THE PERFORMANCE OF FISHERIES MANAGEMENT SYSTEMS AND THE ECOSYSTEM CHALLENGE

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ABSTRACT

This paper has three objectives. First, it presents a modest update of the evidence used in the 1997 study by the Organisation for Economic Co-operation and Development (OECD) that showed which management measures are effective in conserving marine fisheries and producing significant economic and social benefits. In its original report, OECD found that competitive TAC management results in a race-to-fish, with all its attendant effects; and that individual fishing quotas are an effective means of controlling exploitation, of mitigating the race-to-fish and most of its attendant effects, of generating resource rent and increased profits, and of reducing the number of participants in a fishery. In addition, the OECD evidence indicated that time and area closures have not been effective in ensuring resource conservation, though conservation might well have been poorer without them. The update indicates that most of the original results are upheld.

The second objective is to report on recent trends in policy since 1995, with a focus on ecosystem-based management policies. These include large marine ecosystem (LME) programmes, marine protected areas (MPAs), and measures to protect habitat.

Third, the paper examines the governance challenges of ecosystem-based fisheries management. The paper argues that the political marketplace that produces fisheries management policies tends to be biased against conservation and long-term economic benefits.

The paper concludes with recommendations for reforming our fishery governance institutions.

INTRODUCTION

[1] In this paper, we investigate the prospects for ecosystem-based management of fisheries. Specifically, we attempt to answer the question: "Can significant progress be made in achieving a broader range of conservation objectives within fisheries management systems if present regimes fail to conserve fishery resources and produce significant economic and social benefits?"

[2] We proceed by first reviewing the evidence of the experiences of the Organisation for Economic Co-operation and Development (OECD) member countries with management regimes that have not been ecosystem based. This includes a modest update of the evidence used in the study by OECD (1997) that showed which management measures are effective in conserving marine fisheries and producing significant economic and social benefits. Second, we summarize

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a few recent trends in fishery management policy that were revealed by our update of the evidence. Third, we examine some of the governance challenges of ecosystem-based fisheries management. The paper concludes with recommendations for reforming fishery governance institutions.

THE OECD RESULTS

[3] In 1997, OECD published a study of fisheries management experiences that showed which management measures were effective in conserving marine fisheries and producing significant economic and social benefits. The data for the study were drawn from over 100 fisheries in 24 OECD Member Countries. This is the only study we know that systematically compares individual fishing quotas (IFQs) with more conventional approaches to fisheries management.

[4] Since the original OECD study assembled information up to about 1994, we attempted to update the experiences with fishery management in OECD member countries for the period 1995 through 2000.[1] The update is not comprehensive. In other words, we have not been able to obtain evidence on all of the fisheries included in the original OECD report. In addition, we were not able to obtain evidence on the economic, social and administrative outcomes for many fisheries in the update.

OECD (1997) analysed three categories of fisheries management measures: output controls, input controls, and technical measures. Output controls include total allowable catch (TAC) (total quotas), IFQs, and vessel catch limits.[2] Input controls include limited licences, individual effort quotas, and gear and vessel restrictions. Technical measures included size and sex selectivity measures that restrict the size and sex of fish that can be taken and landed, and time and area closures limiting the time and place where fishing units can operate.

[5] The analytical framework used in the study assumes that regulations imposed on fisheries affect the performance of the fisheries. OECD measured this performance in terms of biological, economic and social outcomes. Management measures, such as quotas, closed areas and seasons, and gear restrictions, tend to change the way fishing activities are conducted and, in turn, affect outcomes (stock sizes, landings, incomes, etc.) in the fishery. Actual outcomes, of course, are determined not only by the set of measures imposed but also by the biological, economic, social and institutional characteristics of the fishery system (and by influences exogenous to the fishery system).

[6] To update the evidence reported in OECD (1997), we applied the methodology described in Sutinen (1999) for a selected set of fisheries. In the original study, the performance of specific management measures imposed by the respective institutions was assessed through a step-wise process. The first step involved developing a set of expected consequences, the second step confronted these expectations with evidence, and the third step assessed the theory on which the expected consequences were based.

Individual fishing quotas

[7] OECD (1997) presented persuasive evidence that shows IFQs are an effective means of controlling exploitation, of mitigating the race-to-fish and most of its attendant effects, of

1. Similar to the original study, we chose to update fisheries for which a reasonable quantity of good quality information was readily available. The principle sources of information were the Internet, and national fishery web sites and their respective annual stock assessment reports. We collected other information from the OECD Review of Fisheries Reports (1998-2000). Similarly, the majority of the evidence described the biological changes with respect to using different management measures. Evidence to measure the economic, social and administrative performance of a particular management measure was lacking.

2. Vessel catch limits differ from IFQs in that they restrict the amount a fishing unit can catch per trip or short period (such as a week) but do not necessarily restrict the number of fishing units or number of fishing trips or periods.

generating resource rent and increased profits, and of reducing the number of participants in a fishery.[3]

[8] IFQs have been effective in limiting catch at or below the TAC level determined by management authorities. OECD reports that catch was maintained at or below the TAC in 23 out of the 31 IFQ fisheries for which information was available. The TAC overruns that did occur were due to inadequate monitoring and enforcement. Where overexploitation occurred, it was due to poor data that allowed the TAC to be set too high.

[9] The OECD evidence demonstrates that IFQs eliminate or prevent a race-to-fish and the resulting problems of overcapacity, excess effort, waste, unsafe harvesting practices, gear conflict and loss, and reduced product quality. Two of the most notable cases are the Canadian halibut and sablefish fisheries. Seasons that had been reduced to a few days under competitive TACs and limited entry were increased to most of the year almost immediately.

[10] Elimination of the race-to-fish has not been universal, however. For example, in the Netherlands sole and plaice and the Norwegian cod fisheries, IFQs failed to eliminate the race-to-fish.[4] The race-to-fish in these fisheries is because the fishery could be closed down when the national quota was met, even if individual fishing quotas had not been filled. In Iceland, the option to choose between individual effort and catch quotas in the demersal fishery led to an increase in investment. A race-to-fish occurs in the New Zealand flatfish fishery in years of low abundance. Most of the fisheries experiencing a race-to-fish used time or area closures independent of the attainment of TAC, which may have influenced these outcomes.

[11] There is a worldwide trend towards the use of IFQs. A growing number of governments are bringing their fisheries under this form of rights-based management. In our update of the OECD evidence, we found that managers have introduced individual transferable quotas in a number of fisheries during the last few years. This is especially evident in fisheries that formerly were under competitive TAC management.

[12] In Australia, managers introduced IFQs to the remainder of the trawl quota in the Southeast Trawl fishery, and introduced IFQ management for school and gummy shark stocks in the Southern Shark fishery. A few countries, including New Zealand and Poland, introduced legislation that provided a mechanism either to introduce an IFQ system or to move most of the remaining commercial fish species into a quota managed system. Iceland introduced IFQs for Atlantic wolffish and witch, and Canada introduced them to their Pacific herring large-seine fleet. Denmark introduced the experimental use of annual vessel quotas in the Baltic cod fishery, and for their herring and mackerel fisheries in the North Sea. Norway introduced a unit-quota system to their purse seine fleet and cod trawl fleet. In addition, a company-wide quota system was introduced to the groundfish fishery.

[13] We argue that fishery managers are introducing IFQs because they work well. IFQs have a proven record of accomplishment of promoting sustainable management of fisheries and producing wealth. In our view, it is easier to explain why IFQs are used than why they are not used in more fisheries. This is further considered below.

[14] The OECD study also demonstrates that IFQs present problems with the initial allocation of quota and with enforcement and compliance. Of the 55 IFQ fisheries reviewed by OECD, quota allocation problems were documented in ten fisheries, with no counter examples. The initial allocation of quota is the major impediment to the adoption of IFQs in most fisheries. Potential participants in an IFQ programme are commonly afraid that they will not receive their fair share in the initial allocation of quota. The exceptions are fisheries with a relatively small number of producers who are relatively homogeneous. The struggle to find a fair and just

3. The report by the National Research Council (1999) drew upon much of the evidence contained in OECD, 2000.

4. However, the recent evidence from 1998 and 1999 now shows that the number of fisherman employed fell in the Norwegian cod trawler fleet, and that overall profitability had increased substantially.

allocation of harvest rights is difficult, time-consuming and adversarial. The current debate over processor shares in Alaska is an apt example of this.

[15] Allocation of the access to fish, or of the rights to catch fish, is a problem that plagues all forms of fisheries management, whether based on IFQs or traditional methods. Allocation is the constant topic of meetings and decisions made by fishery managers, and even the subject of legislative deliberations. There is a trade-off related to allocation and IFQs that the management system is too frequently unwilling to make. The trade-off is between the ongoing cost of allocation problems with conventional management measures and the high up-front cost of initial allocation with IFQs. Without a market to handle allocation issues, the management system pays the price of allocation struggles on a continuing basis. While the initial allocation of IFQs is extremely difficult, the 'pain' is all up front and once-and-for-all. This is especially true for transferable IFQs, since thereafter a market emerges to handle the re-allocation of quota that is needed for the fishery to evolve.[5] If managers escape the high up-front cost of the initial allocation of transferable IFQs, they must face the continuing distraction of dealing with allocation instead of conservation.

[16] Actual solutions to the initial allocation problem have taken a variety of forms. This variety is probably because there is not universal agreement on what constitutes a fair and just allocation. Each solution is the result of a negotiation and bargaining process. The important aspect of the solution is the process – the process by which the solution is found. An open and transparent process is needed to insure institutional legitimacy, credibility and trust. As an aside, we in the USA have not yet designed a process that satisfies these criteria.

[17] Higher enforcement costs and or greater enforcement problems occurred in 17 fisheries compared to 5 that experienced improvements. Enforcement proved particularly difficult in high-value fisheries, in multispecies fisheries and in transborder fisheries. Although enforcement costs frequently increased under individual vessel quotas, there was often an increased ability and willingness of fishermen to pay these increased costs. Support from industry for increased enforcement is common. IFQ holders recognize that illegal fishing by others damages the value of their quota rights and therefore have an incentive to aid authorities with enforcement.

[18] The rents generated by IFQs provide governments with a source of revenue to cover the costs of enforcement and administration. In the many IFQ fisheries in Australia, Canada, Iceland and New Zealand, industry pays for administration and enforcement with fees levied on quota owners. In some cases quota holders voluntarily paid for added enforcement, such as in the New Zealand lobster fishery. In addition, IFQ management has led to increased cooperation between fishermen and enforcement authorities in several cases, including the New Zealand fisheries in general, and the USA wreckfish fishery. Fishermen reported improved compliance in the Canadian halibut fishery.[6]

[19] We have learned a great deal over the last 20 years of IFQ management. Despite the many and serious problems that have confronted IFQs, fishery managers are finding ways to mitigate or remove these impediments to IFQs. We see evidence that managers can find designs of IFQ programmes that satisfy first principles (such as creating an exclusive harvest right) and still address the concerns of fairness and justice. Where no solutions are immediately evident, countries should craft the legislation to encourage innovation and experimentation.

5. If the IFQs are not transferable, management authorities also will have to re-visit the allocation issue repeatedly.

6 Other problems with IFQs that were identified included: underreporting of catch and data degradation (documented for 12 fisheries, but improvements were made in 6 fisheries); industry resistance to IFQs in 8 fisheries, but the opposite was true in 5 fisheries; several cases where quotas were consolidated (documented in 12 fisheries, but 5 showed contrary evidence), and rules were in place to limit consolidation; little evidence that smaller vessels are eliminated when individual vessel quotas are introduced (2 fisheries where elimination occurred and 5 where it did not); class divisions were documented only for the Icelandic fisheries.

How do IFQs compare to other fishery management measures?[7]

[20] In its assessment of other management measures, OECD (1997) concluded that none of the other (non-IFQ) management measures performs well when used without IFQs. That is, they do not effectively control exploitation and mitigate the race-to-fish. However, they do not present as many social and administrative difficulties as IFQs.

[21] The findings are summarized below:

Total allowable catch quota

[22] OECD (1997) found that competitive TAC management causes a race-to-fish, with the attendant effects of overcapitalization, shortened seasons, market gluts, increased harvesting and processing costs particularly evident. Competitive TAC management generally has not effectively prevented overexploitation of the fishery resource – though it has been successful in some fisheries.

[23] The update of selected experiences supports the original findings that competitive TAC management results in a race-to-fish with all its attendant effects and generally has not effectively prevented overexploitation of resources. For example, in the European Union, recent stock assessment reports indicate that most of the fishery stocks that are managed with competitive TACs are heavily fished. Management authorities have substantially reduced the TACs for a number of stocks over the last couple of years.

[24] Since 1995, TACs have been introduced to several fisheries not mentioned in the original OECD report. In the EU, TACs were introduced to numerous species in the North Sea fisheries, as well as for tuna and swordfish. Japan also subjected six of its commercially fished species to a TAC system, complementing the effort and limited access systems and technical measurers already in place.

[25] There were also some modifications to a couple of fisheries managed with competitive TACs. For example the Canadian Pacific herring fishery continued to use competitive TAC management, but separate TACs were established for the spring and autumn components in the inshore fleet.

Limited licences

[26] OECD (1997) found that overcapitalization and increased harvesting costs occur with limited licences, but the evidence is confounded by the presence of TACs in many of the reported cases. There have been some initial allocation problems, but the amount of evidence is too small to draw a firm conclusion. Limited licences have not stemmed the tendency to overexploit the fishery resource.

Size and sex selectivity

[27] OECD (1997) found that size and sex selectivity measures do not mitigate the race-to-fish and result in increased enforcement costs or other problems, as demonstrated by the evidence. There is only weak evidence that the average size of fish landed increases and that discards increase.

[28] The EU introduced, in recent years, minimum landing sizes for the Mediterranean bluefin tuna fishery. There were also several size and sex selectivity measures that were changed,

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7, The OECD study represents one of the few attemps, if not the only one, to comprehensively assess the performance of the full suite of management measures. The study found considerable evidence, and excellent scholarly studies of IFQs, limited licences and TAC measures. However, there is great paucity of evidence on the performance of the other management measures (size and sex selectivity, closures, effort quotas, vessel catch limits and gear and vessel restrictions). While the theory of how these measures are supposed to work is well developed, the supporting empirical evidence is missing. The actual application of these methods appears to be conducted more on faith than on a sound factual basis.

including increasing the minimum size regulation in the Victorian abalone and scallop fisheries. Contrary to evidence in the 1997 report, which weakly supported the expectations that average size of fish landed increased and that discarding decreased; recent assessments have shown that in the Victorian scallop fishery, average production had in fact fallen and become sporadic.

Closures

[29] OECD (1997) concluded that that time and area closures have not been effective in assuring resource conservation, though conservation might well have been worse without them.

[30] Our update revealed that there have been several time and area closures introduced since 1995. Seasonal closures in the Great Australian Bight Trawl fishery were implemented within the marine mammal protection area of the Great Australian Bight marine park; and demersal trawling was prohibited within the benthic protection strip area. Impacts on the fishery by the marine park are still uncertain. Recent assessments show that there is some variability within the fishery, although it appears to be due to changes in the aggregating behaviour of the fishes. In addition, in the EU, seasonal closures were introduced for the first time to the Mediterranean bluefin tuna fishery. Area and season lengths have also increased in several fisheries, including the Tasmanian abalone fishery and the Icelandic capelin fishery.

[31] In the USA, three large closed areas on Georges Bank and in the Gulf of Maine, initially implemented to improve the recruitment of groundfish, have aided in the recovery of yellowtail flounder and dramatically improved the abundance of large scallops. Scallop biomass tripled in the first 20 months after closure of the areas on Georges Bank.

Individual effort quotas

[32] OECD (1997) found that individual effort quotas (e.g., days-at-sea, trap quotas) result in overcapitalization, increased harvesting costs and increased enforcement problems.

Vessel catch limits

[33] OECD (1997) found that vessel catch limits (as distinguished from IFQs) increase enforcement costs and problems.

[34] We found in our recent survey that none of the fisheries that continued to use vessel catch limits improved resource conservation. Average production in the Victorian scallop fishery, for example, had fallen and, in 1996, the Australian Victorian Government announced that it would buy-out the licences issued in Port Phillip Bay. The Canadian Pacific groundfish trawl fishery declined further, and is currently at historical low levels.

Why do IFQs perform so well?

[35] IFQs provide important benefits that other approaches do not. IFQs effectively constrain exploitation within set limits, mitigate the race-to-fish, reduce overcapacity, gear conflicts, while improving product quality and availability. Producers benefit, consumers benefit, and, when the resource rent is used to pay for the cost of management, the general public benefits. In addition, there are environmental benefits that are often overlooked. For example, reducing the 300 000 traps in Area 2 of the North American lobster fishery is expected to substantially reduce entanglements with whales, while at the same time realizing the same yield.

[36] Why do IFQs and other rights-based approaches have the potential to achieve this much? Fishery economists and most social scientists are not surprised that IFQs perform so well in comparison with other management measures. IFQs solve numerous problems by providing exclusive harvesting rights. Other ‘rights-based’ management measures have the potential to do the same. None of the traditional management measures provides exclusive rights and, therefore, cannot solve the problems created by non-exclusive use of the resource.

[37] In fisheries without exclusive harvesting rights, no fisherman has the right to exclude other fishermen from harvesting any part of the resource. From an individual fisherman's perspective, leaving fish to grow and reproduce is done at the risk of losing the fish to other fishermen. There is therefore no incentive to conserve the resource for future use, since no fisherman has exclusive use. The non-exclusive nature of fisheries resources is the fundamental cause of overexploitation in modern fisheries.

[38] Without an exclusive right to harvest a quantity of fish, competition to catch fish before others do causes then 'race-to-fish.' resulting in fishing seasons that are shorter than optimal for maximum economic performance, landings that are too small and of inferior quality, and excessive investments in vessels and gear.

[39] The non-exclusive nature of harvesting fisheries resources also leads to conflicts among user groups. Since no fisherman has the right to exclude another from access to the resource, two or more fishermen can interact at the same time and place in a fishery. They impose external costs on each other in the form of gear or other losses. Mobile gear (such as trawls) may fish in the same area as fixed bottom gear (such as traps), causing damage to one or both of the gears. Large, efficient vessels can operate in a fishery on which small-scale fishermen are heavily dependent, draining the stock available for capture by the smaller fishermen. Failure to consider these external costs when deciding where and how to fish causes inferior economic performance in the fishery.

[40] Processors, distributors, wholesalers, retailers and consumers are also affected by the non-exclusive nature of harvesting. The race-to-fish can result in large quantities of fish being landed during short periods, requiring the buildup of excessively large processing, storage and distribution facilities to handle the periodic peak loads. Wholesalers, retailers and consumers find supplies of specific fish are abundant for short periods and scarce for long periods; or, the product is processed for long shelf life, generally reducing the product quality and price on the market.

[41] Several attributes appear to contribute to the success of IFQ management. Fisheries with a limited number and well-defined group of participants are more easily brought under and managed with IFQs. Fisheries that were under limited entry or had a very small number of participants provide a well-defined user group and initial allocations are made easier. The quota holders have already developed a sense of property in the fishery in many cases that contributes to acceptance of individual fishing quotas and, at least in some cases, may contribute to improved compliance and collaboration with enforcement. Fisheries with a homogeneous fleet are more easily put under IFQs. Allocations are more easily decided and the fishery typically has less adjustment to go through.

[42] OECD (1997) reported that user participation in the development and implementation of fishery management plans is a critical element for successful management. Co-management arrangements are one of the more promising avenues for greater user participation. Yet there are several out standing questions concerning co-management. How, for example, should co-management be implemented? What rights and responsibilities should remain with government and which with users? Is more user participation better than less in all fisheries? Is user participation feasible and desirable in the cases of straddling stocks and highly migratory species? If producers' organizations are needed for co-management, how can and should fishermen be organized, especially when they have no history of organization?

[43] Canada, Denmark, the Netherlands, Norway, Sweden and the United Kingdom have devolved fishing rights and responsibilities to producers. These countries have found that the co-management approach reduces administrative costs and greatly improves compliance with management regulations. Japan has built on its lengthy tradition of rights-based management and now has the world's most extensive and sophisticated fisheries co-management system. Other countries have much to learn from these experiences.

[44] Of all the management measures available to managers, rights-based management measures (such as IFQs) have the greatest chance of correcting the fundamental problem of non-exclusive harvesting rights and of reducing conflicts among users, producing superior economic performance while conserving fishery resources.

Multispecies fisheries and ecosystem-based management

[45] In theory, most management measures are expected to provide some degree of conservation benefits in the form of maintaining or rebuilding resource stocks to desired levels. Unfortunately, in practice, none of the management measures assures optimal resource conservation. Achieving optimal conservation is complicated by several factors or conditions, including multispecies, by-catch and discards, and wide fluctuations in resource stocks and markets.

[46] Despite the complex challenges presented by multispecies fisheries, the OECD evidence shows that IFQs outperformed all other management measures. This is not to say, however, that only IFQs are needed in multispecies fisheries. Rather, when other management measures (such as mesh size regulations) are used in combination with IFQs, performance was superior. When not used with IFQs, performance suffered.

[47] Fisheries that harvest multiple species are more difficult and costly to manage than single species fisheries. A high proportion of multispecies groundfish fisheries in OECD countries experienced poor resource conservation and economic performance. Relatively non-selective trawls are used in these fisheries, having high by-catch and discard rates, further weakening management's control on exploitation patterns (unless by-catch and discarded catch are monitored adequately).

[48] Multispecies fisheries complicate all forms of fishery management. In multispecies fisheries where several species are caught jointly, no single management measure, or combination of measures, can achieve the optimal fishing mortality for all species. Almost any change in management measures will favour one species at the expense of another. Good conservation on all stocks appears infeasible in such cases.

[49] With respect to the issue of ecosystem management, there is widespread consensus on the importance of accounting for multispecies interactions in fisheries analysis and management, but only a limited amount has been accomplished to date. The theory for developing models to explain and analyse interactions is well developed. Biological and economic empirical evidence, however, is inadequate. Attempts to model multispecies fisheries in several countries are ongoing and are already providing information for the management process in some fisheries. IFQs seem to offer high promise, relative to non-rights-based approaches, for wrestling with the challenge of managing complex marine ecosystems. Other rights-based approaches are currently being explored by researchers, but no experiments or tests of these approaches are underway.

[50] By-catch is inevitable in many multispecies fisheries. Incentives play a major role in determining the amounts of by-catch. An individual fisherman will try to control by-catch as long as the benefits outweigh the costs to him. Effective management recognizes this and creates or modifies incentives to lessen the impact of by-catch.

[51] There is some anecdotal evidence suggesting that substantial discarding at sea and under-reporting of landings have increased since the implementation of IFQs. However, a study done for OECD found no discernible increase in discards under an IFQ system compared to the previous limited effort management scheme.

[52] In our update, we found no information to either support or refute any increase in by-catch under IFQs. However, the development of by-catch action plans were introduced in a few IFQ fisheries, including the South East Trawl Fishery and the Torres Strait Prawn fishery. In Canada, individual vessel by-catch limits were implemented to supplement the IFQ-managed groundfish trawl fishery, resulting in substantial by-catch mortality reductions.

[53] Some countries have developed tools to counteract discarding. These tools include setting TACs by species such that different TACs can be filled approximately simultaneously; employing standard harvesting technologies; simple and well advertised discard rules; flexible monitoring and surveillance designed to deal with the most pressing problems at each point in time; and addressing alleged violations quickly and effectively with penalties high enough to deter such practices.

[54] Highly variable fishery resources appear to be particularly problematic for TAC and IFQ management. However, OECD noted that highly variable stocks are problematic for any management measures in terms of protecting the stocks from risk of collapse. High year-to-year variance in natural mortality and recruitment may lead to stock failures even with conservative management, particularly for short-lived species.

Selected trends in fisheries management policy since 1995

[55] Our review of recent fisheries management experiences also revealed some trends in management policy that were not evident in the original OECD study. This section reports on some of these trends in policy since 1995, with a focus on ecosystem-based management policies. These include closures and marine protected areas (MPAs), large marine ecosystem (LME) programmes, and measures to protect habitat.

Closures and marine protected areas

[56] In 2000, President Clinton signed an Executive Order regarding MPAs in the USA. The Executive Order would help protect the significant natural and cultural resources within the marine environment for the benefit of present and future generations by strengthening and expanding the nation’s system of MPAs.

[57] In Australia, MPAs are also emerging as an important plank in a number of government initiatives to promote sustainable fishery management. For example, their *Oceans Policy* identified principles for the ecologically sustainable use of their fishery resources. Moreover, it provides an infrastructure to examine the need for, and options to achieve, integrated oceans management, and ensure the long-term protection of their marine environment.

[58] In April 1998 Australia’s Commonwealth government proclaimed its second-largest marine park, covering 2.3 million ha and located in the Great Australian Bight. It provides protection for the southern right whale, the Australian sea lion, and a large range of benthic flora and fauna species. It comprises an area designated for mammal protection adjacent to a State inshore park. A second area, 20 n.mi. wide, and extending from the State park boundary to the limit of the Australian Exclusive Economic Zone, is designated to conserve benthic flora and fauna.

[59] In 1999, the first deep-sea seamount Marine Reserve was declared off the southern coast of Tasmania. This MPA consists of two vertical zones. The upper zone from the surface to 500 m is a managed resource zone. The zone deeper than 500 m is a no-take zone. Later in the year, the waters around the southeastern region of Macquarie Island were also declared an MPA.

[60] In addition, in Canada, the *Oceans Act* provided a management system based on the principles of ecosystem management. It provided a framework for establishing MPAs, which, according to the Oceans Act, would include being used for the conservation and sustainable management of their fishery resources.

[61] In 1998, Canada established its first pilot MPAs at Race Rocks and Gabriola Passage. The same year, a pilot MPA was also announced for the Sable Gully on the edge of the Scotian Shelf, just north of Sable Island. It provides habitat for a wide diversity of marine life, including 200 bottlenose whales, a vulnerable species that lives in the Gully year round, and some of the best examples of northern coral. Recently, two new pilot MPAs in the offshore waters of the Pacific Ocean were established at Endeavour Hot Vents Area and the Bowie Seamount. Endeavour Hot Vents lie in the offshore waters of the northeast Pacific, about 250 km southwest of Vancouver

Island. Endeavour Hot Vents Area is the world's first pilot MPA for offshore hydrothermal vents. Bowie Seamount is located 180 km west of the Queen Charlotte Islands in the northeast Pacific. It is an ancient subsea volcano, rising over 3 000 m above the sea bottom.

[62] Only a few studies demonstrate the replenishment of fish stocks on fishing grounds via export from closures. However, in fairness, it appears that few closures have been established solely for this purpose. Interestingly though, several national agencies, including IUCN (1994), state that one of the aims of MPAs is to ensure the sustainable utilization of species.

[63] There are, however, numerous studies that have shown that the density of some species within closures have increased, the average size of individual of a given species can change, and that fish biomass can increase significantly. A few studies demonstrate the potential to replenish exploited fish stocks through the dispersal of larval or adult fish from the closed areas into regions where fishing is allowed.

[64] Two studies, one in the Philippines and the other in Kenya, documented increases in the populations of large adult fish in protected areas and subsequent population enhancements in adjoining regions (McClanahan and Kaunda-Arara, 1996; Russ and Alcala, 1996). The benefits of protecting juvenile fish for their export as young adults to fishing grounds has also only been vaguely documented. Single-species closures used for plaice in the North Sea and mackerel in southwest England have resulted in increased yields by enhancing juvenile survival (Horwood *et al.*, 1998).

[65] On Georges Bank and in the Gulf of Maine, more than 5000 square miles were closed to bottom trawling and dredging in December 1994 in response to the critical decline of groundfish stocks. The intent was to improve recruitment of groundfish by reducing by-catch of juveniles and preventing the disturbance of juvenile habitat in the closed areas. Evidence has shown that the three large closed areas have aided in the recovery of yellowtail flounder and dramatically improved the abundance of large scallops. Scallop biomass tripled in the first 20 months after closure of the areas on Georges Bank (NRC, 2001).

Large Marine Ecosystems

[66] The World Bank and the Global Environment Facility (GEF) have adopted the LME approach to marine ecosystem research and management, viewing it as 'an effective way to manage and organize scientific research on natural processes occurring within marine ecosystems [and] to study how pollutants travel within these marine systems …' (World Bank, 1995: Annex A). There currently are 11 active LME projects, funded at US$ 2 750 million, involving 62 countries.

[67] The concept of LMEs is a science-based method for dividing the world's oceans, developed 15 years ago by Kenneth Sherman and Lewis Alexander. LMEs are geographic areas of oceans that have distinct bathymetry, hydrography, productivity and trophically dependent populations. The geographic limits of most LMEs are defined by the extent of continental margins and the seaward extent of coastal currents.

[68] Among these are the Northeast USA Continental Shelf, Southeast USA Continental Shelf, Gulf of Alaska, Gulf of Mexico, Eastern Bering Sea and the California Current. Some LMEs are semi-enclosed seas, such as the Caribbean, Mediterranean and Black Seas. LMEs can be further divided into sub-systems such as the Gulf of Maine, Georges Bank, Southern New England, and the Mid-Atlantic Bight in the case of the Northeast USA Continental Shelf (Sherman *et al.*, 1988).

[69] Approximately 95% of all fish and other living marine resources produced are taken from the world's 51 LMEs. Unfortunately, many LMEs are currently stressed from overexploitation of marine resources, habitat degradation and pollution.

[70] The LME management approach links the management of drainage basins and coastal areas with continental shelves and dominant coastal currents. The approach (i) addresses the many-faceted problem of sustainable development of marine resources; (ii) provides a framework for research monitoring, assessment and modelling to allow prediction and better management decisions; and (iii) aids in focusing marine assessments and management on sustaining productivity and conserving the integrity of ecosystems.

[71] The assessment, monitoring and governance challenges of LMEs are enormous. The report by Sutinen (2000) presents a methodology for determining what is known of the socio-economic and governance aspects – the human dimensions – of LME management. The report describes a basic framework for identifying the salient socio-economic and governance elements and processes of an LME. Methods for monitoring and assessing the various elements and processes are also discussed.

[72] LME management increases the need for intergovernmental and intersectoral management. Government agencies will have to identify barriers to interagency coordination and develop alliances and partnerships with non-federal agencies and private sector stakeholders (Hennessey, 1997). Management agencies must learn to cope with the uncertainty associated with the complexity of ecosystems as natural systems, and the organizational and institutional complexity of the implementation environment (Hennessey, 1997; Acheson, 1994).

[73] A major impediment to successful management is imperfect fit between the spatial and temporal scales of government jurisdictions and ecosystems. Ways to connect ‘nested’ ecosystems through ‘networked institutions’ at federal, state, local and NGO levels will have to be found (Hennessey, 1997). How these institutions adapt to deal with the complexity of the ecosystem and the complexity of the governance system in order to achieve an optimal mix of benefits and costs is a fundamental issue (Creed and McCay, 1996).

Habitat

[74] Historically, marine fish habitat conservation has not been a priority of fishery management agencies such as the USA National Marine Fisheries Service (NMFS). Activities associated with threats to marine fish habitat continued because NMFS was not usually equipped with either the resources or the mandate to deal with these problems. The situation and perceptions have been changing during last two to three decades as the understanding of ecological relationships has improved and agency priorities have changed.

[75] In 1996, the US Congress added new habitat conservation provisions to the Magnusson-Stevens Fishery Conservation and Management Act that mandate NMFS and Regional Fishery Management Councils to identify and protect important fish habitats. The law requires the NMFS and Councils, to the extent practicable, to take action that minimizes fishing-related adverse effects on Essential Fish Habitat (EFH) and to identify other actions to encourage the conservation and enhancement of EFH. In addition, NMFS established an Office of Habitat Conservation to protect and conserve habitats and to ensure that living marine resources have sufficient healthy habitat to sustain populations.

Other rights-based management approaches

[76] A couple of creative rights-based alternatives to IFQs have been employed in the USA. One of the approaches is Community Development Quotas, and the other is fishery cooperatives. Both of these programmes are in Alaska.

[77] In the USA, a Community Development Quota (CDQ) programme was implemented in December 1992 by the North Pacific Fishery Management Council. The CDQ programme allocates a portion of the annual fish harvest of certain commercial species directly to a coalition of villages in the Bering Sea region. The programme was an attempt to accomplish rural development in rural coastal communities in western Alaska. In its first year, the council

allocated 7.5% of the TAC catch of Bering Sea Pollock to six CDQ groups, organized from 56 eligible communities (recently expanded to 57). They managed their harvest quotas and allocated the returns. The quotas are transferable, and thus those fishing partners authorized by the communities in exchange for royalties can also harvest a portion of this TAC. In 1996, an amendment to the Magnusson Act extended the Community Development Quota (CDQ) Programme to include halibut, sablefish, crab and assorted groundfish managed under Federal Fish Management plans.

[78] The CDQ programme has had a positive economic impact on Western Alaskan communities. During the first four years of operation, the six CDQ groups collected over US$ 92 million in gross revenues from fishing partners. The CDQ programme has enhanced the employment of western Alaskans in the commercial fishing industry, as well as their average income. Evidence suggests that the programme has also contributed to improve understanding of business administration, corporate structure and procedures, and technical skills of village residents (NRC, 1999).

[79] Also in the USA, the Pollock Conservation Cooperatives (PCC) was formed in December 1998, to promote the rational and orderly harvest of pollock by the catcher/processor sector of the Bering Sea and Aleutian islands trawl fisheries off Alaska, through the mutual cooperation of PCC members. The PCC is made up of 8 companies that own 19 catcher/processors eligible under the American Fisheries Act (AFA) to harvest and process pollock in the directed pollock fishery. Under the PCC, each company is contractually allocated a percentage of the directed fishery catch specified under the AFA. The cooperatives for the factory trawler sector began in 1999, and the cooperatives for the mothership and inshore processor sectors began in 2000.

[80] For the Bering Sea - Aleutian Island area (BSAI) and the Gulf of Alaska (GOA) fisheries as a whole, the annual discard rate for groundfish decreased from 14.6% in 1995 to 9.4% in 1999, after a very large reduction in 1998 and a small increase in 1999. The 43% reduction in the overall discard rate in 1998 is the result of prohibiting pollock and Pacific cod discards in all BSAI and GOA groundfish fisheries beginning in 1998.

[81] The ex-vessel value of the domestic landings in the FMP fisheries, excluding the value added by at-sea processing, decreased from US$ 585 million in 1995 to US$ 531 million in 1996, increased in 1997 to US$ 615 million, decreased again to US$ 416 million in 1998, and increased to US$ 488 million in 1999 (Hiatt and Terry, 2000).

The political economy of fisheries management[8]

[82] Despite the promising trends towards more use of rights-based management measures, our fishery management institutions do not have a good record of conserving and managing fisheries. The Food and Agriculture Organization of the United Nations (FAO, 2000) reports that about 65% to 68% the world’s fish stocks for which data are available are exploited at or beyond the level corresponding to their maximum limits. Another 9% to 10% of stocks have been depleted or are recovering from depletion. In the USA, of the 200-plus fish stocks under the purview of NMFS, 46% of the fish stocks whose status are known are overexploited. Another 38% are fully exploited and may be in danger of becoming overexploited.

[83] FAO has characterized this record as ‘partially successful.’ We look at the record and conclude that our fishery management institutions have failed to conserve resources and improve the economic health of fishing communities. Why have our management institutions not done better? FAO claims that the poor record is due to problems that include:

(i) uncertainty about the status and dynamics of the stock;

8 The arguments in this section are based on extensive public choice literature, e.g. Buchanan and Tullock, 1962; Buchanan, 1980; Niskanen, 1971; Olson, 1964; and Wolf, 1988. Applications of public choice to fisheries can be found in Andersen *et al*., 1998, and Upton and Sutinen, 2000.

(ii) a tendency to give priority to short-term social and economic needs at the expense of the longer-term sustainability of the stock;

(iii) poorly defined objectives; and

(iv) institutional weaknesses, particularly in relation to the absence of long-term rights amongst the different key stakeholders and decision-making structures and processes.

[84] We focus here on the last three problem areas for fisheries management. The first is not necessarily a cause of management failure. After all, managers in the private sector routinely succeed in the face of severe uncertainties. We view the last three problem areas as manifestations of the incentive structure found in most fisheries governance regimes. Unless the incentive structure in our collective-decision-making organizations is repaired, it will remain biased against the conservation of fisheries resources.

[85] The political process controls government and, in most Western democracies, political decisions are produced by a legislative process. Voters elect representatives to guide government policies and actions; agencies are formed; and bureaucrats hired to implement government policies. These three groups are the major players in the political process, and government policies and actions result from complex interactions among these players. Voters – especially groups of voters with special interests – express their demand for government policy and action. Elected representatives supply legislation (policy) and government bureaucrats implement the programmes and rules specified in the legislation. In the fisheries context, the principle products of this political marketplace are fisheries laws and regulations related to conservation and management, safety, environmental protection, etc.

[86] We now look at the supply and demand conditions for government policy and action in more detail.

[87] Voters are the consumers of the political process, demanding political products. Voters, groups of voters (that form to pursue their special interests) demand public-sector action to reduce inefficiencies and to redistribute income, usually in a self-interested redistribution. Votes, campaign contributions and lobbying are the currency by which these demands are expressed.

[88] Politicians are the elected administrators and legislators in federal, state and local government, including members of executive and legislative branches. Politicians are motivated by the need to be elected or remain in power by supplying the political goods that are demanded by voters. Therefore politicians select positions that maximize the probability of re-election.

[89] Bureaucrats also work at federal, state and local levels as hired officials. Agency employees implement laws, implement regulations and develop programmes. In pursuit of self interest, they maximize their power in the bureaucracy by increasing the size of their budget and number of employees. They typically achieve this objective by appealing to politicians with programmes that will be favoured by voters.

[90] Political equilibrium is reached as voters, politicians and bureaucrats make choices to achieve their own objectives. Both socially desirable and undesirable outcomes are possible, depending on the underlying incentives of these groups.

[91] Governance failure (a.k.a. socially undesirable outcome) is due to a number of inter-related causes, including:

(i) special interest effects,

(ii) rational voter ignorance

(iii) bundling of issues,

(iv) shortsightedness effects,

(v) de-coupling of costs and benefits, and

(vi) bureaucratic inefficiencies.

[92] Special-interest effects occur when a relatively small number of voters make large individual gains at the expense of a large number of citizens who bear small individual losses. Rent seeking occurs when individuals and groups attempt to use the political process to redistribute income from others to themselves. Special interests gain disproportionate power relative to their numbers because they can provide campaign funds, publicity and delivery of voters who are passionate about a particular issue. Meanwhile rational voter ignorance occurs because it is seldom worth the cost for the typical voter to acquire the information needed to make a fully informed voting decision. In addition, the choice of a single voter is seldom decisive when the overall number of voters is large. This further decreases the voter's motivation to acquire more information, while in many cases the individual may not bother to vote at all. These factors induce the politician to favour special interests.

[93] The packaging or bundling of the candidate's positions further accentuates special interest effects and rational voter ignorance. Members of the general public who are relatively disinterested in a specific issue are unlikely to vote on the basis of that issue alone. It is likely that many other issues are of greater importance to him or her, especially when the impact on their welfare is small. Yet members of an interest group are likely to vote strictly according to the issue, especially when it has a significant effect on their welfare. A given political candidacy will be accepted or rejected on the basis of the entire package of positions and not on the basis of a single special-interest issue. Since voters can only express their will through a legislator who represents a bundle of political goods, the political process becomes imprecise with regard to voter preferences. For example, it has been estimated that the typical citizen makes only one public choice decision for each thousand made in the private sector. In addition, politicians often package issues in a complex manner so that most voters will be unaware of the true costs that programmes will impose upon them. However, special interests are likely to be well informed regarding the underlying costs and benefits of a policy that is specific to their interests.

[94] Politicians tend to be shortsighted because they face short re-election cycles, of 2, 4 or 6 years.[9] They are concerned about the consequences of policies and programmes before the next election. The long-term consequences tend to carry little weight in the calculations of the politician. Politicians often exhibit shortsightedness. They regularly enact special legislation and appropriations for fisheries, and periodically attempt to directly influence the contents of fishery management plans. Shortsightedness is a natural attribute of a politician.

[95] Shortsightedness also is present on the demand side. Fishing interests in most managed fisheries tend to be shortsighted about fishery management policy. In open-access fisheries, fishermen have no secure claim on future outcomes in their fishery. That is, they have no assurance that they will reap the benefits that might accrue from their short-term sacrifices. Fishermen in rights-based fisheries, on the other hand, are expected to be less shortsighted. Fishermen also tend to be shortsighted because of the great uncertainty they face regarding future fishery policies, fish stocks and markets. Fishermen are simply being rational in their shortsightedness.

[96] The shortsightedness on both demand and supply sides combines to favour legislation that provides easily identified current benefits at the expense of future costs that are complex and difficult to identify. Conservation, which requires short-term sacrifice in exchange for long-term gains, tends to be disfavoured in this environment.

[97] Another characteristic that strongly influences fishery policies and outcomes is de-coupled benefits and costs. Political products have benefits and they have costs. For many fishery products, those who benefit are not those who pay the cost of a product. For other products,

9. We use the term shortsightedness to describe the tendency by people to ignore, or give little weight to, future consequences, especially consequences in the medium to distant future.

benefits accrue at a different point in time from the costs. An example of de-coupled benefits and costs are government-financed vessel buyback programmes, such as the US$ 25 million vessel/permit buyout programme in the USA Northeast fisheries. The beneficiaries are the fishermen whose vessels are purchased by the programme and those remaining in the fishery. The costs, on the other hand, are borne by the general taxpayer. The beneficiaries do not pay in proportion to the benefits they receive; and the payers do not benefit in proportion to what they pay.

[98] Government agencies do not face incentives to produce goods and services efficiently. By cultivating the political influence of powerful politicians and groups of constituents, bureaucrats create opportunities for themselves to lead larger government agencies. While bureaucrats compete for tax revenues, promotions, higher incomes and greater power (just as employees do in the private sector), they do not face incentives to increase the value and decrease the costs of their outputs. Public employees cannot increase their income by improving the efficiency of the agency, and their job performance is usually difficult to measure (at least in terms of the contribution to the agency's output). As a result, they tend to be less conscious of costs, especially since they are spending other people's money. There is no need to compare revenues with costs; there is no measure of inefficiency and no pressure to reduce it. The incentives inherent in government agencies leads to inefficient production of government goods and services.

[99] In addition, government is often the sole provider of the good or service. The exclusive right of production is often mandated by law. Education and postal services in the USA are exceptions. In general, the lack of constant competition for customers leads to inefficiency in government production.

[100] Unlike the private sector, there is no systematic mechanism to weed out governmental inefficiencies. In the private sector, inefficient firms do not survive – they go bankrupt. In the public sector, agencies with high costs or that cannot meet their targets are often rewarded with increased funding. Agencies that reduce costs and do not spend their budget allocation are penalized with the threat of a smaller budget the following year.

[101] These two characteristics, shortsightedness of the principal actors and de-coupled benefits and costs of fishery products, have a powerful influence on the choice of fishery management policies. The presence of shortsightedness and de-coupled costs and benefits works against adoption of effective conservation policies. The structure of the fishery management system tends to disfavour effective conservation policies because they concentrate short-term costs upon resource users in exchange for benefits in the future that would not necessarily accrue to those users who make the sacrifice.

[102] There are many examples in which the political marketplace favours fishery policies and programmes where benefits are distributed to a few and the costs are borne by taxpayers. Fishery policies and programmes with short-term benefits, and costs to be borne in the future are also favoured. The political marketplace disfavours policies and programmes for which costs are concentrated on a few and benefits accrue to many; and policies and programmes with short-term costs in exchange for future benefits. The fishery political marketplace can be expected to produce effective conservation policies only when those who sacrifice in the present can expect to receive benefits in the future.

Challenges of ecosystem-based fisheries management

[103] As FAO describes, as management expands its focus from target stock to ecosystem, all of these problems increase in an exponential way and biological uncertainty becomes ecological uncertainty, which is even more complex. The number of competing users increases, as do the resulting conflicts of interest. Objectives become more complex and conflicting, and the number of stakeholders is expanded to include all the users of all the different ecosystem components. Of

course, this expanding complexity is a result of recognizing the reality of the inter-dependence of all ecosystem components, instead of the false assumption that stocks are independent.

[104] Our model of the fishery political marketplace strongly supports this observation by FAO. We have developed the model in the context of a single fishery, or a simple set of fisheries, and conclude that the governance dynamics tend to be biased against conservation of the fishery resources and the generation of long-term sustainable economic benefits.

[105] Ecosystem-based management of fisheries will tend, we believe, to increase the chances of governance failure. The unfortunate implication is that attempts to implement ecosystem-based management programmes may actually slow progress towards achieving a future of sustainable fisheries.

Summary and conclusions

[106] We have outlined a model of fishery management policy-making. Fishery management policies are the products of a political marketplace. The principal actors that interact in the fishery political marketplace are fishermen, environmental advocates, politicians and officials of government agencies. Some of these groups demand and others supply fishery policies and programmes. We conclude that this politico-economic marketplace is biased against conservation, and recommend reforms to counter this bias.

[107] Our current fisheries governance system requires fundamental reforms in order to put this simple principle into practice. What are some of these reforms?

[108] One obvious way to avoid government failure is to privatize the fishery resource. Privatization of government-owned and operated industries has been carried out in several countries for several industries, including railroads, utilities, communications and energy industries. Complete privatization of fisheries is rare. However, there is a recent trend to devolve more management responsibility down to users, in effect privatizing many management functions. See OECD (1997) for descriptions and analysis of some co-managed fisheries.

[109] We use the term ‘self-governance’ to describe a fishery in which users of the resource, without the participation of government, take all of the principal management decisions. If all external effects can be internalized by self-governance (and there are no other conditions that cause market failure), a fishery has the potential to operate efficiently. While today there is a trend towards co-management, we see no pronounced trend towards self-governance of fisheries. Numerous obstacles lie in the way of privatizing a fishery and complete self-governance may not be desirable from an efficiency perspective.

[110] A partial step towards self-governance would be to devolve to users and others with strong interests in a fishery a greater share in the rights and responsibilities of setting management policies and bearing the full consequences of those policies. This would more strongly couple the future benefits with the current sacrifices needed for effective conservation. In other words, users should be assured of reaping the benefits in proportion to their sacrifices. Such action would better harmonize the interests of users and managers with the nation’s interest.

[111] Another reform is to implement the principle of beneficiaries paying in proportion to the benefits they receive. In our current system, too many policies and programmes provide benefits for a select few and impose widespread costs. The costs of fishery management need to be recovered from the beneficiaries of that management. This would mean collecting fees from users of fishery resources. Properly designed and implemented, cost-recovery can have sizeable beneficial effects on the performance of fishery management by minimizing the opportunities for the political marketplace to produce fishery products with de-coupled costs and benefits.

[112] Cost recovery in fisheries appears to be spreading. Australia collects 100% of the attributable costs associated with management and research through levies. In 1996-97, this policy resulted in US$ 10 million being recovered to cover management costs and US$ 11 million

for research and development costs. Canada recovered user fees for the management of its fisheries. In 1997, US$ 38 million was recovered from commercial fishers. It included licence fees for access to the fishery. In addition, fisheries are expected to cover the costs of dockside monitoring and observers at sea. New Zealand recovers costs associated with fisheries management services and conservation services carried out for the benefit of the commercial sector. The principle used for the cost recovery is that costs incurred by the government as a result of the existence of the commercial fishing industry should be recovered from the commercial sector. In 1997, this policy resulted in the recovery of US$ 23 million – a 9% increase over the previous year. Iceland recovered US$ 1.8 million from ITQ owners to cover the costs of managing ITQ regulations. Even the USA has recently begun developing a cost recovery programme for its IFQ fisheries.

[113] Lastly, fishery managers need to be protected from the shortsighted tendencies of elected representatives. Political interference is common in fishery management throughout the world. A mechanism must be found that is both consistent with democratic principles and that allows political involvement in fishery management only at the strategic level. Elected officials need to leave to the designated management institutions the day-to-day responsibility for developing and implementing fishery management plans.

SOURCES USED

Acheson 1994

Andersen, P., Sutinen, J., & Cochran, K. 1998. Paying for fishery management: economic implications of alternative methods for financing management. p.439-454, *in:* Proceeding of the IXth Conference of the International Institute of Fishery Economics and Trade. Tromso, Norway.

Buchanan, J.M. 1980. Rent-seeking under external diseconomies. *In*: J.M. Buchanan, R.D. Tollinson and G. Tullock (eds). *Toward a Theory of the Rent-Seeking Society.* College Station: Texas A&M Press.

Buchanan, J., & Tullock, G. 1962. *The Calculus of Consent.* Ann Arbor: University of Michigan Press.

Caton, A., & McLoughlin, K. (eds). 2000. Fishery Status Reports 1999: Resource Assessments of Australian Commonwealth Fisheries. Bureau of Rural Sciences, Canberra, Australia.

Creed & McKay 1996

DFO [Department of Fisheries and Oceans]. 2000. DFO Science Stock Status Reports 2000. Canadian Stock Assessment Secretariat, Ottawa, Ontario.

—— 2001. Marine Protected Areas. Oceans Canada, Ottawa, Ontario.

Dinneford, E., Iverson, K., Muse, B., & Schelle, K. 1999a. Changes under Alaska's Halibut IFQ program, 1995 to 1998. Alaska Department of Fish and Game, Juneau, Alaska.

—— 1999b. Changes under Alaska's Sablefish IFQ program, 1995 to 1998. Alaska Department of Fish and Game, Juneau, Alaska.

FAO [Food and Agriculture Organization of the United Nations]. 1999. *The State of World Fisheries and Aquaculture 1998.*

Hatcher, A., & Robinson, K. (eds). 1999. *The Definition and Allocation of Use rights in European Fisheries*. Centre for the Economics and Management of Aquatic Resources (CEMARE). University of Portsmouth, UK.

Henessey 1997

Hiatt, T., & Terry, J. 2000. Stock assessment and fishery evaluation report for the groundfish fisheries of the Gulf of Alaska and the Bering Sea/Aleutian Island area: Economic status of the groundfish fisheries off Alaska, 1999. National Marine Fisheries Service (NMFS). Seattle, WA.

Horwood, J.W., Nichols, J.H., & Milligan, S. 1998. Evaluations of closed areas for fish stock conservation. *Journal of Applied Ecology,* **35**: 893-903.

IUCN [International Union for the Conservation of Nature and Natural Resources]. 1994. Guidelines for protected area management categories. Gland, Switzerland, and Cambridge, U.K: IUCN.

Lee, D. (ed). 1999. United Kingdom Sea Fisheries Statistics 1998. Ministry of Agriculture, Fisheries and Food (MAFF). London: HMSO.

McClanahan, T.R., & Kaunda-Arara, B. 1996. Fishery recovery in a coral-reef marine park and its effect on the adjacent fishery. *Conservation Biology,* **10**(4): 1187-1199

NOAA [National Oceanic and Atmospheric Administration]. 1999. Our Living Oceans: report on the Status of U.S. Living marine Resources, 1999. NOAA Technical Memorandum NMFS-F/SPO-41. National Oceanic and Atmospheric Administration, Silver Spring, MD.

Niskanen, W. 1971. *Bureaucracy and Representative Government.* Chicago, IL: Aldine Press.

NPFMC [North Pacific Fishery Management Council]. 2001. Joint Report of the Pollock Conservation Cooperative and High Seas Catchers Cooperative, 2000. Anchorage, Alaska.

NRC [National Research Council]. 1999. The Community Development Quota Program in Alaska. Washington, DC: National Academy Press.

—— 2001. Marine Protected Areas: Tools for Sustaining Ocean Ecosystems. Washington, DC: National Academy Press.

OECD [Organisation for Economic Co-operation and Development]. 2000. Review of Fisheries in OECD Countries. Volume I: Policies and Summary Statistics. Volume II: Country Statistics. Paris: OECD.

—— 1997. Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources. Paris: OECD.

Olson, M. 1964. *The logic of Collective Action.* Cambridge MA: Harvard University Press.

Russ, G.R., & Alcala, A.C. 1996. Marine reserves: Rates and patterns of recovery and decline of large predatory fish. *Ecological Applications,* **6**(3): 947-961.

Sherma *et al*. 1988

Sigurjónsson, J. (ed). 2000. *State of Marine Stocks in Icelandic Waters 1999/2000. Prospects for the Quota year 2000/2001. Marine Research Institute Report,* No.75. Reykjavik, Iceland.

Sutinen 1999

Sutinen, J.G. 2000. *A Framework for Monitoring and Assessing Socioeconomics and Governance of Large Marine Ecosystems*. NOAA Technical Memorandum NMFS-NE-158. Northeast Fisheries Science Center, Woods Hole, MA.

Sutinen, J.G., & Upton, H.F. 2000. Economic perspectives on New England fisheries management, *Northeast Naturalist,* **7**(4): 361-372.

Wolf, C. Jr. 1988. *Markets or Governments: Choosing between Imperfect Alternatives*. Cambridge, MA: MIT Press.

World Bank 1995