

ANNUAL MEETING - JUNE 1966Note by the United Kingdom Commissionerson the Regulation of Fishing Effort

1. At its meeting in Halifax in 1965 the Commission considered the Templeman-Gulland Report entitled "Review of possible conservation action for the ICNAF Area", (Commissioners' Document No. 12; also Ann. Proc. 15, p. 47-56). This report made it clear that it was not sufficient to rely on mesh regulations so long as fishing effort continued to increase and that some limitation of effort or catch was required.
2. It was pointed out in discussion that the same general question had been raised at the preceding meeting of the North East Atlantic Fisheries Commission (NEAFC) in Moscow. At that meeting the United Kingdom had drawn attention to the practical difficulties which would be involved in introducing a system of catch or effort limitation and had suggested that member countries should think over these problems and be ready to discuss them more fully at the Commission's next meeting. This suggestion had met with general acceptance in NEAFC. In following up this suggestion the United Kingdom has studied the problems involved in catch or effort limitation in more detail and has circulated a memorandum on the Regulation of Fishing Effort for consideration at the NEAFC meeting in Edinburgh in May.
3. Although this memorandum has been written primarily with reference to the situation in the North East Atlantic in the opinion of the United Kingdom much of what is said - particularly with regard to the practical difficulties - is applicable also to the Northwest Atlantic. Moreover, as was recognized in the discussion in ICNAF last year, regulation of effort on one side of the Atlantic necessarily has implications on the other side. In these circumstances the United Kingdom would wish the considerations set out in the memorandum to be taken into account in any further discussion of this question of regulation in ICNAF. The memorandum is accordingly appended to this note for the information of Commissioners to ICNAF.
4. The memorandum refers to the discussion arranged by FAO in September 1965 between economists and biologists, a report of which is being submitted to the Commission (ICNAF Research Document 66-19) (and also to NEAFC). Paragraphs 22 to 26 of the memorandum deal with the economic considerations involved in conservation and these may be of relevance in connection with the special open meeting of the Research and Statistics Committee on Monday, 6th June, to which leading fishery economists have been invited.

Regulation of Fishing Effort

Memorandum by the United Kingdom Delegation *

Introduction

1. At the meeting of the Commission in Moscow in 1965 the report submitted by the Liaison Committee drew attention to the question of fishing effort regulation. It pointed out that the stock of cod in the Arctic was so heavily fished that further increases in fishing effort would result in a decrease in the average total catch; and that the total catch would increase with any decrease in effort until a maximum was reached about 10 per cent above the catch that would be taken with the effort then applied, at only a little more than half that effort. The report mentioned that the control of fishing effort was already being seriously studied in ICNAF and pointed out that if the amount of fishing were controlled in the Northwest Atlantic surplus effort might be diverted to the North East Atlantic and thus intensify the need for corresponding limitation of effort in the Commission's area. The Liaison Committee pointed out that the biological aspect of effort regulations could not be considered in isolation from the economic effort and said that it would help the further study of the matter if experts in the various fields, including economists, could meet together to discuss it.

2. The United Kingdom delegation welcomed the initiative of the Liaison Committee in raising the question of effort regulation which they thought the Commission would have to tackle if the results expected from other conservation measures were not to be rendered ineffective. They drew attention to some of the practical difficulties inherent in the subject and suggested that further study of the principles involved was needed before a meeting of experts could usefully be held. They suggested, and after a short discussion the Commission agreed, that delegations should give further thought to the problems involved and be prepared to take part in a general debate at the next meeting of the Commission. The purpose of this paper is to present the results of further study in the United Kingdom of the practical problems involved in the limitation of fishing effort in the hope that it may be helpful as a basis of further discussion.

3. To complete this introduction it should be added that at their meeting in June 1965 ICNAF had a general discussion of this subject. That Commission had before them a report by the Chairman of the Research and Statistics Committee (R. and S. Committee) and the Chairman of its Assessment Subcommittee, which showed that in most ICNAF stocks the amount of fishing was expanding and for many of these stocks of major importance had reached such a level that a further increase in the amount of fishing would bring no increase in catch and might even reduce the catch. The Commission approved a recommendation of the R. and S. Committee that it be enabled to seek active participation by economists in its work in the same way as biologists, statisticians and oceanographers at present take part. The Commission were informed of the steps being taken by NEAFC to study the question of effort regulation and agreed to give it further consideration at their next meeting. They were also informed that it was the intention of FAO to convene a small meeting of biologists and economists to discuss the matter later in the year, a report from which is expected to be available to both Commissions.

The effect on catches of Effort Reduction

4. Annexed to this paper is a memorandum by Mr Gulland which first discusses in general terms the effect on catches of reducing fishing effort in two

*presented as Document NC 4/51 to the Fourth Meeting of NEAFC

typical situations illustrated in Figure 1 in which total catch is plotted against total fishing effort, (a) where the size of fish at first capture is small (relative to the potential size of the species), and (b) where the size at first capture is relatively large. In the first case - which applies to most fisheries in the Convention area - if the effort is high a reduction of effort results in an increase both of total catch and still more of catch per unit of effort of fishing. In the second case, if effort is high, reduction of effort results in a smaller total catch but an increase in catch per unit of effort. In both cases there would be a consequent improvement in the economics of fishing. The Annex also shows that at any given high level of effort the total catch would increase with an increase in size at first capture (increase in minimum mesh) but that there are limitations to the increases which can be achieved in practice. More important however it shows that without some control of fishing effort the conservation effect of minimum mesh sizes, and changes to increase the effective minimum meshes of nets in use, may be nullified completely or dissipated in a few years. The Annex goes on to apply these general considerations to the situation in the principal parts of the Convention area.

5. The United Kingdom delegation believes that the basic principles governing the relationship between catch and effort are generally accepted among member countries and that the scientific appreciation set out in the Annex of the effect on catches of regulation of fishing effort is in accord with the views expressed by the Liaison Committee and will command general acceptance. Accordingly the delegation believe that the Annex not only affords a suitable basis for discussion but shows discussion to be highly desirable. In brief, it shows that in most areas of the North Atlantic reduction of fishing effort would reduce the costs of fishing (i. e. the cost of catching a given quantity of fish) in some areas it would also increase the total catch; in others it would at least prevent a decrease in total catch. There is thus both a biological gain^x and an economic gain to be secured from limitation of fishing effort; and the two together provide a clear incentive for action.

6. In the words of the Annex (paragraph 3) the object of effort regulation is to regulate the percentage of an exploited stock of fish that is caught, that is to say, the total catch from that stock*. In the simple theoretical case of a self-contained stock of fish of one species there are two ways of securing this result:

- (a) by regulating the total catch; and
- (b) by regulating the fishing effort applied to that stock.

Even in the simple theoretical case there are advantages and disadvantages attached to both methods of regulation and the choice between them may depend on a variety of considerations. In practice of course the situation is complicated in most North Atlantic fisheries by the facts that several species of fish occur on the same ground (the characteristics of which may not be the same) and that the fishing fleets of more than one country using different types of vessel and different types of gear are involved. These facts naturally affect the advantages and disadvantages of the methods of regulation and the choice between them. Above all, it is clear that in most situations control requires international agreement and has to be considered at the international level as well as at the national level.

^x The term "biological gain" is used in this paper to denote physical increase in the resource and the annual yield from it in contrast to the economic gain resulting from lower costs of fishing (higher catch per unit effort). A biological gain in this sense will often, perhaps usually, increase the total value of the annual yield and constitute an economic gain in that sense.

* More strictly the object of effort regulation is to regulate the fishing mortality rate which is directly proportional to the fishing effort applied and not to the total catch.

International Control

7. The North East Atlantic Fisheries Convention provides machinery for international agreement on either method of control though certain preliminary steps have to be taken under Article 7(2) before specific measures may be considered under Article 7(1). In the following paragraphs the merits and demerits of control by the two methods are first considered at the international level.

Control of Catch

8. There is no difficulty in principle in limitation of total catch. This is the easiest and most direct quantity to measure and there is a common unit of measurement (weight); limitation can be applied to the combined catch of a number of species in an area or to the catch of each species separately. Moreover the collection of catch statistics by area and species, and often for periods shorter than a year, is well developed in most member countries and could doubtless be further refined; and there are regular arrangements for the international publication of these statistics. Regulation by catch, therefore, has the advantage of established means of checking its implementation, that is to say enforcement (though there may be practical difficulties - see paragraph 15 below). On the other hand regulation of catch by itself does not secure any economic advantage. Indeed in the simplest case in which an overall limit of catch from an area is set this method of regulation could have the reverse effect of encouraging the application of higher, and more uneconomic, fishing capacity in an attempt to secure the maximum share of the catch (as happened in the case of Antarctic whales until 1962 and Pacific halibut). In any case an overall catch limit in an area is rather a blunt instrument because it does not distinguish between species and may produce the wrong results for the different species (the needs of which may, of course, differ); but catch limits for each species involve practical difficulties where species are mixed on the grounds. In either case, when the overall limit, or all the species limits, are reached fishing in the area for the species concerned must cease; the fishing capacity may then be diverted to other parts of the North Atlantic and create or intensify problems there (unless it can be diverted to other species or areas which are not in need of protection). A second disadvantage of a different kind is that the level of overall catch needed to secure that a given percentage of the stock is taken will vary from year to year owing to fluctuations in annual recruitment and possibly other factors.

9. The first of these disadvantages can be reduced, or rather removed, from the international field, if the overall catch limit is divided into national quotas. Each country would then have a total quantity of fish it was entitled to catch each year in the area concerned - or if desired a series of quotas for different species. The problem of overcoming the disadvantage is then transferred to the national level (see paragraph 13 below). The other disadvantage may prove more difficult to overcome in practice. Ideally it would require that the overall catch limit for an area must be fixed by international agreement in advance for each year, in the light of information about recruitment. It seems at least open to question whether information on recruitment can be available with sufficient precision, or soon enough, to enable the catch limit to be agreed internationally in time for it to be effective, i. e. some months before the start of the year to which it relates. It would appear to involve not only a more intensive collection of research data but also more frequent international meetings, at the scientific and Commission level, than now occur. An alternative approach may be possible; that is to say, the overall catch limit (and the national quotas) could be fixed on a conservative basis and adjusted in subsequent years in the light of scientific assessment as to whether it had been set too high or too low. Though in theory this alternative may seem a second best solution, in practice, since most stocks in the Convention area are of long lived species, it might provide a reasonable basis of control provided that adjustments could be made speedily, i. e. one year in arrears rather than two years.

Control of Effort

10. In theory regulation of fishing effort in any area provides a means of avoiding some of the disadvantages of catch control. Since fishing mortality is proportional to the total fishing effort, this method would take care of annual fluctuations in recruitment and the total catch would vary, and rightly vary, with these fluctuations; the benefits of good recruitment would thus be secured automatically without the need for annual adjustment. More important, regulation of effort would secure economic as well as biological gain. However, if the stocks are more (or less) available to capture than usual, an effort limit (unlike a catch limit) would take too many (or too few) fish; it is difficult to provide for this in advance because the factors governing availability to capture are changeable and very difficult to predict. Effort limitation or restriction moreover like an overall catch limit cannot distinguish between species when they are intermingled on the grounds and therefore may produce the wrong results for some species; and as in the case of catch limits the diversion of 'surplus effort' might give rise to other problems. For the reasons mentioned in the next paragraph, if effort regulation is adopted it would probably have to be operated on a national rather than international basis.

11. The main difficulty of effort control is that there is no common unit by which effort can be measured. This fact makes it difficult either to fix a global limit or to divide it among countries. In essence the total fishing effort applied to a stock of fish depends on the number of vessels employed, their size, power and type of gear used, on the number of hours spent in fishing and the particular season and grounds fished. A good deal of research has been applied to this subject in several countries and a considerable amount of statistical information is already collected and, if not published in full, made available to the International Council for the Exploration of the Sea. But although some fairly sophisticated calculations have been made about the comparative fishing power of different types of vessel and gear there is still a long way to go before the physical characteristics of all vessels and the gear they use can be reduced to standard units internationally accepted. Moreover, even if this task could be achieved for all existing vessels, constant adjustment would be needed to take account of new designs and technological innovations in both vessels and gear. But as indicated above, measurement and control of the physical characteristics of vessels and gear is not enough by itself. The amount of fishing must also be controlled. Apart from the fact that this depends on natural circumstances, such as weather, beyond control, it would in practice be virtually impossible to control, except perhaps for relatively small vessels making short trips to fishing grounds near their base ports. For vessels fishing further afield the number of trips made per annum could doubtless be controlled, and within limits this might control the number of days spent on the fishing grounds but hardly the number of hours fished. In any event this kind of control gives rise to the same kind of enforcement difficulties as catch control referred to in paragraph 16 below.

12. Another approach to this problem might surmount the difficulties mentioned in the preceding paragraph and secure some of the benefits of full control of effort. This would be to secure international agreement to reduction of fishing effort by each country to a given percentage of the effort applied in an area in a base period. The method of securing this would be left to each country to determine. This would avoid the need to have a common measure of fishing effort and the need to fix in absolute terms either the total effort or each country's share. Moreover the success achieved by each country could in the short term be checked by the total catch taken by each country from the area in question; for, from year to year the catches of each country should change by the same percentage (not necessarily the agreed percentage). The national catches from the area would provide a short-term measure of the relative success achieved and provide a basis for corrective action.

National Control

13. It was stated in paragraph 10 that if it were decided to introduce an international system of effort limitation it would probably have to be operated on a national basis, i. e. each member country would have to institute arrangements for controlling the effort of its fishing vessels. This would certainly be the case if the approach suggested in paragraph 12 were adopted.

14. If the alternative of international control of catch were adopted with division into national quotas member countries might have more freedom of choice. A country might decide, for example, to allow free fishing until its catch quota were reached. This would involve at national level disadvantages of the kind mentioned in paragraph 8 - abrupt cessation of fishing in the area to which the catch limit applied, encouraging operators to apply too much effort in order to secure a maximum share of the national quota, diversion of effort to other areas and so on. Above all, such a system would not secure economic advantages to operators in the form of increased catch per unit cost. A country might decide, therefore, to combine the national catch quota with a system of effort regulation.

15. Where a choice of systems is open to member countries the system they choose is primarily a matter for them to determine. But the system adopted, and especially the efficiency with which it could be operated, would be a matter of interest at international level and might possibly influence the choice of methods of control at international level - by regulation of catch or effort. For it is crucial to any system of international control that the way in which it is implemented is fair, and is seen to be fair, as between the countries concerned. It is relevant, therefore, to consider how regulation at national level could be operated in practice and in particular to consider how the system adopted could be enforced; and to do so in relation to the various possible situations that might arise.

National Systems and Enforcement

16. (a) Suppose first that an annual global catch limit is fixed for the whole of the Convention area and divided into national catch quotas. If a country decided to allow free fishing until the catch quota was reached, fishing by its vessels in the Convention area would then have to stop. Demersal fish supplies from national vessels would then be interrupted except to the extent that vessels could be switched to other species not yet much sought after such as blue whiting or redfish or that the larger vessels could be diverted to more distant areas. The market would no doubt be supplied to some extent from frozen stocks but shortages would be very likely. How serious this would be would depend on the length of the period, freezing capacity and so on. Fishermen, however, would probably try to catch as much fish as they could before the ceiling was reached and possibly to introduce new catching units so as to secure a maximum share of the quota, and this would tend to bring the catch limit into operation sooner and lengthen the remaining period. The interruption of fishing would attract criticism not only from the fishing industry. The resulting strong market demand would no doubt attract increased supplies from abroad (which would intensify the criticism) and also provide a strong inducement to fishermen to evade the catch control by landing their fish in unusual places or by unusual methods. Some might evade control by landing their catch in other countries. Some of these difficulties could perhaps be avoided or lessened if national catch quotas were divided into quotas for shorter periods; then the stoppages and interruptions to regular supplies would be shorter and intermittent. This would help to reduce some of the pressures against control but it might, at the same time, make control more difficult in practice. It

may be noted in passing that control by this method would not bring any economic gain to operators. Indeed insofar as it encouraged additional capacity it might have the reverse effect in two ways - by reducing the catch per unit of cost and by reducing the prices realized by the catch. In fact, whatever refinements of the method were introduced individual operators would have no assurance of being able to catch any particular quantity of fish during the year and would not therefore be able to plan their operations on an economic basis so as to avoid unnecessary effort. This would not be so if a catch limit were fixed for each operator. But it would be almost impossible to divide the national catch limit in this way without running the risk of it being exceeded or not being reached. And more effort than need be might still be employed.

(b) If an annual global catch limit were fixed for a part only of the Convention area and divided into national quotas either on an annual basis or for shorter periods, some of the difficulties mentioned in sub-paragraph (a) above would be lessened. There would be less interruption of fish supplies since fishing would remain free from control in other parts of the area. Indeed there might be little effect on supplies because there would be more scope for the diversion of effort from the controlled area, e. g. to other parts of the Convention area, nearer at hand. This might intensify the pressure on stocks in those areas and necessitate control by separate catch limits in those areas too, at least to prevent the situation in those areas from deteriorating. In either event - whether there was a catch limit for one area or separate limits for two or more areas, there might be evasion and enforcement difficulties.

17. In theory the enforcement of national catch limits should be relatively easy since in most countries a continuous record of catches by species from different parts of the Convention area is kept. It ought, therefore, to be possible to enforce this system of control whether it is applied to the whole Convention area or to particular parts of it; or if separate catch limits are applied to different parts of the area; or if separate catch limits are applied to different species in the whole area or in different parts of it. In practice, however, there might be considerable difficulties. Catch statistics must always depend on what the operators report on their return to port and so long as fishing is virtually free from restriction and operators are free to deploy their effort where they please there is no reason to doubt the veracity of the reports on which the statistics are based. But when restrictions are in force this condition might no longer be fulfilled. When the national catch limit for a particular area had been reached, involving the diversion of effort to other areas, some operators might be tempted to continue fishing in that area and to report their catch as having been taken elsewhere. Although subterfuge might be suspected, it would be very difficult to prove that an infringement had occurred. The more stringent the restrictions, the greater this temptation would be. There would be less scope for evasion of control in this way if there were catch limits in all parts of the Convention area; it might be least if there were a single catch limit for the whole area, though still appreciable so long as a significant number of vessels are capable of fishing outside the area. Moreover, evasion might take place through landings outside the usual ports or abroad. The temptation to evasion would be reduced if alternative and profitable forms of fishing, not subject to control, were available for part of the fleet, e. g. herring fishing. The possible evasions mentioned above would not only make strict enforcement of catch limits difficult, but they would undermine the validity of demersal catch statistics which among other things form one of the main elements in the data on which scientific assessments of the state of the stocks are based.

18. The alternative system of national control by means of limitation of fishing effort, whether alone or in conjunction with catch limits, must now be considered. The difficulty previously mentioned of measuring fishing effort in

standard units would make it difficult to prescribe a national quota of fishing effort within which individual operators could fish freely (though it might be easier to devise a suitable unit at national rather than international level). But this does not rule out some system of effort allocation. It should be possible for example to formulate restrictions on effort in terms of some of the physical characteristics mentioned in paragraph 11. The number of vessels of each type and power could for example be controlled. It so happens that in the United Kingdom there is already legislative authority for a system of licensing of fishing vessels operating in any area which may be invoked provided that restrictions similar in effect are imposed on fishing vessels of other countries fishing in the same area. This system could be applied to limit the number of vessels of each type allowed to fish in any area or areas. Clearly this would be accompanied by difficulties, for some operators might be put out of business or have their scale of operations reduced and new entrants to the industry might have to be prohibited. But in contrast to the effect of other ways of limiting effort, the result might be that a smaller number of vessels caught the same amount of fish resulting in an economic gain to the operators as well as the biological gain from the control. Limitation of this kind applied to the number of vessels might not, however, be sufficient without some other controls. The number of hours spent in fishing - the other element in fishing effort - would remain at the discretion of the operators in so far as they are not already fishing to maximum capacity.

19. The number of hours spent in fishing cannot be directly regulated by the state except at inordinate expense by placing an inspector on each vessel which in any case would be impracticable in all but the largest vessels. Some attempt at indirect control might be achieved by limiting the number of trips per annum by each vessel or by limiting the length of trips - number of days at sea - but at best this would achieve only an approximation to limitation of the total effort to the desired level and then only if the control were applied to the whole Convention area. If effort had to be limited in a part only of the area or if different limits were fixed for different parts of the area, this method of control would be open to the same difficulties of enforcement as catch control. There would be no reliable method of ensuring that the vessels confined their operations to the area for which they were licensed. In consequence, this method of national control, whether or not coupled with catch limits, would not provide an effective means of enforcing any refined system of international regulation requiring different levels of fishing effort in different areas in accordance with the conservation needs of the different areas.

20. The considerations set out in the preceding paragraphs lead to the same conclusion as that mentioned in paragraph 12. The difficulties of enforcement would make it virtually impossible at national level to implement effectively any system of international control that was related to the differing needs of the fish stocks in the different parts of the area. This suggests that some compromise might have to be made between what is desirable and what is practicable. The approach suggested in paragraph 12 of a general agreement among the countries concerned to reduce their fishing effort by a given percentage would be such a compromise. In the first instance the aim might be to secure this result over a period of, say, five years. The means adopted might be left to the choice of individual countries who might adopt different methods. Some countries might for example limit the extent to which new vessels were built as old vessels became obsolescent by positively encouraging the scrapping of old vessels particularly those suited to fishing in the more heavily fished grounds. Other countries might introduce a licensing system; or reduce the extent to which fishing operations were subsidized directly or indirectly; or use a combination of methods. If a scheme of this sort could be agreed, it might achieve some of the objects set out in the Annex though falling short of a strict scheme of regulation based on the scientific assessments of the fish stocks in different parts of the Convention area.

Implementation of the scheme could be checked by regular confrontations in which countries would be required individually to explain what steps they had taken and to demonstrate that they had resulted in, or were achieving, the reduction of effort of the agreed magnitude. A comprehensive scheme of this kind would bring relief to all parts of the Convention area in all of which the Annex shows that the demersal stocks would benefit from some reduction in effort. Moreover, it should be possible, in a general way, to secure greater restrictions on the larger vessels capable of fishing in the more distant and heavily fished areas than on the smaller vessels.

21. In the preceding paragraphs enforcement has been discussed in purely national terms. While it is hoped that in due course international inspection arrangements may be introduced for certain conservation measures, it is generally agreed that the basis of any enforcement arrangements must be national. This is particularly true of most of the possible systems of control discussed in this paper. For example, if there were a predetermined limit on national fishing effort occasional encounters between international inspectors and fishing vessels on the fishing grounds would not help towards enforcement. For the most part this is true of control by national catch quotas. But in some circumstances international inspection at sea might be useful. For example when the national catch limit for a particular area had been reached detection of that nation's vessels fishing in that area would help in blocking one of the loopholes in national enforcement mentioned in paragraph 17. Again, if vessels are licensed to fish in particular areas international inspection arrangements at sea would help to detect infringements.

Economic Considerations

22. The need for regulation has been discussed in this paper mainly in terms of the biological objectives set out in the Annex of increasing the sustainable yield from the fisheries or preventing decreases. These are the objectives which have hitherto governed consideration of conservation measures by the Commission. The Annex and the Liaison Committee report both draw attention to the economic gains to be secured by some forms of regulation and this has been taken into account in the foregoing parts of this paper in discussing the merits of different forms of regulation. The economic aspects of regulation are obviously of great importance since the object of all fishing operations is primarily economic and overfishing is basically economic in causation. The United Kingdom delegation has therefore given considerable thought to these economic considerations bearing on conservation measures and the part which economists can play in studying them; and the delegation has been helped in doing so by the discussion arranged by FAO referred to in paragraph 3.

23. It appears to the United Kingdom delegation that there are broadly two main respects in which economic considerations have a bearing on the question of regulation. The most obvious of these is the economic effects of different methods of international control and their influence on the choice between alternative methods of control designed to secure biological aims. But there is the wider question whether the biological aims of regulation should be supplemented by or combined with economic objectives.

24. The first of these aspects is the only one which has been dealt with in any detail in the earlier part of this paper. It has been shown that regulation by catch limits does not by itself result in economic gain unless accompanied by effort regulation; it has also been shown that the biological objectives of regulation by the measures now in force (minimum mesh sizes) may be defeated unless there is control of fishing effort. The same could be said of other forms of regulation provided for in Article 7(1) of the Convention. In the United Kingdom it is thought that except in relation to special situations which do not generally occur in the demersal fisheries of the North Atlantic,

or in relation to some species of fish - pelagic or anadromous - international control by such methods as closed areas or closed seasons would not generally secure economic advantages. Regulation of fishing gear or limitations on the size or power of fishing vessels could have the reverse effect by decreasing the efficiency of operation. This is true of mesh regulations in the short term: but in the longer term it may increase efficiency and secure economic benefit. Regulation of size limits of fish, given that only a small proportion of most demersal species survive when returned to the sea, is also essentially inefficient and uneconomic in effect but may be justified as a necessary support for the enforcement of minimum mesh sizes. These economic effects of regulation must of course be taken into account in considering different means of international regulation for biological ends.

25. The second main question is whether economic objectives should or could be taken into account in considering international regulation of fishing. It is shown in the Annex that in the typical case where the size at first capture is small there is an economic as well as a biological gain if the total fishing effort is reduced to the level at which the sustainable yield is at a maximum. This is not necessarily, however, the optimum economic level of effort. Reduction of fishing effort below this level should in theory produce better economic results because in economic terms the savings in effort should be greater than the loss of catch. In theory there is a point on the catch-effort curve (to the left of the maximum sustainable yield) where its slope is the same as the graph of costs of catching plotted against effort and the ratio of catch to costs of catching is at a maximum. This could be described as the point of maximum economic yield and it could be regarded as indicating the level to which fishing effort should be reduced in order to secure the maximum economic benefit. A similar point could be fixed on the catch-effort curve for large size at first capture.

26. Although, since economic considerations are basic to fishing operations, it is attractive on the basis of this rather sketchy theoretical analysis to contemplate setting an economic objective for international regulation of fishing it is felt in the United Kingdom that it would be impracticable to attempt to do so. In the first place, the simple theoretical model discussed in the preceding paragraph will not represent the actual position in practice. The theoretical maximum economic yield will be affected by changes in market prices and other relevant factors which reduction in effort may be expected to bring about and the variation between countries of fishing methods, economic and social conditions, as well as international trade in fish would make it difficult to determine on any objective basis at what level of total fishing effort the maximum economic yield would be obtained. There may in fact be no single optimum economic level of effort for an international fishery. Moreover, even if a single optimum level could be established, there are no objective criteria by reference to which the effort could be divided fairly between the countries concerned: it could, it seems, only be done by negotiation. In the opinion of the United Kingdom delegation, it is open to question whether there would be any useful international purpose served in attempting to establish economic objectives for regulation; it would follow that in practice the relevance of purely economic considerations was confined to the narrower field of (a) choice between international measures for securing biological objectives and (b) the manner in which they can be implemented at national level.

Conclusion

27. In presenting this paper the United Kingdom delegation has not attempted to reach conclusions or to suggest any specific action which the Commission should take. Its purpose is rather to set out possible forms of international regulations which would help to fortify existing conservation measures with benefit to the operators in member countries and the resources on which they depend; and at the same time to indicate what would be involved at both the international and national level in their adoption. The United Kingdom delegation

believes that notwithstanding the formidable difficulties with which the subject is fraught it is of such great importance that the Commission should give serious consideration to the matter and it hopes that this paper will be helpful to the Commission and to member countries in further discussion of it.

Office of the Commission
London, S. W.1
April 1966

ANNEX

The Effects of Effort Reduction on Catches

General

1. Any predictions of the effect of reducing effort are, like assessments of the effects of mesh regulation, comparisons of what would be caught with reduced effort with what would have been caught with the present effort. Other changes, unconnected with fishing may make future catches quite different from the present. For instance, North Sea haddock have recently been very good because of the outstanding 1962 year-class; the point is whether the catches from this year-class; would have been even larger if the total effort had been less during its life-span.

2. Before examining the extent to which the yields of different fisheries in the North-East Atlantic area would benefit from a restriction of effort, it is necessary to make one preliminary point. The effect of any given restriction of effort depends on the size of fish at first capture which is determined by the mesh regulations in force. This is illustrated by Figure 1.

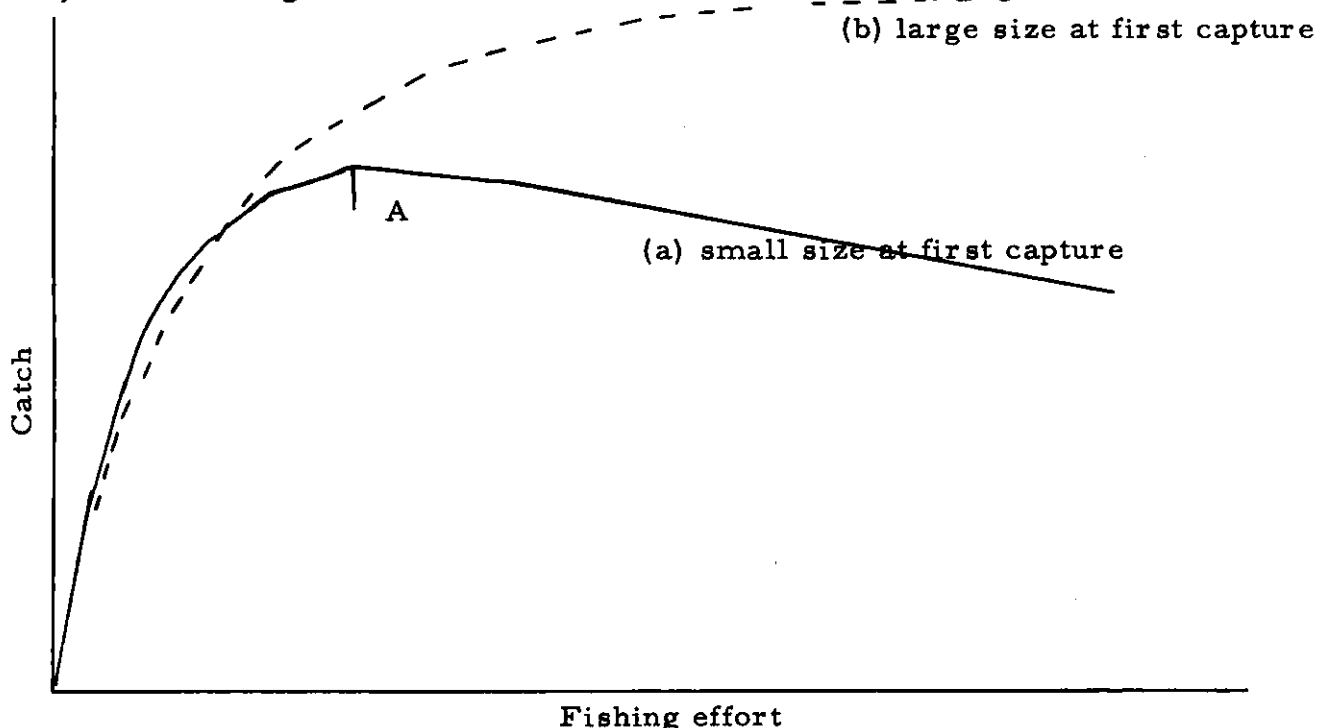


Fig. 1. The relation between total catch and the fishing effort at two sizes at first capture (mesh sizes).

3. In Figure 1 the horizontal axis is given as the fishing effort. Strictly this is the fishing mortality coefficient, i. e. the percentage of the stock of fish that are caught per unit time, which will be proportional to the total fishing effort (number of days at sea, hours spent fishing etc.) provided proper correction is made for size of vessel, type and efficiency of gear, etc. The objective of effort regulation is to arrive at what is considered the optimum

position on the appropriate curve, i. e. to take the appropriate percentage of the stock.

4. Figure 1 shows that at low levels of effort the size at first capture has little effect on the catch, but that as effort increases mesh regulations affecting the size of the fish at first capture become increasingly important.

5. At any given high level of effort, the catch is substantially greater if the size at first capture is large. On the other hand the relative benefit of restricting effort is greater when the size of first capture is small. Then the maximum catch will be obtained at quite a moderate level of effort (Point A) and can be quite pronounced. If effort has expanded beyond this point a reduction in effort will give an appreciable increase in total catch, perhaps 30% or more. In this situation the fishermen will benefit not only from getting a larger total catch, but also in getting it at less cost, i. e. cost per unit of catch will be reduced.

6. With larger size at first capture the peak catch occurs at higher levels of effort and is less pronounced, so that in this case there may be little or no increase in catch from a reduction of effort. But the second benefit of effort restriction will still remain, and may be no less important - it will still be possible to obtain substantially the same total catch with a greatly reduced effort, i. e. to increase the catch per unit of effort.

7. If there is no effort regulation the benefit of mesh regulation, so far as the individual fisherman is concerned, is likely to be transitory, because once regulation becomes effective, and the catch per unit effort rises, the tendency will be for the total effort to increase, bringing the catch per unit effort back to its original level.

8. The predictions presented here refer strictly only to conditions with the present size of first capture.

9. An increase in size at first capture would reduce any relative benefit of reducing the total effort below the present level. Such an increase seems most likely in Region 1 of the Commission, where it may not be too optimistic to hope to solve the chafer problems, and to reach mesh sizes say around 150 mm. Even with this large mesh (compared with the present effective mesh of about 90 mm) and assuming that by then the effort has not increased above the present level, there might be a small gain in total catch of cod from a small reduction of effort, and theoretical calculations suggest that halving the effort would only reduce the catch by about 10%.

10. Conversely, if the size of first capture is reduced, the benefit of reducing effort from the present level would be greater. Such a reduction in size at first capture might occur through a greater concentration on the smaller sizes of fish, such as seems to be occurring in the northern areas on both sides of the Atlantic where the modern factory trawlers can use smaller fish than are generally acceptable on the fresh-fish market.

Present State of NEAFC Stocks

11. In 1964 just under 7 million tons of fish were landed from the NEAFC area. Of this total just over 3 million tons were demersal fish (cod, redfish, plaice etc.), and just under 4 million tons were pelagic fish and fish for industrial purposes (herring, mackerel, sandeels, Norway pout etc.). Since the need for restriction of effort is better established for the demersal fish, and the fisheries are to a large extent distinct, only the demersal stocks will be considered here, though it should be noted that in the Liaison Committee's report to the 1965 Commission meeting it was stated that for some herring stocks any increase in effort would not result in a corresponding increase in landings.

12. The demersal landings mainly come from the northern regions of the Commission's area (Region 1 1,900 thousand tons, Region 2 950 thousand tons and Region 3 200 thousand tons).

13. Region 1. The total of demersal landings in 1964 was 1,900 thousand tons. The major stocks are in the N. E. Arctic and at Iceland, with smaller stocks at Faroes and East Greenland. The landings in thousands of tons of the major species are set out in the table below.

Landings of fish from Region 1 (in thousands of tons)

Species	Area			
	N. E. Arctic	Iceland	Faroes	E. Greenland
Cod	468	434	25	36
Haddock	87	99	19	-
Coalfish	197	60	22	1
Redfish	66	95	8	42
Others	115	77	18	3
Total Demersal	933	765	92	82

14. The state of these stocks has been reviewed recently by ICES working groups. For cod they concluded that, except probably at East Greenland, the stocks were too heavily fished. In the N. E. Arctic a halving of effort (from the 1963 level) would increase the catch by about 10%. (The effort in 1964, and probably also in 1965, was below the 1963 level, but it is too early yet for this decline to show clearly in the catches.) At Faroes and probably also at Iceland, a moderate reduction in total effort will lead to a slight increase in total catch. Only for the small East Greenland stock is it possible that increased effort will lead to any appreciable increase in total catch.

15. The haddock stocks in this region are also too heavily fished. In the N. E. Arctic a halving of effort would increase catches by 10%. The stocks at Iceland seem to have benefited from protection of the small fish, but fishing effort is high, and moderate increases or decreases in fishing will have little effect on total landings.

16. The coalfish stocks are probably less heavily fished than cod or haddock, but tagging experiments have shown that at least locally the fishing rates are quite high. Though in most areas further increases in effort would probably give some increases in total catch, it would be proportionally less than the increase in effort, and the catch per unit effort would fall.

17. The stocks of redfish have proved more difficult to assess, and the working groups have not been able to make any definite statements about the effects of changes in effort. However the history of redfish fishing on both sides of the Atlantic is of declining total catches after an initial more or less pronounced peak in catches; on the known grounds the stocks are probably quite heavily fished, and moderate reductions of effort will not cause any appreciable loss in catch.

18. Region 2. Nearly 950 thousand tons of demersal fish were landed in 1964, mostly from the North Sea. In the North Sea the most important species were

Haddock	199,000 tons
Cod	122,000 tons
Plaice	110,000 tons
Whiting	92,000 tons
Sole	11,000 tons
Coalfish	55,000 tons

19. The North Sea is the area where overfishing was first felt, and where it has been best studied. During the 1920s and 1930s the major stocks were much too heavily fished, and a substantial reduction of effort would have resulted in increased catches. Since then there have been big changes in the fisheries, and these changes have not been the same in all parts of the North Sea.
20. In the southern North Sea the total effort now is less than before the war; there has also been a trend at least in the English plaice fishery away from the small sizes of fish, which has the same effect as using a very large mesh. Probably as a result of the low but increasing fishing, and the large size at first capture, the total plaice catch from the North Sea in 1964 was the largest ever recorded (110 thousand tons in 1964, compared with an average of about 60 thousand before the war). The present total effort on plaice, and its distribution (concentrated on the large/medium fish) is therefore probably not far from the optimum. Unfortunately, there seems to be a tendency in the 1964 landings for more very small fish to be caught. If this tendency continues there would be a gain in total catch by reducing the effort. (To give the same protection to small plaice as is given by the 1963 distribution of English fishing would require meshes in the 120-150 mm range.)
21. The total North Sea cod catches have also, in the last few years, been at a record level (121 thousand tons in 1964 compared with a pre-war average of 70 thousand tons). Like the plaice, this is partly due to a reduced amount of fishing, but there also seems to have recently been increased numbers of young fish, probably for reasons unconnected with fishing. Probably some increase in catch would result from an increase in effort.
22. The haddock situation is somewhat confused by changes which are probably not directly due to fishing, particularly the northward shift of the southeastern boundary of the haddock distribution, from near to the Dutch coast in the 1920s to about the Dogger in the 1950s. This shift has tended to reduce the overall catches, though the catches in the northern North Sea have increased. Theoretical considerations suggest that a decrease in effort from the present levels would give greater average yields, possibly by as much as a 20% increase from halving the effort.
23. The other species in the North Sea (sole, whiting, turbot, etc.) are all probably fairly heavily fished, and would react to changes in effort in much the same way as the major species.
24. Overall, the striking feature of the central and southern North Sea demersal fisheries is how well the changes in catch and catch-per-unit-effort since the war have followed the expected pattern as a result of the considerably lower effort (down by about a third) compared with the serious overfishing of the 1930s; i. e. an increase in total catch, and a large increase in catch per unit effort. The important immediate task is to prevent any increase in effort, particularly as most of the ships fishing in the North Sea cannot easily be diverted to other stocks.
25. Stocks outside the NEAFC area
- Though outside the NEAFC area the stocks of fish in the ICNAF area, especially in the northern regions (West Greenland, Labrador and Newfoundland) are fished by some of the same vessels (and sometimes even on the same voyages) as the stocks in the northern part of the NEAFC area. It should be noted therefore that these stocks are also moderately or heavily fished. The state of these stocks has been reviewed by the ICNAF Assessment Subcommittee. They concluded that the effort generally had been increasing markedly and for all the major stocks the effort was around or beyond that giving the maximum yield, and that further increases in effort would give little or no increase in catch. Probably, therefore, in some areas, e. g. Grand Banks, a moderate decrease in effort would give an increased catch.

Summary

26. In the northern parts of the NEAFC area - Bear Island, Barents Sea, Iceland - a reduction in effort, say to a half or two-thirds the present level, would give an increased total catch of cod, and much greater increase in catch per unit effort. For the other important demersal species - redfish, coalfish and haddock - reduction of effort might also increase the total catch, and would certainly increase the catch per unit effort. If the surplus effort were diverted to the north-west Atlantic this would merely shift the problem, and not add to the catch from the western grounds. There are, however, relatively lightly exploited grounds outside the North Atlantic where much of the effort, e. g. factory ships, could go to. The North Sea fisheries, which were in as bad a state, or worse, in the thirties, have recovered and the problem is to prevent a re-expansion of effort. This problem may now be urgent, as the economic attraction of the North Sea, compared with distant waters, must be increasing.

J. A. Gulland
Fisheries Laboratory
Lowestoft
England
16. 3. 1966