NOAA Technical Memorandum NMFS-F/NEC-99

Sole Ownership of Living Marine Resources

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
Woods Hole, Massachusetts

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Sole Ownership of Living Marine Resources

Steven F. Edwards[1], Allen J. Bejda[2], and R. Anne Richards[1]

[1]Woods Hole Lab., National Marine Fisheries Serv., Woods Hole, MA 02543-1097

[2]J. J. Howard Marine Science Lab., National Marine Fisheries Serv., Highlands, NJ 07732

U. S. DEPARTMENT OF COMMERCE

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D. James Baker, Administrator

National Marine Fisheries Service

Rolland A. Schmitten, Assistant Administrator for Fisheries

Northeast Region

Northeast Fisheries Science Center

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NOTE ON SPECIES NAMES

The NMFS Northeast Region's policy on the use of species names in technical publications and reports is to follow the American Fisheries Society's (AFS) lists of scientific and common names for fishes (Robins *et al.* 1991)[a], mollusks (Turgeon *et al.* 1988)[b], and decapod crustaceans (Williams *et al.* 1989)[c], and to follow the American Society of Mammalogists' list of scientific and common names for marine mammals (Wilson and Reeder 1993)[d]. This policy applies to all issues of the *NOAA Technical Memorandum NMFS-F/NEC* and *-F/NER* series.

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[a] Robins, C.R. (chair); Bailey, R.M.; Bond, C.E.; Brooker, J.R.; Lachner, E.A.; Lea, R.N.; Scott, W.B. 1991. Common and scientific names of fishes from the United States and Canada. 5th ed. *Amer. Fish. Soc. Spec. Publ.* 20; 183 p.

[b] Turgeon, D.D. (chair); Bogan, A.E.; Coan, E.V.; Emerson, W.K.; Lyons, W.G.; Pratt, W.L.; Roper, C.F.E.; Scheltema, A.; Thompson, F.G.; Williams, J.D. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. *Amer. Fish. Soc. Spec. Publ.* 16; 277 p.

[c] Williams, A.B. (chair); Abele, L.G.; Felder, D.L.; Hobbs, H.H., Jr.; Manning, R.B.; McLaughlin, P.A.; Pérez Farfante, I. 1989. Common and scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. *Amer. Fish. Soc. Spec. Publ.* 17; 77 p.

[d] Wilson, D.E.; Reeder, D.M. 1993. Mammal species of the world: a taxonomic and geographic reference. Washington, DC: Smithsonian Institution Press; 1206 p.

INTRODUCTION

But why, it is asked, does the secondary law of nations which [separates animals of the forest and fish of the rivers from the ancient community of rights] cease to operate the same way when we consider the sea. I reply, because in the former case it is expedient and necessary. For everyone admits that if a great many persons hunt on the land or fish in the river, the forest is easily exhausted of wild animals and the river of fish, but such a contingency is impossible in the case of the sea.

(H. Grotius, writing in the 1600s; see Keen 1988, p. 24)

Even when we perceive the errors of the past and the dangers of the future, it is not obvious how we should, or can, alter human institutions to improve human welfare. In this crowded world of ours, unmanaged commons are no longer tolerable: but how shall we manage them?

(Hardin and Baden 1977, p. xii, their emphasis)

Contrary to 17th century thought, open access depletes living marine resources and their economic value despite earnest attempts by governments throughout the world to regulate the fishing industry (Christy 1978; Crutchfield 1961, 1979; Scott 1979; Wilen 1989). In response, coastal states have begun to institute usufructuary rights in fisheries, focusing primarily on ways to limit the number of vessels or on how best to assign catch quotas or fishing effort to individual fishermen (Mollett 1986; Muse and Schelle 1989; Neher *et al.* 1989; Pearce 1979; Rettig and Ginter 1978). In this document, however, the Research Council of the Northeast Fisheries Science Center explores the largely overlooked idea of sole ownership, including common property and individual private property institutions.

Neither limited entry nor individual quota systems comprehensively address the problems inherent with open access or state ownership. Limited entry alone fails to conserve fish resources because it institutionalizes excess capacity of fishing fleets and because fishermen are adept at undermining government restrictions on fishing technology and practices (Wilen 1989). Individual quotas, including ITQs, provide fishermen with incentives to economize on fishing effort. However, significant elements of open access persist under any individual quota system because fishermen are inclined to maximize the return on their quota, not to harvest in ways that husband fish resources (Copes 1986; Keen 1983). In addition, a government's role in setting the overall quota for a fishery invites lobbying that in itself dissipates value because the time and effort expended on influencing regulations does not make a net contribution to a nation's production of goods and services (*e.g.*, Ackroyd *et al.* 1990; Anderson and Hill 1991; Hide and Ackroyd 1990).

Sole ownership would assign the exclusive rights to use a discrete, self-sustaining fish resource to a single public or private entity, such as a cooperative, government board, private corporation, or international authority, to use Scott's (1955) examples. Although considered by many to be politically unworkable, private ownership could potentially provide incentives to husband a fish resource for either commercial exploitation or sale to other interests, including recreational fishermen, conservationists, and oil companies. Indeed, prior to the 20th century, the federal government gave or sold more than a billion acres of federal holdings of natural resources to farmers, miners, ranchers, timber companies, and railroads. Our current distrust of markets is a legacy of Gifford Pinchot and the Forest Service whose views of markets were influenced by open-access exploitation, not by harvest when property rights are unattenuated.

Sole ownership tends to be treated abstractly or ambiguously in the fisheries literature, but there are many real world instances, including those in the United States. For example, small communities and associations have exercised territorial use rights in coastal waters throughout the world for centuries (Christy 1982). In the United States, a sizable fraction of the oyster beds along the coasts of the Atlantic Ocean and Gulf of Mexico are privately owned or leased (Agnello and Donnelley 1979). Also noteworthy is the businesslike manner in which the U.S. government managed the Pribilof fur seal fishery throughout most of the 20th century (National Advisory Committee on Oceans and Atmosphere 1984).

The Research Council's inquiry into sole ownership is intended to promote an informed and timely evaluation of alternative institutions for management of living marine resources within the 200-mile limits of coastal states. Although we only scratched the surface, it is apparent that the potential benefits of sole ownership, particularly private forms, warrant continued investigation.

STATUS OF U.S. FISH RESOURCES AND FISHERIES

Wealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another....the fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today.

(Gordon 1954, p. 135)

TRAGEDY OF THE FISHERY COMMONS

In his popular allegory, Hardin (1968) attempted to illustrate the "tragedy of the commons" with a common pasture.[1] As a rational being seeking to maximize his own gain, each

[1] Actually, Hardin mistakenly refers to common property (*res communes*) when he means open-access resources (*res nullius*). See Bromley (1991). He also failed to see the virtues of the English commons prior to the time prices and technology favored closure (Hanna 1990).

herdsman will keep as many cattle as possible on the pasture. In his mind, the personal gain from adding an additional animal to his herd is outweighed by the effects of the animal on the pasture's productivity and, therefore, all herdsmen. Also, without a binding contract, other herdsmen make similar decisions. Together, then, the herdsmen exhaust the productivity of the pasture.

And so it goes for any open-access resource, whether it be grazing land, forests, water supplies, minerals, or fish. As Gordon (1954) explained in his seminal paper, open-access resources are not valued.

RESOURCE DEPLETION AND EXCESS CAPACITY

The U.S. Congress intended the Magnuson Act to prevent overfishing while achieving optimum yield from each fishery. Although ill-defined, "optimum" refers, in part, to efficient use of fish resources for seafood and recreation. Eight regional fishery management councils (regional councils) were established to "limit access to the fishery in order to achieve optimum yield."

Despite the provision for limited, or controlled, access, and about 15 years of management by regional councils, open access to fish resources prevails in U.S. waters.[2] Foreign fleets have been virtually replaced by technologically advanced domestic fleets, preventing already overfished stocks, such as haddock, Atlantic cod, and Atlantic halibut in the Northwest Atlantic, from recovering. In contrast to expectations, neither commercial landings nor gross revenues (adjusted for inflation) in the National Marine Fisheries Service's (NMFS) Northeast Region or in the conterminous United States increased significantly compared to 1977 (Figures 1a and 1b). (The NMFS Northeast Region, hereafter called the Northeast, comprises the coastal states from Maine to Virginia, the Great Lakes states, and Pennsylvania and West Virginia.) In fact, after experiencing losses in traditional groundfish fisheries during the 1980s, U.S. commercial fishermen redirected effort at previously "underutilized" species, including Alaska groundfishes and, in the Northwest Atlantic, pollock, hakes, and elasmobranchs.

Poor landings reflect the depleted status of the stocks. A report commissioned by the National Oceanic and Atmospheric Administration (NOAA) in 1985 found that by the mid-1980s, 50 percent of the management units (*i.e.*, assemblages of species or stocks covered by a fishery management plan) were being overfished by domestic fleets (Hargis *et al.* 1986). The majority of the overfished species listed in the NOAA report were from the Northeast (*e.g.*, groundfishes and sea scallops) and the Gulf of Mexico (*e.g.*, mackerels and reeffish). In addition, the list of overcapitalized fisheries included Atlantic surfclams and Pacific halibut and other groundfishes (*e.g.*, sablefish), as well as most of the overfished species.

Four years later, in its assessment of the needs of NMFS, the National Fish and Wildlife Foundation reported little positive change in the list of overfished species (Chandler and Turnbull 1990). In addition, the foundation emphasized the following trends, which were apparent as of 1989:

1. Fish stocks managed under 15 of the 30 management plans declined since the Magnuson Act took effect in 1977, and many, including Northeast groundfishes, were still declining.

2. Ten of the overfished units would require 5-20 years to recover, even if all fishing ceased.

3. Stocks of several species that recently became fully exploited are now declining, including Gulf of Mexico shrimp, Pacific groundfishes, and Alaska pollock.

By 1989, management units that were listed as being either overfished or fully exploited and decreasing constituted roughly one-third of the total U.S. harvest of finfish and shellfish.

PROFITABILITY OF U.S. FISHING INDUSTRY

Economic theory predicts that the profits which are attributable to the productivity of a fish resource will attract entry in an open-access fishery until the resource is depleted and its value dissipated (Gordon 1954). Three studies bear out this theory. In the first, Norton *et al.* (1985) found that profits in four northeastern U.S. fisheries--American lobster, groundfish, sea scallop, and Atlantic surfclam and ocean quahog--declined between 1976 and 1982. Kearney/Centaur Corp. (1988) reached similar conclusions for 60 percent of the fisheries that were managed by fishery management plans by 1986, including groundfishes and sea scallops in the Northeast.

Kearney/Centaur (1988) also reported that profitability of 40 percent of the fisheries it studied either remained stable or increased during 1976-86, including gains in fisheries for red drum in the Gulf of Mexico, Tanner and red king crabs off Alaska, and Alaska groundfishes. However, within only a few years, most of these stocks were either fully exploited and decreasing or, in the case of red drum, already overfished, according to the National Fish and Wildlife Foundation (Chandler and Turnbull 1990).

Conrad (1987) reported similar results for the U.S. fishing industry as a whole. During 1977-85, when foreign fleets were

[2] Exceptions include the following: (1) limited entry to the purse seine fishery for bluefin tuna; (2) limited entry to Pacific salmon fisheries in Oregon and Washington; (3) ITQ management of Atlantic surfclams and ocean quahogs in the Northeast; and (4) ITQ management of wreckfish in the Southeast.

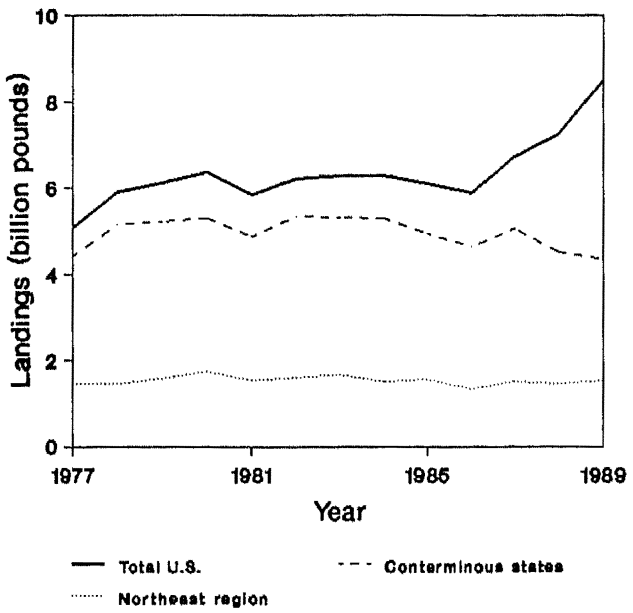

Figure 1a. Size (in billions of pounds) of U.S. commercial harvest of fish resources, exclusive of joint ventures, in the Northeast (*i.e.*, coastal states from Maine to Virginia, Great Lakes states, and Pensylvania and West Virginia), in states conterminous to the Northeast, and in the United States as a whole during 1977-89. (Source: various annual issues of *Fisheries of the United States.* Available from: National Marine Fisheries Service, 1335 East-West Hwy., Silver Spring, MD 20910.)

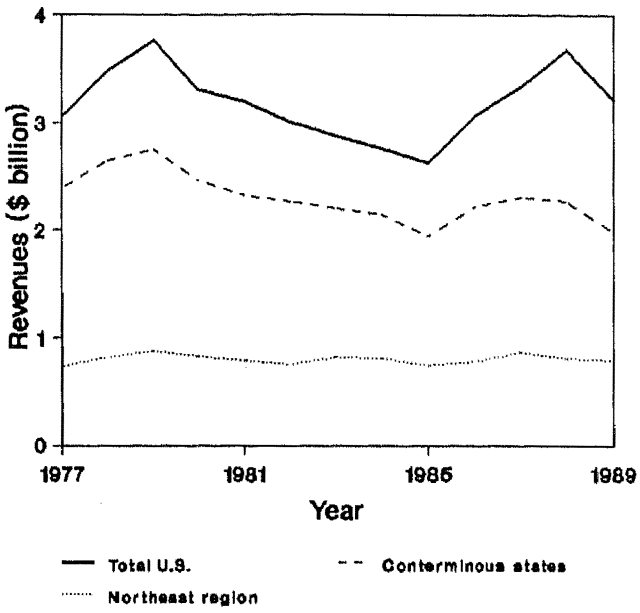

Figure 1b. Revenues (in billions of 1989 U.S. dollars) from U.S. commercial harvest of fish resources, exclusive of joint ventures, in the Northeast (*i.e.*, coastal states from Maine to Virginia, Great Lakes states, and Pensylvania and West Virginia), in states conterminous to the Northeast, and in the United States as a whole during 1977-89. (Source: various annual issues of *Fisheries of the United States.* Available from: National Marine Fisheries Service, 1335 East-West Hwy., Silver Spring, MD 20910.)

greatly reduced in U.S. waters, net earnings soon peaked and then became negative following buildup of the U.S. fleet. Conrad (1987) concluded that not quite one decade after the Magnuson Act took effect, fisheries in what became U.S. waters returned to the overfished situation previously created by foreign fleets.

ECONOMIC VALUE OF FISH RESOURCES

Clearly, under open access, private industry will deplete a resource and dissipate its value in the competitive pursuit of profit.[3] However, reduced profits do not address the broader concerns of economists where resource depletion is concerned. In this section, we attempt to explain what resource economists have in mind when speaking of benefits, costs, and efficiency.

Achieving maximum economic (allocative) efficiency from the nation's fish resources--modified by other important social goals--is espoused by the Magnuson Act. This policy is akin to "getting the most" from the nation's pools of labor, capital, and natural resources, hence its appeal. Maximum economic efficiency is tantamount to maximum net economic value--*i.e.*, the greatest "distance" between the gross value of fish to the public (including recreationists and those people who value species conservation) and the social economic costs of catching and supplying fish.

The gross economic value of a good or service, such as fish, is defined as the maximum amount of income that people are willing to spend to obtain fish, taking into account tastes and preferences. The reference to "maximum" should imply being indifferent between using or not using fish or the marine environment for food, recreation, or conservation. That is, paying one's maximum willingness-to-pay to obtain the good or service in question is tantamount to not having the good or service, but spending the same amount on other things that are valued.

The gross economic value of a good or service is approximated by the area behind a demand curve (Figure 2a). Market prices and the quantities sold at each price are used to estimate demand. Demand is negatively sloped because satiation makes people less and less willing to spend money on additional amounts of a good or service. However, it is the constraint that

[3] Although not treated here, recreational fishermen also dissipate resource rents in an effort to maximize personal utility, or well-being.

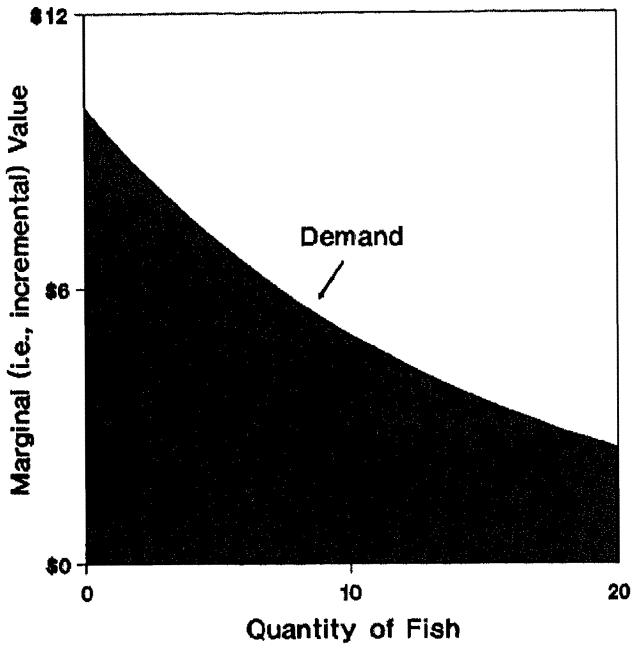

Figure 2a. Economic value as depicted with a generalized demand curve.

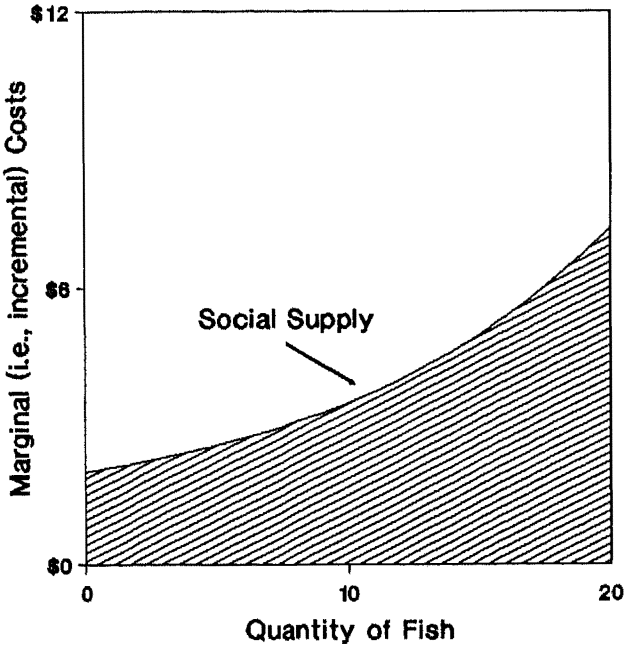

Figure 2b. Social costs as depicted with a generalized supply curve.

one's income places on purchases--not market prices--that gives economic value monetary units. In theory, any constraint on behavior, including one's leisure time, could also be used to measure economic value.

In contrast, social economic costs of supplying a good or service, such as fish, are defined in terms of opportunity costs, or the foregone economic value of the goods or services that the labor and capital used to capture and supply fish could have produced if employed elsewhere in the economy. Opportunity costs include the value of goods and services that the entrepreneur could produce if his/her time and money were invested elsewhere.

Social economic costs tend to be measured by the costs of employing labor, capital, and other productive resources, although factors such as market structure and alternative employment opportunities must be considered (Figure 2b). For example, the financial cost of crew to a vessel owner is the crew's share of landings revenues. However, if the crew had little or no other employment options, the social economic costs of them fishing would be zero because no production is foregone elsewhere in the economy. In contrast, under full employment in a perfectly competitive economy, the crew's salary is mathematically equal to opportunity costs and, therefore, social economic costs.

The three components of net economic value that are germane to maximizing economic efficiency--consumer surplus, producer surplus, and resource rents--can be developed from these notions of gross value and social economic costs. In a market, the interaction of demand and supply determines price. This is shown in Figures 3a and 3b where landings, Q, meet demand at price, P. As just discussed, the area beneath demand and left of Q is the gross economic value of landings in these figures.

Figure 3a is supposed to represent the situation when a fish resource is owned and valued. Here, gross value is divided into four parts. First consider the area above the price line, which is called consumer surplus (CS). Consumer surplus measures the value that consumers enjoy at no cost--a "profit" for consumers, if you will. Consumer surplus can also be viewed as the income that consumers would be willing to spend on fish but, instead, are able to spend on other goods and services. That is, consumer surplus is the difference between gross value, or maximum willingness-to-pay as defined earlier, and what consumers actually spend at market prices.

The remaining areas in Figure 3a are financed by consumers' expenditures on seafood. Beginning at the bottom is an area labeled SEC for social economic costs. This area is supposed to represent the value of goods and services that the nation forgoes when labor and capital are used to harvest fish instead of to produce other goods and services, as discussed above. It is income for labor and capital, but a cost of productive resources for the nation.

Above social economic costs in Figure 3a lies an area called PS, or producer surplus. Producer surplus can be thought of as the amount of income earned by fishermen (*i.e.*, crew, captains, and vessel owners) that exceeds what they could earn being employed elsewhere in the economy. The extra margin of profit earned by "highliners" (*i.e.*, those who land the most fish for the least effort) exemplifies producer surplus.

The box immediately below the price line in Figure 3a is resource rent (RR). Resource rent is the income that an owner of a fish resource could receive from his/her or, if leased,

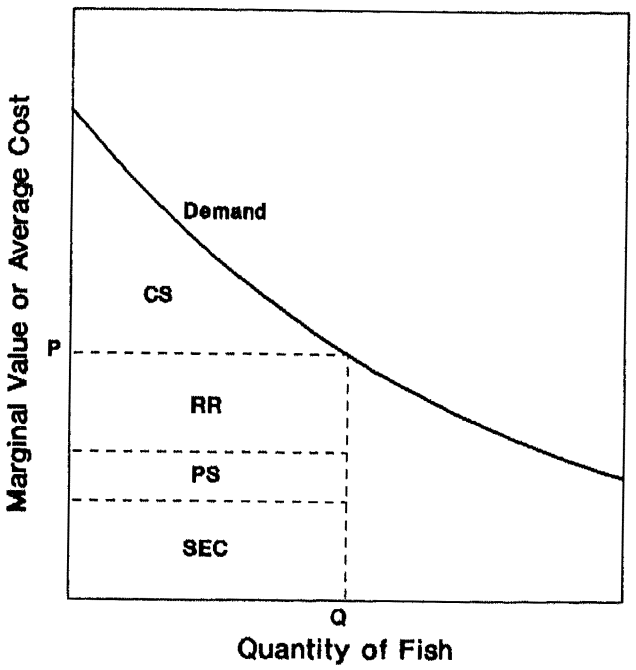

Figure 3a. Components of net economic value of fish resources and harvests when allocative efficiency is maximized (P = landings price; Q = landings amount; CS = consumer surplus; RR = resource rent; PS = producer surplus; and SEC = social economic cost).

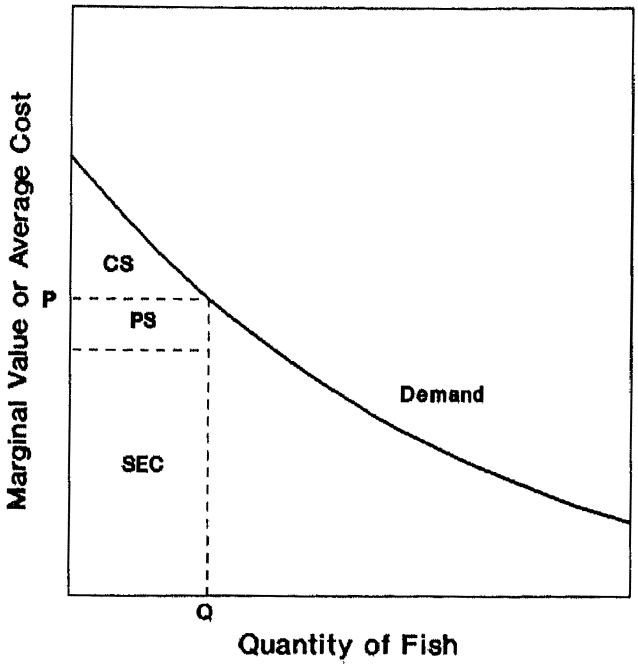

Figure 3b. Components of net economic value under open-access conditions (P = landings price; Q = landings amount; CS = consumer surplus; RR = resource rent; PS = producer surplus; and SEC = social economic cost).

other's(s') use of the resource, as opposed to income earned by labor or capital. Thus, the federal government could, if the Magnuson Act was suitably revised, charge U.S. fishermen a fee for use of fish resources, similar to the way foreign fishermen are charged to fish in U.S. waters. This could be done, for example, through an auction just as tracts of seabed on the continental shelf are leased to oil companies. Alternatively, if fish resources were owned privately by, say, individual fishermen or associations of fishermen or even processors, resource rent would be the market value of their fish resource asset.

The rental value of a fish resource is similar to the value of residential land, farm land, timber land, or any other natural resource. For example, the value of farm land (revealed by sales or leases) reflects its fertility and location to markets; this value is separate from what is paid for the seed, labor, and capital used to farm the land.

Net economic value, then, is the difference between gross value and what it costs society in terms of use of productive resources to harvest, process, distribute, and retail fish. Net economic value is composed of resource rent, producers' surplus, and consumers' surplus. Allocative efficiency is maximized when the combination of these three net values is greatest--not when one or two categories is maximized or when profit is maximized (see Copes 1972).

The dearth of basic economics data on fisheries and related markets precludes estimating benefits and costs in most fisheries. However, crude estimates of the dissipation of resource rents range up to $230 million annually for Gulf of Mexico shrimp (Table 1). Over time, foregone resource rents alone probably amount to tens of billions of dollars.

There are other important categories of efficiency--in addition to allocative efficiency--that tend to be overlooked when fisheries management is discussed; however, they are essential to comparisons of property-rights institutions and the relative sizes of consumers' surplus, producers' surplus, and resource rent. Technical efficiency, or "best-practice" efficiency, concerns use of the most advanced technology available. In contrast, dynamic efficiency relates to the development of more advanced technology. Finally, X-efficiency concerns the ability and inclination of a manager to undertake maximizing behavior in the production of a good or service, including in the public sector.

Technical inefficiency is imposed on the fishing industry and, therefore, the nation when regulations interfere with the application or use of the most efficient technology. Extreme examples include the requirement that oyster dredges be pulled by sailing vessels in parts of Chesapeake Bay and the prohibition of pot and wheel technologies in certain salmon fisheries in the Pacific Northwest. Also, government regulations can distort technological change in ways that "get around" the rules rather than reduce costs, resulting in dynamic inefficiencies. Dynamic inefficiencies may also arise due to disincentives to invest in the fish resource. For example, New Zealand's Chatham Island fishermen did not organize to fund research on growth and recruitment of abalone until they owned ITQs (Hide and Ackroyd 1990). Finally, regarding X-inefficiency, there is empirical evidence that the public sector is less productive than

Table 1. Potential resource rents in U.S. commercial fisheries[a]

Fishery	Annualized Value ($million)	Capitalized Value ($billion)[b]
Pacific groundfish trawl (Huppert and Squires 1987)	14	0.5
Pacific groundfish trawl (Economic Assessment Team, National Marine Fisheries Service 1991)	14	0.5
Gulf of Alaska sablefish (Economic Assessment Team, National Marine Fisheries Service 1991)	16	0.5
Maine lobster (Rothschild *et al.* 1977)	21	0.7
Puget Sound salmon (Crutchfield and Pontecorvo 1969)	24	0.8
New England yellowtail flounder (Gates and Norton 1974)	28	0.9
Alaska halibut (Economic Assessment Team, National Marine Fisheries Service 1991)	74	2
Atlantic sea scallops (Economic Assessment Team, National Marine Fisheries Service 1991)	80	3
New England groundfish (Edwards and Murawski 1991)	130	4
Gulf of Mexico shrimp (Economic Assessment Team, National Marine Fisheries Service 1991)	230	8
All U.S. fisheries (Eckert 1979)	380	13
All U.S. fisheries (Christy 1977)	610	20
All U.S. fisheries (Keen 1988)	1130	38
All U.S. fisheries (Economic Assessment Team, National Marine Fisheries Service 1991)	1800	60

[a] Source: Economic Assessment Team, National Marine Fisheries Service (1991). Resource rent is the value of the resource (*vis-a-vis* labor or capital), net of harvesting costs. Resource rents are reasoned to be zero when open access prevails.

[b] Capitalized values are net present values in perpetuity, calculated by dividing the annualized values by a social discount rate of three percent.

the private sector in the production of similar public goods or services, including forestry products (Button and Weyman-Jones 1992).

OPTIONS FOR CONTROLLED ACCESS

[A]s long as vessels race for fish, neither a tax system nor a quota system will prevent lop-sided overinvestment in speed and capacity. Only sole ownership can do this.
(Scott 1979, p. 736)

According to the property rights paradigm, the maximum value of a good or service requires unattenuated property rights--rights that are well-defined, divisible, transferable, exclusive, and enforceable (Alchian and Demsetz 1973; Anderson and Leal 1991; Cheung 1970; Demsetz 1964; Stroup and Baden 1983). Being well-defined refers to rights being spelled-out and unequivocal. Divisibility allows separate attributes of the resource to be contracted in space and time and for different purposes; although, use of any physical property is limited in certain ways to protect the general public. Just as it is illegal to burn your house down or drive your car recklessly, it is illegal to extinguish a species. Transferability without restriction on duration facilitates ownership moving into the hands that values the resource most (including sometimes disparate interests such as recreation and conservation), and, importantly, ensures that the future value of the resource will be accounted for in current harvest decisions. Finally, without backing by the state, others could not be easily excluded and rights would become tenuous.

To understand the connections between the value of a fish resource--*i.e.*, resource rents--and rights requires the definition of property: Property is a benefit, such as income, that one can expect from use of a resource over time (Bromley 1992). A property right is a claim to property that an authority, such as government, will protect by assigning duties to others who would interfere with property, and by enforcing others' duties. Property is diminished in direct proportion to the attenuation of the above aspects of rights.

For decades, coastal states attempted to control fishing mortality by micromanaging the fishing industry--*i.e.* by setting regulations intended to control the performance of fishing technologies and fishermen. In the United States, for example, the scores of fishery management plans and amendments describe an array of failed fishery quotas and effort controls such as total allowable catches, area closures, and mesh-size restrictions. Due to the failure of these regulations to conserve fish stocks and maximize net benefits, coastal states now seek to infuse usufructuary rights into their fisheries through a number of controlled-access policies.[4] In what follows, four types of controlled access--limited entry, individual quotas, area licensing, and sole ownership--are discussed. This classification is a matter of convenience, not of significance.

[4] For reviews of limited-access programs throughout the world, see Mollett (1986), Muse and Schelle (1989), Neher *et al.* (1989), Pearce (1979), and Rettig and Ginter (1978).

LIMITED ENTRY

Limited entry alone restricts only the number of vessels or fishermen in a fishery. Whether achieved by a moratorium on entry or by culling the numbers of vessels with, for example, "buybacks," only licensed fishermen can harvest fish in a limited-entry fishery. Limited entry is most effective in fisheries with few participants, thus providing an opportunity to plan harvests cooperatively. The early limited-entry prawn fishery in western Australia during the 1970s illustrates how only a few fishermen will collectively plan total harvest of a new resource (Meany 1979).

Sales of fishing licenses reveal that a fish resource attains value in a limited-entry fishery (Meany 1979; Muse and Schelle 1989; Wilen 1989). However, several drawbacks constrain the maximum value of a fish resource and its production, particularly in fisheries with excess effort and capital, such as in the Northeast. Foremost, the persistent incentive to increase one's landings from what remains an open-access resource still leads to overcapitalization and resource depletion as profits are invested into more powerful and effective fishing technology. Consequently, fishery managers and fishermen enter a wasteful and costly cycle of effort controls and subterfuge (Wilen 1989). Another problem with limited entry is that multispecies and multipurpose fleets are difficult, if not impossible, to classify for licensing purposes, often resulting in convenient, but ineffectual regulations. Finally, discarding of illegal and low-valued species reveals little or no incentive to husband the resource in a limited-entry fishery.

All things considered, limited entry contributes little, if anything, to optimum yield over the long haul, particularly in a fishery which already has excess capacity. Limited entry was abandoned in Iceland (Arnason 1986), Australia (Geen and Nayar 1988), and New Zealand (Ackroyd *et al.* 1990) in favor of individual quotas.

INDIVIDUAL QUOTAS

Individual quotas go well beyond merely deciding who can participate in a fishery. Landings (or, conceivably, effort or value) are allocated to individual vessel owners or crew. The quotas may be absolute or a fraction of the total allowable catch (or effort or value), and they may or may not be transferable.

Individual quotas are an improvement over limited entry because fishermen are more free to decide technology and fishing practices, thereby minimizing the costs of inefficient harvesting. The chances of individual quotas achieving optimum yield appear to be greatest in single-species fisheries with few participants and when quotas are transferable and linked to specific geographic areas.

Quota sales are evidence that rights conveyed by an ITQ system increase the value of fish resources (Ackroyd *et al.* 1990; Geen and Nayar 1988; Muse and Schelle 1989). Nevertheless, individual quotas are not panaceas to protect fish stocks or to achieve efficiency (Copes 1986). Foremost, fishermen own shares of total allowable catch, not the resource itself; therefore, there is no incentive to husband the resource. Anecdotal evidence summarized by Muse and Schelle (1989) supports beliefs that illegal landings are commonplace. Also, "highgrading," or discarding lower-valued species and sizes of fish in order to maximize profit from quota, results in untold waste, but indications are that it can be high. For example, in the Lake Superior lake trout fishery, highgrading is placed at 30-50 percent of total catch (Muse and Schelle 1989). A related problem is mislabeling of species when one lacks a quota or when the aggregate quota is filled.

In addition to little incentive to husband a resource, management by the public sector results in "government failures" and waste, including the following:

1. Individual quotas impose rigidity on the system when the fishing industry should be able to respond to market and stock conditions in short time frames.

2. Public officials are influenced by competing special interest groups, which tends to undermine an individual quota system, such as in New Zealand (Ackroyd *et al.* 1990; Hide and Ackroyd 1990).

3. In fact, individual quota systems can increase such "rent seeking" because they result in wealth controlled by government.

New Zealand's experience with ITQs is being watched closely by fishery managers worldwide. According to Ackroyd *et al.* (1990) and Hide and Ackroyd (1990), the husbanding and government failures threaten to undermine New Zealand's efforts to conserve fish stocks and to return economic benefits to the nation. See Muse and Schelle (1989) for reviews of the New Zealand and other ITQ systems throughout the world, and see Neher *et al.* (1989) for proceedings of a recent conference that covered ITQs.

AREA LICENSING

Area licensing might be considered a form of limited entry, except that a license is associated with a specific geographic area of the marine environment, bringing the resource closer to real estate.

Experience with area licensing is greater than one might think. Oyster and other shellfish beds in estuaries along the Atlantic and Gulf of Mexico coasts are partitioned and leased to fishermen (Agnello and Donnelley 1979). In British Columbia, the roe herring fishery is divided into three areas (MacGillvray 1986). Also, small communities and fishermen associations have regulated use of nearshore fisheries throughout the world for centuries, sometimes through illegal means (Christy 1982). Areas can also be cordoned, such as when salmon are penned.

Area licensing is subject to many of the same limitations as limited entry and individual quotas. It can work well when few fishermen are licensed to use an area and when the resource can be confined to that area, such as in western Australia's prawn fishery during the 1970s (Meany 1979). However, when fishermen are numerous and the stock moves about, the fishery is a veritable open-access system.

SOLE OWNERSHIP

From a taxonomic perspective, the literature on sole ownership covers a hodgepodge of property institutions. To help clarify the idea, Bromley's (1992) classification of property rights institutions for natural resources will be applied here.

As currently practiced throughout the world, limited entry, individual quotas, and much of area licensing are parts of state ownership regimes, as are the usual forms of ineffective and intrusive controls on fishing technology and practices. Under common property--a second property institution--a fish resource would be owned and managed by a group of individuals, conceivably those who gained access under state ownership. In contrast, one person or corporation would own rights to the resource under an individual private property regime, such as a commercial fishing corporation, a conservation organization, or an oil company. Of course, a fourth category is open access, which does not qualify as property .

Sole ownership institutions would share the following attributes, however. The state government, common property organization, or private party (possibly nonprofit) would own exclusive rights to the fish resource, including the right to determine harvest policy. Also, the resource and rights would be clearly defined along ecological, technological, and spatial dimensions such that the resource is self-sustaining and use by others is subject to contract. Finally, the property rights would have full backing of the state.

In many cases, the resource would be an assemblage of species that interact with each other and with particular fishing technologies in space and time. The underlying structure of the resource must be based on the species' behaviors, including migrations, and on ecological relations, including considerations of trophic structure, habitat requirements, and the stability, resilience, and persistence of an ecosystem. Accordingly, sole ownership resources should be defined in terms of ecosystems and should be conceptually much broader than current fishery management units that are defined primarily by gear properties. Early life history and seasonal changes in ecological relations must also be considered. Species that undergo extensive migrations, such as bluefish, probably require the defining of large geographic areas, perhaps entire seaboards. Other resources, particularly shellfish, would most likely involve much smaller areas. Still other species that migrate throughout territorial seas and international waters, such as bluefin tuna, require oceanic definition.

Superimposed on the basic ecological definitions of sole ownership resources are constraints imposed by harvesting technologies. Conceivably, a discrete ecological unit could exist within an ecosystem, but it would not constitute a separate sole ownership resource unless it could be harvested independently of other species. If the potential for bycatch is large, the resource should include the entire multispecies complex captured by different gear types, whether or not there are strong ecological interactions among the species. Similarly, indirect effects of harvesting technologies--such as damaging habitat that is important to the production of prey in another fishery--could lead to potential conflicts between ecological units that might be subsumed within a single sole ownership resource.

As noted above, ownership of a suitably defined resource could be public or private. The current system of eight regional councils and NMFS has not been compatible with true centralized decision-making or with this resource definition. However, one should not forget the role that the Bureau of Commercial Fisheries and, later, NMFS played in the harvest of Pacific fur seals (National Advisory Committee on Oceans and Atmosphere 1984). That is, between about 1920 and 1985, the U.S. government subcontracted with the private sector to harvest, process, and auction pelts from fur seals on the Pribilof Islands.

Under the two private forms of sole ownership--common property or individual private property--ownership could be vested with commercial fishermen, recreational fishermen, seafood processors, conservation organizations, or other users of the marine environment, including mining or oil and gas companies. The public sector's role in a private ownership system would depend on how likely it is for a profit-oriented corporation to achieve maximum net economic value and other social goals, including marine mammal protection. Thus, private ownership might be subject to government oversight, as with public utilities, with a minimum attenuation of rights, such as disallowing biological extinction of any species.

There are a number of potential advantages of private ownership that might not be apparent. First, private owners would have incentives to husband the resource for long-term benefits. For example, an owner of exclusive access to Northeast groundfishes could research the food habits of elasmobranchs and then possibly "weed them out" if they were found to compete significantly with, or prey on, gadids and flounders. This type of incentive contrasts with the incentive of a license holder in a limited-entry fishery to maximize his share of landings, or of a fisherman in an ITQ fishery to maximize the economic return from his quota.

Another likely advantage of private ownership is the incentive that private property rights creates to take account of the interests of others. For example, coalitions of charter boat owners or of recreational fishermen could sublet or purchase property rights from a fishermen's cooperative or corporation during a particular time of the year, in a particular area, or *in toto*. This has, in fact, occurred in salmon rivers in Great Britain, and is being discussed in Iceland and elsewhere (Anderson and Leal 1991). In addition, conservation organizations could solicit funds from the public to purchase species or area-specific property rights, including rights to fisheries that interact with marine mammals. This is not unlike what the Nature Conser-

vancy does to preserve rare wildlife throughout the United States and internationally. Also, a private owner might maximize the joint use of its resource, just as the National Audubon Society leases oil and grazing rights to parts of its bird sanctuary at the Rainey Wildlife Sanctuary in Florida (Stroup and Baden 1983). Similarly, an oil company could acquire fishing rights to areas of the seabed where there is likely to be significant oil or gas deposits. In each case, allocation would be handled efficiently by markets rather than the wasteful political process.

Finally, private owners--whether commercial fishermen, sport fishermen, conservationists, or oil companies--would most likely operate more efficiently than government agencies both in terms of X-efficiency (*i.e.*, using less labor and capital in its operations) and of dynamic efficiency (*i.e.*, technological change). That is, government agencies tend to grow with less accountability for results than what is imposed on the private sector (Anderson and Leal 1991; Stroup and Baden 1983; Wahl 1989; Wolf 1990). Also, government regulations on fishing industries are characterized by attempts to neuter technological change and to interfere with the efficient combination of labor and capital, not to promote or reward efficiency. Finally, if private rights are exclusive and enforced by the state, the resources used in rent seeking and political capture would be put to productive use elsewhere in the economy.

Of course, sole ownership is problematical, but many problems are artificial or political in nature. Past efforts by commercial fishermen to control fishing mortality and markets have been scuttled by the government (Johnson and Libecap 1982), but controlled access, including private ownership of a resource, does not appear to be inherently unconstitutional (Fletcher 1965; Koch 1978). Regarding due process in the Fifth Amendment to the U.S. Constitution, the U.S. Supreme Court has upheld government restrictions on the "right" to pursue a specific vocation when the restrictions are in the public's best interest. Equal protection under the 14th Amendment would not be violated either, assuming that criteria used to develop private ownership did not discriminate. Finally, there also seems to be no basis for the legal "taking" of a property right to fish resources, to access, or to capital if, once again, the activity is detrimental to the public's well-being, as resource depletion appears to be.

There is also much mischief surrounding claims that private ownership is tantamount to monopoly whereby the owner can, as is often remarked, deplete the resource and "arbitrarily" raise prices. First, a private owner is not a monopolist unless he is the only supplier of a fish product and, therefore, is the only company facing market demand. This possibility appears unlikely as a rule, though, because the United States imports roughly 50 percent of its seafood.

However, even if a monopoly emerged in certain fisheries, it is unclear whether it would threaten the resource or subtract from efficiency. Consider the evidence. Munro (1982) showed that even a bilateral monopoly in both the harvesting and processing sector could yield more benefits than open access under state ownership. Also, in addition to the Sherman Antitrust Act, which was used between the 1930s and 1950s to dismantle fishermen unions and trade organizations (Johnson and Libecap 1982), contestable market theory argues that in order to discourage entry of new firms, a monopolist would not necessarily undertake monopoly pricing (Baumol *et al.* 1982). Moreover, the rate at which a monopolist harvests a fish resource would depend, in part, on the balance among the rate of return on his highest paying alternative investment (reflecting the monopolist's discount rate) and on the expected growth in the value of the asset. Asset value is determined by expected prices and future technology, not merely the intrinsic growth rate of the fish stock as some people claim. Accordingly, the apparent growth in the demand for fish--stimulated by its health benefits and soon to be accelerated by a seafood inspection program (Edwards 1992)--would deter depletion. Also, even if a monopolist were inclined to deplete a fish resource, conservation organizations could purchase harvest rights from the owner; plus, there is the Endangered Species Act. Finally, it is arguable whether a monopolist with unattenuated property rights poses the same threat that competitive fishermen with uncertain rights in a state ownership regime present to a fish resource.

EXPERIENCE WITH SOLE OWNERSHIP

The abstract notion of sole ownership of marine fish has been known for some time. Recently, though, Keen (1983, 1988) has advocated sole ownership in practice. Although examples of sole ownership--or arrangements that resemble sole ownership--are many, assessments of their performance are difficult to find either because the data are private or because data were never collected for hypothesis testing. Only a few instances related to sole ownership follow.

Transferable Fishing Rights

Scott (1988) described a theoretical progression from open access to limited entry or individual quotas and then to private ownership provided that transfers of licenses or quotas are not encumbered by government regulations or politicians. This would occur as rights to the resource become concentrated by the most efficient fishermen (or other claimants) who seek to capitalize on the value of the resource. Although there are relatively few controlled-access programs throughout the world, it is interesting to note where such a progression has taken place.

In their review of individual quota fisheries worldwide, Muse and Schelle (1989) reported a number of cases when the governments of Australia, Canada, Iceland, and New Zealand abandoned limited entry for individual quotas. In addition, quotas in these ITQ fisheries have been consolidated. For example, during the first two years of ITQ management in New Zealand, the total number of quota holders decreased by only 6 percent; however, the number of quota holders with more than 50 tons decreased nearly 40 percent, and the amount of quota

held by the top 10 owners increased from 57 percent to 80 percent (Sissenwine and Mace 1992). Similarly, in Atlantic Canada where fish markets tend to be vertically integrated as in New Zealand, the four processing companies that owned the majority of the total allowable catch merged into only two corporations within two years (Muse and Schelle 1989). Finally, rights to the western Australia prawn fishery, which initially were issued to several processors, soon became concentrated into fewer companies (Meany 1979).

State Ownership of Pacific Fur Seals

Unlike the cases where private companies harvested the fish resources, it was the U.S. government that ran the business of Pacific fur seal harvests. After purchasing Alaska in 1867, the United States adopted Russia's policy of harvesting only bachelor seals in its two, sequential, 20-year leases with private companies. Each year, the lessee paid the U.S. government a rental fee and royalties on pelts. However, by the early 1890s, technological advances enabled harvesters from the United States, Canada, and, later, Japan to take fur seals at sea, effectively undermining the lease and subjecting the resource to open-access exploitation for the first time since the Alaska purchase. For several years, Canada's pelagic sealers incorporated into a single company which, by retiring vessels, increased profits by one-third (Wilen 1976). However, by the early 1900s the open-access conditions depleted the Pribilof herd once again.

By 1911, the United States convinced Canada, Japan, and Russia to sign the North Pacific Fur Seal Treaty, which has been extended by a number of interim agreements (National Advisory Committee in Oceans and Atmosphere 1984). In return for ending pelagic sealing, the United States agreed to pay Japan and Canada each 15 percent of the total gross earnings annually from the harvest of fur seal pelts. However, unlike during the preceding leases, it was the U.S. government who hired Aleuts to harvest, and an auctioning company to process and sell, the pelts. The U.S. government transferred ownership of pelts at auctions.

Between 1911 and 1980, Alaska and the U.S. Treasury profited from tens of millions of dollars of resource rents from the harvest of fur seal pelts. State ownership by the U.S. government, carried out by NMFS and its predecessors, achieved a level of resource conservation and economic efficiency that was impossible under earlier periods of open access.

In retrospect, though, mistakes were made. In particular, managing on the basis of sustainable biological yield caused NMFS to miss the slump in the global market for furs in the 1980s. By then, environmentalists opposed to killing marine mammals achieved political power, and consumers revaluated their preferences, causing the demand for fur coats to crash. Yet, NMFS continued to harvest at sustained yield targets, resulting in thousands of pelts being inventoried (National Advisory Committee in Oceans and Atmosphere 1984). In addition, there is evidence that Japan, which believes that fur seals compete with fishermen, pressured the United States to reduce the size of the Pribilof herd. As a result, during the 1950s and 1960s, the United States reversed its policy of not harvesting females. Although it is not clear what else might have been done to appease the Japanese, this event illustrates how politics can undercut attempts to achieve optimum yield.

Common Property

For centuries, coastal communities and groups of fishermen throughout the world controlled access to nearby fish resources by establishing territorial use rights, or "TURF" (Christy 1982). A TURF is most easily established for sedentary resources, such as oysters, mussels, and seaweed, and in closed bodies of water, such as ponds and lagoons. However, TURFs have also existed along beaches, on coral reefs, and in open water above areas where fish aggregate.

Like area licensing, a TURF is based on rights to intertidal or submerged land. However, when growth of the resource is not significantly affected by activities outside the TURF, the situation is tantamount to private ownership. Accordingly, leased shellfish beds, raft cultures, and penned fish cultures are examples of private ownership of wild fish populations.

Agnello and Donnelley (1975, 1979) compared production from open-access and private leasehold oyster beds along the coasts of the Atlantic Ocean and Gulf of Mexico. Unlike oystermen in private leasehold areas, oystermen working the open beds did not replace cultch or seed the beds because they alone would not benefit from such husbanding activities. As a result, oysters were harvested before they grew to an optimum size, and landings were unbalanced seasonally because fishermen "raced" to get their share of the beds. The overall effect of these differences in the Chesapeake Bay was a 60-percent-larger catch per unit effort (CPUE) from private leaseholds, even though these grounds were ecologically less productive than their public counterparts (Agnello and Donnelley 1975). Also, in the Gulf of Mexico, average income was four times greater for fishermen working private beds, other things held constant (Agnello and Donnelley 1979).

Finally, the lobster "fiefs" in Maine (where fishermen from certain harbors exclude outsiders from their historical territory and self-regulate their effort) can be compared to production elsewhere in Maine where lobsters are harvested under open-access conditions. Wilson (1977) reported CPUE to be 60-percent greater and gross income to be 40-percent greater for fishermen harvesting lobsters from strictly controlled areas. Acheson (1987), in a more carefully controlled analysis, corroborated Wilson's findings and further reported that fishermen from strictly controlled areas used fewer traps and caught larger lobsters, bringing the fishermen a higher price per pound.[5]

[5] Not all factors could be controlled, though, as one might do in an experiment. It is possible, therefore, that the greater productivity of lobster fiefs is due to the habitat. Yet, even if this was true, it is also conceivable that lobstermen defend only the most productive areas.

POLITICAL ECONOMY OF NATURAL RESOURCE MANAGEMENT

By moving toward political allocation and away from the rule of willing consent, we have moved from a society that rewards productive activity and willing exchange to one where many of a person's best investment opportunities lie in influencing transfer activities.

(Stroup and Baden 1983, p. 2)

Scott (1979) observed that management of marine fish resources has not benefited from the broader experiences and knowledge of natural resources management in the United States. Although a thorough review and synthesis of the vast natural resource management literatures was infeasible, our preliminary findings help to place the management of fish resources into a broader picture.

HARD MINERALS

Libecap explains why the establishment of private rights to hard minerals on federal lands took place rapidly and completely--more so than for any other natural resource in the United States. Beginning with the California Gold Rush of 1848, rich deposits of gold and silver were discovered on unclaimed and unsettled federal land, particularly in California and Nevada (Libecap 1989).[6] In order to avoid imminent open-access losses from a rush of miners, regional mining camps quickly arose and outlined procedures for claiming, enforcing, and exchanging private mineral rights to the gold and silver deposits. Later, the camps' regulations were incorporated into state legislation and judicial rulings throughout the West. Moreover, the regulations were specifically recognized in the federal mining laws of 1866 and 1872, which allowed for the private patenting of federal mineral land. Within this legal framework, private property rights were codified.

Private rights to hard minerals were completely and rapidly institutionalized for a variety of reasons, setting hard minerals apart from federal holdings of forests, grazing lands, and water resources at the time. First, the contracting parties reasonably expected to share in the large potential mineral value without disruptive distributional conflicts.

Second, the contracting parties were small in number and relatively homogeneous with regard to race, culture, skill, and technology. Most miners had similar experiences and expectations regarding legal institutions and private ownership. Also, there generally were no significant, competing interests in the mining regions, except in parts of California where agriculture also spread rapidly. Commonalities eased the way for politicians in state and federal governments to establish property rights.

Finally, the contracting parties had equal information on the valuation and marketing of individual claims; therefore, the risk and suspicion that can emerge from asymmetric information was not a problem.

Except for certain sand, gravel, and tin deposits, nonfuel seabed minerals in U.S. waters are of uncertain magnitude and are too costly to produce when compared to other mineral sources on land (Broadus 1987). Nevertheless, access by private parties to explore and develop mineral sites is available through an auction leasing procedure provided for by the Outer Continental Shelf Lands Act and administered by the Department of Interior.

PETROLEUM

In striking contrast to hard minerals, production of petroleum resources in the United States has been plagued by open-access losses ever since oil was first discovered in 1859 (Libecap 1989). Although federal and state governments lease the overlying land to private parties, ownership of a shared oil or natural gas reservoir often dissipates much of the resource value. Oil fields are inefficiently capitalized with too many wells and with storage tanks that hold vast amounts of oil which could otherwise be stored in the ground. The too rapid extraction also increases production costs because subsurface pressures are inefficiently vented and because large quantities of the resources become trapped in geologic formations. For example, in 1926 the Federal Oil Conservation Board reported oil recovery rates of only 20-25 percent under competitive conditions, versus an estimated 85-90 percent under controlled withdrawal. Much of the residual pools are now accessible to advanced oil and gas extraction technologies, but only at added social costs.

Fieldwide unitization has long been regarded as a solution to competitive extraction of a shared pool of oil or gas. Under unitization, production rights are delegated through negotiations among lessees to a single firm--the unit operator--with net revenues apportioned among all parties on the field (Libecap 1989). In addition to yielding a more efficient time-stream of production, fieldwide unitization eliminates the incentive to overcapitalize production, and it increases the amount of oil or gas that is recovered from a reservoir. For example, early unitization of oil fields in the western United States would have increased recovery with existing technologies by up to a factor of five (Libecap 1989).

The obvious aggregate gains to society of recovering more oil and natural gas over time and at lower costs resulted in the Mineral Leasing Act of 1920, which promoted unitization on federal lands. At present, in states such as Wyoming, the Bureau of Land Management in the Department of Interior facilitates unitization immediately after a field has been discovered when lessees are still inclined to prorate future net revenues according to their acreage. In contrast, on nonfederal land, such as in

[6] Prior to the California Gold Rush, Congress experimented with leasing mineral lands when copper and lead deposits were discovered in the Midwest. However, by 1846, high enforcement costs caused Congress to abandon leasing and to sell land with lead and copper deposits.

Oklahoma and Texas, unitization is disallowed by law until after lessees accumulate private information about their parcels. Asymmetric information and strategic behavior usually undermine a consensus on the value of each negotiator's lease until after much of the resource's value is dissipated (Libecap and Wiggins 1985; Wiggins and Libecap 1985).

The different approaches used on federal and state lands is due to the political power of small producers (Libecap and Wiggins 1985). Oil resource legislation in Oklahoma and Texas awards the most productive leases to small companies who further benefit from individual well quotas that are proportionally greater than the apparent productive capacity of their holdings. When negotiating unitization, small producers generally refuse to surrender this advantage.

The Department of Interior also encourages fieldwide unitization on the continental shelf, but here, too, a well quota policy called "maximum efficient rate" is usually adopted (Mead *et al.* 1985). Having nothing to do with economic efficiency, the maximum efficient rate is that physical production which, if exceeded, results in a significant loss of recovery of oil. However, many of the open-access problems listed here characterize the "maximum efficient rate," although to a lesser degree. Similar to ITQs in fisheries, owners of well quotas maximize the net value of their quota, not of the reservoir. To achieve social benefits for society, Mead *et al.* (1985) recommended that the Secretary of the Interior either exercise his statutory authority to compel unitization, as provided by the Outer Continental Shelf Lands Act of 1953 as revised, or that oil tracts encompass entire oil fields, thus avoiding the social transactions costs of the unitization procedure.

FORESTS

America's early forest policy is best characterized by effort controls in an otherwise open-access system--not unlike fishery management. However, the apparent wasteful harvest of the Great Lakes pineries, plus a desire to promote settlement of the West, led Congress to grant or sell millions of acres of forestland to railroad companies and thousands of small businesses by the turn of the 20th century (Deacon and Johnson 1985).

Intending to settle the West, Congress objected to widespread speculation in timber futures and consolidation of forestlands into large timber corporations. These events led to the General Reform Act of 1891 which granted U.S. presidents the authority to retain the remaining federal holdings for public management.

Under Gifford Pinchot's leadership, the Forest Service initially dedicated itself to using scientific principles of sustained yield for the strictly utilitarian purpose of efficient timber production for the benefit of the nation. However, Pinchot did not see that the "looting" of the Great Lakes pineries was due to a lack of property rights to the resource, not necessarily to any shortsighted greed of private companies (Deacon and Johnson 1985). Indeed, by 1950, silviculture on millions of acres of private timberlands had surpassed the Forest Service's ability to manage the public domain "scientifically."

The Forest Service's current policy of an invariant sustained yield year after year--or what it calls "nondeclining even flow"--has been criticized.[7] Long-term production of timber from public lands could be much greater if appropriate mature, unproductive stands were harvested and the areas replanted. Also, in order to achieve its biological goals, the Forest Service subsidizes private companies to harvest from uneconomical areas that often are not replanted. This policy is defended on the grounds of stabilizing income and employment in local communities; however, because Forest Service operations actually destabilize timber markets, the timber industry and jobs have been moving to the southeastern United States (Deacon and Johnson 1985).

Other uses of forestlands, particularly recreation, wildlife protection, and minerals production, are not being met by the Forest Service either. For example, Clawson (1976) estimated that during the 1970s a more efficient forestland policy could have simultaneously increased timber production by a factor of two or three; expanded wilderness areas three- or fourfold; and more than doubled recreational opportunities. Multiple use conflicts in forestlands have increased greatly since the 1970s.

RANGE

By the 1880s, millions of acres of federal land had been transferred to private ownership under the Homestead, Preemption, and Desert Land Acts, and through grants to transcontinental railroad companies (Libecap 1981). In order to maximize profits, ranchers who owned their land adjusted stocking levels in response to range and market conditions, invested in wells for irrigation, and built fences to retain cattle. In contrast, the overstocking of public range depleted palpable plants and precluded ranchers from husbanding their stocks of cattle and sheep.

As consumer demand for meat increased, ranchers on public lands attempted to resolve the open-access problems by forming cooperatives and imposing extralegal regulations. When the cooperatives weakened and the technology to produce affordable barbed wire became available, ranchers fenced lands which they perceived theirs.

The Taylor Grazing Act of 1934 recognized existing land use arrangements and provided ranchers with a formal definition of their land claims (Libecap 1981). Although title to the land remained with the government, grazing permits, which were leased for up to 10-year periods, were automatically renewed, and they were transferable. Advisory boards of ranchers recommended grazing privileges, carrying capacity, and stocking levels that were widely accepted by the Grazing Service and, later, by the Bureau of Land Management. In addition, the Grazing Service subsidized ranching by building roads, fences,

[7] The Bureau of Land Management, which holds large tracts of forestland in Oregon and California, has a similar harvest policy and is subject to the same criticisms.

and wells. All things considered, the market value of grazing permits during this period reflected the extant property rights and productivity of the grazing lands.

Much of the waste associated with open access to federal rangeland subsided until the Federal Land Policy and Management was passed in 1976, finally empowering the Bureau of Land Management to pursue its goal of dismantling property rights on public rangelands (Kremp 1981; Libecap 1981). Long-run management for sustained yield and multiple uses currently is determined politically in allotment management plans. Security of tenure has been eroded by short term permits. At the extreme, some areas, such as the Rio Puerco in New Mexico, have reverted to open access.

WATER

Much of the federal government's involvement in water resource management concerns use of surface waters in the West.

During the 1800s, farmers, ranchers, and miners vied for use of streams and lakes in the arid West. Private irrigation projects characterized this period, but by 1900 most companies were in debt (Anderson and Leal 1991).

Despite clear signals from private water markets that irrigation of the arid lands was too costly, Congress realized that irrigation was required for settlement. Thus, the Reclamation Act of 1902 was passed, establishing a fund from the sale of public land that was used by the newly created Bureau of Reclamation to survey the West's topography and to construct and maintain irrigation works, particularly dams (Anderson and Leal 1991; Wahl 1989). Settlers who benefited from the irrigation projects were supposed to repay the no-interest loans within 10 years.

What began as a modest federal assistance program in 1902 has mushroomed into a classic "pork barrel" for wealthy farmers and ranchers (Wahl 1989). Throughout the past 80 years, numerous irrigation and other water projects were constructed. However, the Bureau of Reclamation and Congress have deferred, extended, reduced, and, in some cases, forgiven repayments in response to constituents' pressures. Interest is charged on municipal and industrial projects, but interest rates are well below market levels. Recently, Congress attempted to recover more of its loans through the Reclamation Reform Act of 1982, but constituents convinced the Bureau of Reclamation and the Interior Department to repeal the act and to write rules that weaken its enforcement.

In addition to financial costs to taxpayers, the social economic costs of federally subsidized water projects are great. Vast subsidies of inefficient water projects and of water (and hydroelectric) prices waste capital, labor, land, and water that could be put to more productive uses in the economy. Production by some large corporate farms competes with output from farms in the Midwest and South that are not subsidized. Also, other valuable uses of surface waters, particularly commercial fishing, recreational fishing, wildlife protection, and industrial inputs, are not adequately taken into account (Anderson and Leal 1991; Huffman 1983). Subsidies also induce farmers to cultivate unproductive land, resulting in erosion, wetlands loss, and pollution with herbicides and pesticides.

Water districts that regulate use of groundwater and surface water have removed part of the waste associated with open access. However, in most cases, a morass of laws and regulations restricts surface waters (and groundwater) to their original uses, resulting in misallocations on a grand scale (Wahl 1989).

WILDLIFE

Lessons from open-access exploitation of terrestrial wildlife resources are relevant to this investigation of sole ownership, but a literature review must await future work. Suffice it to say (for now) that the earlier extirpation of many species (*e.g.*, bison, mountain lion, grizzly bear) from much of their original range, and the earlier extinction of other species (*e.g.*, passenger pigeon), have some parallels to exploitation of marine fish resources.[8] Also important to learn is whether state ownership of fish and game is optimal, and whether rent seeking by sportsmen/women and conservationists has dissipated the resource rental value of wildlife.

LESSONS FROM PUBLIC-CHOICE LITERATURE

Ownership of natural resources in the United States covers the gamut of possibilities. Prior to the 1900s, the U.S. government sold thousands of acres of mineral lands in the West, particularly in California and Nevada (Libecap 1989). Over a billion acres of forest, range, and farmland were also sold or granted during the 18th and 19th centuries, but by 1900 the remaining federal holdings of such lands were retained for management by the Forest Service and the Bureau of Land Management (Anderson and Leal 1991). Water districts own or control access to much of the water supplies in the West, but federal and state governments play a strong oversight role (Wahl 1989). The right to extract energy resources or hard minerals from public lands are auctioned by the federal government, including rights on the continental shelf (Libecap 1989; Mead *et al.* 1985). It appears, then, that federal holdings of only living marine resources and, to an extent, grazing lands are still subject to open-access exploitation.

Not all forms of sole ownership are equally effective at allocating resource use over space and time, however. Political economists who have studied the management of natural resources emphasize the scope for "government failures" that accompanies state ownership (Anderson 1983; Anderson and

[8] Lund (1980) has reviewed open-access exploitation of wildlife in the United States.

Leal 1991; Deacon and Johnson 1985; Libecap 1981, 1989). Natural resource agencies, such as the Forest Service and the Bureau of Land Management, are vulnerable to pressures brought to bear by competitive lobbyists who work hard to sequester resource rents at the expense of taxpayers and production elsewhere in the economy. As a result, resource rents that were once dissipated by open-access exploitation are now dissipated in the political arena.

Also, public-choice economists argue that despite a commitment to public service, politicians and regulators often lack incentives to optimize national benefits (Anderson and Leal 1991; Deacon and Johnson 1985; Stroup and Baden 1983; Wahl 1989). That is, politicians and regulators do not benefit from efficient resource harvest, nor do they incur the costs of inefficiency. Instead, rewards often come in the form of power, prestige, and perquisites (Anderson and Leal 1991). Accordingly, rent seeking probably also characterizes state ownership of marine fish resources. For example, claimants in New Zealand are working hard to redistribute the abalone ITQs (Scott1993. This expenditure of time and effort adds nothing to New Zealand's gross national product. And in the United States, the federal government has used antitrust legislation to break up fishermen's unions and associations in the Gulf of Mexico shrimp fishery, even though vast imports of shrimp make it unlikely that these organizations enjoyed monopoly power (Libecap 1989).

SOLE OWNERSHIP OF NORTHEAST GROUNDFISH RESOURCES

The cod fishery, the herring fishery, the pilchard fishery, the mackerel fishery, and probably all the great sea fisheries, are inexhaustible: that is to say that nothing we do seriously affects the number of fish. And any attempt to regulate these fisheries seems consequently, from the nature of the case, to be useless.
(T.H. Huxley, writing in 1883; see Gordon 1954, p. 126)

To promote a serious discussion of sole ownership, a strawman for the multispecies groundfish resources in the U.S. portion of the Northwest Atlantic is begun here. **Keep in mind the exploratory nature of this exercise, however. The utility and feasibility of sole ownership should not be hastily discarded because of weaknesses in our strawman.**

The Northeast groundfish resource and fishery present a number of challenges to sole ownership. First is the multispecies nature of the resource with species associations that vary in space and time. Second, the populations of several species are already depleted, including Atlantic cod, haddock, and yellowtail flounder that form the mainstay of the fishery. Third, the fishery suffers from excessive amounts of capital and labor--much more than are necessary to achieve maximum economic efficiency (or maximum sustainable yield, for that matter); therefore, the problem of how to retire vessels and gainfully employ hundreds of fishermen must be dealt with. Fourth, multiple uses of the groundfish resources and environment involve recreation, marine mammal protection, and, potentially, oil and gas exploration/extraction. Finally, groundfishes range throughout federal, Canadian, and, to an extent, state and international waters.

NORTHEAST GROUNDFISH RESOURCES AND FISHERY

The current Northeast Multispecies Fishery Management Plan lists 13 species for management, including Atlantic cod, haddock, and yellowtail flounder (New England Fishery Management Council 1991). Groundfishes are caught primarily by the otter trawl fleet, although recreational fishermen reportedly take about 10 percent of total landings (Conservation and Utilization Division, Northeast Fisheries Center 1991). Other species associated with commercially important groundfishes include the spiny dogfish, skates (*Raja* spp.), and sand lances (*Ammodytes* spp.), an important food source for some whales as well as other fish. The otter trawl fishery involves about 1100 vessels and employs an estimated 5300 fishermen.

Northeast groundfish species migrate seasonally and interact with each other and pelagic species depending on the stage of their life cycle and the time of year. The trophic structure is complex, including predation by elasmobranchs, mackerels (on postlarval fish), and seals, although to an unknown degree.

The Northeast groundfish resource is even more depleted today than before the Magnuson Act took effect in 1977 (Conservation and Utilization Division, Northeast Fisheries Center 1991). Effort on Atlantic cod, haddock, and yellowtail flounder--species preferred by consumers--is at record high levels, and landings and stock abundance are near their historical lows (Anthony 1990). The fishery now survives on small adults of these species and on landings of previously underutilized stocks, some of which, including pollock, American plaice, and witch flounder, are now depleted.

Recently, Edwards and Murawski (in press) estimated a simple bioeconomic model of the New England otter trawl fishery in order to begin to answer questions about losses in seafood and economic value resulting from open access to the resource. They reported that in order to achieve an estimated increase in net economic value of about $150 million annually in the United States (90 percent in resource rents and the remainder in consumer surplus), stock size should be seven times larger and fishing effort should be reduced by 70 percent. Under these circumstances, harvest is predicted to increase by 40 percent over 1989 landings, or by three times what could be sustained by the 1989 stock size. This latter comparison translates into an additional six pounds of fresh fish per capita to the diets of New Englanders.

SOLE OWNERSHIP OF NORTHEAST GROUNDFISH RESOURCES

The Edwards and Murawski (in press) study begs the question of what policy could replace open access in order to achieve maximum economic efficiency in the Northeast groundfish fisheries. Certainly, limited entry would be ineffectual in a fishery with substantial amounts of excess effort and capacity.

The use of ITQs for landings or fishing effort eventually could lead to an increase in stock size and yield, and possibly to a net return to the nation for its investment in fishery management, depending on the social costs of monitoring and enforcing quota, on rent seeking, and on X-inefficiencies in the government. In light of the evidence against state ownership, an ITQ system may not give rise to efficiency in the long run, though. Fishermen probably would not husband the groundfish resource because they would not have exclusive property rights for its use. Given rights only to a share of the total fishery quota, individual fishermen would discard bycatch and would highgrade catches because of price differentials that vary sixfold depending on the species and size of groundfish. Furthermore, resource rents would be dissipated by a wide variety of claimants without making a net contribution to the gross national product. And, as reported by Button and Weyman-Jones (1992), government agencies tend to be more X-inefficient than the private sector.

The remaining possibilities are common property or individual private ownership.

What Species and Area Would Constitute Private Property?

Sufficient information to partition the Northwest Atlantic into ecologically and technologically coherent sole ownership resources may not exist. For example, the relative abundance of elasmobranchs and gadids on Georges Bank flip-flopped since the Magnuson Act took effect, but the nature of the ecological interactions between these groups of species is unclear. Also, the impact of trawls and dredges on benthos is poorly understood. Because of such unknowns, the sole ownership of groundfish resources initially would be defined in terms of major oceanic and geographic features along with what is known about species associations.

Overholtz and Tyler (1985) and Gabriel (1989) used cluster analysis to define Northwest Atlantic demersal fish assemblages and to investigate their persistence over time. Their analyses used data from 10- to 15-year time series of otter trawl catches from a stratified random survey. Therefore, the species and site clusters may reflect more a technological than ecological basis, although a positive correlation is apparent.

Regarding Georges Bank, Overholtz and Tyler (1985) identified five assemblages with relatively stable geographic boundaries and little overlap. Some assemblages showed seasonal shifts in location between spring and fall; however, others remained stable. The assemblages consisted of ubiquitous species, resident species that were present in only one or two assemblages, and periodic species (seasonal migrants). In addition, some species were present in different assemblages at different life history stages. This study suggests that species associations persist in definable locations which might be amenable to defining resources for sole ownership.

A similar study by Gabriel (1989) examined assemblage structure in the larger area between the Scotian Shelf and Cape Hatteras during the autumn. In general, groupings coincided with major geographical features, for instance, the Scotian Shelf, the Gulf of Maine, and Georges Bank. Southerly groups varied spatially from year to year, reflecting the generally more migratory nature of Mid-Atlantic and Southern New England stocks.

If the groupings in Gabriel's (1989) study encompass autonomous assemblages of species, then the Gulf of Maine, Georges Bank, and Southern New England - Middle Atlantic Bight could qualify as three areas for sole ownership. However, if groundfishes migrate among these areas to a degree that catch by the owner in one area would affect catch and recruitment to the area whose rights are owned by a different entity, then the entire Northeast U.S. Shelf Ecosystem may be the appropriate areal extent of sole ownership.

Geographic coverage also raises jurisdictional questions. Harvest of groundfishes from international waters appears to be negligible. Also, less than 5 percent of total U.S. landings of groundfishes are harvested within state waters. Therefore, states' rights would not appear to be a barrier to establishing common property or individual private property in groundfishes, with the possible exception of winter flounder. In contrast, though, Canada harvests considerable quantities of groundfish from the northeast peak of Georges Bank, including Atlantic cod, pollock, and haddock. For sole ownership to work, the United States would have to negotiate harvest agreements with Canada. Negotiation would also be a requirement for any successful controlled-access policy, however.

Should Northeast Groundfish Resources be Publicly or Privately Owned?

With the virtual eviction of foreign fleets and the creation of regional councils, the Magnuson Act established a state ownership system of fishery management. However, this system is vulnerable to the same type of "government failures" that undermined rational use of other natural resources in the United States as discussed earlier, particularly renewable resources. Rather than pursue economic efficiency, which benefits regional fishermen, seafood producers, and consumers, the regional councils have attended to the short-term financial and distributive impacts of their decisions.

Experience from other natural resource agencies casts doubt on whether even NMFS could efficiently manage the

Northeast groundfish resources with such a large number of heterogeneous fishermen and other claimants. The previously successful management of Pribilof fur seals by NMFS and its predecessors was not plagued, until the 1980s, by competing interests in the resource. In contrast, many competing groups of "rent-seeking" commercial fishermen (identified by gear types and states), recreational fishermen, and conservationists would lobby NMFS and Congress for favorable shares of the limited fish resources. Libecap (1989) also argues that politicians and government officials have vested interests in maintaining control over fish harvests.[9]

Alternatively, there is common property or individual private property. Eliminating the tax burden required to support research, management, and enforcement by NMFS, the regional councils, and the U.S. Coast Guard in the Northeast would be a financial boon to taxpayers and, conceivably, the economy. In addition, private parties would be presented with strong financial incentives to husband groundfish resources for long-run use, and to invest in more efficient and conservation-oriented fishing technology.

Private ownership could take on various forms, including the obvious one-owner, one-resource configuration with, for example, a fishing corporation, a conservation organization, or an oil company. Alternatively, there is common property. One possibility is "unification" similar to that used in oil and gas extraction from a shared pool, including on continental shelf lands as described above. A consortium of "stockholders" might pool their shares of the groundfish resource (or, possibly, shares of landings or effort quota) to make cooperative harvesting decisions. Each fisherman might undertake his harvest, or a unit manager might harvest the resource with profits being shared proportionally. Unification of Northeast groundfish resources would differ from an ITQ policy, though, because only one entity would harvest the resource and because shares are to the stock, not to yield.

Despite its advantages over the likely "rent-seeking" and "government failures" associated with state ownership, many people express reservations about the actual performance of private ownership of Northeast groundfish resources. Foremost is the question of "monopoly" power, but this issue was already addressed earlier.

What Would be Terms of Ownership?

As stated previously, the full economic value of a good or service requires property rights to be well-defined, divisible, transferable, exclusive, and enforceable. Any attenuation of private property rights would influence owners, although some restrictions, for example, against biological extinction, are likely. Exclusive use, transferability, and enforcement are essential, though, particularly for Northeast groundfishes, which could take up to a decade or two to recover from their depleted status.

The subject of royalties should also be made clear, including, possibly, a formula for collecting part of the money-equivalent of resource rents, which still allows the owner to make a competitive return on investment and to invest in research and development. The resource rental value may be capitalized in a single lump-sum payment as for oil and gas, or the fee may be collected annually as for use of timber, grazing lands, and water. At present, the Magnuson Act precludes charging fishermen for other than administrative costs, however.

Property rights must also be transferable before a lessee or private owner of Northeast groundfishes will consider the full opportunity costs of its harvesting policy. For example, if transfer was precluded, a private owner might "mine" the groundfish resource throughout the period under his control. Limiting the time horizon of the property rights would only accelerate the mining.

How Would Alternate Uses of Resources and Environment be Factored In?

As mentioned earlier, recreational fishermen harvest 10 percent of total groundfish landings in the Northeast. In addition, seals prey on groundfishes, humpback whales share sand lances with commercially and recreationally important species, and other marine mammals, particularly harbor porpoises, are entangled in nets. Finally, Georges Bank and the Baltimore Canyon are areas suspected to contain oil and gas resources.

Under any form of state ownership, the federal government would be responsible for allocating the groundfish resources over space and time among these competing interests. In contrast to such a "planned economy," the marketplace would readily allocate resources if rights are privately owned. However, transferability is essential for the market mechanism to function properly.

With transferable property rights to the Northeast groundfish resources, the owner could lease or sell rights in time and space to commercial fishermen, recreational fishermen, charterboat associations, conservation organizations, oil and gas companies, or other claimants. Conditions could also be stipulated. For example (and as mentioned earlier), until the Audubon Society obtained what is now called the Rainey Wildlife Sanctuary in Florida, conservationists and capitalists fought in political arenas to determine use of the area. However, now that the Audubon Society is the sole owner, it leases parts of its sanctuary to cattle ranchers and oil companies. The areas and times of year for

[9] Although we could not explore the possibility of an apolitical fish management agency, the existence of the U.S. Postal Service, the Federal Reserve Bank (which determines monetary policy), public education, and police and fire protection indicate the possibilities when matters of vital national interest are at stake.

grazing and extracting oil are chosen by the Audubon Society so as not to affect the breeding and migratory behavior of birds.

What Would be Responsibilities of Public Sector?

The responsibilities of the public sector would be shaped by the form of ownership. Full management and research responsibilities would continue to be the government's responsibility under state ownership. In contrast, private ownership implies the dissolution of the regional councils and the fishery assessment and management responsibilities of NMFS. However, the state would still be called upon to enforce private rights. Without enforcement, property rights would revert to open access.

Also, a number of legal and policy matters would remain the responsibility of the federal government, including negotiating trade issues, settling boundary disputes with Canada and, possibly, the states, and antitrust activities if a private owner managed to develop monopoly power by integrating vertically with the seafood sector of the economy.

How Would Transition from Open Access to Sole Ownership be Accomplished?

Transfer, or "disposal," of federal lands to farmers, miners, railroad companies, and lumber companies occurred on a grand scale during the 18th and 19th centuries. There is also much research on whether and how the government should privatize many of its current services (see Fitzgerald 1988). Lessons from these transfers and research must be deferred to future study, although several practical issues are apparent.

It may be necessary to dissolve the regional council system, even if fish resources remain owned by the state. Congress may have recently moved in the direction of eliminating the regional councils by assigning NMFS the full responsibility to manage large pelagic species. NMFS already has the responsibility to protect marine habitat and protected species, neither of which can be divorced from fishery management.

The possibility of a depoliticized government corporation that hires independent operators to harvest Northeast groundfishes requires further study, beginning, perhaps, with the legislation that created the U.S. Postal Service and the Federal Reserve System.

If fish resources are to be owned privately, then a mechanism for selecting private owners would be needed. Private owners could be chosen at random in a lottery, or property rights could be transferred to the highest bidder(s) in an auction, which is how oil, natural gas, and hard minerals are allocated on continental shelf lands.

A third, and more likely, mechanism for fostering private ownership of Northeast groundfish resources recognizes the historical path dependence of change in property rights institutions as discussed by Scott (1988) and Libecap (1989). If ITQs were established, and if market exchanges were not encumbered, then private property might emerge. Impediments to such contracting should not be underestimated, though, particularly in such a heterogenous fishery as that for New England groundfishes.

Whether private owners lease rights from a public agency or own the rights, there is also the issue of whether and how to collect resource rents. Rights to extract hard minerals or oil and gas from federal lands, including on the continental shelf, are auctioned and royalties are collected on production. In addition, the private sector pays the federal government for use of grazing land, forests, and water supplies. At present, fish resources are the only publicly-owned natural resources that are given to harvesters. On the other hand, siphoning resource rents might inhibit investment in the resource and in new, more efficient fishing technology.

Finally, financing the removal of excess labor and capital from the Northeast groundfish fishery could be problematical, particularly if it is not possible to collect resource rents. As argued above, private ownership is not necessarily precluded by the U.S. Constitution. Nevertheless, language in the Magnuson Act--including the prohibition of fees for resource rents--and subsidies for vessel construction have given fishermen the impression of having a "right" to catch fish. Also, preventing use of their capital will be perceived as an illegal taking by vessel owners.

Allowing sole ownership to evolve from an ITQ system would avoid the financing problem. However, direct implementation of sole ownership may require compensation for idled capital and short-term unemployment. As stated above, it may take 5-20 years for Northeast groundfishes to recover from their depleted status, but some initial rents would come from extant prerecruited fish and from reversing production inefficiencies imposed by the New England Fishery Management Council. Private owners might use these rents to compensate others.

SUMMARY AND CONCLUSIONS

The tendency of careful economic study is to base the rights of private property not on any abstract principle, but on the observation that in the past they have been inseparable from economic progress.

(Marshall 1920, p. 48)

This report explored the meaning and application of sole ownership of living marine resources. Its purpose was to promote an informed and timely discussion of the utility and feasibility of instituting common property or individual private

property in marine waters. Accordingly, why open access results in the depletion of fish resources was explained; both public and private forms of sole ownership were characterized; sole ownership was contrasted with other forms of controlled access, particularly limited entry and ITQs under a state ownership regime; the political economy of natural resource management was surveyed; and a sole ownership strawman of the Northwest Atlantic groundfish resource in U.S. waters was begun.

Our major findings and conclusions are as follows:

1. **The overfished status of open-access marine fish resources in U.S. waters stems from open-access exploitation, and results in profligate waste of the nation's fish resources that has been estimated at two-billion dollars a year.** Of all natural resources owned by the United States government, only living marine resources and, to an extent, grazing lands are subject to open access. Fishery quotas and effort restrictions address only the symptoms of open access, not the fundamental problem of a lack of property rights to the resource and its productivity. The waste translates into lost income for the fishing industry and seafood sector of the economy, a lesser contribution to gross national product, and probably less benefits for consumers.

2. **Incentives are fundamental to the presence of both "market failure" and "government failure."** Under open-access conditions, markets "fail" to allocate resources to their highest-valued use. The resultant distrust of markets has led to management by the public sector. However, regulators and politicians do not share the economic benefits of maximum economic efficiency, nor do they incur the costs of inefficient management.

3. **It appears that private ownership is the only form of controlled access that provides fishermen the necessary incentives to husband fish resources.** Neither limited entry nor individual quotas provide fishermen resource rights. Furthermore, private ownership is less susceptible to the political pressures that have undermined management of New Zealand's ITQ fisheries and of other renewable resources by public agencies in the United States. Also, alternative uses of fish resources and the environment, including recreation for the public and food for marine mammals, would be more efficiently allocated by markets than by the political system.

It would be unreasonable to expect us to have answered--or even asked--all pertinent questions regarding sole ownership of living marine resources in this initial investigation. To our knowledge, only the geographer Elmer Keen (1983, 1988) and a few economists in New Zealand (Ackroyd *et al.* 1990; Hide and Ackroyd 1990) have seriously considered sole ownership as a workable fishery management policy. Much work needs to be done, including the following:

1. Fishery management in the United States should not develop in isolation from experiences worldwide. The review of fishery management programs by Muse and Schelle (1989) should be expanded to include TURFs and additional controlled-access fisheries. The historical management of other publicly-owned natural resources in the United States and the world should be reviewed, too.

2. Sole ownership should be more thoroughly evaluated. The various forms of public and private ownership need to be critically contrasted in more detail than presented here. In addition, one might consider whether other forms of controlled access, particularly ITQs, can be designed to facilitate the evolution of sole ownership.

3. The property-rights, contracting, social-cost, and public-choice literatures in political economy should be studied and related to ownership of living marine resources.

4. Some of the needs, pitfalls, and benefits of a "real world" sole ownership fishery could be learned by further developing and reviewing the strawman for Northeast groundfishes.

Given the deficiencies of limited entry and ITQs for achieving optimum yield as directed by the Magnuson Act, the authors recommend that the Northeast Fisheries Science Center and NMFS soon evaluate common property and individual private ownership of living marine resources.

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Jon A. Gibson, Technical Editor
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543-1097 USA
(508) 548-5123x228

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Allen E. Peterson, Jr., Science and Research Director
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Information Services Unit
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National Marine Fisheries Service, NOAA
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