SOME CONSIDERATIONS OF MANAGEMENT PROBLEMS IN RELATION TO PELAGIC FISHERIES OF THE IPFC AREA

by

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ABSTRACT

The general principles of fishery management are reviewed. The close interrelation is stressed between management and fishery development as aspects of the full and rational utilisation of the fish resources. It is important to consider the possible need of management early in the development of a fishery, and essential that the collection of basic statistical and biological information is started as soon as possible.

Management of pelagic fisheries can offer special problems. Many species are wide-ranging, e.g., individual southern bluefin can move from Australia to South Africa; thus, fisheries some distance apart may share the same interest. Management of these stocks must involve some international coordination and agreement.

Some pelagic stocks seem to be less stable than demersal stocks. Whereas there are few examples of complete disasters occurring in demersal fisheries in the absence of adequate management, several pelagic fisheries, especially of clupeoid fish, e.g., Californian sardine, have collapsed. The need for management, and the penalties for failure to manage, may therefore be much greater in pelagic fisheries.

Analysis of these fisheries presents some special difficulties, especially in the measurement of amount of fishery, or fish abundance. In purse-seine fisheries the usual measures of catch per unit effort (catch per day at sea, or catch per set) may remain high even when the stock is declining seriously. Some independent index of abundance, e.g., from acoustic surveys, is desirable.

1. INTRODUCTION

With the rapid expansion of fishing in all parts of the world, and the fact that all fishery resources, however large, are still limited, problems of management have been receiving increasing attention. In particular it is being realised that these problems are not limited to certain areas or stocks adjacent to the more advanced fishing countries, and that an early consideration of the possible management actions while the fishery is in the comparatively early stages of development can avoid many of the more serious problems.

Management problems have been discussed in a large number of papers, e.g. Gulland and Carroz (1968) and were the subject of a special session at the 1970 IPFC meeting. To a large extent, the management of pelagic resources raises no questions of principle that are any different from those relevant to any other fishery resource. To this extent, the present paper offers little new in addition to what has already been written elsewhere, but it seems useful, within the context of the present symposium, to review certain points - for example the benefits (or losses) from good (or bad) management, the types of decision that have to be taken, and the data that need to be collected. In addition, the later section of the paper reviews some particular points relevant to the pelagic fisheries of the IPFC region.

2. GENERAL CONSIDERATIONS ON MANAGEMENT

At the 1970 meeting at Bangkok, IPFC discussed the general problems of management, and stressed the close inter-connection between management and development. Both are concerned with the proper utilisation of the available fishery resources. Failure to develop means that the resources are under-utilised and are not producing the benefits that they could. Failure to manage the fishery is likely to result in over-exploitation, and again a failure to take full advantage of the resource. Sometimes there will be an actual loss in the weight harvested, but more often - in fact in most unregulated fisheries - there will be a wastage in excess amount of fishing.

This is illustrated in Figure 1, which shows typical relations between the amount of fishing and the value of the catch. In many fish stocks, as shown by the full line, a certain amount of fishery will give the maximum catch, and any further increases in fishing beyond this point will reduce the total catch. In some particularly vulnerable stocks there may be a disastrous fall in catch, as shown by the dotted line.

Important economic aspects of the fishery, other than the gross value of the catch, are shown in Figure 2 using the values corresponding to the full curve in Figure 1. The upper curve shows the net value of the catch, i.e., the gross value less the costs of fishing. This rises to a maximum at a moderately low amount of fishing, and then falls off rather steadily. That is, beyond the point of maximum net yield, any increases in the gross yield are less than the costs of the extra effort required to harvest it. This is shown more clearly in the lower figures, in which the marginal yield - the addition to the total yield resulting from an extra unit of effort - has been plotted. This decreases continuously with increasing effort, and at the point corresponding to the maximum net yield, the marginal yield is equal to the costs of a unit of effort - shown by the horizontal line in Figure 2.

If the fishing was under a single ownership it is unlikely that the amount of fishing would increase much beyond the level of the maximum economic yield. Investment of additional resources of ships, men or money in the fishery would give poor returns, and would give better returns in alternative employment - in other fisheries that are less heavily exploited, or outside fishing altogether. However, most fisheries are not under single ownership, and the decision to invest in further expansion of fishing effort, e.g.

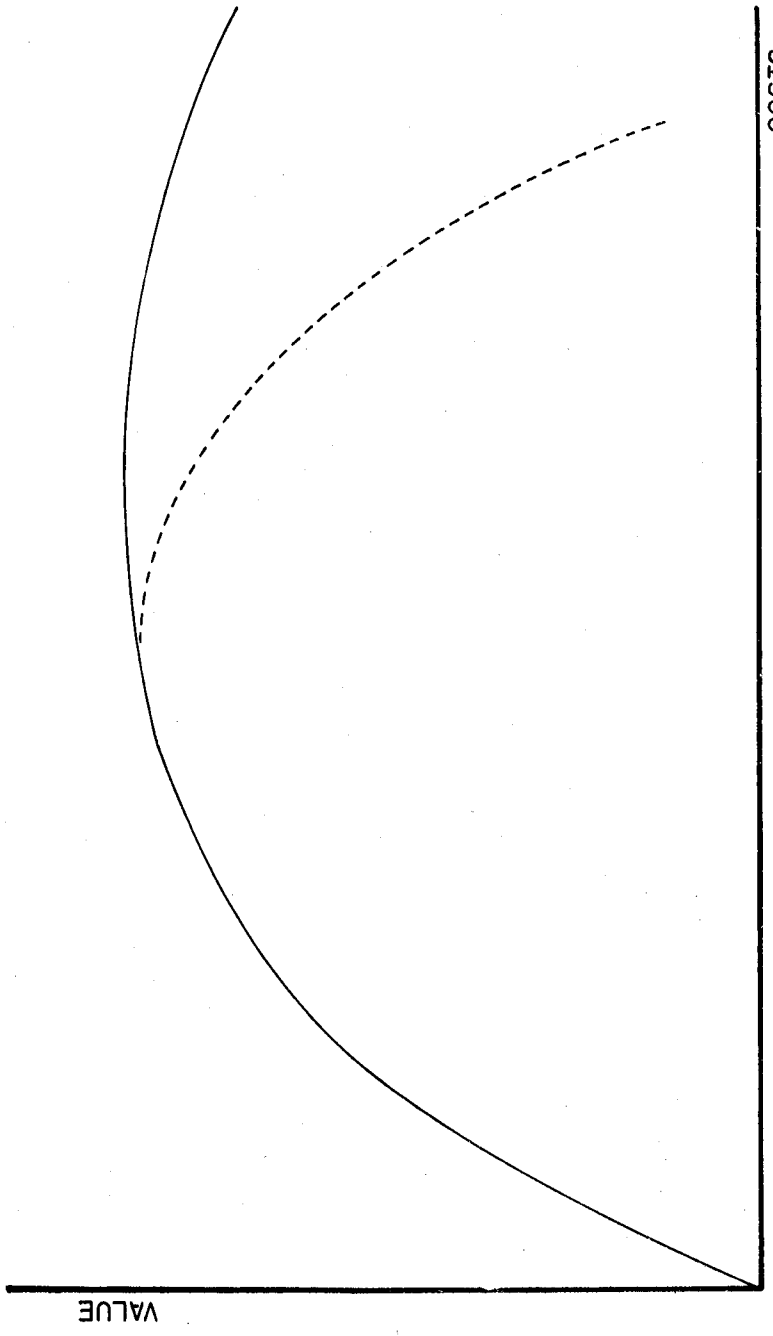

Fig. 1 The value of the catch as a function of the amount (costs) of fishing.

to build a new boat, is not based on the marginal yield - the increase in the total value of the catch - but on the catch per unit effort, that is the value of the catch of the new vessel. The catch per unit effort is also plotted in Figure 2. At very low levels of fishing it is about the same as the marginal yield, but decreases more slowly with increasing fishing. Without any action to manage the fishery, the amount of fishing will tend to increase until the value of the catch per unit effort is equal to the costs of a unit of effort - including in the costs a reasonable return on investment. As Figure 2 shows this can occur at a high level of effort, far above the level giving the maximum net value of the catch and even above the level of maximum gross catch.

In practice this analysis may underestimate the losses due to uncontrolled fishing. In an expanding fishery decisions on further investment will probably be made on the basis of catch rates some time in the past, which are likely to be considerably higher than those occurring when the new boats enter the fishery. It is very likely, unless development is rather slow, that the fishery will overshoot the long-term equilibrium position and the amount of fishing expand to a level where the value of the catch per unit effort is less than the costs. In any event it is very much easier to prevent overexpansion of a fishery than to reduce the capacity of the fleet (number of ships, etc.) once it has expanded beyond the optimum level. Once the fleet is built, and the fishermen settled in employment it can be a difficult and often painful task to divert them to more productive occupation. On the other hand quite simple measures, such as withdrawal of investment grants, may keep the capacity close to the optimum level if applied while the capacity is still below the optimum. Management is therefore not merely a matter of applying restrictive measures after a fishery has run into trouble, but is, or should be, a matter of matching development to the magnitude of the resource.

Attention should be given to the question of management very early in the development of a fishery. Once it is clear that a fishery can be developed on a given resource, estimates should be made of the magnitude of the potential catches, and of the optimum amount of fishing. Since these will not, at first, be estimated at all accurately, a gradual step-wise approach to optimum should be chosen. Each level of fishing will provide better information on which better assessments can be made and further expansion planned - or, if the assessments show this to be necessary, further developments can be stopped. The losses from over-rapid expansion can be large, with the excess effort producing little or nothing, whereas the possible losses from a more cautious development are, at worst, only the difference between what extra fishing would have produced from the resources in question, and the production (not necessarily only fish) that might have been obtained from the use of the resources of money and manpower in some other activity. Such differences are likely to be small.

The other aspect of management that needs early attention is the collection of the basic data. It is essential for any form of management that reliable statistics of total catch are available. With them should also be statistics of fishing effort (number of boats, number of days fishing, etc.) from which changes in the amount of fishing (fishing mortality) can be followed, and also indices of abundance calculated in terms of catch per unit effort. Data should also be collected on the biological characteristics of the catch - at least length composition, but also of possible samples of the ages of individual fish; from these changes in the mortality rates can be determined, and correlated with changes in the amount of fishing.

The usefulness of these data is determined as much by the length of the series of years for which they are available - and, particularly the range of values of fishing effort occurring during this period - as by the accuracy and detail of the data for a particular year. Most assessments are based on studying the changes in various characteristics of the fishery - average size of fish, catch per unit effort, etc. -

following change in fishing. One observation, even if somewhat approximate, at an early period when fishing is light, is more useful than any number of extra observations after fishing has developed. High priority should therefore be given to starting the collection of basic data as early as possible in the development of the fishery.

3. PELAGIC FISHERIES

In principle the management of pelagic fisheries involves exactly the same problems as the management of any other fishery, but in practice certain features increase the difficulties compared with, for example, the management of some demersal resources. These include the extent of the migrations and dispersion of the fish stock, the difficulties of obtaining an adequate measure of fishing effort, and the possible instability of some pelagic stocks, especially of clupeoid fish.

3.1 Migration and stock limits

In the IPFC region an outstanding example of a wide ranging fish is the southern bluefin tuna. The young tuna found off the southern and eastern coasts of Australia tend to move westward as they grow, and fish tagged off Australia have been found as far west as southern Africa. It appears that all the southern bluefin tuna in the Indian Ocean, and at least parts of the southwest Pacific, form a single stock. Management of this stock should take into account all fishing on it, in any part of the range, including the Australian coastal fisheries and the Japanese longline fishery. This of course does not mean that management action, such as the application of specific restrictive measures must necessarily be applied to all the fisheries on bluefin in all parts of its range. Indeed the only specific measure so far proposed by the IOFC/IPFC ad hoc working party of scientists on stock assessment of tuna is the closure to longline fishing of certain areas of the southern Indian Ocean. This would have no immediate effect on the Australian fisheries, but one of the long-term effects of the measure should be an increase in the adult stock, and hence, possibly, in the number of young fish produced. This would certainly benefit the Australian fishery.

Other tunas probably do not move over quite such large distances, but still a single stock of yellowfin or skipjack may cover a wide area. At present most of the catches of the larger species of tuna are taken by longline vessels which move freely over most of the open oceans of the world. Management of these fisheries will have to be considered in terms of very wide areas for practical and economic as well as biologica reasons. The more local fisheries with purse seiners and bait boats, comparable with those off West Africa, are now showing signs of development. When they do, the limit of their expansion will be the magnitude of the resource, rather than the market, which is world-wide. Management action of some sort will likely soon be required, which will make it urgent to determine the relation between say the yellowfin caught in the southern Philippines, or off Somalia, and those caught in the longline fisheri of the open Pacific or Indian Ocean.

Similar problems are likely to arise, if not over such a wide geographical extent, fo other species of pelagic fish. Several of these, e.g. the oil sardine off the Indian west coast, show strong seasonal patterns of availability to the local fishermen, which would suggest substantial migration, though there is not much direct evidence. In other stocks, e.g. Rastrelliger in the Gulf of Thailand, the expanding activities of local fleets from different countries are beginning to overlap on the fishing grou In these cases too it is clear that management is likely to require some form of international action. In this an important early scientific task is to identify the limits and identities of different unit stocks.

Stability of pelagic stocks

The simple theory of fish population dynamics which has been confirmed, at least in general terms, by direct experience with many demersal stocks, is that the impact of fishing is a smooth and gradual process, as suggested by the curve in Figure 1. As the amount of fishing increases, the catch and catch per unit effort change slowly but steadily; when the point of maximum yield is reached the yield will fall, but only relatively slowly. For example the North Sea demersal stocks have been very heavily fished for nearly a century, without any limit being set on the amount of fishing, yet present day catches of cod, haddock and plaice are as high as they have ever been.

Several pelagic fisheries, on the other hand, have shown marked instability. Although some of the biggest fisheries in the world (in terms of weight) have been on pelagic fish such as herrings and sardines, few of the stocks seem to have been able to maintain high levels of catch over a long period. Thus the catches of what had been the world's biggest fishery, that for Japanese sardine, fell from a peak of over 3 million tons in 1935-1939 to a few tens of thousands of tons now. The catches of Californian sardine have fallen to an even lower level, from a peak of nearly 800,000 tons in 1936-37. Herring stocks in the North Sea and off western Norway have exhibited somewhat similar collapses. For no one individual stock has there been clear incontrovertible proof that the collapse has been directly due to fishing and indeed some stocks have shown strong cyclical fluctuations, almost certainly due to natural causes (e.g. the Atlantic-Scandian herring gave peak catches in northern Norway around 1790-1800, and again between 1890 and 1900 with a subsidiary peak around 1910). On the other hand the cases where heavy fishing has been followed by a collapse of the fishery are now numerous. Even if fishing is not the only cause, in several cases fishing may have begun a decrease, which in the absence of fishing might have occurred later or been less pronounced.

An aspect of many of these collapsing pelagic fisheries - the Californian sardine is a particularly good example - is that during the period of decline there were considerable doubts and arguments about the cause of the decline - fishing or natural causes. As a result of these doubts no strong management action was taken, which though correct if only a temporary adverse natural fluctuation was occurring, would be disastrous if fishing were causing the decline. In the event the decline of several of the stocks continued to a very low level. Even after this collapse had occurred, it could still be argued that, in any individual case, the natural factors had been responsible. Against this there are other examples, e.g. the herring fishery of British Columbia, where severe restrictions were supplied soon after a decline became apparent, and the stock subsequently recovered.

Stocks of shoaling pelagic fish therefore appear to be more sensitive to mismanagement than others, and there is a risk of lasting and very severe damage to the stocks. However, it does appear that if appropriate action is taken (which may require very severe temporary restriction of the catch) the stocks can be maintained or rebuilt.

3.3 Difficulties of assessment

The possible penalties of mismanagement emphasise the need for timely and reliable assessment of pelagic stocks. Unfortunately in many ways these stocks are especially difficult to study.

They tend to be highly variable in abundance and also in distribution. As already noted these variations can be confused with changes due to fishing, and also natural

effects and fishing can interact. There is no simple easy answer to these problems. They are best dealt with by intensifying the normal lines of study, and to ensure the availability of adequate basic data on total catches, corresponding fishing effort, distribution of catch and effort by area and time, information on the sizes of fish caught, etc.

Proper measurement of fishing effort presents especial difficulty in relation to shoaling fish. The more obvious measures of catch per unit effort such as catch per haul may estimate the average size of shoal, rather than overall population abundance. If, when the population abundance decreases, or the area over which the stock extends, increases, or the number of shoals fall and the average size of shoals meanwhile remains unaltered then the catch per unit effort can seriously underestimate the reduction of the stock. Indeed it is possible that the catch per haul could remain high up to the moment when the last shoal is caught. In addition changes in efficiency can be difficult to measure. In trawl fisheries development and improvement of gear is largely a matter of building larger boats, with bigger engines. A direct comparison is possible between old and new vessels fishing on the same grounds, from which calibration factors can be deduced to express the effort in any year in standard terms. Improvements in pelagic fisheries are often changes in techniques in fish finding, e.g. with acoustic gears, the effects of which are less easy to measure directly.

The effects of improved fish-finding equipment cannot easily be measured, either by comparing catches of boats fishing at the same time and place with and without the equipment (because the effect of the equipment is on the location of fishing), or by comparison of catches over a period, say a year, because the better fishermen will tend to have the new equipment, and catch more fish. Nevertheless some measure of its usefulness can be obtained simply from talking to the fishermen. This is in fact an important and widely applicable point. The best understanding of what is happening in any fishery comes from close contact with the fishermen themselves. The scientists' job is to put the fishermen's information into quantitative terms. For the purse seine fisheries this implies collecting detailed data on the fishing operations. For each trip (or from at least a sample of trips) data should be collected on the total time at sea, and how this was divided between steaming to and from the chosen fishing grounds, the location of these grounds, the time spent on the grounds looking for fish, and the time spent actually shooting and hauling the net. From this data it should be possible to determine whether they have to go further or look longer for fish, and hence get some insight into changes in fish abundance.

An alternative procedure is to obtain independent measures of fish abundance, from which indices of fishing effort (and fishing mortality) can be calculated by dividing the total catch by the abundance. The difficulty has been to get any reasonable independent measure of abundance, but modern techniques of acoustic surveys are becoming capable of providing this where the importance of the fishery justifies the cost. The latest equipment promises in fact, with a little more development, to provide counts of actual population numbers - or numbers within a determined volume of water from which total numbers can be readily estimated. Until such equipment is available, indices of abundance obtainable from acoustic surveys, such as the total area of certain density of traces, are most useful.

4. THE PROBLEMS IN THE IPFC AREA

At present the only pelagic fishery in the IPFC area for which there is a clear need for introducing management measures is the longline fishery for the larger individual tunas, particularly southern bluefin. For other species, especially the shoaling pelagic fish such as mackerel and anchovies, the actual implementation of management measures remains a problem for the future. However, the current, and hopefully the future, pace of development is such that these problems will need to be seriously considered very soon, and certain actions are required now to ensure that the action taken is correct and timely and serious losses are not incurred. The main actions required are as follows:

4.1 Collection and compilation of basic data essential for stock assessment work covering the whole geographic distribution of each stock. Such data includes catch and effort statistics and size composition information.

4.2 Continuing analysis of available data to provide the most reliable current estimates of the potential yield of each stock, and the desirable level of fishing.

4.3 Continuing review, and as necessary modification, of development plans to take account of the stock assessment results. This should include close co-ordination of plans by different countries if they are both planning to harvest the same stock.

4.4 Consideration of the mechanism necessary to limit the amount of fishing on heavily exploited stocks, including, when relevant, international machinery.

5. REFERENCES

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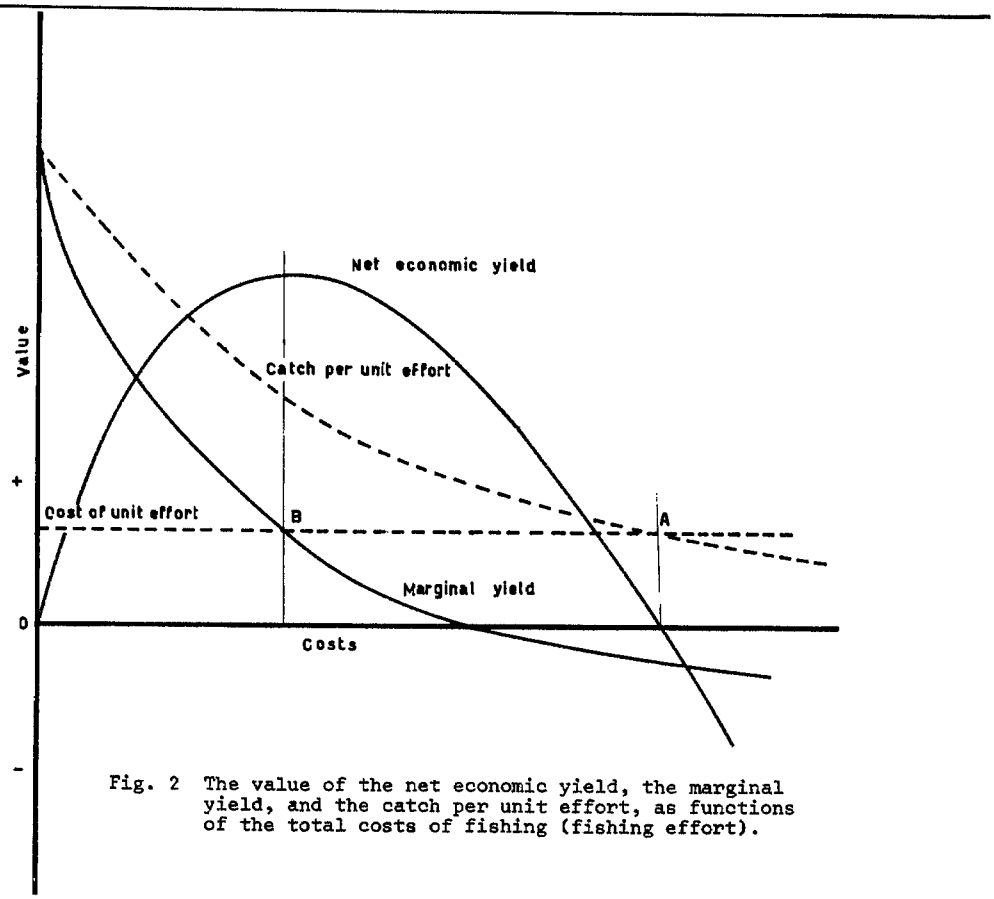

Fig. 2 The value of the net economic yield, the marginal yield, and the catch per unit effort, as functions of the total costs of fishing (fishing effort).