The Role of Government and Industry in Fisheries Development with Special Reference to Under-Developed Countries

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Summary

THE EXTENT to which government regulation and management of the fisheries is justified will depend on the over-all policies of the administration. Although decisions will in the long run be determined by over-all socio-political and economic considerations, it is important that advice on the technical aspects be obtained through trained fisheries personnel.

Because of their common-property nature, the economics of the fisheries will involve special factors which are not apparent in terrestrial activities, where economic "rent" is involved. These may require the attention of specialized fishery economists. Also, both fishing and fish marketing have in the past involved unusual risks but these and the concomitant compensatory cost of financing must disappear as a result of technical development, as will also the concept that fishing is traditionally a lowly occupation. The concept of "incentive" is discussed.

Different types of restrictions are evaluated, and it is stressed that they should not be imposed for emotional reasons but only if there is strong indication that they will lead to sustained optimum consumption; they must be continuously re-appraised through measurement of results.

Self-imposed quality standards and auto-regulation by competitive industry, while healthy signs of a growing awareness of the problems, cannot entirely replace the legitimate role of enlightened government, which alone has access to all the data on which to base its ultimate liability to all sectors of the economy and has the means (and the responsibility) to employ impartial specialists trained in aspects which are not of immediate concern to industry.

Space does not permit of exhaustive treatment but examples are given to illustrate the extremely complex nature of fisheries philosophy as an indication of the need for reconsideration of administrative and institutional action, especially in the so called "under-developed" countries.

Introduction

It is my purpose in this discussion to show what I believe to be the legitimate role of governments and how the administration and industry should work together towards the common aim. The common aim is, of course, to get high quality fish, on a sustained basis, to all those people who want to eat fish, or who would eat fish if it were available and the price were right or if it could become a more familiar commodity in their shopping baskets. In the long run this is the only consideration involved, and the function of the different firms and governments are, or should be, consciously directed towards this economic objective, everything else being incidental. Of course, it is not always immediately obvious that each of us is merely performing an economic function, and some-

times it is difficult to see beyond the immediate incentive which impels us to exert our efforts in one direction or another, but the two things are intimately connected.

It is my belief that this word "incentive" should receive a great deal of attention, and it might even be proclaimed as a golden rule. There is hardly any human activity which is not performed for incentive. This incentive may be, as far as the consumer is concerned, price, quality, or just the satisfaction of a desire; for the fisherman, a means of livelihood; for the investor, profit; for those in employment, wages; for the scientist, a career; for government, basically the need to satisfy the electorate as a whole and keep in office; for the government employee the safeguarding of his all too often precarious employment which, in the case of properly trained fisheries personnel, should simply mean the conscientious pursuit of the aim already mentioned of getting fish to people, but which in a few cases, especially in countries where the need for proper professional training is not fully appreciated, may unfortunately be interpreted as a mandate to impose restrictions for their own sake.

It is only when a proper balance is struck between these different, and often conflicting motives, that optimum results will be obtained. In the long run some sort of equilibrium will establish itself, and the different incentives will cancel themselves out. If the return to the operator is too low, the least efficient or the least active will seek other kinds of employment and income will rise. If a fishery becomes overcrowded, that is to say if the total product cannot be marketed or if depletion occurs, or if, as is more often the case, the existing cake is being cut up into too many slices, the marginal outfit will be forced out of business. If the consumer's requirements, as regards price and quality, remain totally unsatisfied, there will obviously be no business; if the industry can satisfy the consumer and still make a legitimate profit, it will prosper.

Should There Be Government Control?

It is always difficult to determine where government intervention directed towards these aims should commence and where it should cease. Fortunately, this is not a technical problem, but one which has to be decided by the community through the political machinery which, although necessarily cumbersome, does to a smaller or larger degree provide the means whereby policies can be changed when they are notoriously inadequate or contrary to interests of the majority, it being the job of the technician to place the policy maker in possession of the facts, to interpret them to the best of his honest belief and to let him take over from there. It is a healthy symptom that the present historic trend is to equate "government" with "honest government" and "industry" with "enlightened industry."

While the author believes that it is not possible to endorse a policy of *laissez-passer* at the present stage when a limited management of the economy is beginning to show results, there may nevertheless be some logic in the argument that there is little more justification for government to determine who should and who should not fish, and where and when, or on the other hand for protecting the entrepreneur against his own actions (for instance when too many operators invade a profitable fishery) than is the case in any other business. Rightly or wrongly, however, increased government intervention seems to be a sign of the times in which we live and all countries are moving,

at a faster or slower rate, towards collective management and regulation of the economy. Economists state that, as a result, major world depressions and periods of vast unemployment are now a physical impossibility. Hence, what yesterday appeared to be an unwarranted imposition—take income tax for example—is today accepted as a legitimate and necessary contribution to the commonwealth.

The effectiveness of broad policies must always depend on the quality and training of the people who are employed to implement them, and it is part of our duty in the international organizations to help those governments which feel the need for it, particularly those of the so-called "under-developed" countries, towards a better understanding of the principles involved and of the kind of training which is required at the technical and administrative levels if desirable results are to be obtained.

A number of intelligent people still claim that the economic laws should be left to work themselves out and that government should restrict itself to police and military protection of human rights. The doubt has also been expressed as to whether peasant communities (subsistence fishermen) who do not set themselves a high target, should be dispatched on what Kesteven (1952)[1] so picturesquely describes as "a needless saga of human trial" involving more work, in order to get more money, in order to have equipment, which will eventually give them more leisure.

While the expression of these opinions must be respected, it does seem that the world has become a better place for most of us since a concern has begun to develop for the common welfare, although on the other hand exaggerated protection may tend to keep the least efficient operators in business.

Nevertheless, there are certain considerations which distinguish fishing from most other human activities and which may have to be taken into account. In the first place, one of the most obvious aspects of any business activity which takes place on land and which must, in fact, be considered before a farm or a factory can commence to operate is rent. Only in the case of extremely marginal land is this factor absent and as the land ceases to be marginal, the occupier, willy-nilly, acquires a rent, which is the value of the improved land in excess of new marginal tracts.

With the exception of some inland waters, the now extinct feudal fishing rights in Japan and such collectively owned resources as certain oyster beds in Britain, the fisheries have traditionally constituted a common-property resource, although a government may reserve fishing rights and waters within its national boundaries to fishermen of that country, and although the licensing of fishermen and fishing boats and in some cases the granting of concessions may constitute a pseudo-rent, this does not usually alter the common-property nature of the resource, since the surplus yield of the water mass itself is not capitalized but dissipated (Scott, 1956) although these considerations do not hold good for boats, gear and shore installations.

Hence, there is as a rule little or no incentive for industry to concern itself over the conservation of the resource, since if a particular operator does not exploit it to the maximum, others will. As a result, a fishery, which should be a rich and self-renewing resource, after an initial period of large profits often adjusts itself in such a manner as to provide only a poor livelihood for those

[1]Kesteven does not, however, in his paper, specifically endorse a laissez-faire policy.

engaged in its exploitation. This in turn tends to attract and retain, at least in the subsistence fisheries, only those laborers possessing the lowest level of skills and aptitudes, so creating a vicious circle, although a definite tendency towards improvement is becoming apparent as the fishing centers gain contact with and share the benefits of the community as a whole.

When conditions get too bad organized industry will associate itself to consider remedial measures, and this is all to the good if it can be done successfully. But often industry is unwilling to divulge its business to competitors or to hire analysts, and the result is an appeal to the administration (by those who were previously opposed to government intervention), coupled with requests for financial assistance and nearly always with the idea that those who are already in should be protected from newcomers. Particularly in countries where the consumer is quality conscious, it is usually good business for industry to put its own house in order in this respect (Wilder, 1958). But where there has been no consumer education and industry is out for what the traffic will stand, it is difficult to see how government control is to be avoided.

The subsistence fishermen do not as a rule possess the initiative necessary for collective action, and, if they are aware that the possibility of improvement exists, they do not know to whom to address themselves for help. Still less are they likely to pay much attention to quality.

It is apparent that the responsibilty must rest on government. If the framing of policies is entrusted to competent persons, it is probable that emergency situations can be avoided, i.e., that situations will be handled when they are still trivial.

The Fishery Personnel

It is fortunate that, in many countries, a proper government awareness of the complexity of the fishery problems is becoming apparent, and people are being trained. There are still, however, many instances where it is considered sufficient to set up a fisheries desk in charge of an untrained junior civil servant and in such cases the government is indeed fortunate when the resultant action is of a constructive nature.

One obstacle to wise fishery management has been the difficulty in bringing together the different skills required, even where they exist. In the ultimate analysis the logistics of fish marketing cannot be isolated from the general socio-economic picture and, therefore, the trained economist must play a principal advisory role in determining how much fish is needed, how "need" can be translated into "demand," how costs and supply of fish and labor must be correlated with marketing and to what extent the flow of fish and fish products should be encouraged through price control, subsidies, credits, etc.

On the other hand, the fishery biologists have in the course of their work encountered situations regarding the magnitude and availability of the resource which lend themselves to mathematical analysis of the kind used by the economist and without which the decisions of the economist may falter. Nutritionists also should have their say in respect of the kind of foodstuffs which people should be encouraged to consume.

Unfortunately, these different specialists are often located in different ministries and have little or no means of communication. A new and highly specialized type of skill is therefore in demand, that of the fishery economist,

who must, in addition to his formal training in economics, acquire considerable familiarity with the daily work of the biologist, the technologist and the nutrition worker, with whom he should form a team. The highly complex nature of the work of such a team, and the impossibility of obtaining results from one untrained civil servant placed in charge of a desk, become apparent if we glance at some of the diagrams and mathematical models which have been developed in attempts to relate the changing magnitudes of fish populations, recruitment, and natural and fishing mortality, to catch, supply, demand, price, etc., taking into account that none of these factors is static and that each may have an extremely wide range.

The Nature of Restrictions on Fishing

It is essential to keep clearly in mind that restrictions on the fisheries may be imposed for one or more reasons, not all of which have to do with conservation of the resource; some of these may, in given circumstances, be legitimate and needed; others may merely fail to achieve the desired (or in fact any) objective; while others again may be positively uneconomical or even harmful. It is only by careful measurement and evaluation, before, during and after the fact, that proper conclusions can be reached as to whether restrictions would be beneficial and, if so, whether the cost and difficulty of enforcement are justified.

Reasons for restricting a fishery may, therefore, be roughly classified into three categories, as follows:

1 BIOLOGICAL

- 1.1 Legitimate conservational (Gerhardsen, 1957)[2] measures, directed towards optimum sustained yield and arising out of an orderly process of measurement and evaluation.
- 1.2 Exceptionally, a policy decision to avert the total extinction of a species, which is partly emotional.

2 SOCIAL AND ECONOMIC

- 2.1 Closed seasons imposed not strictly for conservation of the resource, but so as to obtain a greater yield per unit of effort during a shorter fishing season.
- 2.2 Restriction of fleet (or other fishing pressures) or the imposition of costly licenses (a quasi-rent) to avoid disastrous competition or wasteful investment.
- 2.3 Regulation of flow of labor, seasonal or otherwise. This may be positive, to compensate seasonal unemployment in agriculture or industry, or negative, to discourage competition with professional fishermen or the distraction of terrestrial labor when casual fishing is adventitiously more profitable.
- 2.4 Control of marketing, i.e., to avoid gluts or to market the fish when it is more profitable or of better quality.
- 2.5 Protection of life and property during bad weather, perhaps with due consideration to later availability, or maintenance of craft during slack periods in shipyards, etc.

[2]The word "management" may be preferred, as it conveys better the concept which most fishery scientists have in mind, as Gerhardsen observes.

3 EMOTIONAL AND POLITICAL

3.1 Religious beliefs (total, partial or periodical abstention from certain kinds of food).

3.2 The emotional and usually un-informed demand for "conservation," apparently for the well-being of the creatures themselves rather than for the benefit of man.

3.3 A deliberate decision taken at the policy making level, to impress the electorate or to satisfy political pressures.

3.4 A similar but un-informed decision taken on the "advice" of untrained administrators.

Based on one or more of the above considerations, restrictions may be brought to bear on the fishery through a number of devices, which we may now examine. Each may be applicable to a different set of circumstances, but each will also, under certain other conditions, have disadvantages, or even dangers, which may not be apparent at first sight.

1 Total Prohibition of Fishing for a Given Species over a Period of Years.

Such drastic action may be justified when recovery is sought for an extremely vulnerable resource which has been seriously and demonstrably depleted through uncontrolled over-fishing. It is particularly applicable to sessile organisms such as molluscs of which the habitat is limited to a small geographic area. It may also be indicated for long-lived species which mature slowly, particularly those which are not prolific, and sometimes when the true conservation of a rare form of life is sought for emotional or cultural reasons.

2 Periodic Closed Seasons.

Although the value of closed seasons is often over-estimated, careful evaluation may show them to be necessary. They should never be imposed inadvisedly but only when the indicated result is preferable to the *status quo.* Decisions in this respect, which require vision and mature understanding, are those which are most often taken by the administrator without a full comprehension of all the circumstances involved. There is seldom biological (although there may be economic) justification in the case of short-lived prolific animals, particularly those giving an annual crop subject to heavy natural predation. It must always be proved that the resulting increased production (if any) fully offsets anticipated natural mortality during the closed period, as well as the economic cost of fixed overheads of marine and shore facilities, which will continue irrespective of whether or not there is fishing.

The extent of the overlap between natural and fishing mortality must also be taken into account, as is shown in Diagram I[3], in which, under (a), natural mortality is taken to be only 5 out of 25 units and fishing mortality 20, with a common mortality of 4 units and a residual natural mortality of 1 unit. If fishing is sacrificed, natural mortality in a given period will increase from 1 to a full 5 units and 20 units will, when the season opens, have remained in the stock for reproduction and fishing, instead of 4.

[3]Dr. Richard van Cleve has drawn my attention to the fact that this is an arithmetical over-simplification since the factors are, in fact, exponentially related. This does not, however, substantially affect the general principle which it is desired to demonstrate.

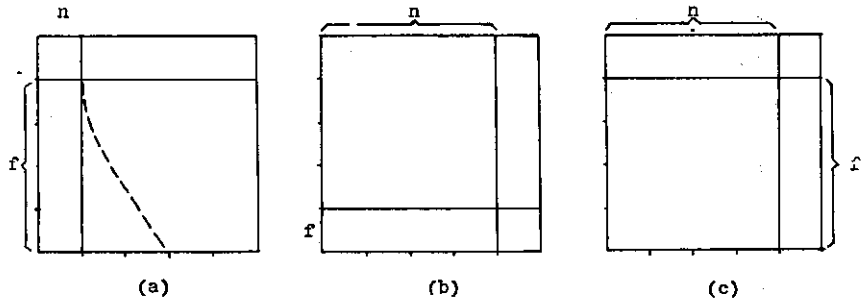

DIAGRAM I

Overlap between natural and fishing mortality, when (a) natural mortality relatively small, fishing mortality relatively large; (b) natural mortality relatively large, fishing mortality relatively small; and (c) natural and fishing mortality both large.

In (b), where natural mortality is large—20 units—and fishing mortality relatively small—5 units—, if fishing ceases, natural mortality will increase from 16 to 20, and 5 units only will be conserved instead of 4, a small gain compared with the sacrifice of 5 fishing units; when both natural and fishing mortality are high, as in (c), if fishing is stopped 20 units are lost to the economy, of which 16 will revert to natural mortality, but 5 units will be protected for reproduction and future fishing, instead of 1 if the closed season had not been established.

It must, of course, be fully understood that Diagram I, which is repeated with variations in the textbooks, is nothing more than an exposition of a general principle and that the real conditions, which are more complex, must also take into account the influence of the socio-political, economic and other non-biological factors, the effect of natural cycles and the fact that since neither fishing nor natural mortality is static, the elimination of the former and the correspondingly increased survival may bring into play new factors, favorable to increased natural mortality, expressed by the hatched line in I (a). This may be expressed percentage-wise as shown in Table 1.

A further illustration of the economics of closed seasons is given in Diagram II, where the total catch in a fishery has reached its peak and has started to descend. If it is assumed that a closed season is imposed at instant x, this will involve a loss equivalent to area "a." When fishing is resumed, there may or may not be an improvement of catch, but let us assume that at point x there has been a recuperation and that thereafter conditions tend to approach the normal curve (the improvement will seldom be permanent), so showing an increase equivalent to area "b," which is less than "a." In this case, the restriction has not shown a profit, although it might at a lower point on the curve, where "b" is in excess of "a." Often, however, the fishing curve may become stabilized (naturally, or as a result of other types of restrictions on fishing pressure), at a level which still does not justify closing the fishery.

It is often open to serious question whether the reason most frequently put forward for closing a fishery, the protection of a stock during its spawning period, has any validity. A point which is often lost sight of is that, in order

to maintain equilibrium, each pair of fish will, on an average, produce only 2 reproducing offspring, *in its whole life*, and that providing escapement is sufficient to take care of this minimum requirement, the loss to future generations of large numbers of potential juveniles is unavoidable, and may or may not be important.

Irrespective of their sometimes doubtful intrinsic value, the establishment of closed seasons usually followed by their progressive shortening, may mean that the fishery simply adjusts itself by employing more men, boats and gear, with a correspondingly higher capital investment. In very many cases, it must be admitted, closed seasons have failed to achieve the declared objective of improving the sustained yield (Scott, 1956).

TABLE 1

Factor	(a) With fishing %	(a) Without fishing %	(b) With fishing %	(b) Without fishing %	(c) With fishing %	(c) Without fishing %
Fishing mortality	80		20		80	
Natural mortality with fishing	4		64		16	
Natural mortality without fishing		20		80		80
Survival with fishing	16		16		4	
Survival without fishing		80		20		20
Total stock	100	100	100	100	100	100
% increase natural mortality if fishing stopped.	400		25		400	

3 Quota Systems.

It is often preferable to seek means to relieve fishing pressure other than closed seasons. Where international agreement has been reached by means of a Convention, over-all quotas may be assigned to countries; in other cases (e.g. the Whaling Convention) it may be agreed that fishing will stop when the total catch has reached a predetermined figure. Within countries, quotas may be assigned either voluntarily (or, more frequently, through government action), to companies, to boats or (more especially in the game fisheries) to individuals. In all cases, except perhaps the last, the quota concept involves in effect a closed season, of which the commencement date will, however, depend on how soon the quota is fulfilled after the fishery is opened.

As in the case of other restrictive measures, quota management of fisheries should only be resorted to when we have some idea as to how much fish can safely be removed from a stock without diminishing its sustained optimum contribution to the economy (Hart, 1958).

Perhaps the most outstanding effects of management of a fishery through an over-all quota are: the accentuation of competition (exaggerated fishing effort)—particularly on the nearby grounds, perhaps to the extent that distant grounds are actually under-exploited (Ricker, 1954); abnormally long working

days; the taking of risks which would normally be avoided; and hardship to individuals who are unlucky enough to suffer from breakdowns or illness during the critical period. Some of these disadvantages disappear if quotas are imposed on individual boats or on sub-areas, but this will discourage initiative, since the more enterprising fisherman can take no more than the others (Ricker, 1954).

Inefficiencies arising from the congestion of shore facilities followed by long periods of inactivity during which overhead expenses continue, must also be taken into account, as must the concomitant sociological dislocations. Intensive fishing at the commencement of the season may involve a minimization of growth in the current year.

The establishment of the quota tonnage must necessarily involve careful study and will usually require year-to-year revision in the light of constant evaluation on the basis of a highly developed (and costly) statistical system which will become extremely critical as the quota limit is approached each year. Quotas may additionally have to be adjusted so as to take into account substantial differences in later recruitment arising from "good" and "bad" years.

4 Size Limits.

Minimum size limits are often imposed on the grounds that insufficient

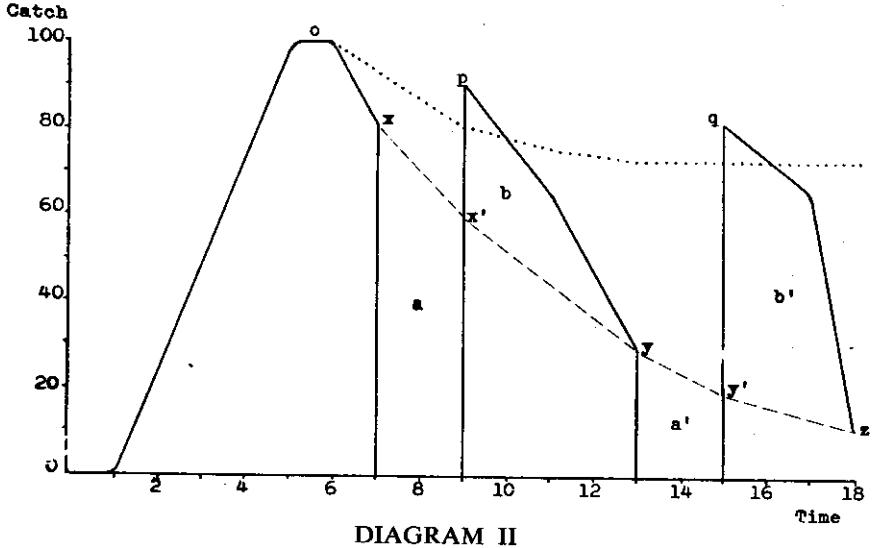

DIAGRAM II

Hypothetical effect of closed seasons.

xx'yy'z represents a normal fishing curve: if it is decided to impose a closed season at instant x and to resume fishing at x' and if as a result the total catch increases so as to give p, reverting to normal at y, the total gain in tonnage will have been equal to area b, but the sacrifice a is greater, indicating that the measure was unprofitable. If depletion continues and fishing is prohibited between yy' with a resulting recuperation to q, the gain b', being in excess of the loss a', may justify the action taken, which would not be the case if depletion were slower, or leveled off at the dotted line.

animals would otherwise fail to mature and reproduce. While it is obviously harmful to a fishery dangerously to reduce the number of residual spawners, the same doubt exists as under 3, above, as to whether the taking of immature fish is essentially a bad thing, provided that there is sufficient escapement, since maximum recruitment may still be achieved by a relatively small number of prolific individuals. There is in most cases so little evidence of any substantial correlation between the abundance of mature fish and commercial production that the effect of size limits on yield is doubtful, even in such an apparently vulnerable stock as the lobster (Turvey, 1957). It does, however, constitute one means of relieving fishing pressure, and it may well be that the growth rate of the sub-legal fish just prior to their natural entry into the catchable classes is such as to over-compensate for natural losses.

Except where a stock is not exploited in the adult stage, it is usually not advisable to permit the wholesale catching of schools of early stage juveniles for reduction purposes by the use of extremely fine mesh nets. Here, the difficulty arises that small mesh nets which must necessarily be permitted for catching species of small adult size may, purposely or accidentally, capture juveniles of other species, and the control of mesh sizes is particularly difficult in the case of mixed fisheries.

When mesh size has to be considered, it is important to attempt to establish for each species the co-efficient of 50% escapement at a given size. While it is true that there must be a good deal of empiricism pending the required original research, especially in tropical waters where so much is lacking, it is disconcerting to find that in many countries there is a general unawareness that such devices exist, and that therefore little if anything is being done to train personnel in their understanding and application, so that such restrictions continue to be legislated without rhyme or reason.

5 Prohibition of Certain Types of Gear.

There can be no discussion in respect of the need for the absolute prohibition of certain extremely harmful fishing methods, such as the use of poisons and explosives, or which involve the use of gear which completely and permanently obstructs a reproductory migration, e.g. in a river.

All too often, however, one finds that certain types of gear which would in fact contribute to optimum exploitation are prohibited in the legislation for no apparent reason. It is common for groups of fishermen using a type of gear to bring pressure to bear for the elimination of other types which they allege, often with little reason, to be contrary to the common good, whereas in fact they are seeking a front to protect their particular interests. Decisions in this respect can obviously only be taken by experts possessing long familiarity with all phases of the fishery.

6 Limitation of Fleet.

Even when there is not yet a depletion of the stock, it is often the case that an increase in the number of boats exploiting a fishery will not have resulted in any increase in total tonnage caught. This situation is sometimes described as cutting the same cake into smaller pieces, and its most obvious effect is unnecessary capital investment by the community and unnecessarily smaller returns per unit of effort expended. As to whether checks should be

imposed is at this stage a matter of policy decision, and the biological factor will only become paramount at a later point when depletion of the stock and a shrinkage of the total catch begin to show up.

Whether adopted for economic or biological reasons, however, limitation of the number of boats (or gear) exploiting a fishery is often the most direct and most easily measurable means of limiting fishing effort, provided that there is also control of size and efficiency, and that the permitted number is established through scientific observation rather than guess-work. It is often difficult to convince a thriving industry of the need for such a restriction until the break-even point is passed and the fishery has become unprofitable. When this happens, industry is often equally insistent on fleet control slanted towards the exclusion of newcomers. Such measures are looked upon, in some countries, as tending towards the establishment of monopolies and when applications are in excess of the established total, serious difficulties may be encountered in allotting boat permits. The imposition of license fees, in order to limit the fleet to the most efficient units, may have the effect of bringing about economic saturation before over-fishing occurs, but it must be ensured that the resulting maintenance of a relatively high yield per unit of effort (and higher profits) does in fact compensate for the fees paid so that these are not passed on to the consumer in the form of greatly increased prices.

7 Economic Controls.

Price control, subsidies, taxes on fish, production quotas for processed fish, limitations on size and number of factories, license fees and other controls of a non-biological nature, may also have a more or less direct influence on fishing operations.

Application of the Above Criteria

It is beyond the scope of this paper to probe deeply into the mathematical aspects of the interrelation between fish populations, year class frequencies, recruitment, mortality, etc. on the lines which are still being actively developed by Beverton, Holt, Kesteven, Schaeffer, Burkenroad, Le Cren, Ricker, Gulland and others. It is, however, aimed to draw attention to these techniques in the hope that administrators may gradually become aware at least of the existence of the general principles involved[4] (only a few will have the time or the specialized training necessary to participate in the detailed reasoning, which is still partly controversial) and to the important fact that biological considerations alone will not suffice to give us the answer to the problems entrusted by the community to government and industry.

As Marr (1954) tells us, "es fácil de imaginar cuán complejas se tornan las variaciones que pueden observarse en las curvas de pesca, cuando la disponibilidad y las tasas de mortalidad natural de pesca varían simultáneamente."

But also, "while the cost of fishing depends partly on the size of the fish population, (conversely) the latter is obviously affected by the size of the

[4]Le Cren (1958) calls attention to the need "for these elaborate theoretical models to be simplified to their essentials" although "their development will (have yielded) valuable improvements to the understanding of the whole subject."

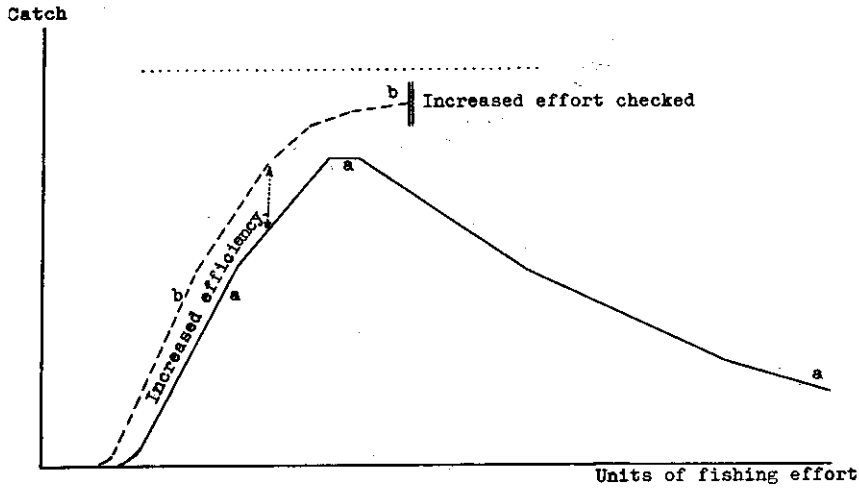

DIAGRAM III

a. "Biological" fishing curve under uncontrolled conditions, assuming successive increases in fishing effort, irrespective of economic factors.
b. Hypothetical "economic" fishing curve under ideal controlled conditions and improved efficiency.

catch. There is thus a close interaction between economic and biological factors and any full analysis of the size (and behavior) of a particular fishery must pay regard to both. The problem is not merely one of intellectual interest, since it must form the background to any examination of conservation measures." (Turvey, 1957)

As an example, let us examine the standard fishing curve shown in Diagram III, in which a steadily increasing fishing effort (irrespective of time) is correlated with catch. The biologists tell us that, as a virgin fish population becomes exploited, each new unit of effort will, after an initial period during which effort as yet results in little or no return, give a relatively large increase in catch, and that returns will progressively decline to a point of equilibrium, after which increased catch from additional units of effort will be negative.

The final shape of the extreme right-hand part of the curve is, of course, doubtful, because before zero catch is arrived at there will either have been economic adjustments or the fishery will have ceased to exist. In any case, it will at first tend to be asymptotic with the zero base line.

So much for the *biological* effect on the stocks of successive increases in fishing effort (of the same kind), and it is here that the fishery-economist-administrator must take over, since it is obviously absurd to tolerate the situation so often encountered in which increased effort results in a serious decrease in yield. It is his task to correlate the social and economic factors so as to *modify* the fishing curve which would result from uncontrolled conditions. He will, first, in consultation with the biologists, try to determine at which point on the curve the addition of extra units of fishing effort should cease, and take the necessary administrative measures to this effect. He will

also, with the cooperation of fishery technologists, see to what extent improvements in gear, boats and fishing methods, and the discovery of new grounds, etc. may be expected to accelerate (and perhaps anticipate) the ascending part of the curve and delay or avoid the descending portion, although the possible results will vary greatly in each fishery. He may with the means at his disposal be able to approximate some such improvements as are shown in the hatched line in Diagram III, in which he will perhaps ideally be influenced by the desirability of the fishing curve becoming, in so far as is possible, asymptotic with a new, hypothetical maximum catch (dotted line), i.e., the "eumetric fishing" of authors.

Some of the specific economic factors which will influence the informed administrator, in addition to purely biological considerations, are given by Turvey (1957)[5], when he graphically illustrated the complexity of the parameters confronting the administrator in his analyses.

The upper part (i) of Turvey's Diagram IV shows the sustainable catch which will exactly balance the excess of population increase[6] over natural mortality, at different levels of exploitation. At population O there can obviously be no increase, and again at the maximum population F[7] there can, under conditions of saturation (equilibrium) and in the absence of pre-

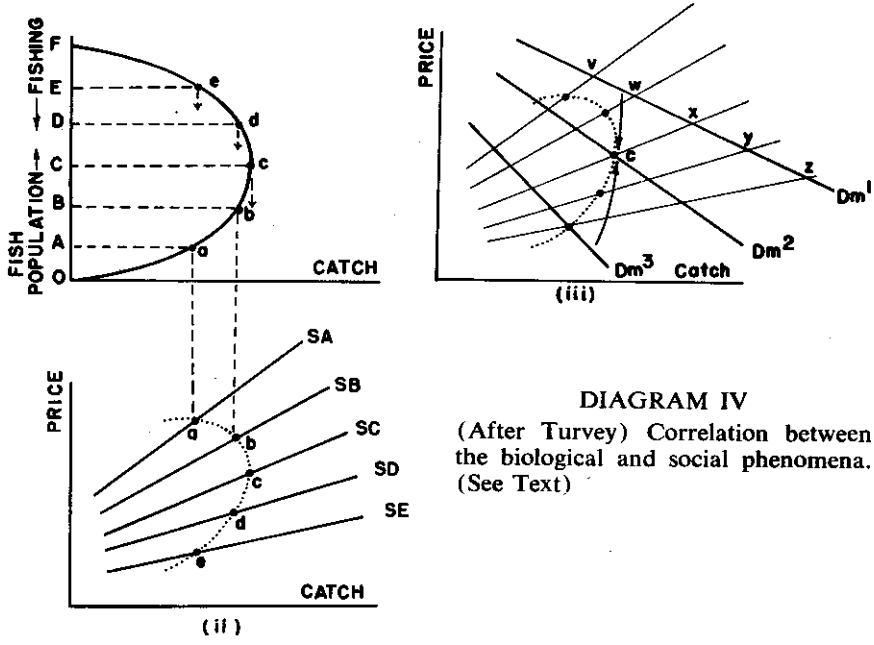

DIAGRAM IV
(After Turvey) Correlation between the biological and social phenomena. (See Text)

[5]For the purpose of this dissertation, Turvey's premises will not be discussed. The shape of the populations curve may be considered to be stylized.
[6]g+z-q, if all parameters are expressed in terms of instantaneity.
[7]This illustrates Ricker's point that "too much preoccupation with size of stock can lead to the (erroneous) assumption that a large stock is an end in itself . . . It is possible for a stock to be too great to provide maximum yield."

dation by man, again be no increase. At all intermediate levels, it is assumed that there would have been an expansion of the population in its attempt to achieve equilibrium, had it not been checked by fishing. At each point on the curve, other things being equal, there may subsequently either be a dynamic adjustment towards F (underfishing) or towards O (overfishing) and a static condition will exist at a given point only if fishing mortality equals the increase in population in excess of natural mortality. It is theoretically possible to strike a fishing point on the curve (around FC) which will take advantage of all the circumstances involved so as to give a maximum (but not necessarily the optimum) equilibrium catch, Cc. For the purposes of projection, this curve has been up-ended through 90°.

Projections ii and iii attempt to relate the social optima, under different conditions, to the competitive equilibrium described, for which purpose five of an infinite number of possible supply curves are drawn in projection (ii).

When there is (in (i), above) a balanced population OA at a maximum sustainable catch Aa, the only point on the supply curve corresponding to population OA which is sustainable under the prevailing natural conditions, is a in projection ii, and so on successively with points b, c, d and e. Hence, the dotted line which is the locus of these and intermediate points shows the set of combinations of price and catch which can be sustained while such natural conditions persist.

Now, supposing equilibrium to have been reached at FAa, between fishing and excess of recruitment over natural mortality, it is obvious that the *same* catch, e, could be maintained with the smaller fishing effort FE, that, subsequently, a *larger* catch (Dd, Cc) could be obtained by a *controlled* increase in fishing effort (FD, FC), and that the social cost of obtaining this saving would be, first, the temporary sacrifice of the catch necessary to allow the fish population to expand from OA to OE and then the acceptance of rational management techniques to permit the catch to expand from Ee to Cc. It should be noted that, in addition to fishing restrictions, some temporary form of marketing control may be required in order to strike the new equilibriums successively at FDd and FCc (or such intermediate point as the demand and other socio-economic factors may warrant).

In IV (iii) Turvey attempts to take his arguments a step further so as to include demand as a (possibly controllable) parameter. Assuming the prevailing demand to be represented by curve Dm′, lying for the whole of its length above the dotted line a b c d e (giving uncontrolled economic "markets" at v w x y z but sustained availability only at lower points, on the dotted line) it is argued that, with free entry to the industry, the community would be exerting more effort than that required, and extracting a portion of the stock which is too large to maintain equilibrium. The present writer concludes that this may represent the extent to which license fees (a quasi-rent) or other deterrents to consumption (e.g. a tax on certain types of fish) might be introduced (with due consideration for compensation of losers), or the extra demand may be satisfied through the favoring of the importation of supplies from other fisheries.

When, on the other hand, the demand curve Dm^3 cuts the dotted line *below* the point of maximum sustainable catch, its intersection with the dotted line coinciding with a corresponding supply curve (in this case SE at e), then,

the market demand being less than the sustainable maximum catch, measures (price subsidies, consumer education, improvement of marketing conditions, etc.) may reasonably be sought to improve the demand or otherwise influence the social optimum, again so as to bring it in line with the biological optimum c. The extent to which such promotion measures are justified may depend on the extent to which optimal welfare conditions are imposed as a matter of policy elsewhere in the economy, since it may be argued that the fisheries *per se* do not warrant a greater degree of management.

Before leaving the question of the factors (biological and socio-economic) which must be taken cognizance of in any enlightened fishery management program, it may be well to stress that the factors so far mentioned, while not always precisely measurable, do lend themselves to some sort of relative evaluation. The existence of additional, but more intangible considerations, which do not lend themselves to measurement by means of such models as those illustrated, should nevertheless be kept in focus. Some of these can only be expressed in terms of human needs and human suffering, as, for instance, a *need* for better nutritional standards, which because of limited purchasing power in "poor" (Kirby and Szczepanik 1957) communities cannot yet be translated into terms of effective economic demand. It is important that, as we approach the point of "take-off into self-sustained growth" (Rostow, 1956) through management of the economy as a whole, these needs should gradually become equated with demand. It is in these fields that the wise and forward looking administrator will keep in touch with the ends which are being pursued by workers in nutrition, labor relations and public health and welfare, to whom we should look to help us in bringing these more philosophical concepts into our long-term calculations.

Ways and Means

One of the principal objects in setting forth at some length a partial exposé of the multiplicity and the complex interrelationships of the biological, economic and social premises to which the fishery administrator must pay attention if he is to come up with the right answers, has been the hope that this paper may come to the attention of at least some government officials at the policy making level in countries where, because of an almost complete unawareness of the real nature of the problems, fishery development is being retarded by defective administrative and institutional action, or even complete lack thereof.

It was precisely with a view to remedying this type of situation that the majority of nations have associated themselves in numerous phases of United Nations activities such as the U. N. Economic and Social Council, with its Technical Assistance Board; Unesco, ILO, FAO and others. It must be stressed, however, that none of these activities can at present in any way be considered as tending towards world government, as is sometimes erroneously supposed, and assistance can only be given to sovereign nations when, having become aware of the need for technical skills and advice which are not immediately available at the national level, their governments formulate a specific request and include it in the limited annual budgets allocated to each country.

FAO—the Food and Agriculture Organization of the United Nations, with

Headquarters in Rome and outposted offices in Asia, Africa and Latin America—was conceived at an international conference at Hot Springs in 1943 and its Constitution was approved by 42 member nations in October, 1945, ante-dating the United Nations Organization itself by about one week. This number has now grown and will probably, as a result of action by the General Conference being held in Rome this month, shortly approach 80 member countries.

The governments associated in FAO are able to call on the Organization for advice at various levels; through the availability of data the compilation, publication and distribution of which is a continuing task at the Headquarters; through the assignment of members of the permanent staff to problems, usually of a general advisory nature, in order to determine requirements; and more specifically, the sending of specially hired experts for a more or less lengthy period to assist the government by working alongside and training the local officers; and through co-operative action brought about by international training courses, symposia and permanent committees or commissions. In the field of fisheries, FAO has so far organized four short term training centers—two of a general nature in Chile (1954) and Mexico (1957) and two of a more specialized nature in Peru (food technology, 1958) and Colombia (fish culture, February 1960), in addition to those held in other regions.

As far as international fishery commissions are concerned, more interest has been shown by the countries of Europe and Asia in the creation of such advisory bodies, than in Latin America, and this is perhaps principally due to the fact that, in the majority of countries, there is a greater lack of trained personnel which could profitably contribute to the discussions.

It is, however, part of the standing instructions of the FAO Secretariat to contribute to and assist in the work of other institutions engaged in the international field, among which we believe the Gulf and Caribbean Fisheries Institute to be performing extremely important work.

As has been stated, one of the principal obstacles encountered by FAO and its member governments, in promoting fisheries development, has been the lack of even partially trained personnel to work alongside our experts and carry the torch when their assignments expire. Without this continued effort, technical assistance loses a great part of its potential value, and there is little to be gained by governments in receiving what may be an excellent report, but which is filed away and does not result in an active national program.

Hence, we believe the training of fisheries personnel in under-developed countries to be the only key to real progress. Our experts are, however, confronted with the problem as to whether they should recommend the sending away of likely candidates for long, academic training, in which case their skills will only become available to the administration (supposing that a new government continues their employment and is willing to offer them a career commensurate with their professional attainments) after the expert has left the country, or whether we should settle for something less, in the nature of on-the-job training plus perhaps a short term in some institution abroad. The answer is, of course, that both are indicated, but only in a few cases at present are governments seized with the need for full basic training,

so that we are thrown back on to the expedient of seeking short term training of an essentially practical nature, to the exclusion of other academic requirements which are usually demanded by educational institutions which cater only to those working for a degree. We have found this question of obtaining purely technical education for promising young people who must carry the load until the necessary time required for full academic training has elapsed, to be an extremely difficult one, and we are hoping that our colleagues in the teaching profession may be able to throw some light on it for us.

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