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Towards an integrated sustainable management of fisheries

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Towards an integrated sustainable management of fisheries[1]

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Contents

[1] This paper will also be published as a chapter in the United Nations Educational, Scientific and Cultural Organisation's (UNESCO) Encyclopedia of Life Support Systems (forthcoming).

Acronyms and Abbreviations

CC Carrying Capacity
CPR Common Property Resource
EFJ Extended Fisheries Jurisdiction
ICES International Council for the Exploration of the Sea
ITQ Individual Transferable Quotas
MEY Maximum Economic Yield
MPA Marine Protected Areas
MSC Marine Stewardship Council
OAE Open Access Equilibrium
TAC Total Allowable Catch

Summary

This article discusses the underlying causes for the problem of managing fish stocks and the aim of fisheries management. It reviews some of the research development in the area and practical experiences. Further, it deals with the future challenges and discusses potential successful strategies and outlines the necessary conditions for actual progress from the current state. The main theme is that the fundamental problem of fisheries is the lack of well defined property rights. Any attempt to solve the problem of fisheries must deal with the property right issue. Two approaches, which meet this requirement, individual transferable quotas (ITQs) and common property resource (CPR) management, are discussed. Further, it is held that fisheries management should be part of an integrated sustainable use of marine resources, where efficient use of fish stocks is one aim. Equal attention should be given to other values from aquatic ecosystems, like ecological services, biodiversity and recreation possibilities. It is concluded that despite the fact that a lot of the world's fisheries are in severe crisis, the future situation can be improved. Necessary conditions for a prosperous future are that current knowledge is used and that all concerned agents, scholars of different disciplines, fishermen, and managers, are involved in the decision making and management process.

1. Introduction

The world's population continues to grow, before the turn of a new millennium we will exceed six billions and within another ten years the population is expected to reach seven billions. More than 60% of the population live in the coastal areas, where most of the big cities are situated, and the figure will grow due to the urbanization. This leads to increasing pressure on coastal areas and meanwhile, important breeding grounds for fish, like mangrove forests and lagoons are depleted, polluted or silted up. Global fish production, excluding aquaculture is constant at 80-85 million tonnes for the period 1987-96. At the same time, we

are fishing down marine food webs as larger and more valuable species disappear, leading to impoverished ecosystems. A recent FAO report provides an estimate in the discards of 'bycatch' in commercial fisheries, low-value species that are 'accidentally' caught and discarded on the spot, of about 25% of total landed catch. In some areas industrial fisheries, i.e. fisheries with small-meshed gear directed at catching fish for reduction purposes, have reached a level where they threat the food supply of seabirds. The well being of seabird communities comprise substantial values in terms of recreation and biodiversity. FAO reports that "69% of the world's marine [fish] stocks... are heavily exploited, overexploited, depleted... and therefore are in need of urgent conservation and management measures" (FAO, 1995) and as late as in 1993, six Canadian populations of Atlantic cod had collapsed to the point when a moratorium was declared. This was due to discarding and too high levels of fishing mortality. Contrasting this with the statement made by Thomas Huxley in 1883: "I believe that the cod fishery...and probably all the great sea-fisheries are inexhaustible; that is to say that nothing we can do seriously affects the number of fish" (cited in McGoodwin, 1990), one might get the impression that fisheries management has deteriorated constantly during the last century.

This article discusses the underlying causes for the problem of managing fish stocks and the aim of marine resource management. It reviews some of the research development in the area and practical experiences. Further, it deals with the future challenges and discuss potential successful strategies and outlines the necessary conditions for actual progress from the current state. Two of the most fruitful approaches advocated here are individual transferable quotas (ITQs) and common property resource (CPR) management.

2. Historical background

By the mid 19th century it was still an undisputed belief that marine resources were inexhaustible and could not be influenced by human actions. Before the twentieth century, the greatest issue was allocation of rights to fish in particular areas or for particular species. Even before any overfishing occurred, certain rich fishing grounds became crowded and fishers sought explicit agreements defining rights of access.

However, concern for development of fish stocks and the potential risk of overfishing are not completely new findings. By the end of the nineteenth century Scandinavian scientists initiated the start of an organization for hydrographic and biological investigations of the sea, the International Council for the Exploration of the Sea (ICES), with a secretariat in Copenhagen, Denmark. The original ICES formed three committees, that would focus on migration of commercial fish stocks, The Baltic Sea, and overfishing. Ninety years ago, a Danish economist described the problem of fisheries. He compared two fishing grounds and showed that, given that access was free to both, the resource rent would be completely

dissipated. The problem was that Warming wrote in Danish, so the article did not reach an international audience, and the forces and outcome of open access for fisheries were not known until the mid 1950ies.

Before World War II harvesting of marine resources rarely reached such levels, that risk of stock depletion occurred. One exception is the 40 years of pelagic sealing in the North Pacific, starting with the American purchase of Alaska in 1867. When Great Britain, the U.S., Japan, and Russia signed the North Pacific Fur Seal Treaty in 1911, stock estimates indicated a reduction from some 1-2 million animals down to 150 000.

3. The Open-Access fishery

During the fifties, the fundament of modern fisheries research was laid by the biologists Schaefer and Beverton and Holt, and by the economists Gordon and Scott. Gordon's seminal paper still provides the essentials for understanding the problems with fisheries. The model he developed, based on the logistic growth model extensively used by Schaefer, is commonly referred to as the Gordon-Schaefer model and I will review it briefly.[2] Logistic growth means that a single species stock can grow exponentially as long as there are no limiting factors, but as the stock increases growth will slow down due to for instance food scarcity. Eventually a long-term equilibrium, the carrying capacity (CC), is reached, if the stock for some reason becomes larger than the CC it will experience negative growth. If the stock size is in the interval between zero and the CC, there is a net surplus production that can be harvested annually without reducing the stock size. Further, assuming logistic growth also requires that recruitment, individual growth, and natural mortality can be lumped together into a single parameter. For a uniformly distributed fish, e.g. bottom feeding species like halibut, one could postulate that the catch per unit effort (CPUE) increases linearly with the size of the stock. This implies two important aspects. Firstly, a declining annual CPUE over several years indicates a diminishing stock, and secondly, fishing from a smaller stock will be more costly.

[2]A lengthy introduction to the Gordon-Schaefer model is found in any undergraduate textbook on environmental and resource economics, e.g. Tietenberg (1996). Clark's seminal work (1990) is still the standard reference for a more comprehensive text.

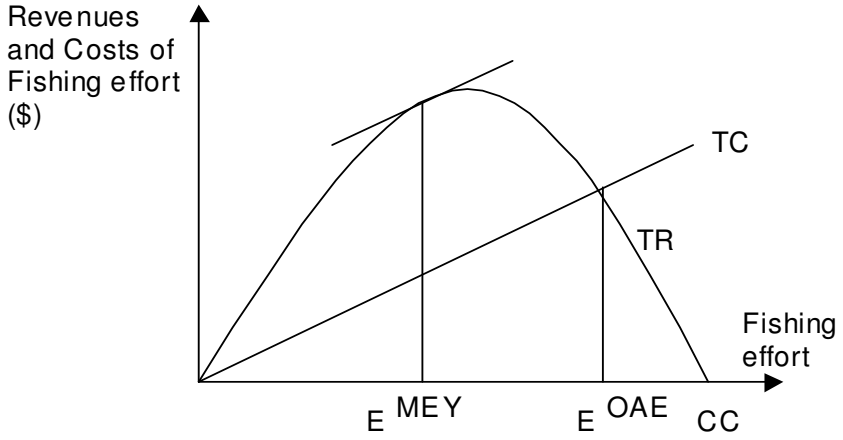

Figure 1. Open access equilibrium effort and maximum economic yield effort.

If we apply a long-term perspective, implying that all costs are variable, we can assume a constant marginal cost of fishing and that for each level of constant effort there is a corresponding equilibrium stock. Finally, we treat the price of the fish as a constant, which is reasonable if the same and similar species are landed in significant quantities elsewhere.

The Gordon-Schaefer model predicts that in an unregulated fishery, effort will increase until a level is reached where the total cost of fishing is equal to the total revenues, E^{OAE} (see figure 1). In this open access equilibrium (OAE), capital costs are covered but the potential resource rent[3] that could be earned due to the scarcity of the resource is completely dissipated. Gordon's major point was that this situation occurs due to absence of well defined property rights. The figure shows a static situation, but intuitively we can see a likely development of the exploitation of a pristine resource. Initially, landings and profits are increasing, leading to an increasing fleet, i.e. increasing effort. During a second stage, technical development leads to more effective fishing, i.e. lower costs, which corresponds to a clockwise turn of the TC line in figure 1. Finally, open access equilibrium is reached, which is characterised by too many vessels (overcapitalisation), too small stock, and small landings at high costs. The poor profitability of the sector often leads to demands for subsidies. This description is of course a simplification of reality and in fact, there are hardly any pure open-access fisheries. Still, it bears a lot of resemblance with real world situation for a lot of fisheries. FAO estimates show that the total revenues of the global fishing fleet in 1989 were US$ 69700 millions, while the total costs were US$ 92200, implying a loss of some US$

[3]A concept, originally land rent, introduced by the British economist Ricardo in the 19th century. In economics competition is assumed to drive profits down to zero, but with scarcity positive profits can persist despite competition. The Oil industry is one example, where we have such rent.

22500 millions before allowing for capital costs. The industry is able to survive on such a loss making basis partly as a result of government subsidies. It should again be stressed that the logistic growth model is questionable when it comes to empirical applications to fisheries, or in the words of an influential scholar: "The above suggest that the logistic model is an oversimplification at best and perhaps better reserved for pedagogical uses with caveat that it has little relevance to many (if any) real world situation" (Wilen, 1985, Handbook p121). Over the years, more complex models have been developed to reflect more realistic conditions.

4. Fisheries management

The work of Gordon and Scott, and subsequent research promoted extension of the national fisheries jurisdiction, which was a great political issue in the 1970s. In 1972 Iceland, with two minor navy vessels, challenged the United Kingdom and denied British trawlers access within 200 nautical miles from the Icelandic coast, an incident popularly known as the “Cod war”. The U.S. and other coastal nations, supported by many years of negotiation, expanded their fisheries jurisdiction in 1976. These actions were finally ratified in 1982 by The United Nations Third Conference on the Law of the Sea, which lead to an Extended Fisheries Jurisdiction (EFJ) from maximum 12 to 200 nautical miles for coastal states. The result was that about 90% of the world catch is based on fishery resources within national waters. EFJ in itself does not guarantee recovered resource rent, but does provide an opportunity for national fishery policies to be successful.

4.1 Traditional management measures

Traditional fisheries management has come up with a battery of different measures to halt the decline in spawning stocks all over the world. These can be broadly categorized as Total Allowable Catch (TAC), Input Controls, Licencing and Restricted Entry, Effort Controls, Gear Restrictions and Catch Rules, and Closed Areas and Closed Seasons. The common feature of these is that they in general, do not come to grips with the fundamental problem of fisheries. In a broad sense they make fishing more costly, which corresponds to an anti-clock wise turn of the total cost line in figure 1. The implication is that despite success of the regulation, rent will remain dissipated.

4.1.1 Total Allowable Catch

TAC is the general measure, applied in most fisheries over the world, set annually for each species based on biologist advice. If the TAC is successfully monitored and enforced, fishing has to stop before the end of the year and the fleet will remain idle, but more likely other species will be caught. A TAC might even induce what is called the race for catch. Each

fisherman will have an incentive to increase catch capacity, the faster you can catch the larger share of the TAC is possible for you to get. Input controls refer to measures like maximum vessel size, limitation on gear size or engine power. The aim is to reduce the fishing power, which is quite the opposite to each fisherman's natural and sound strive to increase it. Inventiveness of the fishermen tend to systematically overcome the original aim of reducing fishing effort by substituting the restricted inputs by unrestricted inputs. If managers stick to this strategy the consequence can be like in the Maryland waters of Chesapeake Bay, where motors on oyster dredging vessels are prohibited and the U.S. have a commercial sailing fleet in the 1990s.

4.1.2. Licensing and Restricted Entry

Licensing and Restricted Entry may seem attractive due to the administrative simplicity and is one of the most prevalent systems. By itself it has never been thought of as a means of reducing fishing effort, but rather as a necessary initial step to constrain further input growth. However, the empirical evidence from using these measures is discouraging. Canada introduced limited entry in the Pacific Abalone fishery in 1977, the Atlantic inshore fishery in 1980, and the Pacific Sable fishery in 1981. All of these reportedly failed to prevent effort expansion and limited entry in the Atlantic wreckfish fishery in 1992, has even lead to overcapitalization and higher fishing costs.

4.1.3. Effort Control

Effort Control can take the form of only allowing fishing certain days. Decline in the Baltic Sea cod stock lead to a Swedish regulation in the early 1990s, which prohibited fishing during Thursdays and Fridays. From a management point of view it was convenient, one airplane could circulate the area to check that no commercial vessels were operating. To the fishermen it meant that they had to give up two potentially perfect days of fishing, while they were forced to give up safety principles if there was a storm Monday to Wednesday. In a dynamic perspective, technological development and creativity among fishermen will lead to more effective fishing. This is also confirmed by the OECD report, based on 22 cases, which concluded that effort control leads to capital stuffing, higher fishing costs, and increased enforcement problems.

4.1.4. Gear Restrictions, Catch Rules, Closed Areas, and Closed Seasons

Gear Restrictions, Catch Rules, Closed Areas, and Closed Seasons can all be justified for biological reasons. If selectivity of a gear is poor, large quantities of low value juveniles will be landed on deck and discarded back into the sea. For several species and fisheries, discard mortality is close to 100%, leading to a drastic cutback of future potential catches. This is an argument for improved selectivity devices, like exit windows, square meshes, and selection

grids, which can lead to improved future yield. Yet, recalling figure 1, total revenues exceeding total costs lead to increased fishing effort and the rent will be dissipated. Closed Areas and Seasons can be a constructive measure to protect important breeding grounds or juvenile fish. The problem of overcapitalization remains and fishing companies are not forced to take the external cost of fishing into account, so a reestablished rent cannot be achieved solely based on such measures. In 1923, the USA and Canada agreed on closing the halibut fishery of the Northern Pacific Ocean during the winter months. By the early 1950s the season had been reduced to a month and two months, respectively, for two of the fishing areas and in 1990 the season was down to 72 hours for one of the areas. Besides the obvious problem of capital stuffing, the huge landings in such a short period imply sales only to the less well paid frozen market leading to lower revenues for the fishing companies.

4.2. Taxes and landing fees

Optimal taxes (or landing fees) were originally suggested by Warming, but the acknowledged introduction of the concept to economics as a general device for correcting negative externalities is due to Pigou (Pigovian taxes).[4] Theoretically they will lead to an efficient solution and in the case of fisheries the rent could be reestablished. In an open access situation the collective behavior implies that effort is expanded until marginal costs equals average returns, which is shown in figure 2. An efficient long term effort level is found where the marginal costs are equal to marginal returns, which theoretically can be achieved by a tax corresponding to the vertical distance between the optimal tax line and the marginal cost line. A practical problem is that the figure shows the static long-term situation, but if a tax is imposed it is quite likely that fishermen increase the short-term effort to compensate for lower revenues. The result would be further depleted stocks before fishermen start to exit from the fishery. Even more important is probably the fact that the rent would accrue to the taxation authority and fishing companies would still earn zero rents. It is no surprise that fishermen are always unanimously against landing taxes and they have never gained the status as a viable practical approach to fisheries management.

[4]An externality is present when some agent's (say A's) utility or production relationships include real variables, whose values are chosen by another agent (say B) without particular attention to the effects on A's welfare and B does not pay (receive) any compensation for this (see e.g. Baumol and Oates, 1988)

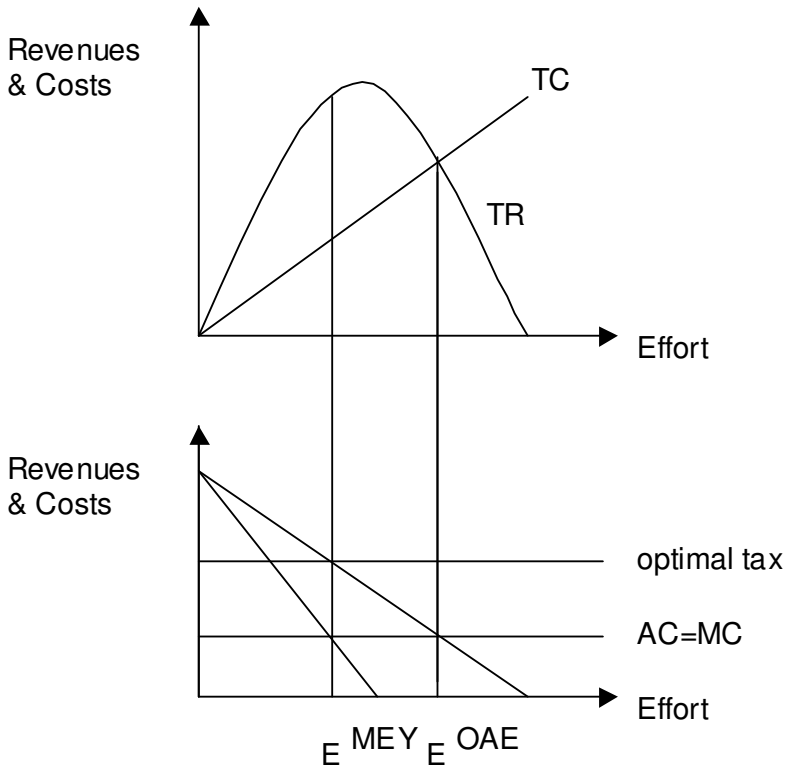

Figure 2. The theoretical optimal tax adjustment of open access equilibrium

Subsidies on the other hand, have been a frequent element in fisheries management. Fisheries managers have recognized old vessels and low profitability and, with the ambition of mitigating these conditions, offered both scrap premiums and investment loans. In 1995, the European Union offered a scrap premium of US$ 1500 per Gross Register Ton and at the same time 25% grants for new vessels. Such policies do not lead to fleet reductions, nor do they improve depleted stocks.

4.3. Rights based fishing

The main theme of this text is that the fundamental problem of fisheries is the lack of well defined property rights. Any attempt to solve the problem of fisheries must deal with the property right issue. Important contributions in economics have been made by scholars commonly referred to as the "property right school"[5], who conclude that private property is

[5]The most prominent paper is Coase's critique of Pigou's idea of optimal tax as a correction device for externalities, which outlined well defined property rights as a solution. Other examples of property right scholars are Demsetz and Cheung.

the one solution. Some authors anticipate such development, but I will not deal with explicit privatization as a potential solution. This leaves us with two major management approaches, common property resource (CPR) management and individual transferable quotas (ITQs).

4.3.1 Common Property Resource Management

Common property, the way Gordon's paper described it meant open access and from then on it tended to be used in such manner. Over a period it seemed like common property was equal to everybody's property, which is nobody's property. Hardin's version of open access popularized it as "Tragedy of the commons." This view was challenged by Ciriacy-Wantrup and Bishop, and by the influential Conference on Common Property Resource Management, the differences between open access and common property gained a broader acceptance and lead to a number of studies where failures of commons were compared with successes. Ostrom identifies seven necessary 'design principles' for a successful common property resource (CPR) management, where the first one is that those with use right as well as the boundary of the resource itself must clearly defined. However not homogenous, a group of institutional economists, political scientists and others have evolved that advocate common property as a practical solution to open access. They criticize the property rights school. Private property rights and perfect markets lead to an efficient competitive equilibrium, given that; enforcement costs are nil, property rights are well defined, markets are competitive, and markets are perfect. The critics of the property rights school and proponents of CPR management usually focus on the validity of these four assumptions. The enforcement costs are crucial when it comes to fisheries, taking these into account indicate a possible change in ranking of regulation measures. This is a potential argument in favor of CPR regimes if the involved fishermen can exercise enforcement at significantly lower costs than e.g. an ITQ regime. One example may be a local fishery in Turkey of about 100 local fishers. An instrumental part of the success was that fishermen defined fishing grounds within the area and then rotated these between them and hereby solving the monitoring and enforcement problem at minimum costs. Noting the divergent views by different researchers, it can be concluded that recent CPR management research has made a significant contribution by showing that joint management can be sustainable and perform well. Another example of successful community-based fishing is the Japanese system where groups of fishermen are accredited territorial use rights in inshore fisheries. The CPR management research has also high lighted different problems associated with private property regimes, which are especially relevant in the context of natural resource management in developing countries. This last point is particularly valid for external actors, like aid agencies and the World Bank. Successful collective action is most likely in communities where at some point in their history collective challenges where met successfully. Still, "collective action may nevertheless be possible even though it cannot be rooted in a long tradition of co-operation. Yet, success will

then crucially depend on external assistance and it is important that the external agency uses a gradual approach starting with concrete, relatively easy-to-solve problems at the most decentralized level, preferably under conditions where social relations are not too distant or antagonistic." (Baland and Platteau, 1997, p.345). A more radical view is provided in an article on American fisheries governance, which argues that: "..,sustainable resource use requires moving toward the commons ideal where the focus is on the expansion of institutional capital rather than physical capital" (Hanna, 1997). This article implicitly disqualifies all forms of privatization of resources as a solution to the problem of sustainability.

4.3.2. Individual Transferable Quotas

Following the idea of tradeable emission permits, Christy suggested ITQs as a means to rationalize fishery management. The basic idea underlying the ITQ system is that the annual surplus production from an optimal stocksize should be landed at minimum costs. Referring to figure 1, it implies that the effort level is equal to E^{MEY} where MEY is an abreviation for maximum economic yield.

Usually ITQs are initiated by governmental fishing authorities, which decide the total allowable catch (TAC) for a certain species and then sell or distribute quotas, which can be fractions of the TAC or a specific weight. Fractions of the TAC and free distribution, based on historical landings (grandfathering), has been the dominating implementation policy. When distributed, the quotas are transferable between the fishermen. More effective fishermen will have a higher willingness to pay for the right to catch for instance a kilogram of cod and hence, less effective fishermen will sell their rights and leave the fishery. Entry is not limited as anyone who is willing to pay the prevailing price of a quota can enter the fishery. If the TAC is adjusted until the optimal steady state is reached, the resource rent will be maximized as the system induces fishermen to include the user cost into their objective function, given that the fishery is perfectly monitored and enforced both for quota holders and others. Theoretical analysis shows that the optimal path from a depleted stock is a complete moratorium, but due to non-malleable capital, loss of specific skills and maintenance of markets a gradual approach is more appropriate.

Today, ITQ schemes have been implemented in a number of fisheries in many countries including Australia, Canada, Iceland, USA and New Zealand and a majority of fisheries economists are advocating the use of ITQ. North American ITQ fisheries include cod and halibut off British Columbia and herring sac roe in the U.S. Pacific Ocean.

Copes lists a number of problems with ITQs of which high-grading and multi-species fisheries are often discussed. If some specimen earn significantly higher prices due to e.g. size or quality, discarding may be profitable and with high mortality rates for discards the outcome of the ITQ system will deteriorate. A similar problem is probable in multi-species fisheries.

Despite short term lease or spot markets for quotas, by-catches of other species are likely to be discarded to some extent. In the ITQ regulated Greenland shrimp fishery, the price ratio of large specimen to small ones was fifteen to one with moderate discard rates. However, even lesser individuals were discarded to a large extent. The latter is rather a problem associated with minimum size regulation and highlights the need of improved selectivity devices for trawls, like exit windows and selection grids. Yet, the problems of multi-species fisheries might be a more severe obstacle to ITQs, especially in the species rich tropical fisheries which account for almost half of the world's catches. Many of these fisheries are in developing countries with insufficient monitoring and enforcement. A drastic example is the frequent use of explosives in fishing, e.g. in Tanzania and Vietnam. In developed countries with a moderate number of species the result might be different and neither multi-species fisheries, nor high grading have been significant problems in the Icelandic ITQ regime.

By 1990 the Icelandic ITQ system encompassed practically all fisheries, leading to improved efficiency and recovery of some resource rent, but what about overcapitalization? Matthiason describes a slow adjustment of the fleet size due to involvement of local authorities, which aim at job security and increased economic activity in the local community rather than efficiency. If ITQs are auctioned instead of grandfathered, such involvement is more costly and hence reduced. Auction and grandfathering both imply an efficient allocation, but the resource rent will be earned by the government in the former and by the current generation of fishermen in the latter. To American fishermen, for example, this difference leads to the perception of ITQs as either adequate policy instruments or completely disastrous (Personal communication, Tom Tietenberg, 1997). In New Zealand, lobbyism by the fisheries sector has kept the TACs at high levels. Hopefully future research will tell us more about institutional obstacles to efficient fisheries management.

ITQs have stirred a lot of debate, some consider it as the greatest achievement in fisheries management over the last 25 years, while others focus on negative aspects. The Icelandic High Court found in December, 1998, that the Icelandic grandfathering, based on catches during 1983-1988, violates the Icelandic constitution. However, the final outcome of that process is likely to remain at a change of the constitution (personal communication Agust Thor Arnason, 1998). Another objection to the ITQ system is an increasing concentration of quotas, from total 535 holders in 1984 to 391 in 1994. During the same period big quota holders with more than one percent of the total quota increased their share from 30% to 50%. A majority of the participants and the managers in the British Columbia halibut fishery and the New Zealand fisheries thought that they are better off since the introduction of ITQs, but in both countries it was agreed that it has become harder for young fishermen to enter.

5. Towards an integrated sustainable use of marine resources

Fisheries management has long focused solely on how to achieve optimal stock sizes and at best how to harvest those at minimum costs. Still, we derive several other values from aquatic ecosystems, like ecological services, biodiversity and recreation possibilities. Those have not so far been given appropriate attention. Maybe some things can be learned from the development of forest management. Historically, it focused on the problem of optimal rotation (i.e. maximizing value from timber), but today it is agreed that the focus should be on total forestry effects.

5.1. Marine Protected Areas

Recently great interest has been given to the concept of Marine Protected Areas (MPA) as a potential measure to solve some of the failures of management hitherto. So far, most economists have been reluctant to this suggestion. MPA will not solve problems of overcapitalization and "A marine reserve of an appropriate size would achieve the same conservation effect as optimum fishing, but with a smaller catch" (Hannesson, 1998). However, most of the work has ignored much of recent achievements in ecology that stresses patchiness, heterogeneity across space, and dispersal processes and linkages between patches. It has been shown that with such aspects included, under certain parameter configurations, there is a potential of increased aggregate biomass and harvest after introducing an MPA. Other scholars list several advantages of MPAs, for instance, protection of biomass and population structure of commercial species, limitation of by- catches of juveniles, and protection of ocean biodiversity. We should also note the sometimes highly non-linear relationship between fish size and egg production, for example the red snapper where a large ripe female of 12.5 kg contains the same number of eggs as 212 females of 1.1 kg. Securing such highly productive specimen is, in economic terminology, to provide a public good.[6] Given that a sufficient number of these ripe females stay within the reserved area, all fishermen will enjoy the benefits from avoiding a potential recruitment overfishing that could have occurred without the reserve. Recalling the huge amounts of discards, MPAs may be an option for reducing the impact on juveniles. The 1992 United Conference on Environment and Development showed that there is now general acknowledgment that the current unprecedented rates of reduction in biological diversity are largely due to human activities, and that they pose a serious threat to continued human development. MPA might prove helpful for handling this problem and, even though other options exist, they may be a less

[6]Public goods are characterized by the fact that one person's consumption does not interfere with other's consumption and when the good is provided it is hard to exclude anyone from enjoying it. These two features lead to an under provision of the good in a market solution. National defense is a classical example, while biodiversity is a more recent one.

costly alternative in terms of monitoring and enforcement. It is a rule of thumb to save 5% of forest areas for natural reproduction for biodiversity objectives, while MPAs account for less than 1% of the world's fishing grounds. The view held here is that the number of MPAs will increase, the challenge to future research is to find the optimal design in terms of allocation and size for different species. The proposition by some authors that they need to include up to 50% of the original population might be challenged.

5.2. Aggregated economic values from marine resources

In environmental economics it is now a well established fact that values from environmental and natural resources are not solely the one's derived from direct use, examples of use values are recreation, fishing and bird watching. Nonuse values are often identified as option values and existence values, where option values imply a willingness to pay for a potential future use. Existence values mean willingness to pay, caused e.g. by motives like saving a resource for future generations or based on moral conviction. Additional work has pointed at other values of an ecosystem like resilience, the capacity to recover from disturbances, and the redundancy capacity, e.g. the emergence of new keystone species and processes as ecosystems respond to unexpected shocks. Nowadays, natural resource damage suits in the U.S. may include claim of damages for both lost use and nonuse values. The area of valuation in general, and nonuse values in particular have gained a huge interest in the recent years. It was further boosted by the Exxon-Valdez oil spill, which lead to an intensive debate especially focusing on the use of the Contingent Valuation Method.

Large coastal areas all over the world are subject to rising pressure due to increasing population, industrial activities and so forth. Conflicting interests of coastal resources are likely to arise. A simple example related to use values in terms of fish management, is whether a particular species should be landed by commercial fishermen or recreational anglers. More delicate matters are aquaculture and sea transports. Aquaculture has increased significantly and now constitutes about 25% of the world's total fish production. Salmon and shrimp are species where the aquaculture production significantly influences the price of wild substitutes. The negative externalities to the environment from aquaculture are well documented and the rapid development of shrimp farming has reinforced the depletion of mangrove. For Atlantic salmon cage-farming it has been shown that the supporting marine production area has to be 40 000-50 000 times the surface area of the cultivation. Sea transports lead to several negative externalities to the environment, like emissions from fossil fuels and more recently, high speed multi-hull ferries on shallow waters affecting sensitive benthic communities. These examples point at the need of integrating fisheries management into broader strategies aiming at sustainable coastal zone use, where international agreements to facilitate internalization of negative externalities are a fundamental part. Even within the area of traditional fisheries management there is a link to environmental degradation.

Mismanaged stocks have a lower value than optimal ones, which means that the cost to society and hence, presumably, the liability to the polluting firm resulting from injury is lower. Thus, producers with potential hazardous waste spill will invest less in reducing the risk of spill, near a depleted fish stock than near an optimal one.

5.3. Straddling and highly migratory stocks

The extended fisheries jurisdiction (EFJ) to 200 nautical miles implies that 90% of the world's fish stocks are encompassed within national waters, but what about the rest? The UN conference on highly migratory and straddling fish stocks in 1995 authorized regional organizations to manage fisheries outside the 200mile limit. Whether such organizations will evolve and be successful is at present uncertain. If the number of countries sharing a fish stock is low and each national fishery is well monitored and enforced, a self-enforcing cooperative solution might evolve. A practical supportive example is Norway and Russia, which to some extent have been successful in restoring the Arcto-Norwegian cod stock. For stocks located outside the 200mile limit prospects are worse, particularly since some boat owners use flags of convenience when fishing on the high seas. If these regional organizations to manage fisheries outside the 200mile limit fail, further expansion of the 200 mile limit for coastal states could offset some problems where fish stocks mostly are contained within the limit, but sometimes straddle outside the limit. Well known examples are the ground fish stocks of the Grand Banks of New Foundland, the Alaska pollack, the Arcto-Norwegian cod and the Atlantic-Scandian herring which straddle what are popularly known as the Donut Hole, the Loophole and the Loop Sea, respectively. The process of reducing international waters might be speeded up by the more common ITQ systems become. Icelandic fishermen, once seen as the 'good guys' during the 'cod wars', now lease out their quotas in domestic waters and go fishing in the Barents Sea, where their behavior have given them a reputation as modern pirates (personal communication Svein Jentoft, 1998).

5.4. Individual consumers and lobbyists

The concept of eco labeling has gained more interest in recent years and has been advocated as a means of letting consumer's express preferences of environmental concern. Given that companies operate under a properly designed environmental policy[7], they can contrary to standard assumptions achieve better productivity and competitive advantages. Can consumers in a similar manner influence fishing practices and support companies, which show concern for e.g. endangered species and habitats? It is sometimes hard to identify the chain from catch to final product within the fisheries sector, but some signs of a parallel development can be seen. By catch of Dolphins in Tuna fisheries has lead to development of more selective

[7]A properly designed environmental policy is preventive, not technology dependent and based on market incentives according to Porter and Linde

methods and tuna cans are labeled 'dolphin safe'. The Marine Stewardship Council (MSC), originally initiated by the World Wildlife Fund and Unilever, is a voluntary organization for promoting sustainable fishing. Certified companies use the MSC logo to assure consumers that the product is from a well managed and sustainable fishery and that it has been fished responsibly. The influence of consumers, environmental and animal rights groups, and other lobbyists is likely to increase. The ban of the imports of seal products into the European Union and the US, which has almost stopped the hunt of harp seal and the complete ban on commercial whaling are two examples, and we will see more of that[8], no matter if we agree or not.[9]

5.4. Employment and equity issues

In several remote areas fisheries have traditionally been an important source of employment and income. The rapid structural adjustment in most parts of the world, leading to temporary and persistent unemployment often hit these areas harder than urban ones. Many fishery authorities, like the European Union's Common Fisheries Policy, include objectives of avoiding undesirable side effects on fishing communities heavily dependent on fishing. Sparre and Vestergaard studied shrimp fisheries in Tanzanian waters. Notable was how well the artisanal fleet performed compared to the few industrial trawlers operating in Tanzania, and the foreseen difficulties in reducing artisanal fishery effort. The latter is probably a general observation for fisheries in developing countries with poor employment opportunities. Pauly shows an increase of small-scale fishermen in the Lingayen Gulf area, Philippines, from 2000 to 15000 during a 30year period. A fisheries policy solely focusing on economic efficiency might run in to severe problems when confronted with real world problems like persistent unemployment, economic decline in rural areas, and demand for regional policy.

6. Conclusion

The main theme of this text is that the fundamental problem of fisheries is the lack of well defined property rights. Any attempt to solve the problem of fisheries must deal with the

[8]Greenpeace has successfully fought the use of a huge industrial fishing vessel, American Monarch, owned by the world's biggest private transnational fishing corporation, Aker/RGI/Norway Seafoods. One of their information managers admitted informally that the company tries to prevent consumers to see any link between their products and the American Monarch (personal communication Jörgen Larsson, management consultant).

[9]Flaaten develops a multispecies model for the Barents Sea and holds that one of the main policy recommendations from the study is that "the sea mammals should be heavily depleted to increase the surplus production of fish resources for man."

property right issue. Two of the most fruitful approaches advocated here are individual transferable quotas (ITQs) and common property resource (CPR) management. ITQs are likely to be successful in a setting where the numbers of species are few and institutions are well developed and functioning, i.e. developed, democratic countries in temperate climate. CPR management may be advisable in less developed countries, in tropical multispecies fisheries or in minor fisheries in rural areas where for instance unemployment is a severe problem. Accomplishment of any management regime relies critically on monitoring and enforcement and the costs of those activities. Prosperous ITQ systems rely on a high level of compliance, while CPR management in some cases may prove preferable due to inter alia its ability to provide low cost monitoring and enforcement. Traditional fisheries management measures do not solve the property right problem, but within an ITQ- or a CPR fishery several measures can contribute. In the New Zealand ITQ fisheries, few if any of the regulations applied have been abolished. Some scholars see ITQs as the only solution and anticipate a complete privatization of marine resources. There are fisheries where such development is possible, and there may exist specific ones where it is even favorable. Yet, with regard given to market imperfections reflected e.g. as persistent unemployment, distributional objectives, or problems of enforcement costs way above nil, it is held here that for some fisheries CPR management or Territorial Use Rights can be preferable also in developed countries. So far, fisheries management has at its best focused on economic yield from fish stocks. But both the stock themselves and the ecosystems they are part of provide other services, of which some have public goods characteristics, e.g. biodiversity and resilience. These in situ benefits should be taken into account and advocate continued public interest in marine resource management. This should also be part of a more integrated approach to avoid the risk to overlook connections at higher levels. The earlier mentioned pattern of declining trophic levels in landings is one example, fluctuations due to climatic disturbances like El niño is another. Something might be learned from forest management, where there has been a reorientation from maximizing economic yield of timber to total forestry effects.

Up til now, costs for monitoring, research and similar have to a large extent been borne by the public, which additionally have provided subsidies to poor performing fisheries. Most commercial species have growth rates, which can generate positive rents. Scarcity of public funding is a general problem and cost recovery for fisheries management is a likely development. It has already begun in the ITQ fisheries in British Columbia and New Zealand. In both cases, the industry has become increasingly interested in how its funds are used for management and research.

The extended fisheries jurisdiction (EFJ) to 200 nautical miles provides the possibility of success for national fisheries. Given the slow progress of the UN conference on highly migratory and straddling stocks, a further expansion of the EFJ could improve the conditions for some stocks. Still, voluntary agreements are instrumental for other stocks and supposedly

even more important to handle environmental problems, of which some are directly related to the conditions of fish stocks. Some authors question the transfer of use rights from the citizens of a nation to individual fishermen and/or companies. Neither ITQs nor CPR management must entail universal property rights of the fish stocks and the waters they swim in. Citizens of a nation can and should claim influence of use and distribution of several goods and services derived from the fish and their habitats. Individuals, be it voters, consumers, or organized as interest groups have had, and increasingly will have an impact on marine use policy and force fishing companies to consider their opinions. A development which is likely to continue, as information and knowledge are quicker diffused and widespread aided by modern technology.

The introduction listed a number of severe facts that indicate a global fishery crisis. The situation is indeed serious for many fisheries, but a lot of knowledge has been gained. Handling the issue as what it is, a property right problem will render possible a more prosperous future for most fish stocks. Realizing other values from aquatic ecosystems will lead to more common use of for instance Marine Protected Areas. Academic disciplines dealing with fisheries have by need been multi discipline oriented, but even more is required: "At least three peer groups are not speaking to each other: fishery scientists, economists, and ecologists" (Roughgarden, 1998). Even more important is that academic scholars are able to communicate and be involved in the decision and management process, where managers, fishermen and fishing companies are equal important participants. If so, fisheries management in the next millennium can be more successful than it has been during the end of this one.

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