GREAT LAKES FISHERY COMMISSION

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Allocation of Fishery Resources With Special Reference to the Great Lakes

by:

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ALLOCATION OF FISHERY RESOURCES WITH SPECIAL REFERENCE TO THE GREAT LAKES

A Report submitted to the Great Lakes Fishery Commission

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CONTENTS

PREFACE AND ACKNOWLEDGEMENTS

This report was prepared at the request and under the sponsorship of the Great Lakes Fishery Commission, a body set up by convention between Canada and the U.S.A. The broad aim is to prepare a review or discussion paper on fishery resource allocation policy and relate it, where possible, to the current situation in the Great Lakes. The paper is directed at the Great Lakes fishery management and research community as well as those members of the wider and more general public who have a keen interest in this topic.

Several important aspects of this subject have been omitted or lightly covered, e.g., artisanal fisheries, the allocation of fishery resources to recreational fishermen as opposed to commercial fisheries, the development of self-regulated fisheries, the Indian fisheries, etc. These topics are not unimportant: there was simply not enough time. Even with this limitation, the report could not have been completed in one year without substantial previous research, both on fishery resource allocation and on policy instruments for natural and environmental resource management.

The Institute for Environmental Studies at the University of Toronto provided a milieu conducive to thinking about policy evaluation for the senior author for several years. The Department of Geography has supported an undergraduate course in environmental management that has been the forum for many stimulating discussions.

This paper is the result of several rounds of discussion and drafting and therefore the attribution of chapters to the individual authors is not easy. W.R. Allison wrote the first draft of most of chapter II. A.P. Grima wrote first drafts of chapters I, III, IV and is responsible for the final draft and organization of the report.

We started to list the names of people who assisted us in this study. We gave up after twenty, not because we were reluctant to acknowledge so much help and cooperation, but because we realize that we would inevitably omit the names of many others. Therefore, we shall limit ourselves to generic classes and exemplars: colleagues on BOTE, the GLFC staff (particularly Carlos Fetterolf and Randy Eshenroder), the administrators of fishery resources around the Great Lakes (particularly Art Holder, Bill Pearse, Jim Addis, Lee Kernen and Wayne MacCallum). Discussion with colleagues, particularly Henry Regier and Ken Loftus, have contributed to the framework for the study presented here. We thank them; shortcomings, errors and omissions are the responsibility of the authors.

We also thank Gail Rania who cheerfully typed the manuscript.

I

INTRODUCTION

At the highest level of abstraction and policy-making, one might consider the aquatic ecosystem of the Great Lakes Region to be allocated among competing uses (e.g. fishery harvesting, oil drilling, power generation, recreation, intensive farming, industrial and municipal water use and effluent disposal, winter navigation, etc.). The political traditions on both sides of the international border strengthen a tendency to make these allocative decisions in a piecemeal and tentative fashion. The reason for this is that these political traditions reflect five ideals or principles which are themselves incompatible. Loftus, Holder and Regier (1982: 255) point out that the use of fish and their aquatic habitats derives from the ideals of (1) common property of natural resources exercised by the state on behalf of all citizens and future generations; (2) open access to this common property; (3) rent-free use of commonly held resources; (4) participation by vested interests in any political decisions that change the status quo. One could add the ideal of property ownership and the overwhelming significance attached to property rights in our culture, even when such rights are simply based on long use or licensed use or simply permitted use (Coase 1960, Dales 1968).

Since these five ideals are not compatible, it is no wonder that policies tend to be piecemeal, ineffective, subject to constant pressure from interest groups, inequitable to some users and favourable to others. It should also be expected that the weak input into the political/administrative system from

future generations and the "general" public (as opposed to single-interest publics) results in the overuse and abuse of the commonly held aquatic habitats.

This level of "allocation" of environmental resources is important to all citizens and policy-makers and particularly to the fishery resource management community* for two reasons. The first reason is related to the integrative nature of fishery resources; fisheries are a useful indicator of the general quality of the Great Lakes ecosystem. For example, a collapsed lake trout fishery not only deprives the community of a valued resource but it indicates a failure to maintain a high quality ecosystem. Because of this integrative quality of fisheries, they deserve special attention in environmental decisions. The second reason is that the fishery managers have to be concerned with more than just fish. Dam building, estuary silting, microcontaminants, overnutrification, are only a few of the myriad ways that the fishery resource may be "allocated" a smaller portion of the ecosystem pie. Fishery resources depend on environmental quality. Without ecosystem health, there will be no fishery resources. Apart from exhorting the fishery management community to continue to be alert about the political decision-shaping process, there is little more than we could say in this report except to note that there is an analogous situation with respect to the allocation of fishery resources among competing user groups or among competing

*The fishery management community includes researchers, native fishermen, recreational fishermen, commercial fishermen and vicarious enjoyers as well as the administrators of fishery related programs.

objectives. The Great Lakes Fishery Commission (GLFC) has strongly supported studies related to the conflicting uses of aquatic ecosystems and the resulting stresses e.g., the Great Lakes Ecosystem Rehabilitation Study (Francis et al 1979, Harris et al 1982). The GLFC has also supported research on the values of fisheries (e.g., Talhelm et al , 1979).

The fishery resource management community should also be aware of and support mechanisms for the efficient (i.e., least cost) allocation of environmental resources within user groups (i.e., less costly ways for industry to dispose of effluents in a river or bay, provided that the total effluent load is not increased). The institutional mechanisms for efficient (i.e., least cost) water quality management are analogous to the mechanisms for allocating fishery stocks within user groups. As Scott (1979) notes, the links in the literature are few and far between. An improved understanding of the institutional instruments for more equitable, more effective and more efficient (i.e., less costly) water quality management can only enhance the effectiveness of the fishery resources management community in their constant effort to improve water quality (Griffith, Bauer and Grima, 1981) and protect fish habitat (Regier, Whillans and Grima, 1980; 139-144).

Statement of the Problem

There is a tendency to overexploit commonly owned resources such as most valued fish stocks, especially when entry into the fishery is relatively easy and/or fishing effort is not regulated. Traditionally, emphasis has been placed on regulation for biological conservation (i.e. the management of stocks and yields). More recently, the economic aspect, such as the income levels of fishermen, under-employment and overcapitalization have become more

significant components in fishery management and in the literature on limiting fishing effort. In addition, technology in the commercial fishing industry (and also in commercial-recreational fishing tends to be flexible; rapid technological advances and/or improved markets for valued stocks tend to aggravate the effects of excessive fishing capacity and make it easier to circumvent regulations of fishing inputs (e.g., gear). The result is increasing harvesting pressure and layers of regulation on gear, season, areas, power of vessels, etc. Therefore, the search for "robust" policy options is timely in order to reinforce conservation, improve efficiency in the industry and reduce the costs of regulation.

Although there is a large literature of a theoretical nature on the economics of allocation (e.g., Scott 1979 for a recent review), there is a relative dearth of syntheses focussing on the practical implications of such policy choices as (i) transferable quotas; (ii) restrictions on gear, closed seasons and closed areas; (iii) restrictions on vessels and other restrictive licensing; (iv) taxation of equipment; (v) royalties on catch, etc. (Pearse 1980). There is also scope for explicating the criteria for undertaking evaluations of proposed policy instruments and of practical experiences. Although such policy instruments as transferable quotas are more applicable to intra-group allocation, they could also be aplied to inter-group allocations if such transactions are allowed.

The allocation of available fishery stocks among direct users is being increasingly recognized as a critical component of managing fish stocks and regulating fishing effort. The Strategic Great Lakes Fishery Management Plan

(SGLFMP) Issues Identification Committee (November 1979) reported that:

> "Allocation of the fishery resources between users appears as a problem everywhere."

Practically all agencies canvassed by the committee consider the issue of allocation "critical" or "significant" in "all lakes."

The Joint Strategic Plan for Management of Great Lakes Fisheries (GLFC, 1980, 6) notes that:

> "Difficulties in providing desired contributions of fish and fishing opportunities arise largely from the difficulty of identifying the harvestable surpluses and of allocating them to competing users.Depletion and loss of important fish stocks will continue regardless of environmental improvements unless acceptable allocation systems are implemented."

Such a strong consensus should have alerted the senior author to the fact that the term allocation was being used to cover more than one process. Initially the study focussed on a critical review of alternative approaches to the regulation of fishing effort and the allocation of fishery resources among individual commercial fishermen. After some discussion with biologist-managers, commercial fishermen, native American fishermen and recreational fishermen on both sides of the border, it soon became clear that inter-group, inter-jurisdictional and international allocation were perceived to be important aspects of fishery resource allocation in the Great lakes. As a result, we have not avoided discussions on inter-group or international allocation, even though this problem does not lend itself to normative decisionmaking. We have tried to steer away from discussions of issue resolution; before one could make time-and-place specific recommendations, one would need more data and resources than we have; moreover, one would need to

make value judgements which should only be made during direct negotiations among conflicting user groups or competing individuals within a user group.

The position of GLFC on this issue merits discussion since it reflects a consensus by varied interests (GLFC 1982). Article IV(A) of the Convention on Great Lakes Fisheries charges the GLFC to determine measures for continued productivity of desirable fish species in the Convention area. The ultimate goal of GLFC is to secure fish communities based on self-sustaining stocks. In the case of lake trout, the Commission has determined that sport, commercial and native fisheries must be effectively controlled so that adequate spawning stock is assured. The Commission urges that these agencies develop mutually acceptable allocation criteria and to develop adequate monitoring programs in order to meet these objectives. We confidently assume that the same policy on trout fishery assessment, regulation, allocation and monitoring to apply to other desirable fish resources in the Great Lakes. We also hope that this review paper will be helpful to GLFC and the fishery management community (e.g., Lake Committees and the Council of Lake Committees) to pursue these topics in workshops, symposia and conferences.

We consider the various user groups and jurisdications around the Great Lakes to be both our clients and our co-investigators. The latter is a particularly appropriate term for the section on current fishery allocation policies around the Great Lakes; we had to pick many brains and to rely on the cooperation of many biologist-managers to give us written or oral information. We consider the various user groups and jurisdictions to be our clients in the sense that conflict is likely to be reduced if the various jurisdictions and user groups share a common -and explicit- information base

that is as comprehensive as possible. New kinds of regulations and licensing are being introduced in various Great Lakes jurisdictions. It would be useful to share such information; particular interest attaches to innovations such as transferable fishing quotas which are being actively considered (or have been recently adopted) in a few fisheries around the Great Lakes. Sharing of information should foster understanding of differences between jurisdictions and also serve as a stimulus for research and planning.

Scope of the Study

The literature on the rationalization of over-exploited and over-capitalzed fisheries is scattered in biological and economic treatises and journals. The purpose of this paper is to review selected material on the theory and practice of fishery reource allocation with special reference to the Great lakes region.

Rational discourse on the allocation of fishery resources is predicated on four sets of assumptions. Firstly, one has to assume that the fishery resource is measurable and that there are reliable estimates and estimating models of the stocks and yields; at a minimum, a reliable estimate of total allowable catch has to be made. Secondly, one has to assume that the fishery resource is scarce, at least in the economic sense (i.e. it can be supplied at a cost and that it commands a price in the marketplace). In other words, the fishery resource is not available in unlimited quantities at no cost. (In the words of one biologist-manager, "It is not a bottomless pit.") Biological scarcity follows from harvesting pressure and advanced fishing technology; population declines of valued species are often the justification for regulating fishing effort and extending jurisdictions. Clearly the biological

criterion of maintaining a population level near "maximum sustainable yield" has to be satisfied in order to protect the renewable resource and the dependent industry from the perversities of exploiting common-property resources and the uncertainties inherent in harvesting. Thirdly, one has to assume that there are alternative options for public intervention or regulation or management. Public intervention is required for three purposes (i) maintenance of the biological stability of the fishery resource; (ii) allocation of the fishery resource among competing user-groups or among competing objectives (e.g., biological stability vs short-term economic returns; a small commercial fishery vs. a more "valued" recreational fishery); (iii) allocation within user groups. Fourthly, one has to assume that there are criteria for evaluating the advantages and shortcomings of alternative institutional instruments. While we do not neglect other aspects of the study, we are more concerned with the analysis of policy alternatives and the critical evaluation of alternative institutional arrangements such as licencing and economic incentives for managing fishing effort. These questions are addressed in the next chapter which is followed by a status report on fishery allocation policies in the Great Lakes Region. In the final chapter we identify some questions for further research.

There is a widespread interest among fishery managers in the Great Lakes in the methods of regulating fisheries and particularly in complementing regulation with individual quotas and self-regulation of Indian fisheries and associations of commercial fishermen. This parallels the recent resurgence for deregulation in other sectors of the eonomy (e.g., airlines, telecommunications, air and water quality). This general interest provides a

fresh opportunity to address the themes of the restriction of entry to fisheries and the regulation of fishing effort. It is useful to put forward a review paper before the various jurisdictions in order to reduce the likelihood of independent moves towards ad hoc, incompatible, and therefore ineffective, regulation. We hope that this draft final report on our research will serve as a discussion document and we plan to revise it in light of comments and reviews. The readership is likely to be mixed: parts of the draft will appear elementary to some readers; other readers with no formal training in institutional or economic analysis may find parts of the analysis unnecessarily complex. The compromises made in the selection and ordering of material may not please everybody; the main objective is to present a cogent and comprehensive argument for policy-shapers (biologists, managers, administrators, fishing interests of all types, interested public).

II

FISHERY RESOURCE ALLOCATION: EVALUATING ALTERNATIVE POLICIES

This chapter is devoted to the evaluation of alternative policies for fishery resource allocation and is divided into 4 sections: a general discussion of the conflicts that arise in sharing out a common, open-access resource subject to capture such as the fishery resource; a brief discussion of reasons for the biological "collapse" of a commercial fishery subject to open-access in terms of the bio-economics model; a discussion of the policy instruments for limiting access and regulating fishing effort; and an evaluation of these policy instruments as means to control biological and economic overfishing.

Conflict in Sharing a Common Resource

Societies have to face two major strategic decisions: (a) how to allocate inputs so as to maximize net output; and (b) how to distribute the output amongst the members of the society. In a free enterprise economy, it is through competition with one another that individuals obtain their share of outputs, so they have an incentive to maintain or increase their competitive efforts. In the case of so-called common property resources, the input allocation and distributional equity issues are intertwined and difficult to separate from one another; within a given institutional context, the inputs of labour and capital by individuals determine the share they obtain of the resource. Thus users of such resources, when access is open, compete for their share by increasing the magnitude of their inputs -- to the point where costs are inefficiently high and the biological liability of the resource may be threatened. The economic analysis of this phenomenon has been well developed for commercial fisheries and is presented below in this chapter.

The problems of competition and conflict as well as the difficulties for shaping an appropriate allocation strategy are complicated by the wide range of fishers in the Great Lakes Region. Regier (1982, unpublished MS) distinguishes twelve types of fishers and seven characteristics of fishing (Table 1). An alternative approach is to distinguish among five dimensions of potential conflict:

(i) ecological values (e.g., present users of fishers vs enjoyers or non-users or future users);

(ii) economic values and motives (e.g., recreational, commercial, artisanal, party boats; derby competitors);

(iii) technologies or equipment (e.g., low cost rod-and reel vs. sonar-equipped recreational fishing; trawlers vs. gill netters vs. fixed gear commercial fishing);

(iv) species fished (e.g., kelp harvesters vs. lobster fishers; smelt vs. perch vs. trout);

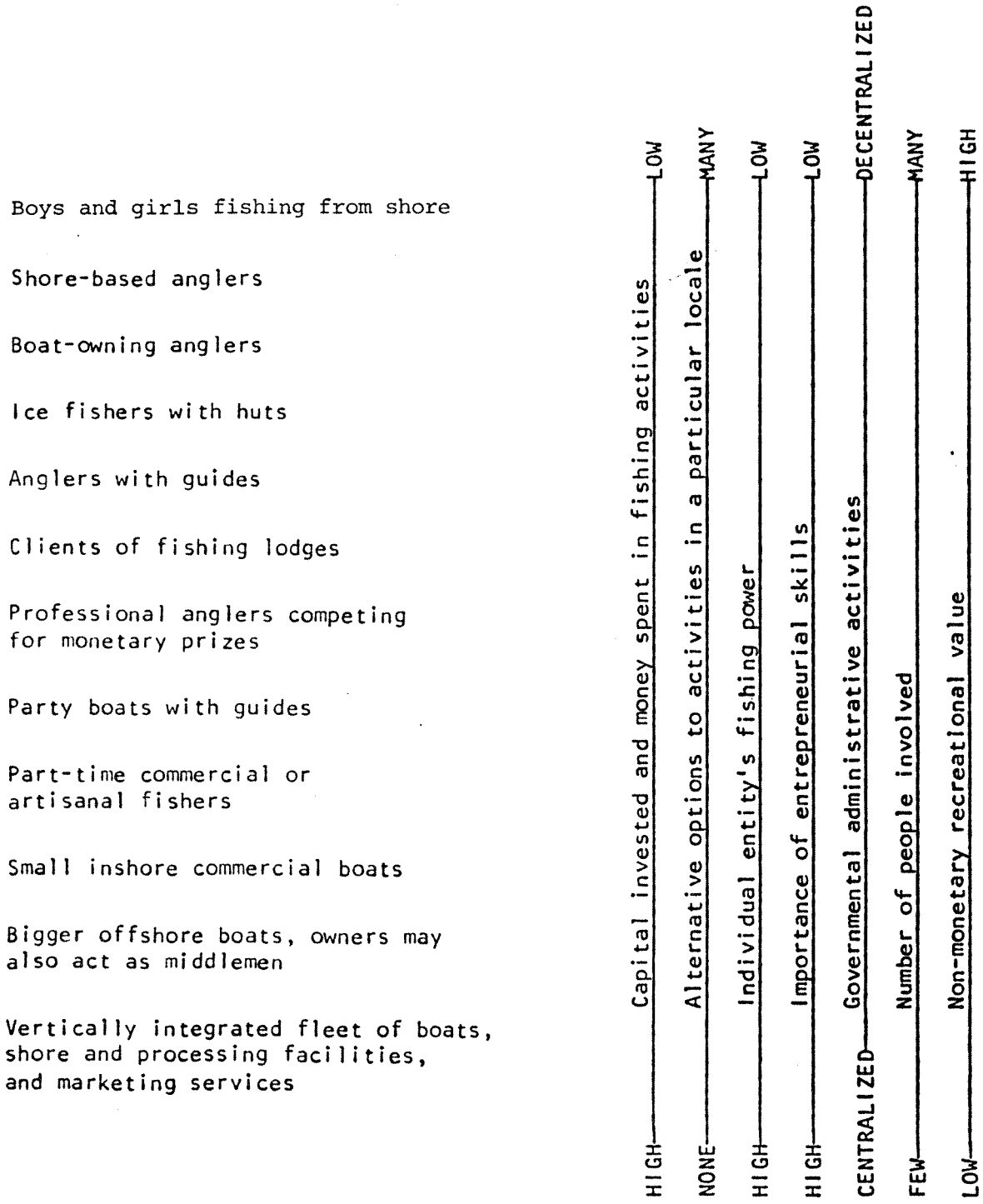
(v) other interests closely related to fishing (e.g., tourist outfitters, fishing lodges, processers, marketing services).

These taxonomical exercises have considerable practical usefulness because these "lists" of economic motives, values, technologies, species and interests could serve, as a practical check on the viability and feasibility of allocation strategies. One could add other characteristics such as political cohesion and organization; power at the polling booth; linkages with other sectors of the economy (e.g., restaurants, boat outfitters, "fishing" lodges). A viable allocation policy has to balance all these factors and adapt to changing conditions (e.g., the increase in the popularity of fishing derbies, new technology and recent concern about microcontaminants).

The competition for a share of a common resource that is subject to capture such as fisheries, requires public intervention both to conserve the biological resource and to set ground rules among competing groups for sharing the resource and reducing conflict. Conflicts may occur <u>between</u> groups with different objectives and values who wish to use the ecosystem or its components for different purposes or at different usage levels. For

Table 2.1

VARIOUS KINDS OF FISHERS IN THE GREAT LAKES REGION
(after Regier 1982, unpublished MS)



example, for some uses the fish resources are incidental, as when the ecosystem is used as a waste sink. For other uses, such as the commercial fishery, fish are the focus of attention. For sports fishermen, the fish are but one important input into a total recreational experience involving many other ecosystem features (Copes and Knetsch, 1976, p. 11; Bishop and Samples, 1979, p. 232).

Conflicts may also occur within groups with similar objectives and values, but different exploitation methods, as for example, between users of different gear harvesting the same fish stock. Since the source of conflict is competition for the resource, conflict is likely within groups using the same types of fishing gear, especially when fishing capacity exceeds the ability of the resource to support it biologically or economically. In general, the intensity of competition and the potential for conflict increases as economic development proceeds.

Since most of the theory has been developed to address within group competition in commercial fisheries, the discussion of the commercial fishery will constitute the bulk of this chapter.

Development of the Fish Resource

A typical fish resource development history begins with a subsistence fishery supplying local demand. Demand from outside the local community increases as does the ability of the marketing system to meet that demand. This increased demand on the resource may result in increased effort by local fishermen and increased exports of product, or increased catches by foreign commercial fishermen or sportsfishermen or both, depending on what the species is valued for, and what ownership and regulatory structure develops.

The profits attract new entrants into the fishery, which increases fishing effort, catch, and supply, and provides incentives to further expand the market -- and hence the fishery. Christie (1978) describes the general chronological sequence of steps in such a process for Canadian freshwater fisheries (Table 2.2). This sequence may be altered where technologically-advanced cultures exist that are able to access the fish resources of lesser developed countries.*

One significant result of this process and the general economic development context in which it is imbedded, is increasing conflict - between and within fishery user groups, and between fishery users and groups who use the same ecosystem for other purposes. The consequences of this tendency is shown in Christie's (1978) classification of existing Canadian freshwater fishery types (Table 2.3). This table also shows the tendency towards economic and biological overfishing which results from the excess capacity created by competition within and between groups. Although inefficient allocation of inputs is usually cited as a feature of a developed fishery, it also occurs in a developing fishery, as participants compete for market share. Conflicts and the overfishing problem are intensified by the fact that the accumulated biomass of the stock initially allows for larger catches (during the "fishing up" period), than can be sustained in the long-run. If the price of the product keeps going up, more capacity can be drawn into the commercial fishery, despite declining catches, further intensifying the problem.

*In fact, "f" is analogous to foreign commercial fleet activity, which is not a consideration in Canadian freshwater fisheries.

Table 2.2

CLASSIFICATION OF FRESHWATER FISHERY DEVELOPMENT STAGES
(from Christie 1978)

The developmental stages of the fishery can be defined as:

(a) Subsistence - fish caught constitutes an important part of the diet and is caught only for consumption by the fisherman and his family. Some trading for other commodities.

(b) Specialized subsistence - fish is caught in excess of local consumption and surplus is traded or sold. Fish constitute an important part of the diet and is consumed locally.

(c) Subsistence trading - fish is caught in excess of local consumption and surplus is sold to distant markets. Fish is often, but not always, an important part of the diet.

(d) Trading - fish is sold to distant markets and is not essential to local diet.

(e) Recreational - fish is not traded, nor is it essential for food; it is mainly a leisure activity.

(f) Commercial recreation - recreational fishing is marketed as a commodity, through sale of licences, local trade, guiding fees or tourist facilities to non-residents.

Table 2.3

A CLASSIFICATION OF CANADIAN FISHERY TYPES

(from Christie 1978)

Zone	Fishery classes	% of Canadian pop.	Biological overfishing	Economic overfishing	Interfishery conflicts	Environmental use conflicts
Extreme North	a	0.001	-	-	-	-
Far North	a,f	0.1	-	-	-	-
Middle North	b,c,f	1	+	+	-	-
Near North outside the Main Ecumene	c,d,e,f	16	++	++	++	++
Main Ecumene within the Near North	d,e	83	++	+++	+++	+++

Measures which effectively ameliorate all aspects of overfishing are difficult to design and implement. It is only since the mid-1950's that the economic inefficiency argument has been defined (Gordon, 1954) and only more recently that rising prices and technological advances have made the gains attractive enough to consider the argument seriously enough to stimulate action (Pearse, 1980). The significance of sport fishing catches has recently been recognized (Gaudet, 1980), and extension of theoretical frameworks to handle this use has barely begun (c.f. Bishop and Samples, 1979). It also takes time for the innovations to diffuse from theoretical literature to practicing managers, especially when there is an existing regulatory structure based on other premises.

While ignorance of the nature of the problem may be one reason that effective regulatory solutions have been slow to appear, another barrier is probably the threat of change perceived by interest groups connected with the fishery. Because it is largely through participation in the fishery that individuals obtain a share of the resource, any change in the regulations affecting the allocation of inputs also affect distributional equity. For a developed fishery in particular, this is one of the main impediments to regulatory change. In some cases, where one interest group dominates the fishery, regulations may be passed excluding other interest groups (e.g., the Canadian lobster fishery where recreational fishing is not allowed). While this may eliminate competition on one level -- say between commercial and recreational fishermen in the case of the Canadian lobster fishery -- the problem persists within the remaining groups, and between the fishers and other groups using the same ecosystem for other purposes. Implementing change

is difficult because fishermen and fishing communities have to be concerned with surviving today rather than with achieving some form of aggregate economic efficiency (Needler, 1979, 723). Politicians are largely tied, through the electoral process, to the same short-run orientation favouring the status quo and existing participants (c.f. Fraser, 1979, 755). To take action in face of such opposition, politicians require (must be confronted with?) convincing evidence, but the complexity and uncertainty of the system makes it difficult to acquire such evidence.* For all of these reasons, the initial regulating measures applied in a developing fishery are those which least upset the status quo (especially politically powerful interest groups). It is probable that over the course of a fisheries' development, the power issue looms as an increasingly large barrier to effective regulation. Fortunately, as the results of overfishing become obvious, measures which protect the resource from depletion are the easiest to support - logically and logistically.

Complicating matters is the fact that the distributional equity question comprises multiple, often conflicting objectives, as well as multiple interest groups (cf. Berkes, et al 1980). In addition to the objectives of profit maximization and resource conservation, fisheries objectives to be considered include:

* This seems to be a general problem in natural resource management; one could formulate an analogous argument for policies designed to reduce acidic precipitation or micro-contaminants.

a) nutritional - the food value of the resource, which may not be maximized at the same level of fishing as that at which dollar value is maximized.

b) recreational - the psychic value of the resource, a component of the total value and the main attraction of the fish resource per se for recreational fishermen, whereas the economic value of the resource probably is relatively more important to commercial fishermen.

c) societal structure - maintenance of communities and their lifestyle, which is important to those in the communities, and also to politicians and some members of the general public (although perhaps for different reasons).

These objectives conflict at both theoretical and practical levels. With respect to the former, it is a truism that simultaneous maximization of more than one objective is impossible (Neumann and Morgenstern, 1947). The more one user group takes, the less remains for other groups. Practically, conflict arises because different interest groups weight different objectives differently. Even so, there are complimentarities, e.g., the removal of coarse fish (smelt, carp) may reduce the competition for some more valued species. Such complimentary objectives ought to be emphasized in order to reduce potential conflicts. Thus, finding a solution means deciding:

1) which of the objectives to maximize, or how to weight them if a joint maximization is sought.

2) what is the most efficient way to achieve an objective; i.e., how should inputs be allocated, an allocational efficiency issue.

3) how the benefits gained will be distributed among social units, i.e., a distributional equity issue.

These issues are not necessarily decided in the order presented, but interact with one another. Useful for managers trying to come to grips with such a complex are the techniques of multiple objective decision-making, designed for situations comprising: a) multiple objectives; b) multiple alternatives; c) multiple impacts; and d) multiple interest groups; e) interactive components; and f) high uncertainty. Such management decision tools highlight the fact that solutions to fisheries problems generally are negotiated solutions. For this reason, and because of the systems' complexity, lags, and uncertainties, objectives such as rent maximization or optimization are not attainable in practise. A more realistic perspective is provided by the concept of "satisficing" advocated by March and Simon (1958), who argue that the best we can hope for, given "bounded rationality," is a short-run satisfactory solution rather than a long-run optimal solution. From this point of view, the objective would be to design and implement regulatory measures which allocate resource inputs and distribute outputs in a satisfactory manner. An important feature of such a regulatory regime would be the incorporation of "slack" into the system to absorb instability and allow for lags. Such a concept is consistent with Meany (1979, 798) and with Pearse (1980), who state that policies should address not only long-run economic performance, but should also reduce "painful" short-run adjustments caused by instability (e.g., fluctuations in supply, demand or price).

An important feature affecting the implementation of regulatory measures, is that over the course of the development of a fishery, the number of interest groups tends to increase, as does the total number of participants. Changes made later will consequently encounter more resistance than those made earlier in a fishery's development. Meany (1979), in an account of the south-western Australia prawn fishery, suggests that effective regulation is easiest to implement early in a fishery's history. Unfortunately, action to avoid the problem is not generally taken at an early stage, and any action at all is delayed until a crisis makes it necessary to do something, cf. Alaska salmon fishery (Adasiak, 1979, 781). This occurs due to ignorance of the problem, government policies favouring job creation, and bureaucratic inertia. This form of management by crisis ensures that future crises will be worse, and solutions more difficult to effect as the fishing effort applied and the number of participants increase over time, and the size of the resource shrinks. As the number of participants increases, and their share of the resource diminshes, conflicts intensify, increasing the need for action, while the political power of participants increases, making effective action harder (cf. Fraser, 1979). The Great Lakes fisheries unfortunately have followed this general pattern and are at an advanced development stage, with the central problem unresolved (viz. overcapitalized commercial fisheries and conflicts and competition within and between groups for a diminished resource).

The Commercial Fishery

A fishery has the potential to produce an economic "resource rent", a profit beyond the normal returns to labour and capital. In fisheries

generally, the resource rent is dissipated because of overcapacity in the fishery -- i.e., inputs of labour and capital, hence costs, in excess of what is required to harvest the resource. Not only is the resource rent dissipated, but in theory, there is an opportunity cost associated with employing the extra labour and capital in the fishery when they could be employed more effectively elsewhere in the economy (Anderson, 1977). Unfortunately the alternative employment opportunities locally available to fishermen are generally few, and the social costs of moving and changing trade and lifestyle high (Needler, 1979; McKay, 1978). For this reason, low-income fishing communities are not uncommon, particularly in isolated communities (cf. Newfoundland). Given the high psychic value attached by fishermen to their trade, and the failure to account for non-cash income and social costs in assessments of the economic well-being of fishermen (McKay, 1978), this argument cannot be dismissed out of hand. Unfortunately, no empirical studies have been conducted to test the argument (Crutchfield, 1979). A second feature, which may be also manifest, especially if the output of the fishery is valuable or the capture costs are low, is biological overfishing (Pearse, 1980). The two features -- economic overcapacity and biological overfishing -- are not necessarily concurrent, but if biological overfishing exists, economic overfishing exists as well (cf. Copes and Knetsch, 1976, 8). It can however be argued, on strictly monetary grounds, using net-present-value cost benefit analysis, that depletion is the profit maximizing alternative (Clark, 1976). Because such logic ignores the wishes of future generations, let alone the intrinsic value of the resources, depletion is generally considered undesirable (Clark, 1976) and the argument

made that the discount rate for a public good should be set at zero (Kalymon, 1981). It may be however, that in the short-run, overfishing which does not threaten future resource viability may be defensible as part of a longer-run strategy, since survival in the short-run is a priority if long-run survival is to be a concern at all. Certainly the majority of regulatory measures currently implemented seem to weight the short-run heavily since the reduction of overfishing in the long-run is negligible.

Two basic conditions produce the overfishing symptoms:

(1) the common property nature of the resource.

(2) a tradition of open access to the resource.

These basic conditions are exacerbated by other fishery features such as:

1. the fugitive nature of the resource (Christy, 1973);
2. the general paucity of alternative employment opportunities available to fishermen, which makes the opportunity cost of remaining in the fishery low (Scott, 1979);
3. low barriers to entry (Scott, 1979); this pushes additional capacity in when poor general economic conditions produce high unemployment, further decreasing the fishermen's opportunity costs;
4. the boom-bust cyclicality of the fishery, which pulls additional capacity into the industry when supply or demand factors produce attractive profits;
5. asymmetry of entry and exit conditions, which retains entrants past booms and into bust (Scott, 1979; and implied by Troadec, 1981, 9);
6. characteristics of fishermen which make them willing to accept risk and variable earnings (Scott, 1979).

If a fishery is considered the property of society at large, then the resource rent should accrue to society, to be distributed equitably among its members, the shareholders in the resource. (The participants' profits are considered to be normal payment to entrepreneurship, capital, etc. and are deducted first). Achieving distributional equity requires equitable decisions about who should have a share, and how much they should get. The spectrum of individuals to be considered extends across both space and time, and includes both extant and future generations. Great differences exist in the expectations of individuals and their abilities to express them. This creates large analytical and practical difficulties in devising and implementing a distribution mechanism which will in fact be, or will even be perceived as equitable. It is this resistance to technical solutions that Hardin (1968) stated was at the root of the "tragedy of the commons." In this sense, the problem of distributional equity is the dynamic behind the tragedy of the commons, and of the problems of biological and economic overfishing confronting the fisheries manager. Basically, these problems exist because individuals assert their claim to a share of the open access resource by participating in the fishery, and how much they get is established by how much effort they apply. The ensuing competition for the resource results in exaggerated costs, which dissipate the resource rent, and, if total effort exceeds the biological capacity of the resource to support it, resource depletion occurs as well. Seen in this way, the problem is that of designing and implementing a system for the distribution of the resource rent which neutralizes it as an incentive to increase capacity or fishing effort. The phenomena of economic and biological overfishing are but

symptoms produced by the underlying problem (i.e., common property and open access), but it is towards amelioration of the latter symptom in particular that most regulatory measures have been directed to date. This may be a necessary first step, but it is not sufficient. On the other hand, the economic theory of the fishery has, since the mid-1950's especially (cf. Scott Gordon, 1954), been concerned with the economic overfishing problem in the commercial fishery, and recently the focus of attention has been expanded to recreational fisheries as well (cf. Gaudet, 1981). More recently, attention has been drawn to the distributional equity issue as attempts are made to close the gap between economic theory and ad hoc regulatory measures.

The fisheries economics literature is considered to be the most complete in the renewable resource area (Peterson and Fisher, 1977). Since a wide range of issues -- biological, legal, sociological, political, economic -- have to be considered in fisheries management, the field has great breadth. Also, very sophisticated analytical techniques are required to deal with the dynamic and stochastic features of fishery harvests. In consequence, the models developed in fisheries bio-economics are complex and often very technical. The purpose of this discussion is to present the salient issues for managerial consideration. For the mathematically sophisticated, Peterson and Fisher (1977), provide a review of the relevant literature, and Clark (1976) is probably the most advanced treatise on the topic.

Biological Growth, Effort, and Yield

Following precedent in fisheries economics to date (Clark, 1976; Anderson, 1977; Peterson and Fisher, 1977) the logistic model will be used to illustrate the biomass growth of a fish stock. This model is based on the premise that biomass tends to increase exponentially, but as available resources in the environment become limiting, growth is eventually constrained. Thus growth rate appears to be a function of population size. This relationship, an inverted parabola, is shown in Fig. 2.1. The biomass of the fish stock which the environment can support is called the carrying capacity of the environment (ECC), and the population at this level is the natural equilibrium level (P_{∞}), measured in units of weight. In theory, because the logistic model is symmetric, maximum productivity occurs at the

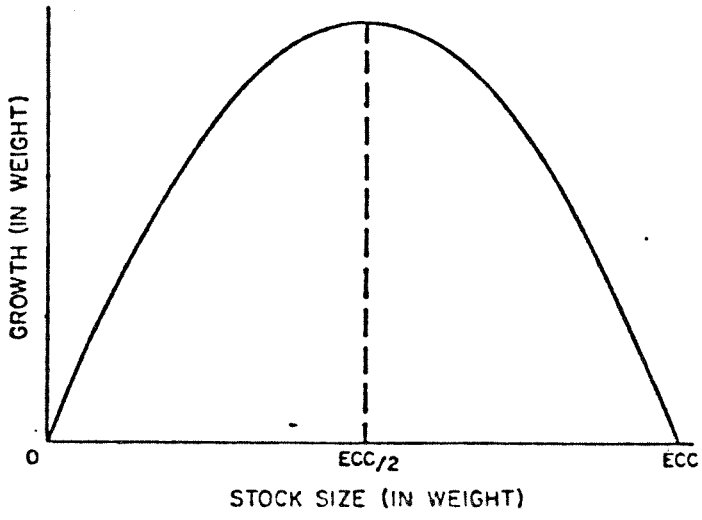


Fig. 2.1 The biological productivity curve.
After Cunningham and Whitmarsh (1981).

population level P = ECC/2. In fact, the maximum sustainable yield (MSY) level appears to be between 40 and 60% of P . The logistic curve is favoured because of its simplicity and desirable mathematical qualities (Clark, 1976). Although these features facilitate economic analysis, the logistic curve is a crude approximation of reality which is seldom observed for metazoans in lab experiements, and almost never occurs in nature, partially because of environmental variability (Krebs, 1978). Underlying biotic and abiotic environmental variables, such as salinity, temperature, prevailing currents, competition, predation, incident solar radiation, and rate of nutrient replenishment (Anderson, 1977), and subtle long-run cyclical changes in these underlying variables, seem to be important determinants of the "boom and bust" feature of numerous fisheries (Gordon, 1954). These variables can be far more influential than population size, as the fluctuations in the shrimp fishery in the Gulf of Mexico (Anderson, 1977), and the disastrous effects of the warm current "El Nino" on the Peruvian anchovy fishery (Boerema and Gulland, 1973; Glantz and Thompson, 1981) demonstrate. The model also assumes that there are no time lags in the system, and that age structure has no effect on the rate of population increase -- and neither assumption is generally met in reality. Bearing these caveats in mind, the logistic model is used as a basis of discussion.

Similarly, although MSY has often in the past been used as a desirable goal for renewable natural resource management, its use has, in the last decade, been severely criticized on both biological and socio-economic grounds (Clark, 1976). Biologists object that maximum yield cannot be clearly defined, especially in a multispecies fishery, and that the large and unpredictable stock level variations characterizing many fish populations make the term "sustainable" meaningless. From an economic point of view (which will be explored later in more detail), MSY ignores cost, which makes it unsuitable for prescriptive purposes. Clark (1976) regards MSY as only a useful constraint on exploitation. The more recently advanced concept of optimum sustainable yield (OSY) is subject to similar criticisms; for practical purposes, management programs should aim to be flexible rather than to aim at a particular level of fishing effort because it is preferred on scientific grounds. That is why, in the next section, individual quotas satisfy this important criterion, a flexible response to fluctuating biological yields.

Catch is a function of fishing effort* (E), stock size (P). Suppose that a fishery stock size is given at ECC (Fig. 2.1) and that harvesting begins. Since growth of the stock (dP/dt) is zero at ECC, the stock size must decrease by an amount equal to the catch and a new equilibrium is established to the left of ECC such that growth is equal to catch; this catch is known as a sustainable yield. In reading Figure 2.2, as the fishing effort increases, the stock size decreases.

*Effective fishing effort is defined in terms of the impact it has on the stock. This is usually assumed to be related to factor inputs such as boats, men, gear, etc. Interested readers are referred to Beverton and Holt (1959), Rothschild (1971) who discuss the concept at length.

In Figure 2.3 some of the economic components of the bioeconomic model are introduced. Total costs (TC) are assumed to be a linear function of fishing effort; it is assumed that in the long run, fishing effort is changed by units (e.g., boats) leaving or entering the fishery since all existing units are operating at their most advantageous point on their individual cost curve. Total revenues (TR) are assumed to be equal to SY times price where price is determined outside the fishery (i.e., by the world market for the particular species) and may be assumed to be constant. Hence the TR curve has a parabolic shape like the SY curve (e.g., TR_1 and TR_2 in Figure 2.3). In an unregulated or open-access fishery, the fishing effort will be such that $TR_1 = TC_1$, $TR_2 = TC_2$ and so on. At levels where TR_i is greater than TC_i, profits encourage expansion while at levels where TR_i is less than TC_i, losses encourage contraction of effort. Over time, fishing costs may be reduced (shifting TC to the right i.e., where TC_2 intersects TR_1 in Figure 2.3); this leads to an increase in effort. Similarly the TR curve may shift upwards as a result of higher prices with the same result of increased effort and reduced stock.

The discussion so far may be related to the concept of biological overfishing (i.e., fishing effort beyond MSY). The conventional response has been to "regulate" in order to reduce access or decrease effective fishing effort. In addition, under open access, the pure economic rent has been dissipated since the tendency for the fishery is to reach an equilibrium where $TR_i = TC_i$. The tasks for management seem to be deceptively simple; (1) to regulate effort in order to reduce catch at or below MSY, thus maximizing food yield and also to have a more viable

stock (i.e., conserve biologically); (2) to regulate fishing effort at such a level as to conserve the economic rent of the resource.*

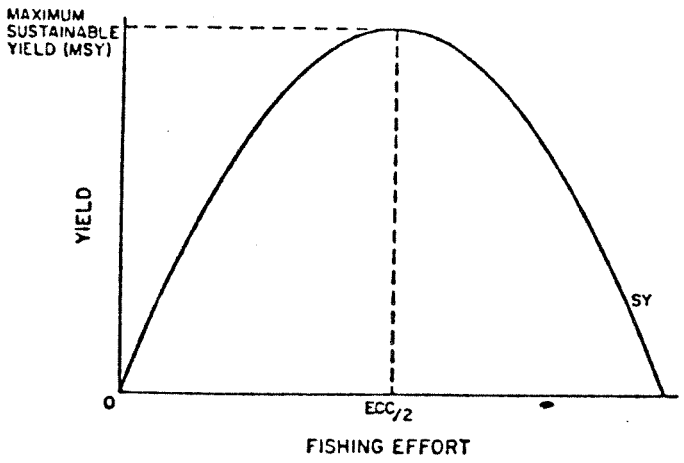


Fig. 2.2 The Sustainable Yield Curve.
After Cunningham and Whitmarsh (1981).

The smooth continuous curve of this yield-effort model, would, if empirically true, greatly facilitate the first management task, by permitting the use of incremental management methods. Unfortunately, this property of the model contributes to what Adasiak (1979) has labelled, "the romance of continuity," whereas the sudden collapse of some fisheries under heavy fishing pressure, implies a discontinuity in the yield-effort relationship.

*We have come across fishery biologists-managers who consider only the first task to be their valid function. We submit that an economically viable fishery is an important social objective.

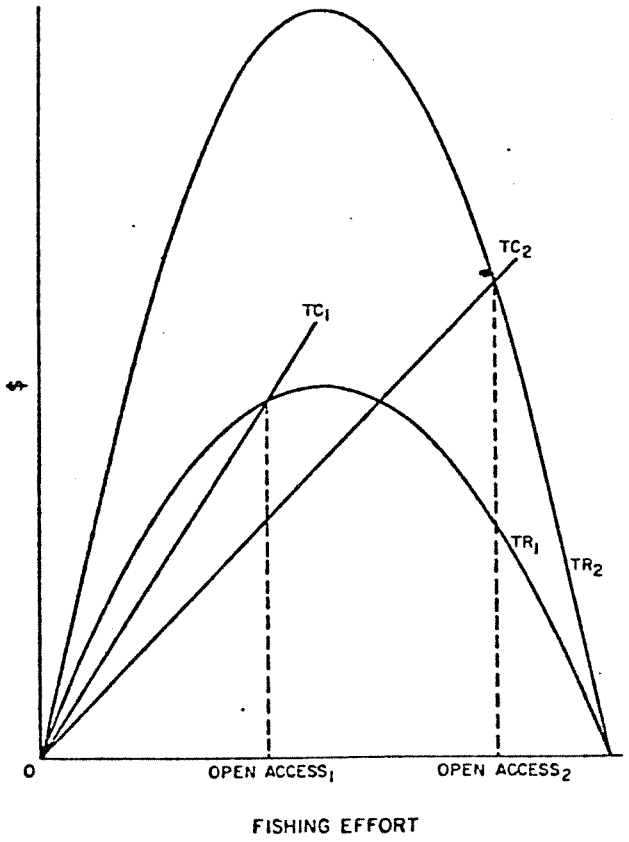


Fig. 2.3 Open-access equilibria.
After Cunningham and Whitmarsh (1981).

The second task is even more difficult, since there is an inherent propensity in open access fisheries to increase effort beyond the point where all or even part of the economic rent is realized. Why is the tendency to economically overfish not self-regulating? In order to explain this characteristic of fisheries exploitation, we shall use a well known static model pioneered by Scott Gordon (1954).

Economic Overfishing

This model assumes that the fishery comprises atomistically competitive participants and that the unit price of fish and the unit cost of effort are constant. Cost includes a normal rate of return to labour and capital and total costs increase in direct proportion to effort. As in the previous discussion, it is assumed that effort is altered by boats entering or leaving the fishery, not by expansion or contraction of effort by existing boats. Figure 2.4 illustrates the resulting long-run total cost (TC) and revenue (TR) relationships, marginal cost and revenue curves (MR, MC) and average cost (AC).

If MR > MC, an increase in effort would increase revenue more than it would increase cost and is therefore worthwhile; the converse applies, where MR < MC.

Therefore, the economic optimum is defined where MR = MC. This is the MEY or maximum economic yield and is the fishing effort that maximizes sustainable economic rent (or "pure profit" beyond the normal profits already included in "costs"). As Cunningham and Whitmarsh (1981, p. 380) emphasize, the level of effort corresponding to MEY is half that of open access. Beyond MEY, the increase in net revenue for the fishery becomes negative with increased effort. But each new boat or fisherman will still catch some fish and will disregard the fact that other boats will lose part of their previous level of catch. Therefore, as long as the average revenue (TR divided by effort) is greater than the marginal cost (which is a constant in Figure 2.4), new boats will be attracted into the fishery so that the open access equilibrium has much greater fishing effort (and lower level of stock) than MSY or MEY.

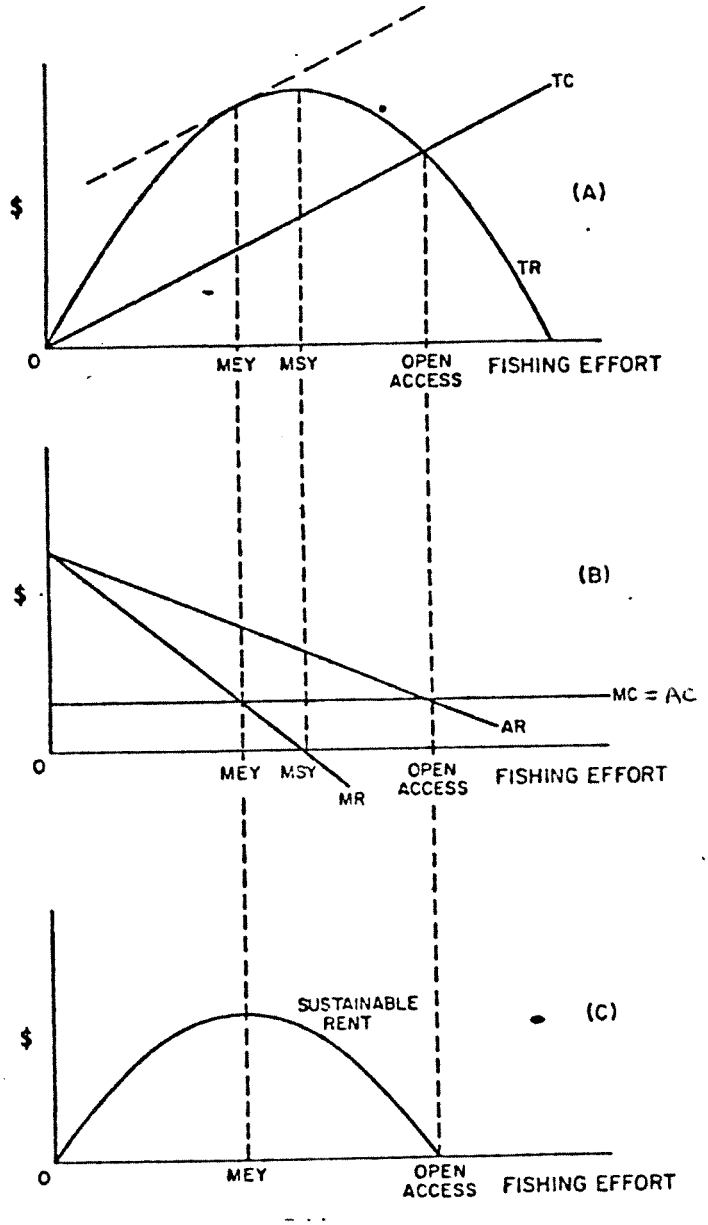


Fig. 2.4 Economic overfishing.
After Cunningham and Whitmarsh (1981).

The bioeconomic model is capable of much more elaboration including the effects of changing parameters such as net growth rate, carrying capacity, price and cost. Such elaborations are not necessary -- even though they are interesting and important -- to the development of our argument. Suffice it to note that even if biological parameters increase, as long as access is open or fishing effort is not regulated sufficiently well, the inherent forces that drive the bioeconomic model will eventually lead to economic overfishing and the dissipation of economic rent; biological overfishing may also occur, depending on the level of success of regulation and environmental changes.

So far, this chapter has traced the argument for the rationale of allocation and regulation of the fishery resource by pointing out the conflicts among a wide range of users and then by using the bioeconomic model to illustrate the inherent forces that drive the system to a level of fishing effort which dissipates economic rent and endangers biological conservation. In the next section, we address directly the issue of regulating access and fishing effort and we attempt to derive some criteria on which to base a pragmatic evaluation of alternative policy measures.

Regulating Fishing Effort

Two distinct types of fisheries regulation exist, as characterized by their emphasis on factor inputs or production output. The first type of regulatory measures control factor inputs and assume that some changes in outputs will follow. Those regulatory measures focussing on outputs involve measures designed to control output directly, with consequences for factor inputs. In both cases, measures can be further classified according to how directly they act. (See Table 2.4).

Table 2.4 : Classification of Regulatory Measures.

application	focus	
	inputs (fishing effort)	outputs (catch)
direct	. traditional measures of time, gear, place restrictions . vessel fishing power restrictions . limitations on number of participants	. individual quotas and quantitative rights . total allowable catch
indirect	. taxation of vessels or equipment	. landings tax or royalty

Measures controlling factor inputs

Direct

The traditional measures are in principle, quite straightforward in both substance and application. Gear restrictions specify the amount and kinds of gear that can be used in a fishery. By thus freezing fishing power along this dimension, increase in effort is inhibited. Time restrictions can be used to prevent fishing during critical periods in the life history of a fish, such as spawning time. They can also be used to control the amount of effort applied since this varies, ceteris paribus, directly with the time fished. Location restrictions also can be used to protect stock during vulnerable periods, and in conjunction with time restrictions, to prevent the movement of capacity from place to place in response to stock movements or seasonal closures.

Restrictions on vessel fishing power are basically extensions of the traditional gear measures to such things as boat length, tonnage, engine horsepower, etc.

Limiting the number of participants is generally accomplished by issuing a limited number of licenses in the fishery, and making them mandatory for participation in the fishery. Either vessels or individuals can be licensed.

Indirect

Taxation of vessels/equipment has effects similar to direct restrictions on factors, but some economic gains accrue to the agency that levies the tax. In theory, it provides a mechanism for manipulating effort allocation among stocks and grounds, and in principle, allows considerable flexibility in response to varying environmental circumstances.

Measures controlling output

Direct

Quantitative rights: rights to catch a specified quantity of fish (a quota) can be assigned to participants in a fishery. This can be done by deciding on a total allowable catch (TAC), which is then subdivided among the participants. This method is being used to control fisheries by allocating quotas at the national level. As yet, experience with individual quotas is slight, and when a TAC alone is used, competition within groups for the assigned portion of the TAC results in rent dissipation. In theory, if individual fishing units are guaranteed a specified catch, there need not be a race to capture fish (except in response to stock effects) and the least cost method of fishing can be used. The TAC can be set to protect the stock. For this system to function, reliable landings data are required. An effective means of monitoring individual landings and controlling cheating is mandatory, otherwise, there will be strong incentives to cheat (as in the game of prisoner's dilemma), and the problem is not solved.

Indirect

Landings royalty or tax: the function of such a tax or royalty is to remove some or all of the economic rent so that less incentive exists to expand capacity. To be effective, such a measure would have to capture virtually all of the rent. To do this, the tax must vary as prices and costs vary across space and time. An accurate means of monitoring landings is required.

Evaluation criteria for regulatory alternatives

In recent years, a number of papers have addressed the issues of evaluation criteria in the context of management objectives (Scott, 1979, Pearse, 1980, Troadec, 1981). The approaches used have been diverse, making it impossible to combine their elements as components of one comprehensive scheme. Instead, they are outlined below, with brief comments. In the next section, we present a synthetic scheme based on our review of this literature.

Troadec (1981, p. 34) in a draft manuscript, suggests a set of conditions that management plans should satisfy. His proposal is quite comprehensive, taking into account objectives other than economic rationalization. According to Troadec, management plans should satisfy three main conditions, and three secondary ones. They should:

a. maintain fishing levels that correspond to management objectives;

b. obtain the corresponding benefits and make sure that these are divided up according to the plan;

c. facilitate implementation.

In addition to satisfying these conditions, such schemes should also:

d. permit technological change that increases efficiency;

e. permit individual initiative that increases efficiency;

f. reduce arbitrary risk and favouritism in the assignment of access rights.

Troadec's scheme is evolutionary, in that measures are to be progressively refined to maintain an orderly fishery development.

Pearse is more specific, focussing on economic rationalization as the objective. His scheme, like Troadec's, is evolutionary. The "criteria" which he presents (pp. 20-21), are in fact, general issues which are likely to concern policy makers. The specific objectives which are derived from these issues will depend on the stance of the user as will the weights assigned to different objectives. These considerations, with Pearse's comments on probable preferred objectives are listed below:

a) Effectiveness in controlling fleet capacity. Given the objective of economic rationalization, then fishing capacity must be restricted to a level compatible with that objective.

b) Implications for technological efficiency. The use of efficient technology should not be inhibited by the policy instruments.

c) Adaptability to changing conditions. Uncertainty of both supply and demand require measures which are responsive to such changes. Regulations depending on discretionary action by authorities are cited as generally inferior to measures which accommodate to changing conditions of demand and supply.

d) Effect on distribution of effort. Measures are preferred which allocate effort efficiently across available stocks and grounds.

e) Distribution of the benefits. Different measures affect the distribution of benefits among participatns, and between participants and the government, differently. The distribution effected by a measure should be consonant with the objectives of the government.

f) Dislocation and employment effects. Government objectives with respect to employment may temper rationalization efforts, as may resistance from established interests. Different measures may allow more or less control over the extent and rate of change, and this must be considered.

g) Administrative complexity and cost. Presumably more cost effective measures are preferred. Measures which are resistant to social and economic pressures are preffered to measures which are not.

Scott(1979, p. 735-758) discusses capacity control as a means to economic rationalization. He compares landings tax and individual quotas, and presents the issues that a regulator would have to consider:

a. Directness of regulatory control. A system which directly determines the level of catch an individual can take is preferable to one which does this indirectly. The former creates less uncertainty for the fisherman and reduces the social costs of the trial and error solutions associated with indirect methods such as a tax on landings.

b. The uncertainty of assessing stock and catch. The preferred instruments are direct measures, which allow more precise adjustment of catch levels to changing information about stock levels.

c. To win the race for fish, fishermen indulge in too-rapid technical innovation. It would be preferable to reduce the incentives to acquire unnecessarily expensive capital.

d. How well interception is controlled. The race for fish encourages fishermen to try to intercept fish before their rivals get to them, i.e., by fishing the same spot earlier in time or fishing alternative

locations to catch the fish before they reach their rivals.

e. Divisibility and size of the units used. Although in some cases, larger units may be preferred for administrative purposes, smaller units would allow more flexibility and greater efficiency.

f. Complexity of the units being controlled. Because the typical fleet comprises a variety of vessel sizes using a variety of gear, and fish are sought from a variety of stocks and places, it is hard to decide on a single unit of entry restriction. A preferred system would cope with this difficulty at lowest administrative costs.

g. Preferred measures should not encourage concentration of fishing opportunities in the hands of a few interest groups or participants.

h. Flexibility is a consideration, in that some flexibility is required to accommodate changes in stock abundance, but too much flexibility makes the measures too susceptible to pressure groups.*

i. A ninth consideration, which Scott presents as the basis for final choice, is the minimization of transaction and administration costs.

Proposed Evaluation Criteria

The criteria for comparing policy instruments may be grouped under three main headings, each of which corresponds to the major objectives of the policy viz. the effectiveness of the policy, the administrative and operational feasibility of the policy and the operational efficiency or

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* The implicit issue here seems to be acceptance of the measures by those regulated.

administrative cost effectiveness.

A. Effectiveness with respect to achieving management objectives. These objectives might be:

1) Distributional equity, or some other desired distribution of the resource among fishermen, and of the product of fishing activity amongst the fishermen and society. This particular objective is unique, in that the objective cannot be established analytically, but depends upon a political decision (Troadec, 1981, p. 29). Furthermore, decisions and actions taken to achieve any of the other objectives will have consequences for distribution (Peterson and Fisher, 1977, Troadec, 1981), and the perceived effect of changes on distribution can have profound effects on both the feasibility of a measure, and the costs of implementation. Because the success of a measure depends largely on its perceived fairness, distributional equity must be a management objective.

2) Biological conservation. Conservation of the resource at a level which makes ecological sense (e.g. for stock maintenance), ought to be a basic objective. Multi-species interactions, the irreversibility of extinction and the concomitant loss of options are factors that need to be included.

3) Food yield. With fisheries; providing 13% of human protein requirements, and demand outstripping supply (Sindermann, 1978), maximizing the food production of the resource is an increasingly important consideration. A persistant view held by biologically trained fisheries managers has been that maximum sustainable yield (MSY) is the preferred objective. Although MSY in principle

maximizes catches, and conserves stock, it has fallen into disfavour among theoreticians and some practitioners because of data and estimation difficulties, and because the concept ignores capture costs. Since dollar capture costs represent a proxy for energy expenditures for capture, and energy is itself a scarce resource, this objection to MSY seems sustainable. The MSY objective conflicts with the MEY objective when a high discount rate invites catches greater than MSY or when restricted demand invites catch reduction as a means of maintaining prices.

4. Rent maximization. Maximizing the rent which a natural resource in theory produces, is a major concern of economists. This involves the production of a sufficiently high quality and quantity to get the highest total revenues, while keeping costs as low as possible, commensurate with this goal. This objective in particular may conflict with other objectives, such as conservation (if the discount rate is high), food yield and employment. It is also influenced by technological change -- which may reduce costs by making fishing operations more efficient, or increase them if participants indulge in capital stuffing.

5. Employment dislocation. A common government objective is to maintain or increase employment levels and to avoid sudden shifts in employment opportunities. Since fisheries are frequently important in localities with few alternative employment opportunities, they are frequently viewed by governments as an important source of employment.

The maintenance of excess labour (and any boats and equipment owned by the same) in a fishery militates against the rent maximization objectives, even though it may be the most economical form of supplying social assistance in some cases. There is no empirical evidence to support or refute this.

6. Community structure, culture. Closely allied to the objective of providing employment is that of maintaining certain elements of the cultural fabric, such as isolated fishing communities and the existing lifestyle of fishermen there and elsewhere. This includes issues such as the part-time "problem" and occupational pluralism. This objective may conflict in particular with rent maximization, as well as with food yield, conservation, and employment objectives.

7. Controlling the rate of technological and tactical change. Some regulatory measures, such as restrictions on equipment, retard the role of adoption of more efficient equipment and methods by fishermen. Insofar as cost reduction is an objective, this is undesirable, although it seems to favour conservation, employment and lifestyle objectives.

8. Foreign exchange. In some situations, particularly in less developed countries where fisheries play a significant role in the economy, there is a temptation to exploit the resource as a source of foreign exchange. This is particularly true with stocks of high value, and unless controlled, leads to the classical problem of overfishing and overcapacity.

9. Industrial structure. There is often concern that regulatory measures will produce an undesirable industrial structure such as monopoly or monopsony, in which either the seller or the buyer, respectively, has excessive market power. In general, one would expect Great Lakes fishermen to face monopsonistic or oligopsonistic buyers. Policy measures which reduce this are preferred to ones which do not.

B. Administrative feasibility

This refers to the feasibility of implementation or the ability to translate a plan into action. Although costs are a consideration affecting the feasibility of a plan, they do not necessarily affect its practicability. Thus the high costs of gathering the data required for certain measures are an efficiency issue (see next section), while the ability or inability to obtain such data at any cost is a feasibility issue. Issues to be addressed under this evaluation criterion include:

1) Data collection problems. Due to environmental uncertainty on both supply and demand sides, the data requirements of certain measures may be difficult, if not impossible to fulfil. Measures with less data requirements are preferred.

2) Acceptance by participants and interested public(s). This issue is critical to administrative feasibility and includes consideration of several aspects that require elaboration.

   (a) Perceived distribution effects. Since, as discussed above, any shifts in management goals or regulatory measures will

have distirbution consequences, resistance to such changes can be expected (Crutchfield, 1979, p. 743), and does occur (c.f. Fraser, 1979, p. 755).

(b) Compatability of measures with cultural norms. Measures which are in harmony with existing cultural norms are more likely to be acceptable than those which are not. The rate of adoption of an innovation generally varies inversely as its perceived "newness" (i.e. how alien is it to the culture) (Rogers and Shoemaker, 1971). If the most effective or efficient measures are radically new, then research into attitudes and marketing programs designed to alter attitudes and perceptions may be required.

(c) Communicability. Preferred measures will be accepted more readily if those affected by them can understand how they work. This is partially determined by the novelty of the measures relative to cultural standards, as well as the complexity and directness of application (Rogers and Shoemaker, 1971).

(d) Relative advantage over alternatives. From the participants' point of view, the relative advantage of a measure depends on its effects on the individual or local community, and is thus inseparable from distribution, employment and lifestyle effects. Unless participants' support is secured, policing and enforcement costs will be high.

(e) Perceived need. As has been well documented in the literature on organizational design, organizations and the people they comprise are more apt to change when there is a perceived need for change. Often, this need is produced by a crisis, and a shared perception of the crisis is required to facilitate change (c.f. Allison, 1981). Since in fisheries, regulatory change seems in general to be precipitated only by crisis (Crutchfield, 1979 p. 343), the main problem, in the short run, is to use these crises to further management objectives, and to try to inform those concerned about these crises as early as possible in order to facilitate the change process. This assumes of course, that management is aware of the impending crisis before those administered are -- which is not always the case (Allison, 1981).

(f) Political risk. The political risk involved in implementing a measure is an important determinant of its feasibility from management's perspective. The risk is determined by factors such as those already discussed above, the strength of those opposing the proposed changes, and the strength of the government behind the changes (c.f. Fraser, 1979 on the B.C. salmon regulatory changes) illustrate. Timing can be critical. Many fish stocks fluctuate in size cyclically, and, as Gordon (1954) points out, it may often be that

improvements in a fishery following regulatory changes are due to natural stock fluctuations, rather than to the regulatory changes. Such improvement makes both management and the changes look good to the public. Conversely, changes instituted while a stock is still on the decline may have no effect until the natural cycle is finsihed, and can easily be seen as failures, imparing management's credibility and hence future effectiveness. We do not mean to imply that management should use stock survival as a pawn in a political game, but that this may be a stategic trade-off. The acceptability of a measure may be determined as much by its political risk, as anything else.

C. Operational Efficiency

This refers to the ratio of costs to benefits of a regulatory regime or to the net benefits generated. Since the goal of economic efficiency has been considered separately, the costs involved here are those associated with operationalizing the regime (administrative, transactive, information and enforcement costs). Unfortunately, very little is known about these costs -- the empirical studies required to compare regulatory measures along this dimension do not yet exist (Crutchfield, 1979, Scott, 1979). It is possible however to conjecture that a) costs will decrease as data requirements decrease; b) costs will decrease as participant and public willingness to accept a regime increases; a number of the issues mentioned under feasibility are relevant here as well, e.g. distribution effects, compatability, communicability;

c) marketing/education expenditures may (must?) be increased to compensate for low feasibility. In general, among alternatives achieving the same objectives, the least cost alternative will be preferred.

Evaluating Alternative Policy Measures

It is clear that evaluation is most usefully done with respect to an objective or a set of objectives. Since the main concerns of the recent literature have been the prevention of biological and economic overfishing, these will be the main objectives considered here; others are discussed as appropriate. The bottom line is that the destructive competition characteristic of a common access resource must be controlled. In this section we discuss a range of policy measures with particular reference to the criteria developed in the previous two sections. Two other preliminary observations need to be made: (1) some of the measures compliment each other and could be combined; for example, some degree of regulation, monitoring and enforcement is common to all policy measures; (2) even though we are more confident about the feasibility of some measures (e.g. individual quotas), the final "management package" would need to be adapted to the biophysical and socio-political conditions of the locality in which the measures are applied.

Restriction on gear, closed seasons and closed areas*

These measures serve a useful purpose by enhancing biological conservation but they are generally ineffective in controlling total effort or catch in the long run, and tend to worsen economic performance (Pearse 1980). Gear restrictions prevent efficient fishing, thus raising costs. Closed seasons impose a time constraint which forces fishermen to invest in faster boats, relocate at ports closest to fishing grounds, and reduce layover time in port (and hence rest and boat maintenance). The concentration of catch at a point in time also causes inefficient use of capacity by fishermen, processors, and marketing systems, since capacity is underutilized during the closed season. (See the discussion on the Wisconsin Chub Fishery below.) One advantage of seasonal closures if applied daily or weekly is improved working conditions for fishermen. Area closures prevent harvesting of immobile stocks in the closed areas, and have the same economic effects as closed seasons for mobile stocks.

Direct restrictions on fishing power

(through licensing of fishermen, vessels, and engine size)

Effectiveness

1. Distributional equity. Any limitation of fishing power through licensing will likely have distribution consequences (e.g. decisions about who or what is licensed and the level of fees applied)** Licensing seems to be as flexible with regards to achieving desired (and probably arbitrary) distribution ends

*This section relies particularly on Pearse (1980) whose comparative analysis of policy alternatives in general is very insightful.

as any other method. As Pearse (1980) notes, supplementary means for acquiring and distributing the benefits can be devised (e.g. landings royalty).

2. Biological Conservation. In principle, this could be achieved through licensing if all dimensions along which fishing power can be varied could be controlled. In the long run, controlling fleet capacity alone will not insure biological conservation because fishing technology is flexible and a restricted input can be substituted for by another (e.g. engine power for boat size). In the short run, there is a limit to the amount fishing power can be increased if key dimensions are controlled. The experience of the B.C. salmon fishery seems to support the conclusion that such controls can at least be partially effective (Crutchfield 1979).

3. Rent Maximization. The comments for biological conservation apply, and in addition, the probability that restrictions on fishing power will inhibit cost reducing innovations must be considered. Indeed, incentives are provided for the adoption of wasteful competitive technologies and/or a rapid turnover in technologies which are likely to increase costs. There is evidence from both the B.C. salmon fishery (Pearse & Wilen, 1979) and the Western Australian rock lobster fishery (Meany, 1979), that capital investment continues to increase, and shifts occur within the fleet from less to more capital intensive capture methods and equipment.

4. Employment changes and dislocations. The degree of dislocation consequent upon direct restrictions on fishing power depends upon the amount of overcapacity present in the industry and upon the specific restrictions. For example, as Pearse (1980) notes, by using a buy-back scheme, involuntary dislocations are avoided. Employment effects are hard to predict because they are sensitive to the labour-capital mix used in the fishery (e.g. smaller but more powerful vessels may require less labour to operate). Similarly, direct restrictions on vessels and fishing power do not improve the distributions of effort among stocks and grounds, unless separate licenses are provided in each.
5. Community structure, culture. This is a political decision resembling the distribution decision and with respect to which a licensing program seems no better or worse than the alternatives.
6. Rate of technological change. As noted above, this can be partially controlled (Crutchfield, 1979), but inefficient changes still occur (Pearse and Wilen, 1979; Meany, 1979), and there is a danger that more cost effective innovation will be stifled.
7. Industrial structure can be accommodated by associating certain qualifications with the licence such as was done in the Alaskan salmon fishery (Adasiak, 1979, pp. 772). Where such conditions do not exist, there is evidence that concentration of fleets occurs (cf. Western Australian prawn fishery; Meany, 1979).

8. Adaptability to changing conditions. Licensing restrictions do not facilitate adjustments to fluctuations in demand or supply (e.g. higher prices or aluctuations in harvest) particularly because the restrictions often require decisions about "lumpy" investments in boats and engines.

Administrative feasibility

1. Data requirements. Requirements are relatively low and easily monitored and regulated.
2. Acceptance. Licensing is not new and has proven acceptable in a number of fisheries. Concerns about the distribution consequences delayed implementation of licensing limitations in the Canadian West Coast salmon fishery for 10 years (Fraser, 1979), although the widespread use of licenses prior to license limitation facilitated acceptance of license restrictions per se. License limitation is not a complex concept and is generally speaking, well understood by participants who usually stand to gain; the buy-back feature facilitates voluntary departure. Because license limitation is relatively acceptable to participants and publics, the political risk is relatively low. Yet the B.C. salmon fishery demonstrates that political risk can be an important consideration (Fraser, 1979).

Operational efficiency

Some direct controls such as vessel licensing are inexpensive; and such a program may be relatively inexpensive to run initially, but as substitutions occur and more regulations are added, the program will become more complex to administer and costs will go up.

Monitoring and enforcement costs may escalate dramatically if the participants adopt obstructive tactics (cf. lobster fishery on East Coast). In summary, a license limitation scheme is feasible and at least initially, it is efficient to administer. As restrictions become more complex administrative costs will probably increase. There is evidence that suggests a degree of success in meeting the economic efficiency objective but this evidence is indirect, e.g. the value of licences in the B.C. salmon fishery. Other evidence from the same fishery and the Western Australian rock lobster fishery indicate that investment in fishing capacity continues to increase, but at a slower rate than before. License limitation does not appear to be incompatible with other objectives.

Taxation of vessels or equipment

The effects of such taxation are similar to those for direct controls on fishing power, but the scheme is less practicable for two reasons. First, it's liable to be unacceptable to fishermen because of: (a) the immediate distribution effects -- the taxing authority must appropriate all the economic gains if there is to be an improvement in economic efficiency; and (b) the fluctuating rates necessary will create additional uncertainty for the fishermen (and make their responses hard to predict). The negative direct effects on fishermen and vessel owners is likely to create resistance to this policy measure.

This policy measure is attractive in theory because it seems to provide a ready mechanism for manipulating the distribution of effort

among stocks and fishing grounds and for adjusting to changing conditions in harvest and demand. In practice, the data requirements of accuracy and timeliness, as well as the administrative complexity required are very serious disadvantages. The system would also produce more uncertainty for fishermen, and appears arbitrary, so that changes would be resisted.

Taxes or royalities on the catch

Effectiveness

1. Distributional equity. All benefits are initially appropriated by the regulatory agency, but can resumably be redistributed among participants. For example, all taxes on catch could be redistributed equally among all licensees. The complexity of such a system could make it difficult to communicate and acceptance would be doubtful.
2. Biological conservation. In theory, the royalty tax could be set up to encourage conservation, but monitoring would have to be very well designed to overcome the incentive to avoid paying royalties on catch. The royalty could be varied to take biological fluctuations into account but this would require assessment procedures with a high degree of certainty and would require information on the response of fishermen. Similarly, different tax rates could be applied to different species, stocks and fishing grounds in order to distribute fishing effort but this would also complicate the administrative structure and increase the information requirements.

3. Rent maximization. At the correct rate of taxation, excess capacity would be forced out. Setting the correct level would be a trial and error process. As Scott (1979) points out, this would create uncertainty about rate levels and fishermen reaction and waste profit during the time the tax was too high or too low. In practice, rent maximization would tend to be fortuitous.
4. Employment changes and dislocations. Dislocations could be spread over time by raising royalties gradually. However, royalties reduce employment and reduce incomes in the fishery in order to squeeze out excess capacity.
5. Community structure, culture. There is no problem with divisibility, so part-timers can still compete, and at least in theory, taxes could be changed locally to protect some local fisheries or some types of fishermen (e.g. artisanal, subsistence fisheries).
6. Rate of technological change. Royalties do not interfere with technological or tactical innovations and act as an incentive to low-cost innovations.

Administrative feasibility

1. Data requirements. Royalties on catch are very data-demanding. The manager would need to have reliable assessments of harvest, reliable estimates of demand and prices and also a good guess as to the response of the fishermen to the taxes, i.e. the amount of excess capacity that is "squeezed out" by lower effective profits. These data requirements are a serious constraint to the feasibility of this policy instrument.

2. Acceptance. Another constraint is likely resistance to a tax, especially one imposed on an already low-income occupation. It will also be difficult to explain the logic of the measure and the need for changes in the tax or royalty.

This measure will be hard to accept on the part of the fishermen because all gains initially accrue to the government and the employment/cash/flow uncertainty are increased due to the need to fluctuate the tax rates. For these reasons, the political acceptability of royalties on catch should be rated very low.

Operational efficiency

Effective functioning of this system requires precise, accurate and timely data on both demand and supply factors. Since such factors are in a state of continuous flux, the tax rate would also have to be changed continuously. The data collection and analysis costs will be high, the administration complex and the participants would probably resist the changes. No new distortions in fishing technology will be introduced, but inefficiences may arise from competition among units for the available catch.

In brief, the administrative costs are likely to be very high due to the data requirements, the costs of monitoring enforcement and tax collection. An expensive information and marketing program will be needed to persuade fishermen and local politicians to accept this policy instrument.

Quantitative Individual Quotas

Effectiveness

1. Control of excess capacity. The incentive to expand capacity beyond that needed to efficiently take the available catch is eliminated; the incentive to adopt special technology or to compete for the catch is also removed.
2. Distribution of fishing effort. Fish will be sought wherever they can be caught at least cost, eliminating incentives for inefficient distribution of fishing effort. If separate management of some stocks is deemed necessary, this can be done by providing separate rights for each.
3. Distributional equity. Any desired distribution of economic gains between holders of the rights and the government can be achieved. The distribution is influenced by how the rights are initially allocated (e.g. on the basis of previous catches, fishing power), and can l altered by supplementary means such as fees, taxes, etc. The major decision is whether the initial allocation is given as a right to the commercial or other fishermen who have a demonstrable commitment or whether the property rights are appropriated by the administrative agency.
4. Biological conservation. This is easily accomplished by setting the total allowable catch every year at an appropriate level and prorating the individual quotas.

5. Dislocation and employment changes. The market for rights would allow gradual concentration of rights in the hands of those fishermen who are more efficient (not necessarily the larger), while the less efficient will sell their rights and receive payment which presumably reflects the net present value of their rights. Thus, no involuntary dislocation need occur. The quota would also allow small operations with low cost to stay in business and would therefore tend to reduce dislocations in the size distribution of the operations in the fishery. Whether entry into the industry becomes more difficult would depend largely on the market value of quotas; if the market values are high, then it would discourage younger people with no accumulation of capital from entering the fishery. There are also concerns that quotas will accumulate in the hands of a few participants. This could be controlled through supplementary regulations and/or differential license fees.
6. Community structure and culture. As with licenses, restrictions can be attached as seen fit to protect local lifestyles. By dividing quotas up into relatively small units, the ability of part-timers and fishermen participating in several fisheries can be assured.
7. Adaptability to technological and other changes. As long as the individual quotas are freely transferable, the fishery will be largely self-regulatory with respect to technological changes.

8. Rent maximization. The holders of quotas will organize their business in a way that minimizes cost. Thus the economic rent realized in the fishery will tend to be maximized.

Administrative Feasibility

The major problem is that quantitative rights are novel in fisheries and conflictwith tradition; even where fishermen would clearly benefit, there is evidence that they will resist the measures (Pearse 1980).

There are four problems in connection with the implementation of quotas that reinforce this resistance:

(1) The initial distribution of quotas is bound to be more advantageous--or be seen to be more advantageous -- to some and less advantageous to others;

(2) The owners of the quotas may be required to pay an annual fee (cf. license fee); clearly the level of this fee may be cause for resistance;

(3) Quotas would require reliable assessments and monitoring;

(4) The total allowable catch is almost certain to vary from year to year and this could create resistance to what may appear to be administrative high-handedness to the individual quota owners.

It should be pointed out that the assessment and monitoring requirements are not more demanding than the requirements for regulations and less demanding for a royalty on landings. An incentive for accurate reporting may be built into the quota system (cf. a two-part quoata, the second part to be a function of the catch in the first part). In addition, quantitative rights provide participants with a

proprietary interest in the harvest and are likely to generate political support on that basis. Since the fisherman is given a set quota which he is entitled to catch, a source of uncertainty is removed and this should also be expected to generate political support for a quantitative rights scheme.

Operational efficiency

A simple version should have fairly low administrative costs (e.g. keeping a register of quota owners) since most of the adjustment occurs automatically. A major cost might be enforcement, especially of full disclosure of catches, but such information is needed for stock management purposes anyway.

Summary Comparison of Alternatives

Using the classification of regulations shown in Table , the regulatory alternatives can be compared along the two dimensions of that classification. First, direct measures are compared to indirect. Such a comparison shows that although both direct and indirect measures could be chosen to achieve similar results (e.g. direct regulation of vessels vs. taxation of vessels, or individual quotas vs. landings tax), the indirect measures present important practical problems. The data requirements of indirect methods are more demanding, requiring accurate, timely and precise data from both the demand and supply sides. Direct methods require only the latter. Indirect methods, since they depend on proper adjustment to demand and supply changes to work properly, require much more frequent adjustment than do direct measures. Aside from the inherent difficulty in deciding what adjustments should be made, there are practical difficulties in communicating them and in getting fishermen to accept them. Also, the

inherently greater complexity of indirect measures makes them difficult to explain to those who have to accept them, and the fact that indirect measures must confiscate all economic gains will not endear them to fishermen. Thus there are substantially greater barriers to the administration of indirect measures. Overcoming these barriers, where this is possible, will cost money spent in educational programs, and the greater complexity and data requirements of indirect methods will probably make them less efficient.

Second, input vs. output controls are compared. The main reason for preferring output control is quite simple -- through it the incentive which leads to distructive competition can be removed. Input control only restricts the ability to compete. There is indirect evidence that input control can increase expected economic yields, as mentioned earlier, at relatively low cost. Thus it may be that the main basis for choosing between input and output control is the relative net benefits conferred when both economic gains and administrative costs are calculated. Unfortunately, no empirical evidence exists upon which to make this decision, and it probably depends a lot upon the particular fishery in question. In summary, the final choice seems to be between two types of direct measures, control of fishing power or individual quotas. Which of these is to be preferred depends upon the fishery in question and is to be based upon the net gain when both effectiveness in reaching objectives and administrative costs are considered. A priori it would seem that individual quotas could be less costly in the long run, as they could be largely self-adjusting, through a market mechanism. Controls on fishing power seem to invite substitution of restricted inputs and proliferation of regulations to retain control.

III

ALLOCATING GREAT LAKES FISHERY RESOURCES: TOWARDS A STATUS REPORT

Generally speaking, the Great Lakes fishery harvests are allocated among and within six categories of fisheries: subsistence fishing, native American (or Indian) fisheries, commercial (food) fisheries, sport or recreational fisheries, charter (commercial-recreational fisheries) and conservation (i.e. to all enjoyers and future generations). These six types of allocations do not provide an ideal taxonomy, since they overlap (e.g. Indian fisheries include both subsistence and commercial operations) and some categories include a wide range of fisheries; for example, recreational fishing could include fishing from well-equipped boats as well as fishing by dangling a line off the pier (c.f. discussion of fisher types in chapter II above). In designing allocation policies, it is important to target a policy to a well-defined group; for example, day-user licenses may not make much sense for recreational fishing as a whole, but may be very appropriate for salmon fishing in a specific estuary where pressure is excessive.

To what extent have the various jurisdictions developed an explicit allocation rationale and/or implemented an explicit allocation procedure among competing user groups and within each user group? Ideally, the allocation of allowable yields among competing user groups should reflect "...adequate criteria based on publicly accepted biological, economic and social values regarding alternative uses." (SPOF, 1978:1) Whether a jurisdiction has an explicit

rationale or not, it still allocates fishery resources. The objective of this draft is to formulate in a preliminary fashion the position of several jurisdictions and to invite comments in order to rewrite the "empiric" evidence. The approach in this chapter, as opposed to that in other chapters, is descriptive rather than normative. The emphasis is on critical interpretation and synthesis of the available documents.

Toward An Empiric Comparative Analysis

A preliminary assessment of fish harvest allocation policies in the Great Lakes, suggests that each jurisdiction practises a range of mechanisms (e.g. licenses subject to regulation of gear, season and area for some fisheries and individual quotas for other fisheries). This range of policy mechanisms within each jurisdiction indicates that policies are in flux; that user groups are in part resistant to change or that there are obstacles to the adoption of more innovative policies. A more detailed comparative analysis of institutional responses to the question of fishery harvest allocation is outside the scope of this report. It is sufficient for present purposes to list the range of mechanisms that have been adopted in the Great Lakes. Table 3.1 lists seven observed mechanisms or policy choices. The list best applies to commercial fisheries. These mechanisms represent a large number of possible combinations. For example, regulation of fishing inputs and limited number of licenses could be combined with royalties or quotas. In fact it is helpful to consider quotas and/or royalties to complement regulation and licensing rather than replacing them. In any case, what is urgently needed is a comparative descriptive study of the experience with these mechanisms around the Great Lakes during the last half

Table 3.1

Mechanisms Observed in Great Lakes Fishery Regulation

1. Non-regulated, open access to fishery (laissez-faire);
2. Regulations on fishing inputs seasons and areas (licenses subject to regulation);
3. Number of licenses limited;
4. Total "zone" allowable catch or quota (a) fixed (b) variable from year to year;
5. Individual quota;

	fixed	variable from year to year
allocated on basis of past catch		
auctioned off		

6. Provision for a buy back of quota;
7. Royalties on catch.

century or so.

There are no organized fisheries in the Great Lakes, as far as we know, that are not regulated and/or do not require licensing. The obligation to have a license is a necessary (but not sufficient) condition for regulation or more sophisticated allocation policy. Regulation and licensing are perhaps the most primitive forms of limiting fishing effort but they could be quite effective in conserving stocks by protecting spawning fish, putting limits on types or size of nets, etc. Regulation and licensing could -- and often do -- apply to recreational as well as commercial and traditional fishery. Regulation and licensing are by far the most common mechanisisms for controlling fishing effort in the Great Lakes.

The next step has often been to limit access by deciding not to issue any more commercial licenses. Practically all Great Lakes fisheries have reached this point because in nearly every case the fishery had collapsed in recent memory (particularly in the 1950's) but limited licenses are also supported by local associations of commercial fishermen. Limits on the number of licenses could be applied to recreational fishing in theory; in practice, potential fishermen may be unofficially steered away from stocks under stress by increasing license fees, reducing the number of boat-ramps in selected localities, etc.

Total allowable catches for a stock (i.e. zone quotas) are usually applied to commercial fishermen and there are even a few cases where individual quotas are set. By and large, the allocation of quotas is linked to a modest license fee; in other words, society at large does not share in realized or potential economic rents. In

order for society to share in the economic rent, either the license fees have to be high, or linked to a royalty catch or the licenses have to be auctioned off. License fees in the range of $2,000 for large boats are very rare; royalties on catch are not levied in the Great Lakes; we know of only one case where a quota is auctioned off and this is for a "new" fishery. Typically zone and individual quotas are fixed; we shall return to these issues below.

Bag limits for recreational fishermen are "pseudo" quotas. Enforcement is difficult not only because the number of fishermen may be very large and the areas to be monitored may also be large but also because the bag limit may be taken every day -- or even every trip. In this case, it may be more feasible to regulate areas and seasons.

Quotas that vary from year to year require very reliable assessments of the size and age composition of the stock. Even fixed quotas require reliable assessments for biological-conservation purposes; such assessments are also required in order to gain the confidence and support of the commercial fishermen. This lack of confidence in assessments may be the second most important reason for user group resistance to quotas.

The most important reason is the lack of confidence in enforcement of quotas. Without strict enforcement, quotas do not reduce the incentives to net fish before others catch them. The quota system should include some incentive not to under-report. The "waybill" procedures go a long way to keeping track of fish consignments from the processor back to the fishermen. Another approach is to reserve the last two or three weeks of the fishing season for special quotas available only to licensees who have filled their normal quotas.

Provisions for a buy back of quotas would enhance the matching of fishing effort with potential total catches in times of low productivity. The major problem is that a source of funding is required in order to buy the quotas. This mechanism has not been used so far in the Great Lakes, but has been used to good effect elsewhere and may be a critical component of a policy designed to have viable fish stocks and a prosperous commercial fishing industry.

If sufficient data were available, an empiric comparative analysis of policy mechanisms for limiting fishing effort and allocating harvest would ideally start with the experience of the twelve jurisdictions with the mechanisms listed above. This information base is not available at this time and we are able to review the policies of three bodies: GLFC, Ontario and Wisconsin.

Damn the Border, Share the Harvest

The experience with inter-national and inter-jurisdictional allocation of fishery harvest in the Great Lakes Region is limited to the attempt to allocate the Lake Trout Fishery in Lake Superior in the early 1960s and to the more recent - and more successful - protocol for walleye management in western Lake Erie.

Lake Superior Lake Trout Fishery*

In June 1960 the Ad Hoc Committee on the Regulation of the Lake Superior Trout Fishery** reported to the GLFC Interim Meeting that

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*This narrative is based on the GLFC Annual Reports for 1960 (pp. 7-8) and 1961 (pp. 16-17). Documents for updating the story would be very welcome.

** The Committee consisted of G.E. Eddy (Michigan), W.J.K. Harkness (Ontario), H.O. Swenson (Minnesota), L.P. Voigt (Wisconsin and GLFC Commissioner) under the chairmanship of R.W. Saalfield (GLFC). W.H.R. Werner replaced W. Harkness who died in July 1960.

> "it had reviewed the present and predicted status of the lake trout stocks and believed that there was definite need for new methods of regulation to control fishing as the population of lake trout built up."

The Committee assumed that sea lamprey would continue to be controlled and based its policy recommendation on the principle of harvesting lake trout to a level that would permit "sustained maximum production". The most direct means of approaching this goal is (i) by adopting an annual catch limit for the lake every year and (ii) by distributing this catch among the four jurisdictional areas (i.e. Minnesota, Wisconsin, Michigan and Ontario); this allocation to be reviewed every five years or on request by any agency concerned.

In December the Committee recommended that implementation of the quota be deferred until sucess of sea lamprey control was evident. It also noted that difficulties were encountered in applying a"proportioning formula to a total lake catch set at a very low level." (GLFC 1961, p. 17). The lake trout catch in 1960 was expected to be about 600,000 lbs. or 15% of normal production (GLFC 1960 p. 13). The angler catch was specifically included in any quota. The GLFC recommended in Nov. 1961 "that the 1962 harvest of Lake Trout in Lake Superior be limited to the fishing effort required to support necessary biological information in changes in population"(GLFC 1961 p. 16).

At first blush the practical effects of this Committee's deliberations may appear to be negligible since the implementation of the quota was deferred. However it is worth noting (1) the emphatic agreement among the members of the committee about the need to regulate fishing intensity as the population of lake trout built up; (2) the objective of "sustained maximum production" which one could interpret as

MSY*; (3) the setting of a varying annual total catch and the pro-portional" allocation among the four jurisdictions; (4) the specific inclusion of the angler catch in the quota. These principles promoted two decades ago, were accepted in the walleye protocol and could serve as a starting point for inter-jurisdictional collaboration in the 1980s.

The Walleye Protocol**

In March 1973, the GLFC sponsored a meeting (chair, Henry Regier) in Toronto in order to discuss the stressed condition of the walleye stocks in western Lake Ontario. Among the objectives were the fair allocation of walleye resource among states and province and the recovery of the resource "to level of maximal harvest" or MSY. The GLFC 1973 Annual meeting accepted the recommendations of the Toronto meeting and particularly the recommendation to establish the Scientific Protocol Committee (SPC) and his recommendation was approved by the two national governments and the SPC submitted its First Technical Report in 1976.

The walleye stocks in western Lake Erie were overfished in the 1960s but recovered during the moratorium on commercial fishing (because of mercury contamination) to a population of fishable walleye of 9×10^6 fish. The 1976 harvest was computed at 9×10^5 fish weighing 1.6×10^6 lbs and the quota was set at 80.5×10^3 fish to Michigan, 479.5×10^3 to Ohio and 355×10^3 to Ontario. This apportionment was presumably based on lake surface area within each jurisdiction. The SPC Report does not explicitly state this but the minutes of a meeting in Toronto in 1976 state that "harvest allocation was apportioned on an areal basis"

*Sustained maximum production could be literally interpreted as environmental carrying capacity (see chapter II above), in which case the harvest would be zero; this would imply an internal contradiction.

**This narrative is based on the minutes of the GLFC 1976 Annual Meeting at Traverse City, Michigan; a memo by Carlos Fetterolf dated July 11, 1977 and an undated enumeration of the "Sequence of Events Relating to Walleye Quota".

or 8.8, 52.4 and 38.9 per cent of the catch to Michigan, Ohio and Ontario respectively. Eventually in 1977 the Lake Erie Committee established the Standing Technical Committee since the SPC had disbanded in 1976.

The successful negotiation and implementation of the Walleye Protocol constitutes a milestone in fishery resource allocation. Not only was a resource equitably shared but a multi-agency team had (1) carried out the required research to estimate stocks and harvest and even more remarkably (2) agreed to "joint surveillance of the fishery, not only to ensure compliance....but also (to obtain) data with which to monitor the harvest, continuously assess the stock(s) and periodically adjust the total permissible catch (and) hence the... quotas."

One of the remarks in the SPC's First Technical Report is worth underlining. If environmental standards are relaxed, "with concomitant degradation of the stock's habitat and productivity in Lake Erie... management plans like the one developed (by the SPC) would be only marginally effective in rebuilding, protecting and perpetrating this valuable heritage". This concern about fish habitat could be expressed more often by the fishery management community who should also give more attention to fostering a constituency that would express a high priority to fish and their habitat.

The Walleye Protocol and its implementation process also point to the "soft underbelly" of this and similar plans, viz. enforcement and catch accountability. In this case the Lake Erie Committee's consensus was that these...were up to each agency. The SPC described the program as inherently self-policing and also expressed concern

about the problem of monitoring the sport catch. In particular it is difficult to apportion that part of any quota set aside for angling. An evaluation of the experience gained in implementing the Walleye Protocol could encourage similar interagency coordination for other fish stocks and lakes.

Ontario

Allocation Among User-groups

Ontario has been involved in the process of developing criteria for inter-group and within group allocations since at least 1977 when the Strategic Plan for Ontario Fisheries (SPOF) working groups were set up under the aegis of the Federal-Provincial Committee for Ontario Fisheries which started its work in 1974.

The "cardinal principles" for fishery resource allocation in Ontario are the maintenance and rehabilitation of the resource in order to ensure sustained benefits to residents. The SPOF document on Allocation Policy (1978 p. 3) is very explicit: "...allocation to the resource (i.e. reproductive stock) must be explicit and must be so perceived by all users if we are to guarantee a sustained supply of benefits to the public. If there is one major principle we would like to establish then this would be it." "Without the resource there can be no allocation." (SPOF 1978 #5, p. 6)

A strong emphasis was also put on the need to prepare an allocation methodology that is flexible over time. These two basic objectives or constraints should be kept in mind in the discussion of Ontario's policy for fishery resource allocation.

The SPOF document on fishery allocation lists eleven

principles for strategic planning which could be used at the local level for allocation decisions or recommendations. As is the case with most principles, these are somewhat general and exhortatory in nature. They are significant for their emphasis on resource maintenance, the need to limit access and to maintain and/or rehabilitate fish resources, the pre-eminent rights of the Crown which holds fishery resources in trust for Ontario residents, multiple use and optimum sustained benefits, protection of jobs and the need to proceed with allocation recommendations even if not all the evidence is in. These general priorities are presented:

i) Maintenance/rehabilitation of the resource (including research for fishery management); an important corollary is the need to develop effective techniques for enforcing allowable harvests;

ii) Allocation of fish in accordance with the stated fishing rights of Treaty Indians;

iii) Allocation of fish "through the assessment of optimum sustained benefits (multiple uses over long periods of time)" (p. 9).

The first two priorities seem to present no major conflicts or insurmountable difficulties. The techniques to estimate accurately the total biomass are not yet developed but it should be possible to determine whether a stock is being stressed through overfishing and to decide whether the consumptive uses should be increased or decreased from the "observed" yields. It is also unlikely that native fisheries would be seriously overfished since (as the SPOF report notes) the subsistence life-style is predicated on a sustained resource base; "self-regulatory" mechanism would be required to control intra-group excesses.

The third priority at first seems to emphasize allocative efficiency. The report uses the terms "optimum" (implying a maximizing algorithm) and "benefit" (implying a measurement of value). In fact the "hierarchical apportionment" within this third priority is based on "judgement" (p. 12); these choices reflect distributional equity as much as efficiency. For example, a very high priority is the retention of cultural values (lifestyles and tradition); therefore local traditional users with "subsistence and/or traditional needs" have the highest priority. The criterion is "humanitarian grounds" rather than efficiency.

A high priority is assigned to recreational fishing on the basis of high benefits (leisure, food, employment, income, etc.). Commercial fishing and outfitters contribute a lower level of benefits but the commercial fishermen harvest fish stock that are not available to or highly demanded by recreational fishermen.

The overall rationale for allocation among user groups is not explicit. However, this priority ranking makes a lot of sense. Firstly, one needs to maintain the resource; secondly one needs to meet legal obligations to natives; thirdly, one should meet traditional/subsistence needs on humanitarian grounds; fourthly, the high returns from recreational fishing and fifthly, the returns from a viable commercial fishery. As it turns out, these priorities seem to be filled in ascending order of demand measured in terms of total catch by sector. If commercial fisheries were given the highest priority there might not be enough left to meet the smaller demands from subsistence fishermen, etc. The stated policy seems to meet all priorities seriatim or as a nested hierarchy. In other words overall conflicts are minimized

even though there could be local or regional conflicts. This allocation on the basis of a "nested hierarchy" may not have been deliberate on the part of the committee members but it reduces the scope of conflicts in those cases where demand exceeds total allowable catch and it also makes it possible to allocate resources on the basis of value at the margin (see below). In effect it allows the reduction in allocation to the user group that (a) has the highest demand in terms of poundage, viz. commercial fisheries and (b) has the lowest "value" in terms of benefits to Ontario residents, viz. day trippers from the U.S. This is part of the decision in a case example (Lake St. Clair) at the end of the SPOF (1978) report on Allocation. The report of the Committee on Modernizing Ontario's Commercial Fishery notes that recreational fisheries exploit "something less than half the resource" (OMNR 1982:10). Therefore it makes sense to allocate a substantial part of the resource to an ongoing enterprise which employs 2200 persons rather than leave untapped an average catch of 51 x 10^6 lbs.of fish, the ex-vessel value of which was \$23.6 x 10^6 in 1980 (OMNR 1982:12).In addition, the commercial catch "enhances fish-community stability through balanced harvesting" (p. 12) and makes available to the general public a food item of high value (e.g. in restaurants)*.

The SPOF (1978) report on allocation comes very close to endorsing the equi-marginal approach to inter-group allocation. This means that ideally fishery resources are allocated among user groups such that it would not be possible to increase total benefits by reallocating even one unit from one user group to another. For example, the last unit

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* One should point out that in future the pressure from recreational fishing may reduce the rationality of this priority listing. Commercial fishing should perhaps be given some indication that the industry would be allocated enough fish to remain viable.

allocated to sport fishermen is assumed to have a "value" equal to the last unit allocated to commercial fishermen. Otherwise it would make sense to increase the share of the latter at the expense of the former. If this principle were explicitly adopted for user groups (except allocation for the maintenance of the resource, allocation to satisfy Treaty obligations and allocation to people with subsistence or traditional needs) it might well lead to the development of a methodology for determining the benefits/costs of participating in/providing fishing opportunities. This seems to be one of the major research and management gaps in the field as far as Ontario is concerned; the other is to develop the most feasible method for intra-group allocation for both sport fishing and commercial fishing (see below).

Ultimately, the allocation process is political, "since the social implications of the decision are best evaluated in that arena" (Holder 1981). However, the development of these two methodologies would assist the elected representatives to reach decisions that not only make sense but can be seen to be sensible.

Ontario has already made a lot of headway in developing an allocation policy. Before we leave this part of the discussion, it seems worthwhile to mention briefly one of the less tractable problems facing Ontario Fishery resource allocation, viz. harvest by non-residents who contribute little to the Ontario economy. One answer seems to lie in much higher license charges for all non-residents with a rebate payable through hotel-keepers for multi-day visitors. Other options (e.g. a non-resident licence for a period shorter than a season) are being examined by OMNR (Holder, personal communication).

Allocation Within a Group: The Commercial Fishery

In December 1980, the Deputy Minister of OMNR appointed a committee to recommend ways and means of reforming the regulation of commercial fisheries. The committee included a substantial representation from the Ontario Council of Commercial Fisheries (OCCF), in addition to the senior biologist-managers of OMNR. The committee was asked to take into account "contemporary societal and industry expectations in as simple, rational and direct a fashion as possible" (OMNR 1982:2).

Complementing Regulation with Quotas

This committee correctly diagnosed the shortcomings of the current regulatory regime. In principle, regulations should control harvests in the biological sense of maintaining fishery resources. In practice, these controls spur the licensed fishermen to increase effective fishing efforts through increased capital investment and labour. The result is an ever increasingly complex regulatory regime and inefficiency in the fishing operation. Since there are few "overall quotas," the controls have "not been particularly effective in controlling the volume of harvests" (p. 7). The few overall quotas or area quotas stimulate competitive fishing in the early part of the season and this depresses prices.

The committee's consensus was: "There can be no doubt that the fishing capability of Ontario's fleet is greater than is needed to land available harvests efficiently or that the present management approach tends to encourage this situation, however unintentionally." (p. 8)

The committee supports in principle the move to individual quotas for each licensed commercial fisherman. The report enunciates some

important guidelines as "principles" which could be summarized as follows:

(i) the quotas would be specific to stocks, fishing areas and traditional fishing practices (p. 8);

(ii) the quotas would be allocated once only by an ad hoc quota-sharing committee; any subsequent increases or decreases would be applied on a pro-rata basis (p. 18);

(iii) the quotas should recognize a variety of factors such as past performance, capital investment, present license provisions, etc.; all current licences would be allocated an initial quota (p. 18) and no more licenses should be issued (p. 22); if no sharing formula is determined, the OMNR will decide (p. 20);

(iv) "all quotas must be enforceable" (p. 18) by means of standardized invoices or records of purchases and sales (p. 20);

(v) quotas (and the license to which they accrue) could be sold in whole or in part (pp. 22-23); the licenses would become, in effect, permanent rather than annual and would become "property" or wealth as long as they are exercised (p. 22) (c.f. land to a farmer or an egg quota to a poultry farmer in Canada)

(vi) the current requirement that licensees be Ontario residents be retained (p. 23);

(vii) only whole licenses could be sold to new entrants so that the number of licenses will not increase (p. 23);

(viii) the license would be terminated for (a) inactivity by the licensee, (b) accumulated demerit points, (c) collapse of the resource base (p. 26);

(ix) basic annual license fee of $100, plus "a percentage of the value of the quotas on the individual licenses" (p. 28)

Discussion

The report of the Committee on Modernizing Ontario's Commercial Fishery and the guidelines summarized above constitute a very significant step forward in fishery resource allocation policy in the Great Lakes Region. The following comments are meant to compare these guidelines to the state-of-the-art review in this study.

The policy statement requires elaboration or clarification in important respects: the initial sharing of quotas; the performance requirements of licensees; and the absence of any role for the Ministry to "buy back" licenses or to prevent monopolies.

The initial allocation of quotas is one of the most critical steps in the setting up of a procedure to manage fish harvests directly by means of quotas. By adopting an initial allocation of quotas, the Province is creating and awarding a property asset which represents the "economic rent" accruing to a well-managed fishery resource. There is a strong a priori reason for allocating this new wealth to the licensees who have devoted their life-long efforts to the development of the resource and its markets. However, there is also a compelling reason to allow the "public" (as represented by the Ministry) to share in this economic rent in the future. This sharing in the resource provides a useful rationale or logical basis for license fees based on the value of the quotas.* The license fee based on the current value

*The report notes that "there is agreement that the license fees are now inadequate and lack a rational base" (p. 27)

of the quota could serve three purposes. First it would raise "an amount toward administration costs." Secondly it would give the general public an incentive to promote and maintain a viable (and profitable) commercial fishery because the public would share in the "economic rent" accruing to the fishery. Thirdly, such a license fee based on the value of the quota would assist in the management of selling and buying the quotas. Without such a fee the quotas could, after a few good years, reach values such that young newcomers could be prevented from buying into the industry resulting in an aging population of license holders (c.f. farming) and perhaps a concentration of quotas by large absentee companies (c.f. agri-business). The spirit of the small vertically integrated company and the individual fisherman has been the tradition in the Great Lakes. The royalty based on the value of quotas could be a useful institutional instrument to help retain such a traditional way of life. (see principle ix above)

The initial quota sharing could be based on several criteria, e.g. previous catch performance, number of licenses currently held by one person, the size of crew or size of boat. Each criterion would result in a different set of outcomes in terms of distribution or equity. Clearly some comprises would need to be made at the local level (Berkes and Pocock, June 1980, p. 71).

The performance levels required of licensees are puzzling. The license could be terminated for inactivity by the licensee.

> "A person should be denied renewal if, for two consecutive years, his performance fell below 60% of similar outfits in the area

> without excuse (such as sickness or death of licensee, disaster to equipment or failure of markets)...the license should not be renewed after four years of complete inactivity (p. 26)

It was pointed out above that a permanent (or perennial, as the report prefers to call it) quota is equivalent to a property asset and is indeed subject to regulation. However, it is essential to allow each licensee to make use of his/her quota by choosing whatever mix of labour and capital resources he/she chooses if the economic rationale (i.e. efficiency) for quota-setting is to be achieved. Firstly, if a licensee was not reaching even 60% of the quota, economic rationality would suggest that he sell part of the quota. If the licensee chooses not to sell at the going price, there should be no compulsion to sell or to be expropriated without compensation. Crutchfield (1979) reminds us that the "stronger" welfare test is that there be no losers. Secondly fishermen with low catching ability but also low operating costs but play a very useful role in diversification of the fishery. As Scott (1979) points out, the possibility of accommodating such a production unit (low costs, low effective effort) is the logical basis for having parts of quotas or small units per quota. Thirdly, the need to satisfy the 60% rule may be the Achilles heel of the quota system. This rule could spur the fishermen to compete for the catch in some years when the quota is overestimated and also in some years when "extra quotas" maybe allowed toward the end of the season.

> "As long as vessels need to race for the fish, neither a tax system nor a quota system will prevent overinvestment in speed and capacity; only sole ownership will" (Scott 1979:)

This performance requirement will only reinforce the tendency among fishermen (or lawyers, etc.) to compete anyhow, the need to be recognized as leaders, as competent, aggressive entrepreneurs.

The report, as noted above, emphasizes that there is overcapacity in the commercial fishing industry in Ontario and perhaps the performance requirement is one way to weed out the "marginal operations." It is also designed to exclude licence holders who do not intend to fish (Holder, pers. comm.)

Given the strong feelings on present overcapacity, the absence of any buy-back component is also puzzling. This is the traditional response to reduce the number of licences and/or overcapacity (Fraser 1979, Adasiak 1979, both on West Coast salmon fishery). A buy-back component is proposed by the committee to compensate licensees whose operations were adversely affected by shifts of resource allocations to other user groups (e.g. from commercial to sport fishing) (OMNR 1982:27). Buying quotas would be a direct way of addressing this problem. Instead of shifting resources to other user groups by fiat, the Ministry could buy a quota or two or a score and the licensees would sell for the market value instead of being forced out and compensated.

The report seems to allow that in principle, this quota system would not prevent the development of monopolies. It also notes that the chances of a monopoly developing is so slight that it could be disregarded for the present (p. 23). How slight is "slight" and how long is "the present"? There are parts of the province where the number of fishermen is very small or where cooperatives are the predominant units in the local fishery. In order to safeguard the interests of the general public (i.e. consumers) and to enlist their support, the policy should unequivocally state that monopolies, quasi-monopolies, monopsonies, oligopolies and other forms of imperfect competition are not in the consumers' interests and would not be allowed unless the entry

costs are very high by the nature of the enterprise or where economies of scale are over-riding (i.e. natural monopolies) or where the resource base allows only one licensee to operate efficiently. Otherwise a monopoly may choose to produce less and exact a higher price than a number of small producers (i.e. price takers) would.*

Conclusion

The Ontario Ministry of Natural Resources has over the last decade articulated a fishery resource allocation policy that is explicit and reflects the needs and values of the user groups. This applies both to inter-group allocation and to intra-group allocations. The major challenge will be to bridge the gap between the ideals expressed as policy objectives and the practical instruments for implementation. As Adasiak (1979:780) puts it: "Certainly a large task is ahead to see what kind of bridge might be built between theory and practicality."

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*The Committee's views are not necessarily inconsistent with our views; a period of "rationalization" may be useful before one decides whether controls related to imperfect competition are required.

Wisconsin*

As in most other jurisdictions around the Great Lakes, fishery allocation in Wisconsin includes a wide range of mechanisms. The policy of the Natural Resources Board of Wisconsin as set out in October 1968, is "to maintain, restore, improve and manage the waters and fish populations in the Great Lakes and Green Bay; to produce the greatest good recreationally, aesthetically and economically" (Kernen 1968, Appendix A). This policy has been replaced by Wisconsin Administrative Code NR 1.04 which reads in part:

> "The board endorses a flexible management system for the protection, development and utilization of the waters and fish populations of the Great Lakes for the maximum public benefit." (Register, October, 1982, No. 322).

The new policy also recognizes the interstate and international interest in the management of the Great Lakes and refers to the "allocation of allowable harvest among various users." A very high priority has been given to conservation by establishing refuges (seasonal and year-round) to protect lake trout (e.g. Gull Island Shoals). However, it is acknowledged that the rate of rehabilitation (e.g. of lake trout) could be accelerated if the allocation to sport, commercial (incidental catch) and Indian fisheries were reduced.

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*Except where other sources are directly referred to, this section is based in large part on Kernen (1981), Addis (1982, personal interview) and comments by WDNR (fisheries) on a previous draft. The weaknesses, omissions and errors are solely the responsibility of the authors.

With one exception (i.e. Lake Superior Chippewas) WDNR does not seem to have explicit allocation guidelines among user groups and this flexibility is probably desirable in order to meet contingencies such as the resumption of harvesting by Indian fishermen in 1972. Sport fishing seems to be given the highest priority implicity, subject to the Indian fishing under treaty rights and conservation of fish stocks. Sport fishing is at present regulated by means of limits on size of fish taken, bag limits and gear limitations; sport fishermen may not sell lake trout. Recently (1982) there has been an explicit policy to separate commercial and sport users to reduce conflict. Commercial fishing is subject to limited entry, harvest quotas and regulated effort; there are provisions for protecting spawning stocks, spawning grounds (e.g. limited marketing, closed seasons, gear and area limitations).

On Lake Superior, 21 licensed commercial fishermen harvest chubs, lake trout and whitefish. There are regulations on gear, season, areas; no total allowable catch is currently set for these species except lake trout. The commercial catch was 186,000 lbs. of whitefish while the tribal fishery catch was 138,000 lbs. in 1980. The Indian fisheries are largely self-regulated, subject to a limited entry agreement; as one would expect, this cooperative venture in fishing effort regulation has worked well since it is in the interest of the harvesters that the fishery be sustained.

On Lake Michigan there is a largely expanded fishery for whitefish which responded well to sea lamprey control. The commercial gillnet fishery expanded from an average 2.3×10^6 feet/year for 1966-70 to 23.9×10^6 for 1974-78. There are 199 licenses (1982); entry has been limited since 1978 but the industry is considered to be over-capitalized. There is no current legal

commercial harvest of lake trout to Lake Michigan. The incidental and assessment catch for lake trout has not baeen marketed due to PCB and DDT contamination.

A sophisticated allocation procedure has been adopted for the coarse fish harvest on inland lakes (e.g. buffalo on Lake Delavan, sheepshead on Lake Winnebago). The right to harvest a species is awarded to the highest bidder. This policy allows the State to share in the economic rent accruing to the fishery and it also allows the "single-owner" of the resource to harvest at the least cost, thus maximizing his share of the economic rent. (Contrast this to the "horse-race" fishing for chub on Lake Michigan). The entrepreneur whose bid is accepted will have the advantage of familiarity, gear and experience the following year and therefore a measure of a stable source of livelihood is likely for the successful bidder.

Wisconsin has adopted an explicit inter-group allocation policy for lake trout in Lake Superior. Native American commercial fishermen are allowed a quota of 100,000 lbs. and 21 other commercial fishermen are allowed a quota of 80,000 lbs. The agreement with the Lake Superior Chippewas allows for co-operation and self-regulation in husbanding the resource.

Wisconsin has adopted another very useful process-oriented mechanism to encourage user-participation in policy-making. There are two Commercial Fishing Boards, one for Lake Michigan and one for Lake Superior. Commercial fishermen make up these Boards on an appointed basis and they are responsible for reviewing licensing regulations as well as allocating quotas to individual fishermen when these are adopted. As these Boards gain more experience, they

could choose to investigate whether the present allocation mechanisms in their jurisdiction are the best under the circumstances.

For example, the Lake Michigan Commercial Fishing Board (L.M.C.F.B.) has recommended that individual quotas be established for the Lake Michigan chub fishery, starting in July 1983. It is worth emphasizing that the L.M.C.F.B. is composed of five commercial fishermen prepresentatives, one wholesale fish dealer, and one citizen. The justification for this recommendation is that the total quarterly quota was taken in a few weeks, flooding the market and making it necesary to freeze the catch (increasing costs and reducing the price) (The Fisherman 1982).

The total annual quota for Lake Michigan chub will likely increase from 1.6 million lbs. to 2.5 million due to an increase in stock. The 34-40 fishermen in the southern region would divide the total regional quota of 2.1 million on the basis of their landings in 1981 and 1982. The five top quotas will reach 70,000 lbs. At the time this report appeared in The Fisherman (1982) the L.M.C.F.B. recommendations required public hearings and review by the Wisconsin Board of Natural Resources before being adopted.

The wide range in fishery allocation policy in Wisconsin suggest that the obstacles to the adoption of inter-group and individual quotas are yielding to reasonable argument and persuasion; it is more than likely that the increased cost to the commercial fishermen and to the distributors would also act as a spur to change as overcapitalization becomes more obvious. The successful examples of Wisconsin's fishery allocation deserve more detailed study and evaluation for possible adoption within and without the state.

IV

CODA

The traditional approach to controlling (or managing) fishing access and fishing effort in the Great Lakes region is through licensing and regulation regarding season, gear, locality, minimum size of fish, etc. This approach has an obvious advantage to administrators and their political bosses: it glosses over controversial and divisive issues such as the economic efficiency of the commercial fishery, the standard of living of the commercial fishermen, the relative allocation among major classes of direct users (commercial, residential, recreational, tourist, outfitters, derbies, party boats, native people, artisanal). In addition, the regulatory approach tends to assume away problems of assessment and enforcement; as one biologist-manager put it, "If we do not assess correctly or there is too much cheating, the regulations are tightened up (e.g. number of fishing days) -- in the end, the regulation works." It should be added that this approach does protect the fishery from extinction. If biological conservation were the only major concern, there would be little else to add.

However, the recent literature on fishery allocation raises several other concerns such as economic efficiency, the living standards of the commercial fishing workforce, the need to improve both assessment and enforcement especially with respect to innovative fishery allocation policies. The innovations under examination in Ontario, Wisconsin and other jurisdictions also point to the relevance and urgency of basin-wide discussions of alternatives to the conventional regulatory approach, now widely recognized as inadequate.

Therefore we consider an urgent task, at both the scholarly

and practical levels, to be a comparative descriptive study of the current experience with the regulation of fishery effort, access and catches around the Great Lakes. The comparative aspect would apply not only across jurisdictions but also across major user groups. This study could best be conducted at a "regional" level (e.g. western Lake Erie). In particular, the study should (1) address the biological economic and social implications of regulation and other policy mechanisms at the regional level; (2) challenge managers to make more explicit their base for the current allocation policies; (3) investigate the data requirements for the implementation and evaluation of innovative allocation mechanisms to specific fisheries.

The non-efficiency aspects of fishery allocation do not lend themselves well to currently available, quantitative analytical methods of decision-making. Such analysis of inter-national and inter-jurisdictional allocation would seem to be the least promising because of political (and often unknown) considerations, divided and competitive responsibilities, different administrative traditions, and so on. Therefore, the evaluation of the experience gained from the implementation of the walleye protocol (western Lake Erie) could be timely. Similarly, a thorough assessment of the regulatory regimes affecting Lake Superior trout stocks could throw light on whether inter-jurisdictional allocation could work better, as suggested by an ad hoc committee in 1960-61.

It is encouraging to note that a recent GLFC initiative may well lead to a major study of the deficiencies and strengths in fishery assessment and predictive capabilities. That initiative will likely produce an important benchmark report; more importantly, it will

provide many practising biologists and managers with the opportunity to think, take stock, listen, discuss, contribute and in so doing, perhaps change. Assessment and prediction are closely related to fishery allocation and the management of fishing effort.

Other related topics or issues that could be taken up for study include:

- monitoring and enforcement of regulations and quotas;
- conflict (potential, real, perceived) between recreational and commercial fisheries and also within the recreational fishing group (e.g. competition and derbies, party boats equipped with sophisticated gear vs. the more conventional hook-and-line fishers) or within the commercial fishing group (large corporate units vs. small family units.)
- native fisheries and subsistence fisheries.

This study was not intended to focus on the empirical or quantitative research on fishing effort, catches, MSY, MEY, etc. Our impression is that more analytical, quantitative work needs to be done in order to throw light on such issues as overcapitalization, economic overfishing and their relation to stock growth or stock depletion.

The Great Lakes fishery community could break new ground by addressing the issue of the cost-effectiveness of various administrative approaches to commercial and recreational fisheries and particularly whether self-regulated fisheries are viable and, comparatively speaking, cost-effective. Similarly, one could undertake an innovative study of a self-regulated recreational fishery (e.g. by means of a tag scheme that would be administered by a club or a municipality or a voluntary association).

The economic and historical geography of the Great Lakes fishery as a whole still needs to be written in spite of the massive data collected by a dozen jurisdictions over many decades. There is an obvious gap that could only be filled by integrative research on the development of fishery resources in the Great Lakes and particularly in the context of the "staple theory" developed by Harold Innis (c.f. Whillans, 1981-82 and Peters, 1981-82). Such a study could attempt to answer basic questions about the employment, location, resource base and economic base of the major fisheries around the Great Lakes. A comprehensive and readable economic geography would in turn stimulate interest in maintaining and restoring an important source of employment, and enjoyment. The research on the Great Lakes fishery has very largely addressed the biological aspects of the resources; an understanding of the patterns of economic activity based on fisheries could be useful in the effort to nourish and enhance the political constituencies that would in turn support the maintenance and rehabilitation of Great Lakes fish stocks.

The Food and Agriculture Organization; the Department of Fisheries and Oceans of Canada; the U.S. Departments of Interior and Commerce sponsored a Technical Consultation on the Allocation of Fishery Resources in 1980; the proceedings edited by Grover (1982), became available after this draft was completed. The recommendations from the consultation are far-reaching and comprehensive and are appended to this draft report. However the suggested policy on allocation merits emphasis, and we quote it in full:

> "Recognizing the diversity of fishermen and their interests, it is policy to allocate a substantial segment of the aquatic resources to each group, and, in recognition of both the dynamic and changing nature of the resource and the environment that produces it, continually review the propriety of the allocations and of the value systems on

> which they are based. Further in implementing this policy, to engage vigorously in the generation, exchange and evaluation of information required for equitable allocation and perpetuation of fishery resources and their multiple values". (Gaudet in Grover, 1982, 7).

The range of concerns of the fishery community needs to be extended to include not only questions of biological conservation, but also economic efficiency, employment creation, economic base, and cost-effectiveness. It is unlikely that a satisfactory broadening of concerns will occur without much debate and discussion. This paper is offered as part of that process; if it succeeds in sparking discussion, our labour will have been well rewarded.

Fishery resource allocation is a controversial topic. We trust that we have steered a careful course between normative-analytical discourse and consensus-building, between "equations and aphorisms... between planners' manipulations and individual freedoms." No reader or reviewer or critic is more aware than we have been over the last few months of the difficulties involved in policy-making for "a social world filled with sentient actors,opendedness ambiguity and indeterminancy." We wish we could stick to equations or at least be satisfied with aphorisms; for the time being we'll opt for indeterminancy in the hope that further fruitful discussion and research will be forthcoming.

REFERENCES

Adasiak, A. 1979. Alaska's experience with limited entry. J. Fish Res. Board Canada 36(7), 770-782.

Addis, J.T. 1982. Personal Communication.

Allison, W.R. 1981. Paradigms, tension and strategic change. Administrative Sciences Association of Canada, Policy Section. Vol. 2/Part 6.

Anderson, L.G. 1977. Economic impacts of extended fisheries jurisdiction, Ann Arbor: Ann Arbor Science.

Anderson, L.G. 1977. The economics of fisheries management. Baltimore & London, John Hopkins.

Bell, F.W. 1972. Technological externalties and common-property resources: An empirical study of the U.S. northern lobster fishery. J. Pol. Econ. 80.(1) Jan/Feb. 148-158.

Berkes, F. and Pocock, D. 1980. Issues and conflicts in fisheries management in Lake Erie. Institute of Urban and Environmental Studies, Brock University, June 1980.

Beverton, R.J.H. & S.J. Holt, 1957. On the dynamics of exploited fish populations. Ministry of Agricuture, Fisheries & Food (London) Fisheries Investigations Series 2(19).

Bishop, Richard C. and Karl C. Samples, 1980. Sport and commercial fishing conflicts: A theoretical analysis. J. of Envir. Economics & Management 7(3).

Boerema, L.K. & J.A. Gulland, 1973. Stock assessment of the Peruvian anchovy (Engraulis ringens) and management of the fishery. J. Fish Res. Board Canada 30, 2226-2235.

Christie, W.J. 1978. A study of freshwater fishery regulation based on North American experience. FAO.FIRI/T180, Rome.

Christy, F.T. 1973. Alternative arrangements for marine fisheries. Resources for the Future. Washington, D.C.

Christy, F. & A.D. Scott, 1965. The Common Wealth in Ocean Fisheries. Baltimore: John Hopkins.

Clark, C.W. 1976. Mathematical bioeconomics: the optimal management of renewable natural resources. Wiley, New York.

Clark, C.W. & G.R. Munro, 1980. Fisheries and the processing sector: some implications for management policy. Bell Journal of Economics 11(2).

Coase, R.H. 1960. The problem of social cost. J. of Law and Economics, 3 (October), 1-44.

Copes, Percival, & Jack L. Knetsch 1976. Management options and management integration in recreational and commercial fisheries. Recreational Fisheries Conference Document, Toronto, July 14-16.

Crutchfield, J.A. 1979. Economic and social implications of policy alternatives for controlling fishing effort. J. Fish. Res. Board Canada, 36(7), 742-752.

Cunningham, S. and D. Whitmarsh 1981. When is overfishing underfishing? Environmental Management 5(5), 377-384.

Dales, J. 1969. Pollution property and prices, Toronto: University of Toronto Press.

Draper, D. 1981. Oceans exploitation: efficiency and equity questions in fisheries management. In J.B. Mitchell and W.R.D. Sewell, Canadian Resource Policies, Problems and Prospects. Toronto Methuen, 109-150.

Eheart, J. 1080. Cost efficiency of transferable discharge permits for the control of BOD discharges, Water Resources Research, 16(6) 980-986.

Eheart, J. M.H. David and E.F. Joeres 1980. Distribution methods for transferable dishcargae permits, Water Resources Research, 16(5), 833-843.

The Fisherman, 1982. "Wisconsin Fishing Board Recommends Individual Club Quotas in 1983," vol. 34, no. 7, p. 3.

Francis, G.R. , J.J. Magnuson, H.A. Regier, D.R. Talhelm (1979) Rehabilitating Great Lakes ecosystems. Great Lakes Fishery Commission, Ann Arbor, Michqian, Technical Report No. 37.

Fraser, G.A. 1979. Limited entry: Experience of the British Columbia salmon fishery. J. Fish. Res. Board Canada, 36(7), 754-763.

Gaudet, J.L. (Ed.) 1981. Report of the technical consultation on the allocation of fishery resources. Vichy, France. April 21-23, EIFAC Tech. Pap. 38, 45 pp.

Glantz, M.H. and J.D. Thompson, 1981. Resource management and environmental uncertainty: Lessons from coastal upwelling fisheries, New York, J. Wiley & Sons.

GLFC, 1960. Great Lakes Fishery Commission, Annual Report, Ann Arbor, Michigan.

GLFC, 1961. Great Lakes Fishery Commission, Annual Report 1961, Ann Arbor, Michigan.

GLFC, 1980. A joint strategic plan for management of Great Lakes fisheries, Great Lakes Fishery Commission, Ann Arbor, Michigan.

GLFC, 1982. Great Lakes Fishery Commission, Position on Lake Trout Rehabilitation, Adopted 14 June 1976, Revised 8 June, 1982 (one page, no date).

Gordon H.S. 1954. The economic theory of a common property resource. J. Pol. Econ. 62, 124-142.

Griffith, C.R., B. Bauer, A.P. Grima 1981. The theory and practice of alternative mechanisms for environmental quality management: A bibliography. Chicago: Council of Planning Librarians, 1981.

Grima, A.P. and C. Griffith 1982. Non-regulatory policies in water quality management. In B. Mitchell (Ed.) River Basin Management: Canadian Experience, University of Waterloo (forthcoming 1982).

Grima, A.P. 1981. Institutional mechanisms for water pollution control, GeoJournal Vol. 5, 503-511.

Grima A.P. 1972. Residential water demand: Alternative choices for management. Toronto: University of Toronto Press, 211 pp.

Grover, J.H.(Ed.) 1982. Allocation of fishery resources, Proceedings of the (FAO) Technical Consultation held in Vichy, France, 20-23 April 1980. Rome: Food and Agriculture Organization (FAO), 1982, 623 pp.

Hardin, G. 1968. The tragedy of the commons. science, 162. pp. 1243-1246.

Harris, H.J., D.R. Talhelm, J.J. Magnuson, A.M. Forbes 1982 Green Bay in the future. A rehabilitative prospectus. Technial Report No. 38, Great Lakes Fishery Commission, Ann Arbor, Michigan.

Heilboner, Robert, 1976. Business civilization in decline. New York. W.W. Norton & Co.

Holder, A.S. (1981). Ontario's fisheries allocation policy. Remarks at the GLFC Interim Meeting, 8-9 Dec. 1981, 2 pp.

Hotelling, H. 1931. The economics of exhuastible resources. J. Pol. Econ. 39, 137-175.

Kernen, L.T. (1981). Wisconsin lake trout harvest allocation policies, Remarks to the G.L.F.C. Interim Meeting, December, 1981, 5 pp. and Appendices A-I.

Kalymon, B. 1981. The management of canadian resources. Toronto, McGraw-Hill.

Krebs, C.J. 1978. Ecology: The experimental analysis of distribution and abundance. 2nd Ed. Harper & Row, New York.

Lindblom, C.E. 1965. The intelligence of democracy: Decision-making through mutual adjustment. New °York: The Free Press.

Loftus, K.H., A.S. Holder and H.A. Regier 1982. A necessary new strategy for allocating Ontario's fishery resources. In J.H. Grover (Ed.), Allocation of Fishery Resources Proceedings of the (FAO) Technical Consultation held in Vichy, France, April 1980, Rome: Food and Agriculture Organization (F.A.O), pp. 255-264.

Loftus, K.H. and H.A. Regier (eds.) 1972. Special issue on the Proceedings of an International Symposium on Salmonid Communities in Oligotriphic Lakes (SCOL). J. Fish. Res. Board Canada, 29(6), 611-986.

McCay, Bonnie J. 1978. Systems ecology, people ecology and the anthropology of fishing communities. Human Ecology 6, (4), 397-421.

March, J.G. & H.A. Simon, 1951. Organizations. New York. John Wiley & Sons.

Meany, T.F., 1979. Limited entry in the Western Australian rock lobster and prawn fisheries: An economic evaluation. J. Fish. Res. Board Canada 36, (7), pp. 789-798.

Murphy, G.I. 1966. Population biology of the Pacific sardine (Sardinops caerulea). Proc. Calif. Acad. Sci. 34: 1-84.

Needler, W.H. 1979. Evolution of Canadian Fisheries Management Towards Economic Rationalization. J. Fish. Res. Board of Canada, 36(7) 716-724.

Nemetz, P.N. Ed. 1980. Resource policy: International perspectives. Institute for Research on Public Policy. Montreal.

OMNR 1982. Ontario Ministry of Natural Resources/Ontario Council of Commercial Fisheries, Report of the Committee on Modernizing Ontario's Commercial Fishery. April 1982, 31+ 15 pp.

Pearse, P.H. 1980. Regulation of fishing effort with special reference to the Mediterranean trawl fisheries. FAO Fish. Tech. Paper No. 197. Rome: Food and Agriculture Organization (FAO).

Peters, J. 1981-82. Commercial Exploitation of the Great Lakes Fisheries: An Historical Perspective, 1800-1930. GIRMS: Geographical Inter-University Resource Management Seminars, 12, 84-108.

Peterson, F. & A. Fisher, 1977. The exploitation of extractive resources, a survey. The Economic Journal. 87 (Dec.) 681-721.

Regier, H.A. 1976. Science for the scattered fisheries of the Canadian interior. J. Fish. Res. Board Canada, 33(5) 35-40.

Regier, H.A. & Hartman, W.C. 1973. Lake Erie's fish community: 150 years of cultural stress. Science 180, 1248-1255.

Regier, H.A., T.A. Whillans and A.P. Grima 1980. Rehabilitating the Long Point ecosystem: Initiating a process, Contact, J. of Urban and Environmental Affairs, 12,(3), 125-149.

Roger, E.M. and F.F. Schumacher 1971. Communication of Innovations. New York Free Press.

Rothschild, B.J. 1972. An exposition on the definition of fishing effort. Fishery Bulletin 70, 671-679.

Scott, A. 1979. Developmnent of economic theory on fisheries regulation. J. Fish. Res. Board Canada, 26(7), 725-741.

Schaefer, M.B. 1968. Methods of estimating effects of fishing in fish populations. Trans. Amer. Fish Soc. 97,231-241

Sinclair, W.F. 1978. Management alternatives and strategic planning for Canada's fisheries. J. Fish. Res. Board Canada, 35, 1017-1030.

Sindermann, Carl J. 1979. Aquatic animal protein food sources. In: World Food and Population. Congressional Roundtable.

SPOF 1978. Strategic planning for Ontario fisheries (Policy Development). An allocation policy for Ontario fisheries (Report of Working Group 5). Ontario Ministry of Natural Resources, October 1978, 39 pp.

Talhelm, D.R. et al. 1979. Current estimates of Great Lakes fisheries values: 1979 Status Report. Ann Arbor Great Lakes Fishery Commission.

Troadec, J.P. 1981. Introduction to fisheries management: Advantages, difficulties and mechanisms. FAO Draft.

Von Neumann, J. & O. Morgenstern, 1947 Theory of Games and Economic Behavior, 2nd ed., Princeton, N.J., Princeton University Press.

Whillans, T.H. 1979. Historic transformations of fish communities in three Great Lakes bays, J. of Great Lakes Research, 5(2), 195-215.

Whillans, T.H. 1981-82. Fishing up: Lake Huron as viewed from Lake Erie. GIRMS: Geographical Inter-University Resource Management Seminars, 12, 109-114.

APPENDIX

ALLOCATION OF FISHERY RESOURCES

Proceedings of the Technical Consultation on Allocation of Fishery Resources held in Vichy, France, 20–23 April 1980

Sponsored by the

European Inland Fisheries Advisory Commission (25 European Countries) of the Food and Agriculture Organization of the United Nations; the Department of Fisheries and Oceans, Canada; the U.S. Department of Interior, Fish and Wildlife Service, and the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; and hosted by the Ministere de l'Environment et du Cadre de Vie (Direction de la Protection de la Nature), France

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CONCLUSIONS AND RECOMMENDATIONS

Recreational fisheries have belatedly reached a threshold level for international recognition and for internationally coordinated action on basic data development that the commercial

fisheries reached 30 years ago. This summarizes the priority area for immediate collective endeavour as based on the following conclusions which were reached:

1. The size and basic social and economic dimensions of the recreational fisheries are no longer open to serious challenge: the recreational fishery is as big, if not bigger, than the commercial fishery in three of the largest and most industrialized countries represented at the Consultation. The country review papers revealed that the sport fishery is the dominant if not the only significant fishery in the inland waters of most of the countries represented at the Consultation. In conjunction with this, it was recognized that the recreational fisheries are comparably important in many other of the more advanced countries which could not provide for one reason or another similar holistic data on their fisheries.

2. Data comparability and relevance have supplanted data availability as the major problem with respect to recreational fisheries information. Many countries have carried out, have underway, or are planning major surveys. Unfortunately, the bulk of the resulting data can seldom be either compared or internationally aggregated because of an absence of common definitions and widely divergent differences in survey purposes, scope, time frames and methods. This however is a problem that can be resolved through international leadership and cooperation—as exemplified, for example, by the report that planners from the Canadian and the U.S. national survey are coordinating their respective 1980 surveys to develop a basic framework of common, comparable data for the Great Lakes area for the international Great Lake Fishery Commission.

3. The intransigence of the problems centering on economic evaluation of market-exempt fisheries has held back recognition of the role and importance of the reacreational fisheries long past the time that such recognition was warranted on the grounds of the size, value and potential of recreational fisheries both nationally and internationally. This dilemma was recognized in that the Consultation considered both fisheries best-use theory and economic evaluation methodology in conjunction with the two areas—data development and fishery conflicts—where realities have to be dealt with on an ongoing basis regardless of the adequacy of economic evaluation theory and methods. Progress with conflicts has been made notably in the recognition that the problem essentially exists only where fisheries are common property and that better cooperation between decision-makers and economists can progressively improve both the methods and results of such evaluations.

4. The Consultation provided the opportunity for key representatives of organized anglers from a number of countries to meet for the first time and to explore areas for possible future liaison and cooperation. Recognition of the importance of this development led to the recognition that other sectors of the recreational fishing industry should likewise open up channels of communication and be appropriately represented at future consultations.

5. It was recognized that the diversity of the fisheries endowments, interests and institutions represented at the Consultation provided an opportunity rather than a problem, and that all the countries could benefit if they could learn about and draw on each other's fishery management expertise and experience.

6. Conflicts involving both the use of fish and their habitat are becoming increasingly complex and acute. Many of these conflicts are international in scope and correspondingly require international recognition and consideration. In terms of fish use, in France for example as well as in a number of other Atlantic salmon-producing countries, the future of the salmon in both inland and ocean waters depends on both the funding and the public support for fishery conservation and enhancement that anglers can provide at both the national and international levels. Though the incidence of the problem varies, acid rain was likewise pointed out as a subject area where international understanding and cooperation are urgently required.

7. Two or three longer term fishery goal themes emerged. Ecological sensitivity was identified as a fundamental requirement for fishery managment that would benefit not only the resource and its recreational and other users, but also society as a whole. The need for improved understanding of their respective roles, and dialogue between disciplinary professionals in the fishery management field was stressed. Finally, it was recognized that this Consultation should go one step beyond urging the development of a holistic fishery management approach, i.e., the formulation of the necessary economic theory for the integrated management of all use of

fisheries, by advocating that FAO should take the lead in helping develop and start publishing statistics covering all uses of fisheries, including subsistence and recreational fisheries.

Recommendation 1—Data and Information

Managers of fisheries need comprehensive information and data on both the users and the resources of an aquatic ecosystem and on the effects that each group of users exert on the ecosystem, both with respect to quality and quantity of the use and output capacity of the aquatic resources. This information is essential to establish an adequate theoretical framework for determining ecologic, economic and social benefits from fisheries, to develop integrated models for use in long-term planning and policy analysis and to manage specific fisheries in the most efficient manner. To be meaningful the data should be based on common definitions and have a high degree of comparability.

The Consultation therefore recommended the establishment of an International Program for assembling, organizing, assessing, refining and communicating data and information. This program will include:

(A) DEVELOPMENT OF DATA

—fishery data covering both supply and demand based on common definitions with an emphasis on basic data;

—social data on quality, motives, barriers, behavior, etc.

Mechanism suggested

1. That FAO/EIFAC established a small international working group to identify, define and specify the basic economic and social data involved.

2. That regional workshops be organized as required on specific topics, such as the collection of data through fishery surveys, sampling design, etc.; that data adapted to existing policy be checked for relevance before a survey starts and that methods be used to produce more reliable and valid data.

3. That fishermen organizations be kept informed and their input be solicited regarding the collection and quality of user data.

(B) PREPARATION OF SYNOPSES

—FAO species synopsis series should be reviewed to determine whether they adequately cover habitat aspects of "species niche;"

—a new series of "stress" synopses should be started that details how major users (or abusers) of aquatic ecosystems other than fisherman impact the fish production capabilities, how these stresses may be regulated or mitigated and how they may be reversed in rehabilitation and restoration programs.

Mechanism suggested

A major working group should be convened under the sponsorship of organizations such as EIFAC, American Fisheries Society, UNEP, etc., to recommend a standard conceptual framework, content criteria and format. Expert individuals or a small group of experts might be coopted to draft specific synopses, which, following the pattern used for species synopses, would be reviewed, published and regularly revised and up-dated.

(C) DEVELOPMENT OF GUIDELINES AND CRITERIA

—additional criteria or guidelines should be prepared that deal with various aspects of ecosystems as they influence valued species such as water quantity, riverbed conformation, habitat, etc.

Mechanism suggested

The EIFAC working party on water quality criteria should continue its work and widen its series of water quality criteria publications to include water quantity guidelines, fish habitat suitability criteria, etc.

(D) PREPARATION OF COUNTRY STATUS PAPERS AND CASE STUDIES

—countries should prepare and/or up-date country status papers on recreational fisheries following the pattern suggested by Panel 1. In addition it was suggested that information should be developed and distributed regarding such things as the organization and operational functioning of efficient and time-proven sport fishery organizations and administrations such as, for example, France's *Conseil Supérieur de la Pêche*.

—a compendium should be prepared of case histories both of successful and unsuccessful attempts at ecosystem maintenance (conservation) and of rehabilitation (restoration) with respect to fishery interests.

Mechanism suggested

The preparation of country papers on the status of recreational fisheries is a national responsibility which should be centered in the national fishery authority. Case histories of local programs in which fishery managers have been successful (or not) in assuming a legal role in the comprehensive management of aquatic ecosystems should be prepared by professional managers for publication or presentation to international gatherings. Compendia of such case histories should be made.

(E) DISSEMINATION OF INFORMATION

The dissemination of information is a critical aspect of the international program. The Consultation suggested a number of steps to ensure better communications:

Mechanism suggested

1. A network for recreational fishery information should be established. This network would be based on a nominative mailing list, beginning with a Management Information Clearing House Service (MICS). EIFAC would maintain the mailing list up-to-date and distribute it to no more than 50 focal points. Each person on the list will have the double responsibility of first, distributing to the addresses all relevant national publications and second, circulating in his country all reports and publications received from the other addresses. The "MICS" system should be started as soon as possible.

2. Better communication should be developed among the various members and cooperators, on a lateral basis, and on a vertical basis between the responsive scientific, administrative and legislative echelons and the public in each country.

3. The flow of information and the decision-making process within fishery management and policy-making should be studied.

4. FAO/EIFAC should take the lead in encouraging and publishing internationally comparable data covering the entire use and contribution of fisheries, i.e., landings by commercial and recreational fisheries in all categories of waters, aquacultural production, subsistence fisheries, etc.

5. Fishery scientists should package fishery information in such a manner that the general public, engineers and trained administrators can understand and see clearly the trade-offs involved with each proposed alternative. For this, an effective two-way flow of information between fishermen and scientists as well as between fishery interests and the general public is necessary.

Recommendation 2—International Consultations

The Consultation recognized that the international dialogue among scientists, managers and fishermen started in Vichy must continue. It was therefore recommended that:

(a) Subject area meetings, workshops and symposia be convened as required to cover technical matters more fully, perhaps on a regional basis, and including specifically:

1. The allocation problems concerning multiple use and conservation of large rivers particularly in developing countries;

2. The specific allocation problems of coastal marine waters in both North America and Europe;

3. Interdisciplinary team work in research and management including contacts with anglers' associations and other relevant groups;

4. Meetings of heads of organized anglers' associations to develop liaison and cooperation in areas of common international interest and concern, e.g., in matters like the conservation of Atlantic salmon and bluefin tuna and acid rain.

(b) FAO/EIFAC, in cooperation with all other interested organizations and countries, should convene another technical consultation on the allocation of fishery resources in 1985 or 1986 to evaluate findings and progress being made on how fishery resources can be conserved, managed and enhanced to optimize overall benefits to all users and to society.

Recommendation 3—Research and Planning

The need for further research to provide decision-makers with better tools to manage the resources was strongly underlined throughout the Consultation. A number of topics were specifically mentioned:

(a) Applied research to gather specific data on fish species habitat requirements for the purpose of developing habitat suitability criteria;

(b) Research and funding for verification and validation studies to establish the credibility of mathematical models used for projecting changes in stream ecosystems to facilitate the use of water allocation formulae in water planning;

(c) Research for the development of contingency plans for drought conditions in arid or semi-arid regions and for the incorporation of such plans into water planning and the operating rules of dams and diversion projects;

(d) Research and interdisciplinary studies of stream systems are required throughout the planning and design of water development schemes. One special purpose is the development of policies for the establishment of stream flow standards to lead to more rational development and control of pollutants and consumptive uses of water;

(e) Theories and models suitable for integration and allocation should be developed;

(f) Special attention in research and management should be given to special population groups, e.g., urban citizens and young people.

Recommendation 4—Protection of the Aquatic Ecosystem

(A) ACID RAINS

The delegates from Nordic European countries specifically recommended that appropriate steps be taken to eliminate, to as large a degree as possible, the ongoing acidification of lakes and streams caused by acid precipitation originating from sources such as the burning of fossil fuels.

(B) WATER POLLUTION

To minimize costs of pollution prevention and abatement measures that are designed to maintain and improve fisheries, studies carried out to date to this end, and other relevant initiatives, should be reviewed to identify the main reasons for success or failure. Areas of interest would include:

1. approaches to the development and implementation of realistic environmental standards, such as water quality criteria and criteria path analysis, and

2. public and institutional organization responsibilities, motivation influence and power.

(C) RADIO-ACTIVE WASTE

Following the increase in the disposal of radioactive waste in the aquatic environment fish populations are increasingly exposed to radio activity. The Consultation therefore recommended that the greatest care be taken in the disposal of radio-active waste (including tritium).

(D) THERMAL POLLUTION

The effects of thermal changes on the aquatic ecosystem should be foreseen even before impact studies are terminated and preliminary measures taken to limit negative effects.

To avoid cumulative effects of various types of stream deterioration, even though each individual pollution may be considered moderate, it is desirable that thermal waste be subordinated to an effective reduction of the overall pollution, an increased protection and, if necessary, a restoration of the habitat.

A system of compensation can be foreseen in an overall plan of energy production. For instance, a reduction of micro power stations in an upper basin if a large thermal power station is allowed elsewhere.

Recommendation 5—Streamflow

(a) Hydrobiologists attending the Consultation agreed that the streamflow is as important for maintenance of fish populations as the physiochemical quality of the water. In many cases flow helps water quality.

(b) Fish can stand low flow levels for short periods in times of natural droughts. It is proven, however, that artificial reduction of river flow to similar levels but for long periods causes reduction of fish population in both quantity and quality. Abrupt flow reduction or increase is also damaging.

(c) In view of the biological degradation resulting from modifications of streamflow it is recommended that at the planning and implementation stages of projects creating a flow change consideration should be given to the principles of ecology which make it possible to arrive at a comprehensive view of advantages and disadvantages of these projects. New projects should be implemented keeping in mind the biological facts stated in paragraphs (a) and (b) above.

In arid regions precautions are absolutely necessary if the biological value of the streams is to be maintained.

(d) Intensification of research and data-gathering on the needs of various fish species at different stages of growth and types of rivers are necessary to evaluate if it is possible, and up to what point, to modify the flow of rivers without dangerously disturbing the fish population and fishery potential.

Recommendation 6—Streambed

(a) It is recommended that hydraulic works such as canalization of rivers (straightening, recalibration, modification) which often have negative effects on fish fauna for many decades be subject to strict control. Where necessary, it is suggested that hydro-ecologic arrangements (e.g., restoration, cleaning-up, maintenance) which are less expensive and better suited to the various users of the river be undertaken.

(b) It is now evident that gravel extraction in the lower riverbed of rivers results in important lasting damages which often are irreversible for (i) the stability of the riverbed and public works, (ii) the water table, (iii) water quality, and (iv) the fish fauna, particularly migrating species. Such extractions should be made only in extreme cases on a temporary basis and, in a quantity always less than the solid flow of the river. Gravel extractions in the higher riverbed can have, in addition to repercussions on the water table, negative ecologic effects particularly on trout streams. It is in the common interest to reduce gravel extraction or even avoid it completely in cases where negative effects are foreseen.

The construction of sills cannot be considered a remedy to the disadvantages resulting from the deepening of the riverbed. Sills became an additional obstacle to fish migration.

(c) It is evident that essential notions of ecology, hydrobiology and hydrology should be included where not already done so in the study curriculum of hydraulic, civil and rural engineers.

Recommendation 7—Conflicts with Other Recreational Uses

Recreational fishermen search for calm and natural conditions. Because of this sport fisheries are often in direct conflict with other recreational uses of water. To help solve these conflicts it is recommended that regulations be made aiming at:

(a) Recreational uses of water other than fishing (such as motorized boating) be limited particularly in cases where effects on the environment, e.g., river banks and spawning grounds, are negative;

(b) Giving priority to recreational uses of water which are not mutually exclusive except in a few restrictive zones.

It is evident that education will improve human behavior in the natural environment and bring better understanding between various users of water. In this respect it was recommended that the philosophy and values of wildlife use and wildlife education (including fisheries) be the subject of studies and the connection with fishery management clarified.

Recommendation 8—Salmon

The Consultation recommended:

(a) To promote immediately the signature of an international convention that would establish an international commission to (i) set up regulations on salmon fishing in the Atlantic, except for a coastal zone, aiming at suppressing abusive or unbalanced exploitation, (ii) to encourage research and conservation of Atlantic salmon;

(b) That, while waiting for the establishment of the international commission mentioned above and keeping in mind the precarious situation of certain salmon stocks, countries concerned need to take urgent and efficient measures to restore stocks: such as free circulation of salmons (removal of obstacles blocking migrations, minimum flow), limitation of catches (also at sea) with sufficient escapement of brood stock, control of all types of pollution including gravel extraction.

Recommendation 9—Allocation Policy

In concluding its work the Consultation felt that the interested users of the aquatic ecosystem would be remiss in their efforts if they did not endeavour to have a fishery resources allocation statement incorporated into their national fishery policy. Such a statement could be phrased as follows:

"Recognizing the diversity of fishermen and their interests, it is policy to allocate a sustainable segment of the aquatic resources to each user group and, in recognition of both the dynamic and changing nature of the resource and the environment that produces it, continually review the propriety of the allocations and of the value systems on which they are based. Further, in implementing this policy, to engage vigorously in the generation, exchange and evaluation of information required for equitable allocation and perpetuation of fishery resources and their multiple values."

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