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Case studies in fisheries self-governance

Cover photo:
Sambro, Halifax County, Nova Scotia: A settlement typical of those involved in the Community Quota Management Programme, Scotia-Fundy Region, Canada. Courtesy of R. Shotton.

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Preparation of this document

The origin of this Fisheries Technical Paper lies in the presentations to a conference on fisheries self-governance held in Anchorage, Alaska, United States of America, in 2003. The papers selected from that conference have been expanded to provide a greater geographical coverage and updated report on the successes of industry involvement in management. Funding for authors' contracts and publication of this paper has been provided by the FAO FishCode Programme, Fisheries and Aquaculture Department, Rome. Support in kind through the editing services for Ralph Townsend was provided by the University of Maine and the Ministry of Fisheries, New Zealand and by the Fisheries Management and Conservation Service, Fisheries and Aquaculture Department, FAO, Rome for the services of Ross Shotton. This is the fourth set of case studies in this series.[1]

[1] The preceding volumes are:
1999. Case Studies on the Management of Elasmobranch Fisheries. *FAO Fisheries Technical Paper.* No. 378. 920p.
2001. Case studies on the allocation of transferable quota rights in fisheries. *FAO Fisheries Technical Paper.* No. 411. Rome, FAO. 373p.
2001. Case studies on the effects of transferable fishing rights on fleet capacity and concentration of quota ownership. *FAO Fisheries Technical Paper.* No. 412. Rome, FAO. 238p.

Abstract

This FAO Fisheries Technical Paper documents 32 case studies and four syntheses (Canada, Japan, New Zealand and the United States of America) on the role of industry in the governance and management of fisheries. The studies are drawn from ongoing practice in Europe, North America, Japan and Australasia. The types of fisheries cover those for crustaceans, fish, molluscs and echinoderms. In general the scale of the fisheries tends to be small, which has been one of the reasons attributed to their success. In all but one case it is clear that well-defined fishery rights have contributed to the success of the programmes though the initiative for development and adoption of the programmes covers a range of institutional causes. The case studies are intended to inform and provide potential models that may be used in other fisheries.

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Foreword

Fisheries, in recent decades, have seen several developments acting in parallel, if not always in phase. Rising demand for fish products, especially since the mid-1980s, a consequence of the new found market popularity of fish as a menu item and the rising ability of consumers to pay for fish in premium conditions have stressed the ability of traditional management approaches to ensure the sustained productivity of many fisheries. Attempts to address these problems through subsidizing the costs of production and refined forms of traditional management approaches have been commonly unsuccessful, indeed, where attempts failed to create effective fisheries management, fisheries became progressively overfished creating less and less wealth, if any at all. Indeed, there exists a cadre of workers in the field of fisheries management, well funded by their sponsors, who predict the future extirpation of major fisheries but have been less helpful in identifying effective proposals for the solution to these problems.

I expect and hope that readers of this volume will be well informed about this sad though well known story. The objective of this volume is to document a number of fisheries management situations from a wide range of geographical situations and types of fisheries where, through the involvement of the industry members themselves, under-performing fishery and management failures have been transformed into sustainable wealth-creating social and economic activities. The reader must refer to the respective chapters themselves to gain insight into how this has been done and make their own assessment of the merit of the different situations. However, Townsend and Shotton (Chapter 1) have provided at least a first-order analysis of the characteristics that mark these success stories and the lessons that the enquiring and progressive fisheries administrator might profitably use.

This is not the first volume to document recent successes to be found in fisheries management – see e.g., Cunningham and Bostock (2007) and McClanahan and Castilla (2007) [1]. Both publications provide descriptions of recent successful stories of fisheries management. However, this is a story that still requires repeating and the Fisheries and Aquaculture Department of FAO, with funding provided by the Norwegian Government though the FishCode programme, is happy and proud to be able to provide descriptions of these interesting management situations.

No doubt different readers will have their own choices as to which particular fisheries study best illustrates the success of its managers – I myself have my own, though I believe it would be unfair to the reader to pre-empt the pleasure and challenge that will be provided by a careful reading of the respective studies.

To the authors, FAO offers its congratulations. If the lessons that are provided in the volume are even partially adopted, then the goal of improved governance of fisheries, our objectives, will have been achieved. Thanks are also given to Ms Marie-Thérèse Magnan, Fisheries Management and Conservation Service, Fisheries and Aquaculture Department, FAO for her persistence and diligence in editing papers and proofs once again.

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[1] Cunningham, S. & T. Bostock (eds) 2007. *Successful fisheries management: issues, case studies, perspectives.* Eburon. 240pp.
McClanahan, T. & J.C. Castilla (eds) 2007. *Fisheries management. Progress toward sustainability*. Blackwell Publishers. 344pp.

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Fisheries self-governance: new directions in fisheries management

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1. INTRODUCTION

This volume brings together 32 case studies of industry self-governance of their fisheries. These cases occur within the context of very different national governance structures for fisheries, types of fisheries and geographical areas. That self-governance has appeared widely across the world suggests some powerful common underlying forces. We hope that presenting these experiences in a single volume will increase the visibility of this important (and perhaps under-appreciated) institutional option for fisheries management and assist in identifying what these forces are.

The widespread emergence of self-governance raises interesting and important questions. Most of the self-governance cases in this volume are of relatively recent development. Have there been policy or institutional changes that have enabled or empowered industry self-governance on this global basis? Although this volume describes some remarkable successes of self-governance, self-governance has emerged in relatively few of the world's fisheries. Are there factors that are limiting the development of fisheries self-governance? If governments wish to promote self-governance, what steps might they take? We hope that this volume will prompt fisheries managers and researchers to explore why governance of the fisheries described here has been so successful and what are the institutional characteristics that have enabled it to happen.

2. DEFINING SELF-GOVERNANCE

The institutions that we call "self-governance" here are often subsumed within the broader category of "co-management". The term "co-management" has been used to describe essentially any governance alternative to centralized command-and-control regulation. We distinguish self-governance here as the delegation of important aspects of management decision-making responsibility to the domain of fishing industry participants: i.e. self-governance is about the fishery participants themselves making governance decisions. The relevant economic concept is that the fishing industry has incentives to increase the value derived from the resource. The objective of self-governance is to empower the industry to operationalize these incentives.

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This definition of self-governance excludes a variety of institutions that are often considered co-management. Notably, self-governance is more than a consultative process, however well-developed. And while reliance on private decision-making is accommodated within the most common definitions of co-management, the focus of co-management is more commonly on creating new governance institutions, especially at the community-level. Self-governance uses existing or new private institutions, rather than creating new political or government institutions or delegating authority to existing lower levels of government. Co-management is often positioned as an alternative to rights-based management such as individual transferable quotas (ITQs). Self-governance, in contrast, expands upon rights-based management by increasing the scope of decisions that are assumed by industry.

Various fishing industries, in embracing self-governance, have assumed *de jure* or *de facto* control of many fisheries management functions that are traditionally the domain of government. The case studies documented here describe situations where the industry: determines seasons; manages closed areas and marine protected areas; administers catch monitoring programmes; fixes daily and seasonal catch limits; rotates fleets; manages research; imposes penalties for violation of rules; implements individual quotas/individual transferable quotas; rationalizes fleets; manages product quality; and manages competing demands for the resource between commercial and non-commercial users – an astonishing range of activities reflecting laudable self-responsibility.

3. AN OVERVIEW OF THE CASES

3.1 National context of self-governance

Self-governance of fisheries occurs within the context of legal, political, economic and cultural institutions that shape the opportunities for such self-governance. Consequently, self-governance of fisheries often has characteristics that are particular to a country. The cases described here are therefore organized by country or region, with introductory chapters for four of these countries (New Zealand, Canada, the United States of America and Japan).

3.2 New Zealand

New Zealand's path-breaking commitment to a comprehensive ITQ programme under its Quota Management System (QMS) is widely known. Perhaps less well known is that New Zealand has also made significant steps in the devolution of management responsibilities to the fishing industry. Administration of the day-to-day accounting for the QMS is now provided by an industry-owned company, **FishServe**, under a combination of devolved responsibility for some functions to industry and contracted provision of other administrative services on behalf of the Ministry of Fisheries (Harte[2]). Scientific research is provided through contestable tender and the responsibility to provide research is devolved to some industry groups.

In the 1990s, New Zealand actively promoted the devolution of responsibility for management services to industry, even though the industry interest in assuming greater responsibility was initially limited. The Orange Roughy Management Company (recently merged into the Deepwater Group) was among the first to develop cooperation among its members, not least prompted by a new industry facing the large costs of developing a new national offshore deepwater fishery. This cooperation has led to management of several sub-quotas within quota management areas (QMAs) to prevent localised depletion (Clement, Wells and Gallagher). The Orange Roughy Management Company has also become active in developing research, including deepwater acoustic surveys and their design, due in part to industry dissatisfaction with the results of traditional stock assessment methods. The Challenger Scallop Enhancement Company

[2] Author citations without dates here are to chapters in this volume.

has made the most comprehensive efforts to embrace self-management (Mincher). This effort was motivated by an opportunity to enhance scallop recruitment by seeding and to optimize catches by spatial rotation of harvesting. Although initial suspicions regarding rights-based management meant that crayfish fisheries joined the QMS after it had become established, various crayfish management organizations (CRAMACs) have now become deeply involved in the delivery of research and management advice (Yandle). There were also limited efforts to self-managed aspects of crayfish management, including one case of voluntary quota-shelving by the industry. Deep-sea crab quota was recently sold by tender, and the winning bidders have joined together in **Crabco** to undertake both the research needed to underpin the fishery and also its future exploitation (Soboil and Craig). The unitisation of the deep-sea crab quota holders into **Crabco** is a path-breaking implementation of Scott's (1955) sole owner concept. A similar company, **Surfco**, has been created for exploitation of part of New Zealand's surf clam resources. While not described in this volume, a number of other industry organizations in New Zealand have undertaken self-governance initiatives, including those for hoki, squid, paua (abalone) and Foveaux Strait oysters.

The high level of government interest in devolution of management responsibilities prior to 2000 has since shifted towards a more traditional government-led co-management approach (Harte). And, cost recovery, an explicit national policy, remains a contentious issue. But the industry role in QMS administration through **FishServe**, by itself, places New Zealand in a unique position of fisheries self-governance, and the ongoing **Crabco** and **Surfco** initiatives are potentially revolutionary developments in fisheries governance.

3.3 Canada

Canada has been innovative and flexible in its implementation of approaches to fisheries self-governance. The Canadian system is officially "co-management" and industry groups are generally careful to use that term rather than self-governance. Under this co-management regime, Canada often devolved substantial authority to industry via contractual joint project agreements (JPAs).

The cases in this volume reflect the diversity of the Canadian approach to co-management/self-governance. For British Columbia geoduck, the Underwater Harvesters Association is broadly responsible under a JPA for implementing an ITQ programme, finances most research, monitors biotoxins, manages marketing and has recently moved to re-seed its stocks (James). A similar administrative programme by industry has been established for red sea urchins (Featherstone and Rogers). Remarkably, the group of 100 red sea urchin harvesters negotiated and implemented a voluntary individual quota programme for two years when government had been reluctant to impose the programme. After government approved a formal ITQ programme, the Pacific Urchin Harvesters Association remained responsible for administrative of the landings validation programme. In British Columbia sablefish, an individual vessel quota (IVQ) programme initially propelled an industry-run dockside monitoring programme (Sporer). Subsequently, the Canadian Sablefish Association has expanded its responsibilities to include contracting for at-sea monitoring, biological sampling, logbook management and stock assessment.

In the Nova Scotia sea urchin fishery, the government allocated individual areas for harvesters to self-manage (Miller). In the complicated inshore groundfish industry, the Department of Fisheries and Oceans (DFO) required inshore harvesters to form "community" associations to manage total allowable catch (TAC) allocations (Peacock and Annand). The form of those associations was left to the participants to determine and the nature of the organizations has varied widely. At least one of these organizations uses an informal ITQ arrangement. In the Nova Scotia snow-crab fishery, the DFO introduced an innovate approach to allow the benefits of an expanding fishery to be widely shared without creating overcapitalisation. In issuing new permits, the DFO required that new entrants join in groups of 10 to 20 'qualifiers' as companies that would exercise the newly allocated fishing rights (Peacock and Eagles). In the Atlantic scallop industry, the DFO has allowed a well-organized industry to lead the direction of both research and management (Stevens *et al.)*. This scallop industry has a successful voluntary programme to maximize yield per recruit. The industry has recently invested heavily in sonar mapping of the entire fishery habitat area to provide the seven companies with information to significantly reduce fishing costs. The scallop industry is deeply involved in research design to the point that the industry has funded "succession planning" in anticipation of retirement of the DFO scientist responsible for scallop research. Examples of fisheries self-governance in Canada that are not represented in this volume include the Bay of Fundy herring (Stephenson and Lane, 1993), Cape Breton Area 19 crab (Loucks, 2005), and Pacific groundfish (Turris, 2000). Blewett (2002) provides a comprehensive listing of fisheries co-management initiatives in British Columbia, some of which have aspects of self-governance.

Government and industry in Canada have developed a generally pragmatic, and thus adaptive, approach to co-management/self-governance. Greater industry responsibility is typically developed incrementally, as government gains confidence in the capacity of individual industry groups. The Government has not insisted upon a "one size fits all" approach to self-governance, but rather has supported implementation of different approaches that individual industries support. The Government has allowed industry to demonstrate the feasibility of management options as in the implementation of ITQs for geoducks on the condition that industry develops an effective monitoring programme (James).

The efforts by the DFO to help (or even to force) industry to overcome barriers to self-management have been especially notable. Government apparently has an informal rule that if two-thirds of an industry supports a co-management approach, they will support the efforts of that majority (Wilson). JPAs have used a number of interesting devices to encourage cooperation. For example, the DFO has required the use of association-provided monitoring and reporting mechanisms in both geoducks (James) and red urchins (Featherstone and Rogers). The DFO has allocated part of the TAC to industry associations as "use of fish" allocations to support industry research in several Pacific fisheries, including sablefish, groundfish and halibut (Blewett, 2002). The result is often that harvesters must join the relevant association (and hence pay dues) to participate in the industry, though some of practices have been subjected to court challenge, and government may face future restrictions on its activities in this area. In Atlantic Canada, the DFO has forced the creation of governance organizations in groundfish (Peacock and Annand) and snow crabs (Peacock and Eagles).

Canada has implemented cost recovery throughout its fisheries. All harvesters are required to purchase third-party dockside monitoring services. Other services may be funded through direct industry provision or by government levies. Exactly what costs are recovered varies across fisheries and is arguably arbitrary (Wilson). Canada also uses its licence fees to extract rents from the fisheries. Licence fees are based on 3 percent of landed value in less valuable fisheries and 5 percent of landed value in more valuable fisheries.

Canada can exercise flexibility in co-management in part because the Minister with responsibility for fisheries has wide discretion (often described as "absolute discretion") to manage fisheries. The DFO has used this power to implement the range of management approaches described in this volume. But this absolute discretion has brought an inherent limitation to the evolution of fisheries governance. While almost all Canadian fisheries have limited entry and many fisheries have individual quotas, these programmes do not create permanent rights. Any future Minister can revoke existing use rights or issue more rights to new users. It is a common theme in industry discussions that this impermanence of rights needs to be addressed (see Wilson, James, and Featherstone and Rogers).

The challenges of managing the Pacific salmon fisheries and the Atlantic groundfish stocks are widely known, and these difficulties may overshadow the remarkable successes of co-management/self-governance in Canada. The significant economic benefits achieved in the British Columbia geoduck fishery and the Atlantic scallop fishery, in particular, offer unequivocal evidence of the potential for self-governance to increase economic rents—even in fisheries that already have IQs.

3.4 Australia

The three case studies presented for Australia arise in State fisheries. In the Queensland stout whiting fishery, the five permit holders implemented a voluntary TAC in conjunction with government (Thwaites and Andersen). In the western king prawn fishery in Spencer Gulf of South Australia, the Prawn Fishery Management Committee designs a system of spatial and seasonal closures that target larger, more valuable prawns and increases catch per unit effort (Zacharin, Dixon and Smallridge.) A "Committee at Sea", in a remarkable display of industry responsibility, manages the fishing activities of the 39 vessels to implement this plan. In the Exmouth Gulf prawn fishery of Western Australia, where one company owns 15 of the 16 permits, the industry association works with the Department of Fisheries to implement seasonal, spatial and time-of-day fishing closures to achieve both biological and economic objectives (Kangas *et al.*). Economic objectives include reducing harvest costs and increasing the average size (and hence value) of prawns. A similar programme, but with more limited self-governance, operates in the Shark Bay prawn fishery of Western Australia (Kangas *et al.*)

These self-governance experiences reflect the broader Australian approach to fisheries management. Industry and government have often successfully developed collaborative approaches based upon input controls whereas elsewhere in the world, input controls often fall into a downward regulatory spiral where government regulates some inputs, industry innovates to counter the regulations, government imposes more onerous input regulations, and so on. With industry involved in the design and implementation of input controls, Australian managers have achieved some remarkable successes with this approach. For fisheries such as prawns, input controls may have advantages over output (quota) systems. In prawn fisheries, annual recruitment is often highly variable, difficult to estimate in advance of the fishing season and may be only weakly correlated with spawning stocks. Economic efficiency may require adaptive management to minimize harvest costs and to maximize yield per recruit. Larger prawns often command substantial premiums, so the return to efficient seasonal management may be large. This has been a common objective of both prawn fisheries described in this volume.

3.5 United States

In the United States, self-governance has emerged in both state and federally managed fisheries. Self-governance is often organized via cooperatives, because fisheries cooperatives enjoy limited antitrust exemptions. However, these cooperatives should not be confused with more traditional cooperatives: they are usually single-purpose fishery management organizations. With the exception of the Chignik salmon cooperative, none of the US cooperatives described here provide the traditional functions of supplying inputs, processing and marketing.

In US federal fisheries, several cases of self-governance were organized to achieve ITQ-like management during the ban on new ITQ programmes during 1996–2002 and within the context of general scepticism about the potential benefits of ITQs in US fisheries. Here, the efforts at self-governance activity by industry are largely to achieve the fisheries management results that have been delivered by governments in many other countries.

Much of the US self-governance is in the Pacific – and in Alaska in particular – the most fisheries-dependent American state. The Pacific whiting cooperative divided the quota for catcher-processors among four firms (Sylvia, Munro Mann and Pugmire). The Pacific whiting cooperative was the first of the west coast cooperatives and provided the model for most subsequent Alaskan cooperatives. Efforts to create a similar cooperative for the Alaska pollock catcher-processor fleet were initially stymied by decisions by the North Pacific Fishery Management Council. Authorisation terms for Alaska pollock cooperatives were subsequently specified in the *American Fisheries Act* (Wilen and Richardson). The pollock cooperatives essentially negotiated individual transferable allocations in each of four separate sectors of the fleet (catch-processors and three catching sectors that delivered to onshore processors, to catcher-processors and to motherships.) For both the Pacific whiting and the Alaskan pollock cooperatives, much of the benefit of self-governance came in the form of getting greater value from landings as fishing slowed under individual allocations. Product recovery increased from 17 to 24 percent in the Pacific whiting catcher-processor fleet and from 19 to 30 percent in the Alaskan pollock catcher-processor fleet. This result is consistent with the argument of Homans and Wilen (2005) that increasing catch value may be at least as important as reducing costs as fisheries are rationalized. The weathervane scallop cooperative established individual transferable allocations in a fishery that is managed under a joint state-federal regime (Brawn and Scheirer.) In an interesting innovation, the scallop cooperative allocated the crab bycatch (which is entirely discarded but can result in closure of the fishery when bycatch limits are exceeded) as well as the target scallop species. The result was a dramatic reduction in the ratio of bycatch to target catch.

The Chignik salmon cooperative was an interesting effort to respond to declining salmon prices by reducing the fishing costs through coordinated fishing (Knapp). The Alaska Board of Fisheries established an allocation that divided the fishery between a cooperative with about 80 percent of the harvesters and an open access fishery for the 20 percent who declined to join the cooperative. This allocation of a share of a fishery to a self-governance organization may provide an important model for other governments trying to promote or to allow self-governance in fisheries that cannot achieve unanimous agreement. Ultimately, in what many believe to have been a backward step, a state court declared the Chignik cooperative illegal.

In the United States, there are also small-scale, informal, almost hidden examples of fisheries self-governance. Given the common US antipathy towards ITQs, industries may have good reason to be quiet about their cooperative management efforts. Further, the informality of these regimes is also a way to reduce transactions costs. The Yaquina Bay roe herring fishery is a small state fishery with only ten permits (Leal.) The permit holders negotiated an equal sharing of the TAC, which reduced fishing costs and allowed the fleet to increase product quality by fishing when roe content was optimal. Nine of the permit holders formed a non-profit corporation to buy out the tenth permit. The agreement also allows the members to coordinate their fishing in this short, but highly valuable, fishery with other fishing activities. In a similar manner, one sector of the federal tilefish fleet, based in Montauk, New York, negotiated an agreement among its four members to share the sector TAC (Rountree, Kitts and Pinto da Silva.) The agreement reduced costs, increased quality and coordinated delivery of a steady stream of product to the market to maximize value. Another example of a small, albeit short-lived, self-governance agreement arose in the Northwestern Hawaiian Islands lobster fishery (Townsend, Pooley and Clarke, 2003). These small self-governance cases raise the interesting possibility that there may be other cases of "niche" self-governance in the United States (and perhaps elsewhere) that are largely hidden.

3.6 Japan

A number of previous studies have discussed the important role of local fishery cooperative associations (FCAs) in fisheries management in Japan (e.g, Asada, Hirasawa and Nagasaki, 1983; Ruddle, 1987; and Makino and Matsuda, 2005.). As Uchida and Makino explain, management is implemented by fisheries management organizations (FMOs), most of which are derivative of FCAs. The FCAs are allocated collective fishing rights, often in the form of territorial use rights. While these rights are nominally bestowed by prefectural or national governments, they have long historical roots. An FCA may itself function as an FMO; multiple FCAs may be represented in an FMO for stocks that span multiple FCAs; or a sub-group of harvesters within an FCA may form an FMO to manage a specific fishery under the jurisdiction of the FCA.

The 13 FCAs in the Ise Bay sandeel industry use a combination of seasonal closures and variable marine protected areas to insure adequate spawning stocks (Tomiyama, Komatsu and Makino). The process to determine the season opening date considers how the size of harvested sandeels will affect price. The sakuraebi (shrimp) fishery in Suruga Bay is managed by two FCAs (Uchida and Baba). A “Fishing Committee” coordinates the fishing activities of all 60 licence holders. Revenues from fishing are shared among all harvesters from the same port. The primary effect of the coordination is to maximize the value of landings. In the sandfish fishery of Akita Prefecture, the Akita Federation of FCAs implemented a three-year fishing moratorium to rebuild stocks (Suenaga). During the moratorium, the prefecture government bought back licences. After the moratorium, the representative organization agreed to a government-set TAC that is divided among twelve FCAs, which manage the allocated TACs. Eight FCAs allow competitive fishing of the allocated quota, three FCAs use non-transferable individual quotas and one FCA fishes its quota collectively. In the walleye pollack fishery in the Hiyama region, fishing of the grounds is rotated to avoid vessel congestion (Uchida and Watanobe). Within the Nishi section of the Hiyama region, a system of pooling revenues is used to further increase incentives to cooperate to reduce costs and thus increase profits.

The Kyoto Bottom Trawlers Union implemented permanent marine protected areas to rebuild snow crab stocks (Makino). Seasonal closed areas are used to reduce bycatch of snow crabs in the brown-sole trawl fishery. Mesh size of trawls were increased and crab exclusion devices were added; minimum sizes were increased for soft-shelled crabs. These changes resulted in a five-fold increase in catch per unit effort and an eight-fold increase in economic yield per unit effort.

There are 1 600 FMOs in Japan, so these five cases can hardly represent the full range of experience. But the cases in this volume show that cooperatives continue to evolve. Both the national and prefectural governments have shown interest in encouraging these cooperatives to develop into more capable fisheries management institutions. This requires careful intervention by government to avoid local harvesters rejecting central government directives as initially happened in the case of sandfish (Suenaga). These case studies also show a concerted effort to deliver more useful and understandable science to FCAs. Scientific studies were important in designing the seasonal closures in the Ise Bay sandeel fishery (Tomiyama, Komatsu and Makino), the marine protected areas in the Kyoto snow crab fishery (Makino) and the stock rebuilding closure in the sandfish fishery (Suenaga).

The Japanese cooperatives often function to reduce short-run costs of harvesting and to coordinate deliveries in order to improve prices. The latter function at times includes some exercice of market power over prices. The cooperatives have been much less active in reducing overcapitalisation within their sectors. As Uchida and Makino suggest for the sakuraebi fishery, the system may function to maximize short-run profits under a constraint that the number of harvesters is fixed. While governments sometimes engage in licence buy-backs to reduce effort, the FMOs covered in this volume do not have strategies to match fishing effort to the stock.

3.7 Europe

The European Union (EU) has struggled to define a Common Fisheries Policy that balances the principles of equal treatment of fleets in all EU waters with the need to restrict fishing activity to achieve management goals. In several countries, producer organizations (POs) have emerged as institutions able to coordinate the competing demands of management and allocation. Two of the European cases in this volume involve producer organizations that have developed such programmes.

In the Spanish fleet that harvests in the Celtic Sea, seven producer organizations are each allocated a portion of the national TAC (Garza-Gil and Varela-Lafuente). These producer organizations then allocate harvesting rights to individual vessels, which can reallocate the rights among themselves. The result is essentially a PO-run individual quota programme.

In the Shetland Islands, the industry and the local community used two strategies to maintain local control of its whitefish industry (Anderson). In 1993, the Shetlands Fish Producer Organization (SFPO) purchased vessels to acquire 2 386 tonnes of landings history (fixed quota allocations, or FQAs) for use by its members. Because this vessel history was available only to vessels within the SFPO, any ‘quota history’ sold outside the Shetlands lost its access to this purchased history. As the quota history was more valuable in the Shetlands, a strong incentive was created to keep quota in the Shetlands. In 1998 and 1999, the Shetlands Islands Council financed the purchase of an additional 4445 tonnes of ‘catch history’ to insure that the quota remained within the Shetlands. That quota was to be used in part to assist new Shetlands entrants into fishing. The European Commission has since ruled that the catch history purchased with assistance from the Shetlands Islands Council violates EU rules about subsidies, although the original SFPO purchases did not. Alas, this decision strikes down an innovative effort to use market-based tools to pursue local social objectives.

A fleet of vessels from Denmark, Norway and Sweden have traditionally harvested Matjes herring under a set of voluntary rules established by the Danish “Matjes Committee” during 1992–1997 (Raakjær and Olesen) and the Norwegian and Swedish harvester organizations voluntarily agreed to the rules imposed by the Committee. The purpose of this coordination was to maximize landed product quality and hence price. When external factors caused the Danish industry to largely withdraw from the fishery, the voluntary coordination ended. This in one of the few failures of industry self-governance and the lessons it offers are salutary.

Six vessels were granted permits to fish in the shrimp fishery in Gullmar Fjord of Sweden for 2004–2006 (Eggert and Ulmestrand). Because this area is a marine reserve, the number of total fishing vessel-days is restricted to 100, which are shared equally among the vessels. The vessels also agreed to a larger mesh size to increase the average size of shrimp harvested and so allow the six vessels to earn higher prices both because they could fish later in the season when prices where higher and because larger shrimp bring a price premium.

In the French Bay of Brest scallop fishery, harvesters formed a cooperative to manage a juvenile seeding and spatial rotation programme (Alban and Boncoeur). Financing of this programme was changed from a public subsidy to licence fees in 2001. When higher licence fees were implemented, harvesters were allocated individual catch quotas.

3.8 Chile and Mexico

Here, self-governance has usually arisen within a restricted pool of resource users. Under past open-access practices, any benefits of self-governance were rapidly eroded by unrestricted entry. In this context, the governments of developing countries face an especially difficult task in trying to limit access to fisheries. Often, high unemployment makes limiting access politically difficult, if not impossible – despite the counter-productive consequences. Even if a government formally limits access, its ability to enforce those limits may be weak or non-existent. For these reasons, devolved governance in developing countries often takes the form of local co-management with significant community involvement. But, the two cases in Mexico and Chile indicate that the institutional framework for self-governance is emerging in at least some developing countries. Moreover, limited access and self-governance seem to mutually reinforcing institutions in these cases.

In the Punta Allen lobster fishery, cooperatives manage exclusive fishing concessions (Sosa-Cordero, Liceaga-Correa and Seijo). The cooperatives partition these areas into individual "campos" or marine plots. Harvesters erect and maintain artificial habitats ("casitas") that are used to harvest lobsters. The effect is to create individual territorial use rights within a higher-level system of territorial rights allocated to cooperatives.

Since 1992, exclusive harvest rights for benthic resources in Chile can be allocated to artisanal fishing associations as Management and Exploitation Areas for Benthic Resources (MEABRs). Management of the loco (abalone) fishery, which was closed between 1989 and 1992 due to overharvesting, was a primary objective in establishing the MEABRs (Castilla and Gelcich). The government has made establishment of a benthic resource management plan a precondition for local harvest of benthic resources. This strongly encourages creation of MBEARs. Since implementation of the MEABRs, landings have increased fivefold, average size of harvested loco has increased and catch per unit effort has increased.

4. ECONOMIC THEORY AND FISHERIES SELF-GOVERNANCE

4.1 Limited entry and ITQs

Economists have long been interested in better governance institutions for fisheries (Gordon, 1954; Scott, 1955). This interest led economists to propose first limited entry and later ITQs. It is rather easy to trace the economic analysis of those two institutions but much more difficult to trace the emergence of fisheries self-governance.

Gordon (1954) explained that the divergence between marginal revenue to the harvester and marginal revenue for an industry attracted too much fishing effort. Fishing effort was typically conceived as the number of fishing vessels, so economists proposed limited entry (also called licence limitation) as a solution to the overfishing problem (Sinclair, 1961; Crutchfield and Zellner, 1962). But as eventually learned, simple equating of fishing effort to the number of vessels was problematic. When the fleet size was fixed, incentives were created to increase the fishing power of individual vessels, often known as "capital stuffing". By the late 1980s, economists had documented these practical problems (e.g. Townsend, 1990; Wilen, 1989) and the enthusiasm for limited entry among economists waned, though their popularity with fishery managers remained in areas where they may still represent the first step towards more effective management.

The idea of individual transferable quotas (ITQs) was first identified by Christy (1973) and Moloney and Pearse (1979) provided a more detailed theoretical basis. Because ITQs regulate outputs rather than inputs, the incentives for capital-stuffing are eliminated. ITQ holders have incentives to maximize the net value of fish landed under the quota (through improving catch quality) while being able to reduce fishing costs by having more control over their fishing activity. ITQs remain the pre-eminent policy choice among fisheries economists and where they have been introduced we are unaware of any cases where the policy has been reversed. (The Russian Federation may be the exception, but for institutional reasons that are not related to the policy effectiveness of this form of management.) In fact, economists often present ITQs as 'the solution' to fisheries exploitation, while failing to stress their variety of applications and the 'tool box' nature by which managers can adapt the policy to their particular legal, social, biological and economic circumstances.

4.2 ITQs: regulatory rights versus property rights

ITQs provide for regulation by cap-and-trade and are analogous to cap-and-trade programmes for regulation of pollutants, such as atmospheric sulphur emission trading in the United States. ITQs create regulatory rights to catch a share of the TAC. Their input-control equivalent may determine that number of days of fishing or units of gear permitted in a fishery. By creating regulatory rights, managers (whether of air pollution or fish harvests) create incentives to minimize the cost of complying with the regulated cap. But the economic incentives created by regulatory rights depend on the nature of the regulations. Thus, ITQs create an incentive to maximize the net value of the quota, but do not, e.g., completely eliminate the incentive to high-grade. Nor is the incentive removed to land catch in excess of ones holdings – compliance with the management regime is still required for it to be effective. Interestingly, it is increasingly reported that this is being achieved through peer-pressure on group participants.

Cap-and-trade regulation requires the regulator to define the level of economic activity that is capped. It also must regulate any aspect of asset use that is not captured under the cap-and-trade rule. The fisheries regulator must still set the TAC, a task common to any output controlled fishery or the total amount of effort permitted in the fishery. The environmental regulator must decide what level of pollution to allow and must manage problems such as localised concentration of pollutants. Under cap-and-trade regulation, the regulator retains ownership of all characteristics of the asset except the individually-allocated cap.

Property rights are more complete than regulatory rights and therefore create a much broader set of incentives. For example, the owner of an aquaculture operation does not have inappropriate incentives to high-grade. An aquaculture owner also does not need to be assigned a production level. Owners of such property possess a complex bundle of rights and within this bundle is usually a residual claimant's right to any aspect of the resource that is not specifically reserved to some other agent. Thus, property rights have a dynamic characteristic: as new uses for the asset are discovered, or the size of the property is increased, e.g. through better husbandry, the benefits of those uses belong to the property rights holder. Property rights owners thus have incentives to invest in the discovery of new economic uses of the asset and to improve the quality and value of existing assets.

4.3 The role of self-governance in the evolution of more complete property rights

Fisheries self-governance is a way to internalize more of the decisions about exploiting fisheries resources. The potential for fisheries cap-and-trade regulation (ITQs) to evolve into more complete property rights is fundamentally different from such opportunities for cap-and-trade pollution rights. Because the economic benefits from a fishery resource can be vested in a closed set of users, the incentives for efficient use can be internalized. The benefits of all uses of the atmosphere cannot be vested with a closed set of users, because everyone uses the atmosphere. Therefore, a closed set of private rights holders cannot be created to internalize the decisions about the optimal level of atmospheric emissions.

The opportunities to increase economic returns from fisheries resources – including resources already subject to ITQs – are many. Most obviously, governments do not make perfect decisions about the TAC or related choices, such as the optimal level of research. Economic theory predicts that a sole owner of a fishery resource will internalize all decisions about the best time-stream of benefits and the optimal costs.

A sole owner would internalize decisions about risk and about future price changes, so a sole owner of the resource has the incentive to set TACs that maximize the expected present value of the resource, an incentive government lacks. And, if a sole owner pays the costs of research and compliance, the sole owner would also have an incentive to make economically efficient purchases of these services. Not surprisingly, self-governance has been more successful when the number of participants is small and they have similar attitudes to risk and discount rates.

TACs may be derived from a uni-dimensional conceptualisation of a stock of fish as some tonnage of biomass. With a more complex stock conceptualisation that includes age/size structures, sex ratios, spatial distribution and market conditions, the benefits of more complex controls to achieve efficient resource use become clear. But such complex controls are difficult for governments to implement, not least because the compliance costs of external controls are high. A sole owner has the incentives to harvest selectively to maximize the productivity of the stock. Complex harvest strategies over space and time are available to the sole owner to maximize product value when market conditions are best and to reduce harvesting costs, e.g. arising from inclement weather or fish distribution patterns. And, a sole owner may, for suitable species, be able to use stock enhancement and habitat enhancement to increase natural productivity.

The opportunities to create more comprehensive property rights are most appearent for sedentary resources such as shellfish. The institutions that define spatial rights for land can be applied directly to sedentary resources. (And technological innovations such as global positioning systems [GPS] have made marine spatial definitions much more practical.) Such rights are illustrated in the creation of exclusive spatial rights for harvesting sea urchins in Nova Scotia (Miller). Such spatial rights for wild resources are essentially identical to aquaculture rights. Further, shared users of scallop resources in New Zealand (Mincher) and France (Alban and Boncoeur) indicate that a set of collective rights holders can use aquaculture techniques to manage wild resources.

While complete private rights for mobile finfish resources are more difficult to as achieve than those for sedentary resources, rights well beyond those for simple cap-and-trade are clearly possible. The **Crabco** example in New Zealand (Soboil and Craig) suggests an interesting model for internalizing and unitizing all dimensions of resource exploitation.

A sole owner has compelling reasons to optimize the benefits from resource exploitation, but most fisheries are exploited by multiple users. ITQs create a set of shares owners in the resource, not sole owners of separate stocks: to create more complete rights, an efficient decision-making structure for the joint owners is required within the context of common interests and utility profiles. An effective structure for self-governance is required. Government, through its legal ability to define the institutional setting, can crucially influence whether efficient self-governance will evolve and as such, self-governance is an institutional option that government policy can encourage or discourage.

5. TRANSACTIONS COSTS, GOVERNMENT AND SELF-GOVERNANCE

5.1 Transactions costs as a limit to self-governance

Most cases in this volume involve industries with relatively few harvesters. This is not a surprise. Because self-governance to date has often been self-organized without explicit enabling legislation, most self-governance occurs under the *de facto* requirement for unanimous consent. Reaching unanimity is difficult because the transactions costs increase more than proportionally with the number of participants, as Olsen (1965) first argued.

But the central issue is not that of the small number of participants, but rather that of transactions costs. Only in small groups have the transactions costs of achieving unanimous consent been overcome. Joint resource users always have incentives to maximize their joint return; achieving that end is limited by transactions costs. As institutions lower the transactions costs of reaching decisions, the opportunity for self-governance increases. Because government has the authority to define the institutional structure, government has the ability to define institutions that decrease (or increase) transactions costs. Among the cases described in this volume, governments have changed institutions both to favour and to discourage self-governance. In a few instances, these institutional changes were intentional. More often, they were unintentional.

5.2 Bargaining within a closed set of users.

Open access creates insurmountable barriers to self-management. Any negotiated agreement will be undermined as new entrants claim (and erode) a share of the benefits of good management. When governments implement a policy of limited entry for fisheries, they make a crucial institutional change that enables self-governance to be an option. Despite the economic constraints of limited entry of vessels (i.e. the existence of incentives for capital-stuffing), the adoption of limited entry by governments since about 1960 has laid the basis for greater self-governance. The recent emergence of self-governance in many management jurisdictions has not been coincidental. Rather, it reflects the adoption of limited entry in fisheries over the past forty years on which self-governance has been able to evolve.

5.3 Transactions costs and characteristics of participants

The transactions costs of negotiations do not depend solely upon the number of participants as the characteristics of the participants will also influence transactions costs. And, the characteristics of the resource and its fishery will also shape the kind of rules that can be defined and be efficiently and effectively enforced.

Operators with similar situations and interests will face lower bargaining costs than will those with dissimilar vessels, markets and financial situations. The simple rule of equal sharing of benefits is available and participants who are identical in most respects will experience the same the economic motivations. The negotiation of a voluntary IQ in the British Columbia red sea urchin fishery by 100 participants was probably facilitated by the relative homogeneity of the divers (Featherstone and Rogers). Similarly, the relatively large number of participants (55) in the British Columbia geoduck industry is, no doubt, facilitated by the homogeneity of the situations of the divers (James).

The co-management literature often argues that non-economic ties between participants, such as family bonds or common social histories, reduce transactions costs. Trust that is formed in other social interactions is "social capital" that can facilitate agreement in more complex and uncertain settings. Such trust can reduce the complexity and cost of compliance regimes that must be implemented. This social capital is clearly demonstrated in the Montauk tilefish industry (Rountree, Kitts and Pinto da Silva). The small group in the Yaquina Bay herring roe fishery may also have benefited from broader social connections (Leal), but in the Chignik salmon cooperative, these community ties seem to have been at least as problematic as helpful (Knapp). But overwhelmingly, the self-governance agreements in this volume have been motivated by narrow economic self-interest and without clear evidence of pre-existing community ties. Legally enforceable contracts, often with specific compliance regimes and penalties, are present in roughly half the cases. While the social capital accumulated from long involvement in broader communities may facilitate these self-governance agreements, it is clearly not a pre-requisite. This experience is consistent with the argument that self-governance is an economic institution, while many other (less successful) models of co-management are based on broader political and social foundations.

Shellfisheries comprise slightly over half the cases in this volume. Eight cases involve scallop, sea urchin, geoduck and abalone resources; nine cases involve prawn, shrimp, lobster and crab fisheries. Shellfisheries are almost certainly over-represented in these cases and this is probably not coincidental. The spatially-limited nature of shellfish stocks makes it much easier to create a truly closed set of users. The migrations of finfish stocks often create multiple sets of users of the same resource who have different opportunities to benefit from the stocks and often have different cost and revenue structures. The sedentary (or relatively immobile) nature of shellfish resources means that the costs and benefits of management intervention are much clearer. The benefits of leaving small scallops and abalone in the water are self-evident: larger scallops and abalone may be harvested in exactly the same area for years. Spatial rotation strategies are both highly effective and relatively simple to implement. The opportunities for stock enhancement through re-seeding have been shown to be attractive in the case of scallops. For prawn fisheries, fine scale management of harvests within a season can have significant effects on average prawn size and thus their weight and value. Shellfish resources benefit more from self-governance both because the costs of self-governance are lower and because the potential benefits are higher, more visible, and thus more certain.

5.4 ITQs and self-governance

The negotiation of self-governance agreements has aspects of both positive-sum and zero-sum games. Better governance can increase the total economic profit to be derived from the resource, which creates a positive-sum game. On the other hand, the division of benefits has zero-sum characteristics, which can make resolution difficult or impossible. Here, the number of actors involved in the negotiations has a major influence on incentives. When there are a small number of players, each player receives a large share of any efficiency gains. The relatively large efficiency gain realized by each individual creates stronger incentives for cooperation in governance negotiations. In contrast, when there are a large number of operators, the gains from gaming strategic behaviour to increase one’s own allocation are large relative to the share of efficiency gains any one player will, on average, realize. Tactics such as threatening to block an agreement (i.e. a hold-out tactic) to win a larger share of benefits become more attractive as the number of players increases. If the allocation issue can be resolved, negotiation costs will be reduced and agreements within larger groups may be possible.

When government allocates individual quotas among users, it resolves the allocation issue and reduces the transactions costs of negotiations. So one might expect ITQs to encourage the adoption of self-governance and, in particular, to make self-governance among larger groups more feasible. The adoption of the quota management system in New Zealand has resulted in significant self-governance activity. **FishServe** provides industry-wide administration of the QMS (Harte). The rock lobster fisheries in New Zealand involve relatively large number of harvesters who have taken considerable steps on research and some modest self-management initiatives (Yandle). Likewise, in Canada the implementation of ITQs seems related to adoption of self-governance under joint project agreements. Relatively elaborate self-governance arrangements are found in Canadian ITQ situations in a relatively large range of fisheries, such as geoducks (James) and sablefish (Sporer). While ITQs are not common in Europe, the allocation of quota to producer organizations on the basis of individual vessel fishing histories – a development driven by the industry themselves and almost in spite of the Common Fisheries Policy – has provided a logical basis for the POs to implement ITQ-like governance.

Government, for itself, faces its own transactions costs. Solving the zero-sum allocation problem inherent in ITQ allocation in the political sector is usually difficult. In the United States, the implementation of ITQs, as elsewhere, often requires many years. The US had a moratorium on new ITQ programmes in federal fisheries for six years, from 1996 to 2002. Four of the six US self-governance cases in this volume involved users who negotiated their own agreements to circumvent the ITQ ban. These include Pacific whiting (Sylvia, Munro Mann and Pugmire), Alaskan weathervane scallops (Brawn and Scheirer), tilefish (Rountree, Kitts and Pinto da Silva) and Alaskan pollock (Wilen and Richardson.) The Yaquina Bay roe herring fishery is also a self-organized individual quota, but at the state level (Leal.)

The self-organized IQ arrangement in the British Columbia red sea-urchin fishery deserves special mention. The Department of Fisheries and Oceans was initially unwilling to implement an IQ programme (Featherstone and Rogers). That 100 divers could respond to this reluctance by the Department by unanimously agreeing both to voluntary individual quotas and to a self-financed implementing framework is truly incredible. Two factors contributed to this remarkable outcome. First, many divers were either participants in, or had observed, the benefits of the geoduck IQ. Second, the dangers to life of competitive diving in short 'Olympic' openings were obvious to everyone. But even these favourable factors do not diminish their achievement: No other industry operating under unanimous agreement rules has achieved such a comprehensive self-governance agreement with anything close to 100 participants.

In several other fisheries, self-governance has resulted in some kind of informal or limited individual quota. In eastern Canada, the government forced the creation of local governance arrangements for the inshore groundfish industry (Peacock and Annand). Some of these then implemented informal IQ arrangements. Producer organizations in Europe have sometimes converted the fishing history of members into individual quota arrangements, as in the Shetlands whitefish industry (Anderson) and the Spanish Celtic Sea fleet (Garza-Gil and Varela-Lafuente) – confirming the role of catch history in these arrangements and the need to anticipate distortions in fishing behaviour it may engender. In the Gullmar Fjord, operators of the six vessels negotiated individual input allocations (Eggert and Ulmestrand). In the sandfish industry in Japan, several of the FMOs manage their TACs by individual allocations (Suenaga). All these cases share an interesting contradiction. On the one hand, self-governance has allowed different sets of harvesters to decide for themselves whether individual quotas are appropriate. On the other hand, official adoption of self-governed individual quotas remains controversial, to the extent that the arrangements remain informal or obscure and unpublicized.

5.5 The role of cost recovery

The role and consequences of subsidies in the world's fisheries remain notorious. Within that context, the frequency of cost recovery among these cases of self-governance is notable. A policy of 'cost recovery' has two major policy implications. First, those who are responsible for creating the administration and management costs – the fishing industry – are responsible for paying for them. Second, when costs must be defrayed by an organization they have reason to minimize their costs by adoption of more efficient practices. Thus, one might expect both that cost recovery motivates adoption of self-governance and also that the greater profitability under self-governance will encourage government to seek more cost recovery. Both forces seem to operate in some jurisdictions, especially in New Zealand and Canada. The experiences in other jurisdictions are less clear. For example, cost recovery is allowed only in limited circumstances in the US.

Cost recovery does provide incentives to undertake broader self-governance. If a service, such as ensuring compliance, is funded by government, there is little incentive to economize on this 'free-to-the-industry' service. Self-governance can result in the replacement of expensive compliance regimes with less expensive alternatives. For example, an industry that does not pay for ships and aircraft to enforce compliance may prefer these expensive options over e.g. more intrusive electronic vessel monitoring systems or persisting with efforts to overcome differences in the industry arising from rigidly pursuing self-interests. But if required to pay for the expensive patrols, industry will weigh the cost of patrols against the costs of electronic vessel monitoring or some other form of self-imposed compliance. More broadly, industry understands both the incentives and opportunities to undermine compliance regimes, so it can often design more effective compliance regimes. Even if industry is not allowed to provide a service itself, it has an incentive to push government agencies to provide services more efficiently and not to provide unnecessary services. In both Canada and New Zealand, cost recovery has resulted in greater transparency in government financing of fisheries functions and both countries have highly effective compliance regimes.

Self-governance that has resulted in, or arisen from, assignment of some form of property right to the participants has also changed the dynamics of compliance. As the direct and exclusive beneficiaries of compliance with conservation regulations, peer pressure to observe regulations develops and has proven to be most effective among small groups of participants, especially when most, if not all of the participants know each other personally.

Wilson uses 'institutional economics' to offer an interesting interpretation of why self-governance may lead to more cost recovery/rent extraction. He suggests that cost-recovery can be a kind of government agency rent-seeking. While Wilson developed his analysis in the specific context of Canada, the argument has general applicability. By empowering industries to better manage their own fisheries, DFO has enabled the generation of greater economic rents. In turn, DFO recovers some of those rents to finance 'public interest' research budgets that have been trimmed in recent years. Note that Canada does have modest resource rent recovery and this rent recovery is generally higher in fisheries with ITQs (see James, Stevens *et al.* and Wilson.) Governments also capture a share of rents through the conventional systems of taxation of company profits.

Cost recovery is a central principle of fisheries governance in New Zealand (Harte) and Australia, at least at the Commonwealth level. Cost recovery includes the costs of administration, compliance and research. Privatisation of the QMS administration through **FishServe** is generally believed to have substantially reduced the administrative costs of the quota management system in New Zealand (Harte). The rock lobster fishery contracts jointly with a science provider for most rock lobster research. But outside of rock lobster, cost recovery for many research programmes is a major point of on-going contention between the industry and government. This friction is unavoidable given the difficulty of determining if certain aspects of marine research are more appropriately considered as 'in the public domain' or whether the primary beneficiaries are in the fisheries sector. It would be naïve to assume that this debate would not be part of the ongoing discourse around a policy of cost recovery.

Canadian practice is to recover the costs of its dockside monitoring programme of catch and effort and they recover research costs from some industries in an *ad hoc* fashion. The high cost of the initial government-run dockside monitoring programme was a major incentive for privatisation of that function through certified third-party providers. As Wilson notes, cost recovery of research costs is negotiated for individual fisheries and has an *ad hoc* flavour. On the other hand, the shared responsibilities for research costs in Canada have led to a generally cooperative approach to research, in notable contrast to the contention over the more comprehensive policy for cost recovery of research in New Zealand.

The differences in resource rent recovery between Canada and New Zealand may influence the way government and industry view cost recovery. In Canada, modest resource rentals are recovered through licence fees and more profitable fisheries face modestly larger licence fees. Resource rentals are explicitly not permitted in New Zealand, because QMS shares were used to partially settle Maori claims of rights to natural resources. Canada may be more flexible on cost recovery because it also collects resource rentals.

5.6 Government action to promote self-governance

Governments have the ability to set the constitution within which self-governance occurs. Governments may simply tolerate self-governance where the industry can establish its own self-governance. This results in the *de facto* requirement for unanimous consent, which inherently limits the scope for self-governance. But in a few cases, governments have taken specific steps to empower harvesters to govern themselves.

Among the countries represented in this volume, Canada has shown the most consistent interest in promoting self-governance, in part because of the diversity of their fisheries and because the regional nature of administration of fisheries permits some limited autonomy in management approaches. Fisheries and Oceans Canada has used the broad discretion of the fisheries minister to enable a wide array of self-governance options. Canada apparently has an informal policy of implementing rules to support policies that are endorsed by two-thirds of permit holders (Wilson.) It has used joint project agreements (JPAs) in Atlantic scallops (Stevens *et al.*), geoducks (James), sablefish (Sporer) and British Columbia red sea urchins (Featherstone and Rogers) to enable groups of harvesters to make a wide array of decisions that are usually reserved for government. To support JPAs in geoduck and red sea urchins, the DFO has required the use of industry-funded monitoring as a condition of the harvester licence. Under some JPAs, part of the quota has been allocated to industry associations as "use of fish" allocations to fund research. Both initiatives provide incentives for harvesters to join the industry association implementing the JPA. In the inshore Atlantic groundfish industry, the Canadian government established rules that forced the creation of community-level governance. In the Nova Scotia crab fisheries, the DFO required the creation of self-governed corporations to receive crab licences.

The national and prefectural governments of Japan have shown recent interest in fisheries self-governance through fishery management organizations (FMOs), which are derivatives of fishery cooperative associations (FCAs). Japan has a well-established system of local responsibility for fisheries management with long historical traditions. While these fishery management organizations often coordinate fishing activity to reduce short-run fishing costs, to provide equity in access to resources and to maintain prices, these FMOs have been less active in reducing fishing capacity or promoting stock objectives. However, the central Japanese government seems interested in promoting a more comprehensive role for FMOs that address overcapacity and overfishing more directly.

The MEABRs in Chile involve a higher degree of central control than, e.g., in Canada. Without the formation of an MEABR, access to valuable loco resources is denied and as a result, MEABRs have formed rapidly.

The United States government enacted a specific statute to allow self-governance in the Alaskan pollock industry (Wilen and Richardson.) But rather than enacting a broadly empowering statute, the federal government enacted legislation that applied only to Alaskan pollock and with specific rules for cooperative formation. This seems to reflect the broader US perspective. While self-governance has attracted considerable rhetorical support in the United States, the enabling legislation is highly prescriptive, which limits the actual scope for self-governance.

The Alaskan Chignik salmon experience offers an interesting approach for governments that want to empower self-governance. Faced with strong, but non-unanimous, local support for a cooperative harvest strategy, the Alaska Board of Fisheries divided the fish between the approximately 80 percent who wanted a cooperative and the 20 percent who wanted open access. By dividing the quota, the

Alaskan government facilitated non-unanimous self-governance, an approach that is reminiscent of the operation of producer organizations in Europe where quota is allocated on the basis of the fishing history of members.

While Alaska and Canada have enabled self-governance to be implemented when support is broad but still non-unanimous, no government seems to have considered allowing simple majorities to decide all aspects of self-governance. Perhaps the lowest transactions costs would be achieved if government empowered corporate governance under one-ITQ-share/one-vote self-governance (Townsend, 1995, 1997).

6. SELF-GOVERNANCE AS A LEARNED BEHAVIOUR

The self-governance cases in this volume are distinctly clustered. Some of this clustering of self-governance reflects policy and administrative structures that encourage and support self-governance. New Zealand, especially, has a legislative framework than enables self-governance. The administrative initiatives of DFO officials in British Columbia and Nova Scotia partially explain why self-governance in Canada is clustered in those two areas. In Japan, the traditional role of fishery cooperative associations provides a natural base for self-governance.

In the US and in Canada, there is also clear evidence that learning about self-governance occurs from observing the earlier successes in self-governance. In the United States, the initial success of the Pacific whiting producer cooperatives (Sylvia, Munro Mann and Pugmire) clearly provided a model that was subsequently followed in Bering Sea pollock (Wilen and Richardson), weathervane scallops (Brawn and Scheirer), Chignik salmon (Knapp) and even in the Northwestern Hawaiian Islands lobster (Townsend, Pooley and Clarke, 2003). Many of the British Columbia sea urchin harvesters who negotiated their own ITQ programme already had experience with the interplay of ITQs and self-governance in the geoduck fishery (Featherstone and Rogers). One of our objectives for this volume is to broaden the scale at which this learning from previous successes can occur.

7. THE FUTURE OF FISHERIES SELF-GOVERNANCE

There are two potential misconceptions about fisheries self-governance. One is that self-governance can spontaneously and entirely replace government regulation. The second is that governments can invoke (or impose) self-governance to avoid difficult choices about restricting access. Both are false. Self-governance requires a closed set of users with reasonable guarantees of exclusivity who can negotiate the terms of their self-governance. As long as the set of users is open, any benefits generated by investments in self-governance can be claimed and ultimately dissipated by new entrants. For most of the world, governments and governments alone have the power to close access to a fishery. For self-governance to continue to spread, governments must continue to address the core economic problems (and costs) of open-access fisheries. Governments have the sovereign authority to redefine institutions by legislative and, with more difficulty, constitutional change. Governments must exercise their power to enable and empower self-governance. Self-governance has much to offer governments: through appropriate institutional changes, much of the complex and often contentious detail of fisheries administration can be undertaken – more effectively – by the private sector and the constraints of command-and-control regulation reduced.

The institutional changes required of governments to empower self-governance depend in part upon the number of participants involved. When there are few users, the transactions costs of collective decision-making are lower and consensual decisions are more easily achieved. Government may be able to empower self-governance simply by defining an exclusive set of users. But as the set of users gets larger, better-defined rights are necessary to encourage participation and to lower transactions costs. Thus, self-governance will be easier for large groups when a well-defined right like an ITQ exists.

There are other steps that governments can take to enable larger groups to embrace self-governance. In several cases, governments have divided users into homogeneous groups or groups with similar attitudes towards self-governance, as occurred in the Chignik salmon fishery (Knapp), in producer organizations in Europe and in the inshore groundfish fishery of Atlantic Canada (Peacock and Annand). Canada, in particular, has shown that the creative use of regulatory tools can encourage self-governance even when the number of harvesters is moderately large. When an industry group has demonstrated wide support within the industry, Canada has used regulations to discourage or prevent free-riders from undermining the benefits self-governance.

The future of fisheries self-governance rests largely on the vision of fisheries regulators. If fisheries regulators are opposed to self-governance, government can easily raise the transactions costs and make self-governance impossible. Alternatively, governments may create greater incentives for industry to make more of the complex and usually difficult decisions that are required for efficient fisheries exploitation. Fisheries self-governance is an opportunity to further rationalize economic incentives that have occurred, first under limited entry and then with ITQs. But the transactions costs of self-governance are large, especially when unanimous consent is the only basis for moving ahead. Governments that want to empower self-governance for more fisheries must creatively redesign institutions to lower the transactions of self-governance and be open to the transfer of decision- making power to those most directly influenced by the outcomes of such decisions

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Tenure rights and stewardship of marine resources – A co-managed Swedish shrimp fishery in a marine reserve

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1. INTRODUCTION

The problems related to open access marine fisheries lead fishers to avoid responsibilities for ensuring future benefit flows. In fact, theoretically, open-access fishery implies that fishers only care about their own catch today, but completely disregard their potential catch tomorrow and in the more distant future (Clark, 1973). It is sometimes held that wealth or the prospect of wealth leads to over exploitation of resources and that myopic behaviour of fishers is a result of the human nature (Ludwig, Hilborn and Walters, 1993). However, from an economics perspective, the problem is rather that poorly defined property rights lead to perverse economic incentives, which causes excessive effort and short-sightedness (Björndal and Munro, 1998).

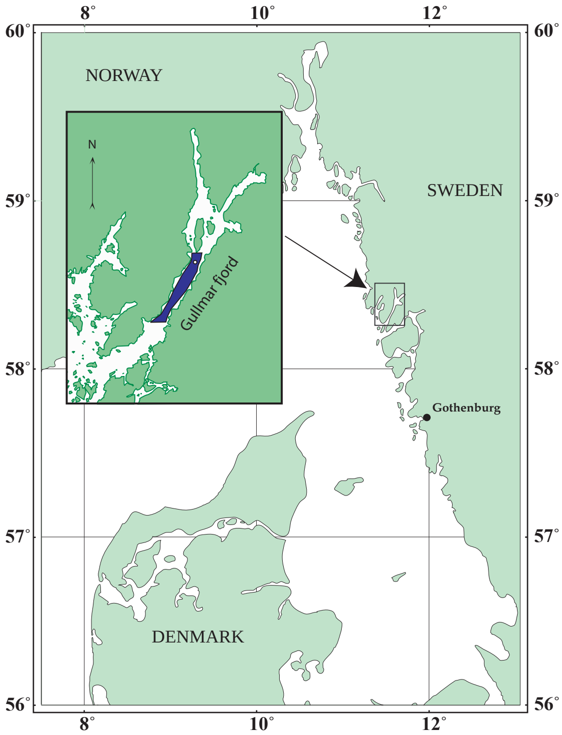
Hence, fishers can be made to behave in a more long-term responsible manner with respect to stocks and landings and the prospect of wealth will foster stewardship and prevent overfishing, given that property rights are improved and fishers are provided with sound incentives. Simply put, fishers should be willing to invest in fish stocks given that they know that there is a fair chance that abstaining from catching a fish today is rewarded in the future. In this study, we report the experiences from a co-managed fishery within the Gullmar Fjord, which is a marine reserve on the Swedish West coast.

2. THE GULLMAR FJORD SHRIMP FISHERY

A fjord is an inlet on the sea that results from marine inundation of a glaciated valley, often with a limited shelf depth at a narrow inlet and greater depths in the upper and middle reaches than on the seaward side. This limits the exchange of deep water within the fjord and the outside sea and provides a unique environment for marine flora and fauna. Hence, from a Swedish perspective the Gullmar Fjord is unique being the only fjord in Sweden (Figure 1).

Northern shrimp (*Pandalus borealis*) trawling in the Gullmar Fjord started in 1902 and three to four boats frequently trawled the fjord until 1960. In 1983, the fjord was made a marine reserve to preserve it as a valuable reference area for marine research. However, limited fishing activities were allowed but by 1990 a ban on trawling was

FIGURE 1
Map of the Gullmar Fjord



introduced in order to study the effects of trawling on the benthic community and on fish species. During 1996–97 a large-scale research experiment of trawling effects was carried out. The results from that project (Lindegarth *et al.*, 2000; Hansson *et al.*, 2000) indicated that trawling had a limited impact on the benthic community and based on these results the management authority, the County of Västra Götaland, decided to re-open the trawl fishery but with new and more strict regulation.

Boats in this fishery are typically small-scale trawlers with a length in the range 8–15 metres (Photo 1), which combine the shrimp trawling with coastal trawling for Norway lobster (*Nephrops norvegicus*). The small vessels benefit particularly from fishing in the fjord during windy conditions when the open sea is accessible only with considerable risk. Thanks to favourable prices, the landings are of value to the vessels concerned. In Table 1 we report aggregated price, landings and fishing effort data of the fishery.

The application fee for a commercial fishing licence is SEK 500, and this licence must be renewed every fifth year at a cost of SEK 300 (SEK 7 ≈ $US 1). The permission to enter a species-specific fishery is free of charge and the same applies for the fishing vessel licence. Indeed, there are no additional licence costs for Swedish fishermen and this applies for the small group of shrimp fishermen described in this study.

3. DEVELOPMENT OF CO-MANAGEMENT IN THE SHRIMP TRAWL FISHERY

In 1999 a new regulation on the requirements for fishing was inacted and the trawl fishery was re-opened. The fishery was opened to any fishers with a size-limited single trawl, minimum mesh size of 35 mm and equipped with a species selection grid (Isaksen *et al.*, 1992; Ulmestrand and Larsson, 2000). To minimize the effect on bottom fauna, a maximum size and weight for the trawl door, i.e. of the size used in the large-scale experiment, was decided upon. The total annual fishing effort was limited to 100

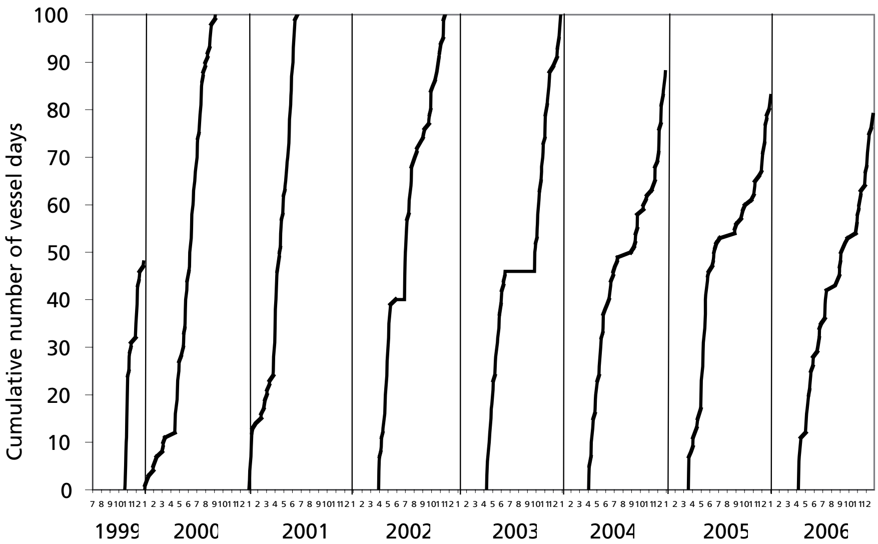
LAURA PIRIZ, SWEDISH BOARD OF FISHERIES

PHOTO 1
Typical shrimp trawler of the Gullmar Fjord Shrimp fishery

TABLE 1
Gullmar Fjord shrimp landings, real value and fishing effort 2000–2006

		Landings (kg)		**Discards (kg)**	**Real price/kg**		**Fishing effort**
Year	Large	Medium	Small	Large	Medium	Hours	Days
2000	3 358	738	55	100 08	15 03	807	100
2001	5 201	1 252	297	93 27	15 59	998	100
2002	10 518	2 744	2 430	112 82	13 51	789	100
2003	11 953	5 756	473	103 09	13 24	945	100
2004	10 391	2 209	369	100 75	11 76	820	88
2005	5 807	5 355	2925	130 83	11 61	845	76
2006	5 377	3 115	831	137 86	12 09	628	71

FIGURE 2
Annual distribution of the 100 vessel days 1999–2006



vessel-days (as was used in the large-scale experiment) and could be distributed over the year during Mondays to Thursdays each week. Each vessel has to report to the Swedish coast guard when they want to enter the Fjord. Further, the allowed trawl area in the fjord was limited to roughly 30 percent of the total fjord area (Figure 1) to limit the effects in general and to avoid trawl activity close to hard bottoms with known rare and/or sensitive marine fauna in particular.

The first vessels were trawling the area by the end of 1999 and during 2000–2001 the allocation mechanism for vessel days was a “race to catch”. As the catch per unit effort (CPUE) by that time was significantly higher in the off-shore shrimp fishery and no price difference between shrimp caught in the two areas existed, the major factor attracting fishers to the Fjord was avoidance of bad weather. In 2000, the 100 days were used by September 6 and during 2001 all days were consumed by June 20, and consequently the fishery shut down for that year. Figure 2 shows the distribution of vessel days for each year during 1999–2006. The “race to fish” in 2001 resulted in both lower price per kilo (Figure 3) and lower CPUE (Figure 4). Individual fishers who were disappointed with the early fishery closure contacted the Institute of Marine Research (IMR), which is the local representative of the Swedish Board of Fisheries. On several such occasions the second author of this article suggested that they should contact other fishers in order to reach an agreement, but the initial reaction to this suggestion was that most often the other fishers were not sensible enough to reach such

FIGURE 3
Annual percentage real price difference between offshore shrimp and Gullmar shrimp

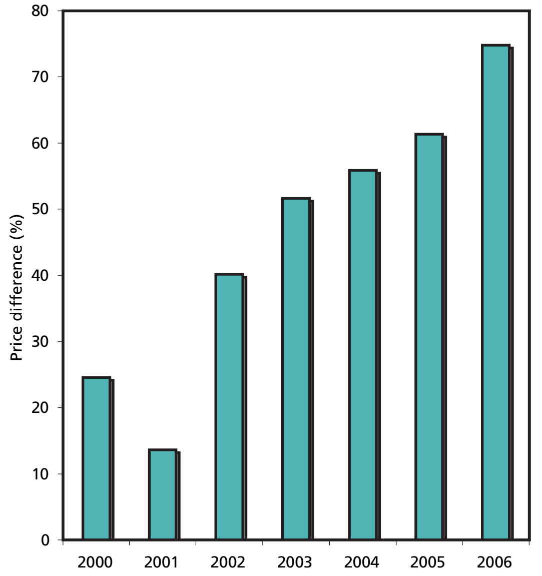
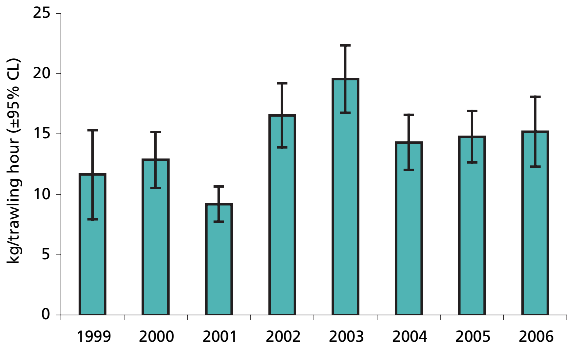


FIGURE 4
Annual average shrimp landing per trawling hour



Error bars represent 95 percent confidence limits.

an agreement. However, later on, the four most frequent trawlers commonly contacted the Institute of Marine Research to get help to reach a voluntary agreement on vessel day distribution, which led to a meeting. The first meeting was held at the end of 2001 and it was agreed that the fishery should open by April in 2002, and that the days should be distributed as 40, 40, and 20 for the second, third, and fourth quartile of the year, respectively. In addition, it was agreed that each vessel should not trawl the area more than twice a week.

In 2002, the five most frequent trawlers in the Fjord asked for a new meeting with the IMR staff, and reached a new voluntary agreement, that stated that the fishery should postpone the opening until 14 April 2003 and use 50 days until June 30, followed by a closure during July–August, and then use the remaining 50 days during September to December. The participating fishers agreed that each fisherman could only trawl the area one day a week. During 2002 eight different vessels had acquired the necessary equipment and tried trawling in the Fjord. Further, a price difference between off-shore shrimp and the Gullmar shrimp, due to superior quality, was established that was on average 34 percent higher for the Gullmar shrimp during 2002. In 2003 the average price difference was 50 percent more, which is likely due to the larger shrimp sizes and better quality of shrimp following the reduction of bycatch thanks to the species selective grid. A simple indicator of shrimp quality is the frequency of straight instead of curly specimens in a batch of cooked shrimp Photo 2 shows on the onboard cooking process. A straight specimen indicates that it was dead when it was thrown into boiling water, while a fresh cooked specimen has a characteristic u-shape indicating a high quality shrimp.

There were still eight trawlers that tried trawling within the area and these two factors led to concern among the most active trawlers and the authority. The first author of this article suggested to the authority that the days could be allocated on an auction basis with a maximum restriction on number of days that each fisherman could buy. This suggestion was ruled out by leading desk officers at the Swedish Board of Fisheries, as it would bear resemblance to Individual Transferable Quotas (ITQs), which at that time was regarded as an unacceptable regulatory instrument both among desk officers at the Board of Fisheries, and among individual fishers (Eggert and Ellegård 2003; Eggert and Martinsson 2004).

Instead of any market based approach, a co-management initiative was encouraged. Until 2002, exclusion of any fisherman was not possible under the prevailing legislation,

PHOTO 2
Shrimps are cooked fresh on board the trawler

but at that time a Governmental proposition on amendments to the *Act of Fisheries* (Anon., 2002) was ratified and it became possible to grant sovereign access rights to the Fjord for a limited number of fishers. Six vessels were granted permits to fish the area from 2004 to 2006 using an application procedure based on historical catches from the fishery. Experience with this system from that period would be evaluated by the end of 2006, followed by a renewed agreement for a three-year period, which in turn implied a high chance of a permanent system of sovereign access and withdrawal rights for the permit holders.

Property rights in economics are often described as a bundle of entitlements defining the owner's rights, privileges and limitations for use of the resource (Tietenberg, 1996). Schlager and Ostrom (1992) refer to five different types of rights relating to property rights listed below and hold that for common-pool resources the two most relevant are access and withdrawal rights.

i) Access: The right to enter a defined physical property.

ii) Withdrawal: The right to obtain the "products" of a resource (e.g. catch fish, appropriated water, etc.).

iii) Management: The right to regulate internal use patterns and transform the resource by making improvements.

iv) Exclusion: the right to determine who will have an access right and how that right may be transferred.

v) Alienation: The right to sell or lease either or both of the above collective-choice rights.

We note that for the standard setting of an ITQ fishery, where the governmental management sets an annual TAC, fishers buy and sell shares of that TAC, all but (iii) are to a large extent fulfilled. In the co-management setting for this particular fishery both exclusion and alienation rights are quite limited. On the other hand, management rights exist in the sense that our group of fishers can regulate internal use and transform the resource by making improvements.

4. EXPERIENCES FROM THE CO-MANAGED SHRIMP FISHERY

Granting the sovereign rights to fish the Fjord for six trawlers, all of them operated by a single crew member most of the time, immediately led to activity to increase the benefits from the fishery. Besides distribution of days over the year, the vessel operators were concerned about the large fraction of small and undersized shrimp in their catches. The Swedish regulations and the market for shrimp basically divide shrimp into three size classes. The largest ones, which we refer to as big shrimp, are big enough to be caught in a 10-mm sieve and earn a price in the range \$10–20/kg depending on supply and demand variations over the year. The medium size are retained by a 8-mm sieve, and are sold to processing factories at a stable price of \$2/kg. The smallest,

PHOTO 3
Cool end with liner visible

undersized shrimp are less than about 15 mm carapace length, go through 8-mm sieve and are discarded back to sea. All of the fishers used a 38 mm mesh size from the start, which is larger than the mandatory 35 mm, and agreed that the four remaining days in the season after each fished for 16 days would be used to test whether a 45-mm mesh size could be justified. A trawl has a retainment profile which follows an ogive curve. Hence, the larger shrimp the larger probability that it will be retained within the trawl. The net selection of shrimp is far from knife-edge and a substantial fraction of medium-sized and even undersized shrimp are caught, while some big shrimp pass through the mesh. Fishers are often critical about regulatory suggestions to increase the minimum mesh size to avoid capture of small shrimp, believing that they will lose too many mature specimens. Here, they eagerly gave up some of the smaller specimens with the objective of increasing the landings of high-valued larger shrimp caught 6–12 months later, instead of catching them as small low-value individuals.

Changing the mesh size from 38 mm to 45 mm implies a short time reduction of about 5 percent for the most valuable big shrimp. By 2006 all of the trawlers had voluntary converted to 45 mm minimum mesh size in trawl codend and extension piece, while most other Swedish fishers still used 35 mm mesh size in the off-shore shrimp fishery (Photo 3). The effect of the increase in mesh size cannot be determined on the basis of a few years of observation. The average proportion of shrimp sizes in the catch from the Gullmar Fjord, 2000–2006, is 67 percent, 25 percent, and 8 percent for big, medium and undersized, respectively, which is substantially below corresponding figures for the off-shore shrimp fishery. A similar co-management initiative for a shrimp fishery 100 km north of this fishery included 20–25 vessels where no one is excluded from the fishery. It is unclear in this fishery whether the fishers still use a minimum mesh size of 35 mm because of the higher number of fishers or because of open access to the fishery, or a combination of both.

In Sweden, monitoring and enforcement of daily fishing activities are carried out by the Swedish Coast Guard. Each skipper that wants to enter the reserve in the Gullmar Fjord calls the Coast Guard prior to entering the fjord. Random inspections at sea and at landing sites have so far, not reported any violation of the prevailing regulations. Marine researchers from Göteborg University using an underwater robot camera once detected traces of trawl activities outside the prescribed area, but that was before the sovereign rights were granted, and since 2004 no such trespassing has been revealed.

The Swedish offshore shrimp fishery has a long regulatory history. The industry had already agreed upon voluntary weekly quotas for each vessel in the fleet by the 1930s. The rationale was to prevent price decreases due to oversupply and a price insurance scheme was developed linked to this agreement that guarantees a minimum price for large shrimp. These measures also had the long-term result that Swedish shrimp trawlers were small compared to those from Denmark and Norway. Further, Swedish landings were kept at a low level that was a small fraction of the quota when a TAC was introduced in 1992. Denmark, Norway, and Sweden share the Skagerrak stock, and while the Swedish area is 30 percent of the total Swedish fishers got 19 percent of the shrimp TAC based on historical landings. This has led to a fishery where the national quota never has been binding on Norwegian or Danish fishers, while Swedish fishers have fully used their quota each year during 1992–2005. The current regulation prescribes a 35 mm mesh size and the fishers also use a voluntary landing composition of 50 percent big and 50 percent medium shrimp. Given the price difference between big and medium shrimp, a factor of 5–10 to one, and the constraint on catches of the annual quota, there is a strong incentive to high grade catches for Swedish fishers, while the Danish and the Norwegians lack such incentive. Preliminary studies of length compositions for catches in the three countries 2003–04 indicate that Swedish offshore shrimp fishers discard (hi-grade) roughly 50 percent of their medium-sized shrimp to increase their landings of larger, more valuable, shrimp.

An immediate effect of the agreement on distributing annual effort was that the Gullmar fishers could aim at landing shrimp when prices are high. A positive effect of the larger mesh size combined with a species selective grid is less weight from bycatch and more live specimen when landing. These factors, combined with some marketing efforts to establish recognition of Gullmar shrimp, led to an increasing price difference compared to the shrimp caught offshore. In Figure 4 we show the price difference for Gullmar shrimp and offshore shrimp during 2000–2006, which confirms the finding by Homans and Wilen (2005) that revenue increases are the first improvement from introduction of rights-based fisheries.

As noted earlier, ITQs are still seen with great suspicion by Swedish fishers, Swedish fisheries managers and by managers at the European Union (EU) level. This negative view is probably the result of two major factors. First, the Common Fisheries Policy aims at maintaining communities with little alternative employment, and at the same time was applied to the previous Swedish national fisheries policy. In Sweden, many fishers fear that ITQ holders in remote areas will be tempted to sell their ITQs to fishers in urban areas. Second, there is a general fear of introducing transferability. A recent document on rights-based management (RBM) from the European Commission (EC) states: "The most controversial aspect of RBM systems is the transferability of rights. The reasoning behind the tradability of rights is primarily economic: the efficiency of fishing enterprises improves following the exit of economically weaker vessels from the fleet while the transfer of quotas from less profitable to more profitable vessels introduces a price for using the resource. The introduction of a resource price may lead to large-scale buying of rights, resulting in concentration of ownership of quotas, geographical distribution of fishing activity and fleet composition." (EC, 2007)

This view is pretty much shared by the fishers exploiting the reserve. In 2004 some of the allocated days were not used, and in 2005 and 2006 this trend was even greater. One important explanation for this was that one of the fishers found alternative job opportunities and only used a few, if any, of his allocation of 16 days. When the others realized this, an informal trading started whereby those who wanted to fish paid approximately US$150 a day to the non-fishing fishers who were willing to sell. Notwithstanding the low sum, this shows that transferability was accepted by these fishers and that some resource rent had already been re-established in the fishery. At the same time fishers within the group thought it was unfair that those who did not fish could enjoy additional income just by leasing their fishing days, and this was an important factor why not all days have been traded.

The issue of skipper skill is sometimes discussed in the literature (e.g. Pascoe and Coglan, 2002). The experience from the Gullmar Fjord shrimp trawling provides overwhelming evidence supporting the existence of skipper skill, where the best performing fisherman clearly stand out as highliners with an average daily income of US$2 000 during 2002–2006, while the average daily income for the other fishers is about US$1 000 for the same period. Hence, in case the days were transferable we would expect this highliner to lease/buy a substantial amount of the fishing days from the other fishers.

5. DISCUSSION

The experiences from the co-management of the Gullmar Fjord trawl shrimp fishery indicate that the small number of fishers that gained rights to a fishing area in terms of access and withdrawal immediately adopted a longer-term perspective: These fishers proved willing to give up short term catches in order to increase long-term catches.

The rights granted to these fishers also included a substantial amount of influence over the management of the resource. The informal meetings between the fishers lead to negotiations whereby agreements on how to allocate days between individuals were reached quite rapidly. Days with expected high demand for shrimp were targeted and the fishers divided days between themselves in order to avoid congestion and get maximum returns. This led to dramatic improvements in price paid per kilogram of shrimp and increased revenues, just as predicted for the introduction of a rights-based fishery (Homans and Wilen, 2005). The meetings between the fishers did not only end the race to fish, distributing the fishing effort evenly over the year, but also meant that some fishers did not use all of their days. The daily comparison between the shrimp fishery and the coastal Norway lobster fishery was in favour of the lobster fishery to a large extent and so the total impact on the marine reserve for these years was below the target limit resulting from 100 days of fishing. Hence, the fishers could compensate themselves with equally rewarding fishery outside the reserve, which implies that eliminating the race to fishing days also entailed welfare improvements in terms of sustainability.

The rights granted to the fishers have been quite limited in terms of exclusivity and transferability. The fishers cannot formally transfer their fishing rights, nor can they expect any payment for abstaining from their rights, and in practice they have limited possibilities to influence who can and cannot fish. However, an informal practice of leasing days between fishers has partly evolved, where some of the non-fished days of one fisherman have been bought from one or two of the other fishers.

While the project appears successful in terms of conservation and sustainability, it is less clear how potentially necessary future reductions in harvest can be handled by the co-management agreement. During 2006, one fisherman left and the remaining fishers argued in favour of keeping the exploitation rate at 100 days, or even increasing it. Given the short time series of the biological data and the uncertainty concerning shrimp abundance, little can be said in favour of increasing, or decreasing, the exploitation rate. The fisherman who left did so because of the existence of attractive alternative employment opportunities, i.e. there were high opportunity costs to fishing. Increasing opportunity cost is probably the most important factor in the structural adjustment process of Swedish fisheries over the last 40 years. In terms of numbers, Swedish commercial fishers have been reduced by almost 90 percent since 1960, from 16 000 to less than 2 000, while the real GDP per capita income for Swedes has increased from US$11 000 to almost US$30 000 in 2000 (Eggert and Tveterås, 2007).

The project implies major improvements in efficiency since 2001. Still, efficiency is not an explicit objective of the CFP. The rights of exclusion and alienation are severely limited in the current regime. A fisherman who exits the fishery does not receive any reward for improving the status of the stock or vice versa. This may provide a distorted incentive during the last period prior exiting the fishery. The absence of an institutionalized right to sell or lease the right to fish clearly hampers efficiency development. The two best performing fishers can, according to their record, increase the aggregate landing value substantially and that could be done using less than the allocated 100 days, which would guarantee less impact on the benthic community. Rendering possible such a reform would be strictly welfare improving, given that the other fishers can find alternative employment. The Swedish unemployment rate is below 6 percent and the same applies for the region where the fishers live, but those concerned still want to continue as fishers. This issue reflects the current perception of the new CFP among desk officers and commercial fishers. The new CFP should aim at supporting small-scale coastal fisheries, but the number of small-scale fishers is rapidly decreasing in Sweden and in other European countries. There is a concern that there exists a critical threshold level of fishers in remote areas, when the number of fishers becomes too low to support the land-based activities needed for the fishery to survive. If they cease operations, all commercial fisheries in the area ends. The current management regime, where five fishers are supported to stay in business is in this sense preferable to only two fishers that achieve full efficiency.

A general finding in economics is that a beneficial aspect of improved property rights is that, e.g. a farmer can use his land as collateral. This facilitates more investment and more efficient exploitation of the resource thanks to the possibility of taking a mortgage (Besley, 1995). A fully implemented ITQ system would imply that the ITQ holders could borrow money from the bank with the ITQs as security and improve the technical level of their vessels, but that would come at the expense of less employment opportunities among fishers. Swedish fisheries management has so far been reluctant to use ITQs. The general concern is that ITQs would lead to concentration and large-scale vessels with the loss of the cultural heritage of small-scale coastal fishing. In addition, the idea that an individual can buy or sell the right to fish and even earn money on increasing value for such fishing rights is often seen as unfair. During 2007 the Swedish pelagic fishery will introduce an ITQ system with several constraints aiming at controlling potential negative side effects of the system. Demersal fishing in Sweden remains within the realm of regulated open-access management (Homans and Wilen, 1997). Meanwhile, the co-management experiment with the Gullmar Fjord shrimp fishery provides a good example of how fishers can be induced to change their perspective to a longer term perspective when property rights are improved in a fishery.

6. ACKNOWLEDGEMENT

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Self-regulation of the Danish matjes herring fishery from success to collapse

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1. INTRODUCTION

The Danish matjes herring fishery has a season that usually starts in May and continues for approximately 12 weeks. It is a Scandinavian fishery as it is conducted by vessels from Denmark, Norway and Sweden. The fishery is undertaken in the North Sea, Skagerrak and along the Norwegian coast. A matjes herring[1] is a particular quality of herring and has a high fat content and satisfies various other subjective criteria. In the Netherlands, the Matjes herring are mainly sold as a snack on the streets during the summer. There is also a minor market in Belgium. The market is dominated by 8–10 Dutch buyers who have a market share of approximately 80–90 percent. The matjes herring are sold at public fish auctions in Hirtshals or Skagen in Northern Jutland, Denmark. Despite the fact that matjes herring are sold at two geographical locations the matjes market in Northern Jutland is considered one market.

There are strong links between vessel owners, processors and the Dutch buyers in order to ensure the high-quality (and high-value) product. Dutch buyers purchase the herring at the fish auctions and the majority is processed in Northern Jutland. The processors remove the gills from the herring, salt them and grade them as contract work for the Dutch buyers; 400–500 persons are employed in this operation throughout the matjes season.

The processors from Northern Jutland and the Dutch buyers have a long business record (often more than 20 years of collaboration), which to some extent creates a matjes brotherhood.

The coordination and self-management of the matjes herring fishery began in the 1970s and in 1992 it was institutionalized on a voluntary basis by the creation of the Matjes Committee (MC). The MC was based in Northern Jutland and is composed of regional representatives from the Danish Fishermen's Association and the Association of Danish Fish Processing Industries and Exporters. The MC voluntarily undertook

[1] We only include the matjes herring for the Dutch market. On the German market a matjes herring is something different.

management responsibility for the matjes herring fishery within the framework of EU and Danish regulations, and the MC informed the Ministry of Food, Agriculture and Fisheries about its imposed regulations.

2. AN OVERVIEW OF THE DEVELOPMENT OF THE MATJES HERRING FISHERY

During the period from 1992–97 approximately 25 vessels were participating in the matjes herring fishery, 11 from Denmark, 6–10 from Norway and 6 from Sweden. The Norwegian Herring Sales Organisation decided the number of participating Norwegian vessels based on the size of the total Norwegian catch quota. As more than 100 Norwegian vessels were potential participants, only a fraction of the Norwegian vessels was allowed to participate at a time.

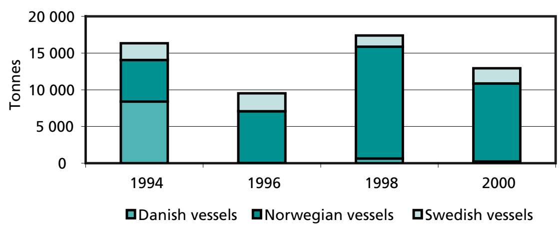
As is clear from Figure 1, the landing of matjes herring has developed from being dominated by Danish vessels to being heavily dominated by Norwegian vessels, the Danish landings having almost disappeared, whereas the share of the Swedish vessels has been relatively stable during the period. Photo 1 shows the type of purse seiner involved in this fishery.

Prior to 1992 the ex-vessel sale of matjes herring in Northern Jutland was not exposed to any major competition from other countries. However, during the early 1990s some Dutch buyers were active in establishing another centre for firsthand sale of matjes herring in Egersund, Norway. The objective of the Dutch buyers was to increase competition on the supply side and subsequently to move the first ex-vessel sale of matjes herring from Northern Jutland to Egersund. Figure 2 shows this trend.

Since 1994 a continuously larger share of the matjes herring has been sold on the market in Egersund. Consequently the share of matjes herring sold in Northern Jutland has dropped from 75 to 60 percent. However, the largest proportion of Norwegian landings has remained in Northern Jutland.

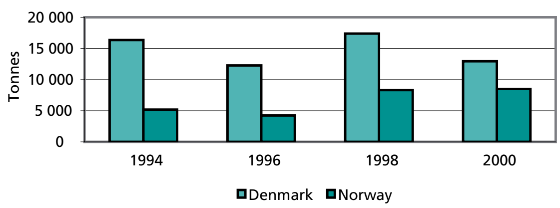
Landings of matjes herring have also become less important compared to landings of herring for filleting. In 1994 approximately 80 percent of all herring landed in the matjes season was sold as matjes, whereas this percentage declined to approximately 40 percent in 2000.

FIGURE 1
Landings of matjes herring in Northern Jutland



Source: Hirtshals and Skagen Fish Auctions and the Norwegian Herring Sales Organisation.
Note: Since 2000 there has not been kept specific landing records herring landed for matjes, as all herrings as been recorded alike. This is also relevant for Figures 2 and 4.

FIGURE 2
Landings of matjes herring in Denmark and Norway respectively



Source: Hirtshals and Skagen Fish Auctions and the Norwegian Herring Sales Organisation.

3. 1992–97 – THE GOLDEN PERIOD FOR SELF-MANAGEMENT IN THE MATJES FISHERY

The rationale for establishing self-regulation in the matjes herring fishery was (a) to coordinate the fishery in order to ensure catches of high-quality herring, (b) to control market supply and thereby preserve a lucrative, high-price market, and (c) to ensure full transparency of the quantity and quality in ex-vessel sale of matjes herring in Northern Jutland.

The core of the self-regulation of the matjes herring fishery is a set of operational rules contained in “The Ten Commandments” of the matjes fishery, which was accepted by all parties.

PHOTO 1

"The Ten Commandments" of the matjes fishery:[2]

i. Herring for matjes shall be landed in fish boxes.
ii. Herring for matjes shall be sold at the public fish auction.
iii. The Matjes Committee decides the maximum weekly quota for all vessels landing herring for matjes.
iv. Herring for the Danish processing industries (non-matjes) must be sold at the tele-auction or directly to the processors; in all cases the buyer takes possession of the herring from the hold of the vessel.
v. Herring for non-matjes markets can be landed in addition to the maximum weekly ration for matjes.
vi. Herring landed for non-matjes markets cannot be used for matjes.
vii. Vessels that want to land matjes herring on a given day are required to sign up for landing at the public fish auction before 06:00 on that day.
viii. Vessels signed up for landing at the public fish auction shall land the quantity signed for and are only allowed to land that quantity.
ix. The quantity signed up for shall be landed at one time.
x. Two weeks before the matjes season starts sale of herring in fish boxes is prohibited at public fish auctions in Northern Jutland.

These rules were drafted by the MC and discussed and later revised in close collaboration with representatives from all involved parties. In 1992 the various players had a mutual interest in ensuring the highest quality of the landed matjes herring and thereby maintaining the matjes herring as an exclusive high-value product. The incentive for the fishers was obvious – to ensure highest possible prices for herring sold as matjes; the incentive of the processors was to maintain as much as possible of the processing in Northern Jutland (see Photo 2).

The incentive for Dutch buyers was to ensure the highest possible quality of herring landed for matjes, realizing that they would not get prime quality without paying a premium price. However, the Dutch buyers also had an interest, at least to a certain extent, in having an oversupply of the market in order to be able to choose the best quality at lower prices.

The third rule of "The Ten Commandments" concerning maximum weekly catch quotas cannot be questioned. This rule is the core method to sustain prices at a high level by regulating supply according to demand. The weekly catch allocations are decided by the MC.

While Danish and Swedish vessels were given weekly vessel quotas, the Norwegian vessels were given a collective quota, which is distributed among the interested vessels, in reality this was done by the Norwegian Herring Sales Organisation. Disputes have arisen, in particular when the weekly quota was reduced. However, in general the MC

[2] Source: The Matjes Committee.

PHOTO 2

was able to resolve disputes and reach agreements that balanced the various interests regarding setting the operational rules and ensuring their enforcement.

An important component of the coordination of the matjes fishery was the weekly "coffee-meetings" as they are called to emphasize their highly informal structure. At these meetings – taking place in Hirtshals or Skagen usually on Thursdays – representatives from the vessel owners, the processors and the Dutch buyers meet to discuss the quantity and quality of the landed herring during the past week.

The Norwegian vessels are represented at the weekly coffee meetings by a Danish shipping company as their local agent, whereas Swedish participation is more sporadic. Four to five Dutch buyers usually attended the meetings and a similar number of Danes representing fishers and processors. The coffee meetings became the focal point for exchange of information between the fishers and the Dutch buyers. The fishers are informed about where the herring have been caught and in which sizes and quantities and about the fishing activities and their expectations for the coming week. The Dutch buyers are informed of the quality of the landed herring, e.g. size, stomach and fat content, appearance and taste (which is hard to measure) as well as the market prospects for the coming weeks. This gives the fishers and the buyers an opportunity to coordinate fishing activities in accordance with the anticipated fishing situation and the quality requirements of the buyers.

Based on the discussions at the coffee meetings – when fixing the weekly catch quota – the MC balances the interest of the fishers in maintaining high prices through undersupply and the interest of the Dutch buyers in ensuring that sufficient quantities of fish are landed to accommodate the demand. The last coffee meeting in the season often becomes an evaluation meeting as well.

In addition to the weekly coffee meetings held during the season a pre-season meeting was held between the MC and representatives from the Swedish and Norwegian fishermen's organisation to prepare and plan the forthcoming matjes season from the supply side. This meeting was usually held in Sweden in early spring. Shortly after, the MC meets with the Dutch buyers in the Netherlands to obtain information of their expectations for the coming season in terms of demand (volume and quality) of matjes herring. These meetings aim at reaching an agreement on the operational rules for the coming matjes season.

An after-season evaluation meeting was held in Norway in the autumn. At these meetings representatives from the Norwegian and Swedish fishermen's organisations and the MC discuss the past season and prepare for the next one. In particular, the effectiveness of the operational rules are discussed in detail and alternatives were considered.

The MC has found it particularly important that to ensure cohesion among the participants, activities are coordinated throughout the year, and minutes from all meetings are distributed to all parties involved to ensure full transparency and minimise the Danish dominance by including the Norwegian and Swedish fishermen's organisations and the Dutch buyers in determining the operational rules for regulating the Danish matjes fishery.

The day-to-day management was conducted by the Purse Seiners' Producers' Organisation[3] (PSPO) on behalf of the MC in close collaboration with a representative from the regional processing industry. The day-to-day management includes monitoring of fishing activities, collection of catch data, determining the size of the weekly landing allocations and distribution of information to fishermen's organisations in Norway, Sweden and Denmark, Danish processors and Dutch buyers.

Enforcement of the operational rules is the responsibility of the respective national organisations representing the fishers: the PSPO only has enforcement authority over its own members and can only inform Norwegian and Swedish fishermen's organisations to encourage them to take action against the violators if some of their members break the rules. The coffee-meetings were also used to discuss quay-side rumours regarding non-compliance, particularly with the 6th commandment that states that herring landed for non-matjes purposes cannot be used for matjes. Both Hirtshals and Skagen are small communities, and thus stories (true or false) easily circulate. To prevent mistrust that potentially could undermine the self-regulation of the matjes fishery, the companies involved in the rumours were approached and given the chance to explain themselves. This also contributed to the transparency of the system.

The Danish processing industry ran two types of production during the matjes season: the matjes herring for the Dutch buyers and processed herring for their regular markets. The fact that both products used herring that was caught on the same fishing grounds sometimes created rumours that the herring bought directly from the vessels were used to produce matjes. This would have been a contravention of "Ten commandments" as all herring used for matjes should be bought at the public fish auction. Matjes herring bought at the fish action were more expensive than herring bought directly from the vessels and an economic gain could be made by cheating the system through use of herring brought directly from the vessels to produce matjes. The authors do not remember any case where there was substance to the rumours, but by discussing the rumours in the open as part of the coffee-meetings cleared the air and maintained legitimacy and trust in the system."

As the MC is a 100 percent voluntary agreement it only holds the power delegated to it by the organisations involved. Thus, the enforcement of rules is an integral part of the agreement and is built upon trust and confidence among all the participants, not only within the MC. Enforcement is undertaken by the respective organisations involved. Swedish vessels always complied with the regulations, and if Norwegian vessels were discovered violating regulations, the Norwegian Herring Sales Organisation excluded the vessel from participating in the matjes fishery in coming weeks. The Danish Purse Seiners' Producers' Organisation confiscates the profit obtained by Danish fishers with non-complying behaviour.

The open exchange of information and equal participation from all organisations created trust and confidence among participants and this mechanism has generated an economic surplus in the matjes fishery. This has only been reached through close cooperation among the parties involved. The institutional arrangements were an important factor in balancing the different interests in the matjes fishery.

Figure 3 shows clearly that it is possible to generate an economic surplus from this fishery. In 1996 the price paid for matjes herring was 2.5 times higher than the price

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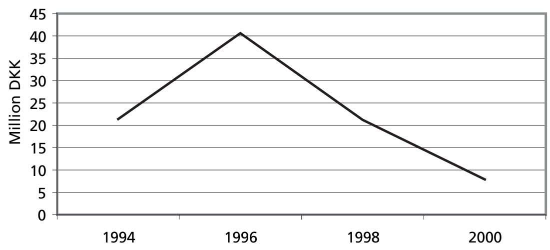
[3] In 2001, the Purse Seiners' Producers' Organisation was renamed the Danish Pelagic Producers' Organisation as membership is opened to all pelagic vessels independent on the type of fishing gear used.

FIGURE 3
Surplus profits in the Matjes Fishery 1994–2000



Source: Hirtshals and Skagen Fish Auctions, the Norwegian Herring Sales Organisation and the Danish Directorate for Fisheries.

paid for herring for filleting, thus generating a surplus profit of 40 million DKK by the vessels involved.

Raakjær Nielsen and Vedsmand (1999) found that "The Ten Commandments" were crucial for the success of the self-management of the matjes herring fishery and for maintaining a lucrative market for the fishers and a high quality of the herring landed for matjes for the Dutch buyers. The self-regulation of the matjes fishery was outstanding because Norwegian and Swedish fishermen's organisations voluntarily accepted to comply with regulations introduced by a regional Danish management committee, which proved that it is possible to increase profit in the fishery by collaboration and market adjustment.

4. 1998–2000 – THE PERIOD WHERE THE MATJES FISHERY LOST ITS EXCLUSIVENESS AND SELF-MANAGEMENT FELL APART

In 1997 very strong external pressure influenced the fishery, and the participation in the matjes fishery was changed dramatically. The recovery of the Atlanto-Scandian herring[4] and the fact that fishing rights to this stock were not allocated - neither inside the EU nor among EU, Iceland, Norway and the Faroe Islands – had the consequence that the Danish vessels entered this fishery to establish historical catch rights. The fishery for Atlanto-Scandian herring outside the Norwegian EEZ peaked in the same period as the matjes season. The increased competition for the matjes market in Egersund led to a demand to reduce the landing and handling costs, which were quite high due to requirements in the "The Ten Commandments".

The herring processing industry changed its production strategy during the 1990s and moved from having fresh herring fillet as the primary product to producing marinated herring. This had the effect that the processing industry, in contrast to the situation before, now was able to use a higher fat content herring in their production. Further, the herring stocks in the North Sea were low and the Danish processors were generally undersupplied with herring. Both the Danish processing industry and the Dutch buyers had an interest in sharing the landings among them: the Danish processors would secure more raw material and the Dutch would benefit from lower prices. In addition the economic significance of the contract work for Dutch buyers became less important for the economic performance of the processing plants.

In the view of the Danish processing industry and the Dutch buyers, "The Ten Commandments" gave little flexibility and the Danish vessels were no longer active participants, the essential actors – the Danes – in the self-management of the matjes fishery withdrew from the daily management process. This lead to a major change in the self-management of the matjes fishery and in 1998 "The Ten Commandments" was abolished, and a new set of landing rules was introduced.

The 1998 landing rules

These were as follows. Auction sales can take place in 3 different ways:

- in boxes (as usual)
- in containers and
- according to samples taken from fish tanks.

[4] The TAC increased to approximately 1 000 000 tonnes in only a few years.

According to the samples

- Every tank is offered for sale separately.
- At least 160 kg are sampled from every tank.
- The vessel decides the smallest (minimum 5 tonnes) and the largest volume to be sold as a sale lot.
- If the volume in a vessel hold is larger than stated, the buyer is not obliged to buy the extra volume – but has a right to do so.
- The buyer has no right to receive compensation if the volume is smaller than stated.
- The buyer decides how to unload the herring and pays all associated costs.
- Unloading takes place in the order the matjes herring has been sold at auction.
- The vessel can be requested to unload its catch immediately after the fish auction has finished.
- The sample remains in the auction hall as a reference until unloading is finished.

Thus, the self-management of the matjes fishery has become reduced to the introduction of a set of sales principles rather than self-management of the matjes fishery. From 1998 no coordination or matching of supply to demand has been undertaken that would have maintained a high-price market, and subsequently the ex-vessel sales of matjes lost their exclusivity. As a consequence the matjes market has developed into a bulk market, characteristic of the herring market in general – a high volume low-price situation. Another factor was that by allowing three different sales methods the ex-vessel sale process became less transparent, which contributed to undermining the system.

In 2000 the self-management of matjes fishery completely collapsed and the MC was dissolved. In reality, the self-management of matjes fishery was irreversibly damaged in 1998 when "The Ten Commandments" were abolished. As the self-management became only a sales principle, it was no longer possible to coordinate or manage, and consequently there was no possibility of collective action.

5. EVALUATION

The fact that there are many unquantifiable factors determining the quality of matjes herring may be one reason for the need for a close user-producer relation among the fishers, processors and the Dutch buyers in the matjes fishery as it was the case in the period 1992–97. The fact that the fishery was conducted by a small number of technologically homogenous vessels also made it more manageable.

The self-management undertaken by the MC seemed to be successful in creating incentives for collective action. The process of cooperation among different nationalities and *ceteris paribus* division of economic interests in the context of clearly defined operational rules with the possibilities of refinement was important. The self-regulation of the matjes fishery clearly demonstrated that it is possible by collective action to increase the economic output of a fishery by controlling the supply to the market, but this requires clearly defined rules.

Raakjær Nielsen and Vedsmand (1999) found that the reasons for the successful performance of the MC during the period 1992–1997 were as follows:

i. Clearly defined boundaries concerning the institutional set-up that made it possible for the MC to manage the matjes fishery.
ii. A limited number of vessels using the same gear participating in the fishery.
iii. A single-species fishery concentrated in a short period, with the herring sold to a single market with relatively few buyers.
iv. A high degree of participation by all parties involved in the decision-making process together with a transparent decision-making process and open distribution of information to all participants.
v. The creation of a set of clear and specific operational rules.
vi. Large economic benefits to the fishers from taking collective action.

In addition, the success of the self-management of the matjes fishery in the period 1992–97 can be traced back to the efforts of a few individuals and their professional capabilities, personal enthusiasm and the interpersonal relationships within the group. These people managed to ensure compliance and enforcement of the rules.

As in most fisheries it is important to have clear and simple rules such as “The Ten Commandments”. Their importance became obvious when the management measures were changed and the key-person withdrew from the MC.

However, the success of this example of self-management was also due to the fact that the external environment made it easy to create strong incentives for collective action. In practice the increased herring stocks in the North Atlantic, in particular for Norwegian vessels, created a situation where the importance of a high-price matjes market became almost non-existing for Norwegian vessels as lower matjes prices could be compensated by larger landings and the increased market share of the matjes market in Egersund is a good example of this.

The close user-producer relation, especially on quality aspects, might lead to increased discards as a way to maintain high-grade quality in the future, in particular if vessels have low catch allocations and can easily catch another school of herring. If this becomes a habit it will have a negative impact on the preservation of the herring stocks in Skagerrak and the North Sea and might create a political pressure on the matjes fishery e.g. from environmental lobby groups.

6. LESSONS LEARNED

The matjes fishery provides some general lessons for successful self-management.

- The more specific management objectives user-groups are given, the more important is homogeneity of the user-groups involved in terms of gear type and vessel size.
- Giving users competence in rule-making should lead to simple and clear rules, e.g. “The Ten Commandments".
- Giving fishermen's organisations competence in rule-making can increase responsible performance of the involved organisations, as they encourage their members to comply with the rules.
- Multi-user-group participation in co-management arrangements increases the legitimacy of decision-making and thus compliance with decisions.
- The co-management process depends heavily on the commitment of a few essential people and is best when driven from the bottom up.
- It is of major importance that user-groups can see the economic benefits of cooperation, not least in a short-term perspective.
- Self-management lead to improved economic performance of the fishery, in the case of the matjes fishery through coordination and market adjustment.

To integrate information and knowledge of resource fluctuations, fishing patterns and market trends in decision-making, institutions need to be flexible and able to adapt to external conditions. The close user-producer linkages and the weekly meetings in the matjes fishery provides strong resiliency in adapting fishing effort to market demand. However, the matjes case also illustrates that self-management arrangements are vulnerable to changes in the external environment, and that institutional resiliency is low in such situations.

7. IS THERE ANY FUTURE FOR (SELF-MANAGEMENT IN) THE MATJES FISHERY?

A number of external factors have changed in this fishery and some are likely to have a positive effect.

i. The Danish regulatory system for herring changed from 2003 with the introduction of ITQs. This should encourage fishers to do their utmost to maximize the value of their quotas and thereby have incentives to get involved in self-management to re-establish matjes herring as an exclusive product – and a consequential high-price.

ii. The Atlanto-Scandian herring stock has been allocated internationally including to EU member states. The Danish and Swedish vessels are therefore now free to pursue the matjes fishery and indeed, in 2003 there has been participation in the matjes fishery by Danish vessels.

iii. In the past, the Danish parties took all initiatives – and the others followed. When the Danish effort decreased, no one took over. However, in 2003 the Norwegian Herring Sales Organisation approached the Danish Pelagic Producers' Organisation to investigate how the two organisations could re-introduce self-management in the matjes fishery with the objective of obtaining a higher price in the market and a meeting was held to this end in March 2005. However, the meeting was unsuccessful in re-establishing joint Norwegian-Danish self-regulation of the matjes fishery.

iv. With the decrease in prices, the Dutch buyers have experienced increased difficulty in attracting sufficient supplies of herring to meet their demand, both in terms of volume and in terms of quality.

Others changes will have a negative impact.

i. The introduction of ITQs in the management of the Danish herring fishery means direct competition between the matjes market and the other herring markets through the year, i.e. the fishers are now free to decide themselves which market to supply.

ii. The production of matjes herring is becoming less and less important for Danish herring processing companies and the processing industry in the matjes season are ready to process large volumes of herring.

iii. The renewal and technological up-dating of the pelagic fleet has increased their capitalisation and lead to improved handling and cooling facilities. The result is that the low-volume matjes fishery is no longer financially attractive even if the landing price were to be higher as it cannot compensate for the higher costs associated in landing a substantial lower volume.

iv. The income obtained from fishing the North Sea herring is of minor importance to the fishers involved – irrespective of nationality. This is a consequence of the substantial increase in the price of mackerel in the last couple of years, the huge quantities of Atlanto-Scandian herring to be caught and the development of the fishery for blue whiting.

We believe that the change in external factors such as the implementation of IT/ITQ schemes for the pelagic fisheries in Denmark/Norway/Sweden, which has lead to fleet concentration and capitalisation, will make it impossible to reintroduce the matjes market as a high-price product. From a fisher's perspective the present matjes market is characterised by relatively high production costs per volume, production of small quantities per day and a high risk of unsold product. The herring fillet market, in comparison, offers lower costs, higher daily quantities and practically no risk of unsold product and, most importantly, the possibility of landing high volumes.

Fishers will only supply the matjes market if they are sure to be compensated with a much higher price that will compensate for the reduced volumes. Taking into account the structural development in the pelagic fleet, which is composed of a relatively small number of new or small vessels with large quotas, it will be impossible to obtain a price for matjes that will be attractive compared to supplying high volumes to the processing industry.

We are convinced that the days of the matjes fishery as an exclusive lucrative and well managed fishery are gone and will never return as the market niche has become too small for a fishery depending on economics of scale as is the case for the main pelagic fisheries.

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Sea-ranching in the Bay of Brest (France): technical change and institutional adaptation of a scallop fishery[1]

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1. INTRODUCTION

Despite a long tradition of cohabitation between fishing and shellfish farming along French coasts, interactions between these two activities are rather limited[2] and consist mainly in the fishing by some shellfish farmers.[3] The two industries have completely distinct professional organisations, they seldom hire the same manpower and they concentrate the bulk of their respective activities on different species.[4]

The Bay of Brest, which is located at the extremity of the Brittany Peninsula (Figure 1), is at odds with this general picture. This traditional shellfish-harvesting area had its first experience of strong interaction between shellfish farming and fishing after the collapse of its scallop fishery in 1963. Deprived of their major source of incomes, local fishers attempted to diversify their activity by targeting other species of shellfish (including two types of smaller pectinids), but also by developing a new business in the field of shellfish farming. This innovative process was based on the indigenous flat oyster (*Ostrea edulis*), a species traditionally cultivated in various places along the French coast of the Atlantic and English Channel, but which so far was mainly harvested on natural beds in the Bay of Brest. A cooperative created by fishers at the beginning of the decade became the major tool of their diversification towards oyster farming. Its output of farmed oysters soared from 320 tonnes in 1962 to 1 600 tonnes in 1973. However, a parasitic disease, which appeared in the Bay in 1973, put an end to this experience (Anon., 1977).

A second experience of interaction between fishing and shellfish farming has developed in the Bay of Brest during the last two decades. In contrast to the former, it involves integrating both activities in a unified process, rather than (partly) substituting

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[1] A first version of this paper was presented at the international workshop on "Regulating access to marine living resources in the coastal zone: international experiences and prospects for Brittany (France)" IUEM, Plouzané (France), 20–21 January 2006 <www.gdr-amure.fr>. The authors acknowledge J.-P. Carval (CLPM du Nord-Finistère), O. Curtil (UBO, CEDEM) and S. Julien (GdR AMURE) for their documentary help and comments.

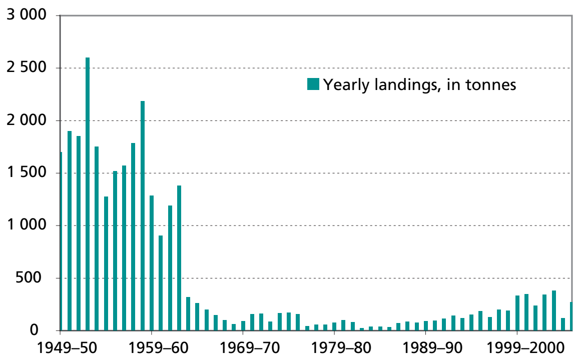
[2] Though the development of deepwater shellfish farming might develop space competition with inshore fishing.

[3] At the end of 2004, 11.7 percent of the total number of active fishing boats were registered in the "marine aquaculture/small-scale fishing" mixed category (Anon., 2005).

[4] In France, shellfish farmers grow mainly oysters and mussels and shellfish-capture fisheries mainly target scallops and clams.

FIGURE 1
The Bay of Brest

FIGURE 2
Bay of Brest scallop fishery: long-term evolution of landings



Source: local fisheries committee.

one for the other. The initial objective of the programme, which was launched in 1983, was to revive the activity of scallop dredging in the Bay by enhancing the natural spawning stock (Boucher and Dao, 1989). After a trial-and-error process resulting in a significant change in its initial philosophy, the programme took off during the second half of the 1990s (Fleury *et al.*, 2003; Boncoeur *et al.*, 2003).

The technical innovations behind this expansion required some institutional changes. A noticeable feature was that fishers themselves introduced these changes, in a legal and political context that could be seen as rather unfavourable. After a brief description of the fishery and of its restocking programme, we analyse the institutional mechanisms developed by local fishers to manage the new productive process. The last section of the paper discusses the limits of the system and its possible evolution.

2. THE FISHERY AND ITS RESTOCKING PROGRAMME

2.1 Shellfish dredging in the Bay of Brest

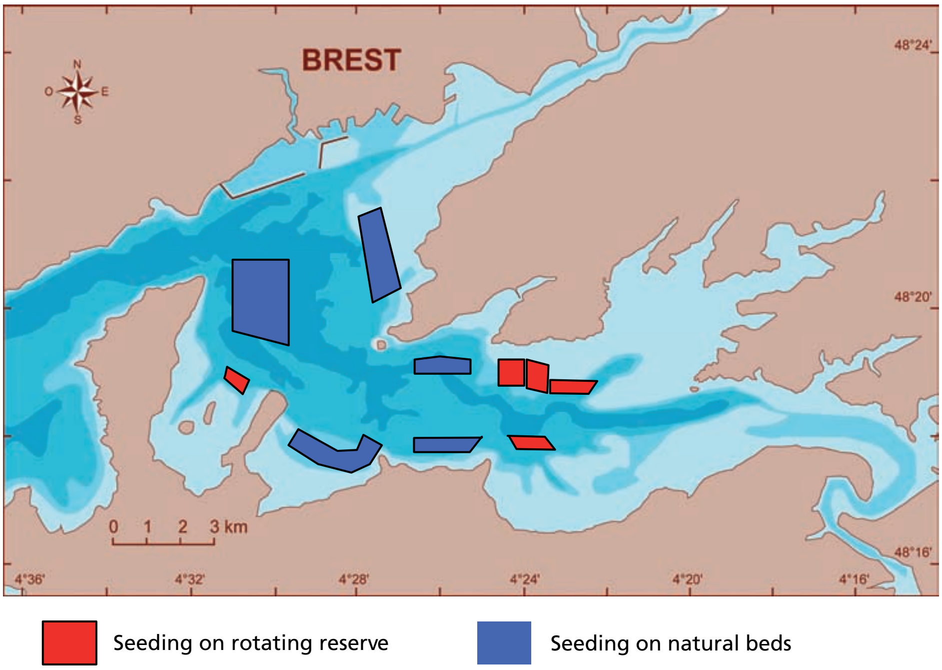
The Bay of Brest is a sheltered area of 180 km^2 and is surrounded by a densely populated zone[5] that is the base of various economic activities (naval base and military shipyard, commercial port, marina and intensive farming). Shellfish dredging is the only significant professional fishing activity in the Bay. It is a seasonal activity, with fishing campaigns usually taking place from October to March. When the season is over, most boats leave the Bay, to undertake various activities along the North-West coast of Finistère (Western part of Brittany) such as kelp harvesting or fishing with nets, pots and lines. The fishery is small-scale: in 2006, the fleet was composed of 50 boats, under 11 metres long, each of them operated by a crew of one or two. Though various species of shellfish are harvested in the Bay, the bulk of catches nowadays relies on two species: common scallop (*Pecten maximus*) and warty venus (*Venus verrucosa*). An estimated 273 tonnes of shellfish were landed in 2005–2006[6] and landings from the Bay of Brest represent approximately 1 percent of total French common scallop landings (Anon., 2006). The relative share of the Bay of Brest is more significant in the case of warty venus for which estimated landings amounted to 218 tonnes in 2005–2006 and represented approximately 20 percent of total French landings of this species (Ibid.).

Compared to the situation prevailing half a century ago, the present importance of the fishery is quite limited: in the beginning of the 1950s, the Bay of Brest was one

[5] The population of the urban area of Brest, the second most populated city in Brittany, was 303 484 persons in 1999 and the average population density of municipalities surrounding the bay is close to 400 persons per km^2 (Anon., 2003).

[6] Unless otherwise stated, data used in this paper were provided by the Local Committee of Fisheries of North-Finistère.

FIGURE 3
Scallop sea-ranching in the Bay of Brest: seeding strategy



Source: local fisheries committee.

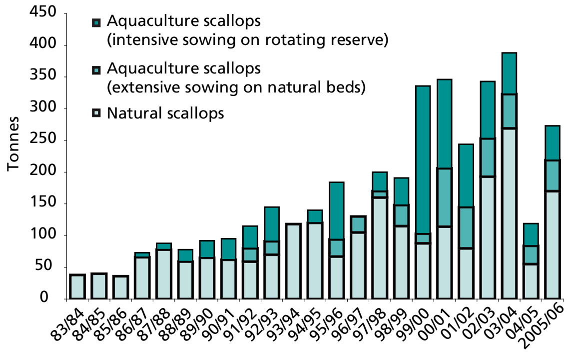
of the major common scallop fisheries in Europe with landings between 1 500 and 2 500 tonnes a year (Figure 2). However, the unusually cold temperature during the winter of 1962–1963 dramatically increased the mortality of juveniles and this climate accident accelerated the decline of a fishery, which was also exposed to a rapid increase in anthropic pressure, related to the motorization of the fleet after World War II (Piboubes, 1973; Boucher and Fifas, 1995). Only 362 tonnes of scallops were landed in 1963–64 and the downward trend continued during the following two decades. In the 1980s, common scallop landings from the Bay of Brest were less than 100 tonnes a year and a minimum of 25 tonnes was reached in 1983–84.

2.2 The scallop restocking/sea-ranching programme

A restocking programme, operated with scientific support from the marine research institute IFREMER, was officially launched in 1983. This programme relies on the activity of an aquaculture unit, including a hatchery-nursery,[7] and a farm growing scallop juveniles in cages at sea. Its original philosophy was to restore the biomass of potential spawners at a level high enough to restart the natural dynamics of the stock. However, the relation between spawning stock biomass and recruitment proved "extremely loose" in the case of *P. maximus* (Boucher and Dao, 1989) due to the fact that yearly recruitment of this species mainly depends on fluctuating water temperature (Fifas *et al.*, 1990). This empirical evidence led to a reorientation of the programme towards a strategy of sea-ranching: scallop juveniles produced by the aquaculture unit are placed in the Bay when they reach the size of 3 cm, so that fishers may harvest survivors two or three years later, once they have reached the minimum landing size of 10.5 cm. Two different sowing methods are used in parallel (Figure 3): extensive sowings on natural

[7] Inspired by the observation of Japanese techniques concerning another variety of pectinids, prior attempts had been made to collect natural post-larvae. The failure of these attempts led to the production of larvae in a hatchery, which was an innovation in the case of *P. maximus* (Fleury *et al.*, 2003).

FIGURE 4
Scallop fishing in the Bay of Brest: yearly landings by type of scallops, 1983–2006



Source: local fisheries committee.

beds and semi-intensive sowings in a rotating zone, closed to fishing during a three-year period (so-called "reserves").[8]

It took the programme a relatively long time to succeed. During the first 12 years, the restocking programme could not provide a significant contribution to the fishery because the yearly output of the aquaculture unit was too limited and fluctuating. As a result, in the middle of the 1990s, the perspective of cancelling the programme, which so far had been funded almost exclusively by public subsidies, was considered imminent (Boncoeur and Guyader, 1995). IFREMER ended its involvement in 1995. However, during the second half of the decade, the production of aquaculture juveniles grew rapidly and, as a result, the number of juveniles sown in the Bay each year rose from an average of 2 million in the first half of the 1990s, to almost 10 million in 2000. The increase in restocking favoured a recovery of harvested quantities (Figure 4): landings of scallops of aquaculture origin (which may be distinguished from naturally-spawned scallops because sowing generates a stress ring on their shell) rose from approximately 30 tonnes in 1990–91 to 230 tonnes ten years later. During the dredging campaign of 2000–2001, scallops originating from aquaculture amounted to more than two-thirds of overall scallop landings. Simultaneously, the financial scheme of the programme changed drastically. This transformation was critical for the programme survival, as public subsidies, which covered nearly 90 percent of its operating costs in 1995, fell to zero in 2000. Alternative funding was provided by a dramatic increase in the yearly cost of licences charged to fishers: from 70 euros a boat in 1994, it soared to 5 200 euros in 2001!

In 2000–2001, a survey was conducted to assess the economic impact of the scallop-restocking/sea-ranching programme for fishers and to investigate their opinions concerning this programme and its financial basis (Boncoeur *et al.*, 2003). According to a simulation developed within the survey, the estimated net contribution of the programme to fishers' annual income was 28 percent in 2000–2001. This contribution is substantial, considering the high cost of the licence fee and the fact that shellfish dredging is only a part-time activity. Unsurprisingly in these conditions, most fishers interviewed during the survey expressed positive opinions on the programme. Less obvious was the acceptance, also revealed by the survey, of the cost-recovery principle by a majority of fishers.

These results were made possible by several technical improvements in the productive process of the aquaculture unit (Fleury *et al.*, 2003). But this alone was insufficient and it was necessary to develop adequate management mechanisms for the new productive process.

3. MANAGEMENT

3.1 The Institutional Framework

French marine fisheries are controlled by the general rules of the EU Common Fisheries Policy (CFP). However, in the case of inshore fisheries, some specific rules apply. The

[8] On natural beds, density of scallops is normally around one individual per 10 to 25 m2, but it can get to one individual per square metre (Quero et al., 1992). In the case of intensive sowings, density rises up to 4-5 individuals per square metre.

most important is the ability for each member-state to exclude foreign boats from fishing in its own territorial waters (12 NM zone)[9]. Another important requirement is due to the fact that inshore fish resources are largely composed of "non-quota species", i.e. species that are not managed on the basis of the European system of TACs and quotas and to which only limited specific EU regulations apply (most shellfish species fall within this category).[10] These legal requirements allow significant latitude to member-states in the management of their inshore fisheries. As a result, a purely inshore fishery such as that of the Bay of Brest is mainly controlled by national rules.

At first sight, the French tradition of political centralism and bureaucratic interventionism fully applies to fisheries management. According to French law, all national decision powers in this field belong to the state, either directly or ultimately[11]. The administrative body in charge of implementing fisheries management decisions is headed by people with military status,[12] reminiscence of Colbert, a minister of the absolute monarch Louis XIV who showed great interest in fishers as a reserve of manpower for the king's navy (the present welfare system for fishers and merchant navy sailors was introduced by Colbert). Another aspect of the Colbertian tradition in French fisheries management (revived during World War II by the Vichy administration) is its corporatist style. The law has instituted a professional organisation of marine fisheries, where by all members of the industry are represented, with a parity of representation for boat-owners and crew members.[13] This organisation is hierarchical, with national, regional and local levels. Each fisher necessarily belongs to a local fisheries committee and participates in the election of the board of this committee. Local committees are represented in the board of the regional fisheries committee where they belong and regional committees are represented in the board of the national fisheries committee. The Bay of Brest fishery falls within the scope of the local fisheries committee of North-Finistère, which belongs to the regional fisheries committee of Brittany.

In the pure Colbertian tradition, the law stipulates that the professional organisation of marine fisheries is under the administrative control of the ministry in charge of the fishing industry.[14] However, it also gives this organisation the opportunity to take part in the fisheries management with a deliberative, though conditional power. According to this legal disposition, the national committee and regional committees are entitled to take resolutions concerning the conservation of fish resources and the administrative authority has the option (but not the obligation) to give these resolutions a compulsory character.[15] In practice, the top-down appearance retained by this formulation is largely a fiction: nowadays, most decisions concerning inshore fisheries management are taken by the professional fisheries organisation and are simply endorsed by state administration. The most dynamic trend concerning inshore fisheries management is the development of a variety of fishing licences by regional fisheries committees. The regional fisheries committee of Brittany has played a pioneering role in this field (Curtil, 2006).

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[9] Except in case of duly recognized "historical rights".

[10] In the case of *P. maximus*, the only specific regulation concerns the minimum landing size, set at 10 cm. Member-states may adopt more restrictive regulations: in the case of the Bay of Brest, the minimal landing size for common scallops is 10.5 cm.

[11] The basic French regulation concerning marine fisheries is a XIXth decree (*Décret du 9 janvier 1852 sur l'exercice de la pêche maritime*), which was modified several times since its first publication. Since the beginning of the CFP in 1983, there have been major modifications to make it consistent with EU rules.

[12] *Administration des Affaires maritimes.*

[13] The present status of this organisation is defined by a 1991 law (*Loi n°91-411 du 2 mai 1991 relative à l'organisation interprofessionnelle des pêches maritimes et des élevages marins et à l'organisation de la conchyliculture*). Shellfish farming (*conchyliculture*), which represents by far the major part of marine aquaculture in France and has its own professional organisation while the rest of marine aquaculture (called *élevages marins* by the law) is administratively tied to the fishing industry.

[14] Article 16 of the above-mentioned 1991 law.

[15] Ibid., Article 5.

Unlike national and regional fisheries committees, local fisheries committees are only given an advisory role by law. However, according to circumstances, these committees may play a much more active role than simply providing advice, especially in the case of purely local fisheries. This consideration fully applies to the Bay of Brest shellfish fishery, which, in practice, is managed by the local fisheries committee of North Finistère, under the formal supervision of the regional fisheries committee shellfish commission and the state administration.

The management of this fishery is based on two specific regulations. First, the fishery was declared a "registered site" in 1964, an administrative decision making it possible to take special conservation measures for local endangered shellfish resources. Second, a limited entry licence system was introduced in 1985. In practice, the two mechanisms have merged and are managed jointly by the local fisheries committee.

3.2 Management innovations

Adapting the management of the fishery to the new productive process generated by the restocking/sea-ranching programme raised two types of institutional difficulties. One concerned space management and the other regulating access of fishers to the resource. Successfully sowing juveniles at sea requires exerting some control over the zones where these operations take place. First, it is necessary to protect beds from disturbance by human activities soon after juveniles have been sown.[16] A second condition, critical in the case of intensive sowings on the rotating reserve, is to make sure there is no premature harvest of the scallops. Fulfilling these conditions is complicated by the fact that fishers, unlike farmers, have no property rights, or exclusive use rights, on the space where they do their scallop restocking. To overcome partly this difficulty, the local fisheries committee first thought of providing a legal status to its rotating reserve by having it classified as a shellfish-farming concession. However, this idea proved unrealistic from an economic point of view because the fees paid to the state for shellfish-farming concessions are established on the basis of oyster or mussel cultivation, which corresponds to much higher densities (and hence revenue per surface unit) than scallop farming.

Another institutional difficulty was related to the regulation of access to the resource. If the French system of licences empowers the industry to control, under formal state supervision, the access to inshore fish resources, it is a well-established tradition, in this country, that fishers should not be charged much more than a symbolic fee for this access, which implies administrative rationing rather than market equilibrium.[17] As a result, the idea that fishing licence fees should bear some relation to the scarcity of fish resources and with the cost of fisheries management is quite unfamiliar to the national political culture. In this context, convincing fishers that they should cover the operating costs of a restocking programme (so far entirely funded by public money) was anything but trivial, even assuming a substantial improvement in the results of the restocking programme.

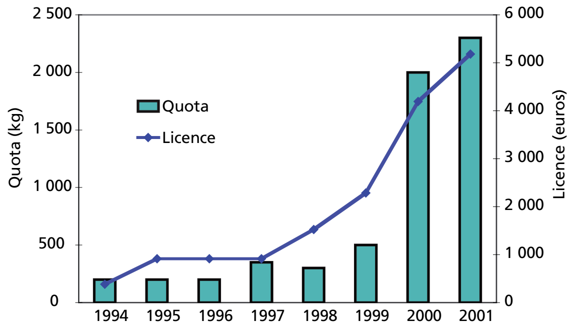
The local fisheries committee addressed these institutional problems quite pragmatically.

Concerning space management, the committee took advantage of the possibilities offered by the joint system of "registered site" and shellfish licence to delimit the zones open to dredging each year and fishing season. In this way, it was possible to prevent

[16] A typical cause of disturbance is the use of towed fishing gears in the area. As trawling is forbidden in the bay, the problem amounts to controlling the time and place of shellfish dredging operations.

[17] Of course, this well-established principle does not imply that access is actually free: using hedonistic prices methodology, Guyader *et al.* (2006) demonstrated that, on the average, 50 percent of the price paid for a second-hand fishing boat in France during the 1990s represented an implicit cost of access to the resource (notwithstanding the fact that, according to French law, specific licences are not supposed to be sold with boats).

FIGURE 5
Scallop fishing in the Bay of Brest: shift towards cost recovery and 'quota strategy', 1994–2001



Source: local fisheries committee.

natural scallop beds from being dredged too early after the sowing of juveniles and also to ban scallop fishing for the number of years considered appropriate (usually three) in the zones of intensive restocking. The so-called "reserve" has no other legal recognition.

As regards cost-recovery, it was necessary to convince fishers of accepting a dramatic increase in the yearly shellfish licence fee. To this end, the local fisheries committee adopted a strategy based on the harvest of the reserve. In contrast to the harvesting of natural scallop beds, which are managed on an input-control basis (limitation of fishing time and fishing power), harvesting the rotating reserve is managed by means of individual catch quotas. The size of these quotas is the same for all licensed boats. These are established each year by the committee according to the abundance of harvestable scallops in the reserve. The improved technical results of the aquaculture unit made it possible to raise the quota from 200 kg a boat in 1994 to 2 300 kg a boat in 2001. During that period, the policy adopted by the committee was to increase the annual quota and licence fee proportionally (Figure 5), so that the fee charged to fishers could be kept below the revenue provided to them by the quota. As a result of this "quota strategy", fishers concluded that the quota, which could be harvested with little effort due to the high density of scallops in the reserve, "paid the price of the licence" and, moreover, left them a bonus. Naturally, the success of this policy relies on the productivity of the reserve, which depends on the quantity of juvenile scallops that were sown and of their survival rate. It is also conditioned by the level of landing prices.

4. DISCUSSION

4.1 Recent history

The technical and financial achievements observed during the second half of the 1990s were critical for the survival of the scallop-restocking programme of the Bay of Brest. Moreover, during this period, Bay fishers demonstrated their ability to transform a scientific experiment funded by public money into an economically sustainable activity based on cost-recovery and to manage it. To this end, they created a new cooperative in close relation with the local fisheries committee. The cooperative sells the juveniles to the committee at a price covering production costs. The committee restocks the juveniles, manages the fishery and collects the cash necessary for buying the juveniles through the licence fees. This sea-ranching model is quite innovative in France and managers of other scallop fisheries have expressed their interest in this innovation buying limited quantities of juveniles from the Bay of Brest cooperative to test the feasibility of the model in their own fishery.

However, the recent evolution of the Bay of Brest fishery shows that this model is not yet stabilized. It faces several important risks that might jeopardize its economic sustainability. Some of these risks are due to exogenous threats (3.1) and others are related to endogenous deficiencies of the management system of the fishery (3.2).

4.2 Exogenous threats

First, the fishery is exposed to significant environmental risks. One of them is due to the increasing frequency of various toxic microalgal blooms in the Bay, probably related to the influx of nutriments generated by agriculture and other human activities around the Bay. Some of these blooms (*Gymnodinium cf. nagasakiense*) cause a high mortality of scallop larvae and post-larvae; others make adult scallops temporarily unfit for human consumption. The 2004 *Pseudo-Nitschia* diatom bloom cut the 2004–2005 by four months and there was a resulting drop in quantities harvested from natural beds of 72 percent compared to the average of the three previous campaigns. Another environmental risk is due to the proliferation of an exotic shellfish (*Crepidula fornicata*), accidentally imported in the Bay some decades ago that acts as a competitor with common scallop for space. The proliferation of *Crepidula fornicata* is a challenge to sea ranching in the Bay, because it reduces the number and surface of areas that are fit for restocking of scallops juveniles. The local fisheries committee has elaborated a containment programme (Frésard and Boncoeur, 2006), but the problem raised by the disposal of significant quantities of valueless harvested invasive shellfish is still unsolved. Moreover, some scientists have expressed concern about the environmental risks of this harvest as the invasive species are suspected of acting to limit the occurrence of toxic microalgal blooms (Chauvaud *et al.*, 2003).

Besides environmental risks, the sea-ranching programme faces an economic risk related to price volatility. The landing price of Bay of Brest scallops is mainly influenced by landings from the the Bay of St-Brieuc and the Bay of Seine which are the two major French scallop fisheries (Boncoeur, Divard and Guyader, 1977). Significant fluctuations of landings are observed in these large fisheries, generating considerable price changes with direct repercussions on the Bay of Brest scallop fishery. For instance, in 2004–2005, the average landing price of the Bay of Brest scallop dropped by 20 percent compared to the average of the three previous years and this phenomenon added its negative consequences to fishers' incomes in addition to those of the *Pseudo-Nitschia* bloom (see above). In order to limit these consequences, the local fisheries committee obtained a derogation from the state concerning the scallop fishery closing date[18] and authorized fishers to harvest an extra 30 tonnes of scallops from the reserve. They decided to reduce exceptionally the licence fee by 45 percent for year 2005[19]. However, this was not enough for preventing a decrease in the number of licensed boats, which dropped from 70 in 2004 to only 55 in 2005, endangering the financial equilibrium of the sea-ranching programme.[20]

4.3 Endogenous deficiencies

The impact of environmental and economic exogenous factors might be worsened by some endogenous deficiencies concerning the management system of the fishery and its sea-ranching programme. The financial scheme of the programme offers a good entry point for the analysis of this question. Though it had the great merit of creating the conditions for cost-recovery in a limited number of years, the scheme has two major drawbacks: (a) it generates distortions among fishers and (b), it does not favour their long-term commitment to the programme. Distortions arise from the fact that the annual licence fee is uniform and therefore does not account for the differences between individual harvesting capacities.[21] Advocates of the present system underline that the counterpart of a uniform licence fee is a uniform harvesting quota, but this argument is not fully convincing since the licence covers the various shellfish resources of the Bay and not only the scallop stock of the reserve. Estimations of the resulting distortion showed a significant impact on the income of fishers (Alban *et al.*, 2004). The second major drawback of the present system is the lack of long-term commitment

[18] A national regulation prohibits common scallop harvesting between 15 May and 30 September.

[19] Although each scalloping campaign takes place over two years, licences are established on January-to-December basis.

[20] Despite a recovery of landings in 2005-2006, the number of licenses has continued to shrink and only 49 boats took a license in 2007.

[21] As proven by individual landings declarations, these differences are far from neutralized by the limitations imposed by the licence system concerning boat length and characteristics of dredges.

to the programme and is due to the fact that fishing licences and associated fees are annual. In a fishery where these fees are high, this feature is likely to induce free-riding behaviours, as fishers may be tempted to take a licence only if the next campaign is expected to be rewarding enough. The development of such short-term opportunistic behaviours would directly threaten the sustainability of a programme depending on long-term commitment of stakeholders.

These two deficiencies may certainly be overcome, but significant steps in this direction would probably induce major transformations in the present management system. For instance, putting an end to the distortions between fishers caused by uniform licence fees would require each one to be charged in proportion to the benefits he gets from the fishery. This might be achieved by taxing landings, or by generalizing the individual quota system that, so far, has been used only for the harvesting of the reserve. Both solutions require a good transparency of landings, a condition which was not considered as fully satisfied by fishers themselves at the beginning of the present decade (Boncoeur *et al.*, 2003). Despite their efforts to increase transparency, the local fishers organisation estimates that, on the average, fishers fail to record 20 percent of their catches from natural beds.

In a similar way, stimulating long-term commitment of fishers could be achieved by creating a multi-annual licence, or a system of permanent quotas defined as percentages of a TAC that would be revised each year, according to harvestable stock abundance. But in both cases, fishers would probably not accept the long-term financial commitments if it was not associated with a certain amount of liquidity, which calls for explicit transferability of fishing rights.

5. CONCLUSION

Though the second attempt of Bay of Brest fishers to sustain their activity by combining it with aquaculture shows greater longevity than the earlier one, the fishery is far from having recovered the level of abundance and activity it had reached half a century ago: since 1999, annual scallop landings have amounted to 312 tonnes on the average[22], which is scarcely one fifth of the average level observed during the 1950s (the ratio is only 12 percent for the number of jobs). Nevertheless, compared to the situation prevailing in the 1980s, the improvement is significant. With due provision for fluctuations in natural recruitment, it is clear that the restocking/sea-ranching programme has plaid a major role in this improvement: scallops originating from aquaculture have amounted to 55 percent of total Bay scallop landings over the period 1999–2004. Moreover, this technical achievement was combined with a spectacular evolution towards economic sustainability: the programme moved in five years from complete financial assistance to a situation of cost-recovery. The fact that the level of the annual licence fee paid by the Bay of Brest fishers has no equivalent in the whole French fishing industry underlines the unusual character of this transformation.

Probably the most striking feature of the programme management is its adaptability. This feature first showed itself on a technical ground: initially aimed at rebuilding the biomass of the spawning stock, the programme was redirected towards sea-ranching when it became clear that the spawning stock biomass had little influence, if any, on annual recruitment. The same pragmatism may be observed in the field of institutions and finance. Facing an original configuration and an inappropriate institutional environment, the local fisheries committee showed a real sense of creativity. Taking advantage of the licence system, it demonstrated a capacity to manage space so as to make restocking operations viable and to durably operate a reserve in the absence of

[22] Dredging campaigns from 1999-2000 to 2005-2006, excluding 2004-2005 campaign where the fishery was closed for four months due to a toxic microalgal bloom. Including this campaign would bring the average down to 286 tonnes.

any legal base. The programme was initially conceived as a simple technical experiment, but the reserve then came to play a highly political role when the committee had to convince its members to pay for the cost of the programme.

Notwithstanding the undeniable merits of this institutional creativity, outcomes are fragile. As regards space management, the increase in environmental risks underlines the fact that the sustainability of the fishery and its sea-ranching programme cannot rely only on the control of fishing space: without an integrated management of the Bay area seriously addressing the problem of effluents coming from inland activities, sea-ranching might well be the next victim of the recurrent toxic micro-algae blooms.[23] The problem is not merely institutional: not only is the local fisheries committee deprived of any legal capacity to regulate inland activities, but the economic (and political) weight of these activities is far more important than that of the small-scale shellfish fishery of the Bay.[24] Considering this difficulty, forming an alliance with environmentalist groups might be a rewarding strategy for fishers, but it would require overcoming some cultural barriers.

The existence of serious exogenous threats is undeniable and we argue that the fragility of the fishery and its sea-ranching programme also have endogenous threats, namely deficiencies of the management system. Reforms that could improve the situation may be classified in two categories: (a) actions that are clearly within the scope of the local fishers organisation (which does not imply that they could be easily achieved) and (b), actions probably calling for changes at a higher level. Increasing accurate reporting of landings belongs to the first category. This reform is obviously high on the agenda: it requires an accurate and reliable monitoring of the fishery and is a prerequisite for a financial scheme generating fewer distortions and more incentives for a longer term commitment than exists at present. On the other hand, making fishing rights multi-annual and transferable would contradict present French law.[25] Assuming the local fisheries committee had this type of reform on its agenda, it is not sure that the creativity it showed in the past would be enough to overcome this difficulty.

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[23] An EU directive requires that inshore saltwater, as well as continental freshwater, should have a "good ecological condition" by 2015. This requirement is likely to provide fishers with a strong legal base for defending their cause, though what is exactly meant by "good ecological condition" of water is still a matter of debate. Moreover, 2015 is still in the distant future, compared to the immediate timing of some imminent environmental threats hanging over the fishery.

[24] Farming and agro-industries provided 11,000 jobs in the Brest employment area in 2001 (Anon., 2003).

[25] Loi n°97-1051 du 18 novembre 1997 d'orientation sur la pêche maritime et les cultures marines, art. 4.

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Rights based management in the United Kingdom – the Shetland experience

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1. INTRODUCTION

In 2005, Seafish Economics was asked to undertake a study related to the Shetland community quota (CQ) scheme. The overall objective of the research was to evaluate the impact the scheme had on the Shetland fish catching sector and related onshore industries since its introduction in 1998. The study also formed part of a larger research programme designed to evaluate the effectiveness of Community Quota (CQ) schemes in the UK. In 2006, the findings of that research were used to prepare papers considering the future of the market-based approach to quota management in the UK (Anderson 2005a, 2006). Since then, renewed consultation with the Shetland Fish Producers Organisation (SFPO) took place so that the paper of 2006 could be updated for this publication.

This is not the first time the Shetland CQ scheme has been discussed. In 1998, John Goodlad (then CEO of the SFPO), authored a paper that was published in Shotton (2000). Goodlad (2000) in a paper titled "Industry perspective on Rights-based Management: The Shetland Experience" discussed the development of the UK quota management system, the role of Producer Organisations (POs) and the workings of the SFPOs new entrants scheme as it was then known. The objectives here are to continue the story post 1998 by detailing the development and subsequent abolition of the original Shetland CQ scheme, and to discuss what lessons can be learned from this experience as the UK and EU are both committed to improving the effectiveness of the current rights-based management (RBM) approach to quota management.

2. SHETLANDS' SEAFOOD INDUSTRY AND WHITE-FISH SECTOR

The Shetland Isles, a group of islands approximately 150 miles north of Scotland, have traditionally been one of the most fisheries-dependent communities in Europe. With a population of around 22 500,[1] the islands have historically been heavily involved in fish catching, fish processing and, more recently, have developed a sizeable aquaculture industry focusing mainly on the production of farmed salmon. Shetland seafood products are considered to be of premium quality and are exported throughout the world. Around 2 000 people[1] are employed in the Shetland seafood industry accounting for approximately one sixth of the total employment in Shetland. In 2003, the combined output of all the fisheries related sectors was £243m,[1] four times the output of the oil sector and over half the total output of the entire Shetland economy.

[1] Shetland in Statistics 2005 Economic Development Unit Shetlands Islands Council <*http://www.shetland.gov.uk/council/documents/sins2005.pdf*>.

PHOTO 1
Making the codend fast before emptying a smallish bag on the deck

PHOTO 2
Sorting and gutting the catch prior to icing.

Over the last decade, the number of white-fish vessels in Shetland has greatly reduced, with the catching capacity of the fleet decreasing by approximately 40 percent as a result of three rounds of decommissioning and vessels being sold out with Shetland due to a poor financial climate. Shetlands' white-fish fleet now consists of 26 vessels[2] using traditional trawl, gill-net and seine fishing methods. In 2005, the combined sales turnover of the fleet was £11.6m,[3] primarily comprising approximately 10 000 tonnes of high value haddock, cod, hake and monkfish. Shetlands' white-fish fleet is also supported by a well-developed and long-established shore-based infrastructure that is undoubtedly amongst the best in the UK. Support services include vessel agents, an auction market, quality inspectors, ice providers, engineers, net menders, stores, chandlery and other associated ancillary businesses. Photos 1, 2 and 3 show aspects of fish handling in this fishery.

3. THE EVOLUTION OF RIGHTS BASED MANAGEMENT IN THE UK

UK fisheries management decisions are bound by international obligations under the EU Common Fisheries Policy (CFP). The main aims of the CFP are the sustainable exploitation of fish stocks controlled through management policies specifically designed to protect the commercial fish species targeted by the EU fishing fleet. The main 'output control' of fisheries management in Europe is the annual allocation of Total Allowable Catches (TACs) and quotas. TACs for each fish stock are determined by species and area, and are then divided into national quotas according to a set allocation mechanism known as 'relative stability'. This mechanism ensures TACs are allocated to each Member State based on their historic fishing patterns.

The UK, like most other EU countries, employs a rights-based management (RBM) approach to the allocation of commercial fishing quota. The UK system has evolved in just over 20 years from a 'Sectoral Quota' (SQ) system of allocation to a 'Fixed Quota Allocation' (FQA) mechanism. Prior to 1999, UK quota allocations were based on the

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2 Source: SFPO.

3 Scottish Government Marine Directorate data team.

PHOTO 3
Catch of prime soles being transferred to the hold.

individual track record (recorded landings) of fishing vessels over the previous three years. Formalizing this allocation method led to a system of FQAs being introduced. The FQA system was based originally on the track records of vessels during a fixed reference period (1994 to 1996). The perceived advantages of the FQA system were greater year-on-year stability in both predicting and managing annual quota allocations, less pressure on fishermen and POs to maintain their track records by using their full quota allocation (a disincentive to record "paper" or "ghost" fish), and the more rapid issue of the allocations at the beginning of each year.

FQAs (measured in quota units) are set annually for specific stocks and areas (e.g. North Sea cod) based on the current year's TAC. The FQA is a percentage allocation of the total quota available for a particular species within a defined area, and each UK registered vessel that recorded landings of quota species during the reference period has a fixed number of FQAs. If, for example, the European Commission (EC) decides North Sea cod quota is to be halved between 2007 and 2008, then the volume of catch associated with each vessel's North Sea cod FQA unit should also halve.

4. FORMATION AND FUNCTION OF PRODUCER ORGANIZATIONS IN THE UK

The devolved management of fish quota in the UK is predominantly conducted through POs. There are currently 19 Producer Organizations in the UK (and one pelagic management group – Lunar Fishing), which are responsible for distributing fishing quota to approximately 95 percent of UK vessels (termed 'the sector') on behalf of the government. This could be interpreted as a form of regional 'self-governance'. In the UK, the first seven POs were set up in the 1970s, and the SFPO was created in a second wave of PO formation in the early 1980s, when vessel owners started splitting off from the established POs, mainly due to geographical location. Then, in 1985, POs were given the opportunity for the first time to directly manage fish stocks subject to TAC restrictions. This move meant that POs could plan the optimal uptake of quota allocations for the benefit of their members.

The SFPO is currently the second largest UK PO in terms of output, with 34 member vessels and an annual turnover of around £34m[4] in 2005. The Scottish Fishermen's Organisation (SFO) is the largest UK PO, with over 200 vessels and an annual turnover of around £115m[4] in 2005. Both POs have significant pelagic interests.

[4] A Review of UK Producer Organisations: The effectiveness of service in quota management, quota trading and market/price support. Prepared for the UK Fishery Administrations August 2006 <*http://www.defra.gov.uk/fish/sea/manage/qmcp/pdf/060929-study.pdf*>.

The SFPO is responsible for the uptake of approximately 8 percent[5] of the annual UK white-fish TAC, compared with 30 percent[5] for the SFO.

Although the primary role of the POs is to implement CFP market regulations (e.g. marketing and/or withdrawal prices), in reality, quota management is now the main function for the majority of UK POs, with little attention paid to market and demand conditions[4] as vessel agents have more influence in those areas and therefore POs argue their intervention is unnecessary.[4] The SFPO and the SFO are the exceptions with marketing remaining their primary function. Managing quota is seen by these POs as a secondary, but equally as important, responsibility. Both POs have invested heavily in fish processing facilities. The SFPO is a major shareholder in Shetland Catch, the largest pelagic processor in the UK. It is also a shareholder in Shetland Fish Products, and is active and influential in supporting other local strategic investments – in fishmeal processing, quality management, electronic auction trading and CQ.

POs operate different allocation systems, largely based on the preferences of their members. In order to become a member of a PO, a vessel must usually demonstrate that it has enough fishing opportunities (or FQAs) in relation to the catching capacity of the vessel. Although FQAs are associated with the licences of individual vessels, POs administer the FQAs on their behalf. Each PO can choose how it allocates the quota deriving from the FQAs of each member vessel, providing their method is compatible with the approach agreed by that PO's membership. There are two main systems of quota management operated by UK POs – pooled or individual quotas (IQs).[4]

An IQ system essentially means that vessels manage the uptake of their own allocation of FQAs based on the vessels' track records (1994–1996). In pooled systems, vessels FQA entitlements are combined and managed collectively by the PO for distribution amongst members. In practice, there are a range of management approaches between these two extremes,[4] meaning that either the pool can operate with some of the flexibility of an IQ system, or that a PO may operate both pool and IQ systems at the same time.

For white-fish opportunities, the SFPO operates a pool plus IQ system, which means that the primary management system is a pool, extended by the facility to specifically allocate quota to individual vessels. However, members are also offered the opportunity to operate on an IQ-only basis, and one SFPO vessel chose that option. The SFO operates similarly, except without the IQ-only option. Where POs operate both pool and IQ systems, it is generally larger vessels; in particular those that have accumulated increased FQA entitlements that choose an IQ system, as was the case in Shetland.

5. ISSUES SURROUNDING THE UK RIGHTS-BASED MANAGEMENT SYSTEM

Since their inception, RBM systems have been the focus of much debate.[6] Trade in quotas in the UK began in the early 1990s, and increased dramatically in 1999. The current FQA system also facilitates the leasing of quota, which can be either for a single year or a number of years. UK POs regularly trade quotas with each other to facilitate trade between members, and to help ensure the whole quota allocation is taken. Maximum uptake and vessel profitability are not always mutually compatible, but POs try to allocate FQAs in a way that maximizes fishing opportunities for member vessels. Most operators within the UK industry would agree that the tradability of fishing rights has resulted in a more efficient use of fishing opportunities, and has helped facilitate the concentration of vessel and quota ownership in the UK fleet over the last decade. However, it is also widely recognized that the current management regime is far from perfect.

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5 SEERAD Sea Fisheries quota uptake figures.

6 In February 2007, the Commission tabled a communication on rights-based management tools in fisheries aimed at launching a debate on fishing management systems. <*http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/245&format=HTML&aged=0&language=EN&guiLanguage=en*>

Although 'unattached' FQA units resulting from the various vessel decommissioning schemes have in most cases been consolidated onto vessels remaining in PO membership, in some cases, FQA units have remained out of the active catching sector. As a result, 'slipper skippers' (retired or ex-fishermen, quota traders and financial institutions) have become increasingly engaged in leasing quota to active fishermen. This obviously affects the profitability of active vessels, however most operators would prefer to have the option of paying to lease additional quota rather than discard their catches at sea. There is also evidence to suggest that market forces have resulted in fishing quota being traded away from some fisheries-dependent communities, with negative social and economic consequences for the regions losing the quota. Although some FQA holdings remain out of the active catching sector in 2007, the number of units involved has, according to UK fisheries administrations, reduced significantly in recent years.

The current FQA system has some of the features of property rights and closely reflects an Individual Transferable Quota (ITQ) system. However, unlike an ITQ system where quotas have become private assets, the legal status of FQAs is uncertain. Although FQA units can be bought and sold, the quota holder does not have a legal entitlement to the quota, which remains in the hands of the UK government. Many believe, therefore, that the FQA system is the cause of much uncertainty surrounding investment and long term planning for white-fish vessel owners, some of whom have been unable to use their FQA as security for loans to invest in further FQA holdings.

In March 2004, the Prime Minister's Strategy Unit published a report aimed at securing a sustainable and profitable future for the UK fishing industry. The report suggested that *"the FQA system does not provide the required clarity of ownership, and accompanying rights and responsibilities, nor a liquid and transparent market in fishing opportunities that would enable the UK fishing fleet to compete in world markets."* [7]

To counter these threats, some regions of the UK have implemented various forms of CQ schemes in an effort to retain fishing opportunities within their fishing communities. A CQ scheme is essentially a scheme implemented by fisheries dependent communities to purchase and distribute fish quota in a way that benefits local fishermen. In recent years, at least three CQ schemes[8] have operated in various formats around the UK, with other regions considering a similar approach. This report examines in detail the largest scheme, which is operated by the SFPO in Shetland. Similar schemes were also set up in Orkney and Cornwall; however none were of the same scale as the Shetland CQ scheme.

6. THE SHETLAND COMMUNITY QUOTA SCHEME

In 1993, the SFPO was faced with dwindling fishing opportunities, a poor financial climate, and the inability of white-fish vessels to secure bank loans for investment in quota and borrowed money to fund the purchase of two fishing vessels which had 2 386 tonnes of white-fish quota holdings. The loan repayments were financed through an extra levy paid by SFPO member vessels. At that time, this equated to approximately 16 percent of the total SFPO white-fish FQAs. The vessels were then sold again out of the Shetlands, together with their fishing licence, but excluding the FQAs. The intention was to allow the quota to be accessed as required by current and future SFPO members, through a reserved ('ring-fenced') pool system. The rest of the UK industry

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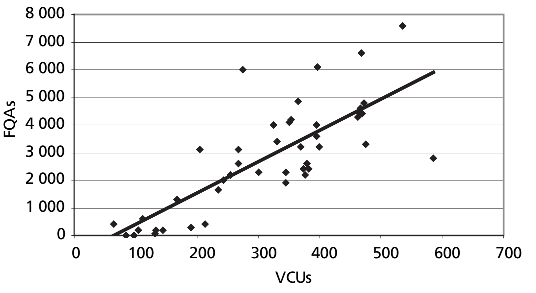
7 Prime Ministers Strategy Unit, March 2004, Net Benefits: A sustainable and profitable future for UK fishing: <*http://www.cabinetoffice.gov.uk/strategy/publications/*>.

8 Argyll and Bute council development services; 4th November 2004; Agenda No. 10: Community held fishing quota in the Highlands and Islands; <*http://66.102.9.104/search?q=cache:V-DereY-_j0J:www.argyll-bute.gov.uk/moderngov/mgConvert2PDF.asp%3FID%3D16026%26J%3D1+orkney+community+quota+scheme&hl=en&ct=clnk&cd=6&gl=ukhttp://66.102.9.104/search?q=cache:V-DereY-_j0J:www.argyll-bute.gov.uk/ moderngov/mgConvert2PDF.asp%3FID%3D16026%26J%3D1+orkney+community+quota+scheme&hl=en&ct=clnk&cd=6&gl=uk*>.

FIGURE 1
Mock VCU/FQA scatter-plot of SFPO member vessels



deemed the investment controversial because this bold move by the SFPO meant they became the first PO in the UK to hold quota in its own right. Purchasing the quota proved both necessary and successful for the SFPO and its members. Since 1993, the FQA holdings of five white-fish vessels were acquired using this method whenever an attractive investment appeared on the market, forming what is currently known as the "SFPO 'ring-fenced' pool". The ring-fenced quota still creates a strong incentive for quota to remain in the Shetlands, because any vessels who decide to leave the SFPO will also lose the benefit of having access to the ring-fenced quota. This quota pool continues to operate successfully today.

In 1998, the SFPO, with the financial backing of Shetland Islands Council (SIC), decided to invest in a further 2 445 tonnes of white-fish FQA through its commercial arm, 'Shetland Leasing and Property' (SLAP).[9] This time, the purchase was funded with £2m[10] from trust funds held by SDT[11] that were generated by the island's oil reserves at the Sullom Voe oil terminal. The main purpose behind this quota purchase was to safeguard fishing opportunities for current and future generations of Shetland fishermen, while at the same time creating a way for young fishermen to affordably gain entry to the Shetland white-fish industry. The purchase again proved successful, and a further 2 000 tonnes of white-fish FQA were purchased in 1999. Therefore, in 1999/2000 the SFPO held two pools of quota: the original purchase of 2 386 tonnes of FQA; and the other 4 445 tonnes of FQA held by SLAP on behalf of the community. In addition, the fleet (SFPO member vessels) privately owned 12 500 tonnes of FQA. Therefore, approximately 35 percent of FQA was held in community ownership in 2000. The current value of the 4 445 tonnes of community quota is estimated to be £16.9m.[12]

The decision to invest in quota holdings for community use was a ground breaking move, although at the time, there were many detractors, particularly other UK POs, who disagreed with what the SFPO was doing. The SIC purchased the quota to increase fishing opportunities for the Shetland white-fish fleet and encourage more vessels to enter into SFPO membership. In order to distribute the quota fairly among members, the SFPO devised a system that established an allocation method for vessels using both the SFPO 'ring-fenced' and 'SLAP/SDT' quota pools.

The SFPO used a scatter-plot analysis to visually assess the relationship between each member vessel's quota entitlement (FQAs) and catching capacity (measured in vessel capacity units or VCUs), similar to Figure 1. A VCU (Vessel capacity unit) is calculated as follows: the overall length of the vessel in metres is multiplied by the

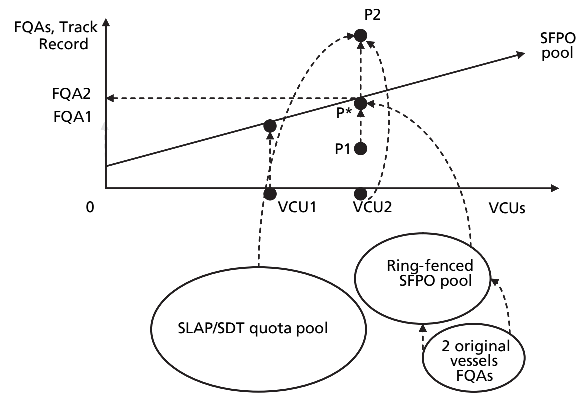
[9] "Shetland Leasing and Property Ltd (SLAP) is a commercial limited company operated for profit. The company's shares are wholly owned by the Shetland Islands Council Charitable Trust (SICCT), the trustees of which also are the councillors of the SIC plus two other persons. The funds of this trust originate from oil companies."

[10] "To assist SLAP in the purchase of track records, SDT procured, in 1998, a loan of GBP 2 million for SLAP at a rate of interest equal to the return required by SLAP from SFPO for the lease of quotas to fishermen (on average 9 %). The purchases were made during the years 1998 and 1999."

[11] "SDT is a discretionary trust set up to foster economic development in Shetland and is operated with funding from the SIC. The trustees are the councillors of the SIC plus two independent trustees. The principal source of funds is the Reserve Fund, established and operated by SIC; the Reserve Fund is funded from the surplus revenues of the Council's harbour undertaking" Source: EU state aid decision 3 June 2003.

[12] Shetland Development Trust investment portfolio; July – December 2006; Appendix 1; page 6.

FIGURE 2
The 'pooled' Shetland quota system in operation



breadth of the vessel in metres. This figure is then added to the power of the engine in kilowatts and multiplied by 0.45 (see UK Sea Fisheries Statistics 2005 p.146): <http://www.mfa.gov.uk/pdf/UKSeaFish2005.pdf>. A basic linear regression equation was then estimated[13] to establish the best fitting relationship between both variables, and this was used as a reference point.[14] Those vessels plotted above or around the trend-line were not required to obtain additional quota to be part of the pool, and those vessels that plotted below the trend-line would either have to purchase quota (from other vessels, quota traders, slipper skippers, etc) or lease additional quota from the 'ring-fenced' pool (through paying a higher percentage of gross earnings to the PO) to take them up to the trend-line in order to ensure membership and access the 'SLAP/SDT pool'. Lack of finance among the Shetland vessels ensured the latter action to be more likely. The 'ring-fenced' pool' was (and still is) allocated equally among all member vessels every two months.

To describe how the SFPO administered its quota during this time, consider the scenario of a Shetland fishing crew with a new vessel and licence, but without any FQA units. The vessel has a certain number of VCUs but no FQAs (point VCU_2 in Figure 2). With no FQA units, the vessel owner must either purchase or lease enough quota to enter the SFPO 'ring-fenced' pool (at point P*, where VCU_2 meets FQA_2). This system was unique because fishermen could enter the SFPO without any FQAs, providing they paid the required levy.

It was decided that vessels entering the SFPO 'ring-fenced' pool without any track record would be charged 5 percent to lease the quota (still a significant barrier to entry) in addition to the 1 percent administration charge (revenue generated from this goes to the SFPO). If, however, a vessel wanted to enter the SFPO pool with half the FQAs required, e.g. at P_1 in Figure 2, in order to reach point P*, the vessel would be charged only 2.5 percent in addition to the 1 percent administration charge, and so on – the more FQA units the vessel had (e.g. P_1 in Figure 2), the lower the levy required. In order to reach point P*, the vessel operators would be charged on a sliding scale basis.

The SLAP/SDT quota was essentially an additional source of quota that vessels used to augment individual quota allocations when the need arose and therefore provided a 'safety net' for member vessels. Before the introduction of the SLAP/SDT quota scheme, if the SFPO 'ring-fenced' quota pool was fully allocated, the SFPO would be required to undertake quota swaps with other PO's in order to allow the SFPO members to continue fishing legally. If the SFPO was unable to obtain additional quota on behalf of its members, fishermen had two options, (a) either to dump their catches at sea or (b), attempt to land fish illegally. Under the SLAP/SDT system, if a vessel used up their own quota as well as their share of the SFPO's 'ring fenced' quota, they then had access to the SLAP/SDT quota pool to fall back on (e.g. at P_2 in Figure 2). The ample availability of the SLAP/SDT quota removed the need for dumping at sea or illegal landings.

[13] Regression analysis is used to determine the relationship between the variables VCU and FQA. Linear regression attempts to explain this relationship with a straight line fit to the data. This procedure was performed using a statistical software package similar to SPSS, the statistical package for the social sciences.

[14] The SFPO formulated the following regression equation to describe the relationship between FQAs and VCUs; FQA requirement = 10.87 * (VCU size of vessel) – 605.

Finally, the SLAP/SDT quota was allocated preferentially. The agreement between SLAP and the SFPO stated that 'SFPO shall only lease FQAs first approved by SLAP, and SLAP will not allow the leasing of FQAs to a party who is not a member of SFPO or is not a PO.'[15] The agreement also stated that the SFPO would use its best endeavours to obtain, via rental income, a minimum net return i.e. after deduction of the management fee of 9 percent per annum on payments made by SLAP.'

7. ENFORCED CHANGES TO THE SHETLAND COMMUNITY QUOTA SCHEME

In February 1999, the EC was informed by a Member of European Parliament (MEP) about a scheme that involved the purchase of fish quota involving the Shetland authorities. The MEP had received complaints about the Shetland CQ scheme from sources within the UK fishing industry. The sources suggested that the scheme '*distorted competition*' and existed '*contrary to the rules governing state aid*'. The Commission invited interested parties to provide their observations in relation to this case. Comments were received from two other UK POs, a private individual and the SDT.

The Commission initially considered that the loan granted by SDT to SLAP to buy FQAs was made on preferential terms, in particular due to the fact that vessel owners were unable to borrow money on the terms available because FQAs could not be used as securities. In addition, the Commission believed that the operation of the CQ scheme had the effect of lowering the rental cost of the quotas allocated in respect of the FQAs acquired, as compared with the perceived leasing costs for UK FQAs under normal market conditions. Therefore, through the system of additional levies, the Commission believed conditions offered to vessels in the membership of SFPO were preferential to the conditions offered to non-member vessels. On those grounds, the Commission considered that the Scheme resulted in an economic advantage for SFPO member vessels.

As the Scheme was set up in 1998, it was assessed in the light of the 1997 guidelines for the examination of state aid to fisheries and aquaculture. The Commission considered that quotas and track records are by nature not durable goods, even though they could be purchased, and they did not retain any value at the end of the calendar year. Aid for their purchase therefore appeared to be aid related to operating costs for the running of the vessels which benefit from them. As aid for operating costs in the fisheries sector is allowed only under specific circumstances that did not exist in this case, the aid did not appear to be compatible with the common market. In addition, the Commission considered that the Scheme could not be considered as implemented by members of the industry, because its effect of ring-fencing FQAs rather than letting the market forces work, was protective in the context that the industry faces and does not contribute to attaining the objectives of the CFP.

The SDT and the SFPO always maintained that the reserve fund (the source of the loan to purchase the SLAP/SDT FQAs) was, according to Scots law, a public trust,[16] not in the sense that it performs public authority functions, but because the potential beneficiaries are geographically linked to the Shetland Islands. However, the private source of funding and the obligation to account to private beneficiaries and third parties indicates the independent and discretionary nature of the activities of the trust. Therefore, the commercial loan by the SDT to SLAP for the purchase of quota was a private transaction with no state aid implications. The SFPO and the SDT maintain

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[15] "The agreement also stated that the SFPO would observe the following order of priority when entering into rental agreements: (i) preference shall be given to persons, partnerships or companies newly established and actively operating in the fishing industry in Shetland over persons or partnerships already established in the fishing industry in Shetland, (ii) preference shall be given to persons, partnerships or companies who own and are actively operating fishing vessels registered with a port letter in Shetland, (iii) persons, partnerships or companies already established and actively operating in the fishing industry in Shetland shall be given preference to POs" Source: EU state aid decision 3 June 2003.

[16] For more details of the issues surrounding the status of the reserve fund see the Commission decision of 3 June 2003.

that the funds are private funds, and therefore, to them, the issues with priority of allocation and preferential leasing costs fell at the first hurdle. The SDT referred to a recent decision adopted by the Commission Directorate-General Agriculture which considered that a similar fund operated by the Orkney Islands Council could be regarded as a private contribution. Both the SDT and the UK authorities believed that the SDT should be classed as a private body.

In its communications with the Commission, the SDT emphasized that it always invests funds at a commercial rate. The main purpose behind the commercial quota purchase scheme developed by SLAP/SDT was to obtain a commercial return for SLAP while at the same time allowing the fishing fleet access to quota at commercial rates. The Scheme did not favour local fishermen over others; each was required to pay the same commercial return to SLAP/SDT. The SDT provided documentation to the Commission that described how the scheme worked, both in the case of vessels in the membership of the SFPO, through the system of an extra levy in addition to the normal membership levy and in the case of those who were not members.

The UK authorities also provided information related to quota rental costs that showed the financial implications for a vessel:

(a) if that vessel rented its entire quota outside Shetland at prevailing market rates and

(b) if it obtained its quota through SFPO via the levy system.

The data showed that vessels under the SLAP/SDT scheme were actually paying slightly more per annum than other operators who used the market place to rent their FQAs. They concluded there was no presumption in favour of vessels subject to charging by percentage of turnover and therefore, the SLAP/SDT scheme did not distort, or threaten to distort, competition.

The scheme resulted in the buying and pooling of FQAs at a time of decreasing fish stocks. The Commission therefore accepted that pooling of fishing opportunities could be considered as rationalisation, since the quota resulting from the purchase was made available, at market prices, to existing fishermen whose catch entitlement had been eroded through decreasing fish stocks. The development of viable fishing enterprises was thereby assured. Thus, the scheme accelerated the adaptation of the industry to the new situation it faced. Such limited market intervention simply resulted in some of those smaller fishermen continuing in business in heavily fisheries-dependent areas where little alternative economic activity existed. That could equally be considered consistent with the socio-economic dimension of the CFP.

In 2003, after a three year investigation by the EC, and despite the best efforts of the SDT, the SFPO and the UK authorities to prove otherwise, the Shetland SLAP/SDT scheme was found to contravene EU State Aid law and was deemed incompatible with the rules of the common market. Article 87 of the EC Treaty states that, '*any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the common market'*. According to the council decision, the following four conditions must be satisfied in order to class a measure as state aid:

i. The measure must provide some advantage to the undertakings which benefit from it
ii. The aid must be granted by the State or through State resources
iii. The aid must distort or threaten to distort competition by favouring certain undertakings
iv. The aid affects trade between Member States

Without getting embroiled in a detailed technical description of the logic behind the ruling, in arriving at its decision the Commission concluded:

i. "The operating aid reinforced the competitive position of those involved in the Shetland CQ scheme to the detriment of those out-with the scheme"

ii. "The operating aid provided to members of the SFPO was deemed to be public funds (disturbance payments from the Sullom Voe oil terminal) and therefore constituted state aid"
iii. "As the quotas originated within the CFP, the quotas granted rights to fisheries products sold on EU markets and therefore distorted competition within the Community market"

After further information was provided, the Commission did, however, agree with the UK authorities that no aid element was included in the £2m loan granted by the SDT to the SLAP in November 1998. Therefore, there was no advantage to the SLAP or to the SFPO when it acted on the SLAP's behalf for the acquisition of FQAs. Also, no action was required to be taken with respect to the original 'ring-fenced' quota pool, as the SFPO used private borrowings to fund that original initiative.

Under normal circumstances, the aid relating to the SLAP/SDT scheme would require to be recovered. However, on this occasion, there was a legitimate expectation by all parties concerned that the funds were believed to be private, and indeed the funds had been treated this way for a number of years. Therefore, the recovery of the aid was not required in accordance with the general principle of Community Law.

To continue using the quota pool, the SFPO was required to make some significant modifications to the SLAP/SDT scheme, including setting quota leasing costs in line with current market rates, and ensuring requests for quota were dealt with on a 'first come first served' basis. The SIC and the SFPO are now confident they have satisfactorily addressed the issues affecting compliance with state aid laws. The SFPO were unable to challenge the ruling and were only able respond to the Commission decision by revealing what changes they intended to make in order to comply with State aid rules. They maintain that a number of wrong assumptions were made in the decision making process.

Above all, the SFPO strongly disagree that their members gained a competitive advantage in relation to leasing costs over non-SFPO members. Although the EC perceived there to be a price preference in favour of Shetland vessels, the SFPO maintain that, in effect, SFPO members were at a disadvantage over other UK vessels. They believe a non-level playing field existed, whereby their member vessels were spending significant sums on quota leasing to catch fish legally, while others within the UK industry were continually under-reporting their catches which meant they avoided paying the additional resource cost. This was an incredibly frustrating period for vessels that did not under-report their landings, as they felt they were being penalised for trying to operate legally and within the confines of the CFP.

How successful was the SLAP/SDT quota scheme in fulfilling its objectives? The SFPO maintain that while the SLAP/SDT scheme and 'ring-fenced' pool were in operation, two new member vessels were introduced to SFPO membership in 2000/2001, creating twelve new catching-sector jobs, something that would have proved unlikely before the CQ scheme was introduced. Further, existing SFPO members kept their association with the Scheme because of the increased availability of FQAs. Some members were considering leaving the SFPO to operate through an IQ style PO. Perhaps most importantly, without the SLAP/SDT scheme, it is likely that a significant proportion of SFPO white-fish vessels would have become non-profitable, leading to an estimated 20 percent of vessel owners either selling or decommissioning their vessels. Lower fleet revenues and expenditures undoubtedly would have caused a considerable negative knock-on impact for the Shetland onshore sector in terms of income and employment. The introduction of the SLAP/SDT scheme has ensured a higher level of income and expenditure by the Shetland fleet by increasing its size and, to some extent, abating the considerable decline in vessel numbers that was already taking place within the UK catching sector.

8. CONCLUSIONS FROM THE SHETLAND EXPERIENCE

Since the new measures have been put in place to ensure the SLAP/SDT scheme is compatible with the rules of the common market, there has been a debate whether the term 'CQ' applies any longer, because there is no allocation preference for Shetland fishermen. Because the EC ruled that the SLAP/SDT quota constituted illegal state aid, it has become much harder to fulfill the objectives of the CQ scheme in the manner it was originally intended. The problem with SLAP was not the quota purchase, as the ruling was positive about CQ schemes using public money, and other UK POs have also considered purchasing FQAs using public money. The way the quota was distributed was deemed unacceptable by the EC. The SFPO believed the money used to finance the scheme constituted private funds belonging to the islands, and therefore, as far as they were concerned, the whole debate about reinforcing the competitive position of Shetland vessels at the expense of other vessels was irrelevant.

The Shetland experience is not an isolated one. The Orkney CQ scheme and a fish quota company in Cornwall both ceased to operate after unfavourable EC rulings similar to the rulings received by Shetland. In all cases, the regions involved are looking at other ways to allocate the CQ without breaking the rules of the common market.

The majority of the Shetland white-fish sector accept the EC decision and acknowledge that they are not disadvantaged, just no longer significantly advantaged. They simply wanted to have more control over the level of fishing opportunities available for current and future generations, and to ensure vessel numbers were boosted sufficiently to climb above the minimum threshold of white-fish boats currently populating Shetlands' fishing ports.

The Shetland CQS was set up to safeguard fishing opportunities and employment for future generations of fishermen in Shetland. Given the prevailing financial climate, developing trade in quotas and significant barriers to entry associated with new vessel business start-ups, it was originally hoped the system would provide a way for new and young fishermen to enter and progress in the industry without any FQA units. However, because of the EC ruling, young vessel owners must now have a fishing licence with the minimum requirement of FQA units before they can become members of the SFPO. Entry requirements in the Shetland PO are now in line with other UK POs. It is no longer possible for fishermen to enter the industry without a track record, and the leasing costs are now the same as everywhere else in the UK.

In 2007, four years on, the business culture within the UK fishing industry has changed significantly. The introduction of the Registration of Buyers and Sellers (RBS)[17] in the summer of 2005 has been heralded as a major success in helping to consign to history the widespread problem of under-reported landings by the UK fleet. As a result, most people would agree that UK vessels now operate on a level playing field, market prices have rapidly increased, and the financial performance of the UK white-fish sector has improved significantly in a short period of time.

Thanks to the Registration of Buyers and Sellers Programme, both competition and the prevailing financial climate have improved significantly, and Shetland fishermen are much more content with the current system of quota management. Previously, most were unhappy at the cost associated with having to lease quota through the SFPO when others in the UK industry avoided this transaction cost. SFPO members' attitudes have now changed because everyone in the UK industry is required to pay the market rate for FQAs, and the leasing cost as a percentage of gross earnings has, in most cases, decreased. This is due to the fact that market prices have risen significantly because all fish landings now go through an auction market.

[17] In September 2005 UK Fishery Departments introduced a scheme of registration for buyers and sellers of first sale fish and designation of fish auction sites. For more information see: <*http://www.defra.gov.uk/fish/sea/manage/registration/index.htm*>

Shetland fishermen prefer the SFPO to operate a more community-orientated approach in managing its quotas, and are happy with the current 'pool plus IQ' system employed by the SFPO. Member vessels, unsurprisingly, are also happy with the investments made by the SDT on their behalf. They would like to see quota being taken out of the hands of non-active ex-vessel owners and other non-fishing interests and returned to local communities in a similar manner to the SLAP/SDT scheme. They feel if this happened, quota trading costs would reduce as demand would be much lower, removing, in their opinion, an unnecessary, man-made cost.

9. LOOKING TO THE FUTURE

Although local authority ownership of quota is permitted, and perhaps even welcomed at the EU level, as the SIC used public funds to distribute FQAs in a 'perceived' uncompetitive manner and as an operating expense, the aid was deemed illegal. The 'ring-fenced' quota pool remains unaffected by the EC ruling because it was purchased using private funds. This could be classed as a successful form of self-governance because SFPO members created an incentive for vessel members, and therefore FQAs, to remain within the SFPO. It does, however, remain unclear how a system could be devised whereby local authorities could legally purchase and distribute quota using public money in a way that retains the economic benefits within the local area. Each case would be subject to the legal interpretation of the scheme.

UK fisheries departments are currently looking at ways to improve the current quota management system in a way that balances both the economic and social objectives of the UK fishing fleet. Given that community schemes, at least in the form of the SLAP/SDT scheme, have had limited success against the backdrop of a poor financial climate and restrictive management regime, fisheries managers appear to be limited in their future choices. The question is: does the UK government try and alter the current system to allow and solidify the individual ownership and tradable rights of quota, or maintain and reform the current system to ensure quota remains a state resource with an emphasis placed on protecting fishery-dependent areas?

A switch to a formal individual tradable quota (ITQ) system would introduce individual ownership rights for quota holders and address many of the problems associated with the current FQA approach to RBM. Ownership of quota could be restricted to specific 'active' fishing interests, and rules put in place to regulate quota trading. However, there would still be insufficient safeguards to stop quota being traded out from control of vulnerable fishing communities. If the UK moved to an ITQ system with full ownership rights, overseas companies could quite conceivably purchase UK FQAs and then repatriate the profits. In addition, under an ITQ approach, the increased transparency surrounding ownership rights is likely to increase the cost of quota even further, creating an even bigger barrier to entry than under the current FQA system. In most cases, tradable quotas would simply go to the highest bidder, unless some safeguards were put in place.

Fisheries managers are currently assessing the possibility of introducing smaller scale community schemes compatible with EU law. Pooled systems with member allocation preferences are permitted as long as such a scheme is financed privately. As long as sufficient 'pooled' quota is made available to satisfy the demands of the local fleet, fishermen are safe in the knowledge they have adequate access to quota to ensure their businesses remain viable. As such, an operation would be financed privately; the decision on who gets access and at what price could be made locally and for the benefit the local fishing industry. The role of onshore support businesses, such as vessel agents and fish processors could therefore play a pivotal part in securing future fishing opportunities for the most vulnerable fishing communities.

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The self-governance in the Celtic Sea Spanish fishery

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1. INTRODUCTION

The Celtic Sea Spanish fleet is composed of 199 vessels (whose average characteristics are: 203 GRT, 419 kW and 14 crew), which fish for demersal species in ICES areas Vb, VI, VII and VIIIabd (Figure 1). The vessels are grouped in seven associations, each of them belonging to one of the main base ports of the fleet. These ports are located along the northern and north-western coast of Spain.

The national Government, together with the European Union define the TACs and allocate quotas to the fleet. Besides, the Spanish law applicable to this fleet activity establishes that every producers association may have a quota of the total fishery input and output. These associations are then granted a maximum number of fishing days and quantities of the regulated species. Both allocations are proportional to the sum of the historic rights of the member vessels. In turn, these associations may allocate these rights among their members in the form of individual access quotas and catch quotas.

The active role the associations have shown within the deep-sea fishing sector in the last decades that their experience in management tasks, together with the existence of common, cultural and social values among the fishery members have favoured a greater involvement of the industry in management tasks. As a result, in the present regulatory scheme users and their associations take the management decisions with regard to the annual rights allocation and these are reported to the Government.

The resource users play an active role, both individually and through their associations, in the development of management policy. Every association enjoys the rights of access and the right of withdrawal. The associations hold the collective rights and decide the

FIGURE 1
Map ICES areas

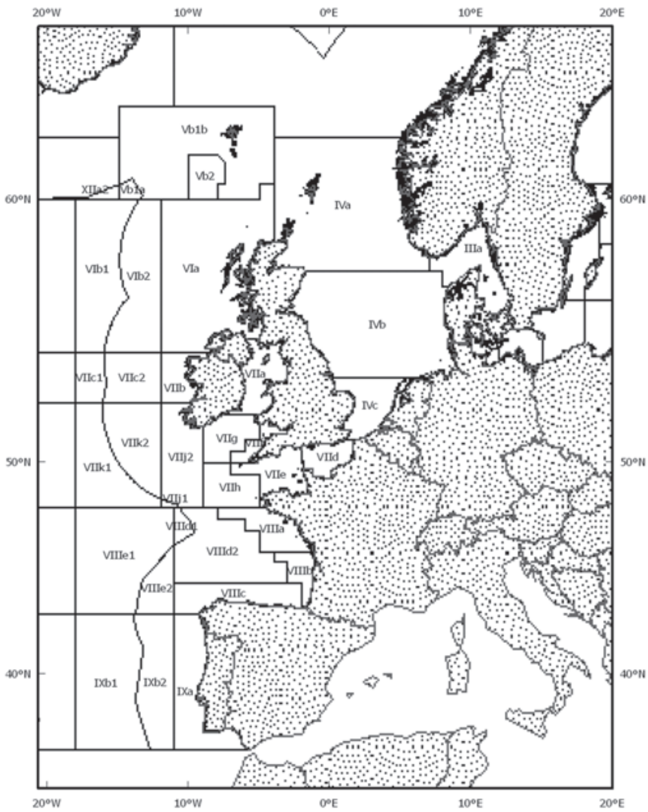

PHOTO 1
Open ocean conditions in the Celtic Sea can make operations challenging in this fishery

availability of the rights of access and terms of withdrawal for their members. In this process, the associations also delegate operational rights to the individual users. The latter, after receiving their rights allocation, may transfer them to other members of the same association according to their needs during the fishing season and as a result of their best operation strategies.

In this chapter, we descript the existing self-governance in the fishery. In Section 2 the fishery is described and in Section 3 the regulatory history. In Section 4 we will describe its self-governance. We evaluate the fisheries governance in Section 5 and, last, in Section 6, we comment on some factors that could strengthen self-governance.

2. THE CELTIC SEA SPANISH FISHERY

The Spanish fleet that fishes in the Celtic Sea fishing grounds (Photo 1) is also known as the "300 fleet" for when Spain joined the EEC it was made up of this number of vessels: at present it consists of 199 vessels. The fleet is divided into seven associations (Table 1) of which approximately 70 percent are Galician. This fleet mainly catches hake (*Merlucius merlucius*), anglerfish (*Lophius piscatorius* and *L. budegassa*), horse mackerel (*Trachurus trachurus*), megrim (*Lepidorhombus whiffiagonis*) and nephrops in the ICES zones Vb, VI, VII and VIIIabd. Fleets from other countries also fish in the Celtic Sea; in particular France, UK, Denmark, Ireland, Norway, Belgium, Netherlands, Germany and Sweden.

Most of the demersal fisheries in this area produce a mixed catch. Although it is possible to associate specific target species with particular fleets, variable quantities of hake, anglerfish, megrim and nephrops are taken together depending on the gear type. Since the 1930s, hake has been the main demersal species supporting trawl fleets on the Atlantic coasts of France and Spain. Spain now takes around 60 percent of the landings, France 30 percent, UK 5 percent, Denmark 3 percent and Ireland 2 percent (ICES 2006, volume 9). Hake are caught throughout the year with peak landings in the spring and summer months. The three main gear types

TABLE 1
Evolution of the number of vessels Spanish associations has in Celtic Sea

Association	Location	1996	1999	2002	2004
PASAJES	Basque Country	34	18	13	10
NORPESC	Basque Country	9	11	8	8
ONDARROA/OPPAO	Basque Country	38	48	47	44
GOLDAKETA	Basque Country	26	--	--	--
ARPOSOL	Galicia	61	53	59	--
ARPESCO	Galicia	51	28	22	16
PESCAGALICIA	Galicia	7	6	6	--
OOPP-LUGO	Galicia	--	37	38	8
OPECA	Cantabria	--	--	8	8
ANASOL	Galicia	--	--	--	105
Total		226	201	201	199

TABLE 2
Catches and agreed TAC in Celtic Sea Fisheries (hake, anglerfish, horse mackerel, megrim and nephrops). (´000 tonnes). 1994–2005

	Hake		Anglerfish				Horse mackerel		Megrim				Nephrops			
	Catches	TAC	Catches		TAC		Catches	TAC	Catches		TAC		Catches		TAC	
	V, VI, VII, VIII		VI	VII, VIII	VI	VII, VIII	V, VI, VII, VIII		VI	VII, VIII	VI	VII, VIII	VI	VII, VIII	VI	VII, VIII
1994	53.1	60.0	6.0	21.9	8.6	23.9	385/0	300.0	3.0	16.4	4.8	20.3	11.1	4.3	12.6	20.0
1995	58.9	55.1	7.2	26.8	8.6	23.2	509.0	300.0	3.3	19.1	4.8	22.6	12.8	4.9	12.6	20.0
1996	48.8	51.1	7.0	30.2	8.6	30.4	379.0	300.0	2.9	18.1	4.8	21.2	11.2	4.3	12.6	23.0
1997	44.4	60.1	6.2	29.8	8.6	34.3	440.0	300.0	2.8	17.3	4.8	25.0	11.2	4.4	12.6	23.0
1998	35.8	59.1	5.4	28.2	8.6	34.3	296.0	320.0	2.7	19.7	4.8	25.0	11.2	5.0	12.6	23.0
1999	40.6	55.1	5.3	24.5	8.6	34.3	274.0	265.0	2.5	16.9	4.8	25.0	11.5	4.2	12.6	23.0
2000	42.6	42.1	4.4	22.0	8.0	29.6	175.0	240.0	2.4	15.5	4.8	20.0	11.0	2.7	12.6	21.0
2001	37.2	22.6	4.0	22.2	6.4	27.6	191.0	233.0	2.4	17.1	4.4	16.8	10.9	3.3	11.3	18.9
2002	40.3	27.0	3.0	26.7	4.8	23.7	172.0	150.0	1.6	17.5	4.4	14.9	10.5	4.0	11.3	17.8
2003	41.8	30.0	3.0	31.7	3.2	21.0	190.0*	137.0	1.7	18.6	4.4	16.0	10.7	2.9	11.3	17.8
2004	47.1	39.1	1.2	34.9	3.2	26.7	157.0*	137.0	na	18.8	3.6	20.2	10.3	2.9	1.3	17.5
2005	46.4	42.6	-	-	-	-	-	137.0	-	-	-	21.5	-	-	12.7	19.5

Catches include discards. Catches from all fleets involved in the Celtic Sea.
*: including VIIIc. na: not available.
Source: ICES Advice 2006.

used by vessels targeting hake are lines (UK and Spain), fixed-nets and trawls (all countries), many bottom trawls and recently, very-high-opening trawls by Spanish vessels. A trawl fishery for anglerfish by Spanish and French vessels developed in the Celtic Sea on the shelf edge around the 200 m contour to the south and west of Ireland and Bay of Biscay in the 1970s and expanded until 1990. Although effort in most fleets appears to have declined since the early 1990s in the anglerfish fishery, the increasing use of twin trawls may have increased the overall effective fishing effort. Megrim is caught predominantly by Spanish and French vessels, which together have reported more than 60 percent of the total landings. The nephrops fisheries developed in the 1970s and 1980s and are an important component of the fleets catches in this area, however the fishing effort has decreased continuously since the early 1990s (ICES 2006).

The state of these stocks has changed considerably over the last decades. In the last assessment of hake (northern stock), ICES classifies the species as being at full reproductive capacity and being harvested sustainably. However, the spawning stock biomass (SSB) has decreased in past decades and the European Commission established measures for the recovery of the northern hake stock (EC Reg. No 811/2004). The aim of the recovery plan is to increase the biomass of mature fish to equal or greater than 140 000 tonnes or precautionary biomass (B_{pa}) for two consecutive years. This is to be achieved by limiting the fishing mortality (F) to 0.25 and by allowing a maximum change in TAC between years of 15 percent. The current assessment indicates that the SSB is close to B_{pa} (ICES, 2006). The increase appears to be due to a combination of good recruitment and moderate fishing mortality. In consequence, the TAC was increased for 2005–06 (Table 2).

Due to quota restrictions for many years in this fishery, the Spanish fleet stopped fishing for up to two months in 2001, 2002 and 2003 and fished for only one month in 2004 and 2005. However, this temporary cessation of the fishery is not mirrored in the overall trend in fishing effort (ICES 2006). Spain accounts for the main part of the landings with 58 percent of the total in 2005. France now takes 29 percent of the total, UK 6 percent, Denmark 3 percent, Ireland 2 percent and other countries (Norway, Belgium, Netherlands, Germany and Sweden) harvest small amounts (ICES 2006).

Based on the most recent estimates of SSB and fishing mortality, ICES classifies the stock of anglerfish as being at risk of being harvested unsustainably (ICES 2006,

TABLE 3
Composition of landings (%) 2000–2004

	Value					Volume				
	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
Anglerfish	12.21	16.92	11.05	8.69	8.77	9.30	15.05	10.56	7.67	6.22
Hake	65.79	30.03	32.10	37.09	25.24	59.88	29.77	30.75	33.74	28.00
Megrim	16.10	19.56	14.90	16.63	7.60	20.93	24.75	17.39	18.40	6.22
Nephrops	3.15	3.30	3.15	3.18	5.83	1.16	1.67	1.55	1.53	2.22
Other fish	2.75	30.19	38.75	34.41	52.56	8.72	28.76	40.06	38.65	57.33
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

European Commission (2006).

Volume 5). A trawl fishery by Spanish and French vessels developed in the Celtic Sea in the 1970s and they together take more than 75 percent of the landings (ICES 2006).

In the absence of defined reference points and a full analytical assessment, the state of horse mackerel remains unknown (ICES 2006, Volume 9). Survey data indicate that the SSB shows a decrease since the late 1980s. The fishing mortality is believed to be relatively low.

In the case of megrim, ICES classifies the stock as at risk of being harvested unsustainably. French trawlers operating in the fishery and targeting demersal species catch megrim as a bycatch. Spanish fleets have a targeted fishery for megrim and also catch this species in mixed fisheries for hake, anglerfish, nephrops and other species. The landings have decreased in the last years (Table 2). Otter trawlers account for the majority of the Spanish landings.

Information available for nephrops stocks is considered inadequate to provide advice based on precautionary limits (ICES 2006, Volume 5). According to ICES, the landings have declined in the last years (Table 2). Spain still makes the largest contribution to total landings.

The vessels which make up the Spanish fishery are middle-distance vessels. Their trips last on average fourteen days, with one day to travel from their port to the fishing grounds and another day for the return. The majority of the vessels use trawl gear, with some use of bottom longlines. These monofilament lines have a hook spacing of 2.7 m and a length of 5 to 15 miles. Boats usually use two lines with up to 9 000 hooks a line. Some vessels may use up to five longlines. It is a mixed fishery. Hake is the target species and contributed around 45 percent of the income for the fleet in 2000-04 (Table 3), although with a downward trend due to reductions in TACs over this period. Adaptation to the changes carried out in the regulatory framework has led to a reduction in fleet size and renovation of the fleet. This has made it possible to increase catch per vessel (even with a reduction in the TAC) and also the average yield of the fleet. In 2004 an average of 230 tonnes was caught and the average income per vessel was $1 111 000 as opposed to 103 tonnes and $239 000 at the beginning of the 1990s (European Commission 2006), making it one of the most profitable fleets during the last decade (Surís-Regueiro, Varela-Lafuente and Garza-Gil, 2002).

3. REGULATORY HISTORY OF THE FISHERY

Up until the 1960s, 500 Spanish vessels fished on the grounds of the Celtic Sea with no restriction from six miles offshore to the deep oceanic waters. When the Convention of London was signed in 1964, countries with coastlines began to establish different regulations with the objective of restricting access to the fishing resources in their waters, although they recognized the fishing rights of the Spanish fleet to a 6 to 12-mile zone.

The European Community implemented a licence system in 1978 and as a consequence the Spanish vessels had to obtain licences that assigned fishing rights. The Spanish vessels involved in the Celtic Sea fishery do not pay any licensing costs. In 1981, a Ministerial Order (Ministerial Order of the Ministry of Agriculture and Fisheries, June/12/1981) recognized fishing rights that were individual and assigned to vessels to fish in those areas for which the access mechanisms were introduced and the resource mechanisms were estimated. The Ministerial Order had the following features: (a) a closed census was conducted for vessels to determine historical catch history and access rights were established and (b), the access rights of a vessel could be transferred to other vessels that belonged to the same company if this firm kept a vessel in the fishing area. The same company could transfer its fishing right without transferring legally one of its own vessels that were included in the census. On the other hand, these rights could not be transferred, assigned or transmitted independently to a fishing vessel.

Initially, 415 trawl vessels (this was the number of vessels included in the census) obtained the right to participate in the annual Fishing Plan by means of which the fishing licences granted by the EEC to the Spanish government were distributed. In spite of the fact that the census only included trawl vessels, the Spanish administration continued to maintain 10 licences in reserve for longliners. Therefore, a new census was taken of this fishery in which 44 longliners over 100 GRT were inscribed. The new census was published in 1983 and consisted of 459 vessels.

When Spain joined the EEC in 1986, the number of vessels authorised to fish in the Celtic Sea (with the exclusion of the Irish Box until December 1995) was cut to 300. Of this number, only 150 vessels could fish simultaneously until the end of 2002, forming the so-called "periodical lists".

A new Ministerial Order (June/12/1992) established the possibility that companies could accumulate the access rights of scrapped vessels in other vessels. This system allowed the number of vessels that are included in the census to have a number of fishing days that were closer, on the whole, to the needs of this fleet.

The Law 23/1997 (July/15/1997) allows firms to transfer all or a part of the access rights or fishing power coefficient of their vessels to other units in the same census. Under this law transferability is authorized either in total or partially but now firms are being given access rights that are for an unlimited time (the period is not stated in the Ministerial Order of 1981). The Spanish government still maintains responsibility for the exercise of access and fishing rights and this is without any compensations.

The new management regime tries to ensure that all vessels have a sufficient number of days on the fishing grounds to achieve a rational and suitable execution of their fishing activities. The new EU regulations governing fishing effort (effort is now measured as the engine power of vessels multiplied by the number of fishing days) have accelerated the need to rationalize fishing activity and has facilitated the transfer of fishing entitlements from holders who have too many to those who need more fishing rights in the grounds.

The Royal Decree 1838/97 (November/5/1997) regulates the beginning of fishing activity, the fishing establishments and changes of vessels. At the beginning of every year each vessel is assigned fishing rights, fishing grounds and a base port. The Spanish Law was completed with the Royal Decree 1915/97 (December/19/1997), which controls overfishing. The only established limit to the free transfer of the access rights is a maximum of 315 fishing days and a minimum of 210 days a year per vessel and the vessel is included in the fleet registry. The minimum effort figure affects the owner of a transferring vessel and it aims at guaranteeing the profitability of the sector. The maximum figure affects the vessel that receives those rights and is established to ensure that a single vessel cannot accumulate more fishing rights than it can use in a year.

Last, the Law 3/2001 of Maritime Fishing of the State establishes a new regulatory framework for the transferability of fishing quotas. The allocation of fishing possibilities can be transferred by both the PO and the vessel owner, but it requires an authorization by both the Ministry and the Autonomous Community (region) of the registered port of the vessel. This regulates the consequences of displacements and the effects of concentration of effort. For the purpose of favouring free competition, this law establishes that the volumes of fishing entitlements that can be accumulated by any

TABLE 4
Membership and number of vessels in the respective Producers Organizations

Producers Organization	Number of members	Number of vessels
PASAJES	7	10
NORPESC	4	8
OPPAO	29	44
ARPESCO	14	16
OPP-LUGO	3	8
OPECA	8	8
ANASOL	87	105
TOTAL	152	199
Rights Management Costs (by month)	US$ 295.22	

Source: Freijeiro, 2004

fishing company should not exceed 30 percent. This law was implemented at the beginning of 2007.

4. SELF-GOVERNANCE IN THE FISHERY

Through this regulatory scheme, the users and their associations take the management decisions and report to the Spanish government with respect to the fishing rights and annual quotas allocations. The resource users play an active role, both individually and through their associations, in defining management policy.

Each association enjoys the rights of access and the right of transfer of their entitlements. The associations are the first holders of the fishing rights. Associations may transfer their initial rights allocation to each other and then allocate their total amount among their members. In this process, the associations are the holders of the collective rights and decide on the availability of the access rights and conditions of withdrawal of their members from the scheme.

The associations also delegate the operational rights to the individual users. After receiving their rights allocation users may reallocate them among other members of the same association according to their needs during the fishing season and as result of their operation preferences.

Both associations and users are granted strong property rights, which enhances the efficiency of decentralized resource management policies in this fishery. Only those vessels that belong to the associations are entitled to enter the fishery. The associations are composed of a few members, who are well known to each other and who usually come from the same geographic area and thus the same cultural and socioeconomic environment.

The Spanish government plays an active role when creating incentives to encourage efficiency and establishes the basic rules that govern the associations´ internal structures, their functions and responsibilities and the right to allocate catch entitlements among them. The associations are responsible for the supervision and control of these rights and must account to the Spanish government if the harvesting rights are exceeded.

Although the number of vessels that each association groups together is different, the organisational structure of the POs is similar and any difference lies among the number of people who make up the organization and the services provided to their members: they all offer assistance in the management of fishing rights and judicial advice.

Table 4 shows the membership and respective vessels in the different POs in 2004. Of the POs involved in the fishery, ANASOL stands out, with more than 50 percent of the fishery's vessels (Table 1). This PO was created in 2001 with the objective of consolidating the Galician fleet that fishes in the Celtic Sea and thus manages the greatest number of fishing rights. When it formed it grouped together all the vessels of the pre-existing POs of ARPOSOL and PESCAGALICIA, an ARPESCO vessel, 30 vessels from OOPP-LUGO, 2 from PASAJES, 1 from NORPESC and 3 from OPPAO. The PO with the second largest fleet is OPPAO. It was created in 1998 through the transformation of ONDARROA PO. It grouped together 22 percent of the Celtic Sea fleet, all of them from the Basque Country.

The remaining POs (PASAJES, NORPESC, ARPESCO, OPECA and OOPP-LUGO) have fleets of between 8 and 16 vessels. These POs have certain unique characteristics. The OOPP-LUGO shares associates with ANASOL as around 10 vessels from the former use ANASOL to manage their fishing rights even though they continue to belong to the OOPP-LUGO PO and, therefore, use the rest of its services. The POs PASAJES and NORPESC, both from the Basque Country, collaborate closely with each other in respect of tasks regarding representation to the Spanish administration.

TABLE 5
Fishing rights* per PO (%). 1996–2003

	1996	1999	2001	2002	2003
PASAJES	18.36	12.78	9.26	7.92	7.17
NORPESC	5.41	6.49	4.67	4.17	5.08
ONDARROA/OPPAO	17.77	29.52	29.03	27.30	27.43
GOLDAKETA	14.26	--	--	--	--
ARPOSOL	22.17	20.04	23.14	--	--
ARPESCO	19.03	12.32	10.15	9.69	7.21
PESCAGALICIA	3.00	2.75	2.91	--	--
OOPP-LUGO	--	16.10	16.42	2.98	3.70
OPECA	--	--	4.43	4.43	4.43
ANASOL	--	--	--	43.51	44.98
Total	100.0	100.0	100.0	100.0	100.0

* The fishing rights are defined taking account access and kW coefficients of each vessel.
Source: González (2006).

5. EVALUATION OF SELF-GOVERNANCE IN THE FISHERY

The regulatory framework, the active role the associations have shown within this fishery in the last decades, their experience in management tasks and the existence of common cultural and social values among the fishery members, have favoured a greater involvement of users in management tasks.

The normal working practices of fishing allow the associations to establish fishing plans that regulate management and promote more efficient commercial operations. Since the implementation of the licence system in EC waters, the Spanish administration has established fishing plans in collaboration with the fishing associations. These plans reflect the fishing power of each vessel and their kW coefficients, to establish equivalences in the average vessels and the total fishing rights of each association.

In this sense, the associations could form a group to enforce fishing rights and to participate in the allocation of access and fishing rights. They could authorize the temporary transfer of fishing entitlements among companies and organizations, avoid vessel layups and ensure full use of their entitlements. Geographical mobility of the vessels between different ports is possible with prior consent and this allows changes in the distribution of the fishing rights.

This process has created a market for fishing rights that alters the geographical allocation of vessels and is supported by local financing institutions, by regional institutional bodies and by some shipowners that have become investment agents (González 2006). The regulations have allowed an evolution of the fleet in accordance with geographical criteria and association needs. Table 5 shows this trend. There is some concentration of fishing rights in the associations ANASOL (45 percent) and ONDARROA/OPPAO (27 percent). The ANASOL PO, which has acquired 50 percent of the fleet from pre-existing POs, consequently, possesses their fishing rights.

Table 6 shows the evolution of transfers of the fishing rights. The traditional concept of 'vessel => licence => right' disappeared at the end of the period 1996–2003 resulting in quite a different arrangement of capture options. A consequence is that PASAJES now has more fishing rights than vessels. In other associations, vessels do not have the same fishing rights, which forces them to stop fishing before the rest of the fleet.

These results show a geographical movement of vessels and high volatility in movement of the fishing rights, because of the ability to transfer rights between firms of the same or different associations. This has facilitated the scrapping of vessels, which accelerated the accumulation of rights and transfers: This has been supported by the sector and its associations.

Other types of collaboration exist among the POs. An example is the limiting of trip megrim catches and vessel limits imposed by some POs since 2004. The extension of this measure to the whole fleet was successfully applied in previous seasons.

TABLE 6
Fishing rights* per PO and vessel. 1996-2003

	1996	1999	2001	2002	2003
PASAJES	0.783	1.030	1.033	1.045	1.040
NORPESC	0.872	0.855	0.846	0.864	0.921
ONDARROA/OPPAO	0.678	0.892	0.896	0.900	0.904
GOLDAKETA	0.795	--	--	--	--
ARPOSOL	0.527	0.548	0.569	--	--
ARPESCO	0.541	0.638	0.669	0.669	0.654
PESCAGALICIA	0.622	0.665	0.703	--	--
OOPP-LUGO	--	0.631	0.627	0.617	0.670
OPECA	--	--	0.802	0.802	0.804
ANASOL	--	--	--	0.619	0.621

* The fishing rights are defined taking account access and kW coefficients of each vessel.
Source: González (2006).

TABLE 7
Economic evolution of Spanish Celtic Sea Fishery. Data per vessel.

	1994	1999	2004
Crew members	16	15	14
Effort (days at sea)	252	268	267
Catches	106	150	230
Landings (1 000 $)	608	768	1111
Gross cash flow (1 000 $)	51	162	179

Source: European Commission (different years).

We also detected changes in the fishing strategies in this fishery in the last decade as a response to successive EU regulations. Adapting or responding to these measures is not uniform throughout the fleet. In part it depends on the technical characteristics of the vessel and the gear used. But undoubtedly the nature of the companies or, even more so, the nature of their business associations has been an influence, as a range of different actions has been evident.

Some vessels have widened their zone of fishing activity in response to quota restrictions, looking for new target species, incorporating significant technological advances and reinforcing their business organization. In other cases, where the target species has not changed, low risk strategies have been followed, e.g. used fewer fishing days and shorter spells at sea and using innovative equipment. Both strategies have been used in the ANASOL PO. However, we have found other vessels continuing to follow a more traditional strategy, fishing the same zones, targeting the same species and undertaking few technical innovations. This appears to be the case of vessels operated by the ARPESCO PO.

One of the most usual measures in recent years has been the closure of certain fishing zones as a result of exhausting the annual TACs. This happened for anglerfish in Zone VIII. The response has been the relocation of the vessels in different seasons of the year via the acquisition of fishing rights in zones in which they do not traditionally fish. This situation explains the summer-winter strategies which the ANASOL trawl vessels are developing, catching megrim in Zone VIII and the OOPP-LUGO's bottom liners catching hake in Zone VIII, which corresponds to the French shelf.

All of these industry responses have favoured better economic performance. As Table 7 shows, the economic data related to this fleet show better profitability. Compared with those of the mid-1990s, the economic results show a positive trend: less fishing effort and an annual landings increase per vessel of 13 percent and better profit margins (the GCF grew by 6 percent a year from 1994 to 2004.

6. DISCUSSION

Two significant trends are apparent in the Spanish fishing companies in recent years: First, associations have been reinforced along with an aspiration to play a more important role in fishery regulation. Second, there is a greater knowledge of market instruments, especially the transferability of fishing rights and greater use of these possibilities by the business associations.

Fishing associations have been favoured by European policy in recognizing and promoting the POs as a basic part of the Common Market Organization. However, the existence and diversity of situations in different countries have not made exchange of views easy. The creation of Regional Advisory Committees (RACs) was the management instrument chosen after the reform of the CFP. These committees and in particular the one relating to the Celtic Sea fishing grounds, are currently being formed and should begin to function within a matter of months.

However, the EC system is still highly centralized and the use of market instruments is limited to the framework of decisions of the member states or the associations themselves, as their competencies allows. The Celtic Sea Spanish fishery is a good example of how a governance structure with full incentives may have a positive effect on the economic efficiency of the fishery.

Despite this, decentralization of management can still go further. In our opinion, a disincentive in the existing system is that users do not participate in management decision-making at higher levels. Every year, the TACs are decided according to political and biological criteria that have nothing to do with the users' expectations and estimates, which does not encourage compliance with quotas. Users could usefully participate in the management decisions contributing the relevant information on fishing mortality and the evolution of the state of stocks and so contribute to improvements in management and efficiency of the fishery. The North-Western Waters Regional Advisory Council would provide an excellent opportunity for this.

7. ACKNOWLEDGEMENTS

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A sea urchin dive fishery managed by exclusive fishing areas

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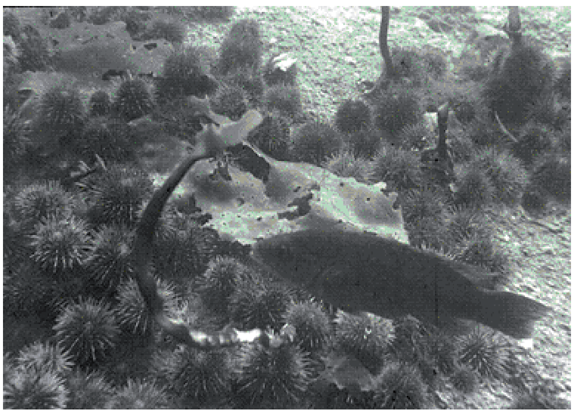
1. INTRODUCTION

The fishery for the green sea urchin (*Strongylocentrotus droebachiensis*) (Photo 1) presents an opportunity to devolve responsibility for management of a fishery resource. A central consideration in the management of the green sea urchin is to maintain a dynamic equilibrium between the sea urchin population and the kelp beds on which it feeds (Photo 2). The management strategy described here sought to implement this management task by allocation of exclusive fishing grounds to most of the fishing fleet. A small part of the fleet chose not to fish exclusive zones and shared a fishing ground equally and had some control over management of the resource.

Spatial property rights are an old approach to fishery management. The inspiration for exclusive fishing zones described here came from Johannes' (1978) description of a reef and lagoon tenure of fishing rights in the South Pacific. Ruddle (1988) described the long history of community management in Japan, and Kurian (1999) described similar institutions in India. More recent examples have been described for Chile (Castilla *et*

R.E. SEMPLE

PHOTO 1
Urchins on kelp



K.H. MANN

PHOTO 2
A sea urchin feeding front that has nearly consumed the kelp plants at the front. Bare rock is located to the right and dense kelp to the left

al., 1998), Mexico (Miller, 1989), and the South Pacific (Viswanathan, 1999). Reports of community spatial rights are much more common that individual spatial rights.

Most of the Nova Scotia green sea urchin fishery has been brought under a habitat-based regime. Individual fishers had exclusive access to a fishing area and were given responsibility to manage the stock in their area. Habitat-based management can be considered as an intermediate step in a continuum of fisheries management categorized by the degree of habitat control. Specifically:

i. *Stock-based Management* manages within the natural habitat carrying capacity to address problems of growth overfishing, recruit overfishing, and wasteful fishing practices such as discarding. Typically, catch and/or fishing effort are controlled.

ii. *Sea Ranching* grows and releases early life history stages to more fully use the habitat carrying capacity for later life history stages. This is intended to overcome bottlenecks of low spawning stock or loss of juvenile habitat (Travis, Coleman and Grimes, 1998).

iii. *Habitat-based Management* opens production bottlenecks by manipulating the balance between the target species and its resources (e.g. physical habitat or prey).

iv. *Aquaculture* spans a wide spectrum of habitat control from adding artificial habitat (e.g. mussel culture in the sea) to housing and feeding all life history stages in man-made facilities (e.g. trout culture).

The Nova Scotia sea urchin resource is well suited to habitat-based management. The sea urchin and its principal food, kelp (a category of large brown sea weeds), are abundant, but not optimally distributed for high sea-urchin fishery yield (Wharton and Mann, 1981; Miller, 1985; Scheibling, 1986). Much of the sea urchin stock is of no commercial value because the sea urchins have removed most of the kelp, the urchins are poorly fed, and the gonads poorly developed (Fletcher, Pepper and Kean, 1974; Keats, Steele and South, 1984; Meidel and Scheibling, 1998; Wahle and Peckham, 1999). Sea urchins congregate in dense feeding fronts at the deep edge of kelp beds and most harvesting occurs at these fronts. The low motility of sea urchins (Garnick, 1978; Scheibling, Hennigar and Balch, 1999; Dumont, Himmelman and Russel, 2004) and nature of kelp make them well suited for manipulation. The abrupt changes of habitat and sea urchin abundance on a scale of metres make it more suitable for in situ management by a harvester than remote management on a large scale by a bureaucracy. As a dive fishery, the results of harvesting and enhancement are visible to the fisher, unlike most fisheries where perceptions of the state of the stock are clouded by selectivity of the fishing gear.

2. THE FISHERY[1]

The Nova Scotia sea urchin fishery is located on the outer Atlantic coast from Shelburne to Cape Breton Counties, plus Digby County at the mouth of the Bay of Fundy (Figure 1). Capture is by diving only. Although called a roe fishery, gonads of both sexes are marketed.

The market is almost entirely in Japan. When the prices were highest, the best quality sea urchins were shipped live by air to Japan, but most roe extraction was carried out in Nova Scotia and Maine. Of the several processing plants in Nova Scotia that attempted roe extraction, only one survived more than a few years. After 1997, processors in Maine purchased most of the Nova Scotia harvest.

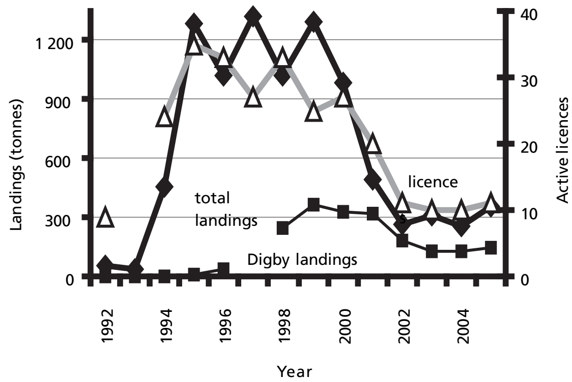
Landings first exceeded 100 tonnes in 1994 and peaked at 1 300 tonnes in 1997 (Figure 2). Beginning in 1994, an amoeboid disease spread in both directions from

[1] The author has been conducting research on this fishery since 1991, and much of the descriptive and historical material is drawn from that experience.

western Halifax County until all the stock within diving depths was eliminated from Shelburne through Richmond Counties by 2002. Cape Breton and Digby Counties were unaffected (Scheibling and Hennigar, 1997; Miller and Nolan, 2000; author's pers. obs.; urchin harvesters pers. comm.). The decrease in active licences followed this trend (Figure 2). Stock recovery had begun in parts of Shelburne and Halifax Counties by 2005.

FIGURE 1
Nova Scotia counties referred to in text

FIGURE 2
Total annual Nova Scotia sea urchin landings, annual landings from Digby County and number of active licences



Some of the usual sea urchin stock assessment and management methods are expensive and of uncertain value. Diver surveys of biomass are slow and expensive. Nutritional state and seasonal cycle affect gonad size (Himmelman, 1978) and hence sea urchin marketability. This varies on a small spatial and temporal scale (Keats, Steele and South, 1984), which makes it difficult for a management agency to monitor. Predicting recruitment to legal size is also difficult, because growth rate varies on a small spatial scale (Robinson and MacIntyre, 1997; Vadas *et al.*, 2002). Unknown stock-recruit relationships preclude making an informed choice of spawning stock biomass. Catch rate has been shown to be an unreliable indicator of stock size in many dive fisheries (Prince and Hilborn, 1998). If a biological basis for setting catch quotas can be found, they can be expensive to generate, administer and enforce.

Competing for catch can have undesirable social and economic consequences. Time spent hunting for commercially viable beds adds to the cost of fishing. Fishers lose incentive to schedule harvests for times of high prices or high gonad yields because another fisher can harvest them first. Conflict can result when one fisher harvests a bed first found by another. Under a common property management regime, the lack of agreement and cooperation is an obstacle to decision-making about efficient harvest and resource use.

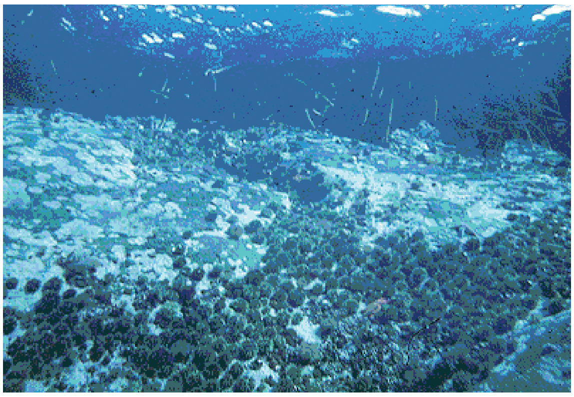
Several entrepreneurs attempted to move beyond habitat-based management into "feedlot" aquaculture, but unsuccessfully. One operation fenced urchins on a smooth bedrock bottom in the sea, but the location was too wave-exposed (Photo 3) and the sea urchins were scattered. About ten other operations collected commercial sized sea urchins with sub-commercial sized roe, placed them in wire cages, and added kelp for food. The labour cost of collecting and adding kelp was high and in some locations wave action destroyed the sea urchins. Confinement in cages removed the sea urchins' ability to seek shelter.

3. MANAGEMENT REGIME

3.1 Initial management, 1991–1999

Fishery regulations evolved from 1991 through 1999. Initially, any commercial fisher could obtain a sea urchin licence. Next, applicants were limited to participants from

PHOTO 3
An aggregation of sea urchins unable to reach kelp located in shallow water because of wave turbulence



G.P. ENNIS

the recently collapsed groundfish fishery. By 1995, successful applicants were chosen by draw from a large pool of interested commercial fishers. There could be only one licence a boat. To control effort and promote diver safety, each licence was allowed a maximum of four divers. An exploratory licence holder had to provide proof of sale of two tonnes of sea urchins the first year and 4 tonnes in subsequent years to maintain a licence. After being active for three years, an exploratory licence could convert to a permanent licence. A permanent licence required no minimum landing and could be transferred to another fisher. The minimum legal size was 50 mm test diameter and urchins culled from the catch had to be discarded on the fishing ground. Seasons initially corresponded to the months of best roe yield, but this restriction was removed when fishers demonstrated that dates of beginning and end of acceptable roe size could change abruptly on a small spatial scale and from year to year.

Fishery monitoring was entirely from catch records and from personal communication with fishers and buyers. Mandatory catch records with daily landed weight and prices for each fisher were initially supplied from buyers' sales slips. Beginning in 1997, fishers were required to hire a commercial monitoring company to enter their daily catch record and fishing location on a government database. For 20 percent of fishing trips, a monitoring company representative met the boat to verify that the landed catch was reported correctly. Data from both types of reporting suffered from lack of quality control. Under reports from buyers, not all catch records were submitted. Under commercial monitoring, fishers were asked to buy a service they did not want, the commercial firms serviced a database they did not use, and the government branch that administered the database also made minimal use of the data. Better data on landings, diver hours, detailed fishing location, and percent roe yield were obtained in volunteer logbooks from most fishers from 1994 to 2000. Frequent reminders to fishers and feedback with data summaries were needed to maintain this source.

Licence holders formed organizations in Guysborough, Halifax, Shelburne, and Digby Counties. Each group used peer pressure to moderately improve the adherence to regulations and made constructive contributions to formulating some rules. However, their strongest actions were reserved for lobbying senior government officials when they disagreed with the fishery manager and scientist assigned to their fishery. Their level of cooperation with the management agency reflected the personalities of their leaders.

In 1995–96, licensees and their divers developed diver safety guidelines. Because few of the licence holders were divers, some lacked appreciation for the hazards of winter diving and made unreasonable requests of their divers. The guidelines were practical and generally supported. An exception to support was in Digby County where strong currents, fog, and depth of fishing made it the most hazardous place to dive. The fishery's only fatality occurred there.

Initially, licence holders fished competitively and were each limited to one of three large areas. By 1994, each fisher was limited to one of 10 smaller areas, usually adjacent to one county. This restriction reduced concentration of fishing effort and responded to complaints that harvesters from outside the local area were taking a local resource. Under certain conditions, a fisher could fish his own exclusive area called a restricted zone. Except for Digby County, all fishers that were permitted to apply for a restricted zone did so.

In Digby County, two fishing areas provided the best catches and the most shelter from ocean swells. Because the five licence holders could not agree on dividing these preferred areas into restricted zones, they first set a short fishing season for the preferred areas. They later changed this to a maximum number of fishing days for each boat within a longer season.

3.2 Restricted zones

After a year of many public meetings and one-on-one discussions, a new management plan including restricted zones was approved in 1995. The licence conditions for a zone were:

i. only one licensee could fish in a zone and he could not fish outside it;
ii. the zone applied to no fishery other than sea urchins;
iii. the licensee must enhance the resource productivity in the zone; and
iv. after a trial period of four years, an audit of compliance with the enhancement requirement would be carried out.

Legal authority for zones was found in the *1985 Canada Fisheries Act*. This act provides for many types of management areas that can be used to regulate catch and fishing locations. Urchin zones were an extension of this provision that limited fishing in an area to one licence. Although not unique to this fishery, an owner-operator policy also limited each fisher to one licence.

The one-fisher/one-zone concept strongly diverged from tradition among coastal fishers. Typically, fishers are hunters who like the option to seek their prey wherever it occurs, as well as competitors who take pride in a reputation of community highliner. They also expect the opportunity of returning to port with a saleable catch nearly every time out and do not dedicate days to resource enhancement.

During planning meetings, licensees were asked to propose zone boundaries no larger than they could manage and to attempt to resolve overlapping borders with other fishers. The proposal to introduce zones created bedlam for several months both in and out of the urchin fishery. In Guysborough County, the most lucrative fishing area, a group of eight licensees lobbied three levels of elected officials plus senior bureaucrats with the argument that the county urchin resource was only large enough to be divided among themselves. During this time, the author quickly surveyed the county in order to negotiate boundaries. Nine zones were negotiated in Guysborough that year. Two years later there were 14 zones, with room for several more.

In Shelburne County, no fisher applied for a restricted zone in 1995, but six fishers negotiated an informal agreement to remain in separate fishing areas. This agreement failed on the first day of the season, when four of the six chose to fish on the same shoal. After a year of conflict over fishing areas, all six asked for zones for the next fishing year. Borders were settled amicably except for one overlap of about 200 m of shoreline. After two weeks of negotiation failed, the parties agreed to binding arbitration.

Two groups strongly objected to the zone concept. First, chiefs of 13 Nova Scotia First Nation bands objected on the grounds that private ownership of fishery resources was contrary to their traditions. They recommended another type of property right, transferable quotas. Second, fishers in communities near the fishing grounds who did not obtain sea urchin licences objected on the grounds that restricted zones were non-traditional and that new applicants should not be permanently excluded from the fishery.

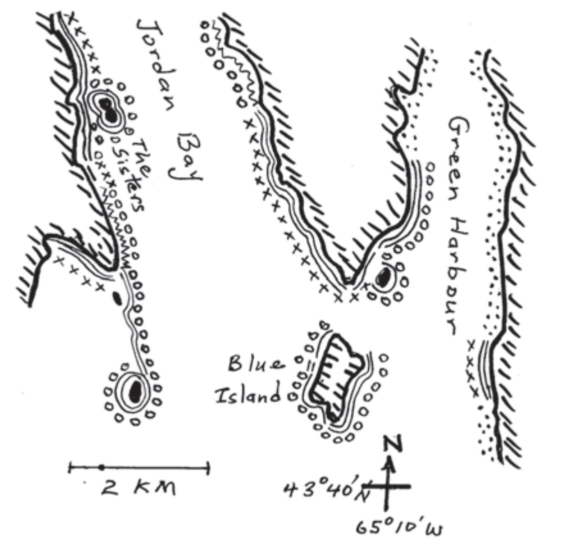
By late 1997, boundaries of 26 zones had been negotiated and a few others denied. A requirement that new applicants for zones must have harvested 25 t/yr was added to demonstrate competence in this fishery. Fishers were often assigned a zone larger than they could manage (with one vessel and four divers) to overcome their apprehensions about confinement to a single area. However, this created the need for later realignment.

Only a few fishers were successful in stock enhancement activities, i.e. bringing more of the stock up to marketable quality. These activities included: collecting under-fed sea urchins from areas of over-abundance and dumping them offshore to allow seaweed to recover from sea urchin grazing; moving under-fed sea urchins to kelp; and moving kelp to under-fed sea urchins. A financial grant to develop sea urchin stock enhancement methods was offered to an organization of coastal fishers, only a few of whom were licensed to fish sea urchins. Not only did the organization refuse the grant, it also strongly objected to anyone receiving the grant on the grounds that sea urchin abundance might be increased and thereby negatively affect other species of interest to the organization. However, the grant was given to one fisher (Mr Allan Baker), who was very successful in developing enhancement methods, and he willingly shared results with other interested parties. Because fishers with zones were not competing for catch, the usual barriers to communication were removed.

A second requirement of zone-holders was more successful. They were asked to provide a detailed map of the sea urchin and seaweed distribution along shore. This was to insure that they knew the resource in their zone well enough to develop a harvest plan. The biologist could check the accuracy of the maps from prior knowledge of each zone or could make spot checks in the field. Nearly all harvesters admitted finding new urchin beds and most maps were well done.

Figure 3 is an example of such a map. The following conclusions may be drawn from the map and annotations. On the west side of Blue Island and around the small island at the mouth of Green Harbour, urchins have reduced the kelp bed to a shallow fringe. Immediate harvesting is needed before all the kelp is eliminated and the sea urchins are without food to build roe. On much of the shore, urchins were too small and would be of no value for a few years. If the zone included areas with large but underfed urchins, these urchins could be moved to under-populated zones to feed on abundant kelp. Much of Blue Island and the shoal to the west is exposed to ocean swells and can be harvested on only calm days. The more sheltered areas inside Jordan Bay near The Sisters should be reserved for harvest on stormy days when outer areas are inaccessible. About 12 km of feeding front are available for harvesting.

FIGURE 3
Map of most of one sea urchin fishing zone in Shelburne County



Symbols show kelp and sea urchin distribution: ooo-harvestable sea urchin feeding front, xxx-sea urchins too small for harvest, single line-deep edge of kelp bed <3 m, double line-deep edge of kelp bed 3-6 m, wavy line-deep edge of kelp bed >6 m, stipple-bottom unsuitable for kelp or sea urchins (mud, sand, or loose cobble).

By 1999, the first 14 recipients of zones had completed the four-year trial period. Industry and government representatives jointly developed audit criteria based on the length and depth of sea urchin feeding fronts. The important criteria (i.e. decision rules) were:

i. All feeding fronts included in the audit had sea urchins of commercial densities. (An experienced commercial sea urchin diver participating in the audits made this judgment.)
ii. Unmanaged fronts were defined as locations where dense kelp extended

from the low tide line to less than 6 m depth, in areas where the bottom was capable of supporting kelp to that depth. (Kelp beds ending at less than 6 m deep are at risk of being eliminated by sea urchin grazing.)

iii. If greater than 1 000 m of unmanaged front was found in a zone, new borders would be negotiated to bring the total under 1 000 m.

Only one of the 14 zones met the criteria for being well managed, i.e. less than 1 000 m of front at less than 6 m depth. All but two zones also had more than 1 000 m of front at less than 4 m depth. For the 14 zones combined, the total front at less than 6 m and 4 m were 281 km and 192 km respectively. Using the method discussed by Miller and Nolan (2000), it was determined that the total length of front fished by 14 fishers in one season at all depths was 89 km. Thus, they were fishing only a small portion of their zones.

3.3 Licence fees

Licence fees to participate in the sea urchin fishery consist of:

Fisher's Registration Card	Can$50.
Vessel Registration Card	Can$50
Sea Urchin Licence	Can$100.

The fishers' registration card would be required of all divers (2 – 4) on a boat. Only one of the fishers' associations levied fees and this lasted for only a few years. The fees paid by each fisherman would have been on the order of Can$200/yr.

3.4 Failures

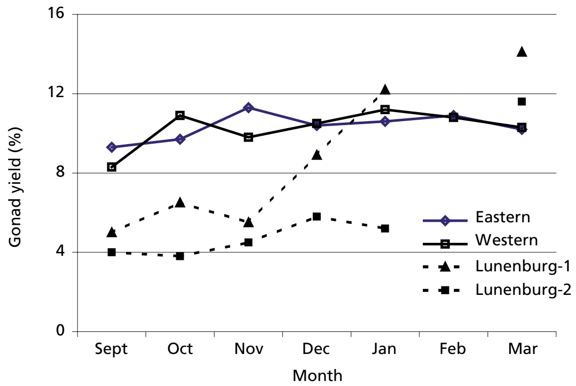
Negotiations to establish the habitat-based regime were acrimonious, but may have been unavoidable because this approach differed so much from traditional fishing practices. The level of underutilization of most of the audited zones indicates areal high-grading. Probably, only the areas most accessible or with the best roe yields were fished. We expected the percentage roe yield to increase with time as a result of enhancement activities. However, most plots of mean annual gonad yields for 13 fishers for which we have 4 or 5 years of records showed only modest or no improvement. From a starting mean yield of about 10 percent, three increased more than 3 percent, one by 2 percent, two decreased about 2 percent, and the remainder changed by 1 percent or less.

Fishers whose zones were audited were unwilling to relinquish a portion even when it was clear much of the stock was unfished. The terms of the audit were negotiated between DFO and zone holders, and the management plan called for a review of zones after four years. But prior to the audit, some zone holders realized they would loose a large portion of their zones under the negotiated criteria. They convinced fishery managers that they had not understood the negotiated terms, even though these negotiations occurred over a period of months with detailed minutes circulated at intervals. The fishery managers did not participate in resource surveys or observe sea urchin fishing and did not accept advice from those who had. They deferred to the arguments of the fishers. The audit results were never applied, and sea urchin resource worth several million dollars was left unharvested and died of disease in 1999–2001. Licences promised to new entrants to the fishery following the four-year trial period were not made available.

3.5 Successes

The benefits of zones are not easily quantified, because most were not fully exploited. Most fishing areas without zones, which might serve as the control areas, were scarcely fished. Digby County was the exception as an unzoned area consistently fished. Catches there declined from 362 to 125 tonnes over four years (Figure 2) even though there was no disease. Total catches from zones in Halifax and Shelburne Counties ranged from

FIGURE 4
Mean gonad yield for months the fishery was operating in 1998–99



Open diamonds and squares represent the fishery in Halifax plus Guysborough Counties and Shelburne County respectively. Closed triangles and squares represent feeding fronts at each of two locations in Lunenburg County (Meidel and Scheibling 1998).

835 to 1 140 tonnes with no trend over time for the four years from 1995 to 1998 before the major impact of disease.

The zone maps of sea urchins and kelp were successful. They provided harvesters with information to develop a harvest plan, including the distribution of the resource and identification of areas that did and did not need enhancement.

By knowing their fishing grounds, fishers were able to maintain gonad yields at commercially-acceptable levels, in spite of wider fluctuations in yields during the harvest season. In eastern Canada, the green sea urchin typically spawns in April and then gradually rebuilds its gonads to a peak size in March (Miller and Mann, 1973; Himmelman, 1978; Meidel and Scheibling, 1998). Figure 4 gives the monthly mean yield values taken by the fishery in Halifax plus Guysborough Counties and Shelburne County in the 1998–99 season. This is compared to the more variable monthly means from two feeding fronts located in Lunenburg County between these fishing areas (Meidel and Scheibling, 1998).

Because fishermen did not compete for resource, they could target high prices and save time searching for resource. At times of low prices, they sometimes refused to sell at all, which they could do without fear of losing their stock to another fisher. The opening of the Maine fishery in October 2006 depressed the Nova Scotia price to US$1.40/kg and fishers stopped harvesting. By Christmas, prices recovered to US$2.20/kg and fishing resumed (Garland, fisherman, pers. comm., 2007). Zones also gave fishers at least one-third more fishing days, because they spent less time searching for sea urchins and they could reserve sheltered areas for stormy days (Baker, Giroux, and Garland, fishermen, pers. comm., 2007).

Some of the usual resource management costs were eliminated. Enforcing regulations was not a problem. Fishermen policed their own borders and regulations were kept to a minimum. Initially a few misunderstandings over the location of boundaries were resolved by negotiation. Only one violation for fishing illegally in a zone occurred over six years. Without catch quotas or quota monitoring, the incentive to misreport landings was reduced. Except for initial zone allocations, the assessment costs were low. Fishers paid for the zone audits following the four-year trial period. Audit criteria based on length and depth of feeding fronts were easy to survey. Zone holders were adamant that zones were beneficial, and no fisher asked to give up the allotted zone to re-enter the competitive fishery. With the exception of one county, the fleet had a good diver safety record with a high awareness of safety issues.

4. DISCUSSION

The habitat-based management regime was economically successful and increased profits of participants and reduced costs of fishing and resource management. The social success was more equivocal. Participants were pleased to have zones, but prospective new entrants, who were promised zones, were not accommodated and the resource was under-harvested. Biological sustainability was not adequately tested because the resource died of disease after 3–5 years under the plan.

Prince *et al.* (1998) discussed issues for an abalone dive fishery similar to those encountered for the sea urchin fishery. Abalones are highly aggregated with variable growth and mortality on a small spatial scale. Because a management agency cannot afford to assess or regulate a fishery on such a small scale, they proposed that exclusive fishing areas be assigned to individuals or small groups. However, they found many fishers unwilling to relinquish their right to roam or to accept stock management responsibilities. They also found making the area allocations a daunting task. In the sea urchin fishery, fishers were given the choice of choosing a zone or not. This choice was easier than for the abalone fishery, because existing sea urchin licences were fewer than necessary to fish the entire resource.

A few important changes could improve the habitat-based management regime. Although zone holders were keen to eliminate competition through exclusive access, they were less keen to work to improve resource yields. Therefore, rules are needed to require resource enhancement. Eligibility criteria for obtaining a zone should be described in detail. When fishers apply for a zone, they and the management agency could sign a contract that includes the responsibilities of both parties for the duration of the contract, the details of the audit and the consequences of not meeting audit criteria for a well-managed zone. So that a fisher would not hold a zone while not fishing and denying access to others, a minimum annual landing should be required. A contingency plan for loss of the resource to disease should be included, e.g. exclusive zones would be eliminated and reallocated to participants after the resource recovered. These changes should reduce acrimonious negotiations for issuing and downsizing zones.

The objective of areal sea urchin management is to create a fishery with individual fisher-managers responsible for a zone large enough to support a single vessel and with incentives to use habitat-based management of their resource. The costs of regulation and fishing are reduced and the yield can be enhanced. Matching fishers to area included unusual problems. In most regulated fisheries, the fleet fishing power is in excess of what is needed to harvest the resource and regulations restrict the effort (e.g. with limits on catch, seasons, or gear). In the one-area/one-boat urchin fishery with few regulations, the balance must include enough effort as well as not too much effort. Because some fishers fish harder than others, and because environmental differences make some areas easier to fish than others, the required sizes of area varies. Therefore, one needs an empirical measure of how completely an area is fished; this was the intent of the zone audits. Given exclusive access, the fisher will hopefully not overexploit the resource. Because the amoeboid disease largely eliminated the stocks in 1999–2001, this experiment has not generated a sufficient time series to adequately assess the long term effect of the programme.

Conflicts arose over the spatial allocations, because many fishers viewed allocations as a competition to obtain as large an area as possible and then believed that they had earned a right to retain it. Also, fishers without sea urchin licences viewed zones as a threat to their future access. Finally, the radical departure from 300 years of fishing tradition and 100 years of fishery management tradition presented fishers and the regulators with unfamiliar and uncomfortable problems.

5. ACKNOWLEDGEMENTS

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Community inshore company development as a means of support for fishing community governance

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1. INTRODUCTION

The use of quasi-property rights (QPR) in the form of individual quotas began in the Canadian East Coast fisheries in 1977 when Canada extended its Exclusive Economic Zone to 200 nm. The reduction of foreign fishing activity was heralded as providing a new frontier in prosperity for Canadian fish harvesting and processing. Even though several traditional stocks such as herring and groundfish were depressed due to high levels of exploitation, the "new era" anticipated growth in stocks of fish as well as all other venues of the fishing industry. Therefore, with the announcement of the extended jurisdiction euphoria abounded in Canada as fishers, both traditional and new to the game, planned how to divide up the expected spoils of this good fortune.

The policy and decision-making processes of the day resulted in numerous and often conflicting principles of conservation, economic viability and more social objectives related to community support. By the late 1980s the real phenomenon of too many fishers and too few fish suggested that the vision of the government in its 1976 policy was wrong or that both industry and government were unable to make it work.

It was in this light, during the 1980s that government in concert with the industry began to seriously look at property right schemes as possible solutions for some of the problems. QPRs were seen as providing feasible solutions to some of the major problems in exploding fisheries in that they tend to make people accountable for their actions and can be successful, when used in a transferable format, at controlling capacity growth. In consort with stringent conservation controls for rebuilding resources, QPRs can become formidable tools for adjustment in a way that industry supports.

Kirby (1982) recommended the allocation of non-transferable quotas to large fish companies, which he termed Enterprise Allocations or EAs, as a means to encourage companies to live within their quotas. Since that time Individual Quota (IQs) and Individual Transferable Quota (ITQs) have been introduced for various fisheries from groundfish and herring to shrimp and snow crab. Within the Scotia-Fundy region more than 50 percent of the landed value is now covered by these management approaches. In almost all cases those programmes introduced prior to 1996 have had as a major objective balancing capacity of the fleet with the resource, which coincidentally were in a state of decline at the point of introduction. Since their introduction, two salient points have become apparent among all QPRs, namely that fleet rationalization has occurred and stocks have stabilized or expanded since the time of introduction.

The issue of rationalization is really a translation of economic self-sustainability or economic efficiency while conservation, leading to stock stabilization/growth, comes from the need by stakeholders to invest in the stocks for the future.

Two decades ago, the 200-mile limit promised a new dawn of prosperity largely to be based on groundfish. But the 1990s brought a codfish collapse and one of the largest employment losses and aid programmes in Canadian history. More recently, unprecedented growth in invertebrate resources has resulted in shellfish becoming the largest source of revenue in the fishery. Several factors can be identified as pertinent in developing a mechanism that could deal effectively with the cyclic nature of the East Coast Fisheries. These included ecological changes as well as economic and social considerations. An obvious question that arose related to the impact of resource fluctuations on management thinking.

Currently there is no established policy framework or regulatory mechanism to determine when and how wealth created in a given fishery might become subject to redistribution. A clear policy framework needed to be developed, however in the end a 'one-size-fits-all policy' may not be acceptable. When no clear policy exists, Integrated Fishery Management Plans (IFMPs) do provide a process that allows industry to decide these issues with a minimum of political interference.

The goal within a QPR system could be to attempt to allow market forces to function while at the same time ensuring that at some point of constraining market forces a level of protection is provided at predefined thresholds. These thresholds, when defined, could include such things as super-profit limits and increases in resource abundance. Without a framework, every improvement is subject to political lobbying by various interest groups.

Thresholds are seen as one way of triggering a wider distribution of the resource in a way that is not as subject to political interference in the methods of reallocation while satisfying the needs or demands of others. Several issues have contributed to development of the threshold mechanism in QPR fisheries.

i. Much of Canada's commercial fishery is based in areas where there are few non-fishery employment opportunities and the commercial fishery has to reconcile the realities of a modern fishing industry in a global market environment with other public concerns including the maintaining of coastal communities.
ii. The fisheries have achieved a high degree of efficiency, which manifests itself in several forms namely, (a) excess profits per individual and/or company and (b), concentration of activities among a few vessels and/or companies thereby affecting the coastal community network.
iii. In light of the groundfish collapse, rapidly-growing resources have demanded a rethinking of old solutions as disputes among existing users and those wishing to gain access to these lucrative resources intensified and both government and industry looked for ways to avoid the mistakes of the past and come up with innovative solutions that satisfy all concerned.

Central to this, and in the context of community infrastructure and support, are the small, inshore vessels which generally have not subscribed to such programmes in the past. This is changing as these fleets experience resource declines, reduced revenues and often community dislocations. The price paid by these groups is considered to be significant and something that political groups at all levels try to address. The issue of coastal community infrastructure is gaining popularity in many venues worldwide as the social values switch from those related solely to economic development to those encompassing both economic and social concerns with life style and location being vitally important. The cry of "community death" and "save the community" is now common in Canada and in many nations worldwide. It is in this scenario that coastal community networks, marine protected areas (MPAs), coastal infrastructure support etc., have their followers and supporters, which include many pre-eminent groups worldwide.

Within the threshold concept, questions will naturally arise including the following.

i. What is an excessive share of wealth under a QPR privilege?
ii. Who should decide when there is a resource surplus?
iii. What criteria should be used to trigger the use of thresholds in a particular fishery?
iv. What would be the future status of participants entering the fishery?
v. If abundance is increasing should the licence pool be extended and if so should the number of participants bear any relation to the long-term stability of the resource?
vi. Does the Department of Fisheries and Oceans have a mandate to meet social objectives or is this better left to industry or other government departments to address?

Thresholds can best be described as mechanisms by which QPR participants can define when, for how long, and what resources will need to be compromised within the QPR format, to ensure devolution of activity to new participants. This approach has the advantage of defining the long-term objectives of management plans as well as allowing the permanent stakeholders the opportunity to define its parameters. For coastal communities and fishers it provides a counter to the fear of consolidation/concentration and allows for income opportunities to a wider number of people who often live close to the resource under consideration. By introducing the threshold approach the number of fishers would vary depending on abundance and would avert a repeat of the late 1980s situation where too many fishers had been introduced to be viable during periods of low abundance.

2. THE INTRODUCTION OF A NEW ACCESS POLICY

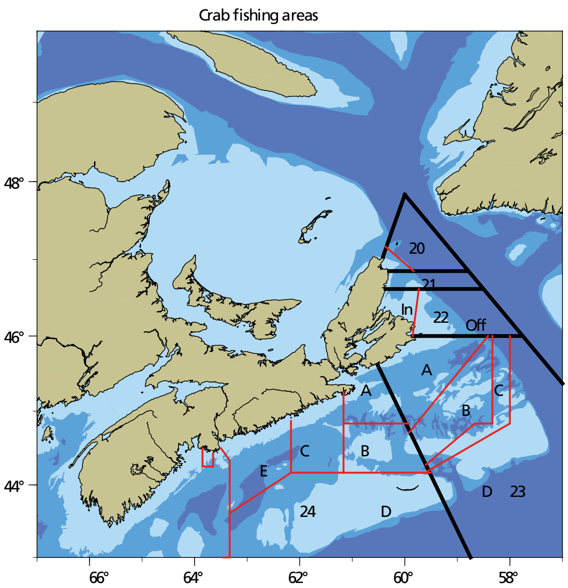
2.1 Policy background

The current snow crab (*Chionoecetes opilio*) (Photo 1) fishery consists of small vessels (under 19.8 m length) based in five crab fishing areas (CFAs) in the eastern part of Nova Scotia (Figure 1). It operates from several local ports, which have a mix of fishers, with and without crab licences. The gear used by these fishing vessels are a number of traps (Photo 2).

Through the 1970s the number of licence holders increased, with landings and licences keeping pace with one another. However, by 1982 quotas were not being reached and in 1984 quotas were removed as a management tool due to lack of scientific ability to predict stock biomass. Throughout the late 1980s increased abundance resulted in a resurgence of effort. The number of licences distributed remained stable until 1995 and resource biomass continued to increase. Although initially a nearshore fishery, with the increased abundance and access in the southern areas of eastern Nova Scotia (ENS), the fishery expanded outside of the traditionally fished areas and now extends 120 miles from shore where the fishable seabed is not as evenly distributed and snow crab are found in gullies.

PHOTO 1
An adult snow crab

FIGURE 1
Eastern Nova Scotia CFAs



While enjoying the benefits of QPRs, the snow crab fishery remained a common-property resource. Declines of both groundfish and lobster resource levels in the early 1990s caused increased hardships for many fishers and created a need for fishing alternatives. Increased market prices following these declines for snow crab, due to the collapse in the Alaskan crab fishery in the mid 1990s, resulted in demands by many inshore non-licensed commercial fishers for social benefits to flow from this unexpected growth situation.

Basic arguments for increased sharing focused on quota concentration, perceived excess profits by the existing licence holders, intra-port jealousies and the adjacency issue. All arguments played a part in demands for more access not only through the advisory committee system, but directly to officials' and the Minister's office. This in turn created suspicions of undue influence and politicization of the fishery's management.

Under the snow crab management plan (DFO 1998) permitted also was a "broader distribution of wealth from this fishery to other members of the CORE fishery when resource and market conditions are favorable, in a manner that will not threaten the viability of the fishery for the regular licence holders". But the vagueness of this wording allowed industry members to argue that any of the options should prevail.

The rivalries between existing users and others demanding a place in the snow crab fishery intensified in the late 1990s as resource biomass increased. Although the management plan identified that new entrants should be allowed in it did not address issues such as,

(a) should communities be allocated shares or
(b) should we allow fleet-efficiency to continue to increase at the possible expense of coastal communities' welfare?

The co-management approach identified through the IFMP encouraged industry to reduce the political volatility by bringing the decision-making process closer to the local level. Rather than accepting an external process that is subject to rigid rules or political pressures, industry defined its own mechanisms to avoid this as stock biomass

PHOTO 2
Retrieving a snow cab trap

increases or declines. Through a cooperative process involving science, management and industry the basic rules for management and allocation were established.

Through this process management responsibilities for administering their share of the total allowable catch (TAC), including biomass thresholds for management action, as well as other aspects of the fishery, were designed. These co-management arrangements provide industry with better security of access, clearer roles for government and industry, and more opportunity for industry to put its expertise to use in managing the fishery. This process allowed the next logical step to occur i.e. the introduction of thresholds in 2000 as adopted for use under a new snow crab management plan (DFO, 2000).

2.2 The temporary solution

Licence holders recognized that their fishery could tolerate additional effort on a temporary basis. The emphasis must be placed on the temporary aspect of this type of solution for wealth distribution.The introduction of temporary access attempted to balance the needs of viability for the existing licence holders with the desire to help economically affected communities.

Therefore, TAC thresholds were established that when exceeded allow more fishermen to share resource surpluses. The long-term objectives for this fishery included (a), the continued biological and economic viability of the stocks and (b), the broader distribution of temporary access within the fishery to other core licence holders when both market and resource conditions were favorable, and in a manner that did not threaten the viability of the regular licence holders.

The threshold plan for each CFA was different but the principles were generally the same. These objectives were achieved through the following tactics.

i. The identification of exploited areas (traditionally fished) and lightly exploited areas (non-traditionally fished areas where most of the new access would be provided).
ii. Threshold amounts (tonnage or tonnage and value).
iii. A mechanism for sharing growth beyond a threshold. That is, sharing of access to temporary rights holders, which may involve reciprocal zone-sharing, straight access-sharing or sharing of fishing zones.
iv. A complex tiered approach was developed, which if TACs continued to increase, would result in the temporary fleet receiving the majority of excess above the threshold and with equal access to the entire zone.
v. Plans for crab are normally for a period of five years at which time issuance of thresholds based rights revert to a ground zero situation and negotiation recommence.
vi. Provide special consideration to Aboriginal peoples for commercial access.

All fishers eligible for temporary access were represented by associations that were charged with maximizing returns and for distributing wealth to members. Temporary licences were provided through the associations to individual fishers who fished for all eligible fishers in the association. Limitations were placed on the number of licensed participants to reduce effort and maximize revenue generation. In addition, temporary licences were restricted to non-traditional fishing areas and temporary access was to be provided only during the period of surplus abundance.

In total, over 700 inshore commercial fishers and Aboriginal Bands, who were non-licence holders, participated in the fishery by being provided one of 4 levels of quota allocation. The amount of quota allocation was based on a priority assigned to the fishers.

i. Aboriginal Bands were provided an amount based on the size of the band.
ii. Fishers who lived adjacent to the resource were provided the largest individual amount.

iii. Fishers who were deemed to have been affected by the downturn in the cod fishery were provided an intermediate individual amount.
iv. Any other fishers identified as not living adjacent to the resource were provided the lowest individual allocation.

2.3 The permanent solution

The introduction of this social accommodation into the snow crab fishery created the need to look at innovative approaches to share benefits from a fishery among coastal community populations while at the same time maintaining the integrity of the IQ approach among all licence holders.

Under temporary access no governance structure was introduced as community groups managed a harvest and dollar distribution but not the harvesters or community members. Elements essential for a community management application to succeed are:

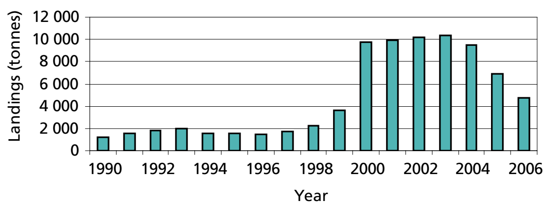
- broad based community support
- essential community infrastructure for long term viability
- a CORE group of fishers and enterprises – CORE is a designation that identifies license holders in the inshore who earn the bulk of income from one or several fisheries.
- a willingness to support a cooperative or collegial approach to fish management
- a solid business plan that does not require government support or intervention
- legal basis for operation with accountability process and public reporting and
- structural support via a rights-based allocation system.

The lack of cohesion with no long-term management structure put in place by community groups or commitment by non-license holders to any kind of long term community infrastructure lead to numerous situations of disagreement. The temporary solution distributed wealth but in the absence of a logical management structure social-demand weaknesses became paramount in this temporary process making it largely problematic to the orderly management of the fishery at conclusion.

The threshold approach had originally been thought to be for a three-year period due to anticipated stock declines. However, because of a build up in resource biomass, TACs were not changed during that period and by 2004 (four-years after the introduction of thresholds) it became apparent that abundance would remain high compared to pre-2000 levels and while abundance fluctuations were expected in the future, the fishery was not expected to return to the low levels of 1990 when fishing effort was restricted to a small portion of the CFAs. In addition, by the end of 2004 the maintenance of high levels of temporary access and the application of the structural design of the threshold approach for five years allowed fishers to become dependent on this temporary allocation and increased demand for distribution changes occurred (see Figure 2).

The dependence of such a large number of fishers did not allow for "planned for attrition" or drop off when the biomass decreased and infighting between groups resulted in a lack of consensus on co-management decisions. With no attachment to the fishery through a licensed rights-based approach, fishers attempted to force management from a biological, stock-based approach to a political approach based on individual demands. In order to stabilize access and allocations as well as address the long-term requirements for this fishery a more structured solution for a permanent rights based system was required.

FIGURE 2
Historical snow crab landings in eastern Nova Scotia



In general, this permanent system would continue to apply the principles of conservation and sustainable use with the fishery. However, the success of the system would be measured by the manor of the introduction of additional licences while continuing to adhere to the principle of social balance. Safeguards must be present in the ecological processes and ensure genetic diversity for present and future generations and that as a common property resource it be managed for the benefit of all Canadians.

TABLE 1
Access in the eastern Nova Scotia snow crab fishery

	1994	2000	2006
Permanent access			
Total number of licences	119	121	193
Number of aboriginal licences	0	3	33
Number of fishers	119	118	843
Temporary access			
Total number of licences	0	130	0
Number of aboriginal licences	0	26	0
Number of temporary fishers	0	725	0

More specifically, the system would build on the principles used in the introduction of temporary access. The proposed approach contained initiatives to stabilize communities and fisheries access by maintaining the priorities of conservation, the constitutional protection afforded Aboriginal and treaty rights, and the viability of commercial licence holders. The system, to be functional, had to establish new levels of limited entry consistent with viability of all participants and convert temporary communities to licensed groups. The approach allowed communities to self-adjust through allocation transferability and to ensure coastal community stability and community infrastructure/membership control/governance exists through use of legally based "CORE companies", which support coastal community interests.

The new long-term access and allocation arrangement was introduced in 2005. To provide a more fair and equitable approach to access, the varying allocation amounts provided to temporary fishers were equalized within a CFA and converted to permanent access as individualized quota shares. Although these quota shares had no intrinsic value within the fishery and could not be fished, fishers holding these new quota shares were then provided the opportunity to consolidate, based on accumulated allocations to pre-determined minimum levels, to form CORE Companies with up to one-third the quota holdings of an existing permanent licence. Once formed the CORE Companies were provided a permanent licence with access to the entire CFA and a percentage share of resource depending on the consolidation level.

The establishment of the CORE companies allowed for every CORE fisher in eastern Nova Scotia to be accommodated within the snow crab fishery without increasing the effort on the stock above a level which would diminish the biological or economic viability of the fishery. The CORE companies also alleviated concerns within communities that processing firms and other non-licence holders would control the fishery. Members of the CORE companies determine how their individual quotas are fished and profits distributed.

In total, 72 new licences were created via this conversion process. These changes resulted in 193 permanent licences in eastern Nova Scotia with over 800 individual participants and eight Aboriginal Bands involved as licence holder or shareholder in one of the new CORE companies (Table 1).

2.4 Establishing policy

During the implementation/transition year of 2005, the policy was applied to the formation of CORE companies by eligible snow crab quota holders in each of three CFAs (20, 23 and 24). The establishment of CORE companies was for the purpose of participating in the snow crab fishery only and no CORE companies formed under the policy were eligible to hold a licence for any other species.

The policy used in the establishment of the CORE companies and applied after formation, followed as closely as possible departmental policy for regular licences. Normally snow crab licences may be issued to a qualified new entrant (full time) or to another CORE entrant registered with DFO in the Scotia-Fundy Sector of the

Maritimes Region subject to regular Change of Licence Holder policies as outlined in the Commercial Fisheries Licensing Policy for Eastern Canada, 1996 and/or any additional requirements outlined in the snow crab IFMP for Eastern Nova Scotia.

However, a licence issued to a Company cannot be reissued to an individual fisher. Therefore, a policy was required to address the issue of owner operators and to include provisions for the transfer of quota, licence transfers, vessel replacement and operator designation.

The following definitions were applied to the terminology used in the establishment of the policy.

i. *CORE* – a designation that identifies license holders in the inshore who earn the bulk of income from one or several fisheries.
ii. *Permanent Licence Holder* – a fisher who held a permanent snow crab licence that was valid in 2004 within eastern Nova Scotia.
iii. *Quota holder* – a fisher, who by meeting the 2005 access criteria, was allowed to amalgamate to form a new CORE company.
iv. *CORE company* – the legal company formed by the amalgamation of a group of quota holders to which a new snow crab licence may be issued.
v. *Owner operator* – a requirement whereby the licence holder must operate the vessel during any fishing activity.

To reduce the potential for overcapacity, quota holders were not authorized to harvest their individual snow crab allocations. The establishment of the CORE company reduced the number of active participants but allowed the listed share holders in the company direct control of the licence that was issued to a CORE company and operation of the licence using a specified vessel on behalf of all share holders.

Eligibility criteria were announced to provide access to fishers who held an enterprise that was eligible for temporary access in 2004. Only those identified fishers were authorized to be a share holder in a CORE company. Fisheries and Oceans Canada was responsible for establishing an official list of these quota holders. To further support a community approach quota holders were only eligible to be shareholders in a snow crab CORE company holding a licence for the nearest CFA. In addition, to ensure that quota holders do not acquire control of excessive amounts of quota, individual allocations cannot be split among more than one CORE company.

Under the new access arrangement, 5 percent of the licences in CFA 20 and 40 percent of licences in CFA 23 and CFA 24 would be held in the name of CORE companies. Based on this breakdown and the number of eligible quota holders, the approximate consolidation ratios established for a new licence to be equal to a Permanent Licence Holder's quota were:

CFA 20	–	10:1,
CFA 23	–	16:1 and
CFA 24	–	20:1.

When consolidation to these levels, or higher, was achieved the CORE company was issued their harvesting licence. To ensure full community distribution, a CORE company was also limited to a maximum consolidation not exceeding 133 percent of the minimum requirements.

Quota holders who could not meet the above ratios were required to wait to be issued a licence as a CORE company until most consolidations were completed to ensure that the maximum number of new licences would be maintained. Once the appropriate number of licences had been approved remaining quota holders were required to become a share holder in a CORE company meeting the requirements.

Once formed each CORE company had to register with the Registry of Joint Stocks and provide a certified list (verified by a solicitor) of each of the share holders in the CORE company. Only quota holders could be listed as share holders; no other parties are authorized to hold any shares in the CORE company.

Each CORE company also identified those officers of the CORE company that would be authorized to conduct business on behalf of that CORE company. These officers could be share holders, but could also be a non-share holder (Director of an Association for example). The DFO only takes direction from a designated officer of the CORE company for any transactions requested of the department (quota transfer, vessel identification, etc.).

After the first year, when the initial minimum requirements were met and a CORE company was issued a licence, share holders could leave or be added to the list of share holders subject to the Articles of Incorporation of the CORE company. It is the responsibility of the Company to notify and provide a revised certified list of share holders to a DFO Licensing Authority within 15 days, whenever a Core shareholder is added, replaced or removed as a shareholder in that Company.

Shareholders within the CORE companies must be the head of a CORE enterprise and shares in the CORE companies are transferable to any eligible fisher within the Maritimes region. Eligible fishers are those meeting the criteria under the Commercial Fisheries Licensing Policy for Eastern Canada, 1996 for change of Licence Holder.

A change in membership of CORE companies could be the result of a quota holder moving between companies or the purchase of shares by other eligible fishers including other quota holders. After initial formation, any CORE company issued a licence must maintain at least one remaining CORE licence holder to continue to be eligible for a licence.

There is no upper limit on the number of CORE shareholders a Company can have, however, the amount of quota issued with the licence will not change except through regular permanent and/or temporary quota transfers that are subject to transfer limits established for the fishery.

2.5 Quota transfer

Departmental policy allows for quota transfers, both permanent and temporary, within established transfer limits, between all licence holders within a CFA. Quota transfers may also be subject to the Articles of Incorporation of the CORE company. When quota is transferred on a temporary basis the quota is reallocated to the original licence holder at the start of the following season. Therefore any licence holder would remain eligible for the snow crab fishery.

However, in the case that all quota held by the CORE company be permanently transferred departmental policy had to be clarified. The CORE company was only eligible to hold a snow crab licence therefore a minimum amount of quota is required to maintain the eligibility of the CORE company to continue to hold a licence. Without maintaining the minimum quota required the licence would be permanently removed.

2.6 Vessel designation

All snow crab licences are restricted to the use of a vessel(s) less than 19.8 meters (65') length overall. (see, e.g. Photo 3) In some of the CORE companies more than one of the share holders wished to actively fish. With the normal restriction that only one vessel could be assigned to a licence for any 30 day period this restricted the activity of the CORE companies. Since a vessel allocation could be fished in less than 30 days the CORE company would not be able to maximize effort during the season and catch rates would decrease late in the season further affecting the economic return to the company.

To address this each CORE company is eligible to identify up to a maximum of three vessels they intend to use on their licence prior to the licence being issued. These vessels are named in a schedule attached to the licence and are authorized to fish on that licence only during the period of time the vessel is registered with DFO in the name of that CORE company. Subject to their licence conditions only one vessel may fish at any one time but up to three vessels may now be active within the 30-day period. The CORE

PHOTO 3
Example of a vessel licensed to fish snow crab

company must notify DFO and request an amended schedule for their licence each time a vessel completes fishing and will no longer be authorized to fish on their licence.

In accordance with regular departmental policy any vessel placed on a CORE company licence will be required to be registered with DFO in the name of the CORE company as the licence holder. The CORE company does not have to own the vessel it registers and only Canadian vessels are eligible to be placed on a licence. In addition, anyone who is using their vessel on a CORE company licence must meet department policy; i.e. any individual (personal) licences issued in respect to that vessel must be removed (banked) for the period of time the vessel is registered to the CORE company.

Vessels being removed from a CORE company licence may be replaced on any previously "banked" licence(s) from that vessel before the 30 days has expired. However, the 30 day requirement must be met before further changes to the vessel may occur. After 30 days, an additional vessel(s) may be registered in the name of the CORE company, provided no more than three vessels are registered to that CORE company at any one time.

2.7 Licence fees

In all fisheries, fishermen must be licensed annually (Can$50/yr) as must be fishing vessels (Can$50/yr). In addition a fee is assessed based on the individual quota available to the fishermen. The base fee for snow crab is (Can$123/t) and a fee reduction of 40 percent up to a maximum of Can$1 000 is then applied. Note that Competitive and IQ snow crab fisheries differ in their fee structure, but there are no competitive snow crab fisheries in the area covered by this study.

2.8 Operator designation

The owner operator policy applies to the snow crab fishery where the licence holder must be the operator of the vessel licenced to fish. Since the CORE company is named as the licence holder the owner operator policy needed to be modified. The CORE company must name an operator for the licence.

Departmental policy requires that any registered fisher (full-time or part-time) may be named as an operator of a vessel. Some CORE companies require through their Articles of Incorporation that the operator must be a shareholder in the company. The CORE company must notify the DFO and request an amended licence condition if another operator is to be named in their licence, prior to any fishing by the new operator. A CORE company will not be authorized to use more than one operator at any one time. Licence conditions must identify the operator and can be amended at a DFO Licensing Centre.

2.9 Industry response

Initial industry response to the decision to convert temporary access to permanent status was negative. The snow crab fishery is cyclic in nature and existing permanent licence holders took the position that the downturn in abundance was going to continue and felt that the introduction of additional permanent effort would have a negative impact both on the stock and the economic viability of all licence holders. They were also concerned that the effort distribution limiting the temporary licence holders to the non-traditional fishing areas would be removed producing additional effort on the nearer shore areas thereby increasing exploitation on that portion of the stock.

However, the available information at the time suggested that the abundance levels would not decrease as low as predicted by the permanent fleet. By 2006, the expected increase in recruitment was beginning to enter the fishery thereby reducing concerns of the impact on the stock. Shifts in fishing effort have occurred such that previously temporary fishers have moved from the furthest offshore areas but have not concentrated in localized areas sufficiently to cause localized over exploitation.

The temporary licence holders desired permanent access but with larger individual allocations. Within the temporary group some fishers felt that rather than the equalized allocations provided, unequal allocations should have been provided based on varying levels of priority. They were also concerned that the number of quota holders required to consolidate to form a CORE company was too large. This requirement was expected to make agreement on consolidation more difficult and lower employment by reducing the number of active vessels.

Initial requests for allocations from the temporary groups all centred on obtaining the maximum amount of quota possible. However the approved policy provided an equitable distribution, which fishers have accepted as the most reasonable and fairest approach. In addition, it was much easier to consolidate and form the CORE companies than they had expected.

The general lack of co-operation in the management of the resource seen during the period of temporary access was initially increased by the decision to increase permanent access. However, once the fears expressed by the two fleets were allayed fishers have accepted the new approach and have moved forward to work more cooperatively within it.

3. CONCLUSIONS

After two fishing seasons the impact of this policy can be assessed. Discussions on the management of the fishery have become more unified as organization within the industry increased. This organization has been partially possible due to the reduction in the numbers of groups with varying interests. The previous social/political considerations that directed discussions in the past has been reduced now that concerns over security of access, individual allocations and regional imbalances have been removed. And, fishers have a more directed interest in the sustainability of the resource.

Fishers within the existing fleet may now adapt to biomass changes without fear of additional access being provided during periods of abundance or reduced shares during periods of low abundance. This has allowed participants to make long-term operational decisions that were not possible with temporary access. In the last two years fishers were required to make adjustments according to circumstances of both reduced abundance and lower market value. Current recruitment projections indicate that they will need to make future adjustments according to an increasing abundance and higher market value. This ability to adjust guarantees the long-term viability of the fleet.

The formation of the CORE companies has provided previously non-licenced holders with access to a property rights fishery. Policy modifications such as the multiple vessel provision have provided economic support to all interested share holders. The ability for quota transfers and the sale of shares in the CORE companies have provided the flexibility to allow for the consolidation of access to fishers interested in the development of the fishery.

Many of the fishers see access as a share holder in the CORE company as equivalent to a guaranteed income upon which long-term plans may be based. The introduction of this policy may even have an impact on the effort capacity in other fisheries. Since the number of CORE enterprises in the region is constant and share holders in CORE companies must be CORE fishers, any inactive fisher who chooses to remain a company share holder will have to continue to hold appropriate licences to maintain their CORE status. This may produce the long-term affect of reducing activity in those other fisheries.

With all harvesters regulated as equals, the policy has normalized the activities of all participants. Community support has increased with the establishment of the CORE companies as companies and licence holders within the community are working together. In three separate areas of eastern Nova Scotia (Cape Smokey area (CFA 21), Port Morien (CFA 23) and Richmond County (CFA 24)) several CORE companies have Terms of Agreement such that if a share holder wished to sell their share the companies would have the right of first refusal. In addition subject to price considerations these companies would sell the crab to local buyers.

By creating an infusion of product and thus money into the eastern Nova Scotian coastal communities, local fishers influence the financial and employment benefits that flow to their communities. Since the harvesting and processing sectors are also affected by the marketing decisions made by community members this guarantees that the entire community will obtain maximum benefit from the fishery.

The introduction of this innovative policy addressed the need to provide a large number of participants with a reasonable and sustainable access to a fishery that had gone through a period of increased abundance. Currently all participants have a rights-based stake in the fishery that promotes a common goal for the long-term management of the resource and fosters greater economic viability of the fishery sector as a whole.

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Community management in the inshore groundfish fishery on the Canadian Scotian Shelf

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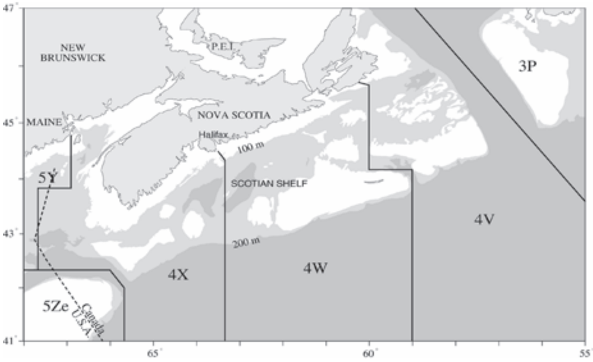
1. HISTORY LEADING TO COMMUNITY MANAGEMENT

The groundfish fishery in Atlantic Canada is arguably the most complex fishery in Canada. Groundfish is the generalized term for a number of species of fish, mostly gadoid that are harvested separately or collectively by many fleets involving thousands of fishermen throughout Atlantic Canada. This chapter will focus on the inshore, fixed-gear sector of relatively small, inshore vessels 10–14 metres in length. This sector uses handline, longline and gillnet gear to harvest groundfish along the Scotian Shelf, in the Bay of Fundy and on Georges Bank (see Figure 1). Groundfish fishing by this sector involves seven separate and distinct fleets harvesting mostly cod, haddock, pollock, flatfish, halibut, redfish and a variety of bycatch species.

Following establishment of the 200-mile limit in 1977, Canada began to develop an extensive domestic groundfish fishery that utilized both inshore and offshore fixed and mobile gear. Harvest expansion in the 1980s was followed by significant declines in species populations and associated harvest levels. Harvest moratoria were implemented for several cod resources in Atlantic Canada during the early 1990s and several of these moratoria continue today. On the Scotian Shelf, these included haddock stocks and cods stocks in areas 4V and 4W. The cod stocks in this area were formerly among of the largest in Atlantic Canada. These closures, along with significant declines in other groundfish resources on the Scotian Shelf, have resulted in significant declines in employment. The management response to the problems facing the groundfish fleets has moved forward on the basis of a two-part strategy: (a) an expansion of enterprise allocations (EA)/individual transferable

FIGURE 1
Scotian Shelf, Bay of Fundy, and Georges Bank fishing areas



Source: Peacock and Hansen 2000.

PHOTO 1
Cape Islander fishing vessels characteristic of the maritime inshore fishery

quotas (ITQ) for vessels greater than 45′ and (b), a new community quota approach for the inshore fixed-gear less than 45′ sector. This paper addresses the latter.

In the 1970s and 1980s, the inshore, fixed-gear assemblage was a diverse group of over 3000 licence holders. Photo 1 shows the types of boat active in this fishery. They had varying degrees of economic aspirations and there was little cohesion among fleets, communities or port clusters. Management approaches devised through two task force studies in the 1980s considered these inshore groups to be of little significance in the overall scheme of management, as their effort seemed minor compared to the large mobile gear (Kirby, 1982; Hache, 1989). By the early 1990s, this sector remained without an overarching management approach and functioned within a "least common denominator" management philosophy. The management approaches were fraught with difficulties and tailored to no one group. The need for change was apparent.

Attempts began in the mid 1990s to manage the inshore fixed-gear (FG) sector. Trip limits were used to tighten controls on effort. Previously (see Hache, 1989), the smallest vessels, while numerous, were not felt to be a major burden on resource viability. When quotas were reached, vessels under 13 metres were permitted to continue fishing on a limited basis through trip limits, typically 3 300 lbs/trip, until the end of the fishing year. Many of these small vessels were handliners, so this treatment supported both small communities and the associated small vessels. These flexible arrangements for small operators (less than 13 metres) were eventually eliminated in an attempt to bring harvest activities in line with resource abundance. However, the development of management for this diverse sector proved long and circuitous. During the process, many associations that represented inshore, fixed-gear interests arose. This resulted in intense competition within the advisory committees for allocation advantage. The process often culminated with demands for the Minister of Fisheries and Oceans to intercede to change sharing arrangements. The priority given to continued viability of the inshore fleet resulted in destructive management decisions and often in overfishing of dwindling fish resource.

2. THE COMMUNITY MANAGEMENT SYSTEM

2.1 Origins

The new community approach was introduced on a trial basis in 1995 in the Halifax west area of Nova Scotia as a one-year trial. It became effective for all fleets in 1996. This was followed by a 3-year test application beginning in 1997, which introduced community management boards for all inshore fixed-gear fishers. This resulted in the establishment of eight community zones. The approach recognised differences within the inshore sector by using either geography or "like-minded" views to define fleet structures. The term "like-minded" refers to the recognition of groups of fishers who have common management objectives. The trial process became the community-based management approach, which has operated continually with little modification and within the same 8 community zones as in 1997.

TABLE 1
Inshore fleet composition, 1995 and 2005

Vessel size	Mobile gear (67% of inshore allocation)			Fixed gear (33% of inshore allocation)		
	1995	2005	ITQ introduced	1995	2005	ITQ introduced
10–13.7 m	500	92	n/a	2542	532	n/a
13.7–19.8 m	361	52	1991	66	20	1999
Total	861	144		2608	552	

TABLE 2
Inshore licences by area, 1996–2005

Year	Eastern Nova Scotia	PAFFA	Southwestern New Brunswick	Yarmouth	Lunenberg Queens	Digby	Shelburne	Total
1996	54	45	97	106	177	151	644	1 274
1997	52	40	97	127	155	154	513	1 138
1998	50	40	63	85	133	104	394	869
1999	46	37	41	64	118	83	382	771
2000	36	34	41	74	102	90	335	712
2001	41	30	53	87	81	93	274	659
2002	43	32	48	87	78	95	257	640
2003	43	32	46	75	77	82	237	592
2004	36	19	41	34	56	68	182	436
2005	21	20	37	43	45	62	156	384

TABLE 3
Locations of Community Management Boards and targeted species

Southern New Brunswick	Eastern Nova Scotia	Halifax West	Queens County/ Lunenburg	Shelburne A	Shelburne B	Yarmouth	Digby
Cod	Cod	Cod	Cod	Cod	Cod	Cod	Cod
Haddock	Haddock	Haddock	Haddock	Haddock	Haddock	Haddock	Haddock
Pollock	Pollock	Pollock	Pollock	Pollock	Pollock	Pollock	Pollock
	Halibut	Skate/ Halibut		Halibut	Halibut	Halibut	
		Dogfish		Dogfish	Dogfish	Dogfish	Dogfish

As a start, vessels within the 13.8–19.8 m category were excluded and were treated as a ninth community group. This allowed an independent management application for a relatively small number of vessels. The inshore fixed-gear fleets had objected to any quota transfers between mobile and fixed-gear, notwithstanding the choice of management regime. Separating the 13.8 m–19.8 m vessels from the rest of the inshore fleet allowed this sub-group to consider a broader ITQ approach that would not have been possible within the inshore fleet. An ITQ approach was adopted for these vessels in 1999. The change allowed this part of the fleet to interact with the inshore mobile gear (>19.8 m) fleet and allowed for transfers of ITQ between the two fleets.

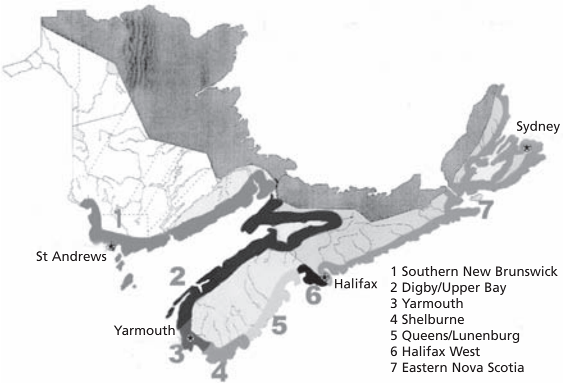
Table 1 lists the fleet compositions at the time of implementation in 1995 and ten years later in 2005. The number of active participants in all vessel types has been reduced, largely due to quota reductions and to participation in the lucrative lobster and crab fisheries, as well as through self-rationalization plans implemented by community management boards. Table 2 shows that these decreases have been spread across all seven communities. Table 3 shows the species that are targeted by the respective community-based fisheries.

2.2 Structure of inshore community management

2.2.1 Defining communities

To implement community management for the inshore fleet under 13.8 metres, three steps were required. The communities (ultimately eight) had to be defined. Allocations had to

FIGURE 2
Geographic extent of community groups



Source: Peacock and Hansen, 2000.

be made to each community. And a governing structure for each community was required.

A series of eight communities were established, based on seven geographic areas (see Figure 2). Six of these areas and seven of the community groups, were in South-West Nova Scotia. In most cases, the geographic partitioning also supported the "like-minded" approach favoured by government. Industry support for the geographic areas was based in part on the assumption that the geographic criterion would prevent ITQ implementation, which was opposed by most fixed-gear operators. A mediator was used to resolve differences in opinion with respect to the development of the community boundaries. Within the Shelburne geographic area (zone 4 in Figure 2), major differences in vessel performance, attitude and objectives existed. Shelburne was also the area with the most historical landings. This area required further partitioning and the "like-minded" application provided for an effective division between the two groups. The result was one Shelburne group of high-line operators and a second group of relatively lower-performing fishers.

All fishers were assigned to a community on the basis of the port of registry as of 31 December 1996. Initial allocations (next section) to communities required a past reference point to determine community composition and associated allocations. An "opting out" provision is available on an annual basis. This option is relatively unattractive, because it is a competitive fishery based on the historical landings of the individual licence holders, in a tenth group called "Group X". All licence holders are in Group X at the start of the season and then leave Group X to join a community group. The Group X participants consist of those who choose not to join a community group. Annually, there are fewer than 15 that choose to remain in Group X, with no more than five of these choosing to fish.

2.2.2 Allocations to communities

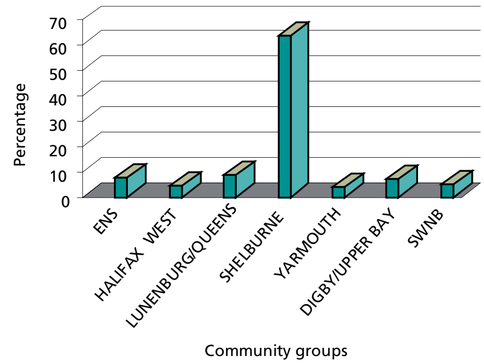
The determination of allocations though always a contentious issue was an essential step in the process of shifting responsibility to the industry in many decision-making areas. The problem of unknown catch histories further complicated this allocation. Quota was allocated to each community on the basis of the catch history of all individuals with a registered homeport in that community in 1996. The catch history was calculated using the 1986–1993 period. The final calculations included both landings that could be attributed to an individual licence holder and also landings at processors within these communities that were unidentified by licence holder. This process used numerous sources, including the DFO, for data analysis. In the end, fishers agreed upon a sharing format using the following criteria:

i. Cumulative catch history of all the licence holders in a community for the three main species: cod, haddock and pollock. Other species are fished as a collective bycatch or a small directed fishery, based on decisions taken by all communities at the annual FG < 45 Committee.
ii. Unidentified landings (at the vessel or individual level) from each community were added to the cumulative catch for each community.
iii. Upon completion of the share calculations, which apportioned 97 percent of calculated amounts, the remaining 3 percent was supplied to individual communities to address to inequities.

iv. Each fisher in the Shelburne community groups had to choose one of two sub-groups.

The resultant geographic allocation (showing the total for the two Shelburne groups) is shown in Figure 3.

FIGURE 3
Allocations to community groups



2.2.3 Community Management Boards

Community Management Boards (CMB's) were created to implement decision making. The elected members in most cases are fishers, but occasionally are non-fishing representatives. These private, industry boards provide input into in-season management and develop, implement and monitor controls on the activities of the community fleet. Activities internal to the board are not the purview of government, unless such actions result in measures that would be illegal, be contrary to Conservation Harvesting Plans (CHPs) or be contrary to the management measures required for all community groups. Management boards also provide representatives to the public advisory process. Each community management board has three seats on the Fixed-gear < 45 Groundfish Committee. All of the management boards meet each year at the Fixed-gear < 45 Groundfish Committee and develop a single CHP that all boards must support.

2.3 Decision-making by CMBs

Each CMB develops a community harvest plan (CHP) for its fleet, is responsible for controlling fishing activities of members and must adopt standardized monitoring and catch controls. Without a plan that respects conservation and at the same time delivers industry requirements, no fishery can occur. They also develop and implement penalty provisions for violations of their measures, such as trip limits. These are not enforced by the DFO; they are imposed under civil agreements. However, imposing penalties such as loss of fishing time is becoming increasingly more difficult without a legislative framework.

The foundation for this process is the Dockside Monitoring Program (DMP). DMP is a 4-step process of:

i. hail (i.e. reporting, usually by radio) out prior to fishing,
ii. hail in of amounts caught from at sea,
iii. verification of unloading amounts at the dockside and
iv. collection and entry of catch data on a real-time basis.

This service is an independent function of several companies and is totally funded by the fishers. The type of management adopted (ITQ or quota-limited competitive catch) and vessel characteristics determine the level of recorded detail that is required.

Additional requirements to ensure the conservation of the resource are delivered through a combination of government activities and industry commitment and delivery. Government controls involve the use of at-sea boardings, observers and sea/air surveillance to augment the hail/DMP process. Industry supplements at-sea monitoring through the funding of the "at-sea" portion of the costs of observers.

Industry peer-pressure has provided a significant deterrent to illegal fishing activities, including those that compromise conservation or compromise industry harvest plans. In some communities, industry sanctions have been adopted. Penalties are normally reductions in quota and/or time that can be spent at sea and can be more draconian than government penalties issued by courts. All penalties are determined by the fishers.

The CMBs have been able to trade quota with other communities, trade or exchange members, apply penalties for breach of a CHP and generally conduct a business-like approach to fishing within the conservation umbrella demanded by a precautionary approach. Transfers of quota among communities and movement of fishers between communities require agreement from both communities, including agreement on whether the catch history would move as well.

2.4 Government role

Within this "new arrangement", government maintains the activities of licensing, registration of vessels, identification and limitation of gear and the description of area to be fished or controlled. Many of these applications occur through the DFO-administered licence conditions with delivery through the DFO enforcement.

There are different fee rates associated with the community (competitive/informal ITQ) and in the formal ITQ approach. In non-ITQ fisheries the fee rate was set at Can$100 based on the average landed value of a licence holder. In moratorium areas this was reduced to Can$30. For ITQs the fee is applied individually based on quota holdings. All licence holders also pay a vessel registration fee of Can$50 and a fisher registration fee of Can$50.

In the competitive or non-formal ITQ community management approach this is the total fee prescribed by DFO. For ITQ fisheries it covers their competitive species and they also pay an additional ITQ fee. The fee for cod is Can$40.50, haddock Can$77.50, pollock Can$39.00, redfish Can$14.50, silver hake Can$1.10 and halibut, Can$243.50.

The role of government is to ensure that the overall conservation objectives are met and that the overall agreed community-allocations are respected. This government audit function ensures both that conservation approaches are adopted and respected and that industry-agreed sharing occurs. The government lists and records seasonal quota-limits developed by the management boards. Individual vessel landings are provided to boards to assist in managing industry-imposed or conservation-dictated limits.

2.5 Community approaches

The CMBs are now vested with the responsibility for defining entitlements on how to harvest the assigned allocation. The eight communities have taken a number of approaches. The two Shelburne community groups illustrate the range of different approaches.

In Shelburne, there are various approaches even within the two management boards. One Shelburne board is comprised of five different associations, each of which develops a harvesting plan. In the other Shelburne CMB, there are three associations and corresponding plans. The harvesting options at the association level range from a competitive fishery (by gear type) within an overall quota to an industry-developed and delivered ITQ initiative. Combinations or permutations of these approaches were also used in the other community groups. The approaches can vary and can be independent, or work in conjunction with each other.

3. IMPACTS

3.1 Resource analysis

Community-management has improved the scientific understanding by industry in two ways. First, there has been more dialogue between scientists and industry. Partially aided by an industry advisory council (the Fishery Resource Conservation Council), this dialogue has advanced the understanding within the communities of scientific issues and species interactions. Improved knowledge provides for a better approach to management. Second, the communities have provided additional funds to extend government surveys and have participated in the survey process. In both cases, the enhanced knowledge has proved beneficial. This improved knowledge base is manifested in a science-advisory process that is more interactive and more detailed in its analysis. Community fishers participate in the Regional Advisory Process and provide valuable comments on suggested inferences from data sets. An increased industry knowledge base also contributes to overall knowledge that translates into better community decisions. By understanding the process in more detail, the delivery of data by fishermen improves.

3.2 Reduction in inter-community conflict

Prior to the introduction of the community-management approach, inter-community conflicts over allocation were the norm. Today, the intercommunity disagreements have largely disappeared, with the exception of the rift discussed below (Section 4.1). Given the difficult times faced by groundfish fishers in these fixed-gear communities, most efforts have focused on economic efficiency. Cooperative approaches include the Bay of Fundy Council, which is a council made up of two CMBs and several non-consumptive users and is dedicated to developing an ecosystem management approach in the Bay of Fundy. One sees cooperation between CMBs in the transfer of quotas and other management related issues, which suggests that the autonomy provided by such a management system provides for ancillary cooperation benefits as well.

3.3 Economic analysis and effort reduction

There has been little economic analysis of the community-management approach to date. However, initial comments suggest that the cost of fishing has gone up. This is largely due to transaction costs and to the additional costs of setting up the systems, complete with controls. The increased cost of management appears to be due to the costs of establishing the community boards. In the long run, savings are expected to occur as more responsibilities flow to the harvesters.

The decline in fishery participation raises a variety of economic and social issues. As seen in Tables 1 and 2, the number of licences in this fleet has declined significantly over the period of community management. The number of active vessels in all communities fishing in the NAFO Division areas of 4X and 5 has decreased from 1 274 in 1996 to 384 in 2005 (Table 2). While the community-approach did not reduce licence numbers directly, the opportunity for communities to address issues in a more business-like manner has resulted in a reduction in total participation. Today, licence numbers are closer to a balance with resource levels. Even in communities where a more socially oriented approach to sharing has been adopted, the adjustment in participants has occurred. That said, how to adjust the still-large number of licence-holders relative to this resource remains a challenge. In the highline fleets, some level of licence stacking has occurred and the use of informal ITQ arrangements has provided for some balancing. However, in other communities, there are no mechanisms to afford adjustment other than attrition and retirement. There is a need for a more economic solution if greater efficiency is to be achieved. In spite of this deficiency, community-management has afforded opportunities to acquire more quota from other communities when community/association quotas are exceeded or to invoke closure when community quotas are reached.

4. ISSUES AND CHALLENGES FOR THE FUTURE

4.1 Conflict over social versus economic objectives

In spite of the advances achieved by these communities, a number of problems persist. First and foremost, a rift continues between individuals and groups that support a more socially guided fishery (based on competition within an overall quota) and those that support a more economically driven fishery (using quasi-property-rights mechanisms). The social camp argues that community control should not allow evolution towards economic rationalization, which they feel creates a “have versus have-not” syndrome that is widely disliked by small boat owners. They also argue that any IQ system will lead to further reductions in participation, because the economics of having to buy the quota will force many out of the fishery.

The use of an ITQ-like programme by one group in Shelburne B (the high-line vessel group) has been vigorously opposed by all other community groups. Within the Shelburne B group, which is composed of five different management entities, there is no majority support. Government identified options to allow for formal ITQ development within sub-groups of a community within certain defined provisions. But the conflict is so deep-seated that no uptake has occurred to date. These sub-groups favour the informal process, which avoids much of the internal conflict.

The informal quasi-property-right approach adopted by some community-management groups is also criticized by formal ITQ groups who, under the current system, must pay larger access fees to acquire individual quota. Allowing such informal quasi-property-right arrangements is said to be a mechanism by which the government "subsidizes" the inshore fixed-gear fleet.

4.2 Conservation

A second issue focuses on conservation. In most instances, there have been positive responses with respect to conservation approaches. While the fleet is more conservation-oriented under this system, problems continue. There has been a significant reduction in discarding and high-grading, but low quotas and quota imbalances ensure that these practices continue at a level believed to be too high. It has been suggested that this problem is more severe in the groups that use informal IQs, as the economics of their quasi-property systems drive full utilization of the quotas purchased, even at the cost of discarding small fish or unwanted species. Under the current management framework, this comment could apply to any fleet-group. The declines in groundfish stocks overall and the apparent imbalance in relative quotas contributes to these problems, but clearly the industry continues to have some distance to go to be a fully conservation-oriented harvest sector. The husbandry of the resource, while prominent in the minds of most, can be overshadowed by the needs of survival. Where there continues to be an imbalance between resource and fleet numbers, the problems of conservation will continue. Industry self governance may be best served with an approach that allows rationalization as conditions evolve (even though self-rationalization schemes have to date been opposed by almost all groups).

4.3 Environmental challenges

The recent move toward ecosystem-based fisheries management will be a challenge for industry. The work with the DFO to identify sensitive cold-water coral areas and protect these is but one example. Ecosystem approaches could prove costly for industry as conservation objectives related to productivity, diversity and habitat are developed and implemented.

4.4 Conflicting government policies

Some significant conflicts stem from external actions by the DFO that appear to decrease the efficiency of operation for community fleets. The lack of linkage between DFO actions and fleet reliance on DFO provision of services often results in compromises and decreased efficiency in community management. For example, licensing policies that affect factors such as processing at sea and vessel replacement are currently viewed as barriers to efficiency and economic viability. And government is perceived as imposing unnecessary operational cost challenges through activities such as observer coverage, dockside monitoring and licence fees. This experience suggests that the industry operation must be totally industry based, supported by few if any external information or enforcement applications. There is a need for a legislative overhaul to allow a more private operation to occur. This is now being developed as part of the new *Fisheries Act*.

4.5 The new Fisheries Act

Some progress has been achieved on conservation issues and on better quota management due to improved reporting and industry understanding. But the future will be difficult without consideration of more far reaching changes. Some of the necessary changes may be provided in the new *Fisheries Act*.

The community management approach is a self-governance system that, while not reaching down to the individual level like an ITQ, represents a quasi-property approach at the community level. Changes being considered to the *Fisheries Act* in Canada would allow self-governance to be strengthened in several ways. The new Act will empower organizations to take a larger role in managing their members' harvesting operations. The Act will provide the authority for the Minister to enter into legally binding arrangements with fleets. Under these agreements, the DFO and fisheries organizations would share the responsibility for the programmes covered by the agreement. Agreements could specify such things as harvest rules, programmes, services and funding arrangements. The new Act will allow an allocation of fish to be set aside to defray the cost of science and management. The provisions of these agreements will be dependent on the willingness and capacity of each fisheries organization to assume a greater role in the day-to-day management of the fishery. The new Act gives the legislative authority to and broadens the scope of the co-management approach currently in place.

It is envisioned that the new *Fisheries Act* will include an administrative tribunal, long suggested by industry, that would replace the court system for licence condition violations. Industry groups operating under a Fisheries Management agreement could provide guidelines to the tribunal in terms of appropriate penalties, which will make them similar to the industry-imposed sanctions under community management.

5. CONCLUSIONS

The community-based management has received wide industry acceptance. Industry management boards have control within this process and have moved the concept well beyond the initial vision. This approach may have other applications within fisheries management, including emerging fish rights approaches in aboriginals' fishery situations.

Partitioning the resource among communities and giving communities the flexibility to devise appropriate management applications has virtually eliminated all of the criticism and lobbying of previous planning approaches. The approach allows community solutions to the problems of fish management, including many aspects of monitoring and enforcement, transfers of quota and catch history and conservation of the resource. Over time, remaining issues associated with the imbalance between fleet size and resources will be resolved within the context of the community.

The community management plans after 1996 are distinguished by several strategic changes that contributed to the success of this approach. Historically, plans for this sector had been developed through a "top down" process with the DFO as lead developer, implementer and controller and with industry relegated to an advisory role. This approach created an adversarial system with little positive dialogue and where no climate for change existed. This was most evident among the smallest of the vessels, which, while comprising 30 percent of the fleet, had over the years been able to effect great protection from the system and had been ensured some degree of viability at the expense of other fixed-gear groups.

The need for a bottom-up approach became evident. However, to move to the current situation, several pre-requisites were required.

i. The government needed to change its approach to management. An internal programme review proposed a change in philosophy to a process where the government facilitated direction and assisted industry uptake.
ii. The industry needed to want to change the process, which in this case generated the 1995 experiment.
iii. Government was required to stop pandering to lobby groups, which occurred to a limited extent in this case, but was sufficient to remove the leverage of the small boat owners.
iv. New ideas needed to be developed, which directed the industry to new avenues of approach.
v. The industry needed organizers who could develop plans on behalf of industry and who could work together for the collective good of the fleets in question.

Significant issues still face all fleets (for all species) on the Scotian Shelf and will place high levels of stress on operations. Conditions impacting the economic viability of the fishing industry continue to worsen. These factors include global factors such as low market prices, a strong Canadian dollar, increasing fuel costs and global competition. The availability of established community groups may prove to be a significant asset in addressing these numerous and unexpected challenges.

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The evolution of management in Canada's offshore scallop fishery

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1. INTRODUCTION

For 40 years, the Canadian offshore scallop fishery operated as a competitive fishery. At its height, 76 vessels greater than 19.8 m (65') in length were licensed to fish by ten companies. After 30 years of operation, overcapacity was recognized and the first effort controls were introduced by government in the form of limited entry. Between 1984 and 1986, three events changed the course of the offshore scallop fishery and paved the way for self-governance. Those events were: (a) the International Court of Justice (ICJ) decision that awarded Canada the Northeast portion of Georges Bank, (b) the implementation of a trial Enterprise Allocation programme and (c), the permanent separation of the inshore and offshore scallop fleets from common fishing grounds. Since 1986, the offshore scallop fleet modernised and rationalised its capacity to match the available resources. Offshore scallop stocks have been rebuilt and, to the degree possible, landings have stabilized over time. Through government-industry cooperation and increased self-governance, costs to government have been reduced while the role of industry has increased in the areas of science, management, enforcement and decision-making.

* The comments contained herein do not reflect the official policy of Department of Fisheries and Oceans.

PHOTO 1
Offshore scallop freezer vessel

Designed in Norway and built in Spain, the Atlantic Leader is 134′LOA and 964 tons. The vessel is powered by a Caterpillar 3606 1950 kW hp engine with a 968 kW Caterpillar 3508 auxiliary. The vessel is a member of the Canadian Offshore Scallop Industry Mapping Group.

2. DESCRIPTION

2.1 Overview

The offshore scallop fishery was established after 1945 in response to the growing demand for scallops. The offshore fleet's primary fishing ground is Georges Bank, but other banks such as Browns, German and Sable–Western are also important. The fleet must fish more than 12 miles from shore and cannot fish in the Bay of Fundy north of the 43º 40′ parallel.

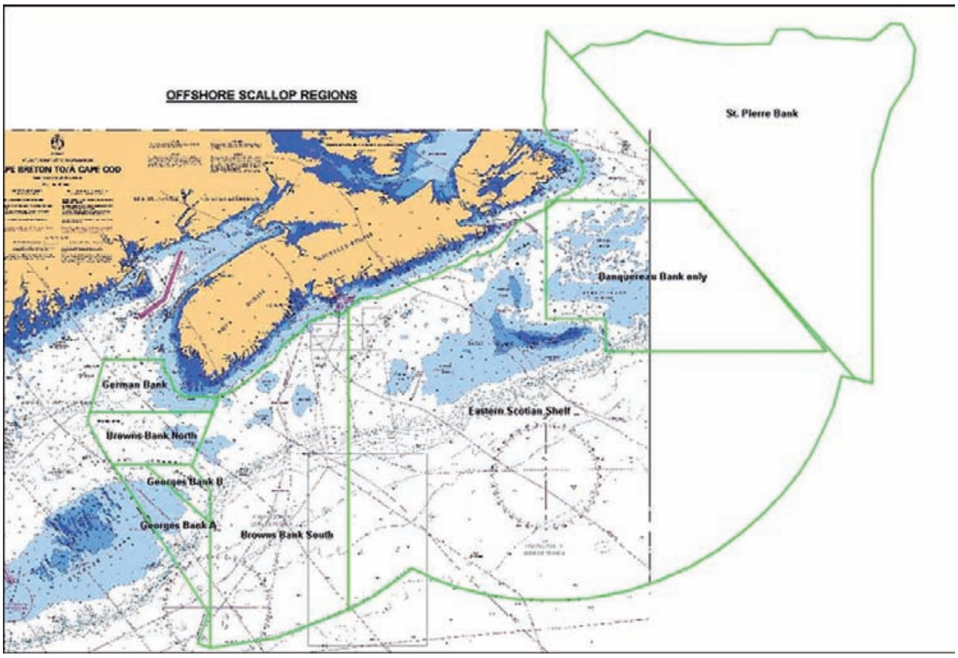
Currently, the fleet consists of 25 vessels of 27 m (88') to 43 m (141') in length. These vessels fish by towing scallop rakes (drags) along the seabed. Most vessels are capable of towing two steel rakes at a time; each rake is approximately 5m (15') wide. Of the 25 vessels, four have on-board freezing technology. Three of the four freezer vessels have been recently joined the fleet (see Photo 1). Freezer vessels have 28 crew members and remain at sea roughly 28 days a trip. The remainder of the vessels in the fleet have 17 crew members with trips usually lasting 10 to 12 days. The fishery operates 12 months a year and scallops are landed in five ports in Southwest Nova Scotia (Lunenburg, Riverport, Liverpool, LaHave and Meteghan). The vessels are owned by six companies and most of these companies own the plants that process the scallops. Scallop meats are shucked on board and either frozen or kept fresh on ice. Onshore, the scallops are further processed and repackaged in fresh, frozen or roe-on product forms. The United States (US) is the major market for Canadian scallops, taking about 75 percent of sales.

2.2 History from 1970 to 1989

In the early 1970s, the offshore scallop fishery had excessive catching capacity. In 1973, limited entry was introduced and the fishery was restricted to 76 offshore licences (vessels greater than 19.8 m [65'] in length). In 1977, Canada and the US had each declared a 200-mile fishing zone. The result was that Canadian access to Georges Bank was limited to a zone disputed by Canada and the US. Previously, Canadian vessels had often fished as far southward as the Great South Channel. By the late 1970s, much of the fleet, which consisted of wooden vessels, was reaching the end of its useful life span. However, reduced profitability and the uncertainty over which country would finally have jurisdiction over what parts of Georges Bank delayed any serious actions by vessel owners to replace the fleet.

Competitive fishing by both the Canadian and US scallop fleets continued in the disputed zone and grew more intense until 1984, when the International Court of Justice (1984) established an international boundary in the Gulf of Maine. The Northeast portion of Georges Bank (acknowledged to be the most productive area of the Bank for scallops) was awarded to Canada. Figure 1 shows the scallop fishing areas. Because of the intensive fishery prior to the Court decision, Canadian scallop landings

FIGURE 1
Offshore scallop fishing areas



from Georges Bank were less than 2 000 t of meats in 1984, the lowest on record. The ICJ boundary decision cleared the way in Canada for serious discussions to develop and implement a management strategy to rebuild and maintain offshore scallop stocks as well as to address the orderly replacement of the ageing fleet.

A series of discussions in 1984-85 between industry and the Offshore Scallop Advisory Committee (OSAC) led to significant conservation measures, including a larger minimum size limit and a restrictive total allowable catch (TAC). Industry unanimously supported a TAC as all parties recognised that size limits alone would not rebuild the stocks given the high levels of fishing mortality (up to 80 percent).

It was generally accepted by the industry that a fully-replaced fleet of 76 vessels could not be economically viable. According to an economic model developed by Gardner-Pinfold Consulting Economists (1983), a much smaller fleet of 30 to 35 vessels could harvest the resource more efficiently and profitably. Similarly, a 1985 DFO report (Nelson, 1985) determined that the optimal fleet size could be in the range of 39 to 44 vessels. By fall 1985, the ten companies holding offshore scallop licences had identified the Enterprise Allocation (EA) concept as the preferred method to achieve stock rebuilding, stabilized landings and fleet rationalization. However, vessel captains and crews rejected the EA because it threatened employment levels. The captains and crews proposed more effort control mechanisms (closed winter seasons, 16 day maximum trip length and reductions in trip limits from 30 000 lbs to 14 000 lbs) to achieve essentially the same objectives. Internally, DFO supported the EA option as the better path to fleet rationalization. DFO organized further discussions between vessel owners and crew. DFO ultimately recommended an experimental implementation of EAs, conditioned on a workable and affordable enforcement programme and administrative rules. By June 1986, following eight more months of discussions between DFO, the vessel owners and crew representatives, agreement was reached on implementing a three-year experimental EA programme to run from 1 January 1986 to 31 December 1988.

Since 1978, the inshore scallop fleet, based primarily in the Digby area, had annual access to Georges Bank at 2.9 percent of the previous year's offshore scallop catch.

That fleet proposed an increased allocation of at least 500 t on Georges Bank (or 12 percent of the 1986 TAC). Members of the offshore fleet feared that long term access to Georges Bank by the inshore fleet, particularly at the levels requested, would result in a serious depletion of stocks and the collapse of the experimental EA programme. The inshore fleet access issue was resolved on 30 October 1986, when the Minister, following extensive regional consultations and agreement between inshore and offshore representatives, announced the permanent separation of the inshore and offshore fleets at the 43° 40′ parallel near Yarmouth. The offshore fleet was restricted from fishing waters of the Bay of Fundy north of 43° 40′. The inshore fleet was phased off Georges Bank over two years, from 1987 to 1988.

A review of the trial EA programme was conducted by OSAC during the final three months of 1988. The general consensus of OSAC was that the trial EA programme had contributed to the objectives of the Offshore Scallop Management Plan. A wider range of year classes was appearing in the stock that would continue to assist the stabilization of the fishery over time. All members concluded that the trial programme had contributed to increased economic benefits to the fishermen, vessel owners, shore workers and the Canadian public and that all those engaged in the fishery were better off than they would have been had the fishery remained competitive. With the exception of the Nova Scotia Fisherman's Association (representing crews of one company), OSAC members recommended that the EA programme continue. However, crew representatives strongly recommended trip length restrictions, maximum trip limits and season catch limits, because they wished to address working environment issues such as length of time spent at sea on fishing trips. Crews also expressed concerns over the degree to which fleet downsizing would occur in the future. Vessel owners countered that trip limits were inappropriate under an EA because they prevented efficient harvesting plans. Vessel owners argued that these issues would be more appropriately addressed in labour/management negotiations.

In February 1989, a draft of *The Enterprise Allocation Programme in the Canadian Offshore Scallop Fishery* was forwarded to the Minister. DFO recommendations accompanying the draft were: (a) that the EA programme be renewed based on industry advice and the success of the experimental programme and (b), that the regulations on trip catch limits, trip duration and related restrictions, be revoked with the option of applying these restrictions by licence condition if required for conservation reasons and in consultation with OSAC. In June, the Minister approved the 1989 Offshore Scallop Management Plan and the continuation of the EA programme for an indefinite period, subject to the review provisions contained within the EA document itself.

2.3 Regulations after introduction of enterprise allocations

Table 1 shows a timeline of fishery regulations for the scallop fishery since implementation of EAs. The rules within the fishery continued to evolve and implementation of the EA programme did not lead to deregulation. Further regulations to define specific fishing areas with closed times, which were implemented as conditions of individual fishing licences, were deemed necessary to better define the fishing privileges under the EA programme. To promote stock rebuilding and to ensure the integrity of TAC's and individual EA's, stricter measures were implemented for shell height restrictions, lower meat counts, hail requirements, prohibition on transshipping and requirements to weigh scallops on landing. Amendments also increased licence fees. Table 2 lists government licence fees.

Although a number of regulations were officially revoked, the same basic restrictions were re-established as conditions of the EA licences. For example, the requirements for 100 percent industry-funded dockside monitoring, log books, release of bycatches, to fish only one scallop fishing area (SFA) a trip and to install and maintain an electronic monitoring system, are all conditions of the EA licences. The notable exception was

TABLE 1
A timeline of regulations in the offshore scallop fleet

1986	1. Scallop Fishing Areas (SFAs) were treated and closed fishing times established for each area. 2. Offshore scallop vessels >19.8 m (65') in length were prohibited from fishing in the Bay of Fundy north of 43° 40' and from fishing inside the outer boundary of the Territorial Sea. 3. A 33 per 500-gram average meat count was in effect for all SFA's. (Variation orders were used annually to adjust this count in certain SFA's.) 4. The average count is determined on the basis of eight or more samples of meats, each sample weighing 500 grams or more. 5. Offshore vessels were restricted: a) to trip limits of 13,700 kg (30 000 lb) and b), quarterly limits not to exceed 82 200 kg (181 000 lb) 6. Offshore vessels could not fish for more than 12 consecutive 24-hour periods. 7. It was prohibited in any SFA to have scallop drags onboard a vessel unless that vessel was authorized to fish for scallops in that area at that time, or the scallop drags had to be unshackled and stowed.
1987	1. Vessel classes for nine offshore scallop licence holders were introduced and closed times established for each vessel class in each of the SFA's. 2. The regulations which prohibited offshore scallop vessels from fishing in the Bay of Fundy north of 43° 40' and from fishing inside the outer boundary of the Territorial Sea were revoked. But the same restrictions were implemented as a condition of the EA fishing licences. 3. Licence fees were increased (essentially doubled). 4. A definition for "shell height" was introduced. 5. A 45 per 500-gram average meat count was specifically implemented for SFA 25 (Eastern Scotian Shelf). 6. Any scallops caught and retained or found on board a vessel were deemed to have been caught in the SFA area in which the vessel was authorized to fish. 7. It was prohibited to have on board a vessel any scallops caught in SFA 27 (Georges Bank) unless the shell height was 105 mm or greater. 8. Offshore scallop vessels were required 'to hail' to a fishery officer 12 hours before a vessel arrived at port: a) the port where the scallops would be landed and b), the time when scallops would be landed. 9. It became an offence to land at a port or time different than that hailed unless by permission of a fishery officer. 10. A fishery officer could direct that scallops not be landed until they were first inspected and it became an offence not to comply with the fishery officer's direction. 11. Transshipping of scallops to another vessel was prohibited. 12. Offshore scallop licence holders were required to weigh all scallops caught in SFA's 26 and 27 (Browns/German banks and Georges Bank) at the time of landing.
1989	1. Offshore vessel classes were revoked from the regulations but implemented as a condition of the fishing licence.
1991	1. The regulations restricting fishing trips to a maximum of 12 days duration and establishing trip limits of 13 700 kg (30 000 lb) of meats, and quarterly limits of 82 200 kg (181 000 lb) of meats were revoked.
1993	1. It was prohibited in any SFA, other than SFA 26 and 27 (Browns and German banks and Georges Bank), to have scallop drags onboard a vessel unless that vessel was authorized to fish for scallops in that area at that time, or, the scallop drags had to be unshackled and stowed. 2. In SFA 27 (Georges Bank) it was prohibited to have scallop drags on board a vessel unless the vessel was authorized to fish for scallops in that area at that time even if the drags were unshackled and stowed.
1996	1. Licence fees were amended and the new fee based on $547.50 a tonne of scallop meats allocated (previous fees were based on the number of vessels eligible to licensed by each company).

the removal of restrictions on fishing trip length, trip catch limits and quarterly catch limits in 1991, over the objections of union and non-union crews. The cost of dockside monitoring is estimated to be Can$40 000/yr ((Barrow, Jefferson, Eagles & Stevens 2001)

TABLE 2
Annual licence fees for scallop fisheries, Eastern Nova Scotia

Area	Fee (C$)
16	580
23,29, 30	30
28C, 28D	640
28A, 28B, 28C & 28D	6500
All other areas	100

http://www.canlii.org/ca/regu/sor86-21/part253317.html

3. SELF-GOVERNANCE IN THE OFFSHORE SCALLOP FISHERY

3.1 Overview of governance

Fisheries management in Canada can be described in terms of seven high-level service functions. Figure 2 is a networked view of management and the interdependencies of the functions. Two are planning functions: strategic planning and operational planning. Two are research functions in natural and social sciences. Three are operational implementation of the management plan: fisheries

FIGURE 2
Fisheries management functions

entitlement administration, enforcement and monitoring.

Up to the mid and late 1980s, all of these functions were performed and/or funded entirely by the government in Canada. The commercial fishers enjoyed access to most resources and paid nominal licence fees. During the 1990s, responsibility to perform or fund some of these functions was shifted to industry. This change was introduced through management plans on a fishery-by-fishery basis. This change has proceeded further in some fisheries than in others. Typically, fisheries with the strongest possibilities for rights-based management had the incentives to accept more management responsibility and costs. The offshore scallop fishery was an example of one such fishery.

In 1996, the government also increased commercial licence fees. The approach charged higher rates to more lucrative fisheries. In fisheries where the average annual landed value a licence was less than Can$50 000 over the 4-year period 1990–1993, the licence fee charged was 3 percent of that average landed value. In fisheries where the average annual landed value a licence exceeded Can$50 000, the licence fee was 5 percent of that average landed value. Offshore scallop licence fees were in the latter category.

We now examine how self-governance in the offshore scallop fishery has evolved in each of the seven management functions since management of the fishery became rights-based in 1986.

3.2 Strategic policy planning

This function establishes the policy and planning parameters within which fisheries will be conducted, including the development of regulations, creation of support institutions and definition of the objectives and strategies to be applied in the fishery management plans.

The shift from a competitive fishery to an EA fishery in 1986 led members of the industry to take a more active role in management. One of the first actions by industry was to develop the *Enterprise Allocation Programme in the Canadian Offshore Scallop Fishery* document ("EA document", which can be found in a slightly updated form in DFO [2000]). That EA document, submitted to, and approved by, the DFO has remained the cornerstone of the fishery for 17 years. From a strategic planning perspective, the EA document:

i. outlined the need for new regulatory initiatives;
ii. maintained the Offshore Scallop Advisory Committee (OSAC) as the primary consultative mechanism;
iii. established the goals and objectives for the fishery; and
iv. defined how the goals could be achieved through implementation of TAC's and EA's.

3.3 Fishery operational planning

This function supports the development of seasonal harvesting plans. It defines quotas, quantities, seasons, areas, input controls, reporting requirements and other parameters related to harvesting activity

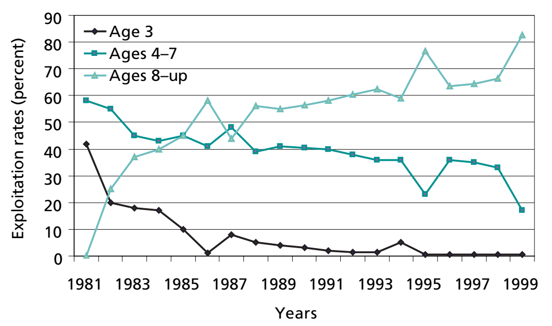
Each offshore scallop (EA) licence holder participates on the OSAC along with union and crew representatives. In this forum, industry recommends annual TACs, seasons and meat counts for each of the eight offshore scallop fishing areas (SFAs). But the industry has moved well beyond simply providing advice and recommendations to DFO on these matters. The industry has now taken on an active role in several areas of scallop management.

In several fishing areas, recruitment is sporadic and, in deeper waters growth is slow. Annual stock assessments are not possible for all fishing areas particularly for those that are considered marginal. An innovative approach to management of these areas has developed. Industry and the DFO have agreed to a protocol that sets small TACs for short incremental periods. On German Bank, for example, a 200 t TAC is established for each 6-week period commencing 1 June to 15 November. If, at the end of the first 6-week period, meat counts and catch rates have been maintained at certain levels, another 200 t TAC is assigned. To make this system work, industry must provide timely catch and effort data to the DFO prior to the expiry of each incremental period. When catch and effort data do not support a further TAC increment, the DFO must be confident that fishing will cease immediately. Formal closing of a scallop fishing area through the variation order process takes several days and requires formal notification of the order to each licence holder. To make the system feasible, industry voluntarily ceases fishing upon receipt of a fax from the DFO. To date, there has been no incident of non-compliance with this protocol.

A second major strategy of the industry is to avoid areas with high concentrations of juvenile scallops, whether identified by industry or through DFO surveys. To protect these areas, each EA licence holder voluntarily instructs its captains not to fish these areas. This approach is timely and saves administrative costs for the DFO by eliminating the need for variation orders. Figure 3 shows the increase in the average age of scallops captured over the past twenty years. It is clear that the implementation of protection measures by the DFO and the industry have largely contributed in increasing the average age at capture, which permits results in harvests of larger scallops and conservation of the resource.

The offshore scallop plan is adaptive in nature and its fine-tuning is a regular occurrence. Harvesting strategies may change throughout the season in response to markets, weather conditions, recruitment pulses, catch rates, meat sizes and so forth. The fishing plan must be able to accommodate some changes on a timely basis without the need

FIGURE 3
Georges Bank exploitation rates for different age categories



to seek consensus at formal OSAC meetings. Adjustments to the length of periods between incremental TACs, minor adjustments to interim TACs and meat count and shell height changes are often handled by fax. All six companies (licence holders) are represented by the Seafood Producers of Nova Scotia (SPANS). The Executive Director of SPANS, on behalf of all six companies, makes the request for changes to DFO. An industry request for change is faxed to each member of OSAC with a science and management recommendation. Non-response by a specific date means acceptance and a revised fishing plan is prepared and faxed to each OSAC member.

3.4 Social and economic analysis

This function conducts research on the performance of enterprises and of the industry as a whole. It addresses all aspects of the economic, social and business climate in the country and abroad that could have an impact at the strategic or fishery specific level. It provides timely analysis of the impact of management options. This function is primarily performed internally by companies for their own business purposes. Companies seek to maximize returns by adjusting their fishing to the market (time of year, size and product form of highest demand).

Since implementation of the EA programme, the industry has continued to streamline its operations. Through purchases, the number of companies has decreased from nine to six. Fleet rationalization and modernization continues. In the past five years, three new vessels with freezing capacity were added to the fleet as replacements for older vessels. Freezer vessels provide flexibility in product form (fresh and frozen), have improved product quality and provide a more comfortable and safer working environment. Considerable benefits have accrued to this industry since it assumed more management responsibility in 1986. Although these changes occurred gradually over time, the social cost was the loss of over 700 jobs to this sector (crew and onshore workers).

3.5 Resource research and analysis

This function involves research on marine resources and their ecosystems to understand ecosystem dynamics and to assess fisheries resources. Scientists and members of the industry provide regular evaluations of the status of marine resources (fish stocks), make recommendations on harvest levels and assess the impact of various fisheries management and conservation measures.

The offshore scallop industry plays its second major role in this area. Under a Joint Project Agreement (JPA), industry provides a scallop fishing vessel complete with crew to conduct two 10-day surveys annually under the direction of DFO's offshore scallop assessment biologist. The contribution by licence holders to this JPA is Can$520 000 annually.

During the past five years, most licence holders have also entered into a series of JPAs with the Canadian Hydrographic Service to carry out seabed mapping on Georges Bank, Browns Bank and German Bank. Computer software programming provided a 3-dimensional image of the bottom and identified the type of substrate. Offshore scallop vessels are now able to target fishing on particular substrates where scallop concentrations are known to be greatest (pea gravel). Benefits include reduced fishing time, fuel savings, savings in loss and repair of gear and ecosystem protection. It is estimated that as much as two thirds less dragging occurs on these banks as did previously – see, for example, the significant increase in catch per unit effort on Georges Bank beginning in 2000 (Figure 6). Further benefits occur in the form of less bottom contact and, in some cases, no contact at all when the scallop substrate is poor. Selectivity in dragging has led to important reductions in bycatch.

Scientific information has played a key role in rebuilding scallop stocks and stabilizing landings since 1986 and industry members recognize the value of good scientific advice. To ensure the provision of scientific information, licence holders recently entered into a JPA to assure with the long-term succession planning to replace the current DFO stock assessment biologist. The annual contribution by licence holders to succession planning under this JPA is Can$47 000.

3.6 Fishing entitlements

This function supports the needs of fishers and vessel owners to register and be licensed for entitlements to fish and to receive fishing allocations in accordance with seasonal harvesting plans. This includes transfer of those entitlements between companies and any resulting revocation or suspension of entitlements.

Each company must renew their EA licence annually. The fee for the licence to engage in offshore scallop fishing is based upon the tonnage of scallops allocated multiplied by Can$547.50 per tonne of allocation. The fee to register these vessels is Can$50 a vessel. So if the offshore scallop TAC is 6 000 tonnes of meats, the licence fees for that year would total Can$3 285 000 plus Can$50 for each vessel registered to fish. Each licence specifies the vessels that can be used in fishing and each vessel must be registered with DFO as a commercial fishing vessel. Licence holders are eligible to have any number of vessels, up to the maximum licensed before 1986. In 2003, only about 25 of 76 eligible vessel licences were used. Also, each person fishing on board an offshore scallop vessel is required to be registered as a commercial fisher, at an annual fee of Can$50.

Temporary EA transfers are permitted within season. Although temporary transfers require approval by DFO, it is the responsibility of individual companies to track their catches against their EAs for each fishing area. At the end of each fishing year, DFO quota monitoring officials and EA company staff reconcile catches. Overruns are handled in the following manner:

i. In the case of a 1 percent overrun or less, that amount is deducted from the following year's quota.
ii. In the case of an overrun exceeding 1 percent, twice that amount is deducted from the following year's quota.

3.7 Catch and effort monitoring

This function provides timely, accurate data related to the use of entitlements and the fulfilment of harvesting plans. Under licence conditions, companies are responsible:

i. To pay 100 percent for dockside monitoring (DMP) of all scallop landings (weights) by an independent third party funded by industry.
ii. In lieu of observers, to install an approved electronic vessel monitoring system (VMS) that provides hourly signals to DFO during all fishing trips.
iii. To provide accurate catch and effort information to DFO at the conclusion of each fishing trip.

In addition to these requirements, licence holders entered into another JPA with DFO that provides port sampling of catches from each fishing trip (meat counts). The annual cost to licence holders for this JPA is approximately Can$90 000.

3.8 Protection and enforcement

This function monitors compliance with regulations and management plans and takes necessary action against violators. It includes the adjudication of guilt and the imposition of penalties.

Protection and enforcement is primarily a DFO role. The DFO conducts at-sea surveillance using both offshore patrol vessels and aircraft. These insure that the boundaries between inshore and offshore areas and the Canada-US line are respected. Fishery officers conduct routine boarding at sea, carry out routine inspections and perform meat counts on shore. The DFO also conducts audits on dockside monitoring and on the VMS data.

Industry's role in this function is more passive, but nevertheless important. Installation of VMS provides a higher degree of confidence that offshore scallop vessels are only fishing in the SFA for which they are authorized to fish on a particular trip. This ensures the integrity of all TACs is maintained, as landings from each vessel can be attributed to a specific SFA. Because of this improved confidence level, the DFO can allocate less at-sea surveillance time to monitor offshore management areas.

Offshore scallop vessels are prohibited from retaining incidentally caught species like groundfish. To ensure the best possible survival rates of these species, companies have provided written instructions to captains and crews to treat bycatches as a priority and to release them immediately.

Compliance within the offshore scallop industry is high. There has been little in the way of violations noted or charges laid in the past decade, with two exceptions. Fishery officers apprehended crew members on separate occasions removing scallops in the middle of the night from vessels that had been offloaded earlier in the day. Captains and some crew members were stealing the scallops from the company, hiding them onboard the vessel until the dockside monitor left, offloading the scallops under cover of darkness and selling them. DFO laid charges, convicted the captains and assigned the weight of the illegal scallops to each company. The companies responded by improving security, firing the captain in one case and firing the captain and entire crew in the other case. Active industry support for compliance is a clear deterrent for any individual who might consider violating the rules.

Under the port sampling JPA, the DFO is provided meat counts from each scallop fishing trip. Meat counts have not been an enforcement issue with this fleet for years. Stocks have been rebuilt and consist of multiple year classes. The industry focus has been removing fewer animals, with a higher average size, to reach their quota. At one point, the DFO sampled upwards of 50 percent of offshore scallop landings. Because of the port sampling JPA and recent fishing trends, the DFO has been able to reduce the number of meat counts taken by fishery officers to less than 10 percent.

4. EVALUATION OF ENTERPRISE ALLOCATION OBJECTIVES

4.1 Enterprise allocations objectives

The shift in the Canadian offshore scallop fishery from a competitive fishery to a rights based (EA) fishery in 1986 had three major objectives:

i. to ensure conservation and restoration of the resource;
ii. to the degree possible, stabilize annual landings over time; and
iii. to provide increased economic benefits for fishers, vessel owners, shore workers and the people of Canada.

We will discuss briefly our evaluation of how well these objectives were met.

4.2 Ensure conservation and restoration of the resource

Total Canadian offshore scallop catches were the lowest on record in 1984, less than 25 000 t round weight (Figure 4). Average catches in the last three years (2000–2002) have been about 73 000 t, despite a fleet reduction from 68 active vessels in 1986 to about 25 active vessels. A wider range of year classes is now found within the populations and the size at which scallops are removed has increased (millions fewer animals are harvested to attain the same TAC). Catch rates have been the highest on record for 2000–2002, double to triple those previously recorded on Georges Bank (Figure 5). In terms of hours towed annually, effort has decreased from a high of about 125,000 hours in 1979 to only about 25 000 hours in 2000–2005 (Figure 6). An internal review of the EA programme by the DFO in 1997 concluded that most industry members agreed that the conservation objective has been achieved.

4.3 To the degree possible, stabilize annual landings over time

From the start of the EA programme in 1986 to 2002, the total annual catch in the offshore scallop fishery has ranged from a low of approximately 32 000 t round weight to a high of approximately 75 000 t, or a ratio of about 2.3 to 1. During the period from 1967 to 1985, catches ranged from a low of approximately 22 000 t to a high of 102 000 t, or a ratio of about 4.3 to 1 (see Figure 5).

Much of the fluctuation from 1986 to 2002 was the result of low catches in 1995 and 1996, which were due to back-to-back year-class failures on Georges Bank in 1990 and 1991. Early detection of this situation and a rapid response by industry in reducing TAC levels may have contributed to a more rapid recovery. It seems that the landings stabilization objective has been achieved to the degree possible and this conclusion is supported by the industry.

FIGURE 4
Scallop catches (round weight tonnes) for all offshore scallop fishing areas

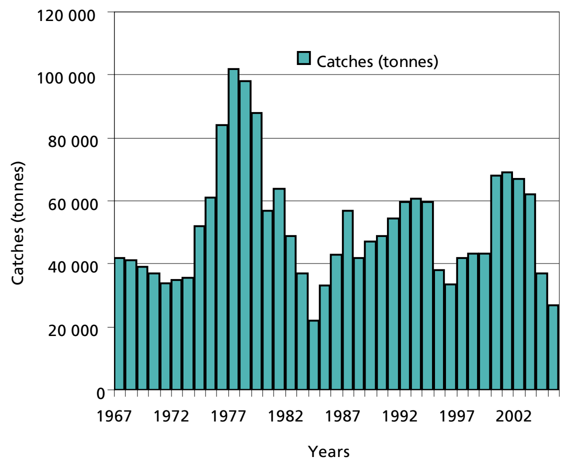


FIGURE 5
Annual scallop catch rates (kg meat/hour) for Georges Bank

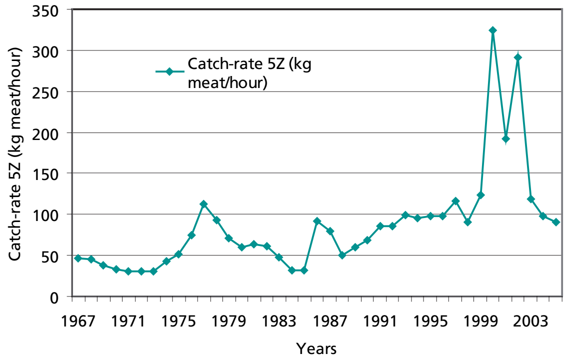
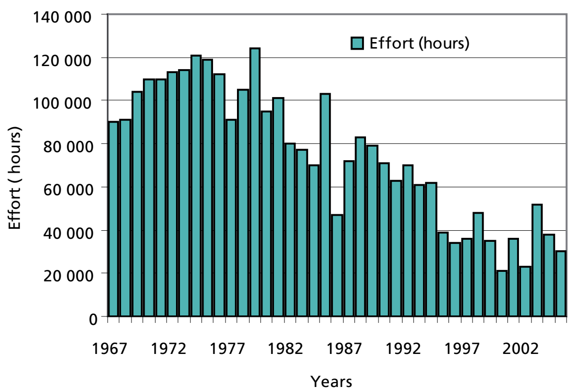


FIGURE 6
Annual scallop effort (hours) for Georges Bank



4.4 Increased economic benefits for fishers, vessel owners, shore workers and other Canadians

As discussed above, the EA programme has enabled vessel owners to use a smaller fleet of vessels to catch the available resource at reduced cost. Vessel owners continue to support the EA programme, so the expectations of vessel owners have been met.

The benefits to the people of Canada are less direct, but arguably also clear. The offshore scallop resource is healthy, thereby assuring a larger volume of product to consumers in Canada and Canada's principal trading partners. Licence fees paid for access have increased from just over Can$111 000 in 1986 to Can$5 000 000 in 2002, which represents in part an extraction of rents that benefits Canadian citizens. In addition to the licence fees, industry bears a substantial share of the costs of management. Licence holders pay for 100 percent of the dockside monitoring and provide approximately Can$650 000 to support research. On the other hand, regulatory activities by the DFO have increased and the costs of these activities may have increased. Fleet reduction was accomplished without the need for government funds for buy-outs, although the social costs for displaced human resources are unknown. Although employment has been reduced in this sector, those who remain generate more personal income and pay more personal income taxes and corporate taxes (subject to prevailing capital gains provisions for fishermen)[1].

5. DISCUSSION

The Canadian offshore scallop fishery is an example of an evolutionary process toward more self-governance, but with careful monitoring by the DFO. The following events have contributed to the success of this particular case:

i. the implementation of the Enterprise Allocation programme;
ii. the International Court of Justice decision to assign the Northeast section of George Bank to the Canada;
iii. the separation of the inshore and offshore fishery;
iv. the successive implementation of regulations in the fishery as seen in Table 1;
v. strong leadership within a small number of EA licence holders and their willingness to cooperate with DFO through partnership agreements;
vi. fleet rationalization and modernization, which largely resulted from the EA programme;
vii. a fishery that, once re-established, could generate sufficient rent to satisfy the demands of both the industry and DFO; and
viii. a flexible response by DFO.

The Canadian offshore scallop fishery started as nearly an open access fishery where government assumed all costs of science and assessment. It moved to a management style that involved the industry more, but which also expected more industry involvement in assessment and in-season management. The industry's role was increased through time in the areas of science, management, enforcement and decision-making. However, the industry still remains tightly linked to the DFO, compared to similar experiments in self-management elsewhere. The DFO retained a substantial discretionary power but still works closely with the industry. This may not be too surprising, since Canadian public managers may have a comparative advantage in fisheries science and stock assessment techniques that cannot be easily duplicated by others.

Enterprise Allocations provided the opportunity for industry to realise substantial economies in the harvest of the resource. These results are perhaps typical of individual quota programmes, of which EAs are a variant. But greater self-governance has enabled the industry to undertake initiatives that otherwise would have been impossible. Industry has been able to dramatically increase yield-per-recruit through a combination of formal closures and informal industry closures. Scallops of age eight or greater now account for 70 percent to 80 percent of harvest; age eight is probably near the age that maximises yield-per-recruit. The voluntary programme to stop harvest under the incremental opening programme enables the DFO to monitor and manage areas with limited assessment information. The recent investment in side-scan mapping is expected to reduce fishing effort by up to 50 percent, in addition to the 50 percent reduction already achieved under EAs.

The increased role of industry is apparent across all three functional areas of management: planning (Strategic Policy and Operational Planning); research (Social Economic Research and Analysis, Resource Research and Analysis) and operations (Fishing Entitlements, Catch and Effort Monitoring and Compliance & Enforcement). The role of industry in each of these functional areas is summarized below.

For the planning functions, the industry's role has evolved with the implementation of the EA programme and the DFO's policy shift to JPAs. The industry became more active in management through OSAC, which is still the link between the government and the industry for management advice. The degree of flexibility in the process of

[1] Marilyn Crook, IFQ Program Summary Series No. 3' on the following internet page: *http://www.lobsterconservation.com/canadianscallop/*

implementing plans is remarkable. Voluntary initiatives by industry have enabled the DFO to adopt plans that would have been impossible otherwise. The industry also has an important role in reporting data, which helps stock assessment and the recommendation of an appropriate TAC by the DFO.

The industry has played its largest role in the research functions. The industry is responsible for funding stock assessments with JPAs. This has allowed obtaining information on dynamics of the stock and seabed mapping, which permits improvements in terms of impacts on the stock and on the ecosystems. Those innovations also helped rebuild the stock and stabilise landings. The voluntary programme to avoid areas with small scallops, whether revealed by the DFO assessments or revealed by industry landings, has been important in increasing yields and harvest efficiency.

In the operational functions, the Fishing Entitlements are responsible for the rent extraction from the fishery. The enterprises are obligated to pay these fees for the renewal of their licences, as well as annual registration fees. In addition, under their licence conditions, owners are also responsible for monitoring and reporting their catches and effort. New technologies like VMS have been useful in that regard. The industry's role is more passive in areas of protection and enforcement. However, by respecting the designation of one SFA a trip and complying with the various rules and protocols, both written and informal, captains and crews help in the conservation of the resource.

The EA programme has been in place for eighteen years and appears to have been successful. The industry's role in the management has become more important. The industry has improved fishing methods, modernized its fleet and also has agreed to take part in JPA programmes related to management. Those functions have helped the conservation of the resource and the sustainability of the fishery. This type of management could be useful to guide similar fisheries in Canada or even worldwide. However, this particular case from Canada may be special, in that a potentially highly lucrative fishery under the leadership of a limited number of firms faced by a public agency that not only has strong skills in fisheries science, but also fairly broad discretionary powers.

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The joint planning agreement experience in Canada

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1. INTRODUCTION

Co-management evolved in Canada in response to calls by industry, the scientific community, and the public for more involvement and transparency in public management of fisheries. While development towards more transparency did occur, Fisheries and Oceans Canada (DFO) also embarked upon policies of cost recovery for services rendered and of resource rent extraction, mainly though yearly licence fees. Moreover, co-management arose within a broader governance system that does not provide for secure, long-term rights. The division of responsibilities under co-management in Canada occurs in individual fisheries through Joint Planning Agreements (JPAs). These agreements, also generally called Partnerships, were negotiated largely privately. The terms of the agreements changed from fishery to fishery but typically included both some sharing of responsibility with industry and also cost recovery to fund DFO services. Understanding these intertwined objectives of responsibility sharing and cost recovery provides a clearer understanding of both the evolution of co-management in Canada and also the context in which further evolution of this shared governance will occur.

The development of joint project agreements can be understood through some ideas from public choice theory and institutional economics. From institutional economics comes the argument that resource users may have a comparative advantage in some aspects of management of their fisheries. Public choice theory helps understand the motivations of government. The ministerial system in Canada provides great discretion to the Minister of Fisheries. This discretion both provides great flexibility in the response to political demands of constituents, but also means that a Minister or government can reverse policy initiatives. And public choice theory also emphasizes that the implementing government agency, in this case the DFO, may have its own institutional objectives. As the cases in this volume indicate, this political and economic environment has yielded interesting and innovative cases of public management that mix resource management objectives with other social objectives. But as governments and the DFO pursue their future interests, these governance structures may be subject to adjustment and even reversal over time.

2. AN OVERVIEW OF FISHERIES MANAGEMENT IN CANADA

The 138-year-old *Fisheries Act* governs fisheries management in Canada. Responsibility for the Act has changed over time with changes in government. Different ministries that have been responsible for the Act have had varying degrees of responsibility and visibility. For example, the *Government Organization Act of 1979* moved fisheries management and responsibility for the *Fisheries Act* out of the Department of the

Environment and into the Department of Fisheries and Oceans (DFO), which then became a ministerial post in the government.

In April 1995, the role of the DFO was further enlarged by the incorporation of the Canadian Coast Guard. The *Government Organization Act* also gives the DFO residual authority over all matters relating to the coordination of the policies and programs respecting oceans under Canadian jurisdiction that have not been assigned by law to any other department, board or agency. This residual authority is reaffirmed in the *Oceans Act* of 1996. Language in the *Oceans Act* favors integrated ocean policy, with an emphasis on protection of marine ecosystems. The DFO has characterized the Act as a significant step toward "consolidating federal management of oceans and coasts", entrenching an ecosystem perspective and, more recently, as "a framework for modern ocean management." A basic premise of the *Oceans Act* is that an oceans management strategy will require a collaborative and inclusive effort among stakeholders both inside and outside of government (Juda, 2003).

Among the most significant landmarks in Canadian fisheries management were the initial experiments with limited licensing. The first limited entry program was for lobsters in the Maritime Provinces in 1967 (Smith, 1978). Other fisheries followed in succession over the early 1970s: herring in 1970; Bay of Fundy scallops, offshore scallops, offshore lobster and groundfish in 1973; snow crab in 1974; and tuna in 1976. Licence limitation also occurred in British Columbia, where the salmon fishery went to limited entry in 1969 (Fraser, 1978). After this came other experiments in capacity control, including individual vessel quotas, a precursor to ITQ fisheries. These management changes laid the groundwork and possibly the economic motivation on the part of the industry, for further developments in management.

By the early 1990s, dissatisfaction with the decision-making process in fisheries governance was widespread. There has been an undercurrent of debate within Canada over the role of the Minister in fisheries management. From the side of the government managers and the scientific community, Ministers have been perceived as too ready to listen to the industry, at the expense of the health of the resource and the points of view of other stakeholders. Industry, on the other hand, has often argued that more management power should be given to those who use the resources. Both arguments are aimed at limiting the discretionary powers of the Minister. This debate over the appropriate division of public management responsibilities is one of the main drivers of the evolution of fisheries management in Canada. The question of who should pay for management is also a sub-text of this debate.

Creation of the Fisheries Resource Conservation Council (FRCC) in 1993 on the East Coast (FRCC, 2007) and the parallel Pacific Fisheries Resource Conservation Council (PFRCC) in 1998 for the West Coast salmon fishery (PFRCC, 2007) seemed to be a concession by the Fisheries Minister to these criticisms. These two bodies are advisory in nature, composed of specialists from academia and industry named by the Fisheries Minister, but financed at arms length by the DFO. Both organizations play a role in keeping the Minister of the DFO informed on both the biological and socioeconomic issues in the regions. And both organizations play similar roles with respect to the DFO.

On the east coast for example, the FRCC was envisioned as a partnership between government, the scientific community and direct stakeholders in the fishery. The FRCC is composed of up to 14 members, with a balance between "science" and "industry". In this organization, the social sciences are also represented. The Minister appoints the FRCC members for three-year terms. *Ex-officio* members can be appointed by the DFO. Most administrative aspects of the FRCC are analogous to other consultative systems, such as the U.S. Fishery Council system, except that the FRCC decisions are based upon consensus. The FRCC can be dissolved by Ministerial decree. Finally, the discretionary power of a Minister to ignore the advice of the

FRCC and apply other objectives is far greater than in the U.S. Even though Canada has been experimenting with different models for decentralized management, ultimate decision-making authority remains in the hands of the Minister. This has been a source of consternation at times, not only for members of the industry, but at times for the scientific community as well.

3. MINISTERIAL DISCRETION AND INTERNAL DFO CULTURE

The combined responsibility of the *Fisheries Act*, the Coast Guard and the *Oceans Act* gives substantial power to the Minister of the DFO. The Minister's office is a "lightning pole" not only for the industry constituencies, but also for any agendas that the government may want to put forth. In the case of governments with strong party discipline, part of the DFO policies might be aimed at keeping the ruling party in power. The more politically important a management issue is in a region, the more likely that these issues will receive special attention from the Prime Minister.

Lane and Stephenson (2000) provide an appraisal of the role of the internal culture at the DFO on Canadian fisheries management . Lane and Stephenson quote Larkin, who says that the organization is paternalistic, leaning heavily towards the "ichthyocentric" side. The objective of management has been mainly concerned with understanding the state of the exploited stocks and not necessarily on understanding the social and economic impacts of policy alternatives. The policy agenda of the DFO may have been influenced by the backgrounds of staff from the life sciences. There has been a shift in philosophy since World War II towards the pursuit of the more diffuse concepts of best use or optimal yield that incorporate biological, social and economic information (Stephenson and Lane, 1995). However, invoking a *raison d'être* for this additional scientific input can be challenging when, as Lane and Stephenson suggest, "all participants in the system converge on the Department and it's Minister (as the ultimate authority) to influence the trade-off between resource conservation and socio-economic health". If the political process mandates that the Minister is responsible for dealing one way or another with socio-economic impacts, one of two outcomes might occur. A Minister might ask for advice on these impacts from specialists in the social sciences. Alternatively, a Minister might fall back on discretionary power and make decisions based upon his/her own understanding of these socio-economic impacts. If the latter case prevails, how significant will the advice from social scientists likely be?

An important result of ministerial discretion is that whatever "rights" might have been created for fishers are themselves subject to future ministerial discretion. Fishing permits or individual quota programs exist only as elements of fishery plans. The Minister can amend those plans. Such amendments could invalidate any pre-existing privilege enjoyed by a fishing firm. Individual quotas are set as part of a condition of the licence. Quota transferability rules are found in licence policy and fishery management plans. In many fisheries, these regulations allow for transferability of quota only under limited circumstances. Permission of the DFO may be nominally required for transfers of licences or quota. This can result in civil contracting that attempts to circumvent these restrictions through informal market transactions. Because the Minister retains so much discretionary power over allocation, the risk that a future ministerial action could alter a "rights" regime can limit the asset value of quota. Without a clear future stake and with a limited ability to transfer any asset value that is created by management, the incentives for stakeholder involvement in management may be comparatively modest in Canada.

This quality of the ministerial system in Canada is a two-edged sword. It allows for a rapid deployment of policy changes at low cost, in part because decision-making is more centralized. It can be quite responsive to the evolving needs of constituents. And, as seen in the case studies, there is a high degree of initiative and innovation in the formulation of policy responses at the regional DFO level. However, because ultimate decision-making authority rests with the Minister and because of the responsiveness of the system to political changes, the development of property rights regimes at the collective or at the individual level can be rapidly subverted by changes in policy or government. Innovations in new community based management initiatives may occur, but the development of new property institutions will be difficult, if not impossible, under this governance structure.

4. PARTNERSHIP AGREEMENTS

Roughly coinciding with the creation of the advisory Councils and the inclusion of the Coast Guard, the DFO began experimenting with "partnership agreements." This move was taken to project a new image of accessibility and willingness to engage in co-management contracts with fishermen's groups. This appears to have been motivated by several factors. First, the DFO felt it necessary to restore public confidence in the department. Second, this policy was considered supportive of a general objective to reduce overcapacity in the domestic fishery. Third, and importantly, these policies responded directly to the call by the fishing industry for more transparency in the decision-making process. Finally, the New Partnership (as it was called at the time) was designed to help reduce the deficit by placing more of the management responsibility and the costs of management, into the hands of the resource users themselves.

The DFO proposed to develop long-term contracts with specific fishing groups called "Joint Project Agreements" (JPAs). These agreements provide a complement to the discretionary powers of the Minister in setting quotas, permit numbers and permit prices. They usually cover the various shared responsibilities in management, which may include the payments in money or in kind that each partner is liable for under the agreement. DFO policy states that JPA's can only be negotiated with licence holder associations that represent at least two-thirds of the licence holders in any given fishery (Michelle James, Underwater Harvesters'Assn, pers. comm.). The parties can amend a JPA at any time. There is usually an annual sub-agreement or amendable annex regarding costs and specific responsibilities for the year. Under most JPAs, the DFO offers management services to the industry, which industry finances through direct payments, in-kind contributions (such as boat time for research), or other negotiated solutions.

Negotiations for JPAs can occur most easily with organizations that can easily communicate with the DFO and are economically motivated to do so. Smaller fisheries have an advantage, because the representation requirement to get two-thirds of the licence holders into one association is easier to meet. The agreements, which vary from fishery to fishery, are negotiated directly with the industry, usually through organizations and are not necessarily made public. This negotiation process raises questions. From a pragmatic standpoint, a fishery-by-fishery approach may be more cost-effective, but piecewise co-management may not be globally efficient when fisheries have interdependencies, such as bycatches. There are also clear questions of transparency and equity. In practical terms, the DFO is involved in bilateral negotiations, so different fisheries groups end up paying different amounts for similar services.

5. COST RECOVERY AND RENT EXTRACTION UNDER PARTNERSHIP AGREEMENTS

Although the *Oceans Act* of 1996 further consolidated many federal responsibilities for oceans under the DFO, it may have deflected attention (and funds) from fisheries management. The year 1996 saw fewer budgetary resources for fishery management services. At the same time, the DFO negotiated and extended co-management arrangements with Canadian fishers, which were precursors to partnering agreements (DFO, 1997). This process of moving toward partnerships has always involved two components: the formulation of "integrated fisheries management plans" for the target stock and the signing of JPAs. The stated purpose behind these agreements was to foster greater accountability and cost sharing with the stakeholders in the fishery (Anderson, Sutinen and Cochrane, 1998). In May 1996, the Department issued its "*Fisheries Management Partnering Policy Principles*", which defined as a principle of cost recovery that "... all resource management costs that are attributable to the fleet and that result in or support private benefit to the fleet should be either paid for or undertaken by the fleet."

One question is whether cost recovery was the main policy objective driving JPAs, or simply an ancillary component. The Auditor General of Canada (AG) concluded in its review of shellfish JPAs that "Co-management arrangements examined by the AG were largely cost-sharing arrangements and have involved no sharing of real decision making powers." (Auditor General, 1999) The AG concluded that the Department had not determined which of its resource management activities, including science activities, resulted in or supported private benefit to the various fleets. In addition, the DFO did not and does not have a costing system that generates this information. The AG determined that the types of costs recovered from each fishery varied. These ranged from negotiated arrangements for industry groups to conduct stock assessments to no management charges at all.

Similarly, the AG reports that a panel appointed by the Minister to study the partnering concept concluded that the people consulted outside the DFO felt that co-management simply implied transferring fisheries management costs from the DFO to the industry. Kaufmann and Geen (1997) argue that most plans for "cost recovery" under the DFO "Partnership Program" were actually motivated by the desire for rent extraction. Kaufmann and Geen conclude that the 1995 DFO Regulatory Impact Analysis on the new fee initiatives confused the issues of cost recovery and rent extraction. They further conclude that the approach amounted to partial cost-recovery across all fisheries on the basis upon the ability of the fishery to generate revenues, rather than cost-recovery of specific costs by fishery. With this approach, some industry members would pay resource rents over and above costs of management, while others would not.

The realities of the partnerships seem more modest and piecemeal than envisaged in either *The Fisheries Act* or *The Oceans Act*. The partnerships appear to be driven largely by economic considerations. It was easier to negotiate with small groups of organized fishers than with large numbers of disorganized fishers. Fisheries whose wealth positions, or potential wealth positions, were relatively solid became some of the first partners. The pilot projects usually involved fisheries that had already undergone a transition to a rights regime and notably fisheries under an IQ or IVQ scheme. The AG report agreed that this was arguably a rational approach on the part of the DFO, but that it may have led to incoherencies in the definition of public services for private benefit and that it raises issues about fairness in taxation and rent extraction. In a sense, co-management may amount to reverse lobbying by the DFO after an initial phase of rationalization. The DFO, in order to reduce costs of negotiation, develops relations with easily identifiable stakeholders who are also sources of resource rent.

6. AMENDMENTS TO THE FISHERIES ACT

The new minority government of Canada intends to modernize the *Fisheries Act* (DFO, 2007). The proposed changes give clues as to the issues that have driven co-management. The proposal changes reiterate and enlarge the original mandate of the *Act*, which is the conservation and protection of fish and fish habitat. But a second objective is to expand roles for fisheries participants in decision-making and reinforce responsible fishing behavior. Removal of words like "absolute discretion" to describe the decision-making powers of the Minister of the DFO may be the result of the underlying debate over the sharing of fisheries management responsibilities in Canada.

At the same time, the Minister announced investment in fisheries science of Can$61 million over three years to broaden ecosystem-based science to more fish stocks and to incorporate that data and knowledge into fisheries management decisions. There has been a reversal of the previous government's decision to collect administrative costs for logbooks, gear tags and the at-sea-observer programs. A Licence Fee Review program is being proposed to examine the relative cost of licence fees in different fisheries to address equity issues. DFO will also re-examine how the government assesses licence fees. The thrust of these financial announcements might suggest that the cost recovery provisions of JPAs could also face scrutiny.

7. ECONOMIC INTERESTS AND THE EVOLUTION OF JPAS

Economic theories of institutions can help observers understand the factors that drove development of JPAs. Economists and other social scientists have made convincing arguments for the decentralization of management powers to fishing communities or organizations. Communities may have a comparative advantage in information and they may also have a compelling economic interest to manage the stocks they exploit, even in a commons setting (Anderson and Hill, 1983). This has been a common theme among institutional economists. The theme and the arguments are relatively straightforward.

The argument that alternative institutional arrangements may out-perform central government is part of a broader argument in social sciences against government control as a general solution to social and economic challenges (Jentoft, McCay and Wilson, 1998). This is why, in other articles Jentoft (2000) cites the community as the "missing link" in fishery management. For many applications in fisheries, governments have found that policies based upon centralized management, while easy to develop and put into place, can be costly in their application and enforcement (Nik and Pomeroy, 1998). This has led some governments to question their own competence in fisheries management and to search for other viable management models.

The argument that local control can out-perform central government control explains why groups of fishers would be interested in assuming greater responsibility. In addition, a strictly altruistic public agency might also search for more efficient management solutions and therefore would be interested in the social benefits of more localized control. But one could also turn to public choice theory and ask whether strictly self-interested elected officials and public servants would not also gain from shared responsibility. This perspective might explain why cost-recovery figured so prominently in the development of JPAs and why the fisheries "rights" created in Canada are less secure than they should be, from the standpoint of social and economic efficiency.

Mueller (1997) describes public choice theory as an interdisciplinary agenda of research that uses economic methodology to study politics. The field, in the words of one of the founders James Buchanan (1979), is the study of "government failure" in the same sense that earlier economists have written about "market failure." Public choice theorists have sought to study and to explain issues such as public sector growth, agency capture by special interest groups, free riding, vote buying, log rolling, bribe-taking and expansion of agency power. The focus of this research agenda is on the economic behavior of the elected official and the public servant (Wilson, 2007).

The behavior of bureaucracies has been an important issue within public choice. The public choice approach assumes that unconstrained bureaucrats would purse their own economic self-interest, such as higher salaries and bigger staffs. But this activity is constrained to some degree by the political process. Breton and Wintrobe (1975) identify two main themes in modern theories of bureaucratic behavior that suggest how bureaucracies may be constrained. The first deals with questions concerning how the political system creates incentives for bureaucrats that align their self-interest with those of their political masters and of the broader public. The second line of research is whether bureaucracies are compelled to act as political competitors that deliver services efficiently or whether they are insulated from the process sufficiently to act as monopolists that raise prices and restrict output.

Another important line of inquiry related to public choice overlaps organizational theory as well. The idea of "bounded rationality" has been used to explain organizational behavior. In a widely published article on the subject, Herbert Simon (1991) argued that organizations, because they are composed of rationally bounded individuals with limited capacities to store and use information, are complex and relatively stable structures that evolve by bringing new people with different ideas on board or through learning by the actual members. One intuition from Simon's work is that organizational behavior may be relatively slow to change and this may pose problems during periods of rapid change outside the organization.

One important idea coming out of public choice is that of the economics of rent seeking. This was originally explored by Kreuger (1974) and further by Buchanan (1980). The argument is that the potential accumulation of rent brings on competition aimed at capturing a part of that rent. In extreme cases, the expenditures of resources among rent seekers may be large and actually may exceed the total value of the rent competed for. Governments are not immune to these pressures and the way in which rents are accumulated could result in their dissipation by the competitive process. On the other hand, limiting competition for rent may result in its accumulation, which can then be divided among fewer contestants.

These theories lead us to look more closely at the history of co-management in Canada. The Canadian case studies in this volume lend themselves to the interpretation that co-management was an institutional innovation that enabled specific fisheries facing inefficient resource use to organise more efficiently. However, the public choice literature reminds us that public servants are rational economic actors themselves, but "bounded" in terms of how they look at problems and how they design solutions. While an agency may place great professional value on promoting the welfare of its citizens, it also has its own internal agendas, objectives and inefficiencies. In the case of the DFO, the growth of the agency has meant that the Minister has high visibility within Canada and substantial decision-making power. In safeguarding that authority, it is reasonable to expect that devolving management powers to industry would proceed slowly. On the other hand, the DFO probably has more formal knowledge of natural systems and scientific capacity in the life sciences than they do in the economics of the fleets they are managing. It may not always have the information and expertise to regulate in a manner that generates economic surpluses, which might be used to fund DFO initiatives. When DFO delegates to industry the authority to search for management efficiencies, the DFO itself may be able to share in those efficiencies through cost recovery and rent extraction. Although this is also technically "rent seeking," the extreme result predicted by public choice specialists does not occur. The partnership limits competition and therefore generates rent. This prospect motivates the remaining partners to conserve and distribute the rent being generated.

8. CONCLUSIONS

This overview of Canadian fisheries management provides some insights as to why a variety of co-management experiments have arisen in Canada. Most of these seem to have been motivated by the twin desires of the DFO to extract resource rents/recover management costs while at the same time passing some management authority to the contracting party in industry. These organizational and economic explanations of why the DFO has experimented with co-management may also explain why Canadian fisheries management has often stopped short of creating the secure, long-term rights advocated by most economists. This has probably led to higher management costs in some cases and it certainly has exposed industrial partners to costs that have not been equitably distributed across fisheries.

In discussing governance issues, political precepts and philosophies matter. In the Canadian example, "good government" may mean that the DFO must retain more decision-making authority than we might see in another country. However, the Minister then must deal with stakeholders whose behavior is affected by this policy environment. Industry members may not always act as rational economic stakeholders with long-term interests in the resource, precisely because most long-term decision-making authority still resides with the Minister.

Canadian fisheries managers and the industry have become partners in a form of co-management, as evidenced by the Canadian case studies in this volume. However, there are broader questions to be asked. These relate to the durability of co-management experiments in Canada, whether the new institutions lead to efficient contracts and the role of the public management structure in the ultimate success or failure of the experiments. Passage to a more decentralized and rights based fisheries management in Canada has long been proposed by a number of authors (Pearse and Walters, 1992; Grafton and Lane, 1998; Lane and Stephenson, 2000). However, change in this direction may require a fundamental re-examination of the economic motivations of those within the DFO who have the responsibility of fisheries management in Canada.

9. ACKNOWLEDGEMENTS

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Complexities of collaboration in fisheries management: the northeast United States tilefish fishery

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1. INTRODUCTION

In recent years, the social and economic impacts of depleted stocks on fishing businesses, families and communities in the northeast United States have been significant. Regulatory regimes to reduce fishing pressures have often exacerbated these impacts. In some cases, new regulations have heightened competition between fishery sectors or among stakeholders with the result of suboptimal prices and more dangerous fishing practices. In other cases, fishers have reacted to this environment by cooperating with others to improve the viability of their livelihoods. Numerous groups in the Northeast US have organized themselves to become more active in the management process and in the decisions affecting their livelihoods (Pinto da Silva and Kitts, 2006). These initiatives are changing the way fishers relate to other fishers, to the stocks they depend on and to the management process that governs their fishing activities.

This paper presents a case study of the complexities of creating long-standing collaborative management arrangements within the construct of the existing US regional fishery management council system. It reviews the history of the North Atlantic golden tilefish (*Lopholatilus chamaeleonticeps*) fishery, the development of the Tilefish Fishery Management Plan (FMP) and the evolution of collaboration between permit holders in the vessel categories (A, B and C) established in the FMP. Category A members have achieved positive outcomes through collaboration since the development of the FMP. Categories B and C vessel owners have been less successful in achieving similar results. This fishery is ideal as a case study due to its small size (approximately 30 permits and 12 active vessels) and its simple marketing structures.

Collaboration among fishers was not an explicit objective of the Tilefish Fishery Management Plan. The organizations and relationships that have developed have done so despite the management process. This paper expands on earlier work by the same authors on emerging co-management initiatives in the Montauk Tilefish Association (Kitts, Pinto da Silva and Rountree, 2007; Pinto da Silva and Kitts, 2006) to tilefish fishery participants in all three permit categories. This paper examines the different outcomes for these other participants and highlights various policy implications related to this experience.

2. BUILDING COLLABORATION IN FISHERIES MANAGEMENT

Fisheries management in the United States has frequently been criticized for failure to foster trust between fishers and government agencies (Gilden and Conway, 2001; Grafton, 2005). An adversarial environment has been the backdrop for the fisheries management process (Kaplan and McCay, 2004). Although the US Regional [Marine] Fisheries Management Council system (coupled with the requirements of the National Environmental Policy Act) provides ample opportunities for participation, most of these are limited to passive forms of participation (GAO, 2006). Improving the quality of participation by fishers is considered by many as essential for achieving more sustainable, equitable and efficient management outcomes (Pinto da Silva and Kitts, 2006; Ostrom, 1990; McCay and Jentoft, 1995; Weber and Iudicello, 2005).

Collaborative management of marine resources involves shared responsibility between government and fishery stakeholders. In the Northeast US, collaborative approaches among fishers have emerged despite the absence of an enabling environment. In principle, fostering greater fisher participation should be simple: in practice, stakeholder groups need to be ready, willing and able to assume greater responsibility. Our study suggests that the ability of fishers to organize themselves to participate in the management process depends, in part, on the existence of social networks and trust among the fishers involved. It also suggests that obstacles to collaborative behaviour can occur at regulatory, community, family and individual levels.

The literature on common property resource theory points to design principles that can determine the ability of user groups to sustain cooperative behaviour. Ostrom's (1990) well-know principles include small group size, effective monitoring and enforcement, and minimal rights to organize. Critical too are relationships between resource users and the relationships between resource users and the government. Ostrom (1990) also identifies the degree of trust and sense of shared identity within a group as important ingredients. Local-level social capital facilitates such management by providing the social relationships and the trust upon which rules and monitoring can be based (Grootaert, 1998). Putnam (1992, p. 167) defines social capital as "trust, norms and networks" that facilitate social co-ordination and co-operation for mutual benefit. Social capital generally refers to the institutions, relationships and norms that shape the quality and quantity of a society's social interactions. Social cohesion is critical for economic prosperity and for sustainable development (Ostrom, 1990; Ghai and Vivian, 1992; Pretty and Ward, 2001). Social capital is not simply the sum of the institutions or individuals underpinning a society; it is the 'glue' that holds them together.

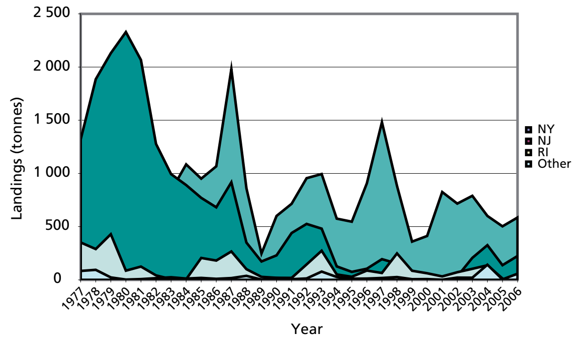
Baland and Platteau (1996) assert that government should support communities in areas that complement local capabilities. Such areas include providing a legal framework that legitimises collaborative arrangements and furnishing technical assistance or guidance. When relevant, economic incentives for participation and rule compliance should also be considered.

3. THE TILEFISH FISHERY

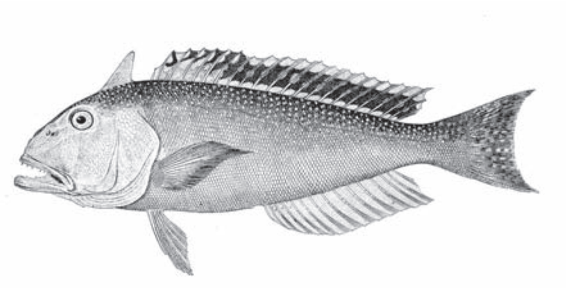
Since the early 1900s, tilefish have been harvested off the Mid-Atlantic and New England coasts using longline gear, and to a lesser extent, otter trawls. The trawl fishery, developed in New England after World War II, accounted for most of the landings through the mid-1960s. In the late 1960s and early 1970s, a directed commercial longline fishery rapidly developed and subsequently expanded into the Mid-Atlantic region. Barnegat Light, NJ, quickly became known as the 'tilefish capital of the world'. The initial gear used was tub trawl gear as used in earlier years of fishing for cod. This gear has since evolved to the circle hooks that all tilefish longliners use today. Currently, longline vessels account for more than 80 percent of the commercial catch. Longline vessels typically set 40 to 45 miles of gear a day and fish between 4 000 and 4 500 hooks a day. Gear is set during the day and hauled back at night. Hooks are snapped on by hand, a fairly labour intensive process and baited with *Illex* squid or frozen mackerel. Many of the longliners in Barnegat Light are related to each other by family or friendship and think of tilefish as historically significant to their personal histories and community.

As the size of the fish decreased in the early 1980s, several Barnegat Light vessels switched to other longline fisheries such as swordfish and tuna. Others diversified further to survive financially and, as many fishers argue, to give the stock time to recover. By the late 1980s and early 1990s, participants in the tilefish fishery were primarily from eastern Long Island, NY and were using upgraded vessels adapted to newer technologies. These larger, steel-hulled vessels from New York were more resilient to bad weather and able to fish further offshore. As a result, trip length increased and the New York fleet became more dedicated to, and dependent on, tilefish fishing. The historical shift from New Jersey ports to ports in New York is illustrated in Figure 1.

FIGURE 1
Tilefish landings by state



Source: NMFS Dealer data, Northeast Fisheries Science Center 2007.



NORTHEAST FISHERIES SCIENCE CENTER

PHOTO 1
*Tile fish (*Caulolatilus chrysops)

The majority of the tilefish catch comes from an area in the offshore Mid-Atlantic region between the Hudson and Veatch Canyons (Figure 2). Tilefish (also known as golden tilefish) (Photo 1) inhabit the outer continental shelf from Nova Scotia to South America and are relatively abundant at depths between 80 m and 440 m (NEFSC, 2005). Tilefish reach lengths of up to 1.3 m and live as long as 35 years. They are bottom-dwellers and are generally found around canyons, where they dig out large burrows on the ocean floor.

Most tilefish landed are gutted, iced and trucked to New York City's Fulton Fish Market and sold on consignment. Small fish markets in New York, New Jersey and Connecticut buy whole tilefish daily from the Fulton Fish Market in one of two carton quantities (132 or 264 kg). Tilefish purchased at the retail level are primarily cooked at home or used for sushi. While landings at Long Island, NY are the primary source of tilefish for the Fulton Fish Market, other vessels truck some to the New York market from New Jersey, Rhode Island and Massachusetts. In an attempt to avoid the price sensitivity of Fulton, vessels landing in NJ have sought out more diverse markets, both nationally and internationally.

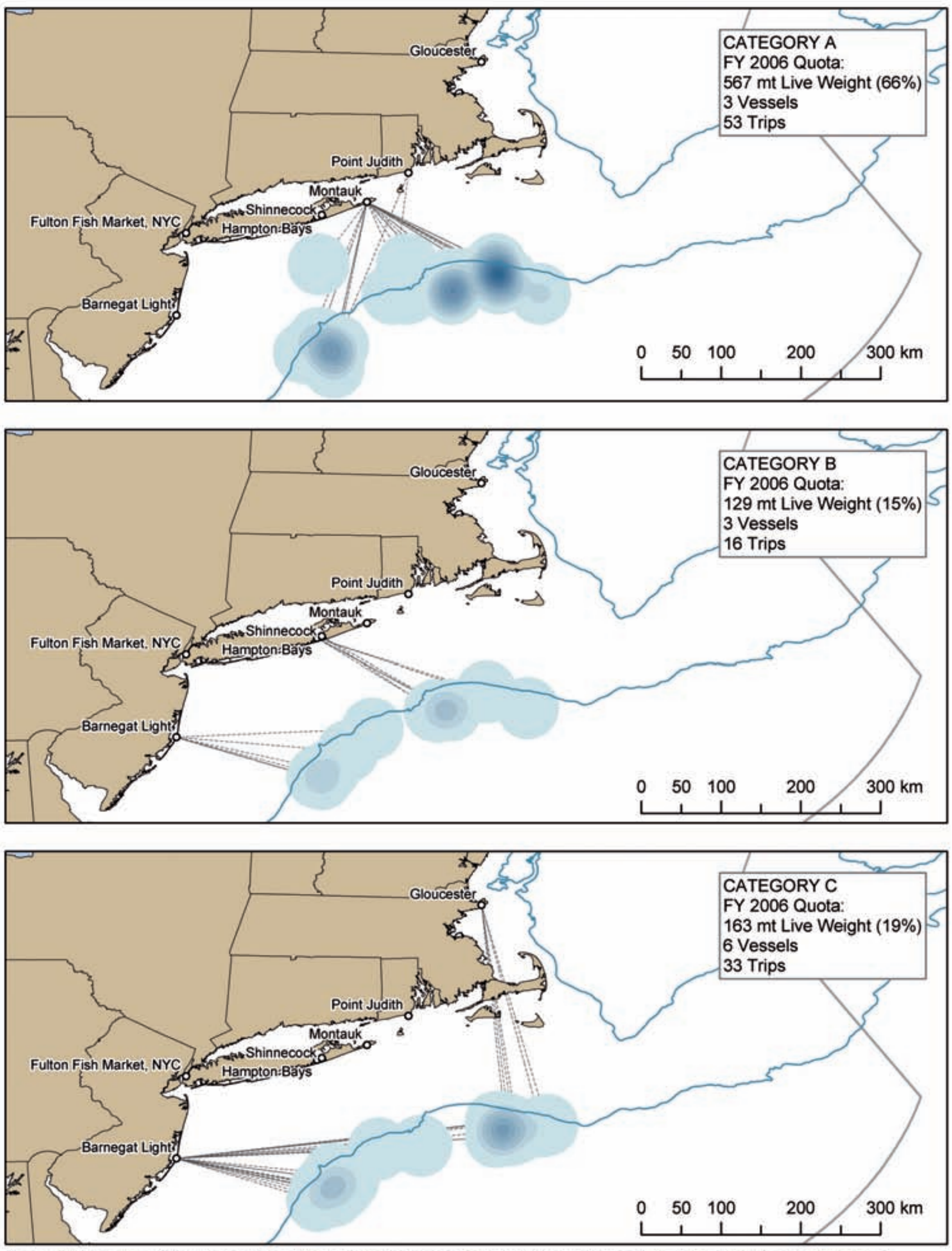
The market price for tilefish is significantly affected by the amount of product on the market at any one time. The ex-vessel price of tilefish tends to be sensitive to both the timing and quantity of tilefish landed. When the market is flooded *(*i.e. if more than 27 tonnes are landed in one week), prices typically decline as much as $2.20 a kilo.

4. THE REGULATORY ENVIRONMENT

4.1 Development of the Fishery Management Plan (FMP)

Prior to implementation of the Tilefish FMP on 1 November 2001, the tilefish fishery was an open access fishery. The stock was determined to be in an overfished condition (MAFMC, 2001). Fishing trips were about 10 days long, crews worked up to 22 hours a day and full-time vessels fished up to 330 days a year. Vessels came to port only

FIGURE 2
Tilefish fishing areas, 2007



Source: US Department of Commerce, National Marine Fisheries Service, Northeast Fisheries Science Center Vessel Trip Reports and Northeast Regional Office Permit Records. Created by Charles Fulcher, Northeast Fisheries Science Center, 2007.

long enough to land their catch, to replace crews and to perform necessary vessel maintenance.

The goals of the FMP are to eliminate/prevent overfishing, rebuild the tilefish stock, prevent overcapitalisation in the fishery and limit new entrants. Although some tilefish fishers were in favour of using individual fishing quotas (IFQs), the US Congress had imposed a moratorium on IFQs during this time. The tilefish FMP applies to US waters north of the Virginia/North Carolina border: tilefish south of this border are managed under the South Atlantic Fishery Management Council's FMP for the Snapper-Grouper Fishery.

The FMP enacted a suite of management measures. The principal measures included a: 10-year stock rebuilding schedule; a commercial quota divided into full-time (with

TABLE 1
Qualification criteria per permit category

Permit category	Number of qualifiers	Proportion of quota	Qualification criteria
Category A	4	66%	>250 000 lb of tilefish a year for any 3 years between 1993 and 1998
			> at least 1 lb of which was landed prior to 15 June 1993
Category B	5	15%	> 30,000 lb a year for any of 3 years between 1993 and 1998
			> at least 1 lb of which was landed prior to 15 June 1993
Category C (part-time)	42	19%	10 000 lb of tilefish in any one year between 1988 and 1993 and 10 000 lb in any one year between 1994 and 1998, or landed 28 000 lb of tilefish in any one year between 1984 and 1993, at least 1 lb of which was landed prior to 15 June 1993

two different tiers), part time and incidental categories; a trip limit for the incidental category; and limited entry for the full-time and part-time categories. An annual Total Allowable Landings (TAL) fishing quota of 905 t live weight was established, which reduced landings by half. A limited access program established three permit categories (A for one full-time group, B for a second full-time group and C for part-time). In developing the qualifying criteria for the limited-access program, the Mid-Atlantic Council considered a number of alternatives to address historical participation in the fishery. Access was limited and quota allocations were based on tilefish landings from 1988 to 1998 (see Table 1). The FMP qualified 51 vessels, only nine of which were considered full-time. The number of vessels that have maintained their qualification status since the FMP has gradually declined to 30. Photo 2 shows an example of a vessel targeting tilefish.

The development process for the Tilefish FMP provided the impetus for the initial collaboration of different fishery stakeholder groups. One of the groups to emerge was the Montauk Tilefish Association (MTA), a group of four highly active tilefish fishers in Montauk, NY whose combined harvests accounted for 90 percent of the total US Northwest Atlantic commercial tilefish landings in the three years prior to the FMP (1998–2000). The members of this group later became the only vessels in Category A. Since landings were to be reduced under the FMP, the MTA's primary concern was that reductions occurred proportionally across all vessel size categories. The MTA did not want to incur what they felt was more than their fair share of the cost of rebuilding.

The Historical Tilefish Coalition (HTC) was also formed during the development of the FMP by approximately 24 fishers and dealers from Barnegat Light, New Jersey and Hampton Bays, New York. HTC members had developed the longline tilefish fishery during the late 1970s, but, by the beginning of the 1980s, many Coalition members had left the tilefish fishery to pursue other fisheries. Unlike the HTC, whose strength was in landings early on, the MTA's strength was in landings just prior to the FMP. Since limited access programs were becoming increasingly used as a management tool in

PHOTO 2
F.V. Restless, *a tilefish vessel based in Montauk, New York*

the Northeast and qualifying criteria were usually based on landings history, the main concern of the HTC was to secure future access to the tilefish fishery. Members of the HTC would emerge from the FMP divided between the B and C categories.

The annual TAL is distributed among the three categories after deducting quota for incidental bycatch of tilefish and research projects (not yet utilized). Of the remaining TAL, 66 percent is allocated to Category A vessels, 15 percent to Category B vessels and 19 percent to Category C vessels (see Table 1).

4.2 Amendment 1: The potential for IFQs

The Congressional moratorium on IFQs has now been lifted and the current administration is encouraging market based management (NOAA, 2005). Amendment 1 of the Tilefish FMP is currently under development (as of 2007) and incorporates the implementation of IFQs for one, some, or all permit categories. The most controversial issue for IFQs is the determination of initial shares. Initial allocations are currently being proposed to be based on historical landings from one of three time periods: average landings from 1988 to 1998 (the same period used in the FMP); average landings from 2001 to 2005 (landings since the FMP); and average landings for the best five years from 1997 to 2005 (five years before the FMP until 2005).

Interviews with permit holders from each permit category revealed varying opinions about the merits of IFQs. Those with nothing to gain under any time frame remain strongly opposed to the IFQ suggestion and those with higher relative landings were likely to be supportive. These varying opinions will be discussed in detail in following sections, as it is one of many factors that influence the degree of collaboration in the fishery.

4.3 Licence and association fees

There is no license fee for this fishery: vessels receive an allocation for an individual vessel quota (IFQ) under their federal fishery permit, which they receive at no charge. However, a public hearing document for Amendment 1 to the tilefish fishery Management plan was submitted in September 2007 in which IFQs are proposed. It is expected that this will happen for some or all of the participants. This plan suggests that a cost recovery fee of 2% be collected for the first year only. The issue will be re-addressed after the first year when the marginal increase in costs is better known.

The MTA do not pay any association fees, but rather share the cost of any item that is incurred, e.g. the need to hire a lawyer for some reason. The New Jersey sector might hire a lawyer for the public comment period and share that cost, but otherwise they have no formal association fees.

5. COLLABORATION IN THE TILEFISH FISHERY

5.1 Experiences among three permit categories

With no expectation of cooperation and, more importantly, no conditions placed on the allocations of TAL to foster cooperation, the Tilefish FMP became an 'experiment'. Participants were free to cooperate or not with no regulatory consequence of either path. This becomes an interesting case study that serves to illuminate the contrasts in cooperation among the three vessel categories. Table 2 reveals, in a simplified manner, some of the factors that have supported and constrained collaboration among the different categories of permit holders.

A general sense of how fishing behaviour differed among the categories can be seen in the 2006 fishing year landings patterns (Figures 3, 4 and 5). Category A vessels (i.e. the MTA vessels) spread their landings evenly over the year. Category B landings followed a steady progression similar to Category A but fell short of reaching the TAL and landings flattened at the beginning of August through November 2006. This was due to the National Marine Fisheries Service (NMFS) closing the fishery for this

TABLE 2
Factors affecting collaboration among fishermen in the tilefish fishery in the NE United States

Permit Category	A	B	C
Level of current collaboration	High	Low	Low
Number of vessels	3	5	22
Number of active vessels – FY2006	3	3	6
Vessel size	Large	Med/Lg	Small/Med/Lg
Homogeneity of geography within permit category	High	Low	High
Level of dependence on tilefish	High	Mix	Medium
Trust and familiarity among category members	High	Mix	Mix
Participation in FMP development	High	Med	Low
Individual satisfaction with expected IFQ allocation	High	Uncertain	Uncertain
Number of years in fishery	Medium	Mix	High

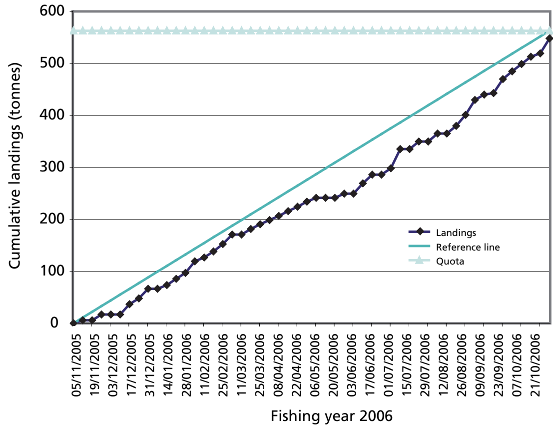
category in anticipation of reaching its TAL. Category C vessels landed (and exceeded) their quota in four and a half months, which resulted in a prohibition on landing tilefish by these vessels for the remainder of the fishing year (until 1 November 2006). This pattern indicates a race to fish that was confirmed via interviews with Category C permit holders.

The consequences of racing to fish are well documented (Leal, 2002; Committee to Review Individual Fishing Quotas, 1999) and are also well understood among fishers. This fishing strategy leads to over-investment in fishing inputs and induces such behaviour as fishing in bad weather and delaying needed repairs. Derby fishing shortens the fishing season, which generates shortages and gluts in the market. Members of all categories noticed that when multiple vessels landed tilefish at the same time, ex-vessel prices dropped. Consumers and fish dealers prefer and are willing to pay more for a steady supply of fresh fish. In the tilefish fishery, the benefits of a steadier landings pattern can be seen by comparing the average monthly prices among categories. Figure 6 illustrates that Category A vessels generally receive the best prices followed, respectively, by Category B and C. Recognizing these price differences, members of all categories attempted to avoid derby fishing. The outcomes from their attempts differed widely.

5.2 Collaboration in Category A: Montauk Tilefish Association

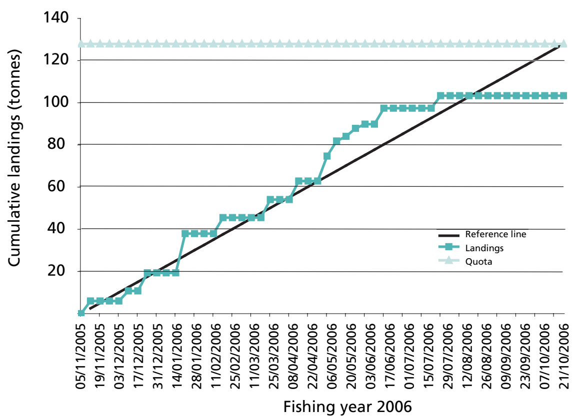
Members of Category A have had the most success in establishing cooperative institutions. They were organized before the implementation of the FMP and had formed a registered non-profit organization, called

FIGURE 3
Cumulative landings for permit category A



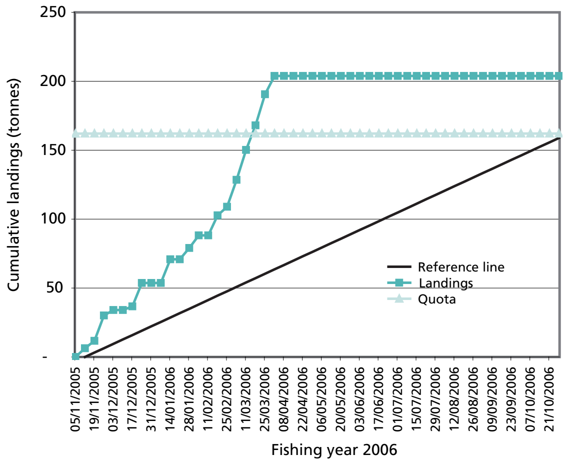
Source: NMFS Northeast Regional Office Individual Vessel Reports 2007.

FIGURE 4
Cumulative landings for permit category B



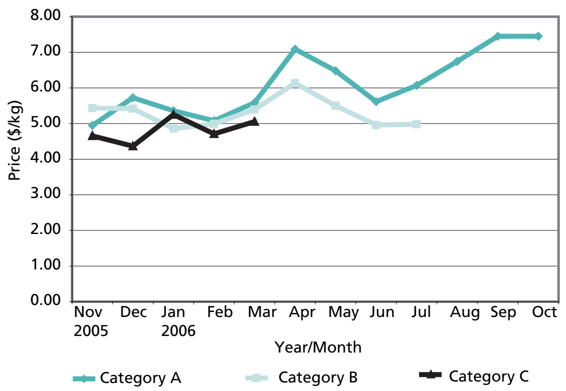
Source: NMFS Northeast Regional Office Individual Vessel Reports 2007.

FIGURE 5
Cumulative landings for permit category C



Source: NMFS Northeast Regional Office Individual Vessel Reports 2007.

FIGURE 6
Fishing year 2006 tilefish prices



Sources: NMFS Northeast Regional Office Individual Vessel Reports, NMFS Dealer data, Northeast Fisheries Science Center, 2007.

the Montauk Tilefish Association, whose objective is to provide an organizational structure for making collective decisions for its members. The MTA also provides members legal protection under the *Fishermen's Collective Marketing Act* against possible antitrust issues (Kitts and Edwards, 2003). Members share association costs equally, not according to quota share. The collective decisions made by the MTA are intended to enhance the performance of all member businesses.

The Montauk Tilefish Association was formed so that its members would have a common voice in the development of the FMP. The group supported the introduction of IFQs in the tilefish fishery but this option was unavailable due to the national moratorium. With IFQs unavailable, the MTA felt that if they could be grouped into one permit category they could collaborate with each other to achieve a similar outcome. All four members were grouped into Category A.

While being grouped into the same category was important, group characteristics were also important for fostering collaboration. For example, all members live and fish out of Montauk, NY, use the same dock and packing facilities and have known each other and each other's families for many years. Close social and business ties coupled with the Category A allocation of the majority of the TAL (66 percent) provide MTA members with a unique foundation for collaboration

The FMP did not include any restrictions on how Category A members could fish their quota. The MTA had many options on how to collectively harvest their allocation of the TAL. The key element in the strategy of MTA's four members was the division of the Category A allocation among the four members on the basis of the same 11-year period (1988–1998) used in the FMP. The members with the highest historical landings conceded some allocation in favour of those with the lowest landing history, resulting in shares that ranged from 20 percent to 29 percent of the total Category A catch quota. In 2004, subsequent to the implementation of this agreement, one of the MTA members decided to sell his vessel. Two of the three remaining MTA members formed a corporation and purchased the vessel and its Category A landings history. The corporation then sold the vessel and divided the vessel's share of the Category A quota between the vessels of the two corporation members.

Given the close relationship among MTA members, agreements were made expeditiously and without the aid and cost of a lawyer. Decisions concerning allocations of quota were reached via consensus as are all decisions made by the group. Members signed an allocation agreement more as a formality than a necessity. There is no formal mechanism (e.g. based on business contract law) in the MTA agreement with which to enforce the share agreement or to apply sanctions if a member exceeds his agreed share of the quota. To track their landings, MTA fishers call in their trip totals to one of the members who coordinates the Association's fishing activities. Given the small size of the MTA, members feel they "are either all in or all out". Formal internal enforcement and monitoring of the group is not considered necessary.

MTA members coordinate their landing patterns to ensure that multiple vessels do not land within the same week and so ensure a stable flow of product. Members also try to stay aware of Category B and C vessel activity. Since Category C and to a lesser extent Category B, vessels have continued to derby fish under the FMP, the landings from these fleets generally occur in the early part of the fishing year. Because each permit category has a separate annual allocation, there is no incentive to race for fish between categories. The relationship between the MTA and its primary dealer in the Fulton Fish Market is also important. Fishing trips are scheduled so that deliveries to Fulton can be made on Mondays to enable the dealer to hold fish in cold storage and thus have supply available over the course of a week.

MTA members have not considered pooling their revenues and expenses, as is done, for example, in the Chignik Alaskan salmon fishery (see Knapp, this volume). Although MTA fishers enjoy the benefits of cooperation, they wish to continue to maintain their separate businesses. While members make collective decisions on many levels, some decisions are made independent of the group. For example, though members have traditionally used the same delivery service, one of the MTA members recently decided to work with another company. This same member, who has the smallest share of the Category A quota, has temporarily re-rigged his vessel to participate in other fisheries for part of the fishing year.

Cooperation among MTA members has resulted in improved product quality and a more stable operating environment. A steady supply of fresh product benefits fish dealers, since they can be more confident about future supplies, can avoid market gluts, can make longer range business plans and can explore new market niches. Fresher fish translates into higher prices. The higher prices do not result from withholding product from the market, since the MTA annually lands the entire Category A quota. The higher prices result from meeting consumer needs and providing a higher quality product.

Fishing has become safer for MTA members. If the weather is bad or a piece of equipment is broken, a trip can be postponed until weather improves or repairs made without fear of 'losing' catch to someone else. MTA fishers no longer need to invest in equipment or fishing power that is necessary only to catch fish faster.

Category A permit holders are hoping for the implementation of an IFQ program that would formalize their cooperative agreement. Members of the Category A feel that IFQs will provide them with more security, flexibility and control, and will protect their future fishing rights. While MTA members can currently trade their internal catch quotas within their agreement, it is unclear how this might affect a vessel's landings history in any future IFQ allocation decisions. IFQs may also allow the MTA to purchase quota from vessel owners in the other two permit categories, which is currently not possible. The MTA also feels that IFQs would help avoid some of the uncertainties that would arise if one of their members wanted to leave or decided to break the internal agreement. While this particular issue might be resolved through the use of private business contracts, IFQs achieve the same result without additional expense, planning and negotiations. The two MTA members who bought out the fourth member are concerned about the status of the fishing history associated with the purchased vessel. Even though NMFS provided them official documentation confirming their ownership of the vessel's fishing history, the new owners are uncertain how tenable that history is if the vessel is no longer fishing for tilefish. IFQs would resolve a number of uncertainties for MTA members.

5.3 Collaboration in Category B

While Figure 6 shows that Category B's landings pattern is similar to Category A's, the level of cooperation is not as high. The three active members of this category have tried to make verbal agreements to share the TAL, but these have not always been honoured. The evenly distributed landings pattern is a function of both cooperation and individual efforts to spread the landings. That is, even though one member has caught more than agreed, there is evidence that those landings are spread over the fishing year.

Not all Category B vessels are from the same dock, port or even state, so communication and within-category monitoring of landings is more difficult. Nor are all members of this category active tilefish fishers. Even among active participants, some are fishing more than others. The disproportionate landings increases the level of uncertainty among those actively fishing. There is also some risk that inactive vessels will re-enter the fishery, which makes it hard to maintain verbal agreements and trust.

All Category B vessels have permits in other fisheries. Some have distinct seasonal rounds determined by the stock abundance of other fisheries or regulations in other fisheries. Although Category B vessels depend on tilefish for much of their income, when the TAL is reached, they shift to other fisheries.

Although several permit holders in Category B are long-time tilefish fishers with established landings records (either historic or recent), they differ in terms of the years in which their landings occurred. This has created mixed opinions within the group about the adoption of IFQs. Positions depend on which time frame is used to determine initial shares and on the status of the inactive fishers. Even those who are currently inactive believe that since they developed the fishery, they should have some long term rights, especially when the stock recovers.

5.4 Collaboration in Category C

Sub-groups of Category C fishers have attempted to establish an agreement to stop the race to fish in this category but have faced a number of challenges. Although this category has the largest number of potential participants (22), only six vessels actually fished during fishing year 2006 (1 November 2005 – 31 October 2006). Communication and coordination with other vessels is therefore possible. While not all Category C vessels currently fish out of Barnegat Light, NJ many have a long history and strong ties to this community. In some cases, fishers are long time friends and even brothers, sons and fathers – all characteristics that could provide a strong basis for cooperation (as it did in Category A). However, other factors facing this group create barriers for collaboration and divisions within this Category.

Category C is made up of active and inactive (or less active) vessels. The active Category C vessels, like Category B vessels, are not entirely dependant on tilefish. All active vessels in Category C are diversified and engage in multiple fisheries (such as swordfish, tuna, scallops and groundfish). Some vessels in this category leave the region entirely during the winter months to take advantage of better conditions and stocks in the South Atlantic. Diversification strategies reduce exposure to drastic fluctuations in stocks or market prices of certain species. The seasons of these alternative fisheries are often short and therefore one fishery alone would not be sufficient to support the vessel year-round. In almost every case, interviewees stated that tilefish represent an essential component of their seasonal round – one that if interrupted would have significant consequences on their fishing businesses.

Although diversification can be a risk-minimizing strategy, engaging in multiple fisheries limits participation in fisheries management. Multiple fisheries require involvement in and awareness of multiple management plans. Interviews indicate that part-time and inactive tilefish permit holders are much less likely to know what is at stake and how they can affect the outcome of the Amendment 1 process, even though IFQs may seriously limit their future in the tilefish industry.

Active tilefish vessels in Category C are more involved and aware of what is at stake. Some fishers see it in their best interest to build as much fishing history as possible (i.e. to race) so they may maximize any future quota allocated to them. This uncertain and dynamic regulatory environment creates perverse incentives for fishers to race against each other. One result is that successful cooperation in this category has been constrained by those engaged in the race to fish.

Vessel size has also created barriers to cooperation in this category. The 1 November start date of the tilefish fishing year has inadvertently created a distinct advantage for larger vessels as the quota for this group may end before the winter is over (as happened in fishing year 2007). This starting date effectively excludes smaller vessels that are unable to reach the fishing grounds due to safety reasons during the winter. This feature of the FMP was never debated or publicly considered; the 1 November start date was defined not by vote but as a consequence of an administrative process.

The initial allocation of IFQs in Category C would clearly benefit some individuals more than others. By reducing the incentive to race, IFQs would allow individual fishers flexibility to schedule tilefish fishing into their seasonal rounds. Once the difficult decisions about initial allocations are made, Category C fishers may find that coordinating the timing of their landings would bring better prices.

6. CONCLUSIONS AND POLICY IMPLICATIONS

Prior to the introduction of the FMP, the tilefish fishery was overfished under open access. Fishers were seeing diminishing returns from their efforts and experiencing other negative impacts (e.g. longer hours and longer trips) as a result of the continuing degradation of the resource. Vessel owners reacted in different ways, with some continuing to fish while others looked to other fisheries to make up for loses in catch and (many argue) to let the tilefish resource rebuild.

The FMP introduced regulations (TAL and limited access) to prevent and halt overfishing and to rebuild the tilefish resource. Landings were reduced, generating social and economic costs to fishery participants and their families. Not only could fewer fish be harvested, but also the new measures did not in themselves change the relationship among harvesters that had led to the suboptimal outcomes of derby fishing and market flooding. Limiting access and creating a system of permit categories (a proposal initiated by participants) did provide Category A fishers with an essential foundation upon which to build by introducing additional, informal, cooperative management measures.

Category A members eliminated incentives to race to fish and helped their fishing businesses stay viable under the new regulations. Their informal agreement enabled participants to tailor fisheries management to help secure their livelihoods. Since the introduction of the FMP and their informal management measures, Category A fishers have gone from being a threat to the resource to being stewards and managers of the resource. They now see a direct connection between their actions and the quality of the resource and their livelihoods, and they have the means to control these outcomes. The development of these informal institutions has also created a different relationship to the management process, which most fishers do not enjoy. They are now proactive participants in the process of designing relevant management institutions and helping to rebuild the resource.

Category A benefited from a number of social characteristics that facilitated cooperation, including social capital and trust between members and small group size. Their early involvement and participation in the development of the Tilefish FMP improved their chances of success. Although the other two tilefish categories exhibited some of these same characteristics, they have not succeeded to the same degree in avoiding sub-optimal outcomes (i.e. derby fishing, lower prices and shorter fishing seasons).

With few exceptions, Category B and C vessel owners have not been active in the management process (a fact that likely influenced the outcome of the FMP to be so favourable to Category A). Many are unaware of even the most basic statistics related to their fishing businesses (such as their yearly landings) that are essential in understanding their role in the fishery, as well as what is at stake with the potential introduction of IFQs. This lack of awareness is a fundamental block to their ability to influence the management process to produce benefits for themselves. The potential introduction of IFQs has exacerbated the race as some vessel owners attempt to build their landings history. Much is at stake in this decision and it is no surprise that this will influence vessel owner behaviour.

Successes and failures of cooperation depend on the time frame and perspective taken. In the short term, Category A vessels are clearly making the best of the current regulatory structure. However, if IFQs are implemented, the strategy some members of Category B and C have taken may result in a larger share within their category than if they would have cooperated. With the differences in group composition, it is difficult to determine the reason for the breakdown of the Category B's and C's agreements. Explanations may include the incentives to pursue a strategy to build history for an eventual IFQ; the desire to increase current revenues through increased landings or simply group dynamics.

These examples of cooperative and non-cooperative behaviour are unintentional (and previously poorly understood) consequences of the Tilefish FMP. While quota management within a limited access fishery is a necessary condition for collaboration, it is not sufficient. If management councils are interested and serious about formalizing opportunities for more collaborative structures to emerge, this case study provides some issues to consider in the planning process.

i. How management measures will impact relationships between and among fishers and incentives (or disincentives) to cooperate?
ii. That incentives for stewardship and rational use should be embedded in management measures (e.g. there should not be incentives to race).
iii. How an atmosphere of ever-evolving regulations impacts fisher's ability to enter into long-standing and stable agreements.
iv. That permit holders should be encouraged to stay informed about their landings history, as this may influence the degree and quality of participation in the management process.
v. The differential impacts/incentives created for part-time fishers pursuing a diversified fishing strategy may need special consideration so they are not disproportionately impacted by management measures.
vi. The characteristics of fishery participants (including group dynamics) may affect the design of management measures that promote cooperative behaviour.

The introduction of IFQs into a fishery is a major management shift. Many of the objectives of individual quota management may also be obtained by cooperative arrangements. Whichever direction is taken, fishery stakeholders should be aware of what they may gain and loose. In the course of carrying out this research, some interviewees have learned more about these issues and so may play a larger role in the development of policies that affect their livelihoods.

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The Punta Allen lobster fishery: current status and recent trends

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1. INTRODUCTION

After artificial habitats or *casitas* were introduced as a fishing gear to harvest spiny lobster in the late 1960s, fishers followed two divergent options in self-organizing practices pertaining to fishing cooperatives in the northern and central coasts of Quintana Roo, also known as the Mexican Caribbean (Miller, 1982a,b, 1989; Seijo, 1993; Briones-Fourzan, Lozano-Alvarez and Eggleston, 2000). In the north, fishers adopted an open access organizational scheme that potentially allowed the entire population of local fishers to use the artificial habitats deployed by only a fraction of the fishers, leading to the demise of that gear less than 15 years after (Miller, 1989; Briones-Fourzan *et al*., 2000). In contrast, in Bahia de la Ascension and Bahia Espiritu Santo, two bays of the central coast of Quintana Roo, local fishers developed by themselves a unique system of individual marine plots or *campos*, formalized internally by the fishing cooperatives (Miller, 1989; Seijo, 1993). This system relied upon a set of simple rules, self-surveillance and rigorous enforcement by the fishing cooperative (Miller, 1989; Seijo and Fuentes, 1989; Seijo, 1993). Hence, after almost four decades (~36 years), their management approach has not only proven its advantage in the long run, as evident by the maintenance of the lobster fishery based upon casitas, but also has proven to be a successful organizational scheme, conducive to the sustainability of the fishery as a whole (*sensu* Charles, 2001).

A number of previous studies deal with various aspects of the Punta Allen fishery system, mostly focused on components such as the casitas and the campos systems (Miller, 1982a,b 1989; De la Torre and Miller, 1987), the spiny lobster resource emphasizing biological and ecological processes (Briones-Fourzan, 1994; Briones-Fourzan *et al*., 2000; Lozano-Alvarez, Briones-Fourzán and Ramos-Aguilar, 2003), as well as descriptions of the fishery and their dynamics (Lozano-Alvarez, Briones-Fourzan and Phillips, 1991; Lozano-Alvarez, Briones-Fourzan and Negreto-Soto, 1993), including bio-economic analysis (Seijo and Fuentes, 1989; Arceo Briseño and Seijo, 1991; Seijo, Salas, Arceo and Fuentes 1991) and socio-economic issues (Cesar-Dachary and Arnaiz-Burne, 1989; Solares-Leal and Alvarez-Gil, 2003). While most of the previous studies highlight issues related to some specific component of the fishery, according to a disciplinary approach, a wider and multi-disciplinary approach to the fishery system has been lacking.

In the context of the pervasive crisis affecting capture fisheries worldwide, after the series of reports published since the 1990s (FAO, 1992, 2002), controversies and debates about symptoms and causes of these crises have arisen (Ludwig, Hilborn and Walters, 1993; Rosenberg *et al*., 1993). Subsequently, attention has been paid to factors leading to the unsustainability in fisheries (Swan and Greboval, 2004) and we conclude that fisheries sustainability as a goal faces difficulties and challenges that are greater than have been anticipated (Hilborn *et al.*, 2001; Caddy and Seijo, 2005). An alternative is to look at fishery systems that can be considered successful according to some specified criteria (Hilborn, Punt and Orensanz, 2004; Hilborn, Parrish and Litle, 2005). A further step is to ascertain which factors are linked to success in fisheries management, in order to learn the lessons that could be valuable as guidelines or inspiring principles in different management regimes. In this context, some references to the Punta Allen lobster fishery in the recent literature on fisheries management have stressed the relative success of a self-organizing scheme developed by local fishers (Caddy, 1999; Castilla and Defeo, 2001; Hilborn *et al.*, 2004, 2005; Defeo and Castilla, 2005). This has prompted a renewed interest on the current status of this fishery system. Increased knowledge and awareness on the Punta Allen lobster fishery experience is particularly relevant in Latin America and other underdeveloped regions where coastal, artisanal fisheries predominate. Last, we think that important features of the Punta Allen lobster fishery, such as the nature of their governance, deserve further attention.

Governance issues are gaining attention in the recent literature of fisheries management, as an essential aspect of fishery systems to be considered regarding sustainability (Hilborn *et al*., 2004, 2005; Kooiman and Bavinck, 2005). We adopt a wider definition of governance to include the whole set of interactions (public and private) taken to solve societal problems and generate societal opportunities (Kooiman and Bavinck, 2005). The purpose of this chapter is to provide an updated and brief account of the status and recent trends of the lobster fishery located at Bahia del Espiritu Santo in Punta Allen, Mexico.

2. DESCRIPTION AND HISTORY OF FISHERY

2.1 Fishery components

According to Charles (2001) a fishery system possesses three components: (a) natural, (b) human and (c), management. In this chapter we adopted a conceptual framework to describe the major features of each of component as identified in the lobster fishery of Punta Allen.

2.2 Natural component

The natural component includes the resource, the ecosystem where the resource inhabits, and the biophysical environment – the habitat, prey, predators and climate. The spiny lobster (*Panulirus argus*) is one of the most valuable resources in the Caribbean (Cochrane and Chakalall, 2001) and a vast amount of information is available on its biology and ecology (Arce and de León, 2000) and fisheries (Medley and Venema, 2000). Here we rely upon the previous synthese in the publications cited above and additional regional studies (Briones, Lozano, Cabrera and Arceo, 1997; Briones-Fourzan *et al*., 2000).

The Spiny lobster has a complex life history with five stages: adult, egg, larvae (phillosoma), postlarval (*puerulus*) and juvenile (Lipcius and Eggleston, 2000).

Reproduction takes place in deeper waters through external fertilization and egg masses are released by females in deep waters. Phillosoma larvae experience a long larval drift in the sea currents and after 6–11 months in the open sea they metamorphose to postlarvae (*puerulii*). Puerulii swim toward the coast and settle on shallow vegetated seabottoms, preferably on the red algae, *Laurencia* spp. (Butler and Herrnkind, 1997). After settling, the puerulii become the first benthic stage, 6–7 mm carapace length (CL). Juvenile lobsters of 5–15 mm CL first occupy algal habitats and later, when they grow to 16– 45 mm CL, shift to distinct habitats such as sponges, octocorales, crevices and hard-bottom. Sub-adult lobsters (>45–74 mm CL) are nomadic and move to reef areas in deeper waters as they approach maturity at 80 mm CL. Thus, each life stage has specific habitat requirements, which probably causes population bottlenecks due to the lack of suitable habitat, for instance when the young juveniles shift from vegetated habitats to hard-bottoms (Arce, Aguilar-Dávila and Sosa Cordero, 1997; Sosa-Cordero *et al*., 1998). The consequences of this complex life history are relevant to management and include the open nature of local populations subject to fishing, and the high probability that local recruits are from upcurrent localities and the local reproductive stock is exporting recruits to down-current localities.

Based on results of tagging experiments in Bahia de la Ascension, Lozano-Alvarez *et al.* (1991) found that lobsters grow relatively fast in the bay; they estimated that one year after settlement a juvenile attains ~45 mm CL, and around 2.2 years after the settlement spiny lobster recruit to the fishery at ~74 mm CL. They also found there is an intense emigration of lobsters toward deepwaters outside the bay. This was corroborated when a deepwater stock of spiny lobsters was found outside the bay (Lozano-Alvarez *et al*., 1993).

2.3 Human component

The human component consists of the fishers, their fleet and fishing gears as well a distinct groups in the fisher communities. Here we present a synthesis of the available information on the fishery (Miller, 1982a,b, 1989; Seijo and Fuentes, 1989; Seijo, 1993; Lozano-Alvarez *et al*., 1991, 1993; Briones-Fourzan *et al*., 2000) that emphasizes the major changes in the fishery and updated catch and effort trends.

In the Mexican Caribbean, three traditional fishing zones – North, Central and South – are recognized based upon physical habitat characteristics and development levels (Miller, 1982a; Figure 1). There are differences in the fishing gears employed in the spiny lobster fishery in each zone. In the central zone (Figure 1), which includes Bahia de la Ascension and Bahia Espiritu Santo, the use of artificial habitats or casitas as fishing gear to harvest lobsters predominates.

Annual volumes of lobster caught by three fishing cooperatives using artificial shelters in the Sian Ka´an Biosphere Reserve are dominated by the catch of the Pescadores de Vigia Chico cooperative that has fishing grounds in Bahia de la Ascension (Figure 2A). This cooperative takes the bulk of the annual catch from the Central zone (Figure 2B). When the catches of these cooperatives are compared with those of the remaining zones, North and South, it can be seen that the contribution of the Central zone has

FIGURE 1
Traditional fishing zones: North, Central and South, after Miller (1982a) in the spiny lobster fishery of the Mexican Caribbean

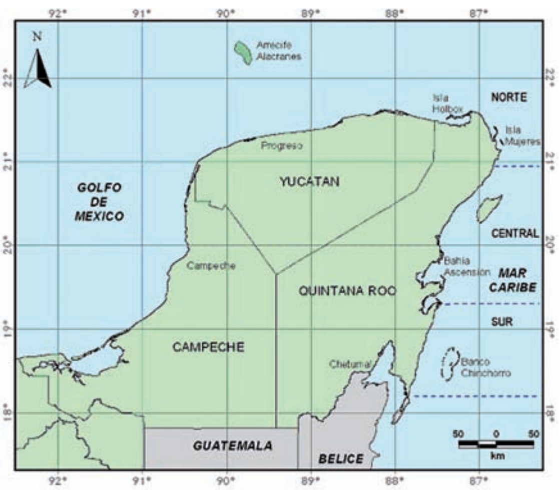
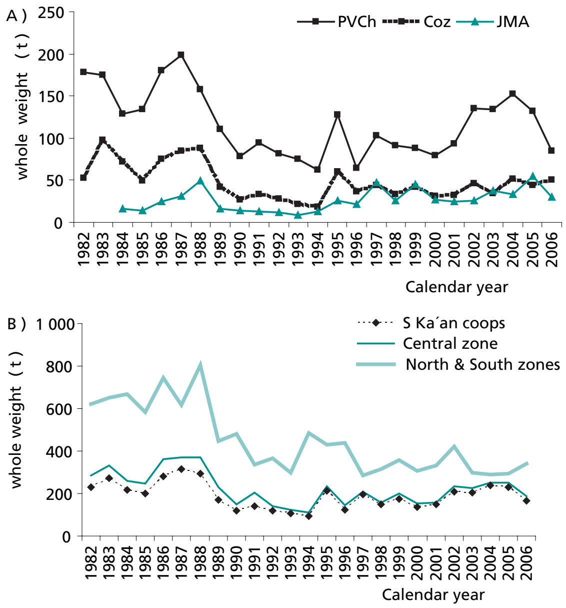


FIGURE 2

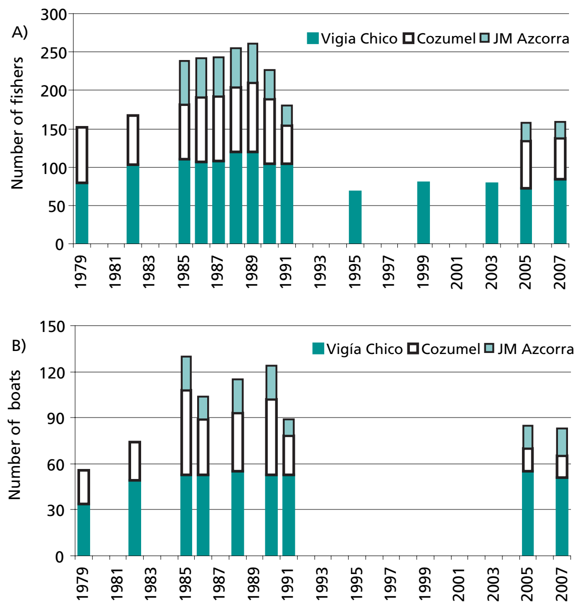
Annual catch of lobster (whole weight) for three fishing cooperatives, *Pescadores de Vigía Chico* (PVCh), *Cozumel* (COZ) and *José M. Azcorra* (JMA) using artificial habitats in the Sian Ka´an Biosphere Reserve (A)



Total catch for these cooperatives compared with the catch from the Central zone, where they pertain, and the summation of catches from remaining zones, North and South (B) are shown. Data provided by CONAPESCA-SAGARPA/*Delegación Chetumal, Mexico.*

FIGURE 3

Nominal fishing effort in number of fishers (A) and boats (B) for different years corresponding to three fishing cooperatives using artificial habitats for fishing lobster in the Sian Ka´an Biosphere Reserve



The most recent data (March 2007) were provided by directors of each cooperatives.

increased during recent years (Figure 2B). Since 1982, the Pescadores de Vigía Chico has been the most productive fishing cooperative in the Mexican Caribbean (Table 1) and their catches of lobster represented almost 16 percent of the total catch. During the last years their catch amounted to 22 percent of the total (Table 1). The annual catch of this cooperative was also the most stable from 1982 to 1999 and the third most stable during the period 2000–2005 (Table 1).

Fishing boats in both bays are made of fiberglass and are between 6.4–7.8 m long, with outboard motors 40–60 hp. The harvesting operation is carried out by skin diving and the use of *jamo*, a hand-net used as a bag to catch lobster in Bahia de la Ascension. Until 1994, a gaff was used instead of the jamo. This change happened for economic reasons and the gaff was abandoned in 1995 when the market for live lobsters opened, and buyers preferred live lobsters without injuries (Briones-Fourzan *et al.*, 2000). In Bahia Espiritu Santo, the gaff is still used in the southern bay by the JM Azcorra cooperative, while in the northern bay fishers of the Cozumel cooperative use the jamo, the snear or *lazo* and, to a lesser extent, the gaff. SCUBA and Hookah are forbidden as fishing gears to capture lobster and fish by internal agreement of all the fishing cooperatives from Bahia de la Ascension southwards.

Nominal fishing effort indices, such as number of fishers and boats are available for the fishing cooperatives (Figure 3A, B). The number of fishers for the Pescadores de Vigia Chico cooperative from Punta Allen increased during the 1980s to more than 100 fishers, which was then followed by a decline in the 1990s (Figure 3A). The current number of members of this cooperative is 80 (Figure 3A). There was a similar trend in the number of boats, but the increase was lower (Fig. 3B). Currently, the Pescadores de Vigia Chico cooperative has 55 boats (Figure 3A). According to these indicators, the nominal fishing effort has been kept under control (Figure 3A, B).

In both bays, the fishing areas granted to fishing cooperatives are partitioned into individual campos or marine plots, internally allocated to members of the cooperative. In January–February 2006 a field survey was

TABLE 1
The ten most productive fishing cooperatives in the Mexican Caribbean according to their contribution to the total catch of lobster during three time periods

Fishing cooperative	n	Contribution to the lobster catch	Average catch (t-tails)	CV
Period 1982–1989				
Pescadores V. Chicoa	8	16.6 %	52.65	19.4 %
Patria y Progreso	8	16.4 %	51.77	36.6 %
Por la Justicia Social	8	10.3 %	32.74	40.6 %
Andrés Q. Roo	8	8.5 %	26.79	56.1 %
Cozumela	8	7.4 %	23.38	28.7 %
Vanguardia del Mar	6	6.3 %	26.52	24.2 %
Pescadores I. Holbox	8	6.1 %	19.34	38.2 %
Isla Blanca	6	4.9 %	20.73	41.5 %
Horizontes Marinos	8	4.8 %	15.34	42.1 %
Caribe	8	4.4 %	13.79	67.0 %
		85.7 % Cumulative		
Period 1990–1999				
Pescadores V. Chicoa	10	15.8 %	28.87	22.4 %
Patria y Progreso	10	10.6 %	19.35	35.3 %
Por la Justicia Social	10	9.8 %	17.86	41.0 %
Vanguardia del Mar	10	9.0 %	16.32	37.6 %
Caribe	10	6.7 %	12.22	46.8 %
Cozumela	10	6.3 %	11.40	35.5 %
Isla Blanca	10	5.7 %	10.41	45.5 %
Horizontes Marinos	10	4.5 %	8.26	38.7 %
José M. Azcorraa	10	4.1 %	7.56	61.5 %
Langosteros del Caribe	9	3.7 %	7.56	32.7 %
		76.2 % Cumulative		
Period 2000–2005				
Pescadores V. Chicoa	6	22.5 %	39.98	23.7 %
Por la Justicia Social	6	7.9 %	14.05	20.1 %
Patria y Progreso	6	7.7 %	13.70	42.3 %
Cozumela	6	7.5 %	13.30	21.6 %
Langosteros del Caribe	6	6.7 %	11.91	18.2 %
José M. Azcorraa	6	6.3 %	11.21	33.9 %
Vanguardia del Mar	6	5.5 %	9.76	36.6 %
Isla Blanca	6	5.1 %	8.98	33.7 %
Caribe	6	5.0 %	8.90	32.4 %
Pescadores I. Holbox	6	4.5 %	8.08	30.9 %
		78.7 % Cumulative		

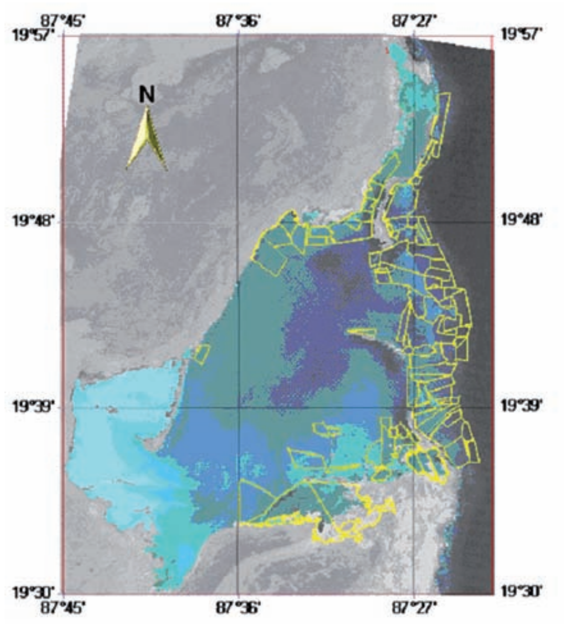
Number (n) of annual catches, average catch, and coefficient of variation (CV %) of annual catch for each cooperative are given. Also shown is the cumulative catch for each period. The number of coops varied between 9 and 12.

Notes: a) This letter identifies the fishing cooperatives using casitas in the Sian Ka´an Biosphere Reserve.

Data are official statistics of catch provided by CONAPESCA-SAGARPA/Delegacion Chetumal, Mexico in some cases corrected with catch data available in files of the cooperatives.

conducted based on interviews to fishers. According to this there were 101 individual campos in Bahia de la Ascension pertaining to the Pescadores de Vigia Chico cooperative; in Bahia del Espiritu Santo there were 84 campos, 45 pertaining to the Cozumel cooperative and 39 to the J.M. Azcorra cooperative. During 2001–2002 a multi-institutional research team, together with the fishers of the Pescadores de Vigia Chico cooperative, mapped 104 individual campos out a total of 120 (Figure 4). Individual maps were delivered to both the cooperative authorities and every fisher owner of campos as a tool to solve boundary limits in the future (Liceaga-Correa *et al.*, unpublished ms). When the available records of the number of artificial habitats or casitas are observed over time (Table 2), it can be noted that this indicator also reached

FIGURE 4
Map of 104 individual "campos" or marine plots in Bahia de la Ascension, Mexico, representing most of the fishing area granted to the cooperative *Pescadores de Vigia Chico* best known as the Punta Allen lobster fishery (Liceaga-Correa *et al*., MS)



a peak in the middle 1980s of roughly 26 500 casitas (Table 2). During the 1990s and in recent years the number of casitas has been slightly under 20 000 (Table 2). Thus, this fishing effort indicator also has decreased.

Members of one cooperative regularly form working teams varying in number from two to four fishers (Lozano-Alvarez *et al*., 1991; Liceaga-Correa *et al*., unpublished ms). In January–February 2006 there were 29 teams in the Pescadores de Vigia Chico cooperative, 12 teams in the Cozumel cooperative and 11 teams in the J.M. Azcorra cooperative. New teams are formed each fishing season, but the duration of a particular team varies from months to years. Not all members possess a campo, but all are taken into account when teams are formed as this provides access to the campos. In some instances, it is a matter of an individual's decision to possess a campo, due the implied investment needed to build casitas. A comparative bio-economical study conducted in several coastal localities in the Yucatan shelf found that fishers of Punta Allen made the large investment needed to get into this fishing activity, but they also obtained the highest economical returns (Seijo *et al*., 1991). According to a survey in progress, this previous result continues.

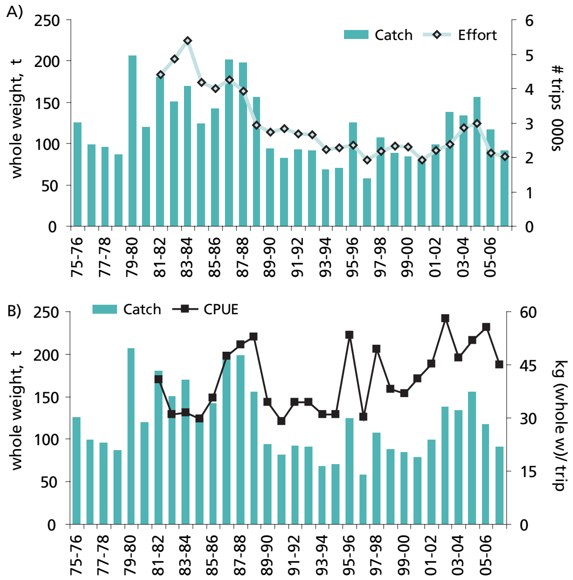
Lobster catch and effort records for a series of approximately 30 successive fishing seasons, from 1975–1976 to 2006–2007 are available for the Pescadores de Vigia Chico cooperative (Figure 5A, B). After a peak catch of 201.2 t whole weight during the season 1986–1987, the catch followed a marked decline, falling to a minimum of 58.2 t during the 1996–1997 season (Figure 5A). Afterwards, the catch recovered, but never

TABLE 2
Number of artificial habitats or casitas deployed for the fishing cooperatives *Pescadores de Vigía Chico*, *Cozumel* and *Jose M. Azcorra* fishing lobster in two bays pertaining to the Sian Ka´an Biosphere Reserve

Year	B. Ascension	B. Espiritu Santo		Author, methods and comments
	P. Vigía Chico	Cozumel	JM Azcorra	
1981	9 500	8 750	-- [a)]	Miller (1982b), 7-12 x 10^3 for B Ascensión; 7.5-10 x 10^3 for B. Espiritu Santo.
1985	>10 000	--	--	De la Torre & Miller (1987), Miller (1989). They report an area of 160 Km^2 occupied by 150 "campos".
1986	20 000	--	--	Lozano-Alvarez *et al*. (1991), inter-views to fishers.
1988	26 526	--	2 500	Cesar-Dáchary & Arnaiz-Burne (1989); interviews to fishers.
1991	--	4 400	1 700	Sosa-Cordero *et al*. (1996), inter-views to fishers. Report 60 "campos" for Cozumel and 54 for JM Azcorra.
1995				
1999	16 950	--	--	Briones-Fourzan *et al*. (2000).
2002	17 600	--	-	Liceaga-Correa *et al*. (unpublished ms); interviews to fishers. Report an area of 246 km^2 occupied by 117 "campos".
2006	18 600	2 300	1 900	This work, interviews to fishers in January-February 2006. Reporting 101 "campos" for Vigia Chico, 45 for Cozumel and 39 for JM Azcorra.

Notes: a) This cooperative was created in 1983.
Authors, methods and some related comments are included.

FIGURE 5
Lobster catch (whole weight) and effort (daily trips) for fishing season corresponding to the cooperative *Pescadores de Vigía Chico* in Punta Allen, Mexico (A)



Catch and catch per unit effort (kg whole weight/trip) (B). Data of catch provided by CONAPESCA-SAGARPA/Delegacion Chetumal, Mexico, and daily catch and effort data available in cooperative files.

achieved the high levels of the middle 1980s (Figure 5A). Fishing effort tracks the catch trajectory, meaning that fishers adjusted to the low abundance and reduced costs when the resource was scarce (Figure 5B). Under these circumstances, the annual catch per unit effort is an index reflecting fishing efficiency more than resource abundance (Fig. 5B). The CPUE index reached high values during the last fishing seasons – closer to those registered in the middle of the 1980s when the catches were noticeably higher (Figure 5A, B).

Most of the catch from the two bays is composed of immature lobsters (Lozano-Alvarez *et al.*, 1991; Sosa-Cordero, Ramírez González and Domínguez Viveros, 1996; Briones-Fourzan *et al.*, 2000). A recent survey carried out in Bahia de la Ascension during the fishing season 2005–2006 found that ~12 percent of the catch are of sub-legal sizes (Sosa-Cordero, unpublished data). Although this can be an anomalous percentage observed after Hurricane Wilma hit the coast (October 2005), it does represent an issue deserving further attention. There, fishers are catching lobster just when they reach the minimum legal size; hence, varying the size of first capture (L_c or $L_{50\%}$) is a question to be explored experimentally, through participative research.

Until the middle of the 1990s, the fishing activity was the only significant economic activity in the Punta Allen community, and there was almost an exact correspondence between fishing cooperative and the Punta Allen community (Seijo and Fuentes, 1989; Miller, 1989). This changed noticeably over the past decade, when tourism activities emerged as an alternative economic activity and increased sustantively (Briones-Fourzan *et al.*, 2000; Solares-Leal and Alvarez-Gil, 2003). In 1994 the first tourism cooperative was formed, and now there are four of these cooperatives and several private enterprises (Solares-Leal and Alvarez-Gil, 2003). The number of visitors, mostly from Europe, grew from 15 000 in 1996 to around 50 000 during 2001 (Solares-Leal and Alvarez-Gil, 2003). The major tourism activities are snorkeling, fly-fishing and wildlife observation, e.g. bird-watching.

Participation of lobster fishers in tourism activities is facilitated by the high complementary seasonality of both, lobster fishing having a peak in July–August; and tourism activity peaking in November–December (Briones-Fourzan *et al.*, 2000), (Solares-Leal and Alvarez-Gil, 2003).

2.4 Management

This component includes management regulation and plans, as well as research and development programmes. Application of federal laws related to fishing such as those for regulatory measures, concessions and permissions is the responsibility of the federal authorities pertaining to the national commission on fishing or *Comision Nacional de Pesca* (CONAPESCA), which is headed by Ministery of Agriculture, Cattle and Fishing or (*Secretaría de Agricultura Ganadería y Pesca* SAGARPA). The enforcement of the law corresponds to another office of the federal government, the *Procuradoria Federal para* *la Proteccion del Ambiente* (PROFEPA). Officers of this department conduct regularly inspections at the docks of fishing boats and of processing plants. A persistent problem is the low number of inspectors and a lack of resources. The fishing cooperatives harvesting lobster in the two bays must regularly fulfill a series of requirements for CONAPESCA and fully observe the current regulations (see Section 3).

Further, the Sian Ka´an Biosphere Reserve (SKBR) was created in 1986 enclosing Bahia de la Ascension and the bay of Espiritu Santo. The management plan for the SKBR defines zones subject to different use patterns and restricts human activities related to fishing and tourism, affecting the fishers and people living in the SKBR. For instance, until the early 1980s, casitas were constructed mostly using logs of a local palm, *Thrinax radiata*. Consequently this palm was heavily exploited and in 1988 a ban was implemented on cutting this palm (Briones-Fourzan *et al*., 2000). In response, fishers from the cooperatives first imported logs from distant areas and then developed alternative designs of casitas built entirely of ferrocement (Briones-Fourzan *et al*., 2000). In some cases, internal rules or cooperative agreements has been included in the management plan, e.g. prohibition of SCUBA and Hookah as fishing gear. Hence, it can be concluded there is a strong interaction between fishers and SKBR authorities. Staff and authorities of the SKBR belong to the national commision of protected areas or *Comision Nacional de Areas Protegidas* headed by the ministery of environmental issues or *Secretaria del Medio Ambiente y Recursos Naturales* (SEMARNAT). A set of internal rules has also been developed by fishers belonging to the fishing cooperatives. The special case of the Pescadores de Vigia Chico cooperative is presented in detail in the next section.

The fishing cooperatives of the two bays are always open to collaboration in research. This has been a particular characteristic of the Pescadores de Vigia Chico cooperative since the late 1970s Miller, 1982 a,b; Seijo and Fuentes, 1989; Seijo *et al*., 1991; Lozano-Alvarez *et al*., 1991; Liceaga-Correa *et al*., unpublished ms). They provide information to any scientist interested in the fishery and its environment. The same applies to the other fishing cooperatives located in Bahia del Espiritu Santo, although there has been only a few studies there (Sosa-Cordero *et al*., 1996). As a consequence the Punta Allen fishery is one of the most studied fishing locality in the Mexican Caribbean (Briones-Fourzan *et al*., 2000).

3. A REGULATORY HISTORY OF THE FISHERY

The current regulations for fishing spiny lobster are contained in the federal law NOM-PESC-006-1993 (*Diario Oficial de la Federacion,* 1993) and are:

i. a four-month closed season from 1 March to 30 June in effect since 1989 and previously (1967–1988) from 15 July to 15 March;
ii. a minimum legal size of 13.5 cm tail length, equivalent to 74 mm of carapace length (CL) in effect since 1979; and
iii. the catch of egg-bearing females is prohibited.

The law includes also a statement on fishing effort, that it must be controlled and stabilized.

A concession, granted by the federal government, is required in order to have access to the spiny lobster resource. This concession refers explicitly to a geographical area (bay or coastal tract) authorized as a fishing ground. From 1950 to 1992, fishing cooperatives in Mexico were by law the only organizations having access to the spiny lobster resources. In 1992, the law was changed and lobsters are no longer exclusively allocated to cooperatives. However, *de facto,* cooperatives are still the only organizations granted fishing concessions, due to their background and expertise as historical users, their readiness to fulfill the new requirements to obtain concessions and their political influence.

The Pescadores de Vigía Chico cooperative has the concession to an area of 850 km^2 entirely enclosing the Bahia de la Ascension (760 km^2) and a narrow tract of the coast (85–90 km^2) northwards of the bay. Two cooperatives possess the federal concession to harvest lobster in Bahia Espiritu Santo (350 km^2), the northern area was granted to the Cozumel cooperative and the southern was allocated to the cooperative "Jose M. Azcorra".

In Mexico, the seabottom is federal property and by law cannot be owned by individual citizens or private companies. This legal restriction has been effective since the early stages of the campos system development though subsequently local fishers grouped in the cooperative *Pescadores de Vigía Chico* found an interpretation to handle this asserting that while the seabottom is federal property, the casitas deployed over the seabottom are property of the fishers who build, maintain and use them (Miller, 1982a,b; Seijo and Fuentes, 1989; Seijo, 1993). Thus, the main purpose of individual campo or marine plot delimitation was to protect the investment on casitas made by the fishers. Internally, the members of the cooperative accepted this view and it provides the basic principle for the respect of individual campos and has become the cornerstone of the campos system until the present (Figure 4).

Federal regulations applying to the exploitation of the spiny lobster not only have been fully observed by the Pescadores de Vigía Chico cooperative, but also have been reinforced through extra penalties internally agreed upon by the cooperative. In some cases, the internal penalties are more severe than those of the federal government (Miller, 1982a,b; Seijo and Fuentes, 1989; Seijo, 1993). This is consistent with the fishing cooperative attitude to the law and has evolved as a remarkable tradition of this cooperative: the high respect for the federal law and internal regulations.

Other cooperative internal policies, such as its closed membership, excepting as members only sons of fishers, and the prohibition of use SCUBA or Hookah diving to harvest spiny lobster represent extra regulations self-imposed by the fishers grouped in cooperatives. These actions also promote the health of the fishery and the resource.

4. DESCRIPTION OF SELF-GOVERNANCE INSTITUTION; HOW IT EMERGED AND HOW IT OPERATES

The fishing cooperatives represent the most important institutions regarding the spiny lobster fishery in Punta Allen, as well as the lobster fishery in Bahia del Espiritu Santo, although the latter is less developed (Sosa-Cordero *et al*., 1996). The legal framework regulating the structure and function of these cooperatives is composed of four laws.

i. Federal fishing law, which applies to fishing activities country-wide. It refers to several resources subject to exploitation, imposing requirements and specific regulations on fishing.
ii. General law for cooperatives: it applies to every cooperative in Mexico.
iii. "*Actas y bases constitutivas de la Sociedad Cooperativa de Producción Pesquera Pescadores de Vigia Chico S.C.L.*" (Anon., 1995), this is a foundational document whose observance is mandatory for each cooperative. It establishes the purpose and scope of activities of the fishing cooperatives, including the specifics of the membership, administrative organization and operational issues,
iv. "*Reglamento interno de Trabajo*" the internal rules of each cooperative. An internal document applying to the Pescadores de Vigia Chico cooperative is reviewed in detail, later in this section (Table 3).

In summary, a fisher belonging to one cooperative must be aware first of (i), and then of (iii) and (iv), because they closely regulate his daily activities.

Since its inception, the campos system required the internal acceptance by the fishers grouped in the Pescadores Vigía Chico cooperative, as well as a form of government recognition that implied an *ad hoc* interpretation of federal law regarding ownership

TABLE 3
Internal rules developed by the fishing cooperative *Pescadores de Vigía Chico* in the Punta Allen lobster fishery

Articles	Purpose of each article or issue it deals with
# 1-7	Declaration of purpose of the internal rules (A1), obligation of every fisher to know them (A2), penalties for fishers who do not attend the General Assembly (GA) meetings (A3, A4) ways to justify the absence in GA meetings (A5), media to announcement of meetings (A6) and frequency of meetings (A7).
# 8	Duties and obligations of cooperative directors and commissioners to accomplish their tasks, setting the penalties (fines and lose of administrative positions) for non-compliance
# 9	On duties and obligations of the cooperative accountant to attend the various meetings and its full availability to provide the needed support.
# 10	Defines procedures for the payment of fines, who is in charge of collection of payments, penalties if somebody reacts agressively.
# 11	Penalties for cooperative members who (a) sell lobster outside to the cooperative and (b), fish lobster during the closed season. In both cases, the fisher will be ejected of the cooperative, losing all their rights and properties: campos, boat, motor and pending payments in the previous season. This property is transferred to the cooperative.
# 12	It is mandatory for fishers to mark properly the borders defining the limits of their campos.
# 13	Set penalties to fishers for using nets, traps, in fishing grounds or campos belonging to other fishers. The fisher invading a campo automatically loses the fishing gear used, which becomes property of the fisher possessing the right over the invaded campo.
# 14	Forbids the deployment of stationary nets (silk or monophilament) in the bay.
# 15	Sets penalties for fishers diving for lobsters in campos of other fishers having artificial habitats, located in either the back-reef or fore-reef: the fisher loses his fishing equipment: boat, motor and artificial habitats.
# 16	Sets fines to fishers throwing fish waste or lobster heads on campos or the beach of the town (specific limits are cited).
# 17	Fisher who hire as partners or helpers somebody who was expelled from the cooperative in the past; the first offence is a fine. The second offence results in loss of the rights to harvest lobster during the current season.
# 18	The cooperative allows only students of fishing technical schools to catch lobsters as helpers of a fisher belonging to the cooperative. They must have the proper identification to show to cooperative officers. In the contrary Article 17 applies.
# 19	Fishers who invite a parent to fish must notify the surveillance commission to get the proper permission.
# 20	Diving for lobsters is forbidden for all fishers who do not possess campos adjacent to the fore-reef, as there are a great number of ovigerous lobsters in this area.
# 21	Fishers in possession of sub-legal size lobsters in his boat or elsewhere will pay a fine, rated at $10/kg.
# 22	Fishers in possession of lobster tails showing remains of egg-mass are fired.
# 23	Fishers in possession of live egg-bearing lobsters must return them to the sea (or pay a fine).

of the seabottom. A key element relating to the first issue is the agreement of a set of internal working rules (*Reglamento Interno de Trabajo*), a document containing a series of rules with the purpose of maintaining the internal structure, promoting cohesion aiming at solving common conflicts and penalizing undesirable behavior of fishers when interacting with (a) other fishers (internally) and (b), external actors, including the government. Due to their importance as a tool for self-governance of this cooperative, these rules are presented here as a synthesis of their 23 articles (Table 3). Four articles, 12–15 are directed to protect the individual campos from other fishers and this is a sensitive issue for the members of this cooperative. It is not surprising that a rigorous penalty applies to fishers diving for lobster in a campo allocated to another fisher: the miscreant forfeits his equipment – boat, motor and artificial shelters (Article 15, Table 3). Five articles (11, 20–23; Table 3) directly reinforce the federal regulations for lobster harvesting contained in the *NOM-PESC-006-1993*. In particular, Article 11 imposes a severe internal penalty for fishers violating the closed season (ejection from the cooperative and loss of their property) compared to the federal law. Less severe internal penalties are prescribed for fishers that contravene the minimum size limit of lobster and catch egg-bearing females. Those differences could imply that the closed season is considered the most important management regulation by the fishers; or alternatively, that it reflects previous experiences for which regulation needs more severe penalties in order to minimize violations.

Although this set of rules is accepted internally, it has been used as evidence in court cases as part of the process of the formal justice system. In at least two cases, members ejected from their cooperative claimed jurisdiction was held by the federal authority and went to trial. After the cooperative lawyers demonstrated that all members of the cooperative had signed and knew the internal rules, the judges delivered sentences supporting the cooperative decision (Manuel Mendoza, pers. comm.). This was one of the first formal acceptances of the internal rules by government authorities outside the cooperative. In general, the federal government has tacitly accepted the internal rules of this cooperative and expressed a high degree of tolerance toward the campos system, which shapes the organization of this cooperative. It can be viewed as a wise response of the federal government in light of the relative success of this cooperative, in terms of productivity and sustainability of the fishery.

5. DISCUSSION

In the face of the need to make a living, local fishers grouped in the Pescadores de Vigía Chico cooperative built with great effort an organizational structure (the cooperative) and a self-governance institution (internal rules) according to their needs and consistent with their interests. During this process they obtained incentives through the lobster catch and the high prices this resource commanded. Their first step consisted in assuring that the campos system was maintained through a single organization that evolved within a smooth organizational climate. In parallel, a second requirement was fulfilled through a tradition of high respect for the law, both federal and internal. Observance of the law was perceived as an advantage by fishers. This desirable individual and collective behaviour was the basis for maintaining the high benefits to all the participants. Since the beginning, the fisheries learnt that it was preferable to solve their conflicts internally, among partners, given the isolation of the fishing village, located far away from the formal authorities.

The efficient gear used – casitas – implied a large investment and, when deployed over a productive fishing ground for lobsters, resulted in relatively high financial returns to the fishers. Both, investment and benefits engendered protection for self-interest. This, in turn reinforced the respect to law. Thus, the circle was closed, circumventing the many forms of `social traps´ often arising in fisheries (Seijo, Defeo and Salas, 1998).

The time trajectory followed by available indicators of catch and effort indicates that the Pescadores de Vigia Chico cooperative achieved success regarding the effective reduction of fishing effort. Effort indices showed that the number of fishers, boats, casitas and daily fishing trips reached their maxima during the late half of the 1980s, after which all of these experienced declines (Figures 3 and 5; Table 3). Effort reduction was not by design, indeed it reflected rational behaviour on the part of the fishers. In the practice, it represented the application of hard and difficult responses to economic problems affecting the cooperative due to a combination of low catches after Hurricane Gilbert (September 1988) hit the coast (Sosa-Cordero, 1995) and a poor financial decision concerning a loan to build a processing plant (Briones-Fourzan *et al*., 2000). Another element of the success of this cooperative is its high productivity (Figure 2, Table 1) and efficiency (Figure 5 A, B). Overall, this cooperative devised original and simple tools such as the campos system and a set of internal rules (Table 3) that have the merit of aligning the self-interest of individual members with their collective interest (Hilborn *et al*., 2004, 2005).

The geographical isolation is among the factors identified to explain the success of the Punta Allen lobster fishery. Although this partially contributed to the cooperative's success, the high mobility and job opportunities outside Punta Allen must also be considered. The fishing localities are relatively isolated, but the adjacent areas offer good job opportunities related to the tourism. Thus, fishers who are expelled, and others looking for alternative jobs, have comparable livelihoods opportunities in nearby towns, such as Tulum and Playa del Carmen. Indeed, in Punta Allen there is now growing tourism activity (Briones-Fourzan *et al*., 2000; Solares-Leal and Alvarez-Gil, 2003). These factors have favored the success and performance of this lobster fishery.

Two factors linked to the success of the Punta Allen must be stressed. One is leadership, the second is the tradition of respect for the law (federal and internal). Leadership and a sense of empowerment are derived from the highly democratic process, open discussion and transparent agreement in the meetings of General Assembly of the cooperative: this provides the maximum authority (Seijo and Fuentes, 1989). In these meetings the principle of one fisher, one vote promotes equity among all the members. When this is combined with the respect for the law as the preferred way to solve conflicts, the means are enabled to achieve the success as observed in the Punta Allen lobster fishery. Both factors are requirements for successful self-governance (Kooiman and Bavinck, 2005). Again, authors arguing that overfishing is a consequence of poor governance systems (Hilborn *et al*., 2004), could use the case of Punta Allen lobster fishery as a basis for this assertion.

Any attempt to replicate the specifics of the system developed in this fishery in different contexts makes little sense. Instead, it can be argued that some general principles inspired by the Punta Allen lobster fishery are feasible to apply in other fishing communities. For example, a first principle could be the need for the creation of a cohesive group structure, e.g. a cooperative, a syndicate, an union of fishers. A second need is to establish a number of internal rules that facilitate the solution of conflicts among fishers and between fishers and external actors, preferably embracing the formal laws of the government. The third, and hardest principle, is to build a tradition of respect for the law, both internal and federal. Other actors, such as governments must collaborate to this end, through thoughtful interventions, as has been the case here.

Among the challenges that can be named for the system developed in the Punta Allen lobster fishery are the following: (a) it is highly desirable that most of the members of the cooperative possess at least one campo – equity from the perspective of a member could be through having a share on the investment in fishing equipment (casitas, fishing boat, etc); (b) mechanisms to maintain a number of desirable properties such as good compliance with the law (federal and internal), existence of the observance of democratic processes within the cooperative, (c) training opportunities for new leaders; (d) closed membership; (e) improved fishing practices to maintain a reasonably low percentage of sublegal sizes in the catch and (f), a balance between fishing and tourism activities so as to minimize conflicts among the sectors. One interesting issue will be how the experience gained by the fishers in facing challenges during the 1980s and 1990s will be transmitted to the new generations that will face new challlenges during this century.

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Walleye pollack (*Suketoudara*) fishery management in the Hiyama region of Hokkaido, Japan

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1. INTRODUCTION

The fishery for walleye pollack (*Theragra chalcogramma*) is important in Japan. The roe is a popular part of the Japanese diet, often prepared either by salting (*tarako*) or by marinating with hot chilli pepper (*mentaiko* or *karashi-mentaiko*). The flesh is used for *surimi* products and is exported to China and Korea. After stock levels and harvests of walleye pollack declined, the fishery was included as one of seven species regulated by the total allowable catch (TAC) system set by the central government.

Walleye pollack are harvested mostly in northern regions of Japan, with Hokkaido producing the most fish. There are four different stock groups of walleye pollack in Hokkaido waters: Japanese Pacific, northern Japan Sea, southern Okhotsk Sea and Nemuro Straight. The Hiyama region is located in southwestern Hokkaido island facing the Japan Sea (Figure 1) and its near-shore area is known as the main spawning ground for the northern Japan Sea stock.

This paper describes co-management of the walleye pollack fishery by a subgroup of fishers who belong to the Hiyama Fishery Cooperative Association (FCA). The Hiyama FCA consists of several "sections" defined according to geography and each section co-manages its fisheries. This paper focuses specifically on the Nishi section, in the middle of the Hiyama fishery (light-shaded areas in Figure 1). The Nishi section harbours the main spawning ground for the walleye pollack, which is an important advantage since the main target of walleye pollack fishery in Hiyama region is its roe. The Nishi section produced 77 percent of total walleye pollack landings by weight in the Hiyama region in 2005 (Watanobe, 2007).

The co-management group in the Nishi section is distinguished by two characteristics. First, the Nishi group emphasizes pre-harvest equity through a sophisticated fishing-ground rotation scheme. Second, walleye pollack migrate along the coast and many other regions of Japan are engaged in fisheries that target the same stock. While successful fishery co-management is often thought to be restricted to sedentary species,

FIGURE 1
Hiyama region in Hokkaido, Japan

or those with limited migrations so that single groups have nearly exclusive access to the fish stock, this case arises in a widely shared stock.

2. DESCRIPTION OF THE FISHERY

2.1 Biological characteristics of walleye pollack

Walleye pollack are found in northern waters of the Japan Sea, the Pacific Ocean, the Okhotsk Sea, the Bering Sea and along the Alaskan coast. The northern Japan Sea stock inhabits waters that extend from the southwestern tip of Sakhalin in Russia, along the western coast of Hokkaido, to Noto Peninsula in the Ishikawa prefecture. The fish are found from near the surface to a depth of 400 metres.

Walleye pollack reach maturity at three to four years, when they are approximately 33 cm long and weigh 230 grammes. (Photo 1) About one-third of the three-year cohort is mature and by six years nearly all fish are mature. At six years, pollack on average are 42 centimetres long and weigh 485 grammes. Their life expectancy is unknown; most of the fish exceeding ten years of age have been found in the Hiyama region.

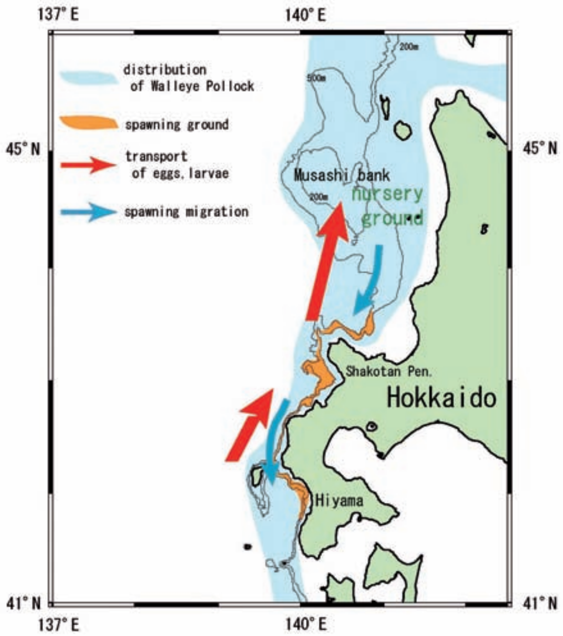
The walleye pollacks' spawning grounds once encompassed the western coast of Hokkaido, but major spawning activity during the past few years has been confirmed only in the Hiyama region. Overharvesting and depleted fish stocks are thought to be the cause of shrinking spawning grounds (Honda and Yabuki, 2006). Hatchlings and juveniles are carried north by the current to an area known as the Musashi Bank and onto the continental shelf off northern Hokkaido (Figure 2), where they grow and mature. The majority of walleye pollack harvested near Musashi Bank and regions north of Shakotan Peninsula are between one and four years of age (mostly young and immature adults). As they mature and become reproductive, they migrate southward. Young adults spawn for the first time around the Ishikari and the Iwanai region, which lies about 100 kilometres north of Hiyama. The migration continues until the pollack reach the Hiyama region, where fish that are five years or older predominate. The peak season tends to be earlier in southern areas and later in northern areas (Hokkaido Central Fisheries Experiment Station, 2005).

PHOTO 1
Walleye pollack
(*Theragra chalcogramma*)

COURTESY OF HOKKAIDO HAKODATE FISHERIES EXPERIMENT STATION.

Like many other fish species, walleye pollack aggregate in dense groups when they arrive at Hiyama's shores to spawn. The aggregations tend to shift rapidly in depth and area and, as a consequence, two vessels fishing next to each other can harvest significantly different amounts of fish.

FIGURE 2
Migration pattern of Japan Sea walleye pollack



Source: Hokkaido National Fisheries Research Institute. Original diagram was modified by the author with permission.
Note: Contour lines are shown at 200 and 500 metres.

2.2 History of the walleye pollack fishery

The walleye pollack fishery in the Hiyama region has experienced a typical boom and bust. The shift toward implementing rigorous fishery management was a response to the bust. (Much of the following historical information comes from Hanashi [1984].)

Fishing for walleye pollack in Hiyama started around 1910 in response to declining harvests of herring. It started slowly as a low-valued fishery. But when a new demand for dried pollack emerged in Korea and China around 1921, it began to flourish. By 1926, nearly all of the local fishermen were engaged in walleye pollack fishing; vessel and engine size became bigger and the fishing season was prolonged. This trend, however, was halted rather abruptly in 1952 and 1953, when migrating walleye pollack stopped arriving. The livelihoods of pollack fishermen suffered. They were forced to work elsewhere during the pollack season, which is in winter months. This experience – cold, harsh weather conditions and living in temporary housing in an unknown land for some fifteen years – led fishermen to implement a rigorous fishery management regime when walleye pollack began to reappear in the mid-1960s. By the early 1970s, the fishery had been re-established in the region. The number of vessels began to increase again for several years during the late 1970s, but decreasing stocks and rising costs rendered the fishery unprofitable for numerous vessels in recent years. The number of vessels today in Hiyama region has decreased to 94.

2.3 Status of the resource stock

According to a stock assessment report provided by the government, the stock level of northern Japan Sea walleye pollack is estimated to be low and continues to decline. Stock levels between 1987 and 1991 were high, with estimates ranging between 722 000 and 868 000 tonnes. The declining trend began in 1992 and as of mid-2006 the stock level was estimated at 147 000 tonnes. The 1998 cohort was expected to yield a high level of stock, but in 2002 it was so extensively harvested that it ultimately produced no more fish than from other cohorts. The recruitment per spawning stock biomass (RPS) has been declining since 1989, which resulted in 2003 posting the lowest recruitment level in more than twenty years (Honda and Yabuki, 2006).

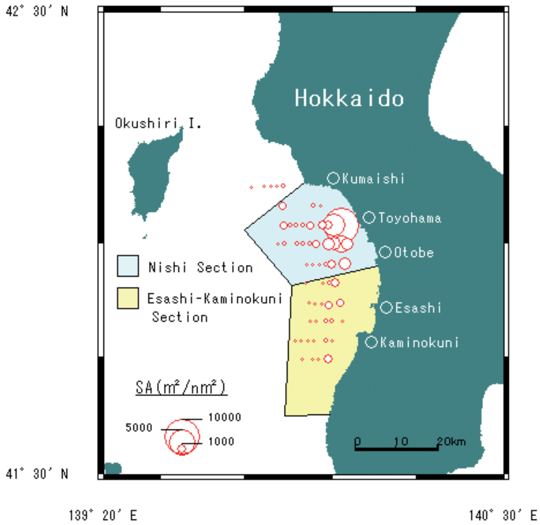
2.4 The fishery

The gear used in Hiyama walleye pollack fishing is longline (Photos 2 and 3). The longline is favoured, rather than the trawl gear used for younger pollack in northern regions of Hiyama, because fishers believe that compressing fish inside a net damages the quality of the roe. The longline is set in a straight line; its length varies from 3 472

COURTESY OF THE HIYAMA FCA

PHOTOS 2 & 3
Hauling the long line (left) and caught walleye pollack brought on board (right)

FIGURE 3
Distribution of walleye pollack measured in early February 2007



Source: Hokkaido Hakodate Fisheries Experiment Station, 2006.

to 5 788 metres, depending on the size of the vessel. There are 100 hooks per "basket" (the fishing lines are coiled in a basket) and pieces of frozen saury and squid are used as bait. The average percent of hooks that catch fish is approximately 50 percent but can rise to 70–80 percent when the catch is good.

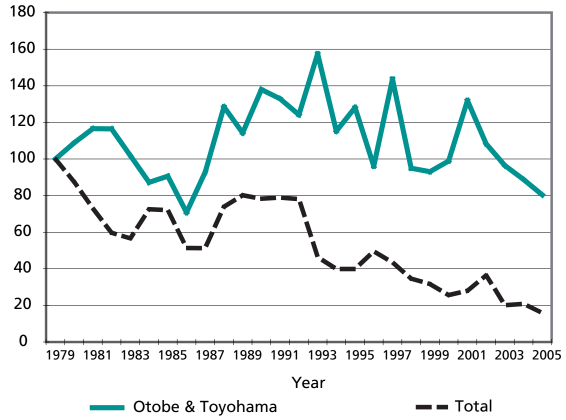
Pollack are unevenly distributed (Figure 3) along the coastline, presenting the major challenge in this fishery. Longline fishing in a relatively small area creates serious problems with entangled lines and hooks. To avoid this, vessels in the Hiyama region line up at the "starting line" spaced 150–200 metres apart from each other and set their lines parallel to each other as they move straight outward to sea. High concentrations of spawning fish are often observed where the ocean floor rises steeply towards the continental shelf, at a depth of approximately 200 metres. Concentrations of fish become more sparse as one moves away from the coast.

As of June 2006, there were 51 vessels in the Nishi section (out of 94 in total in Hiyama region). There has been a trend toward retiring smaller vessels and replacing them with larger ones. While the number of vessels is declining, the number of crew members has remained the same and has even increased slightly as the number of crew per vessel has increased from three to five. As of mid-2006, there were three small vessels (less than 6 ton) and three mid-sized vessels (7–8 tons); the rest exceeded 9.9 tons with some as large as 19 tons. Large vessels (more than 10 tons) accounted for more than 70 percent of the total landing volume in the 2005 season.

No fees are imposed on fishing licences that are issued by the government, either at the central or local level.

Harvest volumes in the Nishi section have fluctuated between 3 000 and 7 000 tonnes since 1979. Harvest volumes have remained near the 1979 level, although a decreasing trend is apparent in the years following 2001. Figure 4 presents a scaled comparison of the trend in landings for two of Nishi's three districts to landings in the northern Japan Sea area. The Nishi section stands in stark contrast to a clear decreasing trend for northern Japan Sea walleye pollack. The total harvest in 2005 for Japan Sea pollack was only 16 percent of the total in 1979, while harvests for the Hiyama region remained at 80 percent. Hiyama region's 2.8 percent share of the total harvest volume of Japan Sea pollack in 1979 has risen to an all-time high of 14.3 percent in 2005. While this difference may not be solely attributed to the management effort by Hiyama fishers, it certainly encouraged them to maintain their management regime.

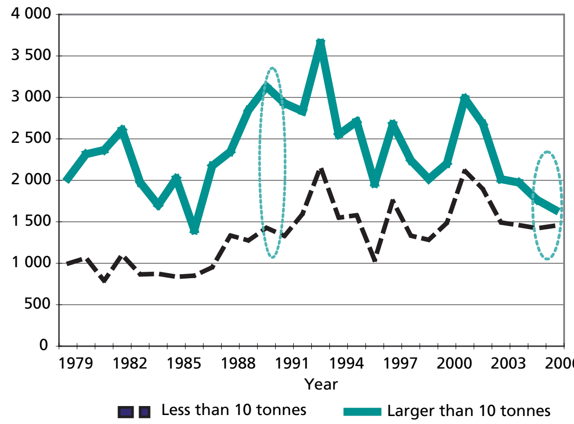
FIGURE 4
Change in total harvest volume index with base year 1979 as 100



Data source: Hokkaido Hakodate Fisheries Experiment Station and Honda and Yabuki (2006).

Decreasing stocks and harvest volumes are raising concerns for owners of larger vessels. Fishermen interviewed by the authors stated that while vessels larger than 19 tons are better for winter fishing (for their stability during rough weather), 10 tons is an ideal vessel size in terms of profitability given the current resource conditions. Larger vessels once caught as much as twice the volume of smaller vessels. Daily vessel catches for larger vessels have since decreased from 2 500 kg to 1 765 kg, while catches of smaller vessels have remained at an average of around 1 500 kg (Figure 5). Such a change has most likely been accompanied by a decrease in profitability for larger vessels.

FIGURE 5
Catch volume per day per vessel by vessel size



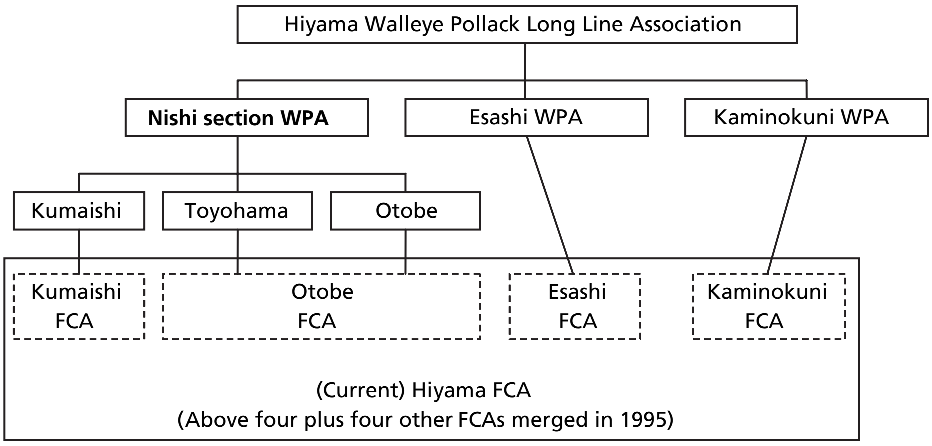
Data source: Hokkaido Hakodate Fisheries Experiment Station.

A vessel owner's average revenue is approximately 20–25 million yen (US$180 000–227 000), which, after costs are deducted, is typically not enough to provide a livelihood for an entire year. Nearly every fisherman must find additional income sources during the off-season. Some fishermen, typically those in Otobe, fish for squid during the spring and summer months. Fishermen in Kumaishi typically engage in set-net and abalone fishing and those in Toyohama travel to Alaska to work as long-line technicians. Many crew members from all three districts also go to Alaska.

Despite rigorous management aimed at creating a sustainable fishery, lack of successors is an issue in the Hiyama region. The average age of fishermen in the region is in their 50s, ranging from the youngest in their 30s to the oldest in their 70s. As one fisherman noted, the declining stocks of walleye pollack are dampening future prospects for this fishery.

3. REGULATIONS
3.1 Government regulations
Walleye pollack is one of seven species regulated under the national total allowable catch (TAC) system introduced in 1997. The TAC is divided between offshore trawlers, administered by the Ministry of Agriculture, Forestry and Fisheries and other gears administered by the Hokkaido prefectural government. The long-line fishery in the

FIGURE 6
Organizational structure of Hiyama's regional fishery co-management system



Note: WPA stands for Walleye Pollack Association.

Hiyama region falls into this second category. For 2006, the TAC for walleye pollack was set at 247 000 tonnes, of which 146 000 tonnes were allocated to offshore trawlers and 98 000 tonnes were allocated to other sectors in the Hokkaido prefecture (Fisheries Agency of Japan, 2007). The allocation to Hokkaido prefecture for the 2007 season was reduced to 86 000 tonnes, reflecting the decline in stocks. Twelve thousand tonnes were allocated to the Japan Sea area, of which 8 300 tonnes were given to longline and gillnet fisheries in the area (Hokkaido Government, 2006).

The effectiveness of the TAC system, however, is questionable. The walleye pollack stock is declining, which suggests that a more conservative TAC should be set. But only 73 percent of the TAC was caught in the 2004 season and 70 percent in the 2005 season (Japan Fisheries Information Service Centre, 2006). The continuing decline of stocks and the fact that the quota limit is not limiting the catch suggests that the catch limit has been overly generous.

3.2 Self-imposed regulations

3.2.1 Organisational structure

The Hiyama Walleye Pollack Long Line Association consists of three sub-organizations: the Nishi Section Walleye Pollack Association, the Esashi Walleye Pollack Association and the Kaminokuni Walleye Pollack Association. (The Esashi-Kaminokuni section lies to the south of the Nishi section; see Figure 6). The Nishi section brings together three groups that correspond to the townships in which they are located: Kumaishi, Toyohama and Otobe (Figure 6). The members of each organization are vessel owners.

Leaders from each of the town groups meet about ten times during the season to make adjustments to operations and the rules. Members are informed each morning before going out about the details of that day's fishing operation. Monitoring is done by the members. One member from each district is responsible for monitoring the group's operations and penalizing violators, which has been necessary several times in the past.

Self-imposed regulations by the Nishi section's walleye pollack fishermen can be divided into three main categories: fishing-ground rotation, pooling arrangements and other operational regulations that overlay government-imposed ones. We first describe the other regulations briefly, as many of them are related to how the two remaining measures are carried out.

3.2.2 Other regulations: seasons, no fishing area and gear restrictions

The official fishing season set by the Hokkaido prefectural government is November through March. These months correspond to the spawning season of walleye pollack, when the fish appear near shore. Hiyama fishermen set their own fishing season within the official period based on weather, conditions of other fisheries and the quality of the walleye pollack's roe. In the early 1980s, the season opened in early December and continued until late March. In recent years, the fishery has opened in early November and closed in early February. The average season length within the official five-month period is 93 days. The average actual number of fishing days is 61 days, or 65 percent of the season. Larger vessels tend to spend more days fishing (50–60) than smaller vessels do (40–45 days).

There are two primary reasons for this seasonal restriction. The most valuable product is roe which has peak quality when it is just ripe. Both not yet ripe and overly ripe roe (called *mizuko)* are considered to be low quality. The yield of mizuko begins to rise in late January to early February, which is one reason to stop harvesting. Another reason is that the survival rate of fertilized eggs is enhanced when the water temperature drops below 10 ^{o}C, which typically occurs in early February. Thus, the motivation for the voluntary seasonal closure is the combination of a marketing decision and an effort to enhance successful reproduction.

Another effort to conserve the stock was the establishment of a no-fishing area in the mid-1990s. The location, west of the town of Toyohama, was chosen because the area is a prime spawning ground for walleye pollack (Maeda , Kakahashi and Nakatanil., 1988). Areas within, and near, the no-fishing zone have the densest schools of walleye pollack (see Figure 3). Rather than concentrating their fishing efforts at this hot spot, the fishermen chose to set in the area aside as a way of contributing to rebuilding the Japan Sea walleye pollack stocks.

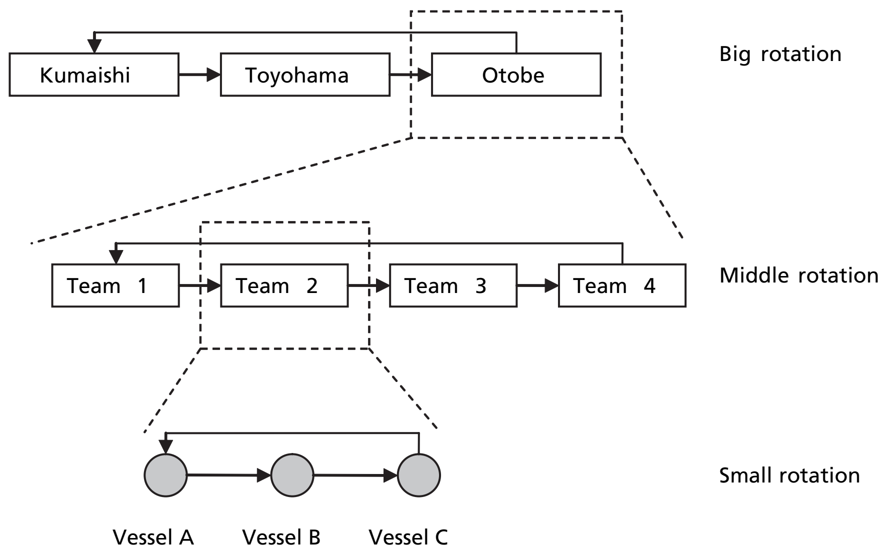
Fishing gear is also regulated. No more than 100 hooks can be attached to the line in each basket. Each vessel is limited to 25 baskets a crew member, so smaller vessels (6 tons or less), which typically have a crew of three, can take up to 75 baskets while larger vessels (10 tons or more), which typically have a crew of five, can take up to 125 baskets.

3.2.3 Fishing-ground rotation

Fishermen in the Nishi section have developed one of the most sophisticated fishing-ground rotation schemes in Japan. Similar schemes are observed in neighbouring walleye pollack fisheries, such as those in the Iwanai region (see Figure 1) (Hirasawa, *et al*., 1985). The rotation scheme was implemented soon after the walleye pollack stock reappeared in the Hiyama region in the mid-1960s. The main objective is to avoid congestion at fishing grounds and the consequent costs, such as gear damage, while maintaining fairness. Fairness is defined differently than it is in other fisheries in Japan, such as the system used by sakuraebi fishermen in Suruga Bay (Uchida and Baba, this volume). In the sakuraebi fishery, fishermen sought post-harvest fairness by adopting a pooling arrangement. In the Nishi walleye pollack fishery, fishermen sought pre-harvest fairness by rotating access to the fishing grounds.

There are three layers of rotation: groups, teams and individuals (Hamada, 2001). Nishi fishermen are divided into three groups based in the town where they are based. In 2006, the Kumaishi group operated 17 vessels, the Toyohama group had 15 vessels and the Otobe group had 19 vessels. The Nishi section is divided into three segments of coastline from north to south (commonly called the top, middle and bottom). Each group rotates through the segments on successive days, so each group is granted access to all of the segments of coastline (the big rotation is shown in Figure 7). Each group consists of several teams and each team consists of several individual vessels. Within the big rotation, teams also rotate within their group (the middle rotation). Further, individual vessels rotate within a team (the small rotation).

FIGURE 7
Schematic of rotation scheme adopted by Nishi fishermen in the Hiyama FCA



The number of teams and vessels are for illustration purpose only; the actual configuration may differ.

This layered rotation equalizes fishing opportunities at the vessel level over the course of the season. In practice, the rotation scheme gets more complicated, because the Nishi WPA sometimes adjusts the rotation to better equalize opportunities for individual vessels. However, even if opportunities are equalized, the actual catch at the same location will differ depending on when one fishes. Hiyama fishers have long regarded such stochastic fluctuations, or luck, as part of fishery's nature and no further adjustments were made – until recently.

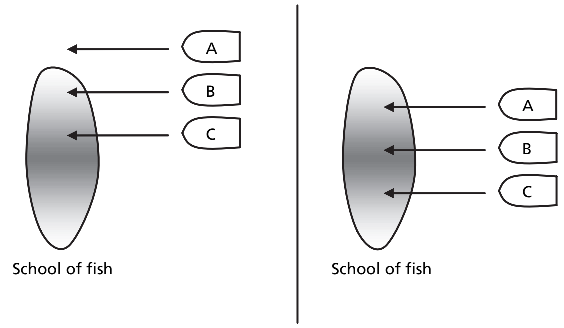
3.2.4 Pooling arrangements

There are several limitations to the rotation scheme due to the rigidity of assigned locations. While schools of walleye pollack shift along the coastline from day to day, the location coordinates of the vessel rotations are largely fixed. In the situation depicted in the left panel of Figure 8, vessel A will harvest few or no fish while vessel C can expect to have a fair catch. For the group, the total harvest will improve if the three vessels adjust their positions as depicted in the right panel of Figure 8. Under the rotation rule, this kind of adjustment is not allowed, since vessels adjusting their locations to areas where the fish schools are dense undermines the purpose of the rotation scheme and congests those areas.

A related inefficiency is that some vessels must travel long distances to reach their assigned fishing area. For example, once every three fishing days some Otobe vessels must travel to the northern edge of the Nishi section (Figure 3). This is not an efficient use of vessel time and the price of the inefficiency has become apparent and acute as fuel prices have soared. This has led to the adoption of a section-wide pooling arrangement in the Nishi region.

The Nishi section-wide pooling arrangement was implemented as a trial at the beginning of the 2005–06 fishing season. Preseason fish-stock and fishing-ground assessments indicated that the walleye pollack schools had declined significantly. This led to the necessity of location adjustments, as described in Figure 8 and implementation of a pooling arrangement. The Nishi section's distribution rule is simple and incorporates the heterogeneity of the size of both vessels and crew members, i.e. each vessel's share is determined by the number of baskets of longline. Earnings are calculated daily;

FIGURE 8
An illustration of inefficiency in a rotation scheme



only vessels that go out fishing that day get a share.

Once the pooling arrangement was implemented, the Nishi group made several changes to enhance efficiency. Joint surveillance of fishing grounds is conducted daily and the results are disclosed to all members. They also can adjust the location assignments while fundamentally maintaining the rotation pattern. In addition to the adjustments depicted in Figure 10, adjustments are made based on the characteristics of each vessel type. For example, when operating in relatively high waves, larger vessels operate upwind of smaller vessels so that they block the high waves, making it safer for smaller vessels to operate.

The most prominent change in fishermen's behaviour has been efforts to reduce costs. In rough weather, vessels from each town fish at the nearest fishing grounds. When a low catch rate is anticipated, each vessel takes fewer units of long line. With such efforts to save costs, the 2005–06 season yielded a smaller total harvest and less revenue but equal or slightly greater profit, according to the Hiyama FCA.

The pooling arrangement seems to have brought positive changes, but some members remain unhappy. The effect of a pooling arrangement is a double-edged sword: it can align an individual's incentive to maximize his return with the group's incentive but it also can encourage members to shirk and take advantage of others' effort (Uchida, 2007). The majority of the claims by those dissatisfied with pooling assert that differences in the skill of the skippers should be reflected in what a vessel earns. So far, the issue of shirking members has not surfaced, but frustrated members with legitimate complaints could undermine the entire co-management regime. The Nishi WPA faces the difficult task of finding a balance between the two opposing incentives involved in a pooling arrangement. Nonetheless, early results from the Nishi arrangement were so positive and persuasive that the trial continued throughout the 2005–06 season and was extended to the following season.

3.3 Licensing costs

There is a flat licence fee of 3 150 yen annually, i.e. the vessel size does not matter. The fees collected by management associations (Figure 6) vary and are used to cover costs such as (a) meetings among the members, (b) representatives attending regional meeting of TAC allocation and (c), the hiring of a skipper when a representative attends meetings during the season. These activities are generally related and necessary for the current co-management regime and thus are considered as co-management-related expenses.

The total annual cost to an operator depends on the vessel size and to which regional association one belongs. For example, for a 9 ton vessel whose owner is a member of the Otobe WPA, Nishi Section WPA, and Hiyama Walleye Pollack Long Line Association, the total annual cost is 98 150 yen (≈. $890), though note that the actual fishing season is only three months (Nov~Jan). Some fishers felt this fee to be somewhat of a burden.

4. MARKETING

The FCA also has tried several ideas to obtain higher prices for the group's catches; some ideas have failed but others have been successful. The primary product of the Hiyama region's walleye pollack is roe. The roe is often simply salted to become *tarako*,

TABLE 1
Hiyama region annual walleye pollack fees

Item	Fee (¥) Active	Idle	
Licence fee	¥3 150	¥0	Flat fee
Hiyama Walleye Pollack Long Line Association	¥10 000	¥5 000	< 5 tons
	¥10 000	¥10 000	<9 tons
	¥15 000	¥10 000	≥ 9 tons
Nishi Section Walleye Pollack Association	¥30 000	¥15 000	Flat fee
Kumaishi Walleye Pollack Association	¥30 000	¥0	Flat fee
Toyohama Walleye Pollack Association	¥25 000	¥0	Flat fee
Otobe Walleye Pollack Association	¥50 000	¥0	Flat fee
Esashi Walleye Pollack Association	¥10 000	¥0	Flat fee
Kaminokuni Walleye Pollack Association	¥0	¥0	Flat fee

Example:	
Fisher in Otobe district, 9 t vessel	¥98 150
Consisting of:	
Licence fee	¥3 150
Hiyama Walleye Pollack Long Line Association fee	¥15 000
Nishi Section Walleye Pollack Association fee	¥30 000
Otobe Walleye Pollack Association fee	¥50 000

a common side dish in Japan. The retail price is 6 000 to 7 000 yen (approximately US$60) a kilogram. The Hiyama FCA is putting significant effort into promoting its own brand, Beni-Otome ("scarlet lady"), to capture greater profits from its product. The fish are also boxed and shipped. The main markets for pollack fillets are in China and Korea or for surimi, but the Hiyama FCA is beginning to promote domestic consumption.

A current marketing effort samples the roe quality and releases the information to buyers prior to the auction. Uncertainty about roe quality prior to bidding results in weaker bidding. With samples of roe quality, bidders can match bids to quality. This system encourages fishermen to be quality-conscious and the market rewards those efforts.

5. MAINTAINING THE WILL FOR BETTER STEWARDSHIP

Catastrophic events, such as collapse of the fish stock, often result in a paradigm shift by fishers' towards engagement in rigorous fishery management by the fishermen. As described above, the walleye pollack fishery of Hiyama region is no exception; the support for sustainable fishery in Hiyama has its roots in those hard days when literally the entire community had to temporarily migrate for jobs after the pollack disappeared. However, that was more than half a century ago and younger generations – fishermen in their 40s – have not experienced those hardships. Leaders of the Nishi WPA are concerned as to whether younger generations can maintain the will to be good stewards and thereby sustain the co-management regime.

Is such catastrophic event necessary for paradigm shift to occur? Must all generations go through the similar experience to actively maintain the co-management regime that their predecessors established in response to their experience of such hardships? The answer that Hiyama fishers came up with is interesting, particularly because it was initially intended for an entirely different purpose. In the mid-1980s, a group of younger fishermen attempted to establish a hatchery for walleye pollack. In the end, the hatchery project failed due to high mortality for both eggs and larvae. Despite its commercial failure, the hatchery project generated some unexpected benefits. These young fishermen realized how vulnerable the eggs and hatchlings are through their failed efforts to lower the mortality rate in the hatchery. As one of the project members remarked, the recognition of the fish's vulnerability and fragility convinced his generation of the importance of fishery management. The hatchery project itself has been extended in an effort to learn more about the fish and to keep the motivation for walleye pollack fishery co-management.

6. FUTURE CHALLENGES

Walleye pollack co-management in the Nishi section of Hiyama has been successful thus far. The fishing-ground rotation, though schematically complicated, successfully meets a simple objective: maintain fairness and avoid gear/vessel congestion. The Nishi WPA also has shown remarkable flexibility when faced with low stocks and increasing fuel costs. Members are actively working on both fronts – cost savings and revenue enhancement through marketing. The Nishi fishermen are an encouraging example of how fishery co-management can be effective and sustainable.

From an economic point of view, the question is whether this co-management regime is capable of reducing the fishing effort to an efficient level, in addition to addressing the short-run crowding externalities. Whether the current 51 vessels in Nishi section is near, or far, from an economic efficient level is unknown, but vessel consolidation and fleet reduction is clearly a recent trend. Specifically, smaller vessels are retiring and crew members are transferring to larger vessels. There seem to be several forces behind this trend. First and foremost is the declining fish stock (despite the management) and rising fuel costs. Consolidation can be viewed as an attempt to take the advantage of economies of scale. However, one must not overlook the effect of highly coordinated fishing practices (i.e. fishing ground rotation) and the pooling arrangement. With these two measures, Nishi WPA fishers are operating as a quasi-single operator. It can be argued that such teamwork facilitates the consolidation by easing the negotiation and transition processes.

There are several issues and challenges facing the Nishi co-management group. One is how to incorporate heterogeneity in the skill of skippers in the distribution of pooled revenue. The group could opt not to incorporate skill at all, but the Nishi WPA would probably need to further enhance profitability for that option to address the dissatisfaction with equal sharing. Alternative methods tend to reduce fairness in other ways and/or induce excessively competitive behaviour that would undermine the purpose of co-management.

The Hiyama region's co-management group, including Nishi WPA, also faces some external challenges, particularly the need to coordinate with neighbouring regions that target the same stock. The ideal would be to merge the various management efforts into a single group with authority over the pollack throughout its migration range over the west coast of Hokkaido. The likelihood of establishing such an ideal institution is small. Fishermen in the southern region, who mostly harvest for roe, argue that the collapse of walleye fisheries is due to overharvesting of juveniles by trawlers. Fishermen in the northern regions claim that southern harvesting for roe reduces the number of young fish that migrate northward to their fishing grounds. Both sides are caught in an endless 'chicken-or-egg first' argument.

The TAC system could have provided a region-wide management tool, but it too poses a serious problem that undermines efforts by Hiyama's fishermen. Hiyama fishermen have intentionally reduced catches both to save money and to conserve the stock. However, the annual TAC allocation is based on the catch history from the preceding three years and is weighted toward the most recent catch. This system punishes fishermen in Hiyama for their conservation efforts, something the Hiyama fishermen perceive as unfair.

Co-management by fishermen in the Nishi section of the Hiyama region is notably successful, but the migratory nature of walleye pollack presents a restriction that

Hiyama alone cannot overcome. Given the overall decline of walleye pollack stocks, especially in the northern Japan Sea stock, some kind of overarching management regime is needed. It will be a challenge for all stakeholders, as development of such a regime will require the cooperation among fishers, government officials, buyers and scientists.

7. ACKNOWLEDGMENTS

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Fishery management and the pooling arrangement in the Sakuraebi Fishery in Japan

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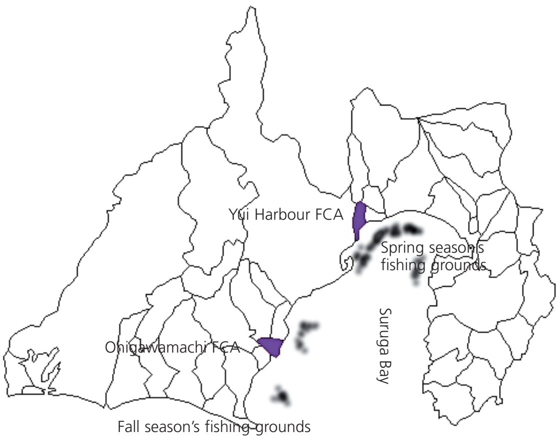
1. INTRODUCTION

This chapter describes self-management in the *sakuraebi* (*Sergia lucens*), or small pink shrimp, fishery in Suruga Bay of central Japan, known for its enduring success in co-management. Since the establishment of the co-managing body of local fishermen in 1968, it has developed a sophisticated fishing effort coordination system coupled with a pooling arrangement for revenues. Consequently, it has become one of the most lucrative fisheries in Japan. While lack of successors and the increasing average age of active fishermen has been a pressing issue in coastal fisheries nationwide, the sakuraebi fishery has been an exception. Although local management is a common institution in Japan, it does not in and of itself assure economic success. This study seeks to qualitatively unravel the mechanics of how fishers' objectives, rules and results are related in this fishery.

The sakuraebi fishery is managed by a local fishers' organization whose members are sakuraebi fishers in the Yui Harbour Fishery Cooperative Association (FCA) and the Ohigawamachi FCA. Figure 1 shows the location of this prefecture. During the fishing season, which has two openings a year, in spring and fall, fishers' representatives meet daily to make decisions on nearly all aspects of fishing operation – to go fishing or not, who goes to where and how much to land. The 120 participating vessels follow these instructions, which we call "fishing effort coordination." After harvesting, all proceeds are pooled. Some common costs such as commission fees paid to parent FCAs and fuel are then deducted and the remaining revenue is distributed back to each member equally – "the pooling arrangement."

FIGURE 1
Location of Shizuoka prefecture

FIGURE 2
Fishing grounds of sakuraebi fishery in Suruga Bay



Drawn by the author based on Hirasawa *et al.* (1985) and Omori and Shida (1995)

The sakuraebi fishery co-management is interesting because its centralized decision making process and equally shared proceeds resemble sole owner-like behaviour as first suggested in Scott (1955). Entry into this fishery is limited by the licence system administered by the prefectural government. Since the stock is confined within Suruga Bay (see Figure 2), these fishers have exclusive access to the resource. However, this has been true since the early 20th century when the licence system was introduced. Prior to the establishment of co-management, operations in this fishery closely resembled derby fishing (Omori and Shida, 1995). Our interest is to understand how a conventional derby fishery converted itself to a sole owner-like fishery and has been able to endure for nearly four decades.

The sakuraebi fishery has several unique conditions that are favourable for achieving positive co-management results, but there are also lessons that can be generalized. For example, the fishery is a *de facto* monopoly. Nowhere else in Japan is sakuraebi harvested. The only competition is from Taiwan, whose scale and quality do not compete significantly with Suruga Bay sakuraebi in the market. However, during the 1960s and early 1970s sakuraebi fishery profits suffered despite their monopoly position. When catch was good, the market was often flooded, which lowered price. There are also substitutes such as akiami shrimp (*Acetes japonicus*) paste, which ordinary consumers usually could not differentiate based on appearance. Under co-management, total landed volume is closely controlled on the basis of recent price trends and information from the buyers. The FCAs have also launched advertising and branding strategies to differentiate their products. Such marketing activities and information sharing with the buyers are the lessons that can be generalized. The question then becomes how they were able to engage in such activities and deliver results with co-management.

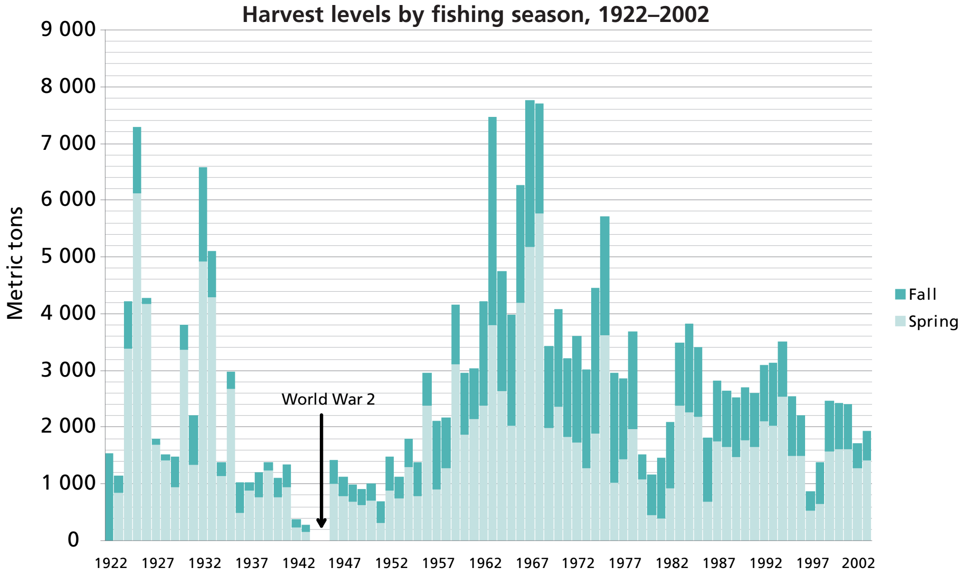
2. AN OVERVIEW OF SAKURAEBI FISHERY

2.1 Biology of sakuraebi

Sakuraebi is a small shrimp, with its jaw-to-tail length measuring only 4 to 5 cm when full-grown. Its lifespan is about 15 months and it normally spawns only once in its lifetime. The spawning season is during the summer (late June to about late October) and it takes about a year after hatching to mature. They do not crawl on the sea floor like larger shrimps but spend their entire life floating in the water. When fully grown they occur at a depth of 200 to 300 metres during the day and are fairly scattered. As dusk approaches, they begin to aggregate and ascend to about 60 metres in depth.

Sakuraebi of Suruga Bay are believed to be sedentary within the bay throughout their lifetime. Suruga Bay is known as the deepest and steepest bay in Japan, reaching more than 2 400 m in depth with virtually no continental shelf. During the winter, the shrimp stay deep (200–300 m) in the bay. As spring approaches, they begin to appear along the coast on the inner part of the bay, which is their spawning area. The spring harvest takes place there. In this area, many river systems flow into the bay. Scientists believe that the minerals and nutrients these rivers bring is one reason the shrimp spawn in this area. From late summer to fall, the shrimp migrate southward along the west coast of the bay, where the fall harvest takes place (Figure 2).

FIGURE 3
Harvest levels by fishing season, 1922–2002



Data source: Omori and Shida (1995) and Shizuoka Fishery Experimental Station.

The sakuraebi population in Suruga Bay is not biologically linked to any outside population. Sakuraebi exists in other coastal areas and bays, such as Sagami Bay and Tokyo Bay. However, the shrimp are not harvested in these areas because the shrimp tend to be too scattered even when they ascend to shallower depth, which makes the fishing operation infeasible. It is believed that the steepness of Suruga Bay is the cause of the shrimp forming dense aggregations that makes the fishery in Suruga Bay feasible. As we discuss later, this "natural fencing" of sakuraebi is one of crucial conditions needed for successful fishery self-management.

Resource stock assessment of sakuraebi still remains a challenge. As is typical of plankton-like creatures, there is no clear relationship between the estimated number of spawned eggs and the number of adults observed the following spring. Currently, scientists use the average size of spring-season shrimp as an indicator of catch per unit of effort (CPUE). It was found that when the average shrimp size is increasing, the number of shrimp caught in a single net hauled for one minute also increases and vice versa (Kobayashi, 2002). The size (width and thickness) of the water layer with a temperature range of 18–25 °C during the winter is also highly correlated with CPUE. However, why and how these indicators affect CPUE and biomass of sakuraebi is still largely unknown (Kobayashi, 2002).

2.2 The fishery

The sakuraebi fishery exists only in Suruga Bay in Japan (except for the small fishery in Taiwan). The fishery began in 1894 when several horse mackerel fishermen from the Yui area coincidentally caught 180 litres of sakuraebi. By January 1895, the sakuraebi fishery was established with 40 units (explained below) each from Yui and the neighbouring town of Kanbara. Figure 3 shows the quantities harvested over the period 1922–2002.

The fishing method is closely related to the biological characteristics of the shrimp. It is conducted during the night when sakuraebi are clustered and have ascended to the depth of about 60 m. The fishing gear is a pair-boat trawl net, where each of the two vessels holds a leading rope and together tow a single net. A pair is referred to as

PHOTO 1
A sakuraebi vessel

HIROTSUGU UCHIDA

a "unit" and a pair is often formed within family members or relatives. The number of units coincides with the number of nets. Ownership of vessels and nets vary from one unit to the other. Typically, the vessels are owned individually, although there are cases of co-ownership. The net is either owned solely by one side of the pair or owned jointly. The structure of ownership is reflected in the distribution of revenues from their harvest.

The average vessel size is 6.6 t (Photo 1). The average number of crew members per unit is 12–13 (6–7 per vessel). Crew consist of one skipper, one engineer, two who control the net roller, one who is in charge of the net and engages the fish pump and one or two for packing shrimp into boxes. With improved equipment and mechanization, the minimum crew required for operation is said to be ten per unit.

There are two fishing seasons: one in spring along the coast of Yui area and the other in fall near the coast of Ohigawamachi. The prefecture regulates the fishing season for sakuraebi to be between 1 October and 10 June. The three months of summer were excluded in this regulation, which was implemented in 1912, because it coincides with the spawning period. Fishers have voluntarily set the actual season from late October until the end of December (the fall season) and from late March till early June (the spring season). The winter three months were voluntarily excluded because the shrimp stay in deeper water during these months, so the fishing efficiency is low. Actual fishing days during the winter, however, are limited due to weather conditions. The average for 1974–2003 was 48 days out of approximately four and a half months.

There are 60 units (120 vessels) engaged in sakuraebi fishery from three fishery districts. The districts are Yui, Kanbara (both under jurisdiction of Yui Harbour FCA, with a total of 42 units) and Ohigawamachi district (Ohigawamachi FCA, 18 units). Each district has a landing port, auction market and vessels that use it as their homeport. Entry into the fishery is restricted by the licence system and the total number of licence s is limited to 60 units. To obtain a licence, a vessel in the sakuraebi fishery must be registered to one of the two FCAs, so the vessel owner must to be a member of one of these FCAs. This exclusion assures that any benefits from co-management will be fully appropriated by the member fishermen, a critical condition for enduring fishery co-management (Uchida, 2004).

A typical fishing operation proceeds as follows. Vessels depart from their home port just before dusk and head for fishing grounds. Once on the ground, the two vessels will shoot their trawl, tow for about 10 to 20 minutes, then haul. Most vessels haul their nets only once a fishing trip; seldom do they haul twice. Therefore, it takes only about an hour or so for the actual fishing activities. The net is hauled between the two boats and they use a fish pump to transfer the catch onboard (Photo 2). A fisherman pours shrimp from the hose into a designated box. One box contains approximately 15 kg of shrimp and one pair typically harvests 100–200 boxes a trip. Units then transfer the boxes such that the total landings per vessel are somewhat equalized, as

KENJI TAKAHASHI

PHOTO 2
Harvested sakuraebi onboard a vessel

part of the effort coordination explained later. Finally, at around midnight, the vessels return to their homeports. Boxes of shrimps are stored in cold storage facilities located on the port until the auction next morning.

Income from the sakuraebi fishery alone is not enough for most fishermen, if any, to make a living. This is not surprising since the fishing days a year are limited to 50 days or so a year. Nonetheless, the fishery is very profitable. For example, in the 1993 season a vessel owner earned more than \$200 000, or \$4 000[1] a fishing day (which usually lasts only a few hours). Note that vessel owners must pay maintenance costs from these figures. A crew member earned \$17 000 in total, or \$336 a fishing day (Omori and Shida, 1995). As one fisherman told the authors, there are no other jobs that provide such amounts in such a short time. More recent figures show that the fishery earned a total revenue of \$36 864 673 in the 2003 season. Since 47 percent of this amount goes to 120 vessels, average revenue a vessel was \$144 387, well below the 1993 level. However, the 2003 season had only 34 fishing days, so the daily average revenue was approximately \$4 247 a vessel owner.

During the off-season, many fishermen farm their own land or work at construction sites. A few switch to other fisheries such as those using small-scale fixed nets for horse mackerel and cutlass fish. Others trawl for young sardines, particularly in Ohigawamachi FCA.

2.3 Markets

The three landing ports of Kanbara, Yui and Ohigawamachi each have their own wholesale auction market. Shrimp are auctioned by the price per box (15 kg) for 20 boxes (300 kg) at a time (Photo 3). Reportedly, buyers look for uniformity of shrimp size within a batch and larger sizes are preferred. Another important attribute is the degree of damage, since sakuraebi are soft and can be easily damaged by rough handling. For this reason, fishermen leave small fish bycatch in the box, rather than removing them, to minimize damaging the shrimp by handling.

Most sakuraebi are processed. Raw consumption exists and is increasing but still constitutes a small portion of total consumption. The dominant processing method is sun-drying. After the morning auction, processors take the shrimp to their drying grounds, typically river banks (Photo 4). Even today shrimps are naturally sun-dried; people say

[1] To convert Japanese yen to US dollars, an exchange rate of yen 110 to \$1 was used throughout this chapter.

PHOTO 3
Box-full of sakuraebi displayed at auction market at Yui Harbour FCA

KENJI TAKAHASHI

PHOTO 4
Shrimp being sun dried on Fuji River bank near Mount Fuji

KENJI TAKAHASHI

machine-dried shrimp lack flavour and taste. Sun-dried shrimp are so dominant that fishermen would normally not go fishing when the weather forecast for the next day is poor. Another main processing method is to boil the shrimp in salt water.

The ex-vessel price of sakuraebi is approximately $13 a kilo, based on the average annual prices during 1990–2003, retail prices are much higher. Based on the 2006 retail prices at the direct-sale shop operated by Yui Harbour FCA, raw or frozen product is sold at about $28 a kilo. Fifteen kilograms of raw shrimp yield about 12 kg of boiled shrimp or 4 kg of sun-dried shrimp. These products are sold at $31 and $90 a kilo, respectively. Retail prices reflect the labour required in processing. Raw shrimp need only be frozen. Since most processors are near the landing port, the cost of keeping them fresh while transporting is not a major issue. Much of boiling process is automated and requires much less manpower today. Sun-drying, on the other hand, is still labour-intensive. Black nets are laid on a flat surface and shrimp are put through a sieve one chunk at a time by hand. Gathering dried shrimp is also done by hand.

Ex-vessel price is very sensitive to the level of inventory. The author was told that informal but constant information exchange is done between the fishermen and the processors. Such information exchange helps fishermen to update their plans on how much to harvest.

3. FISHERY MANAGEMENT SYSTEM

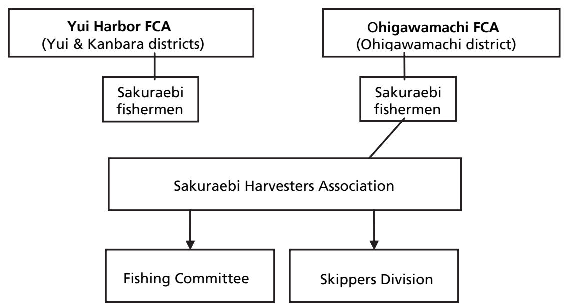
3.1 Government regulations

Fishery management in the sakuraebi fishery consists of government-regulation and self-regulation. The government, in this case the prefecture, regulates the seasonal closure and the maximum number of units through the licensing system. Self-regulations includes additional fishing season closure, gear restrictions (particularly on vessel size) and, most importantly, fishing effort coordination.

The seasonal closure by the prefecture was based on scientific evidence on the spawning season for sakuraebi. It was imposed as early as 1912. Modifications have been minor; the closure period has remained essentially from early June until the end of September.

The licence system was first introduced in 1910. A licence is issued to a harvesting unit, i.e. two paired vessels. It was interrupted in 1912, but resumed in 1915 and continues to date. It started with 101 licences, reached a peak of 196 licences in 1919, and then gradually decreased to current 60 licences. This decrease is a result of voluntary retirement due to poor harvests and low profitability, which were common in the 1930s and the 1950s (Omori and Shida, 1995).

FIGURE 4
Structure of fishery management organizations



3.2 Self-regulation

Self-regulated regimes are at the core of the sakuraebi fishery management. They involve additional seasonal closures, as described in Section 2.2, vessel size restrictions and a broad range of fishing effort control through a fishery management organization called the Fishing Committee.

The organizational structure is shown in Figure 4. Sakuraebi vessel owners and fishermen from the two FCAs formed the harvesters association in 1946. Its objectives were to enable collaboration between the fishermen and the government and more importantly, to set starting and ending dates of each season and other rules concerning fishing practices. It is reported that the main motivation for creating this association was that disputes from the "race for fish" sometimes escalated to violent incidents and fishermen (particularly vessel owners) realized the need for a conflict-resolving institution.

A milestone of sakuraebi fishery management came in 1967 when the Fishing Committee (henceforth "the Committee") was established to unify the fishing operations and to coordinate them. The Committee consists of two vessel owners and five skippers from each of three fishing districts, a total of 21 members. The Committee meets every day during the fishing season to decide on (a) whether or not to fish that day and if fishing (b) the time of departure, (c) vessels' locations, (d) total harvest, (e) landing volume for each port and (f), other operational items as necessary. Note that the Committee does not decide who goes to fish, since the basic rule is that either all 60 units fish or none (there are some rare exceptions). This rule is one of the limitations of sakuraebi co-management. Decisions by the Committee command all 60 units and they are absolutely final; not even a chairman of an FCA is allowed to change them – but individual claims and challenges do exist. The author was told that being a member of the Committee, let alone the head, is a very tiresome task.

Perhaps a unique aspect of the system is the pooling arrangement. All revenues from harvests are pooled, some costs are deducted and then the balance is distributed to all 60 units (details on the calculation below). The revenue received by the fishers in the sakuraebi fishery is only indirectly correlated with one's effort and harvest. Prior to the pooling arrangement and under individualistic competition, that correlation was direct, which fuelled the incentive to race for fish. This system can be seen as a supporting mechanism for various arrangements and regulations that this fishery has employed (Platteau and Seki, 2001). At the same time, the pooling arrangement potentially has its own incentive problems, such as shirking and free-riding.

3.3 Self-regulation

3.3.1 Objectives

Several objectives are sought through this self-regulation: (a) to improve efficiency in fishing operations, (b) to conserve and better manage the sakuraebi stock and (c), to stabilize price through production control. The chairman of Yui Harbour FCA emphasized that the second objective has been the primary one. Some other sakuraebi fishermen whom the author interviewed put more emphasis on the first and third objectives. However, they all agree that these three objectives are closely related and today fishermen are experiencing positive effects on all three aspects as a result of self-regulation.

3.3.2 Improving efficiency

Before the Committee was established, the sakuraebi fishery exhibited the typical open-access race for fish. The race was furious: sakuraebi are distributed in a patchy fashion and "hot spots" are small in size and limited in numbers. The race was already on before leaving the port. For example, when the weather is slightly rough such that everyone is deciding whether to go out or not, crew members of a unit would gather and hang around the area where the vessels are moored. They were keeping an eye on each other. If one unit started preparing to leave, crew members of other units would call their skippers and vessel owners and prepare to go out as well. Then vessels would race to find hot spots. Once found, many vessels would gather in close proximity. Vessels would collide, nets would get entangled and fishermen could begin to fight. Some extreme incidents include where a skipper of one unit threw a lighted wooden torch into other unit's net in anger. There even was a case where quarrels on the sea continued ashore and resulted in bloodshed (Omori and Shida, 1995). Clearly, this created waste.

Today, the rules eliminate incentives for racing and the sources of quarrels. Crew members need not stand as watchdogs, since the Committee would decide to fish only when all units are able to. A vessel departing time is also set. There is no need to race because the fishing spot and harvest amount for each unit is predetermined by the Committee and revenues are shared equally across all participants. These rules are designed for fishing effort coordination and the pooling arrangement dampens the incentives to do otherwise.

The specifics of effort coordination are as follows. On the first day of each fishing season (spring and fall), all 60 units are coordinated to conduct a search to locate 'hot spots' for the season. Based on this information, units are allocated to hot spots by the Committee each fishing day. The Committee also decides how much to harvest on that particular fishing day, expressed as an amount per unit. For example, the Committee would direct "200 boxes (of 15 kg) a unit for today." This decision is primarily based on market conditions, i.e. inventory level of processors and price levels, rather than on the state of the sakuraebi stock. Nor does the Committee set any annual or seasonal total harvest amount. Currently, scientists are unable to provide such information. They decide on a daily basis, observing primarily the market conditions.

Fishing operations are completely synchronized as well. There are three leaders, one skipper from each fishing district, who are responsible for coordinating the operation at sea. All units from a district keep radio contact with their leader and leaders communicate on the radio as well. Each unit would report when they are ready to haul their net. When every unit is ready, leaders give a go sign. After 10 minutes or so, leaders would then radio to the units to pull out the nets. Each unit would then report the amount caught – experienced fishermen can approximate the number of boxes in their catch when they see the volume of shrimp in the net. Leaders would then calculate the total harvest. If the targeted amount is met, they would call off fishing for that day. Otherwise, they would ask several units to go for a second haul.

Finally, before vessels head for their homeport, leaders would conduct a transfer of boxes while at sea. For example, unit A might harvest 250 boxes and unit B only 150 boxes. These transfers enable the landed volume for any unit to be approximately the amount the Committee had initially decided. For the above case, unit A will transfer 50 boxes to unit B, so that each would land 200 boxes at their homeport. The reason for such adjustments is to maintain the sense of fairness for the buyers/processors. While fishermen can choose at which port to land their catch, processors cannot and they rely on shrimp landed and sold in their district's market. Processors are not prohibited from purchasing shrimp landed in another district, but the small size of most buyers/processors puts practical restrictions on such purchases. Fishermen could exploit processors through arbitrary adjustments in their landings, but this conflicts with the need for long run relationships with processors. In addition, processors and fishermen are all members of small communities in Yui, Kanbara and Ohigawamachi.

There is one more form of effort coordination, which is related to the over-capacity problem. On fishing days, all 60 units go out but only about a half of them – 30 units – actually haul their nets. Specifically, units in each fishing district are grouped in four groups and each group has same number of units. When the Committee assigns fishing locations, they also announce which group – say groups 1 and 3 – would haul for that day. The other half simply stand aside. They sometimes search the surrounding area for bigger schools of shrimp. When, on rare occasion, a second haul is necessary they might get the call. Or, if their group gets a good catch, they would help retrieving the shrimp from hauled net with their fish pumps and put them in their boxes.

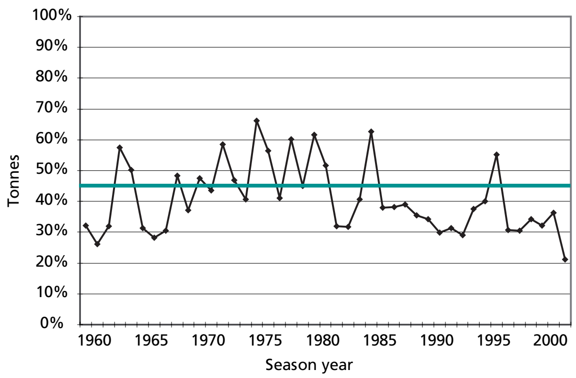
Such enormous over-capacity is a result of improved equipment, particularly of electronic devices. One example is sonar used to search for schools of shrimp. The sonar has two frequencies; high (200kHz) and low (50kHz). Sakuraebi, owing to its small size and transparent body, will appear only in one frequency while other species (e.g. small fish) will appear in both. This allows fishermen to find not just a school of something, but precisely sakuraebi. Another example is a net-sonde. This small device emits an acoustic signal and is attached to the end of a net; it allows the skipper to pinpoint the exact depth of the net. Combined with the information from the scanner, skipper can drag the net into the school of sakuraebi precisely in terms of their location and depth.

That 60 units operate while only half are necessary to harvest the targeted amount suggests that fishermen's objective is not just economic efficiency. Establishment of the Committee and the mindsets of fishermen are based on a cooperative-spirit, i.e. finding ways for everyone to survive. No doubt, if there were only 30 units in this fishery, the revenue would stay the same and each unit would earn twice the income, but that would mean half go out of business. Currently, the only way to reduce the number of sakuraebi licence holders is through attrition, i.e. a fisherman retiring without successors.

3.3.3 Resource stock management and conservation

Fishermen would say that resource management is an important objective for effort coordination. This is a fair statement, at least from a historical point of view. In the 1964 season (fall 1964/spring 1965), fishermen observed a decline in their sakuraebi harvest of several hundred tonnes (Figure 5). Normally, such a magnitude of decline would not bother fishermen. However, the timing was critical: this was just when "capital stuffing" in engine horsepower was at its peak and also coincided with increased anxiety about impacts on fish and fisheries from pollution from local paper mills (Hirasawa *et al.*,

FIGURE 5
Share of fall season harvest



Data source: Shizuoka Fishery Experimental Station.

1985). When fishermen saw these events occurring simultaneously, many worried that if they continued their current fishing practices the sakuraebi fishery would eventually collapse. This led to experimental implementation of effort coordination accompanied by the pooling arrangement in 1966 and establishment of the Committee in 1967.

Resource management considerations do not seem to play much role in regard to controlling the volume of harvest as harvest volumes are mostly determined by market conditions. Shizuoka Prefecture Fisheries Experiment Station, the local public research institution that studies sakuraebi, is currently capable of only giving a forecast of the coming season's harvest level. They have no idea whether that is within the "safe" range or not because they have no estimates on total biomass.

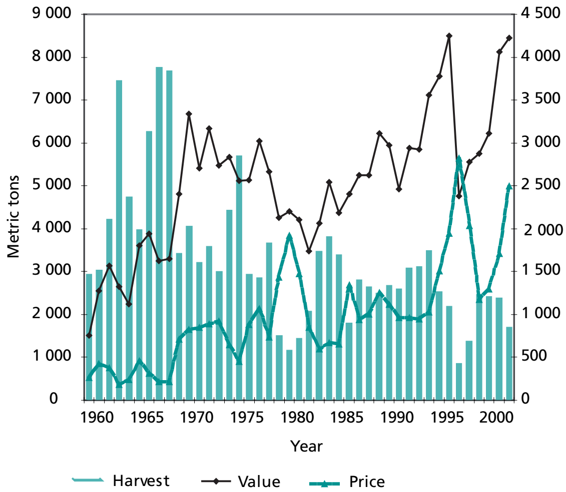
Fishermen are, nonetheless, putting effort into resource management. The most prominent effort is to decrease the fall season harvest. The ratio of fall season harvest to total harvest has declined since the mid-1980s. Sakuraebi spawn during the summer and shrimp hatched early in the season would grow large enough (2–3 cm) to be caught in the net during the fall season. Fishermen know that harvests in fall season contained two distinct groups; small shrimp born that summer and large shrimp born last summer. Sakuraebi form schools from a single generation. Thus, "small" and "large" shrimps do not get mixed in a single haul. They decided to lower the fishing mortality in the fall to secure more mature shrimp for spawning and for following spring season. Fishermen have recently fine-tuned this practice: when they find a school of shrimp, they catch a small amount using a small basket-net. If the shrimp were small, they would leave the school in the water and find another.

Being selective in the fall season harvest has a positive effect on the sakuraebi resource and on expected price, particularly in the coming spring season. Since larger shrimp fetch a higher price, by restricting the fall season harvest fishermen are selecting an optimal timing of harvest. They expect that shrimp will grow larger by the spring season and fetch higher ex-vessel prices. So was higher price a by-product of the resource conserving action, or was it the other way around? This is discussed in Section 3.3.4.

3.3.4 Price stabilization

Price is sensitive to the total harvest volume. Figure 6 shows the total harvest volumes (by calendar year rather than fishing season, due to data availability), unit price and total harvest values (i.e. market sales). One can observe a high negative correlation between the harvest volume and unit price (see also Figure 7). This is not surprising since sakuraebi is only harvested in Suruga Bay, so they are effectively a monopoly.

FIGURE 6
Harvest volume and value and unit price

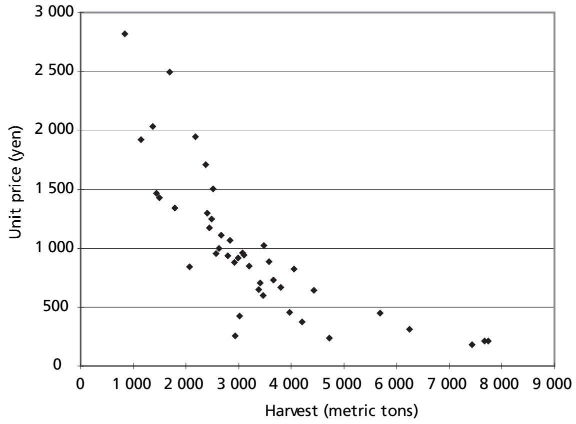


Data source: Shizuoka Fishery Experimental Station. Prices are real (base = 1995)

Since harvest volumes fluctuate due to many unknown factors, fishermen want not price stabilization *per se* but to keep it reasonably high. And, they have been successful as shown in Figure 7 – unit prices were low, below 1 000 yen a kilo, until the late 1960s (recall that the Committee was established in 1967). Since then they have managed to keep it around 2 000 yen/kg or higher.

An effort to stabilize the price at a reasonably high level can be seen in the changes in daily landing volume. Prior to the establishment of the Committee the daily landing volume ranged from 3 000 boxes

FIGURE 7
Total harvest volume and real unit price



(45 t) to 11 000 boxes (165 t). After the co-management was established, the average daily landing volumes are centered around 4 000 boxes (60 t). According to Baba (1991), this number corresponds to the maximum processing capacity for sun-dried shrimp, the main product. Landings exceeding 4 000 boxes would lower market price and so the Committee controls the daily volume to avoid excessive landings.

Resource management and conservation was a historic motivation behind establishment of the Committee. But an incident occurred in 1968 that taught fishermen a hard lesson and made them realize the potential effect of harvest control on price. The spring season of 1968 was exceptionally good – the second highest in history and the highest since 1945. At the end of spring season, on June 3, the auction price plunged to 20 yen (38 yen in 1995-based real terms) a kilo. The price was so low that angered fishermen dumped more than half of their harvest that day into the sea (Omori and Shida, 1995). They learned that harvest needs to be controlled and coordinated to avoid what they called "big-catch loss."

Today, fishermen would admit that resource conservation and maintaining price are both equally important objectives. Historically and especially for those fishermen who initiated the effort coordination system, price maintenance might have been a by-product or secondary effect. But for most fishermen, price maintenance was the key. Although minor complaints are expressed on the technicalities of the system, sakuraebi fishermen whom authors interviewed cast no doubts about the benefit of this system.

In addition to controlling the total harvest volume to keep the price up, the Committee engages in moderate arbitrage among the three markets. They say "moderate", which means they would not do it so explicitly that it would upset processors. The method is simple: fishermen transfer their catches among units before heading back to their homeport. When, for example, recent price in Yui market was higher than the other two markets, then the three leaders would adjust the transfer such that slightly more is landed at Yui than the other two.

3.4 Pooling arrangement

The pooling arrangement is a key mechanism in effort coordination. Coordinating fishing locations would not be stable unless proceeds are pooled and distributed equally (or some similar processes were used). But, the pooling arrangement does have a set of generic incentive problems, such as free-riding.

The current distribution is calculated as follows. After the revenues are pooled, costs paid to parent FCAs such as ex-vessel market handling fee (3 percent of landing revenue), fishing port fund (1 percent) and refrigerated storage usage charges (where landed shrimp is kept until the market begins next morning) are deducted from the total landing revenue (Omori and Shida, 1995). The balance is then divided between the crew and vessel owners in the ratio 53%/47%. These divided sums are then equally distributed among vessels and among crew. This ratio was revised in 2007 to 50%/50%, in response to reduced crew numbers and to provide more funds for investment costs. Each vessel receives 1/120 of the vessel share. In dividing the crew share, skippers and engineers each receive 120 percent of regular crew member shares. The typical vessel owner made $204 000 and a crew member made $17 000 in 1993. Note that vessel owners bear vessel and net maintenance costs individually.

There are some differences in the details of how pooling and distribution are calculated that reflect the characteristics of the three districts. In Yui and Kanbara districts, fuel costs are also deducted before the funds are distributed to vessel owners and crew. Ohigawamachi district does not deduct fuel costs, because 80 percent of its vessels are also used in a daytime *shriasu* (young sardine) fishery that partially overlaps the sakuraebi fishery. It would be troublesome to determine how fuel use should be apportioned between the two fisheries. While many aspects of co-management are set centrally, reasonable adjustments are allowed to meet local conditions.

The pooling arrangement was first tried voluntarily by five vessel owners from Yui district in 1966. Their objective was reported to be cost savings by avoiding the race to fish. Kanbara and Ohigawamachi districts followed and after several trials and failures, each district established individual systems that were implemented from the fall season of 1968. This timing was no coincidental. The price plunge due to the overwhelming big catch in the spring of 1968 persuaded fishermen of the need for effort coordination.

The initial district-based pooling arrangement was not fully successful, although it lasted until 1976. The major flaw was that the market handling fee, which is 3 percent of landed value paid to parent FCAs, was not pooled because the system was district-based. (At that time, there were three FCAs, one in each district. Kanbara and Yui FCAs later merged and became today's Yui Harbour FCA). While competition among individual units within a group was removed, group competition among districts became intense. Committee agreements were often violated and although it had some effects on maintaining higher price and limiting harvest volume, overall performance and particularly the impact on resource management was poor. In 1977, the system was modified and expanded to a unified pooling arrangement covering all three districts and the market commission fee was included in pooling calculation as described above.

In summary, the revenue side is pooled but not the costs. This distinguishes the pooling arrangement that sakuraebi fishermen employed from a corporate-style management. If all the costs – both variable and fixed (capital) costs – were pooled and shared as well, then effectively this is an organization functioning as a single corporation. The Committee members would be the operation managers and fishermen would be employees who receive wages from pooled revenue. With the recent rise in fuel costs, such a transition should be more attractive and eventually fishermen would need to consider the option seriously.

One question still remains: why did fishermen, particularly top harvesters, agree on pooling? Generally speaking, pooling with equal distribution hurts those who are highly successful and favours the less competitive. It is not easy to convince hi-liner fishermen not only to forgo their advantages but effectively to transfer that advantage to less competitive fishermen for free. The answer fishermen in Yui gave to the author is interesting. A consensus was established because highly competitive fishermen were the ones who proposed and initiated the pooling arrangement. They took the initiative because they were the ones most concerned about the possibility of the sakuraebi fishery collapsing. In the mid-1960s, prior to the common adoption of GPS and radar, highly competitive fishermen were those with the greatest experience. Such fishermen not only would have a good sense of the sakuraebi stock being depleted, but they also were more emotionally attached to the fishery. In fact, the first pooling arrangement was first tried in Yui district, where the sakuraebi fishery first began. Since the group of fishermen least favoured by pooling (i.e. the competitive ones) agreed on the pooling arrangement, the others also eventually agreed to join.

3.5 Marketing

Reduced competition for fish enabled sakuraebi fishermen to spend more time on quality control, both before and after harvest. The pre-harvest sampling shrimp not only serves as selective harvesting for resource conservation but also harvests shrimp

HIROTSUGU UCHIDA

PHOTO 5
Yui Harbour FCA's shop behind the monument of sakuraebi

with higher value. Proper packing into boxes and removing bycatch are also part of quality control.

Sakuraebi fishermen and the Harvester Associations are also actively engaged in promotion and direct sales of sakuraebi products. Both Yui Harbour and Ohigawamachi FCAs have shops that directly sell products to local customers and occasional tourists (Photo 5). The Yui Harbour FCA uses its website to promote sakuraebi consumption by introducing sakuraebi recipes. Their objective is to differentiate sakuraebi from other similar small shrimp products and also from imported sakuraebi from Taiwan. They have been reasonably successful thus far.

3.6 Enforcement

A potential issue with the pooling arrangement is 'free-riding'. Other monitoring issues are also of interest – poaching, direct sales to merchants (i.e. bypassing the ex-vessel market) and sakuraebi caught by other fisheries operating in the same area.

Poaching and bycatch are not serious issues, due to biological and technical reasons. Poaching is not practical because (a) during the day shrimp are deep and scattered so fishing efficiency is very low and (b), at night it is easy to spot a vessel's lights. Bycatch is not a problem because (a) no other fisheries operate during the night and (b), during the day shrimp are at depths below those of other fisheries.

Free-riding would take the form of shirking in this fishery. Since all harvests are pooled, why would one not shirk and take advantage of others' efforts? Some fishermen simply feel that shirking is not in the nature of fishermen. Another explanation, cited in Omori and Shida (1995, p.88), is that when boxes from each vessel are displayed at the auction, one can instantly observe who brought back the least, because each box is labelled with the name of a vessel. (Transferred boxes will have different vessel names on them.) Even if it is due to a bad draw from the Committee that day, fishers on that vessel nonetheless feel embarrassed and uncomfortable until the next fishing day. No crew would purposely put themselves in such position. There is no doubt that effective peer pressure exists.

Other fishermen, especially those who tend to be more "aggressive" about harvesting, admit that there is minor shirking. But they also insist that it has never been a severe problem and they credit peer pressure while out in the sea for this. Several units operate as a group so mutual monitoring can occur. Since all operations are coordinated under directions from the leaders, it would be difficult not to fish as directed.

The competitive mentality is suggested by the desire of all 60 units to fish. Half the units could stay at port and save costs such as fuel. If the harvest does not change but the total cost is lower, then everyone is better off if these "redundant" vessels do not fish. Fishermen do not need to shirk at sea secretively because they are given an authorized opportunity to do so. But the other half still go to sea. Members of the Committee, fishers themselves, understand this mentality and do not prohibit half from fishing.

4. CONCLUSION

The Suruga Bay sakuraebi fishery is a unique case in its level of coordination, stability over nearly 40 years and successful performance. Its effectiveness on resource management remains unclear, in large part because the science is limited. It has improved the welfare of fishermen by increasing income.

The sakuraebi fishery owes it success to many favourable conditions. Sakuraebi is harvested only in Suruga Bay and has a reliable market. This allows them to maintain high prices for sakuraebi by limiting their harvest, which greatly improves their profitability. Sakuraebi are not highly migratory and only a limited number of vessel owners and skippers were involved. Limited entry assured that benefits from effort coordination would stay with incumbents.

There are, nonetheless, valuable insights for successful and enduring fishery co-management from sakuraebi fishery management. First, establishing and maintaining a collaborative co-management regime with 120 vessel owners is not easy. The usual wisdom is that collective action is unlikely as the number of actors grows large (Olson, 1965; Ostrom *et al*., 2002) and the sakuraebi fishery seems at odds with this wisdom. But, several incidents have encouraged cooperation. Hi-liner fishermen provided leadership by emphasizing the need for coordinated fishing and the pooling arrangements to support it. The industry faced credible threats to the sakuraebi resource due to two factors: rapid technological improvements that might accelerate over-exploitation and water pollution from nearby paper mills. The sense of urgency coupled with strong leadership were key factors that persuaded other fishers to accept the co-management regime, at least at the beginning.

Maintaining the regime requires an appropriate economic incentive, i.e. improvements in profitability. The sakuraebi fishery, as a *de facto* monopoly, was in a clearly unique situation. But there are also other ways to improve profitability. One can improve the quality by careful handling and/or maintaining freshness. Any differentiation of harvests from others may fetch higher prices. A prominent example would be the snow crab fishery in Kyoto (see Makino, this volume).In the snow crab fishery, prices are largely determined by international markets. But the few FCAs in Kyoto secure a significant premium for their crab through extensive quality control and marketing.

There are some limitations in sakuraebi fishery co-management. Most prominent is the limitation in rationalizing costs. There are two aspects to this. Because of the pooling arrangement, each vessel owner is under peer pressures to maintain his equipments and gear to match the others. If one member installs a more powerful GPS system, other members follow not because of competition but because no one wants to be seen as free-riding on someone else's investment. Why would anyone make such an investment under the pooling arrangement and set off an unnecessary investment race? Gaspart and Seki (2003) explain such behaviour as seeking social status, i.e. the desire to be the top harvester (or, conversely, the desire to avoid being in the bottom group). This behaviour is consistent with remarks made by the sakuraebi fishermen during interviews. Another aspect of limited cost-rationalization is the strong resistance of vessel owners to forgo their vessels. While all 120 vessels go fishing, only about half actually haul the net. Shifting to joint ownership of vessels is rational for the group as a whole. For vessel owners, however, owning a vessel means independence and security. If the sakuraebi fishery collapses, the vessel can engage in other fisheries. Without a vessel, the owner's fate is tied strictly to the sakuraebi fishery. Owners may also have an emotional attachment to being an active vessel operator.

The failure to eliminate redundant vessels could be viewed as an effort to achieve a social optimum. If the objective is to maximize economic efficiency (and profit), then reducing the number of vessels and fishermen would be efficient. However, such actions cause great disturbance within the industry and their communities. If the society's interest is to maximize the profit from the sakuraebi fishery under the condition that all incumbents stay in business, then the current sakuraebi fishery is at, or near, the social optimum.

Effort coordination and the pooling arrangement in the sakuraebi fishery raise an interesting aspect of fairness in fishery co-management. The sakuraebi fishery achieves *ex-post* equality. This allows the Committee to retain maximum flexibility in assigning vessels to multiple fishing grounds and in other aspects of fishing effort coordination. However, this *ex-post* equality rests on a heterogeneity in skills and investments. Conversely, one can consider *ex-ante* equality, as implemented in walleye pollack fisheries in Hokkaido, northern Japan (see Uchida and Watanobe, this volume). That case equalizes the opportunity to fish in all fishing grounds during the course of a fishing season. The actual harvest and revenue are not pooled, so discrepancies due to skill and capital level remain. However, the vessel assignment to fishing grounds is extremely rigid and factors affecting harvest such as weather conditions and shifting hot-spots are left unadjusted. There are multiple definitions of fairness and each society or community has their own definition. Institutional design of co-management can incorporate the community's specific definition of fairness. The co-management described here has shown an inherent flexibility that allows wide applicability.

5. ACKNOWLEDGMENTS

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Sandfish resource co-management in Akita Prefecture, Japan

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1. INTRODUCTION

This paper studies the case of sandfish (*Aroctodcopus japonicus*) resource management in Akita prefecture. This case can be categorized not so much as pure self-governance but as co-management in which government and research agencies are intensively involved in making decisions with local fishers. Such cooperation is necessary in part because the fishery includes twelve fishery cooperative associations (FCAs) and more than 700 operators along the lengthy Akita coastline. Ongoing, persistent conflicts between various groups of fishers moved the government to intervene. Akita's sandfish co-management case demonstrates how collaboration among fishers, government agencies and researchers was able to overcome such obstacles.

Harvests of sandfish in Akita exceeded 20 000 t in the 1960s but decreased sharply thereafter, falling to 71 t in 1991. Faced with such a drastic decrease in catches, fishers in Akita independently determined and implemented a 3-year moratorium on harvesting of sandfish (1992–1995), with support from the prefectural government. The moratorium remains one of the most drastic measures undertaken so far in a fishery in Japan and yielded reasonably good results due to co-management.

The success of Akita's co-management system was instrumental in shaping Japan's national fishery policies. The Fisheries Agency in Japan has been promoting co-management as a key concept for coastal and offshore fishery management since the early 1980s. After Akita's sandfish moratorium was lifted in 1995 and its results became known, it was promoted as a successful example of fishery co-management in a white paper on the fisheries of Japan in 1998 (Ministry of Agriculture, Forestry and Fisheries, 1998). This eventually led to the creation of a resource recovery plan for management of fishery resources nationwide by the Fisheries Agency in 2002. It may be noted that no fees are imposed on fishing licences issued by the central or local governments.

This paper analyses the socioeconomic factors that enabled Akita sandfish fishers to agree on the moratorium and on new fishery management measures that were enacted after the moratorium. It is no surprise from a biological point of view that a moratorium on fishing would contribute to stock recovery for sandfish. The focus of this paper is thus on the relationships among the stakeholders and their roles in the policy processes, with a particular emphasis on consensus-building.

The study identified several factors that are central to Akita's success. First, co-management decision-making should involve all of the parties to the process, including fishers, who must be allowed to present their concerns and ideas regarding fishery management measures. Better still is a decision-making process that resembles or employs existing, perhaps traditional, ways of negotiating and reaching consensus in a community. Fishers must be well informed, not only about policy options but

PHOTO 1
Harvested sandfish

also about the scientific basis for those options. Translating sophisticated scientific concepts and data for fishermen is not an easy task, but their understanding of that information is crucial to avoiding inappropriate decisions. This is where outside parties such as government agencies and scientists become important. Finally, the involvement of government administrative agencies is indispensable to cooperation in cases such as Akita's, where there are multiple interest groups. However, administrative staff members must be content to offer low-profile assistance in a modest capacity so that fishers do not become overly dependent on government help.

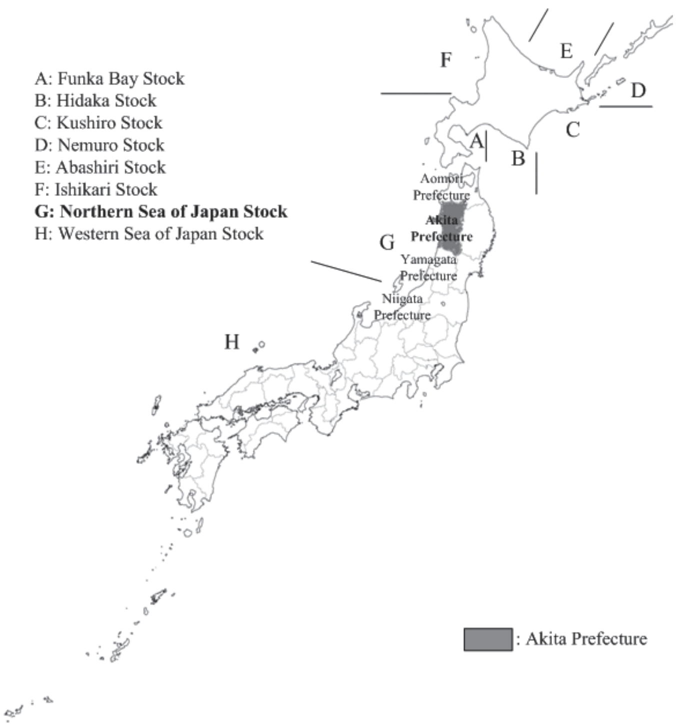
2. THE SANDFISH FISHERY AND THE MORATORIUM

2.1 The fishery

Sandfish, which are called *hata-hata* in Japanese, can be found along the coast of the Sea of Japan (Photo 1). Its winter harvest in the northern Sea of Japan is particularly well known. Females with eggs (*buriko*) are valued more highly than males. Sandfish are migratory and migration patterns define individual stocks of the fish. In Japan, there are eight sandfish stocks and each stock migrates within a specific and stable range. This case study focuses on the northern Japan Sea stock, which migrates from Aomori prefecture to Niigata prefecture (Figure 1).

Sandfish in Akita are harvested in two distinct fisheries, coastal and offshore. In the coastal fishery, sandfish are caught using small-scale set nets and gill-nets during the spawning season, which lasts for about two weeks in December. The number of fishing days can be further reduced by weather conditions such as winter storms. The offshore fishery harvests sandfish by bottom trawling and functions nearly year-round, from September through June. All twelve of Akita's FCAs are involved in coastal fishing and three engage in offshore harvesting of sandfish.

FIGURE 1
Nationwide distribution of sandfish stocks



Source: Adapted from National Federation of Fisheries Cooperative Associations (1997, p. 4).

2.2 Failed attempts at government-led management

Harvest volumes for sandfish began to decrease in the late 1970s due to overfishing. Harvests dropped from more than 20 000 t in the 1960s to a mere 74 t in 1984. Alarmed by the situation, Akita's prefectural government established the Akita Prefectural Fishery Resource Council (APFRC) in 1985. The council was composed of fourteen representatives from fishing operators, four academic experts and one prefectural government representative. However, in an effort to expedite the decision-making process, the prefectural government attempted to control and lead discussions. In 1986, the APFRC decided to establish management measures for seven fish resources, including sandfish. At the same time, the prefectural government asked the APFRC to consider a moratorium on harvesting of sandfish. Such an aggressive move by the government offended the fishers, who felt they had been left out of the decision-making process. Eventually, the fishers rebelled and the APFRC rejected the request for a moratorium on sandfish harvesting. The APFRC dissolved after 1985.

Harvest volumes rebounded to 203 t in 1985 and Akita fishers landed 373 t in 1986. But the improvements were short-lived. In 1987, harvests again declined and in 1991 they reached an all-time low, which forced Akita's fishers to reconsider the moratorium on harvesting of sandfish.

2.3 Consensus-building to adopt a moratorium

The proposal for a moratorium re-emerged as the Akita sandfish stocks continued to deteriorate. At a board meeting in January 1992, some directors from the Akita Federation of FCAs (the prefecture-wide organization representing all FCAs) expressed their pessimistic view of expected catches and revenue for the coming season. Anticipating a harvest of only 35 t and based on an optimistic price of 3 000 yen a kilogram, the revenue per fisher was expected to be only about 500 000 yen ($4 170),[1] which was extremely low. Faced with this crisis, the Akita Federation directors in February 1992 proposed and all agreed to take drastic measures to turn the situation around, including the moratorium on sandfish harvesting. The directors felt that, given the minuscule revenue expected, the impact of a moratorium on fishers would be negligible, which would make an agreement possible.

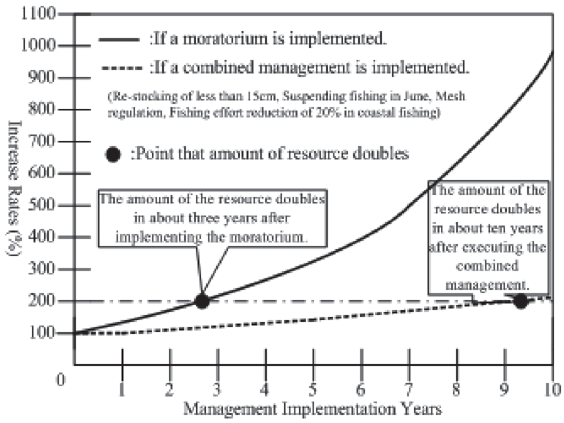
Persuading fishers that the moratorium was necessary and would bring them long-run benefit was no easy task. Fishers knew that the situation was grim. For example, in one FCA, the proportion of income its members earned from sandfish was less than 1 percent ($8 400) of an operator's total revenue. These fishers were forced to work away from home when sandfish were not in season. Yet many fishers remained convinced that the declines in sandfish were a normal event and that current shortages were simply natural ebbs in the supply and would rebound.

Countless discussions between fishers and prefectural government officials took place. The prefectural government continued to press the idea that resource management was necessary for long-run sustainability. Officials presented simulations of the long-term impacts of various resource management schemes. The simulations showed that it would take about ten years to double the sandfish stock without a moratorium, even if some new management measures were implemented. On the other hand, the simulations showed that the moratorium could potentially achieve the same level of improvement in about three years (Figure 2). In addition, officials presented the results of a survey of how fishers viewed the resource management measures that were presented in the meetings. The survey was conducted by the Akita Federation of FCAs and it helped to inform fishers about the views of their colleagues.

In the end, a majority of Akita sandfish fishers came to realize that it was necessary to conserve sandfish for future generations. The "Agreement for Sandfish Resource

[1] An exchange rate of 120 Japanese yen to 1 dollar US is used throughout the chapter.

FIGURE 2
Simulation of the long-term impacts of various sandfish resource management measures



Source: Adapted from National Federation of Fisheries Cooperative Associations (1997, p. 19).

Management" was concluded on 1 October 1992 by the directors of all 12 FCAs, the Akita Bottom Trawlers' Cooperative Association and the chairman of the Akita Federation of FCAs (Table 1). The moratorium went into effect on that date and was in effect until 30 June 1995.

While the efforts of the prefectural government played an important role in reaching this agreement, including their presentation of scientific research in a way that fishers could comprehend, the final decision was made by the fishers themselves. That a consensus was reached makes this a remarkable example of how co-management can succeed. How that consensus was built is discussed in detail in Section 5.

3. DURING THE MORATORIUM

Two major factors supported sandfish fishers in Akita during the moratorium. One was financial support from the government, both central and prefectural. Second, other fisheries in the prefecture yielded unexpectedly good catches.

On 25 September 1992, just days before the moratorium was to take effect, Akita fishers asked the prefectural government, through the Akita Federation of FCAs, for financial support during the moratorium. The request was accepted and both the Fisheries Agency (central government) and Akita's prefectural government announced packages of supporting measures on 30 October 1992. The support measures included (a) no-interest loans to replace some of the income lost due to the moratorium; (b) subsidies for reductions in the number of bottom-trawler boats; (c) a buy-back program for excess fishing gear and (d), investigations into the state of the sandfish resource stock and fishery. Representative fishers from each district and FCA were heavily involved in the process of designing these support measures. The total prefectural budget for these supporting measures was about US$4 160 000.

As a result, the number of offshore trawlers has decreased from 57 to 38 vessels and for the coastal fishery there was a reduction of 20 percent of fixed net and 40 percent of gill-nets through the buy-back program. These reductions of fishing effort were

TABLE 1
Contents of "The Agreement for Sandfish Resource Management"

1. Sea area covered under the agreement	All areas under jurisdiction of Akita Prefecture
2. Targeted fish under the agreement	Sandfish
3. Targeted fishery under the agreement	Offshore trawl fisheries; small steam-scale trawl fisheries; set net fisheries; gill net fisheries; beach seine fisheries; dip net fisheries; and other fisheries that target sandfish
4. Method of managing the fishery resource (sandfish)	Moratorium of sandfish fishery (except capturing adult female sandfish for its roe by the Akita Federation of FCAs)
5. Duration of the agreement	From 1 October 1992 to 30 June 1995
6. Penalties for violation of the agreement	(1) Fine of 100 000 yen
	(2) Violators suspended from fishing for 10 days.
	(3) Fish caught in violation and fishing gear used will be seized.
7. Entry and exit from the agreement	Application for entry or secession must be submitted to Akita Federation of FCAs.
8. Procedure to modify or abolish the agreement	Consensus of all participants in this agreement is needed.
9. Procedure when mediation to administrative agency is requested	Consensus of all participants in this agreement is needed.

aimed to lower the fraction of the biomass to be harvested (number of harvest divided by estimated targeted stock) from a pre-moratorium level of 0.8 to 0.5. The TAC was thus set at half of estimated targeted stock level. The actual harvest volume (coastal plus offshore) after the moratorium ranged from 72–125 percent of the TAC (Table 4).

Even with financial support from the government, Akita fishers had to continue to harvest other species to earn a living during the moratorium. This was challenging because fishers had to change fishing grounds and fishing methods to avoid bycatches of sandfish. However, both the coastal and the offshore fisheries experienced an unexpected benefit from these changes. For example, coastal fishers in the Northern Akita FCA tentatively implemented a long-line fishing for tiger puffer (*Takihugu rubripes*) in the fall of 1992, just as the sandfish moratorium began. Those fishers, like everyone else in Akita, had rarely fished for tiger puffer prior to 1992. Surprisingly, tiger puffer harvests generated $333 000 in revenue in 1992, $775 000 in 1993 and $500 000 in 1994 (National Federation of Fisheries Cooperative Associations, 1997). Likewise, offshore fishers successfully targeted blackmouth angler fish (*Lophiomus setigerus*). During the moratorium, 200 t or more of blackmouth angler fish were caught annually. As with the tiger puffer, fewer than 50 t of this fish had been harvested prior to the moratorium. The income from these fisheries helped both coastal and offshore sandfish operators.

4. POST-MORATORIUM PERIOD: NEW MANAGEMENT MEASURES

Discussions of resource management measures to be implemented after the moratorium began in July 1993, two years prior to its termination. Again, many meetings were held by fishers and between fishers and prefectural government officials. Five months later, the Sandfish Resource Measures Council (SRMC) was established as the official decision-making body and many items on the parties' agendas were discussed during its meetings.

SRMC had a hierarchical structure, as shown in Figure 3, that was divided into two main groups – coastal fishers and offshore fishers. Additional local discussion groups were set up within each subdivision. Fishers in each local discussion group drew up a post-moratorium management plan for their area's sandfish fishery.

Their failed negotiations with the APFRC (discussed above) convinced prefectural government staff not to take the lead in these meetings. Instead, they participated as observers. They intervened when necessary, as when they separated coastal and offshore fishers within the SRMC (Figure 3). Conflicts between the two types of fishers developed because they were targeting the same sandfish stock in different sea areas. Each side suspected that the decline of their own catches prior to the moratorium had been caused by overfishing by the other side. Regardless of whether there was any truth to the claims, such negative attitudes would have undermined any attempt at self-governance. The government's intervention

FIGURE 3
Structure of the Sandfish Resource Measures Council

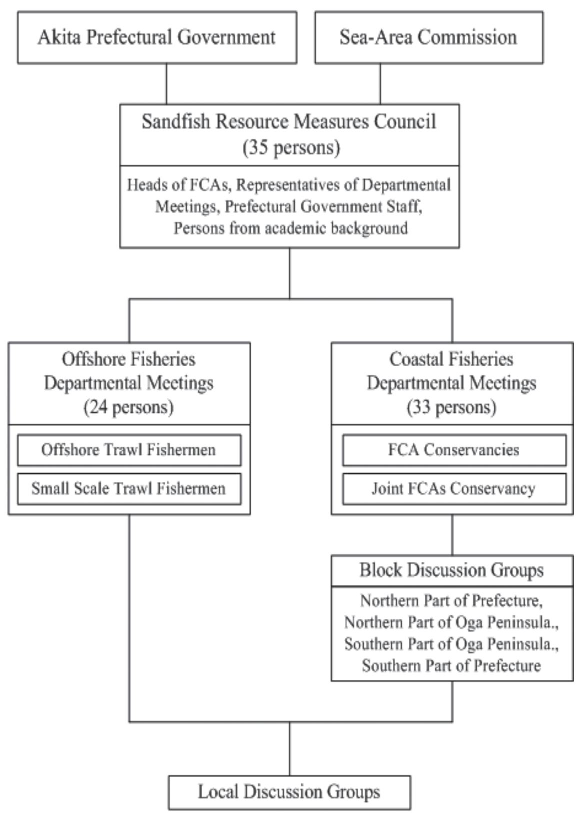


TABLE 2
Self-imposed measures implemented by SRMC after moratorium

Offshore sector	Coastal sector
	Vessel size (length)
Minimum fish size (length)	Season closure
Season closure	TAC
TAC	No-fishing zone
No fishing day	Mesh size enlargement
Number of operating vessels	Gill and set nets reduction
Fishing hours	Gear control
	Fishing effort coordination

in this case was effective in circumventing this obstacle and bringing the two sides together.

The SRMC opted for post-moratorium regulations that controled both inputs and outputs (Table 2). The reduction in the number of boats and modifications to fishing gear, such as enlarging the size of the nets' mesh, were among the new resource management measures aimed at reducing fishing effort. As mentioned in Section 3, these effort reduction measures were based on fishers' inputs, coupled with recommendations from local government and were decided at the SRMC. At the same time, the SRMC agreed to implement a total allowable catch system, ultimately administered by the central government, to limit overall harvest levels. Its target was to lower the catch rate, defined as the ratio of harvest to estimated biomass, from 0.8 to 0.5. The TAC limit was set at half of the estimated biomass (stock level) of sandfish.

Although the overall TAC level was set by the government, the details of how the system was administered at the local level varied with the FCA. Government intervention in the TAC system consisted of setting the catch/biomass ratio and the proportion of the total catch allotted to offshore and coastal fishers. Originally divided equally between coastal and offshore fisheries, the allocation ratio was later changed to allot 60 percent of the TAC to the coastal fishery and 40 percent to the offshore fishery. Within each fishery type, a share of the catch is then allocated by the SRMC to individual FCAs based on factors such as the number of registered vessels and its harvest history.

How individual FCAs managed their allotted TACs varied widely. Among the 3 FCAs with offshore fisheries, one FCA opted for collective use of its share while the other two allocated quota to individual vessels. Among the 12 FCAs with coastal fisheries, eight FCAs allowed derby fishing within their shares, three FCAs assigned shares to individual vessels and one FCA opted for collective use of its share. None of the individually allocated shares were transferable. Collective use of the TAC usually took the form of joint fishing operations by some sub-set of fishers. For example, in fixed net fisheries, a minimum number of fishers of four to six (differs by locale) might be required to operate a net. For gill-net fisheries, some FCAs implemented rotation of fishing among fishers, while others implemented rules similar to the fixed net fishery.

The TAC was enforced at each FCA level. That is, if an FCA reached its allotted TAC, all fishers in that FCA were required to terminate their operations for that year. There were cases where the total TAC was not reached, while several FCAs reached their limits. Table 3 shows the allocated TACs and actual harvest volume during the first year of post-moratorium (i.e. 1995). Some FCAs, for example Northern Akita and Funakawa Port, did not reach their TAC while the Oga City and Southern Akita FCAs exceeded theirs by more than 50 percent. Also, in terms of offshore and coastal sandfish fisheries, the former only caught 63 percent of its allocated TAC and the latter over-harvested slightly in taking 104 percent of TAC. Overall, the actual catch was 83 percent of the total TAC that year (Table 4).

The effect of the TAC system on stock recovery seems to have been largely successful. In 1995, when the sandfish fishery reopened, the TAC was set at 170 t and was allocated to coastal and offshore fisheries at 85 t each. The actual harvest was 142.5 t – coastal fishers caught 88.7 t and offshore fishers caught 53.8 t (Table 4). As the stocks increased, so did offshore harvest volumes. To accommodate the change, the prefectural government discontinued its equal distribution of the quota to coastal and offshore fisheries in 1999. In subsequent years, estimates of the sandfish biomass

TABLE 3
TAC allocation among FCAs and between offshore and coastal fisheries in 1995

Name of FCAs	Offshore fisheries			Coastal fisheries		
	Quota (t)	Catch (t)	Results (%)	Quota (t)	Catch (t)	Results (%)
Northern Akita	23.9	10.1	42.3	32.0	20.6	64.4
Noishi	-	-	-	3.0	2.0	66.7
Oga-City	-	-	-	36.0	55.8	155.0
Funakawa Port	14.4	9.6	66.7	2.0	0.8	40.0
Southern Akita	46.7	34.1	73.0	5.0	8.0	160.0
Others (7 FCAs)	-	-	-	7.0	1.5	21.4
Total	85.0	53.8	63.3	85.0	88.7	104.4

Source: Akita Prefectural Fisheries Research and Management Center (2006).

increased from 360 t in 1995 to 5 100 t in 2005 and the TAC was increased accordingly, from 170 t in 1995 to 2 500 t in 2005.

The last post-moratorium measure was to bring neighbouring prefectures into Akita's management efforts. As previously mentioned, Akita fishers harvest a sandfish stock that migrates from Aomori to Niigata prefecture. If the sandfish resource is to be managed effectively, cooperation among all four prefectures (Akita, Aomori, Yamagata and Niigata) that target the same stock is necessary. Akita fishers began advocating for cooperation with the other prefectures before the moratorium was implemented. Finally, on 29 March 1999, FCAs in the four prefectures concluded "The Agreement of Sandfish Resource Management" for the northern Sea of Japan under the supervision of the central government's Fisheries Agency. However, the extent of cooperative management has been limited. The four prefectures, for example, only agreed to a minimum fish length harvest size of 15 cm.

5. UNDERSTANDING THE SANDFISH DECISION MAKING PROCESS

5.1 Challenges

Sandfish management measures had to be comprehensive to succeed. Most, if not all, of the fishing operators involved had to comply and cooperate for the measures to be effective. At a minimum, all 733 sandfish fishers in Akita prefecture had to be involved. Ideally, fishers in all four of the prefectures that target the same stock would take part in a collective management effort. The trade-off in participatory fishery management is between its potential effectiveness and the increased transaction costs associated with

TABLE 4
Changes in sandfish harvests

Year	Offshore fisheries			Coastal fisheries			Total		
	Quota (t)	Catch (t)	Results (%)	Quota (t)	Catch (t)	Results (%)	Quota (t)	Catch (t)	Results (%)
1991	-	55.5	-	-	16.6	-	-	72.1	-
1995	85	53.8	63.3	85	88.7	104.4	170	142.5	83.8
1996	110	86.1	78.3	110	157.2	142.9	220	243.3	110.6
1997	180	161.2	89.6	180	290.8	161.6	360	452.0	125.6
1998	300	178.4	59.5	300	436.8	145.6	600	615.2	102.5
1999	400	143.0	35.8	600	579.1	96.5	1 000	722.1	72.2
2000	400	265.7	66.4	600	901.8	150.3	1 000	1 167.5	116.7
2001	520	547.8	105.3	780	986.2	126.4	1 300	1 534.0	118.0
2002	680	380.1	55.9	1 020	1 570.1	153.9	1 700	1 950.2	114,7
2003	960	903.9	94.2	1 440	2 058.6	143.0	2 400	2 962.5	123.4
2004	1 000	787. 7	78.8	1 500	2 348.7	156.6	2 500	3 136.4	125.5
2005	1 000	488.2	48.8	1 500	1 866.6	124.4	2 500	2 354.8	94.2

Source: Akita Prefectural Fisheries Research and Management Center (2006).
Figures are in calendar year for 1991–97 and in fishing season (September to following June) for 1998–2005 (e.g., "1998" refers to September 1998–June 1999).

establishing such a regime. The higher cost can result from the involvement of many fishing groups that have conflicting interests and agendas.

The high transaction cost generated by participatory fishery management when the number of fishers is large calls for intervention by the government and/or outside experts. However, such intervention, if done in a top-down manner, is no different in practice from conventional regulation and thus is likely to fail. This was the case when Akita's prefectural government first attempted to impose a moratorium in 1986 through the APFRC (see Section 2.2). The important question is how the government should intervene to avoid disenfranchising fishers and consequently destroying their willingness to manage the resource. The sandfish fishery co-management case offers three general lessons.

5.2 Participatory procedures and consensus-building

The first lesson from Akita's experience is that fishers must be involved in the entire process of planning, negotiating and executing the management measures. Such participatory procedures often require a greater investment of time and consensus among all the stakeholders is essential to their acceptance of the resulting measures as legitimate actions.

This participatory process is much easier said than done. While one can attempt to create an institution for such processes, another option is to use an existing process. In the Akita sandfish case, that process is called *yoriai*, which means "gathering" and it is one of Japan's traditional decision-making styles. Yoriai is a typical form of neighbourhood meeting and occurs in many parts of rural Japan today. An interesting characteristic of yoriai is that it is not a venue for discussion, but rather a place to allow each and every member to express their views on items on the agenda, i.e. a place to exchange and present each member's view to others. The discussions take place outside of yoriai in the form of informal communications. Yoriai is repeated, along with the informal discussions in between, until unanimous agreement is reached.

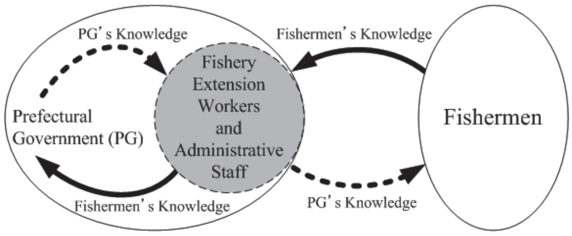
The Sandfish Resource Measures Council (SRMC) and its local discussion groups (Figure 5) were administered in a yoriai style. For example, representatives in discussion groups came from a geographic area typical of participants in a yoriai (Suenaga, 2000). Through participation in local discussion groups and opportunities to express their opinions about items on the agenda, fishers gained a sense of involvement in the decisions made. That sense of satisfaction, even when it was subtly felt, played an important role in the consensus-building process. In the end, the SRMC successfully facilitated consensus-building among the Akita fishers as they forged a resource management plan by ensuring that the fishers affected by it were leading the process.

5.3 Avoidance of overdependence on government intervention

The second lesson from the Akita sandfish case is to avoid letting fishers become overly dependent on government intervention. For example, sandfish fishers received support, but not compensation, from the prefectural and central governments during the moratorium. It is not just that government spending on them was labelled as "support" or that it would have been labelled as "compensation" had the moratorium been imposed by the government. The level of assistance provided had a subtle but important impact on fishery co-management. Had the government given financial compensation – essentially a gift – to fishers when they asked for it, the fishers could have come to depend on government money and stopped putting their own efforts into fishery co-management. Instead, the government provided no-interest loans to fishing operators affected by the moratorium. The loans helped the Akita fishers by supplementing their incomes during the moratorium, but because they had to repay the loans, they remained focused on creating a sandfish management plan that would generate enough income to make repayment possible.

Government took other steps to support the process. For example, the prefectural government held informational conferences and meetings 150 times or more during and after the moratorium period. The labour and associated costs incurred by the prefectural government for the meetings were substantial. In addition, the prefectural government managed tasks such as press reports. These organizational costs are often not obvious to the public, but these government investments are important support for co-management.

FIGURE 4
Structure of interpretation of knowledge



Source: Adapted from Suenaga (2002, p. 53; 2004, p. 8)

5.4 The role and importance of scientific knowledge

The sandfish case demonstrates that scientific research is indispensable in establishing and maintaining a participatory fishery management regime. In the case of Akita's co-management of sandfish, a forecast-simulation model was used in designing the management measures. Fishers witnessed that the simulation results presented prior to the moratorium (e.g. Figure 4) quite accurately predicted how sandfish resources would respond. The process not only improved the fishers' trust in the research but also allowed them to recognize the importance of resource management.

That said, explaining complex scientific knowledge to fishers, let alone ensuring that they understand it, is no easy task. Without such translation of the knowledge, trust cannot develop and no fisher would seriously consider the knowledge as valuable. Government administrative staffs and fishery extension workers (including scientists), who have the most frequent contact with fishers, played an important role in this respect. The roles played by administrative staff members and fishery extension workers exceeded the typical roles of "bridge" and "liaison". (In the communication studies literature, Rogers and Agarwala-Rogers [1976] illustrate the role of a person acting as a *bridge* in which the person belongs to a certain *clique* and facilitates human networks and connections between cliques. There also can be persons who act as *liaisons* and serve to connect cliques, but a liaison does not belong to one of the cliques [Schwartz, 1977].) Administrative staff members and fishery extension workers did more than simply bridge the gap between fishers' knowledge and the prefectural government's knowledge. They also interpreted the knowledge through dialogue with the fishers (Figure 4). Administrative staff members attended most of the conferences and meetings of local fisher groups and patiently explained relevant scientific knowledge. Fishery extension workers used their closer relationships with fishers to follow up on the fishers' understanding of the knowledge presented by the administrative staff. The two typically played a complementary role in the relationship between fishers and the administration.

6. CONCLUSION

This chapter described the case of fishery co-management of sandfish in the Akita prefecture and the highly publicized moratorium on harvesting. Akita's sandfish fishery co-management experience provides several valuable lessons about fishery management regimes for migratory fish species. The transaction costs of establishing an effective self-management regime are inevitably high, not only because of the sheer number of stakeholders but also because there will always be conflicts of interest among them. Establishing such a participatory fishery co-management regime is inherently difficult and therefore calls for involvement by the government.

In Akita's sandfish fishery, involvement of the prefectural government was an important factor. As a consequence, this case is best described as co-management rather than self-management. Note, however, that a system in which the government took the lead would in principle be no different from traditional 'command-and-control' regulatory regimes. The leading role was always kept in the hands of fishers and their organizations, but at the same time government intervened to foster self-management when necessary, as was the case of separating coastal and offshore fishers in the SRMC (see Section 4). What is special about this case is the delicate balance struck between government intervention and self-management by fishers, which prevented fishers affected by the plan from becoming dependent on government.

The case of Akita's sandfish measures identifies some elements that are critical for successful co-management. The first is a participatory process of negotiation and consensus-building. Such a process facilitates a sense of ownership of the management effort – as opposed to "being told what to do" by an authority – and generates outcomes that are viewed as legitimate. The second element is a set of government policies that facilitate fishers' independence. One example previously noted is the system of no-interest loans that required fishers to repay the money. Government also intervened at a critical point to define a decision-making structure with separate fora for coastal and offshore fishers. Finally, this case demonstrates the value of scientific research in guiding decisions and the importance of interpreting that knowledge into terms fishers can understand.

7. ACKNOWLEDGMENTS

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Sandeel fisheries governance in Ise Bay, Japan

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1. INTRODUCTION

The Japanese sandeel (*Ammodytes personatus* Girard) stock in Ise Bay is one of the most important resources for pelagic pair-trawl fisheries in Aichi and Mie Prefectures. Most valuable in the catch are the sandeel's larvae and juveniles, so harvesting is intensely concentrated on the two or three weeks immediately after the fishing season opens. Nearly 90 percent of annual landings occur during this period (Fisheries Agency, 2006). However, it is also prone to overharvesting. Poor harvests in five consecutive seasons between 1978 and 1982 were attributed to overfishing and to a simultaneous unfavourable natural condition called meandering of the Kuroshio Current. Harvests declined from 14 843 t in 1974 to 2 423 t in 1978 and to a mere 515 t in 1982 (Tomiyama, 2007).

Five years of poor harvests induced sandeel fishers to implement several resource management measures, including setting opening and closing dates of fisheries and establishing marine protected areas. All of the measures were designed and implemented through collaboration between fishers and researchers from local fishery experiment stations. Stocks today are considered to be at high levels. The issue now is the extreme volatility of annual harvests, which have ranged from 915 t in 2000 to 19109 t in 2004 (Tomiyama, 2007). Recent fishery management efforts have focused mainly on creating stability in landings.

Autonomous organizations of fishers in both prefectures play a central role in managing the sandeel fishery. To help these organizations make effective management decisions, scientific information provided by researchers is integrated into the decision-making process. The close collaboration between fishers and researchers has been instrumental in helping fishermen understand the necessity of fishery management, which has led to a sense of ownership of the resource.

2. DESCRIPTION AND HISTORY OF THE SANDEEL FISHERY

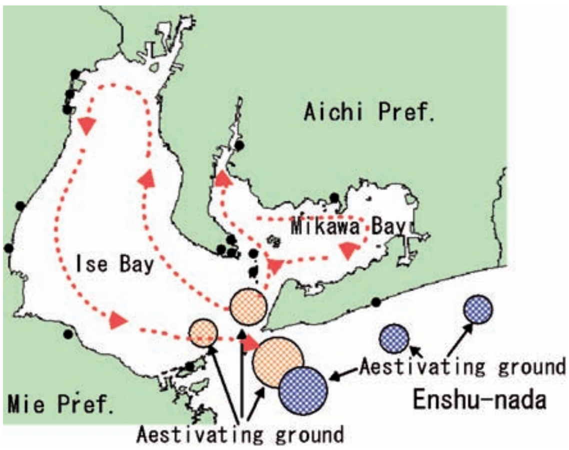
2.1 Ecology of the sandeel

Ise Bay is one of the major fishing grounds for sandeel in Japan. Others are the Tohoku area off northeastern Honshu Island and the Seto Inland Sea of western Honshu Island. Ise Bay occupies the central Pacific coast of Honshu, south of Nagoya between Tokyo and Osaka and is bordered by the prefectures of Aichi and Mie (Figures 1 and 2). The shallow, semi-enclosed bay has a mean depth of 19.5 metres and covers an area of 1 738 km^2. A narrow strait called Irago Channel connects the inner bay to the Pacific Ocean. Ise Bay is a typical estuary that is influenced by relatively large discharges from three major rivers: the Kiso, Nagara and Ibi Rivers all empty into the innermost portion of the bay.

A key characteristic of the Japanese sandeel is aestivation, an event that provides an anchor point for management of the fishery. Aestivation, a state of dormancy similar to hibernation but which occurs during the summer months, begins when the temperature of bottom waters warms to between 17 and 20° C, typically in May. When aestivating, sandeels gather and burrow into bottom substrates (Tomiyama and Yanagibashi, 2004). Their aestivation grounds are widely distributed along the coast of the southern peninsula of Aichi prefecture, where the water is generally between 20 and 50 metres deep (Figure 2). Aestivation ends around November, when the water temperature falls below 15 °C. Maturation begins in November, at the end of the aestivation period. When the water temperature falls below 12° C, usually in mid-December, the sandeels start to spawn in the mouth of Ise Bay (Tomiyama *et al.*, 1999). The sandeel larvae hatch through until the end of December. Currents then bring them into the bay. The number of sandeel juveniles that get transported into the bay, where they are harvested, depends on the direction and intensity of the currents within the bay, which are influenced by intrusions of warm water from the Pacific Ocean (Tomiyama, 2007).

FIGURE 1
Location of Ise Bay and Aichi and Mie prefectures

FIGURE 2
Migration of sandeels from spawning grounds to nursery grounds in Ise and Mikawa Bay



Sandeel larvae are about 3 to 4 millimetres long. By the time they begin to aestivate in May or June, they are 7 to 10 cm long (Hashimoto, 1991). The lifespan of the sandeel is three years and maximum body length is approximately 16 cm (see Figure 6).

2.2 The sandeel fishery in Ise Bay

Sandeels in Ise Bay are harvested using pair trawl nets. An operational unit (a “fleet”) consists of two fishing boats (the pair) and one or two transporting boats (Photo 1). The two fishing boats, each about 15 tonnes, between then haul a single trawl net and both are equipped with a net winch. The transporting boats are also about 15 tonnes. About 200 harvesting units, collectively employing 700 boats from Aichi and Mie prefectures, share the sandeel stock in Ise Bay.

TOMIYAMA, LESAGE, AND KOMATSU (2005)

PHOTO 1
Fishing and transporting boats
The distance between the two fishing boats shown is approximately 100 m.

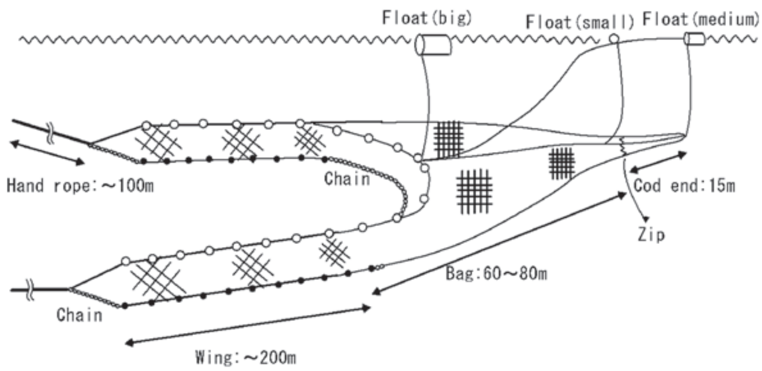
These trawlers can harvest sandeels anywhere in the water column, by adjusting the length of hand ropes and/or the rope attached to a big float (Figure 3). The towing speed is about 1.5 knots. Before deploying the net, all of the boats in a fleet, the transporting boats followed by the two fishing boats, scan for sandeel schools using echo sounder. Fishers can distinguish the species and the size of the school by the school's depth, its shape and the intensity of the echo. Once a school of sandeel is detected, the net is deployed and dragged at that depth.

The trawl net is constructed to allow fishers to quickly haul the catch onboard and redeploy the net. The key structure is the "zip system" on the net's cod end (Figure 3). Using the zipper, the cod end can be removed to open the net and then reattached quickly and easily. This allows them to collect the sandeels without hauling in the entire net. Catches are transferred from the unzipped cod end of the net to plastic baskets containing crushed ice on the deck of the transport boat while the rest of the net remains in the water. As soon as the catch is cleared and the end is reattached, the fishing boats can return to work while the transport delivers the harvest to port.

Landing procedures vary with the size of the fish. Sandeels longer than 5 cm are pumped directly from storage chambers on the transporting boat to a 1-ton container on the dock. Sandeels that are smaller than 5 cm remain in the plastic bins and are transferred by conveyor belt from the boat deck directly to the market floor or to a forklift pallet. All sandeel must be sold through an auction administered by local fishery cooperative associations (FCAs). The price received for the fish depends on its quality, which is determined mainly by size and colour (an indicator of freshness).

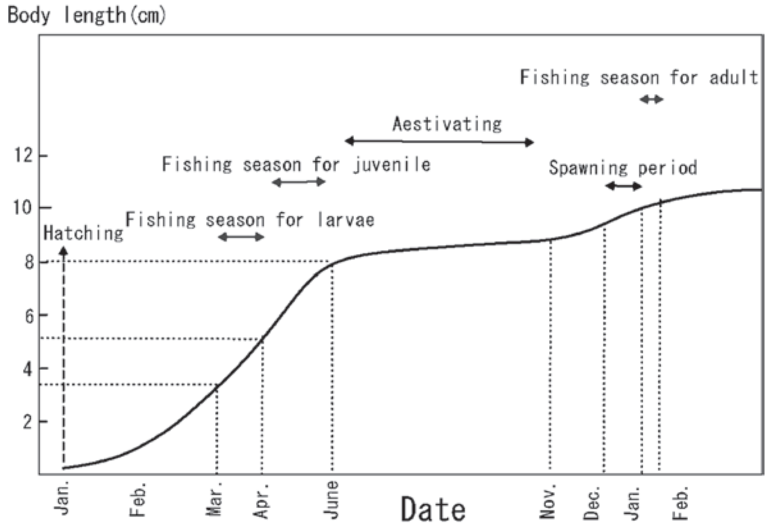
Fishers target three types of sandeels (Figure 4): (a) juveniles with a body size of 3–5 centimetres called *shirasu* (Photo 2a) that are harvested in March and April; (b) juveniles that exceed 6 cm and are harvested in April and May (Photo 2b); and (c), adult

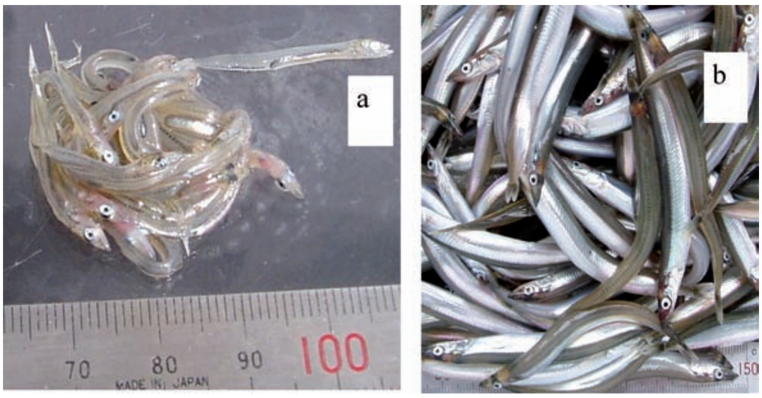
FIGURE 3
Diagram of the pair-boat trawl nets used in sandeel fishing



Source: Tomiyama, Lesage and Komatsu (2005).

FIGURE 4
Growth patterns of the sandeel and related biological and fisheries events





TOMIYAMA, LESAGE, AND KOMATSU (2005)

PHOTO 2
Sandeel (a) larvae (shirasu) and (b) juveniles

fish caught in January and February. In terms of number of fish, more than 90 percent of the catch is *shirasu*. Fishers from Aichi prefecture target sandeel *shirasu* that are then processed for human consumption, while Mie prefecture fishers target larger sandeels (6 to 10 cm in length) that will be frozen and made into fishmeal for aquaculture.

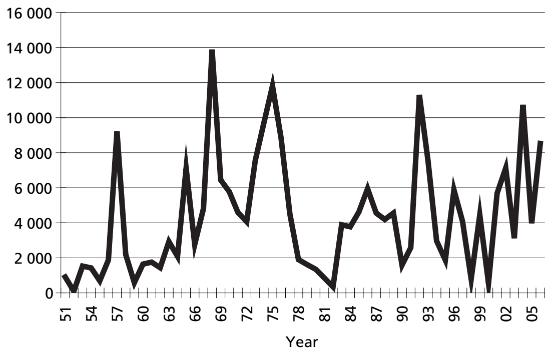
3. DESCRIPTION OF SANDEEL FISHERY MANAGEMENT

3.1 History

In both Mie and Aich, a sandeel fisher must obtain a licence for each fishing boat (but not for transport boats) issued by the prefectural government. Nonetheless, the fishery experienced a boom and bust cycle between late 1960s and early 1980s. Fishing pressure on sandeels intensified in the late 1960s and early 1970s as a result of two factors. One was technological advancement, including enhanced engine power, larger fishing gear and the use of echo sounders. The second factor was an increase in demand for adult sandeels for fishmeal for aquaculture during the 1960s and 1970s (Makino, 2007). As a result of the collapse in 1978-1982, Ise Bay sandeel fishers experienced a paradigm shift toward active involvement in fishery management.

During the period of intensified exploitation, competition among fishers was intense. According to sandeel fishers who participated in hearings conducted by the authors, each fleet endeavoured to catch all of the sandeel in the area as soon as they were located with the echo sounder. Competition was particularly intense near the end of the sandeels' aestivation period (May to November). Since harvesting during aestivation is not allowed, fishers raced out to catch the sandeels as soon as they left their burrows and harvested them before they could spawn. Fishing pressure was particularly concentrated in the area of the spawning grounds, a destructive conservation practice. Fishers were well aware of these facts, but intense competition forced them to disregard considerations of the damage. The price was high and fishers caught as many adults as possible. In 1974, landings exceeded 14 000 t (Tomiyama, 2007).

FIGURE 5
Landing of sandeel in Aichi prefecture



Legends in the figure show implementation of various fishery management measures.
Source: Tomiyama, Lesage, and Komatsu (2005).

The paradigm shift occurred after a drastic decline in stocks. An increasing trend in harvest through 1974 abruptly reversed, and harvest volumes declined quickly. (Figure 5 shows landings from Aichi prefecture only, but gives the general picture). Meandering of the Kuroshio Current also affected the number of sandeels and accelerated the decline. This period of limited harvests lasted from 1978 to 1982. In 1982, the volume landed was a mere 515 t (Tomiyama, 2007).

3.2 Protecting spawners

Current fishery management measures attempt to protect spawning adults (spawners), and to harvest *shirasu* in an economically efficient manner. Specifically, current measures (a) control the opening and closing date for the fishing season and (b), establish marine protected areas.

Protecting spawners allows a necessary level of reproduction. Sandeels spawn shortly after aestivation. The cohort that aestivates for the first time, predominantly one-year-old sandeel adults, spawns. Escapement control is an effective measure to assure the necessary reproduction. Another measure for protecting spawners is a delay in opening the fishery so most adult sandeels have an opportunity to spawn before they are harvested.

Sandeel larvae enter aestivation approximately five months after hatching. They are targeted as *shirasu* immediately prior to aestivation (cf. Photo 2). Since natural mortality during aestivation and during the period between their emergence and spawning is low (about 10 percent), controlling the population of *shirasu* will effectively control the population of spawners. The consensus among researchers is that a minimum escapement of two billion reproductive sandeel adults is necessary for reproduction and recruitment that will ensure sustainable stock levels (Funakoshi, 1997).

Data on the volume of *shirasu* landed is thus important information. In the Ise Bay fishery, data about the number and weight of fish landed at each port and data from fishers on where *shirasu* were harvested are consolidated and analysed at Aichi Fisheries Research Institute. Representatives of fishers' unions are notified when the estimated number of reproductive sandeels drops close to the threshold of two billion, which indicates that fishing for *shirasu* (as well as adults) should soon close. The actual closing date is determined via discussions between fishers in both prefectures: sometimes it is decided quickly over the phone.

After the sandeels enter aestivation, the next decision is when to open the fishing season. Fishers have agreed to delay opening the season until approximately 80 percent of spawning sandeels have actually spawned. Researchers sample adult sandeels using an apparatus called a *karatsuri*, which captures sandeels still burrowed under the sand. The researchers examine the samples and report the results to fishers. The opening date is then discussed and decided jointly by fishers from both prefectures.

3.3 Opening of the *shirasu* fishery

The opening date for the *shirasu* fishery, typically in March or April, is now determined by the sandeels' estimated economic value. Previously, fishers based their decision solely their experience and expectations. The opening date did not always coincide with the best price for the *shirasu*. Researchers have developed a simulation model, the Sandeel Fisheries Management Model, which models the relationships among sandeel size (body length), an opening date for fishing, and the value of the catch over a fishing season. The model estimates values for harvest revenues, costs, and profits based on information on the biological state of the sandeel, potential opening and closing dates for the fishery, and price. According to the model, the optimal size for *shirasu* is around 3.5 cm (it depends on market and resource conditions of the year). Larvae sampling is used to estimate when the juveniles will reach this optimal body size, given annual fluctuations in growth rates. Other environmental data, such as the surface water temperature and intrusion of the current, also are collected. Based on this information, fishers in each prefecture discuss and then select an opening date for *shirasu* fishing. Information on market demand from distributors and processors also is considered. The final decision on an opening date is made at a general assembly meeting attended by fishers from both prefectures.

These measures are effectively a seasonal closure set at both ends of aestivation period. Interestingly, this seasonal closure had a positive side effect. The price of *shirasu* declines as it grows beyond the optimal size of around 3.5 cm, whereas the price of adult sandeel used for fishmeal increases until the fish reaches the body length of 9 cm and plateaus out beyond that length. By closing the fishery for *shirasu* earlier before they are grown too big and delaying the harvest of adult sandeel to allow them grow bigger, fishers can focus their fishing effort when the price level is higher. For these reasons, agreement to implement these management measures was agreed relatively easily by the fishers.

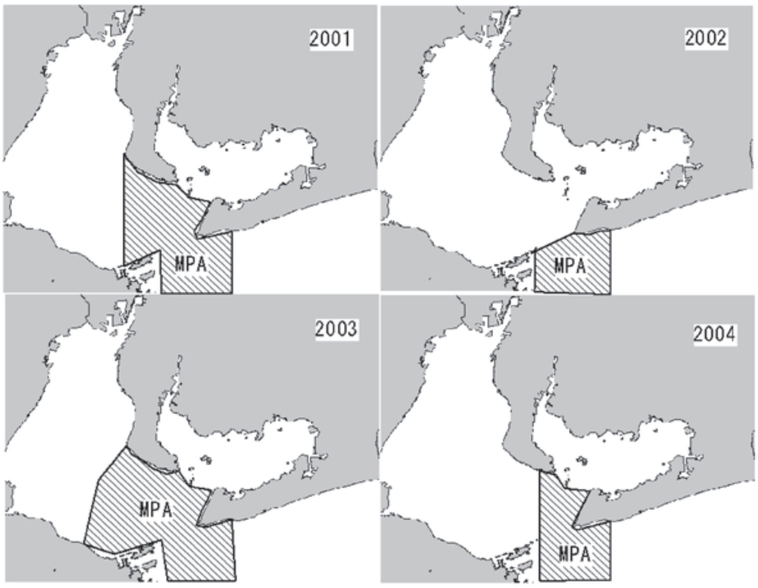
3.4 Marine protected areas

To protect aestivating sandeels, a temporary no-fishing zone is established at the mouth of Ise Bay when the sandeels begin to aestivate there in May and June. As explained, sandeels gradually migrate from the interior of the bay toward the mouth as they mature. The size of the no-fishing zone depends on the size of the stock that year. The smaller the remaining stock, the larger the no-fishing zone established (Figure 6). The location and sizes of the no-fishing zones also vary annually according to ecological information regarding factors such as the distribution of juvenile sandeels in the bay and migration paths to aestivating grounds. All non-sandeel trawl fishers are prohibited from operating within the no-fishing zone until after the sandeels have begun to aestivate, which is determined by surveying at the aestivation grounds in May and June.

3.5 Self-governance institutions

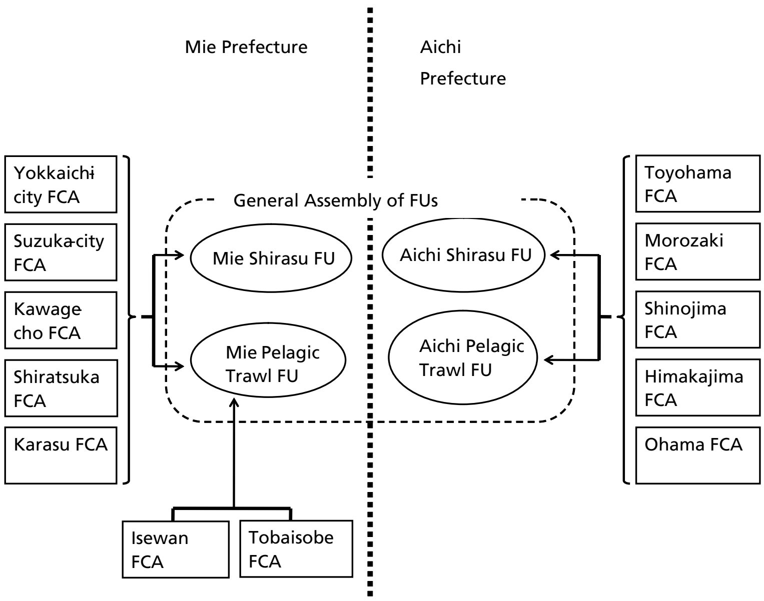
The sandeel stock in Ise Bay is shared and harvested by fishers from both Aichi and Mie prefectures. Management of the sandeel fishery thus requires an inter-prefecture partnership, surpassing the scope of local FCAs and even the borders of the prefectures, to balance the interests of fishers in Aichi and Mie. Fishery management for Ise Bay sandeels has two layers. The bottom layer is the FCAs (seven in Aichi and six in Mie) that operate along the coastline of Ise Bay (cf. Figure 2). Each sandeel fishing operator belongs to an FCA that governs its landings and docking. Atop the

FIGURE 6
Established no-fishing zones for 2001–2004



The area set aside is determined by the size of the remaining stock.
Source: Tomiyama, Lesage, and Komatsu (2005).

FIGURE 7
Organizations of sandeel fishers in Ise Bay



FCAs are four fishers' unions (FUs) (Figure 7): a *shirasu* union in each prefecture (harvesters of juvenile anchovies and sandeels) and a pelagic trawlers' union in each prefecture (for harvesting of adult anchovies, sandeels, and sardines). These four FUs are organized into a single general assembly of the sandeel fishers' unions that meets annually. This framework plays the central role in decision-making in Ise Bay sandeel self-management. Another activity implemented by this framework is the voluntary time limit for operating during the day. The official operating time prescribed in the licence is from sunrise to sunset, but the voluntarily operating time is from 6 a.m. to 10–11 a.m.

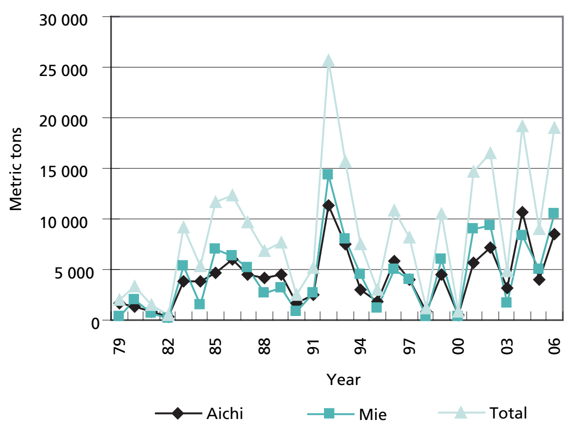
There is no direct cost specific to the licence, which is true for all fishery-related licences. There is an indirect cost, which is a fee one must pay to cover the administration of the local office. This fee applies to all licences and document that are issued, whether they are related to a fishery or something else. This cost is 3150 yen and is thus, an out-of-pocket cost for anyone wishing to obtain a licence: it has no relation to the value of the resource or industry's profitability, etc.

All major fisheries in Japan require either legal access rights to TURFs, which belong to the administrating cooperatives (FCAs). Thus, fishers do not have fishing rights as such but rights of access to undertake fishing. It is equivalent to a license to undertake commercial fishing. Whether the licence is species-specific or gear-specific varies on a case-by-case. In the case of sandeel, a license issued by prefectural governor is required. It may be noted that no fees are imposed on fishing licences issued by the central or local governments. In this particular example, the union is specifically for sandeel fishers. At the lowest local level, the Fishery Cooperative Association (FCA) encompasses all types of fisheries (species and gear-types) that are operated within its jurisdictional TURF. All coastal commercial fishers are members of at least one, though and typically only one, FCA. In the case of sandeel, the fishers have organized an inter-FCA organization specifically for sandeel fishers. Furthermore, these unions are formed by sandeel fishers within each prefecture and these uions are formed into an inter-prefectural organization – the General Assembly.

4. EVALUATION OF SELF-GOVERNANCE INSTITUTIONS

To evaluate self-governance of the Ise Bay sandeel fishery, we present the total landings (by volume and value) for both prefectures, estimated initial stock levels for each year, and the length of the sandeel fishing. The changes between 1979 and 2006 show that, compared to the depleted period 1979–1982, landings have gradually improved, though there are considerable fluctuations (Figure 8). The total harvest by Aichi and Mie prefectures improved from 515 t in 1982 to 19 109 t in 2004 and to 19 073 t in 2006. Although the two prefectures target different sizes of sandeels, the pattern of fluctuations is nearly identical. The landed value (in real [2006] terms) also has improved. The value rose from US$2.1 million in 1982 to US$15 million in 2004 and to US$12 million in 2006 (Figure 9).[1]

FIGURE 8
Landings of sandeel in Ise Bay



Source: Tomiyama, Lesage, and Komatsu (2005).

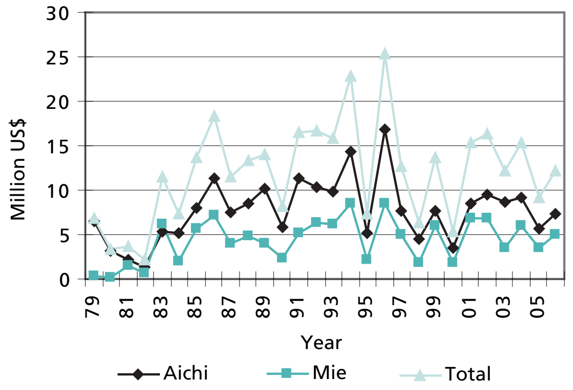
Estimated annual initial stock levels between 1979 and 2006 also show gradual improvement, although there are considerable annual fluctuations (Figure 10). The average number (count) of sandeel increased from 4.8 billion for 1979 through 1982 to 34.2 billion for 2003 through 2006. The length of the fishing season for sandeel has been extended from an average of 64.8 days during the depleted period (1979–1982) to an average of 149.5 days for 2003 through 2006 (Figure11). Despite an extended harvesting period, stocks at the beginning of the subsequent season have shown increases.

The longer fishing season is important to the timing of switching to other fisheries. Many sandeel fishers convert to the sardine

[1] An exchange rate of 118 Japanese yen to one US dollar is used throughout this paper.

fishery (both targeting larvae, also called *shirasu,* and adults) in May or June. But the sardine opening day varies greatly from year-to-year, and it is impossible to predict at the beginning of the sandeel-*shirasu* season. If the sandeel fishery ends too early, fleets remain idle until the sardine fishery opens. Fishers favour year-round operations and therefore prefer to minimize the idle period between the two fisheries. The profitability of pelagic trawl fishery has declined in recent years, and fishers are paying more attention to efficient operation throughout the year over multiple fisheries.

FIGURE 9
Landing value (in real [2006] terms) for sandeel in Ise Bay



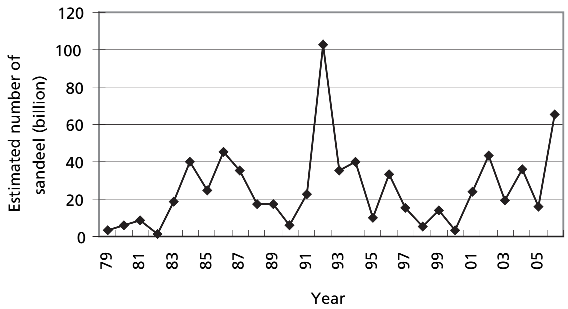
Converted to base year of 2006 using the producers price index.
Source: Tomiyama, Lesage, and Komatsu (2005).

5. DISCUSSION

Ise Bay's measures to protect sandeels are a good example of effective fishery co-management in Japan. Voluntary organizations of fishers from Aichi and Mie prefectures play the central role in managing the sandeel stock in Ise Bay. Through regular meetings that address issues such as when to open and close fishing, fishers from both prefectures have interacted and built trust. This has served to increase the legitimacy of decisions. This trust and sense of legitimacy have led to very strong compliance with virtually no enforcement costs to the government. The leaders of these organizations recognize that the sustainability of their management regime and that of sandeel resource are indispensable.

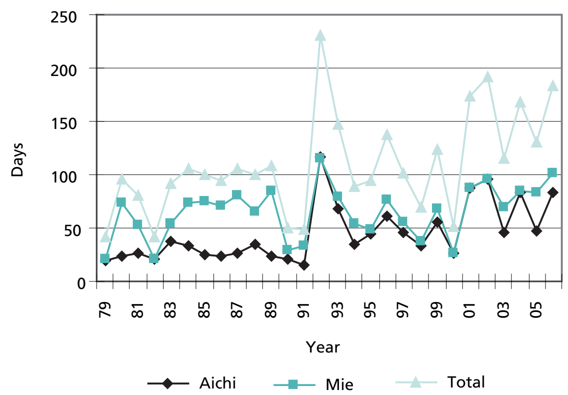
The management measures are strongly supported by data collected and analysed by the fisheries research institute in each prefecture. Self-management by fishers is motivated by their understanding of the necessity of resource management. The paradigm shift was induced by the collapse of the sandeel fishery. For self-governance to endure, a deeper understanding of the ecology of the targeted species and an ability to adjust management measures accordingly is an essential component. Collaboration and frequent communication between researchers and fishers are the keys to achieving sustainable self-governance.

FIGURE 10
Estimated initial stock levels for sandeels in Ise Bay



Source: Tomiyama, Lesage, and Komatsu (2005).

FIGURE 11
Length of the fishing season for sandeels (days)



Source: Tomiyama, Lesage, and Komatsu (2005).

6. ACKNOWLEDGEMENTS

We thank Dr. Funakoshi and Claire-Marine Lesage for providing us with valuable information about the sandeel fishery in Ise Bay.

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Marine protected areas for the snow crab bottom fishery off Kyoto Prefecture, Japan

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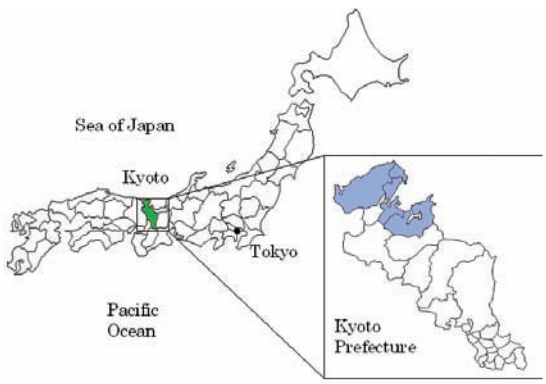
1. INTRODUCTION

Kyoto Prefecture is located on the northern side of central Japan and has about 320 km of coastline facing the Sea of Japan (Figure 1). There are many coastal and near-shore fisheries in the region, including set net (for sardine, yellowtail, red sea bream and squid), pole and line or long line (for red sea bream, bastard halibut, black rockfish and squid), gill net (for flat fish, prawn, blue crab and yellowtail), gathering and collecting (for abalone, turban shell and sea mustard [*wakame*]) and aquaculture (of yellowtail, red sea bream, bastard halibut and oysters and pearls). There are also offshore fisheries, such as purse seine (for sardines, horse mackerel and mackerel) and bottom trawling (for snow crab, brown sole, deep-sea smelt and northern shrimp).

This chapter focuses on management of Kyoto's offshore bottom trawl fishery. In 2005, bottom trawling was the second largest fishery sector in Kyoto prefecture. With fifteen vessels and six or seven crew members on each vessel, the trawlers harvested 437 tonnes of fish valued at US$3.4 million (National Federation of Bottom Trawlers' Unions, 2006). (An exchange rate of 118 Japanese yen per US$, the rate in March 2007, is used throughout this chapter.) The most important species for this fishery is snow crab (*Chionoecetes opilio*). Because of overfishing, catches of snow crab in the region declined dramatically, from 369 t in 1964 to 58 t in 1980. In an effort to restore snow crab stocks and generate more value, the organization of local fishers introduced various management measures. Specifically, a combination of permanent and seasonal marine protected areas (MPAs) were introduced as marine reserves or no-take zones and have been expanded since 1983. Permanent MPAs are meant to provide sanctuaries for snow crabs from fishing and were established around the snow crab's critical habitats. Seasonal MPAs are aimed mainly at avoiding bycatches of low-value crabs. Kyoto prefecture government supported these activities with funding and scientific research and advice. As a result, landing volumes increased from 58 t in 1980 to 195 t in 1999 and the total value produced rose from $914 500 in 1980 to $3 578 000 in 2001 (National Federation of Bottom Trawlers' Unions, 2006).

FIGURE 1
Map of Japan and Kyoto prefecture



2. DESCRIPTION AND HISTORY OF SNOW CRAB FISHERIES

2.1 History of the bottom trawler fishery in Kyoto

Exploitation of snow crab in Kyoto dates back several hundred years. Local records indicate that seine fishing from hand-powered boats started in the area around the end of the Heian era (mid-twelfth century). In the 14th through the 16th century, seine fishing targeted sea bream, smelt, goosefish, goatfish and flat fish. In the Meiji era (the late 19th century), the fishing grounds off Kyoto were expanded to about ten nautical miles from the coast and provided flat fish, deep-sea smelt, cod and snow crab (Kyoto Bottom Trawlers' Union, 1994). In 1919, powered vessels were introduced in the area. Vessel size and engine power increased rapidly, as did the area fished by these vessels. This increase in capacity and area fished led to conflicts among various groups of fishers. All fishers were members of a local fisheries cooperative association (FCA), but the FCA could not respond to the dramatic change in fishery technology. Overcapacity became a chronic problem for Kyoto's bottom trawler industry.

To address the overcapacity, the central government introduced a boat licensing system for bottom trawling in 1922. The government also prohibited bottom trawling in near-shore grounds to avoid inter-gear conflicts. However, the licence system failed to reduce capacity and bottom trawling vessels continued to grow in size and number. By 1930, bottom trawlers were landing more than one-fourth of the total fish harvested in Kyoto, which intensified the conflicts with other fisheries. Because of this continuing and intensifying conflict, the central government introduced a 60 percent capacity-reduction plan for Kyoto's bottom-trawling vessels in 1937. The plan proved to be effective – fishing capacity dropped dramatically after its introduction.

The restrictions on bottom trawler fishing were temporarily relaxed when World War II began in 1941. The central government wanted to enhance food production and secure its supply. Bottom trawler production reached a record high of 3 887 t in 1942. The Kyoto Bottom Trawlers' Union was founded in 1944 to further increase bottom trawlers' harvests. An organization that today is responsible for conservatory fishery management was originally established to further exploit the resource. The union is composed of local bottom-trawling fishers and has played the central role in fisheries governance in the area. Today, there are fifteen bottom-trawler vessels operating in Kyoto, all members of the union. They operate along the 200–350 metre contour, targeting snow crab, brown sole, deep-sea smelt and northern shrimp (Photo 1).

2.2 Ecology of the snow crab

Snow crabs (Photo 2) spawn between early February and late April with a peak in March. After three larval stages, larvae settle to the bottom and metamorphose into the first benthic stage in June (Kon, Adachi and Suzuki, 2003). They moult repeatedly as they mature in September and October. Female crabs moult eleven times over the course of seven or eight years and are mature and reproductive following the terminal moult. Once they are adults, they inhabit a depth of about 240 metres. When a female snow crab spawns depends on its maturity. Females may spawn for the first time spawn in September (these are called primiparous females) while the other females (called

PHOTO 1
Kyoto trawling vessel (less than fifteen gross tons)

KYOTO INSTITUTE OF OCEANIC AND FISHERY SCIENCE

PHOTO 2
Snow crab: female (top) and male

KYOTO INSTITUTE OF OCEANIC AND FISHERY SCIENCE

multiparous females) spawn in March. Male crabs mature a year earlier than females and complete only nine moults before being considered adults. However, they do not mate until they complete the terminal moult, which varies individually and can be anywhere between the eleventh and sixteenth moult. Paul (2000) gives more details on snow crab biology.

Snow crabs migrate between depths as they mature and also during the mating season. Males and females inhabit the same depth until the width of their carapaces reaches about 8 cm. After that, only male crabs move to water that is 260 metres or deeper. During the mating season, males and females come together at a depth of 220 to 290 metres and this most frequently occurs at around 270 metres (Yamasaki, 1994).

2.3 The snow crab fishery

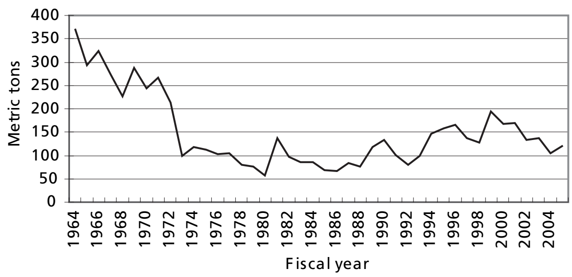
Snow crabs are harvested using bottom trawlers. In Kyoto, two classes of such trawlers, defined by gross tonnage (GT), operate. Small-scale trawlers, of less than 15 gross tonnes, predominate, comprising thirteen of the fifteen vessels. The other two vessels are of 20 GT and are hereafter referred to as offshore trawlers. Both classes of vessels fish offshore in waters 100 to 350 metres deep. The Kyoto Prefecture Fishery Coordinating Regulation sets the official season for bottom-trawler fishing as 1 September to 31 May.

Harvests of Kyoto's snow crab have followed a typical boom and bust cycle during the last few decades. The largest harvest volume of 369 t was recorded in 1964. Landings declined dramatically afterwards, to less than 100 t in the late 1970s and 58 t in 1980. Overfishing was said to be the cause of the decline. Various resource–recovery measures by the Kyoto Bottom Trawlers' Union were introduced beginning in 1983. Landings recovered to 195 t in 1999 (Figure 2). Currently, snow crab makes up about 30 percent by volume and 60–70 percent in value of the total catch from bottom trawling in Kyoto. In fiscal year 2005, snow crab production was 120 t with value at $2.4 million (Figures 2 and 3).

2.4 Markets for snow crab

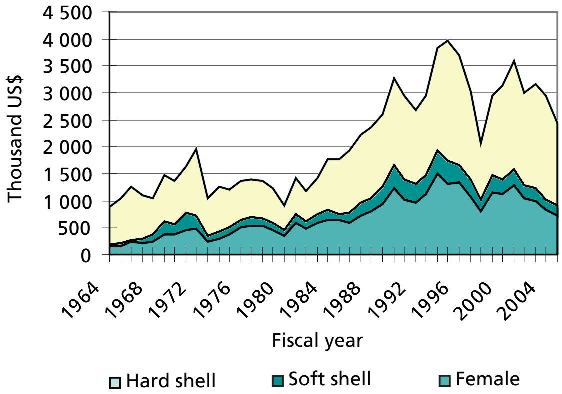
Snow crab is classified into three commercial types: hard-shelled crab (males harvested more than a year after their last moult, which earn the highest price), soft-shelled crab (males harvested less than a year after the last moult, which earn the lowest price because the meat is soft and thin) and female crabs (which earn a medium price). The average price per kilogram in Kyoto's ex-vessel market in 2005 was $61.65 for hard-shelled crab, $5.60 for soft-shelled crab and $11.40

FIGURE 2
Snow crab landings in Kyoto prefecture, 1964–2005



Data Source: National Federation of Bottom Trawlers' Unions, 2006

FIGURE 3
Changes in snow crab real yields in Kyoto prefecture, 1964–2005



Data Source: National Federation of Bottom Trawlers' Unions, 2006

for females (National Federation of Bottom Trawlers' Unions, 2006). Therefore, it is important, ecologically and economically, to preserve the female and young soft-shelled crabs and concentrate fishing efforts selectively on hard-shelled crabs. The efforts of the Kyoto Bottom Trawlers' Union to enhance stock levels and deter catches of female and soft-shelled crabs are discussed in Section 3.2.

3. REGULATORY HISTORY OF THE FISHERY

3.1 Legal frameworks for bottom trawler fishing

The formal regulations for snow crab fishing in Kyoto have four components: (a) total fishing capacity (the number of vessels), (b) length of the fishing season, (c) minimum sizes for crabs harvested and (d), limits on total harvest volumes. Total fishing capacity is managed and restricted by the Ministry of Agriculture, Forestry and Fisheries. The regulation is two-tiered for small-scale trawlers. First, the total number of licences granted nationwide to operate any trawler is prescribed and allocated to each prefecture by the ministry. If a licensed small-scale trawler owner decides to fish for snow crab, the owner must obtain a second permit from the ministry specifically for harvesting snow crab. Offshore trawlers, on the other hand, are simply licensed directly by the ministry.

The season for snow crab fishing is regulated by ministerial ordinances. Male snow crabs can be caught from 6 November to 20 March and the minimum carapace width allowed for harvest is 9 cm. Female snow crabs can be caught from 6 November to 20 January and are not limited by size.

The amount of snow crab that can be harvested is regulated by a total allowable catch (TAC) system that provides for the full utilization of the sustainable harvest and was implemented in 1997. The TAC for snow crab is administered both at the ministry (national) and at the prefectural level. For the 2006–07 season (from July to the following June), the national catch allowed was 7 113 t. Kyoto snow crab fishermen were allowed to tap two allocated TACs: the ministry allocation of 4 523 t to the entire western Sea of Japan region and the prefectural allocation of 130 t.

No fees are imposed on fishing licences that are issued by the government, either at the central or local level.

3.2 Bottom trawlers' self-imposed measures

3.2.1 Marine protected areas

In addition to the formal regulatory frameworks, a range of informal regulations has been implemented to protect snow crab resources and generate more value. The most important measure is the creation of marine protected areas (MPAs). The MPAs for snow crab in Kyoto consist of permanent marine reserves (no-take zones) and areas in which there are voluntary restraints on operations in spring and autumn.

The permanent marine reserves are intended to provide perpetual sanctuaries from fishing and henceforth called a "marine reserve". Since 1983, local trawler fishers have successively established six marine reserves within the snow crab's critical habitats, including its spawning grounds, based on scientific advice from the Kyoto Institute of Oceanic and Fishery Science, a prefectural research station (Yamasaki and Kuwahara, 1989; Yamasaki, 2002). Concrete blocks that are 3 m in length on each side have been sunk to the

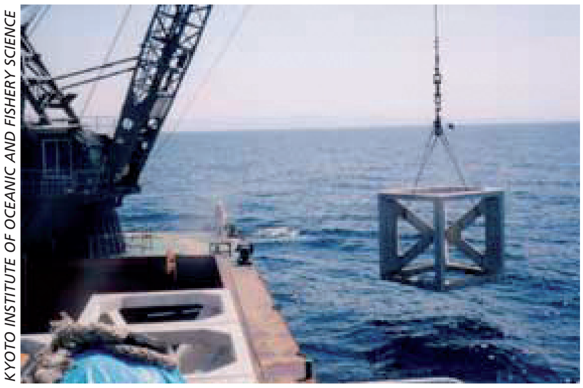


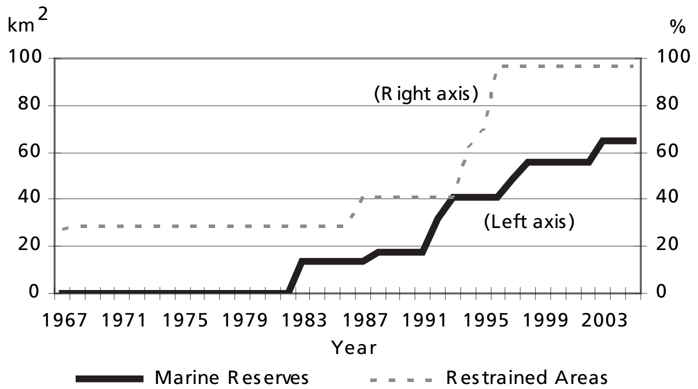
PHOTO 3
Concrete blocks sunk in the marine reserves

PHOTO 4
Bycatch of snow crabs on a trawler's deck and targeted species in fish trays

bottom at a density of 3.8 blocks per km^2 (Photo 3) to ensure that trawlers are completely excluded from these areas. The cost of the blocks was paid by both the prefectural and the central governments. As of 2005, the total area of the marine reserves was 64.7 km^2, which corresponds to about 19 percent of the snow crab fishing ground for Kyoto bottom trawlers (Figure 4). Also, construction began on an additional 3.1 km^2 in 2006.

The second type of MPA is a voluntary restraint on all trawler operations in certain areas, henceforth called a "restrained area". The fishing season for bottom trawlers is 1 September – 31 May, while snow crab fishing occurs only in winter months (from early November until the end of March). During the spring and autumn months, bottom trawler fishing targets other species, such as brown sole, deep-sea smelt and northern shrimp. However, since brown sole and snow crab share the same habitat, bycatch of snow crabs during fishing for brown sole is inevitable (Photo 4). These crab cannot be sold and must be released. The survival rate for the returned crabs is low, particularly for young and soft-shelled crabs. Yamasaki and Kuwahara (1991) estimate that about 45–60 percent of the initial snow crab stocks each year have been destroyed by this discarding required by the regulations. The only way to prevent the snow crabs from being harvested is to prohibit trawling for any kind of fish in those waters.

FIGURE 4
Expansion of established MPAs off the coast of Kyoto



"Marine Reserves" indicate the total area (km^2) of the no-take zones. "Restrained Areas" is the ratio (%) of the fishing-restrained area to the total snow crab fishing ground.
Source: Marine reserve data from the Office of Fisheries of the Department of Agriculture, Forestry and Fisheries in Kyoto. Data on restrained areas generated by the author from agreements from the Kyoto Bottom Trawlers' Union.

TABLE 1
Voluntary shortening of fishing seasons for snow crab

Class of crab	Formal fishing season based on Ministerial Ordinances	Voluntary Agreement
Hard-shelled crab	6 November through 20 March	Same
Soft-shelled crab	6 November through 20 March	11 January through 20 March
Female crab	6 November through 20 January	6 November through 10 January

Restrained areas are intended to prevent the bycatch of soft-shelled crab in spring and fall. Based on agreements among the bottom trawler operators, fishing within the snow crab's habitat (deeper than 200 metres) is restrained on a voluntary basis. Today, about 97 percent of the trawling ground is protected in spring and fall (Figure 4). The restraint is lifted when the snow crab season begins in winter.

The MPAs also generated some spillover effects. For example, the reduction of fishing pressure in the snow crab habitat during spring and autumn led to an increase in product quality, not only for the snow crab but also for other species living in those areas, including brown sole and deep-sea smelt. This increased the total profits of bottom trawler operators more than proportionally to total catch. This suggests that MPAs can provide a wide range of benefits that are not limited to the targeted species.

3.2.2 *Other self-imposed measures*

Several other measures have been implemented on a voluntary basis. Further reductions in the fishing seasons were agreed to for soft-shelled and female crabs (Table 1). A stricter minimum size (for soft-shelled crabs of 10 cm, above the 9 cm regulatory limit), was voluntarily adopted. The size of the trawl net mesh has been incrementally enlarged through agreement. Beginning in 2003, a new technology called the crab exclusion system was introduced to the nets to prevent the bycatch of snow crabs in spring and autumn. While dragging the trawl net, the crab bycatch is automatically passed out through the separator panel at the bottom of the net. This device helps to not only conserve snow crab resources, but also to increase the quality of targeted species by reducing bruises and scars caused by shells of crabs. Also, there is a self-imposed maximum catch limit per fishing trip. For example, catch limits per fishing day are 6 000 individuals for female crabs and 1 000 for soft-shelled crabs.

In recent years, snow crabs from Canada, Russia and North Korea have been sold in the market at much lower prices than domestically caught snow crab. As it is practically impossible for consumers to distinguish between the different sources, the influx of cheap imported snow crab has been a threat to Japanese fishermen. Japanese bottom trawlers responded by identifying their product in the market as domestically produced using a plastic tag. The tag for Japanese snow crab is now widely used by fishers and producers for crabs harvested from the western part of the Sea of Japan.

4. PROCESS OF DEVELOPING MPAS

Management of the snow crab fishery in Kyoto is typical of fisheries management in Japan, whereby the resource users make management decisions. The principal decision-maker for snow crab is the Kyoto Bottom Trawlers' Union. All of the bottom trawler operators in Kyoto belong to this union. Participation in this union has facilitated development of mutual trust among those involved over generations.

MPAs have generated positive results for Kyoto's snow crab fishery and for bottom trawler fishers in general, but a question remains: How did fishers come to an agreement to implement this measure? There are two primary answers to this question: a good choice of location at the beginning and an adaptive decision-making process.

When a local researcher first proposed the establishment of MPAs, many fishers strongly opposed the idea. Consequently, the locations first proposed for marine reserves were waters in which the snow crab stocks were already heavily depleted. Among the proposed depleted areas, however, the prefectural research centre found one location that was biologically meaningful – a spawning area – and suggested in 1983 that it be the first MPA site, to which trawlers agreed. The economic impact for trawlers created by the first marine reserve was minimal. Its location turned out to be a good choice, since it was an area that was overfished but biologically important (Sanchirico and Wilen, 2001).

Under the adaptive decision-making process, MPAs were not implemented in their current scale in the beginning. Rather, marine reserves were first implemented on a small scale as an experiment and the bottom trawlers monitored their impact. This trial learning period lasted from 1983 until 1987. The voluntary restrained area followed a similar pattern – it was expanded only slightly in 1988 as part of the trial period. Once the effectiveness of the first marine reserve was recognized by the fishers, they played a proactive role in setting aside additional marine reserves and by abiding by the voluntary restrictions in spring and autumn. Both measures expanded dramatically after 1991 (Figure 4).

Self-governance activities in Kyoto fisheries can be viewed as a collaborative effort between local fishers and researchers. The Kyoto Institute of Oceanic and Fishery Science, which is the local research facility, has played a crucial role by providing information and guidance throughout the local bottom trawlers' decision-making process. For example, in selecting the size and location for each of the six reserves, bottom trawlers relied on scientific information provided by the institute. Development of the voluntary restraint areas occurred because research showed that regulatory discards in the spring and fall were decimating the crab stocks.

There are strong ties and trust between researchers and the bottom trawlers. In 2006, four experts at the Kyoto Institute of Oceanic and Fishery Science were engaged in trawler fishery research on snow crab and on other species, such as brown sole and northern shrimp. The results of their research are relayed to bottom trawler operators on a regular basis. Some researchers also conduct their work collaboratively on bottom trawlers so using industry vessels and gear.

The local and central governments have assisted fishers in their activities via legal frameworks and financial support. For example, the official fishery systems, such as licences and permits, helped to identify stakeholders and enabled effective exclusion of outside fishing operators. Also, the government financed the concrete blocks sunk in the marine reserves.

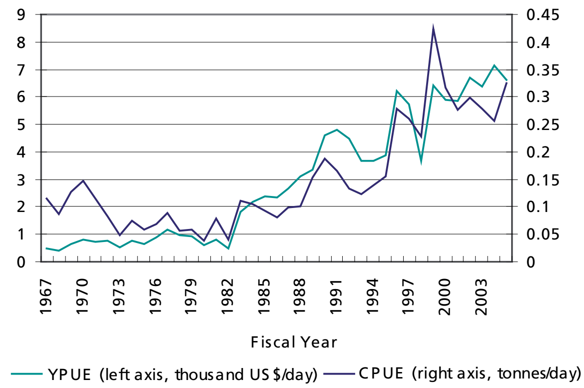
Finally, government action on international coordination was necessary, because the same snow crab stock is harvested by Korea. During the fiscal years of 1997 and 1998, there was a serious territorial dispute between Kyoto and Korea, when Korean vessels entered Kyoto's offshore waters and set bottom gill nets for snow crab. This impeded Kyoto's bottom trawlers from operating (see the declines in landing and yield during this period in Figures 2 and 3, respectively). The central government was required to execute its role as the official authority in coordinating with neighbouring countries in such situations.

Although the local research station provided biological advice for management measures and government supported the process, trawler fishers themselves made the final management decisions. The fishers alone met repeatedly to discuss implementation of the MPAs – without government officers or researchers. They laid aside their differences and finally reached an agreement. Such participation by local fishers in the management process cuts down on transaction costs, particularly those associated with monitoring, enforcement and compliance (Makino and Matsuda, 2005).

5. EVALUATION OF KYOTO'S SELF-GOVERNANCE OF SNOW CRAB

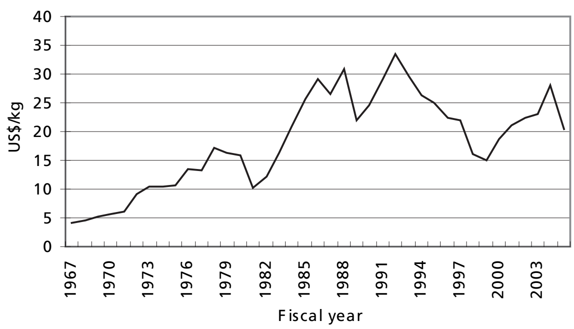
Evidence of the economic benefits of self-governance in the Kyoto snow crab fishery are seen in catch per unit of effort (CPUE) and yield per unit of effort (YPUE) for 1967

FIGURE 5
CPUE and YPUE of snow crab fishery in Kyoto



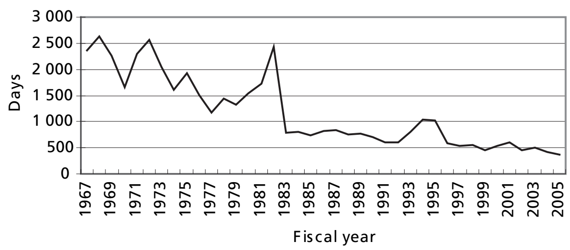
Data Source: National Federation of Bottom Trawlers' Unions, 2006

FIGURE 6
Average price of snow crab in Kyoto



Data Source: National Federation of Bottom Trawlers' Unions, 2006

FIGURE 7
Number of days at sea in the snow crab fishery in Kyoto



Data Source: National Federation of Bottom Trawlers' Unions, 2006

to 2005 in Figure 5. The average CPUE for 1978 through 1982 was 54 kg/day; for 2001 through 2005, it had increased to 287 kg/day. Average YPUE for the same periods were \$758 a day and \$6 540 a day, respectively. The revenue per unit effort (RPUE) shows more improvement than the CPUE – an 8.6-fold increase in the RPUE compared to a 5.3-fold increase in the CPUE – which indicates that the quality of the catch has been enhanced. The corresponding rise in average price a kilo verifies this (Figure 6). According to an empirical analysis by Makino and Sakamoto (2001), the increase in the RPUE was attributed to a voluntary decrease in days fished (Figure 7) and the creation of MPAs.

The positive effects observed in Kyoto could be explained by a natural increase in snow crab stocks, rather than from the affect of MPAs. To examine this hypothesis, changes in real yields after 1983 in five neighbouring prefectures were compared (Figure 8). It is believed that snow crab trawlers in these five prefectures target the same stock or at least a closely related subgroup. One of the four prefectures has adopted management measures that mirror Kyoto's. Fukui's snow crab vessels operate off the coast of Kyoto, so it has been a partner in Kyoto's management of the snow crab fishery. Fukui also has its own MPA system. If natural fluctuations caused the recovery of the snow crab stocks, a similar trend should appear in all five prefectures. Figure 8 clearly shows that this was not the case. The real yield of snow crab in Kyoto and Fukui improved much more than yields in other prefectures. Thus there is strong evidence that the improvements in real yields of snow crab can be attributed to the management measures and MPAs implemented in the two prefectures.

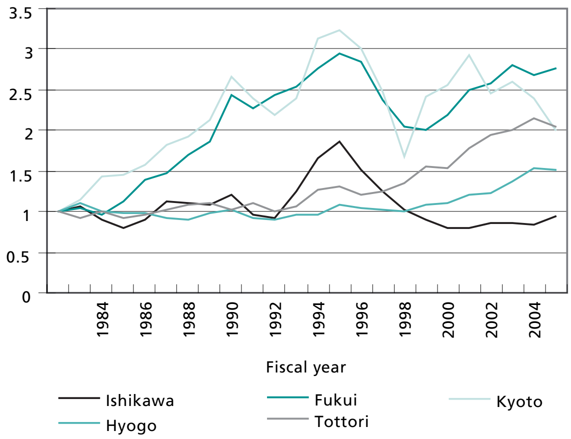
6. DISCUSSION

One reason often cited for the value of fishery self-management has been the ability to use local users' experience with the resource. The adaptive decision-making in the snow-crab fishery brought individual fishers into the process of choosing, examining and evaluating the effect of MPA sites. Their opinions were heard and their feedback was reflected in revised plans. This adaptive decision-making process by resource users reduced the risk of negative results from the MPAs and increased their legitimacy among users (Makino, 2004).

The snow crab case shows that a sense of legitimacy of management plans and regulations is important, especially in terms of compliance. Interviews of trawlers operators suggest that they take pride in perfect compliance and that they believe that no one would violate rules that they create for themselves. Full compliance with the MPAs is achieved virtually without enforcement by the government. Further, this case shows that local resource users will autonomously expand and fine-tune management measures once they understand how effective they are.

There are several factors that are specific to Kyoto prefecture. The number of bottom trawling vessels in Kyoto is small (15) and the size of the vessels is nearly uniform. Such homogeneity among resource users would contribute to effective decision-making and implementation of the governance measures (Dietz and Ostrom, 2003). The roles played by government and other third parties also need to be emphasized. Scientific information provided by the research institute was a valuable resource that supported establishment and improvement of Kyoto's self-management regime. Financial support provided by local and central government also facilitated the construction of MPAs.

FIGURE 8
Changes in yields after 1983 in neighbouring prefectures



The vertical axis shows the ratio of real yield against the average value for the previous five years (from 1978 to 1982).
Data Source: National Federation of Bottom Trawlers' Unions, 2006.

7. ACKNOWLEDGEMENTS

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Japanese coastal fishery co-management: an overview

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1. INTRODUCTION

This section presents the following co-management case studies of five Japanese fisheries.

i. Sakuraebi (small pink shrimp, *Sergia lucens*) fishery in Shizuoka prefecture, central Japan.
ii. Walleye pollack (*Theragra chalcogramma*) fishery in Hokkaido prefecture, northern Japan.
iii. Snow crab (*Chionoecetes opilio*) fishery in Kyoto prefecture, western Japan.
iv. Sandfish (*Arcotodcopus japonicas*) fishery in Akita prefecture, northern Japan.
v. Sandeel (*Ammodytes personatus*) fishery in Aichi and Mie prefectures, central Japan.

Each case offers distinctive features in terms of biological characteristics of the targeted species, the types of gear used, the degree of collaboration with outside parties and the adopted management measures among other factors. There were 1 608 co-management regimes across Japan, called fishery management organizations (FMOs), in November of 2003 (Ministry of Agriculture, Forestry and Fisheries, 2006). While examination of five cases cannot provide a comprehensive portrait of Japanese coastal fishery co-management, they do provide an indication of the wide range of approaches found within the overall Japanese system.

The coastal and offshore fisheries in which most co-management regimes arise are important sectors in Japan's fishing industry. In 2005, coastal fisheries landed approximately 1.5 million tonnes of marine fish, or 25.8 percent of total Japanese landings. Offshore fisheries landed approximately 2.4 million tonnes of fish, or 43.1 percent of the total (Table 1). In terms of value, however, coastal fisheries generated $US4 245 million, which accounts for 34.0 percent of total marine fishing revenue. The offshore fisheries earned $US3 230 million, or 25.9 percent of the total. These figures imply that coastal fisheries harvest relatively higher-valued species. In terms of employment, 94.7 percent of active fishers (defined as a fishery business owner, often a vessel owner, engaged in fisheries for more than 30 days in a calendar year), are involved in coastal fisheries.

TABLE 1
Marine fish harvest (volume and value) of Japan, 2001–2005

Volume (thousand tons)	Total				6 126	5 879	6 083	5 776	5 765
		Marine			6 009	5 766	5 973	5 670	5 669
			Catch		4 753	4 433	4 722	4 455	4 457
				Coastal	1 545	1 489	1 577	1 514	1 465
				Offshore	2 459	2 258	2 543	2 406	2 444
				High seas	749	686	602	535	548
			Aquaculture		1 256	1 333	1 251	1 215	1 212
		Fresh Water			117	113	110	106	96
Value (million US dollars)	Total				14 836	14 357	13 257	13 367	13 339
		Marine			13 905	13 458	12 373	12 502	12 488
			Catch		9 714	9 470	8 643	8 879	8 828
				Coastal	4 529	4 513	4 174	4 170	4 245
				Offshore	3 505	3 442	3 077	3 300	3 230
				High seas	1 674	1 511	1 388	1 409	1 350
			Aquaculture		4 191	3 988	3 733	3 619	3 660
		Fresh Water			930	899	883	862	852

Source: Ministry of Agriculture, Forestry, and Fisheries (2007).
Note: $US1 = 120 yen is used.

Despite their importance, the harvest levels of coastal and offshore fisheries have declined over the past few decades. One index that illustrates this point is the level of self-sufficiency of seafood in Japan. Japan was self-sufficient in seafood until 1975, but with the introduction of exclusive economic zones (EEZ) the level fell below 100 percent for the first time in 1976 (Ministry of Agriculture, Forestry and Fisheries, 2007). The establishment of EEZ's had a significant one-time impact, but the self-sufficiency level continued to fall as both coastal and offshore harvests declined throughout the 1980s and the 1990s, while the level of consumption remained mostly unchanged during that period. The self-sufficiency level was 57 percent in 2005, which was a slight recovery from all-time low of 53 percent in 2000–2002. For these reasons, sustainable coastal and offshore fisheries are critical, not only for biological health but also for economic success. The importance of successful fishery co-management cannot be overemphasized.

Historically, conservation of marine resources in Japan has been administered under rules that fishermen imposed on themselves (Makino and Matsuda, 2005). Individual fishing villages established their own rules regarding the use of coastal resources in their area. In offshore fisheries, cooperative organizations were formed by involved fishermen. Such organizations have set rules on the number of boats, amount and type of gear, the extent of the fishing season, the limits of their fishing grounds, protection of coastal woods and penalties against violators. Most of the managerial power over and responsibility for, Japanese fisheries lies in the hands of fishermen.

Japanese fishery co-management and associated institutions, such as cooperatives and legally recognized fishing rights, have a long history. However, that history is not the end of the story, nor is that history determinative of Japanese success today. Rather, Japan faces fisheries management challenges that are similar to those of contemporary fisheries elsewhere. However, the breadth of experience with co-management in Japan can yield valuable lessons for other fishery management systems.

2. INSTITUTIONS FOR FISHERY MANAGEMENT

2.1 Fishery cooperative associations and territorial use rights for fishing

Japanese coastal fisheries are governed by fishery cooperative associations (FCAs). The associations' jurisdictional boundaries are defined geo-politically, rather than biologically on the characteristics of the targeted species. Members of these FCAs are mostly fishing households and "small" companies as defined by the number of employees and gross tonnage of the vessels owned. The functions of FCAs are similar to other harvester cooperatives and include joint purchases of inputs (e.g, fuel, ice and boxes), administration of ex-vessel markets and provision of insurance and credit to members. FCAs also keep catch records, which are used to provide official statistics. In addition to such conventional functions, FCAs play one unique role—they manage fishing rights. Fishing rights are analogous to territorial use rights for fishing (TURFs) (Christy, 1982), which are granted by the government and protected by law. These two institutions, FCAs and TURFs, form the basis of Japanese fishery co-management.

FCAs are usually associated with specific coastal communities that historically have depended on fisheries resources. Each FCA typically encompasses all the fisheries within that community or communities, so a number of diverse fisheries are under the auspices of any FCA. FCA members are generally granted responsibility for managing all of the fishery resources within the FCA's jurisdiction. These often include sedentary shellfish resources such as clams and mussels, sea urchins and abalone and shrimp. They also include moderately mobile groundfish, including various flat fish and rockfish, and more mobile fish such as mackerel, herring and pollack. Members of any given FCA may employ a wide range of gear, which can include dredges, gill nets, seines, set nets, small trawls as well as diving.

The historical evolution of these institutions and their administrative structures is well documented in the literature (e.g. Asada, Hirasawa and Nagasaki, 1983; Ruddle, 1987; Yamamoto, 1995; Makino and Matsuda, 2005). Coastal waters were defined in Japan as public areas by legal codes dating back as far as the year 701 (Makino and Sakamoto, 2002). Under customary use rules, anyone could extract resources from coastal waters, as is the convention in many Western countries today. The idea of "fishing rights" in ancient Japan was thus nonexistent. During the feudal era in the seventeenth century, the rule changed such that only residents of coastal villages that did not have enough arable land on which to grow rice were permitted to fish. Such villages were given a certain area of coastal waters for exclusive use and harvester guilds were formed in the villages to protect the resource from outside poachers. In these coastal villages, a sense of territorial rights over the coastal waters emerged among the villagers and those rights were eventually recognized by the samurai lords (Asada, Hirasawa and Nagasaki, 1983).

In the late 1870s, the new Meiji government (established after the so-called Meiji Revolution) attempted to convert the fishery management system to a top-down style with fee-based licensing. This change met nationwide opposition, which eventually forced the government to reverse the process. Governance regressed back toward self-governance by local resource users. In 1901, enactment of the Fishery Cooperative Law legally recognized these *ad hoc* user rights. Fisher guilds were transformed into formal organizations that eventually evolved into FCAs. In 1948, the *Fishery Cooperative Law* established the legal foundation of FCAs with responsibility to administer the use of the rights (Yamamoto, 1995).

The fishing rights apply only to coastal fisheries. Offshore and high-sea fisheries are typically governed by a licence system that is managed by either the central or the prefectural government. For coastal waters, there are three categories of fishing rights: common, large set net and demarcated. Demarcated fishing rights are granted for aquaculture and large set nets are treated separately from small set nets, which fall under common fishing rights, because the impacts of large set nets are potentially substantial (Asada, Hirasawa and Nagasaki, 1983). Common rights are granted by prefectures only to FCAs, with nominal ten-year terms. Demarcated rights and large set net rights are granted to FCAs, to organisations other than FCAs composed of many fishers and directly to individuals from prefectures (the priority is given in this order), with five-year terms. Prefectures are required to consult Prefectural Fisheries Regulation Committees in granting of all three types of rights, so fishers have a substantial voice in this process. The renewal of these rights is usual but certainly not guaranteed. If there are serious issues such as noncompliance with regional and internal rules, the renewal of these fishing rights may be denied.

The focus of this study is on common fishing rights, which include all coastal fishing operations other than large set nets and aquaculture. Hereafter, we use the term TURF to refer to this particular type of common fishing rights. While most fishery management organisations (FMOs) are for these coastal TURFs, FMOs do exist for aquaculture licensees, large set net licensees and offshore licensees.

TURF area boundaries are typically seaward extensions of municipal boundaries on land. How far they extend varies; some are one kilometre or less while others extend more than five kilometres. This distance is a function of the targeted species, the type of gear used and the topography of the ocean floor. Again, the Prefecture, acting on advice of its Fisheries Regulatory Commission, determines the geographic extent of these rights (Yamamoto, 1995).

2.2 Fishery management organizations

Co-management of coastal fisheries is carried out by fishery management organizations (FMOs). An FMO is a group of fishers who share the same fishing ground and/or operate in the same fishery and are collectively engaged in resource and/or harvest management according to mutually agreed rules (Ministry of Agriculture, Forestry and Fisheries, 2001). FMOs are autonomous organizations and some of Japan's FMOs have been in operation for decades. These management regimes were codified and implemented as Japan's national fishery policy in the early 1980s. The FMOs still remain as autonomous organizations that have no legal status, unlike their parent FCAs. However, now that the central government has recognized them as an effective tool for fishery management, it actively promotes them by disseminating descriptions of successful cases nationwide. The recent expansion of FMOs reflects this policy change (Table 2).

TABLE 2
Total number of FMOs, 1962–2003

Year	Old definition of FMOs	New definition of FMOs
1962	508	-
1967	670	-
1972	811	-
1977	970	-
1982	1 128	-
1988	1 339	-
1993	1 524	1 133
1998	1 734	1 312
2003	-	1 608

Source: Ministry of Agriculture, Forestry and Fisheries (1991, 1996, 2001, 2004).
Note: The new definition only includes formal FMOs, i.e. those whose rules are written and documented. The old definition includes both formal and informal FMOs.

TABLE 3
Types of operating bodies for FMOs, 1998

Operating body	Number of FMOs
FCA	413
Subgroups within an FCA	1 011
Alliance of FCAs	109
Other than above	75
Total	1 608

Source: Ministry of Agriculture, Forestry and Fisheries (2006).

FMOs and FCAs are interrelated in a number of ways. Nearly 95 percent of Japan's FMOs are operated by an FCA or by an affiliate organization. There are several types of operating bodies for FMOs (Table 3). For example, if the local FCA is small in terms of the number of fisheries, gear types and targeted species that need to be managed, then such an FCA can add fishery management – the task of an FMO – to its responsibilities. The top row in Table 3 corresponds to this case; there are 413 FCAs that also function as FMOs.

If an FCA is large in scale and administers multiple types of gear targeting various species, fishermen often form a subgroup by the type of gear or targeted species (e.g, a pelagic trawlers' group or abalone harvesters' union) to serve for the benefit of that group. If, for example, management for abalone becomes necessary, the harvesters' union will assume that task and become an FMO. If no such subgroup exists at that time, which sometimes happens, then an appropriate subgroup will be formed (second row of Table 3).

Finally, most FMOs cover only their own TURF areas. But since some targeted fish species migrate across TURF boundaries, management within a single TURF area is not always appropriate and effective. In such cases, fishers from two or more FCAs jointly manage such fisheries (third row of Table 3). FMOs in all but one case, the snow crab fishery in Kyoto, described in this book are of this type. The last category "Other" includes, for example, the case where processors' cooperative associations acquire demarcated or large set net rights and engage in commercial fisheries. If these groups actively manage the resource, such as escapement control in fixed net fisheries, then they will be regarded as FMOs. Also, while FCAs are region-specific there are trans-regional fishers' organizations, such as Prefectural Federation of Bottom Trawl Fishery, and in some cases these organizations engage in fishery management. The effect is similar to joint management of multiple FCAs, except it is conducted through a different channel that does not involve FCAs. The snow crab fishery in Kyoto is one such case.

There are many types of self-imposed measures that an FMO can employ. The fishery census categorizes these measures into resource management, fishing ground management and fishing effort control (Table 4). Most FMOs have rules adopted from each of the three categories. However, it is interesting to observe that for each category certain specific measures within a category are more popular than the others, which in turn indicate the top priority issues from fishers' perspectives and their choice of solutions. For example, one can deduce from Table 4 that congestions on prime fishing grounds is a priority issue and as a solution many FMOs have adopted various rules specifying how to use grounds in a orderly manner. One example of such usage rules is the rotation system, where fishers are divided into several groups and rotate access to multiple fishing grounds on a fishing-day basis (e.g. the walleye pollack fishery).

TABLE 4
Number of FMOs by the type of self-imposed measures adopted as of 2003

Regulation type	Number of FMOs	(%)
Resource management	1 361	(84.6)
Stock assessment	527	(32.8)
TAC establishment	477	(30.0)
Stock assessment + TAC	254	(15.8)
Hatchery	1 067	(66.4)
Other	112	(7.0)
Fishing ground management	1 472	(91.5)
Protection	627	(39.0)
Enhancement	433	(26.9)
Usage rule	1 168	(72.6)
Monitoring	885	(55.0)
Other	19	(1.2)
Fishing effort control	1544	(96.0)
Fishing season	1 026	(63.8)
Fishing method	668	(41.5)
Number of vessels	278	(17.3)
Vessel and engine size	158	(9.8)
Fishing gear	796	(49.5)
Days at sea	715	(44.5)
Fishing hours	1 007	(62.6)
Number of crew	265	(16.5)
Harvest (species' size)	855	(53.2)
Harvest (landing volume)	452	(28.1)
Other	59	(3.7)
Total number of FMOs in 2003	1 608	(100)

Source: Ministry of Agriculture, Forestry and Fisheries (2006).
Note: A FMO can adopt various combinations of management measures.

An FMO typically adopts combinations of management measures listed in Table 4. Some FMOs simply set limits to fishing effort (such as days-at-sea or vessel size), while others adopt sophisticated fishing effort coordination measures as if the group is behaving as a sole resource owner. For example, the *sakuraebi* fishery (pink shrimp) in Shizuoka prefecture established a committee that makes decisions on fishing operations and fishing coordination in a centralized manner. The walleye pollack fishery in Hokkaido prefecture does not have such a committee but has developed a complex fishing ground rotation scheme for spatial coordination of fishing effort. Season closures and setting marine protected areas to protect both spawners and juveniles are becoming common measures; all five fisheries documented in the book have these as well.

New entries to the fisheries are typically tightly controlled. First, most coastal waters are included in TURFs belonging to FCAs and hence it is illegal to fish commercially within these waters unless you are a member of administering FCA. Thus, the first barrier to new entry is at an FCA level, i.e. new membership control (for details, see Uchida and Wilen, 2004). Among the legal fishers, entries to specific fisheries are often restricted by the licence system administered by either the local or central government; in fact, all five fisheries documented in this book are under the licence system. However, the pressure exists to allow all fishers who were historically engaged in that fishery to join the FMO. Consequently, certain rotation schemes are designed to reduce the number of fishers operating on any given day while maintaining everyone in the business. This policy can be interpreted as a limitation of FMO-schemes in terms of achieving economic efficiency, but can also be viewed as achieving social objectives, such as sustaining the community by keeping everyone in the industry.

Last, more and more FMOs are getting involved in market coordination activities. This is clearly seen in the sakuraebi, walleye pollack and snow crab fisheries. Specific activities include controlling the landing volume in accordance with processors' inventory levels, developing and advertising private brands and general quality control. FMOs that are actively engaged in marketing activities tend to earn higher revenue per member (Uchida, 2007).

3. ISSUES WITH THE JAPANESE CO-MANAGEMENT SYSTEM

3.1 Weaknesses

There are two main weaknesses within the current Japanese co-management system. First, discrepancies may exist between the area in which a fish species reproduces and migrates and the jurisdictional boundaries assigned to managing FCAs and FMOs. Second, scientific information to support co-management is insufficient and underutilised. These two fundamental weaknesses create specific issues and limitations within Japanese co-management

Despite the recent trend toward ecosystem-based management, as opposed to single-species-based management, the Japanese system remains geared toward the latter. Most of Japan's co-management regimes target a single species and often the choice of species is driven by the species' market value rather than by its ecological importance. A few attempts have been made to incorporate ecosystem considerations into fishery management, such as an experiment in Shiretoko Peninsula in Hokkaido, northern Japan (Makino, 2007). In general, however, the industry lacks the scientific knowledge necessary for effective management based on multiple species and that vacuum impedes development of ecosystem-based management regimes.

Co-management is executed by FMOs, which are typically affiliates of parent FCAs that control areas defined by TURFs. The area covered by a TURF will not necessarily coincide with the area in which the targeted species occurs. One example, described by Uchida and Watanobe (this volume) is the walleye pollack fishery managed by an FMO in the Hiyama region of Hokkaido. This FMO's jurisdiction covers only a portion of the pollack's migration area. There are institutions established for multi-jurisdiction management, such as area and wide area fisheries coordinating committees (AFCCs) (Makino, 2005), but they are rarely used because of the lack of supporting scientific information. Such a mismatch generates conflicts regarding whether benefits are fairly appropriated to those paying the cost, not only for conventional efforts to manage the fishery but also for restoration projects such as release of larvae and juveniles.

The substantial authority and responsibility given to local fishers under the decentralized fishery management system may also have a negative impact. For example, local fishers and the general public may not agree on which species of fish are most important to protect. Yet there are few venues, if any, in which the public can influence such decisions. That decisions must be unanimous, as is typical in these organizations, also means that they tend to be slow in implementing new technologies and/or in adjusting to changing natural and social conditions. For example, suppose as a result of scientific research it was determined that increasing the mesh size of gill nets is strongly recommended from a fishery management point of view and so it was proposed to an FCA. Observing the recommendation inevitably incurs cost, as all fishers need to purchase new nets with wider mesh. Further, suppose that there was one fisher who is unable to afford a new net and he opposes the proposal. Because of the unanimous rule, an outcome such that all but this single fisher implement the new net does not occur. Rather we observe that the change is blocked or delayed until a unanimous agreement can be reached.

3.2 Collaboration among fishermen, regulators and scientists

Collaboration among the three key players in fishery co-management – fishermen (resource users), regulators (authorities) and scientists – is an important factor for successful co-management. There are many advantages when fishermen manage their own resource, which includes the value of their extensive experience. However, solid scientific support is indispensable for ecologically sound management. Regulators can also contribute to this venture by coordinating and facilitating multi-jurisdiction management arrangements.

The relationships between regulators and fishermen are fairly close in Japan. One of the functions of FCAs is to inform their members of new and changing national fisheries policies. Committees such as the area fisheries coordination committees (AFCCs) are comprised of representatives of both industry and regulatory agencies. There are a number of venues in which fishers and regulators can exchange opinions and negotiate specific policies and regulations.

The weak point is collaboration between scientists and the other two parties. For example, compared to the degree of integration of scientific information in determining total allowable catch (TAC) levels in the U.S., the Japanese TAC system remains far behind. The importance of integration of scientific information into Japan's fishery management schemes for success of co-management is discussed in some of the cases in this volume, such as for the snow crab fishery in Kyoto (Makino), the sakuraebi fishery in Suruga Bay (Uchida and Baba) and the sandeel fishery in Ise Bay (Tomiyama *et al*., 1998). These three, and to some extent all five Japanese cases in this volume, illustrate the connection between successful co-management and active integration of scientific information into management design.

The integration of scientific information occurs in two stages. First, reliable information must be obtained. The lack of such information is the main impediment to its use. Second, because it is local fishermen who deliver the resulting management, scientific information must be translated into terms that fishermen can comprehend. This process of knowledge translation is best depicted in the sandfish management case in Akita prefecture (Suenaga, this volume).

4. DISCUSSION: WHY STUDY JAPANESE CASES?

There were 1 608 FMOs in Japan in 2003 (Ministry of Agriculture, Forestry and Fisheries of Japan, 2006) and most were established in affiliation with a local FCA. These FMOs vary in terms of the type of fishing gear used, targeted species, membership size and the management measures they have implemented. Given such diversity and heterogeneity in various factors, Japan's extensive system provides examples of most types of management regimes. Because these various local approaches function within the same overarching legal and social context, the variety of Japanese experience represents a natural experiment that can be used to examine many co-management issues.

An argument is sometimes made that the Japanese experience is based on the country's unique historical, cultural and social characteristics and thus has limited applicability to other regions. However, anyone who interviews active Japanese fishermen quickly realizes that these fishermen are as competitive as any other entrepreneur and no more cooperative than fishermen elsewhere. Cohesiveness of the community surely would enhance the likelihood of cooperation and compliance, but this social characteristic of small coastal communities is readily observed outside Japan. That Japanese fishermen are more cooperative or that their social and cultural characteristics are dominant factors that enable successful co-management are false generalizations.

Japan's fishery co-management and FMOs do hinge on two unique institutions: FCAs and TURFs, which are protected by law. But the literature has overemphasized the historical background of these institutions in concluding that Japan's success in co-management is due mainly to the tradition of these institutions and thus has little relevance for regions without such a tradition. Uchida and Wilen (2004) argue that, while FCAs and TURFS may be unique to Japan, their functions are universal.

Fishery resource stocks under free entry can be characterized as impure public goods – rivalrous (you cannot have the fish someone else has caught) and non-excludable (anyone can harvest). If such an impure public good can be made excludable and if members are better off than non-members, then the potential for economically efficient use of the impure public good exists (Buchanan, 1965). Excludability requires clearly defined geographical and membership boundaries and an affordable exclusion method. FCAs and TURFs, with their accompanying rules and legal authority, function to set boundaries and create exclusion. Any institution that suits cultural and social norms is applicable if it functions to meet the requirements of clearly defined boundaries and affordable exclusion methods. The remaining need is to ensure that members are better off than non-members, which is determined in our context by the benefits of fishery co-management being perceived by FMO members as sufficient. This is an issue that has little relevance to tradition and the Japanese experience can suggest how to meet these conditions elsewhere.

In sum, a number of Japan's fishery co-management regimes have been successful *despite* fishermen being just as competitive and no more cooperative than other fishermen around the world. Japanese fishermen have adhered to their co-management regime because it served their private interest – doing so brought more benefits than doing otherwise. The benefit may be short-term, but in many cases it is more long-term in the sense that fisheries are operated in a biologically and economically sustainable manner. The fact that these benefits were generated and that fishermen were able to appropriate them via functions provided by FCAs and TURFs is the key lesson of the Japanese experience.

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Co-management in the Exmouth Gulf Prawn Fishery with comparison to the Shark Bay Prawn Fishery

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1. INTRODUCTION

The Exmouth Gulf and Shark Bay prawn (shrimp) fisheries are the two most valuable prawn fisheries in Western Australia (WA) (Figure 1), with annual values of US$8–17 million and US$17–25 million, respectively. Both fisheries experienced overfishing in the early 1980s, but remedial action since and good co-operation between licensees and the Department of Fisheries has ensured relatively stable catches under normal environmental conditions. This has provided a level of confidence for the industry to try innovative and adaptive management strategies to ensure sustainability while gaining maximum economic return. These industry strategies include support for reductions in fishing gear, support for various kinds of regulatory closures and voluntary industry-implemented closures. These closures help to reduce the costs of fishing and to increase the size and value of prawns.

The current ownership of licensees in both fisheries is quite unusual. One company owns 15 of the 16 licences in Exmouth Gulf fishery. Eight licensees own the 27 licences in Shark Bay, with one company owning 15 of these licences. This provides for ease of communication when dealing with industry. The large commitment in investment, particularly by the companies owning many licences, provides an incentive for making them proactive and keen to optimize their return on investment.

Because prawns are short lived and have highly variable recruitment, TAC management is not especially appropriate for these species. Input controls, and especially spatial/temporal closures, are better strategies to achieve biological and economic goals, but these kinds of effort control regimes can be difficult to implement. A particular problem is that technological progress slowly renders

FIGURE 1
Location of the Exmouth Gulf and Shark Bay prawn fisheries

any input-control system ineffective unless on-going adjustment of the system occurs. When the industry accepts the logic of the input-control system and works to support it, then the system can work even though it is complex. This is what has successfully occurred in both Exmouth Gulf and Shark Bay. In contrast, in confrontational regulatory systems, this kind of adaptive management is impossible, in part because the industry has individual incentives to find ways to circumvent conservation regulations.

In this case study, the primary focus is on the Exmouth Gulf prawn fishery, which has moved toward strong, industry-initiated co-operative management. Comparisons to the Shark Bay prawn fishery will be noted when relevant.

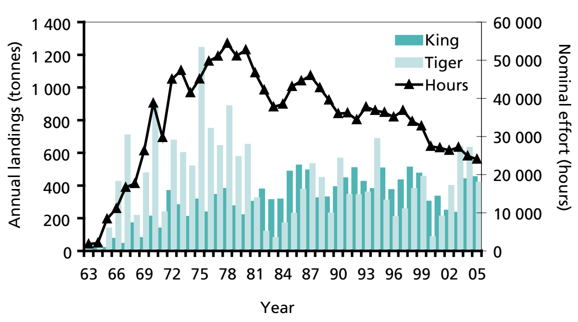
2. HISTORY OF EXPLOITATION OF TARGET SPECIES IN EXMOUTH GULF

The Exmouth Gulf prawn fishery began in 1963. It initially targeted banana prawns *(Penaeus merguiensis)* with 12 boats landing 68 tonnes of prawns comprised of: 52 t of banana prawns; 1 t of western king (*Penaeus latisulcatus*) and 15 t of brown tiger prawns (*Penaeus esculentus*). This early stage of the fishery was a daylight fishery for banana prawns, but changed to an entirely night fishery for tiger, king and endeavour prawns. As the fishery expanded, the target species changed as tiger prawns became more catchable. Since the early 1980s, when the fishing management strategy changed, the two main target species of this fishery have been the brown tiger prawn and the western king prawn. Western king prawns are the staple species in the catch contributing on average 505 t of the total landings each year (Figure 2).

A smaller proportion of endeavour prawns (*Metapenaeus endeavouri*) and a small quantity of coral prawn species (mainly *Metapenaeopsis* sp. and *Trachypenaeus* sp.) are also caught. On occasion, banana prawns make up the remainder of the catch. In addition to prawns, the trawl catch consists of a number of other species that are retained as by-product, which include crabs, squid, cuttlefish, tuna, slipper lobsters, and low numbers of various finfish species.

Until 1980, tiger prawns were the dominant catch and during these years the effort on this species increased (Penn *et al.*, 1997). In 1975, landings of tiger prawns peaked at 1 239 tonnes. Catches then declined to a low of 77 tonnes in 1983 (Figure 2). In 1981 and 1982, growth and recruitment overfishing occurred when boats commenced fishing earlier on smaller prawns and fished longer seasons. Boats began fishing further to the east where the recruitment grounds are located (targeting small prawns) rather than the traditional fishing grounds. This resulted in a serious decline in recruitment and subsequent catches of tiger prawns. Rigid management restrictions were introduced to reduce fishing effort and to rebuild the tiger prawn stocks. Variable closures of the main tiger prawn fishing grounds were introduced. Extension of permanent closure areas (nursery grounds) to allow sufficient escapement to provide a spawning stock irrespective of annual recruit strength were also introduced (Penn *et al.*, 1997). By using historical catch and effort data, Penn and Caputi (1986) concluded that a strong spawning stock-recruitment relationship existed for the tiger prawn. Since the introduction of the additional management measures, tiger prawn stocks have improved, breeding stocks have increased, and tiger prawn catches have been more stable.

FIGURE 2
Catch and effort (nominal hours) history of king and tiger prawns in the Exmouth Gulf prawn fishery 1963 to 2005



During the 1970s, king prawns were under-exploited as effort was focussed on tiger prawns. From the early 1980s, targeting of effort increased on catching king prawn.

Due to their behaviour (burying, nocturnal and a strong lunar relationship) and high reproductive output, king prawns appear to be less susceptible to recruitment overfishing in Exmouth Gulf. This has been demonstrated by the increased effort on king prawns since the 1980s with no evidence of lower production. The annual landings of king prawns generally reflect the overall effort in the fishery and the level of targeting of king prawn areas. This targeting has been a function of the annual abundance of king prawns in the northern sector of the fishery relative to the tiger prawn stocks in the more protected southern sector.

Annual variation in the catches of all species is evident, which are most likely due to weather and especially tropical cyclone events, which may provide either a positive or negative effect (Penn and Caputi, 1985). For example, the 1999 category-5 tropical cyclone Vance probably contributed to record landings in 1999 and a decrease in landings in 2000. On 22 March 1999, cyclone Vance passed through the middle of the Gulf and produced the strongest winds ever recorded in Australia and heavy rainfall. This assisted the movement of tiger and endeavour prawns onto the trawl grounds and increased the level of suspended sediments in the Gulf. This created high turbidity and thus a high survival rate for these species for several months. The short-term effects of the cyclone appeared to be higher catch rates, particularly of endeavour prawns, for the 1999 season.

Conversely, inshore areas (nursery habitats) of Exmouth Gulf were adversely affected by the cyclone. The tidal surge, reported to be approximately 6 metres, had devastating impact on the eastern side of the Gulf, where juvenile tiger prawns and important seagrasses and algal communities are located. A survey carried out by CSIRO in November/December 1999 was unable to find significant quantities of juvenile tiger prawns, which was associated with very low seagrass/algal abundance. Structured habitats, such as seagrass beds, are preferred by juvenile brown tiger prawns (Coles and Lee Long, 1985; Kenyon, Loneragan and Hughes, 1995; Loneragan *et al.*, 1998). Three subsequent recruitment surveys by the Department of Fisheries, in March to April 2000, showed low recruitment indices in the area that contributes around 70 percent of the catch. This low tiger prawn recruitment to the fishery had a negative impact on the 2000 season. The low tiger prawn catch in 2000 was also due in part to the management controls, which ensured that sufficient tiger prawns were left to become the spawning stock for 2001.

During the history of this fishery, low catch years have been followed by several years of rebuilding the stock to average and above average levels. In this multi-species fishery, the primary target species (western kings and brown tigers) and secondary species (banana and endeavour) have overlapping habitats, but different capture rates and spawning strategies. Management must ensure that fishing for one species does not jeopardise the sustainability of the other. The management arrangements try to optimize, not maximize, the catch.

Since 1984, industry funded buy-back schemes have resulted in the removal of seven boats, which reduced the fishing fleet from of 23 to 16 boats. The first of these schemes was initiated by the Department of Fisheries but relied on industry co-operation to remove potential latent effort and active boats for both sustainability and economic reasons. The second buy-back was industry-initiated to remove three boats for improved economic performance. Both buy-back schemes were government assisted via a loan mechanism.

The 16 boats tow twin 7.5-fathom nets to meet the overall headrope net limitation of 240 fathoms (439 metres). Currently, due to internal gear amalgamations, 12 boats operated in the fishery in 2006. This was an industry initiative following consultation with the Research Division about the merit of reducing boat numbers and about gear trials to assess the appropriate net size for the boats. There is an ongoing commitment to further reduce boat numbers.

3. SHARK BAY PRAWN FISHERY

The Shark Bay prawn fishery began in 1962 with a catch of 152 tonnes of king and tiger prawns by four boats. The fishery quickly expanded to a maximum of 35 boats in 1976, landing 1 511 t of king and 771 t of tiger prawns (Figure 3). A peak catch of 2 370 t of predominantly king (2 014 t) and tiger (324 t) prawns was landed in 1981. During the period 1980 to 1989, the annual tiger prawn catch declined to an average of 303 t due to overfishing, as compared with an average of 649 t during the 1970s. In 1990, a buy-back scheme was implemented, which reduced the number of boats to 27, which was the capacity until 2005. The Research Division, Department of Fisheries, WA (DOF) introduced an innovative management and fishing strategy that resulted in the tiger prawn landings returning to acceptable, sustainable catch levels over 500 t.

4. FISHING METHODS

Both fisheries tow low-opening demersal otter trawl nets to harvest prawns, mainly at night (see gear configurations in Figure 4). Each tow is between two and three hours in Exmouth Gulf, while trawls in Shark Bay are under one hour in duration. Two nets had been towed in these fisheries until 1999, when trials by five boats towing four nets (quad-gear) were undertaken in Exmouth Gulf. The lateral spread between headrope and ground rope is vital to the catching efficiency of trawl gear and this determines the area swept. The twin gear spread ratio is around 70 percent of the headrope length. Quad-gear net configuration decreases drag, which improves efficiency of fuel usage and provides increased net spread of 80 to 85 percent. This increases swept area as compared to twin gear. Since 2000, net amalgamations have occurred and all boats in Exmouth Gulf now tow four nets (quad-gear) and the number of boats has been reduced from 16 to 11. Quad-gear trials were undertaken in Shark Bay in 2005 and 2006. Positive results from these trials and economic circumstances prompted the entire fleet to be fitted with quad-gear and to reduce boat numbers from 27 to 18 for 2007. There has been a regulatory decrease in the total headrope allowance for the fleet to account for increased swept area and increased catch rate efficiency for quad-gear boats.

Bycatch reduction devices (BRDs) are compulsory in these fisheries and comprise both grids (Figure 5) (often referred to as Turtle Exclusion Devices) and secondary devices such as square-mesh panels.

FIGURE 3
Catch and effort (nominal hours) history of king and tiger prawns in the Shark Bay prawn fishery 1970 to 2005

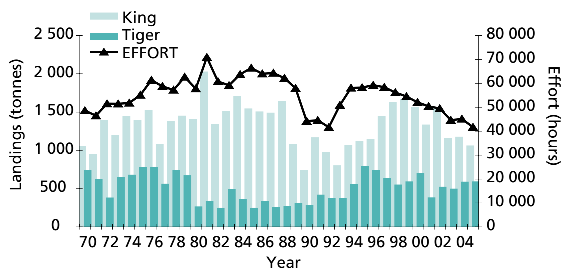


FIGURE 4
(a) Standard twin otter rig gear used by prawn trawlers in Exmouth Gulf and Shark Bay
(b) quad-gear now being trialled

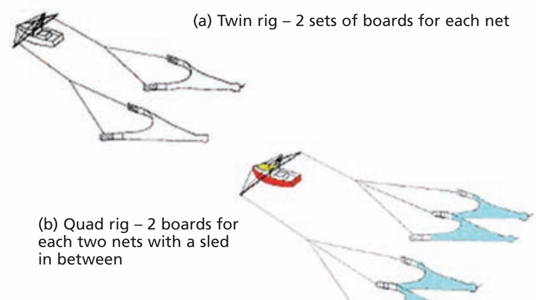
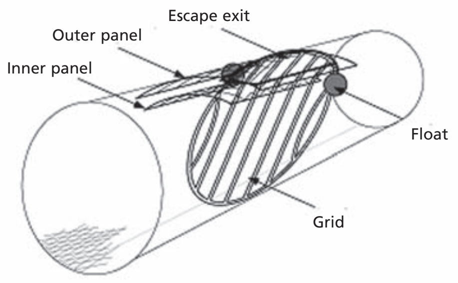


Diagram from Sterling *et al.* 2005

5. ECONOMIC ENVIRONMENT

The major markets for the brown tiger prawns are Japan and Taiwan, where they are sold whole raw. Australia, Europe, USA and Taiwan are the major markets for western king prawn, where it is sold whole cooked. The endeavour prawn is mainly sold in Australia and New Zealand whole cooked. The major markets for the banana prawns are Australia, China, Japan and the USA, where the prawns are sold cooked with head

FIGURE 5
Diagrammatic representation of bycatch reduction device used in Exmouth Gulf and Shark Bay



on. Beach prices in Australia are mainly determined by the world price of prawns, including those fished from the wild and those grown through aquaculture.

In Exmouth Gulf, prawns and retained by-product species are generally chilled, rather than frozen, due to the close proximity of the fishing grounds to a state-of-the-art processing facility. This enables prawns to be landed fresh and fine-graded prior to freezing or delivery fresh to local markets, thereby maximizing economic return. In Shark Bay, prawns and retained by-product species are packed in 10 kg boxes and snap frozen at sea.

The distribution of prawn fishing effort has shifted to later in the year (May/June instead of March/April) due to industry/management efforts. These management measures have been designed to encourage later harvesting of prawns in order to improve their size and quality.

Prawn prices had risen steadily until about 2000, but have undergone a steady decline since then. The reduction in beach price since 2000 can be attributed to two factors, the rising Australia dollar and increasing competition from aquaculture. World prices of prawns began declining from a peak of $17/kg in 1996. The fall in the Australian dollar buffered producers from 1997 to 2003, but in recent years, the Australian dollar value has increased to its current level at a 19 year high of $0.83.

In the long term, competition from aquaculture will be especially challenging. Future prices are likely to be, at best, around US$11/kg, down from a (inflation adjusted) peak of US$17/kg. This price decline is affecting local Australian markets, as well as international export markets. In November and December of 2004 alone, imports of Penaeus vannamei into Australia averaged, for the first time, 2 500 tonnes a month (Sydney Morning Herald, 22 May 2004), which is equivalent to twice the total annual prawn production in Exmouth Gulf.

The other important factor is the cost of fishing. The three major costs of trawling are: fuel and other variable costs; labour costs, typically set as 25 percent of the catch; and fixed costs (including depreciation). Recent fuel cost increases, and prospects for continuing increase in the real cost of fuel, are especially challenging.

The ongoing efforts to improve trawling efficiency have underpinned the fleet's efforts to maintain profitability. Industry has responded by implementing operational changes (e.g. moon closures and targeting larger, higher-value prawns) and more fuel-efficient fishing gear such as bison boards, computerised engine management systems, but the economic margins have become thinner and thinner. Trawling efficiency has been increased over the years as a result of several management measures and research surveys that have had several results:

i. industry-financed fleet reduction;
ii. movement to quad gear, with associated reduction in total headrope;
iii. introduction of moon closures that suspend fishing for periods of up to 6 or 7 days in Exmouth Gulf and up to 12 days in Shark Bay over the low catch periods of the full moon;
iv. temporal/spatial closures that encourage greater effort later in the season with concentration on areas where catches are higher; and
v. surveys to establish prawn size and abundance and provide information for appropriate seasonal commencement of fishing (differing from legislated opening and closing dates) and re-opening of areas formally closed to fishing if abundance (above catch-rate threshold limits) is adequate.

King prawns are the main species caught in terms of weight and total value, though tiger prawns usually have a higher unit value. On average, this differential is about 20 percent and in 2002 it was 39 percent. The temporal pattern of catch and the differences in value of king prawns and tiger prawns could have a bearing on the economics of fishing within a season, although this difference is smaller than the difference in total catch rates and the change in value of prawns as they mature into different size grades.

Harvesting larger quantities of prawns per vessel with the same number of crew means that individual crew members, who are paid on catch shares, have a higher income. This is crucial given the current tight labour market. The structured openings and closings allow crew to arrange activities during down time as well as reducing impacts of fatigue. The longer moon-related closures allow crews to return to their home towns to be with their families.

The final advantage of these flexible fishing arrangements is the ability to target prawns at a time when the market demand is highest, or the economic returns are greatest. While sustainability of the prawn stocks are paramount for fisheries managers, industry operators have the "triple-bottom-line" to consider, and the current management and harvest strategies go far towards addressing these concerns.

6. MANAGEMENT

6.1 Overview

Both fisheries are input controlled and have a complex set of management restrictions, including limited entry, boat size, gear controls and spatial and temporal closures. These management controls, and in particular the spatial and temporal closures, help to sustain all of the prawn species, to maintain the supporting environment and to maximize the size of the prawns at capture. Fishing effort in the fishery is monitored to reduce ineffective trawl hours (i.e. around full moon phases), to maintain high catch rates and to improve economic and energy efficiency within the fleet. The fisheries are managed under a constant escapement policy, designed to leave a minimum level for the tiger prawn spawning stock. Tiger prawns are the management focus with respect to sustainability, as they have been shown to be vulnerable to overfishing (Penn and Caputi, 1986). Industry takes an active and sometimes pro-active approach in management decision processes and implementation of changes through both formal and informal mechanisms that are discussed in Section 6.3.

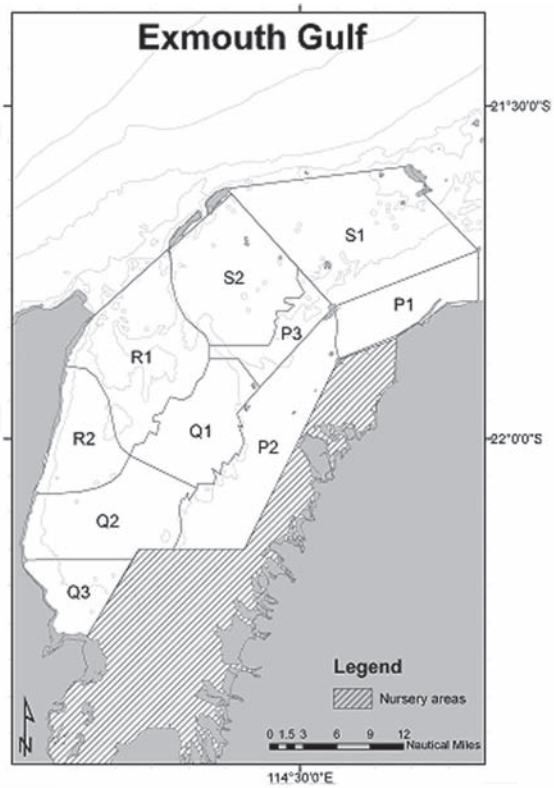
6.2 Evolution of management

The early years of the Exmouth Gulf fishery had a low level of management activity and the Exmouth Gulf fishery was first subjected to limited entry in 1965 when 15 licences were issued. Additional licences were issued until the number of licences was capped at 23. Logbook catch and effort data was gathered from the early 1960s by the Research Division. This data formed the cornerstone for the decision making process over time and for the understanding of the fishery today. No seasonal or area closures were in place, as there was little understanding of spatial and temporal variation in abundance. Between 1965 and 1972, fishers could commence fishing at any time, anywhere, but they primarily stayed in the centre of Exmouth Gulf (areas Q1 and Q2, Figure 6). In 1973, a more structured closure system was introduced in the southern and eastern side of the Gulf, where mainly small prawns were taken. In 1978, a permanent nursery area was introduced on the eastern side of the Gulf (Figure 6). In 1979, an extension of the nursery area was implemented with a complete closure for a limited period of time early in the year (1 December to 28 February).

Due to the collapse of tiger prawn stocks in the early 1980s, further intervention was required, which was achieved primarily by various kinds of closures. This included rotational closures in the southern and eastern parts of the Gulf, both the number of boats and timing, under "roster fishing". In August 1982, because of the decline of the tiger prawn stock to very low commercial catch levels the Research Division implemented a specified spawning area to be closed when the catch rate fell to threshold level to maintain adequate tiger prawn breeding stock. Further, in 1983 the level of monitoring and Departmental involvement in the fishing activities in the southern part of the Gulf increased because of the unprecedented poor levels of recruitment of tiger prawns over the previous two years due to over-fishing in 1981 and 1982.

The Research Division monitored the daily catches of tiger prawns in Area B and the southeast part of the Gulf known as the extended nursery area (ENA). The ENA was subsequently divided into Area C and the nursery area (permanently closed). Areas B and C were closed to fishing when the specified catch rate minimum was reached. Fishing initially ceased at a low tiger prawn catch rate of around 5 kg/hr; this rate was subsequently set at 12 kg/hr (standardized effort). Prior to the start of fishing in these areas, a one-boat two-day survey was done to determine tiger prawn recruitment levels and size grades.

FIGURE 6
Fishing grounds in Exmouth Gulf prawn fishery and permanently closed area



6.3 Current management

6.3.1 Management structure

The current management plans for the Exmouth Gulf and Shark Bay prawn fisheries are a formal statutory document. In Exmouth Gulf, the Exmouth Gulf Prawn Management Plan 1989 ("the Plan") dictates the management measures. The fisheries are two of Western Australia's six major fisheries and are operated under full cost recovery via an access fee. Day-to-day operational management arrangements are carried out cooperatively between the Department and the two existing licensees in Exmouth Gulf and the Industry Association that represents all licensees in Shark Bay. The Industry Association has an Executive Officer, who is the initial contact person. He organizes all relevant meetings/discussions between industry and the Department, and disseminates key information to licensees and skippers.

A Trawl Management Advisory Committee (TMAC) provides broader stakeholder input into the higher-level policy issues. The TMAC provides cooperative management at this higher level through the provision of advice directly to the Minister. The membership on the TMAC includes representation from community and conservation groups to ensure an open and broad consultative process. The advice provided allows the management arrangements to be tailored to achieve maximum economic return from the prawn resource as well as to maintain the sustainability of each fishery and to ensure cost effective management.

6.3.2 Limited entry and gear controls

There are a limited number of boats operating in both the Shark Bay and the Exmouth Gulf fisheries. In Exmouth Gulf, the number of boats has been reduced as fishing efficiency has increased. Currently, there are sixteen Managed Fishery Licences with an allowable total of 240 fathoms (440 metres) of headrope using twin gear (two 7.5 fathom [13.7 m] nets per boat). Fifteen of these are owned by one operator. Since the introduction of quad-gear, net headrope length has been redistributed to four, 4.5-fathom (8.2 m) nets per boat, and the fleet reduced to 13 boats. There has been an overall net reduction/discount of 8–10 percent imposed by the Department to adjust for the increased catch efficiency of quad-gear and for general technological improvements. As the number of boats was reduced, the remaining boats have been upgraded to tow larger nets in quad configuration. The fleet has reduced to 11 boats for the 2007 season.

These arrangements are expected to be formalised in the unitisation of headrope (but with maintenance of standard net sizes) and in the relaxation of vessel size controls (with some maximum) in the longer term. The unitisation of headrope has been proposed to provide a long-term basis for gear amalgamation and increased economic fishing whilst also maintaining standardised effort indices. To provide flexibility in this process, trawl head-rope length will be unitised into standard, transferable entitlements that can be traded among Shark Bay prawn operators. However, given the differences in catching efficiency associated with different gear configurations, it is intended that a standardised gear requirement will remain a feature of this fishery. The planned unit size 10 cm and current legislation requires at least a unit of fishing gear to remain on a licence for it to exist. Other gear controls include restrictions on the mesh size and the size of the trawl otter boards and ground chains.

In Shark Bay, there are 27 licences currently operating in the fishery. The number was reduced from a peak of 35 through a buy-back of licences in 1990. As in Exmouth Gulf, for the 2007 fishing season, gear amalgamation of net allocations have resulted in quad-gear configuration nets (4x5.5 fathom [10.1 m]) being towed by fewer boats (18). The pool allocation of net headrope was reduced 8 to 10 percent to offset increased catch efficiency.

6.3.3 Closures

Regulation uses seasonal closures of the entire fishery area, area closures within the season and time closures with the season. These closures help achieve both biological and economic goals. A variety of closure types are used.

i. *Seasonal closures:* The Exmouth Gulf fishery is generally closed between December and April, whilst the Shark Bay fishery is closed November to March. This allows the small juvenile prawn stocks to grow during the annual recruitment period.

ii. *Permanent area closures:* Parts of Exmouth Gulf and Shark Bay are permanently closed to trawling to stop fishing in areas where prawns are mostly small and to preserve seagrass and other sensitive habitats that are essential nursery areas for prawns and other species.

iii. *Within-season area closures:* There are a complex series of fishery openings and closures as a result of the compartmentalisation of the fishing grounds, which are designed to allow fishing of the prawns as they reach optimal market size. The timing of these openings can vary annually due to the results of pre-season surveys. The actual area trawled in Exmouth Gulf is approximately 40 percent of the licensed area, while only 20 percent of licensed fishing area is fished in Shark Bay.

iv. *Time-of-day closures:* King and tiger prawns are predominantly nocturnal and therefore trawling is generally only permitted between 1700 and 0800 hrs. Trawling for prawns during the day (except for banana prawns for which specific permission may be granted in Exmouth Gulf) is often unproductive as the prawns burrow in the sediment.

v. *Moon closures:* There are several complete 24-hour closures over the period of the full moon, to increase economic efficiency by stopping fishing in low catch rate periods and to protect moulting soft-shelled prawns.

6.3.4 Roster (Rotational) Fishing

At the start of the fishing season in 1983, 21 boats were licensed to fish with otter trawls. On 20 January four boats commenced fishing in Area A only as there was no formal fishing season. From 2 March, size and abundance surveys were done in Area C until the prawn size was deemed fishable (i.e. would provide optimal yield) by the staff of the Research and Industry department. Roster fishing commenced on March 30 using seven boats only. Areas B and C were fished on a daily basis until the catch rates fell to the level that required fishing to cease. During roster fishing periods, research officers monitored fishing on a daily basis for catch and effort information. Also during the roster period the remaining boats fished Area A. The main objective focus to limit fishing effort so that Research Division could monitor the tiger prawn biomass to ensure fishing ceased when a level was reached that returned industry to fishing at reasonable economic levels and to introduce long-term sustainable fishing practices. Areas B and C were closed to fishing either at a predetermined catch rate threshold or 1 August each year, which ever came first) to avoid recruitment over-fishing. Breeding surveys monitoring tiger prawn stock abundance and female spawning condition were also undertaken.

A similar pattern of fishing operations was undertaken in 1984 to 1983. The first legislated season opening and closing dates, 1 February to 16 November 16 were implemented, and roster fishing was again part of the strategy from 25 March 25 until 25 June. Two non-fishing periods were established so that Research Division could determine the catch and effort rates at which to close the fishery. Night-time fishing only was also implemented (1800–0800) to reduce inefficient effort.

In 1985, 19 boats actively fished in Exmouth Gulf and roster fishing was modified so that half the fleet fished each night on a 9 and 10 boat system. Full fleet fishing occurred from 17 to 31 May. Because the fleet was monitored to determine catch rates, two additional fishing periods were permitted during June and July until the catch rate minimum was reached and Areas B and C closed on 17 July. The opening date was later in 1985 than in 1984 (15 February) and the fishery opened progressively later each year until the preferred opening date of 2 April 2 was attained in 1989.

The 1986 fishing season started 1 March with the full fleet fishing in all areas: no roster fishing was undertaken from then on. From 1984 recruitment and spawning surveys were implemented and continue today so that the Research Division can provide a prediction of the tiger prawn catch, management the prawn size and maintain and measure breeding stock levels each year.

In 1985, an industry-funded buyback reduced the number of boats from 23 to 19. Roster fishing ceased at the end of 1985, in conjunction with the introduction of a closed area in the tiger prawn spawning grounds that had a catch-rate threshold level cut off , or a mandatory closure on 1 August. Moon phase closures were implemented in 1985 for three days around the full moon. In 1986, gear restrictions (maximum of 15 fathoms [27 m] head rope per boat in twin gear rig) were implemented and the nursery area was further extended. The overall fishing season was shortened progressively until, by 1989, the season was opened from 2 April to mid November with partial within-season area closures to reduce capture of small prawns. A ban on daylight trawling was introduced in 1986 to further reduce fishing effort on tiger prawns.

6.3.5 Licence fees and cost recovery process and timetable

The cost recovery process commenced in 1995/96 and was a staged approach over seven years. Table 1 outlines the stages of the process. The Development and Better Interest Fund (DBIF) is imposed on each fishery to provide monies to address selected/urgent issues in any fishery within the state. The fisherman's contribution is based on the gross value of production (GVP) of the fishery for the two prior years. For example, the 2007-08 fees will be calculated using the 2007-08 cost recovery budget estimates and

TABLE 1
Staged phases of cost recovery for Exmouth Gulf and Shark Bay prawn fisheries

Year	Cash costs	DBIF levy (% of GVP)	Capital Costs	Employee Entitlements
1995/96	Yes (85%)	+ 0.41	+ no	+ no
1996/97	Yes (85%)	+ 0.49	+ no	+ no
1997/98	Yes (95%)	+0.65	+ no	+ no
1998/99	Yes (100%)	+0.65	+ no	+ no
1999/00	Yes (100%)	+0.65	+ no	+ no
2000/01	Yes (100%)	+0.65	+ yes (100%)	+ no
2001/02	Yes (100%)	+0.65	+ yes (100%)	+ yes (100%)

the GVP from 2005-06 calendar years. How this money is spent is determined by the Minister but departments can request allotments.

There has been full cost recovery (i.e. for research, management and compliance costs) since 2001/02 for both cash and capital costs as well as the DBIF levy and employee entitlements. The level of service provided is determined through consultation with representatives of the industry and quarterly reports and they receive quarterly reports summarizing activities and expenditures for management, compliance and research.

Licence fees are calculated on actual activity and expenditure (including capital costs and employee entitlements) over a three-year rolling average and the licence fee for the Exmouth Gulf prawn fishery has been between A$31 000 and A$34 000 and for Shark Bay prawn fishery between A$34 000 and A$42 000AUD for 2004/05 to 2006/07. The costing also uses 'unders and overs' so there are no refunds or additional licence fees in any one year.

6.3.6 Compliance

Compliance activities have included at-sea and aerial patrols to enforce closed seasons, closed areas and operational rules. In more recent times, compliance activities in the fishery have been based on a risk-based approach, which has included input from industry. As a result of the risk assessments, key compliance strategies now include pre-season briefings of skippers (introduced by Research Division DOF in the early 1980s), pre-season inspection of the trawl fleet and at-sea inspections. The Department's satellite-based vessel monitoring system (VMS) was introduced into the Exmouth Gulf and the Shark Bay prawn fisheries in 2000 and has improved compliance integrity by monitoring vessel location and speed, thus increasing real time compliance with formal closures. The implementation of VMS has the potential to expand the scope for management and to assist the Research Division with in-season, real-time, adaptive management measures.

Compliance levels in the Exmouth Gulf are excellent with few infringements recorded, especially since the single operator has strict internal controls to monitor compliance amongst its own fleet. This includes the use of the 'Smart prawn' system that monitors boat movements and catches during each fishing night and can detect transgressions into industry-initiated 'closed areas'.

7. ANNUAL MANAGEMENT PROCESS

7.1 Seasonal arrangements

Arrangements are developed in consultation with industry during the season and are based on ensuring sustainability and fishing in the most profitable manner. These arrangements are usually ratified three or four months before the season commences to allow the regulatory notices to be gazetted regarding season opening dates and any other proposed regulations. Table 2 provides a list of season arrangements for 2007 that was given to all skippers and licence holders.

TABLE 2
Exmouth Gulf 2007 Season Fishing Arrangements – opening, closing dates and moon closure periods

Recruitment survey (Last quarter 12 March).	10–11–12 March.
Recruitment survey (first quarter 26 March).	25–26–27 March survey
Recruitment survey, last quarter 11 April.	10–11–12 April.
Survey area A. All Survey results discussed with industry to determine the extent of area fished in area A and B.	13 April
Season open, areas A, B, C and D open to fishing.	16 April (last quarter 12 April)
Survey area A	24 April (First quarter 24 April)
Moon closure: full moon 2 May.	Moon closure days to be nominated
Moon closure: full moon 1 June.	Moon closure days to be nominated.
Monitor tiger prawn catch during June and July within areas B and C to ensure catch rate is above threshold level.	June and July
Area C survey may be required to determine tiger prawn size structure and catch rate (kg/hr).	June and July
Moon closure: full moon 30 June.	Moon closure days to be nominated.
Moon closure: full moon 30 July	Moon closure days to be nominated.
1800 hrs. Areas B and C, cease fishing. Fishing Areas A and D.	1 August.
Spawning stock survey. Last quarter 6 August.	5 to 8 Aug inclusive (4 nights).
Moon closure: full moon 28 August.	Moon closure days to be nominated
Spawning stock survey. Last quarter 4 September. Area B re-opening subject to survey data.	3 to 6 September inclusive (4 nights).
Fishing area B and C: subject to survey data.	September/October.
Moon closure: full moon 27 September.	Moon closure days to be nominated.
Spawning stock survey. Last quarter 3 October.	2 to 5 October inclusive (4 nights).
Moon closure: full moon 26 October.	Moon closure days to be nominated.
Fishing areas B and C to the catch rate to the lower threshold level based on 6 fathom boats adjusted catch rate.	After confirmation of survey catch rate data.
Season closed.	0800 24 November 2007.

7.2 Principles determining opening and closing dates for the 2007 Fishing Season in the Exmouth Gulf Prawn Managed Fishery

The proposed date for the opening of the fishing season is 16 April 2007. Prior to the season opening, recruitment surveys of areas B and C will have been completed in March and early April prior to the opening date. It is proposed to have a field-based consultative process whereby industry and Research Division, decide on the extent of area to be fished within areas A, B, C and D when fishing commences utilizing all survey information. Fishing will cease 0800 hrs 24 November 2007. The proposal provides 197 fishing nights for the season. This is taking into account a minimum four-night moon closure period each month around the full moon.

Once the Chief Executive Officer (CEO), Department of Fisheries, has signed off the season notice, the micro fishing arrangements (maximizing size of prawns for commercial marketing, and fleet efficiency) for area openings, closures and moon closure periods will be by consultation between Research Division and industry. In turn Research will provide the moon closure dates to the VMS section for validation. Research shall provide, in writing, advice when the tiger prawn spawning area is to be closed or re-opened by notice to the Policy Officer for approval by the CEO, Department of Fisheries (when appropriate). Industry have the flexibility to nominate the number of non-fish nights (moon closure period) during each month, so that the number of non-fish nights may vary around the moon but the total number of non-fish nights allocated for moon closures during the season (minimum of 28 nights for the 2007 fishing season) shall be taken. The maximum number of nights fishing each season should not exceed 200 nights (based on historical data) except when it is proven that excess stock is available to fish. Non-fish nights shall include nights not fished due to strong wind warnings. When the target of 28 nights moon closure or non-fish nights are reached then it will not be necessary to inform the VMS section of remaining moon closures. However, Research Division would continue to inform the VMS section regarding moon closure periods and nights not fished due to adverse weather conditions.

For the flexible non-fish periods to be workable, a set of guidelines needs to be in place to satisfy sustainability requirements.

- All licence holders agree on the timing and number of nights closed around each full moon during the season. If no agreement can be reached then by default a four-day moon, or longer if deemed necessary by Research Division, closure period around the full moon will take effect and continue for the remainder of the season. The closure will be declared, by notice in writing, signed by the Chief Executive Officer, Department of Fisheries to give effect to the proposed fishing arrangements to permit or prohibit fishing for prawns or any part of it (Clause 10(1) of the Exmouth Gulf prawn managed Fishery Plan).
- The catch rate of tiger prawns will be monitored on a daily basis in area B and C for the purpose of closing the areas B and C when the threshold level is reached.
- When the catch rate threshold level for tiger prawns of 19 kg/hr (based on quad gear 4.5 fathoms nets average catch rate) over 2 consecutive nights is reached prior to the mandatory closure date of August 1, then fishing shall cease in areas B and C. The 19 kg/hr catch rate will be adjusted based on boats towing 6 fathom nets during the 2007 season after trials comparing catch rates from the boat towing 4.5 fathom nets and boats towing 6 fathom nets.
- Areas B and C are closed on 1 August regardless of the tiger prawn catch rate level.
- Spawning stock surveys will be carried out during August, September and October using the standard survey pattern.
- If the catch rate of tiger prawns is above the threshold level after the September survey then a decision will be made after consultation between industry and research whether to re-open areas B and C to fishing.
- From November or a specified earlier date, fishing may take place in area B with a lower catch rate threshold level of 14 kg/hr or amended catch rate based on boats towing 6 fathom nets.

The end of season closure date has been proposed as 24 November 2007. It should be noted that generally in this fishery, during November, as new king prawn recruits move into the trawl grounds the prawn size composition becomes smaller. When the king prawns size composition reaches approximately, on average 23 to 25 per pound, or if 50% or greater of the daily catches are 21-30 and 31 + count per pound (particularly if the catch rate of king prawns is low) consideration should be given to close the fishery if this occurs prior to the promulgated closure. This decision is to be made in consultation with the Exmouth Gulf Prawn Licence holders and Department of Fisheries, Research Division.

8. CO-OPERATIVE MANAGEMENT

The annual cycle of management is dynamic and multi-faceted, with industry participation in the decision-making process. This begins with the initial draft of 'season arrangements' that is provided by the Research Division to the two licensees three months prior to the proposed commencement of the season. This draft contains all the mandatory sustainability requirements embedded within the arrangements. Opening and closing dates vary each year and depend upon environmental conditions, moon phase and the results of standardised pre-season surveys. The licensees provide input and suggestions on changes that suit their marketing or other operational requirements. The CEO of the Department of Fisheries statutorily sets the maximum fishing days (200 days) for the season and broad-based sustainability closures. Industry, in close consultation with the Research Division, works within that framework to maximise the economic return from the prawn resource. The timing and the extent of area fished at the commencement of the season allow the harvesting of the current season's recruits and large 2+ residual prawns not caught in the previous season. Within the main fishing period, there are subsidiary openings and closings to increase size, quality and market value, while protecting stocks from recruitment overfishing. Moon closures increase economic efficiency by shifting fishing effort away from these times of reduced catch rate.

During the season, industry is proactive in determining 'real-time' harvesting strategies to optimise economic efficiency. They initiate area openings to optimize size and value of the prawns and area closures when small or suboptimal quality prawns are encountered. In recent years, they have also stopped fishing for the season based on size (for king prawns) and catch-rate levels, on their own initiative. This is possible as sustainability issues are already addressed through the more formal management arrangements.

The MG Kailis Group (owner of 15 permits in Exmouth) has installed a 'Smartcatch System' on their boats, whereby nightly trawl activity and catches are downloaded to the company database on a daily basis. This information can then be summarised and evaluated by the shore 'managers'. A local processing facility is owned by the company, which provides daily grading information for the previous nights' catches. This enables quick determination as to whether optimal-sized prawns are being caught. Once the information has been evaluated, industry can initiate changes to harvesting strategies or can request small scale 'surveys' to confirm prawn size and abundance in areas. This may result in changes to 'industry closure lines' that can be implemented within 24 hours. In the last two years, this process has been driven by industry 'managers' on site in Exmouth Gulf. Close communication is maintained with, and notification of changes are provided to, the Research Division. In Shark Bay, the fleet now also uses 'real-time' management through surveys with Research Division staff on board to verify size and abundance, which can lead to changes in 'industry closures' at short notice. Feedback from skippers often provides information to initiate area closures when small prawns are found.

The Research Division (DOF) also collects daily catch and effort information via logbooks for every trawl. Currently, this is in paper format but in the future the data transfers will be electronic. This information, in addition to the annual recruitment and spawning surveys, allows for annual stock assessments for each target species.

9. DISCUSSION

The comprehensive management plan and related legislation are performing well. The management plan delegates day-to-day operational management to the CEO of the Department of Fisheries. The fisheries are managed in a dynamic and consultative/cooperative manner whereby the CEO ensures an overall sustainability framework through a statutory Determination of broad openings and closures (outside the permanent Nursery Closures). Having the base management arrangements in legislation provides a high degree of stability. This allows the incorporation of industry-initiated management scenarios into the formalised management practises. Through close consultation between the Research Division and the licensees, real-time management uses in-season vessel surveys of "industry agreed" closed areas to target prawns at premium market sizes and to maintain higher catch rates. This process achieves maximum economic return for licensees and best use of the available prawn resource. The process for achieving management changes are well understood by the stakeholders and the system is flexible enough that the management process can respond quickly to change. In recent years, licensees in Exmouth Gulf have actively taken a role in initiating day-to-day changes to industry closure lines to optimise size and value of the prawns caught.

Without fleet reduction and the subsequent flexible management approach, economic returns would be much lower today. But, attempts to manage trawling efficiency have not kept pace with rising costs and falling prawn prices. The industry is again at a crossroad over declining profitability and requires further management changes to reduce catching costs. Licensees in both fisheries are considering further steps to maintain profitability, including removal of additional licences from each fishery. Fortunately, the record of cooperation between government and industry positions this industry to implement these kinds of strategies.

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Towards self-management for the Western King Prawn Fishery in Spencer Gulf, South Australia

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1. INTRODUCTION

Western king prawns *(Melicertus latisulcatus)* were first trawled from Spencer Gulf by the Fishery Investigations Ship *Endeavour* in 1909. A Danish seine boat made the first unsuccessful attempt at commercial prawn trawling in Spencer Gulf in 1948. The South Australian Department of Fisheries and Fauna Conservation carried out exploratory trawling on a number of occasions between 1957 and 1964, again with no commercial success. Some Port Lincoln fishermen had limited success in 1961.

The industry showed its true potential in 1967. A trawl fisherman began an extensive resource survey of Spencer Gulf in July 1967. After two and a half months of surveying the southern area during daylight and dark, he finally caught the first commercial quantity of prawns from the bend of the "Gutter" in October 1967. Other fishermen joined the new fishery and it rapidly developed. In March 1968, the then Director of Fisheries closed all South Australian waters to trawling and 25 permits for prawn fishing were granted. These early management measures were critical in preventing over-exploitation of the resource and over-capitalisation within the fishery.

In 1981, the first prawn trawl surveys were conducted. These structured surveys were carried out on several occasions throughout the year and aimed at improving the understanding of the distribution and abundance of prawns in the gulf. From these surveys, the first harvest strategies were developed. Over time, industry and government collaboratively improved harvest strategies such that mean harvested prawn size has increased dramatically, trawl effort has halved and catches are optimised for growth and recruitment success.

The Spencer Gulf and West Coast Prawn Fishermen's Association (the Association) was formed near the inception of the fishery in 1968 and has played an increasingly important role in the management of the fishery over time. While fishers were key drivers in harvest strategy development from its onset, the introduction of the *Fisheries (Management Committees) Regulations 1995* provided the industry with a formal role in co-management. Fisheries Management Committees (FMCs) were developed for each South Australian commercial fishery and are responsible for providing advice to the Minister (and Director of Fisheries) on matters regarding management of the fishery.

Today, the Association has a strong membership base, a sound governance structure and is economically self-sufficient. It applies and promotes ecologically sustainable fishing practices and actively endorses the product and management of the fishery. While the imminent introduction of the new *Fisheries Management Act 2007* in South Australia signals the end of the FMCs, its legislation provides even greater opportunity for industries such as the Spencer Gulf prawn fishery to move toward greater self-management.

2. FISHERY DESCRIPTION AND HISTORY

2.1 The Spencer Gulf prawn fishery

The Spencer Gulf prawn fishery includes all South Australian waters of Spencer Gulf that are north of the geodesic line joining Cape Catastrophe, Eyre Peninsula and Cape Spencer, Yorke Peninsula (Figure 1). Commercial fishery licence holders in the Spencer Gulf fishery may engage in the taking of western king prawn (*Melicertus latisulcatus*)[1] by trawling. In addition, commercial licence holders are permitted to retain two by-product species taken incidentally in fishing operations [slipper lobster, *(Ibacus* spp.) and southern calamary *(Sepioteuthis australis)*].

There are 39 commercial fishery licences issued for the Spencer Gulf prawn fishery and registered vessels operate almost exclusively in this fishery. No new licences can be issued under the regulations. There is effectively no recreational fishery for western king prawns in South Australia, due to regulations that prohibit the taking of western king prawns in waters less than 10 metres depth.

FIGURE 1
Spencer Gulf prawn fishery showing statistical catch and effort reporting blocks

Commercial fishing is undertaken using the demersal otter trawl technique, which consists of towing a funnel-shaped net leading into a bag (commonly referred to as a cod end) over the sea bottom behind a boat. Otter boards (or doors) are used to keep the trawl nets open horizontally while being towed. A separate large-mesh bag (crab bag) acts to retain blue crabs and large fish, sharks and rays, while prawns flow through to the cod end. The crab bag reduces blue crab mortality and incidental damage to prawns.

Trawling is undertaken during the night anytime between sunset and sunrise, depending on the season. Trawl shots are of short duration relative to other prawn fisheries, averaging approximately one hour. After each shot, the cod end is emptied straight into a hopper system, which immerses the catch in seawater prior to sorting. The contents of the crab bags are spilt onto sorting tables with separation racks fitted. These racks reduce the time to sort prawns retained in the crab bag from all other bycatch, increasing

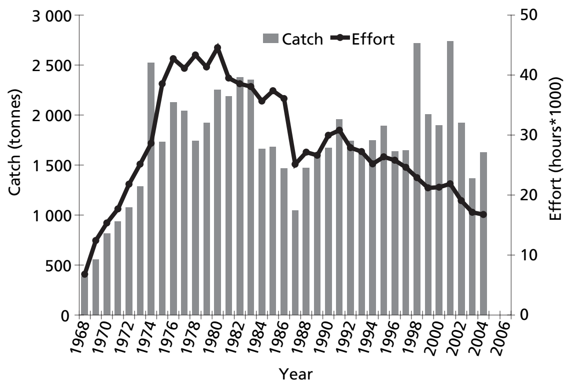
[1] The taxonomical classification of the subgenus of *Penaeus* has recently been revised to the generic level of *Melicertus* (Perez Farfante & Kensley 1997). The new species name for western king prawn is accordingly *Melicertus latisulcatus.*[Pérez Farfante, I. & B. Kensley (1997)]

bycatch survival by minimising handling and ensuring a rapid return to the sea.

After separation, prawns are graded either mechanically or by hand. The prawns are then either cooked before being packed or packed unprocessed to suit market demand and snap frozen. Some catch is still stored in large built-in refrigerated brine tanks before delivery to on-shore processing facilities. At the end of each fishing trip, the catch is off-loaded and either consigned as frozen product direct to markets or transported to fish processing factories for packaging or value-added processing. Major ports for the Spencer Gulf fleet are Port Lincoln, Wallaroo (south of Port Broughton), Port Adelaide (about 150 km east, in Gulf St. Vincent) and Port Pirie (Figure 1).

FIGURE 2

Catch (t) and effort (trawl hours) for the Spencer Gulf prawn fishery from 1966 to 2006



Catch and effort data have been collected for the fishery since its inception in 1968 (see Figure 2). Catches from the fishery increased rapidly from 1968, reaching 2 521 tonnes in 1974. Annual catches thereafter have generally ranged between 1 400 and 2 400 t, averaging almost 1 900 t during that period. Effort peaked during 1980 at 44 563 trawl hours. Thereafter, effort has declined regularly and significantly. The peak catch of the fishery (2 739 t) was obtained in 2001 and required less than 50 percent of the effort expended during 1980 (Figure 2).

Economic reporting on the fishery shows that the average vessel catch over the past ten seasons (years) ranges between 43 and 60 tonnes a vessel, with a current average beach price of A$17 a kilogram. To counter price pressures from cultured prawns, the industry has invested in a marketing strategy and developed a brand name to position their product in both domestic and international markets.

2.2 Biological characteristics

Prawns are crustaceans with five pairs of swimming legs (pleopods) as well as five pairs of walking legs (pereiopods), with the front three having claws. Although they are capable of swimming, prawns spend most of their life on or close to the seabed. They are nocturnal and some species burrow into the seabed during the day, emerging at night to feed.

From about 12 months of age, female western king prawns mature and spawn in the deeper waters of the Gulf (15–60 metres). Spawning occurs between November and March with peak activity occurring in two waves – late November/early December and late January/early February. Mating occurs between hard shell males and soft shell (recently moulted) females. Prawns can become mature as small as 25 millimetres CL (carapace length), but the proportion that mature at this size is small. Fertilisation success increases with increasing size. Each fertilised female can release between 60 000 to 800 000 eggs, with proportionately more eggs released per unit of body weight and increasing size.

After fertilisation, larvae undergo morphological changes and develop from nauplii, then myses, and finally into post-larval stages during four to five weeks of planktonic larval life. The success of larval dispersal to favourable nursery habitats is an important factor affecting reproductive success. During this period of dispersal, high mortality occurs.

Post larvae grow rapidly and juvenile prawns remain in the nursery areas for between 5 to 10 months, depending on the timing of settlement and water temperature. They then move offshore into the deeper waters at a size of 20 to 28 millimetres CL as new recruits. The major nursery areas for the fishery are found in northern Spencer Gulf, predominately on the western side, though recruitment can occur over most of the extent of the Spencer Gulf coastline. There is a strong relationship between the number of spawners and recruits (Dixon, Roberts and Hooper, 2006; Dixon and Sloan, 2007).

The growth of prawns is seasonal with maximum growth occurring in autumn, as spring and summer energy is mostly directed to reproduction. Little growth takes place between July and December. Temperature alone does not control growth, which is also subject to a number of other factors such as spawning date, tidal amplitude and day length. The growth rate of females is faster than males, with substantial differences in sizes for prawns from two to three years of age. Annual differences in growth rates also occur and these can significantly affect the quantities of annual harvest. There are large annual and regional differences in survival and density-dependent mortality that may be important in regulating population numbers.

2.3 Ecological characteristics

In Spencer Gulf, western king prawns prefer to live in depressed gutters comprised of soft, sandy substrate into which they are able to burrow. As with all trawling methods used in the fishing industry, the demersal otter trawl technique used in Spencer Gulf may cause damage to the benthos. There are, however, some mitigating factors that tend to minimise adverse effects on the ecology of the regions fished. These include:

i. Prawn trawling only occurs on sandy or mud bottom where the water is relatively deep (> 10 metres). Accordingly, fishing does not take place over fragile sea-grass areas. In addition, a number of permanent closures in waters greater than 10 metres depth have been introduced to protect environmentally sensitive areas (i.e. areas with high catches of important or abundant bycatch species).
ii. The prawn fishery is spatially focussed in a relatively small area of Spencer Gulf and fishing is limited to approximately 50 nights a year. While catch has remained relatively stable since 1974, commercial trawling hours have more than halved (Figure 2).
iii. The legislation under which these fisheries operate specifically prohibits the taking of the majority of fish and blue crab bycatch species. While some of the bycatch taken in the trawling process does not survive, a high proportion does survive due to the short trawling times and the use of hopper systems and 'crab bags', which allow bycatch to be immediately returned to the sea.
iv. Fishers are sensitive to the goal of reducing bycatch and support bycatch studies (Carrick, 1997, 1999; Dixon, Svane and Ward, 2005; Svane, 2002; Svane, Rodda and Thomas, 2007), which describe the type, variety and number of marine organisms that find their way into the trawl nets.
v. The Prawn Fisheries Management Committee has strongly supported trawl research and technological development to further reduce bycatch.

Prawns are more commonly associated with warmer tropical or sub-tropical water regimes. The Gulfs of South Australia are considered unique in being at the lower limit of temperature tolerance for the western king prawn. The high seasonal variability in water temperatures in the Gulf has a considerable influence on the species biology and behaviour. Of particular importance is the impact of water temperature on growth, spawning and catchability.

Prawns are far less susceptible to capture during daylight hours. Catchability of prawns is also strongly related to the phase of the moon, with highest catch rates during the dark phase of the moon. The proportion of soft-shelled prawns increases over the full to last quarter moon phase in some months, which can result in reduced returns through lower prices.

These biological and behavioural responses to the environment are important drivers in the determination of appropriate fishing strategies. Understanding each of these ecological factors is paramount for the effective management of the fishery.

3. MANAGEMENT

3.1 Regulatory management history

In March 1968, all South Australian waters were closed to trawling and 40 permits for prawn fishing were offered. Of those, only 25 were taken up. The fishery was split into two management zones and all waters less than 10 metres depth were permanently closed to trawling. The *Preservation of Prawn Resources Regulations 1969* provided fishers with a licence to fish for prawns. The number of licences was cautiously increased as knowledge of the resource improved. In 1971, the two management zones were merged and licences restricted to 39 boats.

The *Fisheries Act 1982* (the Act) provides a broad statutory framework to ensure the ecologically sustainable management of South Australia's fisheries resources. The two key objectives of the Act are:

i. ensuring, through proper conservation, preservation and fisheries management measures, that the living resources of the waters to which this Act applies are not endangered or overexploited and
ii. achieving the optimum utilisation and equitable distribution of those resources.

The Act establishes a set of regulation-making powers to formalise a co-management process for fisheries management in South Australia. The *Fisheries (Management Committees) Regulations 1995* outlined a set of co-management principles and established a number of Fisheries Management Committees (FMCs) for key fisheries or groups of fisheries, including the Prawn Fisheries Management Committee (the Prawn FMC). Each FMC is led by an independent chair and comprises commercial fishers, a Government policy manager, a fishery scientist and a recreational fishing representative. Corporate objectives and goals of each FMC are described in a five-year strategic and business plan. The FMCs have provided the principal forum for input into fisheries management and research issues for all stakeholders of South Australian fisheries since 1995.

Management arrangements developed by the Association, in consultation with Government, are raised and endorsed through the FMC process. For example, the Association recently developed an Environmental Management System (EMS) that was endorsed through the FMC and then applied in the fishery. In another example, prior to each fishing period, harvest strategies are developed by an Association sub-committee and ratified through the FMC. This co-management process has enabled the Association to demonstrate its capacity to develop and implement management arrangements that ensure the ecologically sustainable management of the fishery.

3.2 Current regulations and management arrangements

The regulations that currently govern the management of the Spencer Gulf Prawn Fishery are the *Fisheries (Scheme of Management – Prawn Fisheries) Regulations 2006* and the *Fisheries (General) Regulations 2000*. Table 1 provides an overview of the current management arrangements for the fishery.

There are 39 fishers licensed to harvest western king prawn in Spencer Gulf. They are also permitted to harvest slipper lobster and southern calamary, which are a common bycatch. Licences are transferable and corporate ownership is permitted. Any boat used in the fishery must be registered and be appropriately endorsed upon the licence under which it is being operated. Boats must not exceed an overall length of 22 metres and the main engine must not exceed 365 continuous brake horsepower. Both single and double rigged otter trawl nets are permitted to be used in the fishery with a minimum cod-end mesh size of 4.5 centimetres and a

TABLE 1
Management controls in the Spencer Gulf Prawn Fishery

Management tool	Current restriction
Permitted species	Western king prawn (*Melicertus latisulcatus*), Slipper lobster (Ibacus spp.), Southern calamary (*Sepioteuthis australis*)
Limited entry	39 licences
Licence transferability	Permitted
Corporate ownership	Permitted
Spatial and temporal closures	Adjusted based on survey results
Closed areas	No trawling in waters shallower than 10m
Method of capture	Demersal otter trawl
Trawl rig	Single or double rig
Trawling times	Not during daylight hours
Maximum headline length	29.26 m
Minimum mesh size	4.5 cm
Maximum vessel length	22 m
Maximum vessel power	365 brake horse power
Catch and effort data	Daily and monthly logbook submitted monthly (by trawl shot)
Landing locations	Landings permitted anywhere in the State
Landing times	Landings permitted at any time during the season
Season	November, December, March to June

maximum headline length of 29.26 metres. The headline length of any single prawn trawl net used in a double rig must not exceed 14.63 metres.

In addition to the permanent closure of shallow waters (<10 m depth) to trawling introduced in 1968, a series of areas closures (north of Point Lowly, north of Port Broughton, Arno Bay, Cowell, Port Pirie and Port Victoria) have since been voluntarily introduced by the Association. These closures have been implemented to protect important habitats, juvenile prawn grounds and the benthic communities they support. The remaining trawl grounds are primarily sand and mud sediments, with relatively low species diversity and biomass. As harvest strategies developed and fishing became more efficient, seasonal closures have been introduced, so that today, fishing only occurs during November, December and March to June. These seasonal closures aim to protect the spawning biomass, to maximise value by allowing for sufficient growth and to maximize capture efficiency, which is lowest during winter months.

3.3 Prawn surveys

Prawn stock surveys using industry vessels have been regularly conducted in the Spencer Gulf since 1981. Initially, the location and timing of survey shots were highly variable as fishers and researchers tried to obtain an understanding of the distribution and abundance of prawns throughout the gulf that underpined a biological understanding of the resource. Today, surveys have developed to meet the real time management needs of the fishery.

There are two types of prawn stock surveys conducted: stock assessment surveys and spot surveys. Stock assessment surveys are carried out three times a fishing season. The primary aim of stock assessment surveys is to obtain a snapshot of the status of the resource, to provide assurance that harvest strategies are sustainable. Stock assessment survey data are one of the critical elements for assessment of the fishery (Carrick, 2003; Dixon, Roberts and Ward, 2005, Dixon; Roberts and Hooper, 2006). They provide data on relative biomass, prawn size, distribution and abundance, recruitment to the fishery and data on spawning and reproduction.

There are 209 trawl shots conducted throughout the Gulf during each stock assessment survey. These survey shots are repeated at the same locations and times each year, to be directly comparable. The first stock assessment survey is in November, prior to the commencement of the fishing season. The second survey in February is to assess the resource after the November/December harvest period, prior to fishing in March. The third survey is conducted in April, toward the end of the season and during the period with the highest commercial catches per night.

Stock assessment surveys also provide essential information for the development of harvest strategies. The overall status of the resource, determined from average catch rates observed on surveys, as well as the distribution, abundance and size data obtained from these surveys are used to determine closure lines for fishing.

Spot surveys are smaller, targeted surveys that are conducted between stock assessment surveys. They are generally conducted in areas that were previously closed in the hope of being able to include new areas in a revised harvest strategy. Therefore, the location and timing of spot surveys are determined by industry, based on their expectations of changes in the distribution of prawn stocks. New areas are not opened to fishing unless data from a stock assessment or spot survey suggest that it is appropriate.

Survey shots are generally 30 minutes in duration and are located using GPS to ensure consistency. Stock assessment surveys are always conducted during the dark phase of the moon in the same month each year, as catch rates are significantly affected by the moon phase (catch rates are highest during the dark phase of the moon). Spot surveys may be conducted during any moon phase. The data collected on stock assessment and spot surveys include total catch, data on prawn size and trawl time and distance. Additional information is collected on stock assessment surveys to further inform fishery assessment.

Stock assessment surveys are jointly co-ordinated by the Association and the South Australian Research and Development Institute (SARDI) to ensure independence in the information collected. Spot surveys are entirely co-ordinated by the Association. The Government annually issues an authority for the Association to conduct surveys when necessary. Within this authority, the Association must inform the Fisheries Agency of the details of the survey, including details of participating vessels and survey locations. The Association has contractual arrangements with licensed vessels, such that the licensed vessel can conduct surveys on their behalf. Vessels are paid a fixed amount for their services. Survey vessels must process the catch in the manner specified by the Association and all the catch proceeds of the catch are administered by the Association to offset the cost of the surveys.

3.4 Management Plan

The powers contained in the *Fisheries (Management Committees) Regulations 1995* provide the legal basis for the preparation of the Management Plan (Dixon and Sloan, 2007). The Management Plan is an expression of the policy that applies in relation to the Spencer Gulf Prawn Fishery to inform the exercise of any discretionary decision-making powers in the legislation as they apply to the fishery.

There are four key management goals identified in the Management Plan that have been developed by the Prawn FMC:

i. Maintain ecologically sustainable stock levels
ii. Ensure optimum utilisation and equitable distribution
iii. Minimize impacts on the ecosystem and
iv. Enable effective management with greater industry involvement.

Each of these goals is linked to a set of objectives and strategies that operationalise the management goals (Table 2). This comprehensive list demonstrates the competing and compatible management outcomes that the prawn industry and fisheries agency are pursuing to implement an ecosystem-based management approach to fishing. The Management Plan covers both ecological and economic objectives. The Plan recognizes that maximising the value of the resource requires decisions that optimise value (by targeting larger prawns and areas with high catch rates) and reduce fishing costs. High

TABLE 2

Management goals, objectives and strategies for management of the Spencer Gulf Prawn Fishery during 2007–11

Goal	Objective	Strategies
1. Maintain ecologically sustainable prawn biomass	a. Spencer Gulf prawn stocks harvested at ecologically sustainable levels	• Maintain a restriction on the number of licences and the total amount of gear in the fishery. • Develop spatially and temporally explicit harvest strategies for each fishing period in line with established target and limit reference levels and decision rules. • If the stock is determined to be operating below the established limits, the fishery will be managed to promote recovery to ecologically viable stock levels, within agreed timeframes.
	b. Sufficient biological and environmental information exists to inform management decisions.	• Collect fishery-dependent information through commercial logbooks. • Maintain the fishery-independent prawn survey program. • Assess the status of the stock through quantitative stock assessment. • Collect appropriate environmental data to aid assessment. • Review and update the strategic research and monitoring plan.
2. Ensure optimal utilization and equitable distribution	a. A fishery exploited for maximum economic value	• Within a framework of sustainable exploitation, develop harvest strategies that match target size with market requirements • When targets are reached, allow for higher exploitation levels to capture economic benefits from the fishery (subject to the constraints outlined under goal 1).
	b. An economically efficient fleet.	• Develop management arrangements that allow commercial operators to maximise operational flexibility and economic efficiency. • Undertake economic surveys of the commercial fishery to assess economic performance against a set of economic indicators.
	c. Equitable public access	• Review appropriateness of access arrangements between sectors once within the life of the Management Plan • Develop a mechanism for altering access arrangements should a change be required
3. Minimize impacts on the ecosystem	a. Minimize fishery impacts on by-catch and by-product species	• Maintain a limit on the amount of gear used in the fishery. • Maintain permanent closed areas. • Undertake a risk assessment to determine the vulnerability of by-catch and by-product species to overfishing from prawn trawling. • Develop mitigation strategies for bycatch and by-product species deemed at high risk of overfishing from prawn trawling. • Promote the development of environmentally friendly fishing practices.
	b. Avoid the incidental mortality of endangered, threatened and protected species	• Undertake a risk assessment to determine the vulnerability of endangered, threatened and protected species to fishing operations. • Improve data recording systems to capture fishing interactions with endangered, threatened and protected species. • Develop management measures to avoid interactions with endangered, threatened and protected species.
	c. Minimize fishery impacts on benthic habitat and associated species communities	• Maintain a limit on the amount of gear used in the fishery. • Maintain permanent closed areas. • Promote development of environmentally friendly fishing gear and fishing practices. • Develop strategies for assessment of impacts on habitat and associated species communities
4. Enable effective and participative management of the fishery	a. Industry delegated greater responsibility in management	• Industry manage the spot survey process and develop harvest strategies (with reference to PIRSA Fisheries and SARDI). • Industry manage all at-sea operations of the fleet. • Develop an improved industry decision-making structure to satisfy governance requirements. • Develop explicit allocation of prawn resources between sectors. • Develop a process for the industry association to review the necessary ecological assessment report to the CDEH for export accreditation.
	b. Management arrangements reflect concerns and interests of the wider community.	• Promote stakeholder input to the management of the fishery, through established co-management processes. • Ensure that social and cultural issues are given appropriate consideration when new management strategies are being developed. • Communicate management arrangements to the wider community.
	c. Management arrangements are complied with.	• Undertake annual compliance risk assessment. • Implement a cost-effective compliance and monitoring program to address identified risks. • Promote high levels of stakeholder stewardship through established management processes and Fishwatch activities.
	d. Costs of management of the fishery funded by relevant stakeholders	• Ensure stakeholders are involved in development of management arrangements for achieving management objectives • Determine the annual real costs of management, research and compliance for the fishery. • Recover an economic return from commercial licence holders, sufficient to cover the attributed costs of fisheries management, research and compliance in line with established cost recovery principles.

TABLE 3

Performance indicators for assessment of the Spencer Gulf Prawn Fishery

Objective	Performance Indicator	Limit Reference Point
1a	Recruitment index	>35
1a & 2a	Total commercial catch (t)	>1800
1a & 2a	Mean commercial CPUE (kg/hr)	>80
1b	Fishery independent surveys	3 surveys completed
1b	Stock assessment report	Completed
2b	Economic report	Completed
1a	Indices of future and current biomass	Neither index is below lower threshold levels in 2 consecutive surveys
2a	% vessel nights with mean size >280prawns/7 kg	<2%
2b	Gross Value of Production (GVP)	<0% change
2b	Management Costs	>10% increase
2b	Return on investment	<0% change
4a	Committee comply with harvest strategy decision rules	Committee develops all harvest strategies based on results of surveys and in accord with decision rules
4c	Fleet complies with harvest strategies	Fleet operates within prescribed open areas and times described in every harvest strategy

The limit reference point of <0% for return on investment is considered realistic as farmed prawns are driving prices down worldwide: the target is to try and maintain current value – which is a significant challenge in itself!

catch rates also reduce the area trawled and nights fished, reducing total bycatch and impacts on benthic communities.

The extent to which the Management Plan is achieving the range of stated goals and objectives is assessed using a combination of indicators designed to measure performance of the fishery. These performance indicators are assessed against reference points, which are agreed quantitative measures based on clearly defined management objectives. Reference points begin as conceptual criteria, which capture in broad terms the management objectives for the fishery. To implement fishery management, it must be possible to convert the conceptual reference point into a technical reference point, which can be calculated or quantified on the basis of biological or economic characteristics of the fishery (Caddy and McMahon, 1995).

Limit reference points are used for rational exploitation of the prawn resource and are defined as an agreed level above which stock stress may occur and immediate action is required to remedy the situation before long-term damage to resource productivity may result. The Prawn FMC has developed a range of performance indicators and limit reference points from which the fishery can be assessed, each relating to a specific objective of the Management Plan (Table 3).

If a limit reference point is exceeded, a number of explicit actions result:

i. The Minister for Agriculture, Food and Fisheries is notified and participants in the fishery, as appropriate.

ii. A detailed review is undertaken including an assessment of the additional performance measures where appropriate. (Additional performance measures are secondary performance indicators used to help inform assessment in case any of the primary performance indicators are breached.) A synopsis of the causes is to be provided and implications of failure to achieve the minimum desired performance.

iii. Where appropriate, key stakeholder groups are to be consulted regarding the need for alternative management strategies and the collection of additional data.

iv. A report is provided to the Minister within three months of the initial notification on the effects of breaching the performance indicator, including any recommendations on management strategies.

v. Minister or Director of Fisheries must consider recommendations, endorse supported strategies and implement them as appropriate.

TABLE 4
Management costs for the Spencer Gulf prawn fishery for 2005/06

Management activity	2005/06 $	Comments
Research Non Discretionary	331 728	Delivery of stock assessment that reports on fishery performance indicators
Economic Research Non Discretionary	18 613	Report on fishing input costs and market prices
Policy and Management Non Discretionary	67 012	Provision of management services from Fisheries Agency
Legislation Non Discretionary	9 802	Amendments to scheme of management or legal notices that regulate fishing
Licensing Non Discretionary	21 392	Cost to issue licences, collect annual fees and provide advice to licence holders
Compliance Non Discretionary	96 390	Fisheries Agency compliance operations to address fishery risk assessment high priorities
Directorate Non Discretionary	19 904	Service delivery contract management
Fishery Management Committee Discretionary	30 000	Operational expenditure for Fishery Management Committee (*e.g.,* meetings, correspondence, papers)
Extension Services Discretionary	132 609	Prawn industry extension services
Additional Services Discretionary	80 000	Committee At-Sea and Extension services
Fish Research & Development Corporation Levy Discretionary	100 725	National funding contribution based on 0.25% of rolling 3-year average GVP
Total	1 104 129	$28 311/licence

3.5 Cost Recovery for management programmes

There is a minimal administrative charge to register a boat with a prawn licence -A$68. However, the Spencer Gulf fishery licence fee for 2007/08 is A$25,959. Programmes required for management of the fishery are determined each year through consultation with the Prawn FMC. Programmes relate to policy management, research, licensing and legislation, compliance and discretionary industry services. Costs associated with these programmes for 2005/06 are documented in Table 4.

The costs of all programmes are determined through negotiation between the Fisheries Agency and the Fishery Management Committee. Non-discretionary programmes are essential for industry to fund; however, the level of service and associated costs can be negotiated. Where no agreement can be reached, the Minister makes a decision, which may support either the Fisheries Agency or the industry position. However, all parties have come to a realisation over time that it is in the best interests of all parties to determine the services and avoid reference to the political process, as this passes decision-making outside the control of the participants (particularly industry) and can lead to sub-optimal outcomes. Many services are requested by industry.

There have been no referrals to the Minister to determine services in recent years, due to the strong relationship between industry and agency managers and adherence by all parties to the fishery management goals.

3.6 Harvest strategy development and management

The regulations for harvest strategy development and management are documented in the Management Plan. Harvest strategies are the mechanism for managing fishing effort using spatial and temporal closures. Specifically, this involves the development of appropriate fishery closure lines (a series of GPS co-ordinates) and the dates of trawling. The primary aim of the harvest strategy is for the fleet to target areas of high catch rates of larger sized prawns to ensure biological sustainability and promote economic efficiency.

The harvest strategy functions at two scales: (a) harvest strategy development and (b), harvest strategy management. Harvest strategies are developed prior to the commencement of fishing during each harvest period. The development phase involves the determination of suitable areas of the fishery to open based on data obtained from surveys. Strategies are developed by industry, ratified through the FMC process and authorized by statutory notice.

Once established, the harvest strategy is managed on a daily, or even hourly, basis during the fishing as is run by the "Committee at Sea" (a group of vessel skippers that includes Association representatives and the appointed "co-ordinator at sea"). Management of the harvest strategy is refined from data obtained during commercial fishing and involves changing the area open to fishing to avoid areas with small prawns or low catch rates. This real-time management of the harvest strategy, which may be on an hourly basis, is unique to our knowledge within a trawl fishery.

The Committee at Sea became an organised body with the introduction of a Fishery Management Committee in 1985. The Committee at Sea is made up of nine members, the majority of whom are licence holders and the remainder boat skippers. The raw data on daily catches is not currently available to all fishers, but the industry is looking to establish an electronic logbook system that would support industry-wide communication. High catch-rate areas are identified for all fishers. The harvest strategy is determined by the Committee at Sea and relayed to the fleet through an industry-operated radio station.

4. INDUSTRY ROLE

The Committee at Sea makes decisions on the harvest strategy on a majority basis, following the objectives and performance indicators in the Management Plan. The Association Executive Committee also makes management decisions on a majority basis, operating formally with agendas and minutes. Under the current Fishery Management Committee structure, the Association would bring management issues to the table that are to be brought to the attention of the fisheries agency, particularly if some government intervention was required.

The 39 licences are owned by different companies, although there are close family and financial associations between some companies. There are six main prawn buyers, but many licence holders now consign their catch to domestic markets or export directly from the boat to reduce transaction costs on prawns sold to the retail sector. This maintains or increases the returns to the boats. Passing on price increases to the consumer is not realistic, so there is an incentive to ensure that costs in delivering to the market are reduced.

When prawn catch rates fall during a harvest period, it is up to the Committee at Sea to cease fishing. If prawns are considered to be too small, the Committee at Sea will cease fishing. The industry now has the capacity and maturity to manage the resource with a long term view, so fishing will cease if the opportunity cost of continuing does not meet the expected future return from leaving the prawns to spawn and grow. This mindset and understanding underpins the management success of this fishery.

5. DISCUSSION

There are several key elements to the management history of the Spencer Gulf prawn fishery that have enabled the industry to move toward a higher level of self-management. While much of the success of the fishery is attributed to the decision in 1968 to limit entry, collaborative relationships developed between industry and government have enabled greater delegation of management responsibility to industry over time. This delegation is based on the industry's demonstrated maturity and willingness to be responsible for management decisions and the actions of their Association members.

This collaborative relationship began in the 1980s and was strengthened when the *Fisheries (Management Committees) Regulations 1995* were established to provide a legal framework for co-management. Of South Australia's major fisheries resources, the Spencer Gulf prawn fishery has evolved further than other fisheries in the co-management process. This is amply demonstrated through the Association's involvement in harvest strategy development and real-time management, capacity development within the organisation, sound governance, decision-making arrangements and financial self-sufficiency.

The performance indicators and guidelines for harvest strategy development, which are key components of the Management Plan, provide confidence for the Minister and community that the resource is being managed sustainably and in an economically efficient manner. The ongoing, real-time research programme that underpins the data used for harvest strategy development and performance assessment is also regarded as an essential safeguard to the well-being of the fishery.

Harvest strategy guidelines are easily audited and as such the decisions of the industry in harvest strategy development can be assessed. Other non-biological performance indicators include the extent of compliance breaches and feedback control from the Committee at Sea. The effectiveness of the harvest strategy in terms of catch output (prawn size and magnitude of the catch) is also assessed. Other key biological performance indicators include relative biomass (catch rate) and recruitment to the fishery.

Reference points and performance indicators are reviewed periodically. Changes may occur to biological reference points as more scientific information on the stock status of the prawn fishery is provided from the strategic research programme. Other performance indicators may also change to ensure that the management of the fishery is subject to a continuous improvement programme.

Regardless of the level of responsibility provided to the industry for management, the ultimate responsibility for ecologically sustainable development of the prawn resource of Spencer Gulf rests with the Minister. As such, the Minister at all times retains the power to regain control of the fishery, should he deem that it is not being sustainably managed.

Under the current Act, the Minister delegates those day-to-day management responsibilities of the resource to the Prawn FMC. Improved fisheries legislation, soon to be proclaimed in South Australia, will allow for further delegation of management responsibility to certain fishing industry groups. This will include structuring their own programmes for the identification of fishery services and implementation of cost recovery for those services, without the Fisheries Agency funding those services through licence fees. The Fisheries Agency's role will shift more to an audit function, which ensures that the right governance arrangements are in place to provide for scientific reporting to validate that the fishery is being exploited under an agreed, ecologically-sustainable development framework. Notably, however, self-management does not imply that total responsibility for management rests with industry. A number of core functions, such as regulation and compliance prosecutions and auditing, will not be delegated, as they remain a core function of government.

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Cooperative management in the Queensland Finfish (Stout Whiting) Trawl Fishery

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1. INTRODUCTION

The Queensland finfish (stout whiting) trawl fishery is a demersal otter-trawl fishery. The fishery harvests stout whiting (*Sillago robusta*) (Photo 1) and permitted byproduct species off southern Queensland, from Sandy Cape on Fraser Island south to the city of Caloundra. The fishery is the only fishery in Queensland, and one of few in Australia, that is managed under cooperative management arrangements. Management of the fishery is undertaken via a combination of voluntary agreements, permits and legislation.

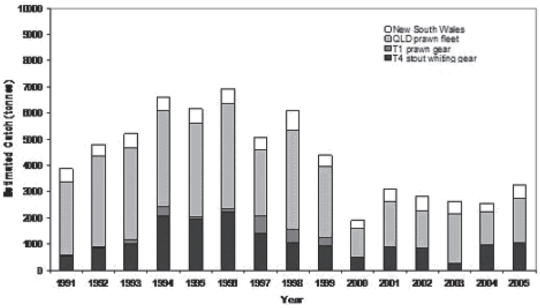
Stout whiting is an offshore whiting found on sandy bottoms across the northern states and territories of Australia from New South Wales on the east coast, through Queensland, around the Northern Territory and along the whole Western Australian west coast. It is a deepwater species and rarely exceeds 230 mm in length (generally about 170 mm). The fishery also takes small amounts of a similar species, red spot whiting (*Sillago flindersi*) (QFMA, 2000). Table 1 summarizes the major features of this fishery.

PHOTO 1
*Stout whiting (*Sillago robusta*)*

TABLE 1
Fishery profile

Total harvest of all species: approximately 1 167 t (in 2005)
Queensland stout whiting fishery harvest: 1 130 t (in 2005)
Recreational harvest: no estimate available but considered negligible.
Indigenous harvest: no estimate available but considered negligible.
Commercial Gross Value of Production (GVP): approximately A$2.5 million
Number of licences: five
Commercial boats accessing the fishery: five
Fishery season: 1 April – 31 December (excluding 20 September – 1 November)

FIGURE 1
Estimated total commercial catch of stout whiting



Stout whiting form fairly dense feeding schools on sandy bottoms but can also scatter more loosely. There is some evidence that juveniles congregate in inshore waters and move into deeper water as they mature. Most females reach sexual maturity at about 145 mm or at one year of age. The major spawning events occur during the spring and summer months between September and March.

The total estimated commercial catch of stout whiting from this stock in 2005 was around 3 000 tonnes (Figure 1). This figure is based on total stout whiting landings from logbook data in the fishery, an estimated total weight of stout whiting bycatch by the Queensland prawn fleet, and an estimated stout whiting harvest by the New South Wales prawn trawl fleet. Of this, 1 130 tonnes were caught and retained by the stout whiting fleet.

2. HISTORY OF THE FISHERY

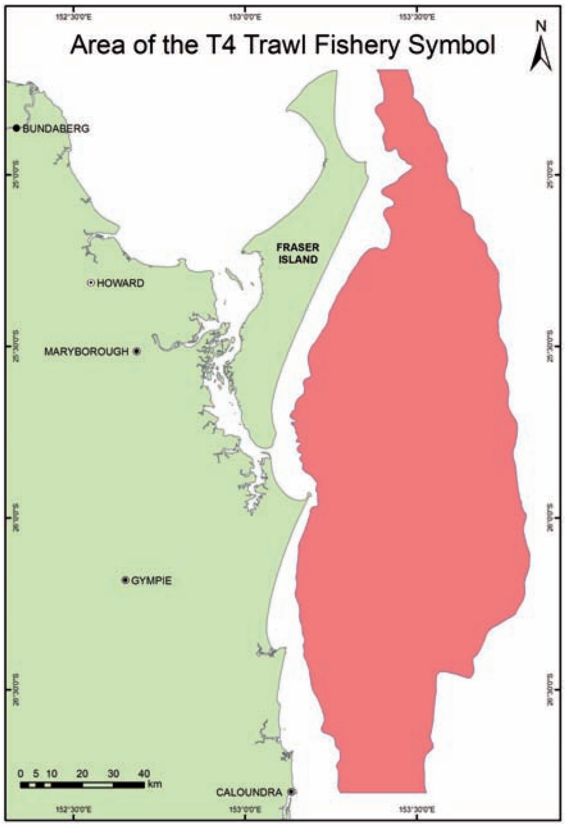
The fishery was established in 1981 on the south coast of Queensland. One operator fished for red spot whiting (*Sillago flindersi)* and progressively moved to target stout whiting (*Sillago robusta)* as exploration of new grounds provided evidence that a commercial fishery existed for this species. The fish were marketed at a relatively stable price of A$1.80/kg when the fishery commenced. Two more boats entered the fishery to satisfy demand. The product was sorted in a land-based factory and sold in 10 kg layered, frozen packs (QFMA, 2000).

At the same time, significant catch was taken as bycatch in the east coast otter-trawl fishery (ECOTF), which targets prawns and scallops. By 1984, up to 1 000 kg a day of stout whiting were being taken by prawn trawlers. The quality of this product did not satisfy market standards and with the entry of Thailand as a supplier into the market with a lower-priced product, the participation in this fishery shrank to the one original operator. This single operator continued in the fishery and up-graded equipment and fishing practices. This included using a large freezer with "snap" freezing capability and specialised hopper and conveyor equipment for at-sea sorting of the catch, which is a feature of the fishery today (Photo 2).

PHOTO 2
Catch after removal from hopper

The fishery underwent rapid expansion between 1989 and 1990 with more than ten boats reported being involved and landings of 1 789 tonnes of stout whiting in 1990. The market collapsed in 1991, which resulted in significant volumes of unsold catch and led to a consequent reduction in fishing effort. Since that time, the market has recovered and catches today average around 1 000 tonnes a year.

FIGURE 2
Area of the Fishery



3. HISTORICAL MANAGEMENT OF THE FISHERY

The fishery originated as a developmental fishery in the 1980s, when there was essentially open access to all of Queensland's commercial fisheries. The fishery was restructured in 1991 as a limited entry, developmental, fish-trawling fishery in the area between 20 and 50 fathoms between Caloundra and Sandy Cape. This fishery area continues today (Figure 2).

The licensing structure was refined under Queensland law with the introduction of the *Fisheries Act 1994* and the *Fisheries Regulation 1995*. The fishery moved from a developmental status to an established fishery with a specific finfish (T4) fishery symbol. Five commercial fishing licences received a T4 fishery symbol. Two of the licences were originally owned by one operator, which meant that there were four licence holders in the fishery (including two brothers). In late 2006 an existing licence holder bought one of the licences that came up for sale. For the 2007 season there are now two operators who own two licences; the two brothers own three of the five licences in the fishery. A fishing licence costs approximately $A5 000.

The new regulations prescribed the gear that can be used, the area and time of operation, and the two species that could be taken (stout and red spot whiting). At this same time, the original four participants in the fishery entered into a memorandum of understanding (MOU) with the Queensland Government. The agreement included a commitment to work together to monitor and assess that fishery and to develop new management arrangements where necessary. The MOU was used as a basis for cooperative management, particularly in the setting of a total allowable catch (TAC) (QFMA, 2000). Licences have changed hands three times since that original agreement. Each time the new licence holder has agreed with the spirit of the MOU and abided by agreements reached between government and other licence holders.

4. CURRENT MANAGEMENT ARRANGEMENTS

4.1 Limited entry

Queensland now has limited entry rules for all commercial fisheries in acknowledgment that existing Queensland commercial fisheries are considered to be fully exploited. Participation in the fishery is only possible by purchasing one of the five T4 fishery symbols and attaching that symbol to a primary commercial fishing boat licence.

4.2 Seasonal closures

The T4 fishing season is restricted (Sch. 14, Sec. 5, *Fisheries Regulation 1995*) to nine months between April and December by law. This four-month summer closure was implemented in the early stages of the fishery's development, when it was thought that January to April represented the major spawning season for stout whiting. Since that time, fisheries biologists have identified that the gonado-somatic index for both male and female stout whiting peaks between August and October, which indicates greater spawning activity during those months (O'Neill *et al.*, 2003). The current closure does, however, continue to have benefits for spawning, even though the ECOTF continues to operate over the stout whiting grounds during the closure.

In 1999, a new southern closure was introduced in the ECOTF for all waters south of latitude 22 °S between 20 September and 1 November each year (Sec. 11, *Fisheries [East Coast Trawl] Management Plan 1999*). This covers the entire area of the stout whiting fishery. While this closure does not apply in law to the stout whiting fishery, the stout whiting licence holders have agreed not to work during the ECOTF closure to minimize conflict with the ECOTF licence holders. It is likely that as a result of stout whiting fishers voluntarily 'sitting out' the ECOTF southern closure, stout whiting are provided with a significant benefit in terms of spawning protection.

4.3 Fishery area

Operators are restricted to fishing only in the stout whiting fishery area. This area is defined in legislation as the area between the 20 and 50 fathom depth contours from Sandy Cape (northern tip of Fraser Island) to Caloundra (Sch. 14, Sec. 2, *Fisheries Regulation 1995)* (See Figure 2.) The stock is afforded protection insofar that juvenile stout whiting inhabit shallower waters outside of the permitted fishery area, which therefore reduces the level of fishing mortality on juvenile stout whiting.

In addition to the protection that the inshore boundary of the fishing area provides, adult stout whiting are also found in large quantities both north and south of the fishery area. Genetic analysis has shown that stout whiting from Bustard Head (near Gladstone) to the north and the northern waters of the state of New South Wales to the south are likely to be a single stock (Ovenden and Butcher, 1999).

There is only one spatial closure within the T4 fishery area. This closure was introduced in late 2003 for the protection of a key aggregation site for grey nurse sharks (*Carcharias taurus*) (Sch. 2, Sec. 40F, *Fisheries Regulation 1995).*

4.4 Gear restrictions

While the voluntary TAC (an output control) is the major form of management, there are also a number of input controls relevant to the T4 fishery in the form of gear restrictions. Total net length (combined head rope and foot rope) is restricted to a length of 88 m (Sch. 14, Sec. 4[2], *Fisheries Regulation 1995)*. This is the same overall size as is permitted in the ECOTF. In contrast to the ECOTF, the stout whiting licence holders are allowed to employ long sweeps to herd the target species into the net. Sweeps are restricted to a maximum length of 128 m each (Sch. 14, Sec. 4[4], *Fisheries Regulation 1995)*. Mesh size is also regulated, with a minimum requirement of 38 mm and a maximum mesh size of 60 mm (Sch. 14, Sec. 4[2], *Fisheries Regulation 1995)*. This mesh size also matches that applicable to most of the prawn fishery.

In late 2006, one licence holder was issued a permit to test modified Danish seine gear (see AFMA, 2007), using the existing trawl net and sweeps without otter boards. Under the permit, each warp of the seine was limited to a maximum of 2 500 m. The trial proved a success. Initial results showed greater selectivity for the target species, which led to greater productivity during sorting and increased product quality as a result of reduced bycatch. Some cost savings from reduced fuel use were also observed.

TABLE 2
Permitted byproduct species

Common name	Species name	Quantity
Pinkies	Family Nemipteridae	41 box* trip limit
Octopus	*Octopus* sp.	20 boxes* trip limit
Cuttlefish	*Metasepia* sp. and *Sepia* spp.	52 boxes* trip limit
Squid	*Loliolus* sp., *Notodarus* spp., *Photololigo* spp. and *Sepioteuthis* spp.	52 boxes* trip limit
Balmain bugs	*Ibacus* spp.	No limit, but 10 cm minimum carapace width
Moreton Bay bugs	*Thenus* spp.	No limit, but 7.5 cm minimum carapace width

* Refers to the standard '5 kg' box, which may hold more than 5 kg of product.

The permit has been extended for the whole 2007 fishing season in order to assess its performance throughout the year.

Turtle excluder devices (TEDs) have been introduced incrementally throughout the various trawl fisheries of Queensland since 1999. Initial concerns were raised over logistical difficulties in installing and using TEDs when targeting stout whiting. However, TED trials have been undertaken during recent years, allowing some initial issues with gear modification to be resolved. Commercial fishers operating in the fishery are now required as part of their licence condition to have a TED fitted to their nets when operating in the fishery.

4.5 Permitted species

Under the *Fisheries Regulation 1995*, stout whiting fishers are permitted to retain stout whiting and red spot whiting. The vast majority of catch is made up of stout whiting and this forms the basis of the fishery assessment. However, since 2002, T4 licence holders have been granted permits to enable them to be able to retain additional species that are taken incidentally while targeting stout whiting. These permits allow trip limits for a number of species (see Table 2). Permits are issued annually and only vary slightly from year-to-year, as operators generally seek standard species and trip limits.

When the fishery first commenced operators would routinely retain any species they caught for which they had a market. With increasing pressures to demonstrate sustainable fishing practices, and with a government desire to stop the fishery from becoming a multi-species target fishery, operators were asked to restrict their catch to those species prescribed under law (i.e. stout and red spot whiting) in 1999.

The introduction in 2002 of the permit to retain other species that are part of the genuine bycatch from targeting stout whiting came about through discussions between managers, scientists and operators. Operators successfully argued that some species were a genuine incidental catch and that their return to the water was a waste of what could be a valuable resource.

4.6 Bycatch of stout whiting in other fisheries

Stout whiting is also taken by a number of prawn trawl operators from New South Wales where they fish part of the same stock. Prior to 2000, these fish were also retained in the ECOTF. However, since 2000, participants in the ECOTF have not been permitted to retain stout whiting as by-product to their prawn trawl operations and it now makes up part of the discarded bycatch in that fishery. Bycatch of stout whiting has been declining in the ECOTF in recent years as a result of fewer participants in the fishery (down from approximately 850 licences in 1999 to approximately 450 in 2006) and the introduction of bycatch reduction devices. Both appear to have had a positive impact on the stout whiting biomass.

5. VOLUNTARY TOTAL ALLOWABLE CATCH

5.1 Stock assessment

The harvest is managed via a voluntary TAC for the coming season. In previous years, the TAC was determined after completion of an annual stock assessment. In January 2007, fisheries managers, researchers, and operators agreed to use a new, simplified framework for setting the 2007 T4 stout whiting quota. Under the new arrangements, a full stock assessment will be undertaken every five years.

The methods used in the stock assessments have varied as the knowledge of the stock and modelling expertise has developed. In years prior to 2003, assessments relied upon time dynamic models, such as a virtual population analysis (VPA) and the surplus production model (SPM). In 2003, a statistical catch-at-age model was employed. While this model is not dissimilar to the VPA, it uses a far greater range of fishery parameters. It also analysed the stock status on a monthly basis, which provided a more robust assessment of the exploitable population. The model and fishery parameters are described more fully in O'Neill *et al.* (2003). This dynamic catch-at-age model fed into a Management Strategy Evaluation (MSE) that helped set the TAC.

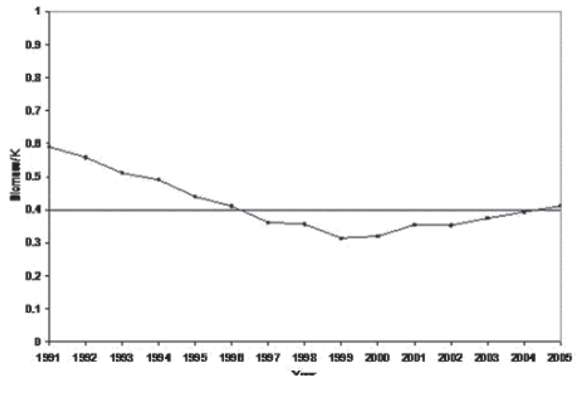
The stock assessment models infer stock status by using the age of fish that are being exploited from year to year. The age structure of the fished population is estimated using length-at-age information that is collected from samples of stout whiting supplied by the licence holders. Catch-per-unit effort is recorded for each of the five boats on an hourly basis and standardised according to the individual boat, skipper, the type and size of net employed, lunar phase, region, and other factors that can influence the catching ability of a boat. Licence holders have agreed to provide this level of detail to ensure that the stock assessments are as robust as possible.

Licence holders play a vital role in the provision of this data. The collection, processing, and analysis of the fish samples are also funded through the licence fees paid by fishers. This licence fee (A$5 000) was originally stipulated through the MOU and was designed to fully fund the annual stock assessment work. This fee has been formalised more recently through a review of the all Queensland licences and fees to ensure fees are based on property rights and it is now contained within the *Fisheries Regulation 1995*.

The Queensland Government has also introduced independent fisheries observers into the fishery to help collect more detailed information and to validate the information that operators supply through logbooks. Licence holders voluntarily provide random catch samples to the Department's Long Term Monitoring Program for age analysis.

The last stock assessment in 2006, based on 2005 data, showed the fishery biomass continuing to recover from a low in 1999 (Figure 3). Current estimates place the stock at greater that 40 percent of virgin biomass, which is the limit reference point for the fishery. While there has been no timeframe set, the objective is to maintain this fishery at a level allowing maximum sustainable yield (MSY).

FIGURE 3
Stout whiting estimated biomass ratio for 1991–2005 (K= estimated virgin biomass)



5.2 Setting the TAC

The TAC for the fishery is a voluntary management arrangement. This is a reflection of the professional relationship that exists between licence holders and managers and research staff from the Queensland Department of Primary Industries and Fisheries (DPI&F).

The new framework, the Total Allowable Catch Table (TACT), is a system that specifies annually adjustments to the quota based on the changes in standardised catch-rates and fish catch-at-age frequencies (catch curves). The TACT has a matrix of these two variables that triggers an adjustment to the previous year's TAC. When CPUE rates are in the upper 25 percent of the historic distribution of these rates, the TACT recommends adjusting the TAC upward. When the CPUE is in the lower 25 percent of the historic distribution of catch rates, the TACT recommends adjusting the TAC downwardsWhen fishing mortality is low, the population age distribution is skewed toward older fish and the TAC is adjusted upward as indicated by the TCAT. When fishing mortality is high, the population distribution is skewed toward younger fish and the management recommendation is to reduce the TAC. The TACT will recommended an adjustment to either (a) keep the TAC the same, (b) increase the TAC by 50 or 100 t or (c), decrease the TAC by 50 or 100 t. Table 3 shows the exact interaction of the two parameters.

TABLE 3
Total allowable catch table (TACT)

Age structure	Standardized catch rate (percentile)		
Z (slope)[1]	> 75 percentile	25–75 percentile	<25 percentile
Low[2]	+100T	50T	0
Between	+50T	0	-50T
High[3]	0	-50T	-100T

[1] The low and high thresholds for Z are based on relationship 1.5*M
[2] *M* = 0.55
[3] *M*=0.7; low threshold = 0.825, high threshold = 1.05.

The TAC for each season is discussed in or around March each year via a joint industry and DPI&F meeting. Licence holders play an active role in providing information for the stock assessment and anecdotal information on the fishery performance. At this meeting, stock assessment modellers and fisheries biologists explain the data and the recommendations of the TACT to the fishers and fishery managers. This is followed by open discussion about the applicability of the TACT results, which includes discussion of real and perceived weaknesses in the data upon which it relied. The sometimes-difficult discussion has always resulted in an agreement regarding the TAC to be adopted for the coming season. Negotiations regarding the TAC do not follow any particular or pre-defined format, but vary according to the results of the stock assessment, the TACT, and the data that was obtained during the preceding season. Through ongoing involvement in this process, the licence holders have had significant exposure to stock assessment results and are now able to adopt an informed, precautionary attitude towards the setting of the annual TAC.

Once agreed, the TAC is evenly divided among the five licences. An equal division of the quota was a feature of the original agreement between operators in the mid-1990s. The agreed allocation was in recognition of equal licence fees paid by each licence holder and the similar catch levels between each operation at the time.

For 2007, the agreed TAC was 1 250 tonnes or 250 tonnes a boat, which was a 50-tonne increase recommended by the TACT over the previous season's 1 200 tonnes. The DPI&F monitors the total catch throughout the fishing year. Most years there is some underfishing or overfishing of quota by individuals, but this, to date, has not resulted in the TAC being exceeded. Total catches are reported to the public in an annual status report each year and operators are aware of other participants' catch totals through the season by sharing information with each other. If the TAC were to be exceeded in a given year, all operators are aware that the flexibility afforded through cooperative management arrangements would be put at risk and that the DPI&F may need to take a more prescriptive approach to ensure sustainable fishing practices.

In the past, quota has only been traded on a limited basis in private agreements between two licence holders without the DPI&F knowledge. In late 2006 one of the existing licence holders bought another of the five licences in the fishery and requested that the catch quota from that licence be amalgamated into their existing licence effectively resulting in 4 boats working in the fishery. This prompted calls from all licence holders to have more transparent arrangements for quota trading. From 2007, licence holders agreed that quota would be included as a licence condition to allow for the tracking of quota as it is traded privately between the five licence holders. The initial 2007 quota for each licence will be written as a licence condition by the DPI&F and those conditions could then be amended through an agreement between the operators who trade quota. Only a minimal transaction fee is charged for each amendment of a licence to reflect the quota trading. Operators agreed to this approach in an attempt to use the whole TAC in the 2007 year. Operators believed this was important, as in previous years each boat would start fishing but inevitably some boats failed to catch their quota within the prescribed season due to weather, breakdowns or opportunities presenting themselves in other fisheries.

6. OTHER INDUSTRY SELF-GOVERNANCE STEPS

For this fishery, the DPI&F has used a regulatory approach to implement a basic management framework for fishery management measures. In recognition of the small size of the fishery and the cooperative relationships forged by licence holders, researchers and fishery managers, a more flexible approach has been taken with some finer scale management arrangements. An industry meeting is held a few weeks before the start of each season with all licence holders, scientists and managers present. A review of the previous season occurs and views are expressed and debated about stock status and management arrangements. Agreements are made at this meeting and a record of those agreements maintained by the DPI&F fisheries managers.

Consequently, management of this fishery is split between a basic regulatory framework and a range of voluntary arrangements that are agreed to by managers, industry participants and researchers. Table 4 lists those management controls and their nature.

The fishery was granted a wildlife trade operation (WTO) approval in November 2004 under Australian Government environmental legislation on the basis of existing management arrangements and cooperative agreements. This accreditation acknowledges that the fishery is being managed in an ecologically sustainable manner and allows the export of the catch. Under Australian law, all fisheries require WTO approval in order to export product. Upon approval, the DPI&F produced a sticker (Photo 3) to help fishery participants to market their product. In some instances, operators cooperate in marketing their catch to meet the needs of specific buyers or markets. But each operator has developed different markets and processing varies between vessels from frozen blocks of fish to individually quick frozen (IQF) whiting.

The cooperative approach to management by industry enables it to experiment with adjustments to the regulatory framework. At the annual meeting of industry and the DPI&F in February 2007, three new initiatives (i.e. quota trading, Danish seine gear and access to new fishing grounds) were agreed to be tested and evaluated. One of these, the new quota-trading system was described above.

The trial of Danish seine fishing gear will continue in 2007 after the initial trial in 2006. The gear, which uses the same basic net and sweeps but a warp line of up to 2500 m to shoot the net, appears to have many environmental and economic benefits

TABLE 4
Summary of management arrangements

Regulatory	Voluntary, through permit or as a licence condition
Fishery area	Annual TAC
Season closure (December - March)	Quota sharing
Gear restrictions	Voluntary seasonal closure (September – October) to mirror the East Coast Otter Trawl Fishery southern closure.
Limited entry	By-product species and trip limits
Spatial closure for grey nurse shark	Turtle Excluder Devices (TEDs)
Licence fees	

PHOTO 3
Sticker produced by DPI&F

over the otter-trawl fishing method. These include reduced benthic impacts, reduced bycatch, reduced fuel usage and improved product quality.

Stout whiting licence holders are also seeking access to areas south of the prescribed fishery area, where they believe a large biomass may be available. In the past, this area has been restricted to stout whiting operators as a result of conflict with the ECOTF and because of sustainability concerns about the possible bycatch of snapper (*Pagrus auratus*) by stout whiting operators. However, licence holders have been flexible with the types of conditions they would apply to their operations to minimise any risks to snapper and to reduce the potential for conflict with the prawn fleet off the Gold Coast. These concessions will assist licence holders in negotiating with other users of the area and in gaining approval for access.

7. EVALUATION

The co-management approach ensures a sustainable fishery, while also giving operators greater flexibility than would be available in similar trawl fisheries in Queensland or elsewhere. This flexibility allows for more rapid change over time, which has resulted in a more adaptive system. The parties involved have expressed their desire to continue the flexible arrangements and have acknowledged the important role they all play in the management of the fishery. The introduction of the new TACT system in 2007 has received support from licence holders, who have recognized its potential to stabilise catch in the fishery and to provide to greater certainty in the annual TAC.

All fishermen involved in the fishery have said in the past that they want to keep the flexibility that exists with the current management arrangements. Their relationship with Government has varied depending on the issues being negotiated and the personalities of those involved. For now, the relationship between the industry and management is considered to be constructive.

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Self governance in New Zealand's developmental fisheries: deep-sea crabs

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1. INTRODUCTION: DEVELOPMENTAL SPECIES AND THE QMS

In 1986, 27 species were introduced into the New Zealand (NZ) Quota Management System (QMS), a system used to manage commercial fisheries on the basis of individual transferable quotas (ITQ). QMS implementation gained new momentum in 2001 when many more species were introduced into the QMS as the *1996 Fisheries Act* was fully implemented. By October 2003, there were 62 species in the QMS and today there are over 100 species managed within this framework.

ITQs and 'deemed values' are the key regulatory measures used to maintain the sustainability within the QMS. At the beginning of each fishing year, quota owners receive "annual catch entitlements" (ACE), which provide authorization to land an amount of fish equal to their respective share of the TAC. Deemed values are civil penalties paid to the Crown for landing fish without ACE. The QMS has evolved into a hybrid system that employs both quantity (ITQ) and price instruments (deemed values) to control catch (Newell 2004).

In the past, initial quota allocations for a QMS species were made to fishers on the basis of their catch within a specified period ("catch history"). When the historical catches resulted in allocations less than the initial commercial catch limit, the remaining quota went to the Crown. The Ministry of Fisheries (MFish) sold this remaining quota by an open public tender.

Following changes in 2004, quota for all future species introduced into the QMS was, with some limited exceptions, subject to a tender process rather than allocation by catch history. For Maori, the Treaty of Waitangi settlement (the Treaty) ensured twenty percent of all new quota species and ten percent of all species allocated pre-Settlement would either be held or purchased by the Crown and made available to Iwi[1].

The change from catch history allocation to public tender is consistent with the New Zealand government's view that the QMS is integral to avoiding over-investment in fishing vessels and overfishing. Since 1992, MFish has constrained new fisheries development by a moratorium on new non-QMS permits. The permit moratorium prevented the expansion of non-QMS fisheries prior to QMS introduction, avoided the creation of incentives to 'race for catch history' and mitigated risks for stock sustainability. It has been argued that the prolonged permit moratorium has created some management issues, such as inhibiting the development of new and under-developed fisheries. The introduction of new species into the QMS via public tender

[1] Iwi are the largest everyday social units in *Maori society*; in many ways its meaning is analogous to that of tribe or clan.

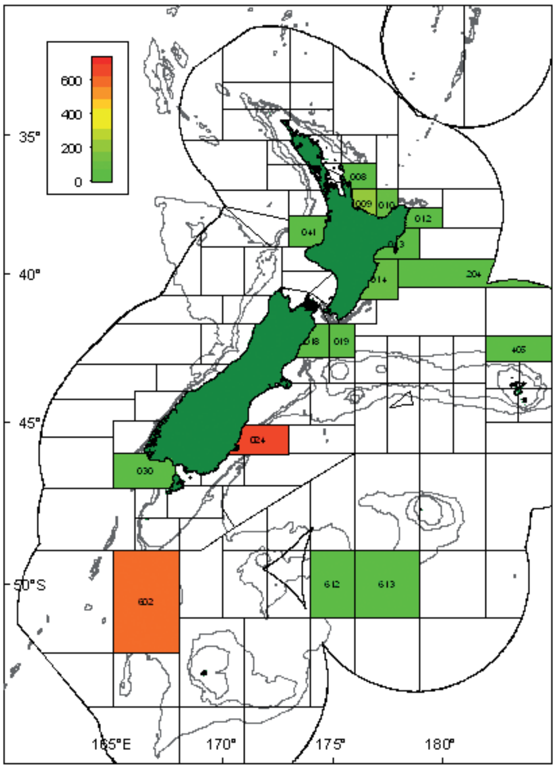
has, however, created an opportunity for more New Zealanders to become involved in developmental fisheries.

Devolution of management functions and responsibilities remains a central issue for New Zealand fisheries management. In 1992, MFish devolved the delivery of administrative registry services to an Approved Service Delivery Organisation, FishServe (see Harte, this volume). The broader devolution of fishery management services, where rights holders have primary input into setting their own regulatory controls, is still to be considered fully. Some piecemeal devolution of fisheries management responsibility has occurred. The company Challenger Scallops, in particular, is a notable example of how self-management can work (see Mincher, this volume). But the current New Zealand government is, at best, sceptical of further devolution of core fishery management services and, at worst, may be strongly opposed to such devolution. The developmental fisheries may present an opportunity to re-open this question in the context of fundamentally new governance institutions.

These developmental fisheries also challenge industry to design institutions to share in management of the resource, as envisioned by Scott (1988). A framework for collective action is required to manage resources sustainability. Developmental fisheries are an opportunity for rights holders to address these challenges by implementing robust governance and planning frameworks from the outset.

In one developmental fishery, the deep-sea crab fishery, the rights holders have developed a governance framework to focus on collective objectives throughout the entire value chain, from harvesting, processing, and marketing to fisheries management. A corporate structure, Crabco Ltd (Crabco), was created to develop, commercialize and maximize value in the fishery. This paper examines the potential gains from the cooperative management, collective action and self-governance by rights holders of this quota.

FIGURE 1
Reported mean estimated annual catch by statistical area for king crab (*N. brodiei* and *L. murrayi*) from the Ministry of Fisheries Catch and Effort Landing Return (CELR) database



Red denotes highest catches, green the lowest. The high catches near the Auckland Islands are probably for the spider crab (*Jacquinotia edwardsii*). Legend for annual catch in kg.

2. DESCRIPTION AND HISTORY OF FISHERY

2.1 Biology

The fishery is characterized by landings of king crab (including *Neolithodes brodiei*, *Lithodes murrayi*, and *L. longispinus*), red crab (*Chaceon bicolor*) and giant spider crab (*Jacquinotia edwardsii*). King crabs and red crab tend to be found in similar habitat in moderate to deep waters. King crabs from the east coast of the North Island to southern parts of the Campbell Plateau and red crabs north of the Chatham Rise. Spider crabs live at depths from the intertidal to 550 metres and have been found predominantly in southern New Zealand waters. Figures 1 and 2 show the reported mean estimated annual catch by statistical area for king crab (*N. brodiei* and *L. murrayi*) and red crab (*Chaceon bicolor*) respectively for the years 1993 through 2001. The high catches of king crab near the Auckland Islands are probably misidentification of the giant spider crab (*Jacquinotia edwardsii*).

Little is know of the biology or behaviour of these species. It is thought that king crabs and spider crabs may aggregate, juveniles forming large mounds presumably for protection and adults doing the same during breeding and moulting periods. The migratory nature of these crabs also suggests they move from deepwater offshore to the intertidal areas to breed. For spider crab, this has become particularly observable around the Auckland Islands, as it has been seen as bycatch in scampi trawling and other fishing activity along their migration route.

2.2 Previous investigations

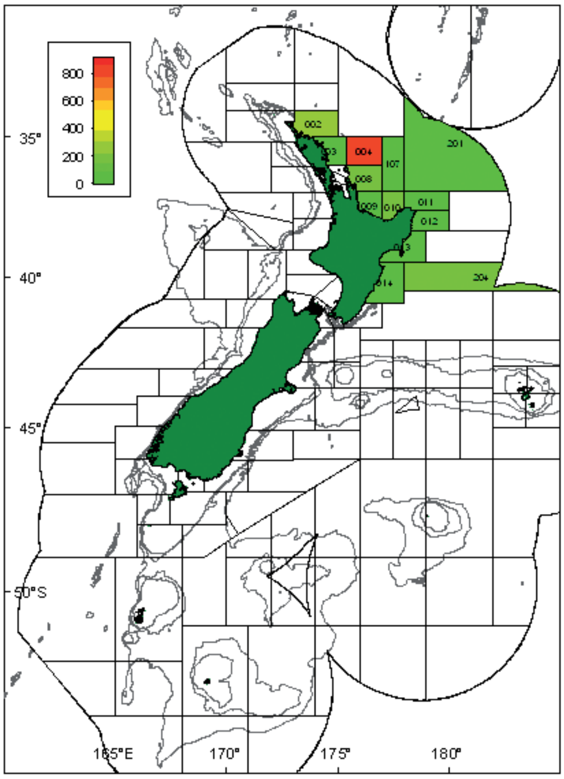
King crabs were the focus of exploratory fishing (potting) permits in 1996 and 2001 and red crab in 2001. Significant quantities were found of all species. The reported landings for king crabs and red crabs between 1993 and 2001 are outlined in Table 1. The catch landing records show only small amounts or reported catch except during 1996 and 2001 when landings were augmented by catches made under the special permit.

The giant spider crab has been the subject of a number of investigations. The first recorded exploratory fishing occurred in the early 1960s in the Auckland Islands and Pukaki Rise areas. Since that time there have been at least three other investigations. The Japanese assessed their commercial potential in 1964-65 and regularly fished giant spider crab between 1968-1974. Two Russian vessels were thought to have fished for giant spider crab during 1976-78 on behalf of a Japanese company.

In 1970, a consortium of South Island processors commissioned work to assess the feasibility of a New Zealand-based commercial industry for giant spider crab. As a consequence of this work, an MFish report suggested that a limited licence fishery of up to three processor vessels should be permitted into the fishery (MAF 1973). Finally, in 1991-92, a New Zealand fishing company exercised a special permit to undertake investigative research. Catch and landing records from this investigation reported greater catch per unit effort (CPUE) than indicated in the Japanese CPUE records. Partly as a consequence of the permit moratorium, there was little other interest in the fishery until 2001-02, when increased landings were reported as bycatch in the scampi trawl fishery. It was thereafter considered as a developmental fishery to be brought into the QMS. (See Table 2 for a history of landings of giant spider crabs.)

FIGURE 2

Reported mean estimated annual catch by statistical area for red crab from the Ministry of Fisheries Catch and Effort Landing Return (CELR) database



Red denotes highest catches, green the lowest. Legend for mean annual catch in kg.

TABLE 1

Reported landings (tonnes greenweight, catch landed and/or discarded) for king crab and red crab

Fishing year	Catch (king crab)	Catch (red crab)
1993–94	55	0
1994–95	64	0
1995–96	0	0
1996–97	4 126	0
1997–98	80	0
1998–99	1	0
1999–00	10	0
2000–01	154	5
2001–02	1 247	1 951

Source: MFish 2004a.

TABLE 2
Reported landings (tonnes greenweight, catch landed data) for giant spider crab

Fishing year	Catch
1968–69	>1 200
1969–70	-[1]
1970–71	-[1]
1971–72	-[1]
1972–73	2 552[2]
1976–77	-[3]
1977–78	-[3]
1988–89	0.01
1989–90	0.13
1990–91	24[4]
1991–92	14[4]
1992–93	2
1993–94	3
1994–95	3.30
1995–96	21.08
1996–97	18.35
1997–98	9.40
1998–99	12.79
1999–00	25.55
2000–01	72.10
2001–02	180.39
2002–03	195.93

Source: MFish 2004a.
"-" indicates no data available.
[1] Fishing by up to three Japanese vessels on Pukaki Rise (catch unreported).
[2] Catch estimate from Pukaki Rise by Japanese vessels.
[3] Fishing by up to two Russian vessels on Pukaki Rise (catch unreported).
[4] Fishing by special permit –NZ Seafood Company (catch records incomplete).

3. CRABCO

In 2006, deep-sea crab, including giant spider crab, red crab and king crab were brought into the QMS through open tender (MFish 2004a). All Crown quota was allocated to the highest bidder through tender. Due to the 2004 changes to the Fisheries Act, there were no allocations based on catch history. Four New Zealand entities that acquired 90 percent of the shares in the tender helped facilitate the development of Crabco. This included the 20 percent allocated to Te Ohu Kai Moana (TOKM) under the Waitingi Treaty. The TOKM was established under the *Maori Fisheries Act 2004* to advance the interests of iwi individually and collectively, primarily in the development of fisheries, fishing and fisheries-related activities. The remaining ten percent was initially purchased by an entity that acquired the quota to balance their bycatch in the orange roughy and scampi fisheries. However, they have recently acknowledged the value in developing deep-sea crabs as a target fishery and have begun to participate in Crabco meetings.

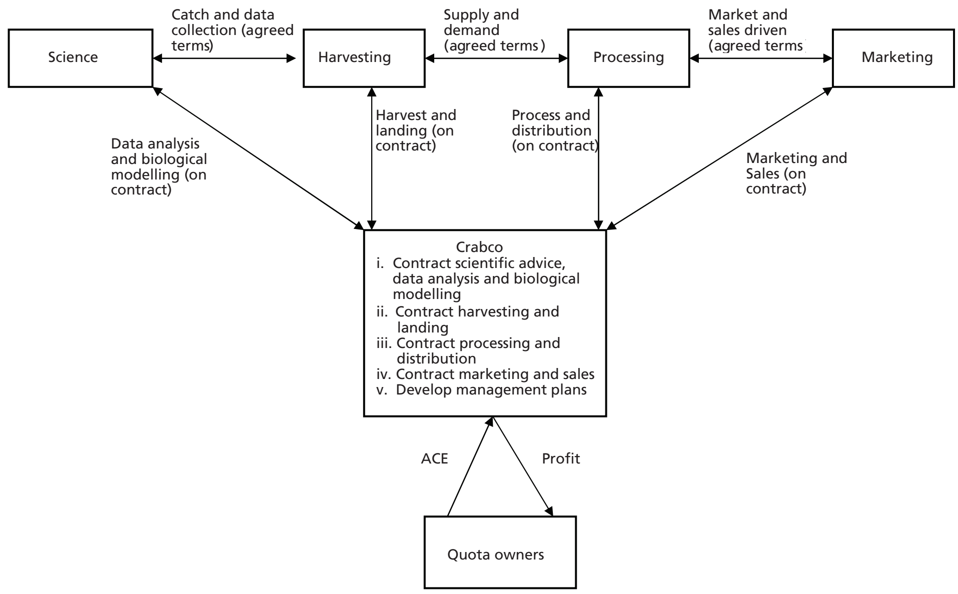
The goal of this joint-venture was to maximize the long-term productivity of stocks and to add quota value by determining if the biological characteristics of the species could sustain higher catch limits. When the rights were first tendered, the TACs were set at low levels to reflect the low knowledge of the biological characteristics of these fisheries. By increasing the TAC and enhanced robust scientific research and accurate fine scale catch and landing reporting, Crabco would increase the value of participants' quota holdings. The company began harvesting king crabs and red crab in May 2007 against a harvest plan that was designed to collect data that would help estimate abundance and distribution across different spatial and temporal scales. Crabco intends to target giant spider crab in mid-2007.

Most deep-sea crab quota owners have previously acquired other quota species and been involved in their development in New Zealand. They learnt that without a devolved fisheries management process, unnecessary economic costs and sub-optimal fishing rules would be imposed. Self management of the fishery was necessary for these rights holders to make collective decisions about fishing patterns and fishing rules, enhancement projects, exploratory fishing and research. The deep-sea crab quota owners see the economic benefits of good fisheries management and the importance to review and monitor TACs, deemed values, and other fishing rules for improved quota value.

In order to achieve their objectives, the quota owners agreed that a new management model was necessary. The Crabco model was developed on the premise of a sole owner, where quota owners entrusted the management of their rights to the company specifically geared towards maximising quota values. The Crabco joint-venture model has participants transfer their ACE to the company at the beginning of each year. The joint-venture is then responsible for delivering optimal governance arrangements and operation, including the following.

i. Planning, both annual and strategic. Plans are signed off by shareholders prior to implementation.
ii. Internal and external communication, including liaison with MFish officials over administrative and regulatory requirements.
iii. Planning and contract management for harvesting and processing.

FIGURE 3
Structure of Deep Sea Crab venture



iv. Planning and contract management for the provision of marketing services.
v. Quality assurance in operational delivery.

Figure 3 presents the relationships between Crabco, its owners, and its suppliers.

Crabco intends to maximize its profit for shareholders throughout the harvesting, processing, marketing and fisheries management value chain. It returns its profits to its ACE holders through a transparent accounting process. Economic analysis and reporting on the quota value is provided to all shareholders and all profits are distributed to quota owners as specified in the ACE transfer agreement.

The price, paid to each quota owner for the transfer of their ACE after the end of each fishing year is the amount equal to all profits earned on that quota owner's ACE during that year. This means that quota owners can own differing percentages of different species. The area of the New Zealand fishery was divided into nine Quota Management Areas, of which the rights for king, red and giant spider crab were tendered in each QMA as separate entities.

Profits are calculated separately for each species, and are equal to total revenues from sales of that species less all costs for that species. These costs include costs for harvesting, processing, marketing, and resource management and research. Profits for each species are then divided among the quota owners in proportion to their share of ACE for that species that each quota owner transferred to Crabco at the beginning of the year.

Under the governance framework, each quota owner will own one share of Crabco, regardless of the amount of quota held. No person can be a shareholder unless they are also a deep-sea crab quota owner. If shares in Crabco are transferred, quota must also be transferred to the same person. If a quota owner wishes to transfer their quota, other deep-sea crab quota owners in Crabco must first be offered that quota at the price offered by any third party. Quota owners have made a commitment to a two-year development phase where all participating quota owners' transfer their ACE into the single management company. Any profits generated during that period are to assist in further development of the fishery.

A quota owner's voting share, on an annual basis, is proportional to the value of the ACE sold by that quota owner to Crabco the previous year. Voting rights for the current year will depend on the price paid for that quota owner's ACE in the previous year. For example, if a quota owner received 25 percent of Crabco's 2008 profit as the price for the ACE sold at the beginning of 2008, that quota owner will have 25 percent of the voting rights during 2009. Voting rights for the first year of trading were determined according to budgeted projections of profit share.

Quota owners are also entitled to appoint representatives to the board of directors in proportion to their voting rights: a minimum of 10 percent of the voting rights equals representation by one director.[2] A board of directors has responsibility for the day-to-day management. This board prepares an annual budget and business plan each fishing year. The budget and business plan set out the contribution/levy required to be paid by each quota owner to fund operations for that financial year.

With the establishment of Crabco, the joint-venture partners immediately began developing a management plan for the deep-sea crab fishery. The company acts as a representative of all quota owners and liaises with relevant governmental entities on a regular basis with a view to playing a larger role in management of the fishery. The establishment of Crabco has created a keen (and aligned) interest in protecting fishery rights held within the company against those who may threaten or diminish their value. The prospect of the rights holders, accepting management and development responsibilities rather than simply harvesting fish, presents a new frontier of opportunities. Self-management is being seen as a crucial step for the future development of the fishery.

All stakeholders, including contract harvesters, have agreed to provide scientific information freely, in order to enable better and more informed management advice. Under their contract, harvesters are to record fine-scale catch and landing information. There has also been more support for management decisions through the internal process and quota owners have readily agreed on self-imposed fishing rules. Crabco directors expect that this will improve compliance and make service delivery more efficient. These rules have provided more surety for long-term planning for future projects, as seen in the improved quota value in recent trades.[3]

Internalizing fisheries management has engendered industry ownership of difficult decisions and encouraged technological innovation to manage environmental, biological and economic concerns. In particular, quota owners have agreed to use only crab pots, rather than trawling, to minimise environmental impacts. Crabco members have also supported a recent increase in the deemed values, which will not only deter free riders from entering the fishery but also help manage bycatch in the scampi fishery. Scampi fishers will probably need to buy ACE for the spider crab landings, which will create an incentive for those fishers to avoid or mitigate their bycatch.

4. EVOLUTION OF FISHERIES GOVERNANCE

In New Zealand, the recent tender of Crown-held quota in new and developing fisheries has provided a perfect opportunity for self management. For deep-sea crabs, the development of Crabco has enabled more efficient, responsive and targeted management decisions that can benefit the rights holders and the fishery as a whole.

However, while ITQs can facilitate the economic efficiency of fishing, this also depends on other processes that encourage quota owners to assume additional management responsibility. This includes government devolving responsibility for, and authority over, fisheries management to resource users and other rights holders to encourage the industry to take more responsibility in managing crab stocks.

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2 This point was included in the Shareholders Agreement so that one director could represent the many Iwi who individually would own only small parcels of quota once the TOKM has allocated the 20 percent Maori quota share as part of the Treaty Settlement.

3 Towards the end of 2006, within a 10-month period of deep-sea quota being tendered by the Crown, a quota owner sold a significant share of their quota to another Crabco participant with a 75 percent capital gain.

To facilitate the shift to self-management, governments needs to provide the institutional framework that enables quota-holders to manage their own affairs so the core responsibilities for each of the stakeholders can be defined. This step will require a common plan by government and industry. While the New Zealand Government has made some initial steps toward devolution, in recent times it has been at best ambivalent about further devolution. In this context, allowing stakeholders a greater role in fisheries management will be, and has been, difficult to implement. The uncertainty around the proposed framework for fisheries management plans (MFISH 2004b, 2007) has resulted in a period of inertia where little advance has been made on self management issues.

Early attempts at self management in other fisheries were not fully successful in part because the roles and responsibilities of stakeholders were never fully defined and because capacity transfer was not implemented to support the new rights owner roles and responsibilities. The Ministry was also reluctant to suspend existing management approaches while the new concepts evolved. This resulted in dual regimes, where industry was required to cover the costs of both. Rights holders have also questioned whether a group functioning as a sole owner of a fish stock, or group of associated fish stocks, should continue to apply fisheries management rules that have become entrenched in the fishery but have been shown not to work.

Managing the resource as a sole owner (Scott 1955) has challenged rights holders within Crabco to revisit traditional industry paradigms (e.g. anti-government and competitive fishing behaviour) and embrace instead a culture of collective value maximization. This value maximisation is delivered through contractual agreements for research, harvesting, processing, and marketing, which are funded though the annual business plan. The underlying objective of the business plan is to add value to the property rights.

The pursuit of collective objectives provides an opportunity for rationalisation of rights ownership, technology advancement, harvesting and processing efficiencies, joint market and product development, co-ordinated responses to common externalities, and, most importantly, increased data collection and information sharing. Targeted research can improve management by adopting finer scale management projects and managing environmental externalities at rates that exceed expectations of government. Crabco presents industry and government with fundamentally new choices in the use and management of fisheries resources.

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Industry management within the New Zealand quota management system: the Orange Roughy Management Company

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1. INTRODUCTION

The New Zealand deepwater trawl fisheries, including those for orange roughy, have been co-managed by the Orange Roughy Management Company Limited (ORMC) and the Ministry of Fisheries. Involvement by industry, through ORMC, is a direct consequence of the quota management system (QMS), introduced in 1986, which afforded property rights to the owners of fish quota. Hilborn, Orensanz and Parma (2005) argue that:

> *"the key to successful management of marine resources is the establishment of appropriate institutions for governance that include a reward system, so that the individual welfare of fishermen, managers and scientists is maximized by actions that contribute to a societally desirable outcome."*

The New Zealand QMS, by providing security of tenure to deepwater fishery quota owners, has brought a paradigm shift in the approach to management by those owners. They have combined their interests through the establishment of the ORMC to provide the capability for co-operative engagement in the sustainable management of their fisheries and a strengthened decision-making position in dealings with the Ministry of Fisheries. The ORMC provides a united and professional forum for quota owners to cooperate in managing, developing and researching deepwater fisheries. Through the ORMC, quota owners have allocated effort to specific fishing areas, closed certain areas to allow for stock rebuilding and reduced fishing pressure by using fewer vessels through co-operative catching arrangements. Economic returns from the fishery have improved from co-operative harvesting strategies that deliver premium quality product to markets on a year-round basis. The company has directly contracted research to improve understanding of stocks and stock dynamics.

New Zealand's deepwater (800–1 200 m) fisheries for orange roughy and oreos were developed in the late 1970s, principally through foreign joint venture arrangements. They underwent a rapid transition to an almost entirely domestic operation following the introduction of the QMS. The orange roughy fishery has been one of the highest value fisheries in New Zealand. In the year ending December 2005, exports were worth $US87.5 million (FOB), equating to 17.2 percent of New Zealand's finfish export earnings (SeaFIC, 2005). New Zealand is the world's largest supplier of orange roughy (Francis and Clark, 2005).

The ORMC has played a major role in creating opportunities and consolidating capital in a highly competitive international fisheries environment. This paper focuses on the development of orange roughy fisheries in New Zealand and the evolution of the ORMC and industry self-management under the QMS from its inception through to 2005. (Since 2005, the ORMC has been involved in a process of integrating its efforts with other offshore New Zealand fishing sectors into the Deepwater Group Limited. This paper does not cover these emerging new relationships.) The development and operation of New Zealand's deepwater fisheries has followed the lifecycle typical of many fisheries (e.g. Caddy, 1984; Smith, 1986; Granger and Garcia, 1996). The Chatham Rise fishery, the oldest and largest orange roughy fishery in the world, is used to illustrate these processes.

2. DEVELOPMENT OF DEEPWATER FISHERIES IN NEW ZEALAND

2.1 Biology

Orange roughy (*Hoplostethus atlanticus)* are deepwater, slow growing, long lived fish, estimated to attain a size of 50 cm and an age of over 130 years (based on otolith counts and radiometric studies by Tracey and Horn [1999]). They are widespread and occur in areas of the continental slope between depths of 500–1 500 m in New Zealand waters (Francis and Clark, 2005). Orange roughy form dense, seasonal spawning aggregations. Feeding aggregations outside of the spawning season are also typical, particularly on underwater topographical features such as hills, knolls and seamounts. Oreos (black oreo [*Allocyttus niger*], smooth oreo [*Pseudocyttus maculatus*] and spiky oreo [*Neocyttus rhomboidalis*]) occur at similar depths and have broadly overlapping distributions. While orange roughy and oreos are largely targeted independently, catches are often mixed. The ratio of orange roughy to oreo in catches varies by region, with oreos being more abundant in southern New Zealand waters.

2.2 The fishery

Japanese and Russian vessels reportedly fished orange roughy off the New Zealand coast as early as 1957 (Johnson and Haworth, 2004). In 1978, the New Zealand government introduced an Exclusive Economic Zone which extended to 200 nautical miles (nm). The government encouraged development in these new offshore areas (i.e. outside the 12 nm territorial sea) through joint ventures by New Zealand fishing companies with partners in Japan, Korea, USSR and other countries. New Zealand companies gained the expertise to catch, process and market orange roughy and oreos using a domestic fleet by the early 1990s. Orange roughy fishing was initially focused on the Chatham Rise, a continental shelf formation east of the South Island. New fisheries areas have been developed continually over the last 30 years. Knowledge of the location and size of orange roughy and oreo populations has unfolded as commercial fishermen and research scientists estimated the apparent size and extent of fishery resources. Two technological advances facilitated the development of these fisheries: 10 kW echo sounders capable of identifying fish marks to 2 000 m and the introduction of global positioning systems (GPS) that enabled discrete fisheries to be located and fished.

Trawlers that target orange roughy now operate as part of the deepwater fleet covering several fisheries including oreo, hoki and squid. Trawlers vary in size between 26 m and 85 m, with a mean length of 43.6 m, a mean tonnage of 793 t, a mean engine power of 1 310 kW and a mean year of construction of 1983. In the 2003/04 fishing year, as many as twenty deepwater vessels caught over 32 000 t of orange roughy. Ten of these vessels capture 70 percent of the annual orange roughy catch, while each of the remaining smaller vessels capture less than 1 000 t per year. Most of the vessels

PHOTO 1
Catch of orange roughy being emptied to processing deck, F.V. San Waitaki

PHOTO 2
Catch of orange roughy being emptied to processing deck, F.V. San Waitaki *East Chatham Rise, July 2006*

deliver to shore-based processors. Some vessels are freshers that land whole fish on ice as opposed to factory vessels that process at sea. Ice vessels typically make trips of 5–10 days and land their catch as whole fish Large freezer vessels land catch in either headed-and-gutted form (dressed) or as skinless fillets and remain at sea for 5–6 weeks. Photos 1 and 2 show catch and gear handling.

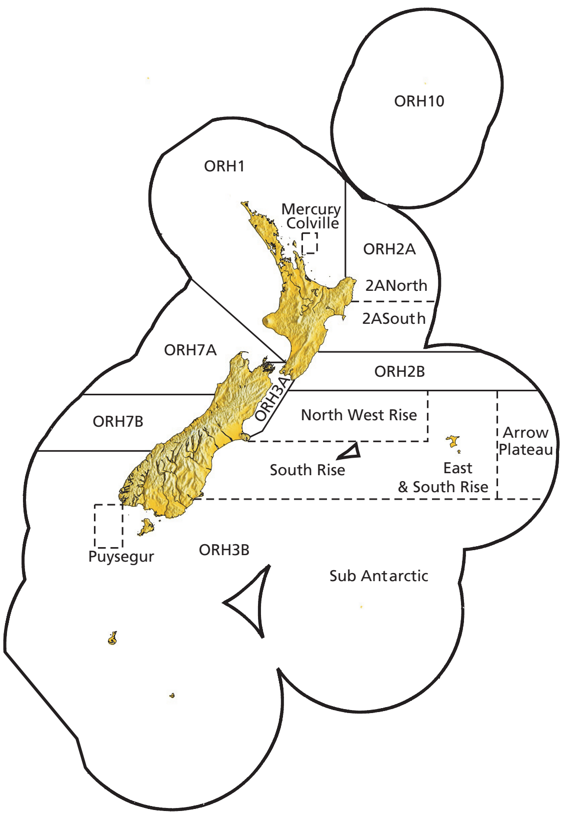
2.3 The Regulatory institution – the QMS

To support the development and management of offshore fisheries, a quota management system was introduced in 1983 for orange roughy, oreos, squid, silver warehou, hake, ling and hoki. Initial allocations of quota were based on an assessment of catch history, investment in vessels and commitment to processing. These deepwater quotas were initially non-transferable. The comprehensive QMS was introduced for 27 fish stocks in 1986. Government and industry agreed to incorporate the seven species under the deepwater quota into the QMS, which provided transferability. New Zealand has acknowledged that quota trading allowed optimization of quota mixes, a reduction in harvesting and processing costs and increased market returns.

In 1985, eight orange roughy Quota Management Areas (QMAs) were established, as seen in Figure 1 (i.e. ORH1, ORH2A, ORH2B, ORH3A, ORH3B, ORH7A, ORH7B and ORH10). There is currently no orange roughy fishing in ORH10. While fishing grounds are distributed about the New Zealand EEZ along the 1 000 m contour, the QMA boundaries serve to broadly separate the known fisheries for stock assessment and management purposes. As knowledge about the

FIGURE 1

Orange Roughy Quota Management Areas (solid lines) and designated sub-areas (dotted lines)



stocks has developed, several QMAs have been subdivided to better align management with recognized, discrete fisheries. These discrete fishery sub-areas have separate catch limits under the TACC, which are managed by quota owners in co-operation with the Ministry of Fisheries. Designated sub-areas on the Chatham Rise are the Northwest Chatham Rise, the East Chatham Rise (incorporating the "spawn box" fishery) and the Arrow Plateau. The South Rise, a subset of the East Chatham Rise, was created in 1991. The region south of 46° S, the Sub-Antarctic sub-area, is considered an exploratory region and a series of smaller orange roughy fisheries there are managed by individual topographic feature.

The objective of the QMS is to maintain biomass (B) at or above B_{MSY}, the stock size that will produce the maximum sustainable yield (MSY). For orange roughy, MSY is interpreted as the catch level that will maintain the biomass above 20 percent of the initial unfished biomass (B_0) more than 90 percent of the time (Francis, 1992). A target reference point of 30 percent B_0 and a limit reference point of 20 percent B_0 have been used for orange roughy stocks (Annala *et al.*, 2004). In New Zealand, two interpretations of MSY have been considered: maximum average yield (MAY), an estimate that assumes a constant proportion of the stock is harvested each year, or a Maximum Constant Yield (MCY), an estimate from modeling the maximum constant catch available with consideration for stock size fluctuations. In the simulation modelling, the above risk probabilities are applied in calculating these yields. Under an MAY strategy, B_{MSY} is estimated to be around 30 percent B_0 and the catch to be around 5–6 percent of the stock size (Annala, *et al.* 2005; Hilborn, Orensanz and Parma 2005). Under an MCY harvest strategy, B_{MSY} is estimated to be around 44 percent B_0.

The Minister of Fisheries sets the annual total allowable commercial catch (TACC) for each QMA based on the best available scientific and fisheries information. The setting and enforcement of TACCs provides for sustainable utilization. Annual catch entitlements (ACE) are generated on quota ownership and afford the right to harvest in a QMA for a single fishing year (i.e. 1 October through 30 September). Financial penalties (deemed values) are paid to the Government when catches exceed ACE owned by an operator. Deemed values are set above the net economic returns from the catch to encourage catches to be balanced within available ACE. Deemed values are set on an increasing scale, so that a vessel pays higher deemed value rates a tonne as the vessel increases the percentage amount by which it exceeds its ACE.

TACC setting is based on a scientific stock assessment program. Industry and government collaborate in a scientific working group to establish the information needs for appropriate fishery management. Scientific research and quota/ACE registry services are cost recovered for each fishery from quota owners, who are levied in proportion to their share of the TACC. The New Zealand fishing industry receives no subsidies from the government.

2.4 Orange roughy fishery management

New fisheries under a B_{MSY} strategy will be managed through three stages: development, fish-down and sustainable management. If a stock falls below the level that will provide MSY, then a fourth stage of rebuilding may be required. New fisheries on long-lived species such as orange roughy have a large, non-sustainable surplus during the development phase of a fishery (Hilborn, Orensanz and Parma, 2005). The fish-down phase, to harvest this surplus biomass, is characterized by a period of high catches until the stock is reduced to the management target. Once B_{MSY} is attained, lower catch levels are set to maintain stocks at or above B_{MSY} in the long-term. For orange roughy, fishery biomass is managed to decline to around 30 percent of the unfished biomass (B_0).

FIGURE 2
Hypothetical fish-down of an orange roughy fishery

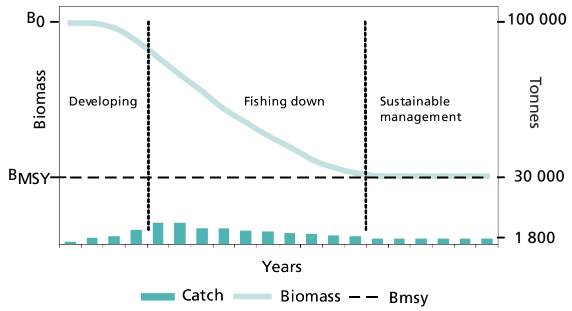
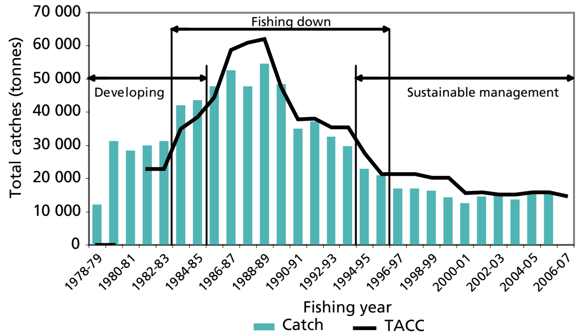


FIGURE 3
Historical total catch and TACC (tonnes) for New Zealand orange roughy fisheries and the associated fishery stages



The life-cycle of a hypothetical orange roughy fishery is illustrated in Figure 2. Assuming the unfished biomass (B_0) is estimated at 100 000 t, a target biomass of 30 percent B_0 or 30 000 t will produce the maximum sustainable yield (MSY). The transition from the unfished level to B_{MSY} provides an opportunity to remove 70 000 t of "surplus" biomass during the fish-down period. This 70 000 t catch could be taken at different rates over time. For example, the TACC could be set at 10 000 t/year for 7 years or 7 000 t/year for 10 years. Managers can select between a "hard-landing" (i.e. large changes in TACC at the end of the fish-down, once B_{MSY} is reached) or a "soft-landing" (i.e. progressive TACC reductions). Once the B_{MSY} target of 30 000 t is reached, the catch must be reduced to a level that maintains the population at or above B_{MSY}. At B_{MSY}, the long term yields are estimated to be 5–6 percent of current biomass, or 1 500–1 800 t in this example.

Early years in the orange roughy fishery were characterised by high catches and high catch rates, some at over 50 t a tow (Annala *et al.*, 2005) and were followed by declines in catch, as TACCs were subsequently reduced. The fish-down and sustainability phases of orange roughy fisheries have been the subject of considerable scientific scrutiny (Clark and O'Driscoll, 2003; Francis and Clark, 2005; Koslow *et al.*, 2000). However, TACC adjustments (by QMA) and catch limits for areas under industry governance over this time have reflected reductions in biomass as stocks have been fished down towards B_{MSY} (Figure 3). Most New Zealand orange roughy management measures use progressive reductions in TACC (i.e. soft-landings).

Research on orange roughy presents challenges. Research trawl surveys, egg surveys and CPUE indices have proven useful during the fish-down phase, during which the management objective is to reduce the population size to the B_{MSY} level. Signals in the data are strong and the resulting relative biomass estimate series prove useful for tracking population changes. Once the fish-down to B_{MSY} is complete and the annual TACC or catch limit has been scaled down to a level that will produce sustainable catches in the long-term, the stock size is expected to display little variability. Problematically, changes in biomass detected by subsequent surveys are usually so small that they fall within the margin of error of the estimates. The measures that had been used during the fish-down phase are not precise enough to be informative for management purposes. Precise estimates of biomass are therefore required and absolute estimates are preferred over relative estimates. This is a technical and scientific challenge that is yet to be resolved.

As a consequence, orange roughy management has experienced sustainability issues associated with limited information. Scientists now acknowledge that stock assessment information was over-optimistic (Annala *et al.*, 2005). Biomass and yield estimates in the 1980s overestimated the resilience of stocks and inadequately reduced TACCs once stocks had been fished down to B_{MSY}. Annala *et al.* (2005) review over 20 years of orange roughy stock assessment research and management in New Zealand. They conclude that there were difficulties in determining catch limits that would result in an orderly fish-down to the target biomass (i.e. B_{MSY}) and that as many as 7 of the 9 major stocks had been reduced below $B_{MSY.}$

2.5 Management costs

For 2007, the levies on the Orange Roughy areas covered by the fisheries described here are NZ$1 573 845. This levy is paid to the government treasury and is a "cost recovery" in the sense that the Ministry of Fisheries has a budget that is not specifically dependent on the levy. The government decides on the Ministry budget and then some of the incurred costs are repaid to the treasury.

The industry must purchase some services directly from Fish Serve. FishServe has a per-transaction fee schedule, which is posted at: http://www.fishserve.co.nz/information/fees. The total budget for FishServe is about $4 million per year, but the orange roughy fleet would pay a relatively small part of this because they are a limited number of members and they deal in relatively large blocks of fish and so would not have many transactions.

3. FORMATION AND OPERATIONS OF THE ORMC

3.1 The ORMC cooperation

The Orange Roughy Management Company Ltd

The development of the ORMC began with successful cooperative actions by ORH3B quota owners to develop and provide scientific research for new fisheries in unexplored areas. The consequent improvement in fisheries management measures led to an agreement with the Minister of Fisheries in 1991 and the formation of the Exploratory Fishing Company (ORH3B) Ltd. In 1994, quota owners extended the activities of the Company to cover all orange roughy and oreo fisheries (excluding ORH1) and renamed it the Orange Roughy Management Company (ORMC). The objective of the management company is to maximize the value of New Zealand's EEZ fisheries through improved research and improved co-operation with the government. The ORMC's vision is to maximize the long-term value of orange roughy and oreo fisheries in world markets by ensuring a consistent supply of high quality product.

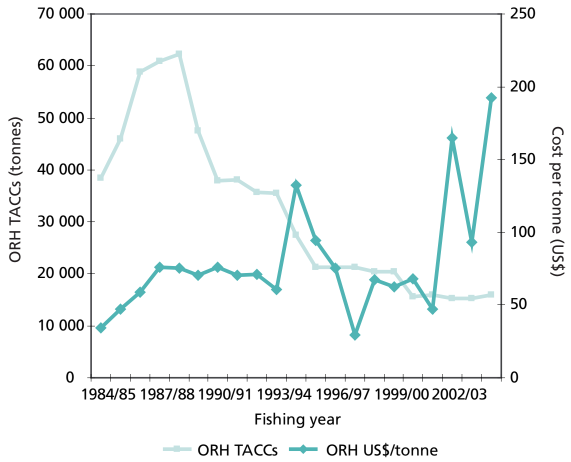
As of 2004, there were 6 to 15 quota owners in each orange roughy QMA, with 86–100 percent of the quota in individual QMAs owned by six companies or individuals. The number of quota owners participating in cooperative management in the ORH3B QMA has declined as consolidation and rationalization of quota has progressed through the fishery phases. In 1994 when the ORMC was formed, all but one quota owner participated. As of 2005, the ORMC represents the owners of over 95 percent of the deepwater quota.

3.2 ORMC scientific involvement

Quota-based management of orange roughy is information intensive. Collection of biological data from the deepwater fleet has become an important component in the assessment and management of fisheries. The ORMC has established a programme to collect biological information from the commercial fleet on new and developing fisheries that uses independent expertise, trained industry personnel and quality assured processes. This work is supplemented by fishery-independent research managed by the Ministry of Fisheries.

FIGURE 4

Orange roughy management costs vs. TACC, 1984–2004



Note: 1984 value: $US 34.37/mt and 2005 value $US 159.91/mt. Government repayment settlements given in 2003/04 and 2004/05 reduced levies for those years.

While fundamental biological and fishery parameters are estimated through modelling, these estimates depend on the underlying assumptions of natural mortality, fishing mortality, age and recruitment and these are not well established for orange roughy (Francis and Clark, 2005). Quota owners need to know the sustainable yields of the stocks to ensure that their investments in quota, vessels, onshore plants and markets are underpinned by sustainable management. It is in the best interests of quota owners to ensure this information is made available by conducting the necessary fishery research commensurate with the status of the fishery (i.e. developing, fishing down, sustainable or rebuilding phases). As fisheries have matured and TACCs have been adjusted to lower, long-term catch levels, revenues have declined. Consequently, the industry has faced increasing assessments per tonne for research and management costs over 1984–2005 (see Figure 4). Research assessments in 1984 were $US 34.37/t and have risen in 2005 to $US 159.91/t. (Note that in Figure 4, data for 2003/04 and 2004/05 are net of government repayment settlements.)

3.3 The ORMC's refined fisheries governance of Chatham Rise and exploratory fisheries

Prior to 1991, the government managed the ORH3B QMA as a single stock with a research focus on a single spawning aggregation on the Northeast Chatham Rise. The industry thought that there are multiple spawning sites on the Chatham Rise and elsewhere in the large ORH3B QMA. The industry believed that management of ORH3B should be based on more than one distinct fishery or stock. Research indicated that the 16 000 to 20 000 t catch from the Northeast Chatham Rise, taken mostly over flat ground during the spawning season, was not sustainable and recommended a revised annual catch of around 6 000–8 000 t (Annala *et al.*, 2005). The ORMC responded by agreeing to the cessation of fishing there to provide rebuilding and to spread catches to other areas within the large ORH3B management areas. To bring this into effect, the ORMC reached an agreement with the Minister of Fisheries in 1991 to establish several discrete fisheries within the ORH3B QMA (shown in Figure 1).

i. Northwest Chatham Rise;
ii. Northeast and South Chatham Rise;
iii. Arrow Plateau (an exploratory fishery area to the east of the Chatham Rise);
iv. Puysegur (a discrete fishery off the southwest coast of New Zealand); and
v. Sub-Antarctic (a large exploratory fishery area south of 46° S latitude).

These designated sub-areas and their associated catch limits were managed with an industry Deed of Agreement signed by all ORH3B quota owners. Since 1991, catch limits have been set for each designated sub-area. Each fishing year, quota owners partition their ORH3B annual catch entitlements (ACE) into the separate sub-areas. Quota owners trade ACE and report sub-area catches to the ORMC monthly and the ORMC manages the designated sub-area catches to the catch limits. The Deepwater Deed of Agreement is annually reviewed and updated to reflect changes in orange roughy (and oreo) TACC, quota ownership, compliance agreements, reporting requirements, notifications of quota and ACE transactions, species restrictions and specific area restrictions. Quota owners cooperate and communicate to ensure that catches from fishery sub-areas are within agreed limits. In some areas, catch limits have subsequently been set at zero by industry to maximize the rebuild rates where populations have been assessed to be below $B_{MSY.}$ For example, the Puysegur fishery was closed from 1 October 1997 and remains closed.

4. EVALUATION OF INDUSTRY CO-MANAGEMENT

4.1 ORMC management leadership

The QMS provides a platform for industry self-governance. The QMS has removed competitive fishing and allowed quota owners to adjust their species mixes, fleet composition and harvest plans to provide a consistent year-round supply of high quality product. The ORMC leadership has brought about further improvements through cost reductions, better stock management and co-operative actions, including resource development. A quota owners' management company, such as the ORMC, provides independent expertise and resources to improve the sustainable management and utilisation of fisheries. The ORMC acts on its shareholder's behalf to

i. implement a range of initiatives to improve the management of deepwater fisheries (e.g. fisheries research, strategic and fisheries planning, dispute resolution and relations with other stakeholders);
ii. provide a united and credible voice on all matters concerning the sustainable management and utilization of New Zealand's deepwater fisheries; and
iii. provide and maintain a direct dialogue with government and, in particular, the Minister of Fisheries.

The ORMC has taken on greater responsibility for managing fisheries by representing quota owner interests with other industry organizations and with government agencies. Agreements, through civil contracts between the ORMC, quota owners and the government, have resulted in self-regulatory management controls that include

i. closing areas to fishing;
ii. establishing and maintaining sub-areas and associated catch limits within large quota management areas;
iii. voluntarily reducing catches through the setting aside of quota;
iv. managing catches from discrete topographic features such as seamounts, hills and knolls within the exploratory fishery sub-areas where science-based stock assessment information is lacking (i.e. to spread fishing effort); and
v. supporting or promoting TACC changes based on the best available scientific information. In some instances, this included basing quotas on more conservative assumptions than the consensus recommendations of scientists.

4.2 The ORH3B industry governance – Chatham Rise and exploratory fisheries

The significance of these industry steps to manage quotas in sub-areas is well illustrated in the ORH3B QMA, which the ORMC manages at three distinct levels. The first is at the QMA level, where ORMC manages the overall catch to ensure it does not exceed

TABLE 1

Catch and catch limits (t) by designated sub-area within ORH3B

Year	Northwest Rise		South & East Rise		Pusegur		Arrow Exploratory		Sub Antarctic/ Exploratory	
	Catch mt	Limit mt	Catch mt	Limit mt	Catch mt	Limit mt	Catch mt	Limit mt	Catch mt	Limit mt
1992–93	3800	3500	10200	10800	4280	5000	10	*	360	2000
1993–94	3500	3500	10000	10800	2410	5000	470	*	260	2000
1994–95	2400	2500	5600	5500	1260	2000	750	3000	900	1000
1995–96	2400	2250	5100	4950	730	1000	170	*	3460	4500
1996–97	2200	2250	5000	4950	490	500	280	*	900	5000
1997–98	2300	2250	6300	4950	0	0	330	1500	850	4000
1998–99	2700	2250	4800	4950	0	0	730	1500	780	4000
1999–00	2100	2250	5700	4950	0	0	290	1500	470	4000
2000–01	2600	2250	5200	4950	0	0	190	1500	1320	4000
2001–02	2200	2000	7800	8400	0	0	70	1000	1200	1300
2002–03	2200	2000	8600	8400	0	0	220	1000	1160	1300
2003–04	2000	2000	8300	8400	0	0	140	1000	760	1300
2004–05	1600	1500	8800	8650	100**	0	60	1000	1680	1300

Notes: East Rise includes the Spawning Box, closed between 1992–93 and 1994–95 and the non-spawn fishery.
* Arrow Plateau included in Sub-Antarctic.
**Puysegur research catch 2004–05.

the TACC. The second is at the designated sub-area level, where the ORMC manages catch limits for each discrete fishery. These fisheries are managed as separate fish stocks. ACE is traded, catch is counted and fleets are managed by designated sub-area. ACE may not be moved between designated sub-areas. The third level involves the management of catch from individual topographic features in the exploratory sub-areas, where 500 t limits apply. A topographic feature is declared closed once the 500 t limit has been taken. An individual feature is managed as an area with a radius of 10 nm around its centre. The ORMC sub-area management paradigm is recognized and supported by the New Zealand Minister of Fisheries. The agreed designated sub-area catches have been well managed and annual catches have by-and-large matched the agreed catch limits (Table 1).

Although the ORH3B TACC has remained at 12 700 t for 10 years (Figure 5), sub-area catch limits within this QMA have undergone periodic changes. This is illustrated in Figure 6 and 7, which show that the catch limit for the Northwest Chatham Rise has declined during this period while the East and South Chatham Rise catch limit has increased. A portion of the ORH3B TACC (250 t) is set aside to cover research survey catches by commercial vessels, when these occur.

FIGURE 5

Catches and TACCs for the orange roughy ORH3B fishery, 1979–2005

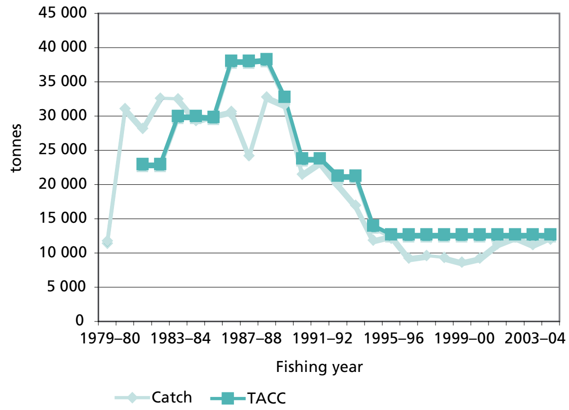


FIGURE 6

Catches and catch limits for Northwest Chatham Rise orange roughy fishery, 1979–2005

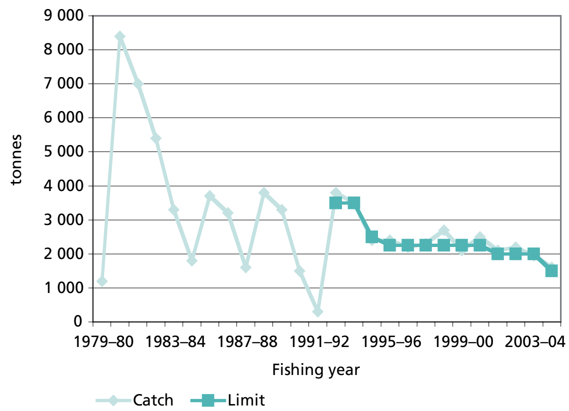
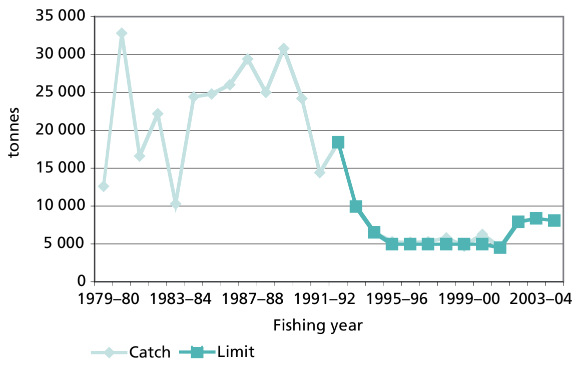


FIGURE 7
Catches and catch limits for the East Chatham Rise orange roughy fishery, 1979–2005



4.3 Improved research from industry involvement

The ORMC quota holders have invested an estimated $US 84.5 million in research since 1983 through direct purchase and through government levies. Both the Ministry of Fisheries and the ORMC have contracted research by independent organisations with international expertise in the following areas:

i. biomass surveys,
ii. stock discrimination (including genetic and morphometric techniques),
iii. age and growth investigations and validations,
iv. biological sampling of commercial catches for stock assessment, and
v. environmental studies on benthic habitats and impacts from fishing.

The transition from government-only to industry-and-government and now towards industry-only purchased research, has been an inevitable and desirable outcome of the ITQ system. There is a greater need by quota owners for information on the state of the stocks to improve management and to ensure sustainable utilization. In the direct purchase of research information, quota owners recognise the need for all research to be independent and to be peer reviewed.

The ORMC has invested in leading edge technologies such as swath mapping, which acoustically maps the ocean floor in swaths up to 12 km wide at orange roughy depths. The data can be digitally enhanced to produce a range of products, including acoustic images of the seafloor. Swath mapping enables a much clearer understanding of these deepwater habitats through refined bathymetric outputs. New Zealand leads the world in this field and the ORMC has now mapped the deepwater fishery areas throughout New Zealand's EEZ. This information is critical in improving the management of these fisheries, particularly for assessing and managing the possible environmental effects of fishing.

The integration of industry research and management strategy is well illustrated by developments in the Chatham Rise fishery. The Chatham Rise fishery initially focused on spawning aggregations of orange roughy between June and August and was steadily fished down. By 1992, this fishery was assessed to be below the management target (i.e. below B_{MSY} or 30 percent B_0) and the quota owners' response was to close the area known as the "Spawn Box" and to support further research to determine the stock size. The "Spawn Box" closure from 1992–93 to 1994–95 resulted in the development of new fisheries within eastern and southern parts of ORH3B, a move to year-round fishing and a reduced dependency on fishing spawning aggregations.

A research trawl survey of the "Spawn Box", undertaken in 1994 by the Ministry of Fisheries, provided a higher estimate of current biomass than the previous surveys, but with greater uncertainty (i.e. a coefficient of variation of 70 percent). Industry expressed concerns about the merits of demersal trawl surveys to estimate the biomass during the spawning season, as aggregations of orange roughy occur in "plumes" rising up to 200 m into the mid-water. The 1994 survey highlighted the inadequacy of this method for assessing highly aggregated orange roughy and trawl surveys were abandoned. Industry challenged scientists to develop alternative methods and turned to acoustic techniques.

To date, the ORMC has invested over $US 4 million in the development of acoustic technology for the biomass assessment. Counting orange roughy acoustically is extremely challenging. Orange roughy have a very low backscattering cross section, are found at depths greater than 1 000 m, form dense aggregations, are often found over sloping ground and are close to the sea bottom. The first acoustic surveys were undertaken on the Chatham Rise stock in 1998. Further acoustic surveys have subsequently been completed by the ORMC on the East Chatham Rise spawning plume annually in 2002, and annually to, and including, 2006.

The acoustic research subsequent to 1994 established that the biomass on the East Chatham Rise was much higher than previously estimated. Subsequent stock assessments were undertaken by a consortium of international scientists from the University of Washington, the Australian Commonwealth Scientific Research Organisation (CSIRO), the New Zealand Seafood Industry Council (SeaFIC) and the National Institute of Water and Atmospheric Research (NIWA). The results of these assessments indicate that the current biomass in the most important sub-areas may to be around 50 percent B_0 (i.e. well above B_{MSY}). Industry acknowledge there is uncertainty around the model outputs and have chosen to harvest at a rate substantially below the 2001 stock assessment recommendation.

The southern portion of New Zealand's 200 nm zone remains relatively unexplored but hosts a number of discrete orange roughy fisheries. Exploration of deepwater fisheries is expensive, difficult and dangerous, but ORH3B quota owners continue to explore these areas. Industry-initiated exploratory surveys in the early 1990s resulted in new fisheries being developed here. An example is the Puysegur fishery, discovered in 1991 that produced a total catch of around 15 000 t over six years before being voluntarily closed by industry from 1 October 1997 to promote stock re-building.

4.4 The ORMC self-management of fishery sub-areas

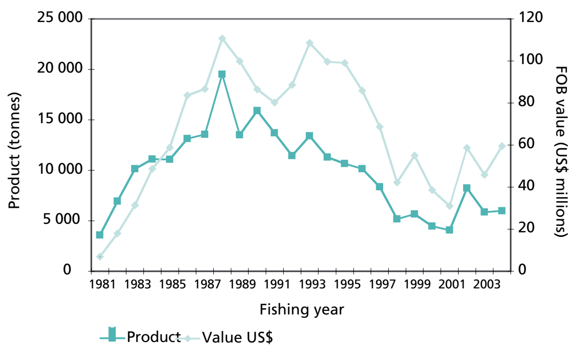
The ORMC has established and managed designated sub-areas within the ORH3B QMA for 15 years. Since its inception, the designated sub-areas have been carefully constructed based on the TACC for the overall QMA. The ORMC has been successful in the management of sub-area catch limits by way of an annual Deepwater Fisheries Management Agreement among quota holders that sets out the available quota and ACE for each designated sub-area. Industry management avoids the administrative costs associated with government responsibility to monitor and enforce sub-area catch limits.

To provide for credible fishery management and a transparent collaborative management arrangement between the Ministry of Fisheries and Industry, the ORMC focuses on an essential auditing and monitoring role of the catch spreading agreements including:

i. annual Deepwater Fisheries Management Agreement Schedule;
ii. monthly reports detailing estimated catch, landings, location and effort data for orange roughy in ORH 3B;
iii. quarterly comparison of QMA catches, reported to the ORMC by sub-area, with the overall QMA catches as reported by ACE-holders to the Ministry of Fisheries;
iv. quarterly audit of Sub-Antarctic feature catches reported to the ORMC against those reported by ACE-holders to the Ministry of Fisheries (i.e. analysis of catches by latitude and longitude); and
v. correspondence to ACE-holders, relating to area closures as sub-area and feature catches reach 80 percent and 100 percent of the catch limits.

The ORMC reporting framework assists in ensuring the robustness of the catch limits in the Sub-Antarctic Fisheries. The Sub-Antarctic exploratory region is not managed with a current annual yield (CAY) policy and has only limited assessment information as the basis for determining whether current or proposed catch limits are sustainable.

FIGURE 8
Orange roughy landings and export value (US$), 1981–2004



5. DISCUSSION

5.1 Economic benefits

ITQs have provided incentives for efficient operators to invest in additional quota, new vessels, improved harvesting and processing capabilities and market development. As management has become more complex, with the introduction of smaller multiple fisheries, large quota owners have undertaken to lease the quota owned by smaller operators. This has resulted in improved utilization of vessels, rationalization of the fleet and processing capabilities and substantially less fishing pressure.

Security of catch access allows quota owners to focus on market needs. Quality of fish products has improved substantially. The industry has moved away from bulk fishing during spawning seasons towards year-round fishing with smaller amounts in each tow to maintain fish quality. Today, less than 30 percent of the Chatham Rise catch is taken during the spawning season. The majority is taken throughout the year by a fleet of less than ten vessels, with fish quality optimized through small catches, targeting of non-spawning fish and, in many cases, processing onboard to produce frozen-at-sea consumer-ready products. There are now fewer than five factory trawlers targeting orange roughy in New Zealand's waters.

Annual export revenues from orange roughy have averaged about $US60 million in recent years. The main markets are the USA and Australia, with additional exports to China, Canada and France. New Zealand supplies over 60 percent of the orange roughy imports into the USA, 18 percent of China's imports and 17 percent of Australia's imports. Since 1985, the value of orange roughy export has grown faster than export volumes (Figure 8). Overall, the value of New Zealand orange roughy and oreo fisheries, as represented by the market value of the quotas, had grown to $350 million (Statistics New Zealand, 2007).

5.2 The new sustainability management paradigm

The difficulties with biological assessment and consequent stock reductions below B_{MSY} in some fisheries necessitated re-building strategies and fishery closures. The slow population recovery rates by deepwater stocks (Koslow *et al.*, 2000), together with global pressure from non-government organizations around the perceived impact of deepwater trawling on benthic habitats, caused scientists to advocate a shift to more conservative assessment assumptions. This more conservative sustainability paradigm, the associated higher target biomass levels and consideration of ecosystem-based environmental management is well understood by the ORMC, which has already taken steps to:

i. reduce fishing effort through catch consolidation;
ii. improve efficiency and catch rates through fleet rationalization;
iii. spatially manage areas where stocks show vulnerability; and
iv. implement benthic protection areas (BPAs) that exclude bottom trawling in 30 percent of the New Zealand EEZ.

5.3 The ORMC now and in the future

The Orange Roughy Management Company, through cooperative arrangements and civil contracts, has successfully transformed competitive quota owners into a sophisticated, co-operative group that participates in science, policy and management decisions. Several factors made this cooperative approach possible, including:

i. a small number of participants;
ii. leadership by quota owners who recognized the improved business environment under the QMS;
iii. a relatively new fishery with little political interference;
iv. a simple fishery with no competing users of the resource;
v. a fishery focused on a high value, high market demand species; and
vi. a fishery requiring close management and facing challenges to estimate stock size.

Industry leadership and participation in the management of these deepwater fisheries has contributed to the international recognition, of the success of the New Zealand QMS. Quota holders, although strongly independent, acknowledge that their best interest is to cooperate on stewardship of the limited natural resources. This cooperation continues to evolve. Two major initiatives from the fishing industry since the year 2005 are: (a) consolidation of multiple deepwater and middle depth fisheries to create The Deepwater Group Limited (DWG) and (b), initiation of benthic protection areas (BPAs). The structure of the industry has also seen some significant change as a large number of small quota holders resulted from the distribution of Maori quota previously managed by the Te Ohu Kai Moana Trust to individual Iwi (local Maori groups and organizations) under terms established by the Treaty of Waitangi Fisheries Commission. Together with the New Zealand Government, the ORMC has successfully evolved through the lifecycle of deepwater fisheries and is well positioned to take on the challenges of the 21st century.

6. LITERATURE CITED

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Rock lobster management in New Zealand: the development of devolved governance

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1. INTRODUCTION

A critical issue for fisheries management is why devolved governance arrangements develop and how the characteristics of the devolved governance organisation influence its success. Competing theories also seek to explain why devolved governance (self-management or co-management) organisations exist. A large portion of the co-management literature argues that these shared management regimes grow from long-lived community-based regimes. Closely linked are the concepts of social capital and civic engagement. However, it is also argued that the devolved governance arrangements can develop out of strong property rights regimes that provide incentives to take on co-management or self-management responsibilities.

Management of New Zealand rock lobster (*Jasus edwardsii* [Photo 1] and *Jasus verreauxi*) provides an important example for understanding these issues. Because of the rock lobster's history as a set of localised fisheries, an extensive history of local and national cooperation existed prior to the introduction of individual transferable quotas (ITQs) into rock lobster management in the 1980s. However, ITQs and their associated property rights created an incentive structure that encouraged the development of strong regional and national organizations, which work with the New Zealand government to co-manage the lobster fisheries. This case shows a combination of industry activity (at the local and national level) and strengthening property rights as the key to the development of devolved governance in the New Zealand rock lobster industry.

NZ ROCK LOBSTER INDUSTRY COUNCIL

PHOTO 1
New Zealand rock lobster, (Jasus edwardsii)

2. THEORIES OF DEVELOPMENT OF DEVOLVED GOVERNANCE

Within the co-management literature, two routes to the development of co-management regimes are described: evolutionary and crisis-driven. Evolutionary development occurs when long-lived institutions based in local communities (e.g. traditional or indigenous management regimes) become interwoven with the existing central or regional government (e.g. Honneland and Nilssen, 2000; Lim, Matsuda and Shigeni, 1995; Jentoft, 1989). For example, use of traditional gear or catching rules may be incorporated into laws, as often happens in the Maine lobster fishery (Acheson, 2003). The co-management literature also suggests that, in the absence of evolutionary development, co-management approaches are most likely to be adopted when there is a period of extreme stress (e.g. Pinkerton, 1989). Pomeroy and Berkes (1997) have argued that a broader set of crisis-oriented conditions can lead to development of co-management. These include: resource deterioration, conflict between stakeholders, conflict between management agencies and the local fishers, and governance problems in general.

Social capital is another important concept in understanding why institutions arise and succeed. Putnam (1993) defined social capital as "features of social organization, such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated action." Ostrom (1990) argues that early success with smaller, localised institutions builds the social capital for future, larger developments by providing a situation where people learn how to work together to maintain a resource and an institution. "[T]hey can learn whom to trust and what effects their actions have ... When individuals ... have developed shared norms and patterns of reciprocity, they possess the social capital with which they can build institutional arrangements." (Ostrom, 1990) Thus, over time, an iterative process allows incrementally larger organisations to develop.

When individuals or groups of resource users have a strong set of property rights to a common pool resource, the security provided by the property rights creates the incentive for them to manage the resource sustainably over a long period of time (Ostrom and Schlager, 1996). This linking of property rights and governance has important implications for developing co-management regimes. Scott (1993, 2000) makes the argument specifically for ITQs. He (1993) argues that once ITQ regimes are set up, self-governing fisher organizations are likely to succeed, as they are better able to work together without fear that their share of the resource will be diminished. There is evidence in the case of New Zealand that, at the national level, the processes theorized by Scott have indeed taken place (Yandle, 2003).

NZ ROCK LOBSTER INDUSTRY COUNCIL/DRS

PHOTO 2
Typical lobster fishing vessels - Island Bay, Wellington

N. GIBBS

PHOTO 3
In many exposed areas, the vessels are beached when not in use – Ngawi, Cape Palliser

NZ ROCK LOBSTER INDUSTRY COUNCIL

PHOTO 4
Setting a lobster trap – bait in the trap is just visible

3. THE NEW ZEALAND ROCK-LOBSTER FISHERY

Rock lobster catching is integral to the history of New Zealand. The Maori, who arrived in New Zealand in the 10th to 14th centuries (Reed, 1970), consider rock lobster to be historically and culturally important. Rock lobster was an important export species as early as the 1940s and 1950s (Annala, 1983a). However, development varied regionally. In the Chatham Islands, rock lobster were known and fished on a small scale as early as 1907 (Kensler, 1969). But the Chatham Islands lobster boom did not start until 1965 when one boat landed two tonnes of rock lobster (Annala, 1983a) and heralded in the short-lived "Crayfish Bonanza" (Arbuckle, 1971). Similar, but less dramatic, booms and busts occurred in other localized fisheries. Photos 2 and 3 show typical vessels used in this fishery.

Rock lobster is harvested with lobster pots boats with one or two crew (Photo 4). Rock lobster is essentially an export species, primarily shipped live to the Asian markets, although some is also sold frozen to the US. It is the third largest export species, accounting for NZ$127 million in 2006 (SeaFIC, 2007). Total allowable commercial catch (TACC) for the 2006/2007 season is set at 2 766.6 tonnes, a sustainable catch level set by annual stock assessment (NRLMG, 2006). Recent fishery stock assessments broadly describe fisheries that are stable or recovering from previous over-fishing, although they caution that large degrees of uncertainty remain due to incomplete information on recreational catches and the degree of illegal fishing activities (NRLMG, 2002; NRLMG, 2001a).

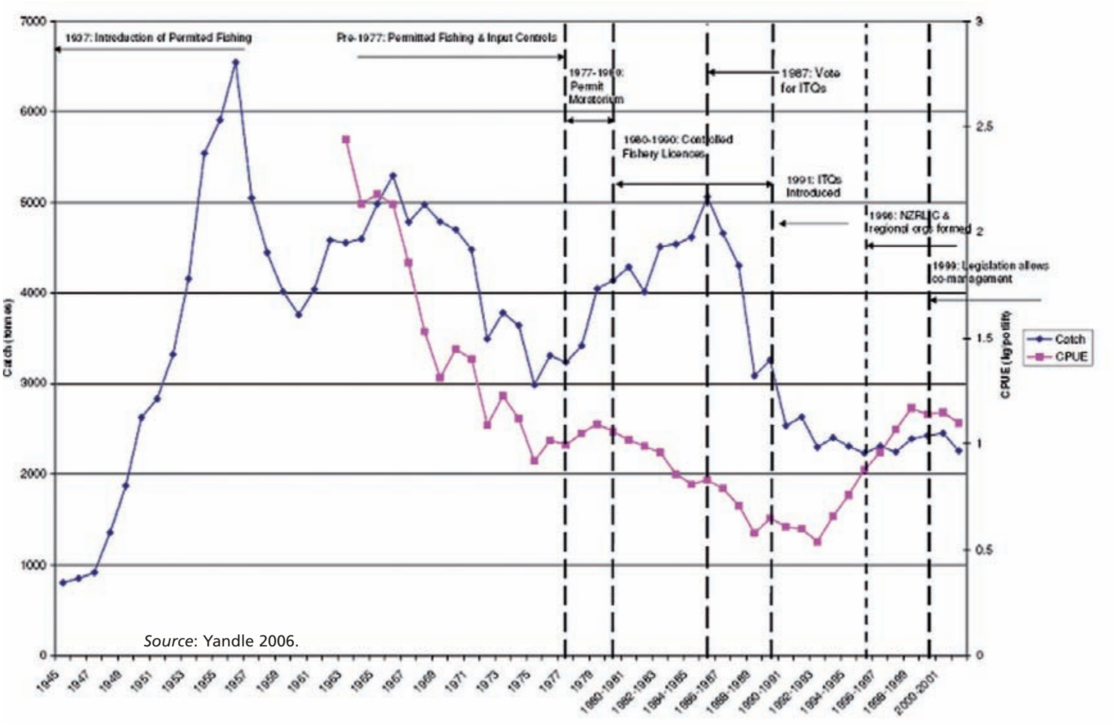
4. HISTORY OF ROCK LOBSTER MANAGEMENT

4.1 Overview

Boom and bust cycles characterised much of the historical record of this fishery (1945–2002). This is illustrated in Figure 1, where after an initial run-up in catching during the late 1940s and early 1950s, several peaks and valleys are evident in both the catch and catch per unit of effort (CPUE) for the national fishery. Data presented in this figure do not include that for the Chatham Islands. The Chatham Islands have a distinctive history and Chatham Islands rock lobster is treated as a separate stock. Since the introduction of regulation in 1937, managerial efforts have focused on maintaining the

FIGURE 1

Historical catch and catch per unit of effort (CPUE) for New Zealand Rock Lobster



Source: Yandle 2006.

TABLE 1

Key Events in Development of Rock Lobster Devolved Governance

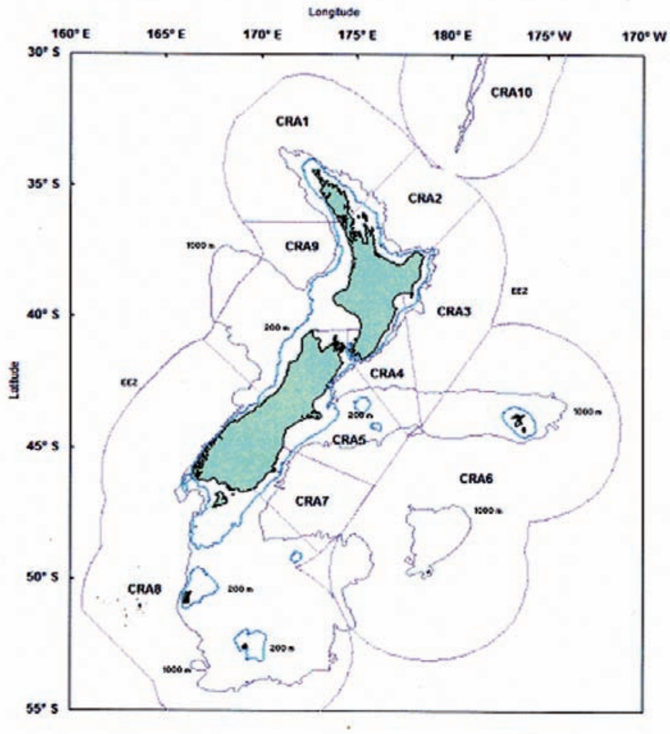
Years	Event
1937–1980	Permitted Fishing & Input Controls – fishing permits required but freely distributed. Considerable input and method controls.
1977–1979	Moratorium on of new permits
1980–1990	Controlled Fishery -- Fishery Licensing Authority issued limited number of fishing licences to approved commercial fishers
1986	QMS introduced into finfish & paua (abalone)
1991	Introduction of rock lobster into QMS – TACCs less than catch histories
1991–1993	TACC Cuts in some areas
1991	National Rock Lobster Steering Group – 10 year plan
1992	Start of National Rock Lobster Management Group (NRLMG)
1993	CRA3 initiative to cut TACC in exchange for other management changes.
1996	Formation of CRAMACs and NZ RLIC, formation of SeaFIC
1997	NZ RLIC becomes research provider to ministry. Continues to today.
1999	Legislation passes allowing fishery management plans/co-management

biological and economic viability of the fishery. Managerial approaches have included: licensing, catching method restrictions, limited entry, ITQs and devolved governance (or co-management). Table 1 provides a summary of this history and related events.

Within the rock-lobster fishery, there is one national set of regulations and TACC for packhorse lobster (*Sagmariasus verrauxi*), but the dominant rock lobster species (*Jasus edwardsii*) is divided into nine regions (See Figure 2). Note that CRA 10 is defined administratively, but has no commercial landings. These regions correspond with the regional rock lobster industry organizations, "CRAMACs" (derived from "Crayfish Management Advisory Committee), which are key to rock lobster co-management in New Zealand.

4.2 Permitted fishing and catch restrictions: 1937–1980

FIGURE 2
New Zealand Rock Lobster Management Areas



Source: NRLMG, 2005.

Annala (1983b) marks regulation as beginning in 1937 with the introduction of fishing permits, when rock lobster fishing licences were first required. Subsequently, input controls and method restrictions were introduced, which included: size limits (often varying by regions); bans on taking of egg-laden females; bans on taking of soft-shelled lobster; seasonal limits; bans on use of SCUBA equipment; escape gap requirements; and area closures. While the fundamentals of the permitted fishing approach remained a constant, the frequency of changes to input controls and method restrictions was dizzying. Indeed, Annala (1983b) documents approximately 60 changes to commercial and recreations catching regulations during this time period.

Concerns about the use of fishing permits as a management approach arose in the 1970s after a rapid decline became evident (see Figure 1). It was decided to institute limited entry, a decision that had broad agreement from the Federation of Commercial Fishermen, the Fishing Industry Board and the Ministry of Agriculture and Fisheries. The Fishing Industry Board acted in an advisory and advocacy role for the entire fishing industry. It was empowered to levy the industry to pay for its activities. In 1997, the FIB was replaced by the New Zealand Seafood Industry Council [SeaFIC], which retains its levying authority, but has a substantively different organizational structure. *The Fisheries Amendment Act of 1977*, or the *Controlled Fisheries Act*, was passed, which resulted in an immediate moratorium on new permits. The moratorium remained in place until 1980 when the controlled fishery policy was introduced in the document "Policy Statement for the Rock Lobster Controlled Fishery" (Annala, 1983b).

4.3 Rock lobster as a Controlled Fishery: 1980–1990

As a "Controlled Fishery," rock lobster fishing permits were distributed by the Fishing Licensing Authority (FLA). In issuing permits, priority was given to fishers who had a long-term documented commitment to the fishing industry and earned at least 80 percent of their income from fishing in general. Note that 80 percent of income was required from fishing in general, not just rock lobster fishing. The number of commercial rock lobster fishing permits issued nationally dropped 38 percent, from 1 574 vessels to 970 vessels (Annala, 1983a). Through natural attrition, the FLA was further able to reduce effort in the fishery.

The controlled fishery divided New Zealand into ten geographically distinct fisheries, with permits usually restricted to one region. The Fishing Industry Board (FIB) organized a liaison committee for each region consisting of fishers and processors who provided industry input into regional fishery management. A national liaison committee composed of representatives from each region also was created. The formation of these regional and national liaison committees was a critical step towards the development of co-management in the rock-lobster fishery.

4.4 Introduction of rock lobster into the QMS

While the rock-lobster fishery continued under controlled management until 1990, the 1980s marked a period of fundamental change in the broader New Zealand fishing industry. In 1986, New Zealand became one of the first countries to adopt market-based regulation when it instituted its Quota Management System (QMS). The emphasis on ITQs, on the removal of subsidies, and on the promotion of exports is viewed as a seminal and long-standing example of the market-based approach to fishery management.

Rock lobster was not included in the initial rollout of the QMS. According to Sykes (2003), the Ministry of Agriculture and Fisheries originally approached the New Zealand Federation of Commercial Fishermen in the early 1980s and sought to use paua (abalone) and rock lobster as pilot species for introducing ITQ management. However, the Federation rejected this proposal because the fishery appeared healthy, and the Federation was wary of a system entailing a total allowable catch (i.e. a catch limit). Thus, QMS was initially introduced in the broader finfisheries first. In the mid 1980s, as pressure on stocks continued to grow, the issue of bringing rock lobster into the QMS was re-examined.

Discussion first took place at the national level through the National Rock Lobster Liaison Committee. As background, the FIB prepared the report "New Zealand's Rock Lobster Fishery: A Fishery at the Crossroads" (Duncan, 1985), which outlined multiple options but centred on how rock lobster could be brought into QMS. MAF prepared a booklet, "Rock Lobster Fisheries Proposed Policy for Future Management" (MAF, 1986a), which outlined four policy options: (a) the existing system, (b) transferable licences, (c) transferable pot entitlements and (d), ITQ management. After a series of public meetings, the Federation of Commercial Fishermen held a vote in October 1986 on the four policy options. This ballot showed no single policy option receiving majority support. ITQ management received only 21 percent support, while transferable pot entitlements received 39 percent support, and transferable licences received 34 percent support (Branson, 1986).

In the wake of this vote, in November 1986, a new round of consultation started. In the new MAF discussion booklet (MAF, 1986), the Minister of Fisheries removed transferable licences and transferable pot limits as options and made clear that the choice was between ITQs under the QMS and the existing controlled fishery with the addition of TACs. With the two most popular options removed and with TACs inevitable, it is perhaps not surprising that the second vote on 16 April 1987 showed that 71 percent of votes cast were for the ITQ system (Jarman, 1987).

The Ministry initially planned to bring rock lobster into the QMS in 1988, but Treaty of Waitangi fishery claims by Maori put a hold on the introduction of new species into QMS (see Moon, 1999). Rock lobster was finally brought into ITQ management as part of the *1989 Maori Fisheries Act*, for implementation in the 1990 fishing year. This one-year delay in implementation resulted in a year of "last hurrah" intensive fishing that can be seen in Figure 1 just before the ITQ introduction.

Introduction of rock lobster into the QMS required reductions in the TACC for the fishery. All regions received cuts that brought their TACC below their historical documented catch, with the Southern region receiving the largest cut of 35.1 percent and the Chatham Islands receiving the smallest cut at 20.9 percent (MAF, 1990a). Cuts in TACC were also introduced in subsequent years and were subject to organised discussion and contestation by national fisheries organisations.

Although the introduction of rock lobster into the QMS created a period of legislative stability, turbulence continued within the industry and regulatory system.

FIGURE 3

An example of recent advertisements for lobster quota and related goods

Source: Seafood New Zealand

This turbulence focused around both the setting of total allowable commercial catch (TACC) and also a series of national and regional rock lobster industry initiatives on methods and approaches to maintain and improve the fishery. These events were important for their role in developing grassroots input and thus a co-management tradition or ethic within the industry and government. Just how far the QMS has developed is apparent from the recent advertisement shown in Figure 3.

4.5 Industry management advice and industry initiatives

In addition to discussing setting TACCs, industry participated in broader consultative processes surrounding rock lobster management at the national level and also initiated management proposals. The Rock Lobster Steering Committee was convened by Douglas Ladd, the Minister of Agriculture and Fisheries, in 1991 to develop a plan for rock lobster management (RLSC, 1991). The committee composition of commercial fishing, recreational interests, Maori interests, conservation groups and the Ministry of Agriculture and Fisheries was seen as a "shift towards a new management approach based on the direct involvement of user interests in the formulation of a forward looking fishery plan" (RLSC, 1991). The consultative process took a year to develop the plan. The final plan recommended that, rather than focusing on nationwide management with TACC reductions as the primary tool to rebuild lobster stocks, the strategy should be regionally focused and should use a variety of management tools. These would include crackdowns on illegal fishing, handling protocols and changes in size requirements. The committee recommended that management approaches be evolutionary and that a National Rock Lobster Management Group (NRLMG) be created to advise the Minister on rock lobster fishery management for the duration of the ten-year plan (RLSC, 1991).

In 1992, the National Rock Lobster Management Group was created and it continues through to today. The official composition includes all groups that participated in the Rock Lobster Steering Committee, but participation of the environmental representative is not consistent, and in 2001 concerns were raised about the lack of customary Maori (as opposed to commercial Maori) representation on the NRLMG (NRLMG, 2002; NRLMG, 2001b). Over the last decade, the NRLMG has somewhat changed its perception of its role, from providing management advice to the Minister, to that of a user forum that encourages cooperation. (Compare, for example, statements of purpose in NRLMG [1993] and NRLMG [2002].) The group retains its position as primary management adviser to the Minister, so this change in vision has important implications for the strength and role of regional and national organisations in developing management approaches. It also reflects a series of initiatives that have taken place during the 1990s.

Since the early 1990s, the rock lobster industry, both at the national level and regional level, has engaged in a series of management efforts to stabilise or increase the rock lobster stocks and to enhance long-term revenue from the fishery. While these efforts have met with mixed success, they show a consistent pattern of industry involvement in, and often initiation of, innovative management practices. Some of these initiatives are summarized below.

i. *Supplemental Enforcement Initiative*. In 1993, at the instigation of the rock lobster industry, the Ministry and the Fishing Industry Board contracted for additional enforcement to target illegal fishing in both the commercial and non-commercial fisheries, which was funded by the an additional levy of 0.5 percent on rock lobster catches. (The agreement fell apart after the Ministry received legal opinion that the contract was inappropriate for a government agency.)

ii. *CRA 3 Harvest Strategy*. In the early 1990s, the CRA 3 stock was in significant decline. Commercial fishers worked with recreational and customary Maori interests to form the CRA 3 Users Group and to develop an innovative harvest strategy. The key elements of this proposal were: shelving (or agreeing to not harvest) 50 percent of the TACC for three years; closure of the CRA 3 fishery for three months to all fishers; increased enforcement targeted towards poaching; and decreasing the minimum catch size for male lobster from 54 to 51 mm (Branson, 1992). With some modification (most notably changing the tail length minimum to 52 mm), the Ministry accepted the harvest strategy, and elements of it remain in place today. While CRA 3 leadership now expresses concerns over the long-term success of the plan, it remains widely regarded as an important event that built momentum for co-management. It can be seen as an early, important example of fishers (commercial, recreational and Maori) actively engaging in governance activities and putting the long-term health and value of the fishery in front of short-term gains.

iii. *Data Gathering Programmes*. Stock monitoring data are an essential component of rock lobster resource assessments. The rock lobster industry has progressively developed and implemented stock monitoring initiatives such as logbook programmes and electronic data collection and reporting programmes. The CRA 2 industry commissioned and funded an extensive lobster tag and release programme in 1996. The CRA 5 industry established a research committee that initiated commercial logbook programmes and tag and release programmes, and worked with the charter sector to develop a charter logbook programme (Wichman, 2004).

iv. *No Tag/No Sale*. An ongoing problem is illegally caught lobster sold to the retail and hospitality trade. In conjunction with FIB, the rock lobster industry experimented with a programme to identify legally caught lobster with distinctive tags. The purely voluntary programme failed for multiple reasons including: resistance from retailers, consumers and restaurants (which had benefited from the lower prices on the black market), technical difficulties with the tags, and the lack of an enforceable regulatory framework. The programme was shelved after its 1999 trial (Sykes, 2003).

These examples illustrate a pattern of activity during the 1990s in which commercial rock lobster fishers and the leadership of the rock lobster fishing industry at the national and regional levels began to assume some management responsibilities within their fisheries and the industry as a whole. As this movement progressed during the mid and late 1990s, it led to the development of the New Zealand Rock Lobster Industry Council (NZ RLIC) and the regional CRAMACs. Legislation was passed in 1999 that allowed the government to delegate certain fisheries management responsibilities to Commercial Stakeholder Organizations (CSOs), which provided the basis for further expansion of the industry role.

4.6 Development of the New Zealand Rock Lobster Industry Council

The 1990s were a period of intense activity within the rock lobster industry. Not only did the industry enter into the QMS, it also took on an active role in participating in fisheries management. This was largely encouraged by the vision outlined by the Rock Lobster Steering Committee. With this background, during the mid 1990s, efforts began to formalise and institutionalise this industry role in management.

As regional groups took on more responsibility, they began to need more structure and thus formed or revitalized formal organizations. For example, the Southern Rock Lobster Research and Development Committee (Foggo, 1993) was formed to support research activities and the Otago Rock Lobster Liaison Committee (ORLLC, 1994) expanded its responsibilities. The need for national coordination and support of regional activities was rapidly growing beyond that which could be provided by the Fishing Industry Board (Sykes, 2003). During 1996, a series of discussion papers were developed and meetings took place in which the concept of the New Zealand Rock Lobster Industry Council (NZ RLIC) and its relationship with its associated regional groups (or CRAMACs) was hammered out (e.g. Sykes 1996a, 1996b). In June 1996, the NZ RLIC was formed with the understanding that CRAMACs would form and associate with the national organization. The NZ RLIC became one of the first examples of what are now called Commercial Stakeholder Organizations (CSOs).

A final critical development for rock lobster co-management occurred in 1997 when stock assessment research contracts became contestable (i.e. made open for bids, rather than conducted through single party contracts). The NZ RLIC approached the newly formed New Zealand Seafood Industry Council (SeaFIC) fisheries scientists as well as the traditional service provider, the National Institute of Water and Atmospherics (NIWA), about creating a joint venture for providing rock lobster stock assessment research. The consortium won a one-year contract based on the concept of industry and NIWA scientists working together, with coordination and extended voluntary access to fishing boats provided by the NZ RLIC. The consortium now regularly receives multi-year contracts and uses CRAMACs and individual harvesters as subcontractors (Sykes, 2003).

TABLE 2
2003/4 Rock Lobster Research Programme

Region	Intensive Catch Sampling	Tag & Release	Vessel Logbook Programme
CRA 1	15 days	2 500 lobster	No
CRA 2	12 days	5 000 lobster	Yes
CRA 3	28 days	None	No
CRA 4	35 days	None	No
CRA 5	None	None	Yes
CRA 6	None	None	Yes (voluntary)
CRA 7	15 days	None	None
CRA 8	None	5 000 lobster	Yes
CRA 9	None	300 lobster	Yes (voluntary)

Source: Developed from NZ RLIC (2003).

Table 2 summarizes recent research plans, for 2003/04. This table illustrates the devolved nature of this institutional arrangement as the levels and types of CRAMAC research activities vary with the CRAMACs' specific needs and institutional arrangements. Thus, in areas where the fishery was under great harvest and political pressure (such as CRA 3 or CRA 6) and where institutional arrangements were favourable, greater research activity was observed than in other regions. This pattern of varying activity levels between CRAMACs is repeated in other activities and is discussed in greater detail later in this chapter.

4.7 Development of the Seafood Industry Council and Legal Recognition of Commercial Stakeholder Organizations

While the developments in the rock lobster industry were remarkable, they were not occurring in a vacuum. Similar movements towards co-management were taking place in other fisheries. Organizations such as the Challenger Scallop and the Orange Roughy Management Company were forming and seeking to take on management responsibilities (see Mincher and Clement *et al.*, this volume). As this occurred, the needs for a national organisation also changed. The old 1950s/1960s model of the monolithic Fishing Industry Board was no longer appropriate. Instead, the New Zealand Seafood Industry Council (SeaFIC) was formed in 1997, with a model of Commercial Stakeholder Organizations (or CSOs) as the building blocks, all represented on a Board of Directors that governs overall activity. Today, SeaFIC describes its role as "to promote the healthy development of the New Zealand seafood industry. This occurs through advocacy, policy development, and the provision of scientific and educational services to the commercial seafood industry" (SeaFIC, 2003).

The *1999 Fisheries Amendment Act* supported this movement towards CSOs and devolved governance. It allowed delegation of certain management responsibilities to "approved service delivery organizations," or CSOs. Essentially, CSOs are authorized to carry out routine management activities, including research, while the Ministry maintains the role of setting management standards, enforcement and auditing CSO activities. A change of governments, from the National Party to a series of Labour coalition governments, and other factors has slowed the efforts of many CSOs to take on full management responsibilities. But the 1999 legislation provides the legal framework for considerable devolved governance or co-management efforts within the fishing and rock lobster industries.

CRAMACs undertake activities at a variety of levels, as illustrated in Table 3. In 2003, CRAMAC activities primarily centred on scientific data collection efforts, although these groups and NZ RLIC also have a role in formal setting of TACs/TACCs (albeit in a way more closely resembling traditional consultation). However, some CRAMACs (such as CRA 2, 5, 7 and 8) were more aggressively involved in management activities beyond scientific data gathering. These groups either supported the development of NZ RLIC or were actively developing relationships with other non-commercial fishery interests. While there are no universal correlations between fishery and CRAMAC characteristics and management activities, it appears that CRAMACs with high proportions of owner-operators and the use of two-tier voting are closely associated with management efforts. Two-tier voting is a voting system where a system of one-person/one-vote is used on issues other than finance, TACC adjustments and quota management area (QMA) boundary decisions. In these decisions, voting is proportional to quota ownership (essentially, one-tonne/one-vote).

5. DEVOLVED GOVERNANCE UNDER THE NZ RLIC

5.1 Organization and Purpose of the NZ RLIC

The New Zealand Rock Lobster Industry Council (NZ RLIC) is an umbrella organization composed of nine regional organizations or CRAMACs. Geographic

TABLE 3
2003 CRAMAC Characteristics and Activities

CRAMAC	Fishery Characteristics			CRAMAC Organization		Management Efforts
	Tonnes Commercial Catch	% of Fishery Commercial	Proportion Owner-Operator (2002)[1]	Voting Rules	Meeting frequency	
1: Auckland/ northland	130.5	?	Majority	Postal ballot as needed, 2 tiered	1–2 mtgs per year plus postal ballots	No self-developed activity. Cooperate with RLIC activities (catch sampling, tagging)
2: Bay of Plenty	236.1	52%	High	Ltd Liability Co. quota owner vote, proportional voting	2 a year	Most influential in development of RLIC. 1st data collection programme. 1st to employ staff
3: Gisborne/ East Coast	327	72%	Low	Incorporate Society[2] 2 tiered voting[3]	2 a year	Developed own harvest strategy including 50% TACC reduction in 1993
4: Wellington Hawkes Bay	576	75%	Majority	Postal ballot as needed, 2 tiered	Postal ballots only	Constitution being drafted, not share-holder in RLIC Cooperates with RLMC activities (stock monitoring, sampling)
5: Canterbury/ Marlborough	350	75%	High	Incorporate Society 2 tiered voting	3 a year	Research committee initiated logbook programme, tag & release, charter logbook programme. Strong relationship with recreation, employ part time coordinator
6: Chatham Islands	360	97%	Low	Incorporate Society 2 tiered voting	2 a year	Coordinated with national and MFish to create Fisherman's office Cooperative on RLIC activities
7: Otago	89	82%	High	2 tiered voting	3–4 a year	Developed regional management plan, Initiated stock monitoring, tag and release programme, part time coordinator
8: Southland	568	87%	High	Incorporate Society 2 tiered voting, usually consensus	2 a year	Hired regional coordinate and field technicians, extensive tag and release programme, #2 with logbook programme. Works with environmental and Maori interests
9: Westland/ Taranaki	47	?	High	Incorporate Society 2 tiered voting	1 per year	Cooperates with RLMC activities (stock monitoring, sampling)

[1] Percentage of fleet that is quota share owner operater: Majority = >50% High = >66% Low = <50%.
[2] Incorporated society – memberships open to all those actively involved in business of fishing. Quota share owner, ACE owner, skipper, crew, processor/LFR.
[3] While two-tiered voting is in constitution, most issues are decided based on consensus. This holds for all CRAMACs with this voting structure. Two-tiered voting means 1 man 1 vote other than on issues of finance, TACC adjustments, QMA boundary decisions, where quota decides on proportional vote.

boundaries for the CRAMACs are based on the nine regional quota management areas for the species *Jasus edwardsii.* While membership varies based on individual CRAMAC constitutions, in most CRAMACs, quota owners, permit holders, processors and exporters are all eligible for membership. Each CRAMAC appoints a representative to the board of the NZ RLIC and contributes to the national organization's operational budget in proportion to the TACC for their region. Funding is collected through a levy on all rock lobster, which is collected at the point of catch landing. The NZ RLIC has a variety of representation and technical assistance responsibilities for its CRAMACs. These include: advocacy activities, providing (or coordinating) stock assessment research, assistance in developing management plans and other duties. The NZ RLIC represents the rock lobster industry on the board of SeaFIC.

5.2 Why the RLIC and CRAMACs emerged

The emergence of devolved governance under the RLIC and the CRAMACs arose gradually, rather than being crisis driven. Examination of port events suggests that the RLIC and the CRAMACs emerged because of (a) a strong tradition in the rock lobster industry of involvement in the fishery (or the building of social capital) and (b), a growth in the property rights.

Within the rock lobster industry, there is a tradition of involvement and participation in the fishery beyond just catching the fish. A pattern of consistent but growing rock lobster fisher and fishing industry participation in governance activities is clear. This includes:

i. Historical existence of active port associations and the Federation of Commercial Fishermen (in which rock lobster fishers were a significant proportion of members);
ii. Consultation over the decision to introduce the controlled fishery;
iii. The ability of the rock lobster industry to reject the QMS in the early 1980s;
iv. The extensive national-level debate, meetings, manoeuvrings and votes surrounding the introduction of QMS in the late 1980s;
v. The development of the NRLMG and its changing role in promoting fishers' activities;
vi. Movement on the regional and national level towards developing regional management initiatives and scientific monitoring programmes during the 1990s; and
vii. Development of the RLIC and the CRAMACs in the late 1990s.

This development or accumulation of expertise and experience encouraged the emergence over time of the NZRLIC and CRAMACs as institutions capable of sharing governance of the rock lobster fishery with the government. The pattern of development appears subtly different to that which Ostrom (1990) predicts. While development of institutions managing CPR are usually described as localized and then expanding in geographic scope, here the pattern shows involvement starting at the national level then slowly growing in industry's involvement in management, with growth in CRAMAC involvement matching the regional fishery needs and characteristics.

When the QMS was introduced to New Zealand's finfish fisheries in 1986, ITQs represented a simple right to extract a specified tonnage of fish. Over time, the property right that ITQs represent has changed to represent a more extensive bundle of rights.

TABLE 4
Timeline of Events Influencing ITQs as Property Rights: 1986–2000

Event	Description	Influence on Perception of Property Rights
1980–1990 Controlled Fishery	Rock Lobster as a controlled fishery	Rock lobster fishers have extremely limited property rights as number of fishers is severely limited. Rights are non-transferable.
1986 Fisheries Amendment Act	Quota Management System (QMS) introduced	ITQs defined as a perpetually held right to harvest a specific amount of fish, while government retains ownership
Ongoing – Security of ITQs as asset and as loan collateral	ITQs not well accepted as loan collateral by banks. 1996 law provided registry for liens, but loans still difficult to get.	Perception of ITQs as strong property right (or as an ownership right) is undermined by difficulty in obtaining loan financing.
1989/90 Switch from Tonnage to Proportional Allocation	Government stops entering market to change TACC. Instead, tonnage ITQ owners have rises or falls with TACC changes.	ITQ owners bear the risks and benefits of changes in TAC. Large companies and industry leaders saw these changes as improving property rights, small fishers saw as weakening rights.
1991 – Rock Lobster Enters QMS	Rock lobster enters QMS	Fishers in rock lobster fishery have same rights and incentives as other New Zealand fishers
1992 –Treaty of Waitangi Settlement	Maori granted 10% of quota; plus half of Sealord Products (NZ$150 million); plus 20% of all new fish stocks brought into QMS.	Government's use of ITQs as partial settlement of Treaty of Waitangi claims increased perceived strength of ITQs as a property right.
1994 – Switch from resource rentals to cost recovery	Quota owners pay for part of the cost of management, rather than a "rental fee" for the privilege of fishing in New Zealand waters.	End of resource rentals symbolized a reduction of Government property rights and an increase in ITQ owner property rights. Incentive structure of cost recovery encouraged quota owners to become more actively involved in fisheries management.
1996 Fisheries Amendment Act	Primarily administrative reforms, more explicitly defined ITQs, encouraged loans on ITQs (see above)	Provided a more explicit definition of ITQs, created ACE, and encouraged loan financing (see above)
1999 Fisheries Amendment Act	Legislation allows MFish to delegate some management powers to CSOs.	Explicitly recognizes ITQ owners as having a legitimate fisheries management interest that can be exercised through stakeholder groups.

This series of changes is summarized in Table 4. Four changes are especially notable: First, the switch from tonnage to proportionality in 1990 placed the costs and benefits of stock changes on the quota owners, thus giving them an incentive to better manage the fish stocks. Second, the use of ITQs to settle the Treaty of Waitangi Maori rights issues in 1992 strengthened the perception (and political reality) of ITQs as a perpetual ownership right. Third, the switch from resource rentals to cost recovery in 1994 ended the symbolic acknowledgment of government ownership of the fisheries and the incentive structure of paying for management costs encouraged quota owners to become more active in fisheries management and cost control. Finally, the legalisation of stakeholder group management in 1999 recognized the management interests and rights of quota owners.

This strengthening of property rights coincided with events in the development of devolving rock lobster governance in a mutually supportive process in which strengthening property rights and engagement in management reinforced each other over time. The result was the still evolving approach that we see today in the RLIC and the CRAMACs.

The accomplishments of the New Zealand rock lobster industry (and the New Zealand fishing industry in general) in developing this governance approach are remarkable. However, the story is not yet finished and challenges remain. Daryl Sykes (Chief Executive of NZ RLIC) suggests that two issues warrant particular attention (Sykes, 2003):

i. *Separation of Commercial Catching Rights from Commercial Quota Ownership Rights.* When rock lobster was first brought into QMS, most fishers held both property rights (ITQs) and caught their own fish; they were owner-operators. Today, ITQ ownership is often held by one individual (or company) while the catcher is another individual. Sykes argues that this arrangement can reduce the long-term incentives that drive many owner-operators to be proactive in fisheries management. Essentially, those fishing on quota owned by others believe that they will not receive benefits from the long-term improvements (Sykes, 2003).

ii. *Failure to Define All Extractors' Rights*. When the whole rock-lobster fishery – commercial, recreational and customary Maori – is examined, there are differences in how well-defined property rights actually are. Commercial rights are the best defined through ITQs. However, the recreational fishers' and customary Maori fishers' rights are less well defined, even though they often take much larger proportions of the total catch. This makes it difficult for the commercial sector to justify investment in management activities such as scientific research or ITQ shelving when they believe other sectors will receive substantially more benefit while not contributing to the costs. Thus, there may be reduced incentives for continued participation if not addressed through better definition of all parties' property rights (Sykes, 2003).

6. EFFECTS OF DEVOLVED GOVERNANCE AND PROPERTY RIGHTS

Catch and catch per unit effort (CPUE) were presented in Figure 1. Since QMS and the later development of devolved governance were introduced, catch levels have been reduced through TACC reductions and CPUE has increased. Scientific stock assessments (e.g. NRLMG, 2002; NRLMG, 2001b) appear consistent in their assessment that the stocks are safely managed, subject to a degree of uncertainty surrounding recreational and illegal catch. QMS and the devolved governance are so intertwined, however, that it is difficult to separate their relative contributions.

The effect that devolved governance had on the process of management is more directly observable. There is clear evidence of increased participation of the fishing industry and individual fishers in the management process. The NZ RLIC acts as an advocate, research provider and coordinator of activities for the regional CRAMACs.

This improvement in the management process in itself has value, as research has indicated that resource user participation in rule-making and management activities increases compliance levels and thus the robustness of self-management regimes (e.g. Ostrom, 1990; Ostrom, Gardner and Walker, 1994).

At the regional level, there are also a variety of activities and activity levels. These range from varying degrees of participation in RLIC sponsored activities to initiating their own efforts, in the form of stock assessment or working with other fishery interests. There are a variety of property rights and voting arrangements at the regional level, which appear to, in part, explain this variation. Table 3 summarizes this considerable variation in activities and property rights arrangements. It shows that property rights have an effect, but it is not a simple one.

In the most active CRAMACs (2, 3, 5, 7 and 8), all except CRAMAC 3 have a high proportion of owner-operators. This supports the argument that groups where the harvesters have a more direct and powerful voice undertake more management activities. However, not all measures behave as property rights as governance literatures would suggest. Ostrom (1990) predicts greater success among smaller groups. There is no consistent pattern here: relatively small groups (measured by tonnes commercial catch, which correlates with number of quota owners) are among the less active, while CRAMACs with larger catch are among the most active. Similarly, whether the commercial sector comprises a relatively large proportion of the fishery (and thus receives more benefit from stock improvement) is not a strong predictor of activity. Some groups with a lower proportion are quite active (e.g. CRAMAC 2) while others with an almost exclusively commercial fishery are less active (e.g. CRAMAC 6). These results suggest that while the distribution of property rights clearly plays a role in the development and success of devolved governance arrangement, how this occurs and how property rights distribution interacts with social capital cannot yet be understood in this case. Both play an important role.

The development of devolved governance in the form of the NZ RLIC and the CRAMACs was a long-term (multi-decade) process that involved both the development of social capital and management experience within the industry and a quite remarkable expansion in property rights. The continuing development of this approach throughout New Zealand's fisheries suggests that the presence of property rights in addition to social capital development are key requirements for the successful development of devolved governance and self-management (Yandle 2003, 2006).

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New Zealand's Challenger Scallop Enhancement Company: from reseeding to self-governance

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1. INTRODUCTION

In the late 1970s, catches in the New Zealand twenty-year old Southern Scallop fishery collapsed as a result of overfishing. The government initiated an enhancement programme and controlled entry to the commercial fishery. It soon began shifting the costs of the enhancement programme to its commercial fishing beneficiaries. With the introduction of the Quota Management System for New Zealand fisheries, control of the enhancement programme was devolved to the commercial fishers, who had become the fishery quota owners. Subsequently, a range of other management functions, including harvest rules, providing for recreational fishery access, water quality assurance, research and compliance were progressively devolved. The Challenger Scallop Enhancement Company ("Challenger") was established by the quota owners as a vehicle for collective exercise of management and enhancement activities in the scallop fishery and has become a model for similar organisations in New Zealand.

2. HISTORY OF THE FISHERY PRIOR TO CHALLENGER

2.1 Description

The Southern Scallop fishery, which is also known as the Challenger Scallop fishery, is located at the top of New Zealand's South Island (Figure 1). The Southern Scallop Fishery Management Area covers 9 631 km^2 of sea space, approximately 2 000 of which are considered to be in harvestable areas. The fishery is managed under New Zealand's Quota Management System (QMS) and is the country's largest producer of the New Zealand scallop (*Pecten novaezelandiae*).

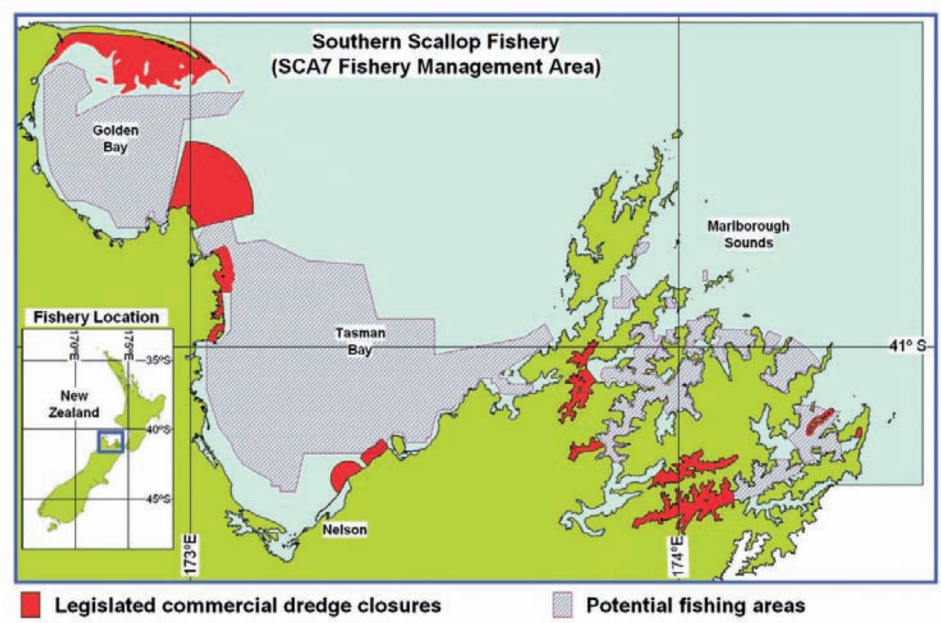
Scallops are harvested with a ring-bag dredge that is not fitted with teeth or a cutter bar and has low impacts on the benthic environment in comparison to many other dredge designs. The fish are harvested and landed the same day, alive and in the shell. Upon landing, they are sold to processors who remove the adductor muscle and gonad, which form the saleable product. With a limited domestic scallop market, the product is largely exported to Europe as frozen "roe-on" scallops.

The Southern Scallop fishery is shared with customary Maori and also recreational fishers who are permitted to harvest by hand (usually with underwater breathing apparatus) and by dredging.

2.2 Development and decline

Tasman Bay and its environs have been commercially dredged since the 1840s. Flat oysters (*Tiostrea chilensis*) were targeted in the 19th and early 20th centuries. In the middle of the 1900s, the green-lipped mussel (*Perna canaliculus*) began to feature in the harvest, as did the horse mussel (*Atrina zelandica*). In light of this dredging activity,

FIGURE 1
Map of the Southern Scallop fishery area

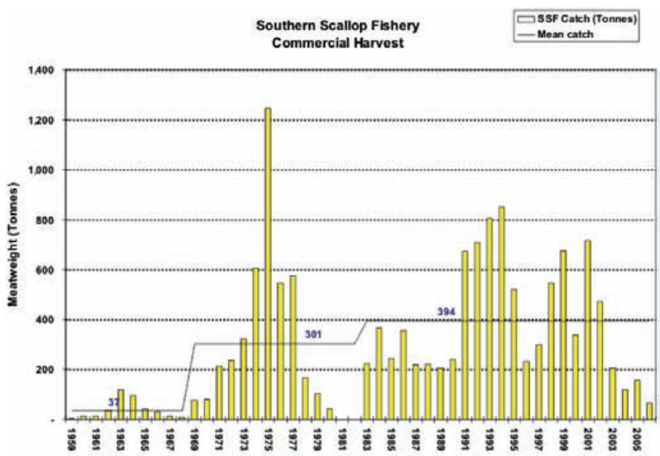


Note: Potential fishing areas surveyed annually.

commercial fishers are assumed to have landed scallops as a bycatch prior to official records, but such landings were not recorded.

The first recorded commercial landings of scallops occurred in 1959 during a survey to locate and map the Tasman Bay scallop fishery. Over the ensuing ten years, beds were found to cover grounds in Golden Bay and the Marlborough Sounds (Bull, 1989a). Catches and vessel numbers increased steadily through the 1960s and 70s (see Figure 2 and Table 1). Catch peaked in 1975 at 1 246 meatweight tonnes (adductor muscle and roe; nearly 10 000 tonnes shellweight) and the number of vessels peaked at 245 the following year (King and McKoy, 1984). Various effort controls were placed on fishers as the fishery was developed. Despite the compounding controls, catches rapidly declined to 41 tonnes in 1980 and 61 vessels and the fishery was closed for the following two years. Figure 3 shows relevant aspects of the fishery.

FIGURE 2
Commercial harvests from Southern Scallop fishery with the average shown from each of three periods



2.3 Recovery and enhancement

Following the closure, the fishery began to recover and was reopened to commercial fishing in 1983. Seasonal catch limits were established and the number of vessels was limited to 48 through non-transferable permits.

Trials of scallop spat-catching and seeding were carried out in the late 1970s by the Ministry of

TABLE 1
Landings, vessels, and TACC for Southern Scallops, 1959–2006

Year	AAC / TACC	Catch (tonnes meatweight)	Vessels landing scallops	Year	AAC / TACC	Catch (tonnes meatweight)	Vessels landing scallops
1959		2	1	1983		225	48
1960		14	6	1984		367	48
1961		13	4	1985		245	48
1962		36	6	1986		355	48
1963		119	17	1987		219	48
1964		95	22	1988		222	48
1965		42	18	1989		205	48
1966		31	21	1990		240	48
1967		13	26	1991		672	48
1968		8	14	1992	1 100	710	48
1969		78	25	1993	1 100	805	60
1970		80	34	1994	850	850	60
1971		215	49	1995	720	521	68
1972		236	67	1996	720	231	64
1973		321	83	1997	720	300	64
1974		606	96	1998	720	547	62
1975		1246	190	1999	720	676	60
1976		547	245	2000	720	338	61
1977		575	189	2001	720	716	57
1978		167	121	2002	747	471	59
1979		104	98	2003	747	206	59
1980		41	61	2004	747	118	40
1981		-	-	2005	747	158	36
1982		-	-	2006	747	65	31

Agriculture and Fisheries (MAF) in association with private organisations. These trials indicated that bottom seeding of juvenile scallops was likely to be viable. In 1982 Talley's Fisheries Limited and MAF carried out seeding trials in Golden Bay and the Marlborough Sounds. In 1983, MAF and the Overseas Fishery Co-operation Foundation of Japan embarked on a joint, pilot-scale seeding operation in the Golden Bay area (Bull, 1989b). Enhancement trials continued through the 1980s and enhanced scallops have formed a part of the annual commercial catch since 1986.

Juvenile scallops for seeding are recovered from two sources. First, some are captured in bags set on longlines. These are transferred from the bags to the beds in April each year ('primary spat'). Second, some attach themselves to the spat catching equipment outside of the bags and then fall to the sea floor beneath ('secondary spat'). Secondary spat are recaptured with a modified scallop dredge approximately four months after the primary spat harvest. A total of eight, 500 hectares, spat catching sites have been established, four each in Tasman and Golden Bays (see Figure 3) One site in each bay is available for use each year and catching efforts peaked in the 1990s at 90 long-lines of bags in each bay. Each source of juveniles

FIGURE 3
Spat catching sites in Golden and Tasman Bays and statistical reporting areas

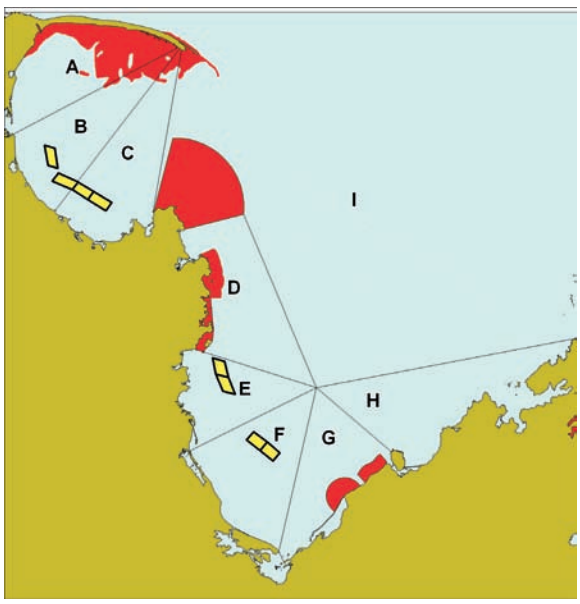


PHOTO 1
Relevant aspects of the Tasman Bay scallop fishery Harvest of primary scallop spat
The 200 m backbone cable and the vertical dropper ropes, each with ten pairs of green spat catching bags, are raised from the water and the bags cut from the line. The primary spat are then removed for seeding in pre-selected areas.

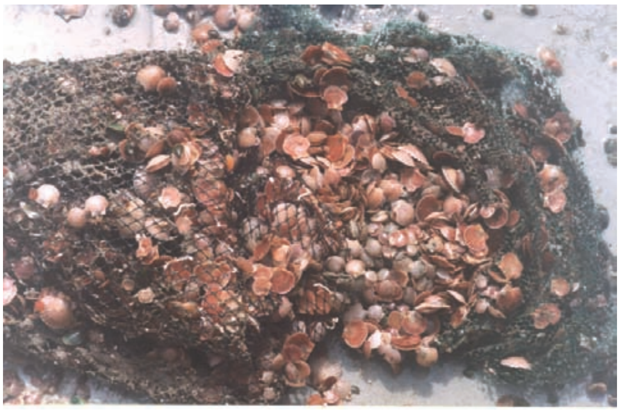


PHOTO 2
View of a harvested spat bag
This shows a bag that has been washed and opened to show the primary spat contained within. The spat in this bag range from 5 to 15 mm in shell length. Up to 2000 spat may be harvested from each bag.

PHOTO 3
View of the deck of the company's 26 m flat-decked vessel
During secondary spat harvesting juvenile scallops are dredged from the seabed under the spat catching site, then stored on deck under salt water sprays until the vessel is loaded. They are then transported to the pre-selected seeding sites for released. Up to nine million juvenile scallops may be seeded in a day using this method.

PHOTO 4
Harvesting scallops on a commercial vessel
One of the two ringbag dredges has been raised above the sorting tray at the rear of the vessel. The dredge is emptied onto the table through its mouth (head-frame) and the scallops are then manually sorted into large 500kg capacity bags – one is visible in the foreground with its top open.

has occasionally failed, but not at the same time and not in both bays at once. Use of both bays and both primary and secondary spat has provided greater surety of successful spat production.

Operational improvements, fluctuations in wild scallop stocks and financial constraints have combined to encourage better tailoring of spat-catching efforts to anticipated needs. The number of lines used in each bay has decreased as the efficiency of spat catching and spat survival has improved. Tasman Bay has had low scallop productivity in recent years and spat catching has been suspended there since 2004. All spat catching efforts have been concentrated in Golden Bay, which went through a short period of poor productivity but is recovering quickly.

This enhancement program, combined with the broader QMS, has resulted in a higher level of sustained harvests. The annual commercial harvest since its introduction into the QMS in 1996 has averaged 468 meatweight tonnes or approximately 3 750 tonnes whole shellweight. This compares to an average of 305 meatweight tonnes during 1982–1991 (under controlled entry, but before QMS) and 301 tonnes average during the boom-and-bust of the pre-1981 fishery.

3. REGULATORY HISTORY LEADING UP TO CHALLENGER

3.1 Overview

New Zealand fisheries legislation has been re-written twice since the start of the commercial Southern Scallop fishery. The fishery was opened under the aegis of the *Fisheries Act of 1908*, which provided primarily for open access to fishing permits and regulatory controls on fishing gear and on times to control extraction. The Quota Management System (QMS) in the *Fisheries Act of 1983* replaced the 1908 Act, although implementation in the scallop fishery did not occur until 1992. The QMS was refined in the current iteration of the Fisheries Act, which was passed into law in 1996. This Act was not fully implemented until October 2001.

3.2 Open access and regulation, 1959 to 1977

In the years 1959 to 1963, access to the fishery was limited by MAF. Controls on the number of permitted vessels were removed in 1964, and the issuance of permits was unrestricted until July 1977. A moratorium on the issue of permits then halted new entrants into the fishery. During 1959 to 1977, regulatory controls were progressively added to manage harvest in the fishery. These controls included:

i. a 4-inch minimum size limit from 1964,
ii. a closed season from 1968,
iii. dredge number and size restrictions from 1971,
iv. fishing limited to daylight hours from 1975, and
v. fishing limited to 5 days each week from 1977.

Table 2 details these and other regulatory measures during the open access period.

During this period, commercial fishers were largely uninvolved in the management of the fishery. Decisions were made by the regulating authority with minimal input from the permit holders.

3.3 Restricted licensing and enhancement, 1978 to 1992

In June 1978, the fishery was declared a controlled fishery. Management fell to the Fisheries Licensing Authority, established under Section 101 of the *Fisheries Act of 1908*. Membership of the licensing authority included representatives of the fishers, which provided the first direct involvement of fishers in decision-making about the fishery. A moratorium was placed on the issue of new permits, and existing fishers were required to apply each year for a new permit. Permits were non-transferable. Applications were judged against criteria to test dependence on the fishery. Issued permit numbers rapidly declined from 189 in 1977 to 61 in 1980 (Buzz Falconer,

TABLE 2
Chronology of Regulations, 1959–1983

1959	First commercial landings of scallops.
1964	Control on the numbers of vessels permits removed. Four inch minimum size limit introduced. The size restriction was accompanied by a requirement to land the scallops alive and in a measurable condition which had the effect of prohibiting processing at sea. The use of underwater breathing apparatus was prohibited.
1968	An annual closed season from 1 March to 31 July was introduced.
1969	Fishers limited to using one 8 feet wide dredge or two 4 feet 6 inch wide dredges except in inner Pelorus Sound where fishers were limited to one 4 feet wide dredge.
1971	Locally registered boats permitted to use two 8 feet wide dredges.
1973	Inner Pelorus Sound dredge size raised to 6 feet wide.
1974	Processing restrictions forced a voluntary daily quota of 100 cases (437.5 kg mwt)[1] per week per boat.
1975	The annual closed season was altered to 15 February to 14 July. Fishing limited to 5 days in each week introduced. Minimum scallop size limit was metricated at 100 mm. 8 feet, 6 feet and 4 feet 6 inch wide dredge sizes metricated to 2.5, 2 and 1.4 m respectively.
1977	The closed season was extended to 31 July. The Southern Scallop Controlled Fishery was declared, new entrants prohibited and permit numbers reduced.
1979	A total season quota of 45 000 sacks (approx 132 tonnes mwt)[2] established for the season. A daily vessel quota of 55 sacks (approx 150 kg mwt) established for the season. Size limit removed but processing requirements defined an effective minimum harvest size of 80mm.
1980	The closed season extended from 1 November to 14 August. All boats permitted to use two 2.5 m wide dredges.
1981	Fishery closed to commercial fishing.
1983	Fishery reopened with 48 licences.

[1] 1 case ≅ 35 kg shellweight (gwt) ≅ 4.375 kg meatweight (mwt) (King & McKoy 1984)
[2] 1 sack ≅ 22 kg shellweight (gwt) ≅ 2.75 kg meatweight (mwt) (King & McKoy 1984)

fisherman and Chairman of Challenger Scallops, pers. com.). The majority of the controls on fishing effort established prior to the licensing authority were continued and many of those have survived to the current day. In 1979 and 1980, the size limit on scallops was temporarily removed and the season was shortened (Challenger, 1994a). The processors introduced a minimum size for purchase in an effort to ensure that scallops received from the fishers could be processed and sold.

In 1983, a replacement Fisheries Act passed. The law maintained the controlled fishery management regime for the Southern Scallop fishery and retained the cap of 48 non-transferable fishing licences. The 1983 Act also provided for the introduction of the QMS, but the QMS was not to be implemented in the Southern Scallop fishery for some years. In 1989, a reduced commercial size limit was introduced in conjunction with the establishment of three fishing areas in each of Tasman and Golden Bays, which were to be fished rotationally in successive years. Recreational fishers share the reduced size limit but are not subject to the rotational fishing regime.

Golden and Tasman Bays are managed under a rotational fishing strategy based on the Statistical Reporting Areas (Figure 3). The default strategy is as follows. In Golden Bay, one of the three statistical areas A, B or C is opened each year in turn. The open area is fished between July and February and then is reseeded in April. In Tasman Bay, statistical areas E, F and G/H are fished and reseeded in the same annual rotation. Sectors G and H are treated as one area because productivity tends to be lower and the main bed generally straddles the boundary between them. Sectors D and I are not included in the rotational system, because the bulk of the scallops they produce are slower growing and a lower proportion reach market condition. The default strategy is sometimes modified by Challenger on the basis of annual survey results to capture scallops that are found to be out of phase with the rotation and to provide for non-commercial fishing access.

3.4 Quota Management System, 1992 to present

The period 1992 to 1994 saw major changes in the legislation surrounding the fishery. Agreements reached earlier with industry representatives were codified in the *Fisheries*

Amendment (No. 2) Act of 1992. This act introduced the fishery into a modified form of the QMS under an annual allowable catch of 1 100 tonnes (meatweight). Of this, 576 tonnes were allocated as 12 tonnes of scallop quota to each of the 48 licence holders and 64 tonnes were allocated to Maori on an equal share to each of the 8 tribal groups (Iwi) located within the bounds of the fishery. The remaining 460 tonnes were held by the Crown. In 1994, a further 10 percent of the total quota was allocated to the 8 Iwi from the Crown holdings in accordance with the terms of the Treaty of Waitangi fisheries settlement. Introduction to the QMS removed the fishery from the vessel limitations of the controlled fishery regime. The allocation of new quota to Maori and a period of high catches led to a rapid expansion of the fleet to 60 vessels. The 1992 amendment also established a compulsory levy to fully fund the enhancement programme in accordance with a plan determined by the Minister of Fisheries.

The *Fisheries Amendment Act of 1995* integrated the scallop fishery quota system into the standard QMS provisions, removed the Crown quota, and set a total allowable commercial catch (TACC) of 720 tonnes. The 1992–1995 period also saw restructuring of fisheries administration into the Ministry of Fisheries (MFish) and simultaneous reform of its funding arrangements. This resulted in the current regime, which recovers the government's costs of the fisheries management attributable to commercial fishing through compulsory levies.

The 1992 implementation of the enhancement programme, with costs recovered through a specific levy and service delivered by the Ministry, did not fit into the accountability structures and redefined role of MFish. Contracting the enhancement services out to an external provider was an option consistent with the Ministry's new and wider purchasing roles (Arbuckle, 1999). This reform was to lead directly to the establishment of the Challenger Scallop Enhancement Company Limited ("Challenger").

4. INDUSTRY ROLE IN MANAGEMENT BEFORE CHALLENGER

In 1963, the New Zealand Fishing Industry Board ("NZFIB") was established with statutory powers to levy fishers and the authority to represent fishers to the Government. The Minister was required to consult the NZFIB before making a range of decisions, including the appointment of one of the five members of the Fisheries Licensing Authority and the declaration of a controlled fishery.

The Southern Scallop fishery was declared a controlled fishery in 1977. The appointment of a Southern Scallop permit holder to the Licensing Authority marked the first occasion when Southern Scallop fishers were directly involved in the management of the fishery. At about the same time, scallop fishers developed their own representative body, the Southern Scallop Licence Holders Association. This Association, together with the local Commercial Fishermen's Association, gained recognition by the NZFIB and MAF as representing the voice of the licence holders.

In June 1983, the Scallop Enhancement Steering Committee held its inaugural meeting. The Fisheries Management Division and the Fisheries Research Division of MAF, NZFIB, Scallop Processors Association, Golden Bay/Motueka Commercial Fishermen's Association, and the Southern Scallop Licence Holders Association were represented on that committee (Scallop Enhancement Steering Committee minutes, 1983). The Fishing Industry Board also established the NZFIB Southern Scallop Advisory Committee, which was comprised of representatives of the NZFIB, four local fishers' associations, the scallop processors and the Licence Holders Association.

While the Ministry retained responsibility for the delivery of the enhancement programme, it discussed management of the programme and subsequent harvesting decisions with the Steering Committee. Fishers' vessels and crews were also used by the programme during the annual spat-seeding season. Trial harvests of enhanced stocks began in 1986. By early 1988, the Ministry was pressing for the beneficiaries of the programme to assist with its funding. A voluntary levying system was introduced that year and most permit holders contributed. The small proportion of fishers who were reluctant to pay a share was identified to other participants, which generally resulted in payment (G.J. Ivey, Administration Manager, Central Region, Ministry of Fisheries, pers. comm.).

The *Fisheries Amendment (No. 2) Act of 1992* replaced the NZFIB Southern Scallop Advisory Committee with a statutory "Southern Scallop Fishery Advisory Committee", which consisted of representatives of scallop quota owners, processors, and Maori interests, together with a representative of the Ministry. The committee was established to advise the Minister of Fisheries on: allowable catches, seasons, exemptions to quota holding limits, the enhancement programme, levies, area and duration of closures, minimum sizes and regulations to be made for the fishery. Allocation of quota to Iwi at this time resulted in Maori representation within the industry representative groups.

5. THE CHALLENGER SCALLOP ENHANCEMENT COMPANY

5.1 Creation of Challenger

With the establishment of the mandatory levy under the 1992 Act, it became apparent to the industry that they would need to provide an alternate funding and administrative structure to protect fishing and management rights. The Challenger Scallop Quota Holders Association was formed for this purpose in December 1993 (Arbuckle, 1999).

In 1993, the Ministry of Fisheries reform was looming. Its new role would not be compatible with direct delivery of enhancement services. The opportunity for the quota holders to be the external contractor to provide those services was established. The quota owners were already paying for the services through a compulsory levy. They believed that they could lower costs so they had incentives to create a structure that could not only deliver those services but also one that would have sufficient credibility and accountability for the Ministry to contract with it.

The structure chosen was a limited liability public company, the Challenger Scallop Enhancement Company Limited, incorporated in May 1994. Its board of directors was drawn from the industry representatives on the statutory Southern Scallop Advisory Committee. Shares in the company were limited to the amount of quota in the fishery and ownership of the shares was constitutionally limited to the owners of Southern Scallop quota at the rate of one share per 100kg of Southern Scallop quota owned. The company's shares were fully subscribed (Challenger, 1994b).

Challenger enhanced its capacity to meet the opportunity for devolution by attracting a Chief Executive (Michael Arbuckle) from within the Ministry of Fisheries. He had been directly involved in creating the framework for service delivery under which Challenger would function. The company moved rapidly to secure a contract to deliver enhancement services as a service provider to the Ministry.

Over the next two years, Challenger developed the devolved fisheries management model by using the framework established specifically for it in the two Fisheries Acts. It developed a formal plan for the enhancement of the scallop fishery, which the Minister of Fisheries approved under the Southern Scallop provisions of the amended 1983 Act. The Minister also appointed Challenger as the organisation to deliver the plan, again under the provisions of the amendment.

5.2 Restructuring in 1996

In early 1996, Challenger redesigned its harvest management strategy by creating a civil contract between itself and every quota owner, permit holder, processor and vessel master. The suite of identical contracts signed each year establishes the rules for fishing, including *inter alia*: earliest start and latest finish dates for the season, area closures, documentary requirements, and limits on daily catches, area catches and scallop sizes.

The rules for each year are developed after information is gathered in the annual biomass survey. Negotiations are also held with recreational fishing groups to establish areas that might be suitable for recreational harvest. Approval for the annual rules is obtained at a general meeting of the company, to which all prospective participants are invited and granted speaking rights. Until 2000, the Minister of Fisheries endorsed the rules before they were implemented and some of the rules (e.g. earliest and latest dates for fishing, Marlborough Sounds catch limit, and area closures) were implemented by regulation. Since 2000 that process has been changed so that annual endorsement of the Minister is no longer required.

Beginning in 1998, a Memorandum of Understanding (MOU) between the Ministry of Fisheries and Challenger specifies requirements for the provision of information by Challenger to the Minister to "ensure that the Minister receives sufficient information, in a timely manner, on which to base decisions regarding the setting of sustainability and other management measures in the Southern Scallop Fishery." The MOU establishes standards for the information required and an audit process to ensure that the delivery of research information is timely and that the information is of sufficiently high quality (Arbuckle, 2000).

As part of its institutional redesign, Challenger also changed its funding mechanism. New Zealand law provides for commodity levies, a mechanism by which groups of primary producers can establish a levy to fund activities such as marketing and research on their joint behalf. Such commodity levies are designed to provide funding for club benefits and to avoid free-rider problems by requiring all producers of the commodity to pay the levy struck under a commodity levy order. The empowering levy order has a life of 5 years but may be extended if the primary producers required to pay it support its renewal in a ballot held before expiry. Once a commodity levy is authorised, unpaid levies can be made subject to additional levies and are recoverable as a legally enforceable debt. In 1996, the company sought and received the requisite approval of its shareholders to establish a commodity levy on commercially harvested Southern Scallops. The levy may be struck as high as 25 percent of the landed value (ex-vessel or wharf price) of scallops. The levy has varied between 14 percent and 20 percent and was 20 percent for 2006. With the establishment of the commodity levy, the government was able to withdraw its statutory levy set under the scallop-specific amendment. Challenger now sets a business plan and budget annually by majority vote in a general meeting of its shareholders. It then seeks approval to strike a levy rate sufficient to fund that budget, again by simple majority but among all prospective levy payers. These are the same individuals who are qualified by quota ownership to own shares in Challenger. Continuing support for levies has been evident through its renewal in 2002 and again in an expanded form in 2007.

Until the *1996 Fisheries Act* was implemented, the currency of Southern Scallop ITQs was measured in kilograms of permanent quota. Every sale of quota generated a series of actions by Challenger upon notification of the transaction. If the transfer of shares would change who was qualified to join, Challenger would extend an offer to a newly-qualifying prospective shareholder to accept a shareholding in the company. Challenger would also initiate removal of any no-longer qualifying shareholder. With the implementation of the 1996 Act, the currency of ITQs went from 720 000 kg of quota in the scallop fishery to 100 000 000 quota shares that generated 720 000 kg of annual catch entitlement (ACE) each year. Under the 1996 changes, ACE trades separately from the generating quota shares. ACE could be counted against fish taken by the quota owner or sold to another fisher. This change led to an amendment of Challenger's constitution to provide for one share per quota owner but with voting rights at company meetings tied to quota shares owned on the day of the meeting. Voting rights were later defined as the number of quota shares owned seven days prior to the meeting.

5.3 Further devolution of authority to Challenger

In 1998, Challenger developed a new enhancement plan. Challenger received Ministerial approval as the organisation appointed to implement that new plan under the 1996 Act. Scientific modelling of the fishery that incorporated rotational harvest and enhancement of the fishery came to several conclusions (Breen and Kendrick, 1997). The fishery could be subject to over-fishing under a constant catch strategy. The fishery was more stable, but still susceptible to over-fishing, under a constant proportion of biomass catch strategy Rotational fishing was highly stabilising, and enhancement together with rotational fishing was considered to be the most stable strategy. That study found that the rotation and enhancement strategy would also withstand the extraction of 10 percent of the recruited biomass under the non-rotational harvests by recreational and customary Maori users.

Breen and Kendrick's (1997) study underpinned the further devolution of harvest management functions to the company. In 2000, the season start and finish dates were set on a permanent basis and the Minister withdrew from regulating the Marlborough Sounds catch limits and rotational area closures. In 2002, a total allowable catch was set at 827 tonnes, with 40 tonnes each allocated to Mäori customary fishing and to recreational fishing. Having agreed that the rotational harvest regime rather than the TACC was the proper management tool to ensure sustainability of the fishery, the Minister set the TACC at 747 tonnes, well in excess of the anticipated average annual harvest. The species is also one of only three listed in the Third Schedule of the Fisheries Act that permits adjustments of the TAC within a quota year (1 April to 31 March for this fishery), should information indicate that such a course is desirable.

The Minister's agreement marked a significant change in the role of enhancement in the fishery. Enhancement had originally been the response to a collapsed fishery that delivered sustainability requirements. Now, enhancement was no longer a required activity (Drummond, 2002) but rather one of a range of discretionary tools available to Challenger to achieve its management goals for the fishery.

The Breen and Kendrick findings also underpinned a Ministerial decision to list the fishery in the Sixth Schedule of that Act, which permits the return to the sea of scallops that are likely to survive return, not wanted by the fisher, and would otherwise be required to be kept and sold.

6. CHALLENGER'S COMPREHENSIVE ROLE

Challenger is responsible for delivering most management functions in the Southern Scallop fishery, subject to Ministry of Fisheries oversight though the accounting functions for quota and ACE transactions are performed by FishServe, as described by Harte (this volume).

Challenger finances an annual survey of the biomass of the stock that it manages. The sampling structure for this survey generates data that are over three times as detailed as the preceding government surveys. Each year Challenger selects a science provider to design the survey to meet the requirements of the MOU. Following Ministry agreement on the methodology and design, Challenger undertakes the sampling itself and delivers the raw results to the science provider for analysis and reporting to the level required under the MOU. That report is then delivered to the Ministry. Apart from using the report for its own purposes, the Ministry is asked to confirm that it is satisfied that the report is sufficiently scientifically robust to properly inform decision making in the fishery.

Challenger's managers take more detailed information from the survey and use it together with the report to create a draft harvest strategy for the upcoming season, which is presented to directors for approval. A strategy will include proposals regarding:

i. areas to be closed to commercial fishing under the rotational fishing programme,

ii. areas to be closed to commercial fishing to provide for good recreational fishing,
iii. acatch limit for the Marlborough Sounds (which is not managed under rotation),
iv. ACE shelving (see discussion below), and
v. daily and weekly commercial catch limits.

Once the Board has approved the draft strategy, Challenger consults with commercial fishery participants, recreational scalloping representatives, customary Maori fishers, Government agencies, environmental organisations and the general public. The Ministry is also invited to comment on the draft strategy and attends all of the consultation meetings. Copies of the draft harvest strategy and the survey report are made available to interested parties prior to the meetings and detailed tow-by-tow survey information is presented and discussed at the meetings. Discussion of the draft strategy at the meetings, negotiated agreements over recreational access and written comments received are considered by Challenger. Improvements to the harvest strategy are incorporated into the final recommendations and approved by Challenger's directors for presentation to a company meeting with a view to obtaining final shareholder approval for the strategy. Challenger also uses the data to estimate potential annual harvest from the fishery, which informs the annual business planning, budgeting and levy setting.

The biomass survey and estimate of potential harvest are used to implement limits on aggregate catching rights (ACE) in the fishery. Because the TACC does not constrain catch in this fishery in the absence of some other mechanism, the available ACE generally exceeds by a significant margin the capacity of the areas to be fished to produce scallops. This does not present a sustainability problem in a rotational fishery, but many efficiency incentives that otherwise exist are lost. This leads to over-capitalisation and a race to catch at the start of the season. Challenger manages this risk by setting an in-house limit on the catching rights available in the fishery at a level a little below the estimated potential harvest for the year. This is implemented by agreeing on a cap with the quota owners, who then transfer a proportional share of their ACE to Challenger in a process known as "ACE shelving". Challenger holds the ACE on behalf of the quota owners, which makes it unavailable for fishing.

Catch in the fishery seldom approaches the in-house limit until late in the season, when the bulk of the catch has been taken, the costs of fishing have risen significantly and many vessels have left for more profitable opportunities. At this point, the ACE is generally released back to quota owners to reduce the costs of access to ACE when other fishing costs have risen. The quota holders have agreed to this mechanism in their contract with Challenger.

The bottom that is dredged for Southern Scallops is also dredged for oysters. Because oyster dredging would impact Challenger's reseeding and rotation programme, Challenger moved in 1996 to resolve this conflict. Challenger encouraged the oyster dredge quota holders to form the Challenger Oyster Management Company. Because many of the Southern Scallop quota holders also dredge for oysters, strong reasons to cooperate existed. Management of the oyster fishery by a similar organisation provides a framework for delivering broader management objectives, including avoiding unnecessary dredging of scallop grounds.

Challenger has also negotiated an agreement with recreational harvesters of Southern Scallops. Among other terms, that agreement allows recreational harvesters to access areas that are closed to commercial harvesting. A process of consultation and sharing of responsibility for management with the recreational group led to an invitation to its Chairman to become a permanent observer on the Challenger Board. This invitation was accepted. In 2005, Challenger's constitution was modified to provide an additional directorship filled by the recreational representative.

Challenger is also responsible for purchasing and providing services for the monitoring of natural biotoxins. The Southern Scallop fishery biotoxin management plan provides for the collection by Challenger and its subcontractors of water and shellfish samples required for analysis. Challenger directly purchases the analysis services from approved laboratories. The results are forwarded directly to the public health and regulatory authorities responsible for declaring the scallops safe to eat and for audit of the sampling programme. Challenger has been able to make significant cost savings by managing the programme directly and by sampling more frequently during peak harvest times than the regulatory programme requires. This reduces the volume of product at risk of being unsafe to eat should toxins be present.

Challenger has also taken a lead role in protecting the value and extent of ITQ rights in the face of attempts to reallocate fishing space to aquaculture interests. Challenger has successfully argued that the expansion of aquaculture must be integrated with the fisheries. Estimates of the loss of production from the Southern Scallop fishery as a result of fishing areas already reallocated to aquaculture interests amount to between 3 percent and 5 percent and further applications being considered in 2007 and 2008 represent a potential loss of production totalling between 12 percent and 18 percent (Ministry of Fisheries, 2007).

Harvests in the fishery have shown a continuing decline since 2002. This cycle began with large spat falls in 1997/98, which were followed by evidence of shellfish starvation in Tasman Bay and the Marlborough Sounds and then repeated natural spat failures. Both enhanced and unassisted spat that settled in the fishery failed to thrive and harvest condition was consistently poor, particularly in Tasman Bay. Challenger responded by stalling the rotation in Tasman Bay to permit fishing on seeded stock that was growing very slowly and to permit other areas to lie undisturbed for longer than normal. Fishing, when it did occur, was extremely light and in short, controlled periods. Despite these measures, Tasman Bay continued to decline and the scallop biomass in 2006 was the lowest observed in any survey. Only one small area had reasonable numbers of fish in good quality and Challenger agreed not to fish that area to permit recreational access to those fish. In 2005 and 2006 surveys, Golden Bay appeared to be recovering with significant numbers of spat growing. Approximately 50 percent of that fish was a product of reseeding. The first harvest of those scallops is expected in 2007, when a reversal of the declining trend in catches is anticipated. Tasman Bay continues to show no signs of recovery. Challenger has continued to carefully husband the scallop resource and to share it with other users, despite the financial hardships suffered by the company and its shareholders.

The suite of functions performed by Challenger (in conjunction with FishServe) includes almost the entire set of management functions normally provided by fisheries management agencies. It has implemented a sophisticated resource survey, reseeding and rotational program with a degree of efficiency that would be difficult for any government agency. It has negotiated resolutions of conflicts with both recreational users and other commercial users of the same area. These kinds of conflicts are often the most intractable of management problems faced by fisheries management agencies. Challenger shows that with the correct incentive structures in place, devolution of responsibility for management functions can result in efficient and effective management.

7. EVALUATION OF CHALLENGER AS A SELF-GOVERNANCE INSTITUTION

In 2000, before the current stock declines, Arbuckle (2000) identified four indicators that the fishery was performing well under the Challenger management model.

i. The high level of agreement reached amongst industry participants and between different sectors that utilise the scallop resource.
ii. Recruited stock biomass indicators show a stabilising and positive trend over time.

iii. Pre-recruit stock biomass indicators also show a corresponding increase over time.
iv. The analysis of implicit discount rates in the fishery by Akroyd *et al*. (1999) concluded that their convergence over time with real interest rates (expressed as inflation-adjusted Government 90-day bill rates) compared favourably with the divergence from that rate by another poorly performing New Zealand scallop fishery.

Arbuckle rated the first indicator as by far the best measure of performance and described the other three independent measures as providing further evidence in support of the cross-sector agreement. Note also the comparison of implicit discount rates in the fishery (iv. above) is confounded by distortions in the reported value of ACE as a result of the novel TACC and the related shelving of ACE in some years.

Stock biomass in the Challenger fishery is subject to environmental factors that are beyond the control of either Challenger or the Government and create high variability in both exploited and unexploited fisheries. In the Challenger case, such externalities have resulted in a continuous decline in stock abundance between 2001 and 2006 when the first indication of improving biomass has been observed. Not withstanding the more recent decline in biomass, average landings have been higher under rotational management. Between the reopening of the fishery in 1982 and the beginning of rotational fishing in 1989, the fishery averaged 272 tonnes of harvest a year. Since rotational harvest began, it has averaged 435 tonnes a year.

The continued, nearly unanimous, support by the quota owners for the levying process and by all fishery participants for the harvest management rules is a strong indicator that the rights' owners value retaining management control within Challenger. Not withstanding the downturn in the fishery, the unpopular adoption of a real-time harvest vessel location monitoring system by Challenger and high costs associated with defending quota rights, support for levying was re-affirmed in 2006. Votes associated with 95 percent of the participating quota rights were cast in favour of renewal of the levy for a further 5 years.

Support for the management programme is also evident from the recreational groups and the Ministry of Fisheries. External observers also view the model employed by Challenger positively.

8. LESSONS FROM THE CHALLENGER EXPERIENCE

The success of Challenger provides several lessons about the role of government, industry and science in effective self-governance of fisheries. Arbuckle (2000) identified three key government innovations in the framework for management that contributed to the successfully devolved management model. Those innovations were: (a) flexibility over prescription, (b) empowerment over coercion and (c), accountability over control.

Drummond (2002) described the role of stock enhancement in the management framework. He noted five key phases as being distinguishable: (a) applying technology and developing management capability, (b) aligning rotational fishing with enhancement, (c) legislative reform, (d) collective action and (e), a consensus approach. Whereas enhancement had been seen as a response to a collapsed fishery, it subsequently became a supplementary and discretionary component of the management framework.

Successful development of Challenger was built on some strong internal direction by the industry. The long history of increasing industry investment in management contributed a sense of responsibility. A closed group of beneficiaries was created by the introduction of the controlled fishery. The desire to attempt enhancement in a collapsed fishery created a unique opportunity. Strong leadership from within the fishing industry helped to develop the capacity and structures required for devolution of the management from government. The theme of strong and capable leadership was continued through the Challenger Board and its choice of founding CEO to manage the company and fishery through increasing devolution of management authority.

Communication between government and industry is an integral component of the confidence building that precedes devolution of managerial responsibility. Government requires confidence that the group has a genuine understanding of fisheries management concepts. A pre-requisite for that confidence is successful communication between the government and stakeholder managers. This paper argues that the successful devolution of management for the scallop fishery was contingent on the permit holders (later ITQ rights holders) developing

i. an understanding of the language and concepts of fisheries management sufficiently well to share meaningful discussions with the government fisheries management body,
ii. a positive view of the opportunities for improved value that could be obtained from the fishery under a devolved management structure, and
iii. A willingness to accept the risks inherent in taking responsibility for managing the fishery.

The success of Challenger is not due to any single factor. The biology of the Southern Scallop made re-seeding a strategy that attracted both industry and government attention. Subsequent contributions by science helped establish the role of rotation in efficient management. Industry took an active role in defining a new approach to management and accepted responsibility for implementation. Government brought a flexible approach to management that permitted devolution of responsibility to industry.

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Assessing the road towards self-governance in New Zealand's commercial fisheries

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1. INTRODUCTION

The management of New Zealand's fisheries is widely regarded as a model for other fisheries around the world. To reach this position, government, customary Mäori, recreational and commercial fishers, and other stakeholders have worked together to meet many challenges. The key has been a willingness to engage in a collective experiment in public policy development. Whether or not government, fishers and other interest groups choose to continue this experiment will determine whether New Zealand remains at the forefront of international fisheries policy and management.

One direction for the continued experiment is the transfer of greater responsibility for management to fishers through the devolution and delegation of statutory responsibilities. This involves setting national standards for the management of fisheries and dealing with fisheries in partnership with other stakeholders. Despite some successes (such as those discussed in later chapters in this volume), progress towards self-governance has largely stalled since 2000 and management has become increasingly centralized within government. This overview of New Zealand's fisheries management institutions will explain why New Zealand is at crossroads on the road to self-governance.

2. NEW ZEALAND'S FISHERIES SECTOR

2.1 Overview

The New Zealand exclusive economic zone (EEZ) is the fourth largest in the world at approximately 1.3 million square nautical miles. A characteristic of the EEZ is its depth, with 72 percent in waters more than 1 000 metres deep, 22 percent between 200–1 000 metres, and only 6 percent less than 200 metres. Fishing within the EEZ is heavily reliant on species found in waters at depths ranging from 200 to 1 200 metres, rather than species found in shallower waters. The fisheries resources in New Zealand's EEZ are not as abundant or productive as in many other parts of the world. Contributing factors include a narrow continental shelf, a lack of nutrient upwelling, and being on the periphery of the range of highly migratory species, such as tuna.

The commercial fisheries sector is New Zealand's fifth largest export earner. In 2003, the export value from the fishing industry was NZ$1.2 billion (US$700 million). These exports account for about 88 percent of the total New Zealand fisheries value. The industry is also a large employer, with some 26 000 people through direct employment and flow on effects. Unlike most other countries, the New Zealand industry receives no direct government subsidies.

The *Fisheries Act of 1996* forms the statutory basis for all fisheries management by the government. Separate management systems exist for recreational, customary Mäori (New Zealand's indigenous peoples) and commercial fisheries. The purpose of the *Fisheries Act 1996* is to enable the utilisation of fisheries resources while ensuring sustainability. It includes provisions for:

i. Environmental protection
ii. Customary fishing regulations
iii. Recreational fishing regulations
iv. Bringing new species into the quota management system
v. Resolving disputes between fishers over access and
vi. Consultation on fisheries management.

Recreational marine fisheries are managed as open access fisheries and, as such, are either non-exclusive or excludable at only very high cost, and the rights to the fisheries are held in common. Recreational regulations determine daily bag limits, minimum fish sizes, method and gear restrictions, closed areas, and closed seasons.

The management of customary Mäori fisheries is based on a territorial-use rights system wherein harvesting rights are restricted to specific groups or communities. Shares are allocated within the group through a variety of administrative or negotiated processes such as rahui (ban on taking of kaimoana [seafood]), mataitai (area of seashore that is managed as a traditional subsistence fishery by iwi or hapu [tribe or sub-tribe]), and taiapure (area managed by an iwi committee that has customary authority to make legally binding rules regarding access and exploitation rates). Tangata Kaitiaki (guardians) are nominated by iwi or hapu and appointed by the Minister of Fisheries to approve the collection of kaimoana for customary purposes. In most cases there is no exclusive access, though spatial exclusivity is guaranteed in the case of mataitai. Customary harvest is affected by (and in turn affects) extractions from the same stock by commercial and recreational fishers.

The main method for managing commercial fisheries is individual transferable quota called the "quota management system" (QMS). The characteristics, strengths and weaknesses of the New Zealand QMS are well documented in the fisheries management literature. (See, for example, Bess and Harte, 2000; Batstone and Sharp, 1999; Clark, Major and Mollet, 1988; Dewees, 1989; Harte, 2001; Hersoug, 2002; Memon and Cullen, 1992). For each QMS species, New Zealand's EEZ is divided up into a number of Quota Management Areas (QMAs). The Minister of Fisheries sets an annual total allowable catch (TAC) for each fish stock in each QMA. In general, the TAC is set at a level that ensures the fish populations remain at or above a level that will produce the maximum sustainable yield. An allowance is made within the TAC for customary Mäori fishing, recreational fishing and any other sources of fishing-related mortality. The remaining portion of the TAC is the total allowable commercial catch (TACC).

The QMS is comprehensive in its application, and 92 species or groups of species representing over 85 per cent of the total fish catch are currently managed as 592 separate fish stocks. The large number of stocks arises for historical, biological and administrative reasons. Generally, New Zealand's EEZ is divided into ten QMAs. Unless there are biological reasons for aggregating quota management areas (or subdividing them further) each species is managed as ten separate stocks. The few remaining non-QMS commercial fisheries are managed through restricted entry licensing, catch limits and gear restrictions.

2.2 Government agencies with fisheries management responsibilities

Two government agencies give effect to the majority of the government's fisheries management responsibilities, the Ministry of Fisheries and the Department of Conservation. The costs incurred by these agencies in the management of fisheries are considered government fisheries management costs for public finance purposes.

TABLE 1
Responsibilities and functions of the Ministry of Fisheries

Core responsibility	Functions
Ensuring ecological sustainability	• Researching and monitoring the health of fisheries and the aquatic environment and the effects of fishing on the aquatic environment. • Specifying environmental standards related to the use of fisheries and the impact of fishing on the aquatic environment. • Maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations. • Setting, implementing and enforcing sustainability measures.
Meeting Treaty of Waitangi obligations to Maori	• Involving Mäori in fisheries management decision-making. • Delivering 20 per cent of new quota to Mäori. • Providing for and protecting customary fishing rights
Enabling efficient resource use	• Defining and allocating rights to use fisheries resources. • Providing management frameworks to allow rights holders to exercise those rights. • Recognizing and protecting New Zealand's fishing and conservation interests during the negotiation of international agreements.
Ensuring the integrity of management systems	• Evaluating and monitoring fisheries plans. • Setting standards and specifications for services such as research and registry administration. • Managing fisheries and aquatic environment information. • Delivering criminal law enforcement and prosecution services. • Ensuring management and information frameworks are consistent with New Zealand's international fisheries obligations.

The *Fisheries Act of 1996* requires the Minister of Fisheries to consult with stakeholders including Mäori, the commercial fisheries sector, recreational fishing interests and environmental groups before making many statutory decisions.

The primary purpose of the Ministry of Fisheries (the "Ministry" or "MFish") is to ensure that marine fisheries are sustainably used within a healthy aquatic ecosystem. The role of MFish, in collaboration with other government agencies, is advising on and implementing government policy in the following areas: ensuring ecological protection and sustainability; meeting international and Treaty of Waitangi obligations to Mäori; enabling efficient resource use; and ensuring the integrity of management systems. For each of these core responsibilities, MFish exercises many functions as shown in Table 1. MFish has approximately 400 staff and has offices in 20 locations around New Zealand.

The Department of Conservation (DoC) has a statutory function to advocate for conservation of natural and historic resources. It has responsibility for marine reserves and protecting marine mammals and seabirds. MFish works with DoC on operational advice concerning protected species interactions with fishing and marine reserve proposals under the Marine Reserves Act. The views and input of DoC officials are often sought in the development of MFish policy. DoC regional offices interact with MFish staff at a local level on fisheries related issues. A Memorandum of Understanding formalises the way MFish and DoC work together. It is aimed at ensuring co-operation in a number of areas including: protected species/fisheries interactions, marine reserves, biosecurity risks, research, and the nature and extent of fisheries and conservation services.

2.3 Commercial stakeholder groups

2.3.1 The New Zealand Seafood Industry Council Limited

The New Zealand Seafood Industry Council Limited (SeaFIC) is an industry-owned, limited- liability company that represents the interests of harvesters, the marine farming sector, processors, retailers and exporters. It provides professional advice to government and the industry on fisheries management policies and practices and scientific issues. SeaFIC's shareholders are Commercial Stakeholder Organisations that represent 94 percent of the productive value of the industry, the New Zealand Federation of Commercial Fishermen, the New Zealand Fishing Industry Association, the New Zealand Fishing Industry Guild, and the New Zealand Seafood Retailers and Wholesalers Association. A board of directors manages SeaFIC.

The company is organised into the following four business units: Science, Business Policy, Trade and Information, and Industry Training. The Science group is responsible for fisheries science, research and development, while Business Policy is concerned with fisheries law and regulations, property rights in capture fisheries and marine farming, and environmental issues. Trade and Information incorporates trade and international policy, seafood standards and the provision of information services to industry. The Seafood Industry Training Organisation (SITO) is responsible for facilitating competence-based training across all areas of the seafood industry including both industry-specific and generic skills. SeaFIC owns the Commercial Fisheries Services Ltd, which is described below.

2.3.2 Commercial Stakeholder Organisations

There are over 30 Commercial Stakeholder Organisations representing specific fisheries or geographic regions. Some of these are described in greater detail in the chapters that follow in this volume. They have several key functions in common (Bess and Harte, 2000):

i. To facilitate the collection of funds to finance fisheries management activities, such as research or bycatch mitigation monitoring and to manage the delivery of such services.

ii. To represent the interests of commercial fishers in consultative government processes such as the determination of fisheries management services and the setting of sustainability regulations.

iii. To promote the expansion and development of commercial management rights.

The Commercial Stakeholder Organisations vary in organization and structure to best meet the needs of the commercial fishing interests they represent. Funding of these groups can be voluntary, by civil contract, or under the *Commodity Levy Act*.

The *Commodity Levy Act of 1990* enables many commodity-producing industries, including the seafood sector, to finance industry activities where voluntary funding would lead to a 'free-rider' problem or would be impracticable. To raise a levy under the Act, an industry group must hold a referendum and gain 50 percent support of those responding and 50 percent by volume of production. The levy is then compulsory. The Commodity Levy Order lasts for five years. To renew or amend the Order, a new referendum is required. SeaFIC is largest stakeholder organization to be funded under *the Commodity Levy Act*. The first *Seafood Industry Commodity Levy* came into force on 1 April 2002 and lasted until early 2007. It has recently been renewed until 2013.

2.3.3 Te Ohu Kaimoana

Te Ohu Kaimoana (Te Ohu) was established by the Mäori Fisheries Act of 2004. Te Ohu is the corporate trustee of Te Ohu Kai Moana Trust, which is responsible for advancing the interests of iwi (tribal groups) in the development of fisheries, fishing and fisheries-related activities. Its main tasks are the administration, allocation and transfer of treaty settlement fisheries assets to mandated iwi organisations. Te Ohu plays a vital advocacy role on behalf of Mäori. Te Ohu aims to provide a central voice when any legal reforms are proposed that relate to either the seafood sector or ownership/management of marine and freshwater environments.

Te Ohu is the sole voting shareholder in Aotearoa Fisheries Limited (AFL) and appoints their board of directors. AFL was established under the Mäori Fisheries Act

2004 to maximise the value of Mäori fisheries assets for the benefit of its iwi (tribes) and Mäori shareholders. The company is a major player in the fishing industry and holds around half the total value of the Mäori fisheries assets, estimated to be worth at least $350 million. All iwi organizations recognized by Te Ohu under the *Mäori Fisheries Act* hold income (non-voting) shares and receive annual dividends from the company.

2.4 Other stakeholders

There are a number of environmental groups such as Environmental and Conservation Organizations of New Zealand, The Royal Forest and Bird Protection Society, and World Wide Fund for Nature with strong interests in the sustainability of fisheries and the effect of fishing on the environment.

Marine recreational fishers do not belong to recreational fishing organisations. However, several voluntary recreational fishing stakeholder organisations represent or advocate for the recreational fishing sector. These include the Recreational Fishing Council, the Big Game Fishing Council and Option 4. Option 4 is a particularly active web-based recreational fishing organization that advocates a priority right over commercial fishers for recreationally caught stocks and a continuation of the current unlicensed open access marine recreational fishery management system (Option 4 2007).

Most customary Mäori fishers are not adequately resourced to participate in statutory consultation processes, although programmes are in place to address this.

3. DEVELOPMENT OF FISHERIES MANAGEMENT INSTITUTIONS

3.1 Fisheries management and public sector reform

The evolution of fisheries management systems in New Zealand cannot be separated from the significant and far reaching changes in public sector management that occurred in the mid 1980s. Boston *et al.* (1999) note that public sector reform was dominated by issues relating to:

i. The appropriate design of incentive structures and governance arrangements.
ii. Avoiding provider capture[1].
iii. Contestability[2] and external contracting of services.
iv. The minimisation of transaction costs and agency costs.
v. The tighter specification of public services as outputs and outcomes.

The resulting public sector reforms are characterized as (Stokes,Gibbs and Holland 2006, Hersoug, 2002):

i. The decentralisation of management responsibilities.
ii. A shift from input to outcome based management.
iii. Commercialisation of many public services (e.g. science).
iv. A shift in emphasis from public service to customer service.
v. Separation of policy and operational responsibilities.
vi. An output-related government agency funding system.

These reforms in New Zealand's public sector found particular expression within the fisheries sector (Harte, 2007; Stokes,Gibbs and Holland, 2006; Hersoug, 2002).

[1] Provider capture can refer to either the provision of public services such as fisheries research or the provision of policy advice. It occurs when one particular provider of services or advice "captures" a government agency purchasing the services or providing advice to decision makers by gaining the influence to determine the relevant public policy in their favour at the expense of the broader public interest. Jasanoff (1990) refers to it as when "an agency grown to close to those it seeks to regulate tends to accept unquestioningly the self-serving view of risk advanced by the regulated interests and their hired experts."

[2] Contestability helps avoid provider capture by allowing a decision maker or agency to take advice or purchase services from multiple sources. For example, a government minister may solicit advice from both a government agency and a public policy consultant. In another example, a government agency may tender out the provision of research services to external research providers rather than use a government department.

For example, commercial cost recovery was imposed in the 1980s. In the 1990s, there were moves to delegate and/or devolve some fisheries management functions from government to commercial stakeholder organizations.

3.2 Cost recovery

Funding of fisheries management in New Zealand has developed in response to public sector reforms and to changes in internal operating practices within the Ministry. The Ministry receives its funding as an appropriation from Parliament. *The Fisheries Act of 1996* enables the government to recover some of these costs from the commercial fishing industry through the cost recovery regime.

From 1985 to 1994, there was limited recovery of the public costs of fisheries management. Government recovered some costs through transaction fees and the government also required the commercial fishing industry to pay resource rentals for both quota and non-quota species. Approximately $22 million a year of resource rentals were being paid by the commercial industry in 1994.

A cost recovery regime was introduced from 1 October 1994. The obligation to pay rentals was also repealed. In the first year of cost recovery the industry paid levies of around $34.6 million. There was an expectation, however, that the levies would decrease over time as:

i. Cost recovery brought efficiency gains within the Ministry because of the requirement to accurately identify the cost of services provided and because of the scrutiny of costs during annual consultation over the services provided to and costs to be recovered from industry.
ii. Industry assumed a more direct role in fisheries management and the purchase of research.

The cost recovery regime operating from 1994 to early 2001 had several key features:

i. The purpose of the cost recovery regime was to "enable the Government to recover its costs" in respect of fisheries services and conservation services.
ii. The Ministry applied a policy known as the "avoidable cost" principle as a matter of administrative practice. This attempted to recover all costs incurred by the Government due to the existence of the commercial fishing industry.

Prior to fixing any annual levy, the Minister was required to consult with the commercial fishing sector on the costs to be recovered. Levy rates were set annually and paid in monthly payments.

As a result of external reviews in 1996 and 1998, changes were made to the cost recovery regime in 1999. The current regime came into full effect in early 2001. The central feature of the revised cost recovery regime is a statutory statement of principle on which cost recovery is based. Five principles in the Fisheries Act provide that:

i. Persons who request a service must pay for that service.
ii. Costs of services "provided in the general public interest, rather than in the interest of an identifiable person or class of person" cannot be recovered and are borne by the government.
iii. Costs must, so far as practicable, be "attributed" to the persons who benefit from the expenditure.
iv. Those who cause risk to or an adverse effect on the aquatic environment must, as far as practicable, pay the costs of services required to manage those risks or adverse effects.

A review of the cost-recovery rules and levying setting process, but not underlying principles outlined above, was announced in late 2006 (Cabinet Economic Development Committee 2006). It is supported by the commercial seafood sector and it is the first of the cost recovery rules since 2001; it is intended to recognize changes in fisheries management over the previous six years. Important objectives that are to ensure revised rules are:

i. Reflect changes in technology or the provision of management services since 2001.
ii. Create incentives for innovation in service provision.
iii. Improve incentives for environmental performance by the seafood industry.
iv. Better allocate non-specific costs to those who benefit from the provision of those services.
v. Reduce the complexity of the levy order process.

The aggregation of non-specific costs and spreading their recovery across all quota owners is of particular concern to the commercial sector. The current rules require these costs to be allocated by application of the "port price index", a measure of the relative values of fishstocks determined through an annual survey of port prices (also called ex-vessel or green-weight value). Concerns with the use of the port price index and the levy order process include:

i. the accuracy of the index as a measure of stock value
ii. doubts over how well the index gives effect to the cost recovery principles
iii. how equitable it is in practice? When the rules were introduced, there was no more satisfactory measure available, so this was difficult to assess.
iv. the complexity and costs to administer the index.

3.3 Delegation and devolution of research and registry services

The Ministry of Fisheries and the commercial sector continued to push for institutional reforms during the 1990s. An independent review of the Fisheries Act of 1996 conducted in 1998 contained many "radical" recommendations about the role of the government and the role of stakeholders. The reviewer recommended that the Act be amended to enable the Minister to devolve fisheries management functions to rights holders groups, to provide for mandated quota owner associations and to provide suitable compliance regimes for devolved management functions.

Amendments to the Fisheries Act in 1999 and their subsequent implementation went part way in implementation of the independent reviewer's recommendations. The amended Fisheries Act allows many duties and powers of the Chief Executive of the Ministry to be delivered either by MFish or by a service delivery agency under a contract. The Chief Executive retains accountability for the provision of a contracted service. Most fisheries research services in New Zealand are contestable services. This means that in principle they do not have to be carried out by MFish but can be contracted out to a third party.

The Act also provides for devolved services, where an external organisation has responsibility for both purchasing and ensuring the provision of relevant services, with the agreement of the Minister of Fisheries. In such cases, the Chief Executive of the Ministry of Fisheries is no longer accountable for provision of the service. Once functions, duties, and powers are devolved to an external organisation, the specific related services become the sole responsibility of the organisation to deliver. Failure to comply with the statute and standards and specifications can lead to civil sanctions imposed on the organization.

4. THE IMPACT OF MANAGEMENT REFORM AND SELF-GOVERNANCE

The relative success and failure of these far-reaching reforms can be seen in three areas: (a) devolution of quota registry services, (b) stakeholder purchase of research services and (c), reduction in the real cost of commercial fisheries management.

4.1 Devolved QMS registry services

Table 2 lists the registry-based QMS services that are devolved or contracted to the New Zealand SeaFIC as an approved service delivery organisation. These services are provided by Commercial Fisheries Services, a wholly-owned subsidiary of SeaFIC that

TABLE 2
Devolved and contracted quota management system services provided by FishServe

Devolved QMS Services	Contracted (delegated) QMS Services
i. Registering clients and vessels.	i. Delivery of catch effort services, including issuing return books and the returns management process.
ii. Licensing fish receivers.	ii. Issuing fishing permits.
iii. Issuing catch return books and operating returns management processes including electronic data transfer for statutory reporting.	iii. Registering foreign owned vessels, charter vessels, and fish carriers.
iv. Processing quota and annual catch entitlement transactions, including mortgages and caveats.	iv. Monitoring catch limits.
v. Reconciliation of fishers' actual catches against their catch entitlements.	v. Delivery of revenue services, including invoicing, receiving and debt management of cost recovery and deemed values.

Source: Harte (2007).

TABLE 3
Cost of FishServe to the industry (millions of current NZ$)

Year	Contract	Devolved	Total	Staff
2000/01	$8.65	N/A	$8.65	84
2001/02	$5.65	$1.98	$7.63	82
2002/03	$4.57	$1.78	$6.35	73
2003/04	$4.12	$1.64	$5.76	69
2004/05	$4.03	$1.51	$5.54	65
2005/06	$3.38	$1.50	$4.98	58

Source: Craig (2007).

operates under the company name "FishServe" (Harte 2007). Essentially, FishServe provides most accounting services for implementation of the QMS.

Registry service provision by FishServe has been an unqualified success. The annual cost of registry services to the industry has decreased annually from NZ$8.65 million in 2000/01 to NZ$4.98 million in 2005/06 (Table 3). The volume of data transferred electronically grew in the same period from 68 percent to 95 percent of all registry transactions.

The reasons for the success of FishServe are fourfold (Campbell 2005). First, the 1999 amendments to the Fisheries Act provided for more streamlined administrative processes that could be delivered by FishServe more efficiently. Second, FishServe is more innovative and less bureaucratic because it is a private sector company and has more operational flexibility. Third, industry has invested in FishServe to acquire new technology that brought major efficiencies. Fourth, given industry ownership, the internal incentives exist for FishServe to reduce costs. If FishServe loses industry support, the industry might look elsewhere for devolved services.

4.2 Stakeholder purchase of fisheries research services

Until 1999, there was little prospect that the responsibility for fisheries research could be delegated to commercial fishery organizations. Research was considered a core responsibility of government and too important to be trusted to fishery stakeholders. The 1999 amendments to the Fisheries Act provided for stakeholder purchased services. These are services for which the Ministry retains accountability but which stakeholders are allowed to purchase directly. The costs of directly purchased services are then removed from the cost recovery regime. It was initially intended that some approved fisheries research services could be purchased directly by industry, thus avoiding high MFish overheads and giving the industry more responsibility.

Directly purchased research was expected to increase economic efficiency due to the lower transaction costs for stakeholder organization to run and to fund research (Harte 2001). Enhancement of a commercial fishers stewardship ethic was seen as another benefit, since they would be directly involved in the purchase and execution of sustainability research rather than indirectly involved through centralized consultative processes. These benefits have been demonstrated in the case of the two commercial fisheries, the Rock Lobster Industry Council and Challenger Scallop Enhancement Company. Both are discussed in detail in separate chapters in this volume.

The Rock Lobster Industry Council (RLIC) represents commercial rock lobster interests. The RLIC has become an accredited research provider to the Minister of Fisheries and has successfully tendered for, and executed, a number of rock lobster stock assessment and related contracts. Research contracts are undertaken in collaboration with national science providers and internationally recognized stock assessment consultants contracted to RLIC. RLIC also uses accredited technicians employed by science providers to undertake an extensive stock-monitoring programme.

The Challenger Scallop Enhancement Company (CSEC) has for many years managed scallop enhancement programmes, including all research, in its area. The main research programme carried out by CSEC is an "annual abundance survey" of stocks. CSEC has improved the precision of this survey at least threefold since taking over this responsibility due to demands from shareholders and fishers. The company needs the information for its business plan and to set levies, as well as to provide the scallop fleet with accurate data about the location of scallops. CSEC runs it own geographic information system for this purpose. In addition, the company commissions independent researchers to provide information on the possible environmental impacts of its scallop harvesting and the company's enhancement activities.

Despite the success of RLIC and CSEC with directly-purchased research, further growth of stakeholder purchased research by other commercial stakeholder organizations has been impeded by a number of factors (Harte 2001, Stokes, Gibbs and Holland 2006). First, there has been opposition by environmental non-governmental organizations and some scientists who believe fishery research is a core responsibility of government. These groups have claimed that industry has a strong incentive to distort the results of research or to pressure contracted providers for short-term gain. Second, some segments of the fishing industry perceive that direct purchase means devolution of management responsibility rather than the narrower delegation of Ministry research purchasing functions. This led them to oppose being accountable to the Ministry for the delivery of required research services. This made MFish reluctant to deal with some segments of the industry and also appeared to give credibility to the concerns of environmentalists. Third, both SeaFIC and MFish overestimated the capacity of many commercial fisher organizations to fund and manage complex fisheries research projects. Fourth, there was insufficient collaboration between the fishing industry and the Ministry over the development of the direct purchasing regime. A formal programme of collaboration would have substantially resolved many of the first three issues.

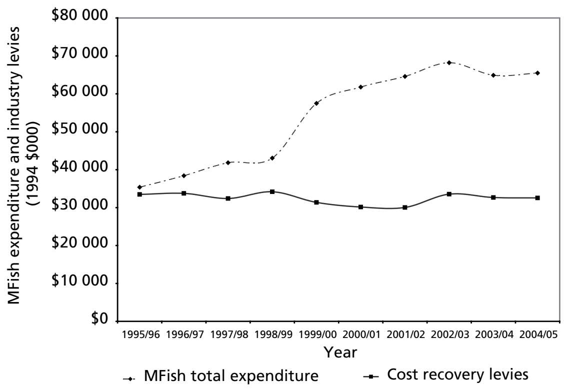
In late 2000, a new Minister of Fisheries became reluctant to delegate research responsibilities to industry. The embryonic policy to encourage the widespread direct purchase of research was officially "put on hold" for further policy evaluation. It remains on hold some seven years later. Stokes, Gibbs and Holland (2006) suggest that since 2000 the government has made little clear progress in encouraging efficiency and in fostering competition in the provision of fisheries research. Of 241 projects tendered out through the contestable process, they found 159 (66 percent by number and 84 percent by value) attracted a sole bid and were awarded to the sole bidder. A further 54 (22 percent by number and 11 percent by value) attracted two bidders, and 11 were awarded as direct contracts. Only 17 attracted more than two bids. No contracts were awarded to offshore international research companies. NIWA, the traditional research provider for the Ministry, which is also a state-owned research enterprise created during public sector reforms, was awarded 206 of the 241 contracts awarded (85 percent by number and 91 percent by value).

4.3 Controlling the cost of commercial fisheries management

Figure 1 shows trends in Ministry expenditure and cost recovery levies under cost recovery from 1995/96. Total Ministry expenditures increased from NZ$35 million to NZ$66 million (in 1995/96 dollars), but commercial cost recovery levies have remained constant at between NZ$30 million and $33 million since 1995/96.

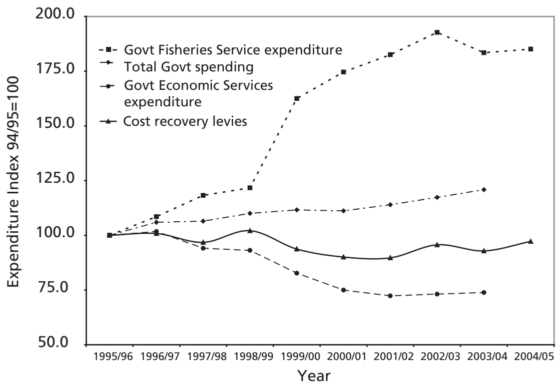
Figure 2 provides an indexed comparison of changes in MFish expenditure and cost recovery levies with the change in total Government expenditure and in like Government agencies for the period 1994 to 2004. MFish is classified as an economic services

FIGURE 1
Fisheries expenditure and cost recovery levies 1994/95 to 2004/05 (Current NZ$)



Source: MFish (2004, 2005), Statistics New Zealand (2005).

FIGURE 2
Indexed comparison of Ministry of fisheries expenditure, industry levies, total Government spending and Government economic services expenditure



Source: MFish (2004, 2005, 2006), Statistics New Zealand (2005).

department for public finance purposes. Similar departments include the Ministry of Commerce and Ministry of Agriculture and Forestry. Total government expenditure on fisheries services has increased dramatically compared to changes in overall government expenditure. The difference in overall trends is even more marked when compared to similar agencies. Overall government expenditure increased by 21 percent in inflation adjusted terms between 1994 and 2004. Expenditure in similar government departments fell by some 23 percent as government continued its policy of less direct intervention in the economy. In contrast, MFish expenditure increased by 85 percent.

This divergence of total fisheries management costs and commercial fishery management costs suggests two trends (Harte 2007). First, efforts by MFish and the seafood industry to improve the efficiency of commercial fisheries management have largely been successful. Second, fisheries management has become more complex and more expensive in the period 1994 to 2005. This complexity required increases in the total Ministry budget and staff to work on non-commercial fisheries management issues such as recreational and customary fisheries management, non-commercial fisheries related research, and the detection of illegal black market and poaching activities (Harte 2007).

5. THE FUTURE OF SELF-GOVERNANCE IN NEW ZEALAND

The public policy experiment in New Zealand commercial fisheries management has by and large been successful, at least from an institutional perspective – the full costs of managing commercial fisheries are recovered from the commercial sector and transparency and accountability in the delivery of commercial fisheries management services have been created. The commercial sector has been meaningfully involved in the determination of commercial fisheries management services and in the successful delivery of some fisheries management services. The combined use of cost recovery and the devolution and delegation of a few, but significant, management functions has generated efficiencies in the delivery of fisheries services.

Several interrelated factors led to this success. First, an ethos of transparency, efficiency and accountability is pervasive in the New Zealand public services. Second, government agencies have strong policy and operational capabilities. Third, the commercial fishing sector has a durable set of fishing rights and can be held accountable for cost recovery and the delivery of fisheries services. Finally, the industry has developed effective commercial stakeholder organisations that can engage government agencies in constructive dialogue and negotiation on issues such as cost recovery and self-governance.

Despite such success and despite the foundations for further success, the future of commercial fisheries management reform in New Zealand is unclear. The potential for more than incremental changes in fisheries policy is constrained by the pressure on management agencies to meet an increasing variety of issues and challenges from multiple stakeholders. The management debate is shifting from relatively practical issues such as the apportionment of management costs to an ideological focus on the relative role of the government and industry in the management of commercial fisheries.

Many in the commercial industry and in MFish consider the future lies in the development of fisheries plans (MFish 2004, 2007). Fisheries plans offer a way to make fisheries management more responsive to the circumstances of particular fisheries. Fisheries plans can be developed by either Mäori, stakeholders, or by MFish. MFish expects to develop most plans in collaboration with Mäori and stakeholders (MFish 2007). The fishery-specific focus and increased stakeholder involvement in fisheries plans is expected to increase the level of innovation brought to fisheries management decisions.

Stakeholder-developed fisheries plans must meet MFish standards and specifications. There is considerable flexibility as to what a plan may contain, e.g. stakeholders may elect to focus their efforts on specific management issues. In contrast, it is expected that MFish-led plans will address all aspects of management for a fishery. If the Minister approves a stakeholder fisheries plan, any associated MFish strategy will be updated to reflect the fisheries plan and to avoid duplication or incompatibility of government services with services delivered by stakeholders. The seafood industry believes that MFish statements regarding the comprehensiveness MFish-led plans and their expectation to develop the majority of plans is evidence of a potential MFish retreat from a policy of promoting self-governance in New Zealand's fisheries (Gibbs 2007).

The diversity of New Zealand's fisheries and marine areas means that fisheries plans will vary widely. Plans will evolve. They may begin with a limited set of objectives and management proposals and then expand in scope as stakeholders gain experience. At their most ambitious, commercial stakeholder organisations could become responsible for the delivery and purchase of a wide range of commercial fisheries services. At their narrowest, MFish-developed plans could entrench the status quo and become a straightjacket that limits further institutional reforms in New Zealand's fisheries sector.

The future of self-governance as a core principle in New Zealand's fisheries management is at a crossroads. Mechanisms, both legislative and institutional, allow for self-governance to occur; yet neither MFish nor the seafood industry has become wholly comfortable with the concept. For self-governance to become a mainstream feature of New Zealand's fisheries management regime, two things must happen. First, MFish must remain open to and actively facilitate stakeholder-led fisheries plans. The enunciation of fisheries management plans suggests that self-governance is not a core policy objective, despite previous successes. Second, the seafood industry must invest much more in the development of institutions and human capital within fishery-specific commercial stakeholder organizations. Successful commercial self-governance has only occurred in New Zealand when this has happened. The seafood industry will remain reluctant to make this investment until MFish signals clear support for self-governance. This appears unlikely in the short to medium term.

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The Chignik Salmon Cooperative

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1. INTRODUCTION

The Chignik salmon fishery is a major Alaska sockeye salmon fishery with approximately 100 limited entry permit holders. In January 2002, responding to a proposal from a group of permit holders, the Alaska Board of Fisheries passed regulations that provided for an allocation of part of the Chignik harvest to a voluntary harvesting cooperative (the "Co-op"). The allocation was based on how many permit holders chose to join the Co-op. Other permit holders could harvest the remaining fish in a competitive "independent fishery", which would receive the remaining allocation of the sockeye harvest.

Over the following four years, from 2002 to 2005, more than three-quarters of Chignik permit holders joined the Co-op. The Co-op hired about 20 members to fish the Co-op's catch allocation. All Co-op members were paid equal shares of the Co-op's profits. By greatly reducing the number of vessels participating in the fishery, the Co-op achieved significant cost savings and changed the fishery in many other important ways. The Co-op was highly controversial and was vigorously opposed by a minority of permit holders. The Co-op ended in 2006 after the Alaska Supreme Court ruled that it violated a provision of Alaska law requiring that permit holders operate their own vessels. This paper describes the Co-op's origins, operations and effects, and provides lessons about the opportunities and challenges of this form of voluntary transition to fisheries self-governance.

2. FISHERY AND MANAGEMENT HISTORY

2.1 Description of fishery

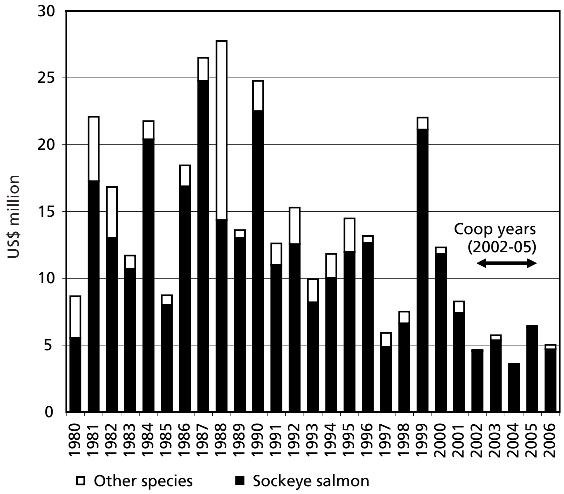
The Chignik salmon fishery is a major Alaska salmon fishery located in a remote area of southwestern Alaska, on the south side of the Alaska Peninsula accessible only by boats and small planes. Harvests occur from early June through early September. Fish are harvested using seine gear. Most fish are delivered from fishing boats to two local processors using tender vessels. Most fish are processed into frozen or canned salmon for sale to markets in Japan, Europe and the United States; only a small share is sold fresh.

FIGURE 1
Location of the Chignik salmon fishery

Between 1990 and 2005, annual harvests in the Chignik salmon fishery averaged 6 900 t with an annual average ex-vessel

FIGURE 2

Ex-vessel value of Chignik Management Area commercial salmon harvests, 1980–2006 (nominal $)



Note: Values are preliminary ADFG estimates which exclude any post-season bonus payments.
Source: Stickert (2006).

value of $11.3 million. Between 1990 and 2005, sockeye salmon (*Oncorhynchus nerka*) accounted for 90 percent of total ex-vessel value in the fishery (Stichert, 2006). Other species of salmon are also harvested, but in smaller volumes and for lower prices. Except where otherwise noted, the discussion in this paper refers to the sockeye salmon fishery only.

Historically, Chignik sockeye harvests have varied widely from year to year, but have commonly been between one and two million fish. After peaking in 1987 and 1988 at more than $25 million, the ex-vessel value of the Chignik salmon harvest trended downwards to an average of $5.0 million for the four Co-op years of 2002–05 (Stichert, 2006). In all but one of the Co-op years, ex-vessel value was less than any year of the preceding two decades – without adjusting for inflation. The dramatic decline in value was the combined result of a decline in catches and a decline in ex-vessel prices. Factors contributing to the decline in prices, which occurred across all Alaska salmon fisheries, included: competition from the growing world supply of farmed salmon; record Alaska sockeye salmon harvests during the early 1990s; a prolonged economic slump in Japan; and stagnant consumer demand for canned sockeye salmon (Knapp, Roheim and Anderson 2007).

2.2 Fishery management

All Chignik sockeye return to the Chignik River, which flows into Chignik Lagoon, a shallow protected bay approximately two miles wide and six miles long, which provides ideal conditions for salmon seining. Historically, the majority of the sockeye have been caught in the lagoon, although some fishing occurred along the coast outside the lagoon, intercepting sockeye returning to the lagoon. As in other Alaska salmon fisheries, Alaska Department of Fish and Game (ADFG) manages the Chignik fishery to achieve seasonal "escapement" goals for the number of sockeye salmon that "escape" the commercial fishery and enter the river to return to two large lakes where they spawn. During the season, managers periodically "open" the fishery for commercial harvesting by the salmon fleet and "close" the fishery to allow more fish to "escape" through the lagoon and into the river. They attempt to schedule openings and closures to keep cumulative escapement as of any given date within a guideline target range for that date.

As with other Alaska salmon fisheries, the Chignik salmon fishery is managed under a limited entry system established in the mid-1970s. There are approximately 100 permits in the fishery, with slight annual variations in the number of permits issued (CFEC, 2007a). Only seine vessels with a permit holder on board may participate in the fishery. A variety of restrictions on vessel size, gear, and participation in other fisheries are intended to promote an owner-operated small-boat fishery (see Photo 1). Costs have increased as permit holders have invested in larger and more powerful boats. For example, between 1990 and 2001, the average horsepower of Chignik boats increased from 392 to 500 (CFEC, 2007b).

Permits were initially distributed for free to individuals with a history of participation in the fishery and are transferable by gift or sale. About 30% of current permit holders

PHOTO 1
Chignik salmon seining

received their permits at no cost in the initial distribution (CFEC 2007d). Because of the historical profitability of the fishery, prices paid for Chignik permits have been the highest of any Alaska salmon fishery. Chignik permit prices reached a peak of $417 000 in 1990 but then declined dramatically as ex-vessel prices fell to $186 000 in 2001 (CFEC 2007a).

For permit holders who have bought into the fishery, the cost of the permit is the highest cost of participation. In addition, permit holders pay an annual permit fee which has risen gradually over time to $600 in 2007 (CFEC 2007e). In 2007, annual vessel license fees were $60, and crewmembers paid annual crewmember license fees of $60 ($175 for non-Alaska residents) (CFEC 2007e; ADFG 2007a).

In the competitive fishery prior to the Co-op, there were wide differences among Chignik permit holders in annual gross earnings. For example, in 2001, the highest-earning nine permit holders had average gross earnings of $227,000, while the lowest-earning forty-two permit-holders had average gross earnings of $50,000 (CFEC, 2007c). As earnings declined and costs increased, participation in the Chignik fishery was becoming unprofitable for some permit holders, as indicated by the fact that some permits were not fished by the late 1990s. Almost all permits were fished between 1980 and 1996. In contrast, 15 permits were not fished in 1998, nine permits were not fished in 1999 and six permits were not fished in 2001 (CFEC, 2007a).

3. ESTABLISHMENT OF THE CO-OP

As the value of the Chignik salmon fishery declined during the 1990s, interest grew among permit holders in forming a harvesting cooperative. Experience gained during price strikes, when a few boats fished on behalf of the fleet, had shown that a small number of boats could catch large volumes of sockeye salmon in Chignik Lagoon. Discussion of forming a cooperative was facilitated by the Chignik Seiners Association (CSA), a permit-holder lobbying and price-bargaining organization (Quimby and Owen, 1992; Anderson, 1994; McCallum, 1997; Ross, 2002a).

Initially, permit holders envisioned a cooperative formed by contractual agreement among permit holders, without any involvement by fishery managers. However, partly because of wide variation in investment and catches, they were not able to reach agreement over how such a cooperative would share profits. In general, highliners (those who caught the most fish) argued for distribution based on "historical shares" of the catch, while others argued for "equal shares."

To overcome this impasse, the CSA executive director suggested the concept of allocating part of the harvest to a voluntary cooperative that would share profits equally, with the allocation based on how many permit holders chose to join. The remaining "independent" permit holders would fish a separate allocation competitively in separate openings. A proposal incorporating this concept was considered by the Alaska Board of Fisheries, a seven-member citizen board that sets policy for Alaska fisheries, at its January 2002 meeting. Prior to the meeting, 42 CSA members voted to support the proposal, with 22 opposing and 10 abstaining (Ross 2002a). In heated public testimony before the Board, supporters argued: that a cooperative was urgently needed to address an economic crisis in the fishery; that a co-op would dramatically lower costs and improve quality; that the proposed "equal shares" allocation to a co-op was both fair and legally required; and that the Board had the authority to make such an allocation. Opponents argued that the proposal was unfair, not necessary and beyond the authority of the Board.

The Board unanimously voted to adopt an amended version of the proposal, which allocated the Co-op only 0.90 percent of the catch a member, rather than 1.00 percent as originally proposed (except that the allocation would increase to 1.00 percent per member if 85 or more permit holders joined). In subsequent yearly meetings, the Board reviewed experience with the Co-op and rejected proposals to end it or to change it significantly.

4. OPERATIONS OF THE CO-OP

Following the January Board meeting, Co-op organizers formed a non-profit corporation, the Chignik Seafood Producer's Alliance (CSPA) to apply for a co-op permit under regulations established to implement the allocation. By the 15 April deadline, 77 permit holders had joined the Co-op, which thus qualified for an allocation of 69.7 percent of the 2002 catch (Table 1). The number of members stayed the same in 2003, increased to 87 in 2004 and fell to 76 in 2005.

The CSPA was governed by a nine-member Board of Directors, elected for staggered three-year terms, with at least one member from each of the five Chignik-area villages. Three Board members did most of the administrative, marketing and fleet management work for the Co-op and were later paid "bonuses" of between \$10 000 and \$16 000 each for a total of \$42 000 in 2002. In 2003, total bonuses increased to \$71 000 as the CSPA recognized that it could not rely on voluntary work by Board members to the extent that it had initially.

The CSPA bylaws established procedures for contracting with members to harvest and tender salmon for the Co-op, with preference given for knowledge and experience fishing Chignik Lagoon, ability to work with other harvesters, condition of vessel and gear, residence in the Chignik area and willingness to hire local crew, among other factors. Of 44 members who applied to fish for the Co-op in 2002, 18 were hired as harvesters, while others were hired to operate their boats as tender vessels for the Co-op. Harvesters that fished all season were paid \$47 000, in addition to their regular

TABLE 1
Co-op and independent fleet allocations

		2002	2003	2004	2005
Allocation formula if total Co-op members is:	50 or fewer	No co-op allocation			
	51-84	0.90% per member*			
	85 or more	1.00% per member**			
Number of permits holders	Co-op	77	77	87	76
	Independent	22	24	13	23
	Total	99	101	100	99
Allocation of sockeye harvest	Co-op	69.3%	69.3%	87.0%	68.4%
	Independent	30.7%	30.7%	13.0%	31.6%
Allocation per permit	Co-op	0.90%	0.90%	1.00%	0.90%
	Independent	1.40%	1.28%	1.00%	1.37%

Note: Table excludes one independent permit holder who did not fish in 2002.
*For 2004 and 2005, the formula was 0.95% per co-op member if the number of members was between 80 and 84.
**The table assumes 100 permit holders. Technically the allocation was "one prorated share" per member if the Co-op had 85 or more members.
Source: Bouwens, 2005; CFEC, 2007a.

TABLE 2
Chignik Salmon Producers Association revenues, expenses and dividends: 2002–2004

		2002	2003	2004
Sockeye harvest volume (pounds)		4 969 261	4 873 914	3 873 448
Number of CSPA members		77	77	87
Total	**After-tax revenues**	**$4 070 519**	**$4 303 586**	**$3 191 874**
	Harvesting	$971 370	$1 158 717	$1 079 023
	Tendering	$419 825	$618 538	$515 312
	All other expenses	$523 324	$381 882	$292 540
	Dividends	$2 156 000	$2 144 450	$1 305 000
Per sockeye pound	**After-tax revenues**	**$0.82**	**$0.88**	**$0.82**
	Harvesting	$0.20	$0.24	$0.28
	Tendering	$0.08	$0.13	$0.13
	All other expenses	$0.11	$0.08	$0.08
	Dividends	$0.43	$0.44	$0.34
Per CSPA member	**After-tax revenues**	**$52 864**	**$55 891**	**$36 688**
	Harvesting	$12 615	$15 048	$12 403
	Tendering	$5 452	$8 033	$5 923
	All other expenses	$6 796	$4 960	$3 363
	Dividends	$28 000	$27 850	$15 000

Source: Author's estimates based on CSPA Financial Reports and ADFG harvest data. Note that a small share of revenues (less than 2%) were from species other than sockeye. 2004 revenue and dividends include projected $261 000 in post-season adjustments over and above amounts reported in financial statement.

Co-op share. Harvesters' and tenders' fuel and insurance were paid by the CSPA, while harvesters were responsible for paying for their crew, groceries, maintenance and repairs (Kopun, 2002). By the 2004 season, full-season contracts provided for payments of $60 000 for harvesters and $51 875 for tenders, with additional bonus payments based on the size of the CSPA patronage dividend CSPA, 2004a).

Following each season, after payment of harvester and tender contracts and other expenses, the remaining revenues were distributed to Co-op members on an equal share basis. Table 2 provides an overview of CSPA revenues, expenses and dividends for the years 2002–2004. In 2002 and 2003 – which had similar catches, revenues and Co-op membership – about half of CSPA revenues were distributed as dividends of about $28 000 a member. In 2004, although more permit holders joined the Co-op and the Co-op's allocation increased, the Co-op's sockeye harvests fell by 21 percent because of a 29 percent decline in the total sockeye harvest. CSPA revenues fell more sharply than costs, causing the annual dividend to decline to $15 000 a member.

5. EFFECTS OF THE CHIGNIK CO-OP

5.1 Overview

The Chignik Co-op had wide-ranging effects on the Chignik salmon fishery, which were more extensive and complex than can be discussed in detail here. Below we briefly discuss selected effects of the Co-op. Note that our ability to quantify these effects is limited both by lack of data and also by the fact that we do not know how the Chignik fishery might have changed in the absence of a co-op. Note also that during the Co-op years (2002–2005), salmon runs were low and market conditions for sockeye salmon were depressed. Under different run and market conditions, different numbers of permit holders might have joined the Co-op and fishing by both the Co-op and the independent fleets might have been different.

5.2 Harvesting costs

The Co-op significantly reduced harvesting costs in the Chignik fishery by greatly reducing the number of boats participating in the fishery. Between 1980 and 2001, the lowest number of permits fished was 85 (in 1998). In all but three of these years, 98 or more permits were fished. In contrast, during the first three Co-op years, a total of 41, 43 and 32 permits were fished–of which 19 were Co-op permits and the remainder were independent permits. The reduction in the number of boat-days fished was even greater, because at any given time only the Co-op boats or the independent boats were fishing.

As an example of the change in harvesting efficiency, during the first two Co-op years, the Co-op fleet used an average of 16 boats to catch daily volumes of between 100 000 and 150 000 pounds of sockeye in Chignik Lagoon during June and July. The independent fleet used an average of 17 boats to catch daily volumes in this range. In contrast, in 1997 and 1998 (when total season catches were similar to 2002 and 2003), the competitive fishery used an average of 46 boats to catch similar daily volumes.

The Co-op's fleet manager described the dramatic change in the fishery as follows (Ross, 2002b): "(U)nder former fishery circumstances, with more than 70 boats fishing the Lagoon, there was always someone waiting to take every jumper that showed its face. . . Now, instead of making four or five sets during the flood for 200 to 300 a haul, [a Co-op harvester] could wait till the Lagoon drained out. At low tide, [a channel in the lagoon] became a slow, meandering river of concentrated sockeye. And now, fishing for the entire co-op, he could make one giant drag for 3 000 to 5 000 fish."

Estimating total cost savings attributable to the Co-op is difficult because of lack of cost data for years prior to the Co-op or for the independent fishery. We also do not know how many boats might have fished had there not been a Co-op. However, rough estimates, shown in Table 3, suggest that the Co-op may have reduced costs in the Chignik fishery by two-fifths or more of the total value of the fishery – depending on the year and which costs are included. Major cost savings were for insurance (an annual average cost of about $8 000 a boat), fuel (about $5000 a boat) and vessel repair and maintenance (about $15 000 a boat) (McDowell Group, 2002). Estimating savings for crew (historically 30 percent of net value after deducting costs of taxes, fuel and groceries) is more difficult because data are not available for crew payments during the Co-op years. These estimates are only for cost savings for boats that did not fish during the co-op years. They do not address how costs may have changed for the boats that did fish (for which increased costs of catching more fish may have been offset in part by fishing fewer days).

Assuming an average of three crew a vessel, the Co-op likely reduced the number of crew jobs in the Chignik fishery by between 130 and 150. Whether the reduction in crew costs should be considered a benefit was a subject of dispute among Chignik permit holders. Some argued that the Co-op cost local youth their only employment

TABLE 3
Rough estimates of the potential magnitude of cost savings attributable to the Chignik Co-op

		2002	2003	2004
Fishery ex-vessel value ($000)		$4 655	$5 738	$3 596
Assumed number of boats which would have fished a competitive fishery		85	85	85
Number of boats which fished for the Co-op		19	19	19
Number of Co-op boats which fished		22	24	13
Reduction in boats attributable to Co-op		44	42	53
% reduction in boats attributable to Co-op		52%	49%	62%
Cost savings ($000)	Insurance, maintenance & fuel	$1 232	$1 176	$1 484
	Crew and groceries	$920	$1 118	$750
Cost savings as % of ex-vessel value	Insurance, maintenance & fuel	26%	20%	41%
	Crew and groceries	20%	19%	21%

Note: Assumes average costs of $28,000 per boat for insurance, maintenance and fuel and average cost of $3500 a boat for groceries. Crew cost savings estimates assume that crew would have been paid a crew share of 30% of ex-vessel value net of 6% fish taxes in a competitive fishery, and that the decline in crew costs during the co-op years would have been proportional to the decline in vessels fishing so that that crew would not have been paid more for catching more fish.

opportunities, while others argued that local crew were hard to find and the lost jobs would have held by non-local residents.

5.3 Distribution of net income

By reducing costs, the Chignik Co-op substantially increased net income (revenues minus costs) from the Chignik salmon fishery. This increase in net income was not distributed equally: some permit holders' net income clearly increased; others' incomes may have decreased.

One indicator that permit holders were affected differently by the Co-op is provided by the responses of 88 Chignik permit holders to a University of Alaska Anchorage survey conducted after the 2002 season. Asked to describe their overall feelings about the Co-op and the change in management, 50 percent were "very positive," 20 percent were "somewhat positive," 11 percent were "mixed," and 15 percent were "very negative." In general, Co-op members reported that they had supported the Co-op, that it had made them better off and that they had positive feelings about the Co-op. Independent permit holders responded that they had opposed the Co-op, that it had made them worse off and that they had negative feelings about the management change (Knapp *et al*., 2003).

The permit holders who most clearly benefited from the Co-op were those who would not have fished – and thus received no income--had the fishery remained competitive. It is likely that this number would have been comparable to the 15 permit holders who did not fish in 1998, given the low prices and catches during the four Co-op years. Assuming that these 15 permit holders received the 2002 Co-op dividend of $28 000, the Co-op gave $420 000 – or 9 percent of the ex-vessel value of the 2002 fishery, to permit holders who would have received no income from a competitive fishery.

Another group who clearly benefited were those who would have fished but who would have made little profit – or lost money. Assuming the same catch distribution as in 1998 (CFEC, 2007c) and lower-range costs as estimated by McDowell (2002), it is likely that most of the 36 lowest-earning permit holders would have been lucky to break even had they fished. Assuming that most of these permit holders joined the Co-op, they were clearly better off from the $28 000 Co-op dividend in 2002 than they would have been from fishing.

Insufficient data are available on the distribution of earnings and costs to reliably estimate how net incomes of the remaining permit holders – those who would have fished a competitive fishery and made money doing so – were affected by the Co-op. For those who joined the Co-op, the answer depends on what their earnings and costs would have been in a competitive fishery, as well as whether or not they fished or tendered for the Co-op and how their costs compared with the Co-op's payments to harvesters and crew. The fact that most Co-op members supported the Co-op suggests that most thought they were better off with the Co-op.

How the Co-op might have affected independent permit holders depends on what their earnings and costs would have been in a competitive fishery. On the assumption that permit holders with historically higher catches were less likely to join the Co-op, the Board of Fisheries had allocated a proportionally greater share of the Chignik harvest to the independent fleet than to the Co-op. An analysis prepared for the Board of Fisheries after the 2002 season found that while independent permit holders' average historical catch shares were higher than average shares for Co-op members, they were not on average higher than the 2002 average independent fleet allocation of 1.40 percent (CFEC, 2002). The Board interpreted this information as an indication that independent harvesters, as a group, were not significantly harmed by the Co-op. However, individual independent harvesters may have been affected in different ways.

The average allocation per independent permit holder was affected by how many permit holders joined the Co-op (Table 1). The allocation declined from 1.40 percent in 2002 to 1.28 percent in 2003 and 1.00 percent in 2004 and then rose to 1.37 percent in 2005. It seems likely that average independent fleet allocations were lower than their historical averages in 2003 and, in particular, in 2004.

Independent permit holders were affected in several ways by the fact that they fished far fewer days than they had during the competitive fishery. Fishing fewer days likely lowered costs. However, financial risks were higher, because an engine breakdown or a bad choice about where to fish on a given day could cost a vessel a much greater relative share of its annual catch. Shorter fishery openings, as well as changes in tendering services, may have negatively affected the catch shares of harvesters who had traditionally fished outside the lagoon (as discussed below).

Clearly, the Co-op changed the relative distribution of benefits in favour of historically less successful harvesters. This effect was perceived in widely different ways by harvesters. To Co-op supporters, it represented an opportunity for permit holders who had participated in the fishery for many years to continue to benefit from the fishery despite the downturn in catches and prices – rather than losing all of the return on their investment in boats and permits. As one permit holder put it, "I invested my whole life in fishing (50 years). I'm 58 years old. I love to fish but not to slowly die. . . I have tried very hard to stay fishing and make my crew good money to endure the long hours and weather that we fish in. But they don't come back to fish with me any more. God bless this Co-op" (Knapp *et al.*, 2003).

In contrast, to its opponents, the Co-op redistributed income away from harvesters able and willing to work for it to those not skilled or hard-working enough to earn it for themselves. As another permit holder put it: "This Co-op is something of a welfare program for the people who have a permit but who haven't fished. They get 9 percent of the total run. Most of those are poor harvesters or they don't really fish their permit" (Knapp *et al.*, 2003).

5.4 Distribution of fishing effort

The Co-op changed not only who caught the salmon, but also where the salmon were caught, when they were caught and how they were caught, both for the Co-op fleet and also for the independent fleet. The share of Chignik sockeye salmon caught in Chignik Lagoon (rather than outside) increased from an average of 62 percent in the decade prior to the Co-op to 94 percent during the Co-op years. For the Co-op, this change reflected an effort to reduce harvesting costs and to improve quality by reducing tendering time (Ross, 2002a). For independent permit holders, many of whom had traditionally fished outside the lagoon, the change resulted from shorter times for fishery openings – allowing less time to search for fish, as well as a reduction by processors in tendering services outside the lagoon.

5.5 Innovation

The Co-op brought about numerous innovations in the Chignik salmon fishery. To minimize handling damage, the Co-op brailed fish directly from harvester vessels' purse seines into tender vessels, resulting in significantly improved quality of the fish delivered to processing plants (Ross, 2002a; Norquest, 2002). The Co-op invested in and experimented with gear for transporting fish and holding fish live, adapting technology used by salmon farmers (Anderson *et al.*, 2003). The Co-op sought and received authorization from the Board of Fisheries to place fixed leads on both sides of the Chignik River where it enters Chignik Lagoon, which reduced fishing costs by channelling returning salmon towards a narrow opening between the leads.

5.6 Fish processors

With control over almost 70 percent of the Chignik harvest, the Chignik Co-op had much greater market power than Chignik harvesters had previously held. This market power dramatically changed the relationship between processors and harvesters. There were two salmon processing plants in the Chignik area, owned by Norquest Seafoods and Trident Seafoods, major Alaska fish processing companies. Historically, each of these plants had purchased approximately half of the total Chignik salmon catch. The relationships between the Co-op and these two companies evolved in very different ways.

The Co-op sold almost all its fish to Norquest and worked progressively more closely with Norquest over the four Co-op years. The relationship included pre-season contracts specifying advance prices, a revenue-sharing formula and quality standards for fish (CSPA, 2004a). In contrast, the Co-op and Trident could not resolve differences over prices and Trident's desire to be guaranteed a share of the Co-op's catch and the Co-op sold almost no fish to Trident. Accusations were traded in the press and Trident actively supported political efforts to end the Co-op. After operating its plant in 2002 and 2003 by processing fish caught by independent harvesters, Trident closed its Chignik plant (Bundrant, 2003; Bundrant, 2004; Ross, 2004).

5.7 Fishery management

Prior to the Coop, the only tool available to Chignik fisheries managers to achieve escapement goals was to "turn on" or "turn off" fishing by a fleet of 100 salmon seiners. This on-off fishing pattern resulted in sequential "pulses" of escapement into the river and of fish deliveries to processors. Managers faced a challenging task. They did not know how many fish would return on any given day, how many would return during the balance of the season, nor how many fish the fleet would catch if allowed to fish. Allowing too long an opening and catching too many fish by any given date risked not achieving the season escapement goal, especially if the later part of the run was weak. Keeping the fishery closed for too long risked "over-escapement" and significant lost economic opportunity for harvesters and processors, as well as potential harm to future sockeye runs if too many fish spawned in the lakes.

The Co-op added the additional challenge of keeping cumulative catch shares of two separate fleets at or close to those specified by the allocation formula. However, the task of management was simplified by the fact that both fleets were smaller. More importantly, the Co-op fleet – which had by far the larger allocation – was willing and able to limit catches during any particular time period to specific numbers of fish requested by managers. This made it possible for managers to allow the Co-op to fish continuously at lower catch rates for longer openings, reducing pulses in both harvests and escapement and allowing for more efficient utilization of processing capacity (Pappas, 2003).

However, the change in the management system also raised a new concern for managers. Prior to the Co-op, catches of fish outside the lagoon had provided an early indicator of the run strength. With the concentration of fishing effort inside the lagoon, managers and harvesters would have less advance notice if very large volumes of salmon were to return within a short period of time (Pappas, 2003).

6. LEGAL CHALLENGES TO THE CO-OP

The Chignik Co-op raised numerous legal and constitutional issues over the authority of the Board of Fisheries to allocate to a co-op and the consistency of the Co-op with the Alaska Limited Entry Act. In October 2002, after the first Co-op season, an Alaska Superior Court upheld the Co-op, rejecting a challenge by two Chignik permit holders. However, in March 2005, after the third Co-op season, the Alaska Supreme Court reversed the Superior Court ruling, holding that the co-op regulation was fundamentally at odds with the Limited Entry Act's requirement that permit holders operate their own boats:

"Participation by the individual is inherent in the limited entry permit system. The Chignik cooperative fishery scheme is fundamentally at odds with this premise because it allows people who are not actually fishing to benefit from the fishery resource... The co-op regulation…transforms the limited entry permit…into a mere ownership share in a cooperative organization…Before this regulatory scheme accomplishes such radical departure from the historical model of limited entry fisheries in Alaska and the spirit of the Limited Entry Act...the legislature must first authorize the board to approve cooperative salmon fisheries."

Justice Carpeneti strongly dissented, arguing that the Co-op advanced the Limited Entry Act's key goal of "economic health and stability of the commercial fishery" and lamented that "the Opinion prefers a wasteful state of affairs in which only a few fishers do better than break even and the cost of producing an inferior product is unnecessarily high" (Alaska Supreme Court, 2005).

At an emergency meeting in May 2005, the Alaska Board of Fisheries attempted to address the Court's concern by adopting a requirement that Co-op members be on board Co-op harvesting vessels (not necessarily their own) for at least ten fish deliveries (Tkacz, 2005). Although the Court permitted the Co-op to operate a fourth season while it considered this change, in February 2006 it ruled that the Co-op was still fundamentally at odds with the Limited Entry Act, ending the Co-op (Alaska Supreme Court, 2006).

As the Court noted, the Alaska legislature has the authority to amend the Limited Entry Act to allow cooperative fisheries. However, at the time of writing, the legislature has not done so. Thus, the ultimate fate of the Co-op might be attributed not to any fundamental legal problem but rather to lack of political support.

After four years of not fishing, many Chignik permit holders faced substantial repair and maintenance costs to prepare their boats, seines and skiffs for fishing. With the prospect of continued low catches and prices, only 48 of 96 eligible permit holders fished the 2006 fishery (Stichert 2006) and a similar number fished the 2007 season (ADFG, 2007b). The number of vessels participating in the Chignik fishery increased only slightly after the Co-op ended, but the distribution of benefits from the fishery changed dramatically.

7. LESSONS FROM THE CHIGNIK CO-OP

7.1 General perspective

What lessons about fisheries self-governance may be learned from the Chignik Co-op? Below we suggest two broad types of lessons. First, the Co-op provides an example of the rapid, dramatic and far-reaching effects that self-governance can have. Second, the Co-op provides an example of a viable method by which harvesters and government can work together to achieve self-governance through an allocation to a voluntary co-op, as well as illustrating broader challenges of achieving self-governance.

7.2 Effects of fisheries self-governance

i. *Fisheries self-governance can bring dramatic economic benefits.* The Co-op immediately and dramatically reduced costs of fuel, insurance, vessel maintenance and labour in the Chignik salmon fishery. While the total value of the fishery was the lowest in decades, most permit holders made money.

ii. *Fisheries self-governance can improve resource management.* The Co-op made it possible for fishery managers to work with harvesters as a group to fine-tune fishing to achieve daily escapement goals much more precisely.

iii. *Fisheries self-governance encourages innovation.* The Co-op brought about an immediate and continuing search for ways to reduce costs and to improve quality and value.

iv. *Fisheries self-governance increases harvesters' market power.* The Co-op exercised its power to deliver exclusively to one of two local processors. For both processors, the Co-op posed significant new challenges. One was able to work with the Co-op and take advantage of new opportunities that it created. The other was unable to work with the Co-op and experienced significant economic losses. Over time, the Co-op brought greater integration of harvesting and processing, more effective marketing and higher value.

v. *Fisheries self-governance imposes new administrative costs.* While fisheries self-governance may greatly reduce fishing costs, it also adds new costs of administration. Over time, the CSPA created paid positions for managing the fleet and administering the CSPA and also had to pay new costs for accounting and legal services and office expenses.

vi. *Fisheries self-governance has more far-reaching effects than most people imagine or expect.* Most discussion prior to the Co-op focused on potential cost savings. There was relatively little anticipation of how the Co-op would affect resource management, innovation and markets. Even less anticipated were changes in tendering services, harvesting of sockeye outside the lagoon and harvesting of species other than sockeye.

vii. *Fisheries self-governance affects different people in different ways.* The effects of the Co-op differed depending on how successful permit holders were in the competitive fishery, whether or not they joined the Co-op and whether they were hired by the co-op for harvesting, tendering or administrative positions. Effects also differed depending upon permit holders' opportunity costs. For some, not fishing meant an opportunity to earn income in other jobs. For others, the effect of not fishing may have been summarized by a local woman who observed, "The problem with the Co-op is that when our men aren't fishing they're drinking."

viii. *Fisheries self-governance selects for different skill*s. Success in the Chignik competitive fishery called for knowledge of how to find fish, before other harvesters found them. Success in the Chignik Co-op required working with other harvesters, devising new ways of catching and delivering fish and working with local processors and new markets to realize higher value. By favouring a different set of skills, fisheries self-governance may over time change who participates in fisheries and the character of fishing communities.

ix. *Fisheries self-governance may be divisive.* Because fisheries self-management may bring dramatic change and may affect people in different ways, it may evoke particularly strong support or opposition. Both supporters and opponents regretted that the Co-op divided Chignik permit holders, communities and even families.

7.3 Achieving fisheries self-governance

i. *An allocation to a voluntary self-governance organization can encourage fisheries self-governance, even with large numbers of participants.* Achieving self-governance without government intervention in a competitive fishery requires agreement among all (or nearly all) persons with the right to participate in the fishery. It is difficult to achieve self-governance in fisheries with large numbers of participants without government intervention. By allocating a share of the fishery to like-minded groups, government can empower a subset of participants to establish self-governance. The allocation need not be limited to a single self-governance organization; multiple sub-groups may be created with different approaches to self-governance.

ii. *Allocating to a self-governance organization is much simpler than creating individual fishing quotas.* The Chignik Co-op began fishing less than six months after the Board of Fisheries approved the allocation. There was no need to calculate individual quota allocations or to devise a method of recording individual catches or enforcing individual quotas.

iii. *Sequential fishing can be a relatively simple and efficient way of allocating to a self-governance organization.* In the Chignik fishery, sequential fishing was relatively easy to enforce. It was not necessary to exactly balance catches among the Co-op and independent fleets in any given fishing opportunity. Note, however, that sequential fishing limits the number of separate allocations that are practical to at most a few and introduces inefficiencies by requiring one group to wait while the other fishes.

iv. *Deriving a formula for allocating to a voluntary self-governance organization is not easy.* Legal constraints aside, it is impossible to devise a "fair" allocation formula which will satisfy everyone, given that self-governance affects different people in different ways.

v. *An "equal-shares" allocation formula between a self-governance group and a residual open access fishery can create difficult choices for fishers.* This is because the relative benefits of fishing competitively depend on which other harvesters also choose to fish competitively. Thus while "equal shares" is easier for managers, it is more complex for harvesters – questions of fairness aside.

vi. *Separate allocations divide harvesters.* Treating two groups differently may result in neither group feeling satisfied. Both Co-op and independent harvesters argued that they were treated unfairly by the allocation formula and other aspects of the Co-op. Giving permit holders an option to choose how they would fish, which was intended to reduce controversy, may in the end have aggravated it.

vii. *The processing industry has a major stake in whether and how fisheries self-governance arises – and may support or oppose it.* The two Chignik processors were affected in very different ways by the Co-op. One was significantly harmed and helped to support the legal effort that eventually brought an end to the Co-op.

viii. *Crisis spurs change.* The Chignik Co-op made economic sense for decades before it was implemented. It was only implemented because an economic crisis created a political consensus – among Board of Fishery members and most Chignik permit holders – that change was essential. More generally, fisheries self-governance may be easier to achieve when times are bad than when times are good.

ix. *Latent (unfished) permits add to the political challenge of achieving fisheries self-governance.* The more latent permits, the more the benefits of self-governance may be diluted by sharing them with former non-participants. Note that the greater the economic crisis in a fishery, the more permits that are likely to be latent. Thus, while economic crisis spurs change, it may also hinder change to the extent that it increases this latent permit problem.

x. *Leadership and hard work are important for achieving fisheries self-governance.* The establishment of the Co-op required vision and hard, effective work on the part of the Co-op organizers to formulate the co-op proposal to bring the proposal before the Board of Fisheries, to incorporate the CSPA, to elect officers and to organize the Co-op's fishing, tendering and marketing.

xi. *Political skill is important for achieving fisheries self-governance when government action is required.* That the Board of Fisheries approved the Chignik Co-op but approved no significant changes in the management of other Alaska salmon fisheries reflects in part the political skill of the Co-op organizers, who understood the Board process and worked hard and effectively to make their case.

xii. *The more constrained the nature of the rights that participants have to a fishery, the greater the challenge to achieving fishery self-governance.* Only Chignik permit holders had the right to participate in the Chignik salmon fishery. But according to the Alaska Supreme Court's interpretation of the Limited Entry Act, that right was restricted to fishing a permit in a competitive fishery and could not be the basis for membership in a co-op receiving an allocation from the total catch.

xiii. Law trumps economics, harvesters and managers. The fate of the Chignik Co-op serves as a reminder that, whatever the economic logic may be and whatever harvesters and managers may want, ultimately the law defines and limits the extent to which fisheries self-governance may arise. Nor are the legal limits to fisheries self-governance necessarily clear or predictable. Neither the opinions of legal advisors to the Alaska Board of Fisheries nor an Alaska judge correctly predicted the ultimate Alaska Supreme Court ruling that ended the Chignik Co-op.

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The Alaskan weathervane scallop cooperative

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1. INTRODUCTION

The Alaskan weathervane scallop fishery is an example where innovative self-governance was successfully employed through a producer cooperative to reduce unwanted crab bycatch. The Alaskan weathervane scallop fishery is managed by the Alaska Department of Fish and Game (ADF&G). A Guideline Harvest Range (GHR) for scallops and a crab bycatch limit is assigned for each of nine management areas. Once either the upper limit of the GHR or the crab bycatch limit is reached, the directed scallop fishery within that area is closed. Prior to the cooperative agreement, the crab bycatch limit was regularly reached in several management areas before the upper limit of the scallop GHR was harvested. In January 2000, a group of vessel owners formed a cooperative that divided rights to both the scallop GHR and crab limit amongst all permit holders. Innovative incentives within this cooperative agreement resulted in substantial bycatch reduction, attainment of a greater percentage of the scallop GHR, and an extended fishing season.

2. FISHERY AND MANAGEMENT HISTORY

2.1 Description of fishery

The Pacific weath ervane scallop (*Patinopecten caurinus*) is one of several scallop species found in the eastern North Pacific Ocean. Its distribution ranges from Point Reyes, California to the Pribilof Islands of Alaska. The highest known densities in Alaska have been found in the Bering Sea, off Kodiak Island, and along the eastern gulf coast from Cape Spencer to Cape St. Elias (North Pacific Management Council, 2000).

Government research and private exploratory vessels began to evaluate the commercial potential of the Alaskan weathervane scallop in the early 1950s (Kaiser, 1986). When Georges Bank scallop catches declined in the late 1960s, interest in the Alaskan resource grew (Orenzanz, 1986). From 1967 to 1973, virgin scallop beds throughout the state were identified and exploited. This was followed by a period of declining scallop harvests from 1974 to 1979. A smaller, more stable fishery followed through the 1980s (Shirley and Kruse, 1995). By 1993, the fishery experienced a second influx of scallop boats from the east coast of the U.S. The fishery changed from one characterized by short trips with numerous deliveries each season to one of long trips with few deliveries as the fleet converted from icing to on-board freezing of product (Barnhart, 2000). Mean vessel size increased by 85 percent from 18.5 m in 1983 to 34.3 m in 1991 (Shirley and Kruse, 1995). By 1996, all boats participating in the statewide fishery were converted to catcher-processors with on-board freezing capability. The average number of deliveries went from 133 (1990-1994) to 20/yr (1996–2001) (Barnhart, 2003). Crew size also increased during this period. In the early 1980s, most boats carried a crew of 5-8 depending on area. By 1993, all but the smallest boats carried a crew of 12 (Shirley and Kruse 1995).

2.2 State regulation

Although the majority of the fishery is prosecuted in federal waters (Figure 1), the North Pacific Fishery Management Council (the Council) did not exercise its management over the resource until the early 1990s. Until that time, the Council concluded that the State of Alaska's scallop management programme provided sufficient conservation and management of the Alaska scallop resource and did not need to be duplicated by Federal regulation (DOC, 2000). From the inception of the fishery in 1967 through mid-May 1993, the State of Alaska managed the fishery passively using minimal management measures (Barnhart, 2003). Scallop dredges with a minimum ring size of four-inch inside diameter were the established gear type. Closed areas and seasons were established to protect crab and crab habitat; scallop management was not based on scallop stock abundance or biology (Barnhart, 2003).

By 1992, fishery participants and management agencies became concerned with what they believed was a potentially excessive harvest capacity in the fishery (DOC, 2000). Decreased landings and a dramatic change in age composition of the resource suggested the maximum sustainable yield had been exceeded (DOC, 2000). The ADF&G responded with an interim fishery management plan. The plan included 100 percent onboard observer coverage, a ban on automatic shucking machines, maximum crew size of 12, crab bycatch caps and establishment of scallop guideline harvest ranges (GHRs) (Kruse, *et al.,* 2005). Minimum dredge ring-size was set at four-inch inside diameter, chaffing gear or other devices that decreased the legal inside ring diameter of a scallop dredge were prohibited, no more than two scallop dredges were permitted to be operated at one time from a vessel, and the opening of a scallop dredge was restricted to a maximum width of 15 feet (4.57 metres) (Barnhart, 2003). Vessels fishing within the Cook Inlet Registration Area were limited to one 6-foot (1.83 metre) dredge. These rules continued in subsequent plans, with one significant change. In 2004, Amendment 10 to the Fishery Management Plan allowed vessels operating within the Cook Inlet Registration Area to use two dredges of up to 20 feet (6.10 metres) total combined length.

The primary purpose for the restrictions of fishing gear and processing efficiency was to prevent overfishing of undersized scallops. The amount of scallops that can be processed on-board vessels is limited by how quickly they can be sorted and shucked. Because larger scallops are worth more per meat and take the same amount of time to process, a limited crew size and a ban on automatic shucking machines provide an economic incentive to target larger sized, higher-yield, mature scallops. Efficiency restrictions would also tend to allocate the resource evenly among vessels, regardless of their harvesting capacity (DOC, 1996). Crab bycatch limits were imposed to protect stocks of king, tanner and snow crabs, some of which were in a depleted or "closed" status due to low stock abundance. These crab stocks support valuable fisheries that experienced dramatic declines in the 1990s, which makes this bycatch an important and politically sensitive topic.

2.3 Council action on limited entry

Twelve vessels took part in the statewide fishery (outside of Cook Inlet) in 1993, despite the fact that efficient harvesting could have been conducted by three to four vessels (North Pacific Fishery Management Council, 1995b). The perceived need to limit access to the fishery was the primary motivation for the Council to begin its consideration of federal management of the scallop fishery in 1992 (DOC, 2000).

The Council believed that federal action was necessary because existing state statutes precluded a state vessel moratorium, and at the time, the *Magnuson-Stevenson Act* did not allow states to restrict access in federal waters. The Council drafted a preferred alternative for a fishery management plan (FMP), which included a federal vessel moratorium and shared management authority with the state. In April 1994, after public testimony and review, the Council adopted a draft FMP for the scallop fishery that proposed to establish a vessel moratorium and to delegate most other routine management measures to the State of Alaska. Under the draft FMP, non-limited access measures would be delegated to the State on the premise that all vessels fishing for scallops in the federal waters off Alaska would also be registered with the State.

While the proposed FMP was being developed into a permanent plan, a vessel without state registration began fishing for scallops in the federal waters of Prince William Sound. These waters had previously been closed to scallop fishing because the upper limit of the GHR of 22 679 kg of shucked meats had been reached. Despite the closure, the state was unable to stop the uncontrolled fishing because the vessel was not registered with the State and was therefore not subject to its authority. The U.S. Coast Guard boarded the vessel and found 24 494 kg of shucked meats on board. This amount, combined with the 22 679 kg of shucked meats already taken by State-registered vessels meant that the State's GHR for the Prince William Sound Registration Area was exceeded by over 100 percent (DOC, 2000).

As a result of this incident, an emergency closure of federal waters off Alaska to scallop fishing was implemented on February 23, 1995. The Council then implemented an FMP in which the only measure was to extend the emergency closure to a full year, during which a more comprehensive plan could be crafted (DOC, 2000).

Management measures have come in the form of amendments to the plan that implemented the emergency closure. Amendment 1 was passed on 10 July 1996. It established a joint state-federal regime under which NMFS implemented federal scallop regulations that duplicated most state rules. At the time, the *Magnuson-Stevens Act* did not allow for state management of fisheries prosecuted in federal waters. The joint management regime was implemented as a temporary measure to prevent unregulated fishing in federal waters. Federal waters were re-opened in August of 1996.

Amendment 2 was passed on 11 April 1997. It established a temporary moratorium on the entry of new vessels into the scallop fishery in federal waters off Alaska. To qualify for a permit, a vessel must have made a legal landing of scallops in 1991, 1992 or 1993, or during at least 4 years from 1980 through 1990. Eighteen vessel owners qualified for moratorium permits. The moratorium was to remain in effect until 30 June 2000, or until replaced by a permanent limited entry system.

The *Sustainable Fisheries Act of 1996* amended Section 306 of the *Magnuson-Stevens Act* to permit Fisheries Management Councils to delegate management to state authority. This set the stage for Amendment 3, which was passed on 17 July 1998 and delegated all management authority except limited access to the state.

The Council designed Amendment 4 in response to extensive public testimony that the scallop fishery suffered from excessive harvesting capacity. Public testimony indicated that vessels could not break even financially if the number of vessels fishing for scallops were to increase (DOC, 2000). Although a moratorium on new permits had been passed, not all permitted vessels were actively fishing and the industry was concerned by this latent capacity. The Council developed six alternatives and two options for a licence limitation programme (LLP). These alternatives ranged from no action, which would result in open access to the scallop fishery, to programmes that would issue between nine and eighteen licences. The Council preferred a programme that would issue nine licences.

Amendment 4 was approved on 8 June 2000. It established a licence limitation programme to replace the federal moratorium. Vessel owners who held a federal or state permit in February of 1999 were eligible to apply for a licence if they made legal landings of scallops between 1 January 1996 and 9 October 1998. Nine vessel owners met the criteria and were issued licences.

Seven amendments were passed after the establishment of the licence limitation programme (North Pacific Fishery Management Council, 2006a):

i. *Amendments 5, 7, and 9* dealt with description and specification of essential fish habitat (EFH).
ii. *Amendment 6* established an overfishing level for weathervane scallops and added more information on bycatch data collection.
iii. *Amendment 8* established sideboard measures for the AFA qualified measures, whereby a limited amount of scallops could be taken by a vessel that was qualified as a Bering Sea pollock vessel under the American Fisheries Act.
iv. *Amendment 10* modified the existing gear restriction endorsement on two LLP licences to allow the use of two dredges not more than 20 feet in total length.
v. *Amendment 11* was a housekeeping measure to update text in the FMP to reflect current management and biological information.

3. CURRENT MANAGEMENT AND THE COOPERATIVE AGREEMENT

3.1 State limits on catch and bycatch

The Alaska Department of Fish and Game (ADF&G) divides the fishery into nine scallop registration areas (Figure 1), three of which (Yakutat, Cook Inlet, and Kodiak) are further divided into separate districts, and sets a guideline harvest range (GHR) for each area or district. GHRs are expressed as shucked scallop meats and are specified as a range from zero to the upper limit (guideline harvest limit, GHL) of the range. ADF&G may decide to close an area at any appropriate level within the range, as conditions warrant. An entire registration area or district within it may be closed in-season based on resource concerns raised by declining catch per unit effort (CPUE), by indications of little or no recruitment of scallops into the fishery, by localized depletion, or by other factors (Barnhart, 2003). ADF&G also limits the incidental catch of crab in each area to a specific number of crabs. Crabs must be discarded; they cannot be retained. The fishing season opens 1 July and extends until 15 February if the limits are not attained or if not otherwise closed by emergency order.[1] Vessels must carry observers who collect detailed information on CPUE, area and depth fished, location, scallop meat weight recovery and catch composition. Data are also collected on crab and halibut bycatch, retained scallop catch and discarded scallop catch. These data are reported to ADF&G at least three times each week during the season and are incorporated into in-season management decisions. They are also used to set GHRs for the following season (Barnhart, 2003).

The quotas set by the ADF&G create an "Olympic" competition. In each area, vessels rush to harvest as much of the scallop allocation as possible before the quota is reached and the fishery closed. In this situation, vessel owners will not slow their harvest rate to minimize crab bycatch. They will also not experiment with crab avoidance techniques during the fishing season, as doing so would likely mean losing harvest opportunities to other vessels.

3.2 The Cooperative

In June of 2000, six scallop vessel owners formed the Weathervane Scallop Cooperative with the goal of reducing inefficiency in the fishery. Although nine permits were issued under the federal Limited Licence Plan, only six permit holders elected to join the cooperative. Of the three non-participants, one individual took part in the negotiation

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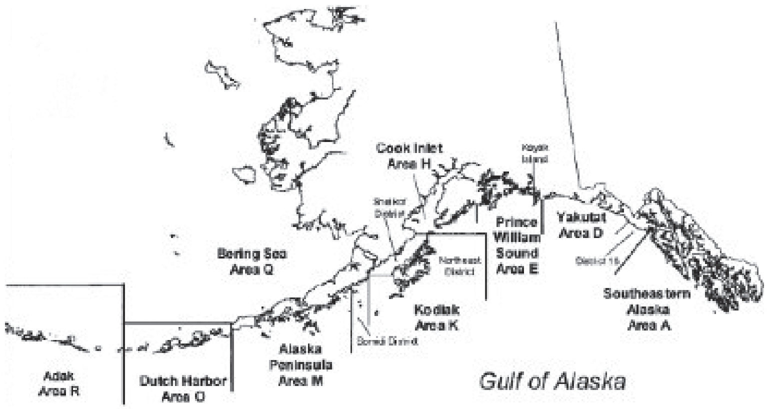
[1] In this paper, annual fishing seasons are referred to by their initial year, thus the 1998/1999 season is known as the 1998 season.

FIGURE 1
Scallop management areas in Alaska



of the agreement but declined to sign, one declined in writing, and one did not respond to the request to negotiate (Ms T. Kandianis, Weather Scallop Cooperative, pers. comm.. 2002). The six participating vessels felt they represented a large enough share of the harvesting power to significantly reduce the inefficiencies of the fishery. (Two of the non-participants had minimal harvesting capacity.)

Teressa Kandianis, one of the founding Cooperative members, described the negotiation process as one in which all players sat down at the table to "hash things out". Because of the relatively small size of the fishery, everyone had a good idea of each other's historic catch levels and harvesting capacity. In order to facilitate negotiations, two large players that had been battling during Council deliberations essentially came to an agreement: to "lay down their weapons" and do what was necessary to make the agreement happen. They asked the other (smaller) players to describe their needs in terms of scallop catch and then agreed to accommodate their needs. A system was established that allowed Cooperative members to trade shares between areas. This allowed smaller boats to choose where they wanted to fish during the year (Ms T. Kandianis, pers. comm. 2007). Some scallops were left unallocated for the (small) vessels that chose not to join the Cooperative. Because these boats were not bound by the Cooperative Agreement, they were able to exceed these shares.

As stated above, nine registration areas are contained within the Alaskan Weathervane Scallop Fishery (Figure 1). Three of these areas were not included in the original Cooperative Agreement: Southeastern Alaska, which is closed to scallop fishing; Adak, which had been open only in 1995; and the Cook Inlet Area, which at the time was open only to vessels utilizing one 6-foot dredge. The Cooperative Agreement classified the remaining registration areas as "scallop-only" (Yakutat including District 16, Prince William Sound, Kodiak-Semidi District); "dual priority" (Alaska Peninsula, Kodiak-Shelikof District, Kodiak-Northeast District); or "crab-only" (Bering Sea, Dutch Harbor). Under the cooperative agreement, vessels are assigned a predetermined percentage of the ADF&G crab and scallop limits for each area. If a member receives *n* percent of the scallop limit for that area, they also receive *n* percent of the crab limit for that area. With their share of the quota determined in advance, vessel owners are able to make more rational decisions about their fishing methods.

Tanner and king crabs are more prevalent in some areas than in others. Where crabs are abundant, the bycatch limits are likely to be reached prior to the attainment of the entire scallop GHL. In these areas, harvesters have a strong collective incentive to decrease their intake of crabs. In other areas, the bycatch limit is rarely reached, so there is less of an incentive to decrease crab bycatch. The cooperative agreement accounts for these differences by "managing by species". In "scallop-only" areas, each member's fishing activity is governed by its scallop allocation for the area. For example, if a vessel is assigned 5000 kg of shucked meats for that area, it stops fishing once that harvest is achieved. In "dual priority" areas, each member's activity is governed by its scallop allocation and its crab allocation. If a vessel is allocated 5000 kg of scallops and 500 crabs in a "dual priority" area, it must stop fishing once either of these limits is reached. In "crab-only" areas, each vessel's activity is governed solely by its crab bycatch allocation. If a vessel is allocated 1000 crabs, it can continue to fish for scallops until it captures 1000 crabs or until the *entire Cooperative's* share of the scallop GHL for the area is reached.

4. IMPACT OF COOPERATIVE

4.1 Incentives created by cooperative

The Weathervane Scallop Cooperative created a private individual transferable quota for scallops and also a private individual transferable quota for crab bycatch. The incentives for fishing under harvest ITQs are well understood. Harvesters have an incentive to transfer quota in order to achieve efficient harvests. They also have an incentive to increase the value of the landed catch by improving quality or timing landings to market demands. Evidence of the success of ITQs is typically seen as consolidation of quota on fewer vessels, increased CPUE, longer seasons and higher profits.

The incentives created by the individual bycatch limits warrant further elaboration. Prior to the cooperative agreement, each harvester faced a powerful incentive to harvest scallops as quickly as possible. The best way to increase one's share of the GHL was to fish quickly to harvest as many scallops as possible before the fishery was closed. The crab bycatch limits increased the likelihood of early closure and therefore increased the incentive to fish quickly. Vessels focused on fishing quickly rather than efficiently and crab bycatch was likely to be high. The crab bycatch limit actually created an incentive that exacerbated bycatch rates and reduced the fraction of the GHL for scallops harvested.

This situation is a classic example of a collective action dilemma (Taylor and Singleton, 1993). Each vessel makes a rational decision to increase its own benefit and in so doing decreases the benefit to the group. Scallops could be caught more efficiently and with less crab bycatch. However, it would not be rational for any vessel to change its way of fishing unless the vessel could be sure that all others would do so as well. If a vessel changes its methods in a way that slows harvesting, it will take less of the overall quota unless all others do the same.

In areas where the crab bycatch limit could constrain the catch of scallops by closing the area, harvesters with an individual crab bycatch limit have an incentive to keep their crab bycatches low enough that they can harvest their entire scallop quota. For areas where the bycatch is low and non-constraining, no *economic* incentive is created to reduce bycatch. But another incentive exists: the fleet knows that crab bycatches are a sensitive issue with crab harvesters, which is a significant fleet in Alaska. It is in the political interest of the scallop fleet to minimize crab bycatches. If crab bycatches are seen as excessive, crab harvesters might exert political pressure to restrain or even close the fishery. Usually, these kinds of political incentives create enormous free-rider problems because the costs of negative behaviour are broadly distributed. The way in which the Cooperative facilitates solution of the free rider problem is summarized by Teressa Kandianis (pers. comm., 2007), a founding and current member of the cooperative: "… the political pressure regarding bycatch accrues to the Cooperative as a unit and we have always viewed it so. It was an inherent reason for forming the Cooperative and continues to be the largest, by far, influence on Cooperative members.

The boats' captains have, despite their competitiveness, begun sharing detailed information about bycatch, gear design and scallop catchability because they realize that problems for one vessel means problems for every Cooperative member. So the political pressure is all for one, one for all. And a swift reaction to another vessel's problem that costs the other members doesn't even give us one second of pause or doubt." The enhanced security of harvest rights inherent in the Cooperative creates an environment in which cooperation can trump competitiveness in terms of crab bycatch avoidance.

The "crab-only" areas create an especially strong incentive to reduce crab bycatch. By not assigning any scallop allocations in the crab-only areas, the cooperative did not alter the scallop incentives. Because the scallop GHL had always been restrained by the crab bycatch limit, they believed that the scallop GHL was not a binding constraint. The crab-only designation created a strong incentive for vessels to learn how to catch scallops in these areas while catching few crab. In theory, one vessel could harvest the entire cooperative's scallop GHL for a crab-only area if it were able to do so without reaching its crab bycatch limit. To create an incentive to develop techniques to reduce bycatch and thereby promote maximum scallop harvest, each member acknowledged and consented to this possibility.

The cooperative agreement serves to bring individual and collective incentives into alignment. Each harvester's percentage of the resource is assured (subject to crab-only area incentives and no decision by the ADF&G to close the fishery), which allows each harvester to focus on catching this percentage more efficiently. The Cooperative also creates an environment in which captains will share information, which enables them to further reduce crab bycatch.

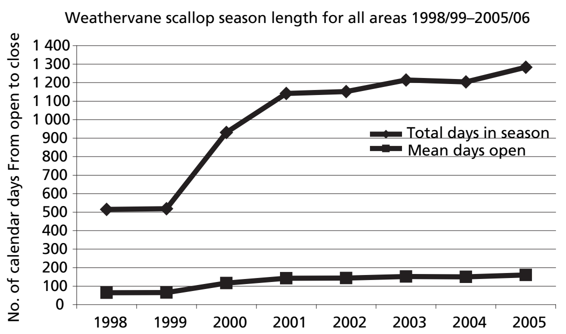
4.2 ITQ impact of scallop allocations

Scallop landings, crab bycatch and season length data were obtained from all areas for the 1998/99 through 2005/2006 fishing seasons. The Cooperative was implemented for the 2000/2001 season, so this represents two years of data before the cooperative and six years after the cooperative. Scallop GHLs and crab bycatch limits change each year based on the ADF&G annual stock assessment for each area. This fluctuation prevents straightforward interannual comparisons. It is therefore meaningful to examine the percentage of the scallop GHL or crab bycatch limit attained from year to year, rather than looking at the number of crabs or scallops caught.

The Bering Sea is the only area ever fished as "crab-only". (Dutch Harbor, although originally classified as crab-only, was not open in the 2000/01 fishing season.) For reasons that will be explained later in this section, the crab-only designation was eliminated after the 2000/01 fishing season (the first year of the cooperative), and the Bering Sea was reclassified as dual priority.

Season length, as measured by the total number of fishing days across all areas, increased significantly (Figure 2) after the establishment of the Cooperative in the 2000 season. This time series is complicated by the fact that areas may be open in some years and not in others. One area (Dutch Harbor) closed in the first year of the Cooperative and has largely been closed since. The Alaska Peninsula was closed for 2001 and 2002. Even with two areas closed in 2001, the number of days the fishery was open totalled 1 142, as opposed to 519 in 1999. In Yakutat (including District 16), the 2000 and 2001 seasons lasted

FIGURE 2
Season length for Weathervane Scallop Fishery



for the entire length (1 July to 15 February). Figure 2 also shows that for areas that are open, the mean number of days open per area increased from 64 days in 1999 to 160 days in 2005. Dramatic increases in both mean days open (average of all areas) and total days open (sum of all areas) were seen after the implementation of the cooperative. Fewer vessels operated for more days after implementation of the cooperative.

The ability to trade scallop shares has led to consolidation in the fleet. Currently only two Cooperative vessels are active, which reduces the fixed costs for the industry. Although fleet consolidation is often cited as a concern when catch rights are established, it should be noted that the small non-Cooperative boats have benefited from Cooperative efficiencies. Prior to the agreement, short season length meant small boats were limited to a few areas. It was not economically feasible for them to steam to areas that might close at any time because the crab limit or scallop GHL had been reached. Now, with longer season lengths, small boats are free to fish in areas they previously would not have targeted (Ms T. Kandianis, pers. comm. 2007). In recent years, the lengthened season has enabled smaller vessels to fish in a variety of areas. Due to the unpredictability of non-cooperative harvests, the Cooperative no longer sets aside non-member shares. Any harvests made by non-cooperative members are merely subtracted from member shares (Ms T. Kandianis, pers. comm. 2007).

There is also anecdotal information that the Cooperative reduced harvesting costs through cooperation among members. Shortly after the Cooperative's inception, data collected by the ADF&G showed dramatic CPUE differences between two Cooperative vessels fishing the same area. The boats' two owners asked the captains to share information to enable the captain with the lower CPUE to increase his harvesting efficiency. Old habits die hard, and at first the "successful" captain was reluctant to share knowledge with a "competitor". The owner persisted, reminding the captain that both vessels were now assured of their scallop allotment, and an increase in CPUE of one vessel would have no impact to other Cooperative vessels. The captain relented, and shared information about the way he set his drag that allowed the less successful captain to increase his CPUE (Ms T. Kandianis, pers. comm. 2007).

Excepting a few smaller non-cooperative boats, the fishery takes place on catcher/processor vessels that freeze the catch at sea. We would therefore not expect to see the kind of dramatic change in markets that occurred, for example, under halibut ITQs. (Under the halibut ITQs in Canada and Alaska, the dramatic increase in season length allowed that fishery to switch to a year-round fresh market with significantly higher prices.). A small change in the weathervane scallop fishery may have had a small impact on prices. The restaurant industry prefers that scallops be packaged in smaller increments. Prior to the Cooperative, the frenzied pace of fishing necessitated large-scale frozen packaging. Harvesters are now able to divide the standard 5-pound package into a preferred "split pack" of two 2.5-pound packages, which commands a higher price (Ms T. Kandianis, pers. comm. 2007).

4.3 Reduced crab bycatch and increased scallop share of GHL

Individual bycatch limits give vessels an incentive to harvest efficiently so they may attain their entire scallop share. With lower crab bycatches, the season remains open longer and the vessels can harvest a greater percentage of the GHL. The effect of this incentive is clear in the dual-priority areas. (In the scallop-only areas, crab bycatch was not expected to constrain scallop harvesting.) The incentives of the Cooperative Agreement's dual priority designation are explicitly linked to the crab bycatch limit (CBL). Figure 3 shows that the Cooperative did indeed reduce bycatch (as a percent of the CBL) and increase scallop landings (as a percent of scallop GLH) in dual priority areas. (As discussed below, the definition of dual priority areas is different in 2000 than in subsequent years.) Prior to the Cooperative, the fleet took approximately half the scallop GHL and also about half the crab limit. After the Cooperative, the fleet took at least 70 percent of the scallop GHL in every year. This figure shows a dramatic decrease in the percentage of the crab limit attained since the inception of the Cooperative, from a high of 57 percent just prior to the Cooperative, to a low of 10 percent in 2002. The percentage of the CBL caught has remained below 15 percent for each of the last three seasons.

It could be said that the "crab-only" incentives for the Bering Sea worked much better than anticipated. In part, simply slowing down may enable a vessel to fish "cleaner" than it could in a derby-style fishery. But also, in the first year of the Cooperative, the ADF&G substantially reduced the Bering Sea scallop GHL between the time the Cooperative was formed and the beginning of the fishing season, but kept a relatively high crab limit. This created unanticipated results. One vessel was able to significantly reduce its crab bycatch rate so that they were able to harvest much of the scallop GHL before other vessels could begin fishing. Captains quickly ascertained that the entire GHL would be harvested before the crab limit was reached in the Bering Sea. Now the scallop quota was binding, and the classic "race for scallops" developed. Captains rushed to harvest Bering Sea scallops without focusing on limiting bycatch. Because this violated a primary purpose of the Cooperative Agreement, the "crab-only" designation was eliminated after the 2001 fishing season. Currently all areas are classified as either "scallop-only" or "dual priority".

FIGURE 3
Dual priority areas

Percentage of crab bycatch limit landed: 1998/99–2005/06
Percentage of upper limit of scallop GHR landed: 1998/99–2005/06

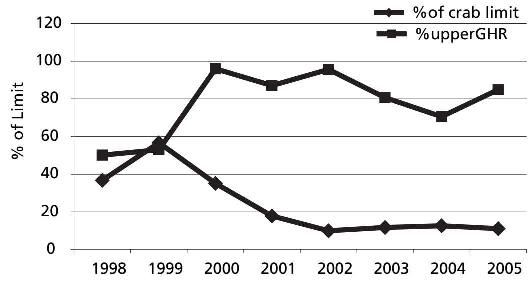
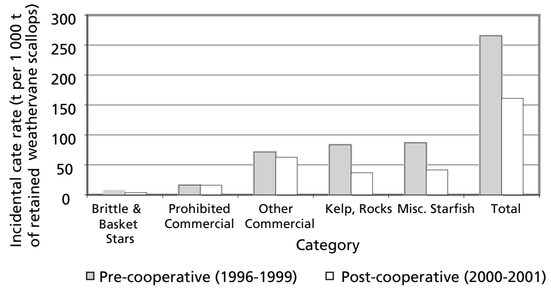


FIGURE 4
Incidental Catch Rates in the Alaska Weathervane Cooperative Fishery



Managing Our Nation's Fisheries, November 2003. Northern Economics, Inc. Presented at Weathervane Scallop and Longline CP Sablefish Fisheries The Effects of Rationalization on Bycatch Rates in the Alaska Hartley, Marcus and Jonathan King.

The increase in harvesting efficiency also resulted in a decrease in other bycatch. The catch rate for brittle stars, kelp and other incidental was shown to have dropped by 39 percent after the Cooperative's inception (see Figure 4, derived from Hartley and King, 2003). This is not the result of any direct incentive; these other species are not under any kind of limit. Three factors may be contributory. First, fishing more efficiently means fewer tows. Second, by fishing more slowly, the gear is more likely to better target the desired catch (scallops) and less at various non-target catch (whether crabs or something else). Third, vessels may reduce the time that they spend sorting unwanted catch by avoiding areas that bring up excessive amounts of unwanted catch.

4.4 Enforcement of cooperative agreement

Enforcement of the Cooperative's agreement relied on private contract enforcement. All vessels carry state-mandated third-party observers that report catch, location and bycatch rates. These data are relayed (often in real time) to ADF&G and to vessel owners, so everyone is aware of what is happening in the fishery.

In 2002, one vessel fishing in the Shelikof District (within the Kodiak Registration Area) exceeded its individual crab bycatch limit in a matter of days. The bycatch limit for the entire district (i.e., including the shares allocated to other vessels under the Cooperative Agreement) was being approached. A Cooperative member (not the boat's owner) learned of the excessive bycatch from the on-board observer's report at approximately 5:00 pm. This Cooperative member tried to contact the vessel captain to ask him to stop fishing, but the captain was "unavailable". She then contacted the boat's owner, and threatened to file for an injunction (which was possible because the captain had violated the terms of the Cooperative Agreement). By 8:00 pm, the captain responded and the vessel had stopped fishing. In a matter of days, the offending vessel had used up three years of crab bycatch that would be allocated to that vessel under the Cooperative Agreement. As a result of enforcement provisions in the contract, the vessel was only allowed to fish in areas without crab limits in the following year. This sanction was actually less severe than what could have been assessed, based on the provisions of the contract. The severity of the punishment may have been influenced by the fact that the Cooperative was still able to harvest the entire 2002 scallop GHL in the Shelikof District. With careful fishing to avoid crab bycatch, the remaining fleet was able to harvest the Shelikof GHL within the small remaining crab bycatch allowance.

5. DISCUSSION

The Weathervane Scallop Cooperative was able to initiate a private agreement that created individual transferable quotas and individual transferable crab bycatch limits. This agreement was formed subsequent to the creation of similar cooperatives in Pacific whiting (see Sylvia and Munro, this volume) and the *American Fisheries Act* pollock cooperatives (see Wilen and Richardson, and Paine, in this volume). Undoubtedly, there was an element of learning from the experiences of these other cooperatives. (In fact, the same lawyer drafted all these agreements.)

The implementation of individual bycatch limits is unique. While the possibility of using ITQ institutions to manage bycatch has been proposed, there are few examples of bycatch ITQs where the bycatch cannot be retained. This case provides strong empirical evidence that bycatch ITQs are not a theoretical novelty, but can dramatically reduce bycatch. The effect of the cooperative's individual bycatch limits was not simply to limit bycatch to the capped value. The individual bycatch limits reduced the fraction of the total bycatch limit taken from 40–60 percent of the limit to 10–15 percent of the limit. The discussion earlier suggests why the fleet may have reduced bycatch so dramatically. The overall bycatch limit itself may have exacerbated the derby and made bycatch worse. And the political incentives to reduce crab bycatch were easier to accommodate under the allocated bycatch limits.

It is also interesting to note that the Cooperative included only six of the nine permits. An obstacle to self-governance is the difficulty of getting unanimous, voluntary agreement among harvesters. Obviously, this was possible because the remaining permits were smaller vessels whose harvests did not undermine the basic principles of the agreement. If one of these permits upgraded its vessel to fish the broader area, the agreement would probably face some challenges.

In summary, scallop landing and crab bycatch data from 1998 to 2005 provide evidence that the Cooperative Agreement increased harvesting efficiency while reducing bycatch of crabs and other species. Scallop landings increased in relation to guideline harvest limits, total crab bycatch declined, crab bycatch decreased in relation to limits and season length increased dramatically.

6. ACKNOWLEDGEMENTS

This paper could not have been completed without a large volume of documentation from Jeffrey Barnhart and Forrest Bowers of the Alaska Department of Fish and Game and pers. comm. from Teressa Kandianis of the Kodiak Fish Company. Ralph Townsend helped us identify this research topic and encouraged us at several points to complete the research.

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Rent generation in the Alaskan pollock conservation cooperative

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1. INTRODUCTION

The idea of open access dissipation of resource rent is surely one of the most powerful insights from the social science literature. While the clever "tragedy of the commons" metaphor often grants Hardin (1968) credit for the insight, the concept appeared in various forms much before Hardin – most comprehensively in Gordon (1954). The Gordon paper ranks as one of the most enduring and most cited papers in natural resource economics. Gordon's description of the process of open access dissipation was also a metaphor that simplified to make fundamental points. An important simplification was the depiction of open-access harvesting in terms of a composite "effort" index. Gordon proposed that readers interpret effort as boats for pedagogical purposes, but as the paper's influence spread, the pedagogical substitution of boats for all dimensions of fishing effort took on a life of its own. Academics and managers came to interpret the rent dissipation process as "too many boats chasing too few fish" in a quite literal sense. This interpretation led early regulators to believe that controlling the number of vessels through limited entry would be sufficient to rationalize fisheries and eliminate the perverse incentives of open access. But evidence from the first limited entry experiments made clear that controlling some dimensions of effort encouraged fishermen to expand others and continue to dissipate rents (Wilen, 1988). The literal adoption of Gordon's metaphor overlooked that there are many ways to expand individual capacity in a race for fish and almost unlimited ways to waste potential rents.

It is probably not exaggerating too much to claim that most fisheries economists anticipated that, with secure use rights, the main adjustment would be a reduction in the number of vessels and the consolidation of catch-history. But this simplified expectation projects earlier misunderstandings concerning rent dissipation onto the rent creation process. In reality, as many fisheries have rationalized, new rents have been generated by making the easy adjustments first, and these often do not involve immediate vessel removal and consolidation. The new rents are generated by maximizing the value of what is caught, reversing regulated open-access incentives to maximize the quantity of what is caught. Increasing net value has been accomplished by opening up new markets, by changing product mix, and by substituting capital and labor tasks in ways that preserve the quality of the harvest.

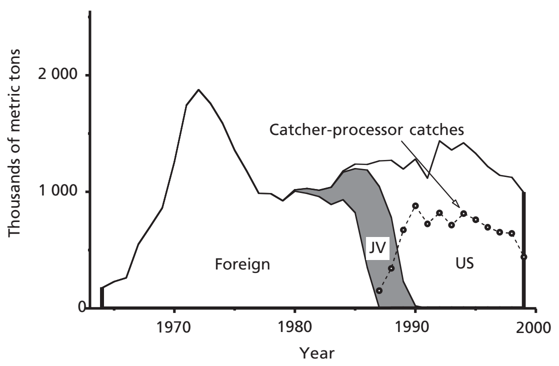
Rent generation in real fisheries has much more texture, with rents produced by complex input combinations such as crew coordination and communication, skipper fish-finding skills, and subtle differences in vessel design, gear efficiency, and travel and search times on the harvesting side of the operation (Wilen, 2004). But the harvesting or production side of fishing is intimately connected to alternatives in the market. And the alternatives presented by the market are not exogenous but instead reflect the fishing process itself. One of the most important lessons in the rationalization of fisheries is how important the market is as a source of rents (Homans and Wilen, 2005). There are seemingly endless ways that economic value can be enhanced once proper incentives to capture this value are in place. In this paper, we look at the changes in the Alaskan Bering Sea pollock fishery after rationalization and the establishment of the Pollock Conservation Cooperative in the winter of 1998.

2. THE BERING SEA POLLOCK FISHERY

With landings on the order of 1.5 million tons, the Bering Sea pollock fishery is North America's largest fishery in total tonnage. Pollock aggregate in large spawning concentrations off the Aleutian Islands and along the southeastern Bering Sea shelf and slope during late winter and early spring. The fishery targets highly-valued roe-bearing pollock during this winter, or "A-season", fishery. In the late summer and fall, the stock is dispersed along the outer Bering Sea shelf and slope from the US-Russian convention line south and east to the Alaska Peninsula. The industry generally begins its "B-season" fishery during July and harvesting generally continues through October. Total allowable catch regulation (TACs) currently apportions harvests seasonally, with 40 percent of the TAC available during the A-season and the remainder available for the B-season.

The eastern Bering Sea pollock stock was initially exploited by distant-water foreign fleets in the early 1960s (Figure 1). During the late 1980s, the fishery was americanized, which involved joint ventures during a transition period and then full development of domestic capacity. Americanization provided new opportunities for US-based surimi and fillet producers to supply world markets. Today, two primary groups of vessels and plants – the inshore and the offshore sectors – participate in the fishery. The inshore sector employs catching-only vessels that harvest pollock using large mid-water trawls and transport the raw fish to onshore processing facilities. The offshore sector, which is the focus of this paper, employs mainly integrated catching and processing vessels that harvest pollock and then process it using machinery installed below deck. Catcher-processor vessels are large, ranging from 70-110 meters in length, and represent significant investments, on the order of US$30-40 million. The offshore sector also includes three floating processors (so-called "motherships") that receive deliveries from a dedicated fleet of catcher vessels.

FIGURE 1
Bering Sea and Aleutian Island pollock catches, 1964–1999



Surimi is a primary input into a broad spectrum of finished and semi-finished fish products. To produce high-quality surimi is complex and requires several steps that must be well managed. After holding raw fish for a period during which they firm up, the fish are filleted using special cutting machines adjusted for the average size of fish. The fillets and other recovered flesh are minced and the protein fibers washed, aligned, dried, and then mixed with ingredients which preserve product quality during freezing. The resulting product is a versatile fish paste of uniform texture and fiber. The frozen paste is sold to secondary processors, primarily in Japan, who use it to make fish sausage, imitation crabmeat, and an array of other, traditional shaped and molded products. Because surimi is an intermediate commodity product that has not been highly valued, the pollock fishery has operated as an industrial fishery with profits flowing mainly from capital investments that provide economies of scale in harvesting and processing.

The inshore sector was developed on Alaskan soils in the early 1990s by many of the same Japanese firms that had pioneered the offshore fishery prior to its Americanization. As harvest opportunities were transferred to US vessels, several Japanese companies established shore-based processing operations to maintain a steady source of surimi. During the 1990s, the inshore sector came to be dominated by two large Japanese seafood conglomerates and one large and vertically integrated US seafood company. These three companies own five groundfish and crab processing plants on the Alaska Peninsula and in the eastern Aleutian Islands, and the inshore harvest is split roughly equally among the companies. Prior to the restructuring of the pollock fishery by the 1998 American Fisheries Act, the offshore sector was dominated by a large Norwegian firm and several US companies headquartered in the State of Washington. These companies operated about 30 catching and processing vessels and sold surimi into the Japanese market in competition with the Japanese-owned inshore plants, but at an outsider's disadvantage. Partly as a diversification strategy, the offshore sector also built up processing flexibility during the 1990s to produce fillet, deep-skinned fillet, and minced pollock products from their integrated operations. These fillet and mince products are sold into the international whitefish markets, in competition with other firm-fleshed species such as cod, hake and haddock.

3. THE POLLOCK CONSERVATION COOPERATIVE

3.1 Events leading to formation

The parallel development of offshore and inshore sectors led to high-stakes allocation disputes over sectoral allocations of the total pollock TAC. During the 1992–1998 period following the so-called Inshore/Offshore Decision, the offshore sector was allocated 65 percent of the Bering Sea and Aleutian Islands (BSAI) pollock TAC (Herrick et al., 1994). Inshore/offshore sector TACs were determined by subtracting bycatch allowances of 4–6 percent and a 7.5 percent community development quota (CDQ) from total allowable catch, and then allocating the remainder with a 65/35 percent split of the commercial catch. The CDQ quota program was established in 1992 to catalyze increased participation of western Alaskan coastal communities in the Bering Sea groundfish fisheries (National Research Council, 1999).

In 1998, the North Pacific Fisheries Management Council (NPFMC), a majority of whose members represent Alaska, reduced the offshore sector TAC allocation from 65 percent to 61 percent as part of the so-called Inshore/Offshore III decision. The offshore sector argued that they could absorb this reallocation only if the NPFMC agreed to allow the offshore sector to set up a harvesters' cooperative. But the NPFMC effectively blocked the formation of a harvesters' cooperative by failing to apportion the offshore TAC between the catcher processor and mothership fleets. After a contentious process of political logrolling, a complicated piece of national legislation called the American Fisheries Act (AFA) cleared the way for the Pollock Conservation Cooperative (PCC) to form during the winter of 1998. The AFA further reduced the offshore allocation from 61 to 50 percent, increased allocations to the Community Development Quota program to 10 percent and removed foreign flagged vessels from the offshore sector. (Figure 2 summarizes the history of allocations.) The 50 percent offshore allocation was divided up between the catcher/processor fleet (CP), a group of catcher vessels delivering to catcher processors (CP CV), and the small group of motherships and their catcher vessels (MSCV).

FIGURE 2
Bering Sea and Aleutian Islands pollock allocation history

	I-O II	I-O III	AFA
CDQ	7.5%	7.5%	10%
Bycatch	4–6%	4–6%	4–6%
–	–	–	–
Inshore (SP CVs)	35%	39%	50%
Offshore	65%	61%	
MS CVs			10%
CPs			36.6%
CP CVs			3.4%

Two legal preconditions were necessary to support the formation of the PCC. First, a secure allocation to the catcher-processor companies was required and the AFA provided this exclusive allocation. Second, the group required the legal blessing of the Department of Justice that it was not violating antitrust regulations, as well as the development of an elaborate set of "sideboard" regulations by the NPFMC. The AFA required the NPFMC to develop these sideboard regulations to protect non-pollock groundfish harvesters from excess effort that may have been released from the pollock fishery due to rationalization. The Pollock Conservation Cooperative first began to fish cooperatively with the start of the 1999 season.

3.2 Expected sources of rents

With only seven independent companies in the catcher-processor segment of the offshore sector prior to 1998, one might have expected that the bulk of potential rents would have been realized. But the offshore sector was allocated its TAC as a common pool quota; the season was closed once the allocation was reached. This created a derby fishery. The processing operations would have preferred a slow and even supply of raw fish of relatively uniform size and condition. This would enable an optimal throughput that maximized processing line efficiency by recovering the largest amount of salable product value. Pollock products include roe (during the A-season), primary products made of flesh from the whole fish (surimi, fillets, mince and meal from whole fish), and secondary products made from processed fish (mince and meal from fillet trimmings and carcasses). But because the catching operation was under a race to fish, cutting, processing, and extraction operations could not be optimized. There was also less time and space available to operate secondary recovery processes efficiently. These recovery processes include specialized machines that remove head meat from filleted carcasses and process-water decanters that scavenge protein fibers from wash-water streams. These machines require space and are time- and labor-intensive. In a derby fishery, the focus is on cut-fish throughput, and the factory is configured with the maximum number of filleting machines. Moreover, since fillet production is time- and labor-intensive, the derby fishery biases product mix toward surimi products rather than fillet products.

Throughput can also be too slow, which leads to the under-use of processing capital and higher unit production costs. If the fishing and processing operations can not be carefully coordinated, then process throughput may be halted due to a lack of pollock. When this occurs, the processing line must be emptied and sanitized, and then restarted and retuned. Prior to the harvesting cooperative, each vessel raced to harvest fish, which resulted in a compressed season with too many fish being run through the onboard processing plants in the time available.

Knowledgeable individuals in the catcher-processor sector believed that they could earn more profits with a slower pace of harvesting. Skippers realized that they could slow down fishing and feed optimal flows of raw fish into the processing lines. Vessel fish masters also spoke of the ability to fish large schools of pollock in ways that generated more returns, *e.g.*, by targeting larger roe-laden females on the leading edge of the moving school when roe condition was optimal. Under the derby fishery, it was common for too many vessels to fish the same school of pollock, which resulted in unnecessary dispersal of the fish. This caused frequent movement and disruption of the flow of fish into the processing operation. Skippers also believed that they could deliver more uniform sized fish to the processing lines.

Net value of final product can be created in at least three ways. First, net value can be created by altering the portfolio of finished and semi-finished products toward higher-valued products. When fillet prices are high relative to surimi prices, it would be profitable to shift some raw product to fillets and away from surimi. Factory managers also expected to fine tune the cutting line to salvage more quantity of high valued primary-product yield per ton of raw fish, regardless of the final product. Cutting line efficiencies could be improved by increasing the uniformity of fish landed, which allows cutting operations to be more precisely tailored to the average size of incoming fish. Saving even small percentages of flesh enables more pollock to be converted into high-quality primary consumer products rather than recovered as a secondary product, raising profits considerably. Processing line managers also expected to improve the recovery and quality of secondary products. A significant amount of pollock ends up as industrial products, including fish oil and fishmeal. Although these products have low unit values, the high volumes of pollock harvested suggests that improving the recovery of these items can increase rents considerably. Prior to 1998, factory managers suggested that total product recovery was about 18 percent. They expected that under the rationalized cooperative, that product recovery might increase to as much as 22 percent. This estimate turned out to be a substantial underestimate.

3.3 Changes under rationalization

The Inshore/Offshore III allocation was superseded by the AFA. The AFA contained a complex set of provisions that transformed the offshore sector in a major way. An Americanization provision forced the large Norwegian firm to divest itself of nine vessels and sell a majority of its harvesting operations to US interests. The Bering Sea pollock CDQ allocation was increased to ten percent from seven percent, and 15 percent of the non-CDQ TAC was transferred from the offshore sector to the inshore sector. Two-thirds of the increased inshore allocation was generated out of the catch history of the divested vessels. The Norwegian owner was compensated $95 million ($20 million from a federal grant and $75 million from a US government-backed loan to be repaid via a $0.006 per pound levy on pollock landings to inshore processors). The uncompensated third of the inshore transfer reflected approximately the prior Inshore/Offshore III allocation. For the purposes of this chapter, the most important part of the AFA was the allocation framework that allowed the offshore catcher-processor companies to form a closed class with a specific allocation. The AFA gave seven firms the legislative blessing to operate 20 catcher-processor vessels in a coordinated fashion. The prospective coop participants reached agreement on a division of the catcher-processor allocation.

The Pollock Conservation Cooperative is not an individual transferable quota (ITQ) system *per se,* since the offshore allocation was not legally parceled out to individual firms or vessels. In fact, at the time of passage of the AFA, the development of new federal ITQ programs was prohibited by law. But, incentives to cooperate exist because the coop members have been allocated a TAC share as a group. The internal incentives are similar to those under other property-rights-based systems, such as territorial use rights in fisheries (TURFs) discussed elsewhere in this volume. Within the cooperative, each firm holds a negotiated share of the catcher-processor allocation, based mostly on historical harvest shares within the group. For each firm, incentives exist at the company level to maximize the value of that negotiated share by increasing revenues and reducing costs.

Since its inception in 1998, the Pollock Conservation Cooperative has successfully generated new profits and efficiencies in several ways. First, a number of the most inefficient vessels were removed from fishing. Of the 29 vessels that fished before

FIGURE 3
Relative fishing power (B-season) of AFA catcher-processors, 1995–1998

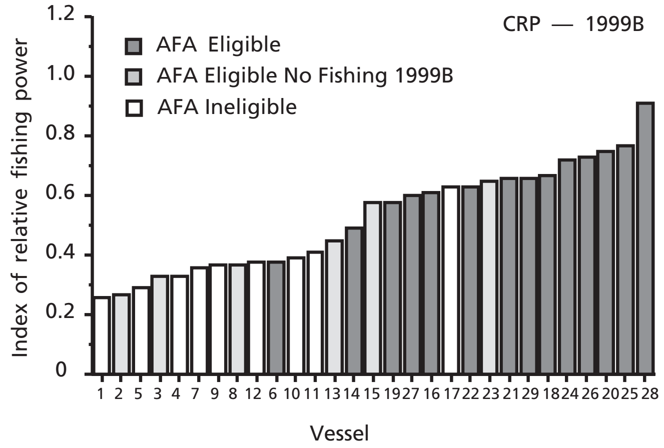


FIGURE 4
Average daily catch of AFA catcher-processors, 1995–1999

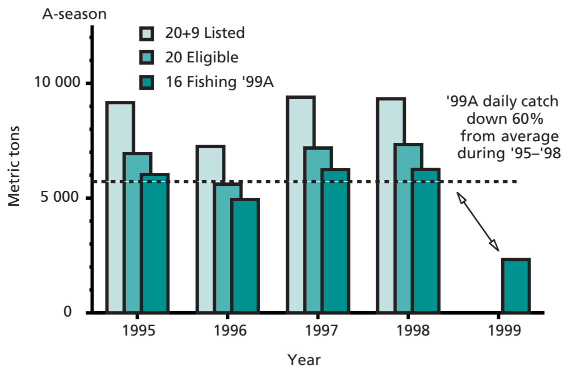
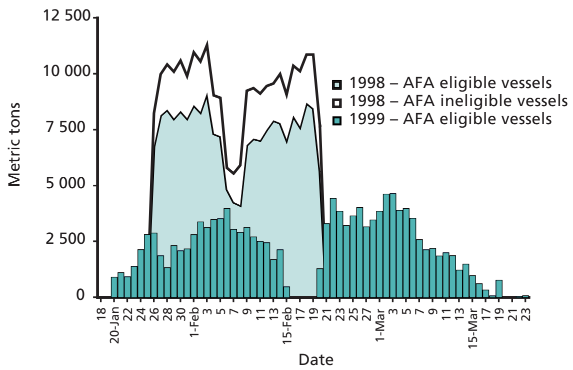


FIGURE 5
Daily A-season catches of AFA catcher-processors (excluding CDQ), 1998 and 1999



At-sea Processors Association, 1 April 1999.
Source: NMFS AKFSC - SeaState, Inc.

the AFA, 9 were removed with the buyout, which left 20 eligible vessels. These 9 vessels tended to be less efficient vessels (see Figure 3). The coop retired an additional 6 vessels, leaving only 14 of the 20 eligible vessels to fish during the first year. The operating costs of these 6 vessels were saved. In addition, the coop acquired the catch shares allocated to the high seas catcher vessels that had previously delivered pollock to offshore catcher processor vessels.

New rents were generated by fine-tuning the fishing operations and coordinating harvesting operations with the onboard processing plants. In the initial year of cooperative fishing, daily catch rates were only 40 percent of those recorded by the same vessels over the 1995-1998 seasons (Figure 4). Catch per haul was 27 percent lower and the number of hauls per day dropped by 45 percent. The length of the 1999 A-season was doubled compared with the 1998 season because of these substantial reductions in daily catch (see Figure 5). Note that CDQ catches are excluded from this data for both 1998 and 1999. Vessel catcher/processor operations are now able to optimize the quality of raw fish harvested by slowing catching operations, while maximizing the value derived from fish landed by improving operations in the processing lines.

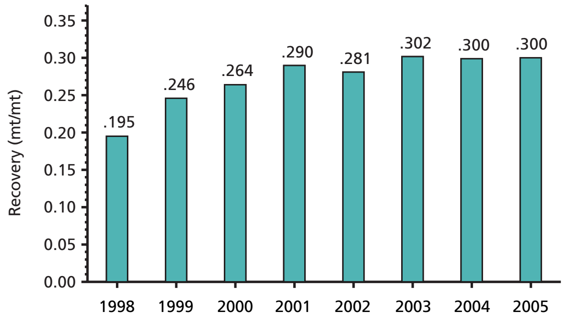
As expected, the value produced a ton of raw pollock increased. Figure 6 shows that before cooperative fishing, total product recovery rates averaged 19.5 percent. In the first year of cooperative fishing, total product recovery shot up to 24.6 percent, exceeding the increases anticipated by most knowledgeable factory managers. The recovery rate jumped another 2 percent in the second year and another 3 percent in the third year, reaching a plateau of a bit over 30 percent in 2003.

Figure 7 shows how total product mix has changed. Some of the yield increase in the first two years emerged by squeezing more surimi paste from the raw pollock. From a pre-cooperative average of slightly over 8 tons of surimi per 100 tons of raw pollock, surimi production rose in the first two years to more than 13 tons per 100 tons of round pollock. The fleet was also developed capacity to shift product mix to adjust to market conditions. In response to market conditions that favored deep skin fillets during the first two years, a significant amount of that product was generated (Figure 7). This pattern of shifting to more valuable fillets and deep skin fillets has continued, along with substantial increases in recovery rates of both fillet types.

Changes also increased high-valued roe recovery during the A-season. Prior to 1998, the A-season fishery that targets fish for roe contributed 45 percent of the total A- and B-season catch. In the first years of coop operations during 1999-2002, the A-season catch fraction was reduced to 40 percent. But finished roe product increased from roughly 1.4 to about 1.8 tons per 100 tons of round pollock, about a 28 percent increase in efficiency in the very valuable roe. Factory managers have also recovered increased amounts of secondary products such as fishmeal and minced pollock. Beginning in 2001, the recovery of minced pollock secondary products increased substantially (Figure 7). Minced pollock and meal production increased both from a better matching of offal flows to meal-plant capacities, and because most of the idled vessels did not possess meal plants. Overall, the pollock case illustrates that even in a fundamentally high-volume industrial fishery, the opportunities for increasing value that are unleashed by creating proper incentives are significant.

FIGURE 6

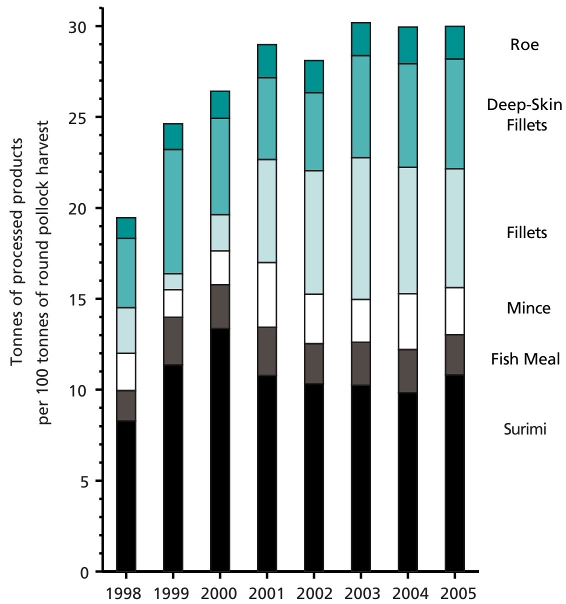
Total product recovery of AFA catcher-processors, 1998–2005



Source: SeaState, Inc. PCC and CDQ catch per haul, 1998-2005; NMFS AK Region Pacific cod and pollock products by processing mode, 1998-2005, BSAI groundfish quotas and preliminary catch in round metric tons, 1999-2005, and CDQ participation and catch by gear, 1999–2005. Total product recovery estimates include both directed-fishing and CDQ pollock harvests, and are calculated as the weight of all products produced divided by the weight of the round pollock used to obtain the products.

FIGURE 7

Total product recovery and mix of AFA catcher-processors, 1998–2005



During 2001-2005 total product recovery is estimated to have increased by 50% over the 1998 open-access "race-for-fish" baseline. Note that this figure does not show product recovery rates, but instead the average product mix produced from the total amount of pollock harvested throughout the entire year by all PCC member vessels. *Source*: SeaState, Inc. PCC and CDQ catch per haul, 1998-2005; NMFS AK Region Pacific cod and pollock products by processing mode, 1998-2005, BSAI groundfish quotas and preliminary catch in round metric tons, 1999-2005, and CDQ participation and catch by gear, 1999-2005.

4. SUMMARY AND CONCLUSIONS

Emerging management innovations will determine not only whether the marine resources of the world can produce more fish, but also the economic values derived from them. It is easy to argue that little of the ocean's potential for generating economic return has been realized. Most fisheries are dramatically overcapitalized, and most of the overcapitalization is a hangover of the open access period prior to extension of nation-state ocean jurisdiction during the 1970s. Since the formation of national Exclusive Economic Zones and the potential for control over effort, some fisheries have adopted schemes that partially mitigate the conditions that Gordon described. Yet most fisheries regulations focus on biological indicators and stock safety goals, rather than rent generation. Most of the wealth-generating potential of the world's fishery resources is still being squandered.

The rent generation process is significantly more complex than might be inferred from the stylized Gordon model. As information about various rationalization schemes around the world accumulates, we will no doubt find that new rents are generated across many margins. This suggests that the rent dissipation process itself must have originally been multi-faceted and spread across multiple margins. We have probably not paid enough attention to how the market side of fisheries is distorted by the race to fish. While some cost-savings gains have clearly emerged in the PCC from retiring excess vessels, significant gains have also emerged from the market side. Many of the process changes that were undertaken were done to vary the product mix to better meet market demands and to squeeze more salable product from the raw pollock.

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The legal context of United States fisheries management and the evolution of rights-based management in Alaska

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1. LEGAL CONTEXT OF UNITED STATES FISHERIES MANAGEMENT

1.1 Overview

Fisheries in the United States are governed under a composite of overlapping federal, multi-state, state, and tribal authorities and are conditioned by treaties and compacts. In general, individual states have jurisdiction over fisheries in lakes, streams, and rivers within state boundaries, and in marine waters within three miles of their coast. For Texas and the Gulf of Mexico coast (i.e. the west coast) of Florida, state jurisdiction extends to nine miles. Before 1976, federal jurisdiction included fisheries in lakes, streams and rivers within federal lands and in waters from three to twelve miles (or nine in Texas and Florida) offshore. That authority was extended to 200 miles pursuant to the *Magnuson Fisheries Conservation and Management Act of 1976* (renamed *the Magnuson-Stevens Fisheries Conservation and Management Act*, MSFCMA, in the 1996 reauthorisation). Multi-state compacts, such as the Atlantic States Marine Fisheries Commission, the Gulf States Marine Fisheries Commission and the Pacific States Marine Fisheries Commission, coordinate state management of shared stocks of migratory species. Subsistence, sport, and commercial fisheries in lakes, streams, and rivers that flow through or abut certain tribal lands are governed under treaties negotiated with indigenous peoples. In addition, the management of some fisheries operates within bounds established under international treaties.

The exercise of federal, state, multi-state and indigenous authority occurs through the interplay of: statutes passed by state and federal legislative bodies; regulations promulgated by federal, state, regional and local executive bodies; common law precedents that evolve through state and federal judiciary processes; treaties approved by Congress; and state and federal constitutions. This chapter will touch briefly on common law and constitutional provisions before focusing more intensely on the principle statutes and regulations that govern fisheries in the US Exclusive Economic Zone (EEZ). This chapter will also review the fisheries management framework in Alaska, as several of the cases in this volume occur in Alaska.

1.2 Common law

Bader (1998) describes common law as:

> *"… the product of courts resolving conflict among individuals by relying on local standards of reasonable conduct and expectations. Once a decision is made, the decision serves as precedent for purposes of analogy in subsequent controversies."*

In the US and other nations that derive legal traditions from the Magna Charta, common law forms the basis for the creation and enforcement of private contracts and the identification of remedies for nuisances and torts. Of particular importance to fisheries are precedents governing property and a concept called the Public Trust Doctrine.

Property law is important to fisheries because it specifies the conditions of ownership, the suite of entitlements and liabilities that derive there from, and how those rights and obligations are distributed between individuals, groups and government (Honoré, 1961). Property law is the governing basis for fishery management regimes we label open-access, regulated open-access, common-property, territorial use rights, community development quotas, limited access privileges, individual fishing quotas, private property and so forth.

The Public Trust Doctrine can be characterized as a common law caution regarding the alienation of public resources (NRC, 1999). For example, in *Illinois Central R.R. Co. v. Illinois* (1892), the U.S. Supreme Court found that title to certain public resources is:

> *" … a title held in trust for the people of the States that they may enjoy the navigation of the waters, carry on commerce over them, and have liberty of fishing therein freed from the obstruction or interference of private parties.*
>
> *… The State can no more abdicate its trust over property in which the whole people are interested, like navigable waters and the soils under them, so as to leave them entirely under the use and control of private parties than it can abdicate its police powers in the administration of government and the preservation of the peace."*

While *Illinois Central R.R. Co. v. Illinois* (1892) does not prohibit alienation of navigable waterways, submerged lands or living aquatic resources (Simmons, 2007), it does suggest that alienation is permissible only when the public interest or public use is improved thereby or when alienation does not substantially impair the public interest or the use of remaining resources (NRC, 1999). Consequently, when the right to harvest fishery resources is conveyed to individuals, the government typically retains a trust responsibility for safeguarding the sustainability of those resources (McCay, 1998).

1.3 Federal Constitutional law

Bader (1998) suggests that federal authority in fisheries management is established in the property clause (*Art. 4, Sec. 3*), the commerce clause (*Art. 1, Sec. 8*), and the treaty clause (*Art. 2, Sec. 2*) of the US Constitution. Under the property clause, the federal government has authority to control the use of federal lands and associated resources. This authority extends to fugitive resources that stray from federal lands and to actions on state or private lands that impinge on federal resources. Under the commerce clause, any activity that could potentially affect interstate commerce is subject to Congressional oversight. Movements of fish across state boundaries or from federal waters represent activities that lie within the scope of the commerce clause. The power of Congress to enact treaties represents another federal authority that is superior to the authority of states and tribes.

Both states and tribes derive authority from, and are limited by, US Constitutional provisions. The federal constitutional authority of states is primarily embodied in their police powers, powers that give the state authority to control the use of state lands and associated resources. This authority extends to fugitive resources that stray from state lands and actions on private lands that impinge on state resources. Interstate compacts are delegations of state authority over particular resources to better account for transboundary characteristics of those resources. While compacts can be formed from the bottom-up, as in the example of the Atlantic States Marine Fisheries Commission, they can also be established by Congress and imposed on the states. Bader (1998) characterizes the regional Fishery Management Councils established under the MSFCMA as compacts imposed on the states and moderated by the federal government. The constitutional authority of tribes lies in their status as dependent sovereigns with authority to regulate non-member access to resources on tribal lands and in their authority to regulate resource uses off tribal lands that might impact tribal resources.

Bader (1998) notes that individuals also hold constitutional rights that relate to fisheries management. For example, the US Constitution prohibits states from discriminating against citizens of other states. While non-residents may be charged higher fees for access to resources, the fee differential must be founded on real differences in the cost of management or in the relative contribution of taxes and fees to the cost of management. The takings clause is an additional constitutional provision that protects private ownership interests once those interests have been established, for example, through capture.

1.4 Statutes, regulations, and common and constitutional law at the state level

Use of fishery resources within each US state is governed under the provisions of a state constitution, coupled with statutes, regulations and common law precedents. These laws differ widely among the states. For example, Virginia law allows for submerged lands to be leased for oyster culture while Maryland law does not. Providing an overview of the organisation and governance of fisheries in each of the fifty states is beyond the scope of this chapter. However, because several cases in this volume arise in Alaska, Alaskan institutions are discussed in much greater detail below. The Alaskan context illustrates how management regimes at the federal and state level interact in the American policy context.

1.5 Federal statutes and regulations

The general relationship between statute and regulation is that regulations are written by the executive branch to implement statutes passed by the legislative branch. Thus, while regulation can have an important role in the operation of fisheries, legislative statutes set the boundaries within which regulations are written. Key federal statutes that affect US fisheries management include the MSFCMA, the *National Environmental Policy Act* (NEPA), the *Endangered Species Act* (ESA) and the *Marine Mammal Protection Act* (MMPA). In addition to these major legislative acts, there are numerous acts, regulations, and treaties that address management aspects of fisheries for particular species, regions and fleet components.

The MMPA requires an examination of adverse impacts that proposed actions might have on populations of marine mammals and also requires consideration of mitigating regulations. The ESA requires the conservation of listed species. Compliance with this requirement is monitored through Section 7 consultations to determine if proposed actions would adversely affect the listed species or adversely modify critical habitat. NEPA requires an evaluation of possible environmental consequences of proposed actions to inform decision-making processes.

While NEPA, ESA, MMPA and miscellaneous other legislative acts and derivative regulations have important roles in the management of US fisheries, the MSFCMA and associated regulations provide the principal basis for fisheries governance in the US EEZ. The MSFCMA may also find application in state waters, through the deference accorded to federal law when state law interferes with federal purposes, such as interstate commerce or management of federal resources. The MSFCMA asserted authority for management of fishery resources in the US Exclusive Economic Zone (EEZ), delegated that authority to the Secretary of Commerce, and created a system of regional Fishery Management Councils (FMCs) that are responsible for preparing Fishery Management Plans (FMPs) for living marine resources subject to directed fishing.

2. MAGNUSON-STEVENS FISHERIES CONSERVATION AND MANAGEMENT ACT

The MSFCMA creates eight regional FMCs, which have much of the authority to determine how the Act will be implemented for individual fisheries. Officially, the FMCs advise the Secretary of Commerce, who is responsible for promulgating final rules and implementing and enforcing those rules. However, the Secretary is constrained legally (and to an even greater extent, politically) to give great deference to the plans submitted by the FMCs. Generally, the Secretary must implement the recommendations of the FMCs unless those recommended plans fail to meet specific provisions of the MSFCMA. The Secretary has the authority to implement "Secretarial plans" if FMCs fail to act.

The eight regional FMCs established under the MSFCMA are:

i. New England (Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut);
ii. Mid-Atlantic (New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina);
iii. South Atlantic (North Carolina, South Carolina, Georgia, and Florida);
iv. Gulf of Mexico (Florida, Alabama, Mississippi, Louisiana, and Texas);
v. Caribbean (Puerto Rico and US Virgin Islands);
vi. Western Pacific (Hawaii, American Samoa, Guam, Northern Mariana Islands, and US Pacific island possessions);
vii. Pacific (California, Oregon, and Washington) and
viii. North Pacific (Alaska).

FMCs have varying number of voting members. Representation on FMCs may include states from outside the governed region. For example, the North Pacific FMC has voting members from Washington and Oregon. Voting members of the FMC include:

i. Each designated state has an official representative of the state agency responsible for marine resource management;
ii. Each designated state has one or more public members. The governors of designated states nominate candidates, who are then chosen by the Secretary of Commerce. Most of these public members have clear affiliations with commercial or recreational fishing interests, although a few have academic, environmental, or other non-fisheries affiliations;
iii. A representative of the National Marine Fisheries Service (NMFS, a division within the federal National Oceanographic and Atmospheric Administration); and
iv. In the case of the Pacific FMC, a tribal representative.

There are also a number of non-voting members to each FMC, including representatives of: interstate fishery commissions, other FMCs, the US Coast Guard, the US Fish and Wildlife Service and the US State Department. Nationwide, the composition of recent (2004–2007) voting FMP memberships has been: 37 percent state or federal fisheries agency representatives, 30 percent commercial sector, 24 percent recreation sector and 9 percent other (DOC, 2007; MSFCMA, 2007).

Although there is some variation across the FMCs, each of the eight FMCs is advised by one or more advisory panels composed of stakeholders representing commercial and recreation fishing interests and conservation and civic organizations. The FMCs are also advised by scientific and statistical committees (SSC) composed of research scientists drawn from state and federal research labs and universities. Under the current version of the MSFCMA, the SSC's role in determining limits for acceptable biological catches (ABCs) and overfishing levels has been strengthened, such that the FMCs are constrained to set total allowable catch limits (TACs) that are at or below the ABCs established by the SSC. This has been the standard operating procedure in the North Pacific Fishery Management Council and has been identified as an important factor

TABLE 1
National Standards for Fishery Conservation and Management

1 Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.
2. Conservation and management measures shall be based upon the best scientific information available.
3. To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.
4 Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (a) fair and equitable to all such fishermen; (b) reasonably calculated to promote conservation; and (c) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.
5. Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.
6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.
7. Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.
8. Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities by utilizing economic and social data that meet the requirements of paragraph (2), in order to (a) provide for the sustained participation of such communities, and (b) to the extent practicable, minimize adverse economic impacts on such communities.
9. Conservation and management measures shall, to the extent practicable, (a) minimize bycatch and (b) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.
10. Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

Source: MSFCMA (2007) Section 301.

in the successful management of fisheries off Alaska (Pew Oceans Commission, 2003; Witherell, 2005).

Section 301 of the MSFCMA identifies ten national standards for fishery conservation and management (see Table 1). With minor modification, these ten standards have been in force throughout the period in which the US cooperatives described in this book were being developed and implemented. While all ten standards have influenced the structure and operation of US cooperatives, the fourth standard is particularly important. The fourth standard stipulates that conservation and management measures must be non-discriminatory with respect to residents of different states, and that allocation of fishing privileges must be motivated by conservation goals, must be fair and equitable to US fishermen, and must not permit the excessive concentration of ownership.

Section 303A, added to the MSFCMA in the latest reauthorisation in 2006, introduces a suite of conditions that govern the creation and operation of Limited Access Privilege (LAP) programmes. As defined in the MSFCMA, LAP programmes include IFQs and limited entry programmes such as the pollock cooperatives described in this volume (Wilen and Richardson, 2007; Paine, 2007). Of particular import are the stipulations that LAPs created, implemented, or managed under the MSFCMA can be modified or revoked without compensation to rights-holders. In addition, the new MSFCMA specifies that LAPs are issued for a period of not more than 10 years, but will be renewed unless their use has not complied with FMP requirements. LAP programmes are to be reviewed within five years of implementation and at least once every seven years thereafter. In addition and in a departure from previous versions of the MSFCMA, the current version specifically permits the use of auctions as a mechanism for accomplishing initial or subsequent allocations of LAPs. To avoid disruption, existing LAP programmes – specifically including the cooperatives authorized under the American Fisheries Act (AFA) – and programmes on the verge of being implemented are exempted from most of the requirements of section 303A.

The MSFMCA has included a number of provisions that either apply only to the North Pacific FMC (NPFMC) or were intended primarily for use by the NPFMC. This reflects a number of unique characteristics of Alaska. Alaska is geographically separated from the continental US. Fisheries have much greater importance in Alaska than in any other state. Alaskan Congressional members, and notably Senator

Stevens, have been active in US fisheries policy. Important examples of Alaska-specific legislation include pollock cooperatives under the *American Fisheries Act of 1998* and the Bering Sea Aleutian Islands crab provisions of the 2006 MSFCMA reauthorisation bill. Both are discussed below.

3. THE EVOLUTION OF RIGHTS-BASED MANAGEMENT IN ALASKA

3.1 Overview

Alaskan fisheries policy is an interwoven matrix of federal and state policies. This interdependence is more pronounced than in most other states. Again, this is due to the unique relation of Alaska to fisheries and Alaska to the rest of the US.

Milestones in the management of Alaskan fisheries include:

i. 1868, when Alaska was purchased from Russia,
ii. 1959, when Alaska gained statehood,
iii. 1972, when the *License Limitation Act* was passed by the Alaska state legislature, and
iv. 1976, when the MSFCMA was passed.

Prior to the Alaska purchase and throughout most of the 19th century, fisheries off Alaska were primarily subsistence fisheries that supported food and trade needs of Alaska's native population. These early fisheries were primarily focused on salmon (*Oncorhynchus* sp.), herring (*Clupea pallasi*), hooligan (*Thaleichthys pacificus*, also know as Eulachon smelt), and halibut (*Hippoglossus stenolepis*).

The late 1800s saw the development of a salt-cod (*Gadus macrocephalus*) fishery in the Gulf of Alaska and Aleutian Islands, development of salmon canneries in proximity to major salmon-producing rivers, and the development of a commercial fishery for halibut. The halibut fishery was brought under an overall quota management structure under the Halibut Convention of 1923. Throughout the first half of the 20th century, salmon production and management was largely devolved to the canneries. Concern about the economic power of the canneries was an important factor in the petition for statehood. Thus, in the immediate aftermath of statehood, the use of salmon traps was prohibited and canneries were faced with a necessity of purchasing catches from fleets of small fishing boats.

From the mid-1950s to the mid-1970s, distant water fleets from Japan, Russia, Korea and Eastern Europe began to focus ever-increasing effort on stocks of walleye pollock (*Theragra chalcogramma*), yellowfin sole (*Pleuronectes asper*) and other shelf flatfish species, Pacific ocean perch (*Sebastes alutus*), sablefish (*Anoplopoma fimbria*), and herring in the eastern Bering Sea. In contrast with the groundfish fisheries, the crab fisheries that developed in the 1960s were dominated by domestic vessels. High-seas drift-gillnet fisheries for salmon flourished from the mid-1950s through 1978, when they were prohibited by treaty. Foreign vessels were banned from fishing within the three-mile territorial waters in 1964, and in 1966, they were restricted to operating under fishing permits in waters from three to twelve miles offshore. As discussed above, these management claims were extended to 200 miles in 1976 with passage of the MSFCMA.

The Alaska Constitution (Article VIII) contains three important sections that govern fisheries policy:

i. *Section 3.* "Wherever occurring in their natural state, fish, wildlife, and waters are reserved to the people for common use."
ii. *Section 4.* "Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses."
iii. *Section 15.* "No exclusive right or special privilege of fishery shall be created or authorized in the natural waters of the State. This section does not restrict the power of the State to limit entry into any fishery for purposes of

> resource conservation, to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of aquaculture in the State."

Together, these sections have been interpreted in the courts as strong limitations on the degree to which the State can issue exclusive licenses. These limitations have been interpreted to set lower bounds on the minimum number of permits that can be included in limited entry fisheries and to prohibit the issuance of individual fishing quotas in state fisheries. Macinko (1993) and Bader (1998) characterize these sections of the Alaska Constitution as constitutional affirmation of the application of the Public Trust doctrine to state fisheries. These state constitutional provisions have had an important role in shaping the structure of the Chignik co-op (see Knapp, this volume).

3.2 Salmon management

By the late 1960s, Alaska's salmon fisheries were the scenes of intensive competitive fisheries. Similar conditions in British Columbia and the Pacific Northwest led Christy and Scott (1965) and Gulland and Robinson (1973), among others, to suggest the adoption of licence limitation as a means of stabilizing fishery revenues and improving management. Alaska legislators acted on these recommendations and passed the *License Limitation Act* in 1972, establishing the Commercial Fisheries Entry Commission (CFEC) within the Alaska Department of Fish and Game (ADF&G). The CFEC quickly introduced licence limitation programmes in salmon and herring fisheries throughout the state and then extended licence limitation programmes to a variety of shellfish fisheries. Because limited entry licences were found to be use privileges that could be acquired through market transaction and because the number of permits issued in each fishing zone was motivated by conservation and was not "overly" restrictive, the Alaska Licence Limitation programme was not found to violate Article VIII of the Alaska constitution (Bader, 1998). However, in Alaska as elsewhere, licence limitation failed to provide the expected stability. The number of platforms was limited, but their fishing power was not. These shortcomings are documented in, among others, Rettig and Ginter (1978), Adasiak (1979), Fraser (1979), Pearse and Wilen (1979) and Wilen (1979).

Despite the intensive derby character of Alaska's principal salmon fisheries, ex-vessel revenues and the price of limited entry permits soared through the late 1980s. Since then, and despite continuing strong catches, ex-vessel revenues and limited entry permit prices have tumbled to about 20 percent of their peak values (Herrmann, 1994; ADF&G, 2007). In 1980, the world salmon supply was around 0.5 million tonnes, with 98 percent coming from capture fisheries. By 2001, the world supply had more than quadrupled, with 62 percent coming from salmon farms (Knapp, Roheim and Anderson, 2007). That this increase in salmon aquaculture production is the leading cause of that decline in prices has been thoroughly documented in, among others, Herrmann (1993), Herrmann, Mittelhammer and Lin (1993), Asche, Bremnes and Wessels (1999) and Knapp, Roheim and Anderson (2007). While Alaska's salmon fisheries have been well managed from the perspective of biological productivity, they have been grossly mismanaged from the perspective of economic value. Indeed, to those unfamiliar with the spendthrift incentives of the race-for-fish, it begs comprehension to learn that Alaska's salmon capture fisheries fail to generate rents comparable to those generated in salmon aquaculture, where feed and smolt costs alone are over $1.50/kg round weight (Bjørndal, 2002).

The financial turmoil occasioned by declining ex-vessel prices and permit values resulted in numerous bankruptcies and debt restructuring and reduced participation in some fisheries. Responses included efforts to improve fish handling to increase product quality, increased marketing activity, and the extension of federal crop insurance programmes to capture fisheries (Greenberg *et al.*, 2004; Herrmann *et al.*, 2004). These financial challenges also prompted interest in the development of an LAP programme that would be consistent with Article VIII of the Alaska constitution. The Chignik salmon cooperative, described in this volume, was the first test case. Despite financial success in its first year of operation, the Chignik salmon cooperative failed to withstand judicial review as initially organized. The cooperative has been re-organized to address judicial concerns, but doing so may have reduced its functionality.

3.3 Bering Sea and Aleutian Islands Pollock

Americanisation policies and vessel loan subsidies included in the MSFCMA caused the Alaskan groundfish fisheries to change from being almost exclusively foreign prior to 1976, to being almost entirely joint venture by the mid-1980s, and to fully domestic by 1990. By 1991, when the first of a sequence of allocation battles erupted in the NPFMC, it was estimated that there was enough harvesting capacity in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries to harvest more than double the TAC and that there was about one-and-a-half times the needed processing capacity (NPFMC, 1991). In this first groundfish allocation battle, the NPFMC established a directed fishing allocation between inshore (catcher vessels that delivered to shore-based processors) and offshore (catcher-processors, catcher vessels that deliver to catcher-processors, and motherships) and created the community development quota (CDQ) programme. The CDQ programme was initially allocated 7.5 percent of the pollock quota for use in economic development by qualifying western Alaskan communities (NRC, 1998). (The CDQ programme was the "price" for a key swing vote for the inshore sector and was not vigorously opposed by the offshore sector because it was anticipated that the offshore sector would lease the CDQ shares from the CDQ organizations.)

The inshore-offshore allocation was revisited again in 1995, with a reduction in the offshore quota and increases in the inshore and CDQ quotas (NPFMC, 1995). In 1996, the Council belatedly adopted a moratorium on entry to the BSAI groundfish fisheries. Despite these measures, harvesting and processing power continued to expand under the stimulus of the race for fish. Between 1994 and 1998, half of the catcher-processors operating in the BSAI underwent bankruptcy or forced sale of their vessel holdings (APA, 1999).

The inshore-offshore allocation issue resurfaced in 1998 (NPFMC, 1998). While the NPFMC was locked in the inshore-offshore allocation battle, representatives of the catcher-processor fleet led a delegation that included representatives of the high-seas catcher boat fleet, the mothership fleet, and the inshore fleet to seek a Congressional resolution to the interminable allocation issues for the fishery. That catcher-processor fleet had experience with the creation of cooperatives in the Pacific whiting (*Merluccius productus*) fishery off Oregon and Washington and sought an opportunity to apply that approach in pollock. The result was passage of the *American Fisheries Act (AFA) of 1998*. As initially drafted, the AFA was intended to disallow participation in Alaskan fisheries by certain catcher-processors that had been extensively rebuilt outside the US. The political process delivered a final bill that has fundamentally restructured regulation of the pollock fishery. The AFA created a limited entry programme for the BSAI pollock fishery and specified sector allocations for catcher-processors, motherships, catcher-boats that deliver to shore-based processors and catcher-boats that deliver to catcher-processors. The statute also set parameters for the formation of cooperatives within sectors, provided funds to buy out nine of the twenty-nine catcher-processors then operating and increased the quota share allocated to the Community Development Quota (CDQ) programme. Sector allocations before and after implementation of the AFA are reported in Table 2.

The sector allocations allowed members of a sector to decide whether to cooperate under terms specified by the AFA or to compete in a race-for-fish within the limits of the sector allocation. Faced with the choice of cooperative and non-cooperative

TABLE 2
Allocation of pollock TAC before and after implementation of the AFA

	1998	1999
	%	
Bycatch set aside	~5	~4.7
Community Development Quota programme	7.5	10.0
Catcher-boats that deliver to shore-based processors	30.6	42.7
Motherships	8.8	8.5
Catcher-processors	45.2	31.2
Catcher-boats that deliver to catcher-processors	3.0	2.9

Source: NPFMC (2002).

solutions, all four sectors quickly organized under civil contracts that created sub-sector allocations to each firm (Criddle and Macinko, 2000). The nine companies that control the 20 AFA-authorized catcher-processor vessels formed the Pollock Conservation Cooperative. Owners of the seven catcher-boats that had mostly delivered their catches to catcher-processors formed the High Seas Catchers' Cooperative and leased their entire sector allocation to the PCC. The remaining sectors were allowed to form cooperatives as early as January 2000 and did so.

NPFMC (2002) reports that the AFA has resulted in higher utilization rates, increased economic returns, reduced bycatch, improved management precision, and helped industry accommodate changes in fishing seasons and areas required to conserve Steller sea lions. NPFMC (2002) concludes, "The AFA has been largely successful in achieving its goals".

How the AFA cooperatives may have affected the relative economic position of shore-based processors versus their catcher vessels has been an important issue. Matulich, Sever and Inaba (2001) explore the opportunity for catcher-boat cooperatives to expropriate rent from shore-based processors. They conclude that while the AFA is likely to increase overall benefit, it may be disadvantageous to shore-based processors. Felthoven (2002) reports that technical efficiency and capacity utilization increased in the wake of AFA for actively operated catcher-processors. This debate over the relative impact on harvesters and processors probably influenced the Bering Sea crab rationalisation programme (see Section 3.6).

3.4 Halibut and sablefish management

An important part of the political dynamics that led to the AFA is explained by the development and implementation of the halibut and sablefish individual fishing quota (IFQ) programme. The abundance of halibut off the Washington, British Columbia, and Alaska declined rapidly in the late-1950s through the mid-1970s. This decline was largely a consequence of foreign catches outside US and Canadian territorial waters. Once the US and Canada asserted exclusive management authority within their respective EEZs, it was possible to rebuild the halibut stock. However, while stock rebuilding was successful and commercial catches increased, the number of fishing vessels also increased and the season length went from over 100 days to as little as 2 days in the main fishing zones. This heated race for fish reduced quality and suppressed market development, prevented rationalization of capital investments, decreased safety and increased the likelihood that catch limits would be exceeded.

Pautzke and Oliver (1997) provide a detailed history of NPFMC actions in the halibut fishery. In brief, from its inception in 1976, the NPFMC began to consider the design of a LAP programme for the halibut and sablefish fisheries. After several abortive attempts, an IFQ programme was recommended by the NPFMC in 1991, approved by the Secretary of Commerce in 1993, and implemented in 1995. The North Pacific halibut and sablefish IFQ programme has been amended to change provisions on consolidation, leasing and to allow community ownership of quota shares. These changes have had little effect on quota shares or quota share value.

As in pollock, the impact on processors has been an issue for the halibut and sablefish IFQ. In the wake of implementation of IFQs, Matulich, Mittelhammer and Reberte (1996), Matulich and Sever (1999) and Matulich, Sever and Inaba (2001) identified theoretical conditions under which processors could be disadvantaged under an IFQ programme. Matulich and Clark (2003) subsequently estimated that the processing sector had indeed been adversely impacted by the halibut-sablefish IFQ programme. Based on a more detailed model of halibut markets, Herrmann and Criddle (2006) determined that the processing sector garnered about 10 percent of the increased value associated with the transition to IFQs while the vessel owners who received the LAPs garnered about 90 percent of the increased value.

The impact of a growing sportfishing catch of halibut on commercial TACs is an unresolved issue. Commercial fishers have been concerned that unchecked expansion of the sport fishery would reduce commercial quotas and the asset value of the IFQ. These concerns have been realized, particularly in southeast Alaska, where the charter-based sportfishing catch exceeded its Guideline Harvest Limit (GHL) by 47 percent in 2006. Concerns about the likely inefficacy of GHL management led the Council to approve an IFQ programme for the charter sector even before the GHL was implemented (NPFMC, 2001). These IFQs were to have been issued to sportfishing charters and would have been transferable between the sportfishing charter and commercial fisheries under conditions intended to provide some stability to both sectors. However, in December 2005, the NPFMC rescinded its approval of the charter IFQ programme. The delayed preparation of regulations raised Council concern over legal and political fallout if an IFQ allocation were based on the original September 2000 control date (NPFMC, 2005). The NPFMC has initiated another analysis of long-term management strategies (including IFQs) for the charter-based sport sector.

3.5 Bering Sea and Aleution Islands crab rationalisation

Since their inception in the 1960s, the Bering Sea and Aleutian Islands (BSAI) crab fisheries have been largely domestic. Within-season management of the BSAI crab fishery has been largely delegated to the Alaska Department of Fish and Game (ADF&G), which has sought to control catch and stabilise crab populations through minimum size restrictions, prohibitions on the retention of female crab and varying season length. Under size-sex-season management, season length became increasingly compressed during the 1980s. Managers introduced limits on the number of pots (baited traps) per vessel for the principal stocks and also “super-exclusive” areas for several minor crab stocks (Greenberg and Herrmann, 1994; Natcher, Greenberg and. Herrmann, 1996; Herrmann, Greenberg and Criddle, 1998; Criddle, Herrmann and Greenberg, 2001). Vessels fishing for crab in super-exclusive areas were forbidden from fishing for crab in other areas. Season compression is particularly problematic in the crab fisheries, because the fisheries occur in the winter in hazardous fishing conditions that can be compounded by the race-to-fish within short seasons. Because crab must be processed live, as the number of crab fishing vessels increased, processors also increased their capacity.

Section 313(j) of the 2006 MSFCMA reauthorisation authorised implementation of the BSAI crab rationalisation programme. The BSAI crab rationalisation programme (NPFMC, 2004) includes harvest quota shares issued to fishing vessel owners and to skippers and processing quota shares issued to shore-based and floating processors. It also includes provisions to encourage the formation of cooperatives among harvesters.

A change from a race-to-fish regime to an individual quota regime invariably alters the value of harvesting capital, processing capital, human capital, infrastructure and derivative economic activities (NRC, 1999). The possibility of processor consolidation also raised serious concerns about employment losses in rural Alaska communities with few alternative shore-based employment opportunities. Experiences in the pollock and halibut fisheries increased awareness of these potential gains and losses. The BSAI king (*Paralithodes camtschaticus*) and Tanner crab (*Chionoecetes spp.)* LAP responds to these concerns by creating processor quota as well as harvester quota. The programme also includes provisions to encourage the formation of cooperatives among harvesters, specifies an arbitration structure for settling ex-vessel price and allows communities to block the transfer of processing quota shares (MSFCMA section 313(j), NPFMC, 2004). Initial analysis suggests that there has been considerable consolidation of fishing capacity and increased ex-vessel net revenues, but little consolidation of processing capacity and insufficient information to determine whether there has been a significant change in processor net revenues (NPFMC, 2007; Matulich, 2007).

4. DISCUSSION

The Alaskan experience with management of salmon, halibut/sablefish, pollock and BSAI crab illustrates the interdependence of fisheries governance institutions in the US. There are fisheries primarily under state regulation (such as salmon), fisheries with considerable shared jurisdiction (such as crab), and fisheries primarily under federal jurisdiction (such as halibut/sablefish and pollock). But the political interconnections are stronger than the *de jure* interrelationships. Through membership on the NPFMC, Alaskans are able to strongly influence the implementation of regulation under the MSFCMA. Alaskan politicians have been successful in adding to the MSFCMA provisions that apply specifically to Alaskan fisheries. While these interdependencies are perhaps greater in Alaska than in other states, similar forces function across US fisheries governance.

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The evolution of co-management in the British Columbia red sea urchin fishery

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1. INTRODUCTION

Each of the major fisheries conducted by diving in British Columbia (BC) (geoduck/horse clam, red sea urchin, green sea urchin and sea cucumber) provides an example of harvesters taking steps to manage some aspect of their own activities. The BC sea urchin fisheries have been in this pro-active situation since the early 1990s, when the licence holders first formed associations. They instituted self-imposed individual quota programmes in the mid 1990s and subsequently began an ongoing collaboration with Fisheries and Oceans Canada (DFO) and coastal First Nations to assess and to manage sea urchin resources for long-term sustainability. This paper documents the development of the red sea urchin (*Strongylocentrotus franciscanus*) fishery in British Columbia and the evolution of the co-management relationship between the DFO and the Pacific Urchin Harvesters Association (PUHA).

2. THE RED SEA URCHIN FISHERY

Red sea urchins (*S. franciscanus*) are the largest sea urchin in the world and are found only along the rocky sub-tidal Pacific shores of North America. The bright red or burgundy animals graze on kelp and opportunistically on many other available organic materials (Photo 1). They are harvested for their gonad tissues, known as “uni”. Uni

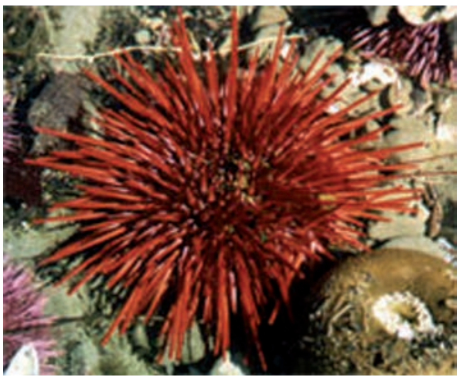


PHOTO 1
*Red sea urchin (*Strongylocentrotus franciscanus*)*

PHOTO 2
Sea urchin uni presented as sushi

PHOTO 3
Sea urchin divers, vessel and harvest

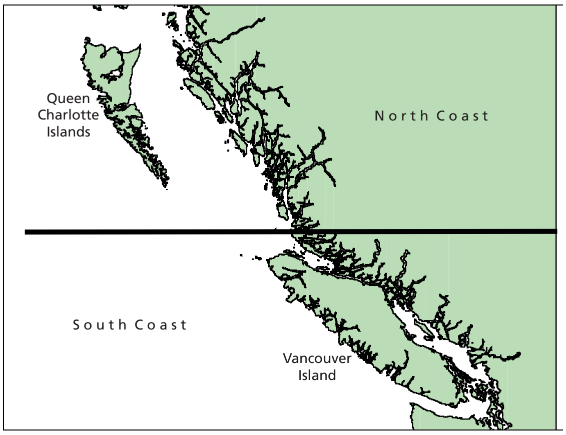
is highly valued as a seafood delicacy. Photo 2 shows a typical presentation of uni as sushi.

Red sea urchins are individually hand picked by divers using SCUBA. The divers pick the urchins off the rocks and put them into a catch bag that is hauled to the surface and stored on the harvest vessel (see Photo 3). Each day, the product is delivered to a packer vessel or directly to a port, where it is loaded on trucks and delivered fresh to plants for processing, packaging and shipping. The yield of roe from a whole animal ranges from 5 to 15 percent of total body weight.

Sea urchins are of some importance to First Nations, who harvest them for food, social and ceremonial use. A small recreational fishery occurs for sea urchins in most coastal areas. Sea urchins have two primary predators, humans and sea otters. Sea otters are a concern as their number and distribution are increasing rapidly. The west coast urchin fishery has suffered severe declines due to sea otter predation. Sea otters are listed as "threatened" and are protected under the *Canadian Species at Risk Act*.

The commercial dive fishery for red urchins began in the 1970s and has grown rapidly since 1982. While stock assessments are undertaken in many areas, the fishery continues to be managed under a precautionary regime that includes limited entry licensing, area licensing, a minimum size limit to allow several spawning years prior to harvest, a precautionary fixed exploitation rate of two to three percent of estimated biomass, area quotas and an individual quota (IQ) programme (see Sections 4 and 5). There are 110 licence eligibilities for this fishery. Individual licence quotas are set at 1/110th of the annual coastwide commercial total allowable catch (TAC) and harvesters are required to select one of two licence areas in which to fish (see Figure 1 for a map of fisheries licence areas in BC). The dividing line between the North and South Coast licence areas is at the northern end of Vancouver Island (Figure 1).

FIGURE 1
Map of red sea urchin licence areas in British Columbia



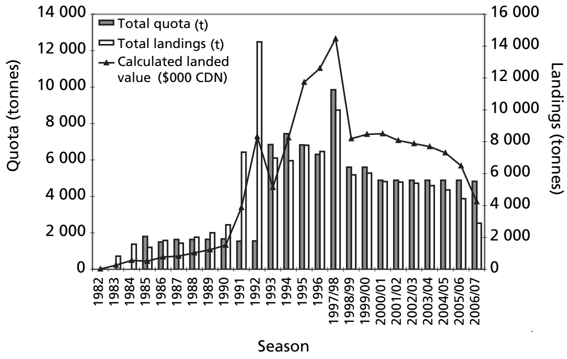
3. REGULATORY HISTORY OF THE FISHERY

Commercial fishing for red sea urchins began in 1971 in the southern portion of British Columbia. (Figure 2 presents landings data for the fishery. Comprehensive landings and licence data are presented in Table 1.) Harvesters were required to have a personal fishermen's registration card and a "C" licence vessel. "C" licences were limited in 1977, but so many licences qualified that there was no limiting impact on the red sea urchin fishery (Muse, 1998). The red sea urchins were included under the "Schedule II" species. The first significant landings for red sea urchins were 75 tonnes in 1978.

In 1983, a personal "ZC" licence was introduced for red sea urchins. A person could hold multiple "ZC" licences, one for each licensed vessel that qualified to fish red

FIGURE 2

Overview of annual red sea urchin applied quota, landings and effort for British Columbia, 1982 to date



Note: As reported on Validation & Harvest Logs. Value information from fish slip program, as reported in Canadian dollars per pound. 1982 to 1992 no limit fishery or TAC for South Coast only; 1993 coastwide TAC; 1994 to 1995 PUHA voluntary IQ programme; 1996 pilot IQ programme; 1997/98 18 month fishery; 2000/01 reduced size limit and TAC; 2003 to date, influence of Russian fishery; 2006/07 data preliminary.

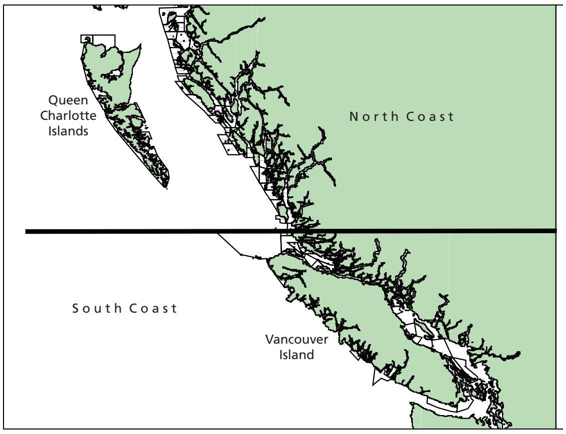
TABLE 1

Overview of annual red sea urchin applied quota, landings and licenses for British Columbia, 1982 to date

Year	Licences issued	Vessels with landings	North Coast quota (t)	South Coast quota (t)	Total quota (t)	Total landings (t)	Calculated landed value (Can$000)[4]	Whole landed value from fish slips (Can$/lb)
1982	C	4				45.4	15.9	0.16
1983	Z64	26				720.2	262.4	0.17
1984	Z85	32				1 377.0	555.8	0.18
1985	Z86	31		1 803.0	1 803.0	1 204.4	506.5	0.19
1986	Z103	49		1 500.0	1 500.0	1 582.0	773.7	0.22
1987	Z184	72		1 632.9	1 632.9	1 435.6	823.6	0.26
1988	Z184	81		1 632.9	1 632.9	1 763.8	1 032.4	0.27
1989	Z240	98		1 644.3	1 644.3	2 004.8	1 230.5	0.28
1990	Z188	86		1 667.0	1 667.0	2 439.7	1 508.7	0.28
1991	Z102	76		1 542.2	1 542.2	6 427.4	3 874.9	0.27
1992	Z108	102		1 553.6	1 553.6	12 479.9	8 326.6	0.30
1993[1]	Z107	95	5 443.2	1 401.2	6 844.3	6 106.4	5 135.8	0.38
1994	Z110	95	5 896.8	1 542.7	7 439.4	5 959.8	8 247.7	0.63
1995	Z108	88	5 443.2	1 383.9	6 827.1	6 806.9	11 732.8	0.78
1996	Z109	77	5 359.7	1 264.6	6 305.1	6 466.4	12 607.4	0.88
1997/98[2]	Z110	82	8 149.8	1 701.6	9 851.4	8 738.2	14 465.2	0.75
1998/99	Z110	64	4 634.0	967.5	5 601.5	5 182.9	8 194.1	0.72
1999/00	Z110	58	4 634.0	967.5	5 601.5	5 282.6	8 464.4	0.73
2000/01	Z110	53	4 042.0	843.9	4 885.9	4 815.3	8 504.0	0.80
2001/02	Z110	48	4 042.0	843.9	4 885.9	4 782.5	8 079.9	0.77
2002/03	Z110	46	4 130.8	755.1	4 885.9	4 722.0	7 883.4	0.76
2003/04	Z110	44	4 130.8	755.1	4 885.9	4 593.5	7 696.3	0.76
2004/05	Z110	44	4 130.8	755.1	4 885.9	4 358.6	7 302.9	0.76
2005/06[3]	Z110	46	4 130.8	755.1	4 885.9	3 873.3	6 489.7	0.76
2006/07[3]	Z110		4 079.5	745.7	4 825.2	2 531.2	4 241.1	0.76

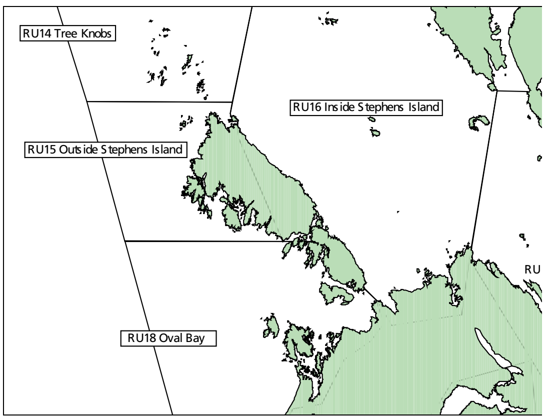
[1] South coast quota includes exploratory areas; North Coast quota new in 1993.
[2] Change in licensing from calendar year to market-driven year. The 1997/98 season ran from 01/01/97 to 06/30/98.
[3] Recent information should be considered preliminary; current fishing season figures provided here in total but not in other tables.
[4] Whole landed value from fish slips from 2002 to date is obtained through a subsample of annual submissions from fishermen.
Note: (as reported on Validation & Harvest Logs) value information from fish slip programme, as reported in Can$/lb. From 2002 to date, fish slip information from fishermen is subsampled to give a representative average annual value; as a result, any fluctuations in price per pound to the fishermen throughout the fishing season are not well reflected.

FIGURE 3
Map of Red Urchin (RU) management areas in British Columbia



Note: Each region of the coast, i.e. Queen Charlotte Islands, North Coast around Prince Rupert, Central Coast around Bella Bella, West Coast of Vancouver Island, and East Coast of Vancouver Island, is divided into small management areas. Each RU area is managed to a TAC. See Figure 2 for more detail.

FIGURE 4
Examples of Red Urchin (RU) management areas on the North Coast of British Columbia



sea urchins. The number of vessels harvesting red sea urchins rose from four in 1978 to a height of 102 in 1992. There were 108 licences issued that year, although the largest number of licences (240) had been issued in 1989 (Table 1).

In 1991, the DFO limited the number of licences in the red sea urchin fishery to those harvesters who had landed 34 tonnes of red sea urchin from 1987 to 1989, recorded 20 days of harvest during this period, or landed 2.3 tonnes of red sea urchin in any year in the North Coast area during the same period. Aboriginal harvesters qualified under less restrictive guidelines. After several appeals, the number of licences qualifying to fish red sea urchins was set at 110. These licences were not transferable. Licences were eventually made fully transferable in 1996 at the time of the institution of the individual quota system.

Over this period, the South Coast was initially managed with a minimum size limit (100 mm test diameter [TD]), seasonal closures and some area TACs. Over time, more area TACs were created to spread effort (this trend continues to this day). Red urchin management areas, or RU areas, have been formally recognized as an important tool for managing the potential for localized overharvesting. RU area boundaries are described in the annual management plan and are attributed a TAC, the sum of which is equal to the Licence Area TAC. Figure 3 shows all red urchin management areas. Figure 4 provides a detailed example of the several red urchin management areas around Stephens Island on the North Coast.

In the North Coast, the regulations were less restrictive, with just a minimum size limit. In 1988, a maximum size limit of 140 mm TD was added to protect larger urchins, which were believed to provide shelter for juveniles. In 1993, the maximum size restriction was removed as it was learned that the larger urchins were not harvested due to market constraints. In 1993, TACs were instituted in the North Coast due to concern over the skyrocketing landings. Initial area quotas were largely arbitrary and precautionary and related to historical harvests.

Since 1995, the quotas for many areas have been based on fishery-independent survey information of sea urchin populations and catch data from mandatory harvest logs. Historically, area quotas in the South Coast were set at 5 percent of the surveyed biomass. This was then extrapolated to include areas where surveys were not conducted. As the fishery area expanded, quotas were based on estimates of standing stock determined through consultation with harvesters.

In 2000, the minimum size limit was reduced to 90 mm TD based on an industry request to match the market requirements. To compensate for this change and to maintain the precautionary approach, a 12 percent reduction in TAC accompanied the reduction in size limit.

A modified surplus production model is used to estimate maximum sustainable yield (MSY) for red sea urchins. Total current biomass of red sea urchins is calculated biannually. These calculations are based on density estimates for red sea urchins (initially in the 100 to 140 mm TD range, more recently 90 to 140 mm TD), new survey results and changes to commercial bed area as estimated from digitized harvest charts provided by harvesters. A natural mortality rate of 0.10 is assumed and a correction factor of 0.20 provides a conservative harvest rate of approximately two percent (Campbell *et al*., 1999b).

4. THE VOLUNTARY INDIVIDUAL QUOTA SYSTEM (1994 AND 1995)

The red sea urchin fishery began a rapid expansion in 1987 as fishing effort and landings increased in the North Coast. These increases continued unabated in spite of the efforts of fishery managers to control the harvest (minimum/maximum size limit, area closures/rotations, licence limitations and seasonal closures) and culminated in 1992 with total landings of 12 480 t. In 1993, fishery managers instituted further controls by setting the North Coast total allowable catch at 5 443 t. In spite of all the fishery managers' efforts, the number of fishing days, number of divers and the catch per unit effort continued to rise over this period until January 1994. All this intense effort resulted in short "derby style" openings, poor prices, market gluts and shortages and harvesters operating with insufficient regard to weather and safety.

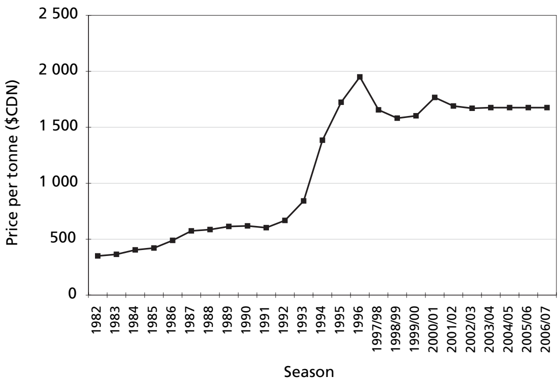
At the beginning of February 1994, the harvesters in the North Coast voluntarily stopped fishing and converged on the Moby Dick Hotel in Prince Rupert in an effort to reach an agreement to solve the predicament. Over the course of a week in February, the divers hammered out the framework for a "voluntary individual quota" (VIQ) system. The idea of a VIQ and also the impetus for the work stoppage and meetings, came from these working harvesters. This initiative was not driven by PUHA. The Association, in conjunction with the Province of BC, had earlier facilitated meetings to discuss the viability of an IQ system and had subsequently requested the adoption of an IQ system to the DFO based on a recommendation at the PUHA Annual General Meeting. PUHA did lead discussions, in conjunction with a representative from D&D Pacific Fisheries Ltd. (D&D is a private firm that supplies monitoring, observing and other fisheries management services to industry and to government.)

The opening meeting was not without controversy and disagreement. Many of the harvesters had experience with IQ systems due to their involvement in the geoduck fishery, which had adopted a DFO-sanctioned IQ programme in 1989. Others had observed the success of the geoduck divers; some had been involved as divers in the geoduck fishery before getting displaced by the rationalization under the geoduck IQ system. These displaced divers may have had some resentment and sought some of the same success for themselves. The dissenting group, a relatively small number, was composed of fishers who had none of the previously described experiences and had not yet secured their own licence in the red sea urchin fishery.

Everyone at the meeting could agree that the industry would not survive under existing conditions and that there was little opportunity to make any profits. It was unreasonable to travel all the way to Prince Rupert to fish for three or four days for low prices and to fish regardless of weather or safety. If a vessel had a breakdown or had a crew problem, the opportunity for that month was lost.

On the second day of meetings, it was agreed to pursue the VIQ system. During all the meetings, there was constant communication with harvesters and licence holders from 'down-south' who were not in attendance to garner their views and support. (All the harvesters lived in the South Coast, mostly on Vancouver Island.) After each day or session, the representatives would gather and summarize the proceedings and in

FIGURE 5
Whole landed value for red sea urchins harvested in BC ($CDN)



some cases come back with proposals based on the consultations as well as the South Coast input.

Once the agreement was made to proceed with the VIQ, the group developed the system to manage the programme. First, it was agreed that the remaining North Coast quota would be split evenly between the authorized "ZC" North Coast licence holders. Second, the quota could be transferred or leased between agreeable quota holders. To monitor the quotas, the group agreed to a system of off-load validation tracked by logbook and managed by D&D. The DFO fishery managers helped by making the validation logbook a condition of licence. Harvesters were required to notify (hail) D&D before commencing fishing. A Can$.01/kg levy, which fishers authorized the fish buyers to deduct and then pay to D&D on their behalf, was adopted. The product was validated at the first point of landing. The system was supported by the buyers and the packer vessels. This made it next to impossible for any vessel not to participate. They would have to arrange their own transportation off the fishing grounds and find a new buyer who was not supportive of the programme.

The immediate effects were increased prices, as harvesters started to focus more on quality than quantity and the fishery slowed considerably. (Price information is shown in Figure 5.) From the fishery managers' points of view, the adoption of the programme "resulted in improved monitoring of catch and effort and a more orderly fishery" (Heizer *et al.*, 1997). The programme was expanded to the South Coast in the fall of 1994, which supported the belief that there were benefits for both parties due to the VIQ.

What happened over those few days in Prince Rupert was quite remarkable. The programme got the support of a fleet of harvesters (and processors), a system to track and to record the product was developed and finally the system and to collect the funds to manage it all was instituted within a week: this was astonishing.

5. THE DFO SANCTIONED INDIVIDUAL QUOTA SYSTEM (1996 TO DATE)

In late 1995, the DFO agreed to adopt an individual quota (IQ) system for 1996 on a two-year 'pilot' programme basis. The system included aspects of the VIQ system with some modifications and additions. The DFO was reluctant to sanction a IQ system prior to 1996 due to tangential political reasons involving native land claims issues, potential windfall profits for licence holders and the debate over IQ's creating property rights. Under the DFO-sanctioned IQ programme, there was first an allocation of 2 percent of the TAC for First Nations food, social and ceremonial use. The remaining coast-wide TAC was equally divided among the recognized licence holders. This equal division differed from the VIQ in that the South Coast licence holders now received the same quota share as the North Coast licence holders.

The off-load validation component of the VIQ was retained, as well as the on-grounds monitor (OGM) for the North Coast. Harvesters were required to hail in to the D&D 24 hours prior to commencing fishing and subsequently to notify the D&D at least two hours prior to off-loading. Once fishing was terminated, harvesters had to notify the D&D when they were leaving the grounds. Any revenue generated from a licence quota overage exceeding 150 pounds was relinquished to the Crown. However, if the overage was less than 150 pounds, it could be transferred to another licence that was still actively fishing.

6. CONSULTATIVE PROCESS

A consultative process was initiated for the red sea urchin fishery in 1989 and is a major part of the planning for the commercial fishery. The primary consultative body for red sea urchins in BC is the Red Sea Urchin Sectoral Committee. This committee includes representatives from Fisheries and Oceans Canada, commercial licence holders, processors, First Nations, BC Ministry of Fisheries and the Sport Fishing Advisory Board (SFAB). Members of PUHA represent commercial fishers on this committee. The SFAB is representative of all parts of the recreational fishing community (such as the BC Wildlife Federation and the Sport Fishing Institute of BC). The Terms of Reference and current membership of the Sectoral Committee are available in DFO (2007).

The Sectoral Committee's primary mandate is to provide the Department with advice in respect to issues important to the management of the commercial red sea urchin fishery, such as developing harvest plans, scheduling research activities and investigating new management strategies. The Sectoral Committee is not a voting body but allows for the Department to receive a broad range of advice from First Nations, stakeholders and other concerned parties. The Department remains the decision-making authority regarding management of the fishery. The Sectoral Committee meets annually to review and provide advice regarding the proposed management plan.

Since the move towards more precautionary management in this fishery, commercial fishers and First Nations have collaborated with the Department to undertake research to better understand the resource. The Research Subcommittee of the Sectoral Committee meets annually to review, to discuss and to advise on stock assessments, recent surveys and future studies proposed for red sea urchins. The Sectoral and Research meetings are generally held together in the spring.

Integrated Fisheries Management Plans (IFMPs) were introduced to the Pacific Region in 1999 to provide a more uniform, integrated, stable and long-term framework for fisheries management. The IFMP planning process paves the way for Objective-Based Fisheries Management, wherein concepts such as "conservation", the "precautionary approach" and "ecosystem management" are translated into explicit and measurable goals.

Fishery managers and PUHA review the range of options available from the assessment and develop TACs for each red sea urchin management area that sum to the commercial licence area TACs. The schematic in Figure 6 gives an overview of the consultation and decision-making process. Resource Managers work closely with their colleagues in the Science Branch and red sea urchin stakeholder groups to: (a) assess the resource in BC, (b) review the annual fishing season and (c), prepare for upcoming harvests. The schematic gives a simplified view of the annual management planning process. For example, after conducting the post-season review and noting the new stock assessment survey information that is available, the lead Resource Manager will request that a research document outlining the change in area quotas be drafted for use in upcoming fishing seasons. Once this document is peer-reviewed, approved by DFO senior management and made publicly available, Resource Managers use the advice contained in it to draft and consult on the new management plan.

Five representative areas have been designated as experimental research areas and are closed to commercial fishing. Studies undertaken in these areas are a co-operative effort between Fisheries and Oceans Canada, PUHA and local First Nations. These studies include investigations into ecosystem interactions, optimal sea urchin population densities and the effects of various harvest strategies on kelp, abalone and sea urchins. These areas are listed in Table 2, along with the First Nations research partners.

Other areas have been closed following consultation with Aboriginal or sport fishing groups. Small area closures are one of the management tools used to provide harvesting opportunity to groups other than commercial harvesters. Following input from the Sectoral Committee, the draft management plan is distributed to

FIGURE 6

Overview of consultation and decision-making process in the BC red sea urchin fishery

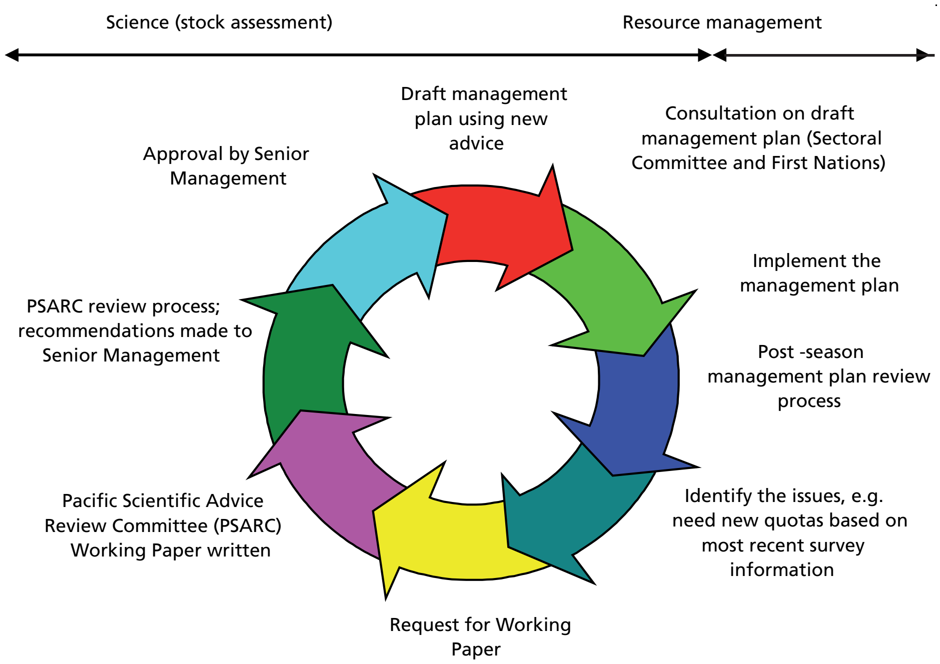


TABLE 2

Red sea urchin special management areas, or experimental research areas in British Columbia

Area	Location	Partners
2	Cumshewa Inlet and Louise Island	PUHA, DFO, Haida Fisheries Program
7	West Price Island	PUHA, DFO, Kitasoo Fisheries Program
23	South east coast of Vargas Island	PUHA, DFO
24	Alert Bay	PUHA, DFO
24	Clayoquot Sound	PUHA, DFO

Note: Research areas are established in collaboration with PUHA and local First Nations. Area refers to Pacific Fishery Management Area, defined by regulation as specific portions of the BC coastline.

First Nations and other stakeholders (*i.e.*, commercial industry representatives) for review and comment at least 30 days prior to the Department's internal finalization process. Stakeholder input to the draft management plan is finalized prior to 1 May. The final management plan (see DFO 2006), which incorporates advice received from stakeholders, is approved in the Pacific Region and published four weeks prior to the fishery opening.

7. PACIFIC URCHIN HARVESTERS ASSOCIATION

The Pacific Urchin Harvesters Association (PUHA) was incorporated under *The Societies Act of British Columbia* in 1992 to represent the 110 red sea urchin licence holders. The goals and objectives of the association are:

i. ensuring sustainability
ii. maximizing economic value and
iii. community awareness and knowledge.

The association generally represents the interest of the harvesters in consultation with DFO.

The fund-raising mechanism used by the association to raise funds is membership fees for the purchase of the harvest validation logbook. The validation logbook is required by DFO as a condition of licence. Until 2003, all licences were activated under this programme. Recently, some licensees have not participated due to market constraints. Also, some licences that were purchased from the commercial fishery for the Aboriginal Fisheries Strategy were not allocated to a First Nations Band during the season and were therefore not fished. The annual budget and work plan are approved at the Annual General Meeting along with the new season management plan.

Since its incorporation, the PUHA has taken on increasing responsibility for the management of the fishery. These functions include the following.

i. Hiring an independent company to monitor all landings, to provide and manage an on grounds monitor for the North Coast and to report to the DFO as information is required to manage the fishery.
ii. Paying the salary of a DFO stock assessment scientist.
iii. Undertaking biomass surveys and experimental management research in collaboration with the DFO and First Nations Fisheries Programmes.
iv. Consulting with other fisheries organization on over-arching industry issues.
v. Developing and instituting a programme of international generic sea urchin marketing of "sea urchin from Canada".
vi. Consulting with Fish Safe BC and distributing safety and educational information to members.
vii. Providing recommendations on fishing area boundaries, area closures and area quotas for preparation of the annual fish management plan.
viii. Providing in-season recommendations on area openings and closures based on weather, roe quality and market.
ix. Funding and developing the technology to spawn and rear sea urchins for enhancement.
x. Consulting with sea urchin processors on market, transportation and logistics, international trade issues and in-season fishing activities.

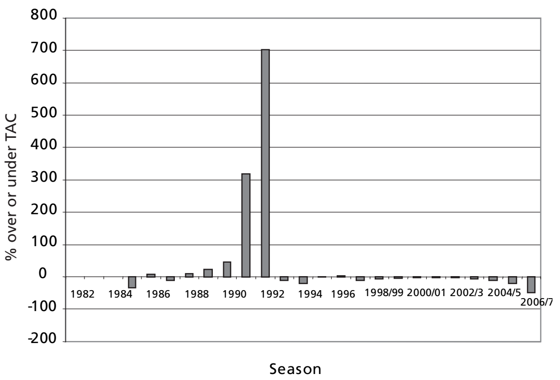
Since 2003, the DFO requirements for the management of the fishery have been outlined in a "Joint Project Agreement" (JPA) that describes the responsibilities of both the DFO and PUHA in co-managing the red sea urchin fishery. The JPA provides details of the activities to be undertaken for the year and the cost commitments of both parties. This agreement provides for catch validation at designated landing ports, in-season collection and compilation of harvest log data, collection of biological samples, an on-grounds monitor (OGM) to attend the remote North Coast fishery for a majority of the fishing season and a year-end summary report of the fishery. These activities are financed by a PUHA membership fee of Can$5 500 per year. In addition, licence holders must pay an annual licence fee of Can$530.

8. EVALUATION OF INDIVIDUAL QUOTA SYSTEM AND CO-MANAGEMENT

The adoption of the voluntary individual quota system, independent of government prompting or support, is quite astounding. To get a group representing 110 licences to discuss, develop and institute a self-governance programme is a difficult (and some would say an almost impossible) task. What set the stage in this case was the absolute desperation of the harvesters and the recognition that something had to change. The harvesters recognized the potential for higher prices and safer fishing conditions. They had experienced the success, either directly or indirectly, of a similar system in the geoduck fishery and there had been preliminary deliberations and forums to explore options to better manage the sea urchin fishery. The time was right and the grassroots harvesters seized the moment. Government could not have acted so quickly. Simply by its nature, government is not nimble enough to quickly react to change. In addition, the cost to government would have been considerably higher to implement the same programme.

The immediate benefits of the VIQ for the harvesters were increased prices, a stable fishery and safer operating conditions. The DFO benefited from the slower, more

FIGURE 7
Red sea urchin landings in BC – TAC overages and underages



orderly fishery with provision of better data and figures supplied in a timely fashion, which resulted in significantly improved management. In the years prior to the VIQ, coastwide TACs were often exceeded (see Figure 7). More regularly, area TACs were exceeded, but in the years following the implementation of the VIQ, the service provider was able to mitigate some of these overages in-season by recommending that other areas be closed before the TAC had been reached. Under this system, the coastwide TACs have not been exceeded since 1993.

On the research side, PUHA established a research fund in 1995 and now co-ordinates vessel and diver participation in surveys with First Nations communities. The DFO, PUHA and First Nations joint stock assessment activities continue coast-wide through biomass transect surveys, experimental harvest sites and selected study sites. DFO develops the survey protocol and conducts the data analysis. The main survey goals are to estimate density, size frequencies, growth and recruitment potential of red sea urchins and to prove and/or adjust quotas accordingly. See Table 3 for a list of such assessment projects.

TABLE 3
Red sea urchin stock assessment projects to date (broadbrush surveys)

Area	Survey	Year
1	Langara Island	1994
2	Rennell Sound	1995
3, 4	Dundas Island Group	2003
4	Stephens Island	1995
5	Banks Island	1997
5	Beaver Pass	2002
6	Price Island	1995
6	Laredo Channel	2000
6, 106	Campania Island	1994, 2004
7	Heiltsuk (Bella Bella) area	1994, 1995, 1996, 1997
7	Price Island	2001
8	Fitz Hugh Sound	2001
11/111	Cape Sutil	1996
12	Queen Charlotte Strait	1994, 1995, 2004
12, 13	Kelsey Bay	1999
12	Deserters Group	2000
12	Robson Bight	2001
13, 14	Campbell River	2002
14	Comox, Denman Island	1999
18	Gulf Islands, Cowichan	1998, 1999
23,123	Barkley Sound	2003
24/124	Tofino	2000
27	Cape Sutil	1996

Note: Area refers to Pacific Fishery Management Area, defined by regulation as specific portions of the BC coastline.

With the improvement in landed prices and a more stable fishery, the value of the licences increased substantially. Prior to 1996, licences traded in the Can$15 000–25 000 range. This increased with the adoption of the Individual Quota system to over Can$200 000. Currently licence values have settled back to the Can$100 000 range due to a decline in the Japanese market. Before the IQ system, licences were not transferable, although they did trade under various trust agreements or even a handshake. Having the licences transferable added a level of security not present before the IQ system, which added value and opened opportunities to new entrants who would not have undertaken the risk before transferability. There is still a level of uncertainty surrounding a sea urchin licence, as the licence is issued at the absolute discretion of the Minister of Fisheries and Oceans and therefore cannot be considered property nor can it be secured by a financial institution. This lack of certainty means the value does not reflect the value of the return or the investment as it would in other businesses.

The cost of the VIQ system was a Can$.01/kg levy, based on validated weight at the landing port. The system was simple and effective and met all the requirements of harvesters and the DFO. Table 4 outlines the development of the Dockside Monitoring Programme requirements under the VIQ and IQ system. In 1996, with the

TABLE 4
Dockside Monitoring Program costs, requirements and progression

Voluntary IQ 1994:	
	No DFO requirements for data reporting
	Validation logbook (catch data only)
	Computerized database (catch data only)
	Landing tax
Voluntary IQ 1995:	
	No DFO requirements for data reporting
	Validation logbook (catch data only)
	Computerized database (catch data only)
	NEW on-ground monitoring (OGM)
	NEW harvest charts provided to fishermen
	NEW landing data voluntarily reported to DFO
	NEW collection of association and monitoring fees prior to fishing
Pilot IQ program 1996:	
	Official dockside monitoring program (DMP)
	Extensive computerized database (catch and harvest data)
	DFO catch and harvest data reporting (daily, weekly, annually)
	Non-compliance reporting
	On-ground monitoring
Additional requirements:	
	1999/2000 in-season harvest chart bed coding (GIS spatial capturing)
	2003/2004 in-season service provider (DMP) certification (Canadian General Standards Board)
	2004/05 abalone presence indicator added to harvest log
	2006/07 Fishers Identification Number (FIN) added to harvest log

implementation of the DFO-sanctioned IQ, the costs doubled to Can$.02/kg. Costs rose again in 2000 to Can$.0225/kg and to Can$.025/kg in 2003. In summary, costs have more than doubled since the adoption of the IQ system and the Government continues to push more cost requirements to the industry. Recent court decisions have ruled that the use of the resource to fund the Government's science and management activities is illegal and this caused turmoil in the DFO as it struggles to develop new policies to address the funding issues. PUHA has requested a full appropriation from Parliament for all fisheries science and management activities across Canada.

Industry cost recovery undoubtedly benefits both parties under the IQ system. More flexibility for the fishers provides greater financial returns and it is acceptable for industry to support and share the expenditures to facilitate these programmes. The ever-increasing requirements and costs pushed onto industry are of concern, however. There needs to be a balance between the costs and benefits and there should be some limit related to the value of the fishery.

9. DISCUSSION

The red sea urchin fishery demonstrates a successful example of co-management that originated through a voluntary programme by industry that evolved into a government-sanctioned individual quota system. The success was influenced by the following factors.

i. A small fishery, with a fixed set of licence holders, who shared a common concern for the economic and safety values of the industry.
ii. An organized fishers' association that represented the broad interests of the group and that was able to facilitate the development, implementation and management of the system.
iii. A small base of local government management support for the programme.
iv. A new and simple fishery with no outside competing influences for the resource.

v. A fishery with the typical problems of a derby style 'race for fish' – TAC overages, loss of economic value and loss of vessels and lives.

As with any business enterprise, there are always new challenges and opportunities. Generally, the current challenges can be divided into three categories.

i. *The market*: Since 2004, the sea urchin market has suffered negative effects from a Russian illegal, unregulated and unreported (IUU) sea urchin fishery in the Kurile Islands where Japan and Russia have a jurisdictional dispute. IUU fisheries are a Can$5 billion problem worldwide and the global community needs to implement measures to control these fisheries. They are destructive both to the resource upon which they prey and to the legitimate fisheries with which they interfere. The "Ocean to the Plate" strategy, where fisheries management focuses on the market and the potential economic returns once conservation concerns are addressed, is important to the continued economic viability of the fishery.

ii. *Government Policy and Regulation*: Security of access is a current concern of the red sea urchin fisheries and many other fisheries across Canada. Security of access is necessary to encourage sustainable fishing practices and to develop the proper business climate for economic and social success. Long term jobs and healthy coastal communities come from strong businesses and business investment. Industry requires a framework that allows it to compete in the global market for food products by providing long term operational sustainability.

iii. *Scientific knowledge:* This underpins all fisheries management and needs to continue to develop collaboratively with government, industry and coastal communities. A continuing healthy resource is the foundation for a healthy fishery. How to fund these important undertakings given the negative impacts of the Russian IUU fishery on licence holders is a current challenge. Certainly, PUHA feels that the DFO should consider allocating some resources to help the industry navigate this troubled water. Predation by sea otters continues to be a challenge and is probably the greatest threat to the sustainability of the fishery.

The red sea urchin fishery has been a leader in co-management and sustainable fisheries practices. Industry and government need to continue to work together cooperatively and collaboratively, with mutual respect and understanding, to address the ever-changing challenges of both partners.

10. ACKNOWLEDGEMENTS

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Co-operative management of the geoduck and horse-clam fishery in British Columbia

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1. INTRODUCTION

The geoduck and horse-clam fishery in British Columbia (B.C.) has been co-managed by the Underwater Harvesters Association (UHA) and Fisheries and Oceans Canada (DFO) since the introduction of individual vessel quotas in 1989. In 2005, the geoduck fishery had a landed value of CanS32.7 million, just under the landed value of wild salmon in B.C. of CanS32.9 millions (Ministry of Agriculture, Food and Fisheries, 2005). This paper will trace the development of the fishery and the evolution of the UHA as a self-governance institution.

2. THE GEODUCK AND HORSE-CLAM FISHERY

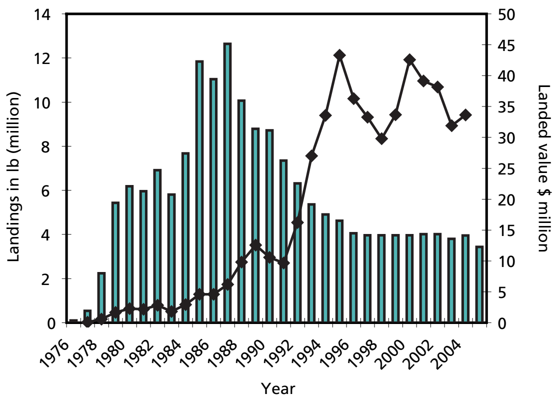
Geoducks (*Panopea abrupta*) are giant deepwater clams that range from Alaska to Baja, California. Graphically dubbed the "elephant trunk clam" by the Chinese due to its large, meaty siphon, geoduck is prized for its incredibly sweet flavour and crunchy texture. They are exported live and are extremely popular in Hong Kong, China and Japan, where these giant clams are considered a rare taste treat. The market in Asia is largely a high-end restaurant market.

Geoducks live buried up to 1 metre deep in sand and mud substrates from the lower intertidal to depths of at least 110 metres. Once dug in, geoducks remain in the same place. If they are removed, they are unable to rebury themselves and will die. They are long lived; the oldest clam aged through research funded by the UHA is 168 years old. Average ages of geoducks vary considerably from area to area, with the lowest mean age of 26.6 years in Georgia Strait and the oldest mean age of 60.4 years on the west coast of the Queen Charlotte Islands (Bureau *et al.*, 2002). Clams can reach a gross weight of 10 pounds, but generally average about 2 pounds.

Geoducks are harvested one at a time by hand by divers using surface supplied air. Divers use high-pressure water delivered through a hose and nozzle system (a "stinger") to loosen the sand around the clam, which allows the diver to remove the animal alive. The diver then places each clam into a bag attached to his waist. Once the bag is full, it is lifted to the surface where the crew bands (with rubber bands) the shell, to stop it from gaping and killing the clam, and places the clams in UHA-provided containers. The clams are kept moist and covered and are delivered, usually the same day, to processing plants in Vancouver. Once in Vancouver, the clams are sorted and packed for airfreight the next day to customers in Asia. When they reach their destination, the geoducks are placed live into saltwater tanks for distribution and sale.

Horse-clams, *Tresus capax* and *T. nuttallii*, are gaper clams that are often found in conjunction with geoducks. In 1992, Fisheries and Oceans Canada (DFO)

FIGURE 1
Historic geoduck landings and value



determined that there was insufficient data about horse-clam stocks on which to base a total allowable catch (TAC), and therefore the fishery was given a zero quota and catch only allowed as a bycatch when fishing for geoducks. Since that time, the bycatch of horse-clams has generally been less than 1 percent of the total catch of geoducks. Other than a bycatch of horse-clams, there are no fisheries interactions associated with the geoduck fishery. The only use of the deep water geoduck resource in B.C. is for commercial purposes. There are no recorded landings of geoducks in either First Nations or recreational fisheries in British Columbia.

Just about everything in the ocean is a predator for geoducks in their early life stages. However, once a geoduck has buried itself more than a quarter metre into the substrate, the primary predators are man and sea otters (although crab, starfish, sea worms, and flatfish do eat adult geoducks). Sea otters, which are listed in Canada as a threatened species, are a concern as their number and distribution is increasing rapidly.

The annual TAC for geoducks is set at a maximum of 1.2–1.8 percent of the estimated current biomass. The biomass is calculated by applying the estimated densities (in kg/m^2) times the estimated bed area. The TAC is calculated annually to adjust for advances in understanding of bed size and geoduck densities. The total catch and value of the geoduck fishery is shown in Figure 1 and the data underlying the chart are presented in Table 1.

3. REGULATORY HISTORY OF THE FISHERY

The geoduck fishery in British Columbia began in 1976 when the Department of Fisheries and Oceans Canada issued seven permits to experimentally harvest geoducks in the Strait of Georgia. Licensing was introduced in 1977, and from 1977 to 1979 the number of licences increased from 30 to 101. In mid-1979, due to concerns about increasing effort and harvest levels, DFO imposed a moratorium on new licences and instituted the requirement for a logbook that recorded fishery activities and catches. In 1981, DFO limited the number of licences in the geoduck and horse-clam fishery to those who were authorized to fish for geoduck and horse-clams by commercial of diving and who had marketed a minimum of 13 500 kg of both species in any combination during 1978 or from 1 January 1979 to 31 December 1980. A limited entry programme was formalized in 1983. The effect of the moratorium and the licence limitation programme was to reduce the number of licences to 52 initially, and to 55 after successful appeals. Licence fees paid to the government for the geoduck licence were $10 annually from 1983 through to 1995.

In 1979, total allowable catches within two management areas (north and south) were introduced into the fishery. Each area was opened to all licence holders as a competitive fishery at the beginning of the year and closed when the TAC was taken. Over the next few years, the coast was divided into more areas to spread effort, but the openings were still derby-style fisheries. The result was a typical race for the fish, regardless of weather or safety. Reporting mechanisms were poor, catch would be focused in areas that were easy to reach and TACs were regularly exceeded. Supply gluts associated with each new opening were common and most of the product had to be processed and frozen.

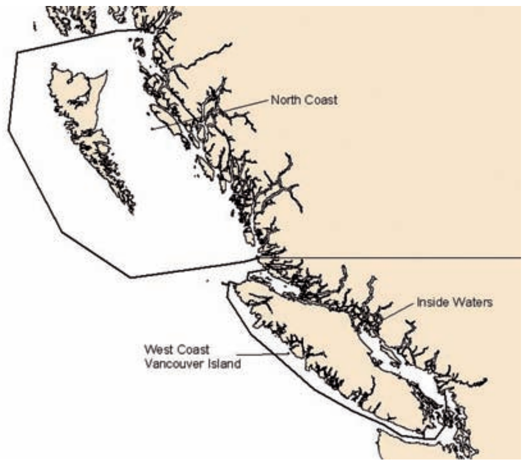
TABLE 1
Geoduck quota, harvests, licences and value

Year	Licences issued	Coastwide quota (lb)	(t)	Total landings (lb)	(t)	Total value Can$ million
1976	7	no quota		97 002	44	N/A
1977	30	no quota		540 898	245	0.09
1978	54	no quota		2 239 950	1 016	0.56
1979	101	8 000 000	3 629	5 429 886	2 463	1.68
1980	95	8 000 000	3 629	6 186 067	2 806	2.29
1981	52	6 176 000	2 801	5 961 405	2 704	2.15
1982	52	6 500 000	2 948	6 910 800	3 134	2.76
1983	54	6 500 000	2 948	5 810 913	2 635	1.80
1984	54	6 600 000	2 994	7 678 465	3 484	2.92
1985	55	6 550 000	2 971	11 838 624	5 370	4.74
1986	55	8 775 000	3 980	11 035 396	5 005	4.30
1987	55	9 345 000	4 239	12 643 298	5 735	6.20
1988	55	8 575 000	3 890	10 068 830	4 567	9.77
1989	55	8 800 000	3 992	8 784 247	3 985	12.56
1990	55	8 800 000	3 992	8 722 366	3 956	10.55
1991	55	7 425 000	3 368	7 346 864	3 333	9.48
1992	55	6 311 250	2 863	6 313 748	2 864	16.16
1993	55	5 362 500	2 432	5 365 420	2 434	26.77
1994	55	4 950 000	2 245	4 908 523	2 227	33.72
1995	55	4 621 650	2 096	4 624 330	2 098	43.28
1996	55	4 058 175	1 841	4 059 917	1 842	36.26
1997	55	3 960 000	1 796	3 960 083	1 796	33.30
1998	55	3 960 000	1 796	3 960 755	1 797	29.78
1999	55	3 960 000	1 796	3 960 676	1 797	32.79
2000	55	3 960 000	1 796	3 960 979	1 797	40.63
2001	55	4 015 000	1 821	4 015 334	1 821	43.49
2002	55	4 015 000	1 821	4 019 398	1 823	38.51
2003	55	3 795 000	1 721	3 802 142	1 725	32.81
2004	55	3 960 000	1 796	3 961 978	1 797	35.66
2005	55	3 437 500	1 559	3 438 214	1 560	32.66

At the urging of the Underwater Harvesters Association, the DFO adopted an individual vessel quota (IVQ) system in 1989. The fishery has operated under IVQs ever since. Although licences can be transferred, the quota may not be split for sale or lease. Up to three licences may be fished from a single vessel. Unharvested quotas may not be carried over into the next fishing year. Small quota overages (200 lbs or less) may be transferred to another vessel that has not harvested its entire quota. Larger quota overages (201 lbs or more) are sold and the proceeds relinquished voluntarily to the UHA.

Area licensing was instituted concurrently with IVQs. The coast is divided into three areas, the north coast (all areas north of Vancouver Island), the west coast of Vancouver Island, and the waters between Vancouver Island and the mainland of B.C. (see Figure 2). Licences are distributed to the three areas such that the TAC from each area is equal to the vessel quota multiplied by the number of licences in the area. The UHA assigns specific licences to areas based on

FIGURE 2
Map of British Columbia fishing areas



historic participation in the area. When a licence needs to be moved, a lottery "draw from a hat" for licence holders who want to move is held.

In 2006, there were 41 "beneficial owners" of the 55 geoduck and horse-clam licences. These 55 licences are fished off 39 vessels that have an average length of 37 ft (11.3 m). Each vessel must have three crew: one tenderman who looks after the divers and two divers. The crewing requirements are specified in worker safety regulations of the mandatory worker's compensation system in B.C. Of the 39 vessels in the fishery, 14 are licensed for other fisheries, 12 of which are also dive fisheries (for red urchins, sea cucumbers and green urchins). Annual licence fees were increased in 1995 to $3 615 and to $3 530.80 in 1997 and 1998. Since 1999, the annual fee for a licence has been based on a formula that is CanS252 per tonne of product authorized for harvest under the licence, minus CanS1 000. In 2006, the annual licence fee was CanS6 144.20.

Under the IVQ/co-management system, the Minister of Fisheries and Oceans maintains complete authority over the fishery and the issuance of licences. The reality, however, is that the DFO relies heavily on the industry to successfully understand and manage the fishery.

4. THE FORMATION AND OPERATION OF THE UNDERWATER HARVESTERS ASSOCIATION

The Underwater Harvesters Association was formed in 1981 to represent the interests of divers in consultations with the DFO. The concept at the time was to represent the interests of all dive fishers, regardless of which fishery they were involved with. It was a non-profit association of fishers with dues of $50 a year to cover the costs of meetings. Meetings were held to formulate common positions on fisheries management issues so that the leadership could go to DFO with a united front.

One issue taken up by the association was to recommend that the geoduck fishery be managed through an individual vessel quota (IVQ) system. IVQs were seen by a few visionary licence holders to solve the problems associated with "derby" fisheries, including erratic product supply, TAC overruns, safety concerns created by an underwater race for fish, and the economic consequences of missing a "starting-gun" fishery opening. Under the derby style fishery, the profitable live market in China, which demands a steady year-round supply of live animals, could not be successfully serviced.

After much discussion, all 55 licence holders were polled by the DFO on the move to IVQs and on a quota allocation agreement. The vote showed 80 percent of licence holders supported equal quotas, with each licence holder allocated 1/55th of the annual TAC. Those few licence holders who did not support the IVQ system rejected it because they disagreed with equal quota allocations. Since the IVQ system had a strong level of support and the fishery was new and small, the DFO agreed in 1988 to implement IVQs for 1989, but with conditions. The primary condition was that the industry pay for the incremental costs associated with monitoring catches to ensure quotas were not exceeded. This required the licence holders to raise the funds to pay for the monitoring programme.

The fund raising mechanism, which is still in existence today, is a membership fee for purchase of the required logbook from a provincially-registered non-profit society called the UHA Research Society. A renewed UHA Research Society (or UHA) was registered in November 1988 for the specific purpose of representing geoduck licence holders in an agreement with the government to contract for third-party monitoring services. The full members of the UHA are geoduck and horse-clam licence holders. Associate members are other individuals or companies with a direct interest in the geoduck and horse-clam fishery, who are generally fishers and geoduck exporters who are not licence holders.

The only inducement to pay fees to the UHA stems from licence conditions that require all landings to be independently monitored and to be reported in logbooks in a prescribed format. These services and logbooks are only readily available through the independent port monitoring company hired by the UHA. The fee is collected when the licence holder "buys" their logbook for the season, which is only available from the UHA.

In the first year of the IVQ programme, several licence holders refused to join the UHA and to pay their share of monitoring costs. The members who did participate had to pay an extra assessment to compensate. In the second year, the success of the IVQ programme and peer pressure resulted in full participation of all licence holders in the UHA. Although membership in the UHA is not legally mandatory, all licence holders have joined every year since the second year of the programme.

Over time, the UHA has taken on more responsibility for managing the fishery. What started as a non-profit association to collect fees and hire independent monitors has evolved into a sophisticated operation with an annual budget in excess of CanS2 million that performs a number of functions, including:

i. Hiring an independent company to monitor all landings and to provide a full time on-grounds monitor for the two zones on the North Coast and on the West Coast of Vancouver Island;
ii. Paying the salaries of four DFO employees involved in geoduck and horse-clam fishery management and science;
iii. Funding DFO enforcement for geoduck and horse-clam specific activities;
iv. Undertaking an extensive programme of surveys and biosampling (over 35 percent of the geoduck bed area in B.C. has been surveyed by the UHA and over 14 000 biosamples taken and aged);
v. Implementing a full paralytic shellfish poisoning (PSP) sampling programme in the North Coast and a partial programme in the South Coast, where there is no government testing to ensure that PSP-free harvests;
vi. Providing safety information and on-grounds safety equipment, particularly for incidents of decompression sickness (bends);
vii. Enhancing geoduck stocks through an extensive programme of seeding and supporting research and development of geoduck culture techniques;
viii. Undertaking an active programme of generic marketing for "Geoduck from Canada" and promoting the product to the public at large as healthy, safe, environmentally sustainable, and well-managed; and
ix. Representing the interests of the industry with other industry organizations and government agencies.

About 30 percent of the total UHA budget is spent on the independent third party fishery monitoring programme, 22 percent on research and management, and 20 percent on enhancement. The remainder is used for various projects such as marketing, PSP sampling and administration.

Until 2003, all activities that required the UHA to provide funding to the DFO and all activities that DFO required of UHA for the management of the fishery were specified in a series of one to five year "collaborative agreements" or contracts. At any given time, the UHA would have had six or seven active contracts with the DFO. In 2003, the UHA signed a five-year "Joint Project Agreement" with the DFO, which comprehensively outlines all the responsibilities of both the DFO and the UHA in co-managing the geoduck and horse-clam fishery. The agreement has an Annual Work Plan attached to it, which provides detail on the activities for the year and the cost commitments of both the DFO and the UHA. For 2006, the total cost to the DFO of managing the fishery was estimated to be Can$771 053, with Can$291 853 contributed directly by the UHA, which leaves Can$479 200 contributed by DFO. This contribution by the DFO is about 70 percent offset by geoduck and horse-clam licence fees paid to the government, which in 2006 amounted to Can$336 000. For 2006, the total cost to the UHA of co-managing the fishery and carrying out the above activities (including the contribution to the DFO) was about Can$2.3 million. This is funded by a UHA membership fee of just over Can$40 000 per licence in 2006.

Some of the programmes and costs assumed by the UHA have been requirements imposed by the DFO, such as landings monitoring and on-grounds fishery observers. Most programmes, however, have been implemented by the Association through enlightened self-interest. For example, the survey and biosampling programme is seen by fishers as necessary to improve the biological data used for setting TACs. The industry has been told that this data simply would not be available if research were left to the DFO. Prior to UHA funding for surveying and biosampling, the DFO did not do any surveys or biosampling. All estimates of biomass were based on fishery dependant data. Without fishery independent data, TACs would be set at lower levels because of the precautionary approach taken by the DFO to managing fisheries. PSP sampling programmes grew out of a desire to expand areas of harvest for live product into areas not covered by government sampling programmes.

Two of the most progressive programmes undertaken by the UHA are the enhancement programme and the generic marketing programme. The enhancement programme has been fully funded by the UHA with no government assistance, except a small contribution in the initial stages to help design a planting machine. The objective of the enhancement programme is to plant one million small geoducks into the common property of the ocean each year. The average weight of a grown geoduck is about two pounds. If all the planted geoducks were to survive, these planted geoducks would mature to be about one-half of annual commercial harvests. To date, survival rates have ranged from 20 to 80 percent, and with improved technology and techniques the survival rates should consistently reach the higher end of this range. In addition, the UHA has acquired a deep water geoduck aquaculture tenure and will be growing geoducks from seed on that tenure. The UHA will use the proceeds to help fund UHA activities.

The UHA generic marketing programme is also very progressive. Core branding issues for the UHA are positioning "Geoduck from Canada" as a high quality, delicious, sustainable, healthy, safe product that is available live and available year-round, and that meets customer specifications well beyond regulatory requirements. For example, a geoduck on a restaurant plate in Shanghai can be tracked back to the day, area and vessel from which it was harvested.

Unlike many other industry-funded marketing efforts, there is no separate or legislated requirement to remit funds from the sale of fish for generic marketing. The licence holders decide on an annual basis what level of support they will provide for generic marketing. Matching funds are then sought from Federal Government export marketing development programmes. All Canadian geoduck exporters are either full or associate members of the UHA and all have access to UHA promotional materials and activities.

Each year, the UHA has two annual general meetings to report on activities and discuss issues. The general meeting in the fall also approves a budget and fees for the following year. At the general meeting held in late spring, elections are held and audited financial statements are approved, as required by the statute covering non-profit societies. The UHA currently has eight elected Directors (including the President), all of whom are licence holders in the fishery. During the year, UHA directors may make decisions on redirecting funds within the overall budget. However, since the fees for the year are set in advance, every attempt is made to stay within the overall budget for the year. There are a number of subcommittees in the UHA to deal with fishery management, research, enhancement and other activities. Regular communication is maintained through a monthly newsletter. A small, but important, indicator of the importance of communication is the self-imposed requirement that all members have a fax machine or, more recently, e-mail. If something important happens, the UHA has the ability to contact all the members within a few hours.

5. EVALUATION OF IVQS AND CO-MANAGEMENT

5.1 Fishery value

Evaluation of the success of the UHA as a self-governance institution cannot be separated from an evaluation of the impact of quotas. The original version of the UHA allowed the 55 licence holders in the fishery to develop majority support for IVQs with equal quotas. Since then, the development of the UHA has been strongly linked with the success of the IVQ programme. The effects of both are assessed here.

The largest effect of IVQs was the ability to service a live market with consistent year-round supply and thereby substantially increase the landed value of the product. Figure 3 shows the changes in average landed prices over time. As previously illustrated in Figure 1, while the overall landings of geoduck have declined since 1986 and then stabilized in 1995, the value of the fishery increased substantially and now fluctuates with market conditions. The average landed price of geoduck was CanS0.17/lb in the first year of the fishery. The landed price in 2005 averaged CanS9.50/lb.

The geoduck market has changed from largely frozen neck meat to live clams. In 1989, 39 percent of geoducks were exported either as processed fresh products or live. By 1994, the percentage sold live rose to 99 percent. Currently, as much as possible, geoducks are sold as live product.

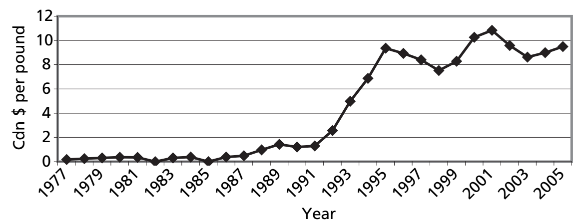
The target market has also changed. In 1989, the first year of IVQ management, 37 percent of geoduck exports went to Japan, 33 percent to Hong Kong and 26 percent to the United States. At present, over 95 percent of geoducks harvested in Canada are exported with over 90 percent of exports going to greater China. The negative side to these market developments is the recent reliance on one market, China. When, as in 2003, the Chinese market collapsed due to an unforeseen event such as severe acute respiratory syndrome (SARS), the effects are not dampened by strength in other markets. On the other hand, fishers and processors work together to time harvests to meet lower market demands and to mitigate the impact on the industry. In addition, the UHA could respond quickly to marketing challenges and redirected marketing efforts to revitalize markets in China.

With improvement in landed prices and gross revenues per licence, the value of licences increased substantially. However, few licences trade and the sale prices are unconfirmed. Muse (1998) cited one anecdotal report of a licence being sold in the mid 1990s for $1.5 million. Despite the value of the fishery and the financial returns, it is impossible to obtain bank financing for the purchase of a licence. Licence issuance is at the absolute discretion of the Minister of Fisheries and Oceans and therefore cannot be considered property in any way. This lack of certainty around licences (and also quotas) means that the value of geoduck licences is below comparable business investments.

5.2 Fishing costs

There are no data on changes in fishing costs associated with the move to IVQs, area licensing, and co-management. Indirect evidence is available. The number of divers and vessels used in the fishery has been reduced. In 1988, the last year of competitive fishing, 233 divers fished from 56 vessels (more than 55 due to licence transfers in-season) for an average of just over four divers a vessel (Muse, 1998). By 1997 there were 86 divers fishing off 42 vessels, about the same number as today (39 vessels). This is a consequence of both decreases in catch and the elimination of the race for fish. By eliminating the capital costs of 16 vessels from the fleet as a whole, the total investment in catching capacity and

FIGURE 3
Geoduck historic price per pound



the overall fleet costs of maintaining that catching capacity (e.g. repairs and insurance) in the fleet have been reduced. Variable costs associated with fishing have not declined, because vessels now fish a longer period of time for less product each day and because the other variable costs of fishing are associated with catch volume. A vessel with two quotas attached to it fishes twice as long and has twice the variable costs.

On the other hand, the costs associated with managing the fishery have gone up considerably and been redistributed from government to the UHA membership. Prior to IVQs, the costs of fishery management were completely borne by the government. When IVQs were introduced in 1989, the UHA annual membership fee to recover monitoring costs was CanS4 700. In 2006, the annual fee for UHA membership was just over CanS40 000. In summary, while most industry participants would agree that overall costs have risen, the increase in value of the fishery and the improvements in management have warranted these costs.

5.3 Fishery management and enforcement

Fishery management has been significantly improved through industry-funded catch monitoring, support to DFO programmes, and improved research. Enforcement of catch limits has been dramatically improved. In the five years prior to IVQs and cost recovery, TACs were regularly exceeded. In 1985, the TAC was exceeded by 81 percent. As shown in Figure 4, after the introduction of IVQs, catch has been within 1 percent of the TAC.

Fishers are supporting further enforcement activities to protect their interests against poaching. A particular concern is if poached product that does not meet the requirements of the Canadian Shellfish Sanitation Programme were to get to market and make someone ill, the market could be devastated.

Because of the high value of the fishery, fishers are able to make considerable investments in the future of the fishery, including long-term research studies and an enhancement programme to increase stock biomass.

FIGURE 4
Geoduck TAC overages

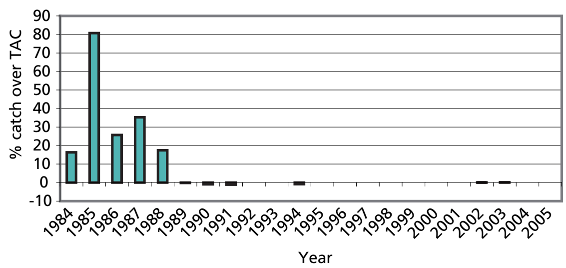
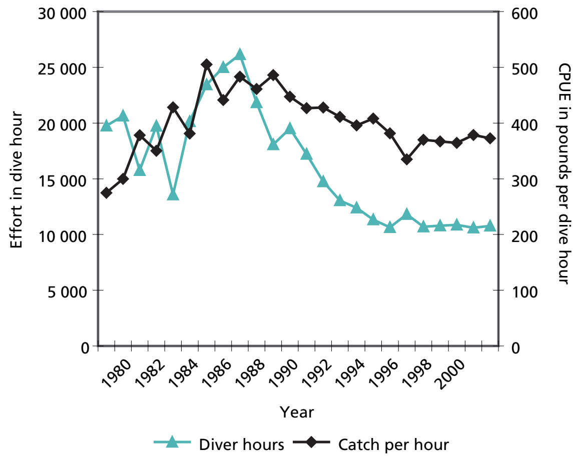


FIGURE 5
Effort and catch per unit effort



5.4 Fishing effort

Effort, as measured in diver hours, has declined and then stabilized since the introduction of IVQs. However, so has catch. The trend in catch per unit effort, measured as pounds per diver hour, shows modest decline, as shown in Figure 5.

With dive fishing, divers have a limited amount of bottom time. With steady work, divers harvest an average of about 380 pounds (170 kilos) an hour. The impact of IVQs on effort has been to allow fishers to time fishing to meet market demands. They can exert more effort when demand is high (i.e. Chinese New Year and the winter "hot pot" season) and less effort when demand is low (the 2003 SARS crisis in China). The market dictates the amount of harvesting effort, not the race for fish.

6. DISCUSSION

The geoduck and horse-clam fishery in British Columbia is an example of a co-management success story. The following factors have contributed to this success:

i. A small number of licences and licence holders;
ii. Leadership within the community of licence holders and industry knowledge of the success of the New Zealand move to IQ management;
iii. A small base of support within government for moving to IVQs;
iv. A new fishery with little political interference;
v. A simple fishery with no competing users of the resource (other than sea otters and other natural predators);
vi. A fishery where the market potential for a live product with a higher price was recognized and could be realized;
vii. A fishery with a recognized problem of catches exceeding TACs; and
viii. The safety consequences of a race for fish underwater (which meant that even the fishers' union could see the benefits to workers from the move to IVQs).

All of these factors contributed to the transition from a limited entry, competitive fishery and associated style of management to an IVQ/co-management structure. Once IVQs and industry involvement in fishery management were in place, the continued development of the UHA and its programmes could proceed because of the increased fishery value and the incentives for cooperative activities under the assured resource access afforded by IVQs.

As with any business, there are always new challenges and opportunities. For the geoduck industry, these include: (a) uncertainty associated with government policy and regulation, (b) biological uncertainty related to the resource and (c), challenges and opportunities associated with the market place.

The greatest challenge of government policy is security of access to resources. In negotiating the current Joint Project Agreement between the UHA and DFO, the DFO refused to allow a clause that would commit the Minister of Fisheries and Oceans to continue to limit the number of commercial licences to 55. The DFO cited the Minister's absolute discretion over licensing matters. Another concern is the ability of the provincial government to alienate aquatic lands with wild geoduck resources for other purposes, including shellfish aquaculture. In neither instance is there a written policy that would provide certainty to commercial harvesters of geoduck and horse-clams. In an ironic twist, any negative impact on geoduck stocks from an aquatic land lease (such as a log dump, fish farm, or floating lodge) would not be considered under the federal *Canadian Environmental Assessment Act* because the fishery is well managed and not a conservation concern. Governments are making aquatic land use decisions without a guiding policy on resource or fishery alienation. Any change in commercial fishery access by either federal or provincial governments could seriously undermine the co-operative behaviour of the existing licence holders.

Biological uncertainty is always a factor in fisheries management. Relative to many other fisheries, the geoduck fishery in B.C. is data rich largely because of industry investments in research. Data and scientific knowledge will continue to be refined to provide better information on stocks and stock dynamics. Risk management and the implementation of precautionary management are always matters of debate between the regulators and the regulated. In the geoduck and horse-clam fishery, the industry and government are working together to improve the scientific basis for managing the fishery.

Market uncertainty is an area that often seems to be beyond the control of fishers. The UHA has recognized that this is not the case. What fishers do, what they catch, where and when they catch it, how it is treated, consistency in meeting customer demands, and how the fishery presents itself to the world, are all important factors in marketing fish products. There are circumstances beyond the industry's control, such as SARS. But the more important question is: how does the industry manage such crises? Other market impacts will be felt from increases in supply due to aquaculture and the harvesting of close substitute clams in other parts of the world. Because all of the exporters of geoduck from Canada are either full or associate members, the UHA presents a consistent and united market message to its customers.

This year (2007) is the nineteenth year of operations for the UHA Research Society as a non-profit association in a fishery managed through a system of IVQs and industry co-management. This voluntary organization has worked because harvesters see that their fishery and the industry is better off with the association. It has also worked because association members have, to a large extent, control over the association and the flexibility to changes activities and priorities. UHA is not burdened or restricted by government regulations that might be required if the association were mandatory. The potential problem is that the factors leading to the cooperative behaviour of harvesters might be undermined by government actions or other outside influences. Hopefully, the nineteen years of cooperation portends a successful future for the UHA and its co-operative management.

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Co-management of Canada's Pacific sablefish fishery

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1. INTRODUCTION

In Canada, the *Constitution Act 1867* gives the federal government exclusive jurisdiction over all aspects of fisheries and fish habitat management (i.e. management, enforcement and monitoring). Through the *Fisheries Act 1985,* the federal Department of Fisheries and Oceans (DFO) administers all laws relating to fisheries. On Canada's Pacific coast, many commercial fisheries are co-managed by the DFO and the fishing industry. These co-management arrangements range from addressing specific tasks, such as industry funding of logbook programmes, to legally binding, multi-year agreements between industry organizations and the DFO that define specific roles and responsibilities, decision making processes and cost sharing arrangements. The sablefish fishery was one of the first fisheries on Canada's Pacific coast to move to co-management. The purpose of this document is to discuss co-management in the commercial sablefish (*Anoplopoma fimbria*) fishery.

2. BACKGROUND

2.1 Overview

Sablefish (also known as blackcod) are found from central Baja California to Japan and the Bering Sea. Sablefish are a charcoal-hued, bottom-dwelling finfish (Figure 1) that inhabit shelf and slope waters to depths greater than 1 500 metres (DFO, 2005). The directed sablefish fishery on Canada's Pacific coast is managed under an individual quota regime limited to 48 licensed vessels (DFO, 2005). Over the past five years, catches have ranged from 1 900 to 3 850 tonnes with an annual landed value ranging from $US20–25 million.

Licensed sablefish vessels are permitted to use trap or longline gear. The catch is taken primarily using trap gear, which accounts for about 80 percent of the harvest (DFO, 2005). The fishery takes place on the edge of the continental shelf at depths ranging from 350 to 1 100 metres (Turris, 2000). The distribution of catches is illustrated in Figure 2.

FIGURE 1
Sablefish

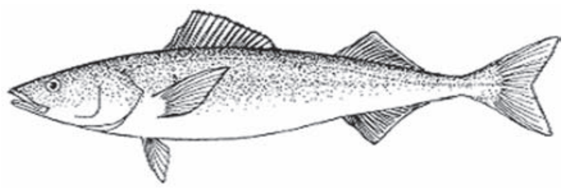


Image provided by the Department of Fisheries and Oceans.

2.2 History of the fishery

Prior to 1977, Canada's Pacific sablefish stocks were primarily targeted by the Japanese distant water fleet and domestic catches were relatively small (Turris 2000, Jones 2003). In 1977, Canada established its 200-mile Extended Economic Zone. This put an end to foreign fishing for Pacific sablefish in

FIGURE 2
Distribution of sablefish fishing activity

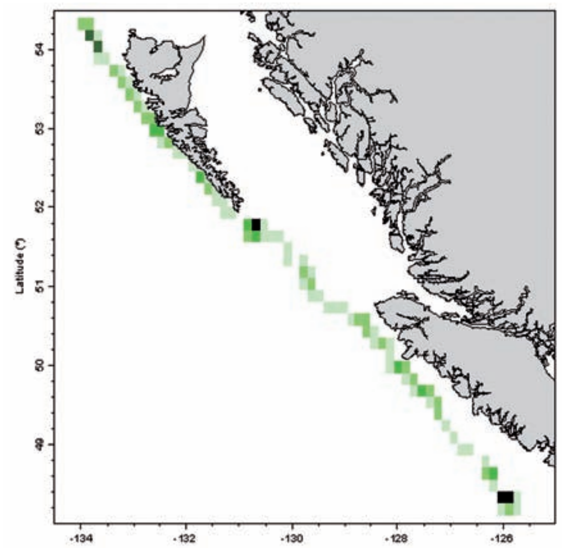


Image provided by DFO.

Canadian waters. Sablefish continued to be caught as a bycatch in domestic groundfish fisheries. However, it was largely considered a nuisance fish due to the low landed prices paid by local processors (Turris, 2000).

In the late 1970s, a small group of Canadian fishermen recognized the potential for exporting sablefish to Japan. They established a directed sablefish fishery and experimented with trap gear as a more productive harvesting method (Turris, 2000). Domestic harvests began to increase significantly as more vessels entered the fishery and as fishing technology improved (Jones, 2003). Faced with escalating trap and longline fishing effort, the Department of Fisheries and Oceans limited entry into the directed sablefish fishery in 1981, with 48 vessels receiving sablefish commercial fishing (Category "K") licences that are issued annually by DFO (Turris, 2000).

The directed sablefish fishery was managed by season length. The DFO closed the fishery when it estimated that the total allowable catch (TAC) had been taken. Unfortunately, limited entry regulation did little to curb the race for the fish due to the common property nature of the fishery. To compete and maintain their share of the catch, vessel owners invested in bigger boats, fished with more crew, fished twenty-four hours a day, deployed extra gear, used packer vessels to transport additional gear to the fishing grounds, and adopted new technology, such as improved sounders, sonars and lorans (Turris, 2000). The DFO responded by steadily reducing the season length.

As early as 1984, it was apparent that there were problems in the sablefish fishery. Various new management concepts were discussed in great length with the Sablefish Advisory Committee (SAC), a DFO stakeholder advisory board that provided (and still provides) advice on management of the sablefish fishery (Munro, 2001). Due to differences in ideologies, vessel size, and investments in gear, the fleet would not support the use of individual quotas (IQs) in the fishery (Munro, 2001). The fishery continued under the current management regime and the fishery went from 245 days in 1981 to just 14 days in 1989 (Figure 3) (Jones, 2003).

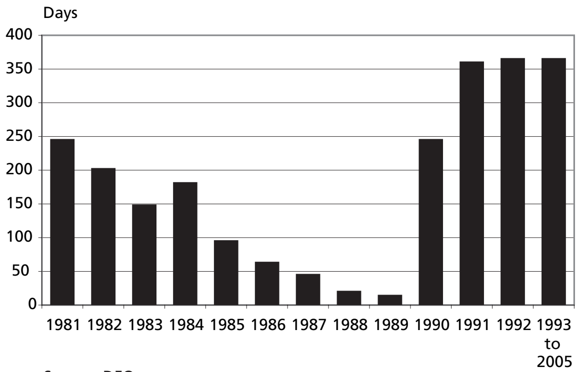
As noted by Turris (2000), the increasingly shorter fishing seasons led to:

i. safety concerns as vessels carried excessive gear and as crews fished around the clock in inclement weather;
ii. poor product quality because fishermen were concentrating on setting and hauling gear instead of properly handling their catch (bleeding, dressing, icing, freezing and storing the catch) and because the fish would often sit on the dock for days due to the large quantities of fish being landed in a short period of time; and
iii. reduced landed prices because the shorter fishing periods meant that the industry could not meet the market demands for a consistent year-round supply of high quality sablefish.

Further, as the seasons grew shorter, the potential for financial loss from vessel breakdowns, sickness, injury and poor weather increased. Major vessel breakdowns could cost licence holders their entire season (Jones, 2003). Even a few days of missed fishing could threaten a season's earnings (Turris, 2000). At the same time, harvesting costs were escalating as fishermen were forced to continually invest in their fishing operations in order to remain competitive. There was concern in the industry that the fishery was not economically viable (Jones, 2003).

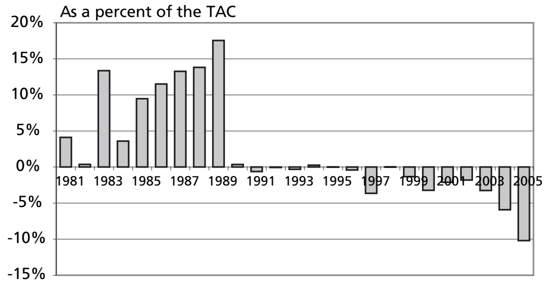
The DFO was also struggling as it was becoming increasingly difficult to manage the annual TAC – the sablefish fishery exceeded its TAC every year from 1981 to 1989 (Figure 4) (Turris, 2000). There were also rumours that sablefish fishermen were fishing before the season started and after it ended, and that other commercial users (groundfish trawlers and longline vessels) were illegally landing sablefish. There were no DFO enforcement officers specifically addressing sablefish issues and landings were not being monitored.

FIGURE 3
Season length 1981–2005



Source: DFO.

FIGURE 4
Catch overage or underage 1981–2005



Source: DFO

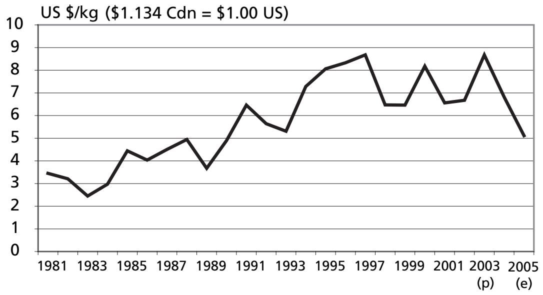
The sablefish fishery was projected to be open no more than eight days in 1990 (DFO, 1994). In October 1989, the Pacific Blackcod Fishermen's Association (later to become the Canadian Sablefish Association), an organization representing the majority of sablefish licence holders, approached the DFO to propose use of individual quota management for the fishery (Jones, 2003). The DFO conducted several months of consultation and a consensus was reached to implement individual vessel quota (IVQ) management into the sablefish fishery in 1990 on a trial basis (Turris, 2000). For the trial period, each licensed sablefish vessel was allocated an individual quota using a formula in which 70 percent of the allocation was based on historical catch (the licence's best catch in either 1988 or 1989) and 30 percent was based on the licensed vessel's overall length (Munro, 2001).

2.3 Individual vessel quota management

The trial IVQ programme proved very successful. Following the trial period and consultations with the industry, the DFO agreed to continue with IVQ management (Jones, 2003). The sablefish IVQ programme remains in place today. Each year, sablefish IVQ is allocated to each of the 48 licensed vessels, expressed as a percentage of the TAC (Turris, 2000). As discussed by Turris (2000), sablefish licences are issued annually by the Minister of Fisheries and Oceans and are considered a privilege that grants the sablefish vessel owner the opportunity to catch a specified share of the TAC. Neither the licence nor the IVQ is considered property.

The sablefish fishery is now open all year (Figure 4). Licensed sablefish vessels are permitted to fish at any time but must "hail-out" prior to fishing and "hail-in" prior to landing (Turris, 2000). Sablefish fishermen must maintain a logbook documenting their fishing effort, fishing location and catch (Turris, 2000). Each vessel is permitted to go over or under their IVQ by up to 15 percent. The amount of the overage or underage is subtracted or added to their quota in the following year (DFO, 2006). Landings are only permitted at designated ports. Industry-funded, DFO-certified fishery observers

FIGURE 5
Landed price 1981–2005 (adjusted for inflation)



Source: DFO, Province of British Columbia

monitor all landings. This information is used to update the vessel's remaining IVQ as well as to provide managers with timely and accurate catch data. As seen in Figure 3, IVQ management has allowed DFO to manage the fishery TAC with much greater precision.

According to Jones (2003), conservation has also improved in the fishery by reducing or eliminating the loss of fishing gear. The frantic pace of the pre-IVQ fishery led to gear being lost or left on the fishing grounds, where it continued to fish. Today, sablefish traps must have two escape rings with openings no smaller that 8.89 cm in diameter and a degradable panel that is sewn with fibre that will rot and prevent ghost fishing if the trap is lost (Turris, 2000).

The introduction of IVQ management also greatly improved the economic viability of the fishery. The longer season has dramatically improved the quality of the product – harvesters can now take the time to properly handle the fish (Jones, 2003). And, the fleet is able to better service the market demand by fishing all year. However, a significant proportion of the catch occurs between September and March to take advantage of greater market demand (Munro, 2001). As a result, vessel owners are receiving real higher prices (i.e. when adjusted for inflation) for their catch compared to pre-IVQ fishing (Figure 5) (Turris, 2000).

Fishing costs have also declined under IVQ management, which further improved the economic viability of the fishery (Jones, 2003). Fishermen are no longer forced to overinvest in their fishing operations to try to maintain a share of the catch. In addition, quota transferability has reduced the number of active vessels, which reduced total fixed costs. Just prior to IVQ management, all 48 vessels were active in the fishery. Since IVQs were introduced, the number of active vessels has ranged from 21 to 35.

The change to IVQ management has resulted in fewer crew being employed in the fishery (Jones, 2003). However, those crew members remaining in the fishery have more stable employment and are better paid (Turris, 2000). According to Turris (2000), the fishery is now safer, working conditions have improved, and the stress created by fishing under a time-competitive or derby-style fishery has been eliminated. The improved financial returns and increased stability of the fishery has led to higher licence and quota values for existing vessel owners (Turris, 2000). This has made it more difficult for new entrants to buy into the fishery.

2.4 Recent developments

Recently, the sablefish fishery (like all other commercial groundfish fisheries on Canada's Pacific coast) has moved to multi-species management, commonly referred to as "groundfish integration" (DFO, 2006). Seven distinct commercial groundfish fleets--Sablefish, Halibut, Inside Rockfish, Outside Rockfish, Lingcod, Dogfish and Groundfish Trawl--are managed as distinct fisheries. But they are integrated by the new requirement to reallocate IVQ between vessels and fisheries to cover catches of non-directed groundfish species (both retained and released). A vessel's catch is calculated by adding both landed weight and the estimated mortality of all catch either utilized at-sea or released at-sea.

Under this pilot programme, there is 100 percent dockside monitoring and 100 percent at-sea monitoring. Commercial groundfish vessels are individually accountable for all their catch (both retained and released). Each commercial groundfish vessel is now required to acquire individual vessel quota (IVQ) to account for mortality of all legal/marketable-sized groundfish that are managed under species and area TACs. A vessel catching fish in excess of the IVQ holdings identified in its licence condition (plus any allowable overages) is restricted from further fishing until additional IVQ has been acquired. For groundfish species that are not managed under a TAC, all catches (retained and discarded) are recorded, monitored, and audited. For most of these non-TAC groundfish species, trip limits are in place.

3. CO-MANAGEMENT

Co-management arrangements have existed for the past fifteen years in Canada's Pacific fisheries. Co-management arrangements have been used to foster improved compliance with fisheries regulations and safer fishing practices and to put in place joint scientific, monitoring, and enforcement programmes. Through the *Fisheries Development Act*, the federal Minister of Fisheries and Oceans has the authority to enter into agreements. Specifically, Section 3(1) authorizes the Minister to undertake projects for specific purposes and Section 3(4) authorizes the Minister to enter into an agreement with an external group (Blewett, 2002).

With respect to financial authorities, any funds paid to a federal government department in Canada must go to the Consolidated Revenue fund. However, there are two exceptions to this general rule that are applicable to co-management arrangements. First, for purposes of *cost recovery*, a federal government department can seek parliamentary approval to retain funds. The funds in question must be tied to specific programmes or activities, and the department must make a clear business case that those activities advance the goals of the department and the interests of those from whom the fees are being collected. Second, under Section 21.1 of the *Financial Administration Act,* the federal Minister of Fisheries and Oceans has a *standing authority* to receive money from an external group that wishes, voluntarily, to provide funds for a specified purpose (Blewett, 2002).

When the sablefish fishery first moved to IVQ management in 1990, DFO's ability to recover costs with parliamentary authority was used as the tool for collecting co-management fees. Sablefish vessel owners were required to fund all the incremental costs associated with the IVQ programme, which included funding the dockside monitoring programme to validate all landings, DFO enforcement, DFO administration, conducting biological sampling and additional stock assessment research. This totalled approximately US$700 000 (DFO, 1994). These funds were collected by the DFO, and in the early stages of the sablefish IVQ programme, the DFO was responsible for most of the tasks associated with the management of the fishery.

The industry was soon given responsibility for coordinating the dockside monitoring programme and co-management evolved from there. Shortly thereafter, the industry, through the Pacific Blackcod Fishermen's Association, was collecting fees from vessel owners and funding DFO management costs in addition to employing service providers, independent researchers, scientists and fishery managers. The Pacific Blackcod Fishermen's Association (later to become the Canadian Sablefish Association) became one of the first vessel-owner associations on Canada's Pacific coast to enter into multi-year, legally-binding joint project agreements (JPA) with the DFO that spelled out respective roles and responsibilities for the management of a commercial fishery. Over time, these agreements became more comprehensive as the industry assumed a greater role in the management of its fishery.

As discussed by Turris (2000), a majority of the management activities associated with the sablefish fishery are now carried out by parties contracted by the Canadian Sablefish Association. The CSA is a legally-constituted organization that represents sablefish fishermen and develops programmes and policies for the protection and conservation of the Canadian sablefish resource and fishery both independently and in conjunction with the DFO. The CSA is governed by a Board of Directors made up of members of the association – any member is entitled to sit on the Board. The CSA Board holds regular conference calls to discuss ongoing business and each year the association members meet to discuss issues facing the industry and to review the annual stock assessments. The CSA contracts with professionals (e.g. manager, administration staff, scientists, biologists and marketing consultants) to conduct the day-to-day business of the association and to undertake specific projects or programmes.

As outlined in the annual fisheries management plan (DFO, 2006), the Canadian Sablefish Association (CSA) and individual harvesters currently contribute, either through the JPA or directly, US$2.1 million for the following activities:

i. *Dockside monitoring programme:* The CSA contracts with an independent monitoring company certified by the DFO to validate all sablefish landings, to collate all data, and to enter it into a database system so it can be readily accessed by the DFO fishery managers and enforcement personnel.
ii. *At-sea monitoring programme*: Sablefish vessel owners directly pay an independent monitoring company certified by the DFO to provide at-sea observer or video monitoring systems to record fishing activity and catch, to audit logbook data, and to enter this information into a database system so it can be readily accessed by DFO fishery managers and enforcement personnel.
iii. *Sablefish Advisory Committee:* The CSA is responsible for covering all costs associated with the DFO advisory process for the sablefish fishery (e.g. meeting rooms, teleconference calls, travel expenses for elected representatives and hospitality).
iv. *Biological sampling and data collection programme:* The CSA contracts with an independent service provider company to collect and process biological samples taken during the commercial sablefish fishery.
v. *Stock assessment programme*: Each year a major stock assessment of the Pacific sablefish resource is conducted. The CSA conducts tagging charters vessel trips with contracted scientific technicians on board. Approximately 20 000 fish are tagged each year. Returns of tagged fish are collected at the point of landing by a company hired by the CSA. The annual assessment is then co-authored by DFO scientists and CSA contracted scientists.
vi. *Seamount programme*: Each year the CSA helps coordinate the application and vessel selection processes for the offshore seamount fishery. As outlined in the groundfish integrated management plan (DFO, 2006), there is an offshore fishery for sablefish on seamounts more than 100 miles offshore. Any vessel eligible for a sablefish licence may apply for a licence amendment to fish for sablefish from these seamounts. Eligible vessels may obtain sablefish from seamount areas in quantities additional to the individual quota issued to that vessel. Each year, the DFO conducts a lottery draw from sablefish licence amendment applications to select participants for the seamount programme.
vii. *Fishing log programme:* The CSA contracts with a service provider company to supply logbooks to all sablefish fishermen, to collect completed logbooks, and to enter the information into a database so that it can be readily accessed by the DFO.
viii. *DFO cost-recovery funding:* The CSA funds some of the DFO salaries, benefits, overtime and capital expenses incurred by the Department in the scientific assessment, management and enforcement of the sablefish fishery. The DFO funds items such as administration, salaries for fishery managers, scientists, biologists, support staff, enforcement staff, and research and patrol vessels and aircraft. The financial responsibilities of both parties are formalized in a legally-binding, multi-year JPA.

ix. *Fishery management programme:*. The CSA contracts staff and incurs expenses to manage the various programmes for which the industry is responsible.

4. EVALUATION

Many of the significant changes (longer season, reduced effort, improved financial returns, and increased licence and quota values) observed in the sablefish fishery can be attributed to the change to IVQ management. However, co-management has improved the monitoring and enforcement of the fishery. As previously noted, prior to 1990 there was little enforcement of the sablefish fishery and landings were not monitored. Today, there is a 100 percent at-sea monitoring programme in place, a dockside-monitoring programme validates 100 percent of the landings in the fishery, and there are five Halibut/Sablefish IVQ (HSIVQ) fishery officers dedicated to the halibut and sablefish fisheries. The positions are co-operatively funded by the two commercial fishing fleets though joint project agreements with the DFO (DFO, 2006).

Co-management has also led to significantly more resources being devoted to sablefish stock assessments and related scientific activities. For example, prior to 1993, major assessments of the sablefish resource only took place once every three years. However, through co-management arrangements, stock assessments are now being conducted annually. In addition to annual stock assessments, co-management has also led to the funding of long-term research (such as the impacts of climate) and the effectiveness of more selective harvesting methods (Jones, 2003). For example, in 1997, research was conducted on the use of escape rings in traps to reduce juvenile sablefish bycatch. The results were so impressive that by 1999 traps were required to have two escape rings (Jones, 2003).

5. DISCUSSION

Co-management of commercial fisheries on Canada's Pacific coast has evolved over time on a fishery-by-fishery basis. The process has been disjointed and generally fishery specific. Some fisheries are far along the co-management spectrum while in other fisheries there is only limited engagement. This can lead to concerns of equality and fairness within the general fishing industry, particularly with respect to the recovery of DFO costs and the funding of monitoring. This, in turn, can make it difficult to move ahead with co-management initiatives.

As a general comment, there should be a DFO policy on co-management that:

i. outlines which activities can be devolved to industry and which activities must remain the responsibility of the DFO;
ii. describes which activities should be funded by participants;
iii. details the core activities for which the DFO will be responsible for funding and
iv. provides some limit or direction on the level of costs that can be borne by the industry.

A general co-management policy would provide greater certainty for both industry and the DFO and would ensure that all parties understand what is expected of them.

As noted by Turris (2000), IVQs created an environment for co-management and greater industry involvement in the research, assessment, monitoring and administration of the sablefish fishery. Sablefish vessel owners no longer have to compete with one another for a share of the catch and instead can focus on working together to improve their fishery. In addition, IVQ management improved the economic viability of the fishery, which enabled the industry to fund various co-management initiatives. It is also suspected that the small number of participants in the sablefish fishery made it easier for vessel owners to form an association and to reach consensus to build the capacity necessary to move along the co-management spectrum.

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A fishermen's agreement and co-op in Yaquina Bay roe herring

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1. INTRODUCTION

Private fishermen harvest agreements have demonstrated that fishermen are willing under certain circumstances to assume various tasks related to governing the fishery. Such agreements have generated interest because they provide an alternative to government-administered individual transferable quotas (ITQs). While they sometimes break down, such agreements have ended the race for fish and reduced excesses in fleet capacity in certain fisheries (e.g. Townsend, 2005). And since they are devised by the fishermen themselves, producer agreements can avoid some of the difficulties encountered when initial allocations of individual shares are carried out in the political arena (Sullivan, 2000).

A government authority can play a supportive role in the formation of such agreements. In single-sector fisheries, the government can facilitate an agreement by limiting the number of participants. In multiple-sector fisheries, the government can facilitate an agreement by determining each sector's share of the total allowable catch (e.g. Loy, 2000). But it is fishermen who formulate an agreement over how to allocate their sector's share of the total allowable catch among themselves. Like ITQs, these allocations are often specified in terms of percentages of the overall catch. Typically, all or part of these allocations are transferable, but certain restrictions on transfers may exist.

Because these arrangements are formed voluntarily and rely on cooperation, their emergence in a fishery depends on certain pre-existing conditions (Ostrom, 1990; Sullivan, 2000). The number of participants forming the cooperative must be relatively small and they must share a common interest. There must be an effective mechanism for preventing those not party to the agreement from entering the fishery. Otherwise, outsiders are "almost certain to be predators on the fishermen who rationalize the fishery" (Sullivan, 2000). There must be a clear indication to fishermen that forming and maintaining such an arrangement will yield economic benefits. Equally important, there must be a clear signal to fishermen that such an arrangement will not be overturned by government.

With the moratorium on new ITQs in US federal fisheries from 1996 to 2002, private harvesting agreements emerged in the late 1990s as an alternative approach to ending the race for fish. One agreement was formed in the Pacific whiting fishery off the Washington-Oregon coast (Sylvia, this volume) and others were formed in the North Pacific pollock fishery in the Bering Sea off the coast of Alaska (Richardson and Wilen, this volume; Paine, this volume). A much earlier fishermen's agreement – dating back to 1989 – was adopted by nine fishermen in Oregon's Yaquina Bay herring sac roe fishery, a fishery that occurs in state waters. This paper provides a historical account of the fishery, its management and performance under the associated agreement.

2. BACKGROUND

Located on the central Oregon coast, Yaquina Bay is the third largest estuary within the state, with just over 4 200 acres at high tide. The Bay's commercial herring roe fishery began in the late 1970s. It is a relatively small fishery by commercial fishing standards. Over the life of the fishery there have been only nine or ten vessel operators. Annual herring landings have ranged from 3 to 248 tonnes and combined annual ex-vessel revenues have ranged from as low as $2 463 to as high as $200 950 (Matteson, 2003b). In comparison, the San Francisco Bay herring roe fishery had over 132 vessel operators and an overall herring quota of 3 747 t for the 2001–2002 seasons (California Department of Fish and Game, 2002).

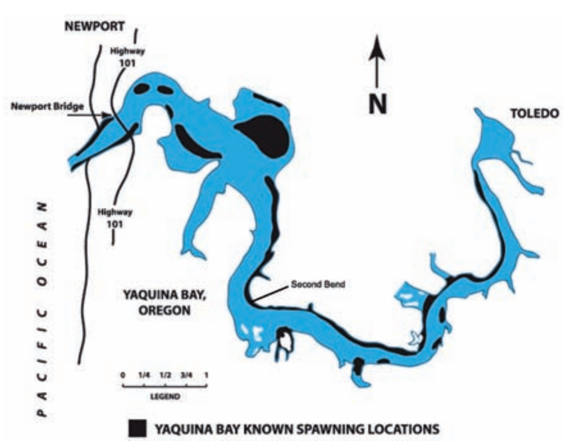
The target species, Pacific herring (*Clupea harengus pallasi*), range from Baja California to Alaska and across the Pacific Ocean to Russia, China and Japan. Pacific herring spend most of their lives at sea, but they migrate inshore to breed in sheltered inlets, sounds, bays and estuaries. Spawning can start as early as October in California and as late as July in Alaska. Off Oregon, the peak period of spawning occurs over the February–March time frame. Spawning appears to coincide with a period when plankton productivity increases. Sometime in late winter or early spring, large schools of herring enter shallow bays, estuaries, sounds, or sheltered inlets where they remain up to three weeks before spawning. Males and females school together and spawn simultaneously. Larger, older herring tend to spawn first. The fertilized eggs attach to various marine vegetations (e.g. eelgrass) in the inter-tidal and sub-tidal areas. Each large female can produce from 40 000 to 50 000 eggs in a year, which commonly hatch in ten days to two weeks. The eggs are vulnerable to predation by marine birds, other fishes and freezing during low tide cycles. Mortality is high (50 to 99 percent) at this stage. Those that survive migrate to the open ocean in summer or early fall, where they face other perils. It takes from two to five years for herring to reach maturity. Information on the life history of the Pacific herring in the open ocean is sparse.

Pacific herring have been exploited for centuries by fishermen for use as a fresh or salted food for humans and for bait in other fisheries. Herring are also important for other species, including salmon, sea lions and gulls. In the 1970s, herring from the waters off the West Coast began being marketed to Japan for their use as kazunoko (salted herring roe). These sales continue today.

The annual commercial harvest for herring in Yaquina Bay for its roe is timed to coincide with the annual spawning run in the Bay, which typically occurs sometime over the February-April period. During this time herring enter the Bay and congregate at various spawning locations (Figure 1). Commercial fishing for herring extends approximately five miles upriver from just below Newport Bridge.

Over the years, Yaquina Bay herring fishermen have experienced wide fluctuations in run size. Such fluctuations have occurred despite state efforts to manage the fishery for sustainable harvests. The primary reason for this variation is that herring abundance is sensitive to habitat and other environmental conditions. Destruction of spawning habitat via man-made or natural causes can reduce herring production, as can unfavourable water temperatures and salinity (Lassuy and Moran, 1989). Survival at sea can be low during periods of warm ocean temperature. Because herring feed on plankton, which is

FIGURE 1
Herring spawning locations in Yaquina Bay, Oregon



generally found in cold-water environments, an overall decrease in the herring population can occur when there is a substantial increase in ocean temperature. Such increases occur periodically in conjunction with El Niño events.

Historical data indicate that Yaquina Bay herring landings drop precipitously during or near each significant El Niño event (Table 1). Information on cold, normal and warm ocean episodes are provided by the National Weather Service Climate Prediction Center (NOAA n.d.). During the 1978–1981 period, annual landings ranged from 40 to 47 t. There was a sharp drop in landings to about 5 t in 1982. This decline coincided with the 1982/1983 El Niño. There was an increase in landings over the 1983–1986 period, with annual landings ranging from 57 to 72 t. A significant increase in landings occured over the 1987–1992 period, with landings ranging from 161 to 248 t. This period coincided with normal and cold ocean surface temperatures recorded during the 1988–1990 period, which was favourable to plankton production. Over the 1992–1993 period, ocean temperatures warmed and landings dropped by more than a half over the next few years. During the late 1990s, there was a significant decline in annual herring landings in the Bay, which coincided with the 1997/1998 El Niño. Because run numbers in the Bay were extremely low, no fishery occurred in 1999 and 2000. In 2001, a small total quota was fished with landings totalling 14 t. In 2001, an acoustic assessment in the Bay indicated the presence of a much larger spawning herring population, but the herring had already spawned and left the bay before fishing could commence. Failure to commence fishing in time appears to be due to the time taken to conduct a special herring survey in the Bay (Matteson, 2003a). A total quota of 126 t was set for the 2003 season by the Oregon Department of Fish & Wildlife. Herring landings totalled 93 t for the season. Poor ocean survival led to low numbers of herring returning to spawn in Yaquina Bay in 2004, 2005 and 2006 (Matteson, 2007). As a result, no commercial fishing for herring was conducted there during these years.

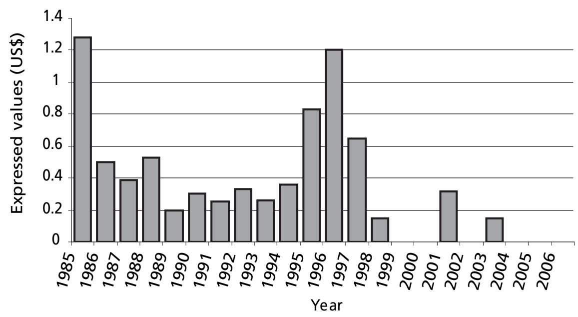
TABLE 1
Herring Landings in Yaquina Bay's Herring Roe Fishery, 1978–2006

Year	Landings (t)
1978	39.6
1979	45.3
1980	47.4
1981	41.3
1982	4.8
1983	55.0
1984	62.2
1985	71.4
1986	57.2
1987	222.4
1988	160.8
1989	247.5
1990	215.0
1991	191.5
1992	191.0
1993	74.1
1994	3.3
1995	48.7
1996	47.3
1997	49.9
1998	7.4
1999	(no fishery)
2000	(no fishery)
2001	13.9
2002	(no fishery)
2003	92.5
2004	(no fishery)
2005	(no fishery)
2006	(no fishery)

In addition to widely fluctuating herring abundance, Yaquina Bay fishermen have had to contend with dramatic price changes (Figure 2) for which there are a number of possible reasons. One is the Japanese economy, where most, if not all, of the demand for herring roe emanates. When the Japanese economy is growing and incomes are up, prices for herring tend to rise. When the economy performs poorly and incomes fall, prices for herring roe tend to fall. In addition, the final product, kazunoko, is a food that Japanese consumers consider a luxury and, as such, any change in income in either direction results in a greater change in its demand.

Another possible influence is the size of herring landings in the San Francisco Bay herring roe fishery. This fishery is located several hundred miles south of Yaquina Bay. Herring landings in this fishery total several thousand tonnes per year, compared to an average of nearly 90 t a year in Yaquina Bay. The San Francisco Bay fishery starts in December, two months earlier than the Yaquina Bay fishery and lasts through mid-March. Oregon herring fisherman Eugene Law (2003b) believes that when herring landings in San Francisco Bay are quite large, the price paid to Yaquina Bay fishermen tends to be lower due to a glut of herring on the market. In years with abnormally low landings in San Francisco Bay, the opposite effect on the Yaquina Bay herring price is believed to occur. While no statistical estimate of the extent of such an influence on the

FIGURE 2
Average price per pound of herring



Yaquina Bay herring price is available, this opinion seems plausible.

Another possibility is the roe content of the herring catch, the only factor under the control of Yaquina Bay fishermen. As an incentive, roe buyers pay a higher price if the roe content is above the target level. If roe content varies annually, then this may be another reason for fluctuating prices. Based on information that roe content was higher, on average, during the 1989–2006 period than during the 1978–1988 period (Law, 2003b), one might expect prices over the 1989–2006 period to be higher on average. But this is not the case (Figure 2). While roe content influences the ex-vessel price, it is not dominant enough to manifest such a trend.

3. HISTORY OF FISHING OPERATIONS

The Yaquina Bay herring roe fishery is affected by a number of state regulations. The fishery is the only commercial herring roe fishery allowed in Oregon's territorial waters. It appears that limiting the roe fishery to Yaquina Bay is a consequence of the state's limited resources for managing state fisheries (McCrae, 1994). Other herring fisheries in Oregon waters are allowed either for bait or for recreation, but their aggregate landings average less than 4 tonnes a year (McCrae, 1994). As it did from the start, the state sets the season's schedule and the total allowable catch in the Yaquina Bay herring roe fishery. In 2003, the season for commercial herring roe in Yaquina Bay ran from 1 February through 15 April, with the added restriction that roe herring could not be taken commercially from midnight Friday through midnight Sunday. The total allowable catch is set equal to twenty percent of the prior year's spawning biomass in Yaquina Bay. This biomass figure is estimated through a state-run survey of egg deposition in Yaquina Bay. In 2003, the state set the overall quota at 126 t based on estimated spawning biomass of 629 t in 2002 (Matteson, 2003b).

Fishermen are allowed to net herring until the conclusion of the season or until the total allowable catch in the fishery has been reached, whichever comes first. In contrast to the San Francisco herring roe fishery, which is limited to gill nets, gill nets are not allowed in the Yaquina Bay fishery. According to Eugene Law (Fisherman, Toledo, Oregon) a gillnet with a large mesh size has the advantage of being able to select only the largest herring, including large females with the highest roe content. But there is concern that the use of gill nets could restrict the gene pool of the herring population. In Oregon, the only legal gill net fishery is an indigenous one for salmon. Herring fishermen in Yaquina Bay are allowed to use hook and line or seines, but the gear of choice is either lampara or purse seines. Photo 1 depicts a lampara seine being used to net herring in the Bay. By state regulation, purse seines can be no larger than 50 fathoms (91 m) by 7 fathoms (13 m).

Fishing does not take place during the defined season until large schools of herring appear in the Bay and female herring in the schools have the desired roe content to meet buyer specifications. The rule of thumb is that roe content must be at least 10 percent of total fish weight (Matteson, 2003a). This determination is made through daily test fishing exercises. Each day, one or two fishermen net a small number of herring from various schools in the Bay and then weigh the females landed and their roe content to compute percent roe content. When test fishing indicates the target level is reached, actual fishing begins. In 2003, test fishing for roe content took place over the 3–10 February period and actual fishing began 10 February when the desired level was reached (Law, 2003a).

PHOTO 1
Fishing for herring using a lampara seine

KEITH MATTESON, ODFW AT-SEA RESEARCH/DEVELOPMENTAL FISHERIES

There is an incentive to land herring with the highest possible roe content. Buyers pay fishermen a bonus for herring with roe content above the target level. The industry standard is to pay fishermen a base price plus an additional ten percent of the base price for every percentage point that roe content is above ten percent. Thus, a roe buyer would pay herring fishermen $600 a tonne for landing herring with a roe content of 12 percent and a base price of $500 a tonne.

4. LIMITED ENTRY

In the early 1980s, there were ten Oregon fishermen participating in the Yaquina Bay fishery, an open access fishery at the time. The ten fishermen feared that leaving the fishery open access would eventually attract other fishermen and erode their profits (Law, 2003a). As a result, they urged the state to impose limited entry. The state did so in 1984 as part of a broader move to establish limited entry systems in several state-run fisheries during the 1980s. The state limited the number of permits in the Yaquina Bay herring roe fishery to ten and assigned them to the ten fishermen with catch history in the fishery. A permit is transferable from one vessel of the permit holder to another vessel of the holder. A permit holder can sell his permit to a fisherman outside the fishery, but the transfer requires state approval. No permit holder may hold more than one permit in the fishery, which prevents consolidation of permits on a vessel.

Before the start of the 1989 season, one fisherman decided to leave the fishery. He sold his permit to the other nine participants for an estimated $20 000 (Law, 2003b). The jointly held permit proved to be an important factor in the eventual formation of a private harvest agreement and co-op by the other nine fishermen.

5. THE AGREEMENT AND CO-OP

After several years under limited entry, the nine remaining participants decided that they wanted to go further in controlling fishing activity. Under limited entry and a total allowable catch, each participant tried to catch as many herring as quickly as possible before the total allowable catch was reached and the season closed. With this pattern, there was increasing pressure on the participants to invest in costly upgrades of vessel and gear. By one account, participants were under pressure to own both lampara and seine gear (National Marine Fisheries Service 1991). Given the modest and highly fluctuating run size of herring in Yaquina Bay and unstable prices, the participants believed that such costly investments were unacceptable.

Other factors also made the competitive fishery untenable. Preventing overfishing in the competitive fishery was becoming increasingly difficult. Greater gear sophistication and more vessels on the water at one time were already creating problems. In 1984 and 1985, when Yaquina Bay herring runs were slightly below average, landings exceeded the overall quota by 7 and 16 percent, respectively (Matteson, 2003b). With evidence that the total allowable catch was being exceeded, the nine participants believed that the state would come under increasing pressure from other interests to close the small fishery (Law, 2003b). The hectic pace of fishing was also causing operational problems. It was not unusual for the season to end in a matter of hours because fishermen had harvested the season's total allowable catch (Law, 2003a). Under such a compressed season, an equipment breakdown on opening day spelled financial disaster and each of the nine fishermen had experienced such a disaster. Safety was also sacrificed; if a storm was forecast, a fisherman might lose his share of the season's catch if he stayed ashore while others ventured out. The race for fish meant that fish was of lower quality because fishermen landed every fish they netted, including immature ones with little roe. This lowered the value of the catch by as much as 20 to 25 percent (Law, 2003a).

In 1989, the nine fishermen agreed to individual shares in the total allowable catch for each of the next three years. Each fisherman agreed to try to catch one-tenth of the total allowable catch. To allow for a margin of error, landings that exceed the combined quota of the nine fishermen are allocated to the quota associated with the tenth permit that is jointly held by the nine fishermen. To facilitate administration of the private agreement, the nine fishermen formed a nonprofit, Chapter S Corporation called Yaquina Herring, Inc. (YHI), essentially a producer cooperative. According to Law (2003b), YHI serves the primary purpose of assuming joint ownership of the tenth permit and any overage that is allocated to the tenth permit. Earnings from the quota held by YHI are devoted to funding activities that contribute to fishery health, such as funding an assessment of the herring stock in the Bay.

6. RESULTS UNDER THE AGREEMENT

The agreement has alleviated the race for fish that plagued the fishery under the old regime. Seasons that lasted only a few hours have disappeared. Fishermen can now choose the most opportune time to fish, such as when roe content is higher. Law (2003b) estimates that roe percentage in herring landings has averaged between 12 and 13 percent since 1989, the inaugural year of the agreement. Prior to the agreement, Law estimates that roe percentage averaged slightly less than ten percent. When immature fish with low amounts of roe are netted, fishermen can now safely return them to the Bay to mature in approximately seven days and enhance the stock. Fishermen find it easier to balance the herring fishery with other fishing activities, such as crabbing and shrimping. Equipment breakdowns are no longer a catastrophe as they were before individual quotas.

On the cost-saving side, there is no need to invest in periodic gear and vessel upgrades because fishermen are no longer competing to catch the largest share of the total allowable catch. Savings have also resulted from economies of scale as fishermen have co-operated to catch their shares. For example, one of the fishermen who previously brought his larger vessel down the coast to fish no longer does so. Instead, he uses a skiff to net herring and has an agreement with another fisherman to off-load his catch. There are far fewer vessels, gear and labour than there were prior to the 1989 agreement. Prior to the agreement, Law (2003b) estimates that the hectic pace of fishing typically entailed the use of 8 to 10 catching boats to net herring and another four packing boats. Landings averaged about 81 t a season over the 1980–1988 period. After the agreement, Law (2003b) estimates that cooperative fishing typically entailed the use of three catching boats and another two packing boats (Law, 2003b; Matteson, 2003a). Landings averaged about 99 tonnes over the 1989–2003 period, above the average for pre-agreement period.

Harvest and stock management appear to be better as a result of fishermen cooperation. State fishery managers are pleased with the programme because it helps keep the actual catch in line with the total allowable catch. During years of poor runs in the Bay, the nine fishermen tend to be "quite conservative" and want managers to set the total allowable catch carefully to protect the resource for the future (Matteson, 2003a). The agreement has also led to investments by fishermen in research on Yaquina Bay's herring stock. In 2002, for example, the nine fishermen used funds from the tenth permit to pay $6 500 to BioSonics, a research firm, to conduct an acoustic assessment of herring numbers in the Bay during spawning (Law, 2003b). The state of Oregon contributed another $1 000 for the assessment. For this effort, the fishermen also donated their time and vessels to help locate schools of herring. One of the fishermen donated the use of his vessel as a platform for BioSonics' measuring equipment. The resulting estimate of herring numbers assisted in developing the following year's overall herring quota (BioSonics, 2002). As the state of Oregon had insufficient for resources to manage state fisheries in recent years, investments such as this by the fishermen are good news for the future health of the herring stock.

7. DISCUSSION

An important question to ask is, what factor(s) contributed to the Yaquina Bay agreement? One factor is the small number of participants. A small group lowers the cost of reaching an agreement and lowers the cost of monitoring the agreement. Notably, there does not appear to be any enforcement concerns in the fishery under the agreement. There have been periodic individual overages, but they have not surpassed the amount allocated to the jointly-owned tenth permit. The absence of enforcement concerns appears related to the high level of cooperation among the nine fishermen in sharing fishing inputs. Given such cooperation, fishermen tend to know who catches what (Law, 2003b). Interestingly, when the nine fishermen made their initial agreement, they were able to come to terms despite differences in fishing ability. Prior to the 1989 start of the programme, two of the nine fishermen were catching 30 percent of the total catch while the others caught roughly ten percent each.

Apparently an agreement to share the catch equally was expected to produce enough benefits in terms of lower financial risks, more operational flexibility to fish and higher roe percentages to satisfy everyone. All members, including new recruits, possess one important trait, which contributes to maintaining the agreement. All participate in other state fisheries and have other sources of income. The herring roe fishery, while it is profitable, is not critical to the financial well being of the participants (Law, 2003b). Of course, financial well-being would be adversely affected if competition returned and costs escalated for the fishermen. As a result, the fishermen want the fishery to continue as a cooperative effort.

California's San Francisco Bay herring roe seine fishery, with 42 permit holders, provides an interesting contrast to the Yaquina Bay herring roe fishery. Beginning with the 1982–83 herring season, the 42 permit holders agreed to an individual quota programme to overcome the rising costs of competition and low roe recovery rates. With the support of the California Department of Fish and Game, they agreed to allocate shares of their overall quota among themselves. As in Oregon's Yaquina Bay herring roe fishery, the shares are divided equally among the forty-two participants, but there is not an extra permit to cover overages in landings. The permits can be bought and sold.

As with the Yaquina Bay fishery, the private agreement led to successes. It enabled fishermen to land fish with higher roe percentages. It also gave fishermen greater operational flexibility. For example, herring fishermen who also fished for squid did not have to be on the herring grounds at the opening. The pressure on Washington-based fishermen to reach the fishery on opening day, despite poor weather conditions, was reduced. Overall, fishermen were pleased with the benefits from the programme (Maxwell, 1992).

With the higher number of participants, enforcement was imperfect but state officials noted that violations were not serious. Cases of high-grading and fish smuggling by some fishermen were reported by other fishermen in the early 1990s, but state managers thought they had more significant enforcement problems with the San Francisco Bay gill net herring fishery, which has an overall catch limit without individual quotas.

Unfortunately, despite its success, the private agreement among the 42 participants could not overcome governmental interference. The use of purse seine and lampara nets was outlawed by the state of California in the mid–1990s and all 42 permits were converted to permits in San Francisco Bay's gill net herring roe fishery (Ashcroft, 2002).

For the gill net herring fishery in San Francisco Bay, which had 430 permits in 2002, a private agreement over individual shares of the catch appears unlikely (California Department Fish and Game, 2002). Susan Ashcroft (2002), San Francisco Bay herring fishery manager for California Department of Fish and Game, states that there exist "huge ranges in catches between individual boats" and the fishermen "like to compete." But there are other factors. The gill nets used have a mesh size that snares only large mature females with high roe percentages. Compared to the Yaquina Bay seine fishery, which is less selective, the gain from timing their catches better without competition is not as great in the gill net fishery. Fishing is structured to extend over a long enough period to allow for the availability of mature females with high roe content. The fishery is divided into three platoons, each with a fleet quota set by state managers based on the previous year's biomass estimate. The "DH platoon," with 133 permits, fishes in December. In January, the "Odd" and "Even" platoons, with 150 and 147 permits respectively, are rotated into the fishery on a weekly basis. Once those fleets have reached their quotas, the DH platoon is allowed to return and can land any of its remaining quota until the end of the season.

Another critical difference is that, while the fishery is subject to the same low roe prices as the Yaquina Bay herring roe fishery experiences from poor economic conditions in Japan, its total landings are typically more than forty times larger than the Yaquina Bay fishery. This may help ameliorate the risks of investing in the San Francisco Bay fishery, although they certainly still exist.

The Yaquina Bay agreement has proven resilient to widely fluctuating resource and market conditions and to recently lower economic prospects. Despite fluctuating stocks and demands, the agreement has been renewed every three years since 1989. Two of the original 1989 participants sold their permits to two new fishermen, but these sales have not prevented the agreement from being renewed every three years. The new entrants signed onto the agreement and are members of the co-op. Neither weak roe demand nor a lower return in recent years has been grounds for ending the agreement. Law (2003b) estimates that a permit sale today would probably bring a lower price than the estimated $20 000 received for the permit sold just prior to the agreement in 1989. But he contends that everyone wants to continue the agreement. In fact, there is now discussion among fishermen to make the agreement permanent.

In economic terms, the benefits of continuing the agreement outweigh the costs. All nine fishermen participate in other fisheries, including more lucrative Oregon crab and shrimp fisheries. By not having to be on the herring grounds at the outset of the season, the fishermen have greater freedom to participate in these other fisheries. While not a dominant factor, the ability to time harvests to obtain a higher roe percentage is still important. Cost savings are also contributing to continuing the agreement. Given the uncertain conditions in the fishery, fishermen appreciate that they do not have to make costly upgrades to compete and can save on inputs by teaming up with one another on their catch. They also believe the fishery would not continue as a competitive fishery. Either it would be too costly, or it would be closed by the state because of the inability to prevent overfishing.

To be sure, there are challenges ahead. A stagnant Japanese economy and shifting tastes have dampened the demand for herring roe for the time being. And, improved biological assessments of the Yaquina Bay herring stock are needed to enable the fishery to have a reliable total allowable catch. Fortunately, the agreement allows fishermen the flexibility and opportunity for collective investment to meet these challenges.

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Achievements of the Pacific whiting conservation cooperative: rational collaboration in a sea of irrational competition

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1. INTRODUCTION

The design and allocation of harvest rights and privileges[1] can profoundly influence the evolution and success of a fishery. The structure and security of rights will engender, shape or constrain the ability of rights-holders to act to promote individual and collective welfare. The use of these rights will also be influenced by the characteristics of the fishery. Such factors as the number and types of rights-holders and their working relationships will shape and influence the institutions and collective strategies that rights-holders develop. This may be particularly true when the rights are coarse, lumpy, or constrained relative to the refinement and flexibility needed to maximize fishery management objectives.

A compelling example is the Pacific whiting fishery off the west coast of the United States and Canada. Before 1997, the Pacific whiting catcher-processing fleet, along with other sectors of the Pacific whiting fishery, was overcapitalized and engaged in Olympic style or "race-for-the-resource" harvest and processing strategies. This resulted in welfare losses to the industry and coastal communities and the failure of the fishery to meet biological, economic and utilization goals articulated in the Pacific Fishery Management Council's (Council) Groundfish Fishery Management Plan

[1] In the context of fisheries, user privileges are a weak form of access "property rights" that can be nullified or reallocated without compensation by the resource owners (usually the federal or state government). In the United States, licences, permits and individual fishing quotas are common examples of user privileges. For the purpose of this paper we use the term "rights" to represent a wide range of strong and weak rights including non-compensable user privileges.

(Larkin and Sylvia 2004, PFMC, 1997). However, in 1997 a dramatic change took place in the offshore catcher-processor sector of the fishery with the formation of the Pacific Whiting Conservation Cooperative (PWCC) (Sullivan, 2000). The PWCC ended the race-for-the-resource and generated significantly higher economic and conservation benefits. The PWCC proved so successful that it became the model for the design of the *American Fisheries Act (AFA)*, which authorized the development of the Bering Sea Pollock Cooperatives (Criddle and Macinko, 2000). In contrast, the other sectors of the Pacific whiting fishery were unable or unwilling to reach cooperative agreements and have continued to engage in "race-for-the-resource" strategies.

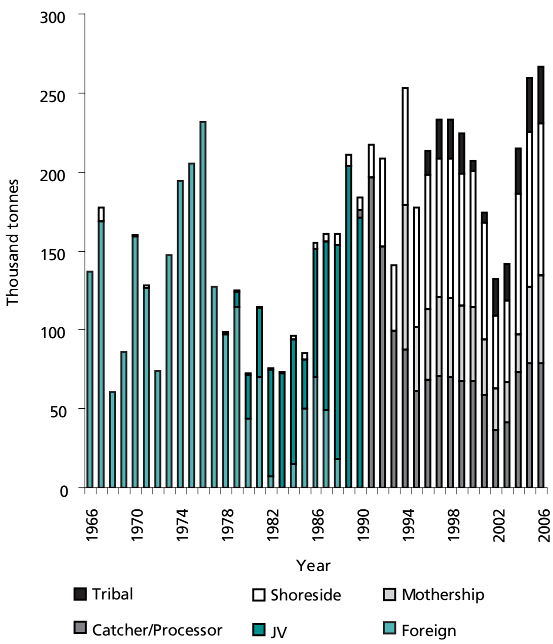
So what happened prior to, during and immediately following 1997 that led one sector of the fishery to engage in "rational" (welfare enhancing) collaboration, while other sectors continued to engage in "irrational" (welfare reducing) competition? What were the short and long run achievements of the Cooperative? Could the lessons learned from the Pacific whiting fishery be applied to other fisheries both inside and outside the Pacific Northwest? The following case study addresses these questions by reviewing the biology of the species, the history of the fishery and the development and achievements of the PWCC relative to the other sectors of the whiting fishery. The discussion then analyses the key factors in the success of the Cooperative and highlights potential future risks.

2. BIOLOGY OF PACIFIC WHITING

Pacific whiting (*Merluccius productus*), also known as Pacific hake, is the largest stock of groundfish south of Alaska and is ecologically the most important West coast finfish species (Livingston and Bailey, 1985; Nelson, 1985). Pacific whiting range from the Gulf of California to the Gulf of Alaska but are most abundant from Baja California to southern British Columbia. The coastal stock migrates seasonally from its wintering and spawning grounds off Baja California to its summer feeding grounds from northern California to British Columbia. The northernmost regions have, on average, larger and older fish and a higher proportion of sexually mature females.

The stock may vary from one to four million tonnes and sustains an average annual North American harvest between 140 and 450 thousand tonnes. Industrial scale harvesting of Pacific whiting began in the US zone in 1966 and recorded landings have ranged between 100 000 to 350 000 tonnes annually (Figure 1).

FIGURE 1
Pacific whiting landings in the United States, 1966–2006



Sources: PFMC, 2002; Helser *et al.*, 2005; PFMC, 2006a; NMFS, 2007.

Pacific whiting are moderately productive and long-lived with an average life span of 15–20 years. The average individual mature fish (3–4 years old) weighs approximately one kilogram. The stock size varies as a result of highly variable annual recruitment. Variation in recruitment appears to be environmentally driven and strong year classes appear to be linked to years of weak January upwelling (Methot and Dorn, 1995).

Pacific whiting are a relatively delicate fish and must be handled carefully after catch (Photo 1). Pacific whiting are infested with a myxosporidean parasite and the production of

PHOTO 1
Pacific whiting, headed and gutted ready for freezing

protease enzymes by the fish in response to the infestation can lead to rapid breakdown of the muscle tissue after death. Special care to avoid soft and mushy flesh includes relatively short tows and rapid chilling in refrigerated seawater tanks, particularly if there is a lag between harvesting and processing (Peters, Sylvia and Morrissey, 1995).

3. HISTORY OF THE FISHERY

3.1 1960–1990: Foreign vessels and joint ventures

Prior to the implementation of the *Magnuson Fishery Conservation and Management Act* (Magnuson Act), whiting were harvested only sporadically off the West coast and were not considered an important or economically valuable species (Nelson, 1985). In 1966, Russian and Japanese fishermen entered the fishery and were followed by other European and Asian countries during the 1970s. Some shore-based landings of whiting occurred after 1966, when government subsidies supported industry development. When subsidies ceased in 1968, the shore-side landings of whiting decreased dramatically. Even after the passage of the Magnuson Act in 1978, which created the regional fishery management councils and gave the U.S. control over all fishery resources within 200 miles of shore, domestic fishing operations did not have the necessary infrastructure, technologies, or market access to catch and process the available resource. However, joint venture fisheries were established during the early 1980s between U.S harvesters and foreign processing vessels, including vessels from the Soviet Union, Poland and Japan.

In 1987, the West coast groundfish fleet began discussions on establishing limited entry. It would be seven years, however, before a limited access plan for the groundfish fleet would be approved and implemented.

During the late 1980s, the Japanese began to produce surimi from whiting after development of enzyme inhibitors that prevented protease enzymes from denaturing whiting muscle proteins. Surimi is a fish paste produced by dewatering fish proteins and adding chemicals and stabilizers (Peters, Sylvia and Morrissey, 1995). It is used to make seafood analogs such as "artificial" crab and shrimp. As a relatively firm, pliable, odourless and tasteless protein-based product, it can be used as an ingredient for many food products. Japan, the world's largest surimi market, has over 200 products that include surimi as an ingredient. Prior to production of surimi, the joint venture fishery produced mainly frozen blocks of headed and gutted and fillet products (Nelson 1985, PFMC, 1997). By 1989, all foreign harvesting had been eliminated. However, except for a small amount of product processed on shore for domestic headed and gutted markets, most of the catch was still processed by foreign vessels in joint venture operations.

3.2 1990s: Allocation battles and domestication

In 1990, US factory trawlers entered the fishery. Factory trawlers, which are also known as catcher-processor vessels, harvest the fish and then process the catch directly aboard the vessel. Because of over-capitalization in the Alaskan pollock fishery and

PHOTO 2
F.V. Pacific Glacier*, an example of a factory trawler now operatingin the West Coast Pacific whiting fisher*

PHOTO 3
Discharging H&G product from two catcher-processors, F.V. Northern Hawk *and* F.V. Northern Jaeger*, Bellingham, Washington State*

the end of year-round fisheries, these vessels were now seeking alternative fishing opportunities. Photo 2 shows an example of a current factory trawler in this fishery and Photo 3, discharging the catch of Belllingham, Washington.

Because of the huge capacity of the catcher-processing fleet, within one year all joint ventures had ceased fishing operations. In 1991, all harvesting and processing operations for Pacific whiting were domestic. Initially, the Council managed the fishery through a total allowable catch and season closures. These management tools, however, were no longer sufficient because the Council recognized that at sea processing capacity had the potential to usurp shore-side operations. In 1991, the at sea component of the fishery harvested 91 percent of the allowable catch. Of that catch, factory trawlers were responsible for 60 percent of the harvest. Catcher vessels delivering to motherships that process at sea made up the remaining at sea sector. By 1992, a cap was implemented on the amount of fish that could be processed at sea and the Council allocated the allowable catch between the two sectors (at sea and shore-side). The entrance of the factory trawlers also increased the harvesting pace and condensed the season. Before 1991, the fishery lasted eight months, but with the large increase in fishing effort in the at sea sector, the fishery lasted less then three months in 1991 (Dorn 1992, PFMC, 1997).

Tensions between the shore-based and at-sea sectors escalated into a race for the resource and a political battle for allocation and rights of access (PFMC, 1997). Shore-based fishing communities were concerned that a dislocated joint-venture whiting fleet would result in a cascading effect of displaced vessels overcapitalizing other coastal fisheries. With the backing of state government, these communities had made major investments in shore-based infrastructure to support development of a Pacific whiting processing industry. With the demonstration by the Oregon State University Seafood Laboratory that quality surimi could be produced in shore-based operations, new surimi plants were constructed in Oregon and Washington ports and mid-water trawlers were fitted with refrigerated seawater tanks (PFMC, 1997).

In 1992, the limited entry plan proposed for the west coast groundfish fleet was approved, but would not be implemented until January of 1994. The fishery was managed under a total allowable catch (TAC), which limited the annual harvest. The Council feared that the at-sea sector of the fishery would dominate harvesting of the allowable catch and leave the shore-side sector disadvantaged. A Council proposal that would (a) force at sea participants to either process or catch whiting, but not both and (b), allocate quota based on "shore-side priority" was rejected by the Secretary of Commerce. The Council then developed new allocation rules (PMCC, 1993). Ninety-eight thousand tonnes were set aside for at sea processors and 80 000 tonnes were allocated to the shore-side sector. In addition, the Council maintained a reserve quota with priority for the shore-side fleet.

As the allocation conflict continued, a committee was appointed by the Council to resolve the allocation issues (Freese, Glock and Squires, 1995). The committee negotiated an agreement, which was to be implemented for three seasons (1994–1996). Sixty percent of the allowable catch was open for a competitive fishery where all sectors competed for the resource. The other forty percent was allocated specifically to the shore-side sector. If the shore-side allocation, however, was not used prior to 15 August, then a percentage of the remaining quota was released for open competition.

When the Council's limited entry plan was implemented on 1 January 1994, all of the factory trawlers that had been participating in the whiting fishery were excluded since their vessels did not meet the qualifying period for receiving a groundfish permit (PFMC, 1997). There were provisions, however, that allowed factory trawlers to purchase newly created groundfish permits from qualifying catcher boats according to a formula based on vessel length and gross tonnage. On average, each participating factory trawler purchased 11 groundfish permits at an approximate cost of US$1.5 million (PFMC, 1997). The 10 factory trawlers that bought back into the fishery replaced 109 groundfish trawl-catcher boat permits, most of which had never participated in the whiting fishery.

In 1994, four Washington coastal Indian treaty tribes were recognized by the United States as having treaty rights to fish for groundfish in the Pacific Ocean. Of the four coastal Indian treaty tribes, only the Makah Indian Nation has participated in the Pacific whiting fishery. In 1995, the Makah Indian Nation notified the Council of their intent to harvest Pacific whiting based on their claim of entitlement under treaty rights. This action created an additional sector for which the Council was required to allocate a portion of the allowable catch that "comes off the top", prior to allocations to other sectors. The Makah tribe allocation is based on 50 percent of the proportion of the whiting resource found off the state of Washington. Beginning in 1999, the Council has allocated fish to a tribal whiting fishery using a sliding scale method proposed by the Makah tribe in 1998. The tribe has received an allocation every year since 1995 (approximately 25 000–35 000 t annually).

In 1996, the industry negotiated a five-year allocation scheme that created four distinct sectors: tribal, catcher-processors, motherships and shoreside. After providing the Makah allocation, the remaining quota shares were allocated to each sector: 42 percent to the on-shore sector; 24 percent to motherships and 34 percent to catcher-processors. Since harvests fluctuate according to the allowable harvest quota, all sectors were affected equally and the race for fish between sectors was eliminated. The race for fish within sectors, however, continued and each sector of the fishery engaged in its own unique "race for the resource" fishing competition. The effects of this race were obvious. One result was the decrease in season length. Other problems also became noticeable, including excessive bycatch, poor product quality and poor product recovery rates. These problems were prevalent in all three sectors. In addition, reductions in the allowable catch due to a decreasing stock size increased tension between the four sectors

4. EMERGENCE OF THE PACIFIC WHITING CONSERVATION COOPERATIVE

The four catcher-processing companies that bought Pacific whiting harvest rights had previously worked together in attempts to solve over-capacity problems in the Bering Sea pollock fishery (Sullivan, 2000). After two seasons, these companies realized they were facing similar problems in the Pacific whiting fishery. To maximize return on investment, they recognized the need to eliminate the race for fish. In addition, they confronted the critical need to reduce bycatch of "depleted" rockfish species and of salmon, which could result in premature closure of the fishery. The companies also realized a collective solution was possible: a voluntary quota allocation scheme within their sector.

The reauthorisation of the *Magnuson Act* in 1996 included a moratorium on the issuance of individual transferable quota (ITQ) programmes. The ITQ moratorium reflected in part some political concerns that any ITQ programme for the Bering Sea pollock fishery might allocate most harvest rights to non-Alaskan fishing companies. Coincidentally, the whiting catcher-processors were owned by some of those same companies. The catcher-processing fleet in the Alaskan pollock and Pacific whiting fisheries had limited mechanisms for rationalizing their collective behaviour given the moratorium on ITQ's. One alternative, however, was a voluntary cooperative arrangement that would mimic many of the benefits of ITQ programmes. The Council had already provided a regulatory framework that would support formation of this type of cooperative by setting a fixed number of participants in the sector and a predetermined catch allocated to the sector. Increasing the potential for achieving agreement on a plan was the small number of participants in the catcher-processor sector.

As investigations for a cooperative venture continued, the group began discussions with the Antitrust Division of the Department of Justice (DOJ) (Sullivan, 2000). Initially it was unclear whether the cooperative would need an exemption under the *Fishermen's Cooperative Marketing Act of 1934* (FCMA). The companies considered a cooperative structure in part because they might be able to qualify under the FCMA antitrust exemption. The FCMA was intended to give fishermen limited protection from the *Sherman Antitrust Act of 1890*, which prohibits restraints on trade. FCMA exemptions were originally intended to benefit small, independent producers who were insufficiently integrated to perform their own processing. The four harvester and processing companies recognized that in the case of Pacific whiting (and Alaskan pollock), cooperative behaviour, rather than restraining trade, would encourage competition in output markets. By ending the race for fish, greater quantities of higher quality product could be produced for national and international markets, potentially at lower prices while also achieving greater utilization and less waste.

Based on preliminary findings by the DOJ, the four companies began negotiations to form a cooperative founded on a mutual harvest allocation agreement. Forming a cooperative to allocate harvest shares was a new concept in the U.S. Most U.S. fishery cooperatives had been organized to improve collective bargaining power, to undertake processing and marketing or to share risks and profits (McCay, 1980; FAO, 1971). In one afternoon of bargaining, the companies agreed to specific percentages to divide their sector quota allocation, based primarily on historic catch (Sullivan, 2000). The companies agreed to allow leasing and trading of quota. The companies also agreed to employ full-time observers, even though observer coverage was not a federal requirement at the time of the agreement. The companies hired Sea State, a private centralized reporting service, to monitor catch and provide real-time reports of at sea activities. The PWCC also implemented penalties for violating various provisions of the agreement, including fees for exceeding individual harvest shares.

In mid-season 1997, the DOJ Antitrust Division issued a favorable "no enforcement intent" letter and the factory trawler fleet responded by immediately adopting the provisions of the PWCC agreement and converting to share-based fishing operations. The DOJ findings (Klein, 1997) read in part:

"(I)t does not appear that the proposed elimination of the olympic system race to gather the governmentally-fixed quota of Pacific Whiting would have any incremental anticompetitive effect in the regulated output setting in which the harvesting agreement would take place. The Department of Justice has previously stated that reliance on an olympic race system to gather a fixed quota of fish 'is both inefficient and wasteful' because it is likely to generate 'inefficient over- investment in fishing and processing capacity.'… To the extent that the proposed agreement allows for more efficient processing that increases the usable yield (output) of the processed Pacific Whiting and/or reduces the inadvertent catching of other fish species whose preservation is also a matter of regulatory concern, it could have procompetitive effects."

Because the conversion occurred halfway through the Pacific whiting season, the fleet was able to compare key performance criteria before and after the agreement, including product recovery and bycatch rates. The changes in performance were immediate and exceeded the companies' expectations (Sullivan, 2000).

5. PACIFIC WHITING COMMERCIAL LICENCE AND PERMIT FEES

Vessels intending to participate in the shore-based Pacific whiting fishery are required to carry an exempted fishing permit (EFP) from 2007 if they intend to land their catch unsorted. Only Limited Entry Permit holders with a trawl endorsement are eligible to fish for whiting under the Pacific whiting shore-based fishery EFP. An **EFP** enables vessels in the shoreside hake fishery to retain and land unsorted catch at participating shoreside processing plants. A separate EFP is required for each of the two components of the shoreside fishery: South of latitude 42° (this fishery opens 1 April) and the primary fishery, which opens 15 June.

A **Processor-State Agreement** allows for processing plants to receive unsorted catch from EFP vessels in the shoreside hake fishery. Processor-State Agreements vary slightly depending on the State of processor operation. Processors must contribute monetarily to the Shoreside Hake Observation Program (SHOP). Pre-season invoices covering the first half of the season are distributed to each processor based on the percentage of shoreside hake it landed in the previous year, or is expected to land in the current year. These invoices must be paid in full and confirmed by PSMFC prior to the state entering into a Processor-State Agreement. After closure of the fishery, invoices reflecting the total hake weight landed during the season will be distributed. This payment will cover the second half of the season.

Groundfish limited entry renewal fee with trawl endorsement is $152. Vessels in the shoreside fishery are required to pay an Oregon Trawl Commission Fee. The fee is an *ad valorem* tax of 0.5 percent of the gross value of fish landed (Pettinger, Pers. comm., Oregon Trawl Commission). Shore-side processors are responsible for paying a landings fee. The landings fee for whiting is 1.09 percent of the gross value of fish landed (Grooms, Pers. comm., ODFW Commercial Fish Information Office). Vessels in the shoreside and mothership sectors are responsible for paying a 5 percent vessel buyback fee that is 5 percent of the gross value of fish landed (Pettinger, Pers. comm.).

Regulations require that catcher/processors and catcher vessels have limited entry permits with trawl endorsements to operate in the fishery. A groundfish limited entry renewal fee with trawl endorsement costs $152. PWCC members are assessed a tonnage fee that is used to fund scientific research, including funding stock assessment and bycatch avoidance programmes.

On board observers that are required for motherships and catcher/processors are funded by the vessels themselves. Vessels over 125' are required to have two observers on board, while those under 125' required only one (PFMC regulatory branch, Pers. comm.). At a cost of $300 a day, the average cost to the vessel for each observer was

TABLE 1
Licensing, permit, and other associated fees in the shoreside, catcher/processor and mothership sectors of the Pacific Whiting Fishery

	Shore-side	Catcher/Processor	Mothership
Groundfish limited entry permit with trawl endorsement	$152 annual renewal fee	$152 annual renewal fee	Not applicable
Exempted fishing permit	No fee	Not applicable	Not applicable
Required on-board observers	Not applicable	1–2 observers per boat with an average cost of $10 550 per observer	1–2 observers per boat with an average cost of $10 550 per observer
Processor State Agreement	Fee based on the percentage of fish landed and SHOP budget requirements	Not applicable	Not applicable
PWCC tonnage fee	Not applicable	Value not made public	Not applicable
Landings tax	1.09% of gross value of fish landed	Not applicable	Not applicable
Oregon trawl commission fee	0.5% of gross value of fish landed	Not applicable	Not applicable
5% vessel buyback fee	5% of gross value of fish landed	Not applicable	5% of gross value of fish landed

$9 300 (ranging from $3 950 to $36 650) during the 2001 whiting season. In addition, training and debriefing costs would have been approximately $1 250 an observer.

No permit or licence is required for a mothership. But, onboard observers, funded by the vessels themselves, are required for motherships and catcher/processors. Vessels over 125' are required to have two on board, while those under 125' only require one. With a cost of $300 a day, the average cost to the vessel for each observer was $9 300, and ranged from $3 950 to $36 650 during the 2001 whiting season. In addition, training and debriefing costs would be approximately $1 250 an observer.

Vessels in the shoreside and mothership sectors must pay a 5 percent vessel buyback fee, which is 5 percent of the gross value of fish landed. Table 1 summarizes the fee information.

6. THE BENEFITS OF COOPERATIVE BEHAVIOR

6.1 Economic efficiency

Companies with more than one vessel immediately transferred excess capacity out of the fishery and only 7 of the 10 original vessels participated in the 1998 fishery. Each year since the implementation of the cooperative, the companies have employed less then the 10 permitted vessels. Before 1998, each company employed all their permitted vessels in order to catch fish as rapidly as possible. A high catch rate per unit time became a primary imperative. With the implementation of the cooperative, catch per unit time became less important, since each company could now plan its activities according to individual needs and opportunities. This included matching raw input product quality characteristics with output product forms and developing portfolios of products, including frozen block fillets, individual quick frozen fillets and surimi (Larkin, Sylvia and Tuininga, 2003).

Economic efficiency also increased in other ways. Under the cooperative agreement, companies were able to trade or lease quota. These trade provisions allowed vessels to lease quota from vessels that were less efficient or had other more profitable fishing and processing opportunities. In addition, under the cooperative agreement there is no set date when the vessels must begin fishing.[2] If a mechanical breakdown or other

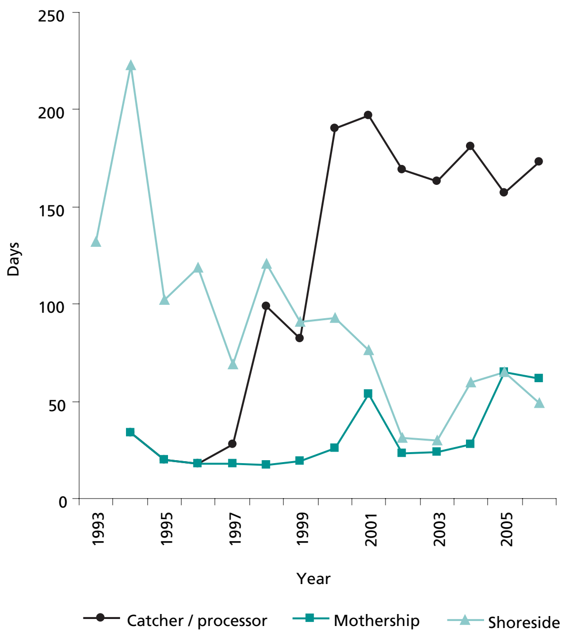
[2] For the offshore sector, the beginning of the season had been changed by the PFMC from 15 April to 15 May in order to reduce salmon bycatch and allow Pacific whiting a chance to grow and recover from the rigors of spawning and migration. The on-shore sector opens their season even later, on 15 June. This date, however, is flexible and is determined based on a formula that accounts for seasonal improvements in product quality and recovery, harvest quota and processing capacity (PFMC, 1997; Larkin and Sylvia, 2004).

incident were to prevent a vessel from completing its normal fishing operations, the opportunity would not be lost. For example, under the race-for-the-resource in the mothership sector during the 1998 season, a mothership broke down for five days with resultant loss of $500 000 in revenue (American Seafoods, 1998). Prior to the implementation of bycatch caps for the whiting fishery, which were implemented in 2005, vessels could fish for their quota at any time without the fear of being usurped by other vessels. In addition, firms have the ability to select optimal fishing conditions that depend on opportunities in other fisheries, fish size and quality, fish location, schooling characteristics and output market demand. In 1998, the season lasted 83 days, almost 60 days longer then previous years. Although not all boats were fishing during this entire time period, each company had the opportunity to adjust their operations to meet their respective needs.

6.2 Increased product quality and recovery rates

The PWCC agreement also resulted in significant improvements in product recovery or yield, producing more food from each pound of fish landed. Product recovery rate or yield is the ratio (expressed as a percentage) of the weight of raw processed product relative to landed product. Prior to the formation of the cooperative, catcher-processors achieved on average a 17.2 percent yield in surimi operations. In 1998, the first full year under the harvest cooperative, catcher-processors were achieving an average yield of 24 percent. Based on 1998 landings, this equated to over 10 million more pounds of food from the same number of fish (ASPA, 2003). While engaged in the "race for fish," vessels had prosecuted the fishery at the highest possible speed without taking the time to consider product quality or output quantity. Inferior quality and low product recovery rates were simply necessary trade-offs given the time constraints of a race-for-the-resource management system. Rationalizing the fishery allowed the vessels to prosecute the fishery at slower speeds and choose the time and location of fishing that would optimize returns. It allowed fishers to search for schools of larger and higher quality fish that generated higher yields than smaller fish (ASPA, 2003). It also motivated vessel owners to invest in equipment that would improve product yield and quality rather than simply maximize capacity for rapid throughput.

FIGURE 2
Season length of the Pacific whiting fishery, 1993–2006

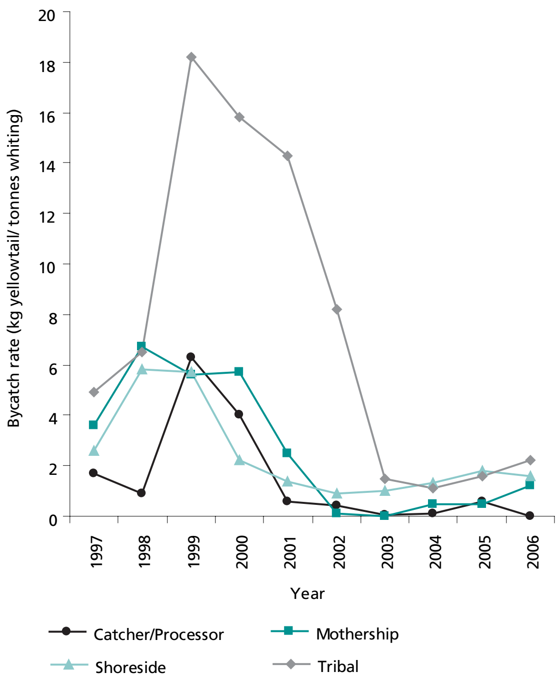


Sources: PFMC, 2002; ODFW, 2006; Renko, 2007; Federal Register, 2003, 2005, 2006a, 2006b

6.3 Season length increased

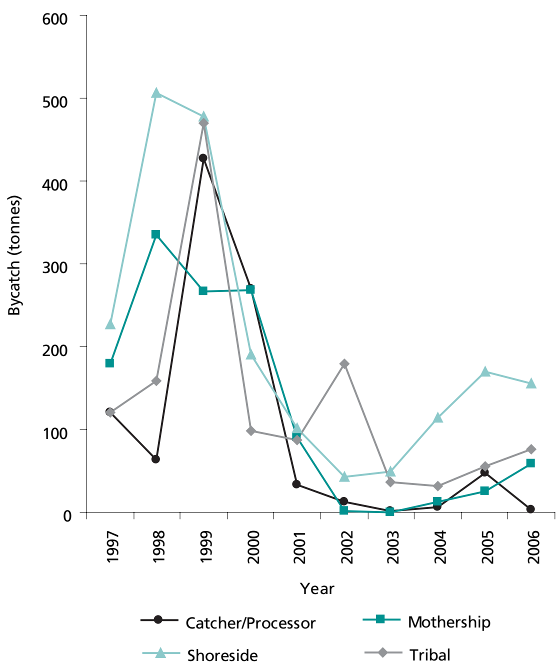
Season length had been dramatically reduced after the factory trawlers entered the fishery. Their ability to catch and process large amounts of whiting in a short period meant that the quota could be harvested in a period of weeks rather than months. Even after direct allocations were made to each sector, the race within each sector ensured that seasons would continue to contract. Following the implementation of the cooperative agreement in the catcher-processor sector, the season length increased significantly (Figure 2). Prior to 1998, the season for the at-sea sectors ranged between 18 and 34 days. During these derby fisheries, boats were fishing all day, everyday. Since the implementation of

FIGURE 3
Yellowtail rockfish bycatch rate in the Pacific whiting fishery, 1997–2006



Sources: PFMC, 2006a; NMFS, 2007.

FIGURE 4
Yellowtail rockfish bycatch in the Pacific whiting fishery, 1997–2006



Sources: PFMC, 2006a; NMFS, 2007.

the cooperative, the average season length for the catcher-processor sector has ranged between 82 to 197 days. While the shore-side sector and mothership sector continue to race for fish, vessels in the rationalized catcher-processor sector have been able to slow the pace of harvesting and each firm now selects the most profitable period for participating in the fishery. In some years there have been breaks within the harvesting season of two or three months. In other years, such as 2003, some percentage of the catcher-processor's allocation was harvested in each month beginning 15 May and ending 24 October.

With increased season lengths and the elimination of the dangerous behavior of racing for fish, improvements have also been made in the areas of safety. Having the flexibility to choose when to fish allows companies the luxury of not fishing during extreme weather.

6.4 Reductions in bycatch

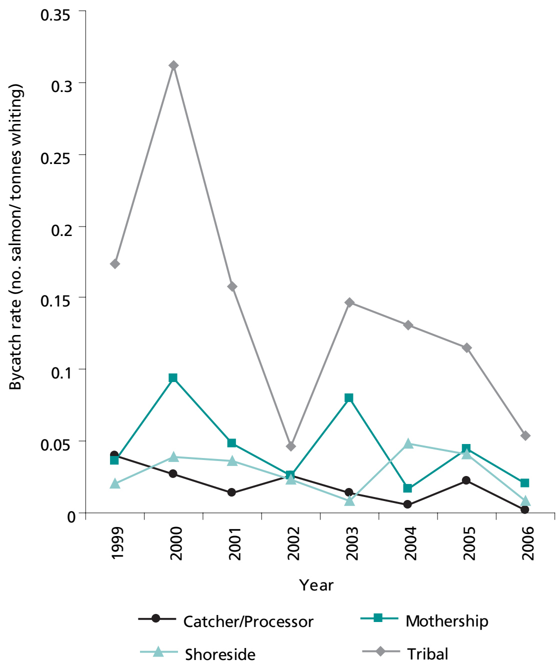
Another important issue related to establishment of the cooperative was the potential for reduction in bycatch of salmon and various rockfish species. Up through 2007, the PFMC has managed bycatch in the Pacific whiting fishery using enforceable aggregate caps across all sectors (rather than sector specific caps). Under cooperative management, vessels could take the time necessary to avoid areas of high concentrations of bycatch species and search for schools of Pacific whiting with a relatively lower mix of other species. Sea State monitors provide real time data to the catcher-processor vessels on "hot spots" (areas of high bycatch rates) so vessels can alter their fishing behaviour.

The evidence on bycatch reduction is ambiguous. While the bycatch rates have generally fallen under the PWCC, so have the bycatch rates for the mothership and shore-based fleet. The PWCC reports that the bycatch rate for yellowtail rockfish decreased by more than 60 percent from 2.47 kg of yellowtail rockfish a tonne of whiting under the race-for-fish to 0.96 kg a tonne under cooperative management (ASPA, 2003). Figures 3 and 4, however, show that the mothership and shore-based fleet have also significantly reduced yellowtail bycatch since 1996. Figures 5 through 8 also show the same general trends for salmon and widow rockfish bycatch, respectively. Although the catcher processing fleet has a relatively low level of total bycatch relative to the other sectors, in 2001 and 2002 the catcher-processor fleet had the highest bycatch of widow rockfish relative to any sector of the fishery. Figures 9 and 10 demonstrate that all sectors of the fishery had reduced overall groundfish bycatch since 1998.

The factors influencing bycatch include: (a) the specific harvest practices of each sector; (b) the length, timing, location and depth of tows; (c) the relative proportion of stock size and harvest quotas of targeted and non-targeted species; (d) changes in stock migration patterns; and (e) regulatory or market forces influencing fleet targeting behaviour. This can lead to differences in bycatch rates across sectors and years. Due to improving ocean conditions, salmon populations have increased significantly over the last five years. Conversely, darkblotched, canary and widow rockfish have been declared as "overfished" species and have been placed under a rebuilding plan and significantly reduced harvest quotas.

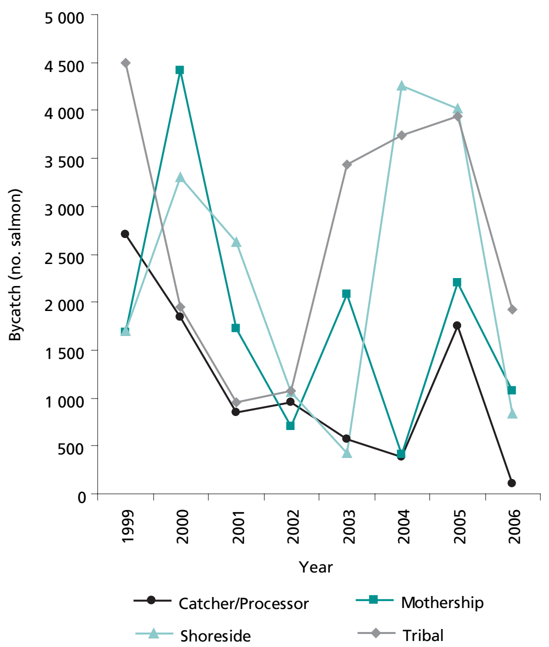
In 2005, the Council implemented bycatch caps for depleted species in the non-tribal whiting fishery. This has compelled all sectors of the Pacific whiting fishery to reduce bycatch or face potential closures or other regulations controlling fishing behaviour. In 2007, the hard caps are set at 4.7 t for canary rockfish, 25 t for darkblotched rockfish and 220 t for widow rockfish (PFMC, 2006). If these caps are met or exceeded during the fishery by one or all of the sectors, the entire whiting fishery for all non-tribal sectors will be closed. If the whiting fishery is approaching the canary rockfish bycatch cap, the National Marine Fisheries Service may require participants to fish seaward of the 150-fathom isobath to prevent early closure of the whiting fishery. Also, the NMFS may take action to implement the Ocean Salmon Conservation Zone during the season if it is projected that non-tribal participants in the whiting fishery will take in excess of 11 000 Chinook salmon within

FIGURE 5
Chinook salmon bycatch rate in the Pacific whiting fishery, 1999–2006



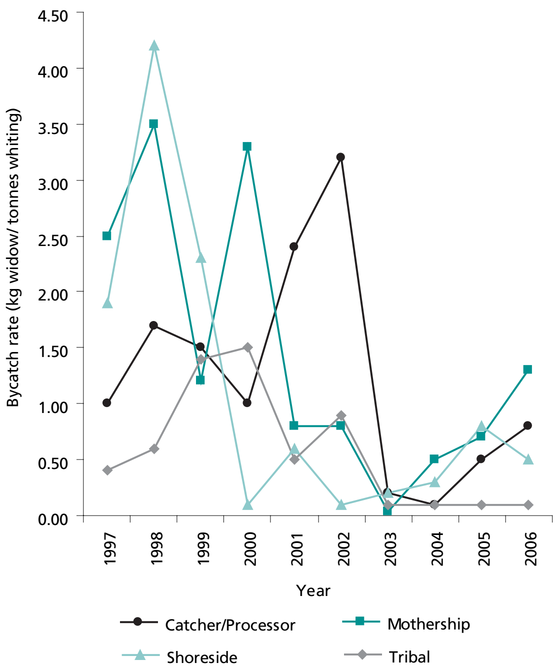
Sources: NMFS, 2003; NMFS, 2004; PFMC, 2006b; NMFS 2007.

FIGURE 6
Chinook salmon bycatch in the Pacific whiting fishery, 1999–2006



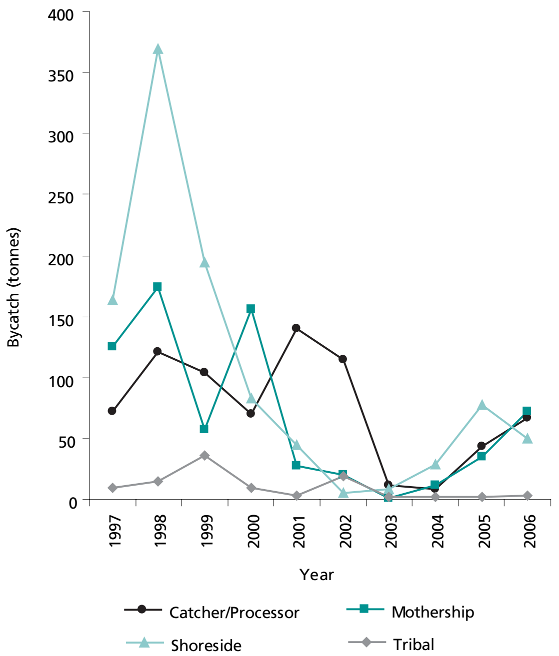
Sources: NMFS, 2003 ; NMFS, 2004 ; PFMC, 2006b ; NMFS, 2007.

FIGURE 7
Widow bycatch rate in the Pacific whiting fishery, 1997–2006



Sources: PFMC, 2006; NMFS, 2007.

FIGURE 8
Widow bycatch in the Pacific whiting fishery, 1997–2006



Sources: PFMC, 2006; NMFS, 2007.

a calendar year. If this projection is made, fishing shoreward of the 100-fathom isobath can be prohibited.

All of the non-tribal sectors have met informally prior to and during the season to discuss bycatch issues and present solutions as bycatch issues arise. The different sectors of the Pacific whiting fishery have agreed to voluntarily cooperate to manage bycatch, particularly by sharing information. However, with (a) the implementation of binding bycatch caps in 2005, (b) the relatively small size of the caps, (c) the absence of sector specific caps and (d), the need to protect and rebuild a variety of rockfish and salmon stocks, the incentive for voluntary cooperation is reduced. Bycatch is expected to remain a critical and controversial problem for those stocks classified as depleted. Development of groundfish IFQ's or sector specific caps may provide more flexible approaches and effective incentives to manage this growing problem.

6.5 Cooperative research

Members of the PWCC have engaged in other activities to improve fishery management and scientific research (Sullivan, 2000). PWCC members are assessed a tonnage fee that is used to fund scientific research, including stock assessment and bycatch avoidance programmes. PWCC has worked cooperatively with the National Marine Fisheries Service in co-sponsoring a juvenile recruitment survey for Pacific whiting. In addition, the cooperative is a member of the Pacific Groundfish Conservation Trust, a non-profit research and education corporation focused on Pacific groundfish research. To date, PWCC members have assessed themselves almost $1 million to fund cooperative research (ASPA, 2003).

7. DISCUSSION

7.1 Why only the catcher-processor sector?

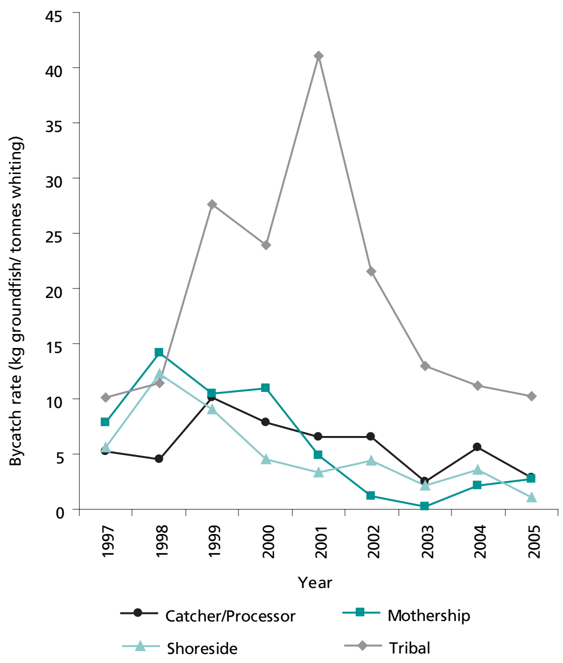
Forming the PWCC and rationalizing the catcher-processor sector of the Pacific whiting fishery generated significant benefits including greater economic efficiency, higher product recovery rates, improved product quality, greater potential control in managing bycatch and longer and potentially safer seasons. A fundamental question is why didn't other sectors of the Pacific whiting fishery develop cooperatives or similar organizations in order to generate greater benefits?

The formation of the PWCC was attributable to a set of conditions necessary to support a formal cooperative arrangement. These factors include (a) a fixed set of players (licences), (b) a sector allocated right (a fixed percentage of annual harvests) and (c), a flexible right (an overall harvest quota that could be divided). However, these attributes also characterized the mothership and shore-side sectors of the whiting fishery. The single factor that differentiated the catcher-processor sector was the limited numbers of players. Not only were there few players (four companies), but the companies also had similar vertically integrated operations and good working relationships. In contrast, during 2006, 37 vessels and 12 seafood processors participated in the shore-side whiting fishery and approximately eight floating processors and 24 harvesting vessels in the mothership sector (Wiedoff, Conrad and Parker, 2003). The sheer number of players representing different two market levels (harvesters and processors) has made agreement extremely difficult. In addition, the harvest rights in these sectors are allocated only to vessels, not processors, further complicating efforts to reach agreement. While strides have been made in improving working relationships, the difficult regulatory environment has confounded efforts to improve cooperation. Consequently, for the last ten years these sectors have continued to engage in "irrational" competition and inefficient harvest and processing strategies that result in dissipation of economic and social benefits.

In 2003, the Pacific Fishery Management Council began a process to investigate individual fishing quotas (IFQ) for the groundfish trawl fleet, which includes the Pacific whiting fishery. Prior to 2003, any discussion of new IFQ programmes for federal fisheries was prohibited due to the moratorium on IFQ programmes. The moratorium has since been lifted and since 2004 the Council has undertaken a comprehensive effort to evaluate IFQs and

FIGURE 9

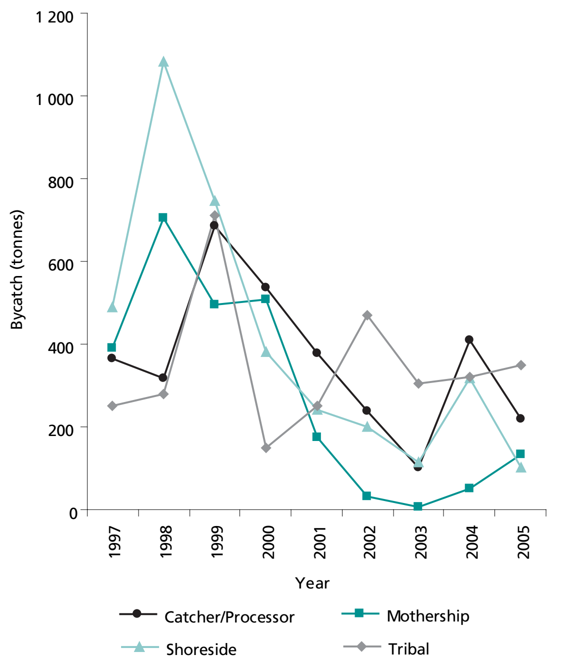
Total groundfish bycatch rate in the Pacific whiting fishery, 1997–2005



Sources: PFMC, 2006; NMFS, 2007.

FIGURE 10

Total groundfish bycatch in the Pacific whiting fishery, 1997–2005



Sources: PFMC, 2006; NMFS, 2007.

similar forms of rationalization for the groundfish trawl fleet. The trawl IFQ process has been cumbersome and complex and, even in 2007, several years are expected to pass prior to implementation of any programme.

7.2 Risks to the PWCC

The PWCC has been in existence since 1997, but recent problems have threatened its existence. The PWCC is a voluntary cooperative. If any member decided to terminate their agreement, the PWCC would crumble and return the sector to an Olympic fishery. There is also a risk of new entrants. The groundfish regulations would require a new entrant to purchase at least ten groundfish trawl permits at a cost of perhaps $1 million or more. With recent price increases for whiting, the cost of entry seemed prohibitive. But, in late 2006, the *F.V. Starbound* did buy the necessary trawl permits with the intention to participate. Entry of the *F.V. Starbound* would change the dynamics of the fishery and probably result in the collapse of the PWCC, at least in its present form.

In late 2006 and early 2007, the Council forwarded recommendations to the National Marine Fisheries Service (NMFS) to implement an emergency rule prohibiting new entrants into the Pacific whiting fishery (PFMC, 2007). The original request for action came from the shoreside industry, which voiced concern over an influx of AFA-qualified vessels into the shoreside fishery. In simplified terms, AFA-qualified vessels are Alaskan pollock vessels that were covered by the *American Fisheries Act* [AFA]. The AFA delegated responsibility to the Pacific Council to develop management plans to control any negative impact that might result from fishing effort leaving a rationalized Alaskan pollock fishery and entering west coast fisheries. No action had been taken by the Council and AFA-qualified vessels without prior participation in the whiting fishery were indeed entering the fishery. A second concern was that increased pressure might be placed on depleted species such as canary rockfish. With more vessels entering the fishery, additional pressure on these depleted species might cause an early closure in the whiting fishery, prior to full harvest of the whiting quota.

Advocates contended that emergency action should be taken while Amendment 15 to the *Pacific Groundfish Fishery Management Plan* was completed and implemented. Amendment 15 is focused on implementing the mandates from AFA. The Council's first emergency rule recommendation, forwarded to NMFS in September of 2006, would have prohibited all AFA-qualified vessels that had not participated in the whiting fishery prior to 31 December 2005 from entering any non-tribal sector of the fishery. This rule was subsequently denied by the NMFS, because it discriminated between AFA and non-AFA vessels. The Council forwarded a second rule to the NMFS in March 2007 that would prohibit all vessels (regardless of AFA qualifications) who had not participated in the whiting fishery prior to 1 January 2007, from entering any sector of the non-tribal fishery. At the time this paper was written (2007), the NMFS had not taken action on the emergency rule request. If approved, this second emergency rule would prohibit the *F.V. Starbound* from participating in the fishery during 2007 and thus would prevent any disruption to the current make-up of the PWCC. If, however, the emergency rule is denied, the *F.V. Starbound* is poised to enter the at-sea sector of the fishery and would likely cause the dissolution of the PWCC and a return to a race for the resource situation in the catcher-processor sector.

A second possible risk to the PWCC is the establishment of an IFQ programme that would eliminate the primary purpose of the cooperative, to establish and allocate individual harvesting quotas. The degree of this threat may depend on how the IFQs are structured and how well initial issuance criteria match up with the historical allocations currently utilized by PWCC. However, even in the presence of an IFQ programme, the PWCC members may elect to continue the organization to facilitate cooperation in research and management, such as bycatch management. This is consistent with the actions of many rights-based fisheries that form self-governing organizations in order to enhance the value of their fishery rights.

At present (2007) the Council is also considering co-operatives in lieu of ITQs for the three non-tribal sectors. This alternative could impose mandatory co-ops for the fishery. These cooperatives may be structured differently to the current PWCC agreements, as many more individuals, including the Council, NMFS and the public, will be involved in the decision as to how the co-ops are structured and would operate. This process could result in a framework that requires major changes to the current PWCC structure. The process could also involve much higher transactions costs, as more actors are involved in a more public process. This would be quite different from the process that the four companies completed in one afternoon in 1997.

8. CONCLUSION

The development of fishery property rights can result in greater economic efficiency and higher levels of private and public benefits. Achieving these benefits, however, also depends on the characteristics of the fishery. Given the limited and relatively weak form of property rights that characterized the Pacific whiting fishery, only the catcher-processor sector was able to capitalize on the sectoral-based quota rights. The other two sectors continued to engage in economically irrational competition and race-for-the-resource harvesting and processing strategies. In contrast, the catcher-processor sector formed the PWCC, a self-governing institution that ended the race-for-the-resource harvest strategies. Firms were able to meet their individual needs and eliminate over-capitalization, improve product recovery and product quality and manage bycatch. These benefits were the result of the unique conditions that characterized this sector and notably of the limited number of players with similar characteristics and good working relationships. Given their size and complexity, other sectors were unable to develop similar self-governing institutions. It will require more carefully structured and refined property rights (e.g, appropriately crafted ITQ's) before these sectors of the Pacific whiting fishery achieve the same level of performance and economic benefits. Although it is uncertain whether the PWCC in its present form will survive contemporary threats and challenges, by almost any standard the organization has been a successful model of voluntary self governance.

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Management of the loco (*Concholepas concholepas*) as a driver for self-governance of small-scale benthic fisheries in Chile

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1. INTRODUCTION

Fishery policies that ensure sustainable exploitation of marine benthic resources contribute to food security, protect them and preserve the social and economic status of dependant communities (Bene, 2003; World Bank, 2006). In Chile, due to the social and economic importance of artisanal benthic shellfisheries, there has been a strong political desire to achieve sustainable exploitation in these fisheries (Castilla and Defeo, 2001). This was reflected in the 1991 Chilean *Fishery and Aquaculture Law* (FAL; D.S: 430) that regulated access to benthic and pelagic coastal resources by the artisanal fisher sub-sector. The FAL defined this sub-sector and incorporated new regulations that affect their user rights through three management steps: (a) Exclusive fishery access rights within a zone that extends to 5 nautical miles from the shoreline along around 2 500 km of coast (18º 36' S, 70º 30' W to 41º 27'S, 74º 10' W) are assigned to artisanal fishers; (b) artisanal fishers are restricted to working (diving, finfishery) within the coastal region adjacent to their area of residence (regionalization); and (c), the allocation of exclusive harvesting rights for benthic resources to legally registered artisanal small-scale fishing associations, under what was defined as Management and Exploitation Areas for Benthic Resources (MEABRs) that was perhaps the most innovative management instrument of the law (Castilla, 1994, 1996; Castilla *et al.*, 1998; Gelcich, 2005a). Through this policy, the Undersecretary of Fisheries allocates territorial user rights for fisheries (TURFS) to artisanal registered associations (Castilla and Defeo, 2001; Defeo and Castilla, 2005; Gelcich, Edwards-Jones and Kaiser, 2005a). This includes the right to exclude non-members of fisher associations from exploiting the seabed area of MEABRs.

The rationale behind TURFS is based on a common property approach which proposes that property rights will create institutional arrangements among fishers, who will then manage, collectively harvest and sustain the resources (Ostrom, 1990; Ostrom and Schlager, 1996). In addition, MEABRs should contribute to more effective enforcement of regulations by increasing the likelihood of compliance (Jentoft, McKay and Wilson, 1998; Castilla, 2007; Gelcich, Edwards-Jones and Kaiser, 2007). The MEABR model, which effectively takes the form of co-management, was derived from field experiments conducted mainly at the Estación Costera de Investigaciones Marinas, Las Cruces, Pontificia Universidad Católica de Chile (Castilla and Fernández, 1998). In fact, the first MEABR was established experimentally in 1989 (Caleta Quintay, central Chile), before the law was introduced (Castilla, 1994). MEABRs regulated by the law began to be decreed in 1997. According to the National Fisheries Service (SERNAPESCA, 2005) there are currently 547 decreed MEABRs in Chile, with a total seabed area of 102 338 hectares.

In this chapter we highlight the importance of the gastropod *Concholepas concholepas* (loco), the cornerstone species that drove legislation on MEABRs as well as the role of this policy to achieve wider fishery objectives and generate incentives and conditions for self-governance.

2. ARTISANAL BENTHIC FISHERIES IN CHILE

The definition of artisanal and small-scale fisheries versus mid-scale and large-scale or industrial fisheries varies enormously and is country dependent (Castilla and Defeo, 2001; Berkes *et al*., 2001). The 1991 Chilean FAL defined two main fishery sub-sectors: "Artisanal" and "Industrial". An artisanal fishery is defined as a fishery extractive activity carried out by fisherfolk that personally direct and who normally work in coastal areas. For this purpose, and interpreting the law, "coastal" means the oceanic realm within the first 5 miles from the littoral line. To be considered an artisanal fisher one must be registered as such with the National Fisheries Service and fishing vessels must not exceed 18 m in length and a maximum of 50 gross register tons. Four categories of artisanal vessel/boats are defined in the Law: (a) Artisanal open boat: with or without outboard engine (most of the artisanal benthic small-scale fishery activities and artisanal small-scale pelagic fin-fish fishery belong to this category), (b) Small-vessel (*lancha artesanal*): fully covered with inboard engine and maximum 12 m in length, (c) Medium-vessel: fully covered, inboard engine and between 12 to 15 m in length, (most of the sword-fishery fleet in Chile belongs to this category) and (d), Large-vessel: fully decked, inboard engine and maximum 18 m in length (most of artisanal small-pelagic fishery fleets belongs to this category) and maximum 50 gross register tons (FAL, 1991; World Bank, 2006).

To obtain an artisanal fisher licence it is required to be registered in the *Registro Nacional de Pescadores Artesanales de Chile*; fishers are also registered for the target species they fish. Fishermen do not have to pay a fee to register to harvest the particular resources they wish to fish. Once a resource reaches the category of "fully-exploitation" within a region, no further registration for that specific species is accepted. In regard to MEABRs, artisanal fishers do not pay any form of fee, but they do have to pay a yearly fee per hectare once the MEABR has been in operation for 4 years (now about US$ 6 per hectare).

According to SERNAPESCA (2005) there are a total of 54 751 registered artisanal fishers, which depend on different resources and livelihood strategies. Artisanal fishers include: (a) Armador Artesanal (boat owners), (b) Shellfisher, (c) Algae Extractor and (d), Artisanal Fisher as such (definitions are given in the Law). The categories are non-exclusive and therefore can be used simultaneously. There are 6 920 algae gatherers, 13 199 shellfishers (including divers) and 39 995 fishers (mainly finfishers) in Chile. Currently, indigenous (first nation) groups along the Chilean coast must also subscribe to one of these categories to be permitted to extract marine resources

Artisanal fishers in Chile, irrespective of livelihood strategy or vessel type, are organized around areas of coastal land which are officially designated as 'coves' (*caleta* in Spanish). These are strips of land above the high tide mark that are granted as a concession by the state and provide rights to users, such as the right to have access to the sea, the right to land a boat, the right to land catch and to erect certain buildings (Gelcich *et al.*, 2005a). According to SERNAPESCA (2007) there are a total of 453 permanent artisanal caletas along the Chilean coast.

A subset of artisanal fishers in Chile is composed of artisanal benthic small-scale fishers (Castilla and Defeo, 2001), these extract most species of benthic shellfishes (over 60 species of invertebrates, including crustaceans, molluscs, sea-urchins and tunicates are harvested) through: (a) manual collection during low tides (Castilla,

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PHOTO 1
*Landings of a collective harvest of loco (*Concholepas concholepas*) from the MEABR at Caleta el Quisco in 2001*

Campo and Bustamante, in press), (b) skin diving and (c), semi-autonomous or air compressor ("hooka") diving gears (Bustamante and Castilla, 1987). Hooka gear fishers' activities usually involve an artisanal open-boat (5–9 m long), outboard motor (10–45 hp), air compressor and a crew of 3–4 (boatman, assistant and one or two divers). Diving trips are normally during the day, usually less than 15 miles from the base port and diving in no deeper than 25 m (Castilla and Defeo, 2001). In Chile, the most economically important benthic artisanal resources are the muricid snail *loco* (*Concholepas concholepas;* Photo 1), the red sea urchin *erizo* (*Loxechinus albus*) and *lapas* or key-hole limpets (several species of genus *Fissurella)* (SERNAPESCA, 2005; Moreno *et al*., 2006).

3. REGULATORY HISTORY OF THE LOCO FISHERY: A DRIVER FOR MEABR POLICY

The loco fishery is considered as the main catalysis for the inclusion of MEABRs within the FAL (Castilla, 1996; Gelcich, Edwards-Jones and Kaiser, 2005a; Castilla, Gelcich and Defeo, 2007). The loco fishery showed three fishery phases prior to the implementation of the 1991 FAL. The first (1960–1974) was characterized by landings of around 3 000–6 000 tonnes, used mainly for domestic consumption. These landings probably represented a sustainable harvest level for loco (Figure 1). Chile then adopted a neo-liberal policy framework. This, together with the implementation of an aggressive exchange rate policy and open markets in 1974–75, substantially improved fishing export earnings, and produced the necessary incentives for Chile to become the region's leading fish and shellfish exporter (Thorpe, Ibarra and Reid, 1999). Demand from Asian markets was constantly increasing and local credit programs created by the government provided favourable investment opportunities for new boats, diving gear and processing plants, thereby stimulating even further product demand (Schurman, 1996). At that time, as most loco fisheries in Chile operated under an open access policy, artisanal fishers, although based at specific artisanal caletas, used to migrate along the country. Thousands of divers moved around Chile, mainly to the southern regions, sparking fights between locals and outsiders in what was named at the time the "loco war" or "loco fever" (Meltzoff, Stotz and Lichtensztajn, 2002; Reyes, 1988). Between 1976 and 1981 loco landings abruptly increased reaching a peak of 24 800 tonnes in 1980. According to a Fisheries Department official, the open-access state of benthic resource fishing in Chile and the newly opened export markets

FIGURE 1
Evolution of total landings (MT) of loco including conch (shaded dots) and price (US$/MT) of loco without conch (open dots)

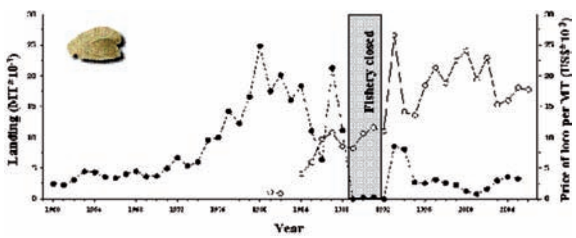
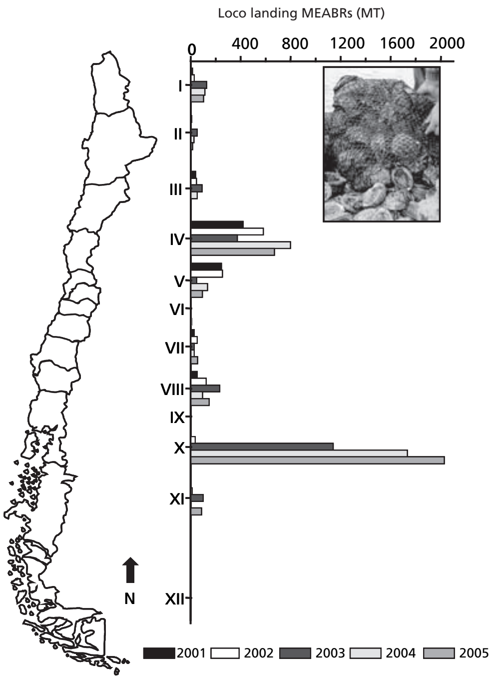


FIGURE 2
Loco landings in tonnes (locos with shell) exclusively from MEABRs in Chile across different regions (2001–2005)



were enough to lead to a "tragedy of the commons" situation (see Castilla, 1994; Gelcich *et al.*, 2005b). The loco fishery was closed between 1989 and 1992 (Figure 1).

Since 1992 the loco fishery has been regulated by the FAL and since the year 2000 loco can be extracted exclusively from inside allocated MEABRs. When harvested from MEABRs, the total allowable catch (TAC) of loco has previously been evaluated by biological consultants (final approval is made by the Under-Secretary of Fisheries) and the objective is that the fisheries are biologically sustainable. This represented a strong move toward rationalizing the fishery for loco and other benthic resources. Between 1993 and 2005 the annual extraction of loco fluctuated between 2 500–5 000 tonnes a year (weight values include conch). Landings were similar to those experienced during 1957–1974, which can be considered as a sustainable fishery period (Castilla *et al.*, 2007). Nevertheless, during the post MEABR-policy period (1997–2006) the market export value of a loco has ranged between US$ 15 000–25 000 a tonne (without conch) with an almost doubling of loco price during the open access period. These prices were in general lower during 2003–2006 as more fishery associations obtained TACs for loco. This suggests that in the past 10–11 years under the FAL management guidelines, the supply and demand market dynamics had conditions that could increase sustainability of loco fisheries operating in Chile. Importantly, biological data support the fact that MEABRs have been successful in maintaining target species. Castilla *et al.* (1998) showed that the number of loco was significantly higher in a MEABR (El Quisco) compared to nearby open-access areas. Mean sizes of individuals and catch per unit effort values were also significantly higher (for other shellfish resources see Castilla and Fernández, 1998). In addition Manríquez and Castilla (2001) have shown the importance that MEABRs and No-Take areas have as spawning grounds for the loco.

Since 2000 loco landings have risen considerably from around 1 000 tonnes to around 5 000 tonnes. Initially, during 2001–2002, Regions V and VI in central Chile contributed most loco landings. Currently, most landings come from Region X in southern Chile (Figure 2). These landings have been increasing since 2002 and have already reached more than 2 000 tonnes/yr (Figure 2). This has generated fear in caletas of central and northern Chile that prices will drop drastically.

4. MEABRS POLICY BEYOND THE LOCO: MULTIPLE SPECIES AND SELF-GOVERNANCE

The loco has formed the main fishery that has motivated the MEABR policy; in fact 85 percent of the operating MEABRs have loco as a one of the principal species to be managed (Castilla, Gelcich and Defeo, 2007). However, the implementation of MEABRs has gone beyond an exclusive focus on the sustainable harvest of loco. In this section we examine MEABR policy in terms of the number of different benthic species included in management plans and the implications of MEABR policy over fishers' self-governance.

The MEABR experience

Since the implementation of the first official MEABR in 1997, policy uptake has constantly increased throughout all regions of Chile. Of a total of 547 MEABRs (May 2005), 301 have fully-approved benthic resource management plans and are in full operation. The remaining 246 are not allowed to operate until they have their plans approved. The total area of sea floor comprising MEABRs is approximately 102 338 ha. Species that are included in MEABR management plans vary between fisher associations, however loco, key hole limpets and sea urchins are the most important, representing around 85, 70 and 30 percent of MEABR management plans respectively (Castilla, Gelcich and Defeo, 2007). Currently there are around fifty species included in MEABR management plans in Chile; these include algae, bivalves, echinoderms, gastropods, tunicates, cephalopods and crustaceans (Table 1).

Loco has been the most important species to be harvested from MEABRs, accounting for around 30-60 percent of landings; however, algal species (mainly *Gracilaria*) have also played an important role (Figure 3). It is important to note that variability observed in landings of the beach clam macha (*Mesodesma donacinum),* and scallops (*Argopecten purpuratus*) from MEABRs may have been due to the highly variable nature of the stocks that appear to be affected by El Niño events (Stotz and González, 1997; Wolff and Mendo, 2000). Therefore, in making MEABRs that focus on

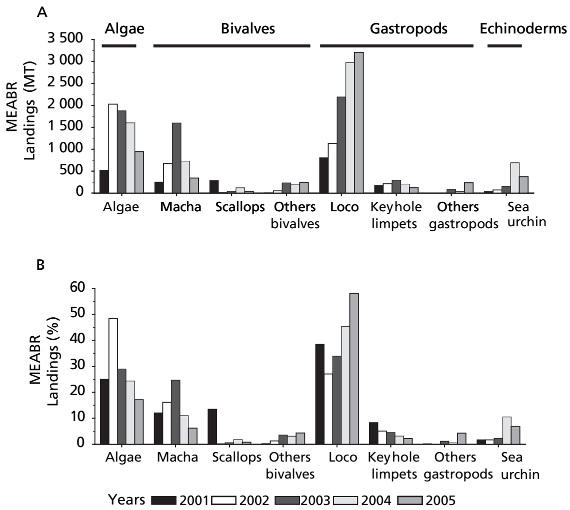
TABLE 1

Benthic species included in MEABR management plans along the Chilean coast

ALGAE	**GASTROPODS**
Luga negra (*Sarcothalia crispata*)	Loco (*Concholepas concholepas*)
Luga roja (*Gigartina skottsbergii*)	Lapa rosada (*Fissurella cumingi*)
Picuyo (*Odontocymbiola magallanica*)	Lapa negra (*Fissurella latimarginata*)
Huiro palo (*Lessonia trabeculata*)	Lapa bonete (*Fissurella costata*)
Huiro negro (*Lessonia nigrescens*)	Lapa picta (*Fissurella picta*)
Huiro flotador (*Macrocystis integrifolia*)	Lapa reina (*Fissurella maxima*)
Chasca (*Gelidium* sp)	Lapa (*Fissurella sp*)
Luga (*Mazzaella laminarioides*)	Lapa (*Fissurella nigra*)
Cochayuyo (*Durvillaea antartica*)	Lapa (*Fissurella pulchra*)
Chicorea de mar (*Chondracanthus chamissoi*)	Lapa (*Fissurella bridgessi*)
Pelillo (*Gracialaria chilensis*)	Locate (*Thais chocolata*)
	Caracol (*Argobuccinum sp*)
BIVALVES	Caracol palo palo (*Argobuccinun argus*)
Macha (*Mesodesma donacium*)	Caracol trophon (*Thophon* sp)
Ostion del norte (*Argopecten purpuratus*)	Caracol rubio (*Xanthochorus cassidiformis*)
Chorito (*Mytilus chilensis*)	Chocha (*Calyptrea trochyformis*)
Cholga (*Aulacomya ater*)	
Culengue (*Gari solida*)	**CEPHALOPODS**
Almeja (*Protothaca thaca*)	Pulpo (*Octupus mimus*)
Choro zapato (*Choromytilus chorus*)	Pulpo (*Enteroctopus megalocyathus*)
Almeja (*Venus antiqua*)	
Disco (*Semele solida*)	**CRUSTACEANS**
Navajuela (*Tagelus dombeii*)	Jaiba peluda (*Cancer setosus*)
Taca (*Mulinia* sp)	Jaiba mora (*Homalaspis plana*)
Taquilla (*Mulinia edulis*)	Jaiba reina (*Cancer coronatus*)
Ostion del Sur (*Chlamys vitrea*)	Picoroco (*Austromegabalanus psittacus*)
EQUINODERMS	**TUNICATES**
Erizo (*Loxechinus albus*)	Piure (*Pyura chilensis*)

Source: SERNAPESCA (2007).

FIGURE 3
Landings from MEABRs for years 2001–2005 in Chile



A represents total landings and B represents landings from MEABRs as a percentage of total annual MEABR harvests. Data for macha (*Mesodesma donacium*), loco (*Concholepas concholepas*), key-hole limpets (*Fissurella* spp.), sea urchin (*Loxechinus albus*) are shown.

these species, there can be shifts from great successes to failures (González *et al.*, 2006). Other gastropods (mainly *Thais chocolata*) have begun to be harvested during the last 3 years accounting for around 5 percent of total MEABR landings.

It is important to highlight that 100 percent of loco landings in Chile come from MEABRs. However, in the past five years only around 5 percent of key-hole limpet landings are from these areas. Sea urchin landings from MEABRs represent around 1 percent of national open access landings. Therefore, although key-hole limpets and sea urchins are present in MEABR management plans, their harvest from the MEABRs is secondary.

Self-governance and MEABRs

From 1997 to the present, Chilean small-scale fisher associations have gradually been adapting to their new lifestyles as non-migrating businessmen and as part of co-management regimes. In general, fisher associations have been able to follow policy requirements identifying areas of sea floor over which they wish to make a claim and pay for baseline studies from which resource TACs and management plans are established. Fishers are following MEABR regulations to the extent that they are beginning to pay an annual fee to government for the right to maintain the management area. This fee is fixed per hectare of seabed and as such is not related to catch or revenue; it is paid after the fourth harvest.

Fisher associations pay external consultants to undertake yearly follow up assessments of stock in the management area as required by the Law. Effectively, fishers' have taken control of their harvesting decisions regarding: (a) The amount of TAC to be gathered and the timing of this harvest, within the officially designated harvest season and approved TAC, (b) the price fishers will accept for their resources, (c) the number of buyers to whom fishers sell and (d), how income is distributed within the associated members (Gelcich, Edwards-Jones and Kaiser, 2007). Fishers have responded to the challenge of these new harvesting decisions that involve dealing with new responsibilities associated with management and commercialisation (Gelcich, Edwards-Jones and Kaiser, 2007). Fisher association leaders have also started to view the MEABRs as more than a marine tenure. Now they see them as a way towards organization that would facilitate fisheries and non-fisheries related business activities such as tourism and seafood restaurants. An important driving force for this was the fact that MEABR resource TACs are given to the association and not individually. This promotes the right incentives for cooperation instead of confrontation between fishers (Castilla, Gelcich and Defeo, 2007).

Fishers have attached important non-economic values to the existence and ownership of MEABRs, such as pride and accountability. As part of MEABR consolidation, innovative strategies that account for fishers' entrepreneurship include attempts to sell management area resources collectively between associations, for instance in the form of cooperatives, such as PACIFICOOP in central Chile or TERPESCAR in Carelmapu, Southern Chile. PACIFICOOP is a selling cooperative formed by 15 fishing associations of central Chile. They are trying to find new markets for benthic resources and are currently seeking a way to export live loco to Asian markets. This will add value to the low prices that have been paid for their resources during the last three years (Castilla, Gelcich and Defeo, 2007). TERPESCAR is a private company formed by fishers from five fishing associations and represents around 700 artisanal fishers. This association has managed to administer the landing ports thus acquiring new responsibilities and incomes. In the year 2004 they sold 1 197 227 loco worth around $US2 000 000. They have also managed to contract the services of a general manager for the company and an accountant (World Bank, 2006). These initiatives, although so far unique in the country, show how the MEABR policy has opened new ways for fishers' long-term engagement as resource stewards and how it has encouraged self-empowerment and self-governance to solve fishery problems.

5. FISHERS CURRENT PROBLEMS WITH MEABRS

The problems associated with 'open-access' and the traditional 'command and control' approach to fisheries, led the search for MEABRs as a management alternative under which the responsibility for benthic resource sustainability is shared by those who have an interest in the fishery's success (government and fishers). The Chilean fisheries department has addressed the issues of government legislation to support legal rights as recommended by much of the co-management and common-property research literature (Ostrom, 1990; Pomeroy and Berkes, 1997). However, fisher associations have had to implement the MEABRs at local scales and have faced different problems. Small-scale artisanal fishers are not homogenous and do not share a common understanding of the problems that confront them (for studies on fishers perceptions of MEABRs see Gelcich *et al.* 2005a,b, Gelcich *et al.*, 2006; Castilla *et al.*, 2007; Gelcich *et al.*, in revision; World Bank, 2006).

Studies that have looked into the functioning and fishers perceptions regarding MEABR agree that it is essential to address enforcement problems in order for MEABRs to develop into successful enterprises and not just another of many development narratives. Granting user rights is not enough and a strong policy to stop encroachment is needed. In fact, within a questionnaire study published by the World Bank (2006), when small-scale artisanal fishers (N= 143) were asked about their main problem with MEABRs, 65 percent mentioned encroaching (theft) from other fishers. This study also highlighted that MEABRs have provided basic elements to increase collective action and generate new business and collaboration ideas. Further, Gelcich *et al*. (2005a,b) provide evidence that the speed of MEABR uptake has had an important effect over the abundance of "open-access" diving grounds, which are becoming increasingly scarce. This has important livelihood consequences for artisanal fishers. Table 2 presents factors that artisanal fishers identified as those important to address as well as the solutions they propose.

TABLE 2
Problems with MEABR policy identified by artisanal fishers and their suggested solutions

Factor to be addressed	Fishers' solution
Enforcement	- More support from the national fisheries service to oversee execution of MEABRs
	- Stronger sanctions for fishers caught steeling from MEABRs
	- Financial support to look after areas
Increase MEABR productivity	- Include more species in MEABR plans
	- Experiment with feeding locos in ponds (e.g., grow-out/ranching *in situ*)
	- Rescue *locos* from sand embankments
	- Experiment with re-populating sea urchins and other species
	- Adopt a multi-species/ecosystem approach
	- Feeding *loco* in mesh bags
	- Rescuing juvenile loco from harvested shells

Source: World Bank (2006), Gelcich unpublished data.

6. DISCUSSION

Over the past several decades, scholars have argued over governance strategies for management for commons and common-pool resources (CPRs). In fact, the theory of the commons has undergone major transformations, moving from the "tragedy of the commons" model, to dealing with small-scale, community-based systems as ways of promoting self-organization and self-governance (Ostrom, 1990; Berkes, 2006). Within the fisheries sector, the use of rights based management strategies to re-establish sustainability in open-access fisheries is becoming increasingly popular. The experience with TURFS in Chile, which was implemented as a way to avoid the collapse of the loco fishery, has been successful in terms of managing some benthic artisanal fisheries in a sustainable way and generating basic incentives for fishers' empowerment. However, if the policy is going to succeed in the future, scientists and practitioners must respond to important challenges. Most published studies on the human dimensions of MEABRs stress the need for fishers to have more liberty managing MEABRs as a way to adapt these to local realities and create incentives for developing institutions of self-governance (Castilla and Defeo, 2001; Meltzoff *et al.*, 2002; Castilla *et al*., 2007; Gelcich *et al.*, 2005a,b, 2006, 2007; World Bank, 2006), i.e. to shift from the current co-management approach used in Chile (= collaborative co-management; Sen and Nielsen, 1996) towards an adaptive co-management approach. Folke *et al.* (2002), defined adaptive co-management as "the process by which institutional arrangements and ecological knowledge are revised in a dynamic, ongoing process of learning by doing".

Adaptive co-management combines the 'dynamic learning' characteristic of adaptive management (Holling, 2001) with the 'linkage' characteristic of cooperative management (Jentoft, 2000), and collaborative management (Olsson, Folke and Berkes, 2004). The adaptive co-management approach treats policies as hypotheses and management as experiments from which managers can learn (Gunderson, 2000). Most importantly, adaptive co-management theory implies that management practices should be adjusted by the monitoring of feedback signals of social-ecological change (Berkes, Colding and Folke, 2003). This shift towards adaptive co-management would imply the need for participatory research. Small-scale coastal artisanal fisheries with well-demarcated fishing grounds provide ideal situations for experimental management research (Castilla, 2000; Johannes, 2002; World Bank, 2006). In addition, if MEABRs are going to successfully adapt, managers should encourage local communities (associations) to experiment and continuously adapt to changes (social or ecological). These are factors we feel are an essential part of the so-called Ecosystem-Based Management Approach (FAO, 2003; Arkema, Abramson and Dewsbury, 2006; Christie *et al*., 2007).

At present the MEABR policy has left few legal alternatives for community experiments and subsequent governance adaptations. This is unfortunate as participatory research in support of adaptive management is becoming almost commonplace in many developing countries (Edwards-Jones, 2001) under the premise that the participation of resource users and other stakeholders is important not only in the management of resources, but also in research orientated toward the generation of information and innovations that shape how resources are understood and exploited (Johnson *et al.*, 2004). In addition it forms a basic building block for self-governance of MEABR resources.

Coastal management beyond MEABRs

A new self-governance policy in Chile that attempts to grant user rights to first nation coastal communities is currently being discussed in the Chilean senate. This initiative originated in a bottom-up manner from first nation Lafquenche and Huiche cultures and has the support of the Undersecretary of Planning and the Undersecretary of Fisheries. Use-rights will be granted depending on the importance of specific coastal areas for cultural manifestations (defined as "customary use" in the policy) and on the way the community attempts to manage the area. Cultural manifestations include fishery, religious, recreational and medicinal uses. Adolfo Millabur, a mayor of an important council in Chile and part of a Lafquenche community, highlights that the policy "is very important in order to legitimize coastal first nations communities rights to govern coastal areas". It is important to highlight that in theory the policy will grant autonomy to the first nation community to govern defined coastal areas. This includes autonomy for management and conflict resolution. In this way this policy will have the potential to generate the first self-governed coastal management practices in Chile (Ecoceanos, 2005).

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This FAO Fisheries Technical Paper documents 32 case studies and four syntheses (Canada, Japan, New Zealand and the United States of America) on the role of industry in the governance and management of fisheries. The studies are drawn from ongoing practice in Europe, North America, Japan and Australasia. The types of fisheries cover those for crustaceans, fish, molluscs and echinoderms. In general the scale of the fisheries tends to be small, which has been one of the reasons attributed to their success. In all but one case it is clear that well-defined fishery rights have contributed to the success of the programmes though the initiative for development and adoption of the programmes covers a range of institutional causes. The case studies are intended to inform and provide potential models that may be used in other fisheries.

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