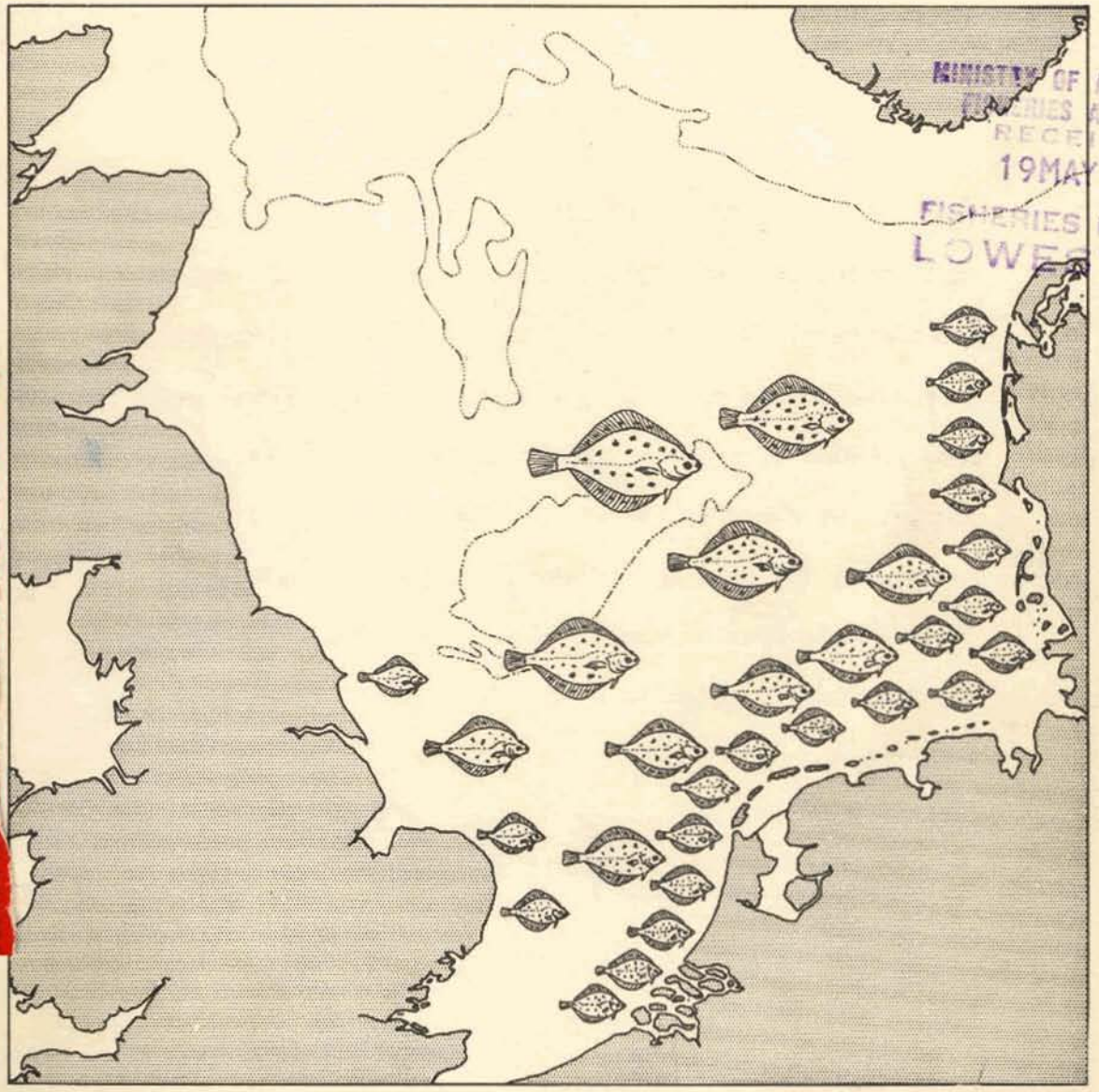
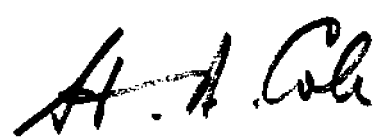
MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

NORTH SEA PLAICE STOCKS



LABORATORY LEAFLET (NEW SERIES) **No. 11**
FISHERIES LABORATORY
LOWESTOFT
SUFFOLK
APRIL 1966

Catches of North Sea plaice are at present very good. In this leaflet John Gulland shows how these good catches are the result of a reduction in the total fishing and also a redistribution of fishing effort, i.e. a movement away from grounds with small fish to those carrying larger plaice. He shows how easy it would be to slip back by increasing the landings of small plaice. His advice is "Keep to big fish and do not fish them too hard". This is not a matter for regulation but for action by owners and skippers.



H. A. Cole

Director of Fishery Research

CONTENTS

Laboratory Leaflet (New Series) No. 11

North Sea plaice stocks

INTRODUCTION

The North Sea plaice stocks have been the subject of many of the classical studies of the effect of fishing, from the early work of the Russian Baranov in 1918 onwards. This has been so partly because the statistics of the English trawl fishery comprise one of the best and largest series of data of the type used in these studies of overfishing, and partly because, at least during the period studied, particularly the 1930s, the North Sea stocks of plaice, cod, etc. were among the most heavily fished in the world. Since the war there has been a remarkable revival in the North Sea fisheries (Figure 1). This leaflet is

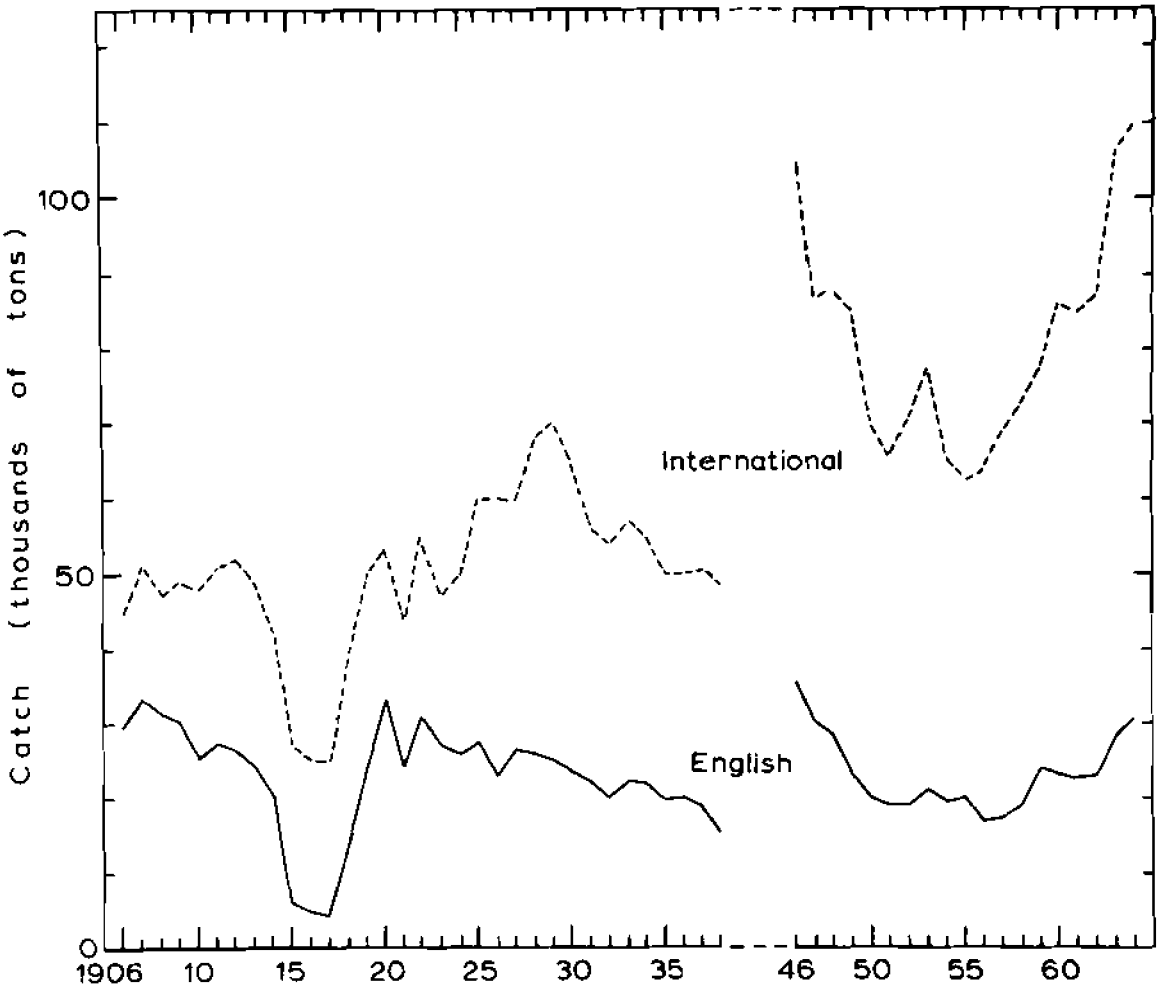


Figure 1. Total landings of North Sea plaice

concerned with describing this recovery, and considers how far it can be explained by the changes in the pattern of fishing.

THE CATCHES

The trends in the total landings of plaice from the North Sea are shown in Figure 1, which gives the total catch by all countries, and by England and Wales, since 1906. Apart from the drop in supplies during both wars the total catch remained remarkably steady up till 1940. Immediately after the war the catches were very high, but then they declined to a smallest post-war catch in 1955, though even this was rather above the pre-war average. Since then there has been a steady increase, reaching an all-time peak (in total catch) in 1964. The English share has tended to drop, so that the 1964 English catch, though very good, is slightly below the record 1947 catch. Each country's share of the landings is shown in more detail in Figure 2, which shows the proportion taken by the major countries in certain years - 1909, 1932, 1947 and 1964. In 1909 England dominated North Sea fishing, taking over 60% of the total plaice catch, but Denmark took the lead between the wars, and in 1964 took 35%, compared with England's 28%.

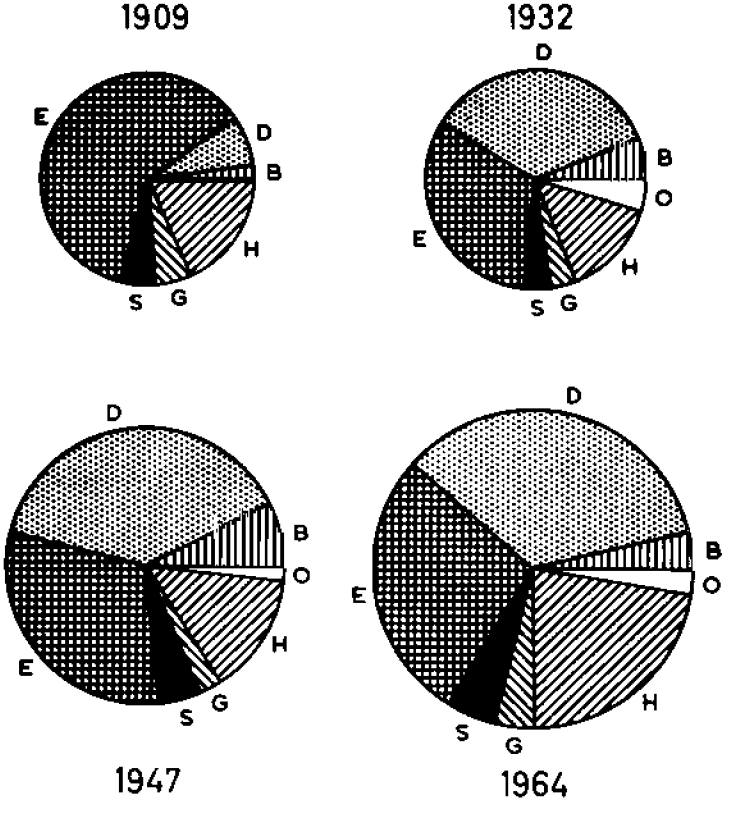


Figure 2. National shares of North Sea plaice catches:

E. England; D. Denmark; B. Belgium; S. Scotland; H. Holland; G. Germany; O. Others

The catches are only part of the story. Equally important are the amount of fishing required to take the total catch, and the abundance of the fish. Since 1922 detailed information is available on the amount of fishing by English trawlers in terms of the number of hours spent fishing. From these data the abundance of the stocks can be reasonably well estimated as the average catch per hour's fishing, and the total international fishing can be estimated from the ratio of English trawler catch to total catch. These estimates of stock abundance and total amount of fishing are plotted in Figure 3. Like the total catch the figures for the 1930s are remarkably constant, with a tendency for the amount of fishing to decrease, and the stock to increase very slightly. During the war the total amount of fishing, though not known precisely, was very low; it increased quite quickly in the first few years after the war, but after reaching a point well below (about two-thirds of) the pre-war level in 1949 has since remained comparatively low. The stock

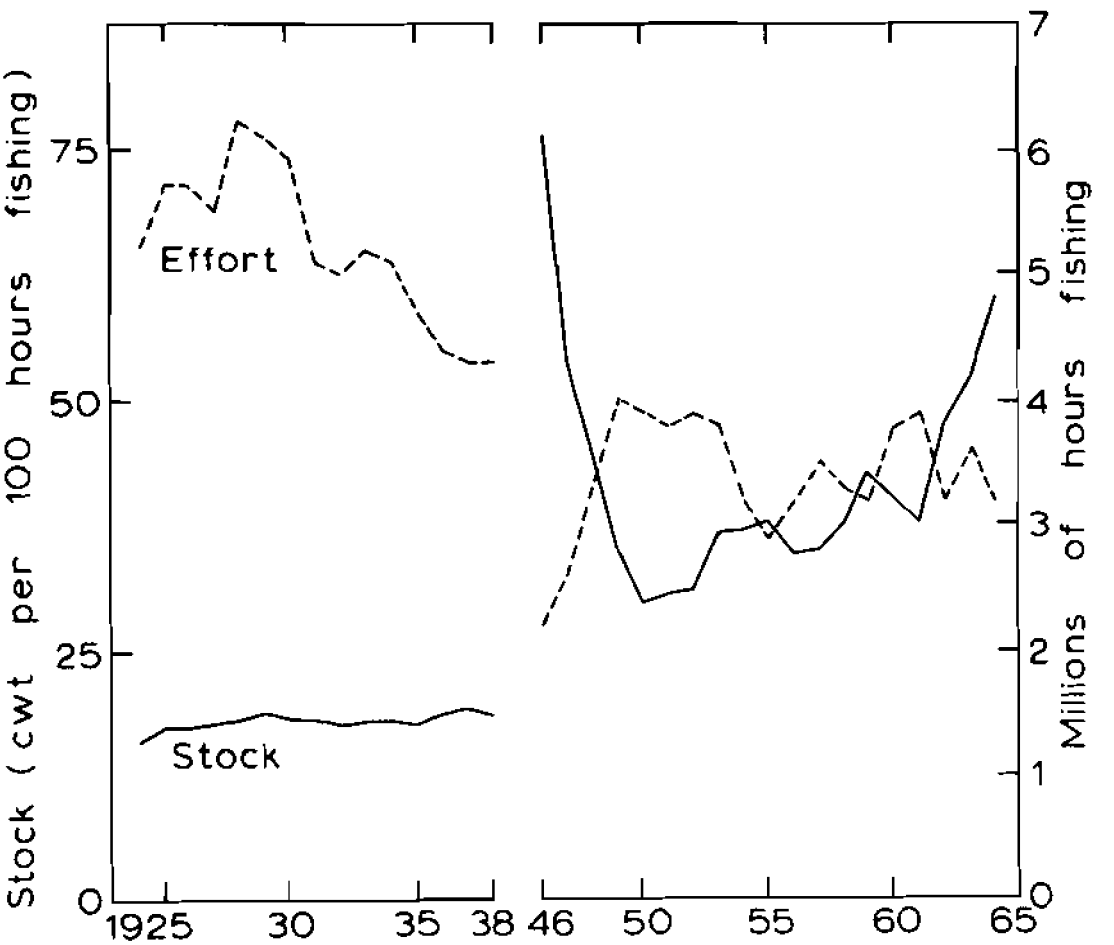


Figure 3. Estimates of stock abundance and total amount of fishing for the North Sea plaice

increased very greatly during the protection of the war years, but declined from the post-war peak to a low level in 1957, though this was about 70% above the pre-war average. Since then the stocks have increased again to well over twice their pre-war abundance.

These results pose two major problems: why are the post-war catches, and still more the catches per hour's fishing, so much better than those before the war, and why have both recently been steadily increasing? - the stock since 1951 and the catches (both English and total international) since 1956.

OVERFISHING

The North Sea plaice stocks in the 1930s were one of the best known examples of overfishing - the fish were being caught before they could grow to a decent size, so that while the numbers of plaice being caught were very high, their average size was so small that the total weight caught was considerably less than it could have been. Bigger, though probably fewer, plaice could have been caught either by avoiding catching the very small plaice at all, or by reducing the rate at which the fish, of all sizes, were being caught. The first objective, of avoiding the capture of small fish, can of course often be achieved for some species by suitable regulation of mesh sizes, but because of the plaice's shape the current North Sea mesh regulation cannot do much for it. The present legal minimum mesh (80 mm for manila) will release plaice up to only about eight inches long - well below the present minimum market size, and also smaller than is generally found on the main grounds. To give protection to the size of plaice for which it is really needed - those just below the legal minimum size - a much larger mesh is required - around 110 mm. Such a mesh is about the size used by the Danish seiners operating from Grimsby (and also from Denmark), which are fishing almost entirely for cod or plaice, but it would be impracticable for trawlers interested in haddock, or still more for soles. Thus mesh regulation cannot be expected to be of practical help to the plaice fishery so long as the same mesh size has to be used also for sole and haddock fishing. The possible benefits of protecting the very small fish are, however, very great. A very detailed study of the effects of possible conservation measures on the plaice fishery showed that, compared with the situation in the 1930s, the catches could be roughly doubled if the plaice were not caught until they were almost ten years old (about 16 inches long and weighing about a pound and a quarter) rather than from three and a half years old (rather less than 10 inches long, weighing a quarter of a pound).

The same study also predicted the effect of changing the amount of fishing. Again, in comparison with the 1930s, a reduction would give substantial benefits; with about a third of the amount of fishing the total catch would be about 30% greater. We can now examine to what extent the recent changes have fitted these predictions.

CHANGES IN THE AMOUNT OF FISHING

The biggest changes in the amount of fishing occurred of course during the two wars, when, especially on the western side of the North Sea, fishing practically stopped. The extremely high catches when fishing started again each time are well known, and show very clearly both how the stocks had been depleted by fishing and also how quickly they could recover once it was reduced.

The other important change in the amount of fishing is the considerably lower level since the 1939-45 war. The average amount of fishing in the 1950s was about 65% of that in the 1930s, and this reduction in fishing effort would be expected to cause an increase in stock of about 70% and in total catch of about 10%. This agrees reasonably well with the state of the fishery in the early fifties. Confirmation that this agreement is not mere coincidence can be obtained by looking at the sizes and ages of the fish caught, and especially the rate at which they are dying. As the fishing effort is down by 35%, then the rate at which the fish are being caught should also be down by 35%. Before the war about 55% of the plaice in the sea were dying each year - about 10% from natural causes, and the rest from being caught. Thus in the 1950s we would expect only about 40% to die each year - 10% from natural causes, and the rest from fishing; in actual fact the estimate from landings at Lowestoft from 1950 to 1958 was 42% - an extremely good agreement.

Changes in the amount of fishing can therefore partly explain the better fishing since the war, but not the increase in both stock and total catch since 1951 - a period during which the amount of fishing has been, if anything, increasing. To explain this the catches, and especially the grounds on which they are taken, and the size of fish being caught, must be examined in more detail.

CHANGES IN FISHING GROUNDS

The life history of the North Sea plaice has been studied for many years, and is well known, at least in broad outline. Spawning occurs in a few fairly well defined areas - mainly in the Southern and German Bights, and off Flamborough. The fish spawning in each area form separate groups which may mix to some extent during the summer when they are dispersed in the central North Sea, but which separate to their particular spawning grounds each winter. The eggs and, at first, the baby fish, drift with the current, but after a few weeks the young fish settle on the bottom in shallow water, especially along the Dutch and German coasts. As they grow they move out into deeper water, until at about three or four years old they become mature and join in the spawning movements. Thus the size of fish caught by a fisherman depends on where he fishes; the small fish are mainly inshore and in shallow water, and as a rule the deeper one fishes the bigger are the fish taken. The extent of the difference can be seen from two landings by Lowestoft trawlers in the same month (July 1959). The details are given in Figure 4, which

shows for each landing the number of fish and the weight landed in each size category. Both ships landed about the same number of fish, but the one fishing well down on the Middle Rough caught mostly large fish (97 kits, with a total landing of 146 kits), while the one fishing on the Haddock Bank caught mainly small fish (44 kits out of a total of 49 kits) and thus caught only a third of the weight (and probably considerably less than a third of the value) of the other ship.

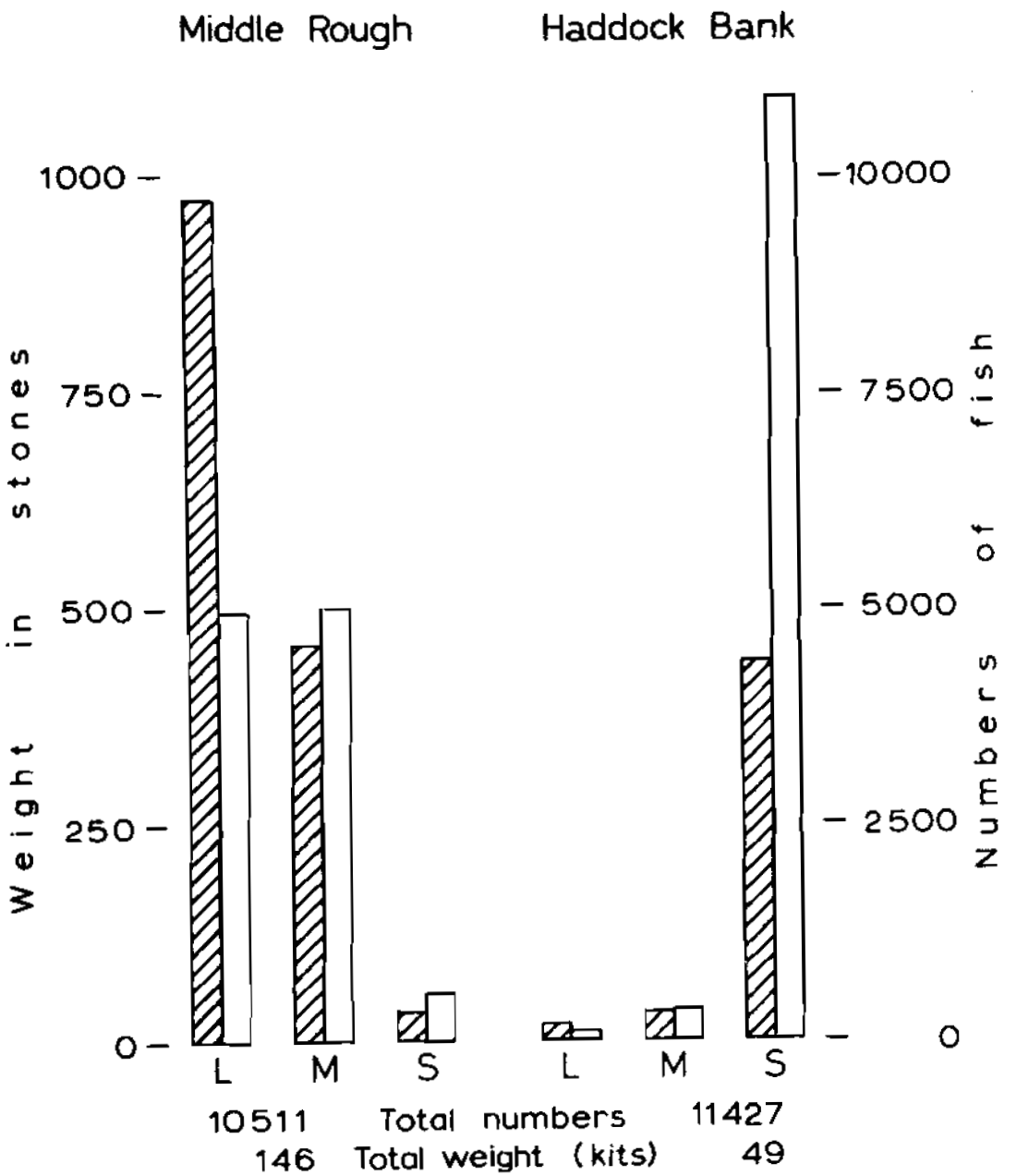


Figure 4. Composition of the plaice landings from two areas of the North Sea in July 1959

Particulars of where British fishermen fish are collected regularly by officials of the Ministry of Agriculture, Fisheries and Food after each trip. These are tabulated to give the total catch and amount of fishing in each statistical rectangle (approximately a 30-mile square, one degree of latitude by half a degree of longitude) in the North Sea. These rectangles have been grouped into half a dozen larger areas, which are shown in Figure 5. This figure also shows the British trawl catch in each of these areas in 1932, 1947 and 1964. Between 1932 and 1947 there was no very great change - in most areas the 1947 catch was slightly greater - but there was a very big shift by 1964. In the

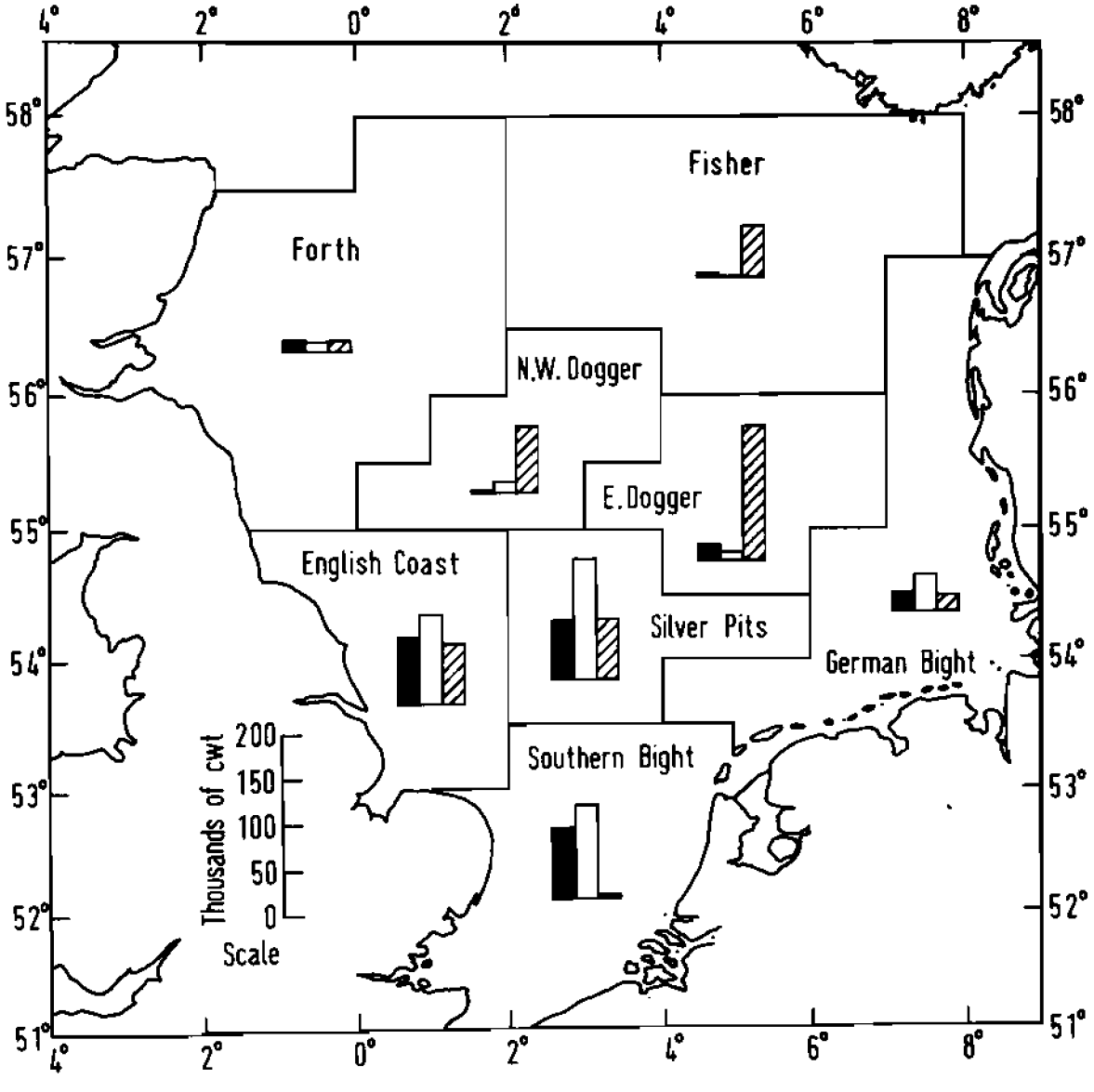


Figure 5. Plaice landings from various areas of the North Sea in 1932 (black), 1947 (white) and 1964 (shaded)

Southern Bight catches have dropped away almost to zero, but this has been more than balanced by a very great increase in the catches from the more distant grounds to the north and east of the Dogger. The trends in catches in the various areas can be seen in more detail in Figure 6, which shows the annual total British steam trawl catch from 1932 to 1956, and the combined steam plus motor trawl catches from 1957 onwards. The increase in the catches from the more distant areas started quite recently, between about 1955 and 1960; it is probably due both to the introduction of the larger diesel trawler, particularly at Lowestoft, which can fish further afield, and to the increasing use of synthetic twines, with which the fishermen can afford to work such rough grounds as the Middle Rough and the Inner Shoal.

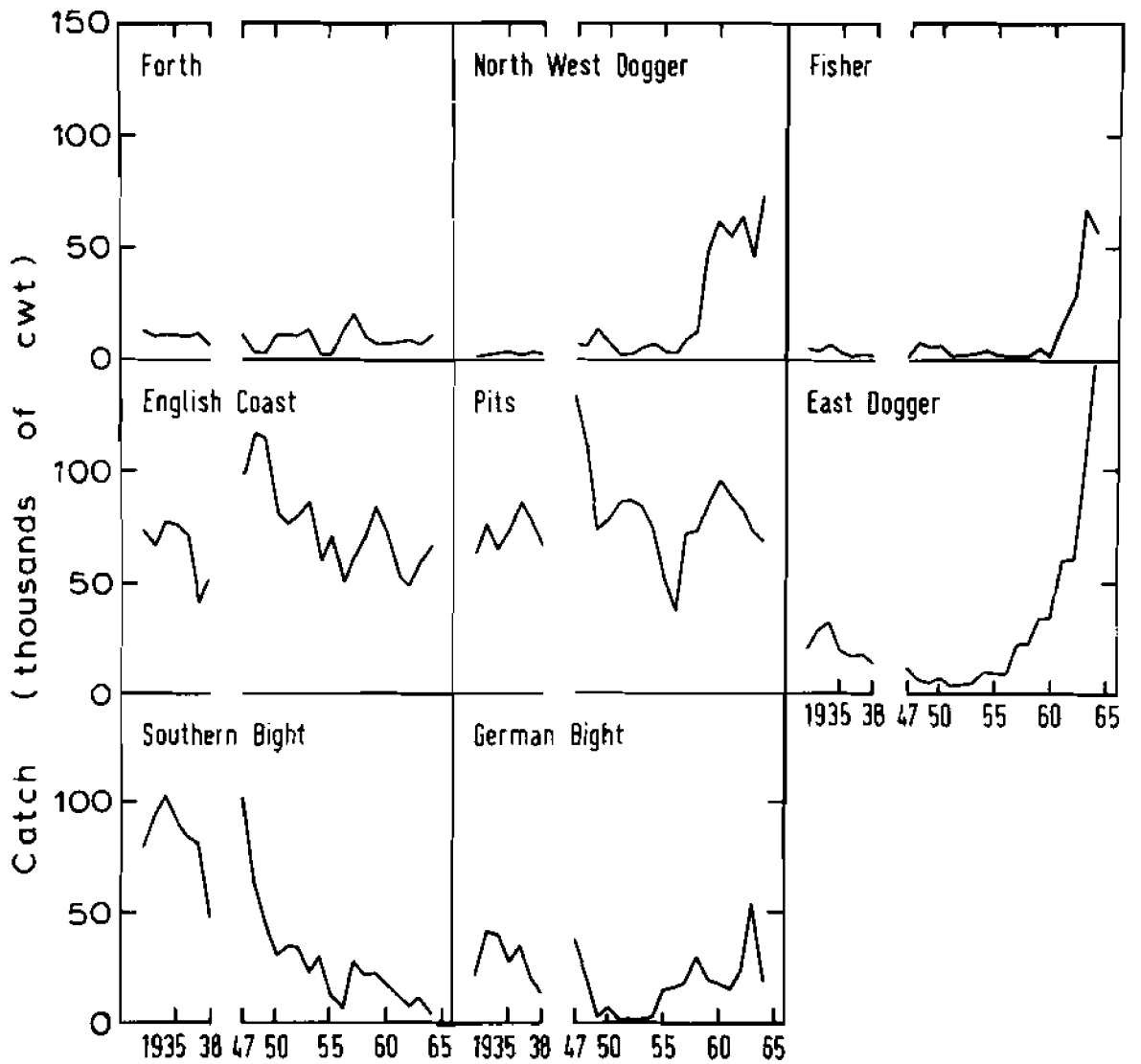


Figure 6. Trends in British trawler landings of plaice from different areas

The areas shown in Figure 5 cannot be divided into those with big fish and those with small fish quite so distinctly as in the case of the two landings shown in Figure 4; nevertheless, the distant grounds in which fishing has been increasing do definitely contain bigger fish than the nearer ones. Thus the shift in the grounds fished has caused a big change in the sizes of fish being caught. This change shows up in the data of the various size categories landed on the markets; however, the boundaries between the categories are not absolutely precise, and there have been changes in the number of size categories. More accurate information is provided by the regular measurements made by the Ministry scientists on Lowestoft and Grimsby markets. These measurements have been grouped into four sizes - under 30 cm (12 inches, corresponding to "small" fish), 30-34 cm (12-13½ inches, corresponding to "best small"), 35-44 cm (13½-17½ inches, corresponding to "medium"), and over 45 cm (over 17½ inches, corresponding to "large"). The comparison between the catches in 1949 and 1963 is shown in Figure 7, as the proportion in each

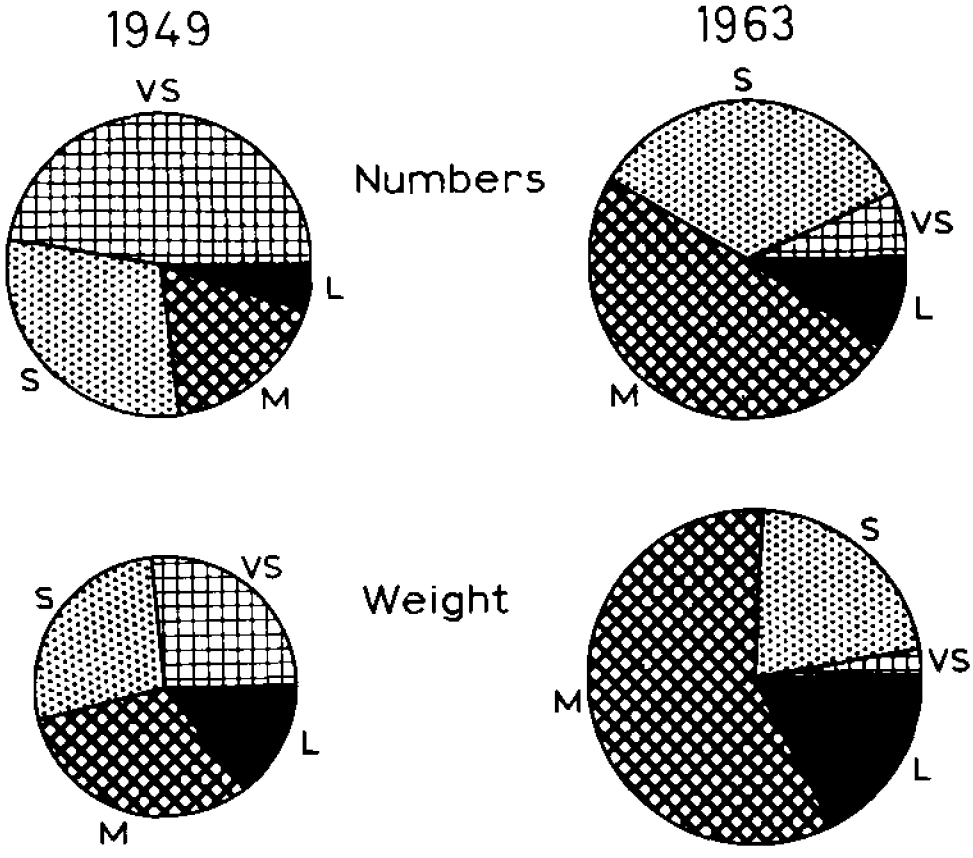


Figure 7. Comparison of the composition of the Lowestoft and Grimsby landings of plaice, by size categories, in 1949 and 1963:

L. Large; M. Medium; S. Small; VS. Very Small

category in terms of both numbers and weight. There has been a very big and steady decline in the "smalls", from 47% by numbers and 26% by weight to only 7% by numbers and less than 6% by weight, while the proportion of medium and large fish has risen correspondingly. The annual trends in the numbers landed in each size group are shown in Figure 8. This shows that the numbers of very small fish have been falling more or less steadily from 1949 to 1963, but the numbers of the large and medium fish did not start to increase substantially until after 1955.

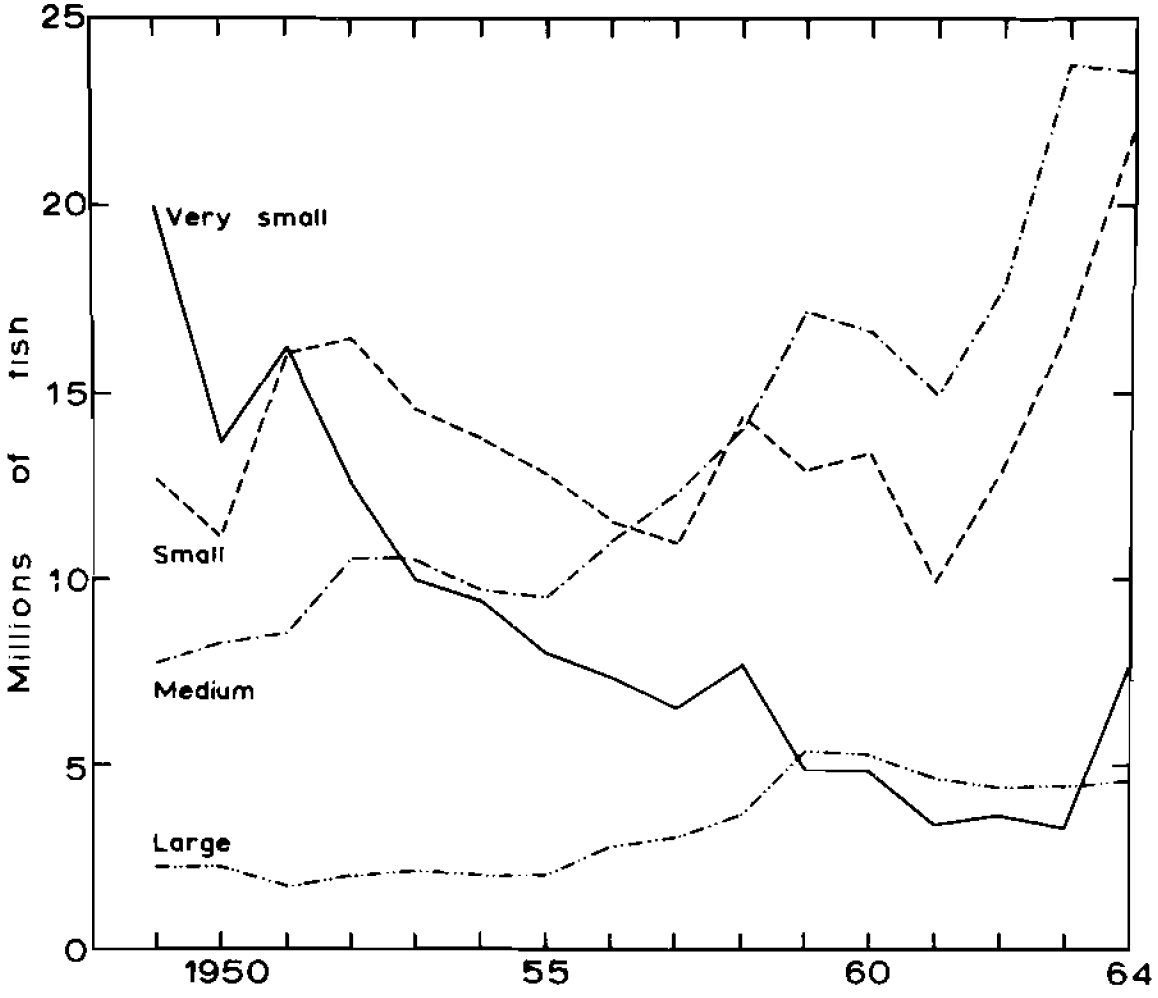


Figure 8. Trends in the Lowestoft and Grimsby landings of the four categories of plaice

The trends in total numbers landed, the average weight of the individual fish, and the total weight landed are shown in Figure 9. As well as the values for each year since 1946, the values for 1932, a typical pre-war year, are also shown. The total numbers landed directly after the war were slightly above the pre-war average, but quickly

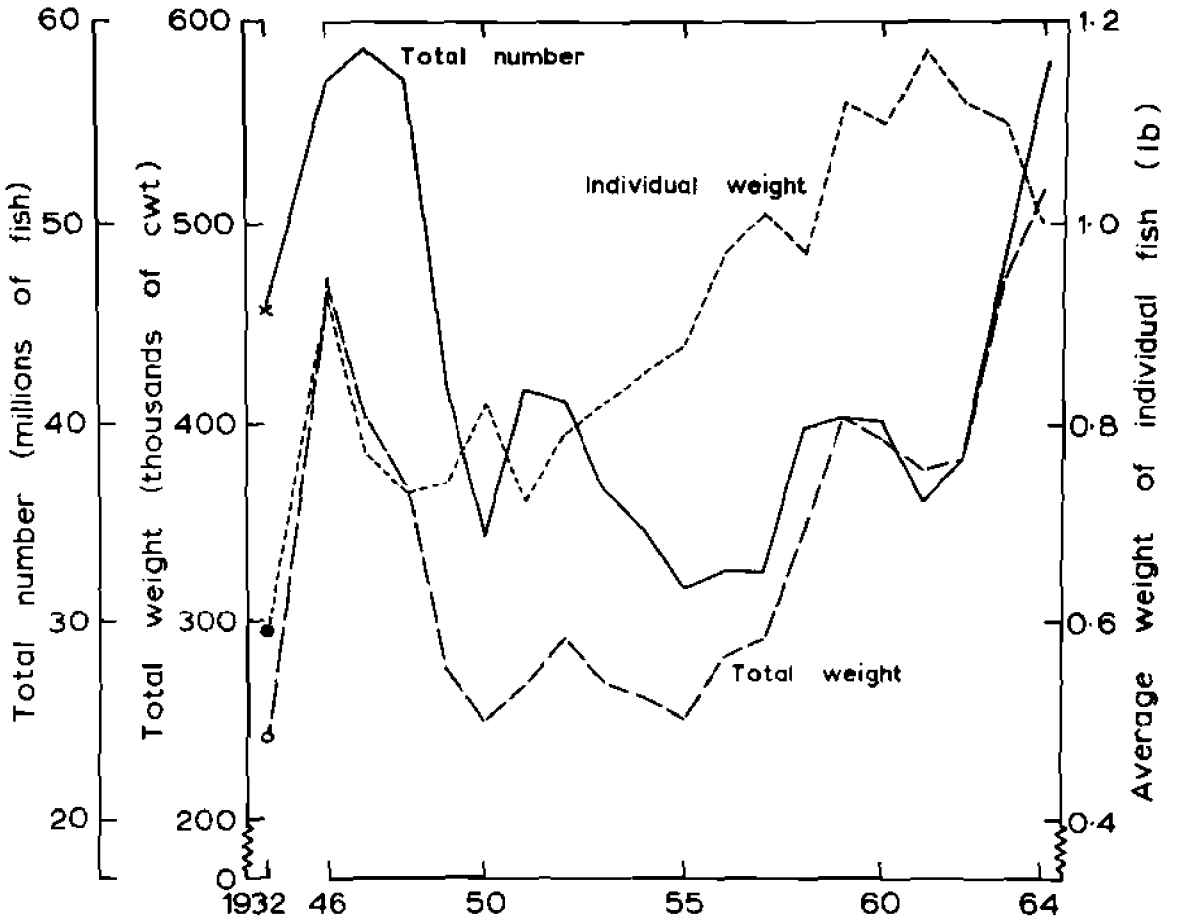


Figure 9. Numbers, weight and average weight of plaice landed at Lowestoft and Grimsby

declined to well below the pre-war level; the numbers reached a minimum in 1955 and have since increased, especially in the last couple of years. The average weight of the individual fish also increased during the war and decreased immediately afterwards, but even at the lowest level (in 1951) was much greater than the average pre-war weight. Between 1951 and 1961 the average size increased continuously, and by 1961 the average weight of plaice in the landings was a little less than twice that in the pre-war landings.

Before considering to what extent the changes in the stock and catch can be accounted for by these changes in the amount and distribution of fishing, it must be determined whether it is possible to treat the North Sea stock of plaice as a whole.

The adult plaice spawn in a number of distinct areas, the more important being the Southern Bight, Flamborough, and the German Bight. Recent tagging experiments by Dutch and English scientists have shown that fish spawning in one area will return to it year after year. During the summer they move away from the spawning grounds, and there is some degree of mixing between the different groups. This can be seen from Figure 10 which shows, for fish tagged on the Southern Bight grounds and in the German Bight, the returns in each quarter of the year following tagging. The figure shows separately the results from taggings

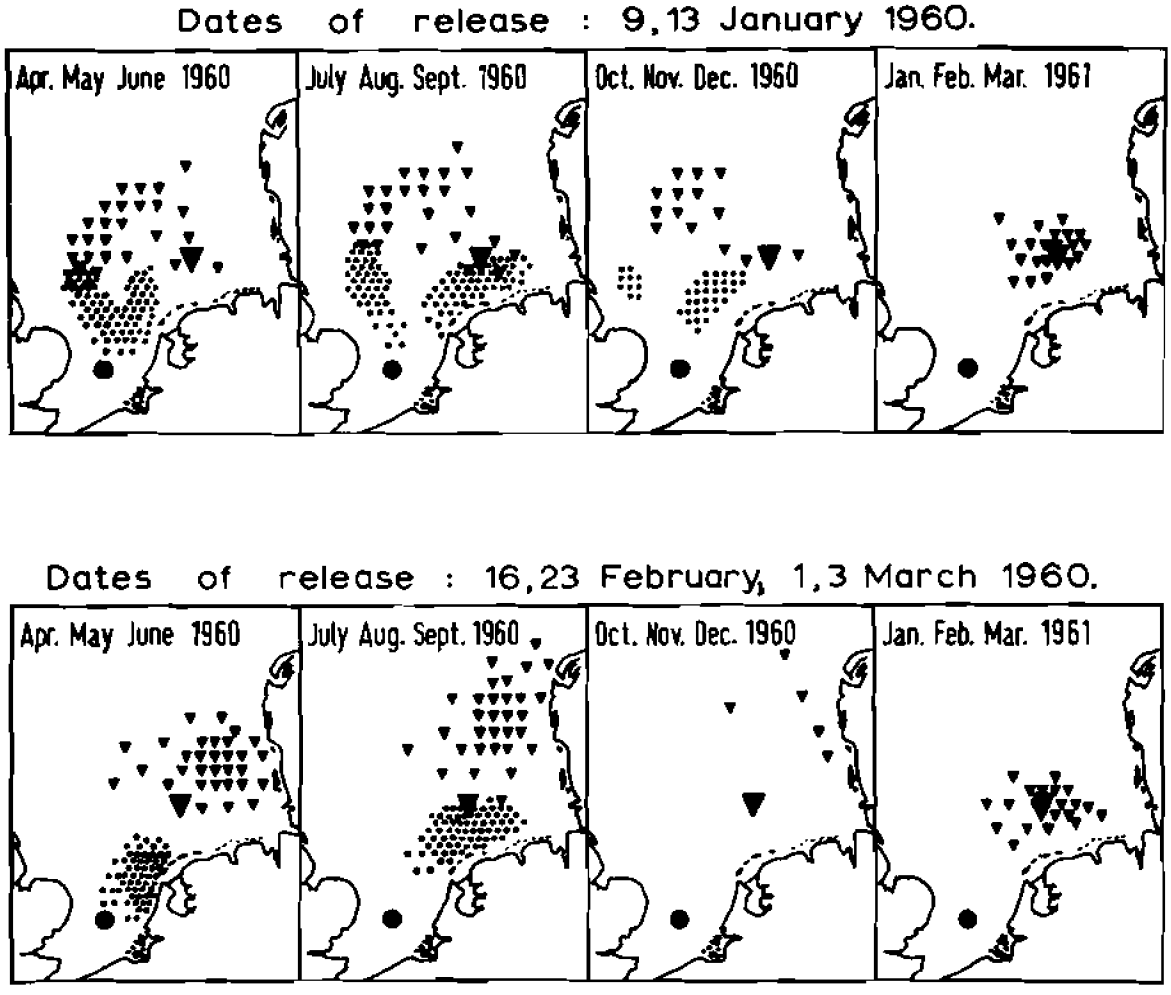


Figure 10. Dispersion of plaice tagged on two spawning grounds, the Southern Bight (circles) and the German Bight (triangles). The positions of tagging are shown by the large symbols

at the beginning and end of the spawning season. After spawning all the fish tend to move north, the early spawners moving north and west, and the later spawners moving north and east. It appears that the fish on

the grounds well to the north, where the most striking increases in the English catch have occurred, come from several spawning groups, including a large proportion of German Bight spawners, while the main area of reduction in the English catch has been in the Southern Bight. Thus the proportion of the German Bight spawners in the catches has increased. An increase also occurred in the stocks in the sea, as shown by the number of eggs found by research surveys - the numbers in the German Bight grounds have increased very greatly since 1950. There has therefore been a real shift in the geographical distribution of the plaice stocks as well as in the fishing, with an increase in the German Bight spawners, and a decrease (partially masked by the reduction of effort there) in the Southern Bight spawners. This shift is presumably related to the other natural changes which have occurred in the North Sea, e.g. the shift northwards of haddock.

The differences between individuals from the different spawning groups of plaice are, however, not large. The fish grow at about the same rate (though within each group there are differences between the faster growing ones in deep water, and the slower growers inshore), and die off from natural causes at similar rates. Therefore, the effects of changes in fishing practice (fishing less hard, or avoiding catching the smaller fish) will have much the same effect on the stock and on future catches, whichever group of plaice is concerned.

Thus changes in the proportions of the various spawning groups of plaice will not have any very great effect on the size of the total stock or of the total catch, provided that the total number of all groups, reaching commercial size remains the same. This number can be estimated quite closely from the commercial catches; even at the present rather reduced level of fishing the great majority - something like three-quarters - of the deaths among commercial-sized plaice are due to fishing, so that, as an average over a period, the number reaching commercial size each year is 4/3 x number caught. (Before the war it was about 5/4 x number caught.) As Figure 9 shows, comparing the 1950s with the 1930s there has been a slight decrease in the number caught by the English fleet, which suggests that, allowing for the slight drop in the English share of the total catch, and in the proportion caught, the total numbers of young fish reaching commercial size have not changed much. It is therefore probably reasonably correct to look at the effect of the various post-war changes on the plaice stock as a whole, without worrying too much about the different stocks, even though the real situation is not as simple as taking fishing effort off the small plaice in the Southern Bight and putting it on the same fish further north when they have grown.

We can now turn again to examining how much of the post-war changes in stocks and landings can be attributed to changes in the pattern of fishing. As already described, the events up to the early 1950s agree well with the expected changes following the post-war resumption of fishing at a level substantially below that of the pre-war years. Compared with the pre-war period, the deaths due to fishing after the

war made up a lower proportion of the total deaths, so that the numbers caught were less. Because of the lower death rate, the fish lived longer and had a higher average size; the bigger size more than balanced the smaller numbers, so that the weight caught increased. This accounts satisfactorily for the events up to about 1951.

Up till then the distribution of fishing was about the same as before the war - it was concentrated in the south-western part of the North Sea, on grounds where there are large numbers of small plaice. About 1952 there began a shift towards the areas containing bigger fish, as is suggested by the fall in the number of the category "small" and by the increase in the average size. This sort of change is self-perpetuating; less fishing on the small plaice means that more survive to become medium and/or large fish; more large fish means less incentive to fish on the small-fish grounds, so more survive to a good size, and so on. This swing to larger fish has continued, at least up to 1961; since then the average size has dropped a little, but is still some 50% greater than in 1951 and nearly double the pre-war size. This increased size of fish accounts for all the increase in total catch between 1950 and 1962, with the numbers landed changing very little.

This is precisely what would be expected theoretically; the change in grounds has had the same effect on the stock and catches as an increase in mesh size. Instead of being caught from a size of about 10 inches onwards, the fish do not enter the main fishery until they are 12-13 inches long. This is equivalent, in mesh terms, to a change from about 115 mm to about 150 mm, or protection for about an extra two years of life. Theoretical calculations show that this extra two years of protection, plus the reduction in the amount of fishing, should increase the catch by 50-70%. This agrees reasonably well with the actual increase in the international catch between the 1930s and 1960-62 (55 000 to 85 000 tons). However, the bigger catches in 1963 and 1964 have been due to increased numbers of fish being caught, and this improvement is likely to be only temporary.

OTHER CAUSES OF CHANGES IN THE STOCKS

It appears that the plaice stocks and catches have been increasing as a result of the two well known antidotes to overfishing - to fish less hard, and not to catch the very small fish. However, although these two changes are undoubtedly the most important factors affecting the North Sea plaice stocks, there are other points which should be considered. In most of the analysis only English data have been used; clearly the grounds fished and possible also the sizes of fish caught by our ships are not the same as those of other countries; regular information on these questions is now being collected by the countries concerned and will be available for future analysis.

Some other changes not directly connected with fishing have already been mentioned, for instance, the fact that the decline in the Southern Bight spawning stock has been balanced by the increase in the German Bight group, leaving the total number of young plaice reaching commercial

size about the same. This change is probably unconnected with any effect of fishing; the recent big drop in haddock catches and the increase in sole catches in the southern half of the North Sea are also the result of a similar northwards shift of the stocks over the past forty years. Changes in the total plaice stock may well occur in the future, though such changes will not lessen the need to make the best use of whatever numbers of fish do reach commercial size; to achieve this, do not catch them at all until they reach a good size and then do not fish them too hard.

The analysis has dealt only with the landings. Especially before the war (e.g. in the Danish trawl fishery) quantities of undersized plaice were caught, but rejected at sea. Though plaice are much tougher than many other fish (with luck in favourable conditions - damp cold weather - a plaice can survive on deck for some hours) undoubtedly a large proportion, and probably the majority, of these rejected fish failed to survive. Large numbers of very small plaice are also caught in the coastal shrimp fisheries, and changes in these fisheries could make a big difference to the number of young plaice reaching a commercial size.

EFFECTS ON OTHER SPECIES

Though plaice is the most important single species, it makes up only 32% of the total weight of demersal fish landed in England from the North Sea (rather more in terms of value). The changes in the catches of some of the other important species are summarized in Figure 11 which shows the English and total international landings of cod, haddock and sole for certain years from 1909 to 1964. The 1964 catches of haddock were exceptional, so the figures for 1962, which are more typical, are also shown. The changes in the cod catches have been much the same as for the plaice, to some extent for the same reasons - heavy fishing before the war, protection during the war, and moderate fishing since the war - giving average post-war catches higher than those before the war. The trends in haddock and sole have been in opposite directions. Over the past fifty years the total haddock catch, and still more the English catch, has been declining, while the sole catches have been increasing; it is tempting to ascribe both changes (and also the shift in the proportions of the different plaice spawning groups) to a common cause - possibly the slight warming of the North Sea that has occurred. Direct evidence is scanty; some support is given from the fact that the decline in the haddock stocks is not general throughout the North Sea, but there has been a northwards shift of the southern or south-eastern boundary of its distribution, though there is not such an obvious shift northwards of the boundary of the sole's distribution. In the past couple of years both trends in total catches have been reversed, but for different and well known reasons. In the spring and summer of 1962 conditions for young haddock were exceptionally favourable, and the 1962 brood is probably the largest ever known. The following winter (1962/3) was exceptionally cold and this decimated the sole stocks, both directly (dead soles were frequently reported in the catches during the coldest time), and also because the severe cold made soles easy to catch and vast

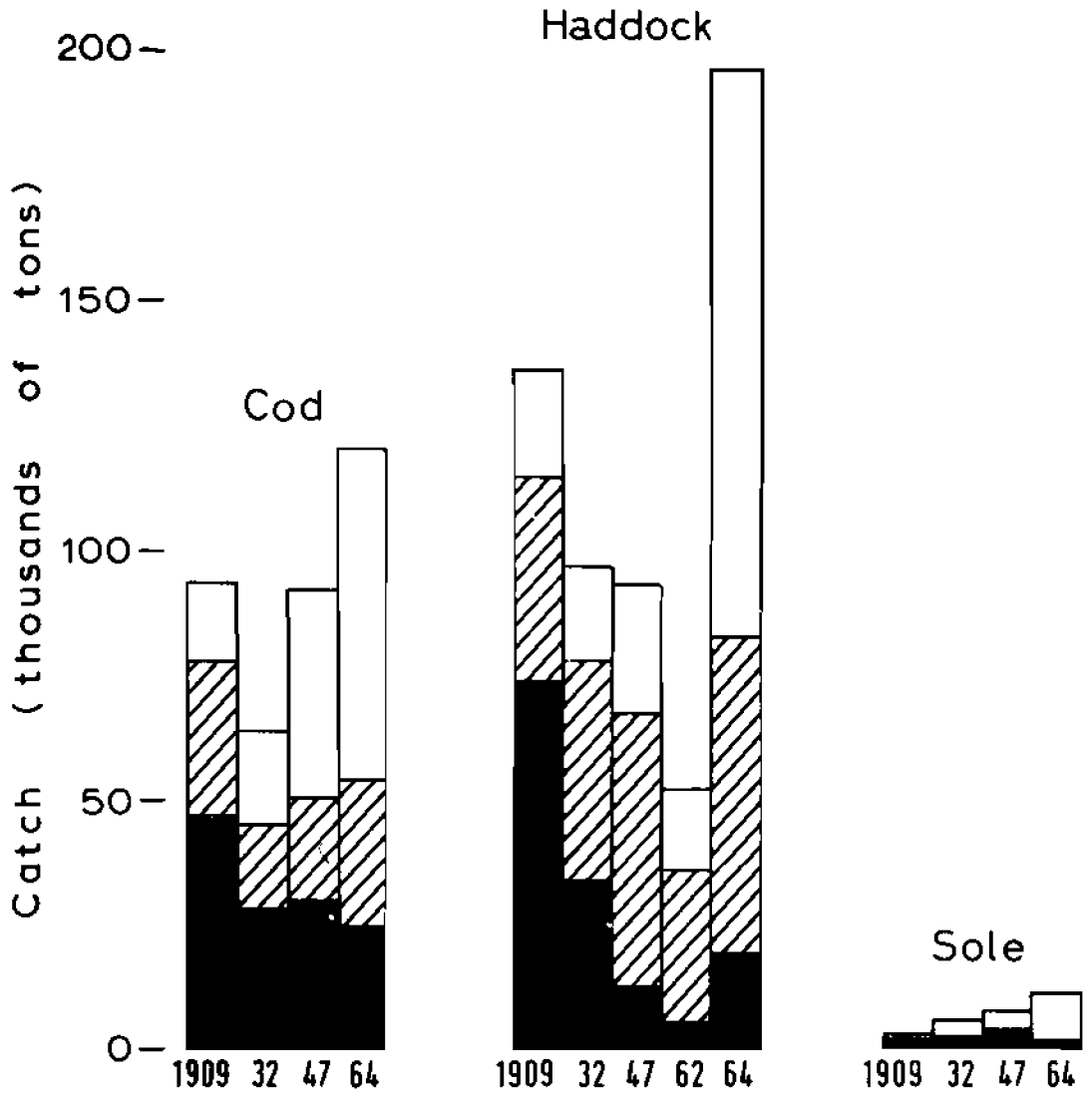


Figure 11. Landings of cod, haddock and sole from the North Sea by England (black), Scotland (shaded) and other countries (white)

quantities were taken in the early months of 1963 by fishermen of all countries. Though the 1963 sole brood seems to be strong, and should give better catches in the near future, at present the stocks of commercial-sized soles are extremely low.

Of the other important stocks therefore some have been affected by factors quite independent of fishing, but the cod stocks, and possibly others, have also benefited from the reduction of total fishing.

THE FUTURE

The present situation in the North Sea is very rosy; catches of plaice and several other important species are running at record levels. How long can this last? So far as the plaice is concerned this depends on the answers to two questions: (1) will the total amount of fishing remain low, and (2) will fishing remain concentrated on the larger fish? Whilst there is no fundamental reason why both of these should not happen, recent events are not too encouraging. In both 1963 and 1964 there were substantial increases in the numbers of fish caught, and though the estimated effort, in terms of hours fishing by an average English motor trawler, did not change, this estimate did not include any allowance for changes in the average power and efficiency of ships. In fact the average size of ship has increased; there are more of the larger trawlers from Grimsby fishing in the North Sea rather than in middle waters, while some of the older and smaller trawlers are no longer fishing. The distant-water and middle-water fishing has declined so much in the past ten years that it is likely that some new investment will be attracted to building ships to fish the North Sea rather than distant waters (for instance in one week in August 1965 the two top North Sea vessels at Grimsby, both 110 foot boats, grossed over £450 per day at sea, the same as the top distant-water grossing per day by a 180 foot ship). Certainly, because the vast majority of the ships in the English North Sea trawl fleet are less than ten years old (compared with an average of thirty years old in 1955), there is unlikely to be any decrease in the amount of fishing. Trends in foreign fishing are equally important, and though it is less clear what these may be, the trend in fishing generally is for more and more to be done; with the decline in most North Atlantic demersal stocks (and to some extent also in herring) the relative prosperity of the North Sea demersal stocks seems bound to attract some of the new vessels. Therefore, unless positive action is taken to stabilize the total fishing at around the present level it is likely that it will increase, leading certainly to a decline in the stocks (and therefore in the catch per boat), and probably also in the total catch.

Similar trends back to the unwelcome situation of the 1930s may also be occurring in the sizes of fish caught: in 1964 for the first time since the war there was a substantial increase in the number of small (under 12-inch) plaice landed at Lowestoft and Grimsby (from 3 million to over 7 million). This may have been due to the increasing demand for this size of fish for freezing, but if it continues it is bound to lead to a drop in the average size of fish caught, and hence (since the number of fish caught is limited by the number reaching a marketable size) to a drop in total catch. Unfortunately the trend to smaller fish, once started, is self-perpetuating; more small fish caught means that less reach a larger size, therefore it is less attractive to fish where the big fish are, so still more fishing becomes concentrated on the small-fish grounds. Not much can be done about this by regulation - the mesh size necessary to produce the same effect in protecting the small fish as is achieved by the present distribution of fishing is around 135 mm ($5\frac{1}{2}$ inches). The shift to the small-fish grounds would be discouraged

by increasing the minimum legal size, though on all grounds some small fish are found which it would be wasteful to discard, because a large proportion would fail to survive. It therefore depends very much on the individual skipper whether the trend towards smaller fish increases, or whether these small fish remain protected and the catches stay at their present good level.

A SUMMING-UP

Most analyses of the state of stocks in the sea, whether of whales in the Antarctic or cod in the Barents Sea, produce very gloomy pictures - sometimes catastrophic falls in total catches, as in the Antarctic, or at best large and costly increases in the total amount of fishing which fail to produce any corresponding increase in the total catches, while the catch per unit effort falls steeply. Scientists are therefore repeatedly advising on the need for conservation - protection of the small fish, e.g. by mesh regulation, and less fishing generally. Unfortunately, it has too often proved difficult to get the agreement necessary to put such conservation measures into effect; it is therefore very encouraging to see the increasing catches of North Sea plaice. This may not have been directly caused by conservation measures - the size of mesh at present in force in the North Sea has little effect on plaice catches, though the size limit must have had some effect in diverting fishing by several countries away from the grounds where the smallest fish are found. However, the changes which have occurred in the fishery - less fishing effort, and reduced catches of the smallest fish - and the observed results - increase in the total catch, catch per unit effort, and size of the individual fish - are precisely what would be expected from a sound conservation policy. These results are welcome, not only to those interested in North Sea plaice, but as an example of what can happen with good conservation.