RESOURCE CONSTRAINTS TO THE DEVELOPMENT OF SMALL-SCALE FISHERIES

by

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Abstract

The availability of adequate resources now appears as one of the main factors limiting the development of small-scale fisheries. Many factors external to the fishery can affect the fish stock. Some of the most drastic of these arise from human interference with the environment, and by reducing the quality or quantity of water available to fish have damaged many inland and some coastal fisheries. Small-scale fisheries themselves also affect fish stocks and three cases of such interactions may be distinguished. In those fisheries where the resource is effectively unlimited, the small-scale fishery will have little effect on the resource. In those fisheries where the small-scale fishery acts upon some phase in the life history of the fish important to its life-cycle, detrimental effects of heavy fishing may soon make themselves felt both on the small-scale fishery and on any other type of fishery exploiting the stock. In those fisheries where the small-scale fishery exploits the whole stock, a classic situation exists which enters within the standard concepts of fish population dynamics and this permits the application of several simple indices to measure the well-being of the fishery. Because of the dependence of small-scale fisheries on a healthy environment, close links are needed between fishery departments and those concerned with general development planning.

CONTENTS

1. INTRODUCTION

Resources - the stocks of fish in the sea, lake or river - have not always been considered as being among the more urgent problems of the development of small-scale fisheries. To the individual fisherman the problems have been those of getting a better boat, providing it with an engine, improving his fishing gear, and - probably commonest of all - getting a good price for the fish once he has caught it. That fish stocks are limited, and that all plans for fishery development must start with some assurance that the fish resources are adequate, are now well accepted for the large-scale industrial fisheries - largely as a result of hard experience.

The same is true for small-scale fishermen. The number of fishermen involved, especially in the IPFC region, is usually large. Even primitive fishing gear can exert a high fishing mortality, and thus reduce the stock, provided there are enough of them. Further, small-scale fishermen are limited in their range of operations and tend to operate in somewhat restricted waters - a river, an arm of a lake, or a narrow and shallow strip close to the seashore. They, therefore, tend to operate on fish stocks of rather similarly restricted range. Such stocks are clearly more vulnerable to heavy fishing than larger and more widely ranging species. Also, they are more vulnerable - whether in inland waters or in the coastal zone - to pollution and other human interference with the environment.

When planning the development of small-scale fisheries, it is therefore dangerous to assume, without a proper check, that the resource can give the increases in catch that are hoped for. For example, providing improved equipment (e.g., outboard motors) to a group of fishermen that are already fully exploiting a lake would be worse than useless. After a short interim period of adjustment - in which all fishermen would have to adopt the new gear, otherwise their catches would fall - each fisherman would end up catching the same amount but with additional expenses for fuel and payment for his engine. It can even be dangerous, if other developments such as land reclamation, building of dams, additional use of insecticides in agriculture, etc., is going on, to assume that catches can be maintained. If developments such as these are not carefully monitored and the interests of the small-scale fisherman protected, the whole basis of his livelihood can be threatened.

2. RESOURCE AND ENVIRONMENT

Human interference with the environment can affect fish stocks in many different ways; their habitat can be destroyed completely, it can be made unsuitable for one or other species, or it can leave the fish (or other animals) themselves almost unaffected but make them unsuitable for human consumption.

The most drastic effects are various forms of land drainage and reclamation. The coastal zones, especially near cities, are among the most valuable sites for building for housing and industrial development - and also for agriculture - and their importance for fisheries is often forgotten. The positive effects of a proposed dam construction, in terms of the fisheries that can develop in the new lakes behind the dam are usually remembered in drawing up the balance-sheet for the new construction. Sometimes forgotten are the facts that, first, fisheries in new lakes often go through an initial boom period, before the nutrients are locked up, with the peak catches two or three years after filling seldom being repeated and, second, that dams change the flood cycle downstream. Changes from a sharp cycle of inundation over an extensive floodplain, followed by a dry season, to a more uniform controlled flow can alter the whole nature of the fish stocks and of the fisheries on them. Usually these changes are for the worse.

Changes in the pattern of water use, poor land management and deforestation can also greatly increase the silt load of rivers. Silt deposited over the river channel and its floodplain can choke waterways and lakes and modify both fauna and flora. The siltation process continues through the coastal fringe, building deltas, but at the same time clogging beds of molluscs. Further out to sea coral reefs and their rich fish fauna are particularly vulnerable to siltation, either from the land or from marine activities, such as blasting for harbour construction.

Oil pollution from extraction or transport has attracted much attention. So far the impact on large industrial-scale fisheries of oil pollution has been surprisingly small. This is mainly because these fisheries generally operate on bottom-living or mid-water fishes of comparatively deep water, while the effects of oil pollution are principally found in the surface layer and, especially, in the inter-tidal zone. Small-scale fisheries are, in comparison, much more vulnerable to this type of pollution.

Untreated sewage poses the most severe health problems. Mussels and other molluscs will grow well with moderate (or even quite severe) doses of domestic sewage, but they are efficient at concentrating whatever unpleasantness there may be in the water. Eating these animals can, therefore, be a health hazard, especially when, as in the case of oysters, they are eaten uncooked. The damage to fisheries is not confined to the inability to use the production in certain polluted waters. Public suspicion of contamination can discourage consumption from unpolluted waters. This is particularly serious because molluscs provide one of the best opportunities to increase production from small-scale fisheries in coastal waters, from either natural stocks or from culture.

The immediate impact of pollution or environmental change may not occur in the same areas in which most fishing is done. Many species of fish - and also shrimps, etc. - spend the first few weeks or months of their life in shallow areas quite separate from the grounds where the larger stages pass their time and are caught. These nursery grounds can be easily affected by pollution or land reclamation. It should not, therefore, be assumed that because nothing alarming seems to be happening or to be planned to happen on the fishing grounds, that the fisheries could not be affected. It is important that the entire life-cycle of at least the main species or species groups supporting small-scale fisheries be known, and actual or planned developments (land reclamation, industrial construction) be carefully monitored in respect of the whole area in which any part of their life is spent. Mangroves are a good example of the type of environment that can be a very important link in the life of commercially valuable species. Though more research is needed on the relation between mangroves and different species, there seems little doubt that the preservation of mangrove areas is important, if not vital, to the well-being of many of the small-scale fisheries in adjacent areas.

3. EFFECTS OF FISHING

In discussing the possible effects of fishing on the stocks of fish exploited by small-scale fisheries, it is useful to distinguish three cases; when the stocks are limited in extent and the small-scale fisheries exploit them over their whole range; rather larger and more migratory stocks, which can be exploited by the small-scale fisheries quite intensively at some particular phase of their life-history, but at other times are available to other fisheries, and those which are widespread and of which the small-scale fisheries exploit only a small part.

The third case presents the least problems for those responsible for small-scale fisheries. So far as they are concerned, the resource is effectively unlimited and anything that happens in the small-scale fisheries will have a negligible effect on the stocks as a whole. A good example of this situation is the fishery off western Sumatra by small boats trolling for skipjack. However, even in this situation the resources set some constraints on the development of the fishery. The skipjack being caught probably come from a large stock (the whole Indian Ocean?, the northeast Indian Ocean? - the detailed structure is unknown), but the portion migrating into Sumatran waters may be only a small part of the total stock. Current catches may be a significant part of this migrating segment. There is a limit - which may be being approached - beyond which the catches by the existing small-scale fishery cannot be increased until the vessels are able to go further afield, and to intercept a greater proportion of the stock. However, where both industrial and small-scale fisheries are exploiting the same stock, heavy fishing by the industrial fishery will make itself felt by falling catches in the small-scale fishery.

The best example of the second situation - of a small-scale fishery being based on a particular phase of life of a species exploited by other fishermen - is provided by tropical penaeid shrimps. Details of the life-history vary from species to species but typically they

spawn offshore. The young larvae drift or actively migrate inshore, and the nursery grounds are in the estuaries, backwaters and coastal lagoons. At about the time they become commercially valuable they migrate offshore, and when approaching full size are exploited by the larger trawlers. As can be seen, the nursery grounds are also the typical fishing grounds of small-scale fishermen. In some areas, e.g., in West Africa, there is a traditional fishery on the moderate-sized shrimp as they migrate to sea through the narrow entrances to the coastal lagoons.

If resources were unlimited, all would be well. Though the shrimp available to the small-scale fishermen are not, in general, sufficiently large to command the highest prices, they are valuable, and provide one of the few opportunities for the poorest sections of the community, e.g., in Kerala, to get some of the benefits from a lucrative export trade. However, once the shrimp stocks as a whole become fully exploited - which is likely to happen very soon after an industrial-scale export-oriented trawl fishery on the offshore stocks begins - then fishery administrators are faced with some difficult choices.

From what is known about the growth and natural mortality rates of shrimp on the ocean, and the increase in price with size, it is highly probably that the greatest gross value from a brood of shrimp will be taken by avoiding catching them until they have grown larger than the sizes mostly taken in the small-scale fisheries. Therefore, if there is a developed fishery on the large shrimp, the presence of a small-scale fishery on the small shrimp probably decreases the weight and, still more, the value of the total catch. Further growth of the small-scale fishery, perhaps as a result of a development programme, would reduce the total still further. This is not to say that it would be desirable to reduce or restrict the small-scale fishery on shrimp - there are considerations of employment, distribution of social benefits, etc., that are likely to be more weighty than simple economics - but it is certainly desirable to give very careful thought about all the consequences of encouraging further growth of fishery on small shrimp.

The shrimp situation has been discussed at some length because (with some differences of detail) it is a situation that occurs in many parts of the world, including many IPFC countries. It is also a good example of a more general situation, in which plans for the development of small-scale fisheries must take account of interactions with other fisheries. The life-history of many marine fish that are exploited both by small-scale fishermen and by others is generally the same as that of shrimp. The younger animals tend to live in shallow water and then migrate offshore into the deeper waters fished by the larger vessels. This, somewhat fortunately, gives some competitive advantage to the small-scale fishermen; they have the first opportunity to exploit a brood of young fish once they reach a catchable size. The major interaction is, therefore, the impact of the small-scale fishery on the fishing of the larger fish. Interaction can also be the other way. Plans for developing small-scale fishing must recognize that growth of other types of fishing on the same stock may reduce the availability of fish to the small-scale fishermen to a level at which the planned development ceases to be attractive or even practicable.

The third situation, in which the small-scale fishery exploits a stock over its whole range, is one in which the standard concepts of fish population dynamics, and of the effect of fishing on a stock of fish, can be applied directly. In any fishery, as the amount of fishing expands from an initial very low level, in which there is only a negligible effect on the stock, total catches at first increase almost in proportion to the increase in the amount of fishing. Soon fishing will have some effect on the stock, abundance will fall, as will the catches by the individual fishermen. The total catch will continue to increase but more slowly than the total amount of fishing. Later, the stage will be reached when the productive capacity of the resource will be approached, and no significant increase in total catch is possible. Increased fishing beyond this point will at best mean that the same catch will be divided between more and more fisheries, and will be taken at increasing costs; at worst, the stocks may collapse, and the total catch drop to a low level.

It will be seen that there are several indices that can be used to describe the success or well-being of the fishery and they change in different ways as fishing increases. From the viewpoint of the individual fisherman the important quantity is the amount of fish he will catch, i.e., the catch-per-unit effort; this will always decrease as the total amount of fishing increases.

From the point of view of society, one important measure is the total catch. This tends to have a maximum at a fairly high rate of fishing, at the point often referred to as the level of the Maximum Sustainable Yield (MSY). Total catch is by no means the only important measure; equally important are the costs of taking it. A better measure of the success of any fishery is, therefore, the difference between the value of the catch and the costs of taking it. This also has a maximum, but at a lower level of fishing effort than the MSY, and beyond this point decreases rapidly. The point of greatest returns (Maximum Economic Yield, MEY) provides a reasonable objective for the fishery manager. In industrial fisheries both costs and value can be readily expressed in straightforward monetary terms. This is not so easy, or so meaningful, in small-scale fisheries. The real costs of increasing the amount of fishing can be very different, depending on how the increase is achieved. If it is a matter of improving the technology in ways that require expensive equipment (or at least expensive on the scale of the individual fisherman) or significant additions to the running costs (e.g., fuel for engines), then the real costs may be high and will have to be very carefully weighed against the expected net increase in total catch. On the other hand, if the increase in the amount of fishing involves a simple improvement in technology - training of fishermen to use existing equipment in better ways, or bringing in additional fishermen who have no alternative employment - then the real costs may be small. In these cases, increasing the effective amount of fishing will be worthwhile, taking the fishery as a whole, provided that there is some increase in total catch, however small. However, it must be remembered that there will be effects on the existing small-scale fishermen (unless they all adopt improved technology), who may well not be happy to see their catches drop.

The big question concerning any given small-scale fishery is where its current position is on these curves relating the gross catch, catch-per-unit effort, or net benefit (value less costs), to the amounts of fishing. Until this is known with an adequate degree of reliability (which need not imply very great precision) the previous discussion on possible objectives is academic. The implication of many discussions on small-scale fishery development has been that the amount of fishing is relatively low, well below the MSY or MEY levels. This assumption is far from being true.

For several reasons (poor data, variety of species caught and gear used, lack of marked changes in the amount of fishing), which are discussed in another paper to this Symposium, there have been few detailed assessments of small-scale fisheries. The data that do exist suggest fairly clearly that wherever fish stocks are accessible to small-scale fishermen, the fisheries are having a significant effect on the stock available to them. A good example is the fishery on African lakes. Figure 1, taken from Henderson and Welcomme (1974), shows how the yield in many of these lakes is related to the number of fishermen. To make the data from different lakes comparable they have been expressed as weight caught and numbers of fishermen/km^2. Though the curve represents different lakes, rather than the same body of water under different levels of exploitation, it does give an idea of the latter curve, and the state of exploitation in each lake. The curve has the typical form of many yield-effort curves, and flattens out at a level of fishing of about 1.5 fishermen/km^2. Of the lakes studied, several are already exploited at this level; increasing fishing (e.g., by introducing more powerful fishing methods) will not increase the yield from these lakes. Other lakes are moderately fished (on the left-hand slope of the curve) and only a few are clearly lightly fished (in the bottom left-hand corner). The situation may be different in detail in other ecosystems, but these results clearly show that heavy fishing is not confined to large-scale fisheries.

This analysis concerns the total weight caught. Small-scale fishermen, like others, have definite preferences for certain species, usually those reaching a larger size, and generally longer lived. The fishing gears used are, therefore, usually adapted to select

for these species. The degree of selection, which is usually governed by the size of fish, the type of habitat and the behaviour of the different fish species, will vary from fishery to fishery. In some, most fishermen will use the same type of gear, which may be highly selective, giving rise to a very narrow spectrum of fishing. In others, different gears may be used at different seasons or by different groups of fishermen, giving rise to a much broader spectrum. The problem with the narrow selection, directed at a few highly valued species, is that these species may be fished down to a level at which they cease to be significant members of the fish community. Attention may then shift to the next most valuable group of species, which, in turn, may be fished down. This process of the successive elimination (wholly or partially) from the catches of the larger elements of the fish community can continue, often without loss of overall weight of catch, until none but the smallest and least desirable species remain. The process of species succession has been most clearly described for the Great Lakes of North America (Regier and Loftus, 1972), where the effect of fishing was accompanied by other stresses on the fish stocks. More relevant to small-scale fisheries has been the observed decline of larger fish in systems such as coral reefs and African lakes.

Special care is needed where industrial fisheries and small-scale fisheries are exploiting the same stock. Where the stock is large and industrial effort is low, the small-scale fishery may continue without undue disturbance although plans to expand such fisheries would have to take into account the effects of the industrial fishery on the stock. Furthermore, where it is judged important to conserve or expand the small-scale fishery for social or other reasons, controls may have to be placed on the industrial fishery so as to preserve the balance in total fishing effort needed for the conservation of the stocks.

4. DISCUSSION

The constraints set on small-scale fisheries by the resources that they exploit have several implications for those responsible for policies which might affect, directly or indirectly, small-scale fisheries.

Just as fisheries depend on the fish stocks, the stocks depend on a healthy environment. The environment of small-scale fisheries can be affected by numerous human activities, other than fishing. It is, therefore, a prime concern for those responsible for the well-being of small-scale fisheries to be aware of any development (dam-building, land reclamation) that might affect the small-scale fisheries. Awareness is only a start. There must be some involvement by fisheries interests in the decision-making process. Further, this involvement should begin at a very early stage in the planning. Once government departments and investment banks have become committed to a particular multi-million development, it can be very difficult to modify the plans to accommodate the requirements of small-scale fishermen. These difficulties may be as much matters of prestige or administrative convenience as practical problems of modifying the design of a dam, but either type can be equally real. However, if the needs of the small-scale fisherman, e.g., to protect the spawning grounds of a valued species, are explained before development plans have reached an advanced stage, adequate modifications can usually be made to the plans without trouble.

One implication of this is that there must be close links between the fisheries department and those concerned with general development planning. The common weakness of the fisheries department may be helped here by a more general strengthening, within the planning office, of the awareness that environmental protection (in a positive sense) is a vital aspect of national planning, without which the interests of some of the poorest parts of the community can be seriously damaged. It should be stressed here that man-induced changes in the environment are not necessarily harmful, either in general, or to small-scale fisheries in particular. The new fisheries in lakes behind irrigation or power dams, for example, can be more valuable (economically and socially) than losses in the downstream fisheries.

A further implication is that the fishery department should be reasonably familiar with the biology of the major species - their distribution and life-cycle, location of spawning and nursery grounds, susceptibility to various types of pollution, etc. - so that the impact, at least in general terms, of any proposed development can be quickly evaluated.

Apart from the possibilities of modifying non-fishery development plans to minimize any harmful impact on fisheries interests, close links between fisheries and general planning are useful in fisheries planning. It would be clearly foolhardy to plan a major fishery development in a river or lagoon where waters were shortly to be the target for some alternative use. Equally, it is better to start the planning to take advantage of fisheries opportunities arising from favourable developments, such as the construction of a new reservoir, early in the construction phase rather than when the lake is already full.

The fact that small-scale fishing can have an impact on the abundance of the stocks, and hence on the success of the small-scale fishermen themselves, and (as in the case of shrimp) of others, has several consequences. The most obvious implication is the need for some information on the magnitude of the resource. This does not mean having detailed and sophisticated assessments of the state of exploitation, but it does mean having enough information to know, for example, whether doubling the amount of fishing will approximately double the total catch (which will happen only if the stock is very lightly fished), increase it by 50% (for a moderately heavily fished stock), or hardly increase it at all. To this should be added the corresponding information about likely trends in catch-per-unit effort, and net returns (or total benefits less total costs). The problems of doing these assessments, which nearly always should be initiated as a permanent arrangement, to monitor change in the stocks and the fishery, are discussed in another paper for this Symposium.

While this information is not generally available, circumstancial evidence indicates that the stocks of fish accessible to small-scale fisheries are generally fully exploited in the IPFC region. Plans to increase the effective amount of fishing in small-scale fisheries (e.g., by increasing the efficiency of the existing fishermen, or bringing new fishermen into the fishery) should therefore proceed with extreme caution and, as far as possible, in small incremental steps. In these cases, some careful economic and social analysis will need to be made, and possibly difficult decisions taken, before development plans are implemented. The situation is aggravated by the uneveness of population distribution relative to the available stocks. In areas of high population density, pressure on the fishery is apt to increase disproportionately as the fisheries sector is one of the few avenues of employment open to the extra units of population. In areas of low population density, however, some stocks remain at a relatively low level of exploitation but are inaccessible to the small-scale fishermen from more densely populated areas. Where the stocks are heavily fished, the lot of the individual fisherman can be improved only if the number of fishermen is reduced, thus allowing a fixed size of cake to be divided into thicker slices. Once this reduction is assured, then it makes sense to go about improving the catching efficiency, thus allowing the remaining fishermen to profit by their opportunities. If there are obstacles to resettling fishermen in other ocupations or areas, then plans for improving their well-being must be free of the resource constraint, for example, improving the treatment of the catch so as to obtain more money for the same size of catch.

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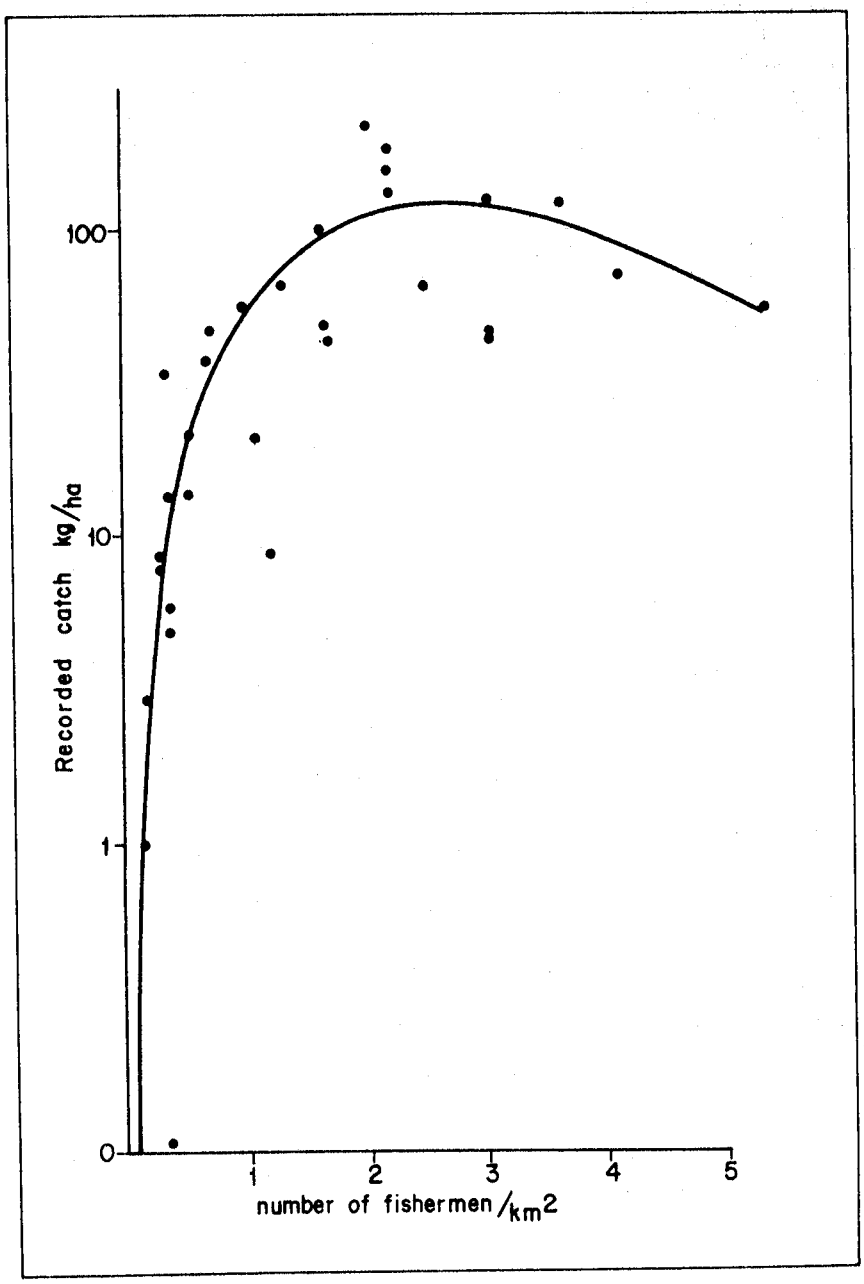

Fig. 1 Variations in recorded catch at different numbers of fishermen/km^2 in 31 African lakes