Earth Report 2000: The State of the World's Fisheries

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Highlights

- The global fish catch continues to increase despite claims that it has reached its upper limit. The 1996 world fishery production was 115.9 million tons, an increase from 113 million tons in 1995.
- Despite large population increases, per capita fish consumption has grown modestly over the past quarter century, from about 10.5 kg in 1970 to slightly over 13 kg in the last three years.
- World fishery production is now over six times what it was in 1950, and fish destined for direct human consumption has increased almost three times over the past 37 years, rising from around 27 million tons in 1960 to 90 million tons by 1996.
- Recent increases in world production, however, have come primarily from aquaculture and newly discovered stocks – many of the world's depleted stocks are *not* recovering.
- There is hope that depleted stocks can recover, however, as fisheries have generally shown a remarkable resiliency when given the chance.
- In addition, when people are given the opportunity to conserve marine resources, they generally do.
- To give people that opportunity, however, there must be a dramatic shift in the way fisheries are managed, away from many current regimes that all too often encourage the profligate waste of resources, time, effort and capital.
- As long as the incentives created by fishery management institutions favor rapacious extraction of fish from the sea, then the prospect for marine life will be bleak. If, on the other hand, these institutions provide incentives for conservation and stewardship, then the outlook for these fish stocks will be bright.
- The difference, in most cases, is between public and private management of the fisheries. Government regulation of resources previously controlled by local participants has invariably proved to be less effective and efficient, if not disastrous in its consequences.
- Until fishing rights are safeguarded from the vagaries of public management, the incentive to harvest stocks sustainably will remain weak.
- Government programs that are moving toward more private control of the fisheries, however, are proving to be more successful.
- One such program, while certainly not without its problems, is the development of a system of Individual Transferable Quotas (ITQs) for fisheries, especially in New Zealand.
- the closer an ITQ resembles a private right, the greater flexibility the system has to adapt and evolve into a system of real private rights with the strongest possible incentives for conservation

If one considers only the plight of the Atlantic cod, it is tempting to agree with these sentiments. Cod are one of the world's most fecund fishes (an average female produces one million eggs) and have been a staple of many diets for centuries. Cod has even been called the "beef of the [iii] Today, however, the cod fishery in New England and Atlantic Canada is the prototypical example of catastrophic fishery decline. Once one of the world's richest fishing grounds, cod are so scarce there now that they are close to commercial extinction[iv].

While the cod fishery is certainly not an isolated example, there is also a rosier view. Many fisheries are healthy, and recent evidence indicates that even those that have been stressed may be remarkably resilient.[v] Based on a slowed, but still increasing world fish catch, the late economist Julian Simon even went so far as to claim that 'No limit to the harvest of wild varieties of seafood is in sight' Julian Simon[vi]

Proponents of the divergent views of such optimists as Julian Simon and such pessimists as Greenpeace are often referred as the doomsayers and the cornucopians; surely they both go too far. The world harvest of marine species *has* risen slowly in the last few years, but the increase has come primarily from harvests of lower value species and the discovery of new stocks.

What both ignore is fundamentally important: the role of institutions – the laws and social norms that constrain the behavior of individuals and groups. If the incentives created by these

institutions favor unhampered extraction of fish from the sea, then the prospect for that targeted marine life will be bleak. If, on the other hand, these institutions provide incentives for conservation and stewardship, then the outlook for these fish stocks will be bright.

Searching for Solutions

There is no single answer as to how to conserve the ocean's resources. However, experience shows that when people are given the opportunity to conserve marine resources, they generally do. On the other hand, when leaving fish in the water simply means letting someone else catch them, far fewer fish get left in the water. Resource conservation is not happenstance; it is a rational response to a given situation.

Institutional constraints determine these responses, and are intrinsically bound to the question of who owns the rights to do what with a resource. Thus, property rights (rights to such things as the use of a resource, the income derived from a resource and the ability to transfer part or all of these rights[vii]) are a crucial element in any analysis of why some resources are conserved and others are not. The structure of property rights affects behavior because it establishes different allocations of benefits and harms among individuals. Any attempt to exert control over a resource is an attempt to define property rights in that resource, whether through regulation, a group rule or a form of exclusive ownership.

In the absence of any institutional constraints (a situation commonly referred to as open-access), each user will tend to extract as much as possible, regardless of the consequences for the resource, because they bear only a fraction of the harms (e.g. a degraded fishery for everyone) but reap all of the benefits (i.e. the fish they haul up on deck).[viii] Thus, a crucial element of conservation is that anyone depleting a resource bears the full consequences of that harm (or, conversely, captures the benefits of conserving the resource). In other words, both positive and negative effects must be internalized.

Responses to depletion

Open-access does not cause problems when fish are plentiful and catches are small, but as the pressure on a fishery grows, so does the potential for depletion. Thus, as pressures on resources increase, open-access regimes become rarer, and property rights wind up either held publicly by government or privately by groups or individuals.

Government control

The most common response to open-access and depletion has been government intervention, which normally results in restrictions on fishing gear, effort and seasons. This relationship separates the steward (the state) from the exploiter (the fisher), who still benefits most from maximizing harvests instead of maximizing the value of the resource.

As the state takes responsibility for the fisheries, it also becomes responsible for taking care of those who depend on the resource. This creates a "moral hazard", which means that generous

government benefits to alleviate hardship today ends up encouraging the very behavior that helped to create the misery in the first place. In this case, because of government intervention, fishermen bear only a fraction of the consequences of their actions, and their impetus for continuing to deplete the fisheries remains. In fact, it is often stronger. Government regulation all too often encourages the profligate waste of resources, time, effort and capital.

In the case of the U.S. and Canadian cod fisheries, calls to increase or maintain harvests levels were common, even in the face of drastic population declines. Responding to constituents, governments allowed overharvesting to continue, even encouraging investment in fishing capital as fish became more scarce, and, not surprisingly, resulting in the depletion of the fishery. When the fishery finally crashed, the government was on the hook and responded by pouring millions into communities that depended on fishing for a living (while steering clear of substantive reform and doing little to address the decline of the fishery). These efforts have included area closures, all manner of restrictions on fishing effort, boat buyout schemes, re-training programs, and simple handouts. All the while harvests remain at all-time lows and stock recoveries have been minimal.

The problem is the politicization of fisheries management. The National Marine Fisheries Service in the United States routinely generates good science on the health of the fisheries, which is then just as routinely ignored in favor of conservation measures that lack teeth. Such ineffective reforms and bailouts are politically expedient because they obscure the need for drastic changes in the way fisheries are managed. Such has been and continues to be the case in New England, where the current situation was summed up nicely by an article from the *Bangor Daily News* in the summer of 1998. It reads: "For each of the last two years, the New England Fishery Management Council used a variety of mechanisms to reduce cod catches. But fishermen still brought to shore more than twice the target amounts the council's actions intended to reach – and roughly half of the total amount of cod in the Gulf of Maine." [ix]

When efforts are made to restrict harvests, fishers are quite adept at staying one step ahead of restrictions imposed on them, often with ridiculous and sometimes dangerous results. So many variables influence harvest that regulators cannot hope to keep up. As seasons are shortened, fishers might respond with larger nets. As larger nets are restricted, more horsepower may take up the slack, and so on. One of the more extreme examples was the Alaskan halibut fishery, where the primary limitation was the length of the fishing season. As the season shortened, larger boats, larger nets, and technologies such as fish-finding sonar began to appear. Before long, a season that was once months long was down to two days, with no discernible reductions in the total harvests.

Thus, while government control may define who has the right to fish, it fails to make fishers pay for th[x]e damage they are causing to the resource.

Public oyster beds

Much like the Atlantic cod of New England, the oyster fishery in Maryland was once a great source of industry and a staple of many diets. Oysters in the Chesapeake declined precipitously

despite warnings stretching back well into the last century. As stocks continued to decline over time, the Maryland government continued to increase its involvement in the fishery, presenting a dramatic case of regulatory failure. In fact, it has been said that Maryland has passed more legislation dealing with oysters than any other issue.

In 1891, William Brooks, a scientist and Maryland Oyster Commissioner in the 1880s, writing about the public nature of the oyster fishery, declared even then that "all who are familiar with the subject have long been aware that out present system can have only one result –" [xi] Brooks recommended creating privately owned oyster beds to encourage oyster cultivation and stewardship, but regulation was chosen instead, resulting in all sorts of restrictions on harvesting, including when, where, by whom and how. Watermen on the Chesapeake fought over both these restrictions and the oysters themselves so ferociously that gunfights were not uncommon. These skirmishes that took place around the turn of the century are commonly referred to as "The Oyster Wars."[xii]

Today, oyster harvests in Maryland are only 1% of what they once were (the diseases Dermo and MSX have exacerbated the problem since the 1970s, but the fundamental damage was done long beforehand).

Restrictions on technology were (and still are) so severe that the Maryland skipjacks that ply certain oyster beds are the last commercial fishing fleet in the United States still powered by sail. As if that wasn't arcane enough, the boats are given an exemption on Mondays and Tuesdays when they are allowed to dredge for oysters with a "push" – a small motorized dinghy tied to the back of these large, wooden sailboats. This is all on top of restrictions on the oyster season, minimum size limits for harvestable oysters, specifics for the types of dredges that may be used by different people in different places, and specific demarcations over certain areas that are open to harvesting. Nevertheless, and not surprisingly, the oyster beds remain severely depleted.

Private ownership

Private ownership is the alternative to public management that *does* force people to bear the costs of their use of a resource. The crucial determinant for whether a resource is privately owned or not is whether the welfare of the decision makers is tied to the economic consequences of their decisions.[xiii] Private property rights must also be well defined, enforceable, and transferable.[xiv] As private property rights become more well defined, resource stewardship becomes more attractive and, equally, owners bear more of the costs of any rapacious behavior.

Unfortunately, clearly defined and readily enforceable private property rights to marine resources are rare. However, those few examples that do exist strongly support the arguments of theorists who have promoted private property rights in the oceans as a means to improve resource management.[xv]

Private ownership institutions cover a wide spectrum ranging from communal to individual ownership. Both private communal and private individual property rights regimes create positive

conservation incentives by allowing fishers to receive directly the benefits of conservation, and both allow owners to exclude others, decide how to manage resources, and bear the consequences of these actions. Private communal rights may not be so easily transferable, but in either case the welfare of either the individual or group is tied directly to the health of the resource. There is no government agency standing ready to ameliorate resource deterioration, thus the fishers who own the resource owner intimately feel any effect, positive or negative.

Unfortunately, anthropologists, economists and policy makers often promote either individual or group ownership at the expense of the other, even though the distinction is frequently muddled. Adding to the confusion are the varying definitions that different (and even often the same) schools of thought apply to terms like "the commons", "common property" and "private property". For example, biologist Garret Hardin used the word commons to mean open-access, anthropologists often use it to mean a strictly monitored form of group ownership, and economists frequently dismiss the concept entirely under the assumption that only individual ownership institutions are private.

Private individual property rights offer the greatest rewards for conservation to their owners, but are also the most costly to define and enforce. Thus, in some instances, private communal property may be optimal, depending on the resource and the costs of monitoring and enforcing rules and excluding outsiders. Private communal property rights may range from nearly open-access to a strict system of controls and rules, but essentially they define the rights shared by the members of a group with exclusive access to a resource.[xvi]

Margaret McKean and Elinor Ostrom, for example, provide an explanation for the existence of private communal rights: 'Common property regimes are a way of privatizing the rights to something without dividing it into pieces … Historically, common property regimes have evolved in places where the demand on a resource is too great to tolerate open access, so property rights in resources have to be created, but some other factor makes it impossible or undesirable to parcel the resource itself'.[xvii] One such factor is uncertainty, and one advantage of common property arrangements may be risk sharing.[xviii] An example cited by McKean and Ostrom is a very large, forested area where edible flora and fauna are very patchily distributed.

Although similar in many ways, there remains a crucial difference between most communal and individual forms of ownership – transferability. Transferability is normally restricted in communal arrangements as they tend to rely on maintaining a closely-knit group to monitor and enforce rules (by using sanctions such as social ostracism or even mere disapproval). This may lead to problems of transition for communal property owners, as transferability is crucial for owners to capitalize on the value of their assets, to use them as collateral and to capture the future returns that stem from investments.

Transferability also bolsters resiliency in the face of pressure from outsiders. If out-transfers are not possible, pressure from outsiders for access often leads to expropriation, either of the resource itself or of the right of access to it. Legal recognition of communal rights would go a long way toward resolving this problem, but unfortunately, especially in developing countries, expropriation is the norm.

This may explain much of the current emphasis that many policy makers place on maintaining small fishing communities and their "cherished way of life". Barring legal recognition, sentiment seems to be the next best alternative. Unfortunately, this may do more harm than good, as it tends to work toward entrenching the status quo. Property rights institutions, including communal ones, are constantly evolving, and while some communities may choose to maintain a certain way of life, others may not. Legislating stasis is bad policy.

Private oyster beds

In marked contrast to public oyster beds in Maryland or unrecognized communal ownership arrangements, the oyster beds of Washington state are owned in fee simple – completely privately, and with a title to prove it. As a result, harvests of oysters in Washington state look very different from those in Maryland.[xix] Additionally, the oysters are harvested by relatively modern means and the beds are often seeded from high-tech hatcheries financed by the oyster growers themselves.

One of the few empirical studies of the effects of the private institutions on marine resources compared oyster beds managed by state regulators to those leased privately in the Chesapeake and the Gulf of Mexico (in the Chesapeake, leased beds are common in Virginia).[xx] This study found that the leased oyster beds were healthier, better maintained, and produced larger, better quality oysters. Leaseholders invested in protecting their oysters and enhancing oyster habitat. One way they did this was by spreading old oyster shells on their beds, providing an ideal substrate for larval oysters to settle on. On public beds, no such steps were taken voluntarily. Watermen in Maryland were more interested in government sponsored bailouts and subsidies for oyster bed maintenance than in taking steps on their own to improve harvests. It is possible to lease beds in Maryland, but there has been little interest – once the myriad state-sponsored programs were underway, watermen were loathe to give them up.

A similar dichotomy of approaches and results occurred in England and France, where English oyster beds declined under public regulation, while those in France were nurtured by private cultivation.[xxi]

ITQs

Although the benefits and feasibility of private ownership are most readily apparent for sedentary species like oysters, they may also be perfectly applicable to more far-ranging species as well. Of course, fisheries are rarely either wholly private or wholly public, but many countries are attempting to improve fisheries management by introducing some limited forms of private ownership into the fisheries, specifically by creating Individual Transferable Quotas (ITQs).

ITQs grant a right to harvest a certain percentage of the Total Allowable Catch (TAC) of fish in a given year, and ITQs can be bought or sold. Over time, ITQs may also offer a real opportunity to move towards the private ownership of marine resources. Over the last few years they have been introduced most notably in New Zealand, Iceland, Australia, the United

States and Canada.

While not really private rights, ITQs can be a tremendous step in the right direction. In contrast to regulation-based controls, they provide positive conservation incentives for those harvesting resources, in large part due to the fact that the health of the fishery is capitalized into the value of the quota. In other words, the brighter the prospects for future harvests, the more ITQs will be worth, allowing ITQ owners to gain now from steps they take to ensure the long-term future health of the fishery. Even some banks are beginning to accept ITQs as collateral, improving access to the fishery by making loans easier to secure for new entrants.

New Zealand

Until the introduction of ITQs, fisheries management in New Zealand followed a familiar pattern. Since 1960 the government had condoned free entry into the fisheries and subsidized development, producing a predictable result: falling fish stocks and rising investment in fishing boats, nets, and other technologies.[xxii] The deplorable state of many inshore fisheries led to the Fisheries Act of 1983, which consolidated all previous legislation and, most importantly, set out to both improve resource conservation and increase economic returns from the fisheries.[xxiii] This led to the creation of tradable quotas for some of the deep-water fisheries and, in 1986, ITQs were introduced for all significant commercial finfish species with the creation of the Quota Management System (QMS).

Today, following numerous improvements, the program appears to be tremendously successful. Fish stocks are generally healthy and ITQs have ended subsidies, reduced fishing capacity, and encouraged investment in scientific research.[xxiv] The New Zealand Ministry of Agriculture's Philip Major described a remarkable transformation after the creation of the ITQ system; "It's the first group of fishers I've ever encountered who turned down the chance to take more fish".[xxv]

It has been suggested that ITQs will result in the consolidation of the industry and the elimination of the small-scale fisher. While there has been some consolidation, especially in the capital-intensive deep-water fisheries, the total numbers of vessels, full-time employees, and quota owners have all increased over the period from 1986 to 1996.[xxvi] Limits do exist on the percentage of the overall quota any one fisher may own, ranging from a limit of 45 percent in a given area for species such as hoki and orange roughy to 10 percent for rock lobster.

The New Zealand quota system seems to be moving closer and closer to a real system of privately owned fisheries. In the orange roughy fishery, for example, quota owners got together in 1991 to form the Exploratory Fishing Company (ORH 3B) Ltd., in large part to fund management science and research.[xxvii] An another example is the Challenger Scallop Enhancement Company Ltd., whose shareholders are the owners of scallop ITQs. These owners manage the fishery through contracts that allow the company to levy money for research, enhancement (a vigorous reseeding program), monitoring and enforcement, which includes daily catch limits.[xxviii] They have even contracted with fishers in other fleets to

ameliorate the effects of other fisheries (in this case the oyster fishery) on the habitat and productivity of the fishery.[xxix]

Fishers in New Zealand are taking on more and more responsibilities for fisheries management and scientific research, and it appears that the trend will continue, and the government's role in the fisheries will continue to shrink as the health of the fisheries improves.

Private communal rights - coral reefs in the South Pacific

While New Zealand is striving to create private solutions where none existed before, other nations are turning back to existing, private communal conservation regimes. One such example occurs throughout the South Pacific in the form of village control over coral reefs.

Coral reefs in the South Pacific have suffered of late from destructive fishing practices such as fishing with dynamite or cyanide. The World Wildlife Fund's Hong Kong office investigated the problem of cyanide fishing and found that reef fisheries in Southeast Asia 'work in a sustainable way only in those few places where the rights to fish a particular reef are clearly established.'[xxx]

Reef tenure typically takes the form of ownership by a clan, chief or family, and marine tenure in these areas often extends from the beach to the outer edge of the reef, sometimes even miles out to sea.[xxxi] Biologist Robert Johannes studied coral reef conservation throughout the Pacific and also found village control over local marine resources to be the surest indicator of reef health.[xxxii] The reefs are valuable assets to the community and so are fiercely protected. In Fiji some communities employ fish wardens to watch over the reefs. In Johannes' study of Palauan fishers, he found community managed fisheries that employed closed seasons and areas, abided by size limits and even imposed forms of quotas to ensure conservation.[xxxiii] These measures generally showed the greatest concern around spawning times and areas for certain species, and sanctions ranged from mere disapproval to ostracism and, in the case of outsiders, even severe physical atonement.

Japanese cooperatives

A much more formal communal arrangement exists in Japan, where Fishery Cooperative Associations (FCAs) frequently hold the rights to coastal marine resources.[xxxiv] FCAs impose strict conservation measures on their members and coastal marine resources in Japan are generally healthy. Cooperative ownership in Japan is so strong that FCAs have even been able to block potentially harmful or polluting coastal development by asserting the primacy of their fishing rights.[xxxv] As described by Kenneth Ruddle and Tomoya Akimichi, "Because fisheries rights have a legal status equal to land ownership under Japanese law, … a private developer must … either purchase all of the fisheries rights … or compensate for any reduction in the [xxxvi]

These cooperatives are hardly private endeavors (they receive significant government subsidies as do most Japanese farmers), but they do demonstrate the emphatic link between exclusive

control and the stewardship of marine resources.

Barriers to private solutions

Legal recognition

One major reason the Japanese cooperatives have been so successful is that they have been recognized by law, which allows them both to defend their rights in court and develop ways of accommodating out-transfers. Unfortunately, in most places around the world, not only does the legal system not recognize private communal rights, it is often biased against them. While some regimes may disappear naturally, in many instances they are simply legislated out of existence.[xxxvii] And when resources that were previously controlled by local participants have been nationalized, state control has usually proved to be less effective and efficient, if not disastrous in its consequences, than control by those directly affected.[xxxviii]

This was certainly the case in the Pacific Northwest, where Native Americans had developed complicated arrangements, both within and between tribes, to manage their salmon fisheries.[xxxix] They relied heavily on fixed nets and weirs along the riverbank, but were careful to allow plenty of fish to pass in order to maintain the spawning runs and ensure a future supply. According to Robert Higgs 'Indian regulation of the fishery, though varying from tribe to tribe, rested on the enforcement of clearly understood property rights. In some cases these rights rested in the tribe as a whole; in other cases in families or individuals.' [xl]

But as the numbers and power of settlers increased, these property rights were quickly expropriated by force. Ironically, intra-settler expropriation soon followed. Some of the new arrivals set up fish wheels (very effective fish harvesting contraptions resembling water wheels) and fish traps along the riverbanks while others used labor-intensive methods to chase down their prey at sea. Sensing their great superiority of numbers, the hook and line fishers went to the ballot box and were able to have all fixed fishing gear banned in 1934.

Allocation problems

Once this cycle of expropriation has started, it is very difficult to return to a private system. In fact, more often than not, private conservation solutions are opposed not because of their effectiveness, but over how private rights might be allocated.

ITQs have most often been allocated on the basis of historical catch, and so some of the most vehement opposition to ITQs has come from those whose historical catches have been low. For example, when ITQs were recently under consideration for some species in US waters off of Alaska, any sort of fishing rights were vehemently opposed by the Alaskans in Congress out of fear that much of the new rights would be allocated to fishers in Washington state, who had historically fished off of Alaska.

Of course, it is rarely politically expedient to be so honestly direct, so many other objections are typically lodged against ITQs. One of the most common is the fear of consolidation. Some claim that the quota system in New Zealand has excluded 'small-scale and independent fishers from fisheries, which fall increasingly under the control of large, profit seeking corporations', [xli] but

this is far from the case. Consolidation in New Zealand has occurred, but primarily in the offshore fisheries for orange roughy, hoki and squid that have always involved large, capital-intensive efforts. The number of vessels (2,768 in the 1994/5 fishing season) in the domestic fleet, however, has remained relatively constant.[xlii] If it is accepted that there are too many boats chasing too few fish (and it generally is), then some reduction of the fleet can only be expected. At least when everyone receives an initial quota, they leave the fishery by choice. (Consolidation may, however, be more likely if rights are auctioned rather than allocated based on historical involvement in the fisheries.)

Another example is the argument that fisheries are a public resource, and that any move in the direction of privatizing them will deny "the public" from benefiting from the resource. But surely the greatest public benefit is derived from a healthy resource. Maintaining open-access may appeal to egalitarian values, but in reality a shift to private ownership is more likely to ensure access to a valuable, plentiful resource, as opposed to a depleted wasteland.

Additionally, the greater the formal recognition for private arrangements, the easier it becomes for new entrants to lease or buy their way into a fishery. If there is no collateral in the fishery, entry is much more difficult. When a form of private rights was instituted in New Zealand, researchers found almost immediately that "transferability … allowed fishers to enter and exit [xliii]

Political battles are inevitably fought over pieces of a pie that never gets bigger. Instead of investing in efforts to enlarge the pie, resources are devoted to attempts to grab a bigger share at some else's expense.[xliv] Moving resource allocations out of the political arena turns a zero-sum game into a positive one. Of course ITQs themselves are also a political solution. They do not confer a private right to the fish themselves, only to a percentage of an annual harvest determined by fisheries regulators. They are, however, an important recognition of the importance of institutions, and in the case of New Zealand, offer the real potential to smooth the transition to self-management.

Overcoming these obstacles

Francis Christy, a noted fisheries economist, believes that the transition to property rights regimes in fisheries is inexorable.[xlv] He has also perceived that the political feasibility of a move to private fishing rights is "inversely proportional to the degree of vested interests in the [xlvi] The strongest resistance to change comes from those who have adapted and are doing relatively well under the current system, or who may have invested in the expectation that the status quo would continue.

Such was the case in the increasingly capital-intensive halibut fishery off of Alaska, where Christy notes that the theoretical arguments for limiting access to the fishery had been clearly laid out as early as 1961. Even so, reforms were minimal until the fishery endured a two-day season that created a dangerous and expensive race for fish. As one fisherman put it, the fishery was "flat ruined."[xlvii] In the late 1980s a concerted effort to introduce ITQs into the fishery began, and eventually succeeded. In 1995, the first year of the quota program, waste in the fishery (as

defined by the International Pacific Halibut Commission) declined by eighty percent.[xlviii] As further evidence of the change wrought by IFQs (Individual Fishing Quota – a form of ITQ), processors now grade halibut according to quality, where before there was always just one price. A recent letter from a small boat halibut fisherman to the *Alaska Fisherman's Journal* summed up some of the advantages of the ITQ program: "We fish better weather, deliver a better product, and have a better market. This is a better deal."[xlix]

The other major fishery under an ITQ program in the United States is the surf clam and ocean quahog fishery on the East Coast. These species are generally found in canned clam chowder. This fishery went through a series of booms and collapses as new stocks were discovered and boats rushed in and out of the fishery. Regulatory responses invariably lagged behind these cycles, often restricting harvests of plentiful stocks while acceding to harvest of depleted stocks. In the late 1980s effort restrictions permitted only six hours of fishing every two weeks.[l] The surf clam and ocean quahog ITQ program which began in 1990 – the first in the U.S. – solved these problems, and has since been called the "best managed fishery" in the U.S. by a senior scientist at the National Marine Fisheries Service.[li]

So why aren't more fisheries moving toward some kind of ITQ management? No matter how flawed a system is, changing it is difficult. The Maryland oyster and North American Atlantic cod fisheries are perfect examples. Someone will always do well under a given system or, at least, believe that they will not be better off under a new system, creating a vested interest in the status quo and vehement opposition to change. Even though these resources may be in dire straits, resistance to change has been strong enough to prevent any substantive reform.

Another example from the Chesapeake Bay bears this out. At one point not long ago the striped bass (rockfish) was nearly gone from the Bay, and both Maryland and Virginia responded with total moratoriums on fishing the species (conservation-wise, the only type of regulatory conservation to commonly succeed). As the fish came back, commercial fishers had already given up on the species, and so Virginia was able to devise an acceptable ITQ program for the fishery that should vastly improve the sense of stewardship among fishers.[lii]

Still, when more is at stake, most fishers are quite savvy, and they know that getting access to the fisheries depends upon political clout – if they do not have it, they will not trust any change in thecurrent system. Additionally, creating rights to marine resources by definition results in a distribution of wealth, which creates real political problems and strong obstacles to substantive reform.[liii]

Oyster beds in Washington state are private because their creation pre-dated statehood. After the open-access fishery for the native Olympia oysters was cleaned out, ambitious oyster growers staked out territories and began both trying to revive the Olympias and introducing the Pacific Oyster from Japan that still predominates today.

Well-established rights are also behind the recent creation of an exclusive lobster-fishing zone around the island of Monhegan in Maine.[liv] Maine lobstermen have long formed 'harbor gangs' that mark territories and turn away outsiders. Even though these arrangements have always been extralegal, the gangs tend to have higher catches, larger lobsters, and larger incomes than

lobstermen who fish outside controlled areas.[lv]

Unfortunately, the major impetus for a move to more private arrangements seems to be crisis. This was certainly the case in New Zealand where the deplorable state of many fisheries coincided with a governmental financial crisis, precluding the sorts of bailouts that have prevented meaningful reform elsewhere.

Along with New Zealand, Iceland has the most comprehensive ITQ system. The first transferable quotas appeared in 1979, and in 1990 a uniform program of ITQs was instituted for all commercial fisheries. Icelandic stocks have not suffered from catastrophic declines, but in a country where fishing is the island's principal industry, even a slight decline verges on a crisis. Thus, the will to move toward the ITQ system in Iceland was much more politically attractive than elsewhere.

Private alternatives improve resource management but are politically very difficult to establish. The above examples all indicate that private management systems are most likely to succeed either when they already exist – beating politicians to the punch – or in crisis – when politicians and vested interests have little to lose.

Overcoming political nature of ITQs

The most notable aspect of the New Zealand ITQ system has been the evolution of ITQs. Through a series of upheavals, most notably the Maori claim to a significant portion of the fisheries based on their treaty rights, some ITQs seem to be evolving ever closer to real private rights. In the case of the Maoris, establishing even a limited form of right to the fisheries allowed them to settle their treaty claims to the fisheries with the government, which greatly strengthened the security of the ITQ system. Another notable incident resulted in a tradeoff where the government ceased compensating fishermen for low harvests in return for strengthening ITQ rights and eliminating the threat of stiff taxes on the value of the quotas. The latest evolution is now taking place on the management level, where quota owners are banding together to invest in research and enhancement activities, drawing some of the fisheries closer self-management.

In other places and in many cases, however, ITQs are explicitly set up so that they cannot evolve into stronger rights. The IFQ program in Alaska, for example, specifically states that IFQs are not private property rights and that they can be taken away without compensation at any time, which strikes at the very reason why ITQs have had some measure of success in the first place.

Subjecting ITQs to bureaucratic whim severely limits the positive incentives that ITQs are created to mimic. As long as the system remains publicly managed it will be susceptible to many of the pitfalls discussed earlier. It limits the impetus for innovation and resource enhancement, and also discourages the exploration of alternative resource uses. For example, in some cases it may be more efficient to own the rights to a particular area rather than the rights to particular species.

Thus, careful consideration is crucial before ITQs are implemented. In particular, the central

lesson from the New Zealand experience should always be borne in mind: the closer an ITQ resembles a private right, the greater the flexibility there is to adapt and evolve into a system of real private rights with the strongest possible incentives for conservation. Unfortunately, real world examples are few and far between, but those cases that have been mentioned such as the Washington oyster industry, Japanese cooperatives, reef stewards in the South Pacific and the New Zealand ITQ system, all seem to bear this out, especially in comparison to their publicly managed counterparts.

The closer ITQs come to resembling government management as usual, the more ineffective the system becomes. There is also a real danger that ITQs will be used to tax the fishing industry, which would reduce the positive incentives created by ITQs to conserve resources, innovate new techniques, invest in research and enhance the fishery. As economist Ron Johnson has pointed out, taxing away the value of an ITQ would also have a negative impact on cost-reducing activities, encourage government to meddle in the fisheries to increase tax revenue, create perverse incentives for industry to lower total catches, and impede collective action to try to raise the value of the quota.[lvi] Such was the case in New Zealand before the idea of capturing resource rents was finally abandoned, and it appears to be a growing issue in Iceland.[lvii]

Fear of taxation or redistribution also greatly reduces the efforts that fishers are willing to invest in substantive reform. One Maryland waterman recently agreed that a move to privately leased oyster beds was a good idea, but he personally was opposed to it because he'd hate to invest in enhancing and protecting an oyster bed only to have the state take it away again.

The real dangers that ITQs present all lie in failing to divorce politics from conservation. Creating ITQs addresses open-access problems, but rigidly and inappropriately defined ITQs will not be much of an improvement over the status quo. Until fishing rights are safeguarded from the vagaries of public management, the incentive to harvest stocks sustainably will remain weak.

What the future might look like

Of course it is impossible to tell what the future will look like, except to say that a greater reliance on private solutions to marine conservation problems would certainly be a shift toward more effective stewardship of marine resources. Innovation would no longer be about finding ways to catch fish more quickly, but about protecting the value of the resource - by harvesting more economically, by treading more lightly on the resource, and by investing in scientific research and resource enhancement.

Of course there is also no one answer as to what sort of private ownership schemes might develop in the long run. For example, in fisheries with greater uncertainty and catch fluctuations there would no doubt be more risk sharing and group ownership, while those with more predictable harvests, individual ownership would be more likely.

The evolution of property rights

How and why private rights develop depend on the value of resources and the costs of monitoring them. The process is circular; as resources become more valuable owners invest more in monitoring and enforcing private ownership rights, which in turn make resources more valuable, and so on.

An exemplary case study is the American West at the end of the nineteenth century. Much like the oceans not so long ago, few could imagine depleting its vast resources. But as the West was settled, its water and grassy lands became progressively more scarce and more valuable. Research by economists Terry Anderson and P.J. Hill has shown that, as the rights to these resources became more valuable, more effort went into enforcing private property rights, and therefore into innovation and resource conservation.[lviii]

Defining private property by physical barriers was desirable, but there were too few raw materials, so livestock intermingled and monitoring was difficult. However, frontier entrepreneurs soon developed branding systems to identify individual animals, and cattlemen's associations were formed to standardize and register these brands, allowing cattlemen to define and enforce ownership over a valuable, roaming resource.

In the 1870s another innovation came along that radically altered the frontier landscape: barbed wire. Barbed wire was an inexpensive and effective means of marking territory, excluding interlopers, and keeping in livestock. It made it easier to enclose property and exert private ownership, and illustrates how private property rights encourage innovation.

Just as the Washington oyster growers staked their claims to the tidelands in the nineteenth century, the potential exists today to 'homestead' the oceans. And as rights are asserted, no doubt new innovations will help to both make those rights more secure and to protect those resources.

Advanced technologies

"The engineers who maintained the invisible fences of sound and electricity which now divided the mighty Pacific into manageable portions …. [held] at bay the specter of famine which had confronted all earlier ages, but which would never threaten the world again while the great plankton farms harvested their millions of tons of protein, and the whale herds obeyed their new masters. Man had come back to the sea, his ancient home, after aeons of exile; until the oceans froze, he would never be hungry again."
– Arthur C. Clarke, *The Deep Range*, 1958 [lix]

"Sound will pen fish inside a sea ranch."
Fish Farming International, 1996[lx]

Arthur C. Clarke specialized in imagining the future, but to see the potential f or technology to revolutionize fishing and marine conservation, one need only look to the present. A host of advanced technologies already exist that could be used to define and protect private property in the oceans just as branding and barbed wire did in the frontier American West.

For example, each and every stream has a unique chemical signature, and a firm in British Columbia called Elemental Research can identify the exact origin of individual salmon by using a non-lethal technique involving lasers and mass spectrometry to analyze its scales. By analyzing fish scales in this way, it is possible to accurately identify even the smallest individual populations of salmon. Fish can also be identified using a bone in their inner ear called an otolith, which produces daily rings much like those produced annually on a tree. In a hatchery, distinct patterns can be made in fish otoliths simply by altering water temperatures.

Large animals can also be tracked using satellites. Transmitters have been attached to manatees that use satellite telemetry to communicate the exact location, identity, water temperature, and which way a manatee appears to be headed.[lxi] Devices can also be placed on board a fishing vessel to constantly relay its exact location via satellite, to identify whether it belongs in a certain area, or to periodically record information in a 'black box.' Heat-sensitive satellites can not only monitor a ship's location, but can also use its heat profile to tell if it is towing nets or not. Heat profiles of the ocean's surface can be used to provide accurate clues to the whereabouts of certain species of fish commonly found at the interface the cool, nutrient-rich waters and warmer, higher visibility waters.

Scientists at MIT are working on a 'robo-tuna' that mimics the very efficient propulsion system of real tuna that may one day allow it to stay at sea for up to six months patrolling spawning grounds or remote shellfish beds.[lxii] As one researcher in the lab said, "We herd cows. Why not [lxiii]

These technologies may facilitate private conservation, but people often underestimate the extent to which marine resources are already parceled throughout the world, even without the advantage of advanced technologies.

"It is one thing to contemplate the inshore sea from land's end as a stranger, to observe an apparently empty, featureless, open-accessed expanse of water. The image in a fisherman's mind is something very different. Seascapes are blanketed with history and imbued with names, myths, and legends, and elaborate territories that sometimes become exclusive provinces partitioned with traditional rights and owners much like property on land." John Cordell[lxiv]

In the final analysis, it is the institutions and the incentives that matter most.

Aquaculture

A decade ago, a fish Malthusian might have predicted the end of salmon as a food. Human ingenuity seems to have beaten nature once again. Forbes, 1990[lxv]

While the world fish catch has stagnated in recent years, aquaculture production has grown dramatically. It is now responsible for nearly twenty percent of the world fish production, and is one of the world's fastest growing industries. In 1991, world aquaculture production was approximately 13 million metric tons, double what it was seven years before.[lxvi] By 1995 that number had jumped to over 21 million metric tons.[lxvii]

The reason for these increases is that aquaculture facilities have allowed entrepreneurs to set up

[lxix] In one sense they are right. According to United Nations estimates, in Thailand only 40,000 acres of mangrove forest remain, down from nearly a million acres just thirty years ago.[lxx] Shrimp farming has certainly been a significant factor in this decline. Indeed, it is apparent that abandoned ponds can 'saturate the surrounding soil with salt and pollute the land and water with a chemical sludge made up of fertilizer and antibiotics as well as larvicides, shrimp feed and waste.'[lxxi] But the root cause of this problem is a lack of secure private rights to marine resources, which is the result of government intervention, *not* an inherent feature of

aquaculturists (who are merely operating within the incentive structure defined by the extant institutions).

In Thailand, aquaculture is heavily subsidized and in many cases farms are built in areas that were previously managed much more sustainably by a system of customary tenure.[lxxii] In Malaysia, the Land Acquisition Act was amended in 1991 to allow the state to grab land for any reason deemed beneficial to economic development, including the construction of fish ponds.[lxxiii] Similarly in Ecuador, bribes, corrupt government partnerships and land grabs are common because 'by law, coastal beaches, salt water marshes, and everything else below the high tide line is a national patrimony.' [lxxiv] Not only shrimp farms but city slums regularly invade these areas, even in national ecological preserves.[lxxv]

Alfredo Quarto, a director of the Mangrove Action Project, has pointed out that the main reason why shrimp farmers choose to clear mangrove forests is that they are usually government owned.[lxxvi] In other words, government sanctioned open-access and expropriation of common property rights are really to blame for coastal habitat destruction in places like Thailand.

Moving operations offshore can often solve Nearshore aquaculture problems, where water circulation is better and risks from pollution, both exogenous and endogenous, are limited. Offshore aquaculture is now beginning to move beyond the experimental stage.[lxxvii] The engineering problems of raising fish far from protected shores are substantial. Nevertheless, offshore net pens and cages are increasingly appearing off the coasts of places like Norway and Ireland.

Self-contained, indoor aquaculture facilities are another relatively new development, but one with tremendous potential. Aquafuture, a firm in Massachusetts, raises striped bass in a closed tank system.[lxxviii] The process uses much less water and feed than conventional fish farms, produces fewer wastes (which can be converted to fertilizer) and by changing the water temperature fish can be grown to market size either faster or slower than in the wild depending on the current market. The enclosed environment is also more sanitary, so Aquafuture's mortality rate (fish that die before they are ready to market) is half the industry average.

Conclusion

Attention to the world's oceans has been growing in recent years – 1997 was the International Year of the Reef and 1998 the International Year of the Ocean. A number of environmental campaigns have also been launched to coincide with these events, also aimed at drawing attention to some of the problems that plague the seas.

Unfortunately, while some of these problems are very real, little of this attention has been focused on the institutions that govern fisheries management or the benefits of private conservation and stewardship. From the shrill voice of Greenpeace decrying that "the financial captains of the global fishing … rush to vacuum the oceans and turn fish into cash" [lxxix] to a more even-tempered petition called "Troubled Water: A Call for Action" that still "paints a

dismaying picture" of the destruction of the marine environment,[lxxx] much of the environmental activism in this arena begs for more government involvement instead of less.

Some exceptions are the Marine Stewardship Council, set up by Unilever and the World Wildlife Fund to certify certain fish as caught sustainably, and the Environmental Defense Fund's (EDF) sponsorship of ITQs.[lxxxi] EDF, however, recently came out strongly critical of the environmental effects of aquaculture, even though, as discussed earlier, that too is a result of ill-defined ownership and perverse government programs.[lxxxii]

Entrepreneurs around the world are not nearly as hesitant to embrace the opportunities afforded by private stewardship. Ten years ago the economist Elmer Keen envisaged the potential increases in productivity in the oceans that could take place if the extent of ownership in the seas was vastly increased.[lxxxiii] Today quota holders in New Zealand are moving in that direction, and an even more ambitious project is underway to fertilize the oceans – only made possible by an exclusive arrangement with a small island nation in the Pacific to that countries fisheries (whose fisheries will of course benefit as well).[lxxxiv]

It is these kinds of visionaries who will continue to offer real solutions to the problems of overfishing and marine habitat degradation. Their impressive results to date suggest that private conservation is the answer to these persistent problems.

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[i] Associated Press, press release June 7, 1996.

[ii] Greenpeace, "Fishing in Troubled Waters", press release found at http://www.greenpeace.org/~comms/fish/part1.html, 1993.

[iii] http://www.fao.org/waicent/faoinfo/fishery/sidp/htmls/species/ga_mo_ht.htm, taken from D.M. Cohen, T. Inada, T. Iwamoto and N. Scialabba, 1990. Gadiform fishes of the world (Oreder Gadiformes). FAO Species Catalogues, FAO Fisheries Synopsis, no. 125, vol. 10.

[iv] Commercial extinction occurs when it is no longer economically viable to catch the remaining fish.

[v] R. A. Myers, N.J. Barrowman, J.A. Hutchings and A.A. Rosenberg "Population Dynamics of Exploited Fish Stocks at Low Population Levels," *Science* 269. Pp. 1106-8, 1995.

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[viii] This scenario has come to be known as the 'Tragedy of the Commons', following the famous essay by Garret Hardin (1968) (who drew on the earlier work of economists like Gordon, 1954, and Scott, 1955).

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