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INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

ICNAF Res. Doc. 66-19

Serial No. 1616
(J)

ANNUAL MEETING - JUNE 1966

Economic Aspects of Fishery Management

(made available by FAO
on the basis of papers prepared by Professor J. A. Crutchfield)

FAO Fisheries Circular No. 27
(Distribution restricted)

FEe/C 27
Fishery Regulation

A NOTE ON ECONOMIC ASPECTS OF FISHERY MANAGEMENT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, April 1966

PREPARATION OF THIS CIRCULAR

This circular has been produced by the Fishery Economics and Development Branch of the Department of Fisheries, FAO, based on a report on a meeting of biologists and economists held in Rome 27/28 September 1965, prepared by Professor James A. Crutchfield, University of Washington.

MI/44084

I. Introduction

A. Scope and Purpose of Meeting

It has become increasingly clear to fishery experts throughout the world that sound biological condition of fish stocks is a necessary but not a sufficient condition for healthy fishing industries. There is also increasing awareness of the interdependence between the physical aspects of fisheries management and the economic motives that govern private and government enterprises in both fisheries and the related processing and marketing sectors. Regardless of the specific objectives laid down for management agencies, by legislation or by choice, a better knowledge of the interplay between economic factors and the intensity, location and composition of fishing effort is essential if the full potential of fishery management is to be realized.

In recent years increasing interest in the economic aspect of fishery management has been expressed by several of the major regulatory commissions. In particular, at the Annual Meeting of the International Commission for the Northwest Atlantic Fisheries held in June 1965 support was given to a suggestion that a small group of experts should meet to discuss this aspect of management and in particular to indicate a program of studies and investigations necessary to develop economic indicators relevant to the problems of management of fish stocks.

The meeting convened in Rome on 27-28 September as a result of this initiative directed its attention to the following questions. (1) To what extent can economic analysis clarify the results that will follow the adoption of alternative methods or combinations of methods of regulation designed to increase physical yields from overfished stocks? It was considered particularly important to indicate the advantages and disadvantages, in economic terms, of particular types of regulatory activity that could be predicted with confidence even before accumulation of additional statistical data. (2) What types of statistical and other analytical material are required to refine the analysis of the economic effects of various types of regulation, and to "meter" the impact of both regulation and external factors on the economic performance of the fisheries in question? (3) What problems are involved in assembling these materials and in presenting them in timely fashion to permit maximum effectiveness in the formulation of management policies by regulatory commissions and their implementation by the commissions and by the individual nations concerned?

B. The Role of the Economist in Fishery Management

Before undertaking discussion of the three topics, however, the meeting considered carefully the relevance of economic criteria in fisheries management, particularly in the case of internationally shared fisheries. It was noted, first, that there are certain generally accepted criteria for good economic performance that apply to the fisheries as to any other industry. In their simplest form, these call for the use of all resources to provide the largest possible net economic yield. This implies not only the production of the correct amount of end product, but also the use of most efficient methods and the most efficient number of units in producing any given output. Over time, an efficient industry would also provide both incentive and means for further improvements in product utilization and cost-reducing technical developments. It would be expected that the incomes generated by fishing activity be acceptable in terms of equity and incentive. Finally, subject to both technological and marketing limitations, it would be desirable to have incomes, prices and employment opportunities as stable as possible.

Obviously, not all of these objectives are consistent with one another. Maximum technological progress, for example, may result in considerable displacement

of both men and capital equipment which cannot be easily absorbed elsewhere in the national economies affected. Similarly, regulatory methods required to produce maximum net economic yield from a marine fishery for the world as a whole may be inconsistent with distribution of resulting incomes and employment opportunities among nations in a way that would satisfy standards of fairness and equity - standards that simply cannot be defined in economic terms.

There was general, though not unanimous, acceptance of the fact that the economist stands in a somewhat different relation to policy formulation than does the fishery scientist. In his role as scientist the fishery biologist or technologist is properly concerned with definition of results to be expected from alternative courses of actions, and the development of a scientifc framework within which such relations may be quantified. There is little or nothing that the biologist can say about which of the alternatives should in fact be adopted. Economics, on the other hand, is essentially a methodical approach to the problem of human choice in which market prices, even in socialistic economies to some extent, provide objective measures of aggregate preferences. Given the fact that we cannot have as much of every possible product as we would like, it seeks to establish an orderly way of determining priorities. In this sense an analysis leading to the conclusion that a given output can be produced at lower cost under one method of regulation than any other frequently constitutes an implicit recommendation, since it rests on data that reflect society's preferences.

The economist cannot beg the responsibility for his actions by saying that he can only lay out the alternatives, leaving the choice among them to some political process. He is, in fact, charged with the responsibility for indicating the superior choice of action insofar as economic efficiency is concerned. There may well be non-economic reasons for doing otherwise, and this does lie outside the scope of a social scientist. But most economic analysis is closely tied to policy recommendations, and its usefulness lies in its obligation to focus attention on the decisions that must be made.

These remarks apply, however, only to the efficiency effects of regulatory actions. These actions may also have distribution effects and here the role of the economist parallels that of the fishery scientist. He can clarify alternatives but cannot provide any basis, on economic grounds, for choosing among them. This is true with respect to the vitally important division of catch and employment opportunities from a regulated fishery among the participating nations, and - within each nation - the division among different fleets and types of gear. It is possible to determine whether or not particular methods of regulation result in both "winners" and "losers", and it seems logical that use of regulatory techniques that result in economic gains for all participants (or, at least, compensation from the winners for the relatively small losses of others) would be preferable to the economic losses inflicted on all under unrestricted fishing. It is also probable that regulatory methods that distribute the gains from controlled fishing fairly equitably among participants would be preferred to those in which one or two nations make very substantial gains relative to others. However, it must be acknowledged, without reservations, that economic analysis as such can provide no basis for distribution decisions of this type. It can only clarify the alternatives, and thus improve the essentially political decision-making that must be involved.

Clearly, then, no statement of general economic objectives can define a firm and unique set of policy recommendations for any regulated international fishery. There are important policy problems in the management of any international fishery to which economic analysis can contribute little or nothing. Nevertheless, there remains a wide area in which the economist can shed useful light on the efficiency effects of alternative methods of regulation and on the expected reaction of industry units to specific opportunities and restrictions. Both would enable the regulatory authority to forecast more accurately the results of its actions and to appraise them in terms of their impact on output, prices, and incomes, and the distribution of catch and income among participants.

The remainder of this report is divided into three sections. Section II is a statement, drawn from the literature, of present knowledge of the economic effects of certain methods of fishery management. Obviously the details will vary from fishery to fishery, but certain general results can be identified, explained in terms of normal behaviour of fishing units, and illustrated from actual experience. Some of these general conclusions are sufficiently firm and of sufficient importance to be of some use immediately.

Section III sets forth the general conclusions of the meeting as to the factual and statistical information needed to measure the economic performance of any given fishery and the economic effects of regulatory measures.

Section IV is devoted to a summary of problems of data collection, presentation, and analysis, including but not limited to matters discussed at the Rome meeting.

II. Economic Effects of Alternative Methods of Fishery Regulation

A. The Literature on the Economics of Fishery Regulation

The attention of economists was first drawn to the fisheries by glaring evidences of poor economic performance in the absence of regulation. The pioneering papers by Scott, Gordon, and Gerhardsen all stressed the fact that the absence of ownership or control by the individual units concerned would lead to serious overfishing in any fishery in which price-cost ratios are favorable at high levels of output.

Since no individual unit can reap the benefit of "investment" in future supplies, it has no incentive to restrict fishing effort in the current period to that which will maximize either physical or economic yield over time. The more competitive the industry involved, the more destructive the race to catch fish before others can take them. Extension of this analysis to the international arena involved the same theoretical considerations, with additional complications. Specifically, different patterns of consumer preference and different labor and capital costs would make it impossible to define, even in theory, a fishery that would be economically ideal for all participants.

From this beginning the economic literature has branched off in two directions: to explore more fully the economic reaction of a regulated fishery to various types of controls that may be imposed on the assumption that maximization of physical yield was the prime objective of the regulatory authority; and to investigate individual fisheries to see if the theoretical model applied in practice and to indicate reactions to regulation in various kinds of fisheries.

A number of such studies have now been published. These include the study of the Pacific halibut industry by Crutchfield and Zellner; the New England groundfish industry by a Boston College group; the British Columbia salmon fishery by Sinclair; and the Puget Sound salmon fishery by a University of Washington group. A number of excellent case studies of more limited scope were presented at an FAO Conference on the Economics of Fishery Regulation held in Ottawa in 1961.

One general conclusion emerges from all of these studies. The logic of the argument that unrestricted entry to a marine fishery by private firms will inevitably lead to continuing overcapacity, inefficient use of labor and capital, and (if price-cost ratios are very favorable) overfishing severe enough to pose a threat of serious physical depletion, is confirmed. Moreover, the amount of economic waste appears sufficiently large in the case of high-valued fisheries such as halibut and salmon to warrant serious concern. Since this seemed to be a matter of general agreement at the meeting, the point need not be labored further.

The earlier literature also suggested that of the several types of regulation that might be employed to reduce fishing mortality or to alter the age and size at which fish are first exposed to capture, only those accompanied by some effective limitation on entry will enable the regulatory authority to reap the full economic benefits from rebuilding a depleted stock. The individual studies confirm this prediction. They also provide considerable insight into the secondary reaction in regulated fisheries as the effects of regulation show up in increased catch per unit of effort, and indicate the efficiency effects of various techniques for reducing fishing mortality. The conclusions that emerge from these studies are discussed below with respect to individual types of regulation.

B. Economic Effects of Alternative Methods of Regulation

There is an almost endless number of specific regulations that can be devised to alter the effect of a commercial fishery on exploited stocks. As noted by Beverton, however, mortality in a given fishery is functionally related to only four basic factors: the number of units participating; their catching power; their total fishing time; and their spatial distribution during the fishing period. All effective controls based on fishing mortality must operate through one or more of these factors. In addition, regulation may lessen the impact of the commercial fishery by changing the age (and thus average size) at which fish are first subject to capture. For purposes of this discussion, the following classification of basic regulatory techniques is used.

Regulations Affecting Minimum Age (Size) of Recruits

Gear Selectivity

Nursery Areas

Seasonal Closures

Regulations Affecting Fishing Mortality

Sweep Efficiency

Areas Fished

Time Fished

Catching Power of Gear

Numbers of Operating Units

Quotas

As Professor Scott and others have pointed out, the economic effects of a particular type of regulation must be broken into two parts: the direct or short-term effects; and the longer run effect (often unintended) that emerge as the fleet adjusts to the new measure. Since any effective fishery management action must alter either money receipts, money costs, or both, it is almost certain that some subsequent adjustment will take place.

1. Regulations Affecting Minimum Age and Size of Recruits

a. Selectivity Controls

Selectivity regulations involving mesh size and minimum size of fish are, in economic terms, investment decisions involving a sacrifice of present yield for a larger future yield. They rest on the assumption that to allow fish to grow to larger

size before capture will produce an addition to aggregrate weightgreater than the decrements from increased losses to disease, old age, and predators. There seems little reason to doubt that mesh size regulations that meet this requirement are economically efficient, since they produce a net addition to sustainable rates of physical output by gear restrictions that normally result in lower rather than higher costs of operation. As long as the net addition to economic yield is greater than the going rate of interest - a condition probably fulfilled in many heavily exploited demersal fisheries - such regulations are efficient on economic as well as biological grounds.

On the other hand, economic analysis suggests undesirable secondary effects if selectivity regulations are not backed up by restrictions on the number of units of gear. Assuming that such measures are effective, larger yields will be realized for a given effort and operating costs will, if anything, be reduced. If the fishery was originally in equilibrium both biological and economic, the resulting increase in profits will attract new vessels into the controlled fishery, and all or part of the potential increase in net economic yield will be dissipated in excessive capital and labor inputs. A larger yield in weight can be taken, but only at the sacrifice of other goods and services that could have been produced by the capital and labor in excess of that actually required.

b. Size Limits and Nursery Areas

In most marine fisheries size limits are an ineffective protective measure, since the mortality of undersized fish returned to the water is very high. They may, however, provide a useful complement to selectivity controls to ensure greater compliance.

Area closures may also operate as a complementary measure to restrict capture of immature fish, provided the grounds in question are actually "nursery" areas. Their economic aspects are exactly the same as those outlined above for selectivity controls, involving an investment decision to defer capture until a greater weight yield can be obtained.

2. Regulations Affecting Fishing Mortality

Of the family of regulations affecting fishing mortality, only the restriction of the number of operating units, with each unit of optimal efficiency in an economic sense, really meets the efficiency criterion for the overall fishery. As indicated below, all other types, to the extent that they are effective at all, operate to reduce the catch by decreasing efficiency and therefore the incentive to overfish or do so as a by-product of the direct restriction involved.

a. Closed Periods

Closed fishing periods will have little or no effect on fishing mortality except through their impact on economic costs. If, for example, the fish are available more or less continuously and if storage and freezing costs are very low, fishing for relatively high-valued species will be little affected by seasonal closures - effort will simply be intensified during the open period. In most cases, time closures operate to increase total costs for any given quantity taken, and thus induce a reduction in fishing effort. It is also possible that closed fishing periods, in cases where fish migrate on a regular pattern, become area closures for some of the fleet, and raise the time and distance of travel for others. In either case the operative effect on fishing mortality is through increased costs of production.

In the case of anadromous and some pelagic species, however, properly timed closed fishing periods can be a highly effective and flexible device. For reasons outlined above, it is likely to prove inefficient over time in an economic sense, since any recovery of stocks as a result of skilful use of seasonal and intra-seasonal

closures simply induces more units of gear to enter the fishery than are actually required. The Puget Sound salmon fishery provides a perfect illustration. Recovery of the famous Fraser River runs under a highly successful management program based on seasonal closures induced such a tremendous influx of boats and gear that only two or three days fishing per week during the season can be allowed at present. A University of Washington study indicates that no more than half the gear now in use could harvest the full allowable catch, at a saving of perhaps 40 percent of the gross value of landings. In addition, the lengthening of in-season closures reduces the flow of information to the regulatory commission and leads inevitably to unbalanced harvesting of the different races that make up the exploited stock. Both factors reduce the total sustained physical yield and add to aggregate fishing and management costs.

b. Closed Areas

Area closures, given seasonal variations in the availability of fish, frequently become merely limitations on fishing time, and as such are covered in the discussion above. If fish migrate freely over an entire fishing area, with the same size-composition of the population throughout, area closures would be completely ineffective except as they reduce efficiency by forcing the fleet to incur higher costs to reach open areas.

c. Efficiency Reduction

The economist's reaction to regulations specifically designed to reduce efficiency may be summarized very briefly. First, there can be no rational defence of a technique that maximizes the inputs required to produce any given output, which is the essence of gear restriction, in its manifold forms, as a control device. Secondly, the economist can only view with dismay the fact that most regulations of this type are the product of gear competition, contribute little or nothing to control of physical catches, and seem to be increasing rather than decreasing. Limitations on the length of vessels or on the size or amount of gear fished, prohibitions against the use of electronic fish-finding equipment, and similar measures are all inefficient in any sense of the word. It is highly likely, moreover, that in most instances efficiency reducing regulations complicate the task of the regulatory agency unnecessarily, and build a formidable barrier to effective enforcement by requiring fishermen to use equipment which they know to be inefficient in light of current knowledge. The extraordinarily bad record of compliance and enforcement in the Alaska salmon fishery can be traced in large part to the resentment, inherent in any kind of control over economic activity, provided by the economic absurdity of many of the efficiency-reducing measures that have been adopted over time.

d. Quotas

From a regulatory standpoint, the catch quota is by all odds the simplest and most direct way of controlling fishing mortality. In analyzing its economic effects, however, it becomes evident that the quota device is a complex technique, operating primarily as a limitation on fishing time, with secondary effects on area distribution of fishing effort, and - in some cases - on the numbers and type of vessel and gear employed. Administratively, there can be little doubt that this is one of the most attractive types of regulation to curb excessive fishing effort: it is flexible, enforceable, largely non-discriminatory, and lends itself to straight-forward allocation of catches among participating countries and fleets.

Nevertheless, the practical difficulties of securing international agreement on the basis of such allocation must not be under-estimated. Economic considerations do not produce any objective method of allocating total catch or effort between nations and this has to be done by negotiation. While existing levels of national effort may be a good starting-point, it is unlikely that general agreement could be reached on a straight percentage reduction of such levels. Some countries may claim that in the period suggested as the base particular circumstances had adversely affected their

effort level. Other countries may consider their fisheries as developing in the control area. Countries not fishing in the area at all may have a claim for a quota allocation if the resources are being pre-empted; this claim would be particularly difficult to resist from coastal states. These remarks do not take into account different national interests, due to differences in market preferences for the various species of fish caught in the control area, nor do they attempt to analyse the additional problems that would arise if only certain of these species were placed under quota control.

The effects of quota regulation, particularly those involving economic reactions, are far from simple; some are distinctly undesirable if the quota regulation is not backed up by restrictions on entry. In essence, the following sequence is to be expected. The quota system, if effective as a regulatory device, presumably will increase landings as fish populations are rebuilt. On the assumption that the industry was in equilibrium at the outset, the effect is to induce new entry as costs per unit of catch decline with increasing abundance and size of fish. The result is a progressive shortening of the fishing season as the rebuilding process continues and unit costs continue to drop. In the Pacific halibut case, for example, an increase of only about 25 percent in the total quota over a period of about twenty years induced an increase of nearly 300 percent in the number of vessels participating. As a result, the season, originally about nine months in length, fell to as little as fifty-nine days. The increase in real income of halibut fishermen from all sources, adjusted for changes in the general level of prices, fell considerably short of the average for all employed labor in the regional economy involved. There are also other secondary effects on costs directly attributable to the shorter season. Higher storage costs must be incurred, some loss of quality is inevitable, and the risks involved in holding inventory over longer periods of time, borne initially by fish processors and marketers, ultimately result in lower prices to fishermen. Shortening of the season also requires that boats and men find other off-season employment, and - as noted above - this invariably involves some loss of labor time that cannot be recovered.

Moreover, the quota system per se produces certain reactions on the part of the fishermen that operate to eat up the physical productivity in rising costs. Given a fixed aggregate catch, each fishing unit will obviously find it advantageous to get the largest possible share, and thus to make as many trips as possible each season. The intensity of fishing effort on the part of individual units will therefore be as great as men and gear can stand. This also implies that fishing time can be maximized by running to the nearest ports on all but the final trip. This would produce a geographic pattern of landings that would result in the lowest total cost for any given quota catch only by sheer accident. There is also a built-in tendency to skimp on ice and other protective techniques in order to increase the total catch per trip, and to remain out as long as necessary to take a full or near-full load before returning to port, since only a finite number of trips may be made by any one vessel. All of these factors operate to increase costs of production, to reduce quality of the final product, or both. Individually, they may not be serious, but in the aggregate they add up to significantly poorer economic performance than would be the case if the quota were accompanied by restrictions on the number of participants that guaranteed only that number required to take the quota on a full time basis.

The quantitative impact of a quota system on the economic behaviour of a major fishery is examined in detail in the study of the Pacific halibut industry by Crutchfield and Zellner.

The discussion above assumes that an overall quota is established for all participating countries. To some extent the competitive pressure that gives rise to the undesirable economic results indicated would be reduced if national quotas were established as a supplementary technique. There would still be serious problems, however, if one or more of the larger fleets participating were not controlled in terms of number of units as well. It is hard to envisage a more disorderly situation than

one in which some countries license only the number of units required to take the national quota (and thus fish over a prolonged period of time) while others allow completely unrestricted entry and exhaust their quota in much shorter periods. Under such circumstances, one of the undesirable biological results of the season-shortening effect of an overall quota would be found even with national quotas; that is, the tendency to concentrate the fishery on readily accessible locations, and therefore the likelihood of non-optimal cropping of separable sub-groups of the populations involved.

e. Control of Number of Units

The basic argument for reducing fishing mortality by control of the number of units (each of maximum efficiency) has been developed in detail by Scott, Gordon, Crutchfield and Zellner, and in the proceedings of the 1961 FAO Conference referred to above. The logic of the argument is unassailable, but to implement a program of gear reduction, particularly in an international fishery, requires long, hard negotiation to resolve individual group interests under a regulatory scheme that can be of benefit to all. The halibut and salmon studies already cited illustrate that workable programs can be devised - and also that they can be thwarted by ignorance of the alternatives and the traditional conservatism of fishermen. In the few scattered cases where entry has been controlled, the economic performance of the fisheries involved has been vastly superior to that realized under any other form of regulation.

The main weakness of other forms of control is their inability to deal with the normal response of the fleets to an improvement in physical stocks, namely an increase in effort leading to an increase in total costs. Restriction on entry as a regulatory device has an obvious advantage in terms of efficiency, but has met with a number of objections based more on problems of application, which are by their nature more difficult to resolve at the international level. One major problem involves the elimination of excess capacity of boats and men; how is this to be accomplished with reasonable equity, both within a national industry and between nations? This has led to suggestions that an assumption of "ownership" of the resource should be made by an international "authority" and that a "price" for fishing rights should be established - in the form of a fee, vessel tax, landings tax, etc. - which would provide incentive for only the minimum number of units using the most efficient gear and methods. In practice, it seems clear that the reduction in units can only be carried out gradually, possibly initially by licensing existing vessels and making the licences non-transferable and issuing no new ones. Subsequently, as the remaining licences acquired a "property value" in the fishery, some transfer arrangements would be necessary. Whatever technique is adopted should have as its aim the reduction of costs and the encouragement of innovation.

While the theoretical advantage of number limitation is clear, it will also be necessary in most cases to apply supplementary controls to provide the necessary flexibility: these might be quotas (global and area) and gear regulation, in order to ensure an optimal geographic distribution of fishing effort and to avoid the danger of competitive building of vessels too large for optimal operating efficiency for the given catch quotas.

We conclude that much can be accomplished immediately in an economic evaluation of alternative methods of fishery regulation. Even when we give full weight to the practical realities of international cooperation in marine fishery regulation, it is still possible to say that certain types of regulation are inherently superior to others in terms of their economic effects. It is also possible to state, unequivocally, that significant improvements in the net economic contribution of regulated fisheries can be achieved by consciously avoiding those types of regulation in which inefficiency is the operative force reducing fishing effort and emphasising those that provide both the opportunity and incentive to improve economic efficiency. The regulations which have the greatest potential for producing economic benefits are those which restrict entry, of which control of the number of optimal fishing units at a level where their full-time use would produce

only the permitted catch is the ideal. It is also clear that the practical realities of international fishery regulation and the wide variances of input-output relations suggest that each fishery must be analyzed individually to determine the general impact of various types of regulations, and that in some cases a combination of techniques may be required. The development of economically sound management techniques requires an equally sound educational and negotiating campaign before there can be any hope of adoption.

III. Data Requirements

Information required for effective integration of economic criteria into regulatory programs may be divided into three categories:

A. information relating to the structure of the regulated fisheries and the associated processing and marketing industries;

B. statistical data to "meter" the economic performance of the fishery, and to measure the impact of changes in regulations; and

C. information to forecast the effect on the fisheries of developments in the regional and national economies to which the programs relate.

The bulk of this information would have to be assembled at the national level rather than by the regulatory commissions, at least during the initial stage. The problems encountered in analyzing, and applying the results in management programs, of the findings of enquiries of national fishery services prepared to cooperate with the commissions, would provide an indication of the extent to which the latter might have to start economic data collection under their own auspices.

In the first instance, therefore, much will have to be done to improve statistical programs at the national level. A search will have to be made for data which may already be available in various places; arrangements will have to be made for assembly of the scattered information under the auspices of one agency; uniformity of data-collecting and reporting among the countries cooperating in the program will have to be ensured; and collection and compilation of information for additional economic and statistical data will have to be encouraged.

At first glance, it may seem to be a formidable task to venture into these new fields. The difficulties, however, can be exaggerated. Similar problems are likely to have been encountered when data-collection programs in other sectors of the national economy, e.g. agriculture, forestry, mining, shipping, etc., were started and in many instances solutions have been found by the administrators, economists, and statisticians assisting in policy formulation in these sectors.

While some problems may be peculiar to the fishing industry, much can be learned from careful study of data-gathering programs that have been set up, especially in sectors concerned with the exploitation of common property resources.

A. Studies of Industry Structure

The physical aspects of most internationally regulated fishing operations are understood, but in the absence of a specific mandate to consider economic effects of regulation, some aspects of the economic organization of the fisheries and their related processing and marketing activities may require further analysis. If we contemplate the possibility of shifting to types of regulation more satisfactory from the standpoint of economic efficiency, it may be necessary to develop considerably greater understanding of the following:

1. Virtually all regulatory actions have differential effects on different kinds of equipment used in the same fishery. Consequently, it is essential to gather

data on the economic operating characteristics of gear presently in use and of gear that might come into use with changes in regulatory methods.

2. More accurate information is needed on the distribution of landings from regulated fisheries by types of processing, allocation among domestic markets and sub-markets, and allocation between domestic and foreign markets. In addition, the effectiveness of the economic performance of the fishing industry requires, typically, considerably more sophisticated analysis of the performance of port area market mechanisms, including pricing, physical transfer of fish, availability of associated services, and accessibility. To the extent that improved regulatory techniques may alter the quantity or composition or landings in given port areas, it is essential that we be able to evaluate the impact of those changes on the orderly flow of fish through the full sequence of operations required to bring it to final users.

3. Although it may be outside the purview of the fishery regulatory agency as such, the economic structure and performance of the processing and marketing sectors are of critical importance to the demand for fishery products at the primary producer level. Whether it undertakes the research or not, the regulatory agency would do well to encourage the development of studies - both analytical and statistical - of these sectors.

B. Statistical Series

1. Costs and Earnings of Fishing Vessels

Reliable statistical information on the value of output and cost of inputs of the fishing units operating in a regulated fishery is the primary need in assessing economic performance.

Information on value of output - or catch returns - involves data on prices of fish ex-vessel, which are unfortunately very inconsistent in quality. Difficulties arise unless the price and value data accurately reflect the exact form of the landed product, that is, includes specific reference to the amount of processing undertaken aboard the vessel. Careless identification of species can also lead to inconsistent and unreliable price reporting.

Costs of inputs include the returns to fishermen, as well as other running and operating costs, fuel, gear, ice, bait, insurance, etc. The collection of income level data also presents a number of difficulties. The share method of payment makes it impossible to convert man/hours into money earnings directly in many cases. Also, in all but a few highly organized commercial fisheries some income is paid in kind, which involves value estimates which are not always accurate nor consistent. Most important, fishermen often earn income in more than one fishery and sometimes in non-fishery occupations and in the form of social security payments of various kinds. All these factors make time series of fishermen's total incomes difficult to calculate. In fisheries that are inherently seasonal in nature, it is to be expected that fishermen will earn income from more than one source, non-fishing as well as fishing. In many cases, however, the direct and indirect effects of regulation, as indicated in Section II, may cause a shortening of the season in a particular fishery or group of fisheries. If a new regulatory program is initiated that permits fishermen to operate over a longer period of time (by reducing the number of participants, for example), income from the regulated fishery may increase substantially, but the net increase in income to fishermen may be considerably less since their opportunities to earn income elsewhere may be reduced.

Similarly, if we look at total incomes to fishermen without reference to source, a satisfactory level of income in annual terms may conceal the fact that a major portion of it represents transfer payments from general government revenues. Lengthening of the Pacific halibut season, for example, probably would result in

relatively small increases in incomes to fishermen at the outset, but would involve substitution of earned income for the unemployment compensation payments that now account for 8 to 10 percent of total incomes. Clearly, this is a net gain to the regional economy. Other examples could be cited. Unless we know the level of total income to fishermen and its composition, we can draw no firm conclusions as to the desirability or undesirability of particular types of regulatory action in their effect on income from the regulated fishery.

The calculation of net earnings of fishing vessels - the principal measure of return on capital in the fisheries - is also subject to a number of problems. The prime requirement here is to collect data from structurally correct samples of the fishing fleets involved, and to insure that accounting methods used make the data reasonably uniform, as between fleets and countries, and over time. Even if complete consistency among different countries cannot be obtained, reasonable uniformity within each segment would make it possible to develop an index of earnings that would be a significant measure of performance by the industry and of the effects of regulatory activities.

It became obvious during the discussion at the Rome meeting that data on net earnings of fishing vessels would be difficult to obtain in fisheries dominated by integrated concerns, in which costs and earnings from the operation of fishing vessels are merged with those of the operation as a whole. This also presents problems in developing meaningful time series on fishermen's incomes, since the method of paying fishermen obviously differs significantly when the output of the vessels does not go through a port market pricing mechanism. The changing techniques of catching and processing on board fishing vessels are also of significance in this connection, and will have to be taken into account in developing comparisons between fleets and over time.

2. Fishing Effort

At present data are already collected on fishing effort and catches by species and according to fishing areas in certain parts of the world. It will be necessary to stress to national administrations the urgency to improve the accuracy of the data on effort and catches to be collected by them and to report it internationally, particularly those data showing fishing time and fishing areas.

Once economic efficiency is introduced as a criterion, it becomes vitally important to analyze the economic performance of various types of vessels and gear, and to incorporate this information in evaluation of alternative regulatory programs that will produce different combinations of vessels and gear.

3. Fishing Capacity and Capacity Utilization

A very important kind of information relates to fishing capacity and the rate of utilization of that capacity. It is essential that some measure of actual and potential capacity be obtained by a major inventory study, and that it be updated periodically as required. Any regulatory agency dealing with marine fisheries must be able to anticipate changes of fishing effort associated with changed prices and/or costs in order to forecast the degree of pressure - actual or potential - on the resource under its control. Capacity in fishing activities, as in other industries, is a slippery concept to qualify. In the case of the fisheries it includes not only active vessels but also those that might be induced to enter the fishery - standby units or those in other fisheries - with improved catch and/or price prospects. It also embraces both numbers of units and their sweep efficiency.

C. The Fisheries and the Regional Economy

One of the prime requirements for effective regulation of any fishery, national or international, is the ability to forecast changes in the level and composition of fish at dockside. There are therefore compelling reasons why the regulatory agency should support and encourage studies that quantify the impact on the fisheries of developments in the regional and national economies of which they are a part. The following are illustrative:

1. Surprisingly little use has been made of modern econometric techniques for quantifying demand functions. Such studies have been most useful in agriculture, and in many cases the techniques are directly applicable to the analysis of both short and long term demand functions for fish products. The importance from the regulatory standpoint, of developing a capacity to forecast changes in the demand for fish, need not be elaborated.

2. Economic performance of a fishery is closely tied to the effectiveness of the transportation, communications and service facilities associated with major landing ports. Consequently, the future development of demand for fish from any regulated fishery would require careful and continuing study of development in such facilities, together with analysis of industrial development and its impact on local labor markets and thus on fishing costs.

IV. Analysis and Presentation of Data

A. General Problems

The immediate objectives of regulatory agencies contemplating incorporation of economic criteria into their research and operating programs must be to provide a current economic profile of the fisheries and related processing and marketing industries; a means of measuring changes in economic performance over time; and a set of techniques for assessing alternative regulatory methods in terms of an accepted and feasible model fishery. To be most useful, economic data must be collected and analyzed in timely fashion, and useful summaries of such information must be made widely available if the bases of action of the regulatory agency are to be understood. Much of the discussion at the Rome meeting centred on the practical problems of collecting, analyzing and presenting these data.

The nature of the industry makes the organization and presentation of fishery data difficult. There is, first, invariably a wide variance around mean values in economic as well as biological magnitudes associated with fishing operations. In organizing and presenting data on fishermen's incomes and vessel earnings, for example, means must be devised to indicate the spread of values around central tendencies, to account for these, and to indicate how they are to be dealt with in arriving at policy decisions. Similarly, few industries present as many difficulties as the fisheries with respect to multiple sources of income, particularly where seasonal availability of fish, weather conditions, and regulatory activities themselves dictate relatively short seasons for particular types of fishing activity. It is essential, in interpreting income data, that a full and accurate tabulation of fishing, non-fishing, and transfer incomes be presented. Otherwise, completely misleading pictures of the relative economic position of fishermen can easily be projected. The confidential nature of this information raises difficulties of its own.

It is obviously impossible for any agency to present complete data on a fishery on a continuing basis. Techniques must be devised to economize on the effort involved in gathering and presenting data without excessive loss of detail and accuracy. Most countries undertake periodic censuses of manufacturers, agriculture and distribution. A few do similar work for the fishing industry. It is highly desirable that periodic censuses of this type be undertaken in each country concerned with a regulated

international fishery, and that efforts be made to unify census techniques and definitions to ensure a maximum degree of comparability. Such censuses are indispensable as a reference point from which subsequent sampling studies can be used to provide time series of reasonable reliability. Similarly, detailed analyses of yield-effort relations for various types of vessels and gear are prohibitively expensive on a continuing basis, but can be undertaken periodically with a degree of detail that makes them extremely useful.

Perhaps the greatest challenge to a regulatory agency in relating its own activities to the planning of the industries involved is the development of continuous time series of prices and incomes. These must, of necessity, be based on sampling procedures. What is really needed is an indication of relative economic position and of change, rather than of absolute money earnings for fishermen and vessel owners. Consequently, an occasional synoptic study of fishermen and vessel earnings, supplemented by a carefully planned continuous sample, could provide indexes of returns to fishermen and vessel owners that are current and reasonably accurate during intervals between studies.

It was suggested above that a regulatory agency would wish to carry out on a regular basis studies of the operating characteristics of major types of vessels and gear in order to determine lowest cost combinations for given catch levels. Analysis and publication in summary form of such data would be of direct use to many sectors of the fishing industry and to national fisheries administrations. At present, the fragmentary nature of information of this sort makes it difficult or impossible in most countries to obtain yardsticks against which to measure performance of individual vessels and companies.

Even where reasonably satisfactory data on income to fishermen and net earnings to fishing vessels are available, collection of the necessary information by government agencies is an expensive, time-consuming process. Experience in many countries, including some high-income countries, indicates that there would be much resistance to assumption of this additional burden. It is obviously necessary to demonstrate beyond any reasonable doubt that each country concerned could benefit substantially and directly. This implies, in turn, that there must be some reasonable assurance that the data will be used to bring about a shift to more economic types of regulation. Otherwise it is difficult to see how the governments concerned could expect any return on the considerable investment that must be made in the new statistical programs.

B. Preliminary Steps

Several conclusions emerge from the Rome meeting and subsequent discussion of the questions raised at the meeting.

1. There is a general consensus among economists, not completely shared by biologists, that much can be accomplished in the way of economic rationalization of control programs on the basis of present knowledge. The reaction of a regulated fishery to quotas, for example, has already pointed the way to remedial action that would permit achievement of the desired physical results at far lower economic costs. Similarly, the stultifying effects of gear restriction have been amply demonstrated in a number of fisheries throughout the world.

2. While there is definite reason to urge initiation of analytical and statistical programs that would enable us to measure more accurately the economic performance of regulated fisheries and to assess individually the effects of various regulatory actions, the practical problems (and costs) are severe. Moreover, it would be necessary, in the case of an internationally shared fishery, to have parallel data collection programs in operation at least in the major countries, and preferably in countries accounting for the bulk of the total catch. This suggests that the first

step toward the incorporation of economic criteria and techniques in fishery regulation would be a series of discussion meetings with the various regulatory agencies and with leaders from government and industry in each of the major fishing nations involved. Some of the problems may simply dissolve after detailed conversations with informed parties. In other cases, resistence to incorporation of such programs might be allayed if not eliminated by a clearer understanding of the potential gains to be realized.

3. Both the economic effects of various types of regulation and the problems involved in implementing them will vary widely among different fisheries. Quite apart from technical differences, each internationally shared fishery presents its own peculiar problems in terms of national aspirations and policies, differences between market-oriented and planned economies, and different degrees of dependence on fishing as a source of income and employment. The usefulness of the economic services that could be provided to a regulatory commission will vary directly with the degree of familiarity with economic conditions in each of the major nations participating in it. One of the urgent needs, therefore, is for principal regulatory commissions to establish such services, either by creation of staff positions for economists, or development of liaison with universities or government departments that can make them available on a contract basis. Even without further development of statistical information, an economist thoroughly familiar with the technical aspects of the fisheries in question could be very useful. In addition, he would be able to provide the technical assistance required in setting up statistical programs only if he were thoroughly familiar with local conditions and local attitudes in each of the countries concerned.

4. It is suggested that the formidable obstacles to be overcome in securing better economic results from international regulatory programs should not deter efforts to make a start. It must be stressed as strongly as possible that the objective is not ideal economic performance but the ability to demonstrate the proper direction in which to move and the basis of choosing among alternative regulatory procedures that might be available. In this limited sense a start could be made immediately, and with considerable advantage to all countries concerned.