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ECONOMIC DIMENSIONS OF FEES AND ACCESS CONTROL UNDER THE FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

Robert C. Anderson* and James A. Wilson**

I. INTRODUCTION

The continued interest of economists in the private exploitation of living marine resources arises from the perception that significant social gains would accompany the implementation of a well-designed resource management plan. Historically the fisheries of the high seas have been open to all nations. Such open access has led to recurrent interest in a comprehensive management program, because the unrestrained access to a fishery can lead to a greater than optimal rate of investment and use.¹ Private harvesting decisions generally fail to maximize the social value of a resource exploited through open access. Neither individual fishermen nor national fleets have adequate incentives to consider their respective impacts on the quality of the resource or the costs incurred by others. For example, immature fish are sought along with mature fish on the individual fisherman's theory that a fish lost today is lost forever. Of course, to society they are not lost, and the social value of the resource is lowered by the harvest of immature fish. Would-be fishermen are attracted to the industry when their expected earnings exceed those in other available activities. What these new entrants fail to consider is their impact on the fishery and incomes of other fishermen. The result is overcapitalization of the industry and increased pressure on the resource base, which can lead to reductions in breeding stocks and lower harvests.

An open access fishery functions quite differently from ordinary

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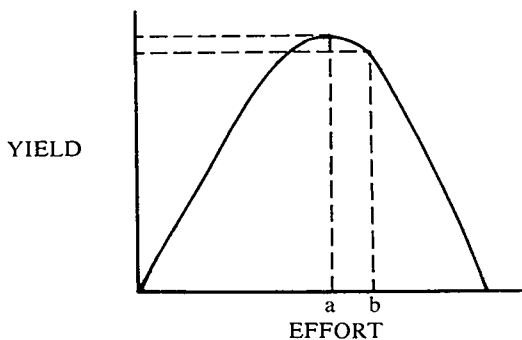
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1. Economists consider the rate of investment and use to be "optimal" when the largest social value is imputed to the resource; this value is the largest excess of what the products of the fisheries are worth to present and future consumers over and above the full costs of harvesting the fish. For a basic review of the economic problems that arise in the development of common property resources, see Dorfman, *The Technical Basis for Decision Making*, in *THE GOVERNANCE OF COMMON PROPERTY RESOURCES* 5 (E. Haefele ed. 1974).

economic activities. When profits above full costs are earned in an ordinary activity, new investment is stimulated. In most activities the new investment takes the form of additions to productive capacity, and in the long run output is increased. Profitability of a fishery also attracts new investment, but there are biological limitations on how much output can be increased without *reducing* the long-run productivity of the resource. Fisheries investment, therefore, can be excessive not only from an economic point of view but also from a biological point of view.²

In the past, when the profitability of a high seas fishery threatened its biological productivity international agreements were sought to impose a variety of controls to reduce the harvest. These controls usually took the form of restrictions on one or more of the following: (1) When and where fish could be caught, (2) the minimum or maximum size of fish that could be caught, (3) the gear that could be used,

2. This can be visualized with an effort/yield function, a basic tool of fishery management. For a specified level of effort (input), one may forecast an expected yield or catch (output). The graphing of the effort/yield function is generally seen as nearly parabolic.



Point a indicates the effort that will produce the "maximum sustainable yield." *i.e.*, the level of effort that will result in a harvest which may be taken consistently without diminishing the stock, thereby rendering the stock perpetually renewable. If fishery investment is such that effort is expended at the b level, yield will decrease and the size of the fishery will decline. *See, e.g.*, Limited Entry into the Commercial Fisheries (J.C. Mundt ed., Institute for Marine Studies, University of Washington 1974); Bromley & Bishop, *From Economic Theory to Fisheries Policy: Conceptual Problems and Management Prescriptions*, in *ECONOMIC IMPACTS OF EXTENDED FISHERIES JURISDICTION* 281 (L. Anderson ed. 1977); Christy, *Limited Access Systems Under the Fishery Conservation and Management Act of 1976*, in *ECONOMIC IMPACTS OF EXTENDED FISHERIES JURISDICTION*, *supra* at 141; Wilson & Anderson, *Fee Management Systems for the Northwest Atlantic*, in *ECONOMIC IMPACTS OF EXTENDED FISHERIES JURISDICTION*, *supra* at 195.

and (4) the number of fish that could be harvested.³ Occasionally some nations limited the entry of fishermen into a fishery. With the exception of entry limits, none of the control mechanisms adequately dealt with the impact of new entrants on the incomes of existing fishermen; more often, such regulations had the undesirable side effect of raising fishing costs by mandating the use of inefficient technologies.⁴ Furthermore, traditional forms of control protect the biological productivity of a fishery only to the extent that such restrictions are honored by all participants in the fishery; in practice it proved difficult to obtain full international cooperation in the management programs for the fisheries of the high seas.

The failure of traditional forms of regulation to induce economically efficient behavior was not in itself sufficient cause for a change in basic management strategies. Rather it was the failure to meet the goal of resource conservation that ultimately provided the impetus for comprehensive national management programs for the fisheries of the high seas.⁵

In 1976 the United States established a conservation zone, extending from the three-mile territorial limit of the coastal states outward to a 200-mile limit.⁶ The scope of coverage of the Fishery Conservation and Management Act of 1976 is unique in federal wildlife law.⁷ The Act provides for the continued use of the traditional forms of regulation⁸ and adds two important policy options: Fees for fishing

3. Examples of international agreements and controls are the Interamerican Tuna Commission, which controls seasons and areas among other factors, and the International Commission for Northwest Atlantic Fisheries, which relies primarily on quotas and mesh size restrictions. See J. GULLAND, *THE MANAGEMENT OF MARINE FISHERIES* 156-81 (1974). Similar regulations have been used for fisheries within national territorial seas.

4. For a discussion of the problems with such regulations, see J. CRUTCHFIELD & G. PONTECORVO, *THE PACIFIC SALMON FISHERIES* (1969).

5. See Magnuson, *The Fishery Conservation and Management Act of 1976: First Step Toward Improved Management of Marine Fisheries*, 52 WASH. L. REV. 427 (1977). Chile was the first nation to claim for itself a 200-mile conservation zone contiguous to its coast. Later, Peru and Ecuador established similar 200-mile conservation zones to protect their rich fishing grounds from intrusion by foreign fleets.

6. Fishery Conservation and Management Act of 1976 (FCMA), Pub. L. No. 94-265, 90 Stat. 331 (codified at 16 U.S.C.A. §§ 1801-1882 (West Supp. 1977)).

7. The Act claims for the United States exclusive management authority over fish, including "all other forms of marine animal and plant life other than marine mammals, birds, and highly migratory species," FCMA § 3(6), 16 U.S.C.A. § 1802(6) (West Supp. 1977), within the 197-mile conservation zone, *id.* § 102(2), 16 U.S.C.A. § 1812(1). For an excellent historical review of United States fishery and other wildlife law, see M. Bean, *The Evolution of National Wildlife Law* (Council on Environmental Quality, in press).

8. See FCMA § 303(b)(2)-(4), 16 U.S.C.A. § 1853(b)(2)-(4) (West Supp. 1977).

rights⁹ and limitations on entry.¹⁰ This article is devoted to an analysis of how these new management tools can be used most effectively as applied to domestic and foreign fishermen.

II. ECONOMIC TOOLS FOR MANAGING DOMESTIC FISHING EFFORT

A. Fees

For domestic fishermen, permits and fees may be imposed.¹¹ The Act specifies, however, that the fees charged domestic fishermen may not exceed the administrative costs incurred by the Secretary of Commerce in issuing domestic fishing permits.¹² From an economist's perspective, this requirement is the least desirable feature of the Act,¹³ as it makes the efficient and equitable management of domestic fisheries much more difficult. Market prices can be relied upon to signal the relative scarcity of fishery products; but, due to the common property nature of fisheries, fishermen cannot respond to price signals of scarcity by "planting" more fish and thereby relieving the longer term problem. Fishermen can respond to higher prices by increased fishing effort, but often this only creates greater long-run scarcity. Furthermore, individual fishermen may impose other costs on one another (for example, congestion costs) that are not transmitted through

9. *Id.* § 303(b)(1), 16 U.S.C.A. § 1853 (b)(1).

10. *Id.* § 303(b)(6), 16 U.S.C.A. § 1853(b)(6).

11. The Act provides as follows:

Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, may—

(1) require a permit to be obtained from, and fees to be paid to, the Secretary with respect to any fishing vessel of the United States fishing, or wishing to fish, in the fishery conservation zone, or for anadromous species or Continental Shelf fishery resources beyond such zone

Id. § 303(b)(1), 16 U.S.C.A. § 1853(b)(1).

12. *Id.* § 304(d), 16 U.S.C.A. § 1854(d).

13. Inasmuch as both the House and Senate versions of the Act would have permitted fees to be as large as the value of the right conferred, it is somewhat surprising that the conference report adopted such a strict limit on the fee level. See S. REP. NO. 94-416, 94th Cong., 1st Sess. 25-26, 35-36 (1975), reprinted in SENATE COMM. ON COMMERCE & NAT'L OCEAN POLICY STUDY, 94th CONG., 2D SESS., A LEGISLATIVE HISTORY OF THE FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976, at 681, 691 (Comm. Print 1976) [hereinafter cited as LEGISLATIVE HISTORY]; S. REP. NO. 94-711, 94th Cong., 2d Sess. 53 (1976), reprinted in LEGISLATIVE HISTORY, *supra* at 89; H.R. 200, 94th Cong., 1st Sess. (1975), reprinted in LEGISLATIVE HISTORY, *supra* at 796. However, this limitation is expressed only in terms of fees and might not prohibit recovery of economic rent through taxes. See Burke, *Recapture of Economic Rent Under the FCMA: Sections 303-304 on Permits and Fees*, 52 WASH. L. REV. 681 (1977).

Economic Dimensions

normal market forces. In short, the self-regulating characteristics of most free markets are not present for common property resources such as a fishery.

Consequently, economists have suggested that a system of fees or taxes be used to alter relative market prices in such a way that the resulting level of fishing effort approximates that in a market with property rights.¹⁴ As prices rise and fall, so does profitability and, over the long run, total fishing effort. Hence, the ability to manipulate costs and prices¹⁵ through taxes and fees implies the ability to control indirectly the level of effort in the fishery.

For example, if fisheries managers find that the unconstrained level of effort in a fishery exceeds the level compatible with optimum yield, taxes or fees could be used to increase costs incurred by fishermen, thereby resulting in lower profits and a reduced level of effort expended in the fishery. It is possible to find a fee or tax level that would lead to the level of effort necessary to sustain a harvest at the optimum yield determined by fishery managers.

Several advantages result from a fee or taxation approach to management. First, the social value of the resource can be maximized. The optimum annual harvest of fish can be assured at the least cost to society; that is, with the most efficient use of capital and labor. Second, a fee or tax system automatically places the benefits of rational fisheries management in the public treasury, thereby avoiding windfalls for certain elements of the fishing industry.¹⁶ Finally, the tax or fee approach generates information on catch and levels of fishing effort, which can be useful for "fine tuning" the management system.

One disadvantage of this approach arises when fees are imposed on an overcapitalized industry. Fees large enough to reduce effort to de-

14. See, e.g., Bell, *Technological Externalities and Common-Property Resources: An Empirical Study of the U.S. Northern Lobster Fishery*, 80 J. POL. ECON. 148 (1972); Copes, *Factor Rents, Sole Ownership and the Optimum Level of Fisheries Exploitation*, 40 MANCHESTER SCH. ECON. & SOC. STUD. 145 (1972); Gordon, *The Economic Theory of a Common-Property Resource: The Fishery*, 62 J. POL. ECON. 124 (1954); Scott, *The Fishery: The Objectives of Sole Ownership*, 63 J. POL. ECON. 116 (1955).

15. Economists typically view taxes as lowering the price received or equivalently raising the producer's costs.

16. Assuming that effort in an unmanaged fishery will likely be at that level where revenue equals costs and that a rational management program will produce a level of reduced effort, an increase in profit (or windfall) will be realized. See note 2 *supra*. By gathering this excess profit into the public treasury, a fee or tax system not only eliminates potential windfalls, but may also promote self-sufficient administration of the management program.

sired levels will also result in severe financial hardship for the participants in such a fishery.¹⁷ Furthermore, assuming taxation on catch rather than effort, taxes may be difficult to administer and enforce unless a fishery is characterized by centralized marketing and processing.

The value of fee systems in controlling the level of fishing effort (and the allocation of effort among species) should not be underestimated, although considerations of financial hardship may temper the use of fees as a management tool in overcapitalized fisheries. The Act, however, effectively rules out the use of fees as a tool for managing domestic fishing effort by limiting the level of any fees for permits to the costs incurred in issuing such permits.¹⁸

B. Limitation of Entry

Although the Act does not permit the use of fees to control domestic fishing effort, it does allow the establishment of systems for limiting access.¹⁹ It should be noted that many of the crab, lobster, clam, oyster, and other fisheries within the three-mile territorial seas of

17. A fishery becomes overcapitalized once the capacity of the fleet exceeds the minimum necessary to obtain the optimum yield. A fee works to reduce capacity by reducing the earnings of the fishermen to less than they could earn in alternative forms of employment. Some of the fishermen retire their boats and seek jobs elsewhere. In the process the entire industry suffers capital losses on investment; unemployment rises; and wage rates fall. Once the capacity has been reduced, the remaining boats gain in value and wage rates rise, but the level of employment remains permanently lowered.

18. See note 12 and accompanying text *supra*.

19. See FCMA § 303(b)(6), 16 U.S.C.A. § 1853(b)(6) (West Supp. 1977). Although not required by this provision, adoption of access limitation may be necessary to meet other requirements of the Act. The Act specifies that the Regional Fisheries Management Councils must manage each fishery to produce the "optimum" yield. *Id.* § 301(a)(1), 16 U.S.C.A. § 1851(a)(1). The Act defines the optimum yield as the amount of harvest which provides the greatest overall benefit to the nation in terms of maximum sustained yield, as modified by relevant economic, social, or ecological factors. *Id.* § 3(18), 16 U.S.C.A. § 1802(18). The Act also reserves for domestic fishermen that part of the optimum yield that can be harvested by the domestic fleet. *Id.* § 303(a)(4), 16 U.S.C.A. § 1853(a)(4). This will limit the intrusion of foreign fishermen in the conservation zone and ultimately increase the biological abundance of many species. As the profitability of the fishery increases, new domestic investment will be attracted; and in order to assure that the optimum yield is not exceeded, the Regional Councils will have to control the amount of such new domestic investment. This can be done through a continuation of the traditional forms of regulation such as size, gear, area, and season limitations, but economic waste will increase if the Regional Councils rely solely on traditional management tools, because overcapitalization will again occur. The only management alternative available to the Regional Councils that can generate the maximum overall benefit to the nation is the use of entry controls.

the coastal states are not covered by the Act's provision for limitations on entry.²⁰ For fisheries in the 197-mile conservation zone, the Act provides specific criteria that must be considered in granting access.²¹

The intent of limited access programs is to create "shares" in the fishery equivalent to the level of effort necessary to sustain optimum yield. Shares may be created in a number of ways—for example, through the use of fisherman quotas, vessel and gear limits, or licenses.²² The problem with implementing a limited entry program arises not from calculating the optimal level of effort or determining how to obtain it, but rather from the practical difficulties created by the initial assignment of property rights among a large number of competing individuals. An abrupt transition from a freely accessible and overfished state to one of limited access may be neither desirable nor politically feasible because of likely short term dislocations. Rapid transitions can be expected to lead to greater unemployment in the short run than would a more gradual transition relying on labor force attrition through retirement, death, and alternative employment. Thus, it would appear desirable to plan for a slow transition in those fisheries presently characterized by overcapitalization.²³

20. *Id.* §§ 101, 306(a), 16 U.S.C.A. §§ 1811, 1856(a). It may prove difficult for coastal states to enact similar limited entry programs for these and other noncovered fisheries. See F. Cameron, *State and Federal Constitutional Impediments to State Limited Entry Fisheries Legislation: States from Maine to Virginia* (1973) (Marine Affairs Program, University of Rhode Island); H. Knight & T. Jackson, *Legal Impediments to the Use of Interstate Agreements in Coordinated Fisheries Management Programs: States in the NMFS Southeast Region* (1973) (Office of Sea Grant Development, Louisiana State University).

21. The Act states that any fishery management plan may provide as follows:

(6) establish a system for limiting access to the fishery in order to achieve optimum yield if, in developing such system, the Council and the Secretary take into account—

- (A) present participation in the fishery,
- (B) historical fishing practices in, and dependence on, the fishery,
- (C) the economics of the fishery,
- (D) the capability of fishing vessels used in the fishery to engage in other fisheries,
- (E) the cultural and social framework relevant to the fishery, and
- (F) any other relevant considerations

FCMA § 303(b)(6), 16 U.S.C.A. § 1853(b)(6) (West Supp. 1977).

22. See Christy, *Limited Access Systems Under the Fishery Conservation Act of 1976*, in *ECONOMIC IMPACTS OF EXTENDED FISHERIES JURISDICTION* 141 (L. Anderson ed. 1977).

23. During the early years of the Act, United States fleet capacity will be insufficient to harvest the full optimum yield of many species. This presents a unique opportunity for the Regional Councils to implement limited access programs before excessive new entry occurs. Waiting to implement limited access will only exacerbate the problems of controlling fleet size in the future.

Historically, these slow transitions have been accomplished by including all current fishermen in the program and then adopting a procedure for license attrition. When no compensation is given for surrendering fishing rights, it is to be expected that rights will be retained so long as they have some value. If, on the other hand, the fishing rights could be "bought back" by the state, the attrition process could be facilitated greatly. In such "buy back" schemes, fees or taxes would have another distinct advantage. Rather than through forcing the management authority to rely on general public revenues to finance the repurchase of fishing rights, a procedure that might arouse significant political opposition, the repurchase could be financed through fees currently imposed on the fishing industry. Financing "buy back" programs through industry fees has the additional advantage of placing the major cost of effort attrition on the major beneficiary, the remaining fishermen.

A priori reasoning and experience with limited entry programs elsewhere suggest that such programs should generate a considerable economic surplus in the fishery.²⁴ The Act as written does not permit the use of fees to transfer this surplus to the treasury. Individual coastal states could attempt to capture some of the surplus by raising landing fees, but their success would depend upon the simultaneous adoption of increased landing fees by other coastal states. Attempts by individual states to act alone in raising fees would tend to be self-defeating, as fishermen would transfer landings to non-fee states.²⁵

If governmental agencies are unable to tax away the surplus, the question becomes which economic agents within the industry—fishermen, dealers, processors, or retailers—will be able to capture the surplus? In much the same way that a tax may be "shifted" from the shoulders of the person or firm on which it is initially imposed, a surplus may be captured by persons other than those who may appear to be the recipients. In general, economic surpluses can be earned as payments to necessary inputs, the supply of which is constrained by

24. Experience in British Columbia suggests that the economic surplus resulting from entry limitation may be partially dissipated through an expansion in the level of effort of those granted access. Old boats may be replaced by larger and faster boats, new gear may be used, and longer hours may be spent fishing. See Christy, *supra* note 22, at 152.

25. States with long coastlines, such as Alaska and California, would be better able to effect a unilateral increase in landing fees without diverting catches to neighboring states.

Economic Dimensions

regulatory programs, nature, or monopolistic forces. Entry limitation programs would act as a constraint on effort; this suggests that fishermen could be rewarded with earnings in excess of what they could earn in other forms of employment. Good harbors and wharf space represent inputs, the supply of which is controlled by natural forces, and the owners of such facilities may be able to capture some of the surplus by raising dock fees.

Monopolistic forces may also affect the distribution of any economic surplus arising under limited entry. Because the buying, processing, and retailing sectors would continue to have no legal constraints on entry, one is tempted to conclude that competition in these sectors would eliminate any excess profits, with a resulting allocation of the economic surplus to fishermen and other inputs whose supply is constrained by natural forces. But the processing industry may be far from competitive. High transportation costs and traditional patterns of marketing behavior (including contracts with processors) restrict the marketing options available to individual fishermen; processors are thereby able to capture some or all of the surplus in the short run. In the long run, entry of new processors may be constrained by physical limitations on wharf space, suitable processing sites, and other market barriers, with the resulting creation of opportunities for the accrual of monopoly profits in the processing sector.

The presence of a significant economic surplus in the fishing industry would provide strong incentives for cooperative arrangements among fishermen to strengthen their relative bargaining positions.²⁶ Ultimately the market for fresh fish may resemble a bilateral monopoly, as a fishermen's cooperative negotiates with an equally powerful processor. The outcome of negotiations in such situations cannot be predicted. It is possible that the very threat of a fishermen's cooperative may induce processors to integrate backward and buy vessels and entry rights from fishermen.²⁷ It appears that such a backward inte-

26. The legal constraints on bargaining must be examined before one can assess the likelihood of such cooperative arrangements. Several years ago, Maine lobstermen struck for higher prices from processors and were successfully prosecuted for restraint of trade. *See United States v. Maine Lobstermen's Ass'n*, No. 5-76 (D. Me. 1958). On the other hand, west coast salmon fishermen have long bargained collectively with processors.

27. Backward integration of processors into ownership of access rights to raw materials is a relatively common occurrence, especially when the supply of raw materials

gration may be taking place in the domestic tuna industry, as several of the large processors have recently acquired their own fishing fleets.

III. ECONOMIC TOOLS FOR MANAGING FOREIGN EFFORT

The Act creates a dichotomy in the treatment of foreign and domestic fishermen. For foreign fishermen, a quota will be established for each species equal to the difference between the optimum yield and domestic harvesting capacity.²⁸ This quota will then be allocated by the Secretary of State in accordance with specified criteria among foreign nations that apply for fishing permits.²⁹ Foreign nations wishing to fish in the conservation zone will be required to pay "reasonable" nondiscriminatory fees for this privilege.³⁰ Because the fees charged for foreign fishing permits are limited only in that they be "reasonable," such fees can be used as a management tool.³¹ This Part discusses the appropriate magnitude of such fees and the basis upon which they should be assessed.

In principle, fees may be levied on many of the inputs or outputs of the fishing industry, including man-days at sea, vessel-ton-days at sea,

is limited. For example, Mancke observed that the domestic steel industry acquired rights to most of the domestic iron ore deposits during the late nineteenth century, apparently out of fear that an iron ore cartel could be formed. Monopoly profits earned at that time in the steel industry would otherwise have been captured by the iron ore cartel. See R. Mancke, *The American Iron Ore and Steel Industries: Two Essays* (1969) (unpublished Ph.D. dissertation, M.I.T.).

28. FCMA § 201(d), 16 U.S.C.A. § 1821(d) (West Supp. 1977).

29. *Id.* § 201(e), 16 U.S.C.A. § 1821(e), provides as follows:

The Secretary of State, in cooperation with the Secretary, shall determine the allocation among foreign nations of the total allowable level of foreign fishing which is permitted with respect to any fishery subject to the exclusive fishery management authority of the United States. In making any such determination, the Secretary of State and the Secretary shall consider—

(1) whether, and to what extent, the fishing vessels of such nations have traditionally engaged in fishing in such fishery;

(2) whether such nations have cooperated with the United States in, and made substantial contributions to, fishery research and the identification of fishery resources;

(3) whether such nations have cooperated with the United States in enforcement and with respect to the conservation and management of fishery resources; and

(4) such other matters as the Secretary of State, in cooperation with the Secretary, deems appropriate.

30. *Id.* § 204(b)(10), 16 U.S.C.A. § 1824(b)(10).

31. In determining the level of fees, the Secretary of Commerce is directed to consider, *inter alia*, costs of conservation, management, enforcement, and research. *Id.* Reference to such factors, coupled with a general "reasonableness" standard, could enable the Secretary of Commerce to control foreign fishing.

variable or fixed costs of effort, the catch in tons, the value of the catch, and similar parameters. The variables upon which fees could be levied may be categorized as either measures of inputs to the fishery, normally denoted by the term "effort," or measures of output, denoted by the term "catch." It is submitted that fees on catch, if differentiated by species, are generally preferable.

In theory, fees on either effort or catch could protect the longrun productivity of the fishery and reduce or eliminate economic inefficiencies in developing the resource. In actual practice, the choice of fee must be based on the ability of the fee to enhance the overall objectives of the fishery. Among the factors that should affect the choice of fee are (1) the choice of variables used to define effort; (2) the problem of allocating effort by species in a multiple species fishery; (3) the behavior of fishermen with regard to fee-induced uncertainty; (4) the degree to which the fee depends on accurate biological data, the information provided to fisheries managers about the state of the fishery, and the degree of administrative flexibility under changing biological and economic conditions; (5) the costs of administration, surveillance, and enforcement; and (6) whether the fee is non-discriminatory.

A. The Problem of Defining Effort

"Fishing effort" may be defined as a composite index of inputs to harvesting fish. When this index of inputs is constructed in such a way that the weight applied to each input is the same as the price of the input, fishing effort is defined as the total cost of hiring the inputs of capital and labor. For a given expenditure on fishing inputs, the profit-maximizing fisherman finds the highest attainable level of output. The relative proportions in which he uses inputs (his "method of production") will be determined partly by the relative costs of inputs. When effort is so defined and weighted, a tax on effort will produce a lower level of total industry output, but should not cause the methods of production of individual fishermen to be changed.

Unfortunately, effort is difficult to define. Furthermore, any definition is subject to continuous revision as technology changes. Thus, a tax on effort is likely to induce changes in the method of production, leading to higher total costs for society. In effect, a tax based on an incomplete definition of effort alters the relative scarcity of factor

inputs as perceived by the fishermen and encourages them to adopt methods of production that emphasize the use of nontaxed or underweighted components of effort. In other words, such a tax would amount to a regulation-induced inefficiency—the very thing economists hope to avoid.³²

Taxes on effort may also lead to some loss of management control. Specifically, the input substitution effects created by the “new” (taxed) set of relative input prices may serve to invalidate predictions of catch based on the observation of pre-tax catch relationships. The management authority may minimize this impact in the short run by limiting the allowed effort to less than what would be predicted from past catch-effort relationships. Over the longer run, managers will have new data based on the post-tax catch-effort relationship, making the prediction problem less severe. Of course, if technological change necessitates continued revision of the definition of effort, the problem of prediction will remain.

B. Allocation in a Multiple Species Fishery

A multiple species fishery is one having more than one target species present at the same time and in which all target species are vulnerable to the same gear.³³ This discussion assumes such fisheries to be marked by a distribution of species known to the fishermen; that is, the fishermen can target their effort so that the preponderance of their catch will be composed of their most desired species. As effort is freely mobile from one species to another in such a fishery, the managers must be able to influence the amount of effort targeted at each species in order to obtain optimum yields thereof.³⁴ A failure to differentiate among species could have dire results. Our current problems of selective overfishing reflect the relative profitability of harvests of various species.

32. See Wilson & Anderson, *Fee Management Systems for the Northwest Atlantic*, in *ECONOMIC ASPECTS OF EXTENDED FISHERIES JURISDICTION* 195 (L. Anderson ed. 1977).

33. The New England groundfish fishery is an example of such a multiple species fishery.

34. It is possible to estimate the optimum yield of an ecosystem only if the details of interspecies competition and predator-prey relationships are known. Present data bases typically are inadequate for such calculations; therefore, the allocation among species must be fairly crude in practice.

Economic Dimensions

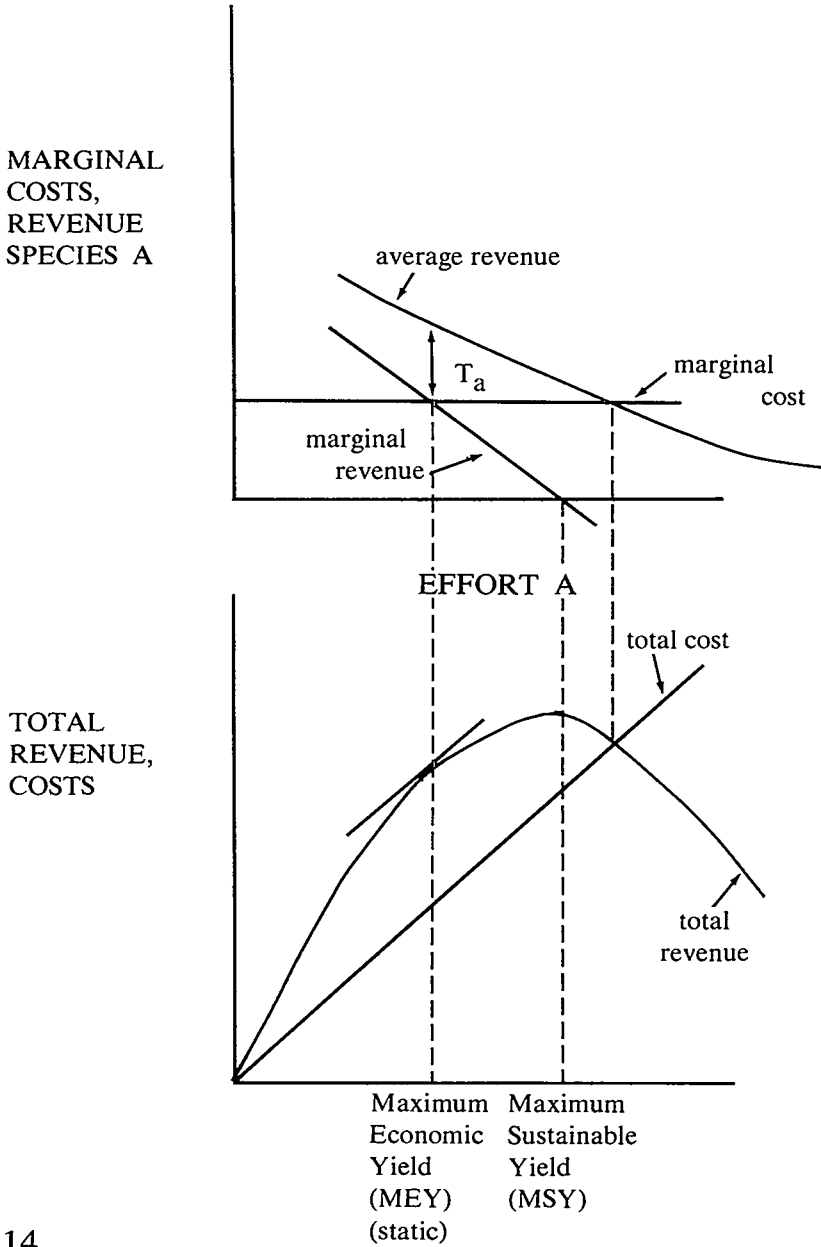
Fees or taxes based on the weight of the catch, the value of the catch, and the total fishing effort are all inadequate for the management purpose of directing relative effort among species in a multiple species fishery. Two management tools that can ensure the desired allocation of effort among species are quotas for each species and fees which vary according to the species caught. Because the allocation of effort in a multiple species fishery will be a continuing management problem for the Regional Councils, it deserves more discussion than some of the other factors that should be considered in the choice and design of fee systems. For expositional purposes we have chosen a static model to support the discussion. Such a model considers only the costs and revenues for harvests in one time period; any impacts on longrun productivity are ignored. Such a model has the twin virtues of simplicity and of yielding correct answers for the more complex dynamic case.

Figure 1 depicts the relevant cost and revenue functions for a two-species fishery. The value of the resource is maximized when the difference between revenue and cost is maximized (effort equals maximum economic yield level). To restrain effort from expanding beyond that level which maximizes the value of the resource, a fee in the amount T_a on each unit of effort directed at species A and T_b on each unit of effort directed at species B must be imposed. Such fees force the individual fishermen to equate their marginal costs of fishing with their marginal contribution to the total industry revenue for each species.³⁵

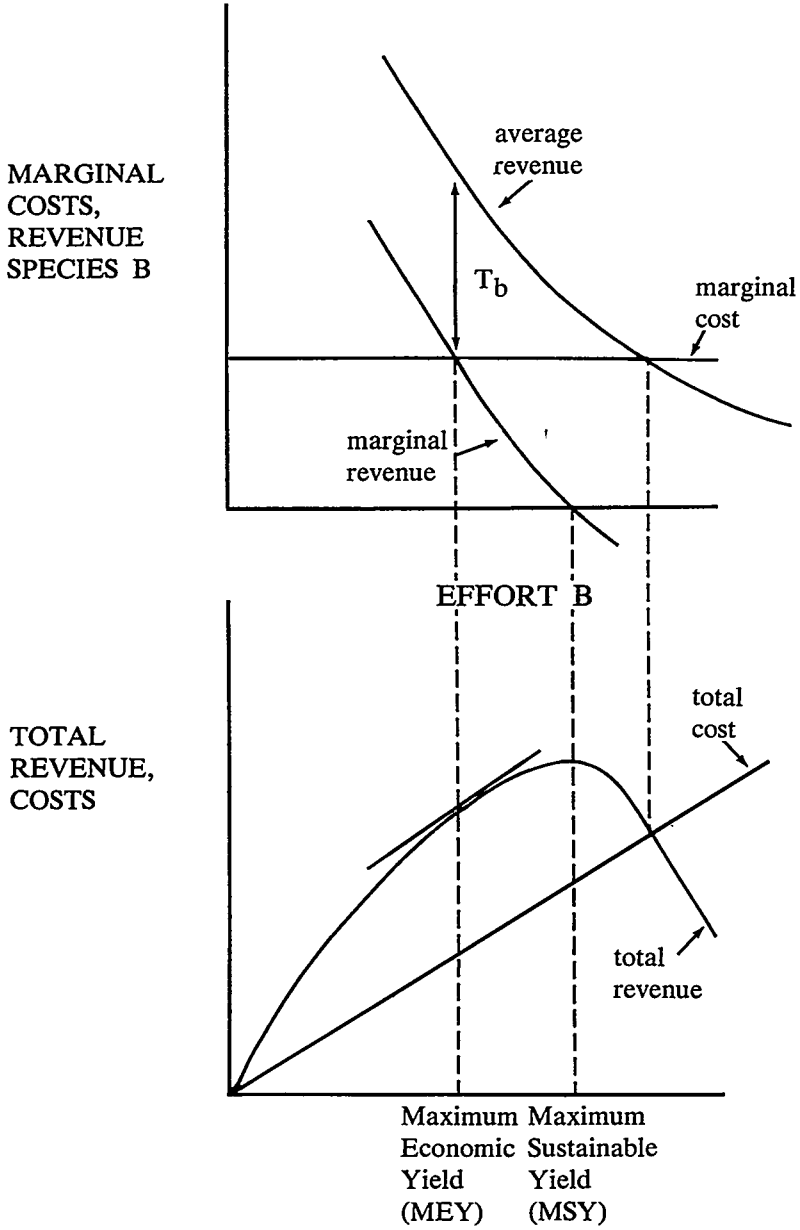
As the figure is drawn, the level of the fee must vary between the two species. The fee on effort directed at species B should be much larger than that for species A. The important feature to be noticed is that to be able to allocate effort properly between the two species, the fee must be based on a difference between revenues and costs. Fees which are based on the weight of the catch clearly fail this test, as do fees applied uniformly to effort irrespective of where it is targeted. Fees based on the value of the catch are better in that they incorporate at least one of the important parameters; nonetheless, such fees make no allowance for differences in the costs of catching the different species.

35. Without a fee, the individual fishermen will continue to increase effort until they perceive that there are no more profits to be earned. This is the level of effort where average revenue equals marginal cost.

FIGURE 1
1a: SPECIES A



1b: SPECIES B



A similar allocation problem occurs with the so-called "by-catch phenomenon." By-catch is usually defined as catch that is incidental to the catch of the targeted species; for example, haddock in a cod fishery. Quota systems usually make allowance for a reasonable by-catch by establishing a separate by-catch quota. When the market price of the by-catch equals or exceeds the price of the target species, however, one suspects that economic factors are as important as biological factors in determining the size of by-catch. To the extent that the problem is an economic one, it is really a question of allocation. Fees on effort cannot be used to attack the problem; fees on catch have the potential, at least, of minimizing the economic aspects of the problem.

C. *Consideration of Uncertainty*

The ultimate allocation of uncertainty³⁶ between the taxing authority and the foreign fishermen may significantly affect the amount foreign fishermen are willing to pay for fishing rights. It may, therefore, be an important test of the desirability of alternative fee systems.³⁷ In the highly simplified model discussed herein a fee or tax based on effort increases the risk borne by individual fishermen relative to taxes based on actual catch. By shifting the burden of uncertainty from fishermen to the taxing authority, a fee on actual catch should result in higher receipts than a fee on the effort which, on average, produces the same level of catch.³⁸

D. *Fees and Biological Data*

Optimum yields and hence the level of fees depend on a thorough knowledge of the fishery ecosystems. The quality of data preferred by

36. We do not distinguish between uncertainty and risk. As we use the terms, uncertainty and risk arise when the outcome of a situation is subject to an estimate of its probability; for example, a 50% chance of getting heads on a coin flip.

37. For an investigation of how fees or taxes based on actual catch and on effort affected the allocation of risk between fishermen and the resource owner, see Wilson & Anderson, *supra* note 32.

38. The allocation of risk may have serious operational consequences. A taxpayer under a high-risk system is likely to view the entire process as either very unfair or as an ill-defined game in which one element—the fee—is capriciously determined. Both perceptions would encourage tax avoidance behavior, leading to a need for greater enforcement and surveillance expenses.

economists is normally unavailable. Biologists can make general statements about the condition of the fishery as well as the direction of recent changes and, in some cases, probably future changes. But most reputable biologists will shy away from the precise estimates of fishery parameters that naive economists demand. Consequently, the optimum yields of any fishery are subject to considerable uncertainty.

Given such uncertainty, preference should be given to a fee system which (1) does not require highly accurate biological information, but (2) generates accurate information on the state of the fishery. Fees on catch, differentiated by species, would be the most useful in terms of producing new information, but they would require the estimation and establishment of separate schedules for each species—more information than would be required for fees based on effort. The method of fee assessment should also be scrutinized with regard to its effect on other anticipated forms of regulation.³⁹

The interaction between regulations and the fee system will take place in two spheres: management and administration/enforcement. In the management sphere, fisheries biologists will use devices such as quotas to try to make harvests correspond with a predetermined level of “optimum” yield. As economists, we may be tempted to argue that a well-designed fee system can better accomplish the same objective, and in principle this is true. As an actual matter, however, our ability to implement such a system is seriously constrained by a lack of adequate data, by a paucity of predictive and reliable models of foreign fleet harvesting, and, of course, by the legal mandate.⁴⁰ Consequently, the most reasonable approach is to ensure that fee systems may be used to reinforce and complement other management tools. This means that fee systems should be designed as if they were the sole management tool.⁴¹ It also means that fees, quotas, and other regulatory tools can be used to backstop one another.

The fee system will also interact with administrative and enforcement devices and thus will affect data collection, inspection, and sur-

39. Continued regulation in the form of quotas with respect to foreign fleets is assured by the method of determining access rights outlined in the Act, as well as by conventional practice among fisheries managers. See FCMA § 201, 16 U.S.C.A. § 1821 (West Supp. 1977). Mesh size regulations and perhaps seasonal closures can also be expected.

40. See, e.g., *id.* § 301(a)(5), 16 U.S.C.A. § 1851(a)(5) (no conservation and management measure “shall have economic allocation as its sole purpose”).

41. In practice, this may not always be possible. Consider the externality posed by the premature capture of young fish. Although it is in the interests of the industry

veillance. As a quota system requires that data be collected on catch by species, there is reason to believe that fees based on catch rather than effort would reduce information and surveillance costs, especially if the measure of effort is a complex system of weights attached to various fishery inputs.

E. Nondiscriminatory Fees

The Act states that fees shall apply nondiscriminatorily to each foreign nation.⁴² Nondiscrimination should mean that each foreign nation pays identical fees for identical fishing rights. But what are identical fishing rights? Is the harvest of one ton of cod by a modern purse seiner equivalent to the same catch by handlines? Do fishing rights depend on the costs incurred by the two fishermen? Charging identical prices to all nations for the rights to harvest a given catch would be nondiscriminatory. If fees were based on vessel costs or other factors which vary from one nation's fleet to another, they could be interpreted as being discriminatory. Thus, fees based on the age or tonnage of a vessel, distance to port, crew size, and so forth could potentially discriminate among nations for the rights to identical quantities of fish and should not be permitted under the Act.

IV. SUMMARY

Congress decision to prohibit the application of fees to domestic fishermen is, in our opinion and that of most resource economists, unfortunate. The prohibition removes or impedes the application of management policies that could lead to more efficient and equitable fisheries. Among these prohibited policies is a system of fees which

to permit the young to survive for harvest at a later date (the rate of increase in value of the young exceeding the rate of return on alternative investment opportunities of the industry), individual fishermen have no such incentive to avoid the capture of young fish. To the individual fishermen a juvenile fish permitted to escape a net is a fish lost forever; any price received for the fish that covers the variable costs of harvest justifies its capture. A system of taxes or fees designed to protect the young fish must be based on the type of gear used rather than the actual landings of fish. That mesh size regulations should be used in conjunction with taxes or fees has been argued in Turvey, *Optimization and Suboptimization in Fishery Regulation*, 54 AM. ECON. REV. 64, 69-70 (1964). See also Christy, *The Fishery Conservation and Management Act of 1976: Management Objectives and the Distribution of Benefits and Costs*, 52 WASH. L. REV. 657 (1977).

42. FCMA § 204(b)(10), 16 U.S.C.A. § 1824(b)(10) (West Supp. 1977).

simultaneously would remove the surplus value and maintain effort at an efficient level. The Act prohibits the use of fees to facilitate the transition and to equalize the burden of costs and benefits in those instances when the management authority attempts to make the transition from overfishing to optimum yield through the application of limited access programs.

As far as the application of fees to foreigners is concerned, the application of fees to catch rather than to effort is preferable. This preference is not absolute, however, and is subject to trade-offs that are difficult to quantify. The primary reason for preferring catch fees is the problem of species allocation in multiple species fisheries. Most important United States fisheries are multiple species fisheries. Selective overfishing has been severe in the past and will continue to be a problem absent a method to allocate catch by species. Fees on effort would not alleviate the allocation problem. Fees on catch, on the other hand, could alter the allocation of catch and make by-catches truly incidental. Benefits of fees on catch, however, can probably be had only through more rigorous enforcement and surveillance. Because the cost of enforcement and surveillance does not relate solely to fees, the operational trade-off concerns only the additional expenses necessary.

Another consideration favoring fees on catch is the likelihood that fees based on effort would be based on an inadequate index of effort and would thus cause inefficiency. Also, our current knowledge of catch-effort relationships and of the production functions of the foreign fleets is so sparse that any attempts to tax effort would probably be confounded by input substitutions by the foreign fleets. Once again the trade-off appears to be between some loss of management control and the expense of exercising control.

Effort-based fees would also involve more uncertainty. The rather simple model presented earlier conforms with the intuitive judgment that fees on catch reduce the risk to the fisherman and presumably raise his willingness to pay to fish. More tentatively, risk-minimizing fee systems may be viewed as more equitable and consequently are likely to require less enforcement and surveillance. There is no trade-off here between fees on catch and fees on effort—fees on catch are clearly superior.

Fees on catch also appear less dependent on accurate biological information and more compatible with other data collection needs.

Finally, the legal requirement of nondiscrimination among foreign fleets is easily satisfied by fees on catch. In sum, there is a strong case for assessing fees on the basis of catch, based on a judgment that fees on catch will lead to more rational management of the resource.

V. POSTSCRIPT

To date the only significant official development has been the publication by the National Marine Fisheries Service of a draft fee schedule for foreign vessels.⁴³ In light of the analysis in this discussion, certain observations regarding this proposed three-part fee structure are appropriate. First, each foreign nation would pay an annual fee for access equal to \$1 per gross registered ton for all vessels for which a permit is requested. An upper limit of \$5,000 would be placed on this fee so that large support vessels would not pay excessively large fees. Second, each foreign nation would be required to pay an amount equal to 3.5 percent of the ex-vessel value of the catch of the various surplus species allocated to that nation. Third, each foreign nation would have to pay for the costs of placing United States observers aboard its vessels. The estimated revenue from each provision is \$2 million, \$19 million, and \$0.75 million respectively. In addition to the fees, each foreign nation would be required to return to the sea any incidental catch of species not allocated to that nation.

A fee on vessel size should be viewed as a fee on one component of fishing effort. The analysis of this paper demonstrates that fees on effort are generally undesirable. Perhaps the most obvious flaw in this particular measure is that it creates an incentive for foreign nations to reduce the taxed factor, which is boat size, and increase the untaxed factors, including crew size, gear carried, vessel speed, and the like. Fortunately, the distortions in efficiency created by this particular component of the fee should be small in view of its nominal size.

The fee on catch is to be based on estimated ex-vessel value of the catch allocated to each nation. Such a provision is desirable, and it is proper that this portion of the fee predominates over the portion based on effort. The only apparent weakness of fees based on the value of catch is that they are inadequate for guiding effort among species in a multiple species fishery.

43. See 41 Fed. Reg. 55,925-26, 56,879 (1976).

Economic Dimensions

Because fees will be assessed as a percentage of value, and value will vary from species to species, the regulations properly create a fee schedule differentiated by species. Nevertheless, it would be possible to alter the fee for each species in line with the biological state of the species (higher percentages of value for overfished species, perhaps lower for underfished) and thereby use the fee system to reinforce the species quota system. If the quota system proves as deficient under our jurisdiction as it has been under international jurisdiction, this use of fees will probably be required.

The treatment of the incidental catch is truly unfortunate. The requirement that any incidental catch not covered by the permits be returned to the sea will result in an unnecessary waste of valuable resources. If the incidental catch could survive the experience of being caught and released, there would be no objection to this regulation. Regrettably, most fish cannot be expected to survive such treatment, with the result that resources which are valuable as a source of protein for mankind will be wasted. Rather than returning these fish to the sea, it is preferable that their full economic value be realized. An alternative would be to give the foreign vessels a choice between (1) delivering the incidental catch to United States ports and (2) retaining them aboard and making an additional payment of some amount less than the wholesale value of the fish in world markets.