PERC POLICY SERIES

HOMESTEADING THE OCEANS:

THE CASE FOR PROPERTY RIGHTS IN U.S. FISHERIES

By Donald R. Leal

ISSUE NUMBER PS-19
AUGUST 2000

PERC

Jane S. Shaw
SERIES EDITOR

P E R C

502 South 19th Avenue, Suite 211
Bozeman MT 59718-6827
Phone: (406) 587-9591 • Fax: (406) 586-7555
perc@perc.org • www.perc.org

ISSN 1094-6551

The PERC Policy Series
A Select List

PS-19 **Homesteading the Oceans: The Case for Property Rights in U.S. Fisheries**
Donald R. Leal

PS-18 **Federal Land Exchanges: Let's End the Barter**
Tim Fitzgerald

PS-17 **Paying to Play: The Fee Demonstration Program**
Holly Lippke Fretwell

PS-16 **A Trust for Grand Staircase-Escalante**
Terry L. Anderson and Holly Lippke Fretwell

PS-15 **Environmental Progress: What Every Executive Should Know**
Lynn Scarlett and Jane S. Shaw

PS-14 **Bootleggers, Baptists, and Global Warming**
Bruce Yandle

PS-13 **The Common Law: How It Protects the Environment**
Roger E. Meiners and Bruce Yandle

PS-12 **Who Will Save the Wild Tiger?**
Michael 't Sas-Rolfes

PS-11 **The Mining Law of 1872: Digging a Little Deeper**
David Gerard

PS-10 **Back to the Future to Save Our Parks**
Donald R. Leal and Holly Lippke Fretwell

PS-9 **Priming the Invisible Pump**
Terry L. Anderson and Pamela S. Snyder

PS-6 **Conservation—Native American Style**
Terry L. Anderson

CONTENTS

To the Reader

Ocean fishing is often cited as a classic example of the "tragedy of the commons." Overfishing occurs because no owner has the authority or incentive to prevent excessive fishing. Since the mid-1970s, the U.S. government has managed marine fisheries in waters from 3 to 200 miles from shore, yet overfishing has not ended. The reason, as Donald R. Leal explains in this paper, "Homesteading the Oceans: The Case for Property Rights in U.S. Fisheries," is that government control establishes the wrong incentives. Instead, private property rights are needed.

Donald R. Leal is a Senior Associate of PERC (the Political Economy Research Center). He studies institutional arrangements for the management of land, forests, water, and other natural resources. An earlier study, "Community-Run Fisheries: Avoiding 'The Tragedy of the Commons'" (*PERC Policy Series* PS-7) showed how some fishing communities, relying on traditions and custom, avoid the tragedy of the commons.

This essay is part of the *PERC Policy Series*, edited by Jane S. Shaw and produced by Dianna Rienhart. The M. J. Murdock Charitable Trust and an anonymous donor provided financial support for Leal's research and for the publication of this paper, which is available as a PDF file on PERC's Web site, www.perc.org.

"**M**ost U.S. fisheries stocks
are facing a disaster. . . ."
—*Zeke Grader, Jr.*
Pacific Coast Federation of
Fishermen's Association

INTRODUCTION

Nearly twenty-five years have elapsed since the United States government extended federal control over ocean fishing from 3 miles to 200 miles from its shores, primarily to eliminate foreign fishing pressure on declining fish stocks. Unfortunately, federal control has not eliminated overfishing. A 1999 report to Congress by the U.S. Department of Commerce's National Marine Fisheries Service (NMFS) listed 98 species as overfished—that is, experiencing fewer or smaller fish each succeeding year because of too much fishing—with another five species approaching an overfished condition. For 674 fish species, or 75 percent of all species it assessed, the agency does not know whether they are overfished or not (NMFS 1999b).

Overfishing stems from a combination of government failures and the response of the fishing sector to these failures. "Most U.S. fisheries stocks are facing a disaster due to overcapitalization of the fishing industry and the mismanagement practices of the U.S. Department of Commerce's National Marine Fisheries Service and their appointed regional councils," says Zeke Grader Jr., executive director of the Pacific Coast Federation of Fishermen's Association (quoted in Sutherland 2000).

In the end, the taxpayers pay. According to a study by the Marine Fisheries Conservation Network, since 1994 taxpayers have spent more than $160 million in federal assistance to fishers hurt by stock collapses in New England, Alaska, and along the West Coast. And Congress is about to consider an additional $421 million in disaster relief for fishers impacted by recent collapses in groundfish, crab, and salmon stocks in those regions (Lazaroff 2000).

This paper examines the failure of government regulations to halt excessive harvesting capacity and stock depletion in U.S. fisheries and recommends policy reforms based on well-specified property rights. It will discuss fisheries that are using individual transferable quotas and give examples of exclusive access rights to local fisheries.

THE OCEAN COMMONS

The fundamental reason for depleted fisheries has been known for decades.[1] Ocean fisheries provide the classic case of the "tragedy of the commons,"[2] in which lack of ownership of jointly exploited fish stocks often leads to depletion of the stocks.[3] There are two reasons for this outcome.

- Fishers cannot save fish for the future; if they restrain their harvest to leave enough to reproduce for the following season, the fish may be taken by someone else. Without ownership, any fish left remains available for harvest by any other fisher. The rule of capture prevails.

- Each fisher can capture all the benefits of catching more fish while facing only a fraction of the costs—the harm caused by overfishing—because the cost of stock depletion is split among all the fishers. As a result of this disparity between full benefits received and fractional costs paid, there will be too many fishers in the fishery and too many fish taken. This is the tragedy that no one wants but that commons tend to dictate.

In a commons situation, entering the fishing grounds first and capturing the fish fastest is a compelling strategy. This is the time when search and capture costs are the lowest. Thus, each fisher is motivated to invest in equipment (e.g., faster boats and better detection devices) that improve the chances of winning the race for the fish—equipment that would not be necessary if the fishery were not under the strain of such competition. Not only do the stocks decline, but fishing becomes wastefully expensive as too many fishers invest in too much capital to catch too few fish.

Because costs tend to rise rapidly as fish become scarcer, fisheries have historically reached commercial extinction before they are totally depleted. The additional costs of capturing the few remaining fish exceeded the returns, so that it became unprofitable to continue.[4] Thus, while extinction may be avoided, the fishery frequently results in a lower-than-optimal (and perhaps severely depleted) fish population and an overinvestment in fishing effort.

Economist Frederick Bell provided one of the first empirical verifications of the overexploitation of a commons fishery open to all. Studying New England's northern lobster fishery in 1966, he found that an efficient output of lobster would have occurred at 17.2 million pounds. To attain this output, the efficient number of lobster traps would have been 433,000 traps. However, during 1966 Bell found that fishers employed too much capital—891,000 traps—to harvest too many lobsters—25 million pounds (Bell 1972, 156).

For many of the world's ocean fisheries, government control has replaced no control (Eckert 1979, 116–47). Today's tragedy is that government control has not halted overexploitation in fisheries but has greatly increased costs.

Regulating the Ocean Fishery

Government regulation has been the primary tool for managing ocean fisheries. However, because government regulators do not own the resource, they typically ignore the economic factors that a private resource owner must consider in order to sustain maximum profits year after year—the situation that reflects the best use to society of the resource. Regulators attempt to sustain the maximum yield of a fishery, that is, allow harvest of the largest quantity of fish that can be caught year after year without depleting the stock. Economists argue that this targeted harvest level is usually higher than the yield that sustains maximum profits (Tietenberg 1988, 258-64). Ross D. Eckert (1979, 124) points out that it does bring higher employment in the short run, and that may be why it is chosen.

Regulations have led to enormous waste. The Pacific salmon fishery provides a classic example. Early in the twentieth century regulators prohibited the use of fish traps such as rock or pole barricades used to trap salmon in tidal waters (Allen 1992, 67). Such devices had been perfected by Indians, who caught the salmon along the rivers of the Northwest when the fish returned from the ocean to spawn. The Indians were careful to allow escapement for future production. With traps eliminated, fishers chased the salmon in the open oceans. They began to use very expensive, sophisticated equipment—equipment that became so effective that salmon continued to be overexploited.

Facing reduced salmon numbers, regulators then restricted the number of fishers and the length of the season. So entrepreneurial fishers bought still bigger boats, better detection equipment, and more efficient nets. To plug these loopholes, regulators then established other layers of regulations setting limits on seasonal catches. The salmon catch was ultimately controlled, but the whole approach was wasteful, as more labor and capital were applied to catch fewer fish. Fishers were forced to fish longer in less productive areas with more expensive equipment (Crutchfield and Pontecorvo 1969).

In addition to overcapitalization, the regulatory process spurred sometimes absurd restrictions. For example, Maryland oystermen at one time could use dredges but had to tow them behind sailboats on all but two days of the week, when motorized boats were allowed (Christy and Scott 1965, 15–16). And in some Alaskan fisheries, fishing boats were required to be no more than

50 feet in length (Crutchfield and Pontecorvo 1969, 46).

Such restrictions often favored one user group over another. After examining a host of data on regulatory policies during the 1960s and early 1970s, economist James Crutchfield concluded that the regulatory process had "generated an ever-increasing mass of restrictive legislation, most of it clothed in the rhetoric of conservation, but bearing the clear marks of pressure politics." The overwhelming majority of these restrictions, Crutchfield decided, reflect "power plays by one ethnic group of fishermen against another, by owners of one gear against another, or by fishermen of one state against another state" (Crutchfield 1973, 115).

During the early 1970s, many fisheries, including those beyond the twelve-mile territorial waters of the United States, were either overfished or on the verge of being overfished (Committee on Commerce 1976). In 1976, the U.S. Comptroller General concluded that these fisheries suffered from three major problems: "common property resources,[5] fragmented jurisdiction, and imprecise biological data." The Comptroller General also found that "many fish stocks were depleted or threatened with depletion through overfishing by U.S. and foreign fishermen and alteration of habitat, and that domestic fisheries management had been uncoordinated and ineffective, causing excess harvesting capacity and depletion of some stocks" (Pautzke and Oliver 1997, 2).

The Magnuson Act and Its Aftermath

The Magnuson Fishery Conservation and Management Act of 1976[6] was supposed to correct these problems by setting a new direction for fishery policy. The law extended federal fishery control beyond the twelve-mile limit to 200 miles offshore, setting the stage for the removal of foreign fishing fleets and the development of domestic fisheries in this newly claimed territory. Foreign fishing had been blamed for overfishing, so the act at least addressed this problem. As for the domestic fishing sector, the act created eight regional councils with the authority to "establish a system for limiting access to the fishery in order to achieve optimum yield."[7] Optimum yield in this case was expected to take into account economic variables, such as interest rates, fish values, and the cost of alternative technologies.

The Magnuson legislation eliminated uncontrolled foreign fishing out to 200 miles from U.S. shores and called for economic considerations in regulatory policy. However, major problems remain. The legislation encouraged licensing entrants to limit the number of fishers or vessels in a fishery, but limiting entrants is only a partial solution. It "cannot prevent crowding, congestion, strategic fishery behavior, racing, and capital stuffing," says one prominent critic. Fishermen still have an incentive to substitute fewer larger boats for more smaller boats. A few powerful fishing vessels can do in a few minutes what used to take days. Thus, Anthony Scott continues, "rising fish prices constrained by a limited number of vessels, and unconstrained by any sort of territorial limit, has led to vastly increased individual fishing capacity" (Scott 1988, 7–8). The bottom line is that the Magnuson Act has not prevented overfishing or the continued buildup of excessive harvesting capacity in U.S. fisheries (NMFS 1999a, 1999b).

Nor has the act improved the government's ability to assess stock conditions in a timely fashion. In 1998, for example, the Marine Fisheries Service reported to Congress that the majority of groundfish species off Washington, Oregon, and California were not overfished and were not even approaching an overfished condition (NMFS 1998). A year later, the Department of Commerce on behalf of NMFS declared the Pacific groundfish fishery a "disaster" due to overfishing. To allow stocks to recover, the total allowable catch had to be drastically reduced in one fell swoop (Sutherland 2000).

It appears that the agency had used three-year old data to make its 1998 stock assessments of Pacific Coast groundfish (General Accounting Office [GAO] 2000, 10). For its 1999 assessment, the agency used more recent information and found that stocks had been severely depleted. A report by the GAO (2000, 4) points out that the such incidents have "led to criticism by fishermen and others who have been adversely affected by fishery management decisions."

Complicating the regulation of commercial fishing is recreational or sport fishing. In 1996, 9.4 million anglers spent 103 million days catching cod, flounder, bluefish, salmon, striped bass, mackerel, and other popular game fish in U.S. marine waters (U.S. Department of the Interior 1996). Saltwater angling enthusiasts have had a greater impact on the size of some fish populations than have the activities of commercial fishers. Sport anglers, for example, are allocated 68 percent of the total allowable catch set by fishery managers in the king mackerel Gulf of Mexico fishery (NMFS 1999a). In 1987, NMFS had to ban commercial fishing of king mackerel after recreational fishermen from Texas through southeast Florida exceeded a 740,000-pound limit (Maranto 1988, 144–50). The growing influence of saltwater sport fishing coupled with commercial harvesting has intensified pressure on U.S. fish stocks.

Given the long history of regulatory failure and growing fishing pressures, it is time to consider policy alternatives. One of these is individual transferable quotas (ITQs). While they are not perfect, ITQs have the potential to get rid of the mess generated by the failure of state and federal authorities to stop wasteful competition and the destruction of fish populations.

Individual Transferable Quotas

ITQs are a relatively recent innovation in fishery management. Typically, an individual quota entitles the holder to catch a specific percentage of the total allowable catch of a season (specified by a government agency). Thus an individual quota holder with a 0.1 percent share in the king mackerel Gulf of Mexico fishery would be entitled to harvest 740 pounds of king mackerel for the fishing season if the total allowable catch is 740,000 pounds. Because the individual quotas are transferable, individuals can add to or subtract from their shares by buying or selling all or a portion of the quotas. Individuals wishing to enter the fishery can buy or lease quota from current quota holders who want to sell or lease all or part of their shares.

An ITQ system is attractive for two main reasons. First, each quota holder faces the certainty that his or her share of the total allowable catch will not be taken by someone else. Thus it removes one of the characteristics of a commons. Under the current system, a fisher's share of the total allowable catch is determined by who is best at capturing the fugitive resources—the situation that leads to waste by encouraging ever more sophisticated and expensive fishing equipment. With ITQs, fishers do not compete for the shares of the total allowable catch, so there is less incentive to race against other fishers.

Second, because trading is allowed, quotas tend to end up in the hands of the most efficient fishers—those with the lowest costs, who can pay the highest prices for the ITQs. Rather than engaging in dangerous and unrewarding battles for fish on the high seas, less efficient producers sell their shares and move to other industries. Thus, ITQs help reduce the cost of catching fish and enhance the quality of the fish delivered to markets. Fishers who adopt cost-reducing or quality-enhancing methods make more money with their quota and are in a better position to purchase quota from those who are less efficient. This is in marked contrast to regulations, which encourage overinvestment in the race for fugitive resources.

INTERNATIONAL EXAMPLES

Several nations employ ITQs as a component of their fishery management systems. Where they are applied, ITQs have had considerable success in reducing the race to catch fish.

New Zealand

By 1981, the New Zealand government realized that its subsidy programs to expand the domestic fishing industry had led to severe overfishing and overcapitalization in many of its fisheries (Arnason 1996, 130). In 1986, ITQs were introduced in twenty-nine inshore and offshore fisheries following the failure of regulations to rectify the problems.

Over the 1986 to 1994 period, the value of fresh fish exports increased from NZ$64 million to NZ$102 million; the value of frozen fish exports increased from $367 million to NZ$565 million; and the value of processed fish exports increased from NZ$5.4 million to NZ$92.8 million (Sharp 1996, 18). In addition, fish stocks were considered generally healthy by 1996. Overall, the value of fisheries, as represented by the market value of the quotas, had grown to nearly NZ$2 billion (McClurg 1997, 103). All of this was accomplished without government subsidies.

In New Zealand, ITQs are property rights. Because their value reflects the health of the fish stocks, ITQs encourage cooperation among fishers in assessing and enhancing the state of fish stocks. For example, overfishing had decimated the paua (abalone) fishery before the introduction of ITQs. Afterwards, quota holders in the Chatham Islands off New Zealand agreed to limit their catch and invest in research, forming the Chatham Islands' Shellfish Reseeding Association to enhance production of paua (Hide and Ackroyd 1990, 42, 44). Similarly, quota holders in the orange roughy, scallop, rock lobster, and snapper fisheries have been investing in research efforts to improve fish stocks (Hartley 1997, 97).

Iceland

Iceland has used ITQs as its main tool in managing fisheries for more than two decades. For example, the herring fishery was suffering from too many vessels and too few fish prior to ITQs. The new system appears to have addressed both those problems. In 1980, the first full year of ITQs, over two hundred vessels caught herring. Fifteen years later, in 1995, there were less than thirty vessels in the fishery. Yet herring had become more abundant under ITQs. The thirty vessels were harvesting twice as much herring as the two hundred did in 1980. Productivity, as measured by catch per unit of effort, has increased by a factor of five.

There is also evidence of more efficient fishing for capelin (a smelt-like fish). Since the introduction of ITQs, the total tonnage of the fleet has been reduced by 25 percent, and fishing effort has contracted, with total days at sea reduced by 25 percent (Arnason 1996, 120–21).

Canada

A growing number of countries are using various forms of ITQs. In the British Columbia halibut fishery, individual (transferable) vessel quotas[8] (a modification of individual fishers' quotas) have helped spread out the harvest over a nine-month period, rather than six days. Now, fishers supply the market with fresh halibut for a much longer period during the year, and their catch commands a much higher price. Furthermore, the number of active vessels has decreased, reducing fleet crew payments and fixed costs (Sporer 1998, 12–13). In a similar way, ITQs in Canada's Atlantic shore crab fishery have reduced the race for crabs, and the fishing season is longer. ITQs in the Gulf of St. Lawrence herring fishery have eliminated excessive fishing effort (Grafton 1996, 159–60, 163).

Australia

Australia's national government is using ITQs for the southern bluefin tuna. Tuna are caught by fishers from Australia, New Zealand, Japan, and several other southeast Asian nations. Problems in coordinating harvest levels among the southeast Asian nations and other factors have forced severe reductions in the total allowable catch for Australia, New Zealand, and Japan over the last decade and a half. Along with reduced catches, Australia needed to lower its fleet capacity for its tuna fishery to remain economically viable.

ITQs helped curb fleet capacity by 60 percent in the first two years of operation (Robinson 1986, 189–205). They have also helped increase the value of the catch. Fishers no longer race to the catch. Instead, they spent more time and resources enhancing the value of the tuna by processing it quickly and storing it properly to avoid spoilage. Both improvements have helped the fishery remain highly profitable in spite of significant reductions in the total allowable catch (Morris 1994).

ITQs are also being applied at the state level in Australia. They have increased fishing productivity—the amount of catch per unit of investment—in the rock lobster fishery off New South Wales (NSW 1999). In South Australia, they helped reduce pressure to harvest abalone too quickly, giving divers time to target the larger and more valuable abalone for harvest (Muse and Schelle 1989, 91). In Western Australia, they prevented overcapitalization in the oyster fishery (North Pacific Fishery Management Council and NMFS 1991).

Northern Europe

Greenland and the Netherlands employ ITQs for some fish. Prior to ITQs, Greenland's offshore fishery in shrimp was largely open access and was plagued by the typical problems. The fishing fleet expanded exponentially and individual catches and profits became progressively smaller. Following the introduction of ITQs, fleet size contracted and individual catches and profits rose (Arnason 1996, 113). ITQs for the Netherlands' flat-fish (mainly plaice and sole) have led to reductions in fleet size and fishing effort. The fishery is now highly profitable (Arnason 1996, 129).

The United States Experience

To date, ITQs have been adopted in fewer than a handful of federally managed fisheries in the United States.[9] Because ITQs are a vehicle for eliminating economic waste in a fishery, they can be controversial. A slower pace of fishing under ITQs may allow vessel owners to fish with smaller crews, thus reducing employment in the short run. Balanced against that is the fact that those who remain will be employed longer during the year.[10]

Another controversy stems from the allocation of ITQs. If they are initially allocated on the basis of catch history, fishers with little or no catch history may feel unfairly treated. While they can enter the fishery by purchasing quota from current holders, they no longer have free access to the fishery. Fishing interests other than the fishers themselves—e.g., processors, dock owners, and suppliers of boats and fishing gear—also may fear that their returns on their investments will be hurt if the fishery is no longer open to all.[11]

Such concerns can pose considerable political obstacles, since politicians are often more attuned to maintaining short-term employment than eliminating fleet excesses that may ultimately destroy a fishery. For many non-ITQ fisheries plagued by overcapacity, those excesses have not yet reached a crisis stage and politicians have opted for the status quo, at least for awhile. Congress imposed a moratorium on adopting ITQs in other federally managed fisheries in 1996, and a decision on whether to lift the moratorium is scheduled for October 1, 2000.[12]

Surf Clam and Ocean Quahog

The longest-running federally managed fishery with ITQs in the United States is the mid-Atlantic surf clam and ocean quahog fishery,[13] for which ITQs were adopted in October 1990. The fishery is currently ranked among the top twenty U.S. fisheries in terms of the annual revenues that fishers receive for their catch (Wallace 1996).

ITQs were adopted because this fishery was plagued by problems, even though it was the first U.S. fishery to be managed under the Magnuson Act of 1976 as a limited entry system. A moratorium was declared on new vessels in 1977, and other measures designed to protect the fish were imposed during the 1980s, including a total allowable catch that was set for each year and for each quarter of the year.

Although these measures protected the resource, the fishery experienced overcapacity and dangerous fishing. Because vessels were required to limit the number of trips and the duration of fishing per trip, fishers tended to fish their allotted time no matter what the weather conditions. During periods of bad weather disaster struck on a number of occasions, resulting in lost vessels and crew. There was still a strong incentive to invest in new vessels and larger vessel gear in order to win the largest share of the annual catch. As vessels and gear became more powerful, allowable fishing time had to be steadily shortened to prevent exceeding the total allowable catch.

This resulted in considerable down time for crew and equipment. By the end of the 1980s, a surf clam vessel was allowed to fish only six hours every other week during the year-long season.

Under ITQs, safety has improved and crew and equipment are more efficiently used. Fishing trips are no longer limited by regulation, and as a result fishers have more opportunity to fish under safer weather conditions. In the five years prior to ITQs, ten vessels were lost. In the five years after ITQs were implemented, only three vessels were lost (Wallace 1996).

In addition, the fishery has been able to downsize without a taxpayer-funded buyout of surplus vessels, which has occurred in other non-ITQ fisheries that have collapsed.[14] As quota owners bought quota from other owners, the number of active surf clam vessels went from 128 in 1990 to fifty in 1997. With excess fleet capacity eliminated, those remaining in the fishery are making better use of their boats and crew. For example, fishing hours per surf clam vessel went from 154 hours in 1990 under the pre-ITQ system to 1,400 hours in 1994 under the ITQ system, and vessel productivity reached record levels. After two years under ITQs, catch per vessel almost doubled to 47,656 bushels (National Research Council 1999, 293; NMFS 1996).

While the ITQ fishery has fewer participants, many small quota holders remain. In fact, today the majority of quota holders have only one or two boats. Before ITQs, small operators were often outfished by large-scale operators who took most of the total allowable catch. With ITQs in place, small operators are guaranteed a fixed share of the catch. As a result, they can fish without the concern of losing out to large-scale operators (Wallace 1996).

Alaskan Halibut

The Alaskan halibut fishery is a more recent example. ITQs were implemented in 1995 in response to a myriad of problems: high fish mortality from abandoned gear, declining product quality, hazardous fishing, and seasonal catches that exceeded the overall harvest level set by managers. The most striking evidence of the problematic nature of the fishery was the extremely short fishing season, a few days a year.

From 1970 to 1994, the halibut fishery had a total allowable catch but no limit on the number of participants. As participants increased, fishery managers responded by shortening the fishing season. Fishers reacted by investing in bigger and more powerful boats. Before long, a season that at one time took several months was down to a few 24-hour periods a year. Under these conditions, fresh halibut from the fishery could be supplied for at most a few weeks a year. The glut of fish on the market during these periods depressed prices, while customers had to accept frozen fish the rest of the year. With the season so short, fishers went out in hazardous weather, and fishing gear was often lost or abandoned, no doubt due to the hectic fishing conditions. (The lost nets still caught fish even though there was no one to take them in.) And in spite of the restrictions, the fishery frequently exceeded the total allowable catch (National Research Council 1999, 306).

Under ITQs, the length of the fishing season increased from an average of two to three days per year (between 1980 and 1994) to an average of 245 days per year. In addition to providing more fresh fish, the longer season has made fishing less hazardous. The annual number of search and rescue missions for halibut fishers reported by the U.S. Coast Guard decreased by 63 percent following introduction of ITQs (National Research Council 1999, 99). Fish mortality due to lost or abandoned gear went from 554.7 metric tons in 1994 to 125.9 metric tons in 1995 (74). In addition, in the first two years of ITQs the actual harvest of halibut did not exceed the total allowable catch (75). Trading of halibut ITQs has been active, and, as a result, the number of quota holders declined by 24 percent between January 1995 and August 1997 (76).

DRAWBACKS OF ITQS

Despite their growing acceptance in other parts of the world, ITQs are not free of criticism. Parzival Copes (1986) argues that ITQs do not eliminate bycatch problems in regulated fisheries. These are fisheries in which the harvest of one species results in the harvest of another species.[15] An ITQ system that encompasses quotas for the mix of species caught in a fishery appears capable of handling the problem, however. In New Zealand's multispecies fisheries, fishers must purchase quotas for each of the species they catch during a single outing. This internalizes the costs of catching each species and compels individuals to adjust their fishing operations to match the quota mix they are willing to purchase. While matching the proper mix of quotas with the actual catch was difficult in the early years, New Zealand fishers appear to have adjusted their operations so that fewer overruns are occurring (National Research Council 1999, 108).

ITQs are also criticized for exacerbating "high-grading," the tendency of fishers to discard smaller fish in hope of catching larger, more valuable ones. One argument is that because ITQs slow the pace of fishing, participants have more time to fish selectively, keeping the larger, higher-valued fish and discarding the smaller, lower-valued fish. High-grading is a problem, however, only if the fish discarded do not survive. With more time to fish, fishers have time to handle the discarded fish properly, so their chances of survival are greater. Fish discarding is often conducted with little care in a highly competitive fishery, where time is of the essence.

Empirical evidence of high-grading in ITQ fisheries is scarce, although it does appear in a few fisheries (Grafton 1996, 164) where monitoring and enforcement are weak. High-grading does not appear in the surf clam fishery because fishers select areas where only large clams reside, and it is insignificant in the halibut and sable fisheries ITQ fisheries (National Research Council 1999, 108–110).

Two other potential problems may negate or reduce the benefits of ITQs. First, because ITQs are generally set by a bureaucratic regime, there is the question of whether bureaucratic managers will establish the efficient level of harvest. In spite of the intent of the Magnuson Act, it is still standard regulatory practice to aim for maximum sustainable yield. As discussed previously, this is rarely the yield that sustains maximum profits year after year. To the extent that fishers can carry quotas over into the next season or catch more in the current season by borrowing against future quotas, they may adjust toward the economic optimum. However, restrictions on quota transfers frequently reduce these options.

Even when sufficient scientific information on the condition of the stock is available to set a safe maximum sustainable harvest, political pressures can cause managers to ignore such information and allow unsustainable harvests. If the total catch is set too high, an ITQ fishery will suffer stock depletion.[16]

Another potential problem with ITQs stems from the time and money that would-be quota holders are willing to invest in lobbying to secure claims to valuable quota rights. In other words, the race to catch fish may be replaced by a race for the quota (Anderson and Hill 1983; Anderson and Hill 1990).

If the quotas are allocated by auction or on the basis of historical catch prior to anticipation of ITQs, such investment will be minimized. However, if quotas are allocated on the basis of historical catch, fishers may overfish in an effort to increase their share of the quota. Alternatively, if bureaucratic discretion determines the allocation, fishers will invest in influencing the decision. In either case, at least some of the potential profits from the ITQ fishery will be dissipated through the race for the property rights.[17]

FULL PROPERTY RIGHTS

Where feasible, a superior approach to either regulation or a politically managed ITQ system is to allow the establishment of full property rights. Exclusive rights to fishing areas are not new; in fact, many of the best examples stem from the past.

Examples, Past and Present

Robert Higgs found that Indians along the Columbia River had well-established rights to salmon fishing sites long before white settlers arrived in the area. "In some cases, these rights resided in the tribe as a whole; in other cases, in families or individuals" (Higgs 1982, 59). The Indians had developed technologies for catching the salmon, and they avoided overexploitation by allowing sufficient upstream migration for spawning purposes. Their "conscious regulation of the fishery played an important role in maintaining its yield over time," says Higgs. Unfortunately, the state government of Washington allowed salmon to be intercepted at sea, and legislation outlawed traps and effectively eliminated Indian fishing rights. The result was "legally induced technical regress," says Higgs (55).

British common law also had a place for private rights to coastal fisheries—rights that the Washington state legislation overran. As one observer notes:

> . . . when we consider that there were already, in 1200 AD, in tidal waters, territorial fishing rights in England and a form of territorial salmon rights throughout the world in the 19th century, the legislative process can only be said to have reduced the characteristics of individual fishing rights. (Scott 1988, 19)

For fish that are not mobile over wide ranges, property rights can be defined by specifying ownership of ocean surface area or of ocean floor, so-called territorial use rights in fisheries (TURFs).[18] Oyster fisheries along the United States coast illustrate such rights and show how property rights can improve resource allocation. Some regions have both private oyster beds and public oyster beds subject to the conditions of the commons.

Richard J. Agnello and Lawrence P. Donnelley (1979) used data from oyster fisheries in Maryland, Virginia, Louisiana, and Mississippi from 1945 to 1970. After controlling for other variables, they found that fishers in the private leasing state of Louisiana earned $3,207 per year, while their counterparts in the Mississippi, where the beds are public, earned $807. They also found that the ratio of harvest during the earlier part of the season to the later part was 1.35 for public oyster beds and 1.01 for private beds—that is, fishers using public oyster beds had a tendency to harvest earlier rather than later, while fishers with private beds felt little need to harvest early. These findings support the expectation that private property rights solve the commons problem.

Some parts of Maine's lobster fishery continue to offer an example of private control, although the unofficial ownership is held by a community rather than individuals (Acheson 1992, 69–83). In order to harvest lobsters in a particular territory, a fisher must be a member of a "harbor gang." Nonmembers attempting to harvest lobsters are usually warned first and then disciplined if the violation continues. The extralegal harbor gangs cut the buoy rope to the lobster traps. Though the system is not officially recognized by the state of Maine, it is recognized by Maine lobster fishers and has a significantly positive impact on productivity.

A number of fishing communities around the world have avoided overexploiting fish stocks for decades by limiting entry and managing the use of coastal fishing grounds (Leal 1996, 195, 203–206). While many arrangements are informal and traditional like the Maine lobster fisheries, others are not. A large network of fishing cooperative associations governs much of Japan's nearshore fisheries with government approval. By law, these fishing cooperatives own the fishing rights to specific territories extending as far as five and a half miles seaward.

The community approach, however, is not costless to maintain, and community-run fisheries can easily succumb to governmental interference. For example, after decades during which local fishermen successfully managed a coastal fishery in Valensa, Brazil, the Brazilian government decided to modernize fishing equipment. In the 1960s, it made nylon nets available to anyone who qualified for a bank loan arranged by the government. The local fishermen who had been managing the fishery did not qualify for the loan and did not have enough capital to purchase the nets on their own. They were displaced by a few outsiders hired to fish with the nylon nets. The local management system crumbled as old and new fishers fought over fishing spots. Eventually the fishery was overharvested and, ultimately, commercially abandoned (Cordell 1972).

Earlier in the century, the shrimp fishery in the Gulf Coast had unofficial private territorial rights that were not formally recognized by the federal or state government. Fishers used informal contracting and unions and trade associations to reduce problems of the commons (Johnson and Libecap 1982, 1007). Fishing unions were particularly active from the 1930s through the 1950s, implementing policies along the Gulf Coast to limit entry, conserve shrimp stocks, and increase members' incomes (1008). Such activities eventually met their demise in the courts, which refused to exempt these collective actions from antitrust prosecution. A federal court stated:

> A cooperative association of boat owners is not freed from the restrictive provisions of the Sherman Antitrust act . . . because it professes, in the interest of the conservation of important food fish, to regulate the price and the manner of taking fish unauthorized by legislation and uncontrolled by proper authority.[19]

For a short time, the unions and associations succeeded in internalizing the cost of regulations and conserving shrimp stocks. But as this situation reveals, any agreement establishing property rights to resources is difficult to maintain if the government declares it illegal.

Property Rights in the Future

Property rights have come to the fore with the dramatic growth of fish farming or aquaculture. From 1984 to 1995, world aquaculture production grew from 6.5 million metric tons to 21 million metric tons (De Alessi 2000, 109). Aquaculture has the potential for increasing fish production while reducing pressure on wild stocks, but it also poses problems of pollution and escapement. Because investment in aquaculture requires secure property rights and because property rights are more likely to evolve where the costs of establishing rights are lower, sedentary species such as oysters have the most promise.

Salmon Ranching and Farming. The emergence of salmon ranching indicates that a solution based on property rights can also be applied to anadromous species that return to their original spawning ground. In contrast to farmed fish, which always remain in enclosed areas, ranched salmon are raised in pens, allowed to journey to the sea to mature, and harvested upon return to the areas where they were hatched.

Before salmon ranching can realize its full potential, property rights problems must be resolved. For example, a ranch operator has control over the fish stocks only while the salmon are in captivity—before they are released and after they return for spawning. Otherwise, the salmon reside in the open sea beyond the rancher's control. Under these conditions, the rancher may lose a substantial portion of his investment to natural mortality and commercial and sport fishers. Some of these problems can be overcome through better coordination between ranchers and commercial fishers. Economists James J. Anderson and James E. Wilen (1986, 877) argue that salmon ranchers would be willing to pay for a reduced season length and for reduced public smolt releases in return for compensation from those who catch ranch fish in the ocean (which can be identified by various techniques).

Raising salmon in pens eliminates interactions between fish ranchers and fishers. When the salmon reside in pens for their entire lives, there are no losses due to commercial and sport fishing in the open ocean. This method has proven highly successful for Norwegians, who are the leading international producers of Atlantic salmon. In the United States, however, salmon farmers and ranchers still face political opposition. Commercial fishermen, alarmed about the competition, have sought government protection of their markets, while environmentalists fear that salmon farming will pollute bays and inland waters.

In 1987, commercial fishers in the Pacific Northwest convinced the Alaskan government to impose a one-year moratorium on net-pen salmon farms. Protests from local environmentalists in Washington have led the state to impose stringent guidelines in siting salmon farms (Iverson and Iverson 1987; Sullivan 1987; Sticker 1988). More recently, pen-raised Atlantic salmon operations in Maine have encountered opposition from seaside residents who do not want salmon farms spoiling their views and from federal officials at the Fish and Wildlife Service and the National

Marine Fisheries Service who perceive domestically raised salmon as a threat to wild salmon stocks (Goldberg 1999; Higgins 1999).

In response, salmon farming interests cite scientific evidence that salmon farming meets state water quality standards and poses little risk of breeding with wild salmon stocks.[20] Apparently, however, there is a risk of disease. Escaped farmed salmon have been linked to the spread of disease in wild fish (Environmental News Network 2000).

Nonetheless, the salmon farming industry contends that the science used in salmon farming could be applied to ensure the survivability of strains of wild salmon. For example, Maine salmon farmers explain that they use a much larger gene pool to breed salmon than the one used by the U.S. Fish and Wildlife Service's hatcheries. The larger gene pool reduces the risk of inbreeding among siblings and first cousins mating on salmon farms and improves offspring survival. In addition, farmed brood stock are kept in salt water to better prepare next generations for the rigors of surviving in salt water. This is in contrast to the Fish and Wildlife Service, which keeps its brood stock in freshwater for years, a practice that some scientists contend may limit saltwater adaptability in future generations. Salmon farmers are proposing to use these and other techniques to produce wild salmon.[21]

Salmon Sport Fishing. British salmon sport fishers have already shown how property rights can lead to cooperative solutions. In many cases, the fishers own fishing rights on the streams but find that only a few salmon survive in the ocean and return to spawn. The reductions are due to heavy commercial harvests, especially by fishers who have netting rights at the mouths of rivers (Bryant 1990). To combat the problem, the Atlantic Salmon Conservation Trust of Scotland, a nonprofit group, has purchased 280 netting rights at a cost of $2.1 million. The trust expects to reduce the netting catch of salmon by 25 percent (Anderson and Leal 1997, 103). Most of these netting rights have been purchased from private owners, but some have come from the Crown. The idea of this buyout program began in Canada, where the federal government bought and retired commercial netting rights in New

Brunswick, Nova Scotia, and Quebec (Bryant 1990).

Wild Atlantic salmon recovery was given another boost with temporary purchases of ocean salmon netting rights in Greenland and Faroese fisheries. In 1989, Icelander Orri Vigfússon developed a proposal to buy commercial salmon netting rights held by fishers in Greenland and the Faroe Islands. The Atlantic Salmon Federation fully supported Vigfússon's proposal and began raising funds. In 1991, Faroe Islands fishers agreed not to exercise their netting rights during 1991, 1992, and 1993. In return, they received $685,500 not to fish for salmon. As a result, in 1993, nearly twice as many salmon returned to their native rivers in Iceland and Europe (Anderson and Leal 1997, 135). Vigfússon also temporarily bought out netting rights of fishermen in Greenland for 1993 and 1994. The buyout paid fishermen $400,000 each year and reduced salmon netting off Greenland from 213 metric tons to 12 metric tons (Scott 1993). Such arrangements, which Vigfússon and the federation hope to make permanent through a comprehensive financing and job training program, are possible because of a legal environment that includes transferable netting rights.

Overcoming Obstacles

Unfortunately, institutional roadblocks stand in the way of other private operations, including oyster production. In Maryland, only a thousand of some nine thousand acres of privately leased oyster grounds are in production. (Public acres total 280,000.) Weak enforcement of private leases has discouraged use of Maryland's Chesapeake Bay private oyster fishery. "It's hard to find an oyster ground that hasn't been poached upon," complained a planter on the Tred Avon River (Leffler 1987). "It's the main reason why so many people are reluctant to take their ground and invest their money in it." To realize the full potential of aquaculture in the United States, defense of private property rights must be strengthened.

Japan has been a leader in establishing private property rights in fisheries. As access to foreign fishing grounds was increasingly restricted by laws like the Magnuson Act, the Japanese took bold steps to allow the privatization of the commons. The Japanese government now initiates the property rights process by designating areas that are eligible for aquaculture. The fishing cooperative associations are given the responsibility of partitioning these areas and assigning them to individual fishers and fish farmers for their exclusive use.

An exclusive right to harvest resources from a marine area allows an entrepreneur to invest in improvements and to capture the benefits of his or her investment. Consider the story of Ocean Farming, Inc., a company in the business of fertilizing the seas to enhance growth of phytoplankton, which nourishes fish production (Yandle 1999, 32). Based on actual experiments, company president Michael Markels estimates that with continuous fertilization about one thousand tons of catchable fish per square mile can be produced each year. At this rate, 100,000 square miles of fertilized ocean, a mere fraction of the world's oceans, could produce about the amount of fish the world currently produces each year.

Ocean Farming recently entered into a contract with the Republic of the Marshall Islands that gives the company an option for exclusive fishing rights on up to 800,000 square miles of deep ocean. Once harvesting starts, Ocean Farming will pay the Marshall Islands government $3.75 per square mile of ocean optioned or 7 percent of the value of the catch, whichever is more. Ocean Farming can charge other companies to fish the waters, and the firm has agreed to allow previous small-scale fishing to continue.

This same approach could be used for many other fisheries. For example, suppose the National Marine Fisheries Service allowed people to "homestead" sections of the ocean within the 200-mile limit and harvest bottom fish from their homestead.

In the Gulf waters off Alabama and Florida, even a very limited sense of ownership has fostered private provision of artificial reefs. These two states allow private individuals or companies to construct artificial reefs in parts of their territorial waters. These structures encourage fish production because they provide more surface area for the production of small encrusting organisms that fish feed on. They also provide some species with places to hide from predators. The reefs are considered public property as soon as they hit the water, but knowing the exact location of a reef has provided enough security to encourage private initiative (De Alessi 2000, 61). However, the tenuous nature of reef ownership limits the potential for privately-created reefs.

One company, Artificial Reefs, Inc., recently completed a multifaceted artificial reef structure off the Gulf Coast near Destin, Florida, to enhance recreational fishing and provide an area for skin diving (Environment News Service 1999). The project was financed with a grant from Florida's Department of Environmental Protection. It could have easily been financed privately if exclusive fishing rights to the state-owned Gulf Coast area where the reef was deployed could be purchased from the state. Owners of such homesteaded areas could catch the fish themselves, lease out fishing rights, or even lease recreational fishing rights.

For highly migratory fish, one property rights solution is to establish the ITQ as a private property right rather than a privilege revocable by the government and allow the quota holders themselves to manage the fishery. Like shareholders in a public company, "[h]olding an ITQ will allow large numbers of fishers . . . to come together and cooperate" in regulating fishing and coordinating their fishing with other users, contends one expert (Scott 1996, 97). The costs of obtaining stock information, making management decisions, and monitoring and enforcing decisions "need not be higher—and can be much lower—than when these services are performed in a uniform way by a government agency." If there are some fisheries where costs are higher, then, as in New Zealand, fishers can literally hire the government agency to perform the services.

Indeed, the New Zealand ITQ management system appears to be moving toward a real system of privately owned fisheries. For example, Challenger Scallop Enhancement Company Ltd., whose shareholders are the owners of transferable quotas for scallop, manage the fishery through contracts that allow the company to collect money from the shareholders for research, monitoring, and enforcement of daily catch limits. They have even established contracts with oyster fishers to reduce adverse environmental impacts on the scallop fishery (De Alessi 2000, 99).

ITQs and Beyond

While they are by no means the complete answer, current ITQ systems are a positive step toward addressing the tragedy of the commons in ocean fisheries. Their immediate benefit cannot be denied: ITQs end the race to catch fish.

The more secure ITQs are as property rights, the more they compel fishers to take a longer view and protect the resource. They appear to make it "easier and cheaper" for fishers holding quotas "to act collectively" in managing the size of their catch (Scott 1996, 23).

One unfortunate sequel to the success of ITQs and collective action by fishing associations or communities is political action by special interest groups who want a share of the growing economic bonanza. In countries where ITQs have become prevalent, some argue that the income generated by ITQs is a windfall to quota holders and belongs to the government. Such conflicts focus only on how to carve up the pie, not on how to make it even larger (Johnson 1995).

One limitation of ITQs is that determining the size of the total catch remains a governmental function. Fishery regulators determine the total catch, presumably based on biological sustainability and economic factors. Regulators are susceptible to political pressures from the special interest groups they regulate. Their incentive to please such groups by maintaining an inefficient industry size can overshadow the goals of efficient production and sustainable future catches.

A superior solution, especially for species with limited mobility, is to establish private property rights to specific coastal areas. Some steps have been taken. Aquaculture is one example. In addition, many communities hold de facto property rights to coastal fisheries around the world. While many are at risk from government interference, occasionally some arrangements are afforded legal recognition and succeed in managing fisheries. There is also evidence that if barriers to property rights to ocean areas beyond the coasts are removed, entrepreneurs will invest in raising the productivity of fisheries.

Establishing property rights will not be easy for highly migratory species, but, as in the frontier West in the nineteenth century, we can expect increasing efforts at definition and enforcement as the value of the resource increases (Anderson and Hill 1975). A key element in enforcing property rights is identifying ownership. Technologies already exist that can help define and enforce property rights in ocean fisheries.

For example, transmitters on manatees use satellite telemetry to identify the exact location, water temperature, and the direction in which an individual manatee is headed. Similar techniques can be used to identify fishing boats. "Devices can also be placed on a fishing vessel to constantly relay its exact location via satellite, to identify whether it belongs in a certain area. . . ." writes De Alessi (2000, 108). "Heat-sensitive satellites cannot only monitor a ship's location, but can also use its heat profile to tell if it is towing nets or not."

Same-day DNA field tests to monitor whale stocks in the wild already exist (Christainsen and Gothberg 1999). For tracking individual whales, the most promising are various tags that can be attached to a whale. Each tag is actually a data collecting and broadcasting unit capable of transmitting radio or sound waves. Such techniques offer promise of genuine property rights protection in the future.

In the meantime, several steps can be taken to improve ocean fisheries.

- Congress should remove the moratorium on ITQs in U.S. fisheries.

- Where ITQs are determined to be the most feasible approach, as for highly mobile species, they should be established as secure property rights.[22]

- Legal roadblocks such as antitrust laws that make it difficult to manage fisheries collectively should be removed.

- Territorial fishing rights should have legal recognition.

Such steps will move us a long way toward reducing the overexploitation and depletion of ocean fisheries.

Conclusion

In summary, lack of ownership of fish frequently results in lower than optimal levels of fish stocks and overinvestment in fishing effort. It may eventually lead to severe depletion. However, years of governmental control of fishing resources have not prevented this from happening in many fisheries.

The solution to the current wasteful race to fish involves establishing property rights. Individual transferable quotas represent a positive step toward private property rights, and they have stopped excessive exploitation and improved fisher profitability. With the exception of New Zealand, however, current ITQs still rely heavily on political management of the resource.

The ultimate solution is full-fledged property rights. Aquaculture and other approaches that have been used for nearshore fisheries already demonstrate the efficacy of property rights for species whose territories are limited. Even for migratory species on the high seas, new technologies are making it possible to define and enforce property rights. The more secure the property rights, the healthier fish populations and fishing communities will be.

Notes

1. For a classic article on the fisheries problem see Gordon (1954). See also Clark (1981).

2. The term “tragedy of the commons” was taken from Garrett Hardin’s (1968) influential article.

3. Community-run, coastal fisheries are an exception. See Leal (1996).

4. For example, highly prized halibut in the waters off the northeastern United States reached commercial extinction nearly a century ago due to overfishing. Halibut numbers in these waters

have never recovered enough for fishers to target them for commercial purposes, although a few are caught incidentally when fishers catch other species (Keen 1988, 32).

5. In this context, the term common property resources is more appropriately defined as open access resources.

6. Magnuson Fishery Conservation and Management Act, 16 U.S.C. 1801-1882 (1976).

7. Pub. L. No. 94-265, Sec. 303(b)(6), 94th Congress, H.R. 200, April 13, 1976.

8. As the phrase implies, individual vessel quotas allocate percentage shares of the total allowable catch to individual vessels. Like ITQs, these shares are transferable.

9. Wisconsin, Michigan, California, and Oregon use ITQs in a few of their state-run fisheries and have found a number of improvements as a result. See Anderson and Leal (1993, 169–77).

10. In their initial phase, ITQs will probably result in social and economic dislocations as excess capacity is eliminated. But those remaining in the fishery will find their operations more stable and less costly. And while total crew employment will drop in the fishery, those who remain have more steady employment because the fishing season tends to last much longer.

11. Indeed, more than a decade of haggling among various fishing interests preceded adoption of ITQs in three of the four federal fisheries that now have them. The one in which ITQs were adopted fairly easily, the South Atlantic wreckfish fishery, had just started when ITQs were being considered, so fishing interests were not firmly entrenched.

12. Congress placed the moratorium through the Sustainable Fisheries Act of 1996 (Pub. L. No. 104-297, 110 Stat. 3559), amending the Magnuson Fishery Conservation and Management Act. The act is now generally called the Magnuson-Stevens Fishery Conservation and Management Act.

13. Surf clams and ocean quahogs are bivalve mollusks that occur along the East Coast, primarily from Maine to Virginia. Surf clams are found in commercial abundance primarily off the mid-Atlantic coast from the beach zone to a depth of 60 meters. Ocean quahogs overlap with the distribution of surf clams considerably,

but they are also found in much deeper waters to 256 meters depth (National Research Council 1999, 281).

14. Dave Wallace of Wallace & Associates also points out that a fisher-generated reduction in the size of the fishery via ITQs creates instant stakeholders who are now invested in the fishery's future. This is something that is absent from government-generated buyouts of excess capacity. In addition, a fisher-generated buyout tends to increase efficiency as more efficient fishers buy out less efficient fishers. A government-generated buyout can still leave the fishery with marginal fishers. See Wallace (1996).

15. This can be accidental in the case of a fishery where a catch results in the harvest of a nontargeted species or deliberate in the case of a multispecies fishery where more than one type of species are targeted at once.

16. This occurred in the initial stages of Iceland's ITQ fisheries, but was later rectified. See National Research Council (1999, 329).

17. Hide and Ackroyd (1990) describe this problem in the context of New Zealand's efforts to establish ITQs.

18. Francis T. Christy (1996, 14) uses this term.

19. 15 U.S.C.A. Sec. 522.

20. Melissa Field, public relations director, Schiedermayer & Associates, Portland, ME, undated letter and fact sheets on salmon breeding and habitat impact.

21. Melissa Field, letter and fact sheets.

22. Unfortunately, individual quotas in the Alaskan halibut program are not secure property rights. The program's implementing language specifically states that individual quotas are not private property rights and can be taken away without compensation at any time.

REFERENCES

Acheson, James J. 1992. Capturing the Commons: Legal and Illegal Strategies. In *The Political Economy of Customs and Culture: Informal Solutions to the Commons Problem*, ed. Terry L. Anderson and Randy T. Simmons. Lanham, MD: Rowman & Littlefield, 69–83.

Agnello, Richard J., and Lawrence P. Donnelley. 1979. Prices and Property Rights in the Fisheries. *Southern Economic Journal* 42(October): 253–62.

Allen, Jane, and Patricia Charles. 1992. *Spirit! Historic Ketchikan, Alaska*. Ketchikan: Historic Ketchikan, Inc.

Anderson, James J., and James E. Wilen. 1986. Implications of Private Salmon Aquaculture on Prices, Production, and Management of Salmon Resources. *American Journal of Agricultural Economics* 68(November): 866–79.

Anderson, Terry L., and P. J. Hill. 1975. The Evolution of Property Rights: A Study of the American West. *Journal of Law and Economics* 18(1): 163–78.

———. 1983. Privatizing the Commons: An Improvement? *Southern Economics Journal* 50(October): 438–50.

———. 1990. The Race for Property Rights. *Journal of Law and Economics* 33(April): 177–97.

Anderson, Terry L., and Donald R. Leal. 1993. Fishing for Property Rights to Fish. In *Taking the Environment Seriously*, ed. Roger E. Meiners and Bruce Yandle. Lanham, MD: Rowman & Littlefield, 161–83.

———. 1997. *Enviro-Capitalists: Doing Good While Doing Well*. Lanham, MD: Rowman & Littlefield.

Arnason, Ragnar. 1996. Property Rights as an Organizational Framework in Fisheries: The Cases of Six Fishing Nations. In *Taking Ownership: Property Rights and Fishery Management in the Atlantic Coast*, ed. Brian Lee Crowley. Halifax, Nova Scotia: Atlantic Institute for Market Studies, 99–144.

Bell, Frederick W. 1972. Technological Externalities and Common-Property Resources: An Empirical Study of the U.S. Northern

Lobster Fishery. *Journal of Political Economy* 80(January-February): 148–58.

Bryant, Nelson. 1990. A Scottish Group Protects Salmon. *New York Times*, January 8.

Christainsen, Gregory B., and Brian C. Gothberg. 1999. The Potential of High Technology for Establishing Tradable Rights to Whales. Paper presented at the 1999 Political Economy Forum, "The Technology of Property Rights," Emigrant, Montana, December 2–5.

Christy, Francis T. 1996. Paradigms Lost: The Death Rattle of Open Access and the Advent of Property Rights to Regimes in Fisheries. Paper presented at the eighth Biennial Conference of the Institute of Fisheries Economics and Trade, Marrakesh, Morroco, July 1–4.

Christy, Francis T., and Anthony Scott. 1965. *The Common Wealth in Ocean Fisheries*. Baltimore: John Hopkins University Press.

Clark, Colin W. 1981. Profit Maximization and the Extinction of Animal Species. *Journal of Political Economy* 81(August): 950–60.

Committee on Commerce. 1976. *A Legislative History of the Fishery Conservation and Management Act of 1976*. Washington, DC: U.S. National Marine Fisheries Service, October.

Copes, Parzival. 1986. A Critical Review of the Individual Quota as a Device on Fisheries Management. *Land Economics* 62(August): 278–91.

Cordell, John C. 1972. The Development Ecology of an Estuarine Canoe Fishing System in Northeast Brazil. Ph.D. dissertation, Stanford University, Stanford, CA.

Crutchfield, James A. 1973. Resources from the Sea. In *Ocean Resources and Public Policy*, ed. T. Saunders English. Seattle: University of Washington Press, 105–33.

Crutchfield, J. A., and G. Pontecorvo. 1969. *The Pacific Salmon Fisheries: A Study of Irrational Conservation*. Baltimore: John Hopkins University Press.

De Alessi, Michael. 2000. Fishing for Solutions: The State of the World's Fisheries. In *Earth Report 2000*, ed. Ronald Bailey. New York: McGraw-Hill, 85–114.

Eckert, Ross D. 1979. *The Enclosure of Ocean Resources: Economics and the Law of the Sea*. Stanford, CA: Hoover Institution Press.

Environment News Service. 1999. Artificial Reef 'Neptune' Complex Deployed. *E-Wire Press Release*, May 26. Available: http://ens.lycos.com/e%2Dwire/may99/may269901.html. Cited: July 10, 2000.

Environmental News Network. 2000. Farmed Atlantic Salmon Threaten Pacific Cousins. June 7. Available: http://www.cnn.com/2000/NATURE/06/07/atlantic.salmon.enn/index.html. Cited: July 10, 2000.

General Accounting Office (GAO). 2000. *Fishery Management: Problems Remain with National Marine Fisheries Service's Implementation of the Magnuson-Stevens Act*. GAO/CED-00-69. Washington, DC, April.

Goldberg, Carey. 1999. Fish Farms Breed Fight over a Way of Life. *New York Times*, August 28. Available: http://archives.nytimes.com/archives/.

Gordon, H. Scott. 1954. The Economic Theory of a Common Property Resource: The Fishery. *Journal of the Political Economy* 62(April): 124–42.

Grafton, R. Quentin. 1996. Performance of and Prospects for Rights-Based Fisheries Management in Atlantic Canada. In *Taking Ownership: Property Rights and Fishery Management on the Atlantic Coast*, ed. Brian Lee Crowley. Halifax, Nova Scotia: Atlantic Institute for Market Studies, 148–81.

Hardin, Garrett. 1968. The Tragedy of the Commons. *Science* 162: 1243–48.

Hartley, Peter. 1997. *Conservation Strategies for New Zealand*. Wellington: New Zealand Business Roundtable.

Hide, Rodney P., and Peter Ackroyd. 1990. Depoliticising Fisheries Management: Chatham Islands' Paua (Abalone) as a Case Study. Prepared for R. D. Beattie Ltd. Center for Resource Management. Christchurch, New Zealand: Center for Management, Lincoln University, March.

Higgins, Margot. 1999. Atlantic Salmon Protection Expected. *Environmental News Network* (October 15). Available: http://

www.enn.com/enn-news-archive/1999/10/101599/asalmon_6485.asp. Cited: July 10, 2000.

Higgs, Robert. 1982. Legally Induced Technical Regress in the Washington Salmon Fishery. *Research in Economic History* 7: 82–95.

Iverson, Edwin S., and Jane Z. Iverson. 1987. Salmon-Farming Success in Norway. *Sea Frontiers*, November-October, 355–61.

Johnson, Ronald N. 1995. Implications of Taxing Quota Value in an Individual Transferable Quota Fishery. *Marine Resources Economics* 10: 327–40.

Johnson, Ronald N., and Gary D. Libecap. 1982. Contracting Problems and Regulation: The Case of the Fishery. *American Economic Review* 12(December): 1005–22.

Keen, Elmer A. 1988. *Ownership and Productivity of Marine Fishery Resources*. Blacksburg, VA: McDonald and Woodward Publishing.

Lazaroff, Cat. 2000. New Law Could Save Millions Spent on Fisheries Management. *Environment News Service* (March 10). Available: http://ens.lycos.com/ens/mar2000/2000l%2D03%2D10%2D06.html. Cited: July 10.

Leal, Donald R. 1996. Community-Run Fisheries: Preventing the Tragedy of the Commons. In *Taking Ownership: Property Rights and Fishery Management on the Atlantic Coast*, ed. Brian Lee Crowley. Halifax, Nova Scotia: Atlantic Institute for Market Studies, 183–220.

Leffler, Merrill. 1987. Killing Maryland's Oysters. *Washington Post*, March 29.

Maranto, Gina. 1988. Caught in Conflict. *Sea Frontiers* 35(May-June): 144–51.

McClurg, Tom. 1997. Bureaucratic Management versus Private Property: ITQs in New Zealand after Ten Years. In *Fish Or Cut Bait*, ed. Laura Jones and Michael Walker. Vancouver, BC: Fraser Institute, 91–105.

Morris, P. 1994. *Economic Aspects of Living Marine Resources: Australian Contribution. Fisheries Management Arrangements in Australia: An Overview*. Canberra: Australian Bureau of Agricultural and Resource Economics.

Muse, Ben, and Kurt Schelle. 1989. *Individual Fisherman's Quotas: A Preliminary Review of Some Recent Programs*. CFEC 89-1. Juneau: Alaska Commercial Fisheries Entry Commission.

National Research Council. 1999. *Sharing the Fish: Toward a National Policy on Individual Fishing Quotas*. Washington, DC: National Academy Press.

NMFS. 1999a. *Our Living Oceans: Report on the Status of U.S. Living Marine Resources, 1999.* U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-41. Online: http://spo.nwr.noaa.gov/olo99.htm Cited: July 10, 2000.

———. 1999b. *Report to Congress: Status of Fisheries of the United States* (October). Available: http://www.nmfs.gov/sfa/StatusOfFisheries99.pdf. Cited: July 10, 2000.

———. 1998. *Report to Congress: Status of Fisheries of the United States* (September). Avaiable: http://www.nmfs.gov/sfa/98stat.pdf. Cited: July 10, 2000.

———. 1996. *The Economic Status of U.S. Fisheries, 1996*. Available: http://www.st.nmfs.gov/econ/oleo/oleo.html.

North Pacific Management Council and NMFS. 1991. Appendix I: Survey of Individual Quota Programs. In *Environmental Impact Statement. Regulatory Impact Review. Initial Regulatory Flexibility Analysis for Proposed Individual Fishing Quota Management Alternatives for the Halibut Fisheries in the Gulf of Alaska and Bering Sea/Aleutian Islands*. Anchorage, Alaska, July 19.

NSW Fisheries. 1999. Rock Lobster (February). Available: http://www.fisheries.nsw.gov.au/pages/commercial/rocklobs.htm. Cited: July 10, 2000.

Pautzke, Clarence G., and Chris W. Oliver. 1997. *Development of the Individual Fishing Quota Program for Sablefish and Halibut Longline Fisheries off Alaska* (October 8). Anchorage, AK: North Pacific Fishery Management Council.

Robinson, William L. 1986. Individual Transferable Quotas in the Australian Southern Bluefin Tuna Fishery. In *Fishery Access Control Programs Worldwide: Proceedings of the Work-*

shop on Management Options for the North Pacific Longline Fisheries. Alaska Sea Grant Report 86-4. Orca Island, WA: University of Alaska, 189–205.

Scott, Anthony. 1988. Market Solutions to Open-Access, Commercial Fisheries Problems. Paper presented at tenth annual APPAM Research Conference, Seattle, October 7–8.

———. 1996. The ITQ as a Property Right: Where It Came From, How It Works, and Where It Is Going. In *Taking Ownership: Property Rights and Fishery Management on the Atlantic Coast*, ed. Brian Lee Crowley. Halifax, Nova Scotia: Atlantic Institute for Market Studies, 31–98.

Scott, Sue. 1993. Greenland Salmon Fishery Ends. *News Release Communique*, August 1. St. Andrews, New Brunswick: Atlantic Salmon Federation.

Sharp, Basil M. H. 1996. Kiwi Quotas: Ten Years of Tradable Fishing Rights in New Zealand. In *Rising Tide? Rights-Based Fishing on the Atlantic Coast*. Halifax: Atlantic Institute for Market Studies.

Sporer, Christopher. 1998. An Intelligent Tale of Fish Management. *Fraser Forum*, December, 9–13.

Sticker, Robert R. 1988. Commercial Fishing and Net-Pen Salmon Aquaculture: Turning Conceptual Antagonism toward a Common Purpose. *Fisheries*, July-August, 9–13.

Sullivan, Cheryl. 1987. Salmon Feedlots in Northwest. *Christian Science Monitor*, July 23.

Sutherland, Donald. 2000. U.S. Harvesters Up on Financial Rocks. *Environment News Service* (April 25). Available: http://ens.lycos.com/ens/apr2000/2000L-04-25-01.html. Cited: July 10.

Tietenberg, Tom. 1988. *Environmental and Natural Resource Economics*, 2d ed. Glenview, Ill.: Scott, Foresman and Company.

U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Bureau of Census. 1996. *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*. Washington, DC.

Wallace, David. 1996. A Review of the U.S. East Coast Surf Clam and Ocean Quahog Fishery ITQ Management Plan. In *Ris-*

ing Tide? Rights-Based Fishing on the Atlantic Coast Halifax, Nova Scotia: Atlantic Institute for Market Studies.

Yandle, Bruce. 1999. The Commons: Tragedy or Triumph? *The Freeman*, April, 30–34.