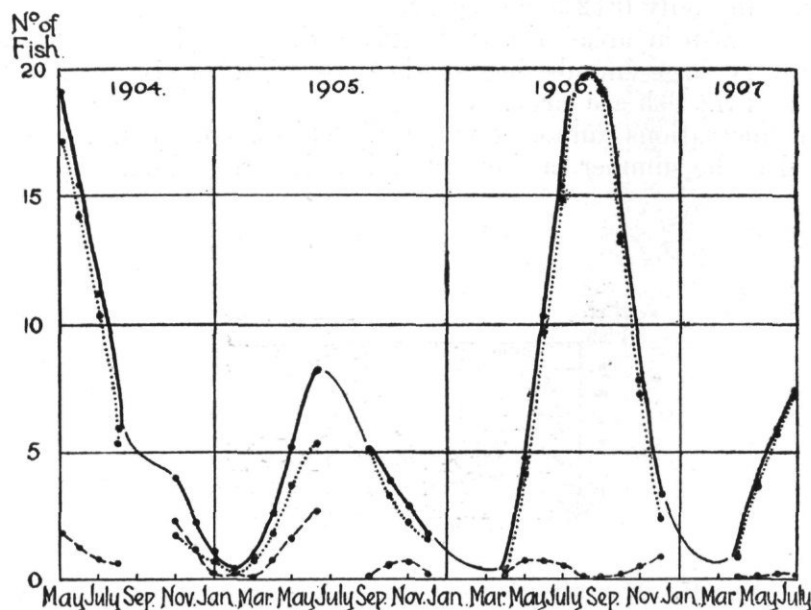


FIG. 38.—TURBOT. *Area M.* Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

year. This maximum occurred in different months in each year. In 1904 it was in May, in 1905, not before June, in 1906 in July or August, and in 1907 not before July. In 1904 there is a distinct decrease during May and June, which is evident throughout the two months. The large fish were caught very much less frequently after the middle of June, and small fish too were noticed to be decreasing.

In 1905 it is noticed that there were very few fish up to April, when from one to four small fish were taken. There were no large fish caught regularly till about the 25th of May. Large turbot were recorded as spawning from the 26th May, and these increased in numbers during June.

In April, 1906, there were very few fish, those present being mostly small. A few more appeared in May and a lot in June, but the large fish were disappearing rapidly towards the end of that month and none were taken in July. The course of the variations is precisely the same in 1907, but the large fish were still more scarce. A skipper remarked in May, 1907, that the turbot are very small—about the size of an ordinary dinner-plate. In November, 1907, there was an exceptionally large number of small turbot, 9 and 20 taken in two successive hauls. These are probably very small fish, for we have a note by one of the fishermen on some of the November hauls of 1905 of a similar occurrence of a large number of tiny brill and turbot. These were not included in the 1905 average. Large fish seem only to appear in this area during their spawning period.

In comparing the averages of the four years concerned, we find that 1904 has generally the highest figures, and that there is a decline between this year and 1907. However, some of the 1906 averages are better than those of 1905.

Area Q.—More fish are taken on this ground than in the shallow waters to the immediate north. The curves for the two areas show very similar fluctuations, *i.e.*, minimum catches in the early part of the year—a sudden increase with the oncoming of the spawning season—a maximum about July, August or September, and then decreasing quantities to the minimum about February.

There is no real drop from July to August as shown on the curve (Fig. 39), for in each year the average increases between these two months. The appearance is due to the preponderance of the 1904 figures which are exceptionally large, in the July average, and of the 1905 figures in August, these being low. Large fish are proportionally and actually

more numerous than in M. They average as high as 3.45 in July, more than double the highest average in M. They are, on the average, 13 per cent. of the total while in M they were only 7 per cent.

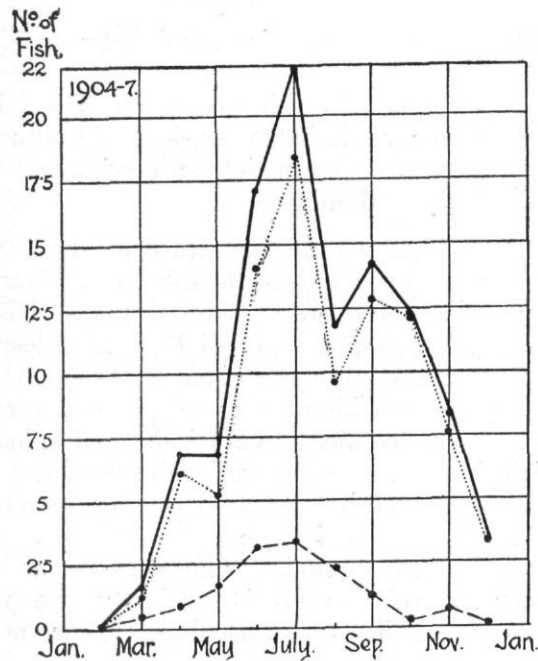


FIG. 39.—TURBOT. Area Q. Monthly averages, 1904-1907. Continuous line represents all sizes combined ; dashed line, large fish ; dotted line, small.

We notice in each year a comparative scarcity of turbot in March, and that soon after the beginning of April they make their appearance much more frequently.

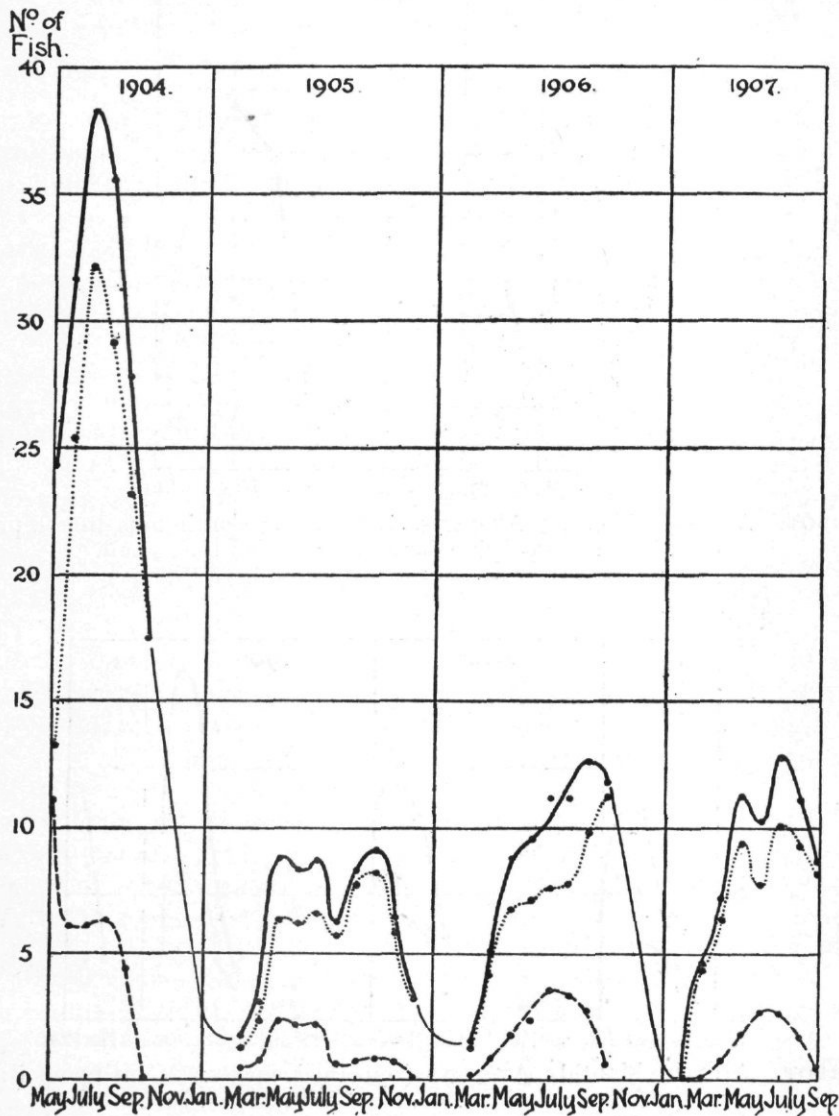


FIG. 40.—TURBOT. Area Q. Monthly averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, large fish ; dotted line, small.

1904 seems to have been an exceptionally good year for turbot in this region. (See Fig. 40.) Its averages are very much higher than those of the other years, and in August it reaches the very high maximum of 44.79 per 10 hours. This maximum comes in July on the smoothed curve.

The averages in 1905 are somewhat low, and between 1906 and 1907 there is but little difference.

Area W.—There is very little to be said about this area. It probably has much the same characteristics as area Q, for we find that considerable numbers were taken in the few hauls made here in the summer, numbers which approximate roughly to those in area Q at the same time. Small turbot predominate.

These eastern areas all show much the same features in their seasonal fluctuations, the appearance of the fish being sudden between the minimum about February or March and the maximum in summer. The departure of the fish takes place more slowly, and up to November and December there are quite appreciable quantities although they are much smaller than in the months of maximum abundance. The average yield is very good for the whole region, but decreases considerably as we proceed northwards, the grounds off the Dutch coasts being the most prolific. Small fish predominate greatly in the catches, except in area H, in which they are nearly equalled by the large fish. Large fish are most abundant in these areas at the height of the spawning season, and quickly take their departure when it is over.

1904 is the best year of the period. There are some very large catches then, especially in the summer months; 1905 is probably the worst year, although the differences between this year and the two succeeding ones are not very great.

Central Areas.

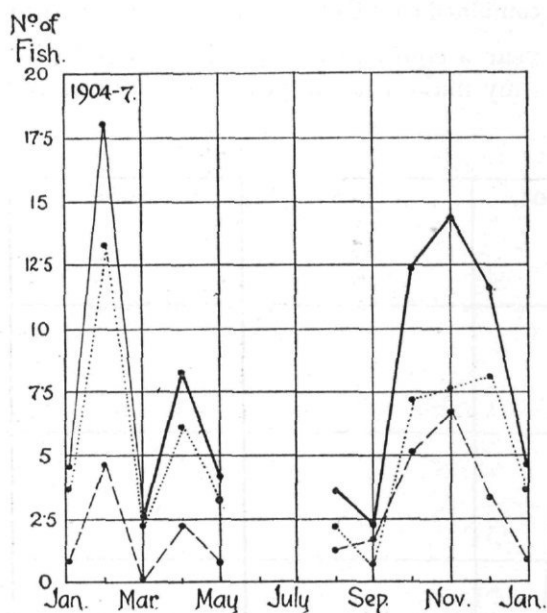


FIG. 41.—TURBOT. Area J. Monthly Averages, 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

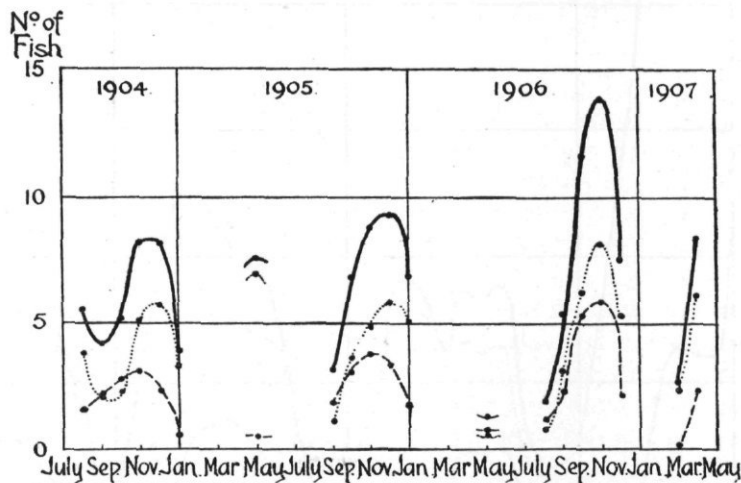


FIG. 42.—TURBOT. Area J. Monthly Averages (smoothed curves.) Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area J.—This curve (Fig. 41), though of a rather indefinite and incomplete nature, indicates that the late summer catches are small, while those in the last three months of the year are very high. The highest general average obtained is 14·37 in November: the maximum catch occurs in December, 1904. The fluctuations are not very well determined for the first half of the year (Fig. 42), but as the March average is very low, there is probably a minimum about this time, followed by a secondary maximum between then and the September minimum. The fish probably migrate into this area to form the autumn and winter maximum after they leave the shallow waters at the approach of the cold season.

Large fish are comparatively abundant, averaging numerically about one-half the small fish. In the months where comparisons can be made, we find a decline in the averages between 1904 and 1906. October and November are exceptions to this. They had very large catches in 1906, a fact which is probably due to local differences in the various parts of this area.

Area N.—This area, including the grounds outside the 20-fathom line off the Dutch and German coasts, give by far the best yield of turbot of any of the areas considered. The lowest averages obtained are about three (per ten hours), but the general average is never below 6·75, while the highest average is 40·29 in July, 1904, and the highest general average is 25·85. Therefore on this ground comparatively good numbers of turbot are to be found at all times of the year, and in nearly all months the general average is higher than that for any other area.

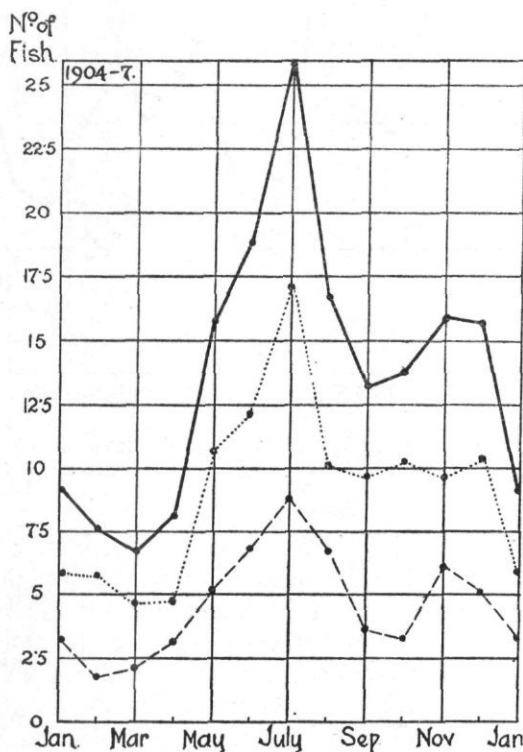


FIG. 43.—TURBOT. Area N. Monthly Averages, 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

The general curve (Fig. 43) shows two maxima, with the corresponding double minima. The spring values are lowest, February to April being months of minimum abundance. From thence onwards the averages are high, but there is a slight depression beginning in the middle of summer. This is followed by a recovery in the numbers and a secondary maximum in November and December, after which the numbers fall off till the spring minimum. These features are shown in greater detail in Fig. 44, showing the fluctuations, smoothed by the method of three-monthly averages, for each year.

In this figure the small summer depression between the two maxima is quite evident as a periodic occurrence. In each case the *spring* minimum is the lowest. In 1904 the summer maximum is very high; in the other years it is only slightly higher than the autumn one. The curve also brings out the fact that there is a distinct downward trend throughout the period, at least between 1904 and 1906, for 1907 does not differ much from 1906.

The fluctuations in this area are such as one would expect to get when there is a stock of fish migrating across it to and from the inshore areas. We found that the stock on the inshore areas was increasing from the spring onwards to the height of summer.

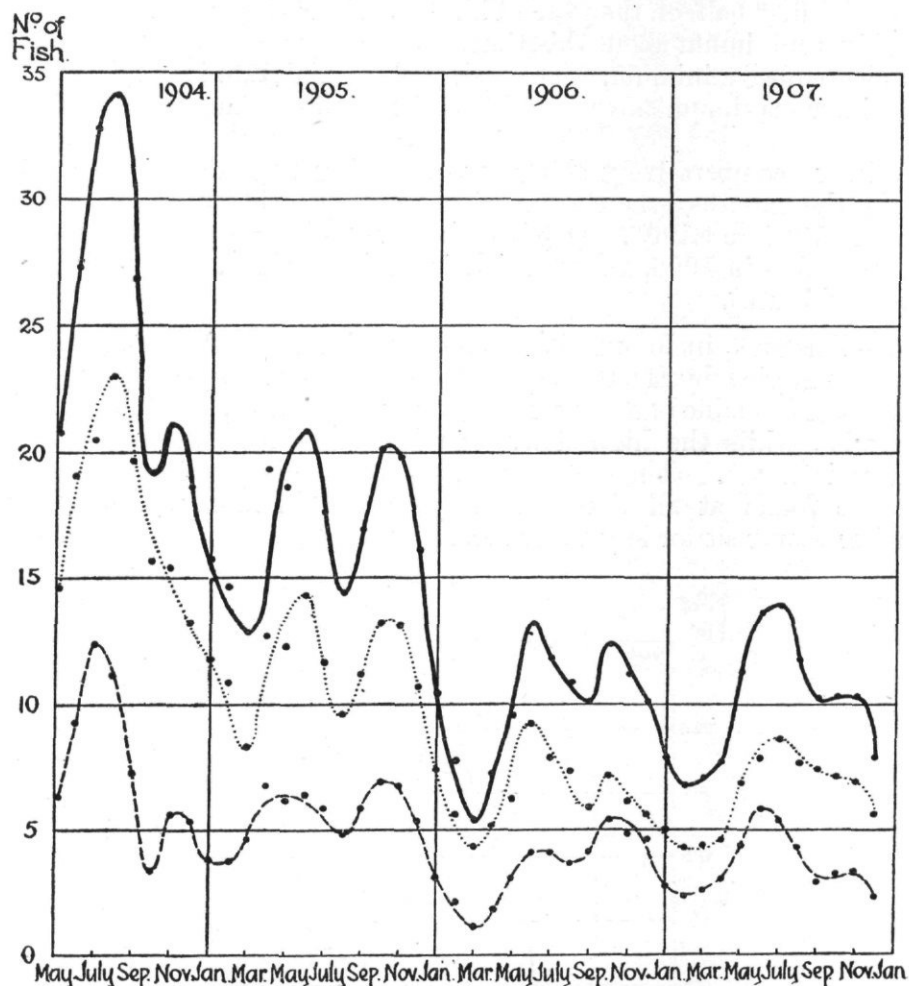


FIG. 44.—TURBOT. Area N. Monthly Averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

At the same time, the stock in area N is also increasing, but it has a somewhat earlier maximum. The large stock of fish is present over a longer period, as this area, being intermediate, partakes of the characters of both the inshore and offshore areas, and the time of abundance of both sets of areas affects the nature of the stock in this one. The summer depression is probably caused by the extended migration of some of the fish into still further inshore waters, while the secondary maximum in autumn and winter, which occurs at the time when the stock of fish is beginning to decrease on the inshore areas, is evidence of the return of the fish towards the somewhat deeper water at the approach of the cold weather.

They are present in considerable numbers even in the middle of winter, and the fact that the numbers are falling off slightly during these months may be explained by some of the turbot passing out of this area into still further offshore areas.

As in the adjacent offshore area J, we find that the large fish are in the minority and form about one-third of the total number. It should, however, be mentioned that several of the fish recorded as "small" are in reality of a medium size, a fact noted by one of the recording skippers.

There were exceptionally large numbers taken in March, 1905. These were all caught on the Oyster ground.

Area I.—The curve of combined averages for this area is not very definite or complete, but if we compare the most reliable averages we may surmise that the seasonal fluctuations are somewhat as follows: The summer averages are fairly high, ranging from six to nine per 10 hours. There is a drop in late summer and early autumn, and a considerable influx in the winter, forming a maximum in November to January, which in the best years reaches the value 14 or 15 per 10 hours, *i.e.* about double the summer

values. There is no fishing in the spring, but there appears to be a downward trend in the curve, and by analogy with the similar area N, we may suppose that there is a minimum at this time.

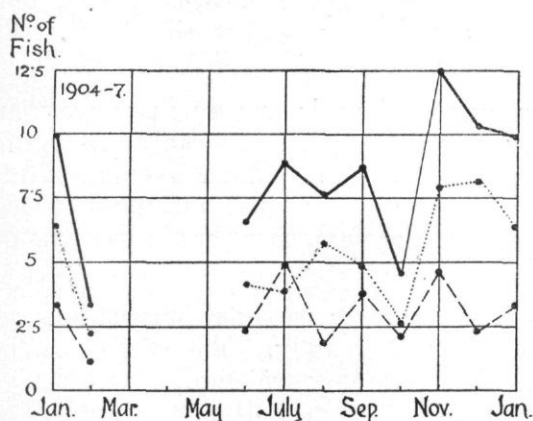


FIG. 45.—TURBOT. Area I. Monthly averages, 1904–1907. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Large fish are still numerically less than the small, but they form a larger proportion (about 37 per cent.) than in the more inshore ground N.

The 1905 averages are a little higher than those of 1904 generally, and there is no evidence of much change in the succeeding years.

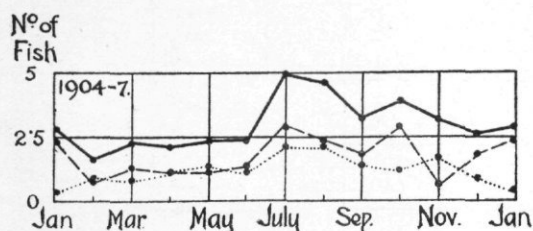


FIG. 46.—TURBOT. Area O. Monthly averages, 1904–1907.

Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

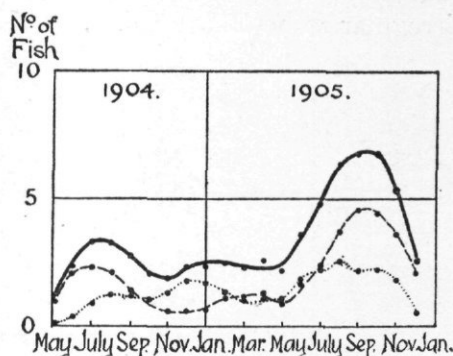


FIG. 47.—TURBOT. Area O. Monthly averages (smoothed curves).

Area O.—The quantities of turbot taken on this area are very small, and in these the large fish predominate and form 59 per cent. of the total. The general averages (Fig. 46) fluctuate but little. From January to June they are between two and three per 10 hours, in the latter half of the year a little more, but they never exceed five. However, in 1905, the averages from July to November are all between six and seven. 1905 is therefore the best year (see Fig. 47), and the 1907 averages that are present indicate very small catches in that year. The seasonal variations, as determined by the smooth curve in Fig. 47, are not very great, but in 1904 we find a slight summer maximum, and in 1905 the catches from July to November are about double those of the previous winter and spring.

These central grounds, with the exception of the Dogger Bank, are some of the best turbot grounds in this region, N especially having a very good supply. Small fish predominate and form about two-thirds of the total number caught, but the proportion decreases relatively to the distance from shore.

Some of the grounds show the features common to intermediate areas, through which the fish migrate periodically, namely a double period of maximum. The first occurs in early summer while the fish are approaching the inshore grounds, and the second maximum in autumn and winter, when they leave those grounds and make their way off-shore and become more scattered and spread out in the deeper parts of the North Sea.

The annual trend is not the same for all four areas. In J and N there is a distinct tendency to decline between 1904 and 1906. In areas I and O the best catches were generally in 1905.

Northern Areas.

Area D.—This area, of all those under our consideration, presents much the smallest yield of turbot. The catch never exceeds one in ten hours' fishing. It is greatest in January and shows a steady decline till April. The winter averages are higher than those of the summer.

Area K.—The average catches for this area fluctuate between one and three (per 10 hours), if we omit the May average, which is probably too high. We find a downward trend between January and March—the summer averages are uncertain—the autumn ones show a slight increase on the spring ones, but those of October and November are rather uncertain. Nevertheless, in 1904, there are indications of increased quantities at this time.

Area L.—This area has also very irregular fluctuations, increased and decreased averages succeeding one another alternately. The largest catches are made in the early part of the year. Both March and May are high, averaging 6.15 in March, 1905, and 4.77 in May, 1906. The summer averages, June to August, are, on the whole, much lower. Large fish are the most numerous.

The quantities of turbot caught in these three areas are very small, especially in D, where the averages never exceed one per 10 hours. In the other two areas the catch fluctuates between one and three, and is seldom more.

The fluctuations are not very regular, and the seasonal variation for this reason are not well marked, but on the whole the summer numbers seem to be the smallest. The curves of monthly variation for these areas are not given, as they are too incomplete and irregular to be of any value.

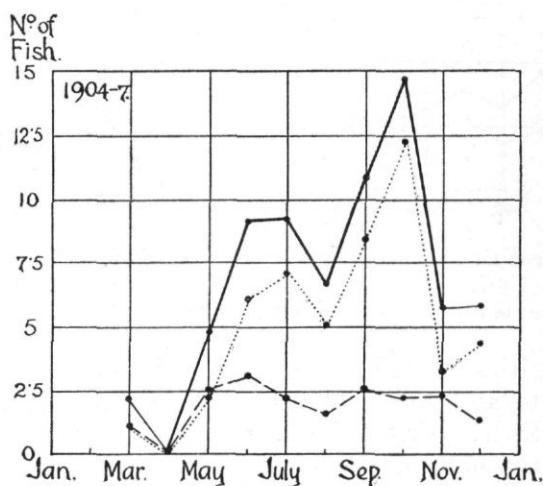
Southern Areas.

FIG. 48. TURBOT. Area S. Monthly averages, 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area S.—The numbers of turbot caught are fairly good, for in seven months of the year the general average exceeds five per 10 hours and the catches in September and October sometimes average over 20. There are some local differences in this area, turbot being most abundant in the northern part, just south of the 20-fathom line, dividing it from area T: the largest catches, those of October 1905 (23.78) were taken on the Botney ground. In the southern part of the area they were somewhat less frequent. Except in May, small fish generally outnumber the large by a considerable number.

We can study the seasonal fluctuations only between May and October, the averages for the other months being too uncertain. Large fish are fairly steady, varying during this time between 1.5 and three, the greatest change being the downward trend between June and August. The small fish have much greater fluctuations. In 1904 they have a maximum in July, decrease slightly in August, and become most numerous in October. There is a similar trend in 1905, but the 1906 figures, while showing the decrease in August after the July maximum, show a very small recovery in the early autumn.

Taking all sizes together, we find a rise to June and July, a small decrease during the summer, and a second maximum at the beginning of autumn.

The 1904 averages are the highest by a considerable amount, and we find a decline throughout the period wherever we can make reliable comparisons.

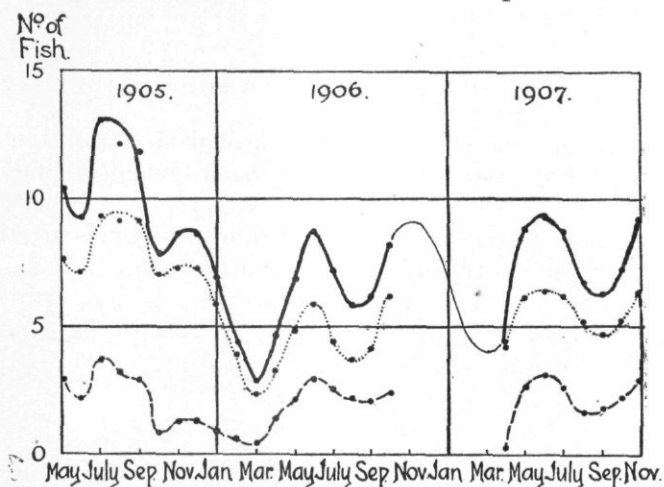


FIG. 49.—TURBOT. Area T. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area T.—The yield of turbot from this area is very similar to that from area S adjacent to it. The maximum general average is 13.58 and the minimum is 1.54, while in eight months of the year the average is over seven per 10 hours.

Spring fishing only took place in 1906, and a little in 1907. The trend is downwards from the beginning of the year till March, then rapidly upwards till June, after which a fairly high level is maintained for the rest of the year. In 1906 and 1907 there is a decline after the maximum in May–June till about August or September. This decline is also shown in 1905 with the exception of the high average of 21.9 in August. The catches increase again till about November, when there is another maximum. (See Fig. 49.)

The chief features are: a long period of greatest abundance extending over several months, with a small depression in the middle of this time (about August), and a decided minimum about March which lasts only for a short time.

These fluctuations are very similar to those of area N, and characterise, as in that case, an area across which there is a double annual migration, to and from the inshore grounds. The quantities here are much smaller than in area N.

All the 1904 monthly averages are based on very few hauls, and so are useless for determining the seasonal fluctuations. However, they indicate the presence of very large numbers from May to September in that year, a condition which has been shown to exist in the adjacent areas. The 1906 and 1907 averages are also distinctly smaller than those of 1905.

Small fish predominate, forming, on the whole, nearly three-quarters of the total. Large fish appear to be proportionately less numerous in the latter part of the year than in the first seven or eight months.

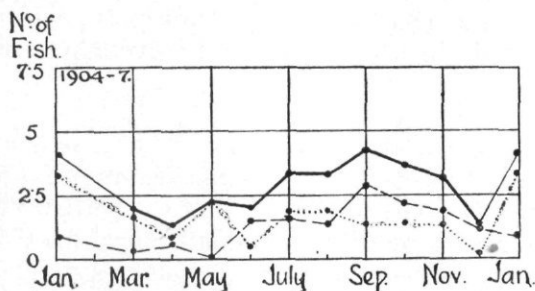


FIG. 50.—TURBOT. Area V. Monthly averages, 1904–1907. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area V.—The average catches here are small, on the whole being very similar to those on the Dogger Bank. Omitting the February value (only four hours) we find that they vary between 1.32 and 4.24 in the combined average. In 1905 two months have an average of over six per 10 hours, but the majority of the averages are generally less than three.

With this low stock of fish we get very small seasonal fluctuations. The winter values are uncertain, the March to June values are lowest, and the summer and autumn values are highest. September and October are comparatively high compared with other

months of the same years, but it must be admitted that the seasonal fluctuations are not shown with any reliability by these incomplete figures.

Large and small fish are nearly equally abundant. We notice a continued yearly decline throughout the period in the months of July, August and September. The other months do not admit of yearly comparisons.

The southern areas have a fairly good stock of fish, S and T comparing favourably with some of the eastern areas—only area V has a small yield. They are most abundant around the Botney ground.

Small fish are the most numerous, forming from two-thirds to three-quarters of the catch. The seasonal variations are not very determinate, but in two of the areas we seem to have a spring minimum period of short duration, a sudden influx in early summer, a slight drop in the middle of summer and higher values in late autumn. The average catches generally decline year by year between the beginning and end of this period.

Western Areas.

Area E.—Only one fish was taken on this ground during the few hauls made on it.

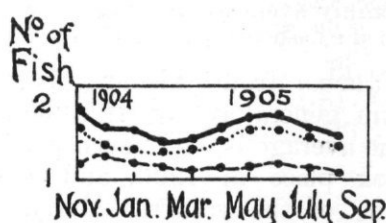


FIG. 51.—TURBOT. Area R. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area R.—There is a very small stock of turbot here. Most of the averages are under 1.5 per 10 hours. The highest average (omitting the unreliable ones) is 2.21 in May, 1906. The course of the figures in this year, which has the most complete records, is shown in Fig. 51, and is as follows: There is a decline from the comparatively high values of November and December, 1905, to the early spring minimum about March. A maximum occurs in May, and afterwards the quantities very slowly fall off. Small fish always outnumber the large.

Area X.—This is very similar to area R in its average yield, its mean average, however, coming out somewhat higher owing to the inclusion of more fishing in 1904 and 1905, years of comparative plenty.

The maximum appears to come a month earlier (in April). The fluctuations afterwards are small, but they are probably similar to those in R, viz., a slight fall in the summer followed by a recovery in the numbers by November and December. The January and February values are most probably erroneous and much too low. Large and small fish are more nearly equal than in R.

Area P.—The amount of fishing does not result in much satisfactory information. The March, April and September values are unrepresentative, but the July values approximate to those of July in area X, the 1904 average, 1.50, being a little less than that of July 1904 in X.

These western areas, by contrast with those of the east and south of this region are most poorly supplied with turbot. They seldom average more than 1.5 per 10 hours fishing. The fluctuations are small, and, according to the figures, rather irregular, but the most reliable averages indicate that there is a small influx in April and May, a slight and gradual falling off in the summer, and another increase in the autumn. Small fish generally predominate, but in X and P, the deeper areas, they are often equalled or exceeded in numbers by the large fish.

Spawning.

The distribution and frequency of the spawning turbot are shown in Table XIII. It has been prepared by taking the number of hauls in each area in which spawning turbot were recorded, as the numerator of a fraction whose denominator is the number of hauls in the area in which any turbot appeared. Thus we have omitted numerous hauls when no turbot were caught, and also the records of fishermen who did not seem to be recording the spawning fish, for there is reason to believe that the recording of the

spawning fish, especially of the less numerous species, was carried out somewhat spasmodically. At any rate in 1907 we have very little of it, only one man noting the appearance of the spawning turbot.

TABLE XIII.—Showing the number of hauls in each month in which spawning TURBOT are recorded.

The denominators of the fractions are the monthly total number of hauls by the fishermen who have recorded the cases of spawning turbot, those hauls in which no turbot were taken being excluded.

| | D. | F. | G. | H. | J. | I. | K. | L. | M. | N. | O. | Q. | R. | S. | T. | X. | All Areas. |
|--------------|---------------|-----------------|-----------------|-----------------|-------------------|-----------------|-----------------|-----------------|-------------------|------------------|----------------|-----------------|----------------|------------------|------------------|-----------------|------------|
| 1904. | | | | | | | | | | | | | | | | | |
| May ... | — | — | — | $\frac{5}{12}$ | — | — | — | — | $\frac{8}{19}$ | $\frac{4}{6}$ | — | $\frac{1}{1}$ | — | — | $\frac{3}{3}$ | — | 21 |
| June ... | — | $\frac{6}{15}$ | $\frac{2}{3}$ | — | — | — | — | — | $\frac{9}{65}$ | — | $\frac{3}{20}$ | — | — | — | — | — | 20 |
| July ... | — | — | — | — | — | — | — | — | — | — | — | $\frac{2}{19}$ | — | $\frac{2}{84}$ | — | — | 4 |
| December ... | — | — | — | $\frac{2}{52}$ | — | $\frac{22}{51}$ | — | — | — | — | — | — | — | — | — | — | 24 |
| 1905. | | | | | | | | | | | | | | | | | |
| January ... | — | — | — | $\frac{2}{41}$ | $\frac{1}{4}$ | — | $\frac{7}{7}$ | — | — | $\frac{2}{5}$ | — | — | — | — | — | — | 12 |
| February ... | $\frac{1}{1}$ | — | — | — | — | — | $\frac{6}{13}$ | $\frac{4}{11}$ | — | — | — | — | — | — | — | — | 11 |
| March ... | $\frac{2}{6}$ | — | — | — | — | — | — | $\frac{3}{3}$ | — | — | — | $\frac{5}{23}$ | — | — | — | — | 10 |
| April ... | — | — | — | — | — | — | — | $\frac{7}{10}$ | — | — | — | $\frac{11}{31}$ | — | — | — | $\frac{1}{1}$ | 23 |
| May ... | — | — | — | $\frac{18}{33}$ | — | — | — | $\frac{7}{8}$ | $\frac{584}{154}$ | — | — | $\frac{11}{73}$ | — | — | — | — | 94 |
| June ... | — | — | — | — | — | † | — | — | $\frac{34}{105}$ | $\frac{10}{11}$ | † | $\frac{9}{21}$ | † | — | — | — | 53 |
| July ... | — | — | — | — | — | — | — | $\frac{11}{12}$ | — | $\frac{1}{6}$ | — | $\frac{9}{49}$ | — | — | — | — | 26 |
| December ... | — | $\frac{1}{1}$ * | — | — | $\frac{14}{14}$ * | $\frac{4}{4}$ * | — | — | — | — | $\frac{1}{28}$ | — | — | — | — | $\frac{3}{4}$ * | 36 |
| 1906. | | | | | | | | | | | | | | | | | |
| January ... | — | — | $\frac{1}{1}$ * | — | $\frac{1}{2}$ * | — | $\frac{3}{4}$ * | — | — | — | — | — | — | — | — | — | 5 |
| May ... | — | — | — | — | — | — | — | † | $\frac{1}{17}$ | — | — | — | — | — | — | — | 1 |
| June ... | — | — | — | — | — | — | — | — | $\frac{7}{21}$ | $\frac{11}{19}$ | — | $\frac{3}{26}$ | $\frac{2}{25}$ | — | $\frac{3}{15}$ | $\frac{1}{7}$ | 27 |
| July ... | — | — | — | — | — | — | — | — | — | $\frac{1}{17}$ | — | — | — | — | — | $\frac{1}{5}$ | 2 |
| 1907. | | | | | | | | | | | | | | | | | |
| June ... | — | — | — | — | — | — | — | — | — | $\frac{1}{16}$ † | — | — | — | $\frac{6}{16}$ † | $\frac{8}{35}$ † | — | 15 |
| Total ... | 3 | 7 | 3 | 27 | 16 | 26 | 16 | 32 | 117 | 35 | 66 | 6 | 2 | 8 | 14 | 6 | — |

* "Spawn forming" or "spawn in."

† "All the large turbot are very full of spawn, and several of the small ones have spawn in them."

‡ "Turbot full of spawn, but not quite ripe."

The real spawning period is chiefly during the months of May, June and July. We also have records in the months of December to April, but remembering that the fishermen do not always distinguish between "maturing" and "spawning," we can well believe that these are cases in which the spawn is in process of maturing. They are said to be such in December, 1905, and January, 1906. In May and even in June there are instances of turbot being "very full, but some of them not quite ripe for spawning."

This table does not show any very definite laws with regard to the distribution, for maturing and spawning fish are found in nearly all the areas investigated. Both the Dogger Bank and the region north of it have a good proportion of hauls with spawning fish. Area M, off the Danish coast, has the largest number of these instances, but it so happens that the turbot spawn at a time coinciding with the season on the eastern grounds, when a very large number of hauls were made. In area N also, adjacent to this and area Q, there is a good proportion during June and July.

As an instance of the irregularity in recording, one notices area S which had two cases in 1904, none in 1905 and 1906 and several in 1907, the last being recorded by a man who seldom records any spawning fish.

Each of these observations given in the table, means the appearance of one or two turbot in the haul which are spawning. It is very seldom that more are found.

Summary—Turbot.

a. *Distribution.*—Turbot are found in all areas in the region investigated, and they are taken at nearly all times of the year. But they are never found in great quantities—from 1 to 3 being the number generally taken in each haul.

A broad line of division between the grounds most abundant and least abundant in this fish may be taken at about the line of longitude 4° East. East and south-east of this line we have comparative abundance, the maximum catches averaging over 25 per ten hours. The general comparative distribution and density of this fish is shown by the chart in Fig. 52.

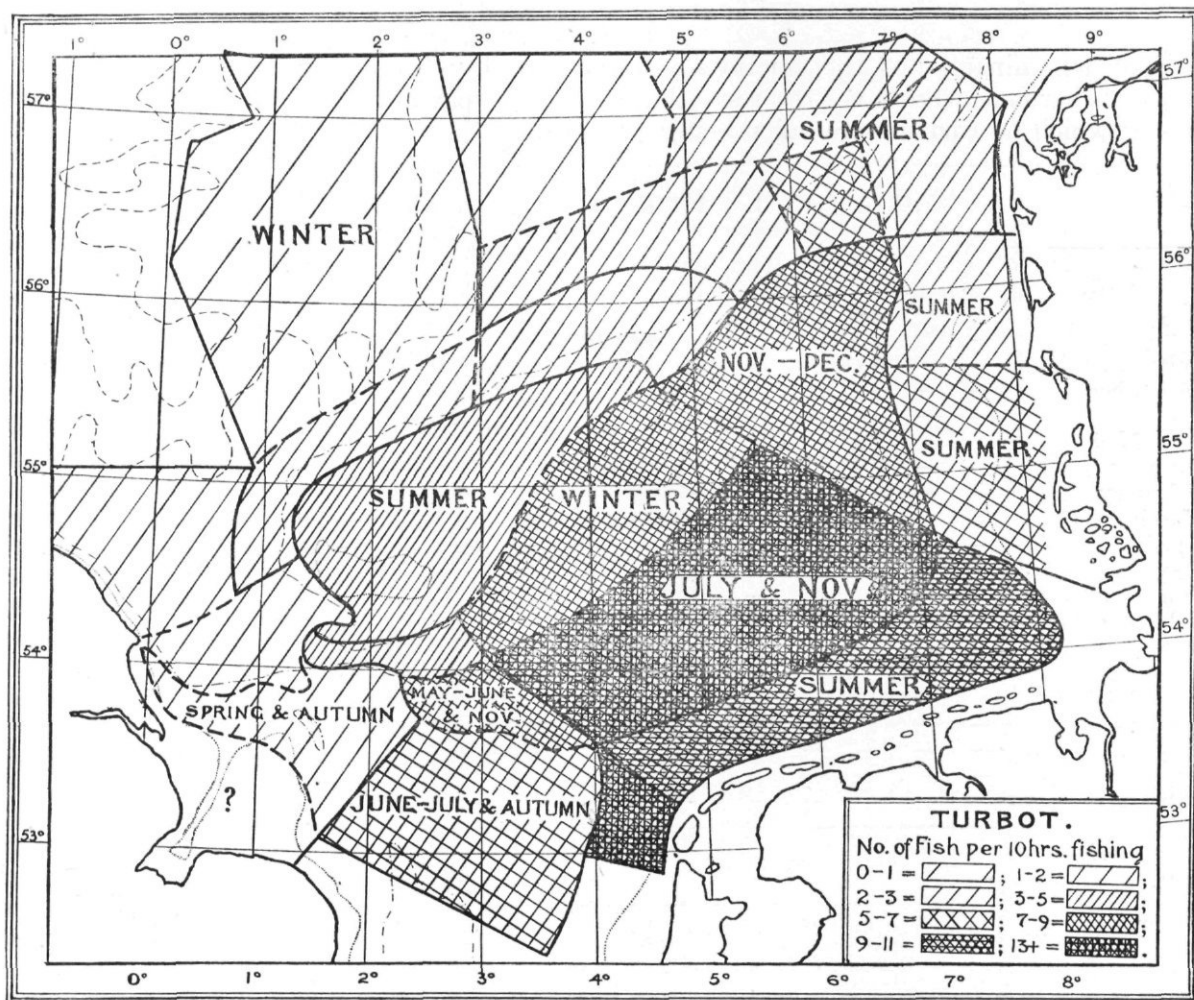


FIG. 52.—Chart showing the distribution of TURBOT according to the mean monthly catch in each area, and the periods of maximum abundance in the different regions.

This chart shows that turbot are most numerous in this region, off the coasts of Denmark, Germany and Holland, the largest catches being made in area N (Oyster Ground, deeper parts of Terschelling, &c.), where both the summer and winter catches are large.

The quantities decrease, proceeding northwards and also as we go from east to west. The quantities taken in the northern areas are very small, especially in area D, where they are of very rare occurrence. The southern areas S and T have a fairly good yield. In the western grounds we find that turbot are very rare, both in the shallow and deep water areas, the average catch being generally between one and two (per ten hours), that is, after two or three hauls.

Large fish form about one third of the total number of fish caught. They generally outnumber the small fish in the northern and north-eastern areas, those deep-water grounds furthest from the nursery grounds off the Dutch coasts. Small fish predominate in most of the other areas, but they decrease in proportion as we proceed from the coasts, while the large fish proportionally increase.

b. Yearly variations.—There is in very many of the areas a decided decrease in the monthly average catch between 1904 and 1907, and this is, on the whole, continuous. The greatest difference is between the first two years of the period, the last two years not differing so very much from one another.

c. Seasonal Fluctuations and Migrations.—Variations in the catch occur in all areas, and in most these show a regular seasonal periodicity. It is only in such areas as the western and northern groups, where the catches are so small, that chance fluctuations obscure the general law of seasonal variations, that these cannot be determined with certainty.

In the extreme eastern areas the summer catches are the highest and the fish disappear almost entirely in the winter. In the central areas adjacent to these there are two maxima situated at the beginning and end of a lengthy period of maximum abundance and separated by a small depression in the summer. In most areas there is a period of minimum abundance earlier in the year, from February to April, followed by a sudden increase corresponding in time with the oncoming of the spawning season, and in several cases there is a more or less marked decrease when this is over. The October to December averages are often fairly high, those of January and February somewhat lower, except in the northern group.

The evidence with regard to the question of migration is not very conclusive. The most obvious movement suggested by the figures is that of the congregation of turbot on the inshore grounds during the summer, and their departure in the winter, when they become very dispersed over the deeper and more distant grounds. The double maximum caused by their passage through the adjacent areas is definitely marked.

In the most northern areas we find the winter catches higher than those of the summer, although the difference is not particularly marked, as the catches are so very small. This may indicate a departure in the summer, probably southwards and inshore. Areas S and T show two periods of maxima like those in area N, divided by a small summer depression, the autumn maximum being much the higher of the two in area S. In these areas, too, the quantities are very small in early spring. The first maximum appears a little earlier in area T (May and June) than that of area S (June and July), while the autumn maximum arrives later, suggesting a condition which would be brought about by a double annual migration through these two areas, this being a southward movement in the summer and a northward movement in the autumn.

d. Spawning.—Occurrences of spawning and maturing turbot are found in most of the areas considered. In several of the most important turbot areas, including mainly the eastern, south-eastern and southern region between the Dogger and the European coasts, the numbers increase rapidly at the beginning of the spawning season. They are recorded as maturing during the months from December to April and actually spawning in May, June and July which are the chief months.

D.—BRILL.

Introduction.

This species is found in nearly all the areas investigated, but in exceedingly small numbers. Generally only one or two fish are taken after several hauls, but in some areas the numbers rise to an average of over 15 per 10 hours (*i.e.*, five or six per haul) at certain times of the year. They are recorded without any distinction of size except in a few cases where the skippers have noted that the brill are very small.

Monthly averages per 10 hours' fishing have been calculated, as for the other species discussed, but the number of fish dealt with is so small that the fortuitous fluctuations in many cases obscure the periodical changes of the catch due to the seasonal influences.

The population on any ground is very variable, not only in comparing one year with another, but also in the course of the year. The trend of the figures throughout the seasons of the different years does not always show the same regular periodicity that was present in the figures of the other species, by which we were justified in combining the figures for the different years to determine general seasonal variations. For this reason the curves of the combined averages appear most irregular and are interpreted with difficulty. Only a few of them are included in the text.

Total numbers caught and the yearly fluctuations.

The following table shows the total number of fish caught :—

Table XIV.—Showing the total number of BRILL caught by certain skippers during 1904–1907.

| — | | | | | Total Number of Fish. |
|-------|-----|-----|-----|-----|-----------------------|
| 1904 | ... | ... | ... | ... | 1,603 |
| 1905 | ... | ... | ... | ... | 3,157 |
| 1906 | ... | ... | ... | ... | 3,709 |
| 1907 | ... | ... | ... | ... | 3,232 |
| Total | ... | ... | ... | ... | 11,701 |

This shows the great scarcity of brill, when we consider that it represents the result of over 49,000 hours' fishing. The average per 10 hours' fishing is therefore only 2·4, *i.e.*, under one per haul. They are also, during this period, much scarcer than turbot, totalling a little more than one-third of that species, which is also very rare.

If we compare these totals with the number of hours' fishing in each year (Table I.), we find that brill are extremely scarce in 1904 and 1905, and that there was a comparatively big increase in 1906 and 1907.*

By comparing the averages of each month with those of the corresponding months in the preceding years, we obtain the following figures:—

1905 is 18 times less than, and 20 times greater than 1904, out of 40 months.

1906 is 15 times less than, and 19 times greater than 1904, out of 35 months.

1907 is 8 times less than, and 15 times greater than 1904, out of 25 months.

1906 is 23 times less than, and 20 times greater than 1905, out of 46 months.

1907 is 12 times less than, and 21 times greater than 1905, out of 34 months.

1907 is 7 times less than, and 23 times greater than 1906, out of 33 months.

From this we may conclude that 1905 and 1904 were not markedly different, but that both in 1906 and 1907, especially in the latter year, the amount of brill was more often greater than less than in the two previous years.

Fluctuations in each Area.

Table XV. gives the average numbers of brill taken from each area in each month. These determine the general distribution and the seasonal variations as follows:—

TABLE XV.—SHOWING for each area the Monthly Average Number of BRILL caught per ten hours' fishing.

| Group | Area. | Year. | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|----------------------|-------|--------|---------------------|--------------------|---------------------|----------------------|-----------------------|----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| North-Eastern Areas. | A | 1904 | ... | ... | ... | ... | ... | ... | ... | 2·73 ²² | ... | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0·45 ⁴⁴ | ... | ... | ... | ... | ... |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | 0·45 ⁴⁴ | 2·73 ²² | ... | ... | ... | ... |
| | B | 1904 | ... | ... | ... | ... | ... | ... | ... | 0·00 ¹⁸ | 0·23 ⁸⁸ | 0·00 ¹¹⁷ | 0·00 ⁶⁴ | ... |
| | | 1905 | ... | ... | ... | 0·00 ³⁰ | 0·80 ¹² | ... | ... | ... | 0·00 ¹⁶⁰ | 0·00 ²⁰ | 0·00 ⁴ | ... |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·00 ¹¹³ | 0·00 ³⁹ | ... |
| | | 1904-7 | ... | ... | ... | 0·00 ³⁰ | 0·80 ¹² | ... | ... | 0·00 ¹⁸ | 0·08 ²⁴⁸ | 0·00 ²⁵⁰ | 0·00 ¹⁰⁷ | ... |
| | C | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1905 | ... | ... | 0·00 ⁸ | ... | ... | ... | ... | ... | ... | 0·00 ⁴ | ... | 0·00 ⁴ |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | 0·00 ⁸ | ... | ... | ... | ... | ... | ... | 0·00 ⁴ | ... | 0·00 ⁴ |
| | F | 1904 | ... | ... | ... | ... | ... | 2·34 ⁶⁸ | 0·00 ⁸ | 2·50 ⁸ | 0·31 ⁶⁵ | ... | 0·47 ⁶⁴ | 1·25 ¹²⁰ |
| | | 1905 | ... | ... | 0·00 ¹² | ... | ... | ... | 1·35 ⁵² | 0·56 ³⁵ | 0·37 ¹⁰⁹ | 1·60 ⁹⁴ | 0·00 ⁸ | 2·50 ⁸ |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | 0·00 ³⁸ | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | 0·00 ¹² | ... | ... | 2·34 ⁶⁸ | 1·17 ⁶⁰ | 0·49 ⁸¹ | 0·34 ¹⁷⁴ | 1·66 ⁹⁴ | 0·42 ⁷² | 1·33 ¹²⁸ |
| | G | 1904 | ... | ... | ... | ... | ... | 1·36 ²⁹ | ... | 0·62 ³² | 0·00 ⁸⁸ | 0·45 ⁴⁴ | 0·00 ⁴ | ... |
| | | 1905 | 0·00 ¹⁰⁸ | 0·00 ⁸ | ... | ... | ... | ... | ... | 0·00 ⁴ | ... | 0·00 ¹⁵ | ... | 0·00 ⁵ |
| | | 1906 | 0·00 ²¹ | 0·00 ⁷⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·00 ⁹⁶ | ... |
| | | 1904-7 | 0·00 ¹²⁹ | 0·06 ⁸⁶ | ... | ... | ... | 1·36 ²⁹ | ... | 0·55 ³⁶ | 0·06 ⁸⁸ | 0·34 ⁵⁹ | 0·06 ¹⁰⁰ | 0·06 ⁵ |
| Eastern Areas. | H | 1904 | ... | ... | ... | ... | 1·15 ⁵² | ... | ... | 0·00 ¹⁶ | 3·33 ¹⁵ | 0·68 ⁷³ | 0·18 ³⁸⁵ | 0·10 ¹⁹¹ |
| | | 1905 | 0·98 ³⁴⁷ | ... | 0·00 ⁹ | 1·63 ¹³⁵ | 0·70 ¹⁷⁰ | ... | 1·25 ¹⁶ | ... | 1·98 ⁴⁰ | 0·27 ⁵⁶⁵ | 0·31 ²⁵⁷ | 0·12 ⁸⁴ |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·63 ¹⁶ | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2·55 ⁷⁰ | ... |
| | | 1904-7 | 0·98 ³⁴⁷ | ... | 0·06 ⁹ | 1·63 ¹³⁵ | 0·81 ²²² | ... | 1·25 ¹⁶ | 0·00 ¹⁶ | 2·34 ⁵⁵ | 0·32 ⁶⁵⁴ | 0·46 ⁷¹² | 0·11 ²⁷⁵ |
| | M | 1904 | ... | ... | ... | ... | 1·71 ⁷⁶ | 1·87 ²⁶² | 4·82 ¹¹⁴ | 1·44 ⁴⁸ | ... | ... | 3·33 ³⁰ | 1·95 ³²⁹ |
| | | 1905 | 10·75 ⁵³ | ... | 0·82 ⁴⁹ | 5·03 ³⁵⁸ | 7·13 ⁸¹⁰ | 9·24 ⁶⁶¹ | ... | ... | 5·53 ⁶¹ | 0·00 ¹³ | 4·04 ²⁸⁴ | 0·66 ⁹¹ |
| | | 1906 | ... | ... | ... | 18·83 ²⁸⁷ | 12·51 ⁴²³ | 9·32 ⁴⁵¹ | 8·76 ²⁸⁶ | 3·55 ⁷⁶ | ... | 18·18 ²⁸ | 10·49 ⁸¹ | 7·39 ²⁰² |
| | | 1907 | ... | ... | ... | 7·85 ¹⁵⁵ | 14·69 ⁴⁴² | 10·95 ³³³ | 15·09 ⁸⁰ | ... | ... | ... | 14·29 ⁷ | 4·13 ¹⁶⁰ |
| | | 1904-7 | 10·75 ⁵³ | ... | 0·82 ⁴⁹ | 10·52 ⁸⁰⁰ | 10·10 ¹⁷⁵¹ | 8·46 ¹⁷⁰⁷ | 8·88 ⁴⁸⁰ | 2·73 ¹²⁴ | 5·53 ⁶¹ | 12·26 ⁴¹ | 5·47 ⁴⁰² | 3·65 ⁷⁸² |
| | Q | 1904 | ... | ... | ... | ... | 0·00 ⁴ | 3·33 ⁴⁸ | 4·64 ¹¹² | 5·00 ⁴⁸ | 2·16 ¹¹⁵ | 0·00 ⁸ | ... | ... |
| | | 1905 | ... | ... | 0·96 ³²² | 2·12 ⁹⁹ | 1·79 ¹⁴⁰ | 6·34 ²⁰ | 5·58 ⁷³ | 5·49 ²⁹⁰ | 3·82 ³⁴ | ... | 3·53 ⁸ | 5·56 ⁹ |
| | | 1906 | ... | ... | 2·35 ⁴³ | ... | 4·63 ⁶⁷ | 6·54 ¹⁰⁶ | 3·75 ⁸ | 4·79 ³⁵ | ... | 16·34 ³⁵ | ... | ... |
| | | 1907 | ... | 0·65 ¹⁵ | 4·24 ¹¹⁸ | 8·77 ⁵⁷ | 1·58 ¹⁸⁴ | 11·85 ⁴⁰ | 1·70 ⁴⁷ | 9·16 ¹¹³ | 2·08 ¹²⁰ | 2·50 ²⁸ | 4·29 ⁷ | ... |
| | | 1904-7 | ... | 0·65 ¹⁵ | 1·88 ⁴⁵³ | 4·55 ¹⁵⁶ | 2·15 ³⁹⁵ | 6·81 ²¹⁴ | 4·32 ²⁴⁰ | 6·24 ⁴⁸⁶ | 2·34 ²⁶⁹ | 9·06 ⁷¹ | 3·87 ¹⁵ | 5·56 ⁹ |
| | W | 1904 | ... | ... | ... | ... | ... | 6·72 ⁶¹ | 5·83 ¹² | ... | 2·50 ⁴ | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | 3·33 ⁶ | ... | ... | ... | ... | ... | ... | ... |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 8·33 ¹² | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | 3·13 ¹⁶ | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | ... | ... | 3·33 ⁶ | 6·72 ⁶¹ | 4·29 ²⁸ | ... | 2·50 ⁴ | 8·33 ¹² | ... | ... |

* This same trend in the yearly averages for brill is shown in the Dutch Statistics, *Jaarverslag omtrent het beheer van de Visscherhaven te IJmuiden*, 1908. Table iv., p. 72.

| Group. | Area. | Year. | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|-----------------|-------|--------|----------------------|-----------------------|---------------------|---------------------|----------------------|---------------------|----------------------|----------------------|----------------------|---------------------|---------------------|---------------------|
| Central Areas. | J | 1904 | ... | ... | ... | ... | 2.22 ⁹ | ... | ... | 0.40 ⁷⁵ | 0.39 ²⁰⁵ | ... | 0.26 ⁷⁷ | 2.69 ⁴⁰¹ |
| | | 1905 | 1.04 ¹⁰⁵ | ... | ... | ... | 2.00 ²⁰ | ... | ... | ... | 0.00 ⁹⁵ | 0.25 ⁷⁸ | 1.41 ⁶⁴ | 0.56 ⁸⁸ |
| | | 1906 | 1.09 ²⁸ | 3.67 ³⁰ | ... | ... | 0.00 ⁷⁷ | ... | ... | 0.00 ⁹² | 0.00 ⁹⁰ | 7.50 ²⁸⁴ | 8.05 ¹³⁰ | 5.00 ³⁸ |
| | | 1907 | ... | ... | 1.48 ⁶⁷ | 0.59 ⁶⁸ | ... | ... | ... | ... | ... | ... | 1.88 ¹⁶ | ... |
| | | 1904-7 | 1.05 ¹³³ | 3.66 ³⁰ | 1.48 ⁶⁷ | 0.59 ⁶⁸ | 0.56 ¹⁰⁶ | ... | ... | 0.18 ¹⁶⁷ | 0.21 ³⁹⁰ | 5.93 ³⁶² | 4.14 ²⁸⁷ | 2.56 ⁵²⁷ |
| | N | 1904 | ... | ... | ... | ... | 0.00 ²⁸ | 2.96 ⁴⁰ | 5.17 ²⁰⁵ | 6.39 ¹⁰⁹ | 3.35 ⁹⁸ | 1.25 ¹⁴⁴ | 2.14 ¹⁸² | 1.90 ¹³⁶ |
| | | 1905 | 1.18 ⁸ | 0.25 ⁴⁰ | 1.73 ⁵² | 1.17 ⁶⁰ | 2.71 ⁵⁹ | 4.03 ¹³⁹ | 0.66 ⁷⁶ | 1.87 ²⁷² | 1.35 ²⁷⁴ | ... | 1.37 ²¹⁹ | 2.07 ⁴¹² |
| | | 1906 | 2.47 ⁴²¹ | 1.55 ³¹⁰ | 117.283 | 2.22 ¹⁴ | 0.56 ⁹⁰ | 1.21 ⁸³ | 2.50 ⁷⁶ | 1.78 ¹⁹⁷ | 1.76 ³¹ | 2.96 ¹⁰⁸ | 4.47 ²⁰¹ | 1.88 ⁷⁴ |
| | | 1907 | 2.64 ³⁰⁶ | 5.36 ¹²⁵ | 2.28 ²²⁸ | 1.21 ¹³² | 0.41 ⁷⁴ | 4.76 ⁷¹ | 0.68 ¹¹⁸ | 3.56 ⁴⁵ | 1.96 ²³⁵ | 3.17 ²⁹⁹ | 4.30 ³⁵⁴ | 4.90 ⁹⁶ |
| | | 1904-7 | 2.53 ⁷³⁵ | 2.44 ⁴⁷⁵ | 1.67 ⁵⁶³ | 1.26 ²⁰⁶ | 0.96 ²⁵¹ | 3.36 ³³³ | 2.91 ⁴⁷⁵ | 2.76 ⁶²³ | 1.96 ⁶⁵⁸ | 2.63 ⁵⁵⁷ | 3.25 ⁹⁵⁶ | 2.38 ⁷¹⁸ |
| | I | 1904 | ... | ... | ... | ... | ... | 0.00 ¹⁰¹ | 0.54 ¹⁸ | 0.19 ³¹⁹ | 0.04 ²²⁵ | 0.83 ²¹⁸ | 2.00 ¹⁹⁰ | 1.09 ³⁵⁹ |
| | | 1905 | 1.03 ⁸⁷ | 0.00 ¹⁷ | ... | ... | ... | 0.58 ⁵² | 0.33 ¹²¹ | 0.19 ²⁶³ | 0.26 ⁶⁵² | ... | 0.22 ¹⁸⁹ | 1.68 ⁴⁷ |
| | | 1906 | 3.16 ⁷⁹ | ... | ... | ... | ... | ... | 0.00 ⁷⁴ | ... | 0.00 ³¹ | 0.87 ¹¹ | 0.61 ⁶⁵ | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | 1.00 ¹⁶⁰ | 0.56 ⁷¹ | 2.22 ²⁷ | ... |
| | | 1904-7 | 2.04 ¹⁶⁶ | 0.00 ¹⁷ | ... | ... | ... | 0.20 ¹⁵³ | 0.23 ²¹³ | 0.19 ⁵⁸² | 0.32 ¹⁰⁶⁸ | 0.77 ³⁰⁰ | 1.21 ⁴²¹ | 1.16 ⁴⁰⁶ |
| | O | 1904 | ... | ... | ... | ... | 0.00 ¹⁰ | 0.20 ¹⁰⁰ | 0.88 ¹⁴⁹ | 0.16 ²⁵⁴ | 0.42 ²¹⁶ | 0.39 ³⁵⁶ | 0.18 ²⁷⁸ | 0.41 ⁹⁷ |
| | | 1905 | 0.50 ¹⁰⁰ | 0.71 ⁵⁶ | 0.00 ¹⁵⁰ | 0.08 ⁶¹³ | 0.08 ³⁹⁵ | 0.33 ¹²¹ | 0.51 ²⁵⁵ | 0.30 ⁹⁹ | ... | 0.31 ³²⁷ | 0.23 ¹⁷⁵ | 0.07 ⁵³⁸ |
| | | 1906 | ... | 0.00 ¹¹ | 0.00 ⁹ | 0.00 ¹⁴ | 0.00 ¹⁰ | ... | ... | ... | 0.00 ⁴ | 1.48 ¹⁴ | 0.00 ⁴ | ... |
| | | 1907 | 0.04 ²⁸¹ | ... | 0.00 ⁸⁰ | ... | ... | ... | ... | ... | ... | ... | 0.15 ⁶⁸ | ... |
| | | 1904-7 | 0.16 ³⁸¹ | 0.66 ⁶⁷ | 0.00 ²³⁹ | 0.08 ⁶²⁷ | 0.07 ⁴¹⁵ | 0.27 ²²¹ | 0.64 ⁴⁰⁴ | 0.20 ³⁵³ | 0.41 ²²⁰ | 0.37 ⁶⁹⁷ | 0.19 ⁵²⁵ | 0.13 ⁶³⁵ |
| Northern Areas. | D | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 ³⁷ | ... |
| | | 1905 | 0.16 ⁶¹ | 0.04 ⁷⁶⁰ | 0.03 ⁶⁴⁷ | 0.00 ²⁴ | ... | ... | ... | ... | ... | ... | ... | 0.00 ⁶⁹ |
| | | 1906 | ... | 0.00 ⁸⁵ | 0.00 ²⁵⁷ | ... | ... | ... | ... | 0.00 ¹³¹ | 0.00 ²⁴ | ... | ... | ... |
| | | 1907 | ... | ... | 0.00 ²⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | 0.16 ⁶¹ | 0.04 ⁸⁴⁵ | 0.02 ⁹³² | 0.00 ²⁴ | ... | ... | ... | 0.00 ¹³¹ | 0.00 ²⁴ | ... | 0.00 ³⁷ | 0.00 ⁶⁹ |
| | K | 1904 | ... | ... | ... | ... | 0.00 ⁴ | 0.26 ³⁸ | ... | 0.00 ⁷ | 0.00 ⁴³ | 0.11 ⁹⁵ | 0.47 ²¹ | ... |
| | | 1905 | 0.14 ²¹¹ | 0.17 ²³⁹ | 0.34 ²⁹ | ... | ... | ... | ... | 0.00 ⁴ | 0.00 ⁷¹ | 0.00 ⁴ | ... | ... |
| | | 1906 | 0.00 ⁸¹ | 0.00 ²⁴ | 0.00 ⁴⁴ | ... | ... | ... | ... | ... | 0.00 ²¹ | ... | ... | ... |
| | | 1907 | 0.00 ⁵⁵ | 0.09 ³³² | 0.00 ³³⁵ | ... | ... | ... | ... | ... | ... | 0.00 ¹¹ | 0.00 ⁸ | ... |
| | | 1904-7 | 0.10 ²⁹⁷ | 0.12 ⁴⁹⁵ | 0.03 ³⁰⁸ | ... | 0.00 ⁴ | 0.26 ³⁸ | ... | 0.00 ¹¹ | 0.00 ¹³⁵ | 0.09 ¹¹⁰ | 0.34 ²⁹ | ... |
| | L | 1904 | ... | ... | ... | ... | ... | 0.00 ²¹ | 0.00 ⁶ | 0.00 ⁵⁴ | 0.15 ¹⁹⁵ | 0.00 ⁶³ | 0.00 ⁸ | ... |
| | | 1905 | 0.24 ⁸⁴ | 0.18 ⁸²⁵ | 0.31 ¹⁹² | 0.09 ¹¹¹ | 0.00 ³⁰ | 0.00 ⁷ | 0.00 ⁷⁹ | 0.00 ¹⁸ | 0.00 ⁸¹ | ... | ... | 0.55 ³⁶ |
| | | 1906 | 0.00 ¹³² | 0.08 ²⁴⁷ | ... | ... | 0.00 ¹⁹⁹ | 0.00 ¹⁰⁸ | 0.00 ⁹⁷ | 0.00 ¹⁰¹ | 0.16 ³⁰⁸ | 0.07 ¹³⁶ | ... | ... |
| | | 1907 | ... | ... | 0.00 ⁶⁰ | ... | ... | ... | ... | ... | ... | 0.00 ¹³ | ... | ... |
| | | 1904-7 | 0.09 ²¹⁶ | 0.15 ⁸⁷² | 0.24 ²⁵² | 0.09 ¹¹¹ | 0.00 ²²⁹ | 0.00 ¹³⁶ | 0.00 ¹⁸² | 0.00 ²⁰³ | 0.14 ⁵⁸⁴ | 0.06 ²¹² | 0.06 ⁶ | 0.55 ³⁶ |
| Southern Areas. | S | 1904 | ... | ... | ... | ... | ... | 3.20 ²¹⁶ | 3.51 ³⁴⁵ | 4.84 ⁴⁵⁴ | 4.60 ¹⁰⁰ | 2.33 ¹⁰³ | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | 2.06 ⁶¹⁷ | 1.91 ⁷⁴⁹ | 1.91 ⁷⁴⁹ | 2.00 ⁴⁵ | 0.00 ⁴ | 0.00 ⁸ | 0.74 ¹³ |
| | | 1906 | ... | 9.09 ⁵ | 0.11 ⁹² | 1.33 ²² | 0.00 ⁷ | 2.18 ³⁵ | 0.72 ⁵³ | 1.52 ¹⁰⁶ | 1.45 ²²⁰ | 4.07 ⁵⁶ | ... | ... |
| | | 1907 | ... | ... | ... | ... | 6.75 ⁴⁶¹ | 5.77 ³⁴⁸ | 3.91 ²⁷¹ | ... | ... | ... | 3.75 ¹⁶ | ... |
| | | 1904-7 | ... | [9.09 ⁵] | 0.11 ⁹² | 1.33 ²² | 6.65 ⁴⁶⁸ | 4.56 ⁶¹⁹ | 2.74 ¹³¹⁶ | 2.90 ¹³⁰⁹ | 2.38 ³⁶⁵ | 2.87 ¹⁶³ | 2.45 ²⁴ | 0.74 ¹³ |
| | T | 1904 | ... | ... | ... | ... | 2.31 ¹³ | 5.00 ²⁴ | 3.00 ¹⁰ | 5.00 ⁸ | 5.00 ⁸ | ... | 3.56 ²² | ... |
| | | 1905 | ... | ... | ... | ... | 1.98 ⁵⁵ | ... | 3.30 ⁴⁸ | 4.05 ⁷⁹ | 2.00 ¹⁰⁰ | 1.80 ¹⁷⁷ | 1.52 ³⁴³ | 0.50 ³⁴⁰ |
| | | 1906 | ... | 0.42 ⁹⁶ | 0.19 ⁵² | 1.51 ¹¹² | 0.94 ⁵³ | 1.86 ⁹⁷ | 2.15 ¹⁸¹ | 3.32 ⁹⁰ | 2.65 ⁸³ | 2.53 ²²⁵ | 0.73 ²⁷ | ... |
| | | 1907 | ... | ... | ... | 4.16 ³⁹ | 4.00 ²⁵ | 4.27 ¹⁴⁸ | 2.31 ⁹¹ | ... | 2.00 ²⁰ | 2.75 ⁸⁴ | 3.40 ²¹² | 2.50 ¹² |
| | | 1904-7 | ... | 0.42 ⁹⁶ | 0.19 ⁵² | 2.19 ¹⁵¹ | 1.98 ¹⁴⁶ | 3.45 ²⁶⁴ | 2.38 ³³⁰ | 3.72 ¹⁷⁷ | 2.37 ²¹¹ | 2.36 ⁴⁵⁶ | 2.22 ⁶⁰⁴ | 0.57 ³⁵² |
| | V | 1904 | ... | ... | ... | ... | ... | ... | 0.30 ¹³¹ | 0.35 ⁸⁶ | 1.32 ⁴⁵ | ... | 0.74 ¹³ | ... |
| | | 1905 | ... | ... | 3.20 ²⁵ | ... | ... | ... | 1.48 ¹⁰⁸ | 0.70 ²⁹ | ... | 1.43 ²⁸ | ... | ... |
| | | 1906 | 0.34 ⁵⁹ | 0.00 ⁴ | 0.38 ⁸⁰ | 0.79 ³⁸ | ... | 0.00 ¹² | 0.76 ⁵³ | 0.62 ⁴⁹ | 1.08 ⁴⁷ | 0.00 ¹⁶ | 0.00 ¹² | ... |
| | | 1907 | ... | ... | ... | ... | 0.00 ⁴ | 0.00 ⁸ | 0.00 ⁵⁵ | ... | 2.02 ⁹⁴ | 0.71 ²⁸ | 1.03 ⁴⁸ | ... |
| | | 1904-7 | 0.34 ⁵⁹ | [0.00 ⁴] | 1.05 ¹⁰³ | 0.78 ³⁸ | [0.00 ⁴] | 0.00 ²⁰ | 0.69 ³⁴⁷ | 0.49 ¹⁶⁴ | 1.20 ⁹² | 1.66 ¹³⁸ | 0.57 ⁶³ | 1.03 ⁴⁸ |
| Western Areas. | E | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1906 | 1.29 ⁸ | ... | 4.00 ⁷ | ... | ... | 1.08 ¹⁸ | 4.35 ¹¹ | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | 1.29 ⁸ | ... | 4.00 ⁷ | ... | ... | 1.08 ¹⁸ | 4.35 ¹¹ | ... | ... | ... | ... | ... |
| | R | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 7.78 ⁹ | 4.44 ⁴ |
| | | 1905 | ... | ... | 0.00 ¹⁴ | ... | 0.40 ⁷⁶ | ... | ... | ... | 0.56 ¹⁸ | ... | 2.80 ¹⁶⁸ | 3.49 ²¹² |
| | | 1906 | 4.11 ¹³⁹ | 3.04 ²³⁶ | 2.36 ²⁸⁰ | 0.75 ²⁶⁶ | 0.45 ¹⁷⁶ | 0.29 ²³⁸ | 2.16 ²²² | 0.62 ¹¹³ | 1.33 ⁷ | 1.38 ¹⁴ | ... | ... |
| | | 1907 | ... | ... | ... | 3.08 ⁶ | 0.00 ²³ | 1.88 ³² | 0.00 ⁴ | ... | ... | ... | ... | ... |
| | | 1904-7 | 4.11 ¹³⁹ | 3.04 ²³⁶ | 2.24 ²⁹⁴ | 0.81 ²⁷² | 0.40 ²⁷⁵ | 0.48 ²⁷⁰ | 2.12 ²²⁶ | 0.62 ¹¹³ | 0.78 ²⁵ | 1.38 ¹⁴ | 3.05 ¹⁷⁷ | 3.51 ²¹⁶ |
| | X | 1904 | ... | ... | ... | ... | ... | ... | 0.28 ¹⁰⁹ | 2.15 ⁶⁰ | 0.33 ³⁰ | ... | 0.90 ³³ | 9.14 ¹⁷ |
| | | 1905 | 0.00 ⁴ | 0.00 ³ | 2.99 ⁵³ | 0.83 ¹² | ... | ... | 0.65 ³¹ | ... | 0.65 ¹⁰⁷ | 2.05 ¹⁰⁷ | 0.00 ¹⁵ | 0.00 ⁴⁴ |
| | | 1906 | ... | 0.00 ⁹ | 0.84 ⁶⁰ | 3.37 ⁷⁷ | 0.19 ⁵² | 0.45 ¹⁵⁶ | 0.36 ¹¹² | 0.43 ⁹³ | 0.47 ⁶⁴ | 1.50 ²⁰ | 0.00 ¹⁶ | ... |
| | | 1907 | ... | ... | ... | ... | 0.19 ⁵² | 1.25 ⁸ | 0.42 ⁹⁶ | ... | ... | 0.44 ¹⁸³ | 1.07 ²⁸ | 1.63 ²⁵ |
| | | 1904-7 | [0.00 ⁴] | [0.00 ¹²] | 1.86 ¹¹³ | 3.03 ⁸⁹ | 0.19 ¹⁰⁴ | 0.49 ¹⁶⁴ | 0.35 ³¹⁷ | 1.11 ¹⁵³ | 0.48 ¹²⁵ | 1.06 ³¹⁰ | 0.65 ⁹² | 2.38 ⁵⁶ |
| | P | 1904 | ... | ... | ... | ... | ... | ... | 0.00 ²¹³ | ... | 0.00 ⁵ | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0.00 ¹⁶ | ... | ... | ... | ... | ... |
| | | 1906 | ... | ... | 0.00 ⁴ | 0.00 ⁴ | ... | ... | ... | ... | 0.00 ²⁴ | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | 0.00 ⁴ | 0.00 ⁴ | ... | ... | 0.00 ²²⁹ | ... | 0.00 ³² | ... | ... | ... |

North-Eastern Areas.

Brill are found in these areas but very rarely. The biggest catches were taken from areas A and F. In B and C they are almost wholly absent, the only ones reported being one fish in May, 1905, and two in September, 1904, in area B.

In F there is some evidence of a decline in the average from 2·34 in June to 0·34 in September, followed by a slight rise to December. In area G also they are generally absent, and the highest average occurs in June.

Eastern Areas.

Area H.—The averages fluctuate between 0 and 3 per 10 hours, and in 11 cases out of 17 they are less than one.

April and May, and perhaps September, are the best months. November and December are very low, and the numbers of brill decrease appreciably throughout these months.

Area M.—This area gives a greater average number of brill than any of those considered. The general average is never less than 0·82, and it rises to over 10 in four months of the year, while the highest average attained is 18·83 in April, 1906. These years, 1906 and 1907, are throughout the best years of the period in the area, while 1904 has very low values.

From April to July appears to be the season of greatest abundance, while August and September show a period of decreasing abundance before an autumn maximum. It appears that most of the brill on this ground are small, as special note has been made that they are so in May, 1904, and in April and May, 1905. In December, 1904, we notice that brill begin to get more numerous, and at the end of the month and during the first few days of January, 1905, several small fish are recorded. This is paralleled by the occurrence in November, 1905, of large numbers of tiny brill on the Sylt Rough.

Area Q.—The course of the monthly averages in this area is most irregular and fluctuating. They indicate, however, the presence of a fair number of brill in this area, which with area W comes next to area M in its yield. The maximum and minimum general averages are 9·09 and 0·65 respectively, while in five months of the year the general average exceeds five per 10 hours. The maximum averages obtained are 11·85 in June, 1907, and 16·34 in October, 1906.

June seems to be the month of maximum, and there is a rise, although irregular, from February to this time. By September the numbers have decreased, and in the months after this they are indeterminate.

Area W.—The total amount of fishing is very small, but the average numbers of brill taken approximate very closely to those of the adjacent area Q. The maxima are 6·72 in June and 8·33 in October.

These eastern areas give the largest average yield of brill, the grounds in the neighbourhood of Sylt and Amrum being among the most prolific. The population of brill consists apparently mainly of small fish and reaches a maximum about May and June, the spawning period. A secondary maximum appears later in the year, about September in H, and in October and November in the others. Very tiny fish were present on the Sylt grounds at the beginning of winter.

By far the best catches of the period were made in 1906 and 1907.

Central Areas.

Area J.—The average catch here is small, being generally less than 2 per ten hours, and in 4 months no fish at all were caught.

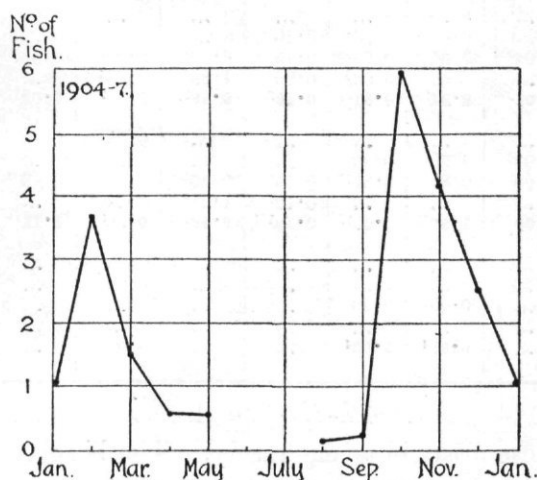


FIG. 53.—BRILL. Area J. Monthly Averages, 1904-1907.

The curve (Fig. 53), is incomplete as the averages for the early summer are missing, but it shows that there is a minimum in summer and a maximum in autumn. Only from October to December of 1906 do we get any large numbers. The highest average reached is 8.05 in November, 1906.

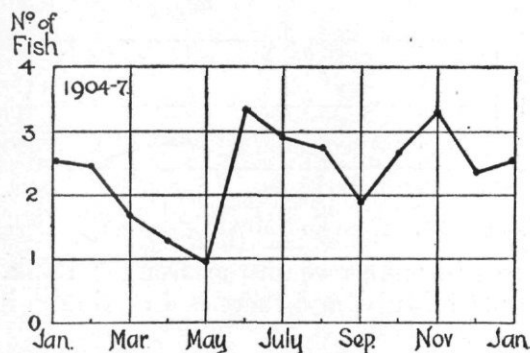


FIG. 54.—BRILL. Area N. Monthly Averages, 1904-1907.

Area N.—The range of variation in the average monthly catch of this area is comparatively small, the general average fluctuating from 0.96 to 3.36, while only four of the twelve general averages are under 2. The highest value obtained is 6.39 in August, 1904. This area, which has through the considerable amount of fishing, yielded very smooth curves for the other species, bringing out periodical fluctuations very definitely, is a good illustration of the great variability in the seasonal movements of the brill. It would be very difficult to interpret the general curve (Fig. 54) as it stands in this respect, and the method of three monthly averages results in a smoothed curve (Fig. 55) which at first sight, serves more to bring out the differences in the trend of the four years, than the similarity in the seasonal fluctuations that generally exists.

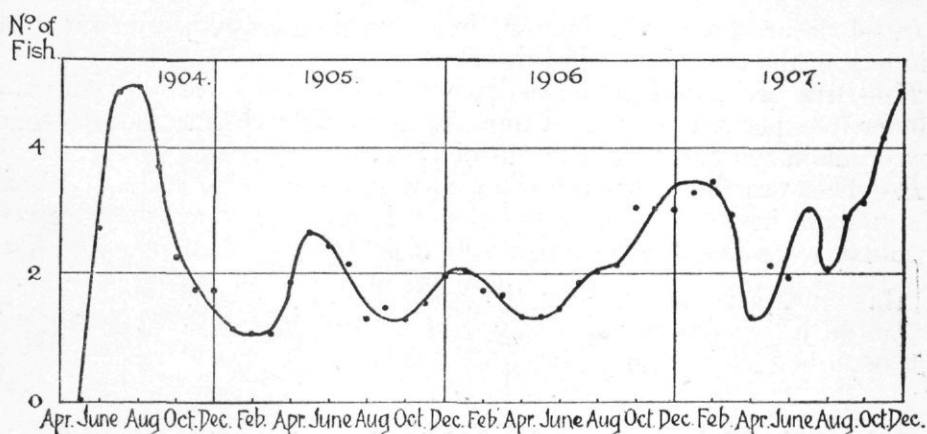


FIG. 55.—Brill. Area N. Monthly Averages, (smoothed curve).

The course of the figures is as follows :—In 1904 we find increasing quantities from May till a maximum of 6.39 in August, and then a sharp and continued decline to a low minimum in February, 1905. After this the curve rises again to a spring maximum, which is only half the maximum in 1904. This is followed by an autumn minimum and a winter maximum culminating in January, 1906. In 1906 we have a minimum about May, and then slowly increased catches till the winter. Both the November and February (1907) averages are very high and there is a decided decrease in the intervening months. There is a sharp drop to a minimum in April or May, and the curve then rises irregularly till the end of the year. It is evident from these figures how very variable is the period of maximum abundance as well as its duration.

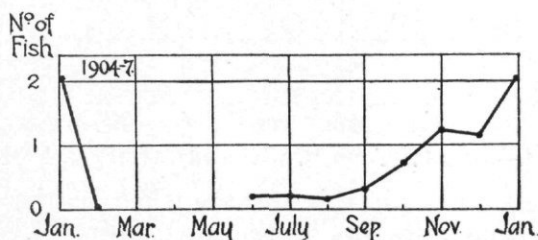


FIG. 56.—BRILL. Area I. Monthly Averages, 1904-1907.

Area I.—The catches are small for the greater part of the year, and considerably less than those in N. November, December and January have the highest general averages, being 2.04 at the maximum. From June to September they are all less than 0.33.

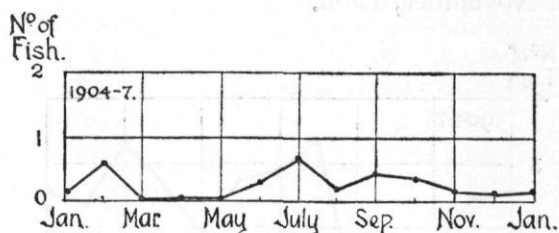


FIG. 57.—BRILL. Area O. Monthly Averages 1904–1907.

Area O.—The brill are still more rare on the Dogger Bank. The highest averages are 0.60 in February and 0.64 in July, and there is a minimum in the spring, for no fish were caught in March.

These central areas show with regard to distribution a marked decrease in the numbers in the more offshore areas. The average yield from areas M, N, I and O forms a rapidly decreasing series, the respective maximum averages attained in these areas being about 12, 3 and 0.6.

The seasonal fluctuations are not always constant for the same area, but as in J we have the highest values from October to December, in N in some years, a maximum in January and February and in I from November to January, it seems that as a rule the autumn and winter catches are the greatest. We may therefore suppose that the fish move offshore into the deeper waters at the approach of the cold weather. The spring and summer catches are generally low, so that an inshore migration, beginning about March and April, may take place.

Northern Areas.

Area D.—Brill are present in the first three months of 1905, afterwards they were not found in any of the hauls taken in this area.

Area K.—Brill are found occasionally, but the averages are all very small, being generally under 0.34 per ten hours, and they are more often absent than present. As in area D, they occur in the first three months of 1905.

Area L.—They are absent from nearly all the hauls of 1904, and are only present in very small numbers in the first four months of 1905, after which they are very seldom found. Two fish were taken in December 1905.

These three northern areas show the same features, viz., a great scarcity of brill. None were caught in the summer and they were rarely taken after the first three or four months of 1905, when they occurred in small numbers.

Southern Areas.

Area S.—This area compares very favourably with some of the eastern areas. The highest average obtained (omitting February 1906), is that of May, 1907, which is 6.75. Most of the other averages vary between 1 and 5. Brill occurred more plentifully in 1907 than in the other years.

Western Areas.

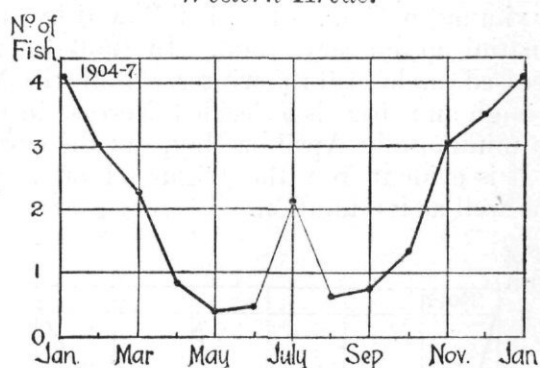


FIG. 58.—BRILL. Area R. Monthly averages, 1904–1907.

Area T.—The greatest catches in this area are taken in the summer, and generally speaking they are fairly good, several of them exceeding 4. 1907 has the highest averages.

Area V.—This has a very poor yield, the highest general average being 1·66, while in several months there were no brill taken. The fluctuations are irregular.

Two of these three areas, S and T give a fairly good yield, but that of the third V, is very poor. The fluctuations are irregular in all cases, but in the neighbourhood of the Leman and Botney grounds, we have some evidence of increased numbers during the spring and summer. The highest averages are those of 1907.

Area R.—The averages in this area vary fairly regularly. We find the numbers increasing from November, 1905 (2·80) to a maximum of 4·11 in January. They steadily decline till June (0·29); July is high, and after the small catch in August they steadily increase again.

Area X.—In this area we find the May to September averages very low. Those of March, April and October are higher, the rest more or less indeterminate.

Brill were absent from all hauls taken in area P, but were found in area E in all the months in which fishing took place. Areas R and X together show a probable summer minimum, with a maximum in winter.

Spawning.

The fishermen are not required to note the occurrence of spawning brill on their record forms. However, a few cases were noticed and these are as follows:—

1904, May—one spawning fish in area M out of seven hauls with brill.

1905, April—one fish with spawn in area L out of one haul with brill.

1906, May—two fish spawning in one haul in area Q out of eleven hauls with brill.

1907, May—one fish spawning in area S out of three hauls with brill.

These fish corroborate what we already know about brill, viz., that the height of their spawning season in this region is in May. The specimen that was nearly ripe in April was taken in deep water north of the Dogger; the other specimens that were spawning were all found in shallow water.

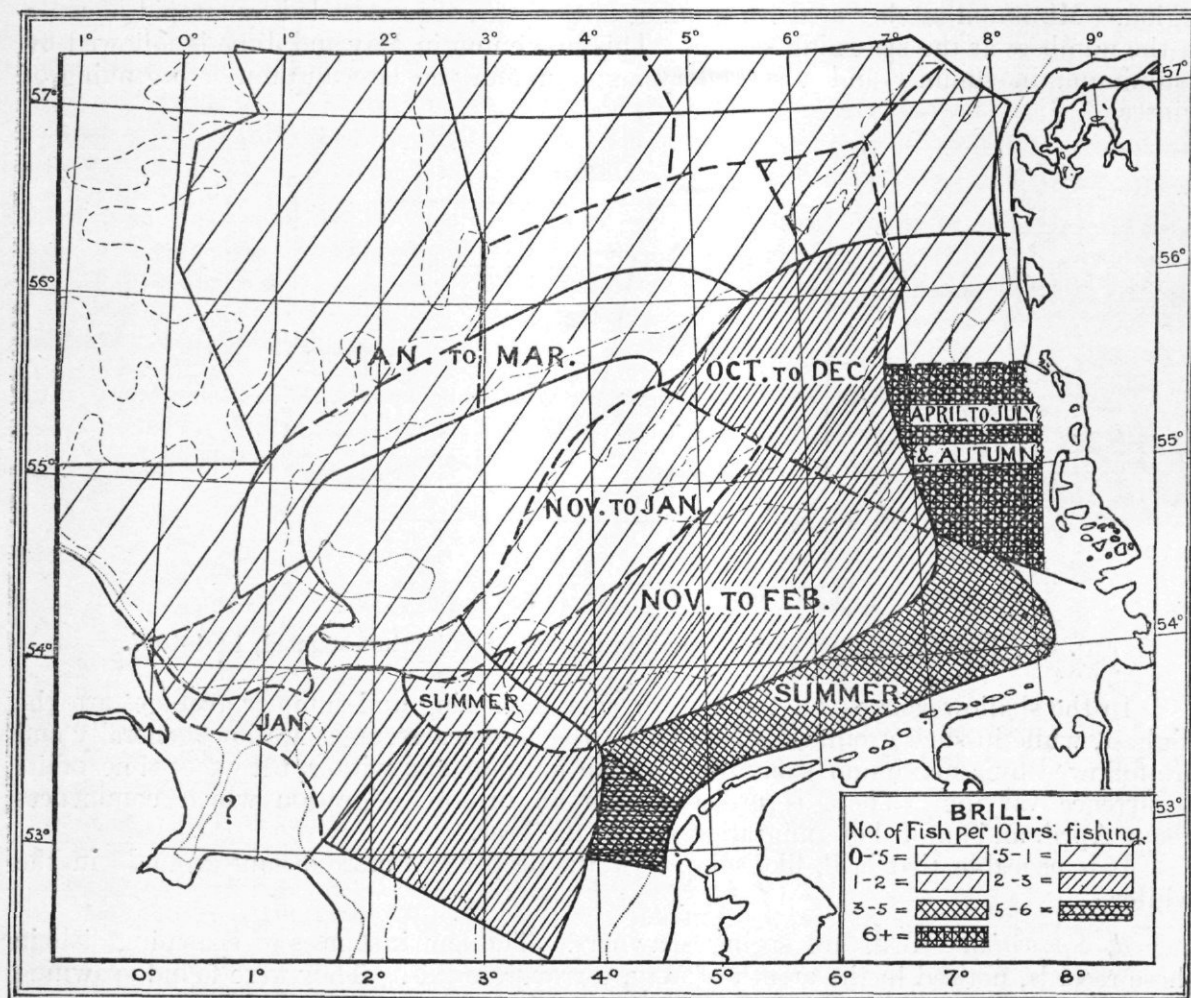


FIG. 59.—Chart showing the distribution of BRILL according to the mean monthly catch in each area, and the periods of maximum abundance in the different regions.

Summary—Brill.

a. Distribution.—Brill are found in most parts of this region, but they are nowhere numerous, the average catch being at the rate of 2·4 per 10 hours fishing. In the northern and north-eastern areas they are of very rare occurrence, and in several months they are not taken at all. The comparative abundance in the various areas is shown in Fig. 59 by the mean monthly catch, and also, where it has been possible to determine it, the period of maximum abundance is indicated.

The eastern areas give the greatest yield, which is made up by a large number of small fish. Proceeding seawards from the shore and also northwards from the southern area S, the numbers decrease rapidly. Area S (Leman and Botney, &c.) and area N (the Oyster ground) yield a fair number (averaging from two to three). On the more offshore areas such as V, I and O, the numbers are very small, under one per ten hours. The western area R has good catches in the winter, and there are indications that brill are also comparatively plentiful in area E. From other sources, the Lowestoft trawling records, we find in the results of the catches of brill (unpublished) that they are much more plentiful on the Cromer grounds than in the neighbourhood of the Brown Bank. Although the other western areas X and P are very poorly sampled, it appears that brill are never more numerous than in the eastern and southern areas.

b. Yearly Variations.—We have reason to believe that brill were much more abundant in 1906 and 1907 than in the first two years of the period. There is no marked difference between the catches of 1904 and 1905.

c. Seasonal Fluctuations and Migrations.—The average catches of brill fluctuate considerably, the fluctuations being partly due to seasonal migrations, and partly, and to a great extent, to fortuitous circumstances which have a great effect on the average, since the number of fish is too small to always hide the effect of the chance occurrence of several more or fewer fish. For this reason considerable irregularity is shown, and the true seasonal fluctuations in each area are not definitely determined. Fig. 60 is included, because it shows in a general way the nature of the fluctuations in the average catch over the whole region. Minimum catches at the beginning of the year, are succeeded by a rapid increase in the numbers at the spawning season. This maximum in May and June is followed by a minimum in summer and a secondary maximum in the late autumn or beginning of winter.

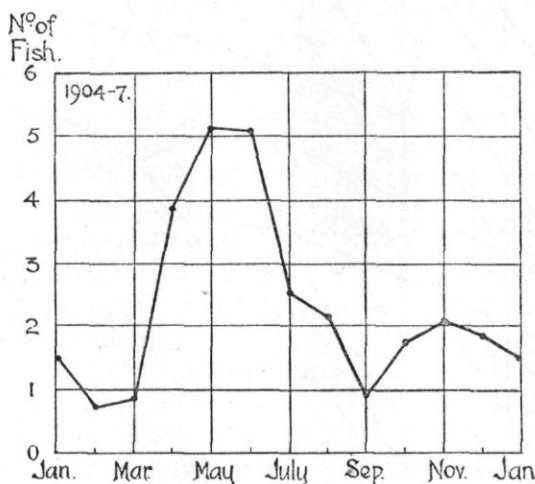


FIG. 60.—BRILL. Monthly average catch in the whole region investigated, 1904-1907.

In the shallower areas on the eastern side the spring and summer averages are the highest, while in such grounds as N, I and J the summer averages are low generally and are followed by a maximum some time in the autumn and winter, the exact time of its occurrence varying. There is probably then an inshore migration which commences about April, and an offshore migration late in the year.

It is probable that brill, like soles, seek the deeper and more distant grounds in the winter.

d. Spawning.—Brill are spring spawners. The few instances of spawning fish in these records, noticed in the month of May, corroborate this. They were found spawning in shallow water.

E. COD.

Introduction.

Cod, although fairly plentiful in this region, only formed about two-fifths by weight of the total catch of plaice taken during the four years investigated, and of course in numbers this proportion would be much smaller. Nevertheless they were taken in greater or less quantities in all the different areas of this region, the numbers in the northern part being far more numerous than in the southern.

The monthly averages of the catches for each month and area have been worked out as for the other species, but additional care is needed in the interpretation of these averages in the case of cod. This is due to the habit cod have of shoaling, so that the catches may be very unequal. It occasionally happens that the number of cod taken in one or two hauls far outnumber those taken in the rest of the hauls of the month, as for instance, when two or three score large cod are caught at one shot, whereas the usual number is two or three fish. On occasions, ten, eleven or twelve score have been taken on some grounds at one haul. The effect of this is to raise the average considerably, unless the number of hauls is very large, in which case the average is still fairly comparable with those of other occasions or other areas when these extraordinary large catches are not made. It follows that the rate of catching, as determined by the average per ten hours fishing, becomes in such a case, a very poor measure of the fish population. In fact, it is impossible to determine any satisfactory average at all from such figures. The method adopted to deal with these has been to note all cases of such catches as are very large when compared with those made under the same conditions, say 20 to 80 times the usual number, and to mark the averages into which these enter with an asterisk, so that they may be noticed in interpreting the statistics and the curves drawn from them. This difficulty will affect the number of large cod more than the codling.

Conversion of the different Measures into Weight.

Large and medium cod are always counted singly or in scores by the fishermen. Codling are measured in baskets except when only a few are caught, and then their numbers are given. The equivalent weights for these different measures have had to be determined and approximate values have been found from several sources. From the report of Committee A of the International Council* we find that the limit between cod and codling is drawn at about 60 cm. A small calculation from the figures there given,† and the conversion of kilograms to cwts. results in the following average weights:—

$$1 \text{ cod} = \cdot 1056 \text{ cwt.}; 1 \text{ codling} = \cdot 013 \text{ cwt.}$$

This latter factor is in close agreement with the information supplied by Mr. Olsen, of Grimsby, who states that the average number of codling to a basket of weight 60 lbs. is 40, whence one codling weighs $\cdot 013$ cwt. For further confirmation I am indebted to Mr. G. T. Atkinson, who has supplied me with the results of some observations made by himself at Hull in March, 1908. He counted the number of Iceland cod, all mature, which went to a "kit" (10 stone), and found that they varied from 12 to 15, and averaged 13.3 in number. From this the average weight of a mature cod is 0.094 cwt.

Medium cod are not distinguished from large cod in the Committee A report. In these Grimsby trawling records this distinction is made on the forms, but is not always kept. The fishermen, some consistently, some only occasionally, divide their fish into "large cod" and "codling," and a few into "medium cod" and "codling." For this reason I have retained only the two classes "cod" and "codling," treating "large" and "medium" as "cod."

In the tabulations I have preferred to give the actual number of "cod" rather than their estimated weight, but for purposes of comparing the two classes, and to give some idea of the total weight, the scale of 1 cod = 0.1 cwt. has been used. In the diagrams the "codling" are always given by their weight in cwts., and so is the estimated weight of the total catch; "cod" are given in numbers, the scale being one-tenth of that for codling, so that their approximate weight is represented also.

With regard to the weight of a basket of codling, we have several approximations. The fishermen say that with codling (as well as haddock and whiting), it takes nearly two level baskets to make a box (about 1 cwt.). According to Mr. Olsen the weight of a basket of codling is 60 lbs. and this is 0.54 cwt.

* HJORT : *Rapport sur les Travaux de la Commission A*, General part p. 108. Rapports et Proc.-Verb. Vol. x.

† *Loc. cit.* pp. 110 and 112.

A further method of obtaining the average weight is to compare the skippers' own records of what they catch with the amounts they land at the end of a voyage. The ratio of the total number of boxes of codling landed, to the number of baskets recorded is given in the following table (Table XV.) having been determined for each fisherman for each year. It should be explained that in this table and also in those for haddock and whiting, the figures in the last column and the last row are not the arithmetic average of the ratios determined in each case, but the ratio obtained by summing up all the catches and comparing them with the sum of all the boxes landed. This method gives the greatest weight to the values determined by those fishermen who have caught the most fish.

It has not been possible to compare these totals from every voyage, for in some cases the catches were too small to be measured in baskets, and in others, the records of several hauls were omitted. If only a few hauls had been left out, it was often possible to estimate the number of baskets of fish taken in these and so make the returns complete. This has been done wherever possible. Nevertheless, the resulting figures, though subject to considerable variation, are approximations to the actual average ratio between a basket and a box.

TABLE XVI.—Showing for each of certain skippers the ratio between the numbers of boxes of CODLING landed, and the numbers of baskets caught.

| Skipper. | | | | 1904. | 1905. | 1906. | 1907. | 1904-7. |
|----------|-----|-----|-----|-------|-------|-------|-------|---------|
| i | ... | ... | ... | ·62 | ·69 | [·59] | — | ·65 |
| ii | ... | ... | ... | — | ·57 | — | — | ·57 |
| iii | ... | ... | ... | ·48 | ·40 | ·53 | [·75] | ·47 |
| iv | ... | ... | ... | — | ·61 | ·60 | — | ·60 |
| v | ... | ... | ... | ·56 | ·61 | ·70 | ·66 | ·61 |
| vi | ... | ... | ... | [·57] | ·64 | ·63 | ·54 | ·62 |
| vii | ... | ... | ... | ·50 | ·67 | — | — | ·58 |
| viii | ... | ... | ... | ·42 | ·48 | — | — | ·46 |
| All men | ... | ... | ... | ·51 | ·57 | ·62 | ·64 | ·57 |

Since the average weight of a box is about one cwt., the value 0·57 cwt. for the weight of a basket of codling, must be closely approximate to the true average weight. It is calculated from 5,385 baskets. The actual value of this fraction is 0·566, and as the error involved in using 0·56 cwt. as the factor, instead of 0·57 cwt. is very small (the error being ·006 in one case and ·004 in the other), this value, 0·56, has been adopted, as being the same as that determined for haddock.

Total quantities of fish and the proportions of Cod and Codling.

TABLE XVII.—Showing the total quantities of COD and CODLING recorded during the period 1904-1907, and the percentage of the total of each group by weight.

| Year. | Number of Cod. | Weight of Codling. Cwts. | Total weight. Cwts. | Percentage of total weight. | |
|-----------|----------------|--------------------------|---------------------|-----------------------------|----------|
| | | | | Cod. | Codling. |
| 1904 ... | 9,331 | 948·24 | 1881·34 | 49·6 | 50·4 |
| 1905 ... | 24,121 | 1564·24 | 3976·34 | 60·7 | 39·3 |
| 1906 ... | 7,498 | 726·19 | 1475·99 | 50·8 | 49·2 |
| 1907 ... | 4,453 | 212·64 | 657·94 | 67·7 | 32·3 |
| Total ... | 45,403 | 3,451·31 | 7,991·61 | 56·8 | 43·2 |

It appears from this table that "cod" exceed the "codling" in weight, but not to a very great extent; 43 per cent. of the total weight of cod were small fish. This percentage is much higher than that given in the Bulletin Statistique.* Of the cod from the whole North Sea caught by English steam trawlers, only 21 per cent. in 1904, 19 per cent. in 1905 and 26 per cent. in 1906 were codling.

* Conseil Perm. Inter. pour l'Explor. de la Mer. Bulletin Statistique. Vols. I, II. and III Table C. II.

We can make a rough estimate for the total *number* of fish caught, by taking $\frac{1}{613}$ codling to 1 cwt., whence the total number of codling becomes about 265,485, and the large fish then form 15 per cent., or a little less than one-sixth of the total number of fish.

A measure of the yield of cod from this region is given by the average per 10 hours fishing for the whole period. This is 9.3 cod, 0.70 cwt. codling and 1.63 cwt. total catch, which is equivalent to about 63 fish. The highest average is obtained in 1905 (2.10 cwt.) and the lowest in 1907 when it is 0.79 cwt. This average yield for the south central region of the North Sea is less than one half that found for the northern areas fished by the Aberdeen trawlers.* We also find that codling are more numerous in proportion to the total catch than in the northern region of the North Sea.

Yearly Variations.

For an analysis regarding the proportions of cod and codling and the fluctuations year by year, this method of lumping together the catches from all areas is very unsatisfactory. A better result would be obtained by treating each area separately, but this is impossible owing to the incompleteness of the data. As a closer approximation to the true values than the above, I have calculated the following figures from the catches from groups of areas :—

TABLE XVIII.—Showing for groups of areas, the yearly averages per ten hours fishing, and the percentage of the total weight formed by “Codling.”

| Group. | North Eastern A. B. C. F. G. | | | | Eastern H. M. Q. W. | | | | Central J. N. I. O. | | | | Northern D. K. L. | | | | Southern S. T. | | | | Western E. R. P. V. X. | | | |
|--------------|---------------------------------|--------------------|---------------|-----------|------------------------|--------------------|---------------|-----------|------------------------|--------------------|---------------|-----------|----------------------|--------------------|---------------|-----------|-------------------|--------------------|---------------|-----------|---------------------------|--------------------|---------------|-----------|
| | No. of Cod. | Weight of Codling. | Total Weight. | Per cent. | No. of Cod. | Weight of Codling. | Total Weight. | Per cent. | No. of Cod. | Weight of Codling. | Total Weight. | Per cent. | No. of Cod. | Weight of Codling. | Total Weight. | Per cent. | No. of Cod. | Weight of Codling. | Total Weight. | Per cent. | No. of Cod. | Weight of Codling. | Total Weight. | Per cent. |
| 1904 | 24.2 | 1.32 | 3.74 | 35 | 17.6 | 0.90 | 2.66 | 34 | 4.6 | 1.01 | 1.47 | 69 | 5.9 | 1.06 | 1.65 | 61 | 0.5 | 0.04 | 0.09 | 45 | 15.6 | 1.56 | 3.12 | 50 |
| 1905 | 18.2 | 1.05 | 2.87 | 37 | 14.3 | 0.49 | 1.92 | 26 | 5.8 | 0.94 | 1.52 | 62 | 30.2 | 0.61 | 3.63 | 17 | 1.1 | 0.33 | 0.44 | 75 | 15.3 | 3.69 | 5.22 | 71 |
| 1906 | 10.7 | 0.34 | 1.41 | 24 | 3.2 | 0.14 | 0.46 | 30 | 4.6 | 0.34 | 0.83 | 42 | 16.1 | 0.54 | 2.15 | 25 | 2.7 | 0.41 | 0.68 | 60 | 6.0 | 1.48 | 2.08 | 71 |
| 1907 | — | — | — | 38 | 3.2 | 0.21 | 0.53 | 40 | 4.8 | 0.23 | 0.76 | 37 | 22.4 | 0.40 | 2.64 | 15 | 1.5 | 0.08 | 0.23 | 33 | 5.7 | 0.43 | 1.00 | 50 |

In this grouping, the catches from area V (the Silver Pits) were included in the western group of areas, as they approximated more in value to these than to the southern group. It must be remembered in drawing conclusions from this table, that the records in 1904 only began in May, so that those groups of areas where cod are very numerous in the winter and early spring, as in the northern areas at the spawning time, result in averages which are relatively too low in that year.

Cod are most numerous and in the largest proportions in the north eastern and northern areas. In the two most northerly (H and M) of the eastern areas, they are also fairly numerous and form the largest portion of the catch. Only about one quarter the number in the most productive areas are found in the central areas, and in the southern areas still less, averaging only one or two. They were found in fair numbers in the deeper parts of the western areas.

The biggest catches of *codling* come from the western areas and the least from the southern. Considering all sizes together, the most productive areas are the north-eastern, northern, and western groups, and the eastern area H. The other eastern areas, and the central group have about one half the quantities taken from these, and in the southern-most areas, S and T, the quantities are very small, and here also the proportion of small fish is large.

The catches of cod seem to be falling off in the north-eastern, eastern and central groups of areas. With regard to the other groups it is more difficult to speak definitely, for the averages are not always representative of the greater part of the year. For instance, in the northern group there are no observations in 1904 in the spring months, which considerably lowers the average, while that of 1907 is raised, because observations from April to September, when the quantities in these areas are low, are lacking.

This yearly decline is further corroborated by the following table, formed by comparing in each area the catches of corresponding months in the different years :—

- 1905 is 19 times less than, and 20 times greater than 1904, out of 40 months.
- 1906 is 25 times less than, and 10 times greater than 1904, out of 35 months.
- 1907 is 18 times less than, and 6 times greater than 1904, out of 25 months.
- 1906 is 26 times less than, and 19 times greater than 1905, out of 46 months.
- 1907 is 25 times less than, and 7 times greater than 1905, out of 34 months.
- 1907 is 24 times less than, and 8 times greater than 1906, out of 33 months.

* D'ARCY THOMPSON. On the Statistics of the Aberdeen Trawl Fishery, 1901-1906, p. 5. Rapports et Proc.-Verb. Vol. X.

Each year, with the exception of 1905, is seen to be considerably more often less than the preceding years than greater than them, and this is still the case, even if we take account of the fact that there are some averages (marked with an asterisk in Table XIX.) which are unduly high.

How far this decline in the averages may be due to chance or to special circumstances connected with this particular region, it is impossible to say. It is, however, a fact that the total quantities taken during the first three years of this period from the whole of the North Sea, do not show the same kind of fluctuation.* The total quantities decreased between 1904 and 1905, but in 1906 there was a considerable increase, mainly in the numbers of small fish. Yet, on the other hand, D'Arcy Thompson† finds declining averages for cod in nearly all regions of the North Sea during the three years 1905-1907, so that the rise in the total quantities is probably due to there being greater catching power, and to the fishing being extended to more distant grounds where cod are more plentiful.

Discussion of the Fluctuations in each Area.

The monthly average number of "cod" and weight of codling per 10 hours fishing is given in Table XIX. together with the monthly averages of the years combined.

North-Eastern Areas.

The averages for this group of areas are very incomplete and no system of combining or smoothing gives a satisfactory result for the seasonal fluctuations. The catches are large, three or four hundredweight being of fairly common occurrence. The large fish were sometimes found in shoals for a short time, so that their proportions to the total were very irregular. They predominate in weight on nearly every occasion—on the whole forming about twice the bulk of the small. The catches of the winter 1904-1905 made in areas F and G were large compared with those of the summer, when, though codling were present in good quantities "cod" were generally scarce, except in several hauls in September, when they were taken in scores.

Eastern Areas.

Area H.—This is an area which yielded very large amounts of cod during the two years when we have fairly reliable averages. In these two years we find a well marked seasonal fluctuation affecting both the large and small fish alike. This is shown on the two following curves. (Figs. 61 and 62).

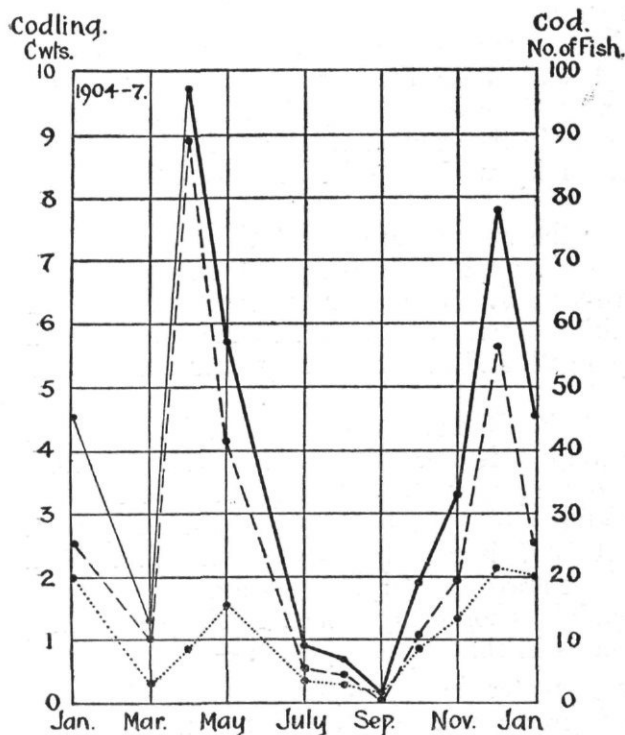


FIG. 61.—COD, Area H. Monthly Averages, 1904-1907.

Continuous line represents all sizes combined; dashed line, "cod"; dotted line, codling.

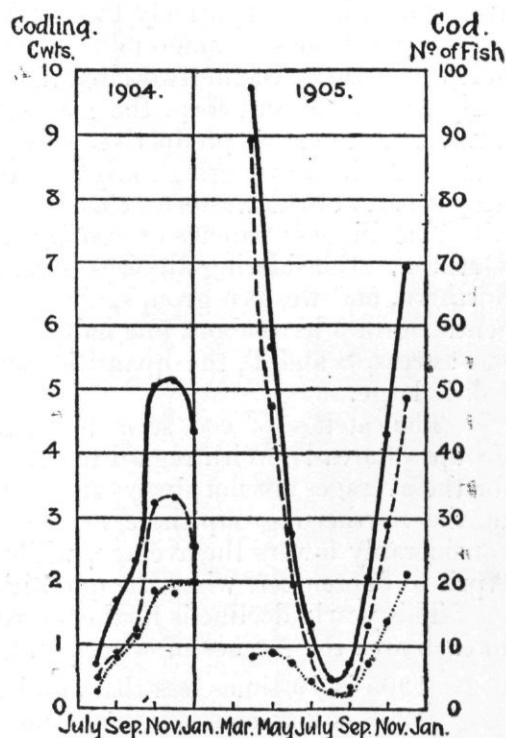


FIG. 62.—COD, Area H. Monthly Averages (smoothed curves).

* Bulletin Statistique. Vol. III., p. 34. Conseil Perm; Internat. pour l'Explor. de la Mer.

† D'ARCY THOMPSON. Report on Fishery and Hydrographical Investigations in the North Sea. Third Report. Northern Area. Cd. 4350. p. v.

TABLE XIX.—SHOWING for each area the Monthly Average Number of Cod, the Average Weight of CODLING, and the total catch of Cod and Codling in cwts. per 10 hours' fishing.

[illegible]

TABLE XIX. (continued)—SHOWING for each area the Monthly Average Number of Cod, the Average Weight of CODLING, and the total catch of Cod and Codling in cwt. per 10 hours' fishing.

| Group. | Area. | Year. | January. | | | February. | | | March. | | | April. | | | May. | | | June. | | | July. | | | August. | | | September. | | | October. | | | November. | | | December. | | | Area | |
|-----------------|-------|--------|----------------|--------------------|---------------------|----------------|--------------------|---------------------|----------------|--------------------|---------------------|----------------|--------------------|---------------------|----------------|--------------------|---------------------|----------------|---------------------|---------------------|----------------|---------------------|----------------------|----------------|---------------------|----------------------|----------------|---------------------|---------------------|----------------|---------------------|---------------------|--------------------|--------------------|---------------------|-----------|--------------------|---------------------|------|---|
| | | | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | Number of Cod. | Weight of Codling. | Total Weight. | | | | | |
| SOUTHERN AREAS. | S | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.8 | + | 0.08 ²¹⁶ | 0.6 | 0.03 | 0.09 ³⁴⁵ | 0.0 | 0.07 | 0.07 ⁴⁵⁴ | 1.0 | 0.00 | 0.10 ¹⁰⁰ | 0.2 | 0.01 | 0.03 ¹⁰³ | ... | ... | ... | ... | ... | ... | S | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.1 | + | 0.01 ⁶¹⁷ | + | 0.02 | 0.02 ⁷⁴⁹ | 0.9 | 0.16 | 0.25 ⁴⁵ | 2.5 | 0.35 | 0.60 ⁴ | 0.0 | 1.32 | 1.32 ⁸ | 3.0 | 0.73 | 1.03 ¹³ | S | | |
| | | 1906 | ... | ... | ... | 0.0 | 0.00 | 0.00 ⁵ | 4.3 | 0.08 | 0.51 ⁹² | 1.3 | 0.04 | 0.17 ²² | 0.0 | 0.19 | 0.19 ⁷ | 0.4 | 0.08 | 0.12 ⁵⁵ | 0.0 | 0.02 | 0.02 ⁸³ | 0.0 | 0.00 | 0.00 ¹⁰⁶ | 4.5* | 0.66 | 1.11 ²⁹⁰ | 0.0 | 0.01 | 0.01 ⁵⁶ | ... | ... | ... | ... | ... | ... | S | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.2 | + | 0.22 ⁴⁶¹ | 0.2 | + | 0.02 ³⁴⁸ | 0.0 | 0.01 | 0.01 ²⁷¹ | ... | ... | ... | ... | ... | ... | ... | 0.0 | 0.02 | 0.02 ¹⁶ | ... | ... | ... | ... | ... | ... | S |
| | | 1904-7 | ... | ... | ... | [0.0 | 0.00 | 0.00 ⁵ | 4.3 | 0.08 | 0.51 ⁹² | 1.3 | 0.04 | 0.17 ²² | 2.1 | + | 0.21 ⁴⁶⁸ | 0.4 | 0.01 | 0.05 ⁶¹⁹ | 0.2 | 0.01 | 0.03 ¹³¹⁸ | + | 0.03 | 0.03 ¹³⁰⁹ | 3.1* | 0.42 | 0.73 ³⁶⁵ | 0.2 | 0.02 | 0.04 ¹⁶³ | 0.0 | 0.47 | 0.47 ²⁴ | 3.0 | 0.73 | 1.03 ¹³ | S | |
| | T | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 5.4 | 0.00 | 0.54 ¹³ | 0.8 | 0.00 | 0.08 ²⁴ | 0.0 | 0.00 | 0.00 ¹⁰ | 0.0 | 0.00 | 0.00 ⁸ | 0.0 | 0.00 | 0.00 ⁸ | ... | ... | ... | 3.1 | 0.23 | 0.54 ²² | ... | ... | ... | T | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.8 | 0.53 | 0.91 ⁵⁵ | ... | ... | ... | 0.2 | 0.13 | 0.15 ⁴⁸ | 0.1 | 0.01 | 0.02 ⁷⁹ | 0.6 | 1.23 | 1.29 ¹⁰⁰ | 1.6 | 0.89 | 1.05 ¹⁷⁷ | 1.8 | 0.73 | 0.91 ³⁴³ | 4.6 | 0.73 | 1.19 ³⁴⁰ | T | |
| | | 1906 | ... | ... | ... | 13.8 | 0.25 | 1.63 ⁹⁶ | 12.3 | 0.18 | 1.41 ⁵² | 2.4 | 0.66 | 0.90 ¹¹² | 3.6 | 0.42 | 0.78 ⁵³ | 0.6 | 0.60 | 0.66 ⁹⁷ | 0.8 | 0.81 | 0.89 ¹⁸¹ | 0.0 | 0.25 | 0.25 ⁵⁰ | 0.1 | 0.30 | 0.31 ⁵³ | 1.6 | 0.43 | 0.59 ²²⁵ | 1.5 | 1.73 | 1.88 ⁹⁷ | ... | ... | ... | T | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 13.0 | 0.11 | 1.41 ³⁹ | 3.6 | 0.21 | 0.57 ²⁵ | 0.4 | 0.08 | 0.12 ¹⁴³ | 0.0 | 0.02 | 0.02 ⁹¹ | ... | ... | ... | 0.0 | 0.35 | 0.35 ²⁰ | 0.8 | 0.52 | 0.60 ⁸⁴ | 3.4 | 0.28 | 0.62 ²¹² | 10.0 | 0.70 | 1.70 ¹² | T | |
| | | 1904-7 | ... | ... | ... | 13.8 | 0.25 | 1.63 ⁹⁶ | 12.3 | 0.18 | 1.41 ⁵² | 5.1 | 0.52 | 1.03 ¹⁰¹ | 3.8 | 0.39 | 0.77 ¹⁴⁶ | 0.5 | 0.27 | 0.32 ²⁶⁴ | 0.5 | 0.47 | 0.52 ³³⁰ | 0.1 | 0.13 | 0.14 ¹⁷⁷ | 0.3 | 0.74 | 0.77 ²¹¹ | 1.5 | 0.61 | 0.76 ⁴⁸⁶ | 2.4 | 0.60 | 0.84 ⁶⁰⁴ | 4.8 | 0.72 | 1.20 ³⁵² | T | |
| | V | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 18.3 | 2.47 | 4.30 ¹³¹ | 27.9* | 2.49 | 5.28 ³⁶ | 6.6 | 0.83 | 1.49 ⁴⁵ | ... | ... | ... | 6.7 | 0.41 | 1.08 ¹³ | ... | ... | ... | V | |
| | | 1905 | ... | ... | ... | ... | ... | ... | 37.2* | 1.90 | 5.62 ²⁵ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 38.6 | 2.97 | 6.83 ¹⁰⁸ | 27.8* | 2.73 | 5.51 ²⁹ | ... | ... | ... | 12.5* | 12.20* | 13.45 ²⁸ | ... | ... | ... | ... | ... | ... | V | |
| | | 1906 | 1.9 | 2.46 | 2.65 ⁵⁹ | 0.0 | 1.56 | 1.56 ⁴ | 10.0 | 1.91 | 2.91 ⁵⁰ | 16.2 | 1.10 | 2.72 ³⁸ | ... | ... | ... | 24.2 | 1.05 | 3.47 ¹² | 14.3 | 1.47 | 2.90 ⁵³ | 9.9 | 2.02 | 3.01 ⁴⁹ | 2.8 | 1.69 | 1.97 ⁴⁷ | 0.6 | 0.59 | 0.65 ¹⁶ | 0.9 | 0.97 | 1.06 ¹² | ... | ... | ... | V | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 6.7 | 0.31 | 0.98 ⁴ | 1.3 | 0.35 | 0.48 ⁸ | 13.3 | 1.26 | 2.59 ⁵⁵ | ... | ... | ... | ... | ... | ... | 9.2 | 0.83 | 1.75 ⁹⁴ | 15.4* | 0.50 | 2.04 ²⁸ | 4.7 | 0.26 | 0.73 ⁴⁸ | V | |
| | | 1904-7 | 1.9 | 2.46 | 2.65 ⁵⁹ | 0.0 | 1.56 | 1.56 ⁴ | 16.5* | 1.91 | 3.56 ¹⁰⁵ | 16.2 | 1.10 | 2.72 ³⁸ | 6.7 | 0.31 | 0.98 ⁴ | 15.0 | 0.77 | 2.27 ²⁰ | 23.2 | 2.28 | 4.60 ³⁴⁷ | 22.5* | 2.39 | 4.64 ¹⁶⁴ | 4.7 | 1.26 | 1.75 ⁹² | 8.8* | 3.10* | 3.98 ¹³⁸ | 10.0* | 0.58 | 1.58 ⁵³ | 4.7 | 0.26 | 0.73 ⁴⁸ | V | |
| WESTERN AREAS. | E | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | | |
| | | 1906 | 0.0 | 0.09 | 0.09 ⁸ | ... | ... | ... | 0.0 | 0.21 | 0.21 ⁷ | ... | ... | ... | ... | ... | ... | 0.5 | 0.97 | 1.02 ¹⁸ | 0.0 | 0.17 | 0.17 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | | |
| | | 1904-7 | 0.0 | 0.09 | 0.09 ⁸ | ... | ... | ... | 0.0 | 0.21 | 0.21 ⁷ | ... | ... | ... | ... | ... | ... | 0.5 | 0.97 | 1.02 ¹⁸ | 0.0 | 0.17 | 0.17 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | |
| | R | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | R | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | 85.7* | 0.00 | 8.57 ¹⁴ | ... | ... | ... | 4.5 | 0.68 | 1.13 ⁷⁶ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.6 | 1.09 | 1.15 ¹⁸ | ... | ... | ... | 4.4 | 7.64 | 8.08 ¹⁶⁸ | 10.6* | 5.88 | 6.94 ²¹² | R | |
| | | 1906 | 2.3 | 0.73 | 0.96 ¹³⁹ | 1.3 | 0.42 | 0.55 ²³⁶ | 2.2 | 1.12 | 1.34 ²⁸⁰ | 3.4 | 2.01 | 2.35 ²⁶⁶ | 8.9 | 1.78 | 2.67 ¹⁷⁶ | 3.9 | 2.13 | 2.52 ²³⁸ | 1.1 | 2.58 | 2.69 ²²² | 1.2 | 2.81 | 2.93 ¹¹³ | 0.0 | 1.12 | 1.12 ⁷ | 1.4 | 0.87 | 1.01 ¹⁴ | ... | ... | ... | ... | ... | ... | R | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 7.7 | 0.00 | 0.77 ⁶ | 0.4 | 0.83 | 0.87 ²³ | 0.6 | 0.16 | 0.22 ³² | 0.0 | 0.70 | 0.70 ⁴ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | R | | | |
| | | 1904-7 | 2.3 | 0.73 | 0.96 ¹³⁹ | 1.3 | 0.42 | 0.55 ²³⁶ | 6.2* | 1.06 | 1.68 ²⁹⁴ | 3.5 | 1.96 | 2.31 ²⁷² | 6.9 | 1.40 | 2.09 ²⁷⁵ | 3.5 | 1.89 | 2.24 ²⁷⁰ | 1.1 | 2.55 | 2.66 ²²⁶ | 1.2 | 2.81 | 2.93 ¹¹³ | 0.4 | 1.10 | 1.14 ²⁵ | 1.4 | 0.87 | 1.01 ¹⁴ | 4.4 | 7.28 | 7.72 ¹⁷⁷ | 10.4* | 5.77 | 6.81 ²¹⁶ | R | |
| | X | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 9.6 | 1.21 | 2.17 ¹⁰⁹ | 0.0 | 1.78 | 1.78 ⁸⁰ | 3.9 | 0.30 | 0.69 ³⁰ | ... | ... | ... | 3.0 | 2.37 | 2.67 ³³ | 119.4* | 1.28 | 13.22 ¹⁷ | X | |
| | | 1905 | 0.0 | 0.23 | 0.23 ⁴ | 0.0 | 0.93 | 0.93 ³ | 36.8 | 0.49 | 4.17 ⁵³ | 43.3* | 0.30 | 4.63 ¹² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.7 | 0.62 | 0.69 ³¹ | 1.6 | 0.39 | 0.55 ¹⁰⁷ | 2.0 | 0.47 | 0.67 ¹⁵ | 2.3 | 0.94 | 1.17 ⁴⁴ | X | | |
| | | 1906 | ... | ... | ... | 12.2 | 0.31 | 1.53 ⁹ | 18.3 | 0.62 | 2.45 ⁶⁰ | 10.5 | 1.12 | 2.17 ⁷⁷ | 17.3 | 0.76 | 2.49 ⁵² | 28.1 | 0.85 | 3.66 ¹⁵⁶ | 8.2 | 1.86 | 2.68 | | | | | | | | | | | | | | | | | |

* One or two hauls with an exceptionally large number of Cod included.

They are present in the spring of 1904 and 1905 in large quantities, the large fish especially being numerous. A rapid emigration takes place in the summer and the quantities taken then are under one hundredweight. In both years they appear again about the middle of October and become still more numerous in November and December. Besides these increased quantities of cod and codling shown on the curve, there is a marked appearance of unmarketable codling towards the end of November. The catches keep fairly high in January, but for February and March we have no information, and it is hardly probable that the quantities decrease so rapidly as shown in Fig. 61.

Horn Reef North appears to be one of the cod spawning areas, and as it is near the coast, they are found already spawning in December and January.

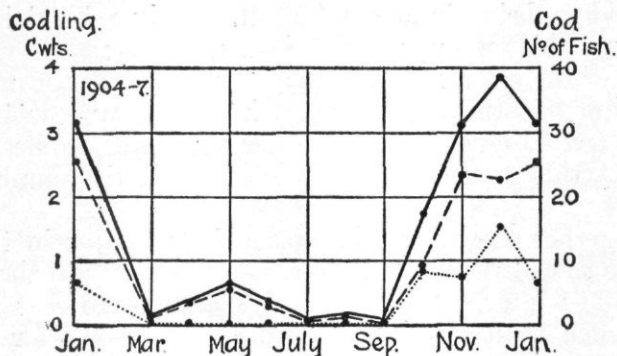


FIG. 63.—COD. Area M. Monthly Averages, 1904–1907. Continuous line represents all sizes combined; dashed line, “cod”; dotted line, “codling.”

Area M.—The curve of averages (Fig. 63) shows considerable differences between the summer and winter catches of cod. The highest averages, from 2 to 9 cwt., are found in November and December of each year and in January, 1905. The summer catches, July to September, are exceeding small; those of April to June are a little higher. The February and March averages are uncertain, but we conclude they must be declining as there is a sharp fall from December to April. This winter immigration consists of a large number of “cod” in the first two years, as well as considerable quantities of codling; in the last two years all are less numerous and the codling exceed the “cod” in bulk (Fig. 64).

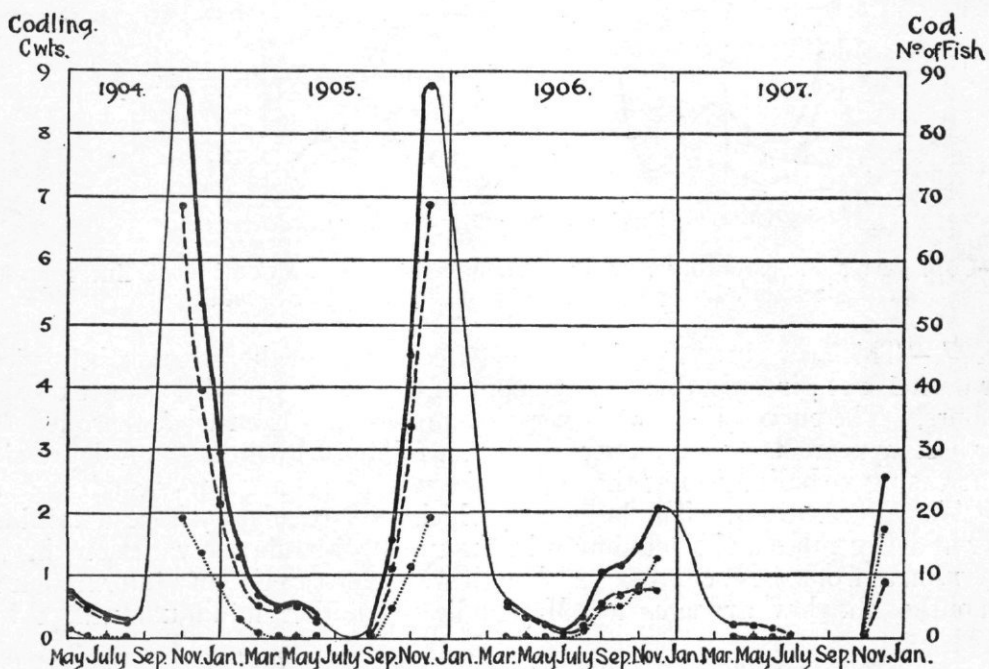


FIG. 64.—COD. Area M. Monthly Averages (smoothed curves). Continuous line represents all sizes combined; dashed line, “cod”; dotted line, “codling.”

The falling off in the catches is evident from the diagrams. In 1904 they are noticed to become rare on the Sylt grounds about the third week in December. In 1905 they are present in November but they do not become at all numerous till the very end of the month. It is interesting to compare these catches with the results of some voyages to the same area in May and June, 1895.* These, worked out as ten-hourly averages,

* CUNNINGHAM.—North Sea Investigations, Loc. cit.

give 12.8 cod in May and 2.9 cod and 0.20 cwt. codling in June, both more than the averages for May and June in these statistics.

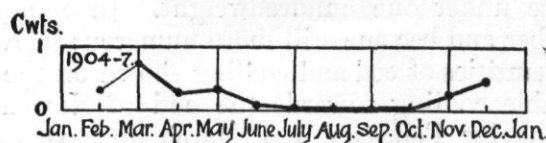


FIG. 65.—COD. Area Q. Monthly Averages, 1904-1907. Continuous line represents all sizes of fish.

Area Q.—This is one of the areas from which Cod are mostly absent. In the summer the hauls seldom bring in any cod at all. Only a few fish, and these nearly all large, find their way into this region, and these occur at the end of winter or beginning of spring. The amount of the winter catches is not known, but the numbers are probably considerably increased at this time, as they are known to appear in the adjacent areas, and the trend of the curve (Fig. 65), points to larger winter catches.

Area W.—Like Q, this ground is also without cod in the summer.

The four areas together show a regular seasonal fluctuation in the cod taken on the eastern grounds. The cod leave the shallower waters entirely in the summer and appear again in the autumn and winter. It is a matter of experience that an *inshore* migration of cod in the autumn, such as that demonstrated by these figures for the eastern grounds, is general on all North Sea coasts—as at Scarborough, Flamborough, Lowestoft and Ymuiden.

The number of Cod in the Horn Reef North ground is large, but in the other areas much smaller, especially in Q where the total catch seldom reaches 1 cwt. Large fish generally predominate in weight, and off the Danish coast in the winter are comparatively numerous.

The four areas also show a decrease in the latter years as compared with the first two.

Central Areas.

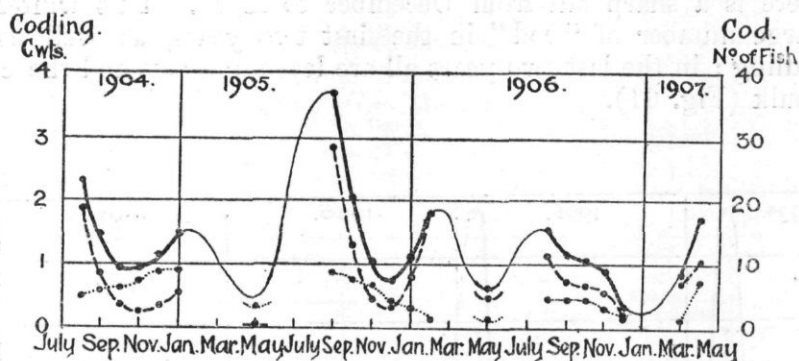


FIG. 66.—COD. Area J. Monthly Averages (smoothed curves). Continuous line represents all sizes combined; dashed line, "cod"; dotted line, codling.

Area J.—This area gives a small amount of cod, most of the averages being less than 2 cwt. or even 1 cwt., in only three months out of the whole period do they exceed 2 cwt. per ten hours. The curve (Fig. 66) is very incomplete, but from what there is of it, we see that there appears to be a summer maximum followed by an autumn depression, the catches increasing in bulk again at the end of the winter. Large and small cod do not have coincident fluctuations. The large cod, which vary regularly, have a minimum in November and December and a maximum in the summer, while the variations in codling are indeterminate from these curves. Although we have scarcely any information for the spring months, the low averages for May indicate another minimum near this time.

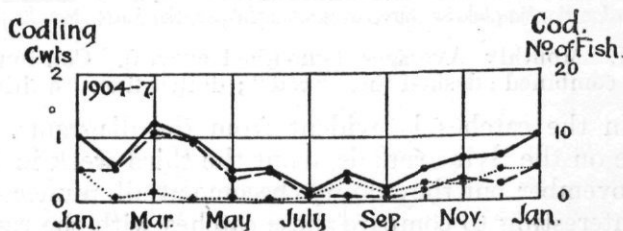


FIG. 67.—COD. Area N. Monthly Averages, 1904-1907. Continuous line represents all sizes combined; dashed line, "cod"; dotted line, codling.

We note the fact that in the grounds to the north of this area, there are, generally speaking, an early summer minimum and a September maximum and a decline in the catch in the autumn between this a winter maximum, which comes earlier than that in in area J. The comparatively large catches in September are in no small way due to some irregularly occurring shoals.

Area N.—This area being more southerly than area J, yields a smaller quantity of cod, the mean monthly value being 0.61 cwt., less than one half that in area J (1.39 cwt.). From Fig. 67 we see that the general average scarcely ever reaches one cwt.

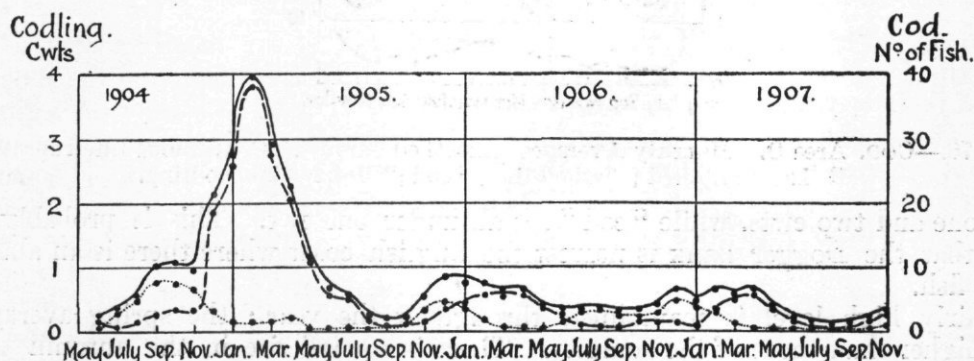


FIG. 68.—COD. Area N. Monthly averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, "cod"; dotted line, codling.

The population is mixed, consisting of large fish and codling in the proportion of two to one by weight. The smoothed curve (Fig. 68) shows periodic fluctuations for cod and codling, which are, roughly speaking, complementary to one another. Large cod are at a maximum at the beginning of spring and at a very low minimum in the summer and September, when they are at times absent altogether. On the other hand, codling are very scarce in spring and early summer. They begin to increase in July and the maximum comes in the autumn and winter. The total catches are at their greatest in winter and spring and are least in summer.

The average number of cod is greatest at the end of 1904 and the beginning of 1905. The 1906 and 1907 averages are much lower but not very different from one another. Codling appear to be least in 1905 and 1907, so that when all sizes are taken together, there is found to be a decline during the period.

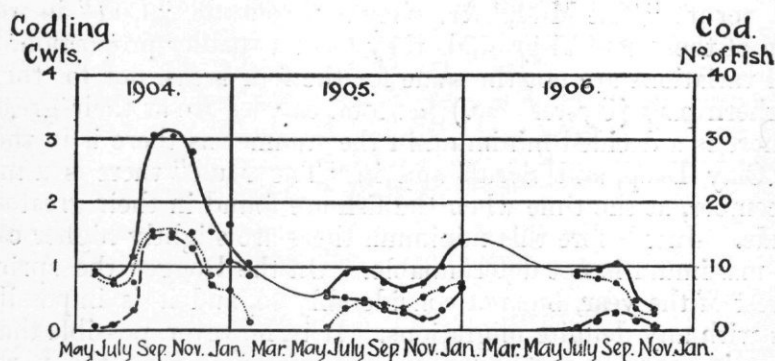


FIG. 69.—COD. Area I. Monthly Averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, "cod ;" dotted line, codling.

Area I.—The average yield from this area is similar to that from area J, and in this case the codling predominate, except in those months when the large cod are found in one or two great shoals.

In 1904 there is a minimum in summer and then a sharp increase to a very high maximum in October—November is low, but there is an increase in December and January. In 1905 the summer and winter averages remain much the same as in 1904, but the October maximum did not appear as there were no observations in that month. In 1906 the summer catches are slightly higher than the autumn ones. In each year the November averages are low. Records for the spring months are entirely wanting so we cannot determine the seasonal fluctuations for the whole year. The outstanding features are a November minimum and slightly increased quantities before and after this.

Herring were present in October, 1904, in the neighbourhood of the hauls made in this area, and their presence may partly explain the large number of cod in that month.

Area O.—Of these four areas, the Dogger Bank has the greatest amount of cod. The large fish are not more abundant than in the adjacent areas, but the difference is

made up in the amount of codling, which in this area are decidedly more numerous than the cod. In the smoothed curve (Fig. 70) the averages for codling alone vary

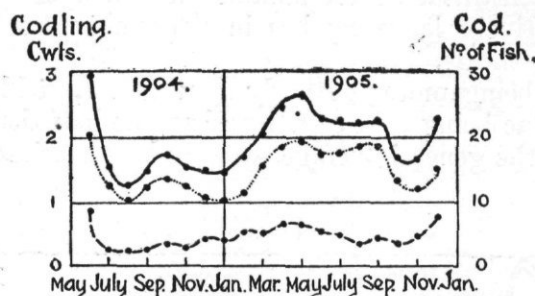


FIG. 70.—COD. Area O. Monthly Averages (smoothed curves). Continuous line represents all sizes combined; dashed line, "cod;" dotted line, codling.

between one and two cwts. while "cod" are all under one cwt. This is probably due to the fact that the Dogger Bank is nearest the English coast where there is an abundance of young fish.

A fairly high level is maintained throughout the year; the spring averages are slightly higher than those of the summer. There is a small rise in the autumn of 1904 and another small fall to December. In 1905 the December value is high and in 1907 there are large numbers in January. In the spring of 1905 an abundance of very small fish was noticed, and amongst these was a number of tiny codlings which were not retained.

The quantities of cod in 1905 are, on the whole, bigger than those in the corresponding months of 1904, and this is wholly due to an exceptional amount of codling. The seasonal variations are small, and one cannot attach much importance to what they seem to indicate.

The four central areas give but a medium amount of cod, averaging between one and two cwts. and this amount, though greater than that from the southern shallow ground (Borkum, Terschelling, &c.) is never half so great as that from the more northerly areas and in the neighbourhood of Horn Reef.

Codling are most abundant on the shallow area of the Dogger Bank, probably owing to its proximity to the western grounds. In the grounds between the bank and the shore, Clay Deep, Scruff, "The Mud," &c., they approach the "Cod" in weight, while in the most southern of these central grounds they form a smaller proportion.

The seasonal variations are not the same for the four areas, nor for the two classes of fish. In the southern part (Oysters &c.) the total catches are at their greatest in winter and spring and there is a decided minimum in the summer as there is in the coastal areas. On the Dogger, Clay Deep, and Scruff and in "The Mud" there is a minimum about November or December, at the time when the fish are found in their greatest numbers in the coastal grounds. Just before this minimum there are slightly higher catches, but the exact time of the maximum is not determinable. On the Dogger the spring catches are higher than the rest of the year, but not considerably so, and it is impossible to connect these fluctuations with any definite migrations. It is, however, possible that the increased quantities in the spring may be partly caused by a migration from the northern grounds to search for food after the spawning season.

Northern Areas.

The grounds north of the Dogger Bank are relatively rich in cod. The three areas, D, K, and L are very much the same as regards total yield and the seasonal fluctuations, so, in order to make as complete a series of monthly averages as possible, the catches from the three areas have been combined and monthly averages for the whole region calculated. These, with a few values interpolated, have been smoothed by the method of three-monthly averages into the curves in Fig. 71.

The seasonal fluctuations are very definite, showing two maxima and minima in each year. The first maximum, occurring in January and February, is wholly due to the appearance of large mature cod in great numbers—most of which are spawning. Only a few codling are present at this time, averaging generally about half a hundredweight. The catches of large cod fall off till their minimum in May and June and they afterwards come to these areas again for a smaller summer maximum. This differs in its nature from that of the winter, which is formed by a regular abundance of spawning fish. In the summer the general catches are not remarkably large, but occasionally shoals appear, and

these contribute largely to the total, as, for instance, in one haul in area D in August, 1906, 400 large cod were taken. Such conditions were precisely similar in the other areas

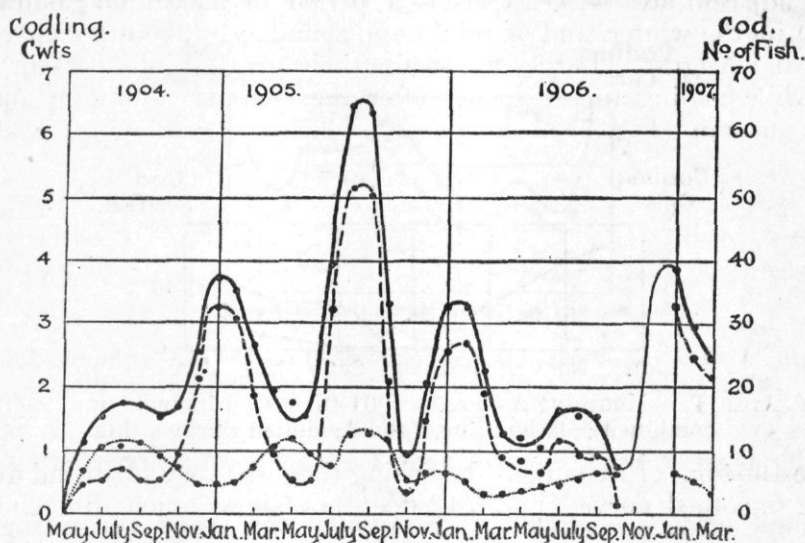


FIG. 71.—COD. Northern areas D, K, L combined. Monthly Averages, (smoothed curves). Continuous line represents all sizes combined ; dashed line, "cod" ; dotted line, codling.

where a summer maximum occurred. Several instances of such catches occurred in the summer of 1905 and this makes the maximum part of the curve remarkably high. This is the herring season in this region and these shoals are probably closely connected with the herring shoals.

There is a distinct minimum about November. Codling appear to have a small summer maximum and a winter minimum, but their fluctuations are not very regular and they form but a small proportion of the catch.

These fluctuations can be correlated with the complementary variations in the grounds to the south and east, on the hypothesis that a double seasonal migration takes place. If it exists, the following movements would explain the phenomena observed.

Large cod are congregated for spawning purposes, mainly in the northern part of this region, about February. After spawning they disperse, probably in search of food, and thus form a minimum in the northern grounds, at the same time as the numbers in the central areas, the Dogger and south and east of it, are being augmented. Scarcely any fish are to be found in the summer on the eastern and coastal grounds, but both large and small cod are present on the intermediate areas in summer, and they occur in considerable numbers in the northern areas. We may surmise that this is caused by an offshore migration in the summer. Cod then appear to leave to some extent the offshore northern and central grounds once more in the autumn, October and November, and appear in their greatest numbers on the eastern grounds, where some spawn in December and January, while others return seawards to spawn.*

Southern Areas.

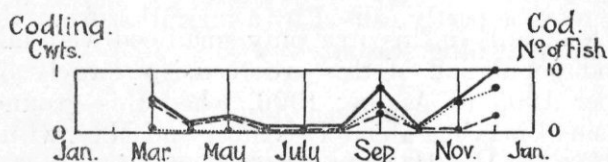


FIG. 72.—COD. Area S. Monthly Averages, 1904-1907. Continuous line represents all sizes combined ; dashed line, "cod," dotted line, "codling."

Area S.—Fig. 72 shows that this southern area has practically no cod at all during the months for which we have statistics, *i.e.*, from March to December. There was no winter fishing so we do not know the conditions then, but the trend is towards increased quantities in the winter as in other shallow and coastal areas. Throughout the greater part of the year they are only taken in very small numbers and on rare occasions. One or two fairly large catches were taken in the month of September on the Leman Ground and on Winterton Twenties amongst many other hauls which were quite barren of cod. These are also possibly connected with herring shoals.

* cf. HJORT.—General report of Committee A. *Loc cit.* p. 116.

Area T.—The Botney grounds and Mud Hole are found to yield more cod than the adjacent more southern area S. The seasonal variations are in their nature very similar to those in the adjacent area N, *i.e.*, there is a period of maximum abundance (between 1 and 2 cwts.) in the winter, and of minimum abundance (about 0.2 cwt. or less) in the summer, July and August. Large cod attain their greatest numbers in late winter or early spring, while codling appear sooner after the summer minimum and are at their greatest in the autumn (Fig. 73).

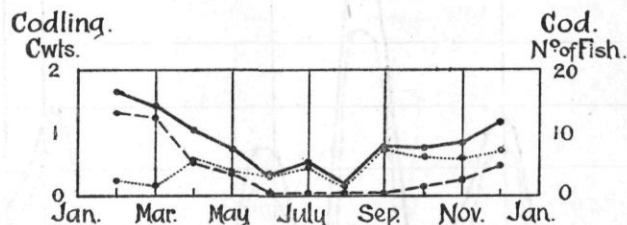


FIG. 73.—COD. Area T. Monthly Averages, 1904-07. Continuous line represents all sizes combined; dashed line, "cod"; dotted line, codling.

If we leave 1904 out of account, as the fishing then was very small and unrepresentative in amount, the smoothed curve (Fig. 74) does not show much difference in the total

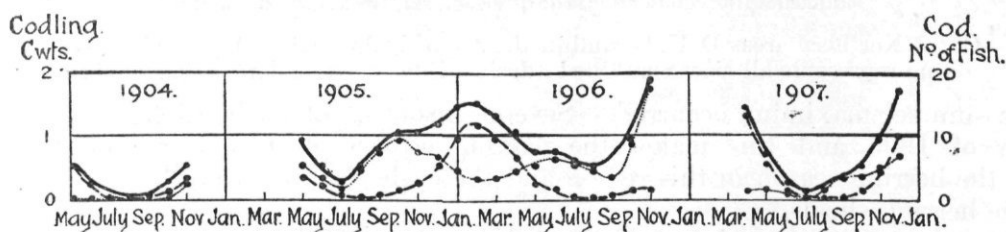


FIG. 74.—COD. Area T. Monthly Averages (smoothed curves). Continuous line represents all sizes combined; dashed line, "cod"; dotted line, codling.

abundance in the next three years. However, by a more detailed study of the figures, when only the most reliable averages are considered, a continued decrease of about 20 to 30 per cent. is evinced in the mean values for these years.

Area V.—Very large quantities of cod are taken in the Silver Pits, the averages seldom being less than two cwts. and often considerably more than this. There are so many gaps in the series of monthly averages, and several which are untrustworthy, that it has been impossible to get a reliable curve to represent the seasonal fluctuations. Large cod have been found in large numbers in the middle of summer, and apparently in the autumn and winter they are much lower. Codling are fairly plentiful at all times, and exceedingly numerous in some months, frequently averaging between $1\frac{1}{2}$ and 3 cwts.

The two most southern of these three areas show minimum abundance of cod in the summer and maximum abundance in late winter and early spring. The quantities taken from them are rather small. In V (the Pits) many more cod are present and they are very plentiful in summer. This area partakes more of the nature of the western grounds where the smaller fish are abundant.

Western Areas.

Area E.—In the few hauls in this area only small cod were taken.

Area R.—The cod population of this area consists largely of small fish. In the months from November 1905 to August 1906, when this ground was well fished, we find large cod having small maxima about December and May, with minima in February and in the summer (Fig. 75). However these fluctuations are not very significant. Codling were exceedingly abundant in the autumn of 1905; they dropped to a minimum in the winter and then rose steadily till August.

In connection with the large catches of November and December of 1905, a skipper notes in November that the fish were full of herring spawn, and on the 15th of December he notes the same thing, with the addition that it was the latest date on which he remembers having caught any feeding on that kind of food. There is great variation in the catches; sometimes a great many baskets of codling were taken, sometimes only a few fish.

Area X.—These averages as far as they go show that very fair amounts of cod are taken (mean value nearly two cwts.). Large cod are apparently plentiful in the spring and early summer, and become very scarce in the late summer and autumn. Codling, which show no regular fluctuations, are not so numerous as they were in the adjacent

shallower area R, but still they show very fair amounts, and in the mean monthly average form 43 per cent. of the total. In the first half of the year they are generally exceeded by the cod in weight. In the latter half the reverse is the case. The greatest average catches are four or five cwts. In December of 1904 one haul contained over 200 large cod besides two baskets of codling. In 1895* the principal item of fish taken from the

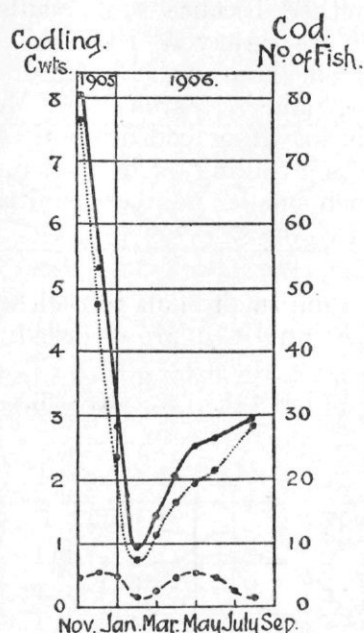


FIG. 75.—COD. Area R. Monthly Averages, (smoothed curves). Continuous line represents all sizes combined; dashed line, "cod"; dotted line, codling.

Flamborough Head grounds in 35 fathoms was large cod. In one voyage 90 score cod and four boxes of codling were landed in February; this is roughly equivalent to about 13 cwts. for 10 hours fishing.

Area P.—Cod were numerous in nearly all hauls, and codling averaged in July between one and two cwts.

Taking all the western areas together, we find that they give a large yield of cod, larger than several of the areas on the eastern side. Large fish are few in the southern and shallower parts (E and R), while they are found in good numbers in the deeper waters (over 20 fathoms) to the north between the English coast and the Dogger. On the other hand codling are very numerous in the shallower areas. The appearance of some of the large shoals is definitely connected with the shoals of herring on the spawn of which they were found to be feeding, and probably also on the fish.

Spawning.

The table (Table XX.) gives simply the number of hauls in each area in each month in which observations are made on the spawning and maturation of the cod, and as a means of comparison of the abundance, the total number of hauls made in each month is also given.

The season covered by these occurrences extends from November to April in 1904–1905, from September to March in 1905–1906, and in 1907 from January to March, the difference in the last case being due to a lack of observations in the earlier months of maturation.

Besides, and sometimes instead of these records in each haul there are notes made by some skippers on the maturity of the fish. One man in particular prefers to give a general statement at the end of his voyage regarding the spawning fish, than to indicate them in each haul.

The earliest records of the season are made in September (1905), when, in the most northerly part of this region, areas B, F, K, and L, some cod are recorded as "starting to make spawn." In October, 1905, the condition is "spawn forming." This applies to the cod in the above areas as well as those of G, J, and O. In November and December they are characterised as "full" and "spawn in," while on the Dogger Bank (O) they are "spawning." In November, 1904, a few cod were found spawning in areas H and M (Horn Reef), and they become more numerous here in the next month, while a few isolated

* CUNNINGHAM. North Sea Investigations. *Journ. Mar. Biol. Assoc.* Vol. IV., 1895, p. 12.

cases of spawning cod were found in the more offshore areas I, J and O in December. In the next month (January, 1905) the occurrences of spawning fish become much more numerous. In the most northern areas D and L the fish are plentiful, and many of them are spawning. An observation of some interest made by a man who was fishing in areas D, K and I in January, 1905, is "The majority of the cod are full of spawn. But I believe that the different kinds go together, because some hauls the cod we get are full of chicklings, and another time they are nearly all roe cod." He obviously means that the shoals of male fish are distinct from those of the females. He also observes in February that "roes are getting very ripe," and by March 3rd "Most of the cod have spawned" (northern areas). In all records spawning cod are noticeably numerous in February in these northern areas, and there is a falling off in their numbers in March. They were present on the Dogger, but in much smaller numbers, and the April records were those of some half-dozen fish in the first two days.

TABLE XX.—Showing the number of hauls in each area in which maturing or spawning Cod are recorded.

| Areas. | B. | C. | D. | F. | G. | H. | I. | J. | K. | L. | M. | N. | O. | R. | T. | V. | X. |
|----------------|----------------|---------------|-------------------|----------------|-----------------|-----------------|-----------------|-----------------|-------------------|---------------------|-----------------|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|
| November 1904 | — | — | — | — | — | $\frac{6}{82}$ | — | — | — | — | $\frac{2}{2}$ | — | — | — | — | — | — |
| December " | — | — | — | — | — | $\frac{24}{42}$ | $\frac{15}{53}$ | $\frac{3}{86}$ | — | — | $\frac{51}{72}$ | — | $\frac{2}{25}$ | — | — | — | — |
| January 1905 | — | — | $\frac{6}{14}$ | — | $\frac{13}{26}$ | $\frac{75}{94}$ | $\frac{7}{9}$ | $\frac{6}{25}$ | $\frac{30}{30}$ * | $\frac{8}{17}$ | $\frac{13}{13}$ | — | $\frac{19}{22}$ | — | — | — | — |
| February " | — | — | $\frac{112}{132}$ | — | $\frac{2}{2}$ | — | $\frac{2}{3}$ | — | $\frac{35}{38}$ * | $\frac{125}{146}$ * | — | — | $\frac{8}{14}$ | — | — | — | — |
| March " | — | $\frac{1}{2}$ | $\frac{90}{152}$ | $\frac{3}{4}$ | — | $\frac{2}{3}$ | — | — | $\frac{4}{8}$ | $\frac{32}{47}$ | — | — | $\frac{10}{37}$ | — | — | $\frac{6}{8}$ | $\frac{13}{14}$ |
| April " | — | — | — | — | — | — | — | — | — | — | — | — | $\frac{4}{158}$ | — | — | — | $\frac{1}{3}$ |
| September 1905 | $\frac{4}{22}$ | — | — | $\frac{8}{24}$ | — | — | — | — | $\frac{5}{5}$ | $\frac{2}{2}$ | — | — | — | — | — | — | — |
| October " | $\frac{5}{5}$ | — | — | $\frac{5}{10}$ | $\frac{3}{3}$ | — | — | $\frac{16}{18}$ | — | — | — | — | $\frac{5}{8}$ | — | — | — | — |
| November " | $\frac{1}{1}$ | — | — | — | — | — | — | — | — | — | $\frac{6}{11}$ | — | — | — | — | — | — |
| December " | — | — | $\frac{12}{13}$ | — | — | — | — | $\frac{4}{14}$ | — | $\frac{7}{7}$ | — | — | $\frac{54}{119}$ | — | — | — | $\frac{2}{8}$ |
| January 1906 | — | — | — | — | — | — | — | — | $\frac{6}{6}$ | $\frac{21}{33}$ | — | — | — | — | — | — | — |
| February " | — | — | $\frac{15}{23}$ * | — | $\frac{7}{15}$ | — | — | — | $\frac{4}{5}$ * | $\frac{51}{63}$ | — | $\frac{1}{1}$ * | $\frac{2}{2}$ | — | $\frac{19}{22}$ | $\frac{1}{1}$ | — |
| March " | — | — | $\frac{17}{65}$ | — | — | — | — | — | — | — | — | — | — | $\frac{2}{6}$ | $\frac{5}{12}$ | $\frac{18}{14}$ | $\frac{10}{13}$ |
| January 1907 | — | — | — | — | — | — | — | — | $\frac{13}{13}$ | — | — | $\frac{13}{74}$ | — | $\frac{39}{69}$ | — | — | — |
| February " | — | — | — | — | — | — | — | — | $\frac{51}{58}$ | — | — | — | — | — | — | — | — |
| March " | — | — | $\frac{7}{7}$ | — | — | — | — | — | $\frac{28}{59}$ | $\frac{12}{15}$ | — | — | — | — | — | — | — |

An asterisk denotes that maturing or spawning cod are present in some hauls the number of which is not specified.

The numerator of the fractions denotes the number of hauls when records of spawning fish were made, and the denominator, which is given as a means of comparison, is the total number of hauls in the area for each month, only those being included which are made by men who have recorded *any* spawning cod or haddock.

In January and February, 1906, the cod from the northern and north-eastern areas and the Dogger are fairly numerous and are described as having "spawn in" and spawning. Those from areas N, I, and J are "very near spawning" and "are all full of roes." In the northern areas they were noticed in the first few days of March, after which none were recorded. Observations of a few spawning cod were also made in the western and southern grounds in March. They occur here in this month and not in those preceding, because these grounds were not well sampled by the fishermen in the earlier part of the spawning season, but there is no evidence that they are at any time very numerous in this part of our region.

The season of 1907 was very similar, although much fewer observations were made. In January, of the few fish in area N, a few were spawning. After this, none were noticed in this part.

In the northern areas and on the Dogger they were found spawning in January and February and in the first half of March.

Thus it appears that the process of maturing begins in the autumn and that the cod become more and more "full" till the end of the year, some becoming ripe in December, and a few more as early as November. These cases of early spawning occur mostly on the shallow grounds of the coast of Jutland (H and M) in depths less than 20 fathoms. But in the majority of grounds the cod are still ripening at this time and it is not till January that the actual spawning begins. It continues throughout February when it is apparently at its height, and ceases some time during March, generally in the first half of the month. Only a few cases of spawning cod were found in April.

With regard to the distribution of these spawning fish, it may be said that they occur more or less in all areas of this region. The greatest numbers come from the grounds north of the Dogger in depths of 20 to 40 fathoms. In area G they were also numerous, but we have a very small amount of fishing in the other north-eastern areas (A, B, C, F) during the spawning season, so the conditions there must be left somewhat in doubt. The western and southern areas are very poorly sampled, but as far as can be judged from the few hauls during the first three months of the year, no great abundance of large cod is indicated and only a few are recorded as spawning. Apparently then the cod seek the more central and northerly parts of this region, around the Dogger and Horn Reef, at their spawning time,* and while they occur in the more southerly grounds and off the Dutch coast, as we see more definitely from the Dutch reports,† they are not nearly so numerous in this part.

The first maturity of cod occurs at a size (about 60 cm.) which coincides approximately with the size limit between cod and codling, that is to say, the group known as "cod" is composed almost entirely of mature individuals.‡

The proportion that these form of the total catch by weight (approximately) is as follows :—1904, 50 per cent., 1905, 61 per cent., 1906, 51 per cent., 1907, 68 per cent., and 1904–7, 57 per cent. On the other hand, if we make an estimate for the number of codling from the weight, we find that only 15 per cent of the total number of fish caught are large and therefore mature. Most of the observations refer to the "large" and "medium" cod, but a few, though very few instances occur in which a few of the codling are spawning.

In those parts of our region which have been sufficiently sampled we find that these results are in agreement with those given by Damas in the report of Committee A,§ where it is shown with regard to the spawning of cod that it begins in December in the neighbourhood of the Danish and German coasts, becomes later in the greater depths and northwards where it is at its height from January to March and ceases in March and April. Furthermore that it is most frequent in depths of 40 to 80 metres, and that the biggest catches of eggs have been made in the neighbourhood of the Dogger and towards the coasts of Jutland.

Summary.—Cod.

The main results obtained from the study of the cod statistics can be summarised as follows :—

a. Distribution.—The distribution of cod in the central part of the North Sea, according to the mean monthly average catch is shown in a comparative manner by Fig. 76. The amounts in the western areas are not represented very accurately, as the most northern ones had very little fishing.

Both large and small fish are found over the whole region. They are generally rather sparsely distributed, but on several occasions they were taken in large shoals, many of which appeared to be intimately connected with the occurrence of herring shoals on the spawn of which they feed.

They are relatively plentiful in the northern half and scarce in the southern and south-eastern parts of the region. In more detail, they are very numerous in the Horn Reef grounds in the autumn and winter; on the northern grounds (below the Dogger) in the winter and summer, and also on the western grounds. In the central areas, Dogger, Clay Deep, &c., they are never actually so abundant, but they are present throughout the year, while in the southern shallow areas and the coastal grounds they are remarkably infrequent, especially in the summer. In respect of their proportions by weight, codling are found to be most abundant on the grounds off the English coasts and on the Dogger. They are also fairly abundant in the autumn and winter on the Horn Reef and Amrum grounds, but there they are exceeded in weight by the larger fish.

b. Yearly Variations.—A decline in the average catch throughout the period is noticeable in some of the areas, while in others there is not enough material to show either increase or decrease in the mean catches. The falling off is most noticeable in the eastern, north-eastern, and central areas, and between 1905 and 1906. In some parts there is a very small recovery in 1907, while in others the decline is continued. This is also shown in the Dutch statistics,|| in which the amount of large cod is greatest in 1904 and 1905,

* Cf. Committee A report, p. 48. *Loc. cit.*

† Verhandelungen mit het Rijksinstituut voor het Onderzoek der Zee 1907–1908. Plate I.

‡ HJORT.—Committee A report, p. 110. *Loc. cit.*

§ DAMAS.—Contribution à la Biologie des Gadides, pp. 64–68. *Loc. cit.*

|| Jaarverslag omtrent het beheer van de Visschershaven IJmuiden. 1908. Table iv., p. 72.

d. Spawning.—Roughly speaking, about 15 per cent. of the total number of cod taken by these fishermen in this region are found to be at or above the size at which they first become mature.

Some of these were recorded as maturing or spawning in the months from September to March and April. The actually spawning fish occur as early as November and December on the eastern coastal grounds, but the majority on the offshore grounds are still maturing then and do not spawn till the height of the season—January to March. The largest number of these spawning fish come from the Horn Reef grounds and the grounds below the Dogger, *i.e.*, the northern areas. They were also found on the Dogger itself and in the grounds south of it, but in considerably smaller numbers. We therefore conclude that in this region they spawn in depths from 15 to 40 fathoms, but prefer water over 20 fathoms in depth.

F.—HADDOCK.

Introduction.

This species is much more abundant than cod in this region. By weight alone the total catch of the four years was more than twice as much as that of the cod, while the total *estimated* numbers, 798,722 large and 1,088,843 small are more than *six* times the number of cod caught in the corresponding time. The total yield of haddock approximates more to that of plaice, but in its distribution, geographically and by seasons, it shows much more similarity to that of cod, *i.e.* it is more abundant in the northerly rather than in the southerly parts of the region.

Conversion of the different Measures into Weight.

The fishermen record their catches of haddock in two classes “large” and “small,” and give the number of “baskets” of these or at times the number of fish. For estimating the weight of these, we have firstly the information from Grimsby that 35 large and 110 small fish fill baskets weighing 60 lbs. and 50 lbs. respectively. From these values the resulting average weights are .015 cwt. for large and .004 cwt. for small fish.

These values closely correspond to those found from the figures given on page 94 of the Committee A report.* In this case the average weight of the “small” is .0048 cwt., and I have adopted .005 cwt. as the best approximation. It is evident from that report that the division between “large” and “small” comes in the neighbourhood of 35 cm., and that the average size of the small is about 30 cm. (12 in.).

The weight of a basket of haddock has been obtained from the “Huxley” records and also from the Grimsby records by the method of comparing the total catches with the totals landed. The former method gives the average weight of 188 baskets as .60 cwt., while the latter results in the following table :—

TABLE XXI.—Showing the ratio between the total number of boxes of HADDOCK landed by certain skippers and the number of baskets caught.

| Skipper. | | | 1904. | 1905. | 1906. | 1907. | 1904-7. |
|-------------|-----|-----|-------|-------|-------|-------|---------|
| i. | ... | ... | .58 | .54 | (.77) | — | .57 |
| ii. | ... | ... | — | .67 | — | — | .67 |
| iii. | ... | ... | .54 | .61 | .61 | .65 | .60 |
| iv. | ... | ... | — | .71 | .64 | — | .66 |
| v. | ... | ... | .57 | .51 | .61 | .55 | .56 |
| vi. | ... | ... | (.44) | .70 | .58 | .61 | .63 |
| vii. | ... | ... | .55 | .54 | — | — | .54 |
| viii. | ... | ... | .54 | .47 | — | — | .49 |
| All men ... | | | .56 | .54 | .61 | .58 | .56 |

In the calculation of the last ratio .56, 28,542 baskets are considered. From this we conclude that the most probable average weight of a basket is .56, the weight of a box, *i.e.* .56 cwt., and this value has been adopted for these statistics.

* *Loc. cit.*

Total Quantities of Fish and the Proportion formed by "Large" and "Small."

TABLE XXII.—Showing the total quantities of HADDOCK (in cwts.) recorded by certain skippers during the period 1904–07, and the percentage of the total by weight of the groups "large" and "small."

| Year. | Large Haddock. | Small Haddock. | Total Haddock. | Percentage of Total Weight. | |
|--------------|-------------------|-------------------|-------------------|-----------------------------|--------|
| | | | | Large | Small. |
| 1904 | 4526·84 | 656·97 | 5183·81 | 87·3 | 12·7 |
| 1905 | 5388·61 | 1970·86 | 7359·47 | 73·2 | 26·8 |
| 1906 | 1270·06 | 1747·64 | 3017·70 | 42·2 | 57·8 |
| 1907 | 955·07 | 742·09 | 1697·16 | 56·3 | 43·7 |
| Total | 12140·58 | 5117·56 | 17258·14 | 70·5 | 29·5 |

The main features shown by this table are the considerably varying and increasing proportion of small fish, with the greatest proportion in 1906, and a decline in the total catch. The average per 10 hours fishing for the four years are 5·11 cwts. in 1904, 3·88 cwts. in 1905, 2·58 cwts. in 1906 and 2·06 cwts. in 1907, which shows a considerable drop,* but these figures are analysed in more detail in the next table. In 1906 there were large numbers of small haddock, while the average catch of the large was less than in many of the other years. Further analysis of the records shows that small haddock were also very plentiful in the latter half of 1905, most of them being so very small that tons of them were thrown away. These facts fully confirm the results given in the general part of the Committee A report, p. 102, and by Helland Hansen† where it is shown that in 1902 and 1903 very few young haddocks were spawned, while in 1904 there was a large number, so that two years afterwards, when these became of a trawlable size the catches of small fish in 1904 were particularly small, while in 1906 very many "small haddock" were trawled.

Yearly Fluctuations.

TABLE XXIII.—Showing for groups of areas, the yearly average catch of HADDOCK per ten hours fishing, and the percentage of the total weight formed by the class "small."

| | North Eastern. A. B. C. F. G. | | | | Eastern. H. M. Q. W. | | | | Central. J. N. I. O. | | | | Northern. D. K. L. | | | | Southern. S. T. | | | | Western. E. R. X. P. V. | | | |
|-------------------|----------------------------------|------|---------------|--------------|-------------------------|------|---------------|--------------|-------------------------|------|---------------|--------------|-----------------------|------|---------------|--------------|--------------------|------|---------------|--------------|----------------------------|------|---------------|--------------|
| | L. | S. | All Sizes. | Per cent. | L. | S. | All Sizes. | Per cent. | L. | S. | All Sizes. | Per cent. | L. | S. | All Sizes. | Per cent. | L. | S. | All Sizes. | Per cent. | L. | S. | All Sizes. | Per cent. |
| 1904. May-Dec. | 7·20 | 1·99 | 9·19 | 21·7 | 1·68 | 0·03 | 1·71 | 1·8 | 6·54 | 0·58 | 7·12 | 8·1 | 6·40 | 2·12 | 8·52 | 24·9 | 0·05 | 0·58 | 0·05 | 0·0 | 2·16 | 1·10 | 3·26 | 33·7 |
| 1905. | 6·87 | 1·56 | 8·43 | 18·5 | 1·06 | 0·23 | 1·29 | 17·8 | 3·28 | 1·58 | 4·86 | 32·5 | 6·45 | 1·16 | 7·61 | 15·2 | 0·26 | 0·68 | 0·94 | 72·3 | 0·38 | 1·90 | 2·28 | 83·3 |
| 1906. | 4·19 | 3·53 | 7·72 | 45·7 | 0·81 | 0·59 | 1·40 | 42·1 | 1·07 | 2·04 | 3·11 | 65·6 | 3·49 | 1·92 | 5·41 | 35·5 | 0·13 | 0·76 | 0·89 | 85·4 | 0·05 | 1·65 | 1·70 | 97·1 |
| 1907. | — | — | — | 34·6 | 0·74 | 0·24 | 0·98 | 24·5 | 1·30 | 1·05 | 2·35 | 44·7 | 3·11 | 3·15 | 6·26 | 50·3 | 0·24 | 0·13 | 0·37 | 35·1 | 0·53 | 1·20 | 1·73 | 69·4 |

All these groups of areas show a distinct and considerable fall in the catches between the beginning and the end of the period, and in most cases it is continuous. The proportion of "small" fish varies very considerably in the different areas in the different years, but all groups with the exception of the northern areas, are alike in showing a maximum proportion of "small" in 1906 with a minimum in 1904 or 1905. Large fish have their minimum catches in the same year (1906) in most groups.

The class "small" forms the largest proportion of the total in the west and south parts of this region, but they are actually most numerous in the northern and north eastern areas, where the large fish are also most abundant, for, like the cod, haddock show a much more northerly distribution than any of the other species yet dealt with. On the eastern grounds, small haddock are scarce and form less than one fourth of the total. With regard to the total yield, we find the north eastern areas have by far the largest amount, averaging over eight cwts. per 10 hours fishing. In the northern areas we have an average of nearly seven cwts., and in the central areas between four and five cwts. The eastern and western grounds have less, those on the western side being made up by

* Cf. HELLAND HANSEN. Statistical Research into the Biology of the Haddock and Cod in the North Sea, p. 43, Report of Committee A.

† Loc. cit., p. 37.

TABLE XXIV. (continued)—SHOWING for each area the Monthly Average Catch of HADDOCK in cwts. per 10 hours' fishing; large (L) and small (S) being distinguished.

| Group. | Area. | Year. | January. | | | February. | | | March. | | | April. | | | May. | | | June. | | | July. | | | August. | | | September. | | | October. | | | November. | | | December. | | | Area. | | | |
|-----------------|-------|--------|----------|------|---------------------|-----------|------|---------------------|--------|------|---------------------|--------|------|---------------------|------|------|---------------------|-------|---------------------|---------------------|-------|---------------------|---------------------|---------|---------------------|---------------------|------------|---------------------|---------------------|----------|---------------------|---------------------|-----------|---------------------|---------------------|-----------|---------------------|---------------------|--------------------|---------------------|-----|--------------------|
| | | | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | | | | | | | |
| SOUTHERN AREAS. | S | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | + | 0.00 | + ²¹⁸ | 0.00 | 0.00 | 0.00 ³⁴⁵ | 0.00 | 0.00 | 0.00 ⁴⁵⁴ | 0.00 | 0.00 | 0.00 ¹⁰⁰ | 0.00 | 0.00 | 0.00 ¹⁰³ | ... | ... | ... | ... | ... | ... | S | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁶¹⁷ | + | + | + ⁷⁴⁹ | 0.00 | 0.00 | 0.00 ⁴⁵ | 0.00 | 0.35 | 0.35 ⁴ | 0.00 | 3.95 | 3.95 ⁸ | 0.21 | 2.59 | 2.80 ¹³ | | | | | |
| | | 1906 | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁵ | 0.00 | 0.00 | 0.00 ⁹² | 0.00 | 0.00 | 0.00 ²² | 0.00 | 0.93 | 0.93 ⁷ | 0.00 | 0.37 | 0.37 ⁵⁵ | 0.00 | 0.07 | 0.07 ⁵³ | 0.00 | 0.03 | 0.03 ¹⁰⁶ | 0.00 | 0.00 | 0.00 ²²⁹ | 0.00 | 0.00 | 0.00 ⁹⁶ | ... | ... | ... | ... | ... | | ... | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.06 | 0.04 | 0.10 ⁴⁶¹ | 0.06 | 0.04 | 0.10 ³⁴⁸ | 0.00 | 0.00 | 0.00 ²⁷¹ | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ¹⁶ | ... | ... | ... | | ... | ... | ... | |
| | | 1904-7 | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁵ | 0.00 | 0.00 | 0.00 ⁹² | 0.00 | 0.00 | 0.00 ²² | 0.03 | 0.03 | 0.12 ⁴⁶⁸ | 0.03 | 0.05 | 0.09 ⁶¹⁹ | 0.00 | + | + ¹³¹⁶ | + | + | + ¹³⁰⁹ | 0.00 | 0.00 | 0.00 ³⁶⁵ | 0.00 | 0.01 | 0.01 ¹⁶³ | 0.00 | 1.37 | 1.37 ²⁴ | 0.21 | 2.59 | | 2.80 ¹³ | | | |
| | T | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.02 | 0.43 | 3.45 ¹³ | 0.00 | 0.01 | 0.01 ²⁴ | 0.00 | 0.00 | 0.00 ¹⁰ | 0.00 | 0.00 | 0.00 ⁸ | 0.00 | 0.00 | 0.00 ⁸ | ... | ... | ... | 1.00 | 0.00 | 1.00 ²² | ... | ... | ... | T | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.44 | 0.00 | 0.44 ⁵⁵ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁴⁸ | 0.00 | 0.00 | 0.00 ⁷⁹ | 0.01 | 0.72 | 0.73 ¹⁰⁰ | 0.05 | 2.40 | 2.44 ¹⁷⁷ | 0.22 | 2.37 | 2.59 ³⁴³ | 1.64 | 1.13 | 2.76 ³⁴⁰ | | |
| | | 1906 | ... | ... | ... | 0.04 | 0.76 | 0.79 ⁹⁸ | 0.00 | 0.19 | 0.19 ⁵² | 0.00 | 2.02 | 2.02 ¹¹² | 0.12 | 2.48 | 2.60 ⁵³ | 0.10 | 2.72 | 2.82 ⁹⁷ | 0.17 | 1.61 | 1.73 ¹⁸¹ | 0.15 | 0.70 | 0.85 ⁹⁰ | 0.00 | 0.34 | 0.34 ⁸³ | 0.29 | 0.38 | 0.67 ²²⁵ | 3.26 | 2.04 | 5.29 ²⁹ | ... | ... | ... | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.36 | 0.65 | 1.02 ³⁹ | 1.68 | 1.57 | 3.25 ²⁵ | 0.97 | 0.64 | 1.61 ¹⁴³ | 0.02 | 0.05 | 0.06 ⁹¹ | ... | ... | ... | 0.77 | 0.35 | 1.12 ²⁰ | 0.89 | 0.32 | 1.21 ⁸⁴ | 0.40 | 0.00 | 0.40 ²¹² | 0.00 | 0.00 | | 0.00 ¹² |
| | | 1904-7 | ... | ... | ... | 0.04 | 0.76 | 0.79 ⁹⁶ | 0.00 | 0.19 | 0.19 ⁵² | 0.09 | 1.67 | 1.76 ¹⁵¹ | 0.76 | 1.20 | 1.97 ¹⁴⁶ | 0.56 | 1.34 | 1.91 ²⁶⁴ | 0.10 | 0.39 | 0.96 ³³⁰ | 0.08 | 0.35 | 0.43 ¹⁷⁷ | 0.08 | 0.51 | 0.58 ²¹¹ | 0.31 | 1.11 | 1.41 ⁴⁵⁶ | 0.45 | 1.44 | 1.88 ⁶⁰⁴ | 1.58 | 1.09 | 2.67 ³⁵² | | | | |
| | V | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.80 | 0.69 | 3.49 ¹³¹ | 2.52 | 0.58 | 3.11 ⁵⁶ | 0.90 | 0.41 | 1.31 ⁴⁵ | ... | ... | ... | 1.14 | 0.00 | 1.14 ¹³ | ... | ... | ... | V | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0.00 | 0.17 | 0.17 ²⁵ | ... | ... | ... | ... | ... | ... | ... | ... | 0.50 | 0.00 | 0.50 ¹⁰⁸ | 0.00 | 2.73 | 2.73 ²⁹ | ... | ... | ... | 6.20 | 10.00 | 16.20 ²⁸ | ... | ... | ... | ... | ... | ... | | | | | |
| | | 1906 | 0.38 | 3.81 | 4.19 ⁵⁹ | 0.31 | 1.24 | 1.56 ⁴ | 0.07 | 4.25 | 4.32 ⁸⁹ | 0.00 | 1.37 | 1.37 ³⁸ | ... | ... | ... | 0.00 | 1.40 | 1.40 ¹² | 0.06 | 4.03 | 4.09 ⁵³ | 0.12 | 6.99 | 7.10 ⁴⁹ | 0.48 | 4.40 | 4.88 ⁴⁷ | 0.51 | 2.04 | 2.55 ¹⁶ | 0.73 | 1.10 | 1.83 ¹² | ... | ... | | ... | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁴ | 0.70 | 2.10 | 2.80 ⁸ | 0.35 | 4.04 | 4.39 ⁵⁵ | ... | ... | ... | ... | ... | ... | 2.11 | 2.13 | 4.24 ⁹⁴ | 1.50 | 0.00 | 1.50 ²⁶ | 1.44 | 1.30 | | 2.74 ⁴⁸ | | | |
| | | 1904-7 | 0.38 | 3.81 | 4.19 ⁵⁹ | 0.31 | 1.24 | 1.56 ⁴ | 0.05 | 3.27 | 3.33 ¹⁰⁵ | 0.00 | 1.37 | 1.37 ³⁸ | 0.00 | 0.00 | 0.00 ⁴ | 0.28 | 1.68 | 1.96 ²⁰ | 1.28 | 1.51 | 2.80 ³⁴⁷ | 1.37 | 2.86 | 4.22 ¹⁶⁴ | 0.69 | 2.43 | 3.11 ⁹² | 2.75 | 3.71 | 6.45 ¹³⁸ | 1.24 | 0.24 | 1.48 ⁵³ | 1.44 | 1.30 | | 2.74 ⁴⁸ | | | |
| WESTERN AREAS. | E | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | E | | | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | | | | | |
| | | 1906 | 0.00 | 0.00 | 0.00 ⁸ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁷ | ... | ... | ... | ... | ... | ... | 0.00 | 0.02 | 0.02 ¹⁵ | 0.00 | 0.00 | 0.00 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | | | | |
| | | 1904-7 | 0.00 | 0.00 | 0.00 ⁸ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁷ | ... | ... | ... | ... | ... | ... | 0.00 | 0.02 | 0.02 ¹⁵ | 0.00 | 0.00 | 0.00 ¹¹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | | | | |
| | R | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | R | | | | |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ¹⁴ | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁷⁶ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 1.87 | 1.87 ¹⁵ | ... | ... | ... | 0.00 | 3.74 | 3.74 ¹⁶⁸ | 0.00 | 1.39 | 1.39 ²¹² | | | | |
| | | 1906 | 0.00 | 0.11 | 0.11 ¹³⁹ | 0.00 | 0.00 | 0.00 ²³⁶ | 0.00 | 0.00 | 0.00 ²⁹⁰ | 0.00 | 0.45 | 0.45 ²⁶⁶ | + | 2.19 | 2.19 ¹⁷⁶ | 0.00 | 2.79 | 2.79 ²³⁸ | 0.00 | 2.35 | 2.35 ²²² | 0.00 | 2.66 | 2.66 ¹¹³ | 0.00 | 3.17 | 3.17 ⁷ | 1.83 | 1.35 | 3.19 ¹⁴ | ... | ... | ... | ... | ... | ... | | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁶ | 0.00 | 0.00 | 0.00 ²³ | 0.04 | 0.04 | 0.09 ³² | 0.35 | 1.40 | 1.75 ⁴ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | | | |
| | | 1904-7 | 0.00 | 0.11 | 0.11 ¹³⁹ | 0.00 | 0.00 | 0.00 ²³⁶ | 0.00 | 0.00 | 0.00 ²⁹⁴ | 0.00 | 0.44 | 0.44 ²⁷² | + | 1.40 | 1.40 ²⁷⁵ | 0.01 | 2.46 | 2.47 ²⁷⁰ | 0.01 | 2.33 | 2.34 ²²⁶ | 0.00 | 2.66 | 2.66 ¹¹³ | 0.00 | 2.25 | 2.25 ²⁵ | 1.83 | 1.35 | 3.19 ¹⁴ | 0.00 | 3.55 | 3.55 ¹⁷⁷ | 0.00 | 1.36 | 1.36 ²¹⁶ | | | | |
| | X | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.95 | 1.23 | 2.18 ¹⁰⁹ | 6.90 | 1.78 | 8.68 ⁹⁰ | 0.41 | 1.84 | 2.25 ³⁰ | ... | ... | ... | 2.94 | 0.98 | 3.92 ³³ | 0.00 | 0.00 | 0.00 ¹⁷ | X | | | | |
| | | 1905 | 0.00 | 0.03 | 0.03 ⁴ | 0.47 | 0.47 | 0.93 ³ | 0.18 | 0.04 | 0.22 ²³ | 0.00 | 0.00 | 0.00 ¹² | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.15 | 1.24 | 1.40 ⁸¹ | 0.00 | 2.10 | 2.10 ¹⁰⁷ | 0.02 | 0.85 | 0.87 ¹⁵ | 1.70 | 4.52 | 6.22 ⁴⁴ | | | | | |
| | | 1906 | ... | ... | ... | 0.00 | 0.00 | 0.00 ⁹ | 0.00 | 0.09 | 0.09 ⁸⁹ | 0.00 | 0.51 | 0.51 ⁷⁷ | 0.00 | 1.29 | 1.29 ⁵² | 0.13 | 1.04 | 1.18 ¹⁵⁶ | 0.06 | 2.31 | 2.37 ¹¹² | 0.00 | 2.65 | 2.65 ⁹³ | 0.02 | 3.50 | 3.52 ⁸⁴ | 0.00 | 1.82 | 1.82 ²⁰ | 1.05 | 2.28 | 3.33 ¹⁶ | ... | ... | | ... | | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 | 0.08 | 0.08 ⁵² | 0.00 | 1.75 | 1.75 ⁸ | 0.04 | 2.90 | 2.95 ⁹⁶ | ... | ... | ... | ... | ... | ... | 0.12 | 0.07 | 0.19 ¹⁸³ | 0.05 | 0.25 | 0.30 ²⁸ | 0.00 | | | | | | |

TABLE XXIV. (continued)—SHOWING for each area the Monthly Average Catch of HADDOCK in cwt., per 10 hours' fishing; large (L) and small (S) being distinguished.

| Group. | Area. | Year. | January. | | | February. | | | March. | | | April. | | | May. | | | June. | | | July. | | | August. | | | September. | | | October. | | | November. | | | December. | | | Area. | |
|-----------------|-------|--------|----------|------|---------------------|-----------|------|----------------------|--------|------|---------------------|--------|------|---------------------|------|------|---------------------|-------|------|---------------------|-------|------|---------------------|---------|------|----------------------|------------|------|----------------------|----------|------|----------------------|-----------|---------------------|---------------------|-----------|------|---------------------|--------------------|--|
| | | | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | L. | S. | All Sizes. | | | | | |
| CENTRAL AREAS. | J | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.49 | 1.56 | 4.04 ⁹ | ... | ... | ... | ... | ... | ... | 8.57 | 0.07 | 8.647 ⁵ | 6.40 | 0.44 | 6.842 ⁰⁵ | ... | ... | ... | 3.27 | 0.35 | 3.6277 | 5.07 | 0.95 | 6.014 ⁰¹ | J | |
| | | 1905 | 2.68 | 0.31 | 2.991 ⁰⁵ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.98 | 0.35 | 1.33 ³⁰ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.91 | 2.53 | 7.44 ⁹⁵ | 7.56 | 2.43 | 9.997 ⁸ | 2.34 | 0.70 | 3.04 ⁶⁴ | 1.99 | 1.96 | 3.95 ⁸⁸ | | |
| | | 1906 | 2.95 | 1.63 | 4.58 ²⁸ | 3.55 | 3.17 | 6.72 ³⁰ | ... | ... | ... | ... | ... | ... | 5.87 | 0.76 | 6.6377 | ... | ... | ... | ... | ... | ... | 5.87 | 6.49 | 11.86 ⁹² | 3.66 | 5.90 | 9.55 ⁹⁰ | 1.18 | 2.31 | 3.492 ⁸⁴ | 1.67 | 0.78 | 2.461 ⁹⁰ | 0.17 | 0.59 | 0.76 ³⁸ | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | 0.48 | 0.45 | 0.93 ⁰⁷ | 0.36 | 2.32 | 2.67 ⁸⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.58 | 0.00 | 1.581 ¹⁶ | ... | ... | ... | | | |
| | | 1904-7 | 2.74 | 0.58 | 3.321 ³³ | 3.55 | 3.17 | 6.72 ³⁰ | 0.48 | 0.45 | 0.93 ⁰⁷ | 0.36 | 2.32 | 2.67 ⁸⁸ | 4.67 | 0.75 | 5.421 ⁰⁶ | ... | ... | ... | ... | ... | ... | 6.82 | 3.59 | 10.401 ⁶⁷ | 5.40 | 2.21 | 7.61 ²⁰ | 2.56 | 2.34 | 4.903 ⁰² | 2.24 | 0.60 | 2.852 ⁸⁷ | 4.20 | 1.09 | 5.293 ²⁷ | | |
| | N | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.26 | 0.79 | 5.052 ²⁸ | 2.50 | 0.14 | 2.64 ⁴⁰ | 0.08 | 0.03 | 0.112 ⁰⁵ | 0.62 | 0.04 | 0.661 ⁰⁹ | 1.96 | 0.47 | 2.43 ³⁸ | 2.34 | 0.25 | 2.591 ⁴⁴ | 4.21 | 0.03 | 4.251 ⁵⁹ | 3.44 | 0.00 | 3.441 ³⁶ | N | |
| | | 1905 | 0.02 | 0.00 | 0.02 ⁸ | 0.51 | 0.07 | 0.58 ⁴⁰ | 0.37 | 0.00 | 0.372 ²² | 1.03 | 0.05 | 1.08 ⁸⁰ | 0.94 | 0.01 | 0.95 ⁵⁰ | 3.62 | 0.24 | 3.861 ³⁹ | 4.00 | 0.41 | 4.407 ⁶ | 0.13 | 0.01 | 0.1427 ² | 0.00 | 0.00 | 0.0074 | ... | ... | ... | 2.22 | 1.22 | 3.4421 ⁹ | 1.13 | 3.74 | 4.8841 ² | | |
| | | 1906 | 0.85 | 1.75 | 2.604 ²¹ | 0.12 | 0.10 | 0.2231 ⁰ | + | 0.00 | + | 0.10 | 1.14 | 1.2414 | 0.67 | 1.46 | 2.13 ³⁰ | 0.27 | 2.12 | 2.39 ⁸³ | 1.18 | 3.11 | 4.297 ⁶ | 0.24 | 3.34 | 3.581 ⁹⁷ | 0.00 | 0.40 | 0.4041 | 0.01 | 0.25 | 0.261 ⁰⁸ | 0.63 | 2.18 | 2.812 ⁰¹ | 0.22 | 2.54 | 2.7674 | | |
| | | 1907 | 0.34 | 2.18 | 2.533 ⁰⁶ | 0.10 | 0.64 | 0.7412 ⁵ | 0.48 | 0.49 | 0.972 ²⁸ | 0.98 | 1.03 | 2.0013 ² | 2.02 | 1.49 | 3.5074 | 2.23 | 0.94 | 3.1771 | 1.83 | 1.10 | 2.9311 ⁸ | 0.00 | 0.06 | 0.0645 | 0.00 | 0.00 | 0.0033 ⁵ | 0.28 | 0.07 | 0.352 ⁹⁹ | 0.69 | + | 0.6934 | 0.49 | 0.00 | 0.493 ⁶ | | |
| | | 1904-7 | 0.63 | 1.91 | 2.5473 ⁵ | 0.14 | 0.24 | 0.3847 ⁵ | 0.23 | 0.20 | 0.435 ⁶³ | 0.93 | 0.75 | 1.682 ⁰⁶ | 1.53 | 1.05 | 2.562 ⁵¹ | 2.36 | 0.84 | 3.203 ³³ | 1.32 | 0.85 | 2.1747 ⁵ | 0.24 | 1.07 | 1.316 ²³ | 0.29 | 0.10 | 0.395 ⁵⁸ | 0.76 | 0.15 | 0.915 ⁵¹ | 1.70 | 0.74 | 2.449 ⁵⁶ | 1.39 | 2.41 | 3.8071 ⁸ | | |
| | I | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.58 | 0.53 | 4.111 ⁰¹ | 3.71 | 0.68 | 4.391 ⁵ | 5.84 | 0.63 | 6.4621 ⁹ | 7.92 | 0.06 | 7.982 ²⁵ | 15.33 | 0.87 | 16.2021 ⁸ | 3.04 | 0.17 | 3.211 ⁹⁰ | 8.58 | 0.73 | 9.313 ⁵⁰ | I | |
| | | 1905 | 4.59 | 0.33 | 4.9287 | 2.24 | 0.21 | 2.4517 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.52 | 0.29 | 4.815 ² | 3.59 | 0.38 | 3.971 ²¹ | 3.33 | 1.47 | 4.808 ⁶³ | 2.47 | 0.64 | 3.1163 ² | ... | ... | ... | 2.49 | 5.12 | 7.661 ³⁹ | 2.18 | 5.31 | 7.4947 | | |
| | | 1906 | 0.62 | 4.75 | 5.367 ⁹ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | |
| | | 1904-7 | 2.71 | 2.43 | 5.131 ⁶⁶ | 2.24 | 0.21 | 2.4517 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.90 | 0.45 | 4.351 ⁵³ | 3.51 | 2.56 | 6.0721 ³ | 4.70 | 1.01 | 5.715 ²² | 3.58 | 0.66 | 4.251 ⁰⁶⁸ | 11.73 | 0.80 | 12.533 ⁰⁰ | 2.29 | 2.31 | 4.6041 | 7.84 | 1.26 | 9.104 ⁰⁶ | | |
| | O | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 8.40 | 3.08 | 11.481 ⁰ | 5.80 | 1.42 | 7.221 ⁰⁰ | 5.04 | 0.98 | 6.021 ⁴⁹ | 5.16 | 0.97 | 6.132 ⁵⁴ | 5.59 | 1.11 | 6.731 ¹⁶ | 18.72 | 0.97 | 19.683 ⁵⁶ | 4.77 | 0.37 | 5.1427 ⁸ | 7.88 | 0.07 | 7.9597 | O | |
| | | 1905 | 6.36 | 0.20 | 6.551 ⁰⁰ | 1.56 | 0.06 | 1.625 ⁶ | 4.23 | 0.86 | 5.091 ⁵⁰ | 5.82 | 0.78 | 6.601 ¹³ | 6.60 | 1.03 | 7.633 ⁰⁵ | 6.20 | 0.94 | 7.151 ²¹ | 4.14 | 0.82 | 4.972 ⁵⁵ | 5.42 | 2.28 | 7.709 ⁹ | ... | ... | ... | 3.08 | 3.11 | 6.192 ²⁷ | 1.85 | 3.71 | 5.5717 ⁵ | 3.17 | 4.11 | 7.283 ³⁸ | | |
| | | 1906 | ... | ... | ... | 2.13 | 3.73 | 5.8711 | 0.21 | 0.00 | 0.219 | 0.00 | 1.24 | 1.2414 | 1.96 | 3.92 | 5.881 ⁰ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | |
| | | 1907 | 4.57 | 3.97 | 8.542 ⁸¹ | ... | ... | ... | 1.89 | 1.73 | 3.62 ⁸⁰ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| | | 1904-7 | 5.04 | 2.98 | 8.028 ⁵¹ | 1.65 | 0.63 | 2.2867 | 3.29 | 1.12 | 4.462 ⁸⁹ | 5.69 | 0.79 | 6.486 ²⁷ | 6.53 | 1.15 | 7.6841 ⁵ | 6.02 | 1.16 | 7.18221 | 4.47 | 0.88 | 5.354 ⁰⁴ | 5.24 | 1.33 | 6.573 ⁵³ | 5.53 | 1.18 | 6.762 ²⁰ | 11.03 | 1.87 | 13.010 ⁰⁷ | 4.02 | 1.67 | 5.683 ²⁵ | 3.89 | 3.49 | 7.383 ³⁵ | | |
| NORTHERN AREAS. | D | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.95 | 5.38 | 8.337 | ... | ... | ... | D | |
| | | 1905 | 1.32 | 0.46 | 1.7861 | 9.47 | 1.27 | 10.757 ⁶⁰ | 6.73 | 2.23 | 8.96647 | 0.97 | 1.60 | 2.5724 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.59 | 2.01 | 6.61 ⁶⁰ | |
| | | 1906 | ... | ... | ... | 6.73 | 0.82 | 7.553 ⁵ | 3.16 | 1.21 | 4.362 ⁵⁷ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| | | 1907 | ... | ... | ... | ... | ... | ... | 3.95 | 1.55 | 5.502 ⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| | | 1904-7 | 1.32 | 0.46 | 1.7861 | 9.20 | 1.23 | 10.4234 ⁵ | 5.67 | 1.93 | 7.568 ⁹² | 0.97 | 1.60 | 2.5724 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.95 | 5.38 | 8.337 | 4.59 | 2.01 | 6.61 ⁶⁰ | |
| | K | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2.10 | 5.60 | 7.704 | 3.93 | 2.33 | 6.25 ³⁸ | ... | ... | ... | 4.80 | 1.80 | 6.607 | 6.31 | 2.64 | 8.951 ³ | 8.09 | 1.58 | 9.67 ⁵⁵ | 2.02 | 0.52 | 2.5421 | ... | ... | ... | K | |
| | | 1905 | 3.28 | 0.63 | 3.91211 | 6.12 | 0.69 | 6.812 ³⁰ | 1.72 | 0.22 | 1.942 ³⁰ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| | | 1906 | 3.25 | 1. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

considerable numbers of small fish which appear to be very scarce on the eastern side (where the total average catch varies from one to two cwt.). The southern areas give a very small yield (less than one cwt. per 10 hours in each year).*

Thus there is found to be a great difference in the yield of haddock in the various parts of this region, and while their distribution is somewhat similar to that of cod, in showing increasing quantities towards the north, they exhibit still more marked and decided differences in the various parts. For instance, the average catch of haddock in the north eastern region is about 15 times that in the southern region, while we find that for cod, this proportion is halved.

The yearly catches are compared in another way by the following summary, which is the comparison of the averages of the corresponding months in the various years.

1905 is 24 times less than, and 14 times greater than 1904, out of 40 months.

1906 is 15 times less than, and 17 times greater than 1904, out of 35 months.

1907 is 13 times less than, and 10 times greater than 1904, out of 25 months.

1906 is 20 times less than, and 24 times greater than 1905, out of 46 months.

1907 is 14 times less than, and 15 times greater than 1905, out of 34 months.

1907 is 19 times less than, and 12 times greater than 1906, out of 33 months.

On the whole, this table shows more decline than increase. There was a decided drop in the yield of 1905 compared with 1904, while in 1906 there is a recovery. 1907 is less than 1906.

The Fluctuations in each Area.

The average catch of haddock in each area is given for each month in Table XXIV. The nature of the variations, as far as they can be determined from these figures for each area or group of areas, is as follows :—

The North Eastern Areas.

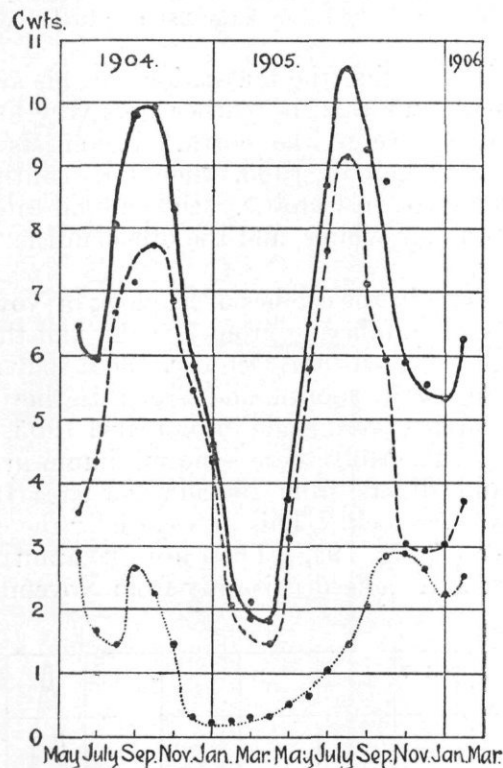


FIG. 77.—HADDOCK. North-eastern areas combined. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

When we compare the averages from the various parts of this group, especially those representing a very fair amount of fishing, we find a certain similarity in amount and trend. Owing to this fact, it is possible to combine the records from all these areas and so obtain a more complete and accurate series of averages than is otherwise possible.

The resulting averages with a few interpolations are smoothed into the curve of Fig. 77, to show approximately the nature of the abundance and the seasonal variations in this region.

* With these facts compare the results given on p. 92, Committee A Report. *Loc. cit.*

The height of the curve is considerable and shows that the stock of haddock is very great. This consists of fish of all sizes, the large fish preponderating and far outweighing the small, although these are not at all inconsiderable in amount. With regard to these small fish it should be mentioned that a number of small unmarketable haddocks were present in area G in January, 1905, but these are thrown away when caught. In area F a lot of tiny haddocks appeared in September, 1905.

Haddocks of all sizes are most abundantly found in the months August to October, in some areas averaging nearly 14 cwt. in September. In some cases, as in F, they appear in unusually large shoals. The averages for the spring months (1905) are based on very few hours fishing, and are possibly erroneous, so we can place no reliance on the position or extent of this minimum.

About ten years before (in 1895) the chief item of fish landed from this region was haddock; vessels would bring in sometimes from two to three hundred boxes of large haddocks as the result of one trip—far more than is now ever taken.*

Eastern Areas.

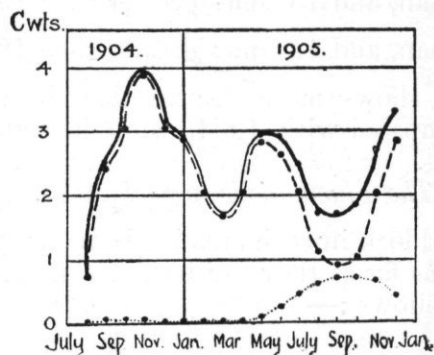


FIG. 78.—Area H. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area H.—The curves illustrating the fluctuations in this area show that a fair stock of haddock is always present, and that it neither gets very low nor has such a high maximum, as the grounds still more to the north. It consists almost entirely of large haddock alone, until the latter half of 1905, when the quantity of "small" gradually increases to a maximum 1.02 cwts. in October. In the total catch, there appear to be two maxima, as in the late autumn or winter and the other in the spring or early summer. The summer catches are low.

Great variation is noticeable in the catches of haddock in November, 1904—sometimes they are caught in basketful numbering from 7 to 11 and then for many hauls only a fraction of a basketful would be taken. In October, 1904, they are absent from most of the hauls up to the middle of the month, and after this they are taken in considerably varying quantities. Good catches were made in January, 1905, and nearly all the large fish in these were spawning. Probably there is no minimum in February and March.

Area M.—This ground differs from its adjacent area further north in yielding generally a smaller catch of haddock. This is especially the case in the summer, when the catches are most often zero (Fig. 79). There are two annual maxima, the one in late autumn being by far the greatest, indeed it is only from November to December that the

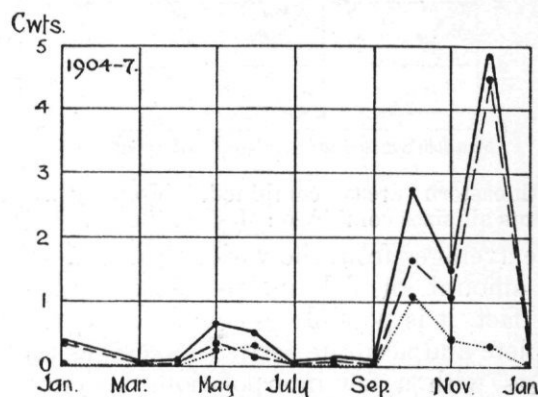


FIG. 79.—HADDOCK. Area M. Monthly averages, 1904-07. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

* CUNNINGHAM. North Sea Investigations. Journ. Mar. Biol. Ass., Vol. IV., 1895, p. 13.

catches are at all large ; for most of the rest of the year they average considerably under one cwt. A secondary maximum occurs about June, but being of such a small extent, it is probably only caused by the spring migration shown clearly in area H extending a little further south into M. It is generally caused by a few very large catches combined with hauls in which none are taken, and is not always indicative of a uniform large abundance.

Small fish are rarely found in the catches till the autumn of 1905. In 1906 they form a still larger proportion of the total, though on the whole throughout the period the large fish exceed the small in weight. (Fig. 80.)

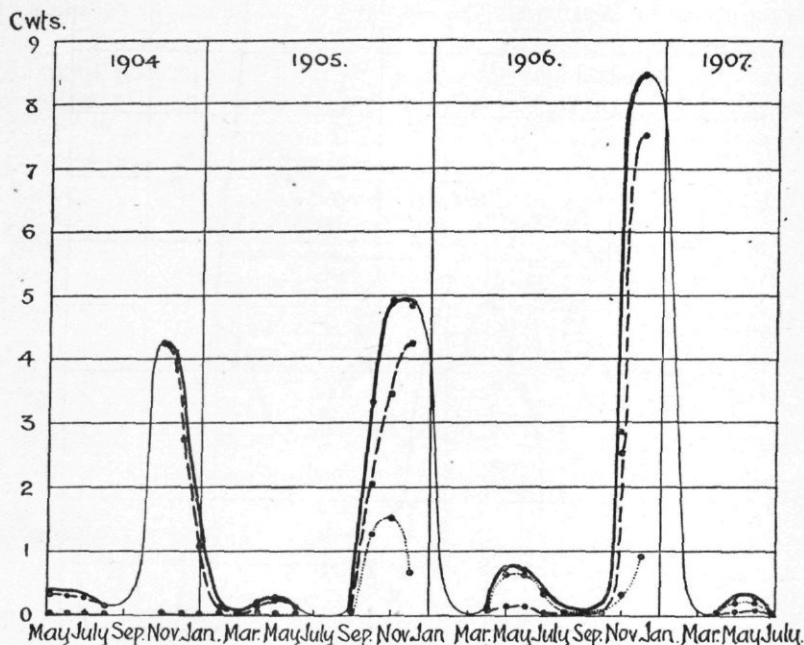


FIG. 80.—HADDOCK. Area M. Monthly averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, large fish ; dotted line, small.

The difference in the yield of the successive years is not determinable from the curves but it is interesting to compare such averages as we have with the conditions that existed here ten years ago. The average catch of haddock in May, 1905, is 0.61 cwt., in June it is 0.12 cwt. In 1895* the results of two voyages in May and June respectively are 11.4 cwt. and 3.1 cwt. per ten hours fishing. It is evident that at one time haddock were much more plentiful on the Sylt grounds than they are now.

In December, 1904, a noticeable diminution in the catches occurs towards the end of the month. This may be caused by an offshore migration of the fish.

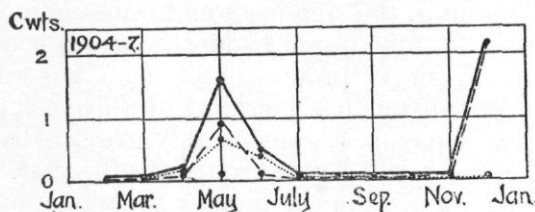


FIG. 81.—HADDOCK. Area Q. Monthly averages, 1904-07. Continuous line represents all sizes combined ; dashed line, large fish ; dotted line, small.

Areas Q and W.—In the latter of these two areas no haddock were taken at all (in spring and summer), while a similar condition of things was the case in area Q for the greater part of the year. The autumn and winter months are not sampled sufficiently for us to know whether the fish come inshore in this part as they do in the other two inshore areas in the autumn, but this is probably the case. They are certainly entirely absent in early spring and are only found in any appreciable quantities in May and June of the months investigated. In 1906 and 1907 they were more plentiful than in the other years.

The four eastern areas yield small quantities of haddock, the northern Horn Reef area having the largest amount. There are generally two maxima, the greatest immigration taking place in late autumn ; the other one occurs about May or June, just after the

* CUNNINGHAM.—North Sea Investigations. *Loc. cit.*, p. 33, *et seq.*

Area N.—The total yield of haddock from this region is much less than in any of the other central areas, the maximum catches being about 4 cwt., and the minimum zero. The seasonal variations are very regular and periodic, giving annually two maxima in June and December, while the minima between these two come in the periods February to March, and September to October. (Fig. 83.)

Fig. 84 shows that in the first two years the stock mainly consists of *large* fish, but these become very scarce in 1906 and make a slight recovery in 1907. This decrease in 1906 is *almost* balanced by the greatly increased numbers of small fish which appear first of all at the end of 1905, but which show a considerable falling off in 1907.

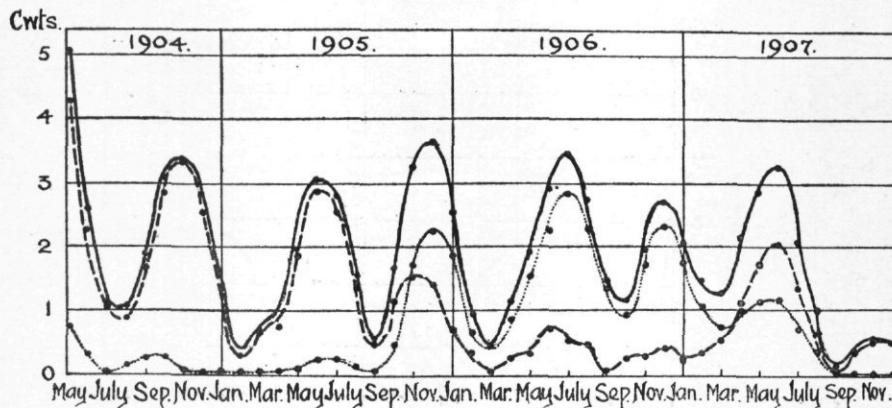


FIG. 84.—HADDOCK. Area N. Monthly averages, (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area I.—This is a good area for haddock, and the average several times exceeds 7 cwt., and on one occasion (October, 1904) it is as much as 16.2 cwt. As in many of the other areas, we find here a majority of large haddock, until the last three months of 1905 and in 1906, when the small fish outweigh them considerably.

For the seasonal fluctuations (Fig. 85) we find the catches rising from the summer of 1904 to a maximum in October, followed by a drop to the following February. In 1905 the large fish show a slow decline from June to January, 1906, but the marked increase in the number of small fish is sufficient to make the total catch rise from a minimum in the summer to a maximum about November. There is a downward trend throughout the summer and autumn of 1906, corroborated by the decreasing averages of September to November, 1907, but the amount of fishing is almost too small to make this conclusion of any value.

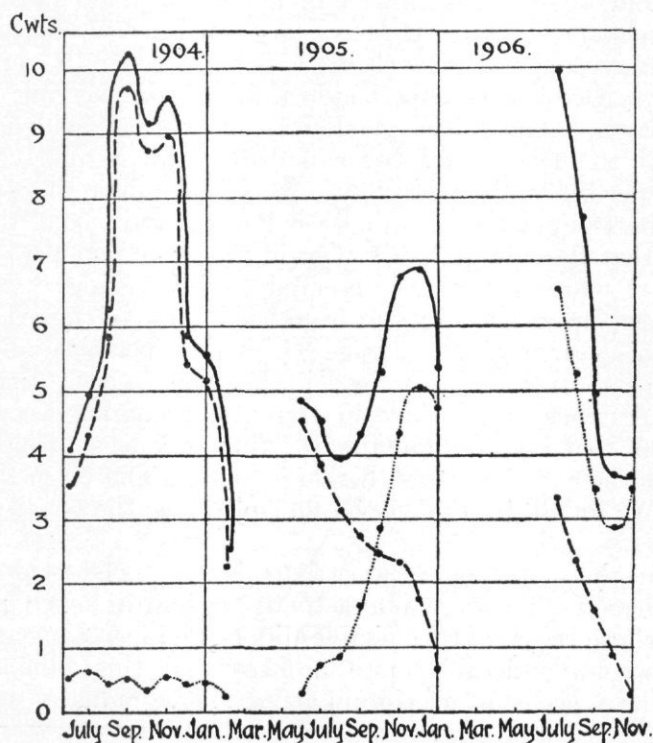


FIG. 85.—HADDOCK. Area I. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area O.—The Dogger Bank appears to be pre-eminently a haddock fishing ground, for it yields a far larger amount of this species than of any of the other important food fishes yet dealt with in this report. In the eight months of 1904 for which we have records, the averages, with one exception, were all over 6 cwt., and in October the total

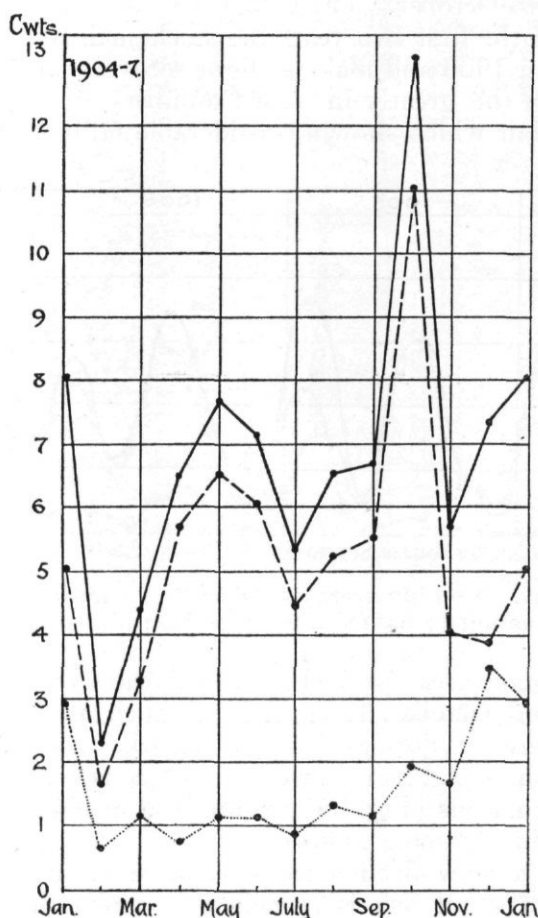


FIG. 86.—Haddock. Area O. Monthly averages, 1904-07. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

reached the high amount of 19.68 cwt. The catches in this month were extraordinarily large, several times from 50-80 baskets were taken, and in one haul on the 22nd October there were 147 baskets, most of them being large haddocks. These large shoals are undoubtedly connected with the herring shoals which are generally very numerous on the Dogger in September to October, and the haddock follow the herring in shoals in order to feed on their spawn. There is a good deal of external evidence to confirm this. Firstly, we know that the Dutch and German drifters go regularly to the Dogger for herring in October. Secondly, the "Huxley" records confirm the presence of herrings on the same part of the Dogger (the South West Patch), and about the same time (the 20th October, 1904) that these large hauls of haddocks were taken by the Grimsby men.*

Cod, haddock and whiting were all observed to be feeding on the herring spawn which the trawl brought up in large masses from the bottom of the sea. Further evidence of the conditions in this year is given on page 34 of the paper by J. Boeke, on the "Fish Eggs and Larvæ in the southerly North Sea,"† where he observes that the Dutch fishermen made enormous catches of haddock in October, averaging about 606 kg. per day (about 12 cwt.), and that the examination of the stomachs of 60 haddocks on the 20th October, showed them to be full of herring eggs.‡ The largest catches were made just north of the S.W. Patch, in the very same place as the Grimsby fishermen found them.

The fact that in the next year (1905) there is no such decided maximum about October may mean that the fish were not actually present in such numbers, or, that if they were, the men whose records are available did not happen to come across the shoals.

The small fish become noticeably more numerous at this time and in 1906, while the large fish, which have a second maximum about May, gradually decline in numbers.

* Voyage 41, Station 19.

† Verhandelingen Uit. Het. Rijksinstituut vor Het Onderzoek der Zee. III.-V. 1906.

‡ Cf. Todd. Food of Fishes. Internat. Invest. Mar. Biol. Assoc. Report II., Part I., 1904-5, p. 127.

Tiny unmarketable haddock were very plentiful on the Dogger in April, 1905, and in the succeeding months. Tons of them were put overboard, and one of the skippers remarked that it was many a year since he had seen so many very small fish on the Dogger. They were mainly haddocks and whittings.*

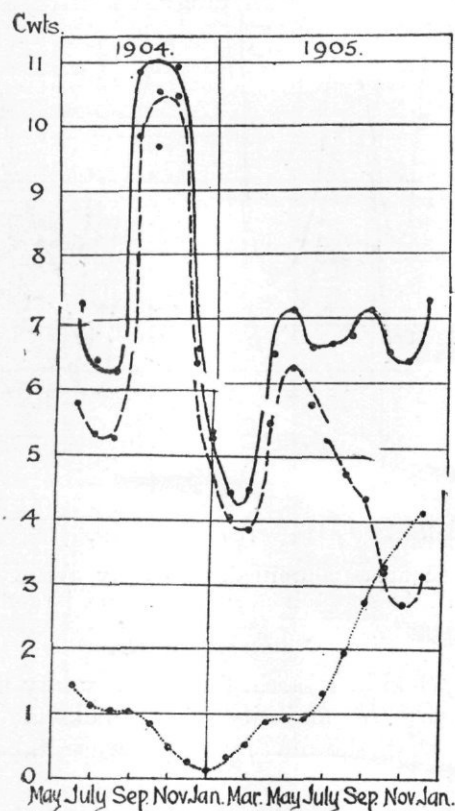


FIG. 87.—HADDOCK. Area O. Monthly averages (smoothed curves). Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

The four central areas, with one exception, yield very large amounts of haddock, the average in many cases exceeded 5 and 6 cwt., and was very seldom less than 2 cwt. The most southern and shallow of these areas show smaller catches with a maximum of about 4 cwt.

In all parts, the small fish were scarce in 1904, and increased significantly at the end of 1905, when they began to exceed the large. The unmarketable fish made their first appearance earlier in the year, when tons of them had to be thrown overboard.

A slight decrease in the total of all sizes together is observed between 1904 and 1907. The periods of maximum abundance appear to be in the summer (and probably at the end of the winter) in the most northerly area J (the Mud Bank, &c.), in spring and autumn on the Dogger Bank (O), and in June and December in area N. In the remaining area the period is not definitely determined by these figures, but there are indications of a maximum some time in the autumn.

Northern Areas.

The catches from these three areas have been combined into the averages which are shown smoothed in Fig. 88. They show that large numbers are present, for they are nearly all over 3 cwt. per 10 hours fishing, and about one half of the averages are over 6 cwt.

Early in the year there is an accumulation of large fish which are nearly all spawning, and they generally reach their greatest numbers in February. They diminish again to 2 or 3 cwt. in the early part of the summer, and rise to a maximum in September or October of each year. Small fish generally form a considerably smaller proportion of the total weight than the large, but towards the end of 1906 they are very numerous. Their seasonal fluctuations are not very definite, but there is some evidence for the existence of a late summer or autumn maximum.

* The average catches of haddock in April, 1895, were about double the amount in April, 1905. See Cunningham's Investigations. *Loc. cit.*

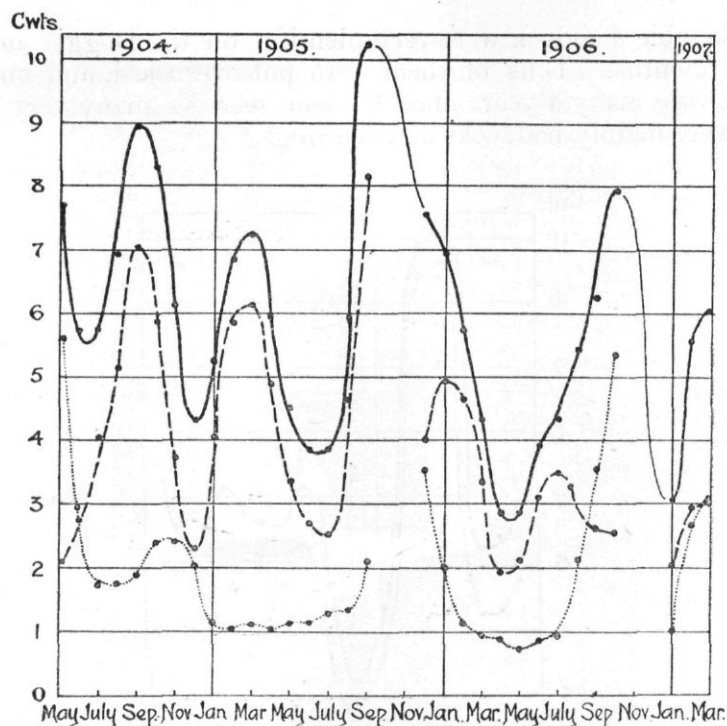


FIG. 88.—HADDOCK. Northern areas combined. Monthly averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, large fish ; dotted line, small.

Southern Areas.

Area S.—This is not a haddock area, for scarcely any fish are reported from this region. It is too far south for the majority of haddocks, and it is only in the spring, and perhaps in the winter, that the few recorded were taken. These were nearly all small fish.

In former years quantities of haddocks used to be landed by Lowestoft smacks from Smith's Knoll. Mr. Atkinson tells me, that as the result of persistent enquiry among the fishermen, it was generally observed that the fish, *which were all large*, made their appearance in August and September. They remained there up to Christmas, and then, according to the fishermen, suddenly and rapidly disappeared. Mr. Atkinson states that haddock are now but rarely seen on the Lowestoft market, but that in the autumn of 1905 he observed a few small haddocks packed in boxes with whittings from the Leman.

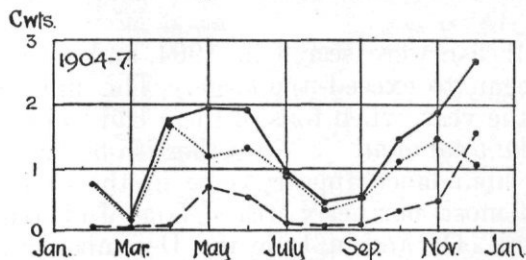


FIG. 89.—HADDOCK. Area T. Monthly averages, 1904-1907. Continuous line represents all sizes combined ; dashed line, large fish ; dotted line, small.

Area T.—Haddocks are found throughout the year in this area, but in small quantities. The maximum monthly catches of the year are 3 cwt. or less, and in 1905.

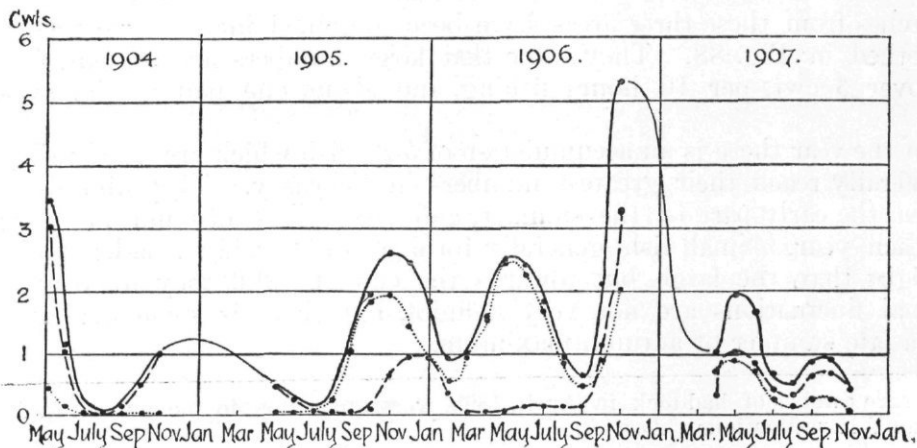


FIG. 90.—HADDOCK. Area T. Monthly averages (smoothed curves). Continuous line represents all sizes combined ; dashed line, large fish ; dotted line, small.

and 1906, when we have the most records, they consist mainly of small fish. The seasonal fluctuations (Figs. 89 and 90) are very similar to those in area N, that is, there are two annual maxima occurring in May to June, and November to December, respectively. In the summer the catch is zero, or almost so.

About the 23rd September, 1905, some of the fish were observed to be full of herring spawn.

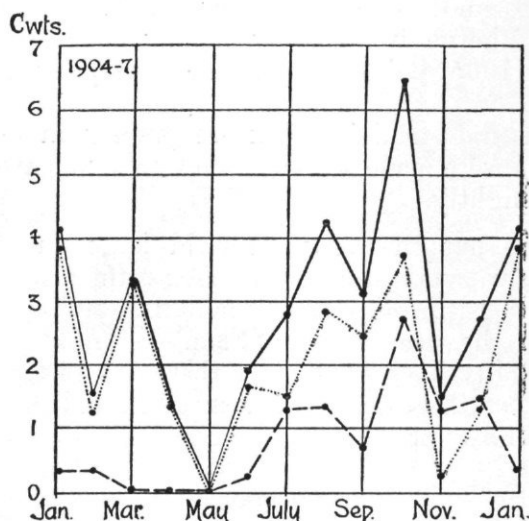


FIG. 91.—HADDOCK. Area V. Monthly averages, 1904-1907. Continuous line represents all sizes combined; dashed line, large fish; dotted line, small.

Area V.—The average catch of haddocks from the Silver Pits compares favourably with the other two southern areas. The maximum catches are between four and five cwts. The hauls of October, 1905, which resulted in particularly large numbers, were all made on the Spit of the Dogger, just over the line bordering the two areas V and O.

The three areas together show rather small quantities of haddock, the most notherly one having the largest abundance. They are absent in the summer in S and T but present, sometimes in their greatest numbers at this time, in V. There are two periods of maximum abundance in T, at the end of spring and autumn, while those present in S indicate the same conditions there. Small fish are mostly predominant.

Western Areas.

Area E.—Only six small haddock were recorded from the few hauls made in this area, in 1906.

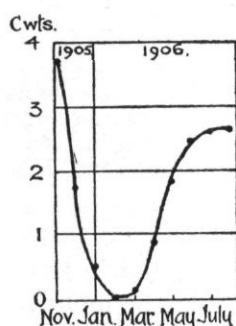


FIG. 92.—HADDOCK. Area R. Monthly averages (smoothed curves). Continuous line represents small fish.

Area R.—The haddock in these grounds, almost without exception, are recorded as small. The curve is shown only for the averages from November, 1905, to August, 1906, as the rest are not reliable. The highest value is in November (3.47 cwts.); it is followed by a sharp drop to a zero minimum in February and March, after which the curve rises to nearly three cwts. in the summer. During this time large quantities of unmarketable haddock were caught in the trawl but not landed. This preponderance of small haddock is probably somewhat exaggerated owing to the fact that 1906 is the year of "small haddocks," and the other years are not allowed sufficient weight in the averages.

The fish caught about 16th November, 1905, when large hauls were taken, were full of herring spawn, and it was noticed that the haddock had eaten only clean spawn. Haddock were seldom taken on this ground after the 22nd November. On the 15th December the skipper remarks on the unusual occurrence of a few haddock still feeding on herring spawn, a "very late date for them to be feeding on that kind of food."

Area X.—The greatest catches appear to be made in the summer; they generally average then between two and three cwts., but on one occasion (August, 1904) the maximum was 8.68 cwts. Large fish are most plentiful in 1904; small occur in increased quantities at the end of 1905 and 1906, but the total quantities on the whole decrease from 1904.

Area P.—Both large and small haddock are present in fair numbers, especially in July, when the most hauls were made. They then averaged between three and four cwts., large fish predominating slightly.

The western areas do not on the whole yield large quantities of haddock. The largest catches (three to four cwts.) are made in the northern deepest part. In the most southern area the catch consists entirely of small fish, and these form no inconsiderable portion of the catch from the deeper water (Flamborough Off, &c.). The summer and autumn catches are generally the highest, and there is a distinct minimum in February and March. A good part of the catch is unmarketable, and the fishermen mention that they throw away large numbers of small haddocks.

Spawning.

Table XXV.—Showing the number of hauls in each area in which maturing or spawning HADDOCK are recorded.

| — | B. | C. | D. | F. | G. | H. | I. | J. | K. | L. | M. | N. | O. | T. | V. | X. |
|------------------|---------------|---------------|------------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-------------------|-----------------|-----------------|------------------|-----------------|----------------|----------------|
| October... 1904 | — | — | — | — | — | — | $\frac{13}{22}$ | — | — | — | — | — | — | — | — | — |
| November ... " | — | — | — | — | — | — | $\frac{53}{27}$ | — | — | — | $\frac{2}{2}$ | * | $\frac{19}{23}$ | * | * | $\frac{5}{5}$ |
| December ... " | — | — | — | — | — | $\frac{42}{53}$ | $\frac{7}{9}$ | $\frac{3}{86}$ | — | — | $\frac{63}{72}$ | — | $\frac{25}{25}$ | — | — | — |
| January ... 1905 | — | — | $\frac{14}{127}$ | — | $\frac{11}{26}$ | $\frac{88}{94}$ | $\frac{7}{9}$ | $\frac{9}{25}$ | $\frac{30}{30}$ | $\frac{9}{37}$ | $\frac{13}{13}$ | — | $\frac{19}{25}$ | — | — | — |
| February ... " | — | — | $\frac{13}{132}$ | — | $\frac{2}{2}$ | — | $\frac{3}{3}$ | — | $\frac{37}{35}$ | $\frac{133}{146}$ | * | * | $\frac{14}{14}$ | — | — | $\frac{1}{1}$ |
| March ... " | — | $\frac{1}{2}$ | $\frac{14}{152}$ | $\frac{3}{4}$ | — | $\frac{1}{3}$ | — | — | $\frac{7}{8}$ | $\frac{37}{47}$ | — | — | $\frac{22}{37}$ | — | — | $\frac{3}{14}$ |
| April ... " | — | — | — | — | — | — | — | — | — | — | — | — | $\frac{10}{158}$ | — | — | — |
| October... 1905 | $\frac{5}{5}$ | — | — | $\frac{5}{10}$ | — | $\frac{2}{17}$ | — | $\frac{1}{18}$ | — | — | $\frac{3}{3}$ | — | — | — | — | — |
| November ... " | $\frac{1}{1}$ | — | — | $\frac{2}{2}$ | — | $\frac{9}{9}$ | — | — | — | — | $\frac{17}{19}$ | $\frac{17}{17}$ | $\frac{1}{1}$ | — | — | — |
| December ... " | — | — | $\frac{15}{15}$ | $\frac{2}{2}$ | $\frac{1}{1}$ | $\frac{11}{21}$ | $\frac{4}{5}$ | $\frac{14}{14}$ | — | $\frac{7}{7}$ | $\frac{11}{11}$ | $\frac{2}{2}$ | $\frac{97}{119}$ | — | — | $\frac{7}{8}$ |
| January ... 1906 | — | — | — | — | $\frac{4}{4}$ | — | * | $\frac{4}{4}$ | — | $\frac{6}{6}$ | — | — | — | — | — | — |
| February ... " | — | — | $\frac{16}{23}$ | — | $\frac{15}{15}$ | — | — | — | — | $\frac{5}{5}$ | — | — | — | — | — | — |
| March ... " | — | — | $\frac{21}{65}$ | — | — | — | — | — | — | — | — | — | — | $\frac{13}{22}$ | $\frac{1}{14}$ | — |
| January ... 1907 | — | — | — | — | — | — | — | — | $\frac{12}{13}$ | — | — | $\frac{48}{74}$ | $\frac{39}{69}$ | — | — | — |
| February ... " | — | — | — | — | — | — | — | — | $\frac{51}{58}$ | — | — | $\frac{31}{31}$ | — | — | — | — |
| March ... " | — | — | $\frac{7}{7}$ | — | — | — | — | — | $\frac{28}{69}$ | $\frac{12}{15}$ | — | — | — | — | — | — |

* Maturing or spawning haddock are present in some hauls, the number of which is not specified.

The numerator of the fractions denotes the number of hauls when records of spawning fish were made, and the denominator, which is given as a means of comparison, is the total number of hauls in the area for each month, only those being included which are made by men who record any spawning cod or haddock.

The observations made by the Grimsby skippers on the maturation and spawning of the haddock are summarised in the table and in the following account:—

The first observations were made in the month of October, 1904, when in the central grounds, Clay Deep, &c., "a few haddock" were recorded as spawning (probably maturing), and this condition is continued throughout November and December on the Dogger, the Dogger Bight, the eastern grounds H and M, while in Clay Deep they became numerous. According to another fisherman, in November and December the haddock from areas N, T, V and X are "developing spawn."

Throughout January and February, 1905, we notice that "the roes of the haddock are getting very ripe"—this applies to the northern and central areas. Numerous haddock are found spawning at Horn Reef in January and still more in areas G, J, D, I, K and L, north and east of the Dogger in January, February and March. They are present on the Dogger and Dogger Bight, but never in such quantities as in the grounds north of the Dogger and the eastern grounds, where the spawning fish are sometimes measured in basketsful.

The spawning of haddock is continued till the first week in April, 1905, the few cases recorded at this time being found on the Dogger.

In the next season the observations begin in the same month, October. Here we find "spawn forming in the haddock" in a few cases in the eastern areas (J, M and H) and in the north eastern areas. In November, in these areas, together with the other central areas I, N and O, the large haddock are very full of spawn. In December, in all these groups of areas and in the western area X, we find spawning haddocks and fish which are full of spawn. A skipper states in the first week in December that "the large haddock caught on the Amrum Grounds are full of roes," while later on, in the last week of this month, he notices that the large haddock are beginning to get roes in them. In this case he was working further offshore, in the neighbourhood of Clay Deep—between the 20-fathom line and the Dogger. According to Damas the individuals inhabiting the regions near the coasts spawn sooner than those farther away.*

During January and February, 1906, the large haddock are reported as "full of spawn" from most of the areas fished over during these months. The northern areas D, K and L have very large numbers of spawning fish, several basketsful being often taken in each haul. In the more southern areas N, T and V spawning fish are present, but they are characterised as "few." Large numbers are spawning in the first week in March in area D, after which none were recorded.

In the next season there are no records till January, 1907 when a few haddock, small and large, from area N were spawning; these records from area N were continued till the first week in February. They were also spawning on the Dogger in January, and from January to about the middle of March in the grounds north of the Dogger.

It is seen that, while a few haddock are found spawning as early as December, the majority are still unripe at this time. The ripe or "full" fish become much more abundant in January, and they are constantly found spawning in this and the two succeeding months, as well as in different stages of ripeness.

Spawning fish are taken over the greater part of this region, but those from the Dogger and the ground south of it are few in number, compared with those from the Horn Reef grounds, and from the areas north of the Dogger.

It seems that the haddock from this region when spawning, seek the central parts of the North Sea where the depths are from 20 to 50 fathoms and congregate in especially large numbers north of the Dogger, avoiding the shallower and more southerly grounds.

If we may judge from the presence of spawning haddock in the Horn Reef area, the Mud Bank and the outside the Tail End of the Dogger, we may infer that they are also to be found abundantly still further north, in the group of north-eastern areas, including part of the little Fisher Bank from which we have, unfortunately, few observations in the winter months.†

Summary.—Haddock.

The comparative distribution of the haddock according to the mean monthly catch in this region is shown in Fig. 93.

a. Distribution.—Haddock are distributed in large quantities over this region. The central grounds are abundantly supplied, and the general tendency is for the quantities to increase as we proceed northwards. They have, however, a southern limit, for they are seldom found south of Latitude 54° N. or in the shallow coastal grounds bordering on the Dutch, German and English coasts. The greatest abundance was found in the group of north-eastern areas, including parts of the Fisher Bank &c., while the Dogger Bank and the Deep Water surrounding it on the north and east were also some of the best grounds in this region (south of 57° N.). The mean monthly catch of these areas was about 6 cwts. per 10 hours fishing for the period 1904–07, while the maximum averages were 12 or 13 cwts. On the other hand we find mean values of only 1 to 2 cwts. on the eastern grounds and in some of the western areas, while the most southern areas yield only occasional fish and for the greater part of the year are absolutely without any haddock.

It was found that small fish form about 30 per cent. of the total weight of fish caught, but this percentage varies for the different regions, and even more for the different years. It is in the western areas that we find the largest percentage of small—on the eastern grounds there are very few. The small are actually the most numerous on the northern and north-eastern grounds.

The abundance of small fish on the western side may be explained by reference to Damas' report on the distribution of eggs and larvae, where we find that the eggs,

* *cf.* DAMAS. Contribution à la Biologie des Gadides, p. 129. Committee A Report. *Loc. cit.*

† *cf.* DAMAS. Contribution à la Biologie des Gadides, p. 132. *Loc. cit.*

spawned in the northerly regions, are carried by the surface currents while they are still in their pelagic state. The current coming down the east coast of Scotland and N.E. England would bring the larval forms to the neighbourhood of the western areas where they develop into small fish. This fact would also account for the comparative scarcity of small fish on the eastern side, for the water here comes in a current from the south part of the North Sea, where no haddock eggs are spawned.

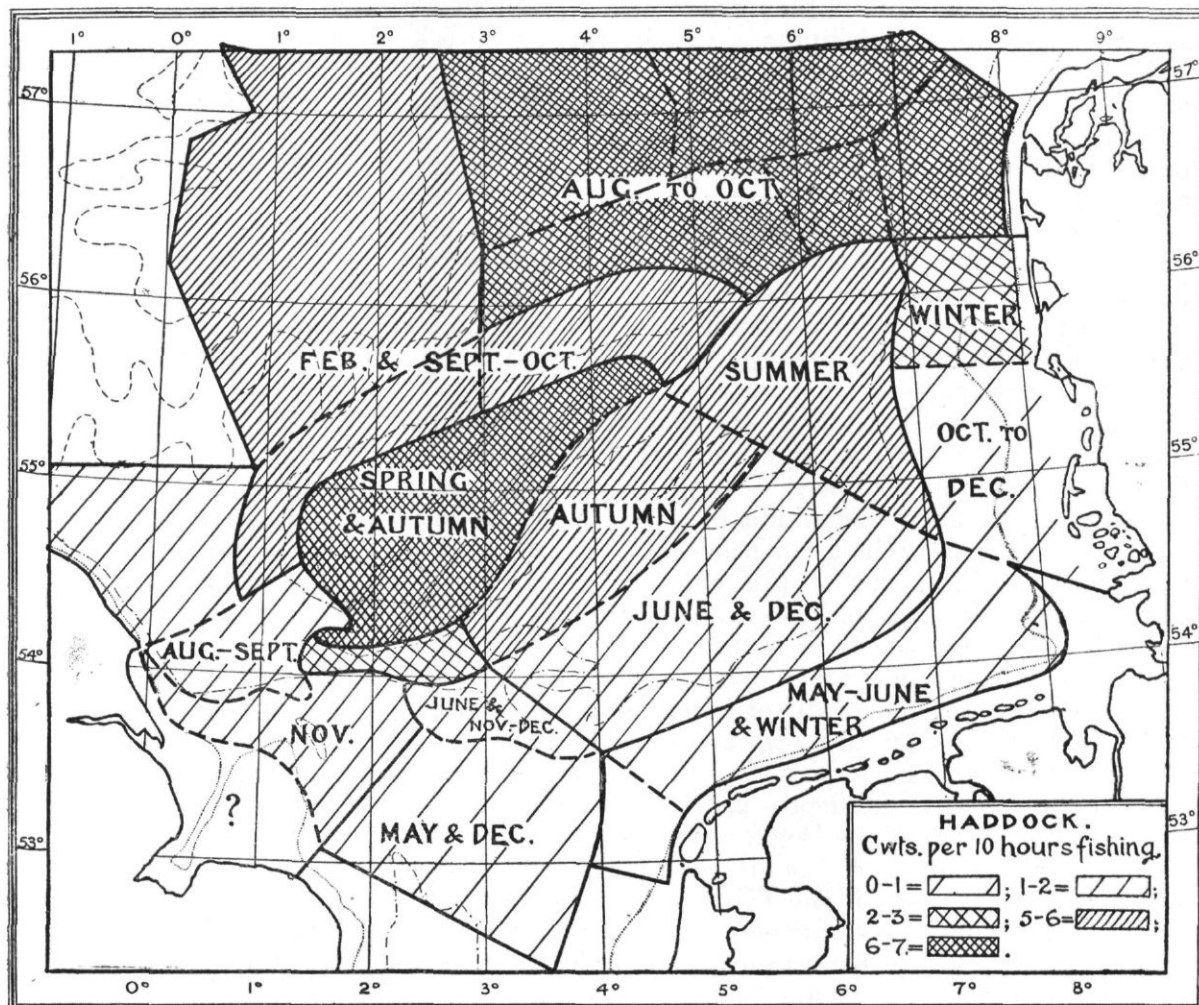


FIG. 93.—Chart showing the distribution of HADDOCK according to the mean monthly average catch in various areas and the periods of maximum abundance in the different regions.

b. Yearly Variations.—We have found for nearly all groups of areas considered a fall in the average total catch throughout the period. The year 1906 is not always significantly less or greater than 1904-5, but it is greater than 1907. The nature of the variations is not the same for the two classes "large" and "small." The large fish fall from 1904 to a minimum in 1906. After this there is, on the whole, a recovery in 1907, but one that still keeps the amounts less than they were in 1904 and 1905. The small fish, however, generally increase between 1904 and 1906 and diminish again in numbers in 1907.

The change in the quantity of "small" is very marked—in nearly every case we find but small quantities of small fish in 1904, while in 1905 the tiny haddocks, of course unmarketable, were thrown overboard in enormous numbers. Toward the end of 1905 they became of a marketable size and helped to swell the amounts of marketable small haddocks, which were so much in evidence at this time and during 1906. This condition, viz., the great number of young haddocks spawned in 1904 and the absence of those spawned two years earlier, has been already noted as remarkable by Helland Hansen.* The Grimsby statistics are therefore strongly confirmatory.

c. Seasonal Fluctuations and Migrations.—The majority of the areas show at least one definite period in the year when the stock of fish is considerably augmented: in some, there are two such periods. On the whole, the fish are most abundant in the last four or five months of the year, and this may be explained in two ways, both of which probably

* HELLAND HANSEN.—Statistical Research in the Biology of the Haddock and Cod in the North Sea, p. 37. Committee A Report. *Loc. cit.*

are responsible for the increase. In the first place, some of the small haddock, which were of an unmarketable size earlier in the year, would in the autumn become just large enough to be caught in the trawl*; secondly, there is a seasonal migration probably between the different areas, and also between this region as a whole and the grounds still further north.

In the northern areas the first maximum occurs about February, and this is undoubtedly a spawning migration, for nearly all the fish that cause the increase are "large" fish and are spawning. It is probable that such is also the case in the north-eastern areas, but the statistics are not complete enough to show it. On the Dogger Bank and in some of the areas to the south and east, we find a spring immigration, culminating in a maximum in May and June, indicating a southerly and coastal migration after the spawning season. A definite offshore migration then takes place, the haddock leaving the southern and south-eastern coastal grounds entirely for a few months in the summer. The catches in the northern and north-eastern areas and the offshore area J are very large in the summer and at the beginning of autumn. An autumn and winter increase is shown on the eastern grounds and southern grounds and it is only at this time of the year (November to December) that these areas show any appreciable numbers of haddocks.

The very large shoals of haddock, which appear on several grounds, such as the Dogger Bank, in the autumn are undoubtedly caused by migration in search of food, chiefly at this time, the spawn of the herring. Haddock have been found in the neighbourhood of the herring shoals, with their stomachs absolutely full of herring spawn.

d. Spawning.—Most of the large haddock and certain of the small were mature. The first observations on their maturity were made in October, but actually spawning fish are seldom seen before January; after this both maturing and spawning haddocks were taken in large numbers, and February and March seem to be the height of the season. The latest records were made early in April.

The spawning fish were found in nearly all areas, but they seem to prefer the central and northern parts, where the water is deeper, to the shallow grounds, and were found there in much greater abundance than in the southern and inshore areas.

G.—WHITING.

Introduction.

The Grimsby fishermen record on their forms the amount of whiting taken in the trawl, and these records have been averaged in the same way as the other species. soon, however, becomes evident that the resulting figures have not got the same value and importance for elucidating the distribution and fluctuations that the corresponding figures for the other species have. In fact, there is evidence that the amounts are not only roughly measured, but that they are inaccurately given so that there can be very few deductions drawn from the resulting averages, since they cannot with any degree of reliability be said to represent the stock of fish in the various areas. For one thing, it is known that large numbers of whiting escape through the net.† Very often they are recorded, merely as "few fish" which may be a very varying quantity. Then again, the fishermen often neglect to record them at all, when we know that they have been caught from the records of the total quantities landed; also, it is possible that many more fish are caught than are sometimes recorded, for a good many are thrown away and only a few of the best kept. This results in a remarkable sameness in the catches of whiting from the different areas and a considerable irregularity in the seasonal fluctuations. There is none of that great difference between east and west or north and south, that was so marked in the case of plaice or haddock, nor are the regular inshore and offshore movements that annually took place in the case of some species so clearly displayed by these figures. All that can be done then is to give the figures for what they are worth, and use great reserve in drawing conclusions from them, pointing out the facts they indicate and leaving it to future and more exact investigations to corroborate them.

* The I Group reaches an average size of 22.5 cm. in October. (Helland Hansen, p. 27.) And Mr. Todd's results from the covered net experiments, show that all haddocks above this size are retained in the nets, while a large percentage of those below it escape.

† TODD.—Covered Net Experiments. These show that the size of the largest fish escaping considerably exceeds that for other species, and in all the hauls examined, nearly one-half the total number of whiting passed through the net.

Conversion of the different Measures into Weight.

Fish of all sizes are measured together. Mr. Olsen gives an average of 220 whiting in a box of 95 lbs. weight, whence one whiting is equal to 0·004 cwt. There are 120 fish to every basket, so that the ratio of the quantity in a basket to that in a box is 0·55. The "Huxley" measurements give similar results. The weight of 24,490 fish measured on board is 3836 kilos., whence 1 fish is equal to 0·003 cwt., a result somewhat lower than that given above, because many very small fish are included in the "Huxley's" catches which would be unmarketable and therefore neglected on a steam trawler. The weight of one basket deduced from that of 44 baskets on the "Huxley" is 0·60 cwt. From the same source we have the number of fish in one basket is 166, whence the average weight of a fish is 0·004 cwt., the value adopted.

The ratio of a basket to a box, obtained from the skippers records, is given in the following table :—

TABLE XXVI. giving the ratio between the total number of boxes of WHITING landed by each skipper in each year, and the number of baskets in the hauls.

| Skipper. | | | | 1904. | 1905. | 1906. | 1907. | 1904-7. |
|----------|-----|-----|-----|-------|-------|-------|-------|---------|
| i | ... | ... | ... | ·77 | ·72 | ·68 | — | ·74 |
| ii | ... | ... | ... | — | ·66 | — | — | ·66 |
| iii | ... | ... | ... | ·59 | ·49 | ·56 | ·61 | ·53 |
| iv | ... | ... | ... | — | ·74 | ·67 | — | ·69 |
| v | ... | ... | ... | ·79 | ·62 | ·62 | ·57 | ·69 |
| vi | ... | ... | ... | ·69 | ·74 | ·66 | ·71 | ·71 |
| vii | ... | ... | ... | ·66 | ·66 | — | — | ·66 |
| viii | ... | ... | ... | ·57 | ·52 | — | — | ·54 |
| All | ... | ... | ... | ·68 | ·59 | ·63 | ·66 | ·63 |

In the case of whiting there is a serious objection to using the ratio ·63 obtained in this way, for there is reason to believe that it is somewhat unreliable as the figures on which it is based are subject to such considerable error. In the first place the number of baskets considered is much less than in the case of cod and haddock, in the second place, the quantities caught and the amounts landed are not always the same thing. Whiting are fish which readily decay, and being relatively unimportant are soon thrown away if not in first class condition. Hence it happens that the amounts landed are sometimes not strictly comparable with the amounts caught. Occasionally, note is made of the fact that the whiting of a saleable size from the first few hauls of a voyage are thrown away. This would result in reducing the *real* ratio of a basket to a box.

On the other hand, there is the real error, which occurs without doubt, namely, of neglecting to record in the individual hauls the catches of whiting, while their presence is known by the record in the summary. Of these errors we cannot gauge the extent, and under such conditions it is better to adopt the value for a basket obtained from the "Huxley" records, viz., 0·60 cwt.

Yearly Total and Average Quantities.

TABLE XXVII.—Showing the Yearly Total Catch of WHITING, in cwts., and the average per 10 hours fishing.

| Year. | | | | | Total Weight. | Average. |
|-----------|-----|-----|-----|-----|---------------|----------|
| 1904 | ... | ... | ... | ... | 647·94 | 0·64 |
| 1905 | ... | ... | ... | ... | 1049·85 | 0·55 |
| 1906 | ... | ... | ... | ... | 376·71 | 0·32 |
| 1907 | ... | ... | ... | ... | 274·98 | 0·33 |
| 1904-1907 | ... | ... | ... | ... | 2349·48 | 0·48 |

It is seen that the catch of whiting is very small, averaging about half a hundred-weight per ten hours fishing. The 1904 average is the highest, and there is a decline to an average one-half the amount for that year in 1906 and 1907. The monthly averages when compared also show a decline on the whole, at least till 1906.

Distribution and Seasonal Fluctuations.

TABLE XXVIII.—Showing for each Area the Monthly Average Catch of WHITING, in cwt., per ten hours fishing.

| Group. | Area. | Year. | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|----------------------|-------|--------|---------------------|---------------------|---------------------|---------------------|----------------------|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|---------------------|
| North Eastern Areas. | A | 1904 | ... | ... | ... | ... | ... | ... | ... | 0.00 ²² | ... | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0.05 ⁴⁴ | ... | ... | ... | ... | ... |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | ... | ... | ... | ... | 0.05 ⁴⁴ | 0.00 ²² | ... | ... | ... | ... |
| | B | 1904 | ... | ... | ... | ... | ... | ... | ... | 0.00 ¹⁸ | 0.54 ⁸⁸ | 0.45 ¹¹⁷ | 0.52 ⁶⁴ | ... |
| | | 1905 | ... | ... | ... | 0.40 ³⁰ | 0.36 ¹² | ... | ... | ... | 0.52 ¹⁶⁰ | 0.45 ²⁰ | 0.00 ⁴ | ... |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.32 ¹¹³ | 0.04 ³⁹ | ... |
| | | 1904-7 | ... | ... | ... | 0.46 ³⁰ | 0.36 ¹² | ... | ... | 0.00 ¹⁸ | 0.53 ²⁴⁸ | 0.39 ²⁵⁰ | 0.32 ¹⁰⁷ | ... |
| | C | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1905 | ... | ... | 0.56 ⁸ | ... | ... | ... | ... | ... | ... | 0.00 ⁴ | ... | 0.00 ⁴ |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | 0.56 ⁸ | ... | ... | ... | ... | ... | ... | 0.00 ⁴ | ... | 0.00 ⁴ |
| | F | 1904 | ... | ... | ... | ... | ... | 0.46 ⁶⁸ | 0.00 ⁸ | 0.00 ⁸ | 0.50 ⁶⁵ | ... | 0.14 ⁶⁴ | 0.04 ¹²⁰ |
| | | 1905 | ... | ... | 0.02 ¹⁷ | ... | ... | ... | 0.12 ³² | 1.27 ³³ | 0.88 ¹⁰⁹ | 0.72 ⁹⁴ | 0.38 ⁸ | 0.38 ⁸ |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | 0.40 ³⁸ | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | 0.02 ¹² | ... | ... | 0.46 ⁶⁸ | 0.16 ⁶⁰ | 0.74 ⁶¹ | 0.74 ¹⁷⁴ | 0.72 ⁹⁴ | 0.16 ⁷² | 0.06 ¹²⁸ |
| | G | 1904 | ... | ... | ... | ... | ... | 0.10 ²⁹ | ... | 0.09 ³² | 0.76 ⁸⁸ | 0.34 ⁴⁴ | 0.00 ⁴ | ... |
| | | 1905 | 0.47 ¹⁰⁸ | 0.26 ⁸ | ... | ... | ... | ... | ... | 0.00 ⁴ | ... | 0.21 ¹⁵ | ... | 0.30 ⁵ |
| | | 1906 | 0.51 ²¹ | 0.40 ⁷⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.31 ⁹⁶ | ... |
| | | 1904-7 | 0.48 ¹²⁹ | 0.39 ⁸⁶ | ... | ... | ... | 0.10 ²⁹ | ... | 0.08 ³⁶ | 0.76 ⁸⁸ | 0.31 ⁵⁹ | 0.30 ¹⁰⁶ | 0.30 ⁵ |
| Eastern Areas. | H | 1904 | ... | ... | ... | ... | 0.46 ⁵² | ... | ... | 0.09 ¹⁶ | 0.00 ¹⁵ | 0.21 ⁷³ | 0.05 ³⁸⁵ | 0.07 ¹⁹¹ |
| | | 1905 | 0.16 ³⁴⁷ | ... | 0.00 ⁹ | 0.00 ¹³⁵ | 0.28 ¹⁷⁰ | ... | 0.00 ¹⁶ | ... | 0.00 ⁴⁰ | 0.17 ⁵⁶³ | 0.05 ²⁵⁷ | 0.32 ⁸⁴ |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.17 ⁷⁰ | ... |
| | | 1904-7 | 0.16 ³⁴⁷ | ... | 0.00 ⁹ | 0.00 ¹³⁵ | 0.32 ²²² | ... | 0.00 ¹⁶ | 0.09 ¹⁶ | 0.00 ⁵⁵ | 0.17 ⁶⁵⁴ | 0.16 ⁷¹² | 0.15 ²⁷⁵ |
| | M | 1904 | ... | ... | ... | ... | 0.02 ⁷⁶ | 0.25 ²⁶² | 0.00 ¹¹⁴ | 0.00 ⁴⁸ | ... | ... | 0.20 ³⁰ | 0.11 ³²⁹ |
| | | 1905 | 0.01 ⁵³ | ... | 0.00 ⁴⁹ | 0.03 ³⁵⁸ | 0.08 ⁸¹⁰ | 0.64 ⁶⁶¹ | ... | ... | 0.00 ⁹¹ | 0.67 ¹³ | 0.20 ²⁸⁴ | 0.28 ⁹¹ |
| | | 1906 | ... | ... | ... | 0.01 ²⁸⁷ | 0.02 ⁴²³ | 0.00 ⁴⁵¹ | 0.00 ²⁸⁶ | 0.00 ⁷⁶ | ... | 0.00 ²⁸ | 0.02 ⁸¹ | 0.45 ²⁰² |
| | | 1907 | ... | ... | ... | 0.00 ¹⁵⁵ | 0.00 ⁴⁴² | 0.02 ³³³ | 0.00 ⁸⁰ | ... | ... | ... | 0.00 ⁷ | 0.71 ¹⁶⁰ |
| | | 1904-7 | 0.01 ⁵³ | ... | 0.00 ⁴⁹ | 0.02 ⁸⁰⁰ | 0.04 ¹⁷³¹ | 0.29 ¹⁷⁰⁷ | 0.06 ⁴⁸⁰ | 0.00 ¹²⁴ | 0.00 ⁶¹ | 0.22 ⁴¹ | 0.16 ⁴⁰² | 0.34 ⁷⁸⁹ |
| | Q | 1904 | ... | ... | ... | ... | 0.67 ⁴ | 0.44 ⁴⁸ | 1.02 ¹¹² | 1.25 ⁴⁸ | 0.10 ¹¹⁵ | 0.00 ⁸ | ... | ... |
| | | 1905 | ... | ... | 1.51 ³²² | 0.64 ⁹⁹ | 0.11 ¹⁴⁰ | 0.29 ²⁰ | 0.00 ⁷³ | 0.00 ²⁹⁰ | 0.00 ⁹⁴ | ... | 0.18 ⁸ | 0.00 ⁹ |
| | | 1906 | ... | ... | 0.14 ⁴³ | ... | 0.11 ⁶⁷ | 0.10 ¹⁰⁶ | 0.00 ⁸ | 0.00 ³⁵ | ... | 0.00 ³⁵ | ... | ... |
| | | 1907 | ... | 0.00 ¹⁵ | 0.00 ¹¹⁸ | 1.59 ⁵⁷ | 0.77 ¹⁸⁴ | 0.15 ⁴⁰ | 0.00 ⁴⁷ | 0.01 ¹¹³ | 0.00 ¹²⁰ | 0.05 ²⁸ | 0.00 ⁷ | ... |
| | | 1904-7 | ... | 0.00 ¹⁵ | 1.02 ⁴⁵³ | 0.99 ¹⁵⁶ | 0.42 ³⁹⁵ | 0.20 ²¹⁴ | 0.47 ²⁴⁰ | 0.13 ⁴⁸⁶ | 0.04 ²⁶⁹ | 0.02 ⁷¹ | 0.10 ¹⁵ | 0.00 ⁹ |
| | W | 1904 | ... | ... | ... | ... | ... | 0.07 ⁶¹ | 0.75 ¹² | ... | 0.00 ⁴ | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | 0.00 ⁶ | ... | ... | ... | ... | ... | ... | ... |
| | | 1906 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 ¹² | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | 0.00 ¹⁶ | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | ... | ... | 0.00 ⁶ | 0.07 ⁶¹ | 0.32 ²⁸ | ... | 0.00 ⁴ | 0.00 ¹² | ... | ... |
| Central Areas. | J | 1904 | ... | ... | ... | ... | 0.33 ⁹ | ... | ... | 0.72 ⁷⁵ | 0.70 ²⁰⁵ | ... | 0.33 ⁷⁷ | 1.25 ⁴⁰¹ |
| | | 1905 | 0.97 ¹⁰⁵ | ... | ... | ... | 0.38 ²⁰ | ... | ... | ... | 1.53 ⁹⁵ | 0.21 ⁷⁸ | 0.21 ⁶⁴ | 0.73 ⁸⁸ |
| | | 1906 | 0.49 ²⁸ | 0.75 ³⁰ | ... | ... | 0.25 ⁷⁷ | ... | ... | 0.36 ⁹² | 0.38 ⁹⁰ | 0.00 ²⁸⁴ | 0.01 ¹³⁰ | 0.00 ³⁸ |
| | | 1907 | ... | ... | 0.02 ⁶⁷ | 0.41 ⁶⁸ | ... | ... | ... | ... | ... | ... | 0.00 ¹⁶ | ... |
| | | 1904-7 | 0.87 ¹³³ | 0.75 ³⁰ | 0.02 ⁶⁷ | 0.41 ⁶⁸ | 0.28 ¹⁰⁶ | ... | ... | 0.52 ¹⁶⁷ | 0.83 ³⁹⁰ | 0.05 ³⁶² | 0.14 ²⁸⁷ | 1.07 ⁵²⁷ |
| | N | 1904 | ... | ... | ... | ... | 0.64 ²⁸ | 0.78 ⁴⁰ | 1.95 ²⁰⁵ | 1.30 ¹⁰⁹ | 1.13 ⁹⁸ | 0.41 ¹⁴⁴ | 1.45 ¹⁸² | 0.64 ¹³⁶ |
| | | 1905 | 0.35 ⁸ | 0.23 ⁴⁰ | 1.48 ⁵² | 0.68 ⁶⁰ | 0.56 ⁵⁹ | 0.99 ¹³⁹ | 1.23 ⁷⁶ | 1.58 ²⁷² | 0.01 ²⁷⁴ | ... | 0.47 ²¹⁹ | 0.90 ⁴¹² |
| | | 1906 | 0.41 ⁴²¹ | 0.07 ³¹⁰ | 1.32 ²⁸³ | 0.67 ¹⁴ | 0.22 ⁹⁰ | 0.11 ⁸³ | 0.58 ⁷⁶ | 0.34 ¹⁹⁷ | 0.38 ⁵¹ | 0.11 ¹⁰⁸ | 0.01 ²⁰¹ | 0.36 ⁷⁴ |
| | | 1907 | 0.77 ³⁰⁶ | 0.27 ¹²⁵ | 0.20 ²²⁸ | 0.83 ¹³² | 0.96 ⁷⁴ | 0.34 ⁷¹ | 0.11 ¹¹⁸ | 0.03 ⁴⁵ | 0.05 ²³⁵ | 0.22 ²⁹⁹ | 0.12 ³⁵⁴ | 0.12 ⁹⁶ |
| | | 1904-7 | 0.56 ⁷³⁵ | 0.13 ⁴⁷⁵ | 0.88 ⁵⁶³ | 0.77 ²⁰⁶ | 0.56 ²⁵¹ | 0.61 ³³³ | 1.17 ⁴⁷⁵ | 1.03 ⁶²³ | 0.22 ⁶⁵⁸ | 0.25 ⁵⁵¹ | 0.43 ⁹⁵⁶ | 0.69 ⁷¹⁸ |
| | I | 1904 | ... | ... | ... | ... | ... | 0.83 ¹⁰¹ | 0.00 ¹⁸ | 0.65 ³¹⁹ | 0.66 ²²⁵ | 1.18 ²¹⁸ | 0.71 ¹⁹⁰ | 1.13 ³⁵⁹ |
| | | 1905 | 0.83 ⁸⁷ | 0.21 ¹⁷ | ... | ... | ... | 1.30 ⁵² | 1.05 ¹²¹ | 1.03 ²⁶³ | 0.85 ⁶⁵² | ... | 0.57 ¹³⁹ | 0.88 ⁴⁷ |
| | | 1906 | 0.81 ⁷⁹ | ... | ... | ... | ... | ... | 0.36 ⁷⁴ | ... | 0.34 ⁸¹ | 0.13 ¹¹ | 0.00 ⁶⁵ | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | 0.36 ¹⁶⁰ | 0.53 ⁷¹ | 0.44 ²⁷ | ... |
| | | 1904-7 | 0.82 ¹⁶⁶ | 0.21 ¹⁷ | ... | ... | ... | 0.99 ¹⁵³ | 0.72 ²¹³ | 0.82 ⁵⁵² | 0.72 ¹⁰⁶⁸ | 0.98 ³⁰⁰ | 0.54 ⁴²¹ | 1.10 ⁴⁰⁶ |
| | O | 1904 | ... | ... | ... | ... | 0.15 ¹⁰ | 0.48 ¹⁰⁰ | 0.60 ¹⁴⁹ | 0.74 ²⁵⁴ | 0.80 ²¹⁶ | 1.33 ³⁵⁶ | 0.68 ²⁷⁸ | 0.68 ⁹⁷ |
| | | 1905 | 0.14 ¹⁰⁰ | 0.04 ⁵⁶ | 0.31 ¹³⁰ | 0.45 ⁶¹³ | 1.11 ³⁹⁵ | 0.52 ¹²¹ | 1.08 ²⁵⁵ | 1.27 ⁹⁹ | ... | 0.61 ³²⁷ | 0.57 ¹⁷⁵ | 0.50 ⁵³⁸ |
| | | 1906 | ... | 0.57 ¹¹ | 0.00 ⁹ | 0.33 ¹⁴ | 0.30 ¹⁰ | ... | ... | ... | 0.43 ⁴ | 0.33 ¹⁴ | 0.38 ⁴ | ... |
| | | 1907 | 0.15 ²⁸¹ | ... | 0.19 ⁸⁰ | ... | ... | ... | ... | ... | ... | ... | 0.80 ⁶⁸ | ... |
| | | 1904-7 | 0.15 ³⁸¹ | 0.13 ⁶⁷ | 0.26 ²³⁹ | 0.44 ⁶²⁷ | 1.07 ⁴¹⁵ | 0.50 ²²¹ | 0.90 ⁴⁰⁴ | 0.89 ³⁵³ | 0.79 ²²⁰ | 0.97 ⁶⁹⁷ | 0.66 ⁵²⁵ | 0.53 ⁴³⁵ |

| Group. | Area. | Year. | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|-----------------|-------|--------|---------------------|----------------------|---------------------|---------------------|---------------------|---------------------|----------------------|----------------------|---------------------|---------------------|---------------------|---------------------|
| Northern Areas. | D | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.56 ³⁷ | ... |
| | | 1905 | 0.25 ⁶¹ | 1.00 ⁷⁶⁰ | 0.99 ⁶⁴⁷ | 0.37 ²⁴ | ... | ... | ... | ... | ... | ... | ... | 0.78 ⁶⁹ |
| | | 1906 | ... | 0.21 ⁸⁵ | 0.17 ²⁵⁷ | ... | ... | ... | ... | 0.48 ¹³¹ | 0.25 ²⁴ | ... | ... | ... |
| | | 1907 | ... | ... | 0.11 ²⁸ | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | 0.25 ⁶¹ | 0.92 ⁸⁴⁵ | 0.74 ⁹³² | 0.37 ²⁴ | ... | ... | ... | 0.48 ¹³¹ | 0.25 ²⁴ | ... | 0.56 ³⁷ | 0.78 ⁶⁹ |
| | K | 1904 | ... | ... | ... | ... | 0.00 ⁴ | 0.31 ³⁵ | ... | 0.43 ⁷ | 0.79 ⁴³ | 0.62 ⁹⁵ | 0.35 ²¹ | ... |
| | | 1905 | 0.38 ²¹¹ | 0.36 ²³⁹ | 0.18 ²⁹ | ... | ... | ... | ... | 0.00 ⁴ | 0.49 ⁷¹ | 0.75 ⁴ | ... | ... |
| | | 1906 | 0.34 ³¹ | 0.56 ²⁴ | 0.14 ⁴⁴ | ... | ... | ... | ... | ... | 0.22 ²¹ | ... | ... | ... |
| | | 1907 | 0.11 ⁵⁵ | 0.08 ²³² | 0.29 ²³⁵ | ... | ... | ... | ... | ... | ... | 0.41 ¹¹ | 0.19 ⁸ | ... |
| | | 1904-7 | 0.33 ²⁹⁷ | 0.24 ⁴⁹⁵ | 0.26 ³⁰⁸ | ... | 0.00 ⁴ | 0.31 ³⁵ | ... | 0.27 ¹¹ | 0.54 ¹³⁵ | 0.60 ¹¹⁰ | 0.31 ²⁹ | ... |
| | L | 1904 | ... | ... | ... | ... | ... | 0.35 ²¹ | 0.50 ⁶ | 0.41 ⁵⁴ | 0.47 ¹⁹⁵ | 0.78 ⁶³ | 0.35 ⁸ | ... |
| | | 1905 | 0.30 ⁸⁴ | 0.26 ⁶²⁵ | 0.24 ¹⁹² | 0.42 ¹¹¹ | 0.46 ³⁰ | 0.21 ⁷ | 0.46 ⁷⁹ | 0.25 ¹⁸ | 0.63 ⁸¹ | ... | ... | 0.62 ³⁶ |
| | | 1906 | 0.30 ¹³² | 0.11 ²⁴⁷ | ... | ... | 0.11 ¹⁹⁹ | 0.38 ¹⁰⁸ | 0.43 ⁹⁷ | 0.50 ¹⁰¹ | 0.47 ³⁰⁸ | 0.41 ¹³⁶ | ... | ... |
| | | 1907 | ... | ... | 0.03 ⁶⁰ | ... | ... | ... | ... | ... | ... | 0.35 ¹³ | ... | ... |
| | | 1904-7 | 0.30 ²¹⁶ | 0.22 ⁸⁷² | 0.19 ²⁵² | 0.42 ¹¹¹ | 0.16 ²²⁹ | 0.36 ¹³⁶ | 0.45 ¹⁵² | 0.44 ²⁰³ | 0.48 ⁵⁵⁴ | 0.52 ²¹² | 0.35 ⁸ | 0.62 ³⁶ |
| Southern Areas. | S | 1904 | ... | ... | ... | ... | ... | 0.40 ²¹⁶ | 0.00 ³⁴⁵ | 0.03 ⁴⁵⁴ | 0.60 ¹⁰⁰ | 1.25 ¹⁰³ | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | ... | 0.05 ⁶¹⁷ | 0.10 ⁷⁴⁹ | 0.63 ⁴⁵ | 0.38 ⁴ | 0.88 ⁸ | 0.78 ¹³ |
| | | 1906 | ... | 0.00 ⁵ | 0.58 ⁹² | 0.33 ²² | 0.40 ⁷ | 0.27 ⁵⁵ | 0.07 ⁸³ | 0.16 ¹⁰⁶ | 0.22 ²²⁰ | 0.03 ⁵⁶ | ... | ... |
| | | 1907 | ... | ... | ... | ... | 0.28 ⁴⁶¹ | 0.31 ³⁴⁸ | 0.04 ²⁷¹ | ... | ... | ... | 0.47 ¹⁶ | ... |
| | | 1904-7 | ... | [0.00 ⁵] | 0.58 ⁹² | 0.33 ²² | 0.28 ⁴⁶⁸ | 0.34 ⁶¹⁹ | 0.04 ¹³¹⁶ | 0.08 ¹³⁰⁹ | 0.37 ³⁶⁵ | 0.81 ¹⁶³ | 0.61 ²⁴ | 0.78 ¹³ |
| | T | 1904 | ... | ... | ... | ... | 0.12 ¹³ | 0.94 ²⁴ | 2.40 ¹⁰ | 5.25 ⁵ | 0.00 ⁸ | ... | 1.07 ²² | ... |
| | | 1905 | ... | ... | ... | ... | 0.78 ⁵⁵ | ... | 0.28 ⁴⁸ | 0.00 ⁷⁹ | 0.42 ¹⁰⁰ | 0.47 ¹⁷⁷ | 0.80 ³⁴³ | 0.94 ³⁴⁰ |
| | | 1906 | ... | 1.19 ⁹⁶ | 0.95 ⁵² | 0.40 ¹¹² | 0.40 ⁵³ | 0.36 ⁹⁷ | 0.36 ¹⁸¹ | 0.30 ⁹⁰ | 0.52 ⁵³ | 0.35 ²²⁵ | 0.71 ²⁷ | ... |
| | | 1907 | ... | ... | ... | 1.25 ³⁹ | 0.84 ²⁵ | 0.41 ¹⁴³ | 0.51 ⁹¹ | ... | 0.90 ²⁰ | 1.15 ⁸⁴ | 0.58 ²¹² | 0.38 ¹² |
| | | 1904-7 | ... | 1.19 ⁹⁶ | 0.95 ⁵² | 0.62 ¹⁵¹ | 0.59 ¹⁴⁶ | 0.44 ²⁶⁴ | 0.45 ³³⁰ | 0.39 ¹⁷⁷ | 0.49 ²¹¹ | 0.53 ⁴⁸⁶ | 0.73 ⁶⁰⁴ | 0.92 ³⁵² |
| | V | 1904 | ... | ... | ... | ... | ... | ... | 1.23 ¹³¹ | 0.73 ⁵⁶ | 2.11 ⁴⁵ | ... | 1.11 ¹³ | ... |
| | | 1905 | ... | ... | 1.50 ²⁵ | ... | ... | ... | 1.89 ¹⁰⁸ | 3.13 ²⁹ | ... | 2.68 ²⁸ | ... | ... |
| | | 1906 | 2.94 ⁵⁹ | 0.67 ⁴ | 0.54 ⁸⁰ | 0.10 ³⁸ | ... | 0.25 ¹² | 2.09 ⁵³ | 1.08 ⁴⁹ | 1.00 ⁴⁷ | 0.45 ¹⁶ | 0.52 ¹² | ... |
| | | 1907 | ... | ... | ... | ... | 0.33 ⁴ | 0.56 ⁸ | 1.16 ³⁵ | ... | ... | 2.01 ⁹⁴ | 0.64 ²⁸ | 1.11 ⁴⁸ |
| | | 1904-7 | 2.94 ⁵⁹ | 0.67 ⁴ | 0.77 ¹⁰⁵ | 0.10 ³⁸ | 0.33 ⁴ | 0.38 ²⁰ | 1.55 ³⁴⁷ | 1.25 ¹⁶⁴ | 1.25 ⁹² | 1.96 ¹³⁸ | 0.74 ⁵³ | 1.11 ⁴⁸ |
| Western Areas. | E | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1906 | 0.00 ⁸ | ... | 0.00 ⁷ | ... | ... | 0.52 ¹⁸ | 0.52 ¹¹ | ... | ... | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | 0.00 ⁸ | ... | 0.00 ⁷ | ... | ... | 0.52 ¹⁸ | 0.52 ¹¹ | ... | ... | ... | ... | ... |
| | R | 1904 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.50 ⁹ | 0.33 ⁴ |
| | | 1905 | ... | ... | 0.00 ¹⁴ | ... | 1.25 ⁷⁶ | ... | ... | ... | 0.52 ¹⁸ | ... | 0.88 ¹⁶⁵ | 0.98 ²¹² |
| | | 1906 | 0.01 ¹³⁹ | 0.00 ²³⁶ | 0.04 ²⁵⁰ | 0.14 ²⁶⁶ | 0.40 ¹⁷⁶ | 0.75 ²³⁸ | 0.89 ²²² | 0.98 ¹¹³ | 0.40 ⁷ | 0.21 ¹⁴ | ... | ... |
| | | 1907 | ... | ... | 0.69 ⁶ | 0.45 ²³ | 0.38 ³² | 0.75 ⁴ | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | 0.01 ¹³⁹ | 0.00 ²³⁶ | 0.03 ²⁹⁴ | 0.15 ²⁷² | 0.64 ²⁷⁵ | 0.71 ²⁷⁰ | 0.88 ²²⁶ | 0.98 ¹¹³ | 0.48 ²⁵ | 0.21 ¹⁴ | 0.86 ¹⁷⁷ | 0.97 ²¹⁶ |
| | X | 1904 | ... | ... | ... | ... | ... | ... | 0.39 ¹⁰⁹ | 1.93 ⁶⁰ | 1.03 ³⁰ | ... | 1.21 ³³ | 0.34 ¹⁷ |
| | | 1905 | 0.13 ⁴ | 0.50 ³ | 0.23 ⁵³ | 0.38 ¹² | ... | ... | ... | ... | 0.44 ³¹ | 0.57 ¹⁰⁷ | 0.10 ¹⁵ | 0.38 ⁴⁴ |
| | | 1906 | ... | 0.17 ⁹ | 0.23 ⁶⁰ | 0.07 ⁷⁷ | 0.20 ⁵² | 0.44 ¹⁵⁶ | 0.33 ¹¹² | 0.47 ⁹³ | 0.61 ⁶⁴ | 0.38 ²⁰ | 0.38 ¹⁶ | ... |
| | | 1907 | ... | ... | ... | ... | 0.38 ⁵² | 0.38 ⁸ | 0.53 ⁹⁶ | ... | ... | 0.49 ¹⁸³ | 0.43 ²⁸ | 0.43 ²⁵ |
| | | 1904-7 | [0.13] ⁴ | [0.25] ¹² | 0.25 ¹¹³ | 0.11 ⁸⁹ | 0.29 ¹⁰⁴ | 0.44 ¹⁶⁴ | 0.41 ³¹⁷ | 1.05 ¹⁵³ | 0.67 ¹²⁵ | 0.51 ³¹⁰ | 0.65 ⁹² | 0.38 ⁵⁶ |
| | P | 1904 | ... | ... | ... | ... | ... | ... | 0.70 ²¹³ | ... | 0.75 ⁸ | ... | ... | ... |
| | | 1905 | ... | ... | ... | ... | ... | ... | 1.03 ¹⁶ | ... | ... | ... | ... | ... |
| | | 1906 | ... | ... | 0.00 ⁴ | 0.00 ⁴ | ... | ... | ... | ... | 0.38 ²⁴ | ... | ... | ... |
| | | 1907 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | 1904-7 | ... | ... | 0.00 ⁴ | 0.00 ⁴ | ... | ... | 0.73 ²²⁹ | ... | 0.47 ³² | ... | ... | ... |

Table XXVIII. gives the monthly averages of the recorded catches of whiting, but we know from the reasons given above, that they cannot be very exact. The curves drawn from these figures are of a very irregularly fluctuating character, and very few are reproduced in the text. The chief facts indicated by the figures for the groups of areas are as follows.

North Eastern Areas.—These have general monthly averages which vary between 0.0 and 0.76 cwt., with a mean value of about 0.3 cwt. There is probably a summer and early autumn maximum in Area F.

Eastern Areas.—The amounts in the Horn Reef, Sylt and Amrum grounds are very small, smaller than in any other areas, the averages very often being zero, and having mean monthly values of about 0.1 cwt. for both H and M. Maximum values occur about June and December. (See Fig. 94).

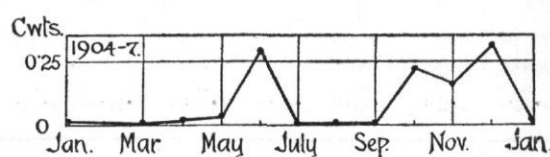


FIG. 94.—WHITING. Area M. Monthly averages, 1904-1907.

In Area Q, much larger numbers were taken. They averaged 1.51 cwt. in March, 1905, and amongst them were many "full of roes." In 1904 they were comparatively abundant in the summer; in the other years there was a spring maximum, and no fish at all in the summer.

The *Central Areas* show somewhat larger averages, the mean values varying between 0.5 cwt. in area J and 0.8 cwt. in area I. Areas N and O both have mean values of 0.6 cwt. and the maximum monthly value is about 1.1 cwt. in all.

There is some evidence for a summer maximum in area J, about August and September, but on the whole the seasonal fluctuations are not very constant in their occurrence. This is clearly shown in the curves representing the fluctuations in area N (Figs. 95 and 96).

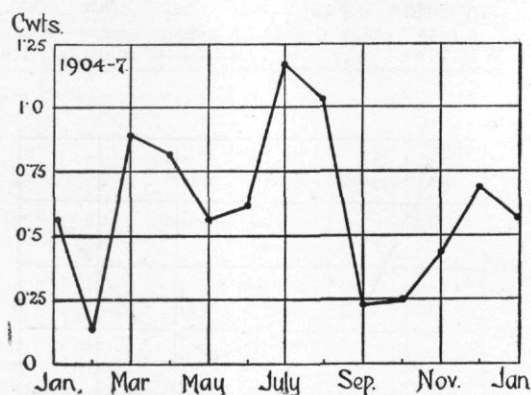


FIG. 95. WHITING. Area N. Monthly averages, 1904-1907.

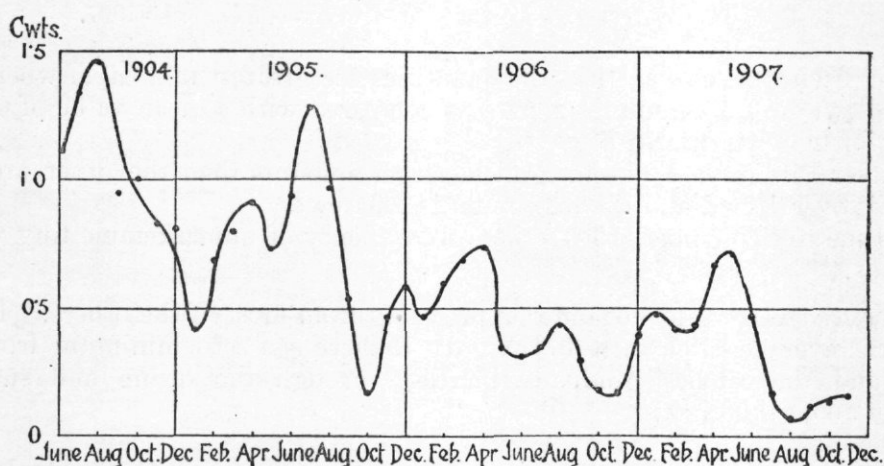


FIG. 96. WHITING. Area N. Monthly averages (smoothed curves).

In Fig. 96 there is a big summer maximum in 1904 and 1905, a very small one in 1906, and a minimum at that time in 1907. Apparently there is also a second maximum in the early spring. Although the seasonal fluctuations are not well brought out, the curve shows plainly the big continuous drop in the catches between 1904 and 1907. This decline is also shown in a greater or less degree in the other areas.

In October, 1904, there were large numbers of whiting congregated on the Dogger Bank and south-east of it, and from other sources we learn that they were feeding on the herring spawn.* In the spring and summer of 1905 large quantities of tiny unmarketable whiting were present on the Dogger Bank.

The Northern Areas.—In area D we have a maximum in February and March, amounting to 1 cwt. in 1905, and this occurs at the spawning season. In the following year the averages are much lower. In K and L the mean monthly average is between 0.3 cwt. and 0.4 cwt., and at their best these areas seldom exceed a yield of 0.6 cwt. or 0.7 cwt.

* Huxley Records. Voyage 41. Station 19.

The Southern Areas.—The curves for area S (Fig. 97) and area T (Fig. 98) give definite indications of a summer minimum and an autumn or winter maximum.

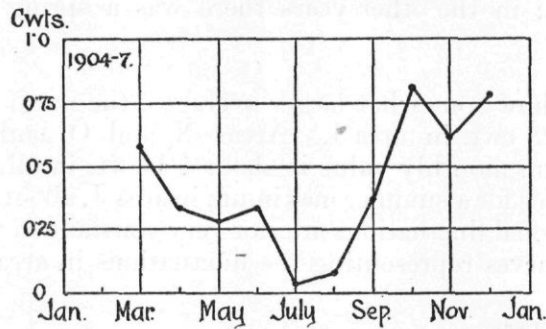


FIG. 97.—WHITING. Area S. Monthly averages, 1904-1907.

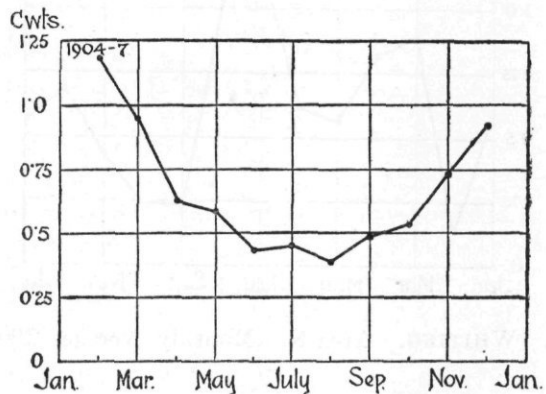


FIG. 98.—WHITING. Area T. Monthly averages, 1904-1907.

We see from the curves that the quantities are greatest in area T, where the mean value is 0.66 cwt. and maximum 1.2 cwt., as compared with a mean value of 0.4 cwt. and a maximum of 0.8 cwt. in area S.

The Silver Pits (area V) seem to yield larger amounts than the other areas, for the mean value is over 1 cwt. and the maximum is 2.94 cwt.

From June to September, 1904, there were plenty of unmarketable tiny whittings on these grounds.

The Western Areas do not differ appreciably from most of the others. From 0.4 to 0.5 cwt. is the average catch in R and X. In R there is a zero minimum from January to March, and the catches gradually increase through the spring and summer to a maximum of about 0.98 cwt.

In the whole region we find the mean values ranging from 0.1 cwt. to 1.0 cwt., and being most often from 0.3 to 0.5 cwt., so that the yield does not vary very much in the different parts of the region, according to these figures, which however cannot be taken to represent the actual population at all closely.

Spawning.

The spawning records of the whiting are by no means satisfactory, and the table appended, Table XXIX., can hardly be considered to give a very true picture of the distribution and comparative abundance of the spawning members of this species. We suffer from a great lack of observation, especially at the end of the spawning season, which, in the case of whiting, is somewhat prolonged. There is reason for this failure on the part of the skippers to note carefully the occurrences of spawning fish. On the one hand, the whiting are not taken in anything like the numbers which are obtained for cod and haddock so the spawning individuals are more likely to be overlooked. As a species, they are not so valuable as some of the other food fishes, and much less attention is paid to them, so that, not only are the spawning fish not always recorded, but the fish themselves are often omitted in the records. Furthermore, since the fish are so easily perishable, it often happens that only a small part of the catch is retained for market, the remainder being shovelled overboard perhaps before their maturity has been noticed. Also it is quite possible that many of the fish, even of the larger mature sizes, escape through the net.

TABLE XXIX.—Showing the number of hauls in each area in which maturing or spawning WHITING are recorded.

| Areas. | D. | F. | G. | H. | I. | J. | K. | L. | M. | N. | O. | Q. | R. | S. | T. | V. | X. |
|------------------|------------------|---------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|-----------------|-------------------|----|---------------|-----------------|-----------------|-----------------|----------------|
| November 1904 | — | — | — | — | * | — | — | — | — | * | $\frac{6}{23}$ | — | * | — | * | * | $\frac{5}{5}$ |
| December... " | — | — | — | $\frac{4}{5}$ | $\frac{49}{53}$ | — | — | — | $\frac{6}{28}$ | — | $\frac{13}{25}$ | — | — | — | — | — | — |
| January ... 1905 | — | — | $\frac{3}{3}$ | $\frac{31}{38}$ | $\frac{5}{5}$ | $\frac{4}{4}$ | $\frac{26}{27}$ | $\frac{3}{9}$ | — | — | $\frac{3}{18}$ | — | — | — | — | — | — |
| February ... " | $\frac{82}{86}$ | — | — | — | — | — | $\frac{29}{34}$ | $\frac{27}{37}$ | — | — | $\frac{1}{1}$ | — | — | — | — | — | — |
| March ... " | $\frac{13}{114}$ | — | — | — | — | — | — | $\frac{24}{26}$ | — | — | $\frac{16}{33}$ | * | — | — | — | $\frac{8}{8}$ | $\frac{3}{13}$ |
| April ... " | — | — | — | — | — | — | — | $\frac{6}{6}$ | — | — | $\frac{9}{158}$ | — | — | — | — | — | $\frac{3}{3}$ |
| May ... " | — | — | — | — | — | — | — | — | — | — | $\frac{116}{118}$ | — | — | — | — | — | — |
| June ... " | — | — | — | — | — | — | — | — | — | — | $\frac{33}{34}$ | — | — | — | — | — | — |
| November 1905 | — | $\frac{1}{2}$ | — | $\frac{1}{1}$ | — | — | — | — | $\frac{9}{11}$ | — | — | — | — | — | — | — | — |
| December... " | $\frac{12}{13}$ | $\frac{2}{2}$ | — | — | $\frac{1}{5}$ | $\frac{11}{14}$ | — | $\frac{5}{7}$ | — | $\frac{1}{2}$ | $\frac{96}{119}$ | — | — | — | — | — | $\frac{7}{8}$ |
| January ... 1906 | — | — | $\frac{4}{4}$ | — | — | $\frac{4}{4}$ | $\frac{5}{6}$ | $\frac{26}{33}$ | — | — | — | — | — | — | — | — | — |
| February ... " | $\frac{11}{23}$ | — | $\frac{10}{15}$ | — | — | — | $\frac{5}{5}$ | $\frac{8}{83}$ | — | $\frac{1}{1}$ | $\frac{2}{2}$ | — | — | — | $\frac{19}{22}$ | $\frac{1}{1}$ | — |
| March ... " | $\frac{15}{65}$ | — | — | — | — | — | — | — | — | * | — | * | $\frac{5}{6}$ | $\frac{17}{20}$ | $\frac{10}{12}$ | $\frac{12}{14}$ | $\frac{6}{13}$ |
| January ... 1907 | — | — | — | — | — | — | — | — | — | $\frac{47}{74}$ | — | — | — | — | — | — | — |
| February ... " | — | — | — | — | — | — | — | — | — | $\frac{7}{31}$ | — | — | — | — | — | — | — |

* indicates the presence of maturing or spawning whiting in hauls, the number of which is not specified.

The numerator of the fractions gives the number of hauls in which spawning whiting occur, and the denominator is the total number of hauls made by the men who record spawning whiting.

The earliest records occur in November (1904) when a few "spawning" whiting are found on the Dogger Bank and the area south-west of it. But these, and the records of "spawning" fish in December in these and other areas, are given by only one man, while the other skippers fishing in the same areas, either fail to notice them altogether, or describe them only as "developing spawn." It is probable then that this man also means "maturing" rather than "spawning."

Spawning whiting are noticed in January, February and March of 1905 by one or two skippers in all the areas they fished in. These were mainly the northern areas, the Dogger Bank and Horn Reef, and in March in the Silver Pits and Flamborough Off grounds. In nearly all these cases with the exception of those in area D, the spawning fish are described as "few." Fish in area Q, which are fairly numerous, were recorded as "full of roes" in March.

Throughout April, May and June, a skipper, fishing on the Dogger Bank, records a few "small" whiting spawning in nearly every haul (some are "large"), and the records cease at the end of June.

In the next season, whiting "with spawn" were taken on the eastern areas as early as November (1905). In December the same skipper describes them as "spawn forming" in the northern, north-eastern and central areas and in area X. A few whiting on the Dogger were "spawning" according to two other skippers. In January they were either "spawning" or "with spawn in." In February and March, most of the whiting from the central, southern and western areas were spawning. Those from areas N and Q were "all very full of spawn and very ripe" from the first to the third week in March.

The spawning of the whiting during the next season (1906-1907) is still more incompletely recorded, a few isolated cases in January and February being the only ones given.

These scanty observations cannot yield many definite results of themselves, but if we compare them with the facts obtained from other sources, we find in them a corroborative value.

It is evident that the spawning begins in January or, at the earliest, in December and continues steadily till March and April, while some are still spawning in June.

Moreover, they are found spawning in all the areas of this region, and, unlike haddock, even in the more shallow southern areas Q and R and S in appreciable quantities.

Summary.—Whiting.

Whiting are found to be very generally distributed over the whole of the central part of the North Sea. The quantities taken are small, being generally under one cwt. per ten hours fishing. They are fairly evenly distributed, although perhaps the central and southern grounds show a slightly greater yield than the northern and eastern.

There is a decline in the average catch between 1904 and 1906, 1907 remaining about the same as 1906.

The seasonal fluctuations are not very regularly marked.

The southern areas and some of the eastern grounds have a summer minimum and an autumn or winter maximum. An annual migration to the coastal grounds takes place in the autumn and winter.

III.—GENERAL SUMMARY.

In the preceding report, I have discussed in detail the distribution and fluctuations of seven of the most important food fishes found in the North Sea, in so far as these are indicated by the records of the vessels examined. These include plaice, soles, turbot, and brill among flat fishes, and cod, haddock and whiting among round fishes. In this summary I propose to compare these species among themselves and to set down shortly and on very general lines the phenomena observed.

a. Distribution.—With regard to the distribution, a glance at the charts showing the mean monthly averages for each species is sufficient to make evident the complementary nature of the abundance of the round fish and the flat fish within this region.

Whereas cod and haddock show a northerly distribution with ever increasing quantities towards the north and almost total absence in the southern region, more especially of haddock, the reverse is the case in regard to flat fish. Here we find that plaice are very scarce in the northern and western regions while soles are almost limited to the part south of a line drawn south of the Dogger Bank from Horn Reef North.

All the flat fish show their greatest abundance in the coastal grounds and are especially numerous in Sylt, Amrum and Terschelling grounds. Turbot and brill show much the same distribution, viz., their greatest abundance in the eastern and south-eastern grounds and a rapid diminution in the numbers as we proceed off-shore in a north-westerly direction.

The grounds off the English coasts are not investigated thoroughly by these records, but there are indications that the catches of flat fishes (with the exception of soles) are never so large as on the eastern side of the North Sea. This great density of flat fishes is made up largely by the small and very small fish of the species. On the other hand, cod and haddock, which are far from being numerous south of Horn Reef North and are found but rarely along the German coasts, show a preponderating amount of large fish in these grounds. It is on the western side that the small fish are relatively numerous for these two species. "Small" fish form 60·5 per cent. of the total catch of plaice (weight), and with "medium" 90·5 per cent. for plaice and 82 per cent. of the soles (by number). Of the turbot, "small" are 68 per cent. by number, and of cod they are 43 per cent., and of haddock, 29·5 per cent. by weight.

This difference in distribution can be understood when we consider the relation of this region to the spawning places. The main spawning region for soles is along these same German and Danish coastal grounds while plaice spawn to some extent further off in the deeper water and in a far greater degree yet further south in the Flemish Bight. The pelagic eggs of these species which are carried by the surface currents in an easterly direction must of necessity develop in the shallow waters off the continental coasts. There are spawning places for soles on the English coasts and there the young fish are also abundant. Cod also spawn in the southern part of the North Sea, but not to nearly such a great extent as in the grounds north of the Dogger, while spawning haddock are very rarely found in the southern region, so that there are naturally no eggs of this species to be carried by the current which runs north and east along the European coast. Although cod and haddock have been found spawning in most of the areas investigated, it is shown that the greatest number of spawning individuals are found in the northerly regions, and it is a probable conclusion that great numbers of the eggs are carried southwards by the surface currents coming from the north down the east coast of Britain, and ultimately develop into the "small fish" found on the western grounds.

Although the same general distribution has been observed for most of the flat fishes examined, yet we find a few differences that are worthy of mention. The chief is that the rate of diminution in the amounts of plaice and soles in the successive areas from the coasts offshore, is very great, while the rate for turbot and brill is much less rapid, not only because the initial greatest density is not so great, but also for the reason that they are more scattered over the whole area. In comparing turbot and soles, it is found that the latter species is about five times as numerous as turbot in the grounds of their greatest density, while the maximum is about ten times as great. When we reach the grounds just south-east of the Dogger Bank we find them about equally numerous, and in the

grounds still further offshore, the turbot occur more frequently than soles. Turbot are very scarce on the western side of the sea; brill and soles are very numerous there in comparison.

The distribution of these species must also be much influenced by the nature of the bottom. We find cod in rough ground where plaice are scarce, and plaice seem to avoid the somewhat muddy grounds of areas J and N in some parts of which soles and turbot are comparatively plentiful. But this is as yet an unproved hypothesis, and it is difficult to separate the influences of depth, nature of the bottom, latitude, and spawning places, in the resultant distribution.

b. Yearly Fluctuations.—Although it has not been possible to determine a definite general measure of the yearly fluctuations of all these species, yet the data have been sufficient to indicate, in the case of some of them, that a falling off in the amount of the average catch is taking place, and though this is not of a very great extent during the four years investigated, it is seen to be far more important when we compare with the amount taken ten or twelve years before. Another interesting comparison is furnished by the records kept by the skippers of certain *sailing* trawlers from Grimsby in the year 1879.* In that year there were very large numbers of large plaice and haddock on the Dogger Bank. From 50 to 200 baskets of these fish† was a very common result of one haul of 9, 10, or 12 hours, with from four to six score cod as well and smaller numbers of the other species. In May the average was about 26 baskets per haul, in June 16 baskets, in July 15, in September 43, and in October about 78. In that month some of the hauls consisted of from 100 to 200 baskets of large plaice and haddock. Several turbot occurred in each haul in some months, whereas now they are only very occasionally taken in the hauls. In February, 1880, one skipper took from 4 to 18 baskets of plaice in each of a number of hauls on the Great Fisher Bank as well as from 10 to 62 baskets of haddock. Seeing that such enormous catches were made by an old type smack of the kind in use in 1880, and knowing that now the Dogger Bank only yields a mean of about 7 cwt. of haddock and less than 1 cwt. of plaice per 10 hours fishing, while the maximum average for the four years 1904–07 is only 13 cwt. for haddock and 1·9 cwt. for plaice, even when fished by the vastly more effective otter trawl of a modern steam trawler, estimated by Dr. Garstang‡ as about eight times as powerful as a smack, we cannot but realise how very great must have been the diminution of the stock of fish on these grounds.

Evidence of such distinct changes in the state of the fisheries in the course of the years is constantly accumulating. It is only necessary to mention the former well-known quantities of soles in the Silver Pits, the presence of large plaice on the Horn Reef, of haddock in the Haddock Bank and Leman and Smith's Knoll region, and of turbot in the western grounds, to illustrate clearly the very changed conditions of the present day.

The question of yearly decline within the four years investigated by the Grimsby Records is complicated by the fact that the yearly fluctuations in some areas are in a way complementary to one another, as was shown in the case of plaice when the inshore eastern grounds showed minimum quantities in 1906 at the same time as the "northern areas" yielded an unusually large amount; and also in the case of soles for the same year. Such variations as these would not improbably be due to the unusual conditions of temperature or salinity—perhaps to both.

In the case of plaice, we found on the whole, a downward trend from 1904 to 1907, the fall being greatest between 1905 and 1906; in some cases there was a slight recovery between 1904 and 1905, and between 1906 and 1907.

Soles, on the other hand, evinced no decline in this period, but there is a very marked fall in the number of turbot.§

Brill, on the whole, increased in numbers in 1906 and 1907 as compared with the two former years. Cod and codling generally decreased. Haddock also decreased in the average total catch, but were marked by great variation in the abundance of small fish. 1906 was a year when they formed a very large proportion of the total. Whiting were most abundant in 1904 and decreased continuously till 1906 to about one-half the amount in 1904.

c. Seasonal Fluctuations and Migrations.—With the exception of whiting and brill, all these species show well marked seasonal fluctuations, giving one or two annual

* Issued by Mr. Buckland. Report on Sea Fisheries of England and Wales. London, 1879, p. 225.

† The species are not separated in the records.

‡ GARSTANG. Impoverishment of the Sea. *Journ. Mar. Biol. Ass.*, 1901. Vol. VI., p. 46.

§ NOTE.—The percentages of recaptures of marked turbot are considerably higher than for plaice. They are thus much more liable to capture, and this fact would probably bring about a rapid decrease in the supply.

maximum periods in each area, and from these we have been able to deduce some hypotheses regarding the annual migrations. For the spring and summer spawners, turbot, soles and brill, there is an inshore migration at the time of the spawning season, all sizes of fish partaking of it. The accumulation of fish on the coastal grounds (8-20 fathoms) is continued throughout the summer, but only with respect to the smaller sizes—the larger ones leaving the shallow waters soon after they have spawned. In the winter these species are not found in any quantities on the inshore grounds, but are dispersed over the offshore areas. The soles especially congregated in deep holes.

For plaice there is a spring and autumn maximum on some of the eastern grounds, the summer minimum being caused by an offshore migration at this time. The increased catches in the central, southern and northern areas in the summer prove that they have moved offshore. The large fish accumulate on the spawning grounds at the beginning of the year, while the small fish manage to escape capture owing to their winter rest.

The other winter spawners, cod and haddock, have a spawning migration, shown in the accumulation of large fish about February in the northern grounds. The intermediate areas show a spring maximum, and there are again numbers of fish on some of the offshore and northern grounds in the summer. These are often found in large shoals, many of which have been found to accompany the herring shoals. During this time they avoid the coastal and southern areas and only approach them in the autumn and early winter. Whiting also show a tendency to accumulate in the autumn and winter in the southern and coastal grounds.

We see then, that in some of the areas at least, there are distinct complementary fluctuations between the round and the flatfish. Such areas as S, T and some of the eastern grounds, have an abundance of flat fish, plaice, soles and turbot in the summer months, attaining a maximum between May and October, during which months, cod, haddock and whiting are particularly scarce, and which only appear in considerable numbers from November to February or March.

APPENDIX I.

THE RELATION OF VARIOUS STATISTICAL UNITS OF FISHING.

(a) FOR STEAM TRAWLERS.

Attention has several times been drawn to the necessity of finding equivalents for the conversion of data resulting from the use of various methods of determining the quantitative distribution of fish. The varying methods arise from the use of different standards to represent the amount of fishing. For instance, various groups of fishery statistics give the average catch per month (D'Arcy Thompson, Granton and Montrose Trawling Statistics); per voyage (Fulton); per day's absence (The Board of Agriculture and Fisheries); per 100 hours' fishing for each month (Fulton); per one hour's fishing (Redeke). What we need is a set of factors to connect these various methods, in order that, if necessary, the figures may be compared or combined. The Grimsby Trawler Records supply sufficiently detailed information to enable us to determine these factors to some extent. We are justified, I think, in taking the voyages of these special Grimsby skippers as a fair representation of the actual kind of voyages made by the fishing industry from this most important of our east coast fishing ports.

The region to which the factors will apply is, of course, that shown on the chart, *i.e.*, the North Sea from the English to the continental coasts, southwards to the Brown Ridges and northwards to Fisher Bank. The fishing is distributed all over this area, and we have samples of both long and short voyages from Grimsby.

As has already been found,* the average duration of a voyage bears a distinct relation to the distance from Grimsby of the fishing grounds visited. But before going into this question in detail, I give some figures for the central part of the North Sea as a whole.

The total number of voyages considered is 431, made by a number of men varying from nine in 1905 to three in 1907 over the period 1904 to 1907. It is found that when fishing very regularly the men can make about three voyages in a month. The greatest numbers of voyages made by one man in a year is 34. But as it generally happens that there are several breaks in the course of the fishing and omissions of records for two or three weeks in some of the months, the average number of trips per month is only two and a half.

The dates of departure and return are given for each voyage. From these we obtain directly, the number of days absence which is 3,551 for the period. This gives an average number of 8.2 days per voyage. The number of days in a voyage varies between 3 and 14, but the modal value is 8 or 9, while half the voyages last between 7 and 10 days.

In the records several hauls have been omitted, firstly, because there was no room for them in the books when they had been filled up, and secondly, because several of the hauls were ineffective through the trawl being torn or fouled in some way. In these foul hauls the result was sometimes, though not always, a total absence of fish. The quantities taken would at any rate be much diminished, and these hauls were omitted in my tabulations. The number of hours fishing equivalent to these omitted hauls has been estimated and added to the totals already determined.

For the purpose of comparing the average duration and amount of fishing of voyages made to near and distant grounds, the voyages were grouped according to the distance from the Spurn Light. The sea was divided into four zones or belts, the outer boundaries of which were distant 70, 140, 215 miles from Spurn, the last being any ground fished by these men, more than 215 miles distant. Each voyage was allotted to its proper zone, that being in each case the most distant one visited. Zone I roughly includes the areas E, R, X, P and V; Zone II, the areas S, T, O and L; Zone III, the areas W, Q, N, I, K and D, and Zone IV, the areas M, H, J, G, C, B and A.

The total number of hours fishing corresponding to the 13,246 recorded hauls is 49,024½, resulting in an average duration of 3.70 hours per haul. But it was found that the duration for each man separately ranged closely round the average 3.7853 hours, with one exception. The average of this man is much lower, 2.578 hours, and as his voyages are made to the near grounds (Zone I), due allowance has had to be made for these different rates. The higher figure, 3.7853 hours, has been used to obtain the equivalent amount of fishing in all zones, except where the hauls of the above fisherman were concerned, when his average 2.578 hours was employed. These estimated numbers of hours fishing are given in the table with the other totals.

TABLE XXX.—Showing the total number of voyages, days absence and hauls, together with the estimated number of hours fishing, in different zones of fishing, made by the Grimsby fishermen, from whom records were obtained during 1904–1907.

| Zone. | Total number of | | | | | | Estimated number of hours fishing. | |
|-----------------|-----------------|--------------|--------------|----------------|-------------|------------|------------------------------------|----------------------|
| | Voyages. | Days absent. | Hauls given. | Hauls omitted. | Foul hauls. | All hauls. | Foul hauls included. | Foul hauls excluded. |
| I | 44 | 216 | 1,103 | 51 | 83 | 1,237 | 3,649 | 3,406 |
| II | 106 | 794 | 3,174 | 88 | 217 | 3,479 | 13,054 | 12,240 |
| III | 125 | 1,049 | 3,923 | 213 | 155 | 4,291 | 16,243 | 15,656 |
| IV | 156 | 1,492 | 5,046 | 142 | 335 | 5,523 | 20,906 | 19,638 |
| All regions ... | 431 | 3,551 | 13,246 | 494 | 790 | 14,530 | 53,849 | 50,940 |

* Board of Agriculture and Fisheries. Annual Report, 1906, p. xxxii.

TABLE XXXI.—Showing the average relations between numbers of voyages, hours fishing and hauls.

| 1 Zone. | 2 Days per voyage. | 3 Hauls per voyage. | 4 5 Hours fishing per voyage. | | 6 Percentage of foul hauls to total hauls. | 7 Percentage number of hours fishing to total number of hours in voyage. | 8 Hauls per day. | 9 10 Hours fishing per day. | |
|----------------|-----------------------|------------------------|----------------------------------|----------------------|---|---|---------------------|--------------------------------|----------------------|
| | | | All hauls included. | Foul hauls excluded. | | | | All hauls included. | Foul hauls excluded. |
| I | 4·9 | 28·1 | 82·88 | 77·42 | 6·7 | 70·45 | 5·73 | 16·88 | 15·77 |
| II | 7·5 | 32·8 | 123·15 | 115·47 | 6·2 | 68·5 | 4·38 | 16·44 | 15·42 |
| III | 8·4 | 34·3 | 129·94 | 125·25 | 3·6 | 64·5 | 4·09 | 15·48 | 14·92 |
| IV | 9·6 | 35·4 | 134·07 | 125·88 | 6·1 | 58·4 | 3·70 | 14·01 | 13·16 |
| All regions... | 8·2 | 33·7 | 124·94 | 118·19 | 5·4 | 63·2 | 4·09 | 15·16 | 14·35 |

The average relations deduced from Table XXX are given in Table XXXI. Columns 2, 3 and 4 show that the duration of the trip and the amount of fishing increase with the distance from Grimsby. On the average a voyage lasts 8·2 days, during which the trawl is shot 33·7 times and fishing lasts 124·94 hours. 5·4 per cent. of this fishing is more or less ineffective, owing to the trawl being damaged in some way, so that, excluding these foul hauls, we have on the average 118·19 hours fishing in a voyage, 60 per cent. of the total time spent on it. Column 7 shows the proportion of the voyage which is spent on fishing. It decreases considerably with the distance from Grimsby. Columns 8, 9 and 10 show the same facts in another form relating to the amount of fishing per day. This naturally decreases when the voyage is longer and more time is spent on travelling to and from the distant fishing grounds. About 4 hauls a day and 15 hours fishing is the average amount attained.

The reciprocals of the factors give the following equivalents :—

100 hours fishing, when foul hauls are included = ·80 of a voyage.
 Do. do. do. = 6·6 days absence.
 Do. do. do. = 27 hauls.
 and when the foul hauls are omitted, 100 hours fishing = ·85 of a voyage.
 Do. do. do. = 6·9 days absence.

The factors for 10 hours' and one hour's fishing are easily deduced from these.

To convert cwts. per 10 hour's fishing to kilos. per one hour's fishing it is sufficient to multiply by five, or more exactly by 5·08. Conversely, to convert kilos. per one hour's fishing to cwts. per 10 hours' fishing, one can multiply by two and move the decimal one place to the left,

e.g. 6 cwts. per 10 hours is equivalent to 30 kilos. per one hour,
 and 15 kilos. per one hour is equivalent to 3·0 cwts. per 10 hours.

(b.) FOR SAILING TRAWLERS.

Similar figures to the above for steam trawlers are necessary for application to sailing trawler statistics. These have been compiled in a similar manner and can be used, when necessary, to convert any average amount of fish taken in a given unit of time, say a month, day's absence, haul or hour, to any other unit.

The material from which these factors have been derived is taken from the Lowestoft Trawler Record Books kept by three skippers in the period April, 1904, to December, 1906.* Their records in the year prior to April, 1904, were not of any value for this analysis, as these earlier books did not contain any information as to the dates of departure and arrival for each voyage.

Such figures as we have obtained will be applicable to statistics of fish landed by smacks at Lowestoft from voyages made, as these were, within a distance of 80 miles or so from Lowestoft.

A total of 306 voyages made by three fishermen was considered. These men make about three voyages a month each, each lasting approximately one week, the books containing records of about 15 hauls, except when unfavourable weather or accidents occurred.

There is some diversity among these men as to the duration of the hauls. Especially in the early years of the period we find one skipper who makes hauls of 9, 10 or 12 hours' duration, averaging over eight hours in some years. The general practice was to make hauls lasting about six hours, the duration of the tide, and the other men average between five and six hours.

Later records of the same and other fishermen, give one the impression that this same man still makes fewer hauls in his voyages, each haul being of a longer duration. Others again make very short hauls and can record from 17 to 19 hauls in a week. There seems to be this distinct tendency at the present time to make hauls of a shorter duration, and counteracting this by taking more of them, so that the total amount of fishing, represented by the number of hours the trawl is down, remains nearly the same. The duration of a voyage is also fairly constant for these smacks.

The total number of hauls in the record books, including some whose details had not been given, was 3,874, and of these 180, or 4·6 per cent. were "foul" or had the trawl torn or destroyed.† These latter ones had been omitted in calculating the totals and averages given in the Report.

Table I., p. 93, gives the average duration of each man's hauls for each year. These were applied to the hauls included in this section, both ordinary and foul hauls and the total number of hours' fishing thereby estimated as 25,506, and excluding all "foul" hauls the total is 24,274.

* LEE.—Report on Lowestoft Sailing Trawler Records, 1903–1906.

† See p. 92. *Loc. cit.*

Those numbers suffice to determine the necessary factors, which are given as follows:—

For the Lowestoft Smacks fishing within a radius of 80 miles from port.

Average number of :

| | | | | | | | | | | |
|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| 1. Voyages per month | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.12 |
| 2. Days per voyage | ... | ... | ... | ... | ... | ... | ... | ... | ... | 7.10 |
| 3. Hauls per voyage | ... | ... | ... | ... | ... | ... | ... | ... | ... | 12.66 |
| 4. Percentage of foul hauls to total hauls | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.65 |
| 5. Hours fishing per voyage, all hauls included | ... | ... | ... | ... | ... | ... | ... | ... | ... | 83.35 |
| 6. Hours fishing per voyage, foul hauls excluded | ... | ... | ... | ... | ... | ... | ... | ... | ... | 79.33 |
| 7. Percentage number of hours fishing to total number of hours in voyage | ... | ... | ... | ... | ... | ... | ... | ... | ... | 48.9 |
| 8. Hauls per day | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.78 |
| 9. Hours fishing per day... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 11.74 |
| 10. Hours fishing per day, excluding foul hauls | ... | ... | ... | ... | ... | ... | ... | ... | ... | 11.17 |
| 11. Hours per haul | ... | ... | ... | ... | ... | ... | ... | ... | ... | 6.58 |
| 12. Number of 6-hour hauls in a voyage, foul hauls excluded | ... | ... | ... | ... | ... | ... | ... | ... | ... | 13.22 |
| 13. Number of 6-hour hauls in one day's absence | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.96 |
| 14. Ditto. with foul hauls excluded | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.86 |

We see from this that not quite one-half of the time spent on the voyage is devoted to the actual fishing. The hauls are just over six hours in length and about two are obtained per day. The actual ratio is 1.78 through the diminution caused by the time taken in sailing to and from the fishing grounds and in spells of calm when they find it impossible to trawl successfully. In the best times the men can make about 15 6-hour hauls in the week's voyage, that is about three a day, from the time they begin fishing after reaching the ground till the time they leave off to return to port. Those who make shorter hauls can get in even more than this.

The number of hours fishing per day's absence is nearly 12 hours, and neglecting the time spent on foul or inefficient hauls, this is just over 11 hours.

One six-hour haul, as used in the Lowestoft Records Report, is equivalent to .54 of the fishing in a day's absence from port and conversely one day's absence includes 1.86 of these six-hour hauls.

The value of such figures as these lies in the great opportunity they afford for the direct comparison of fishery statistics accumulated by different methods at the present time, and with isolated records of catches many years ago. For instance, the catch per day's absence by sailing trawlers in area B₃ (of the Board of Agriculture and Fisheries chart) for the year 1906 is given in their report (1906, p. lxix.) as 1.79 cwts. To reduce this to the rate of catching per six-hour haul we multiply by .54 obtaining .97 cwt. as the result. This is very comparable with the average catch per six hours' fishing obtained from the Lowestoft Trawler Records, which is .91 cwt. for 1906. The greater part of the fishing by these Lowestoft smacks was within the B₃ area as we see from Table II.* where the areas B, C, F, J, M and the eastern side of E and H (20–22 fathoms) fall into area B₃.

Or again, Mr. Cunningham in his North Sea Investigations, 1895†, states that a Lowestoft smack, fishing in the neighbourhood of the Brown Ridges, landed in the early part of September, 18 boxes of plaice. Assuming that the voyage was of about a week's duration, we divide 18 by 13.22, obtaining 1.36 cwts. per six hours' fishing in September, 1895, as against 1.14 cwts., the average obtained for this same ground in September, 1903–1906.

Apart from this aspect of the value of the figures we may look upon them also, as a permanent record of certain conditions of the industry at the present time, which in future years will serve as a measure of certain changes that may have taken place.

APPENDIX II.

SUBSEQUENT RETURNS—ANALYSIS OF THE 1908 RECORDS.

During the preparation of the statistics and the writing of the report on the Trawling Records collected in the period 1904–1907, more Record Books accumulated as they were being filled in by the fishermen. In 1908 they were much less numerous than in the previous years, as from one man we have only the result of one voyage, while another recorded a few voyages discontinuously throughout the year. Only one man has recorded a complete set of records for the year. These few records add little or nothing to the information already obtained with regard to the seasonal and geographical distribution of the species examined, but they are of value in corroboration of these results, and more especially in comparison of the yearly yield in showing whether the yearly decline was continued for the species for which it had been demonstrated, or whether this had been succeeded by an increase. The grounds fished were those lying to the south and east of the Dogger, also including the eastern half of the Dogger itself which was fished over by one man in the spring, and one voyage in October to area G, one of the north-eastern areas.

Area N (Oyster Ground, &c.), a ground already well examined, has the most continuous and greatest share of the fishing. All the other areas visited had fishing in only a very few months of the year, as will be seen from Table XXXIII.

These records have been analysed in precisely the same way as the former ones, the only difference being in some of the factors used to convert the amounts in baskets to hundredweights. As nearly all the monthly catches in any area belong to one man alone, and any bias in over or under estimation would not therefore be eliminated in an average with other men's catches, it was necessary to calculate the ratio between a basket and a box for each man, and apply it separately to his catches. Any bias in the nature of the size classification of the fish is also not measurable by a comparative method, and on this account it has not been possible to detect any changes in the comparative abundance of the different size groups. That such a bias is present we know, for the one man who contributed over

* *Loc. cit.*, p. 94.

† CUNNINGHAM.—North Sea Investigations. *Loc. cit.*, p. 126.

three-quarters of the total number of hauls in 1908, always showed a tendency to maintain very high size limits for plaice. In the early part of the period, although he fished regularly on the "Eastern small plaice grounds," he made a point of not keeping any plaice under 11 inches. In 1908 he adopted a fourth class which he calls "very small plaice," including those from 10 to 8 inches in length, while his "best small" plaice are from 10 to 12 inches in length. Part of the increase in the catches of plaice displayed by the 1908 figures must be due to this tendency to include much smaller fish than formerly. This cannot, however, explain the greatly increased catches on the Dogger in the spring. The probability that such a tendency, namely to retain fish which would formerly have been rejected on account of their small size, is very common amongst the fishermen of to-day, suggests that the decline in the yield is really more marked than it appears.

The following table shows the total and average amounts of fish caught, and the number of hauls and hours of fishing:—

TABLE XXXII.—Showing the Total Amount of Fishing and the Total and Average Quantities of Seven Species of Fish caught by certain Skippers in 1908.

| Total Quantities. | | | | Average per 10 hours' fishing. | |
|-----------------------------|-----------------|----------|-------------------|-----------------------------------|------|
| Plaice | ... (Cwts.) | ... } | L | 79·21 | 0·16 |
| | | | M | 487·69 | 0·98 |
| | | | S | 1319·43 | 2·65 |
| | | | All | 1886·33 | 3·80 |
| Soles... | ... (Number) | ... } | L | 1,335 | 2·7 |
| | | | M | 12,418 | 25·0 |
| | | | S | 6,998 | 14·1 |
| | | | All | 20,751 | 41·8 |
| Turbot | ... (Number) | ... } | L | 994 | 2·00 |
| | | | S | 2,727 | 5·49 |
| | | | All | 3,721 | 7·49 |
| Brill ... | ... (Number) | ... } | — | 2,246 | 4·52 |
| Cod ... | ... (Cwts.) | ... } | No. of Cod | 1,469 | 3·0 |
| | | | Weight of Codling | 83·03 | 0·17 |
| | | | Total Weight | 229·93 | 0·47 |
| Haddock | ... (Cwts.) | ... } | L | 404·14 | 0·81 |
| | | | S | 127·27 | 0·26 |
| | | | All | 531·41 | 1·07 |
| Whiting | ... (Cwts.) | ... } | — | 95·22 | 0·19 |
| Number of hauls | ... | ... | — | 1,297 | — |
| Number of hours' fishing... | ... | ... | — | 4,971½ | — |

We can compare these averages with the yearly average catch obtained by the one fisherman, whose fishing is mainly represented in this year, in the four previous years, for, although the distribution of fishing is not precisely the same, yet he always had a tendency to visit the same grounds at the same time of year, and roughly they are comparable. His average total catches of plaice for the four years 1904 to 1907 are 4·23, 5·23, 2·98, 3·99 cwts. respectively.

A comparison of the monthly averages shows that in the eastern areas and in the most inshore of the central areas the average monthly catches of 1908 were well up to the averages of the four preceding years, while on the offshore areas they greatly exceeded these, so that the decline is not marked in this year.

Soles, (averaging 42) are slightly less than in the previous years, the fisherman's averages for this region being 1904, 42; 1905, 61; 1906, 101; 1907, 65. The changes in 1908 are in no case at all marked.

Turbot still show very small numbers, even though most of the fishing took place in the grounds where they are most abundant. The average 7·49 compares unfavourably with 13·49 in 1904, 9·95 in 1905, 8·16 in 1906, and 7·55 in 1907, attained by this man. In 1870, we have by contrast, a record* of a catch of 1,500 turbot by a smack in one night's fishing about 40 miles from Heligoland in June, an almost incredible number when compared with what is taken now when a fisherman working regularly, even with a steamer, can only catch about twice as many during the year as were taken in that one night.

Brill show very small numbers, but there is no decrease on the previous years—if anything there is an increase.

Cod, haddock and whiting all show a considerable decrease on the previous years. We have only to compare the averages given here in Table XXXII. with those for the eastern and central areas in Tables XVIII. and XXIII.

* BUCKLAND and SPENCER WALPOLE.—Report on the Sea Fisheries of England and Wales. 1879, p. 200.

Table XXXIII. includes the monthly averages of the seven species of fish for each area examined, and while it is seen to be very incomplete in many areas, all the averages that are present tend to confirm the nature of the seasonal fluctuations as already determined, and the general comparative distribution of these species.

TABLE XXXIII.—Showing for each of the seven species of FOOD FISHES the monthly average catch per ten hours' fishing for each area and month investigated in 1908.*

| Area. | Month, | Number of hours fishing, | Plaice (cwt.s.), | | | | Number of Soles, | | | | Number of Turbot, | | | Number of Brill, | Cod. | | | Haddock (cwt.s.), | | | Whiting (cwt.s.), |
|-------|------------|--------------------------|------------------|------|------|-------|------------------|------|------|-------|-------------------|-------|-------|------------------|----------------|--------------------|------------------------|-------------------|------|------|-------------------|
| | | | L. | M. | S. | All. | L. | M. | S. | All. | L. | S. | All. | | Number of Cod. | Weight of Codling. | Total weight (cwt.s.). | L. | S. | All. | |
| G. | October .. | 147 | 0'39 | 0'00 | 0'00 | 0'39 | 0'0 | 0'0 | 0'0 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 10'1 | 0'95 | 1'96 | 4'72 | 1'45 | 6'17 | 0'34 |
| M. | January .. | 56 | 0'00 | 0'35 | 0'41 | 0'77 | 0'0 | 1'4 | 3'6 | 5'0 | 0'36 | 4'64 | 5'00 | 3'57 | 15'7 | 0'80 | 2'37 | 2'93 | 0'03 | 2'96 | 0'11 |
| | April .. | 280½ | 0'00 | 3'10 | 7'30 | 10'41 | 0'0 | 16'1 | 6'9 | 23'0 | 0'00 | 2'71 | 2'71 | 12'79 | 1'4 | + | 0'14 | 0'03 | 0'00 | 0'03 | 0'00 |
| | May .. | 155½ | 0'00 | 1'72 | 5'27 | 7'00 | 1'7 | 33'0 | 13'8 | 48'5 | 0'06 | 5'49 | 5'54 | 9'02 | 3'3 | 0'01 | 0'34 | 0'61 | 0'00 | 0'61 | 0'00 |
| | June .. | 243½ | 0'00 | 0'34 | 3'26 | 3'60 | 22'6 | 75'3 | 43'9 | 141'8 | 0'57 | 7'27 | 7'84 | 12'11 | 0'4 | 0'00 | 0'04 | 0'06 | 0'00 | 0'06 | 0'00 |
| | July .. | 38½ | 0'00 | 0'00 | 0'00 | 0'00 | 24'9 | 91'4 | 54'5 | 170'9 | 0'00 | 6'97 | 5'97 | 18'18 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 |
| | October .. | 40 | 0'00 | 0'15 | 3'85 | 4'00 | 0'0 | 13'5 | 4'5 | 18'0 | 0'00 | 6'50 | 6'50 | 0'50 | 0'0 | 0'00 | 0'00 | 0'00 | 6'00 | 0'00 | 0'00 |
| Q. | January .. | 14½ | 0'23 | 0'44 | 0'32 | 0'99 | 0'0 | 49'7 | 24'8 | 74'5 | 1'38 | 11'72 | 13'10 | 6'21 | 11'7 | 0'19 | 1'36 | 0'78 | 0'00 | 0'78 | 0'00 |
| | February.. | 4 | 0'50 | 1'00 | 0'50 | 2'00 | 0'0 | 15'0 | 30'0 | 45'0 | 0'00 | 5'00 | 5'00 | 25'00 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 |
| | March .. | 171½ | 0'00 | 1'27 | 7'92 | 9'19 | 0'0 | 12'5 | 11'6 | 24'1 | 0'17 | 2'45 | 2'62 | 2'57 | 2'6 | 0'01 | 0'27 | 0'00 | 0'00 | 0'00 | 0'16 |
| | April .. | 31½ | 0'00 | 0'83 | 5'71 | 6'54 | 0'0 | 19'0 | 13'0 | 32'1 | 0'32 | 2'88 | 3'17 | 4'76 | 0'3 | 0'00 | 0'03 | + | 0'00 | + | 0'02 |
| | August .. | 8 | 0'00 | 0'13 | 1'50 | 1'63 | 0'0 | 7'5 | 13'8 | 21'3 | 7'56 | 26'25 | 33'75 | 6'25 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 |
| | October .. | 20 | 0'00 | 0'28 | 1'90 | 2'18 | 0'0 | 32'0 | 17'0 | 49'0 | 3'50 | 14'50 | 18'00 | 3'00 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 | 0'03 |
| | November. | 20 | 0'00 | 0'16 | 1'80 | 1'96 | 0'0 | 64'0 | 43'0 | 107'0 | 7'50 | 29'00 | 36'50 | 23'50 | 1'0 | 0'29 | 0'39 | 0'03 | 0'00 | 0'03 | 0'00 |
| W. | August .. | 4 | 0'00 | 1'50 | 4'50 | 6'00 | 0'0 | 10'0 | 10'0 | 20'0 | 0'00 | 15'00 | 15'00 | 15'00 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 |
| | October .. | 28 | 0'00 | 1'29 | 1'36 | 2'64 | 0'0 | 37'5 | 23'2 | 60'7 | 4'64 | 10'00 | 14'64 | 3'93 | 0'4 | 0'00 | 0'04 | 0'00 | 0'00 | 0'00 | 0'04 |
| J. | January .. | 119 | 0'04 | 0'06 | 0'20 | 0'30 | 7'7 | 33'4 | 4'9 | 46'0 | 3'36 | 6'72 | 10'08 | 3'28 | 3'2 | 0'40 | 0'72 | 2'23 | 0'69 | 2'91 | 0'55 |
| | February.. | 94½ | 0'00 | 0'10 | 0'02 | 0'12 | 0'1 | 12'0 | 3'6 | 15'7 | 0'21 | 2'33 | 2'54 | 0'74 | 1'3 | 0'28 | 0'39 | 0'51 | 0'13 | 0'64 | 0'33 |
| | December. | 31 | 0'00 | 0'28 | 0'19 | 0'47 | 0'0 | 30'0 | 10'6 | 40'6 | 4'84 | 8'71 | 13'55 | 0'97 | 1'0 | 0'36 | 0'46 | 1'63 | 0'16 | 1'78 | 0'50 |
| N. | January .. | 151 | 0'18 | 0'24 | 0'16 | 0'57 | 8'2 | 47'3 | 40'0 | 95'5 | 2'78 | 12'91 | 15'69 | 4'77 | 7'0 | 0'17 | 0'87 | 1'48 | 6'06 | 1'54 | 0'13 |
| | February.. | 284½ | 0'51 | 0'73 | 0'23 | 1'47 | 1'5 | 36'6 | 31'0 | 69'0 | 1'65 | 5'98 | 7'63 | 7'77 | 3'2 | 0'02 | 0'34 | 0'05 | 0'01 | 0'06 | 0'02 |
| | March .. | 92½ | 0'25 | 0'55 | 0'17 | 0'96 | 0'2 | 37'6 | 27'0 | 64'9 | 0'86 | 4'54 | 5'41 | 5'19 | 4'0 | 0'02 | 0'42 | 0'01 | 0'00 | 0'01 | 0'00 |
| | April .. | 49 | 0'00 | 0'20 | 0'07 | 0'27 | 1'6 | 37'1 | 18'8 | 57'6 | 1'02 | 2'86 | 3'88 | 2'65 | 7'1 | 0'07 | 0'78 | 0'09 | 0'00 | 0'09 | 0'00 |
| | July .. | 3½ | 0'00 | 1'14 | 1'14 | 2'29 | 0'0 | 0'0 | 0'0 | 0'0 | 0'00 | 2'85 | 2'85 | 0'00 | 2'9 | 0'23 | 0'52 | 0'29 | 0'11 | 0'40 | 0'86 |
| | August .. | 180 | 0'00 | 1'30 | 3'30 | 4'61 | 0'0 | 11'6 | 4'7 | 16'2 | 3'06 | 3'78 | 6'83 | 2'11 | 0'4 | 0'19 | 0'23 | 0'28 | 0'13 | 0'41 | 0'48 |
| | September | 72 | 0'00 | 2'09 | 6'34 | 8'43 | 0'0 | 5'1 | 0'3 | 5'4 | 0'42 | 0'56 | 0'97 | 2'50 | 0'8 | 0'20 | 0'28 | 0'20 | 0'01 | 0'21 | 0'05 |
| | October .. | 87½ | 0'00 | 0'13 | 1'72 | 1'86 | 0'0 | 22'6 | 7'5 | 30'2 | 2'86 | 12'34 | 15'20 | 4'80 | 0'6 | 0'04 | 0'10 | 0'02 | 0'00 | 0'02 | 0'07 |
| | November. | 393½ | 0'05 | 0'70 | 5'73 | 6'48 | 0'4 | 38'7 | 15'7 | 54'7 | 5'41 | 10'70 | 16'11 | 4'80 | 1'7 | 0'06 | 0'23 | 0'09 | + | 0'09 | 0'02 |
| | December. | 349 | 0'10 | 0'54 | 0'81 | 1'45 | 3'4 | 51'1 | 20'7 | 75'2 | 4'44 | 9'08 | 13'52 | 4'36 | 2'8 | 0'30 | 0'58 | 0'65 | 0'00 | 0'65 | 0'25 |
| I. | February.. | 75 | 0'00 | 0'24 | 0'02 | 0'25 | 0'0 | 5'5 | 0'7 | 6'1 | 0'53 | 1'20 | 1'73 | 0'21 | 17'9 | 0'25 | 2'04 | 3'92 | 2'35 | 6'26 | 1'08 |
| | May .. | 63½ | 0'46 | 0'42 | 0'00 | 0'88 | 0'0 | 0'0 | 0'0 | 0'0 | 1'26 | 0'63 | 1'89 | 0'16 | 2'0 | 0'43 | 0'63 | 3'07 | 0'82 | 3'89 | 0'99 |
| | July .. | 16 | 0'00 | 2'87 | 1'38 | 4'25 | 0'0 | 0'0 | 0'0 | 0'0 | 1'25 | 0'00 | 1'25 | 0'00 | 1'9 | 0'31 | 0'50 | 0'71 | 0'19 | 0'91 | 1'06 |
| | August .. | 179 | 0'00 | 2'89 | 4'39 | 7'28 | 0'0 | 1'5 | 0'0 | 1'5 | 1'07 | 0'67 | 1'84 | 0'11 | 3'5 | 0'32 | 0'67 | 0'12 | 0'08 | 0'20 | 0'46 |
| | September. | 143½ | 0'02 | 2'40 | 5'24 | 7'66 | 0'0 | 2'9 | 0'6 | 3'5 | 0'77 | 0'84 | 1'61 | 0'91 | 3'7 | 0'24 | 0'61 | 0'12 | + | 0'12 | 0'11 |
| | December. | 4 | 0'50 | 0'50 | 1'10 | 2'10 | 25'0 | 50'0 | 15'0 | 90'0 | 2'50 | 12'50 | 15'00 | 5'00 | 2'5 | 0'33 | 0'58 | 0'13 | 0'00 | 0'13 | 0'15 |
| O. | April .. | 164 | 0'27 | 1'01 | 0'48 | 1'76 | 0'1 | 0'2 | 0'0 | 0'3 | 0'79 | 0'85 | 1'65 | 0'06 | 2'0 | 0'25 | 0'45 | 1'84 | 0'38 | 2'21 | 0'58 |
| | May .. | 376½ | 0'50 | 0'49 | 0'01 | 1'00 | 0'0 | 0'0 | + | + | 1'65 | 1'06 | 2'71 | 0'03 | 0'8 | 0'26 | 0'34 | 3'13 | 1'50 | 4'63 | 0'97 |
| | June .. | 43 | 0'66 | 0'66 | 0'00 | 1'32 | 0'0 | 0'0 | 0'0 | 0'0 | 1'63 | 1'40 | 3'02 | 0'00 | 0'0 | 0'16 | 0'16 | 2'23 | 1'13 | 3'37 | 0'56 |
| S. | February.. | 24½ | 0'40 | 0'71 | 0'27 | 1'38 | 4'9 | 3'3 | 4'9 | 13'1 | 0'41 | 4'90 | 5'31 | 0'00 | 14'3 | 0'00 | 1'43 | 0'00 | 0'00 | 0'00 | 0'13 |
| | July .. | 147½ | 0'29 | 1'08 | 6'19 | 7'56 | 1'2 | 11'6 | 6'3 | 19'1 | 1'49 | 3'32 | 4'81 | 4'14 | 0'3 | 0'15 | 0'18 | 0'00 | 0'00 | 0'00 | 0'00 |
| | August .. | 80½ | 0'00 | 1'01 | 1'74 | 2'75 | 0'0 | 9'8 | 4'2 | 14'0 | 1'12 | 3'60 | 4'72 | 2'98 | 2'5 | 0'18 | 0'43 | 0'00 | 0'00 | 0'00 | 0'00 |
| | September. | 96½ | 0'28 | 1'25 | 2'49 | 4'02 | 1'5 | 49'2 | 34'7 | 85'4 | 5'71 | 13'61 | 19'32 | 7'80 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 |
| | October .. | 316½ | 0'14 | 1'12 | 2'53 | 3'80 | 4'8 | 32'6 | 25'9 | 63'3 | 3'22 | 9'00 | 12'23 | 5'53 | 0'0 | + | + | 0'00 | 0'00 | 0'00 | 0'02 |
| T. | February.. | 52 | 0'94 | 1'00 | 0'19 | 2'13 | 8'1 | 3'8 | 2'7 | 14'6 | 0'19 | 3'27 | 3'46 | 0'58 | 30'6 | 0'09 | 3'15 | 0'03 | 0'00 | 0'03 | + |
| | September. | 7½ | 0'15 | 1'29 | 3'10 | 4'54 | 0'0 | 23'2 | 12'9 | 36'1 | 1'29 | 9'03 | 10'32 | 5'16 | 0'0 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 | 0'00 |
| V. | February.. | 8 | 0'38 | 0'02 | 0'00 | 0'40 | 10'0 | 7'5 | 0'0 | 17'5 | 0'00 | 1'25 | 1'25 | 0'00 | 11'3 | 0'35 | 1'48 | 0'28 | 0'00 | 0'28 | 0'94 |
| X. | February.. | 4 | 0'40 | 0'40 | 0'00 | 0'80 | 10'0 | 0'0 | 0'0 | 10'0 | 0'00 | 0'00 | 0'00 | 0'00 | 5'0 | 0'00 | 0'50 | 0'00 | 0'00 | 0'00 | 0'00 |

The following points in the averages of each species are of interest :—

Plaice.—The only observations made in the north-eastern areas were in area G in October, when the average, 0'39 cwt.s., is considerably less than that determined in other years.

The amounts in the eastern areas, M and Q, show much the same trend as has been determined in other years, viz., a maximum in March and April in Q, and in April-May and again about October in M. The minimum in the winter and that caused by an offshore migration in the summer is also marked. The quantities are generally very slightly greater than in 1907, but less than those of the previous years.

In the central areas, we find the same very small catches in area J, while in area N (Oysters, &c.) they are very near the averages for the four previous years. The seasonal trend in the latter area is similar to that determined in the general curve (Fig. 8), but in 1908 the first maximum comes in February instead of March.

The unusually high average in November, 6'48 cwt.s., is due to large catches made in the first week of the month in 20 fathoms at the very border of this area (about 54° 12' N., 6° 50' E.). On the more offshore areas, I and O, much larger numbers than in the previous years were taken. The spring catches on the Dogger are about three times those in 1904-06, and the summer averages on the Clay Deep Grounds are also considerably greater than in previous years. These particular hauls are,

* + indicates the presence of very small quantities of the species, averaging less than 0'005.

however, not representative of the whole area but lie near the dividing line between N and I. We find the usual trend maintained in the southern areas, viz., a summer maximum. The drop here in August is due to the fact that the hauls were made in a different and more southern part of the region from the others in this area, viz., around Smith's Knoll and Winterton Twenties, where they are not generally so plentiful.

Soles.—In 1908 soles were entirely absent from hauls made in area G, and were as rare on the Dogger Bank as they were shown to be in the previous years. The largest numbers in any area were taken from area M (Sylt Amrum) where the catches increase regularly from the minimum in the winter to their maximum about July. The complementary fluctuations of a winter maximum and a summer minimum are maintained in the offshore areas J, N and I, but the amounts taken average on the whole slightly less than in the period 1904-1907.

The southern areas show no great change in their yield of soles, but the autumn maximum is considerable in S. This is made more distinct because all the September and October hauls were taken on the Botney and New Zealand Ground regions, which have been shown to be much more productive of soles than the Leman ground and Brown Bank parts of this area.

Turbot.—Area N still maintains its reputation of yielding the largest number of turbot. The spring minimum appears somewhat later and the summer values are not so high as usual, but the autumn and winter maxima are quite decided and come well up to the average of the previous years. The other areas do not show any marked or unusual features. The winter averages in area J are high and all averages, with the exception of December, in area I are very low (less than two per 10 hours' fishing). In M we find indications of the summer maximum (7·84), and here also the January catches are much larger than usual. No great changes are seen to occur in S (southern area): the autumn maximum is emphasised by the distribution of the fishing (mainly in the northern part at this time and in the southern part in July and August).

Brill.—This species seems to maintain in 1908 the rise in numbers indicated in 1907. In some cases the averages are considerably higher than the average of the four previous years. The seasonal variations are not very regular, but in the cases where the averages are numerous and reliable enough to show them they seem to agree roughly with those already determined. In area N we have a definite winter maximum and summer minimum, the trend of the figures agreeing with that which they showed in 1906 and 1907.

Cod.—We find the average catch of cod is considerably reduced in 1908. Many of the averages are only from one-third to one-half of the corresponding averages for the previous years. The quantities on the Dogger Bank especially show a great reduction, most especially in the large fish. The average of the three spring months of 1908 is only 0·32 cwt. whereas the general average in 1904-1907 was 2·62 cwts. or over eight times as much. In area N the average of all the months examined (except July) is 0·43 cwts.; in the other four years it is 0·80 cwts. In this area the period of maximum abundance occurs in the winter and spring, and there is a minimum in the summer and early autumn as in the other years.

There are no hauls in which very exceptionally large catches of cod were taken. The large fish are generally caught in numbers under 10, while in very few hauls do they reach a score in number.

Haddock.—In all cases considered in 1908, the catch of haddock is found to be decreased by a considerable amount. The only times when the averages appear at all large is in October in area G (6·17 cwts. as compared with 8·85 cwts. in 1904-05) and in area I in February (6·26 cwts.) and at all other times and areas the catches come far below the normal. For instance, in area N the average of the nine months with reliable averages is 0·34 cwt., only a little more than one-fifth of the average of the same months in the previous years. The seasonal variations and the periods of maximum abundance follow the same course as usual and no remarkable feature occurs. The large fish form a very large percentage of the catch.

Whiting.—Very small quantities of whiting were taken from these areas in 1908, for the decline evidenced throughout the former period is continued, and the average amount taken is about one-half or a little more than in 1907.

It is thus apparent that in this region of the sea the seasonal fluctuations, as far as they can be inferred from these few figures, remained fairly constant in 1908, and that the yearly variation determined for these species were, broadly speaking, a tendency for flat fish—to remain nearly the average, some like plaice and brill being slightly greater, and other like soles and turbot slightly less than the years immediately preceding—and for round fish—to be considerably diminished. How far this may apply to the western and northern half of the sea it is, of course, impossible to imagine as complementary fluctuations may possibly take place there.

