Fencing The Fishery

A Primer on Ending The Race For Fish

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ISBN 0-9668243-7-7

Cover design by Mandy-Scott Bachelier.

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Acknowledgments

This handbook would not have been possible without the support provided by key individuals and organizations. I am grateful to PERC and its executive director Terry L. Anderson for allowing me the opportunity to pursue an area of research that interests me greatly—the study of management reforms in ocean fisheries. Personal acquaintances Felix Cox, who fishes in the Gulf of Mexico snapper fishery, and Jean-Guy D'Entremont, who fishes in Nova Scotia's inshore fishery, have provided inspiration through their conviction that such reforms are badly needed.

In addition, the M. J. Murdock Charitable Trust provided the financial support to achieve the goals of this project. I am indebted to Jane Shaw who edited my scribblings and helped turned this handbook into a document useful for the intelligent nonspecialist interested in alternative management approaches to our nation's fisheries. I owe a special thanks to Dianna Rienhart for taking the material from my word processor and turning it into a form suitable for publishing. And I appreciate Mandy-Scott Bachelier's cover design.

INTRODUCTION

Anyone familiar with ocean coastal fishing recognizes that the current system of management is broken and needs fixing. Since 1999, seven species of groundfish off Washington, Oregon, and northern California have been declared overfished by the National Marine Fisheries Service. So have several crab stocks off Alaska's Bering Sea, and the federal government is about to embark on a $100 million vessel buy-out program to reduce the size of the crab fleet.[1] Salmon fishers in the Pacific Northwest are trying to recover from declining harvests over the last decade (Pacific States Marine Fisheries Commission 1999, 20–21), while their counterparts off Alaska must contend with poor product quality and stiff competition from farmed salmon (McCallum 2001; IntraFish 2001).

The current system of management is broken and needs fixing.

The good news is that there is a way to help these and other fishers in the Pacific Northwest and Alaska overcome such problems. A number of ocean fisheries[2] around the world have adopted alternatives to traditional command-and-control fisheries management. These include individual transferable (or fishing) quotas (called ITQs or IFQs), private harvesting agreements, and exclusive fishing rights in marine areas (with property rights in the fish stocks themselves remaining a possibility). All of these fall under the heading of rights-based fishing. By using them, many fisheries have experienced significant benefits.

This booklet explains the reasoning behind rights-based fishing and explores various institutional arrangements along the property rights spectrum. Moving to such arrangements faces obstacles, however, and this booklet offers options for overcoming some of them. It will address problems that remain when ITQs are adopted, such as bycatch and multispecies fisheries and high grading, as well as the tough issue of the initial allocation of individual transferable quotas. It will also address the problem of applying ITQs to anadromous fish such as salmon in the Pacific Northwest. Whether you are an expert or a novice in rights-based fishing, *Fencing the Fishery* will be a useful guide.

Why So Much Overfishing? A Primer

The fundamental reason for depleted fisheries has been known for decades.[3] Ocean fisheries are a classic case of the tragedy of the commons.[4] When fish stocks are unowned and jointly exploited, stock depletion often results.[5] There are two reasons for this outcome.

- In a commons, fishers cannot save fish for the future. If they restrain their harvest to leave enough fish to reproduce for the following season, the fish may be taken by someone else. Without ownership the rule of capture prevails.

- Each fisher in a commons captures all the benefits of catching more fish while facing only a fraction of the cost of stock depletion because the cost is split among all fishers. This disparity between full benefits received and fractional costs paid encourages too many fishers to enter the fishery and too many fish to be taken.

In a commons, each fisher is motivated to be the first to capture fish. Because fish are plentiful then, capture costs are lowest. Thus fishers invest in equipment that improves their chances of winning the race for fish—faster boats and better detection devices. Not only do the stocks decline but also fishing becomes wastefully expensive.

Because costs tend to rise rapidly as fish become harder to find, fisheries often reach commercial extinction before they are totally depleted. When the costs of capturing the few remaining fish exceed the returns, it becomes unprofitable to continue.[6] 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.[7]

Government Regulation: Largely a Failure

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

Typically, government agencies have used various controls to prevent fishers from taking too many fish each season. These include restrictions on the size and power of fishing vessels, the types of fishing gear (e.g., net mesh size), the area where fishing is allowed, and the time during which fishing is allowed. In addition, government managers have attempted to control the total harvest, vessel catch per fishing trip, and catch characteristics (e.g., requiring that all fish landed be of a minimum size).

The risk of severe depletion remains high in many fisheries.

Although regulation is designed to prevent the depletion of fish stocks, its record in stock protection is mixed. In some cases there have been spectacular failures. For example, fish stocks in the New England groundfish fishery and Atlantic Canada's cod fishery collapsed in spite of a host of fishing restrictions (Brubaker 2000; National Marine Fisheries Service [NMFS] 1999b, 1–7).

Most of the world's fisheries have not reached such a state, but the risk of severe depletion remains high in many. The United Nations Food and Agriculture Organization recently classified 28 percent of the world's fisheries as "overfished" and another 47 percent as "fully fished" (Garcia and Moreno 2001, 4, 19). Fisheries in the latter category could easily become overfished because regulators have been unable to prevent the tendency of a fleet to increase its fishing power—the ability to harvest more fish in less time. Nor have they been able to eliminate the excessive number of fishing vessels in many fisheries around the world. A "characteristic of many fisheries today and more generally of the fishing sector, is the existence of significant overcapacity," write two experts (Garcia and Moreno 2001, 9). It is estimated that overcapacity in the world's fishing fleet may run anywhere from 30 to 50 percent above the level that would be considered economically efficient (Garcia and Newton 1997, 20).

Such excesses can be financially devastating. For example, the number of full-time vessels in the Gulf of Mexico shrimp fishery more than doubled between 1966 and 1991, even as annual net revenues per vessel decreased about 75 percent to approximately $25,000 (in 1990 dollars). The actual catch of fish by full-time vessels was virtually unchanged. Two economists suggest that one-third of the fleet of more than 16,000 vessels and boats operating in 1988 could have harvested the same amount of shrimp (Ward and Sutinen 1994).

In the past, the Alaska halibut fishery had a total allowable catch that officials set each season, with no limit on the number of fishers and vessels. As fishing pressure rose from increases in fleet size, officials attempted to prevent overfishing by shortening the fishing season. Fishers reacted by investing in bigger, more powerful boats and other sophisticated equipment to catch more fish in shorter periods. Before long, a season that once took several months was down to a few twenty-four-hour periods a year (National Research Council [NRC] 1999, 306). The glut of fish on the market during these periods depressed prices, and customers had to accept frozen fish the rest of the year. With the season so short, fishers often went out in hazardous weather.

The hectic pace of fishing resulted in tangled fishing gear, much of it abandoned or lost. Unfortunately the gear still caught fish even though there was no one there to retrieve them (NRC 1999, 74). In addition, there were reports of significant spoilage. More than 50 percent of the total halibut landed in 1991 was never iced, and about a third of the halibut landed was "not even gutted" during one of the twenty-four-hour openings in May (Wilen and Homans 2000). In spite of the short fishing season, the recorded catch frequently exceeded the total allowable catch targeted for the season.

Limited Entry

A modification of this regulatory approach has appeared in a number of fisheries.[8] Called limited entry, it is a licensing system overlaid on existing fishing restrictions such as harvest limits and restrictions on gear. Licensing the number of fishers or vessels limits the number of participants in the fishery. This system is a step in the right direction, but it is rarely enough "to prevent crowding, congestion, strategic behavior, racing, and capital stuffing," according to one prominent critic (Scott 1988, 7–8). A limited number of powerful fishing vessels can do in a few minutes what used to take days.

Limited entry failed to curtail investment in the halibut fishery in British Columbia, Canada, during the 1980s. The maximum number of vessels was set at 435 boats in 1980, but over the next ten years the number of crew and the amount of gear used per vessel increased. Regulators shortened the fishing season in order to protect the halibut stock. Yet by 1990, with a season limited to six days, almost 50 percent more halibut was caught than had been caught ten years earlier when the season was sixty-five days long. Many of the problems that characterized the open-access halibut fishery of Alaska—fish mortality due to lost or abandoned gear, hazardous fishing, poor product quality, and market gluts—were present in the limited-entry fishery (Grafton, Squires, and Fox 2000, 684, 686).

Limited entry also failed to address the problem of overcapacity in the commercial groundfish fishery off Washington, Oregon, and California. This complex fishery consists of eighty-two bottom-dwelling species, including lingcod, bocaccio, Dover sole, sablefish, and arrowtooth flounder, and a variety of fishing gear and strategies.[9] In 1994, the Pacific Fishery Management Council, one of eight regional fishery management councils composed of people in the fishing industry, state officials, and various federal officials assigned to the Pacific coast region, authorized a limited entry system, but it did little to reduce overcapacity. A 2000 report conducted for the council estimates that 9 percent of the current fixed-gear vessels could harvest all of their sablefish allocation, and 12 percent of the vessels could harvest the nonsablefish components of the fishery. For the trawl sector of the fishery, only 27 to 41 percent of the current fishing capacity is needed to catch and deliver the harvest to onshore buyers (Ad-Hoc Groundfish Strategic Plan Committee 2000, 5).

Individual Transferable Quotas

In recent years a viable alternative to direct government regulation has emerged: individual transferable quotas (ITQs; also called individual fishing quotas, or IFQs). Although they vary among countries in the extent to which they approach full property rights, overall they are proving quite effective in ending the race for fish and reducing the excesses in harvesting capacity in fisheries. Under ITQs, each quota holder is entitled to catch a specified percentage of the total allowable catch that is set each season by fishery managers. Thus, an individual who holds a 0.1 percent share in the South Atlantic wreckfish fishery is entitled to 7,400 pounds of wreckfish for the season if the total allowable catch is 7,400,000 pounds. Because the quotas are transferable, current quota holders can adjust the size of their fishing operations by buying and selling quotas. Those wishing to enter an ITQ fishery can buy or lease quotas from current quota holders who want to reduce their participation. Those wishing to leave the fishery can sell their quota to other fishers.

New Zealand and Iceland now use ITQs to manage nearly all of their commercial fisheries, Canada and Australia use ITQs in quite a few of their fisheries, and the United States, Greenland, and the Netherlands use ITQs for some fish species. Overall, ITQs have generated higher incomes for fishers and improved product quality for consumers, reduced fleet excesses, and nearly eliminated instances in which the actual harvest exceeded the total allowable catch (Arnason 1996; NRC 1999; Repetto 2001; Wilen and Homans 2000).

ITQs are 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 they remove the destructive race for fish, with its spur to 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. Fishers who adopt cost-reducing or quality-enhancing methods make more money with their quota from those who are less efficient. Less efficient producers sell their shares and leave the fishery rather than engaging in dangerous and unrewarding battles on the high seas. Thus, ITQs help reduce the cost of catching fish and enhance the quality of the fish delivered to markets.

Actual Experience with ITQs

Practical experience with ITQs indicates that they have led to considerable benefits. The experience in various fisheries is outlined below.

British Columbia

Since 1991, individual vessel quotas, a variation of ITQs, have been in effect in the British Columbia halibut fishery. These quotas have allowed managers to extend the fishing season from 6 to 245 days (Grafton, Squires, and Fox 2000, 685). As a result, 94 percent of the total seasonal catch was sold as fresh halibut over the first three years of the quota program, compared with only 42 percent in the previous three-year period (Casey et al. 1995, 219). The ability to sell mostly fresh halibut enabled fishers in British Columbia to receive higher prices for their catch than their nearby competitors in Alaska, where halibut fishers operated without ITQs.

The differences can be seen in Table 1, which compares ex-vessel prices (the prices fishers receive for their fish) for halibut in the British Columbia and Alaska fisheries. The prices are the average annual prices over two time periods, 1988 to 1990 and 1991 to 1993.

In the first period, both fisheries were managed as competitive fisheries with short seasons. The prices were essentially the same; the difference of US$0.22 per pound is largely due to higher transportation costs associated with shipping Alaskan halibut to wholesale markets.

During the next period, after British Columbia adopted individual vessel quotas and the season expanded to eight months, the average price differential jumped to US$0.99 per

Table 1: Pacific Halibut Price Comparison

Time Period	Alaska Halibut Fishery Ex-Vessel Price (US$/lb)	BC Halibut Fishery Ex-Vessel Price (US$/lb)	Price Difference	Price Difference Attributed to IVQs
1988–1990	1.50	1.72	.22	
1991–1993	1.41	2.40	.99	.77
1991	2.00	2.64	.64	.42
1992	.98	2.31	1.33	1.11
1993	1.25	2.22	.97	.75

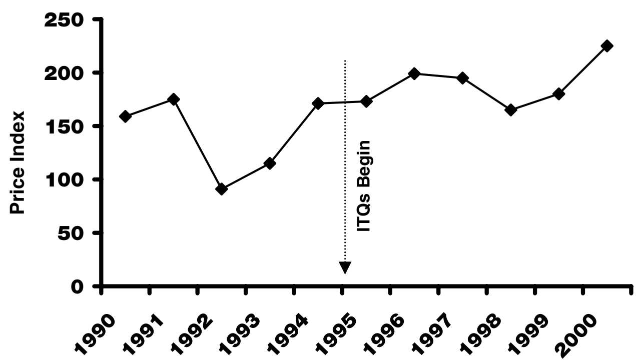
Note: IVQs (individual vessel quotas) are a variant of individual transferable quotas (ITQs).
Source: Casey et al. (1995, 218).

pound. Subtracting out the US$0.22 price premium for lower transportation costs, the British Columbia fishery was getting a premium of US$0.77 per pound. This difference is attributable to the individual vessel quotas. Over this period, nearly all of the British Columbia halibut was marketed fresh, whereas most of the Alaskan halibut was marketed frozen (Casey et al. 1995, 213).

Alaskan Halibut

The price advantage enjoyed by British Columbia halibut fishers was one reason for the adoption of IFQs in the Alaska halibut fishery in 1995. Under IFQs, 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. Most of the halibut is sold fresh, resulting in higher prices on average for fishers (see Figure 1).[10]

Figure 1: Halibut Ex-Vessel Price Index



Note: 1982 = 100.
Sources: NMFS (1999a, 2000b, 2001).

Higher returns to fishers and good prospects have led to a dramatic rise in the value of IFQs in the Alaska halibut fishery. In 1995, the first year of IFQs, the aggregate value of the quotas was just over $295 million. In 1998, the aggregate value of the quotas had grown to nearly $492 million—a 67 percent increase in four years.[11]

New Zealand

Benefits from the 1986 adoption of ITQs in New Zealand's groundfish fishery have been equally striking. Thanks to ITQs, New Zealand fishers were able to respond to an expanding market for high-quality whole snapper in Japan (snapper is a major component of the groundfish species complex). With ITQs, New Zealand fishers had the time to target large snappers and improve product quality. For example, they began to use Styrofoam containers with a water supply so they could deliver live snappers to market. Before ITQs, the race for fish resulted in catching large quantities of fish of varying quality. By catering to the high end of the Japanese market for fish, fishers were able to triple their revenues in the New Zealand groundfish fishery under ITQs (Wilen and Homans 2000).

Australia

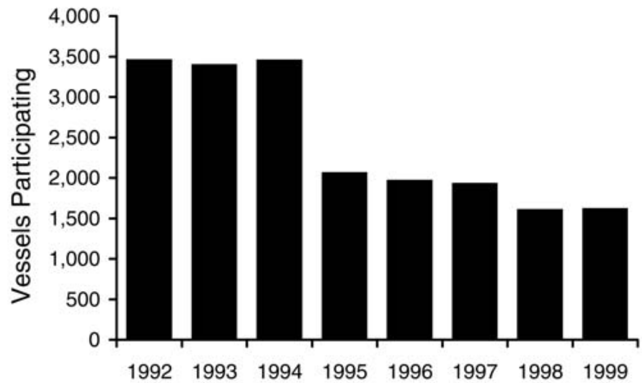
Similarly, fishers in Australia's southern bluefin tuna fishery reaped benefits from ITQs because the longer season and slower pace of fishing enabled them to prospect for larger, more valuable tuna. With secure rights to specific quantities of tuna, fishers switched from fishing near shore and catching mostly small tuna to fishing farther offshore for larger tuna. Before ITQs, only 13 percent of the tuna caught by Australian fishers fell into the larger size class of tuna; after ITQs, more than 35 percent of the tuna fell into this class. Fishing for larger tuna was a direct response to more lucrative prices paid by the Japanese in the sashimi tuna market. Revenues in the tuna fishery more than doubled (Geen and Nayar 1988).

Reducing Overcapacity

Because quota can be bought and sold among fishers, the problem of fleet overcapacity dissipates as more efficient industry members buy out inefficient ones. In 1994, the last year of open access in the Alaska halibut fishery, 3,412 fishing vessels participated in the fishery; by 1999, the number of fishing vessels had dropped to 1,612 (see figure 2).

Individual quotas helped solve overcapacity and other problems in the Mid-Atlantic surf clam fishery off New Jersey. A moratorium on new entrants in the fishery began in 1977, and the number of permitted vessels remained essentially unchanged until 1990 when ITQs were implemented. During the 1980s other measures were instituted to protect fish, including a total allowable catch set not only annually but each quarter. Although these measures protected the resource, overcapacity and dangerous fish-

Figure 2: Fleet Consolidation in Halibut Fishery



Source: NMFS (2000c)

ing remained. Because vessels were required to limit the number of trips and the duration of fishing per trip, fishers went out whatever the weather. Disaster struck on a number of occasions, resulting in lost vessels and crew. As vessels and gear became more powerful, allowable fishing time was 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 through the year.

Under ITQs, safety has improved and crew and equipment are more efficiently used. In the five years after ITQs were implemented, only three vessels were lost compared with ten in the previous five years (Wallace 1996). Also, the fishery has downsized without a taxpayer-funded buyout of surplus vessels, which has occurred in other non-ITQ fisheries that have collapsed.[12] As quota owners bought quotas from other owners, the number of active surf clam vessels went from 128 in 1990 to 50 in 1997.

With excess fleet capacity eliminated, those remaining in the fishery are making better use of their boats and crew. 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 (NMFS 1996; NRC 1999, 293).

Even though the 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

Table 2: Fleets Downsized after ITQs

Fishery	ITQ Period (in years)	Reduction in Fleet (%)
British Columbia halibut	6	35.4
Alaska halibut	5	53.3
Alaska sablefish	5	62.0
Atlantic surf clam	8	60.9
Australia southern bluefin tuna	2	70.0
Iceland herring	15	85.0
Iceland capelin	9	40.0
Netherlands flatfish	3	35.0

Sources: Arnason (1996); Geen, Nielander, and Meany (1993); Grafton et al. (2000); NMFS (1996, 2000c).

large-scale operators, who took most of the allowable catch. With ITQs in place, small operators can fish without fear of losing out to large-scale operators (Wallace 1996).

Other fisheries have undergone reductions in fleet size under ITQs. They are presented in Table 2.

Reaching Environmental Goals

Experience indicates that ITQs can be more effective than traditional regulations in achieving a desired overall harvest for the season. Under a system without ITQs, managers in the Alaska halibut fishery attempted to satisfy the total allowable catch by limiting the duration of fishing. Season length was based on what managers believed fishers would be able to harvest without exceeding the total allowable catch. Unfortunately, this approach proved too imprecise. Actual harvests frequently exceeded the total allowable catch, as shown in Table 3. With individual quotas initiated in 1995, however, actual harvests no longer exceed the total allowable catch.

ITQs can help conserve fish stocks in other ways. For example, fewer immature fish are being harvested in the Alaska sablefish fishery. The areas where mature sablefish are found became less crowded as the number of vessels in the fishery dropped through quota trading. With less crowding, fishers no longer relocated to areas with more immature sablefish. In quantitative terms, Michael Sigler and

Table 3: Alaska Halibut Example

Time Period	Alaska Halibut Management Area			
	2C	3A	3B	4A
1990	102.2	93.0	102.3	139.1
1991	117.4	86.2	135.6	132.6
1992	98.2	100.7	98.0	117.3
1993	112.9	109.8	120.9	126.8
1994	94.4	95.6	96.5	100.2
1995 (ITQs)	85.6	88.7	85.1	80.6
1996 (ITQs)	93.6	96.5	94.4	88.9
1997 (ITQs)	95.6	96.7	97.3	94.0
1998 (ITQs)	90.8	94.3	96.1	91.4

Note: Numbers represent percent of the allowable catch harvested.
Source: Dinneford et al. (1999).

Chris Lunsford (2001, 1300–1312) estimate that spawning potential increased by 9 percent over the first four years of individual fishing quotas.

There is also evidence that an ITQ fishery can generate a stronger incentive among fishers to conserve the resource. In 1986, the Canadian government adopted a system of enterprise allocations (individual quotas allocated to fishing companies) in its Atlantic sea scallop fishery located off Nova Scotia. Robert Repetto (2001, 8) found in response "a strong consensus . . . among quota holders, the workers union, and fisheries managers in favor of a conservative approach to setting the overall catch limit."

When surveys indicate low abundance of immature scallops, fishery managers, with the support of scallop fishers, reduce the total allowable catch so that more of the existing stock will be available for later years. Canadian scallop fishers have opted for this approach because as quota holders they will proportionately capture the benefits in subsequent years. They have succeeded in rebuilding the scallop stock from depressed levels in the early 1980s (prior to enterprise allocations). ITQs have also stabilized the catch of mature scallops—ages four through seven—despite wide fluctuations in the abundance of new three-year-old scallops in the fishery (Repetto 2001, 9).

In contrast, the U.S. scallop fishery, only a stone's throw from the Canadian scallop fishery, is regulated, and individual shares of the harvest are up for grabs.

U.S. scallop fishers typically oppose reductions in overall harvests to rebuild the scallop stock. Hence it is not surprising that the fishery falls far below the Canadian scallop fishery in performance. In side-by-side comparisons, Repetto (2001) demonstrates that the Canadian scallop fishery has greater stock abundance, greater balance in age classes, smaller fluctuations in annual harvests, and greater profitability than its U.S. counterpart.

The closer ITQs are to full property rights the stronger the incentive for fishers to conserve the resource. In New Zealand, where ITQs are property rights and not privileges revocable by government without compensation, fishers are taking an active role in enhancing the productivity of their ITQ fisheries. For example, overfishing decimated the paua (abalone) fishery before introduction of ITQs. Afterward, quota holders in the Chatham Islands off New Zealand agreed to limit their catch and invest in research. They formed the Chatham Islands' Shellfish Reseeding Association to enhance production of paua (Hide and Ackroyd 1990, 42, 44).

In 1991, quota holders in the New Zealand orange roughy fishery got together and formed the Orange Roughy Management Company, Limited (ORMC). The company's goal is to maximize the value of the fishery through a consistent supply of high-quality fish products. To this end, ORMC enforces its own fishing regulations—for example, closing areas to fishing and imposing sub-area limits on catches—and funds research efforts to improve fish stocks (Clement 2000). Other research efforts are spearheaded by fishers in the scallop, rock lobster, and snapper fisheries (Hartley 1997, 97).

Limitations of ITQs

Despite their success, ITQs are not without criticisms. Bycatch and multispecies fishing pose problems, as does high grading.

Bycatch and Multispecies Fishing

Bycatch is the accidental harvest of non-targeted species (the species are also called the bycatch) (Copes 1986). Multispecies fishing is the intentional harvest of different species in a single outing. The classic problem in controlling bycatch or multispecies harvests is that a harvest limit can be reached for one species while another remains underharvested. Simply continuing to fish results in overharvest if the method of fishing is not selective, as when netting is used in an area occupied by different species.

In theory, an ITQ system could address this problem by requiring fishers to obtain a bundle of ITQs covering multiple species and bycatch. Fishers would have the responsibility of managing their harvests in ways that mitigate overruns of ITQs. In practice, however, matching ITQs to actual harvests is problematic because of uncontrollable factors such as ocean temperature and other environmental factors that can lead to variations in the mix of species caught from place to place and over different periods. Thus, overruns of ITQs may be unavoidable at times, creating an incentive to discard fish. Discarding can result in undesired and unknown mortality, making it difficult for managers to plan harvest levels.

Some steps can be taken to mitigate such problems. For instance, the purchase or leasing of additional quotas either during the season or shortly after it has ended can make it easier for fishers to match their actual harvests with their mix of ITQ holdings. This ability to adjust quota holdings postharvest reduces the incentive to discard fish. In addition, managers will have a more reliable system for tallying and controlling fish mortality. Fishers who develop ways to target particular species also stand to benefit because they can sell or lease all or part of their ITQs for species they avoid harvesting to other fishers who desire to fish less selectively.

Of course, there is still a tendency to discard fish under some circumstances. For example, when a fisher's ITQ is filled for one species, he or she may not want to purchase additional quotas and may continue to fish for species in which ITQs are not filled. Such discarding can be controlled through reliable monitoring at sea and stiff fines.

To ensure that an adequate amount of stock is available for quota adjustments in the early years, managers could set aside a proportion of the total allowable catch for each species to serve as ITQ pools. Other measures can also be implemented. For instance, fishers who catch more than their quota can choose to pay the government for their excess (the amount of excess fish caught times their market value) or forfeit their excess catch to the government. In either case the excess will be recorded and mortality can be better controlled. This approach, like ITQ adjustment through purchase, internalizes the costs of overruns for fishers, leading them to adjust their fishing operation to the desired quota holdings and harvest levels.

New Zealand has implemented a system of ITQs that has an array of options for fishers to choose from in its multispecies fisheries.

While it was difficult to match the proper mix of quotas purchased with actual harvests in the early years, fishers have made adjustments in their operations so that there are fewer overruns (NRC 1999, 108, 352–53).

High Grading

ITQs are criticized for exacerbating "high grading." This is the tendency of fishers to discard smaller fish in hope of catching larger, more valuable ones. High grading is a problem, however, only if the discarded fish do not survive. Such is the case for certain species that cannot survive once they are brought up from the depths, no matter how they are handled. For many other species, careful handing can ensure survival. For these species, the more relaxed pace of fishing afforded by ITQs gives fishers the time to handle 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.

Daniel Huppert, Lee Anderson, and Russell Harding (1992, 19–20) offer three options that could be added to ITQ fisheries to discourage high grading. One is to apply a differential landings tax to remove the incentive to high grade. For example, if large snapper sells for $1.80 per pound and small snapper sells for $1.40 per pound, a landings tax of $0.40 levied on the large snapper would remove the premium paid to fishers for large snapper. Such an option internalizes the cost of bycatch, but fishers may oppose it because it sacrifices potential income.

Another option is to outlaw high grading and require at-sea monitoring of its occurrence. Stiff fines would be levied on operators caught high grading. This option appears feasible for factory trawlers and mothership operations in which the number of operators in the fishery is relatively small, but it is probably unwieldy and expensive for a fishery with a large number of catcher vessels who deliver their catch onshore in many places.

Another way to address high grading is to link landings with an estimated amount of high grading. For example, if one ton of low-valued fish is typically discarded for each ten tons of high-valued fish, each participant could be assessed an extra ton of fish for every ten tons of fish landed. Like the previous case, this would help fishery managers account for mortality, and fishers would have less incentive to discard fish, knowing they are already being assessed for lower-valued fish. If high grading varies greatly among operators, however, applying a single adjustment standard could be self-defeating. An operator who discards only a half ton of smaller fish would be penalized another half ton if the standard were one ton of low-valued fish for every ten tons of high-valued fish. This would increase the incentive for that operator to high grade.

Fortunately, the incidence of high grading does not appear significant for most ITQ fisheries. Where it does appear, monitoring and enforcement have been weak (Grafton 1996, 164). In the few U.S. federal fisheries with ITQs, high grading has not appeared. In the U.S. surf clam fishery off the Atlantic coast, high grading is avoided because fishers now have the time to select areas where large clams reside. It is also insignificant in the Alaskan halibut and sablefish fisheries (NRC 1999, 108–10).

The Question of Salmon Fishing

Salmon, a prime commercial product in the Pacific Northwest, presents a number of challenges to fishery management. First, the Endangered Species Act requires the protection of several endangered salmon stocks, such as coho stocks off northern California and Oregon. What this means for commercial salmon fishing in the region is that fishers and regulators must protect endangered salmon stocks while allowing legal harvest of healthy stocks. This is accomplished indirectly by setting overall harvest limits of healthy stocks and time periods of legal fishing that yield maximum protection of endangered stocks.

Second, salmon are anadromous, meaning that after a period of maturation at sea they return to spawn in the rivers of their origin. The size of the returning populations is highly variable each year, so it is difficult to know beforehand what level of harvest will be sustainable. In nonanadromous fisheries, regulators set a total allowable catch before the season begins. With salmon, however, they set a goal for escapement and determine during each salmon run how many fish can be harvested to protect that escapement (Copes 1986; Grafton and Nelson 1996; Schwindt, Vining, and Weiner 2000).

Problems of Salmon Today

During a salmon run, relatively high numbers of salmon show up in coastal waters. After a short while they move to the mouths of coastal rivers and then proceed upriver until they reach the areas where they began their lives and where they will spawn a new generation of salmon.

To ensure that an adequate number of fish reach these areas, fishery managers record the number of fish passing particular points along the route at particular times of the run. Using these sample fish counts, biologists determine the size of the run and the period in which salmon can be safely harvested without sacrificing the escapement goal. Although biologically sound, this approach results in individual harvests that are random and essentially up for grabs, often resulting in a destructive race for fish. Thus, like many other traditionally regulated fisheries, today's approach to salmon fishing in the Northwest generates a lot of wastes.

The most cost-effective way to harvest salmon is to wait until salmon migrate up a river system and harvest them by traps, weirs, or nets. Such an approach (which was followed by Native Americans for centuries [Higgs 1982]), would permit monitoring and enforcement of regulations to protect endangered stocks while allowing healthy fish to be harvested. Unfortunately, this approach was banned for the most part nearly a century ago, and most salmon exploitation takes place in coastal areas or further out at sea. As in many other ocean fisheries, the focus of managing salmon harvest is on restricting the kinds of fishing gear that can be used, limiting the number of entrants, closing areas for fishing, and ultimately shortening seasons. The regulatory process has merely intensified the race for fish.

Can ITQs Save Salmon?

Rights-based fishing rights such as individual transferable quotas could alleviate management problems in salmon fisheries. Designing a system of ITQs for salmon poses special problems, but they are not insurmountable. Three proposals have been offered.

1. Fishery economists Daniel Huppert and Gunnar Knapp (2001, 95–96) argue that the use of radio and real-time reporting technology would enable ITQs for salmon to be set daily during a salmon run. They envision a salmon fishery in which managers calculate a total daily quota to be announced by radio, with individual daily quotas calculated as shares of the total quota. These total daily quotas might on some days be very small, in which case quota holders could arrange through preseason contracting to save on fishing expenses by selling quotas to a few desig-

nated vessels. On other days managers might allow for unlimited fishing to utilize the full extent of fishing capacity.

Daily ITQs have the potential to match fishing effort with daily fluctuations in salmon abundance during a spawning run. They would also reduce the incentive to race for fish because each participant knows the amount of fish he or she is entitled to for the day. As a result, fishers can spend more time focusing on improving the quality of the catch. Larry Vander Lind (1999) has proposed such a system for Alaska's Bristol Bay's valuable but overcapitalized salmon fishery.

2. Another approach would be to set a lower bound for the total allowable catch before the season from which ITQs would be calculated. In-season adjustments to the total catch and to ITQs would be made as salmon enter coastal areas and knowledge of the actual run size improves. Such an approach would let fishers know before the fishing season the minimum amount of fish they will be allowed to catch, which would help them better plan adjustments to quota shares and fishing operations. The preseason total allowable catch would have to be set conservatively so in-season adjustments would be upward, a change more acceptable to fishers than a downward adjustment. An approach of this kind was proposed as a pilot program for implementing ITQs in one sector of British Columbia's salmon fishery. To date, it has

not been implemented (Jones 1997).

3. Another possibility is to build a forecasting model using historical data on annual salmon runs. A simple model would be to forecast annual run size for the upcoming season based on a moving average of past runs. Statistical confidence bounds would then be used to incorporate variations in run size from year to year. The lower confidence bound would serve as the preseason total allowable catch. Over time, refinements to the model would improve accuracy, giving fishers more certainty about what they would be allowed to catch each season.

Political Issues and Design Considerations

ITQs face other challenges, especially in the political arena. These include the problem of setting the total allowable catch so that the fishery remains financially viable, whether individual quotas should be taxed, and the difficulty of agreeing on an initial allocation of individual quotas.

Setting the Total Allowable Catch

Because the quotas are generally set by government officials who have no direct financial stake in the economics of the fishery, the quotas as a whole may not reflect the efficient level of harvest. The standard approach in most fisheries, whether with ITQs or not, is to aim for the maximum sustainable yield—the maximum amount of fish that can be harvested year after year without depleting the stock—when setting the total allowable catch each season. But this is rarely the yield that sustains maximum profits year after year. It ignores economic factors such as the discounted returns of future harvests and the costs of present and future extractions—considerations that will affect the ability of fishers to earn revenue.

This problem can be addressed by two policy changes. One is to allow fishers to carry quotas over into the next season so that whatever is not caught can be added to the next season's allocation. The second is to allow fishers to catch more in the current season by borrowing against future quotas. In theory at least, these steps would allow fishers to adjust their harvests toward the economic optimum.

Taxing Quotas

Another issue is whether fishers should pay an annual tax on their quota value in addition to the taxes already paid on income. The wealth created by ITQs tends to become a target of political action by special interest groups who want a share of this wealth. In countries where ITQs have become prevalent, critics charge that the value of quotas is a windfall to quota holders and argue that the government, as trustee of a publicly owned resource, should capture this windfall through a tax. Moreover, some economists argue that such a tax is a straightforward capture of the resource rent[13] and as such, it would not affect fisher decisions to improve economic performance or the health of fish stocks.[14]

One economist disputes the claim that such a tax is neutral with respect to fishery performance. Ronald Johnson argues that when such a tax is imposed, fishers lose a long-term stake in protecting and improving the fishery. He contends that fishers may actually lobby government officials to set the total allowable catch above biologically sustainable levels. In addition, he argues that taxing away quota value reduces the incentive for fishers "to act collectively to lower costs and engage in activities such as product development and fishery management that have the potential to increase quota value," activities occurring in New Zealand's ITQ fisheries (Johnson 1995, 337). Leaving the quota value untaxed may actually result in higher revenues in the long run from ordinary taxes (Johnson 1995, 335, 338).

It is also highly likely that a tax on quota value would encounter vigorous opposition from fishers, hampering implementation.[15] Notably, New Zealand initiated an incremental approach to charging such a tax (a minimum charge followed by planned increases in later years) in its ITQ program, but the tax was later scrapped due to growing opposition from fishers (McClurg 1997, 94–95). This is not to say that fishers should not pay for the costs of managing the fishery. New Zealand fishers pay the costs of managing their ITQ fisheries through annual fees.

Initial Allocation of ITQs

Another controversy surrounds the initial allocation of ITQs. To date, the universal approach has been to allocate ITQs on the basis of catch history (occasionally with upward adjustments in quotas to those who acquired more capital under the old regime). Some feel that this amounts to a windfall gain for current participants and discriminates against fishers with little or no catch history. Although such fishers can enter the fishery by purchasing quotas from current holders, they no longer have free access. In addition, fishing interests other than the fishers themselves—processors, dock owners, and suppliers of boats and fishing gear—may fear that their returns on their investments will be hurt if the fishery is no longer open to all.[16]

An auction is an alternative for allocating ITQs. Auctions have been used to allocate government-controlled resources such as airport landing slots in the United States and broadcast frequencies in the United States, Egypt, India, Colombia, the United Kingdom, New Zealand, and Australia. The value of broadcast spectrum rights in the United States is on the order of tens of billions of dollars (Morgan 1995, 380).

One difference between an auction and the current approach to allocating ITQs is that an auction would generate revenue to the government up front, thereby addressing the issue of windfall gains to fishers. In addition, an auction would be efficient because it would allocate ITQs to those who value them the highest, as indicated by their bids. Lacking such a process and instead relying on inputs from the political process, the current approach is inherently inefficient. Notably, a secondary market in ITQs has the potential to correct these inefficiencies because the more profitable fishers—those who find ways to lower costs or maximize the value of their catch—tend to buy out the less profitable fishers. With this shift in quota ownership the fishery overall becomes more efficient.

Despite their potential, auctions have critics, too. Current participants in a fishery are likely to resist a simple auction of ITQs—one open to outsiders on an equal-footing basis. They feel that it does not take into account their investments in existing licenses, if they have them, or their investments in time, labor, and capital in developing the fishery. To address some of these concerns, Morgan (1995) discusses various possible design features.

One option is to give current participants a price preference in their bid. For example, to match a bid price from a current participant, an outsider would have to bid, say, one and a half times that price. It would not ensure that the current participant would have a winning bid, but it would give a significant advantage. Students of auction theory have shown that such an approach helps current participants without sacrificing revenue to the government.[17]

Modified or not, auctions still require access to financial capital. And given the current financial situation of many fishers, as well as their leeriness about perceived changes from ITQs, auctions may prove to be an insurmountable hurdle.[18] The current approach—allocation on the basis of catch history—appears to offer the least disruptive transition, as evidenced by its universal use in ITQ fisheries.

There is always room for incremental improvement. For hired skippers and crew with a long history in the fishery but with no observable catch history and thus no eligibility for an initial allocation of ITQs, some sort of public assistance for an initial purchase of ITQs might be appropriate. An ITQ program may gain processors' acceptance if the total allowable catch can be split so that a portion goes to processors as a form of compensation (Matulich, Mittelhammer, and Reberte 1996). Such an approach, however, is likely to incur resistance from current fishers who would feel, correctly, that their previous catch histories used to determine quota shares would be compromised. Another possibility is a buyout program or additional tax benefits to processors for any capital acquired during the open-access fishery that is not easily transferable to other industries and is now unnecessary under ITQs.

Despite the success of ITQs, obstacles to implementing them remain difficult to overcome. For many non-ITQ fisheries plagued by overcapacity and declining fish stocks, the problems have not yet reached a crisis stage and politicians have opted for the status quo, at least for awhile. Such has been the case in the United States where only four federal fisheries have adopted ITQs: the Mid-Atlantic surf clam fishery, the South Atlantic wreckfish fishery, the Alaska halibut fishery, and the Alaska sablefish fishery. In 1996, Congress imposed a moratorium on ITQs in other federally managed fisheries, and (as of mid-2002) the moratorium remains in effect.

Private Harvesting Agreements

With the moratorium on ITQs in the United States, private harvesting agreements have received attention recently as another management approach to the fishery. Although not as durable as ITQs, they can be quite effective in ending the race for fish and eliminating overcapacity.

The government facilitates such agreements by identifying within a fishery individual fishing sectors that share a common trait, such as a particular gear type. The government limits the number of license holders in each sector and then determines each sector's share of the total allowable catch. One sector may be the fleet that delivers fish to the onshore processors, and the other sector may be the fleet that catches and processes fish onboard—the catcher-processor or "trawler" fleet. Then fishers in each sector allocate harvest shares among themselves as well as carry out certain monitoring and enforcement functions. Like ITQs, harvest allocations among license holders are typically specified in terms of percentages of the sector's share of the total allowable catch. All or part of these allocations are transferable.

Such agreements share two important features with government-administered ITQs. First, participants face the certainty that their harvest allocations will not be taken by someone else, so there is less incentive to race for fish. Second, because their shares are transferable, fishers can adjust the size of their operations by buying and selling quotas and thus free up excess harvest capacity.

Because these arrangements are formed voluntarily and rely on cooperation, their occurrence depends on certain preexisting conditions.[19] The number of participants within the group forming the cooperative must be relatively small, and they must possess a sufficient common interest to make negotiations feasible. There must be an effective system for verifying that actual harvests match individual allocations. There must be substantial penalties for violations of the cooperative agreement in order to deter cheating. There must be an effective system for preventing those not party to the agreement from entering the fishery, or else outsiders are "almost certain to be predators on the fishermen who rationalize their harvest" (Sullivan 2000, 1). There must be clear indication to fishers that forming a cooperative arrangement will yield substantial economic benefits.

Finally, there must be a clear signal to fishers that such an arrangement will not be overturned by antitrust law.

These conditions are becoming more common in Pacific Northwest and Alaska fisheries. Open access appears to be on its way out as "[f]ishery sectors are increasingly segregated by species and gear-specific licensing systems, which restrict eligibility to fishermen with recent participation above marginal thresholds" (Sullivan 2000, 2).

In addition, global markets and fish farming have made fish production extremely competitive. To compete in the marketplace, ocean fishers must find ways to improve the quality of their product and lower their fishing costs. These requirements make continuing a race for fish less attractive and joint harvesting arrangements more so. In addition, sophisticated monitoring and reporting services and increasing use of onboard observers, at least on the larger vessels, support strong enforcement.

These practical conditions make private agreements appealing. Also, there are indications that the agreements will not be overturned on antitrust grounds. Although colluding during the marketing phase would be illegal under the Sherman Antitrust Act,[20] these agreements involve cooperation during the harvesting phase, primarily in Pacific Northwest and Alaska fisheries that are currently regulated. In addition, the U.S. Department of Justice tends to look favorably on an arrangement in which there is no private monopolist restricting output to get a higher price, and in which the consumer benefits, in this case from lower-cost harvests and higher product recovery, are clear (Sullivan 2000, 4–5).

The Pacific Whiting Cooperative

Most of the above conditions were in place in the Pacific Coast whiting fishery by the mid-1990s. It looked as though a private harvesting arrangement that slowed the pace of fishing and reduced capacity would lead to more product at lower cost, and the justice department's Antitrust Division had already hinted that it would look favorably on such an arrangement (Sullivan 2000, 5).

The limited entry program already in place allowed licenses for catcher vessels to be purchased and combined to create licenses for larger catcher-processor vessels. Several companies purchased small-vessel licenses and combined them to allow their large vessels to operate in the fishery. This eventually led to a relatively small number of participants in the fishery—ten catcher-processor vessels owned by only four companies. These four companies realized that a joint harvesting agreement would allow each vessel to process the daily harvest more efficiently.

The four companies (Trident/Tyson Seafoods, Alaska Ocean Seafoods, American Seafoods, and Glacier Fish) negotiated a harvest allocation agreement among themselves roughly proportional to their historical catches and established the Whiting Conservation Cooperative. To help reach an agreement, companies operating more than one vessel in the fishery contributed part of their historical catch to companies whose vessel capacity exceeded their historical catch.

In contrast to the long delays typical of initial allocation of ITQs, these companies reached an agreement "in a session that lasted less than half a day" (Sullivan 2000, 5). The agreement permits members to transfer shares to each other without restriction. It requires members to have a federal observer on board each vessel during fishing operations and to report harvests to a private monitoring service. It specifies fines for harvesting more than the allocations and requires members to post bonds or other collateral to ensure payment obligations.

Following a favorable ruling by the justice department, the new harvesting arrangement went into effect near the halfway point of the 1997 season. Immediately, more efficient operators began leasing harvest shares from less efficient operators, and four of the ten vessels were transferred out of the fishery. The amount of final product recovered from landed fish increased from 17.2 percent in the first half of the season to 20.6 percent in the second half. Bycatch of yellowtail rockfish fell from 2.47 kilograms per metric ton of whiting harvested to 0.99 kilogram per ton. Between the 1997 and 1998 seasons, recovery of surimi (used for "imitation" fish products) from harvest of whiting further increased to 24 percent in the 1998 season through processing modifications. Daily harvest rates dropped, and the slower pace of fishing enabled a number of catcher-processor vessels to shift their output from surimi to more valuable products, such as whiting fillets, when surimi prices fell in 1998 (Townsend 2001, 5).

North Pacific Pollock Cooperatives

The four companies that operated in the Pacific whiting fishery were also major producers in the North Pacific pollock fishery located off the coast of Alaska.[21] This offshore fishery was characterized by heavy competition in the race for fish. In early 1998, the catcher-processor sector to which the four firms belonged made a proposal. This sector, which includes ships that both catch and process fish, asked for a pollock quota allocation separate from the allocation to the offshore fleet as a whole. (The offshore fleet included both the catcher-processor sector and the "mothership" sector, which has a fleet of catcher vessels that bring it fish for processing.)

The four firms and the other catcher-processors wanted to form an arrangement similar to the Pacific whiting fishery's. If the catcher-processors had their own allocation of pollock quota, it would be easier to reach an agreement than if they had to negotiate with the mothership fleet as well.[22]

But the North Pacific Fishery Management

Council refused to approve a separate allocation for the catcher-processor fleet (despite a majority of support). Catcher-processors turned to Congress. Through intense lobbying they achieved passage of the 1998 American Fisheries Act, which divided the fishery's total allowable catch into five separate quotas or allocations. Thirty-three percent went to catcher-processors, 3 percent to catcher vessels that deliver to catcher-processors, 9 percent to motherships, 45 percent to the inshore processors, and 10 percent to community development quota holders. The law also allowed fishing interests to form producer cooperatives, beginning with the catcher-processors and catcher vessels that deliver to them, in 1999. Although negotiations took somewhat longer than in the Pacific whiting fishery, two cooperatives were formed: Twenty catcher-processors formed the Pollock Conservation Cooperative and seven eligible catcher vessels formed the High Seas Catchers' Cooperative.[23]

Pollock fishers off the Alaska coast formed cooperatives after passage of the American Fisheries Act.

The sector experienced immediate improvements in efficiency and productivity. With individual harvest allocations no longer up for grabs, owners reduced the number of vessels from twenty-eight to sixteen. Catcher-processor companies also eventually acquired all of the shares held by the catcher vessels that used to deliver their harvests to them prior to the agreement (Loy 2000). Season length nearly doubled to 149 days in 1999, and daily harvest rates were about 60 percent lower than the 1995–98 average, as catcher-processors slowed the pace of fishing. J. M. Sullivan (2000, 7–8) estimates that product recovery in 1999 increased by 20 percent over the 1998 season, production of deep-skin fillets about 40 percent, and surimi by 9 percent, whereas lower-valued products such as standard fillets and mince decreased by about 40 percent.[24]

In 2000, more producer cooperatives were formed and there was further consolidation in fishing operations. Vessels that harvested pollock for inshore processing plants formed seven producer cooperatives. All but two cooperatives saw a reduction in member vessels. For example, 9 vessels in the Akutan Catcher Vessel Association were retired, leaving 18 member vessels fishing for pollock. The retirement of the *Pacific Monarch* was seen as a step toward safer fishing. The vessel "was old and kind of run-down and a little bit dangerous to be fishing," says John Iani, vice president of UniSea (quoted in Loy 2000). In the offshore sector, only 14 of the original 19 eligible vessels fished for pollock in 2000. For the fishery as a whole, 31 out of 129 vessels dropped out, a 24 percent reduction.

Oregon Herring Sac Roe

Oregon's Yaquina Bay's herring sac roe fishery provides an earlier example—dating to 1989—of a private harvesting agreement carried out in a state-managed fishery. As it did before the agreement, the state limits the number of participants in the fishery and sets the season's schedule and total allowable catch. However, it was not the state but fishers who recognized the efficiency gains inherent in a private harvesting agreement based on individual quotas.

Prior to the agreement, competition in the fishery had become so intense that the risks were unmanageable and the net returns low. According to Oregon fisherman Eugene Law, it was not unusual for the season to end in a matter of hours. Under intense competition, an equipment breakdown on opening day spelled financial disaster for the season, and each of the nine fishery participants experienced such a disaster. Safety also was sacrificed; if a storm was forecast, a fisherman might lose his share of the season's catch if he stayed ashore while others ventured out. The race for fish meant that fish were of lower quality because fishers landed every fish they netted, including immature ones with little roe. This lowered the value of the catch by as much as 20 to 25 percent, according to Law.[25]

In 1989, the nine fishers agreed to individual shares in the total allowable catch for each of the next three years. Each agreed to try to catch one-tenth of the total allowable catch. To allow for a margin of error, a tenth permit owned jointly by all nine fishers was established. Income from landings made on this permit was distributed equally among the fishers.

A transfer of share to a new entrant in the fishery can occur only through the sale of one of the nine state-issued permits to fish in this fishery, and each of the original fishers has the first right of refusal if one of them wants to sell his or her share. There have been no changes in the nine members of the group.

The agreement, which has since been renewed every three years, increased returns.[26] Fishers can now choose the most opportune time to fish. Immature fish with low amounts of roe can be safely returned to sea to mature. The ability to land fish with higher yield has led to higher annual profits. Also, there is now no longer any need to invest in annual equipment upgrades because fishers no longer compete with one another. Savings have also resulted from economies of scale as some fishers have teamed up to catch their shares with one vessel. Equipment breakdowns are no longer the catastrophe they were before the agreement.[27] State officials are pleased with the arrangement because it helps keep the harvests in line with the total allowable catch.[28]

The Yaquina Bay agreement has improved fish quality and reduced costs.

Interestingly, the nine fishers were able to come to terms despite differences in fishing ability. Prior to the start of the agreement, two of the nine were catching 30 percent of the total catch whereas the others caught roughly 10 percent each. Apparently an agreement to split the harvest equally among the nine produced enough benefits in terms of lower risks, guaranteed returns, and more flexibility to satisfy everyone. The small number of participants made it possible for the group to enforce the agreement on their own. Although fishers are alert to the possibility that only poorer-quality fish will be put into the tenth commonly held share, there has been little indication that this is a problem.

California Herring Sac Roe

When the number of participants increases, the cost of reaching and enforcing a private agreement may become prohibitive. Two herring sac roe fisheries in California's San Francisco Bay provide an interesting case study. The roundhaul fishery (using seine and lampara nets) reached an agreement among 42 participants. For the gill net fishery, however, agreement among the 375 participants has not been achieved.

At the start of the 1980s, the forty-two participants in the roundhaul fishery concluded that they needed an individual quota program to overcome the rising costs of competition and low roe recovery rates. With the backing of the California Department of Fish and Game, they agreed to allocate shares of the total allowable catch among themselves. As in the Oregon fishery, the shares are divided equally among the forty-two fishers, and the quota can be bought and sold, but there is not an extra share to cover overages.

The agreement led to a number of successes. For example, it enabled fishers to time their catches so that nearly all the herring landed have higher roe content, which resulted in higher returns for a given level of effort. In addition, with individual shares of the total allowable catch fixed beforehand, fishers can choose the most opportune times to fish. Some who fish for other species do not have to be on the herring grounds at the outset of the season. When poor weather occurs, fishers can wait until it blows over.[29]

Unfortunately, despite its success, the private agreement among the forty-two participants could not overcome governmental interference. The use of seine and lampara nets was outlawed by the state of California in the mid-1990s, and all forty-two permits were converted to permits in the gill net herring sac roe fishery.[30]

For the gill net fishery, now with 417 participants, the cost of reaching a harvesting agreement remains prohibitive and shares of the annual total harvests remain up for grabs—i.e., fishers race for fish. Under these conditions, fishers do not have the luxury of timing harvests so that herring landed will have high roe content. When the roe content is low, fishers often feel compelled to throw the herring back, hoping for better. This has resulted in an unacceptably high level of mortality.

ITQs vs. Private Harvesting Agreements

Private harvesting agreements have an advantage over ITQs: Under the right circumstances, they overcome the political problem of allocating shares. The government defines fishing sectors, closes entry, and determines the initial percentage allocation of harvest for each sector. Although this process is not free from controversy, it appears to be easier for the individual participants to allocate individual shares than to have the government do it.

But once established, ITQs have some advantages: A new entrant can simply buy or lease quotas from a quota owner willing to sell or lease. In contrast, with a private harvesting agreement the transfer of shares to a new entrant will require having or obtaining cooperative membership.

Unfortunately, private harvesting agreements sometimes break down.

In addition, ITQs are likely to remain in force, especially once they acquire value through the secondary market. By contrast, the durability of private agreements depends on the agreement's termination provisions and the willingness of parties to renew the agreement if there are sunset provisions. An agreement that may be terminated at will by one or a few individuals or one that is weakly enforced means that a race for fish and its attendant wasteful investment remains a possibility down the road. As a result, members may not retire as many redundant vessels or invest in as much of the product enhancement capital as they would under a system of ITQs.

Even when the arrangement has no sunset provisions or requires a majority of members to rescind it, capital investment decisions remain sensitive to the possibility of a return to the race for fish if expected benefits fall short of expectations. Such was the case in the northwestern Hawaiian Islands lobster fishery.

In 1976 a small, far-ranging fishing fleet began harvesting lobsters in an archipelago of small islands and reefs stretching north and west of the main Hawaiian island chain for 1,000 miles. In 1983, the government limited the number of participants in the fishery to fifteen permit holders and a total allowable catch was established in 1991. Despite the new restrictions, the fishery could not avoid the classic race for fish. Ralph Townsend (2001, 6) notes that in 1997 "nine boats sprinted to the fishing grounds on opening day, and the quota was exhausted in 22 days." Historically, each vessel used to make two or three trips a season with each trip averaging about thirty days.

In 1998, fourteen permit holders agreed that only four of them would fish for lobster.[31] These four would pay the other ten permit holders 20 percent of their gross revenues from the sale of their catch. Each of the four who fished was limited to 25 percent of the total allowable catch, and because one of the four would not begin fishing until about three weeks into the season, the other three holders agreed to take no more than 75 percent of the total allowable catch from the most productive area located near Necker Island.

This private harvesting arrangement reflected a belief that there was an opportunity to sell live lobsters to the Asian market at much higher prices. With the new agreement the season could be extended from twenty-two days to three months, enabling fishers to respond to favorable market and weather conditions. The four permit holders designated to fish owned the only vessels in the fishery capable of delivering live lobsters to market.

Unfortunately, the agreement suffered a setback in its first year. In 1998, higher prices did not materialize, in part because of the Asian financial crisis. Townsend (2001, 8) noted that "[t]otal revenues were perhaps as much as 50% below the most optimistic pre-season estimates." As a result, the fourteen permit holders decided not to renew their agreement for the 1999 season, and six vessels went back to competing for the total allowable catch. The fishery was closed indefinitely in January 2000, when President Clinton declared the area part of a marine sanctuary.

One agreement fell apart when higher lobster prices failed to materialize.

Breakdowns in harvesting agreements can occur because of poor design and changes in government policy. In Canada in the mid-1970s, the Atlantic Herring Fishermen's Marketing Cooperative was given authority for the Bay of Fundy herring fishery (Peacock and MacFarlane 1986, 215–30). There were 57 vessels operating in this limited-entry fishery. In 1976, the Department of Fisheries and Oceans allocated exclusive quota to the cooperative.

In its first three years, the cooperative "so enhanced the earnings of fishermen, the quality of fish caught, and the ability to manage the fishery that many people began to see the Bay of Fundy as a panacea and as a model for other fisheries," writes Bruce Rettig (1986, 18). Unfortunately, cooperation among members soon disappeared because of disputes between small- and large-scale fishing operations. A group of fourteen fishermen split away from the cooperative. The final blow came when the government withdrew the authority of its members to make over-the-side sales to foreign vessels. Members were left with little incentive to stay in the cooperative, and the cooperative unraveled.

Territorial Rights and Beyond

When feasible, an alternative to ITQs or private harvesting agreements is the establishment of territorial user rights in fisheries, or TURFs.[32] Such an approach has venerable precedents. American 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 migration for spawning purposes. Their "conscious regulation of the fishery played an important role in maintaining its yield over time," says Robert 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," notes Higgs (1982, 55).

For species that are not mobile, such as oysters, territorial user rights are easily defined and therefore can be protected. The oyster beds of Washington's Willapa Bay provide an example. Commercial oyster production in Willapa began in the mid-nineteenth century (Wolf 1993, 21–23). Following an initial decline in the oyster commons from overfishing, oystermen began cultivating areas for oyster production and delineating ownership of these areas by marking off boundaries with stakes. As a result, oyster production was greatly enhanced through "innovation and experimentation" (De Alessi 1996, 3–4).

For example, the Pacific oyster, a large and fast-growing oyster, was imported from Japan and eventually became an integral part of oyster production in the bay. Oystermen also developed methods for culturing oysters in areas unsuitable for natural rearing. Such methods included attaching oysters to wooden stakes driven into the ground and on floats or suspended nets. Oystermen also invested in their own hatcheries. These hatcheries were so successful that they served as a source for reseeding oyster beds off Japan.

Oyster fisheries in other areas along the U.S. coast illustrate the benefits of establishing such rights. 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 who leased areas for exclusive oyster production off Louisiana earned $3,207 per year, whereas their counterparts in Mississippi, where oyster beds are public, earned $807. They also found that the ratio of harvest during the earlier part of the season to the later part of the season 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, whereas fishers with private beds felt little need to harvest early. These findings support the expectation that private property rights solve the tragedy of the commons.

Even for mobile species, TURFs could prove to be highly beneficial. Ocean Farming, Inc., is banking its future on the ability to fertilize the seas with iron to enhance growth of phytoplankton and thereby nourish fish production (Hurst 2001; Yandle 1999, 32). Based on actual experiments, company president Michael Markels estimates that with continuous fertilization about 1,000 tons of catchable fish per square mile can be produced each year. At this rate, 100,000 square miles of fertilized oceans, a mere fraction of the world's oceans, could produce about the amount of fish the world currently produces each year.

With TURFs, ocean production of fish could be greatly enhanced around the world.

Ocean Farming recently entered into an agreement 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 begins, Ocean Farming will pay the government $3.75 per square mile of ocean optioned or 7 percent of the value of the catch, whichever is higher. Ocean Farming can charge other companies to fish the waters, and the company has agreed to allow previous small-scale fishing operations to continue.

Artificial reefs encourage fish production by providing surfaces for small organisms.

A scaled-down version of enhanced marine production is already found in certain U.S. coastal areas. Alabama and Florida allow individuals or companies to introduce reef structures in parts of their territorial waters in the Gulf of Mexico. These structures—which range from old cars to prefabricated artificial reefs designed to be durable and blend into the natural environment—encourage fish production by providing more surface area for the small organisms that fish feed on (De Alessi 1997, 78–79). The structures also provide fish with places to hide from predators. The reefs actually become public property as soon as they are placed in the water, but knowing the exact location of a reef has given enough security of ownership to spur some private provision. Private efforts would probably increase if states granted entrepreneurs options for acquiring fishing and possibly recreational rights in areas around the 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 easily have been financed privately if exclusive fishing rights to the state-owned Gulf area where the reef was deployed could be purchased from the state. Owners of such homesteaded areas could catch the fish themselves or lease out fishing—even recreational fishing—rights.

Establishing property rights in marine habitats or the resource itself should not be overlooked. Once barriers to property rights to ocean areas are removed, the evidence indicates that entrepreneurs will invest in enhancing the resource through fertilization and other creative approaches. Beyond this strategy, establishing property rights in fish stocks themselves is on the horizon. Technologies already exist to help the evolution of property rights proceed (De Alessi 2000, 108). 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 technologies can be used to identify fishing boats. Same-day DNA field tests to monitor whale stocks in the wild already exist (Christainsen and Gothberg 2001). High-tech tags are used to track individuals, each tag a data collecting and broadcasting unit capable of transmitting radio or sound waves. Such techniques offer promise for establishing property rights in migratory marine resources.

Conclusion

Many U.S. fisheries are deteriorating. Some stocks, including several populations of coho salmon in the Pacific Northwest, have declined to the point where they are given special protection under the Endangered Species Act. To protect our fisheries, we can no longer afford to ignore the tremendous potential offered by rights-based approaches such as ITQs, producer cooperatives, and TURFS.

In a growing number of fisheries around the world, ITQs are proving highly successful in eliminating the two major problems plaguing ocean fisheries—overcapitalization and overfishing. ITQs work because they allow fishers to end the destructive race for fish. Moreover, when they are established as clear property rights, as in New Zealand, they foster incentives for fishers to act collectively in improving the fishery. Like shareholders in a public company, holders of ITQs "come together and cooperate" in regulating fishing and coordinating their fishing rights with other users (Scott 1996, 97).

ITQs, TURFs, or cooperatives would end the race for fish.

To expand ITQs, there must be creative approaches to addressing technical issues like bycatch and salmon and to overcoming political gridlock. In countries where ITQs have become prevalent, some argue that allocating ITQs to current fishers on the basis of catch history amounts to a windfall. Modified auctions could address this concern, but because auctions require financial capital, their application appears premature at a time when many U.S. fisheries are suffering financially and many fishers are wary about major change.

The adoption of ITQs in the United States is being hampered by politics, but under certain conditions private harvesting agreements are an alternative. Many fisheries in the Pacific Northwest and Alaska appear well suited for such agreements. Open access is disappearing, reliable reporting systems of harvests are in place, and competitive global markets for fish are pressuring fishers to end the race for fish.

TURFs, another rights-based alternative, have historically been well suited for immobile species, such as oysters. Their ability to enhance production for mobile species should not be overlooked, however. To do this, TURFs require legislative reform that recognizes exclusive rights in U.S. marine areas. And to foster enhanced marine production even further, we should not overlook the potential for establishing property rights in the fish stocks themselves.

In the meantime, a number of steps should be taken to promote the expansion of ITQs, private harvest arrangements, and TURFs.

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

- Rather than tax the value of ITQs or limit their duration, Congress should establish them as secure property rights.

- To reduce political gridlock, options for allocating ITQs within fisheries should include auctions.

- Congress should clarify the conditions that exempt private harvesting agreements among fishers from antitrust laws.

- Using the North Pacific pollock fishery as a model, federal and state agencies should pave the way for private harvesting agreements by identifying homogeneous fishing sectors within a fishery and allocating separate quotas to each of them.

- Territorial fishing rights should be given legal recognition.

Such steps will take us closer to reducing the overexploitation and depletion of ocean resources.

■

Notes

1. Sources for these figures are: Marine Fisheries Conservation Network (2001); Department of Commerce (2000, 2001); and NMFS (2000a).
2. The term fishery is used to identify one or more species of fish in a region as well as the fishers, vessels, and equipment used to harvest, process, and deliver the fish to the wholesale market.
3. For a classic article on the fishery, see H. Scott Gordon (1954). See also, Colin W. Clark (1981).
4. The term "tragedy of the commons" was taken from Garrett Hardin's (1968) influential article.
5. Community-run, coastal fisheries are an exception. See Leal (1996).
6. 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).
7. Economist Frederick Bell (1972, 156) provided one of the first empirical verifications of 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 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.
8. Townsend (1990) surveys the evidence of fisheries in the United States and abroad that adopted a limited entry system.
9. For example, pot gear is used to target sablefish, hook-and-line gear to target sablefish, rockfish, and lingcod, and bottom trawl for deepwater species, such as Dover sole, thornyheads, sablefish, and arrowtooth flounder.
10. The longer season has also made fishing less hazardous and less wasteful. The U.S. Coast Guard reported that the number of search and rescue missions for stranded halibut fishers dropped by 63 percent, and fish mortality due to lost or abandoned gear dropped by 77 percent. See National Research Council (1999, 74, and 103).
11. These estimates are based on mean quota share price of $0.89 and total quota share units of 333,000,811 in 1995 and mean quota share price of $1.48 and total quota share units of 331,145,333 in 1998. See

Dinneford et al. (1999).

12. Dave Wallace (1996) of Wallace & Associates also points out that a fishers-generated reduction in the size of the fishery via ITQs creates instant stakeholders who are invested in the fishery's future. This is something that is absent from government-generated buyouts of excess capacity. In addition, a fishers-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.
13. Resource rent from a fishery is analogous to the rent an owner earns from land. A landowner who rents his land to another for farming expects a return above what the farmer earns to reflect the productivity of the soil itself. In the case of the fishery, this would be the value of the fish stock's ability to replenish itself.
14. For example, see Clark, Philip, and Mollet (1989, 138).
15. Taxes of any form, including so-called corrective taxes proposed as an alternative to regulation for eliminating excessive fishing effort, have yet to be used as a management device in global fisheries (Johnson 1995, 327).
16. 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.
17. For a theoretical discussion of price preferences and their ramifications in the auction process see McAfee and McMillan (1987).
18. Such was the case for airport slots and spectrum rights in which allocations by auctions followed a long period of administrative allocation and in some cases allocation by lottery.
19. See also Ostrom (1990, 90).
20. 15 U.S.C. § 1.
21. The North Pacific pollock fishery is the nation's largest single-species fishery. Its directed fishing allowance (DFA) was 973,843 metric tons of pollock in 2000. The DFA is about 85 percent of the total allowable catch set each year for the pollock fishery. The remaining 15 percent is allocated as community development quota for several Native Alaskan communities. See Loy (2000).
22. The mothership fleet was composed of three processing

ships and about twenty-five catcher vessels.

23. Both organizations submitted a request to the Antitrust Division for approval of their proposed harvesting arrangements. However, because they were confident their activities would be approved based on earlier approval of the Whiting Conservation Cooperative, both groups went ahead with their proposed activities for 1999 without receiving approval from the division.
24. Deep-skin fillet prices increased in 1999, most likely due to a drop-off in fillet production from Russia and a decrease in worldwide production of groundfish products. With the changes, catcher-processors were able to increase their production of deep-skin fillets in 1999. They also modified their vessels to increase capacity for fillet production in subsequent years, and this helped decrease fillet prices in world markets for 2000.
25. Eugene Law, Oregon fisherman, telephone interview, January 14, 2002.
26. John Johnson, natural resource specialist, Oregon Department of Fish and Game, Newport, telephone interview, February 2002.
27. Johnson, telephone interview, February 2002.
28. Johnson, telephone interview, February 2002.
29. Bill Maxwell, manager, California Department of Fish and Game, telephone interview, November 18, 1992.
30. Susan Ashcroft, manager, San Francisco Bay Herring Fishery, California Department of Fish and Game, telephone interview, February 4, 2002.
31. The fifteenth permit holder was not party to the agreement. Instead, the holder sold the permit to a new participant. Although this created some concern, the new entrant's impact on the fishery was small enough to warrant going ahead with the agreement. See Townsend (2001).
32. Francis T. Christy (1996, 14) uses this term.

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About PERC

PERC—the Center for Free Market Environmentalis—is a nationally recognized institute located in Bozeman, Montana. The organization's primary goal is to provide market solutions to environmental problems. PERC pioneered the approach known as free market environmentalism and conducts research in the areas of water, forestry, public lands, and endangered species, among others.

Free market environmentalism is based on several tenets: Private property rights encourage stewardship of resources; government subsidies often degrade the environment; market incentives encourage individuals to protect environmental quality; and polluters should be liable for the harm they cause others.

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