The Evolution of Fisheries Management Philosophy

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ABSTRACT—The attitudes governing the management of fishery resources have evolved in important ways during the past 125 years. In 1850, the concept of inexhaustibility stood firmly entrenched, buttressed by tradition, history, the rights of freedom, an untested logic, and Thomas Henry Huxley. The increased fishery exploitation wrought by population increases and technological advances so depleted the stocks of valuable fish that by 1900 the concept of inexhaustibility was forced into submission. The logic of exhaustibility arose in response, and the simultaneous search for biological information and simple management solutions produced a predominant interest in maximizing the physical yield from aquatic environments. The undercurrent of nonbiological forces grew steadily as biologically oriented management failed to produce satisfactory benefits from fisheries resources. The emergence of numerous other criteria relevant to management has fostered the realization that the goal of fisheries management is to optimize society's total benefit from the use of natural resources.

The profession of fishing is among the world's oldest; the profession of fisheries management, however, still labors in adolescence. Concern for the management of fisheries has emerged basically since 1850 and the ideas embodied in fisheries management have evolved greatly between 1850 and the present. Fisheries professionals currently praise the notion of "optimum sustainable yield" as a desirable objective for fisheries resource management. They contend that this viewpoint represents a major development in management philosophy. My intention in this paper is to provide a brief historical survey of the evolution of fisheries management philosophy since approximately 1850, tracing the factors which have led to the optimum sustainable yield philosophy. I have relied almost exclusively upon literature concerning the British Isles and the United States, since that information is most readily accessible and provides a substantially continuous record.

THE DEBATE OVER INEXHAUSTIBILITY

Before approximately 1850, the fisheries of the oceans and large inland lakes were generally considered inexhaustible (MacKenzie, 1860; Whitaker, 1892). Fisheries had been pursued near the shores of oceans and lakes for centuries, and the mysterious waters seldom failed to supply the resources which were sought. This supposed infinity of fishes was one of two facts considered important when Hugo Grotius founded the principle of "freedom of the seas" in 1608 (Christy and Scott, 1965). On the one hand, establishing boundaries on the high seas and enforcing those boundaries was a formidable task. On the other hand, if fishes and other resources could be harvested without limit, as seemed reasonable at the time, maintaining exclusive rights to oceanic resources was unnecessary.

It is relevant, however, to note that not all fisheries were considered inexhaustible. The reality of depleted fisheries in small bodies of water, such as rivers and smaller lakes, had long been recognized. Restrictive regulations existed in the British Isles since at least 1278 (Graham, 1956) and were enacted in North America not long after the landing of the Pilgrims (Idyll, 1966). Human intervention had become an obviously great force in some fisheries, such as in the rivers of the St. Lawrence basin where destructive fishing and dams which spanned the entire breadth of rivers caused declining salmon fisheries (Nettle, 1857). These obstructions permitted the capture of all fish or prohibited the migration of fish to spawning grounds. The supposed difference between oceanic and inland fisheries is further illustrated by the opinions of Thomas Henry Huxley, one of the most eminent scientists and most influential commentators on fisheries during the later nineteenth century. Huxley, while espousing the effective inexhaustibility of oceanic resources in 1860, testified that excessive fishing and poaching had depleted the salmon fisheries in Scottish rivers (Great Britain, 1860).

The first to question the inexhaustibility of coastal fisheries were British fishermen, who frequently complained of depleted fisheries before 1850 (Johnstone, 1905). The complaints were usually accompanied by accusations that competing types of fishing gear caused the alleged depletions. A new technique called "trawling" was the most popular scapegoat and various politically-oriented restrictions on trawling and other methods were

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enacted before 1850 in both the British Isles and the United States.

The dissatisfaction of British fishermen intensified, and precipitated the appointment of various Royal Commissions to more fully investigate the status of fisheries. The most influential was the commission of 1863, comprised of James Caird, G. Shaw-Lefevre, and Thomas Huxley. The commission heard testimony of 3 years and produced a 1,588-page report which verified the traditional view of inexhaustibility (Great Britain, 1866). The commission cited the following reasons as the basis for their conclusions. The oceans were enormous, almost beyond comprehension, and since the small regions then under exploitation were very productive, the reservoir of unexploited areas of supposedly equal productivity promised an effectively infinite supply of fish. The natural predators of fish were so numerous and the human harvest was so small in comparison that fishing was an insignificant cause of mortality and could never alter population sizes. Fish, moreover, were known to be enormously fecund, such that the harvest of even large numbers of fish could be offset by the egg production of only one female. Concern about maintaining a large broodstock was, therefore, unnecessary. The commission's analysis of catch statistics, extracted from railway shipping records, revealed that total supplies of fish were actually increasing, not decreasing, and they reasoned that stable prices indicated no depletion of the stocks. This commission, along with most others, emphasized total catch, and discounted as biased the testimony by fishermen that their individual catches (the catch per unit of effort, CPUE) were declining. Since fishermen could operate wherever they wished, a decreased supply of fish in one area would merely cause a change in fishing grounds. Thus profitability of fishing would prevail, and depleted local stocks would recuperate naturally, without regulatory interference (McIntosh, 1899).

The belief in inexhaustibility was also desirable from a practical viewpoint. If governments admitted that fisheries had been or could be depleted, avoiding that depletion would necessitate restrictions on fisheries, and restrictions were undesirable. Fishing was a complex industry in which the same stocks were exploited by fishermen from many nations using many techniques. Effective regulations would confront the complex problems of fairness and political reality; it was more expedient to avoid regulations altogether. Most importantly, regulations infringed upon personal liberty, and without strong evidence that regulations would help, rather than hurt, the fishermen, acts to limit their personal freedom were considered crimes against humanity. This attitude was aptly summarized in the report of an earlier commission, of which Huxley was also a member, assigned to investigate the atrocities of the herring trawl:

> "Under such circumstances, the herring fishery should not be trammelled with repressive Acts, calculated only to protect class interests, and to disturb in an unknown and possibly injurious manner the balance existing between the conservative and destructive agencies at work upon the herring. If legislation could regulate the appetities of cod, conger, and porpoise, it might be useful to pass laws regarding them; but to prevent fishermen from catching their poor one or two per cent. of herring in any way they please, when the other ninety-eight per cent., subject to destructive agencies, are poached in all sorts of unrecognized piscine methods, seems a wasteful employment of the force of law." (Great Britain, 1863.)

The British Parliament accepted the opinions of the 1863 commission and, in 1868, abolished all regulations regarding the capture and sale of marine fishes. This action set two standards which characterized future fisheries management policies. First, the idea that regulation of fisheries was both unnecessary and impractical became the cornerstone for the decades of laissez-faire management which followed. Second, the importance attached to the personal liberty of fishermen became an obstacle which has inhibited changes in the management of the fishery industry.

Despite the apparent conclusiveness of the 1863 commission, the debate over the depletion of fisheries had hardly begun. Concern in Russia precipitated a series of official expeditions which investigated the condition of fisheries throughout the country. A major expedition to the Barents Sea in 1851 confirmed that fisheries for cod and other species had deteriorated and required regulation (Borisov, 1960). The German government established the Kiel Kommission in 1870 as a scientific organization to study all aspects of the marine environment which related to fisheries. In 1871, the U.S. Congress inaugurated the U.S. Commission of Fish and Fisheries, which was designed to "prosecute investigations on the subject (of the diminution of valuable fishes) with the view to ascertaining whether any and what diminution in the number of the food-fishes of the coast and the lakes of the United States had taken place; . . ." (Goode, 1886). Popular accounts of British fisheries continued to expound the reduced catches per unit of effort (Fig. 1; Bertram, 1873). Responding to continued clashes among fishermen in the North Sea, the British Parliament called another commission in 1878. The commissioners used the same logic and data which had convinced Huxley, however, and echoed earlier conclusions of inexhaustibility.

The debate congealed at an International Fisheries Exhibition held in London in 1883. An impressive audience attended, and the 15 volumes of official literature attest to the contemporary influence of the proceedings (London. International Fisheries Exhibition, 1884). In his inaugural address, Thomas Huxley espoused the traditional view of laissez-faire and emphasized the injustice of regulations which were inflicted without proven need or benefit. Other British contributors concurred with Huxley's position, as did G. B. Goode, head of the U.S. Fish Commission. Moreover, the United States proclaimed its intention to avoid any need for future restrictions by using artificial propagation to assure infinite fish stocks.

The harbingers of exhaustibility were also well represented and vigorously rebutted the established viewpoint with the following arguments. If fisheries were indeed inexhaustible, what was the need for artificial propagation? The enormous fecundity of fishes provided no vast excess of spawn, but was nature's way of

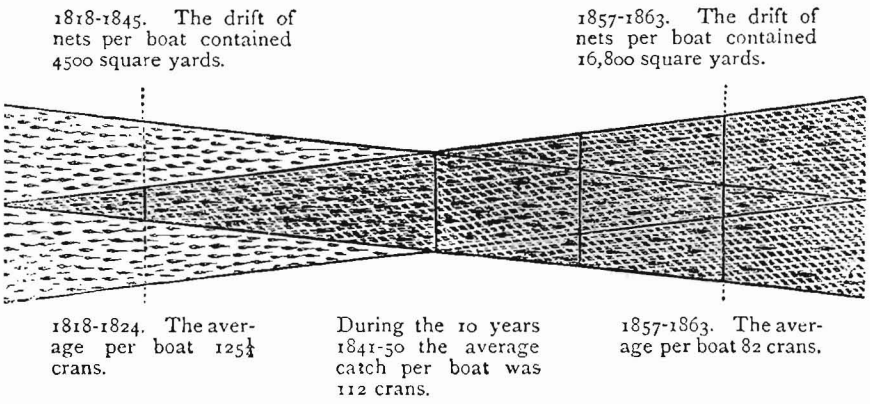


Figure 1.—The declining abundance of herring in Scottish coastal waters is illustrated by the decreasing catch per effort of Scottish gillnet fishermen, 1818-63. Reprinted from Bertram (1873).

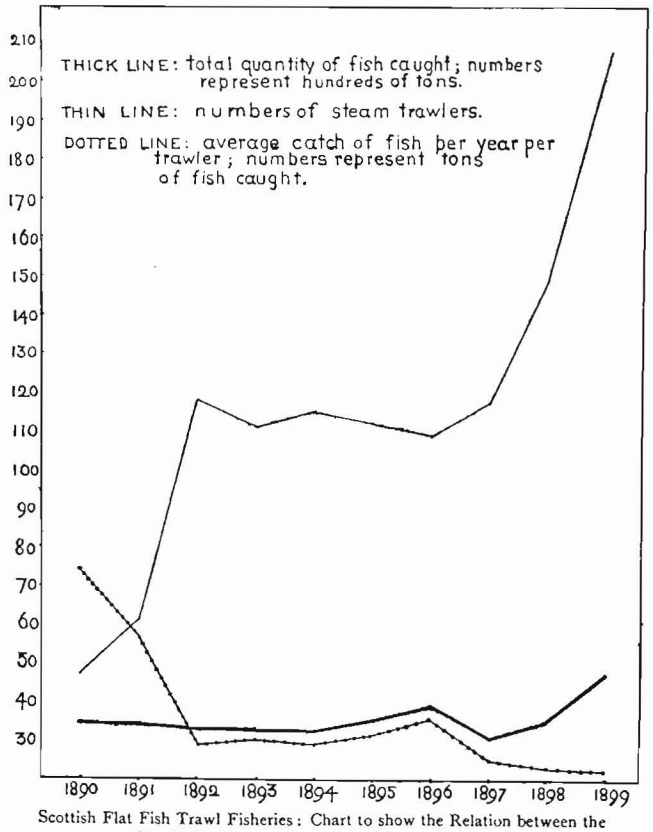
assuring the production of just two more adults in the face of natural mortality. The fishing gears which destroyed these supposedly extra immature fish, therefore, were not innocuous, and the capture of fish before they had spawned and contributed to future populations was illogical. The fact of localized depletion was real, as evidenced by reduced catch per unit of fishing effort. The refusal of governments to react to such depletion caused a change in fishing grounds that reduced the welfare of fishermen by increasing the costs and dangers of fishing. The debate was lively, and despite the aura of Huxley's presence, the exhibition represented a victory for the proponents of exhaustibility (Graham, 1943).

Changes in the technology of the fishing industry and consequent changes in attitudes toward fisheries resources began to accelerate during this period. The supposedly infinite Great Lakes fisheries became imperiled by the employment of pound nets after 1850 and by freezing processes after 1868, which changed local fisheries into a rapidly expanding industry (Whitaker, 1892). Another British commission met in 1883, and this time acknowledged in a very limited way the decline of some fisheries (interestingly, Huxley was also a member of this commission, but ill health prevented his participation). Between 1885 and 1900, the coastal fisheries of the North Atlantic were revolutionized by the otter trawl and the widespread use of steam for power (Johnstone, 1905). North Sea fisheries had so obviously deteriorated that an organization of commercial fishermen voluntarily closed certain grounds between 1890 and 1892. Despite dramatic increases in the effectiveness of the British trawling fleet, the total annual catches increased little, if at all (Fig. 2; Johnstone, 1905).

A British Select Committee fully acknowledged the reality of depletion in 1893. The committee blamed the declining catches on the destruction of immature fish and urged action to prohibit the sale of fish below specific sizes. Their recommendations, however, fell of deaf ears in Parliament and produced no action. Nevertheless, the position of the 1893 Select Committee illustrates the general attitude at the turn of the century: not only were oceanic fisheries exhaustible, but they were rapidly being exhausted (Garstang, 1900).

BIOLOGICAL MANAGEMENT FOR MAXIMUM SUSTAINABLE YIELD

After the turn of the century, the exhortations of both popular authors and fisheries personnel generated extensive agreement on the general



Scottish Flat Fish Trawl Fisheries: Chart to show the Relation between the Total Flat Fish caught and the Means of Capture.

Figure 2.—The declining abundance of flat fishes from 1890-99, is illustrated by the stability of total catch while the fishing fleet greatly expanded. Average catch per effort decreased steadily, except in 1895 and 1896, when otter trawls first replaced beam trawls in general use. Reprinted from Johnstone (1905).

causes of depletion. Overfishing and improper fishing accounted for the depletion of oceanic fisheries. A wider variety of causes had injured anadromous and freshwater fisheries, including overfishing, improper fishing, and habitat disruptions such as dams and pollution (Blackford, 1916). These generalizations lost their force, however, when the questions focused on specific problems and solutions. Demands for fisheries products and the exploitation and depletion of fisheries had developed within a complex framework which depended extensively on local characteristics. Fisheries had been managed with the local "stock" as the unit of consideration, and regulatory jurisdiction had been predominantly local. Similarly, attitudes toward fisheries resources have not evolved along a simple chronological path, and the portrayal of one in this paper would be misleading. This section, therefore, emphasizes the biological aspect of management, and the following section examines other coexistent nonbiological criteria which have influenced fisheries management.

The debate concerning the destructive effects of trawling and using small meshed nets was especially active and persistent in Britain. Opponents of trawling argued that the trawls disrupted the sea floor and destroyed fish eggs and larvae; proponents countered that the damage, if any, was temporary and that most fish eggs floated near the surface (Johnstone, 1905; Howell, 1921). Opponents of small meshes cited the capture and death of unmarketable fish, while others argued that all nets, regardless of mesh size, collapsed during towing and allowed no fish to escape (Russell, 1942; Graham, 1943). One conclusion, however, with which everyone agreed was that no one knew very much about the subject (Howell, 1921). Fish lived in a foreign environment, and the extent of knowledge regarding most species was confined to fishing methodology. The statistics used by analysts of fisheries were generally indirect (for example, railway shipping records) and characteristically lacked the definition required to draw detailed conclusions. In a pioneering attempt to resolve the question of trawling effects, the Scottish Fishery Board experimentally closed a section of coastline to trawling in 1886, and hired a naturalist to collect and interpret data. The results, however, were ambiguous, and were used as evidence proving both no effects of trawling (McIntosh, 1899) and ill effects (Garstang, 1900). The absence of knowledge which had been intellectually deplorable in the preceding century became a critical gap as management of stocks was solicited in the early 1900's. Consequently, calls for biological research were issued simultaneously with appeals for the management of fisheries.

A logical rationale for regulating fisheries, however, had evolved prior to any dramatic outcomes of fisheries research. The fact that depletion had occurred as fishing pressure increased was empirical evidence that instead of infinite effort generating infinite yields, there was some intermediate effort which yielded the greatest amount of fish. A typical argument was a logical analogy to the "capital-interest" system, wherein the highest yield occurred when all the interest (annual production) was used, but further exploitation of the capital (the stock) lowered yields in the future (Bertram, 1873).

The analogy failed to explain what factors affected the capital supply of fish or how they might be managed. The experience of the previous century provided two general answers. First, an adequate supply of eggs was necessary for future generations; therefore, fish should not be caught before they spawned at least once. Second, small fish would continue to grow if allowed to live to a somewhat older age; hence, the yield in weight could be sustained only by ceasing the capture of small fish. This rationale suggested that length limits for landed fish or minimum mesh size restrictions were appropriate ways to assure supplies of both eggs and large fish. Such regulations were recommended by the British Select Committee of 1893 (Johnstone, 1905) and have become standard methods of fishery regulation.

A more direct approach to management was to limit the total annual catch of fish by means of a quota system. This could ensure that the harvest would not exceed the annual production, and in cases where rebuilding the stock was necessary, some production could be reinvested as capital stock to provide for increased future yields. Empirical evidence that reduced fishing allowed recuperation of stocks emerged when fishing effort was necessarily reduced during World War I. The catch of plaice in the North Sea, for example, increased for a few years after the war, as the recuperated stocks were again heavily exploited (Fig. 3; Russell, 1942). The United States and Canada have applied catch quotas throughout the regulation of the Pacific halibut fishery. In 1932 a joint commission empirically set an annual quota, which was then gradually increased in subsequent years (Graham, 1956; Bell, 1970). With the quotas in effect, the stock of halibut, total annual catches, and catches per unit of effort all increased. Contemporaries judged the management program a great success, and envisioned through it the promise which biological management held for the successful exploitation of the sea (Russell, 1942).

More theoretical explanations of depletion were developing in concert with these more-or-less logical and empirical ideas. In Russia in 1918, Baranov published a mathematical model which related the size of fish stocks to the intensity of fishing. Baranov's theory, however, was disdained in Russia (Borisov, 1960) and was largely unavailable to the western world. During the 1930's, E. S. Russell developed the now classical "Russell's equation," which linked stock abundance to additions via growth and recruitment and to losses via natural and fishing mortality (Russell, 1942). The outcome, therefore, of both empirical and theoretical reasoning has evolved into the generalization that for a stock of fish there exists a maximum sustainable yield (MSY) and an associated level of fishing which will achieve that yield. It is important to note that this generalization concerns total catch, which is a biological phenomenon related to the stock, rather than CPUE, which is a phenomenon associated with the fishermen. This predominantly biological inclination of fisheries research and administration has persisted throughout the development of fisheries management.

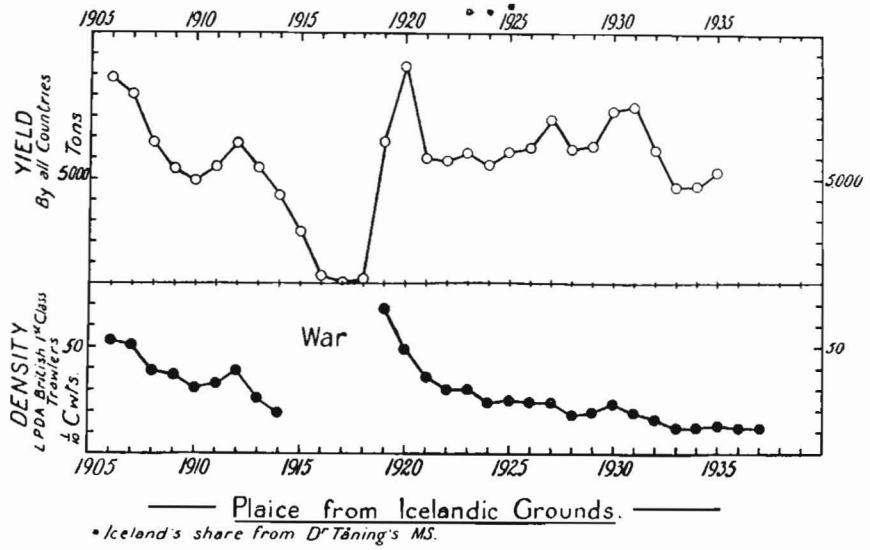


Figure 3.—The recuperation of plaice stocks during the cessation of exploitation is illustrated by increased total catch and catch per effort in the years immediately following World War I. Reprinted from Russell (1942) by permission of Cambridge University Press.

The realization that maximum sustainable yields exist, however, is different from the acceptance of MSY as an appropriate goal for fisheries management. Why did MSY become the principal goal of fisheries management following the turn of the century? First, biologists were charter members of the fisheries management profession. The depletion of fish stocks as a precursor to management caused simultaneous concern for both the fishing industry and the biology of fishes. Biologists, rather than representatives of industry or politicians, generally comprised agencies created to investigate fisheries, draft recommendations, and even enact regulations (Tomasevich, 1943). The first North American Fisheries Policy, ratified by the American Fisheries Society in 1938, decreed that fisheries management should be devoid of political pressure and that biological facts should be the primary basis for management. Moreover, fisheries had prior rights wherever fish occurred, and any loss of fisheries potential should be fully mitigated (Wickliff, 1938).

Second, MSY was an objective criterion. The fisheries regulations which existed in the nineteenth century had been enacted in response to subjective political pressures, and, as Huxley emphasized, were in no way beneficial to fisheries. Maximum sustainable yield contrasted as a logical, scientific foundation for a type of management which focused on the fish, not on the fishermen. Management for MSY could assure the continuation of the stocks and the increase of total catch, as illustrated for Pacific halibut. As a theoretical objective, MSY avoided the myriad problems now labelled "social, political, and economic."

Third, maximizing the food resource was a worthy public goal. Managing fish stocks to attain maximum production was identical to managing agricultural lands for maximum production (Bower, 1910). Either underutilizing or overutilizing a stock of fish wasted food which was essential for human welfare. This rationale pervades the fisheries literature between 1910 and 1920, when providing wartime foodstuffs was a patriotic, as well as a humanitarian, concern.

For these reasons, the objective of attaining MSY's became the avowed goal of fisheries management. In the USSR, the revolution of 1917 established maximizing the production of food as a primary political goal and eliminated many of the social, political, and economic problems which complicate fisheries management in capitalistic societies. The goal of MSY has consequently enjoyed considerable success within the large inland lakes and reservoirs which are important sources of Soviet commercial fish production (Borisov, 1960). Maximum sustainable yield has been the implicit or explicit goal throughout the history of Pacific halibut management (Bell, 1970). The 1958 Law of the Sea Conference in Geneva adopted MSY (although the wording states "optimum," the intent is maximum) as the appropriate objective of international fishery management (Christy and Scott, 1965).

NONBIOLOGICAL CRITERIA FOR MANAGEMENT

Despite its prevalence in fisheries literature, biological management for MSY has witnessed only limited implementation. Maximum sustainable yield is singularly attractive to biologists because it is biological and scientific, devoid of the complications associated with human factors. The nonbiological factors involved in establishing management policies are no less important than the biological factors, and the aloofness of MSY has been a liability, rather than an asset, for its implementation. Nonbiological criteria have gradually become more relevant during this century as the exploitation of fisheries has expanded.

The inability of MSY to represent acknowledged attitudes surfaces immediately in the conflict between sport and commercial fisheries. The importance of sport fishing for psychological well-being has been likened to that of the finer arts, and expositions of the benefits of angling appeared side-by-side with exhortations for maximizing food production (Perce, 1910). Nevertheless, the importance attached to maximizing food production, especially during World War I, allowed commercial fishing to devastate the stocks of some sport fishes. The Black Bass Act of 1926 and subsequent legislation represented victories for sport fishing by protecting highly regarded game species from commercial exploitation (Stroud, 1966). Sport fishing is regarded by some people in the United States as a more desirable allocation of resources than commercial fishing because the recreational benefit extends to more people (Hazzard and Voigt, 1957).

The relevance of nonbiological, especially economic, criteria for commercial fisheries management was realized very early in the evolution of fisheries problems. It was commercial fishermen themselves, concerned about reduced

profitability, who aroused the official machinery of commissions and committees in the nineteenth century. A predominant figure in the modern exposition of economic considerations was Michael Graham (1943), who penned the "Great Law of Fishing" in his book "The Fish Gate": unregulated fisheries become unprofitable. This book represents a unique analysis by a biologist of the entire spectrum of the fishing industry. Graham concluded that all aspects of fisheries required regulation, especially the amount of fishing effort applied to achieve a given catch.

The importance of nonbiological factors in the management of the Pacific halibut fleet attracted attention at about this time. The quotas applied to that fishery had served the intended functions, but also caused the normal fishing season of 9 months to shrink regularly as competition increased. The constriction of the season was initially cited as an indication of enlarged stocks (Russell, 1942), but its continued reduction more importantly signaled the build-up of excessive capital in the industry. Other effects included instability in the associated processing industry and local stock depletions where capture was easiest early in the season (Crutchfield and Zellner, 1962). In 1952, the halibut convention was modified to spread the catch more evenly in both time and space (Graham, 1956).

Beginning in the early 1950's, a large body of economic literature has accumulated which portrays fisheries as classical examples of common property resources. The essential features of such a resource are that no one pays for its use and no one assesses the yields derived from additional units of effort. Consequently, as long as any profit is being made, additional effort will be expended, either by more fishing per fisherman or by more fishermen, until profits as a whole decline to zero. Economists argue that the intended goal of the fishing industry is not to maximize the gross product, which is analogous to the physical yield of fish, but to maximize the net economic revenue, that is, the profit. Even from a theoretical standpoint, the overall goal of society should be to allocate all its resources to maximize total benefit; maximizing the physical yield of fisheries, and then squandering that benefit by applying excessive effort to its capture is foolhardy (Crutchfield and Pontecorvo, 1969). The proper economic management of fisheries should regulate harvest and effort to achieve maximum net economic revenue (Christy and Scott, 1965).

The incorporation of an economic criterion into fisheries management, however, carried an important corollary: economic principles only apply where property rights exist (Christy, 1969). The various forms of property rights all encounter significant social and political problems, including proper allocation of the resource among nations, regions, and individual fishermen, and the displacement and adequate compensation of those denied access. Economic management of fisheries, therefore, opens the Pandora's box of problems which the biological criterion ignored.

A development analogous to the formalization of the economic criterion for commercial fisheries has also occurred for recreational fisheries. The awareness that "sport" should be the emphasis in sport fishing (Davis, 1938) has become well established in fisheries management. The accelerating urbanization of the U.S. population and the corresponding shrinkage of available fishing resources have recently spotlighted concern for the quality of that sport. In 1969, James T. McFadden, relying on concepts from commercial fisheries, added the criterion of "aesthetics" to the traditional curve of physical yield versus effort (McFadden, 1969). Aesthetics in this case included the entire range of nonharvest values associated with sport fishing. McFadden deduced that available techniques could accommodate any level of sport harvest or effort; the challenge to management was to ascertain the values of the public and incorporate those values into management objectives. The recognition that the subjective criterion of "quality" is relevant to sport fishing invites political, social, and economic considerations into the formerly biological field of sport fisheries management.

Even within the realm of biology, MSY suffers recent attacks by what might be termed an ecological criterion. The basis for MSY and most economic analyses has been the "stock"; a stock of fish, however, does not live in a vacuum, isolated from other components of the ecosystem. A few examples will illustrate the breadth of this criterion.

The majority of fishing techniques in use today catch more than one species of fish at one time. Consequently, although reasonable regulation may be prescribed for one method aimed at the species in question, incidental catches of that species by fisheries aimed at other species may substantially alter the intended total catch. The reality for multispecies fisheries is that exploitation of all the stocks for MSY is impossible (Gulland, 1968). The biological associations among species are critical determinants of population sizes. Thus, if both predator and prey species are commercially valuable, exploitation of the prey species at MSY may reduce the yield from the predator species. Human selectivity is also important because demands for fishery products usually specify certain sizes, life stages, or species of fish as the most desirable. Such characteristics do not necessarily correspond to those accompanying MSY.

The influence of politics in fisheries management has been an important ingredient since management was first envisioned, and has usually run counter to the ideas of both biologists and economists. When a British commission finally saw the need for management in 1893, Parliament ignored its recommendations. The biologically based recommendations made between 1902 and 1925 by the Plaice Committee of the International Council for the Exploration of the Sea succumbed to contemporary political problems (Russell, 1942). Whereas the 1958 Law of the Sea Conference accepted MSY in a formal resolution; that resolution has never been ratified by all the participating nations. The necessity for fisheries personnel to address politicians in more persuasive and less scientific terms has been voiced throughout this century (Evans, 1907; Mollan, 1920; Cushing, 1972).

THE PHILOSOPHY OF OPTIMUM SUSTAINABLE YIELD

The existence of these additional criteria for management of fisheries

resources does not mean that each new criterion was smoothly absorbed into the existing realm of fisheries management. Only recently have the various disciplines associated with fisheries begun to accept the relevance of all criteria as the unified basis for achieving optimum sustainable yield (OSY). In 1974, the International Association of Game, Fish and Conservation Commissioners and the Sport Fishing Institute resolved that OSY should replace MSY. The American Fisheries Society did likewise in 1975. What OSY philosophy entails and where the formal recognition of OSY leads fisheries management are the subjects of this section.

The significance of McFadden's (1969) thesis, apart from the formalized treatment of aesthetics, is his admission that the addition of quality factors to effort-yield graphs reveals nothing about what the objectives of management should be. Graphs merely describe the relationships between various related parameters. Similarly, Royce (1975) expressed the opinion that concentration on MSY represented a perversion of the function of a model. The yield-effort model describes the resultant yields over a broad range of efforts; the fact that one of those yields is a maximum is a property of the model, and in no way implies that achieving that maximum is desirable.

This realization represents a primary impact of the OSY philosophy. It severs fisheries management from the grasp of any established discipline, and greatly expands the framework for decision-making. The American Fisheries Society, in a revised American Fish Policy in 1954, deleted the priority right of fishing, and admitted that fishing was only coequal with other aspects of the multiple use of aquatic resources (Hazzard, 1954). The recent American Fisheries Society symposium which examined OSY (Roedel, 1975) nowhere prescribed what the "optimum" is, but only expressed the relevance of political, social, and economic criteria for decision making.

By this admission, fisheries management subjugates itself to the overall benefit of society as society, not fisheries science, perceives it. In some cases, the importance of fisheries might be judged inconsequential in relation to needs such as mineral exploitation, waste disposal, or the maintenance of favorable diplomatic relations. The provision of broad recreational opportunities might justify the abandonment of sport fishing in some waters in favor of uses such as swimming or waterskiing. Such decisions based on OSY philosophy are rational dispositions of fisheries resources.

The management of Murray Reservoir in San Diego, Calif. (Ball, 1967), exemplifies this aspect of OSY. Murray Reservoir is one of a series of reservoirs built in the early 1900's to store water for San Diego consumers. Until 1950, the reservoir was fed by surface run-off with sufficient nutrient content to support a productive warmwater fish community and a vigorous fishery. After 1950, nutrient-poor water diverted from the Colorado River became the major input to Murray Reservoir, and aquatic plants were removed to reduce water loss from transpiration. In consequence, the fish production declined, and the fishery dwindled to a few thousand anglers per year. A strictly biological approach to this situation is the addition of fertilizer to enhance fish production. Fertilization, however, conflicts with the goal of providing high-quality municipal water. An alternate solution was begun in 1959, with the establishment of a "put-and-take" rainbow trout fishery during the 6-month season when water temperatures permitted trout survival. The response was an annual use (1962-65) by more than 50,000 anglers who removed 92-96 percent of the stocked trout. Ball (1967) concedes that the approach is not "fishery management per se." Under the precepts of OSY, however, such a program is fisheries management in the broad context of societal goals.

The goal of maintaining at least some profitability in commercial fisheries compels the reevaluation of the traditional freedom of the seas. On 13 April 1976, President Ford signed the Fishery Conservation and Management Act of 1976, which creates a 200-mile U.S. fishery conservation zone as of 1 March 1977; similar inclinations exist in other nations. Other alternatives include private monopolies, limited entry systems, or a single international fisheries corporation. Whatever method is tendered, the traditional rights of fishermen diminish. Whereas the rights of fishermen have been sacred in the past, OSY philosophy requires that this aspect be placed into perspective with other societal criteria.

An additional corollary of OSY deserves separate mention. Throughout the evolution of the discipline, fisheries management has focused almost exclusively on fishing. Some fish species, however, appeal to neither sport nor commercial interest, and some waters, such as high alpine lakes, are naturally fishless. The self-styled mandate of fisheries management has been to stock those barren waters with sport fishes, and to replace nongame species with game species. For example, the typically complete protection afforded the biota and environment in U.S. national parks does not extend to individual fish or to fish faunas (Wallis, 1960). The charter which authorized national parks also authorized angling, and native faunas and naturally fishless waters have been altered in consequence. Even discounting the pressures of modern multiple use, bodies of water and their fish faunas have values separate from fishing. A countercurrent emphasizing values apart from fishing is gaining momentum. The National Park Service has initiated practices to reconstruct native conditions and is currently considering the elimination of fishing. Concern for small and rare fish species is capturing increased attention in both the British Isles (Maitland, 1974) and the United States. One consequence, therefore, of OSY may be the rising importance of fish species analogous to songbirds and wildflowers.

The fact that OSY philosophy cannot pinpoint specific objectives underlies what may be one absolute goal of fisheries management: the maintenance and provision of a broad range of actual and potential opportunities (Wilkins, 1968). The mosaic of criteria relevant to fisheries management and the diverse populace of the United States indicate that massive management programs tailored to one set of needs are inappropriate. An array of opportunities which can accommodate a diversity of interests seems more de-

sirable in terms of limited fisheries resources and growing demands. Urban fishing is an example of a management alternative which had long been ignored despite the increasing urbanization of the U.S. population (McFadden, 1969). While such programs sacrifice many traditional aspects of "quality" fishing, they can accommodate the recreational needs of a large block of people who cannot participate in other fisheries programs.

CONCLUSIONS

Placed within historical perspective, the predominance of MSY as a philosophy seems unequal in kind to either the recognition of exhaustibility or OSY. MSY seems more comparable to the circa 1850 condemnation of trawling as the cause of all decreases in catch per unit of effort. The dominance of MSY has been one step in the recognition of a larger problem. Trawling eventually took its place among destruction of immature fishes by all methods, environmental degradation, and overfishing in general, as complementary forces which eventually proved the exhaustibility of fisheries. Similarly, maximizing physical yield now takes its place among maximizing net economic revenue, maximizing aesthetics, and maximizing total recreational benefits, as complementary criteria which have melded to reflect the desirability of optimizing the overall yield from fisheries resources.

Neither the recognition of exhaustibility nor the philosophy of OSY have been the direct outgrowths of theoretical or scientific analyses. They represent instead the forced acceptance of new ideas when the established ideas collapsed. Inexhaustibility was discarded only when the practical realities of declining catches and declining profitibility in commercial fisheries could no longer be denied. The recognition of OSY is currently being forced on fisheries scientists and administrators by the unwillingness of the remainder of the world to operate according to biological management. One conclusion is therefore rather discouraging: fisheries philosophy has always lagged behind the facts.

Another conclusion, however, is more optimistic. It is naive to suggest that OSY philosophy will easily solve all management problems; if, however, recognizing the problem is indeed half of the solution, OSY philosophy appears to be a significant refinement in management. The formalization of OSY philosophy provides the opportunity for fisheries management to emerge as a distinct discipline. Semantic arguments aside, a fisheries scientist is primarily an investigator of biological, physical, and chemical phenomena within the aquatic ecosystem. Under OSY philosophy, the fisheries manager should emerge as the coordinator and evaluator of knowledge from diverse sources; the input received from fisheries scientists represents just one such source. Other inputs include those from sociologists, economists, politicians, local interest groups, concerned individuals, or any other relevant sources. In this regard, neither biologists nor economists represent the ideal personnel to adequately absorb "secondary" objectives into their respective disciplines and thereby derive programs reflecting OSY. The promise of OSY as a philosophy for fisheries management is that it implies only an approach to problems, not what the solutions ought to be.

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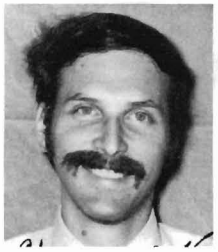
MFR PAPER 1227

Foreign Direct Investment in the U.S. Commercial Fisheries Industry

ROBERT A. SIEGEL



ABSTRACT—This report presents an analysis of data on foreign direct investment in the U.S. commercial fisheries industry. The principal data source is the Survey of Foreign Direct Investment in the United States, 1974 *conducted by the Bureau of Economic Analysis, Department of Commerce. At the end of 1974, the total value of foreign direct investment in the U.S. commercial fisheries industry was $129 million. The sources of these investments were: Canada, Denmark, Iceland, Japan, Kuwait, Mexico, Norway, and the United Kingdom.*

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INTRODUCTION

This is a report on foreign investment activities in the U.S. commercial fisheries industry. It is associated with a larger study undertaken by the Department of Commerce, Bureau of Economic Analysis (BEA), pursuant to the Foreign Investment Study Act of 1974 (PL 93-479). The principal source of information for this report was the *Survey of Foreign Direct Investment in the United States, 1974*, conducted by BEA. The results of the survey describe the direct foreign investment positions as of 31 December 1974. Other governmental sources are used to supplement the survey data.

INVESTMENT SCOPE

Foreign investment in the U.S. commercial fisheries industry has taken place primarily at the processing and wholesale levels. At the end of 1974, 47 firms reported foreign ownership of 10 percent or more of the voting stock of an incorporated U.S. business enterprise or the equivalent interest in an unincorporated U.S. business enterprise. The total value of this investment was $129 million[1].

Much of the foreign investment in U.S. fisheries is of relatively recent origin. More than half the firms involved received these investments since 1970 (Fig. 1). During 1974 direct investment rose 30 percent to its present level.

[1]Investment is defined as the value of the affiliated foreign groups' direct claims on the assets of their U.S. affiliates, net of claims of the U.S. affiliates on the assets of affiliated foreign groups.

SOURCES AND LOCATIONS OF INVESTMENTS

Over half of the total value of foreign direct investment is from sources in European countries (Fig. 2). A more detailed breakdown indicates that 87 percent originates from only three countries: United Kingdom, Japan, and Canada. The remainder is from investors in Denmark, Iceland, Norway, Kuwait, and Mexico.

The 47 firms operate 107 establishments, which include business offices as well as production facilities. A large number of these establishments are located in the States of Alaska and Washington, but there are also operations in several other states, particularly along the east coast in New York, New Jersey, Massachusetts, and Florida.

About one-third of the establishments are located in Alaska. Disclosure