TOWARDS SUSTAINABLE FISHERIES MANAGEMENT

International examples of innovation

A report prepared by

MRAG

List of Acronyms

AMERB	Areas for the management and exploitation of benthic resources (Chile)
BRD	By-catch Reduction Device
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCP	Co-management Committees (*Comités de Co-gestão de Pesca*) (Mozambique)
CCRF	Code of Conduct for Responsible Fisheries
CCS	Conservation Credit Scheme
CPUE	Catch Per Unit Effort
DF	Directorate of Fisheries (Norway)
DFO	Department of Fisheries and Oceans (Canada)
EAF	Ecosystem Approach to Fisheries
EBFM	Ecosystem-Based Fisheries Management
EEZ	Exclusive Economic Zone
EFF	European Fisheries Fund
EU	European Union
FAO	UN Food and Agriculture Organization
GDP	Gross Domestic Product
HCR	Harvest Control Rule
IATTC	Inter-American Tropical Tuna Commission
ICES	International Council for the Exploration of the Sea
IDPPE	Institute for the Development of Small-Scale Fisheries (Mozambique)
IFQ	Individual Fishing Quota
IMO	International Maritime Organisation
ITQ	Individual Transferable Quota
IPOA	International Plan of Action
IVQ	Individual Vessel Quota
IUU	Illegal, Unreported and Unregulated
ISSF	International Seafood Sustainability Foundation
MCS	Monitoring, Control and Surveillance
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NGO	Non-governmental organisation
NPF	Northern Prawn Fishery (Australia)
QECTF	Queensland East Coast Trawl Fishery
RBM	Rights-based management
RFMO	Regional Fisheries Management Organisation
RTC	Real Time Closure
SGC	SmartGear Competition (WWF)
TAC	Total Allowable Catch
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFSA	United Nations Fish Stocks Agreement
UVI	Unique Vessel Identifier
WCPFC	Western and Central Pacific Fisheries Commission
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WWF	World Wide Fund for Nature

Cover photo:
MRAG (2010) Saga Sea Trawling

ACKNOWLEDGEMENTS

This report was written by MRAG as commissioned by the Prince's Charities: International Sustainability Unit. The report was authored by: Robert Arthur, David Agnew, Carl Harris, Tim Davies, Suzannah Walmsley, Francisco Leotte and Tom Peatman. The views contained in this paper those of the authors and not necessarily those of the institutions or of the individuals below who contributed to the case studies and who provided valuable feedback on the report.

MRAG would like to acknowledge the great level of assistance and contributions in drafting reports on the individual case studies from Bob Trumble (Pacific halibut), Guðmundur Thordarson (Iceland), Ngo Tien Chuong and Flavio Corsin (Ben Tre clam), Jonathan Peacey (New Zealand), Robert Rangeley and Robin Davies (Banking on Cod), and Christian McDonald (Fiji) and Duncan Souter (Australian Northern Prawn). We would also like to acknowledge the important contributions that were made to the individual case studies from individual experts and fishers associated with each of the fisheries.

Prior to the release of this report, the authors gained valuable feedback on a draft of the report at a workshop London hosted by the International Sustainability Unit. MRAG would like to thank Ragnar Arnason, Ngo Tien Chuong, David Middleton, John Riley, Nathan de Rozarieux, Robert Rangeley, Tim Bostock, Sebastien Troeng, Yemi Oloruntuyi, Geir Ervik, Chris Glass, Mike Park, Victor Restrepo, Roy Bross, Peter Shelley, Michel Kaiser and Sally Bailey for participating in the workshop and for their comments and suggestions.

The authors are especially grateful to Charlotte Cawthorne, Justin Mundy and others at the International Sustainability Unit for their contributions to the report and their valuable comments on earlier drafts of the report.

Further copies of this report and the more detailed individual case study reports used for the report are available from

MRAG Ltd, 18 Queen Street, London W1J 5PN
Web Address: http://www.mragltd.co.uk
Telephone: +44 (0) 20 7255 7755 Fax +44 (0) 20 7499 5388
E-mail: enquiry@mrag.co.uk

Cite as:

MRAG 2010. Towards sustainable fisheries management: international examples of innovation. MRAG Ltd., London: 93 pages.

TABLE OF CONTENTS

THIS PAGE HAS BEEN LEFT BLANK INTENTIONALLY

EXECUTIVE SUMMARY

1. Several recent papers have highlighted the increasing problems that global fisheries face. Some 28% of stocks are overexploited, depleted, or recovering; most of the world's fishing fleets are overcapitalised; approximately 10 million tonnes of fish are discarded; 11–26 million tonnes (worth USD 10–23 billion) are lost to IUU fishing. Underperformance due to inefficient operations, overexploited stocks and perverse incentives result in an estimated loss of USD 50 billion in economic rent each year.

2. Commissioned by the International Sustainability Unity, this report investigates a number of innovative solutions that have been developed to deal with five key challenges that are impeding progress in achieving sustainable fisheries: overcapacity; perverse subsidies; poor governance; lack of data; and by-catch and discards. These key challenges are interlinked and affect the sustainability of fisheries both directly as well as indirectly by undermining instances of good management.

3. Through 22 case studies demonstrating good practice, we explore how these challenges have been addressed around the world and how these approaches might be scaled up and applied in other fisheries. Each case study draws on published material and interviews with key people involved in the fishery. The main report draws lessons from these case studies.

Table 1: List of case studies and the challenge they address

Case study	Challenge addressed	Page number
Alaska: Transferable quotas for Pacific Halibut	Overcapacity	20
Iceland: Transferable quotas	Overcapacity	22
Canada: Quota pooling for herring roe	Overcapacity	24
Vietnam: Ben Tre clam	Overcapacity	26
ISSF: Market-demand innovation	Overcapacity	28
Chile: Territorial use rights	Overcapacity	30
Tackling subsidies through the WTO	Perverse subsidies	36
New Zealand: Removal of subsidies	Perverse economics	38
Kiribati: Phoenix Island Protected Area	Perverse economics	40
Banking on Cod	Perverse economics	40
MSC: Harnessing market power	Perverse economics	42
The Philippines: Aquaculture governance in Lake Taal	Poor governance	48
South Africa: Certification of the hake fishery	Poor governance	50
Mozambique: Co-management	Poor governance	52
Antarctic: Ecosystem-based and precautionary management	Lack of data	58
Fiji: Local knowledge and traditional management practices	Lack of data	60
Senegal: IUU fishing in small-scale fisheries	Lack of data	62
Scotland: Conservation Credits Scheme	Lack of data	64
Scotland: Salmon aquaculture	Lack of data	66
Australia: Prawn seawater hopper	By-catch and discards	72
Norway: Discard ban	By-catch and discards	74
International: WWF SmartGear Competition	By-catch and discards	76

4. **Overcapacity** threatens the sustainability of fish stocks if fishing effort is not effectively restricted. Traditional "top down" approaches to regulating capacity include decommissioning and limited licensing schemes. Several case studies demonstrate that rights-based approaches, particularly those allowing the transfers and trade in rights and quota, can be an effective and efficient method to align fishing activity with fishing opportunities. For instance, in Alaska the number of licences for fishing Alaskan Pacific halibut greatly reduced from 4,830 to 2,855, once a transferable quota system was introduced, and price for landed halibut increased from USD 1–2 per lb to USD 3–5 per lb. Total revenue increased from approximately USD 50 million in 1992 to USD 245 million in 2008. However, in Iceland the initial limitation on transferability limited the benefits.

5. The implementation of ITQ systems can be appropriate for fleets managed under an objective of maximising economic gain, but safeguards may be required to protect less economically-driven fleets. In Norway and Alaska, this is achieved by limiting transferability of quota between small and large scale fleets. These safeguards are not implemented in Iceland, thus currently Icelandic governments are still trying to manage the social repercussions as a result.

6. Other innovative mechanisms to control capacity and effort are also proving useful. The initiative of ISSF is intended to ensure sustainable, legal, tuna fisheries through market control. Local management measures, often based on traditional practices, have also proven effective in addressing overcapacity and many of these approaches generally have less emphasis on enforcing catch limits. In Fiji the emphasis was on using closed areas to control the overall levels of exploitation.

8. **Perverse subsidies** to the fisheries sector (such as for vessel construction and fuel tax waivers) reduce the real costs of fishing and enable fishing to continue beyond the point at which it would otherwise be unprofitable. The countries that provide the most subsidies are Japan (USD 5.1 billion), India (USD 4.5 billion), the EU (USD 3.2 billion) and China (USD 2.7 billion); seven countries provide two-thirds of all subsidies. The WTO process represents the best opportunity to tackle harmful fisheries subsidies on a global level.

9. Several countries have taken individual initiatives that have shown that, although the removal of subsidies can be painful, it often leads to a stronger fishery sector. The removal of fisheries subsidies cost the New Zealand government USD 25 million to buy back provisional quota allocations, but subsequently approximately USD 20.7 million annually is contributed by a more profitable, robust industry towards management and monitoring costs. The removal of subsidies from fisheries is of particular benefit to taxpayers, who no longer have to support the industry.

10. Positive economic incentives and private financing can also have an important role in stimulating innovation and by enabling better management. One particularly interesting one is an endowment fund that is being established to cover the costs of management of the Phoenix Island Protected Area in Kiribati. This fund provides compensation to the government for the opportunity cost of not issuing fishing licences. The initial aim for capitalisation of the PIPA endowment fund is USD 25 million. This will be used to cover the park management costs as well as an annual payment of USD 1–3 million to the government to compensate for lost fishing licence payments. Banking on Cod is another innovative financial mechanism that enables investors to contribute to a fund that provides loans to fishing bodies implementing stock recovery management plans. Benefits from rebuilding the cod stocks in Atlantic Canada, for example, are expected to be worth in the region of USD 800 million per year .

11. A large number of case studies also involve harnessing ethical purchasing choices through market-based mechanisms, including eco-labelling, which can be very effective in generating positive economic

incentives for sustainable fishing. The Marine Stewardship Council programme generates a market-based incentive, and is currently growing exponentially. Recent estimates suggest MSC certified fishery tonnage is >7 million tonnes, an increase of ~4 million tonnes in 2009 and <2 million tonnes in 2006. Large financial gains of fisheries certified can also be expected. In the Ben Tre Clam case study, unit price has increased from VND 10,121/kg (USD 0.49/kg) in 2007 to VND 36,013/kg (USD 1.77/kg) in 2010.

12. **Poor governance** can undermine sustainable management. A common conclusion from the case studies was inclusive and accountable processes to address governance challenges can be a vital step in making sustainable management possible. This was experienced in Mozambique where prior to implementation of the co-management committees, local communities had little control or input in the management of the fishery. However, conflict has since reduced amongst neighbouring regions and wider uptake of the concept to over 150 nearby villages and increasing representation at the national levels is testament to its success.

13 Similarly in Lake Taal, Philippines, new designated protected areas developed through a participatory multi-stakeholder process has led to a Protected Area Management Plan and resulted in the successful removal of over 5,000 illegal aquaculture structures.

14 **A lack of data** regarding fish stocks and the wider ecosystem confounds attempts to develop effective management measures. Critical data about the operation of fisheries, the target species and the ecosystem are often insufficient to allow for evidence-based decision-making. This can result in inappropriate management measures, appropriate management measures being applied inaccurately, or no management at all.

15. All three situations jeopardise the sustainability of fishery resources. Several case studies show how implementing Ecosystem-Based Fisheries Management in combination with the Precautionary Approach allows for the development of suitable approaches in both data-rich and data-poor situations. Through the employment of the 100% observer coverage program, CCAMLR are able to clearly identify problems with fishing (e.g. high by-catch, declining catches). Costs for this program are estimated at 3% of the USD 293 million annual yield from the fishery. Constant monitoring though has allowed the accurate observation of a decrease in bird mortalities from 5,755 in 1997 to zero within 10 years. The Krill Yield Model, in conjunction with precautionary measures, has also been employed in CCAMLR. Through this and even with the uncertain nature of krill recruitment, managers have been able to maximise the likelihood that krill biomass remains at levels which will cause the least impact to other reliant animals.

16. In the data-poor artisanal fisheries in Senegal, local fishers have collectively developed management committees to regulate fishing and enforce fines for non-compliance, and established marketing arrangements that benefited local fishers. The use of local knowledge in applying precautionary measures can help secure the resource base for a fishery that supports some 57,000 people directly and provides an important food source for many more – up to 75% of local population.

17. **By-catch and discards** threaten populations of target species as well as other marine organisms that may be captured incidentally by fishing operations — other species of fish, seabirds, marine mammals or turtles. Solutions include prohibiting discarding, utilising by-catch, and reducing the amount of by-catch through gear modifications or implementing time or area closures (including Marine Protected Areas). The Norwegian case study has implemented a series of gear modifications, banning of discards and real time closures. The benefits experienced from this have included cod stock increases from 121,243 tonnes in 1987 to 1.1 million tonnes in 2010 (844%). However, the costs involved with the necessary high intensity at-sea enforcement were approximately NOK 800 million (USD 137.8 million) in 2006.

18. The solutions requiring gear modifications are best developed in cooperation with fishers and are most successful if they work to the mutual advantage of fishers and the environment. Industry driven designs are used in Australia's Northern Prawn Fishery where research demonstrated that over a four hour period, discard survival rates doubled from 8% to 16% through the use of seawater hoppers. This allowed for new sorting methods which improved product quality and thus fishing revenue. WWF's SmartGear competition has attracted 70-90 privately funded gear design entries each year. These entries are then judged and first prize designs win USD 30,000 and two runner up designs win USD 5,000. Creating positive financial incentives for fishers maximises uptake or self-implementation of change.

19. Our recommendations for specific actions that will promote sustainable fisheries management are:

a. Fish is the most widely-traded global agricultural commodity **harnessing global markets to generate change in fisheries management** can be one of the most effective way to encourage better environmental performance. Actors external to the fishery but with wide market power can potentially tackle a wide range of problems. Consolidation within the sector means that individual processors and retailers have increasing power to influence the operations of management bodies and to make important contributions to increased sustainability. Similar to meeting health guidelines, requirements for products to demonstrate sustainable sourcing could represent a formal or legislative entry point for change. Raising awareness of sustainability issues within the public arena can create pressure for policy reform and on retailers to source more sustainable fish.

b. **Economic inefficiencies in the global system must be addressed by removing subsidies.** Furthermore, creating positive economic incentives and mobilising private financing in innovative ways can also play an important role in fisheries management and make important contributions to enhancing sustainability. The key challenge is to identify sources of funds which can be made available to support these innovative schemes.

c. **Fisheries managed with the objective of maximising economic returns should become rights-based**, preferably with tradable rights and quota (ITQ). If the fishery is properly controlled, such systems can generate significant increases in wealth and positive incentives for sustainability. However, equity and social issues will also need to be explicitly considered and ITQs may be inappropriate where the main objective of the fishery is not economic (e.g. access to fisheries resources, maximise food production or employment). Convening policy-makers and engaging with civil society representatives to explore the place and potential for ITQs and alternative rights-based approaches will be an important starting point to increase uptake of these approaches.

d. **Promote the use of scientific observers and other methods of comprehensive data acquisition.** The benefits that arise from independent scientific observation of a fishery cannot be understated. All forms of knowledge have a role in management and information from fishers can contribute to understanding stock status and contribute to wider implementation of Ecosystem-Based Fisheries Management. Where the cost of observers is an issue, increased investment in automated data collection is a possibility. Small vessels cannot usually support observers, but here the most effective way of acquiring information may be to engage collaboratively or support fishers in their own research. In these cases, fishers can assist in identifying both the problem and innovative solutions and responses. Increasing investment in data collection, developing new cost effective methods and encouraging collaboration between fishers and the fisheries managers are crucial steps.

e. **Increased application of Ecosystem-Based Fisheries Management.** Where there is uncertainty about the interactions and interrelationships between fished stocks and the wider ecosystem, more precautionary approaches may be more suitable, setting management targets and limits in a manner that accounts for interactions and interdependencies. For static habitats (such as coral reefs, spawning grounds of fish, sensitive habitat types) MPAs can make an important contribution. Additionally. Raising awareness of the importance of considering these interactions and ecosystem dimensions, advocating the wider application of Ecosystem-Based Fisheries Management and promoting risk-based approaches represents an important first step.

f. **Promote collaboration and inclusiveness in policy making and management to solve governance problems**. We recognise that generating collaborative approaches may not be straightforward and conflict and confrontation may be part of the process. collaborative processes that respect the knowledge, perspectives and positions of different parties can help highlight the strengths of stakeholder groups and identify management arrangements that develop their potential roles in contributing to sustainability. Working together to achieve sustainability becomes a means to further develop trust and respect and we recommend support to initiatives that can bring together stakeholders. The most important international governance initiatives currently in existence are the UNFSA and Port States Agreement. A key action that will bring about significant benefits is **to facilitate and assist the ratification of these two instruments by all states.**

g. **Support innovation as a process rather than single solutions**. As initiatives such as ecolabelling, industry-led innovations and multi-stakeholder dialogues have demonstrated, it is possible to initiate processes that contribute to environmental sustainability. Similarly, the WWF SmartGear competition represents an initiative that supports industry (and other actors) to develop innovative solutions to by-catch and environmental impacts. With suitable investment (e.g. from NGOs, governments and the private sector), these types of process have a potentially wider applicability and can be used to address other challenges. Inclusive processes are more likely to identify acceptable solutions and their implementation and uptake is likely to be greater than for imposed solutions. As with many of the management challenges, ultimately the process of arriving at new solutions is as important as the solutions themselves.

THIS PAGE HAS BEEN LEFT BLANK INTENTIONALLY

THE STATE OF GLOBAL FISHERIES

Global fisheries production and the global fishing fleet

Global fisheries and aquaculture production has increased steadily since the 1950s, reaching 144 million tonnes in 2006, up from approximately 120 million tonnes a decade earlier (FAO 2009). However, this increasing trend masks the stagnation of production of wild capture fisheries from the mid-1980s, with the increase in output mainly due to increasing production from aquaculture and questionable statistics from China (Figure 1). The estimated first-hand sale value of capture fisheries and aquaculture production was USD 170 billion in 2006.

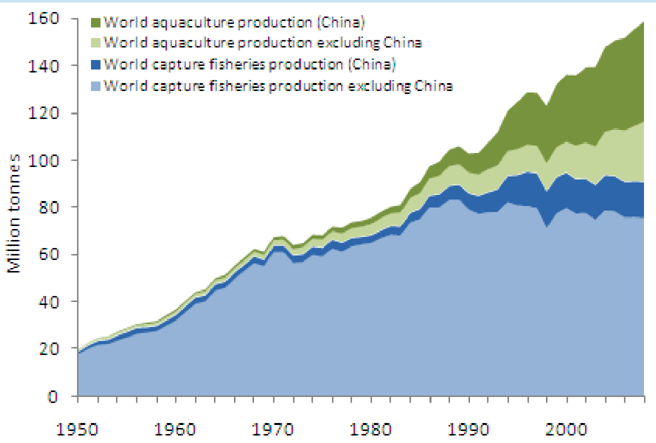


Figure 1: Global capture fisheries and aquaculture production, 1950–2008. Source: FAO (2010)

This increase in production was largely due to the world's fishing fleet expanding steadily since the end of the First World War, when countries supported the development of their national fishing fleets in the interests of food security and national defence. By 2006 there were 2.1 million motorised fishing vessels worldwide, mostly small-scale vessels and 70% of them in Asia. Of these, 1.3 million were decked vessels (with enclosed areas), and 23,000 were industrial vessels over 100GT (roughly equivalent to more than 24 metres in length).

Although the number of vessels has fallen slightly since the 1990s, the actual fishing power and catching capability of the world fleet continues to rise. This is due to more powerful engines, improvements in technology such as fish-finders, and more efficient fishing gears. These factors mean the global fishing fleet can fish further and deeper than ever before. Illegal, unreported and unregulated fishing (IUU), estimated to catch 11–26 million tonnes of fish worth USD 10–20 billion annually (Agnew et al. 2009), puts further pressure on fish resources and undermines management efforts.

The contribution of aquaculture to global supplies of fish, crustaceans, molluscs and other aquatic animals has grown dramatically, from 3.9 % of total production by weight in 1970 to 36% in 2006, accounting for 47 % of the world's fish food supply. With an average annual growth rate of 8.7% since the 1970s, aquaculture is the fastest-growing animal-based food sector. However, there are concerns about the sustainability of the growth of the aquaculture sector. In many places expansion has come at the expense of coastal habitats such as mangroves; its effluents can cause pollution of surrounding waters; production can depend on wild capture fisheries production, either for feed for the culture of carnivorous fish (e.g. salmon), or for the supply of juvenile animals (e.g. shrimp and bluefin tuna).

Decline of fish stocks and damage to the marine environment

Over half of all fish stocks are fully exploited, producing catches at or close to their maximum sustainable limits (Figure 2). Of these, 19% are overexploited, 8% depleted and 1% recovering, yielding less than their potential (FAO 2009; Garcia and Rosenberg 2010); and only about 20% are moderately exploited or underexploited with a possibility of producing more (FAO 2009). The percentage of overexploited, depleted and recovering stocks has tripled since the 1970s.

Over the last 30 years there has been a pattern of serial depletions of fish stocks with fleets targeting different stocks or new, previously unmarketable, species such as deepwater species, estimated now to contribute 4 million tonnes (Garcia and Rosenberg 2010). Consumers have, predominantly, remained unaware of the true situation, as locally-caught fish has been substituted for imports of the same or similar species from further afield. For example, in the UK market, cod from the North Sea has largely been replaced by cod from Iceland, the Barents Sea and the Pacific Ocean.

The situation within European fisheries is illustrative of this situation: 88% of fish stocks in European waters are overexploited, the European fleet's catching capacity far outstrips the potential of fish resources and consumer demand for fish in Europe is increasingly met by imports, with 60% of fish consumed in the EU coming from imports.

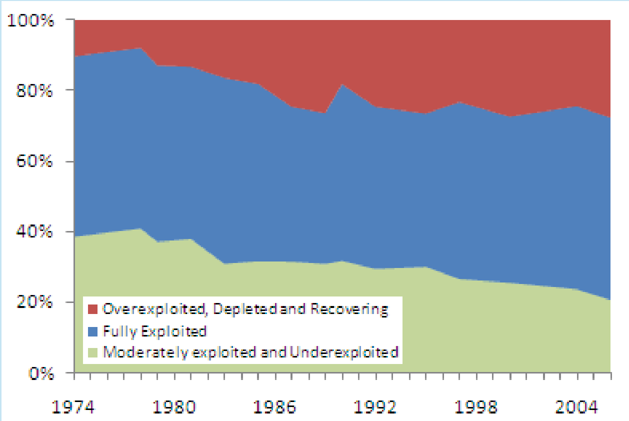


Figure 2: The status of global fish stocks, 1974–2006. Data source: FAO (2009)

In addition to the depletion of fish stocks, fishing can cause impacts on the wider marine ecosystem. Fishing vessels may catch more fish than they are allowed to under their quota allocation, which may be discarded, dead, back into the sea. Fish that are not marketable, either due to their species, or size (e.g. juvenile fish that are too small to sell either because of market requirements or fishing regulations) may also be discarded. The level of discarding has been estimated by Kelleher (2005) as about 9.5 million tonnes, or 10% of landings, but discards are rarely recorded and are difficult to estimate.

Fishing also catches species other than fish, such as birds, marine mammals and turtles, impacting on their populations. Some types of fishing gear, such as bottom trawls and especially beam trawls, sweep the seafloor, damaging ocean floor habitats. This is particularly a concern where these habitats easily damaged, such as corals (which can occur in both tropical and cold waters).

Economic underperformance of fisheries

As a renewable natural resource, fish stocks can generate a sustainable flow of benefits to society. However, fisheries may be operating below their economic optimum even if they are managed effectively at their biological maximum production. The 80% of global fish stocks that are fully exploited, overexploited, depleted or recovering (Figure 2) are underperforming economically, with an estimated annual loss of USD 50 billion to the global economy (World Bank and FAO 2009).

This loss is the result of two main factors: depleted fish stocks mean that there are fewer fish available to catch and the costs of catching are greater than they could be; and the overcapacity in the fishing fleet means that the potential benefits are dissipated through excessive fishing effort. The current marine catch could be achieved with approximately half the current level of fishing effort. Subsidies to the global fishing fleet, estimated at USD 30–34 billion per year, represent a further cost to society, which in many cases continue to support unsustainable fishing practices and are an important factor in the overexploitation of fish stocks.

Why does it matter?

Fisheries provide employment for around 170 million people worldwide, and contribute to food security for many more. Fish and fishery products are one of the most widely traded agricultural commodities; exports were worth USD 86 billion in 2006 (FAO 2009). Fisheries are particularly important for developing countries, contributing to livelihoods of many poor rural and coastal communities, as well as providing export revenues greater than those of other agricultural commodities.

Poorly performing fisheries put at risk these potential benefits, as well as the livelihoods of people that depend on them. With rising food prices and the need to ensure food security for 9 billion people by 2050, fisheries' contribution needs to be maintained and increased where possible. Effective management is required to capture these benefits as well as to ensure greater resilience in natural ecosystems to withstand potential climate change.

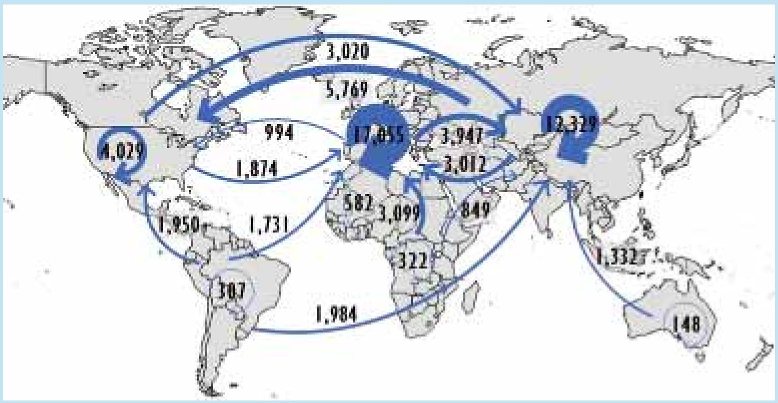


Figure 3: Major trade flows of fish and fishery products. (Adapted from FAO 2007).

Key challenges to achieving sustainability

There are a number of factors that have contributed to the current state of global fisheries. Poor management, partly as a result of a lack of data on which to base management decisions, and often caused by weak governance, results in the application of inappropriate management measures. A lack of control of the activities of the fishing fleet allows overexploitation to happen and results in environmental problems such as by-catch, discards and habitat damage. It also allows illegal fishing to flourish. Subsidies to the fishing fleet exacerbate overcapacity issues and enable vessels to keep fishing when it would otherwise be unprofitable. Coupled with this, perverse economic incentives encourage overfishing and allow overexploitation and environmental damage to continue, rather than promoting responsible behaviour, sustainable practices and resource conservation.

The challenge of achieving sustainability in fisheries requires consideration of ecological, social and economic components (Figure 4). Whilst the biological sustainability of an individual fish stock underpins the flow of benefits from it, the wider ecological sustainability of the marine ecosystem is also necessary to ensure continuing productivity. This is also threatened by fishing, marine pollution and climate change (Perry et al. 2005; Cheung et al. 2007). The social and economic aspects of sustainability must also be considered. Fisheries provide both economic and food benefits to individuals and society and these aspects, if not addressed, may undermine attempts to achieve biological and ecological sustainability. Marine Protected Areas (MPAs) that do not address these social and economic aspects often end up as protected areas in name only, as local people's needs may make compliance with biologically-focused regulations difficult. Alternatively, a fish stock may be exploited sustainably (in biological terms), but the fishing fleet that targets it may be unprofitable and therefore economically unsustainable. Sustainability can be addressed at various levels, from local to international. Many fisheries issues need to be addressed at the global scale and a number of important international frameworks for managing fisheries have been developed over the last few decades (see Box 1).

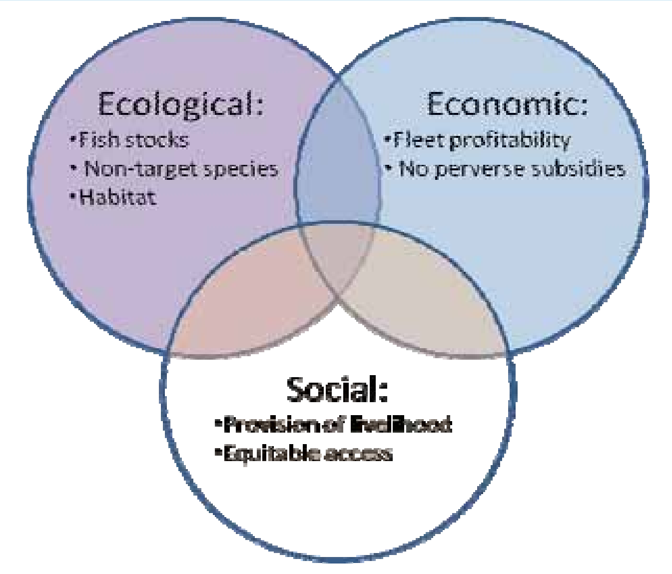


Figure 4: Key components of overall sustainability.

This report identifies five key challenges that are impeding progress towards achieving sustainable fisheries: overcapacity; perverse subsidies; poor governance; lack of data; and by-catch and discards. These key challenges are interlinked and affect the sustainability of fisheries both directly as well as indirectly by undermining instances of good management. The case studies in this report explore how these challenges have been addressed in innovative ways using examples from around the world.

Overcapacity

Overcapacity occurs when the fishing fleet is larger than it needs to be to catch the available fish resources. This capacity is not necessarily a threat to the sustainability of fish stocks if fishing effort is effectively restricted. However, problems arise when effort is not adequately constrained to ensure that catches are suitably limited. Under such conditions, overcapacity results in too much fishing effort and therefore too many fish being caught, leading to overexploitation of fish stocks.

Overcapacity is not just related to the number of fishing vessels, but includes also their ability to fish. More powerful engines and new technologies contribute to increasing fishing capacity. Furthermore, overcapitalised fleets are often unprofitable and this issue of economic overcapacity can increase incentives to overfish. Issues of overcapacity are addressed in Chapter 2, with examples of how capacity has been reduced through the use of rights-based management approaches, cooperative management, the use of market forces, innovative governance structures and improved monitoring and enforcement.

Box 1: The international framework for fisheries management

Throughout the course of human history the oceans have been regarded as common property, and fishers have in general been free to fish with few restrictions. Forms of tenure have existed, with claims of resource 'ownership' subject to varying levels of formal authority: from customary rights over traditional fishing grounds surrounding Pacific islands, to the protectionism of Basque fishers over North Atlantic cod banks. Scotland was the first country to claim exclusive national rights over inshore waters in the 15th century, but until the 20th century, these territorial seas were restricted in size, generally to three nautical miles from the shore.

The United Nations Convention on the Law of the Sea (UNCLOS) entered into force in 1982 and established in international law the right of states to claim sovereignty over waters up to 200 nautical miles from their shorelines (the Exclusive Economic Zone, EEZ), and the right to exploit fish stocks in these waters. Many distant water fleets were thereby excluded from the waters in which they had been fishing previously, instead having to enter into access agreements with coastal states or direct their fishing effort to the High Seas (i.e. outside EEZs). UNCLOS requires coastal states to implement conservation and management measures *to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield*, and to *take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened* (UNCLOS 1982: Article 61).

Arrangements for the management of fish stocks that are shared between neighbouring coastal states, or between coastal states and the high seas ('straddling and highly migratory stocks') are further detailed in the United Nations Fish Stocks Agreement (UNFSA 1995). States must cooperate in management with each other and through regional, sub-regional or international organisations (UNFSA 1995: Articles 63 and 64), generally referred to as Regional Fisheries Management Organisations (RFMOs). RFMOs have been established for most ocean regions and fish species. The main RFMOs are shown in Figure 5. The RFMOs have become increasingly important as more fish is taken from high seas waters; in the 1970s, more than 90% of catches were made within 200 nm of coastlines; by the 2000s, about a third of all catches were from straddling or migratory stocks (Garibaldi and Limongelli 2003). Unfortunately cooperative management between states and through RFMOs is often challenging. There are many continuing disputes over the demarcation of EEZs, as is the case with Russia, Japan and South Korea (Kim 2002). Furthermore, not all states have ratified UNCLOS and UNFSA, and are therefore not yet bound by them.

UNCLOS and UNFSA are supported by several non-mandatory texts developed under the auspices of the Food and Agricultural Organisation (FAO). Key amongst them is the Code of Conduct for Responsible Fisheries (CCRF), a set of guidelines which most countries have agreed to implement voluntarily. There are also four International Plans of Action that recommend voluntary state actions to deal with the problems of seabird by-catch, conserving sharks, reducing fishing capacity and reducing illegal, unregulated and unreported (IUU) fishing (FAO 2000, 2002a, 2002b).

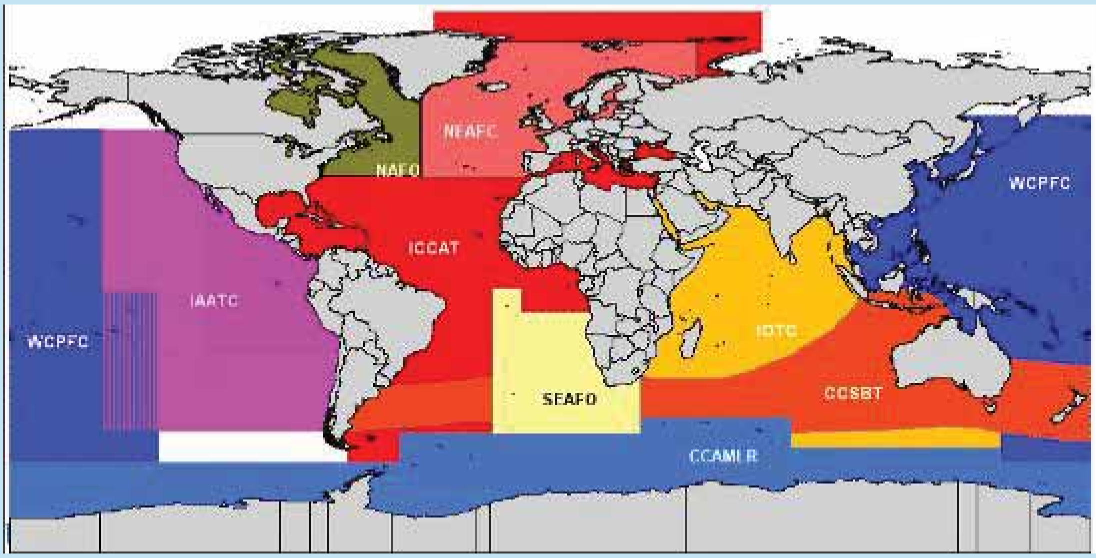


Figure 5: Map showing the main regional-based and tuna RFMOs (Source: MRAG).

Perverse subsidies

Subsidies are financial contributions by a government or public body that provide a private benefit. While it is recognised that some subsidies can be beneficial (e.g. support to research and management), 'perverse' subsidies to the fisheries sector (such as for vessel construction, fuel tax waivers) reduce the costs of fishing and enable fishing to continue beyond the point at which it would otherwise be unprofitable. This can contribute to the build up of excessive fishing capacity and the overexploitation of stocks. As a result, subsidies have emerged as a key threat to global fisheries sustainability.

Chapter 3 addresses subsidies in fisheries. The case studies explore how global negotiations at the WTO could result in the restriction of subsidies to the sector and describe instances where subsidies have been removed at the national level. In addition, the chapter highlights the use of innovative market-based incentives and private financial mechanisms that can redress the incentive structure and promote more conservation-oriented behaviour.

Poor governance

Governance is the legal, social, economic and political arrangements and processes through which fisheries are managed. Governance is linked with issues such as power and authority over resources and the decisions that are made concerning those resources. The key dimensions of 'good' governance are related to ensuring greater participation, accountability and transparency in, and of, the management and policy-making processes and mechanisms. Poor governance can undermine sustainable management. Fishers (and other people) who have not been involved in decisions, and do not agree with them, are much less likely to fish responsibly.

Chapter 4 examines a number of governance challenges, highlighting decentralisation in fisheries management as a means to increase participation and increase accountability. The case studies highlight examples of governance reform that have led to shifts from centralised forms of management in which the state has the authority for making and enforcing management measures, towards more inclusive co-management arrangements wherein this authority and the responsibility for making and enforcing fisheries regulations are shared with local communities and other stakeholders.

Lack of data and stock assessment

There are considerable difficulties that result from attempting to manage resources that are effectively invisible, mobile and have highly variable dynamics. A lack of data about fishing, the fish stocks and the wider ecosystem confounds attempts to develop effective management measures. This can result in inappropriate management measures being developed, appropriate management measures being applied inaccurately, or no management at all. All three situations jeopardise the sustainability of fishery resources.

Chapter 5 explores the challenge of developing management measures that deliver robust fisheries management in the face of a considerable lack of data and uncertainty. The case studies highlight different aspects of data and stock assessment. These include accounting for the environmental and ecosystem effects on fisheries in management measures as well as ways of working with fishers themselves to deliver additional data on the fisheries dynamics and adjust management measures in 'real-time'.

By-catch and discards

In the process of catching the target species, fishing often results the capture of other marine organisms — by-catch — consisting of either other species of fish, seabirds, marine mammals or turtles. Discarding is the return of catch, not including protected species, that has or could have some potential commercial or food value. Discarding and by-catch are both wasteful practices that impact on the populations of the animals that are caught and may also affect the scientific assessments of the status of these populations.

Chapter 6 examines the problems of by-catch and discards, presenting a case studies from around the world that highlight efforts within fisheries to tackle these problems by prohibiting discarding, utilising by-catch, and reducing the amount of by-catch through gear modifications. The chapter also present examples of innovative processes that have been developed to stimulate innovation in the development of methods that mitigate by-catch within other fisheries where there may be particular issues.

Identifying pathways to sustainability

Illustrating positive experiences

While the outlook for fisheries may appear gloomy at the global level, there are many individuals and groups that have been working to innovate and to transform fisheries at an individual, and sometimes regional, level. These experiences, across a diverse range of fisheries in both developed and developing countries, offer increased hope for more positive outcomes for fisheries and point towards pathways to sustainability that others may wish to follow.

This report draws on case studies that serve to illustrate the kinds of challenges facing fisheries globally and the innovative ways that these have been overcome. Twenty-two case studies were selected as being representative of the five key challenges identified (Table 1). They encompass a range of fisheries from small-scale to industrial in nature, from both developed and developing countries, and include various fishing methods and target species that are particularly important in global production and trade. Each case study draws on published material and interviews with key people involved in the fishery. They focus on the drivers and entry points for the development of innovative solutions as well as on the solutions themselves. This report presents a synthesis of the case studies; the full case study reports are available on request (see page 3).

Table 1: List of case studies in the main report and the challenge they address

Case study	Challenge addressed	Page number
Alaska: Transferable quotas for Pacific Halibut	Overcapacity	20
Iceland: Transferable quotas	Overcapacity	22
Canada: Quota pooling for herring roe	Overcapacity	24
Vietnam: Ben Tre clam	Overcapacity	26
ISSF: Market-demand innovation	Overcapacity	28
Chile: Territorial use rights	Overcapacity	30
Tackling subsidies through the WTO	Perverse subsidies	36
New Zealand: Removal of subsidies	Perverse economics	38
Kiribati: Phoenix Island Protected Area	Perverse economics	40
Banking on Cod	Perverse economics	40
MSC: Harnessing market power	Perverse economics	42
The Philippines: Aquaculture governance in Lake Taal	Poor governance	48
South Africa: Certification of the hake fishery	Poor governance	50
Mozambique: Co-management	Poor governance	52
Antarctic: Ecosystem-based and precautionary management	Lack of data	58
Fiji: Local knowledge and traditional management practices	Lack of data	60
Senegal: IUU fishing in small-scale fisheries	Lack of data	62
Scotland: Conservation Credits Scheme	Lack of data	64
Scotland: Salmon aquaculture	Lack of data	66
Australia: Prawn seawater hopper	By-catch and discards	72
Norway: Discard ban	By-catch and discards	74
International: WWF SmartGear Competition	By-catch and discards	76

OVERCAPACITY

Fishing capacity

Fishing capacity is a combination of the number and size of fishing vessels or gear, and their ability to catch fish. Where capacity to fish exceeds the available fish resources, there is overcapacity, and in the absence of suitable control or management, overfishing often occurs. To avoid overfishing, part of the capacity must remain idle for part of the time if catches are to be constrained within sustainable limits.

Although discussions on capacity are common, a globally used method of measuring capacity does not exist. The most usual measures of capacity are the number of people fishing, number of vessels in a fleet or the gross tonnage of that fleet, but this does not adequately measure the fishing power, nor does it account for that fact that as technology increases, so does the ability and efficiency to catch fish.

This increase in technological ability is referred to as 'technological creep', and it may increase effective fishing power by 2–5% per year (Fitzpatrick 1996; Banks et al. 2002). This means that even if the number of vessels gross tonnage remain the same, vessels can become more efficient and catch more fish year on year (Marchal et al. 2007). This is illustrated in Figure 6 — even though global vessel numbers have reached a plateau, fishing power continues to increase.

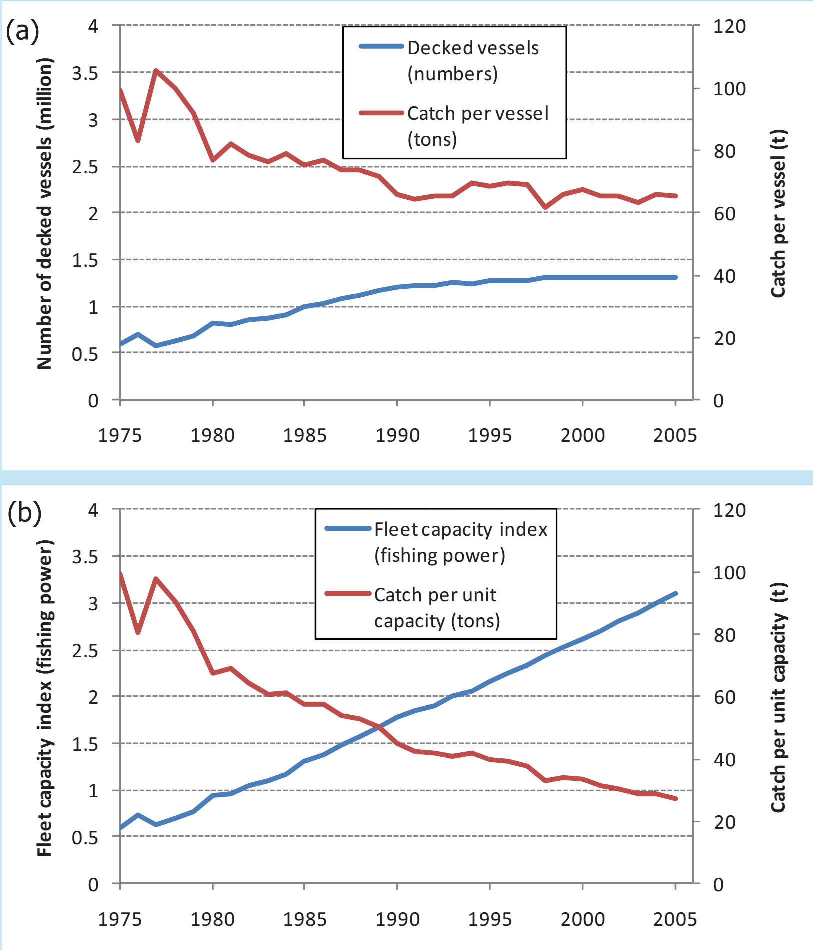


Figure 6: (a) Increases in decked vessels verses the level of decrease in catch per vessel. (b) Identical number of decked vessels as (a) with 3.5% annual capacity increase accounting for 'technological creep' (Fitzpatrick, 1996; Banks et al., 2002). The decreasing slopes indicates an imbalance in capacity to resources (Source: graphs calculated based on Fitzpatrick 1996; Banks et al. 2002; World Bank and FAO 2009).

Overcapacity is one of the most commonly-cited issues with global fisheries, and the need to address it is frequently emphasised (e.g. World Bank and FAO 2009). It has arisen as a result of a range of government interventions in the 1950s which aimed to increase fishing capacity in order to boost food production, employment and the role of fisheries as a driver for community development (Robinson and Lawson 1986). These actions were very effective. However, from the late 1980s, most commercially-exploitable stocks had been discovered and world catches had reached their current maximum, but vessels were continuing to become more technologically efficient, and consequently capacity exceeded the available resources.

The consequences of overcapacity

As a result, overcapacity is implicated in negative biological, social and economic consequences (e.g. Bennett 2005; Neiland et al. 2002; World Bank and FAO 2009). Regardless of the objectives for the fishery, the biological sustainability of the stock is fundamental to ensuring the continuation of the fishery. Overcapacity becomes a problem when control is insufficient to constrain fishing effort on the stock, resulting in overfishing. In the absence of adequate control (including explicit and implicit controls as well as cultural norms), capacity and effort may increase to the point at which the biological integrity of the stock becomes compromised. A lack of control can also lead to a spill-over of effort into other areas and fisheries, increased conflicts, IUU fishing and negative social consequences.

Economic incentives can exacerbate these problems. For example, in quota managed fisheries, if all vessels complied with management measures and only caught their available quota, theoretically overcapacity would simply lead to shorter fishing seasons, as was seen in the Pacific Halibut fishery. However, overcapacity also frequently leads to vessels making less profit and becoming economically inefficient. This is exacerbated if stocks and catch per unit of effort (CPUE) decline. In such circumstances, the incentive to generate additional income through engaging in over-quota fishing, high-grading and discarding is increased. This may further deplete stocks, so accelerating the decline.

Table 2: Varying estimates of global annual economic losses due to poor economic policies

Source:	Annual Estimated Loss
FAO 1993	USD 54 billion (profit/loss calculation)
Garcia and Newton 1997	USD 46 billion
Sanchirico and Wilen 2002	USD 90 billion (future projection)
Wilen 2005	USD 80 billion
World Bank and FAO 2009	USD 51 billion

Source: World Bank and FAO 2009.

Largely as a result of overcapacity the fishing industry in some regions has been extremely unprofitable in recent years. Globally it has been estimated that fisheries were operating at a USD 5 billion loss in 2004 (World Bank and FAO 2009). Simple calculations of profit/loss do not take into account the lost rents from fisheries. Estimates of the global losses of economic rents as a result of poor economic policies range from approximately USD 50 billion to USD 80-90 billion (e.g. FAO 1993; Garcia & Newton, 1997; World Bank & FAO 2009). While it should be noted that these calculations can assume a global objective of maximising economic rents from fisheries, which is not the case in reality, these analyses do provide an estimation of poor economic performance of fisheries in general (Table 2).

Overcapacity can lead to overexploitation, stock depletion and eventual closure of the fishery. Such a situation occurred in the Grand Banks cod fishery, which on its closure, led to the loss of a USD 500 million per year industry in the Newfoundland fishing communities. It was estimated that 40,000 jobs were lost, which represented up to 90% of regional employment.

The problems of overcapacity have often been exacerbated through the use of subsidies, particularly those given for new vessel build, but also those targeted at vessel improvement, subsidising operational costs and the withdrawal of capacity. These subsidies tend to reduce the real costs of fishing, artificially inflating profitability, and enabling vessels to stay in the fishery rather than be removed (see also Chapter 3).

In this chapter, a series of case studies are presented that explore the ways in which overcapacity has been addressed in various fisheries and countries, and how the mechanisms to control capacity have been strengthened.

Increasing numbers of vessels and more sophisticated technology increases the fishing capacity of the fleet. (Photo: © Wolcott Henry 2005/Marine Photobank).

Alaska: Transferable quotas for Pacific halibut

Species	Pacific Halibut
Fishing Method	Longline
Fishery Tonnage	44, 859 (2009)

The problem and driver: Economic inefficiency and a dangerous race for fish

During the 1890s, sailing vessels were being replaced by steam powered vessels and by the 1920s the fishery expanded from Washington state to Alaska using diesel-powered engines designed specifically to fish using hook and line. Through the 1930s and 1940s, multipurpose vessels entered the fishery, targeting Pacific Halibut and other species through trawling and other net methods. In the 1960s and 1970s, foreign fleets also began to fish in the region. The most notable increase in capacity came in the 1970s and 1980s due to a combination of favourable economic and environmental events and an open access fishery.

Despite the steady increase in capacity, the fishery was always considered to be managed sustainably from a biological perspective (Clark and Hare 2006). To accommodate the increase in capacity, the Alaskan fishery season gradually reduced from nine months, to two or three days by the early 1990s. This ensured total catches remained within quotas set by the International Pacific Halibut Commission (Figure 7).

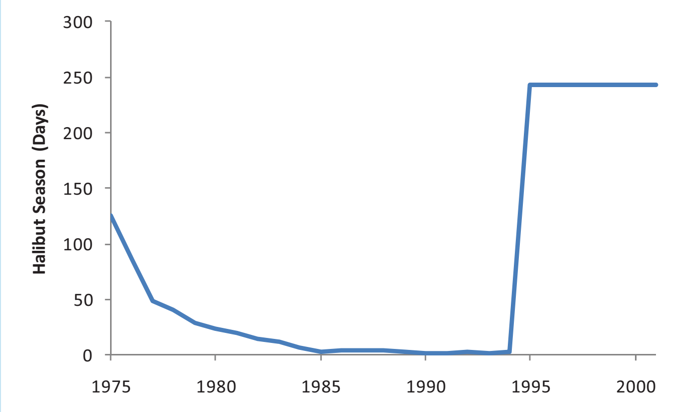


Figure 7: Number of days that the halibut season was open (1975 to 2000). As capacity increased, the season decreased in length, then rapidly increased after the quota share innovation was introduced in 1994 (IPHC 2011).

Under open access conditions there was a large level of ghost fishing due to abandoned gear. This was driven by the short nature of the season and the necessity to maximise catches in this time, therefore often more gear was set than could be hauled.

The 'Olympic' style fishery with thousands of vessels fishing for a very short period of time exemplified a 'race for fish'. This resulted in conflicts between vessels; ghost fishing; poor fish quality; low product value; and small amounts of fish available for the fresh market. The short, intense season was also risky and dangerous for the crews. Furthermore, the fleet was extremely overcapitalised and inefficient from an economic perspective resulting in a lack of profits. Based on this continuously decreasing season and the risks that were involved, two industry-led associations (the Seattle-based Fishing Vessel Owners Association and the Petersburg Vessel Owners Association) requested new management measures from the North Pacific Fishery Management Council.

The innovation: Rights-based management and Individual Fishing Quotas

Rights-based management (RBM) refers to the allocation of rights to fishers, fishing vessels or fishing organisations. One of the most well-known is the allocation of a share of the total level of fishing to authorised participants in the fishery. It can be a share of the total allowable catch or a share of the total allowable effort, such as days at sea. Rights-based systems can come in many forms, but the most economically efficient are those that not only grant rights to fishers but allow these rights and the quota shares that they hold to be fully transferrable, or traded, between fishers (Hanneson 2009). In the Alaskan Pacific Halibut fishery, a rights-based scheme was introduced, based on individual fishing quotas (IFQ) which were transferable. While quotas were freely tradable, as a method of reducing social costs in the small-scale sector, all vessels were categorised into vessel size groups and trading could only occur within the groups.

Costs and benefits

The number of licences for fishing Alaskan Pacific halibut greatly reduced once the IFQ system was introduced, from 4,830 to 2,855 (Figure 8a). This occurred because quotas essentially became private property, so quota holders were able to sell their quota and exit the fishery (Gilroy et al. 2009). With the decrease in capacity, each vessel remaining in the fishery had more quota available to it.

Vessel owners also benefited from a rise in prices, from USD 0.45-0.91 per kg to USD 1.36-2.2 per kg. This occurred because when the fishing season was reduced to 2–3 days, there was a large glut of halibut caught which could not be processed or marketed in time to sell it all fresh, therefore much of the catch was frozen which fetched lower prices.

With the longer season and each vessel having its own quota, supply to processors is steadier. This has meant that the quality of product is much higher and there is a much greater availability of fresh halibut fetching higher prices. The fishery gained MSC certification in 2006 which may have also contributed to increasing prices.

Because catch levels have remained stable while fish prices have increased, there has been a year-on-year increase in the revenue from the fishery (Figure 8b). Total revenue increased from approximately USD 50 million in 1992 to between USD 150 million and USD 200 million by 2003, peaking at USD 245 million in 2008.

After moving to an IFQ system, there has been a reduced incentive to abandon gear as fishers can stagger their effort. As a result, commercial wastage has reduced by 53% - 9.18 to 4.34 million tonnes (Hare 2010).

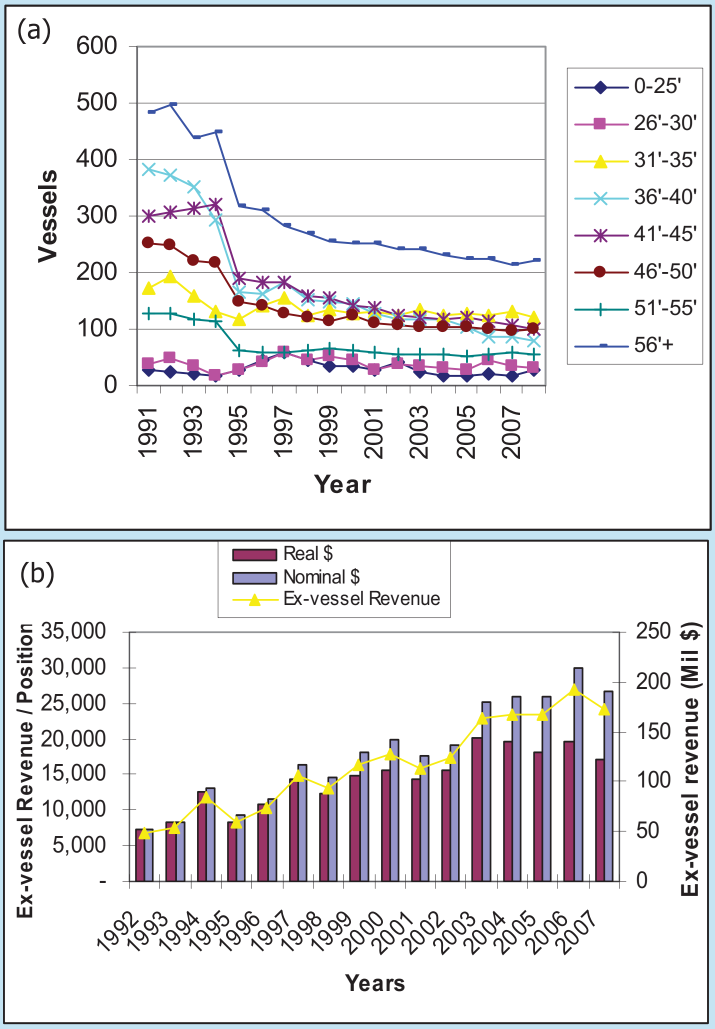


Figure 8: (a) The decline in the level of capacity (number of vessels) per size category as a result of the IFQ 1991–2008 (IPHC logbook data); (b) Ex-vessel revenue generated per crew member in real (1992) and nominal dollars and total ex-vessel revenue, 1992–2007 (Data from NMFS 2009).

Employment opportunities have also changed. While overall crew numbers have reduced due to the reduction of vessel numbers, the season length has increased significantly, allowing a longer period of employment for remaining crew. Furthermore, changes in supply to processing factories as a result of the IFQ system have allowed greater employment in affiliated land-based industries.

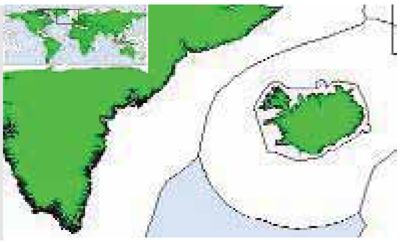
The Alaskan IFQ system implemented a cost-recovery scheme. In order to ensure that new management of the fishery does not incur additional costs to the government, fees are collected from quota owners each year to cover any costs which would not exist in the absence of the IFQ scheme. This amount cannot exceed 3% of the total value of fished halibut. In 2008, to the total value of landed halibut was USD 245 million and the IFQ management costs were USD 3.5 million. The management authorities were able to collect the total IFQ management costs, as they amounted to only 1.4% of total landed value.

Uptake potential: Wider applicability of fishing rights

Transferable fishing rights led to a successful reduction in capacity in this case. However, the wider uptake of transferable fishing rights requires a political commitment to the allocation of fishing rights and a stable free market. If markets cannot set the price for quota which is being sold, or if transfers are overly restricted, the system will result in poor reductions of capacity and poor compliance in the long term (Hatcher 2005).

There are often concerns about the equitable allocation of rights and the potential for exclusion of smaller players in the fishery with the introduction of transferable rights. However, this case study illustrates how safeguards can be put in place to minimise such problems, including setting up a vessel class system and concentration rules.

Iceland: Transferable quotas



Species	North East Arctic Cod
Fishing Method	Trawling, Gillnet, Longline
Fishery Tonnage	181,322 t (2009)

The problem and driver: Stocks decline due to overcapacity

By the 2000s, fish and fishery products accounted for 26% of Iceland's exports (IKR 99 billion, or USD 855.3 million) and approximately 8% of GDP. Cod represented 35–40% of this value.

Despite fluctuating catches for the entire fishing industry, the cod fishery was experiencing a decreasing trend in catches (Figure 9a) and declining cod stocks (Figure 9b). Given the importance of cod stocks to the national economy, attempts were made to reverse this trend in 1984 by introducing a quota system to align fishing capacity with resource opportunities. Total Allowable Catches (TACs) were set for different stocks and then split amongst vessels as Individual Vessel Quotas (IVQs).

Unlike the fully-transferable system in the Alaskan Pacific Halibut fishery, these quotas were attached to vessels. In order to concentrate quota (thus reducing fleet capacity), investors had to purchase the entire vessel. However, poor profitability and catches regularly exceeding TACs (Danielsson 1997) indicated that the IVQ system was failing in its objectives to ensure the fishery's profitability and sustainability. In fact, net profits were made in only four years between 1969 and 1991 (Figure 10a).

Vessels had the possibility of opting out of the IVQ system and operating under an effort-restriction regime instead. Arnason (2005) shows that the concurrent effort and IVQ options meant that the level of overall effort applied to the cod fishery actually increased after the introduction of IVQs, and only reduced once the new management system (Individual Transferable Quotas, ITQs) was introduced (Figure 10b). The declining catches, despite the continuing increase in effort, indicate that the stock was becoming overexploited and the fishery was becoming increasingly inefficient, leading to poor profitability.

The driver for the new management system was a combination of factors: the negative impacts resulting from employing two different capacity-reducing options (IVQs and effort restrictions); the lack of improvement in stock levels from the IVQ system; loopholes created through poor regulation; allowing vessels to fish in excess of the TAC; and, lack of legislative authority to manage capacity.

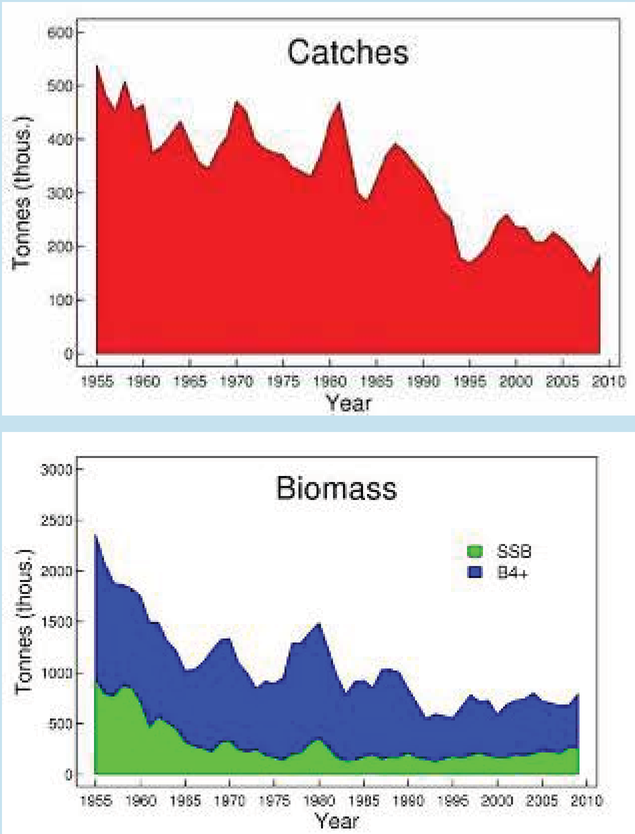


Figure 9: (a) Cod catches in Icelandic waters. Despite the fluctuations, it is clear that the overall trend is decreasing (Source: NWWG 2010); (b) Icelandic cod stock levels as assessed by NWWG (2010). Coinciding with the allocation of stricter management and control of landings, stock levels started to increase.

The innovation: Reducing capacity through Rights-Based Management

In 1990, Iceland passed a new Fisheries Management Act, which abolished the effort option for all vessels (except for very small-scale vessels, less than six tonnes GRT) and also made all quotas fully transferable. This meant that quotas were no longer attached to vessels, and vessel owners could sell portions of quota if they wished. Following the Act, there was a period of public consultation, and in 1991 Iceland implemented the ITQ system across the entire fleet. Unlike the Alaskan case study, there were no safeguards put in place for any fleet segments.

Costs and benefits of Iceland's reduction in fishing capacity

The Fisheries Management Act successfully closed loopholes which allowed fishers to catch more fish than set out in the TAC. In addition, large increases in fisheries enforcement capacity were made to support this. The budget of the Directorate of Fisheries increased from ISK 57 million (USD 492,000) in 1990 to ISK 322 million (USD 2.7 million) in 2008 - a 464% increase in the management and enforcement budget (adjusted for inflation). The budget of the science advisory agency also rose — from ISK 470 million (USD 4.06 million) to ISK 706 million (USD 6.1 million) - to more accurately assess the cod population.

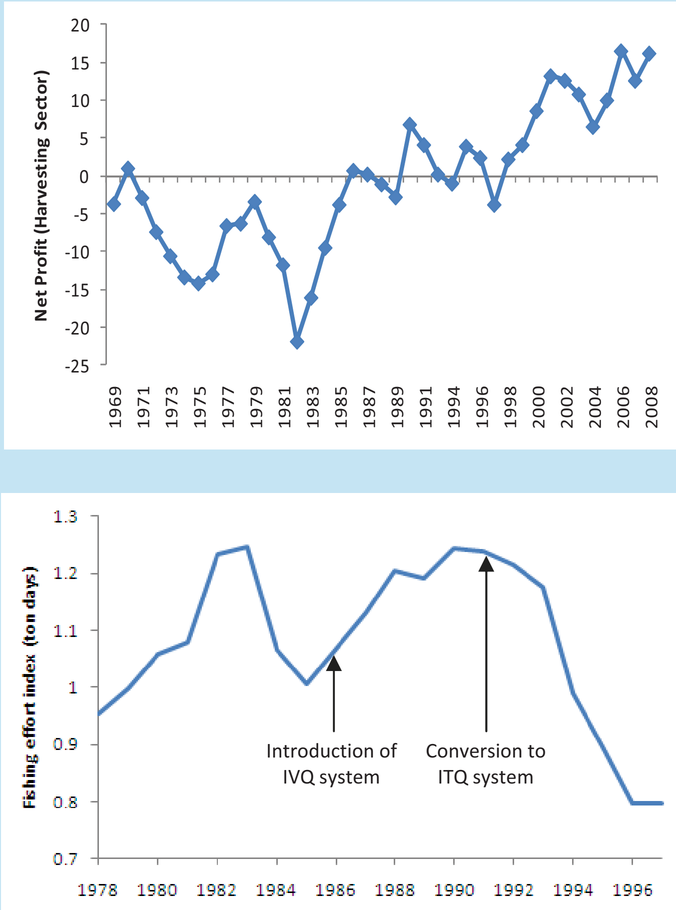


Figure 10: (a) Net profit margin for Iceland's demersal fishery, 1969–2008 (Data source: Statistics Iceland 2010 and Arnason, 1995); (b) Effort levels in the fishery, 1978–1997. Effort only substantially decreased once the fully transferable system was introduced. Source: Arnason (2005).

One social cost to Iceland after the implementation of ITQs in 1991 stemmed from the lack of safeguards in place for small-scale vessels. Quota holders were free to sell their quota, and many small-scale holders did so. This had some unintended consequences. Communities and investment had developed around the fishing activities of these small-scale vessels. The loss of small-scale vessels meant that linked industries suffered. While small-scale vessel owners profited from selling quota, other stakeholders were left with no livelihood and mortgages on assets which then held little to no value (Eythorsson 2000). The best estimate available of this employment loss across the entire Icelandic fishing industry (not just the cod fishery) was 33%, a decrease from 6,200 jobs in 1991 to 4,200 in 2008 (Statistics Iceland 2010).

By 2007, the 40 companies which existed in the early 1990s (and were fishing cod) had reduced by 50%. The number of trawlers had decreased by 44%. Across the entire cod fishing fleet vessel numbers had reduced by 66%. These reductions in fishing capacity resulted in a concentration of quota, with 82% of the quota being held by the top 50 licence holders (up from 60%), which led to the increased profitability of the fleet (Knútsson et al. 2008, 2009; Statistics Iceland 2010). Since the introduction of ITQs in 1991, profitability has fluctuated, but steady increases have been seen since 1996 and the fleet has been profitable for the past eleven years (Figure 10a).

Since the implementation of ITQs, stock levels of Icelandic cod have stopped declining and are showing signs of recovery — ICES estimated the spawning stock biomass at 160,711 tonnes in 1991 and 300,488 tonnes in 2010 (Figure 9b). However, the increasing stock levels cannot be solely attributed to the implementation of ITQs, but are also a result of the stronger mandate awarded to the Directorate of Fisheries through the 1990 Fisheries Management Act, and increased enforcement efforts.

Uptake potential: Further applicability of capacity reduction

As with other individual quota systems, for effective reductions in capacity, markets must have the ability to set prices. This case study highlights the need for quota to be freely transferable in order to result in effective fleet capacity reductions. However, it also raises the issue of the wider social costs of individual transferable rights, as rights can become concentrated in the hands of a few, large companies. Where there are important economic activities based around the small-scale fleet, there may be a need for mechanisms to ensure their continued participation in the fishery.

As the fleet is now profitable, as a direct result of ITQs, it would be possible for the government to offset some of the higher management and enforcement costs through cost recovery schemes as in New Zealand and Alaska, although this does not occur at the moment.

Canada: Quota pooling for herring roe

Species	Canadian Herring (for roe)
Fishing Method	Purse seine, Gillnet
Fishery Tonnage	12,811 t (2009)

The problem and driver: Overcapacity leads to 15-minute fishing seasons

Canadian fishers have long fished for herring as food and bait, and began to fish herring for roe (fish eggs) in 1971, stimulated by demand from Japan (Moloney 1981). Herring roe, or *Kazunoko*, is a traditional food in Japan and until the 1970s, the majority of herring roe was supplied domestically. However, as domestic supplies began to dwindle, Japanese authorities relaxed import restrictions in 1971; between 1972 and 1977, Japanese herring roe imports were 8,000–14,000 tonnes per year.

The investment decision was simple: a CAD 5,000 (USD 5,060) investment could provide access to a share of a CAD 9.1 million (USD 9.2 million) fishery. Because of the large interest in investing in the fishery, a licence fee was introduced in 1974, although there was initially no limit on the number of licences issued. The licence fee was intended to limit capacity to ensure three objectives: to sustain the health of the herring population; to ensure fishing income remained above fishing costs; and, to collect revenue for the Crown. It became clear that the licence fee was not large enough to control capacity as there were further substantial increases in the number of fishers entering the fishery.

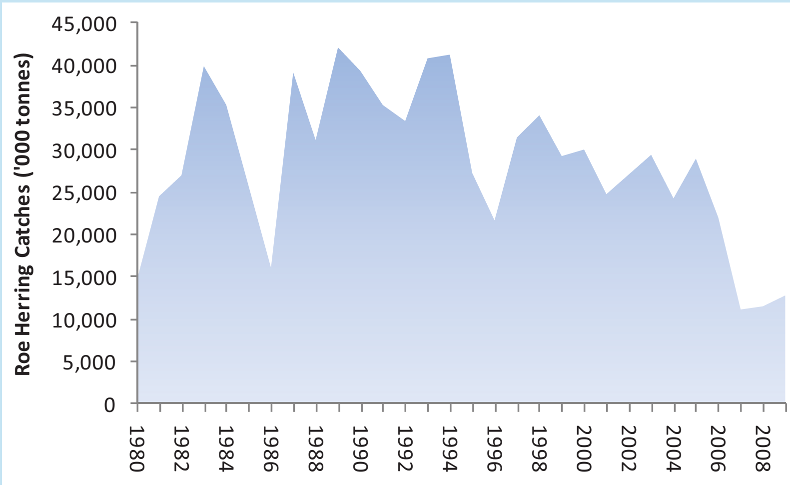


Figure 11: Herring catches for roe in Canada. After the 1998 mandatory licence pooling requirement, there was a gradual decline in catches. Despite this decline, vessels are meeting costs due to the pooling of licences. (Graph created from DFO Herring FMP, 2010).

The landing price of herring roe in Canada increased by approximately 1000% over the period 1975–1979, as a result of increased demand from Japan due to supply problems from other sources. This further encouraged investment in the fishery. However, the increasing capacity was causing negative biological impacts on the herring stock, and catches declined from a peak of 78,000 tonnes in 1976 to 37,000 tonnes in 1979, and by 1980 catches were 15,000–18,000 tonnes (Figure 11). There was concern not only for the viability of the herring population, but also the economic outlook for the fishery. In some areas, fishing was so intense, that the fishery was only open for 15 minutes — the time that it would take the fleet to catch the available herring. The short fishing seasons not only caused reduced revenues per vessel, but the intense nature of the fishing conducted in such a short period time meant that controlling catch levels to keep them within sustainable levels was proving to be a difficult task for authorities. This was evident as the fishery regularly overfished the quota by 10–15%.

This reduction in the economic performance of the fleet and tendency for the fleet to overfish quota were the main drivers for innovation. The Department of Fisheries and Oceans' (DFO) management plan required that total catches of roe herring did not exceed TACs. Much like the Alaskan case, in order to control roe landings, authorities applied shortening of seasons as the management measures. Suggestions were then made through consultations by the Herring Industry Advisory Board as to how pooling of licences could alter the open access character of the fishery.

The innovation: Licence pooling to create economic efficiencies

By 1981, the industry was considering the idea of 'pairing up' to reduce fishing costs. By essentially halving the fishing costs, because only one vessel did the actual fishing, profitability would then increase for both parties. In a round of public consultation in 1997, the Herring Industry Advisory Board (HIAB) recommended that the DFO implement this pooling system as a requirement at the beginning of the season to receive a licence to fish — vessels would have to be part of a minimum sized pool of vessels. The entire TAC is divided into regions along the coast and then vessels from within those regions are allocated a catch share. The pooling vessels must hold catch shares from the same region to ensure catch allocated to one region is not taken from another.

Costs and benefits: Reduced fishing costs

Anecdotal evidence suggests that this system was extremely successful and at least for the last 20 years, fishing for herring roe has remained profitable despite the reduction in overall revenue (Figure 12).

The fishery has been subject to a double decrease: the capture landings from the fishery have decreased substantially, from 31,442 tonnes in 1997 to 11,529 tonnes in 2008; and poor economic performance in Japan has meant that the price per kilogramme has also decreased from CAD 1.56 in 1997 to CAD 1.34 in 2008 (USD 1.58 and USD 1.36 respectively). This has led to a decrease in landings revenue from CAD 49 million (USD 49.6 million) in 1997 to CAD 15.5 million (USD 15.7 million) in 2008 (Figure 12). However, despite this, the fishery has remained profitable.

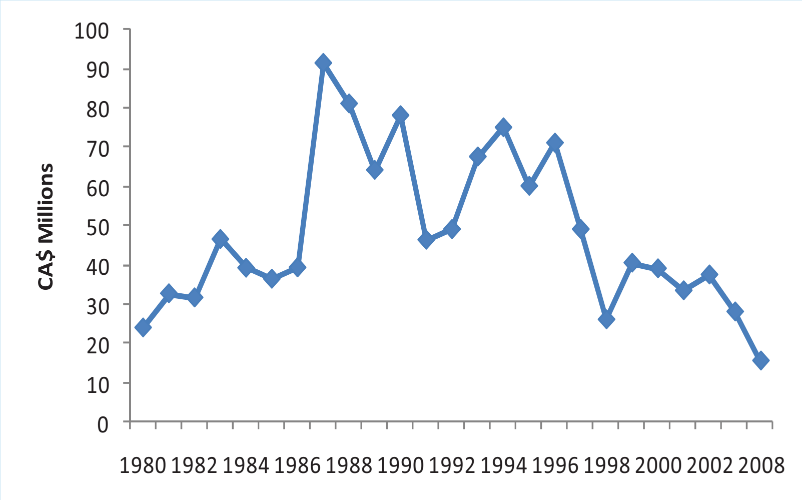


Figure 12: Landed values of roe herring between 1980 and 2008. In addition to the reduced catch levels, the fishery has experienced a reduction in price/kg as a result of poor economic conditions in Japan (DFO, 1998-2009) (Source: graph created from DFO data)

The licence pooling system has been successful in reducing economic overcapacity. In order to remain profitable, vessels had to reduce costs. This has been achieved without the permanent decommissioning or removal of fishing vessels (which are needed at other times of the year in other fisheries).

The fishing season has increased in length from 15 minutes to several days with fewer conflicts between vessels. Fishing is less dangerous and control and enforcement in the fishery is easier.

This season may still seem short, but there is a limited period when herring can be caught for its roe. Furthermore, it would not be sustainable to harvest the herring populations to any substantial level when the main purpose is for its roe is to spawn herring. In order to collect roe from the herring, it must be caught before it has had the opportunity to spawn for that season so any significant harvesting of herring prior to this may negatively affect future population sizes.

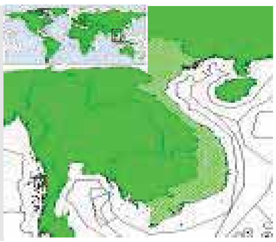
Uptake potential: Licence pooling

Unlike many other cases of reducing fishing capacity in order to increase fleet profitability, the intention of the licence pooling system is not to remove fishers and vessels. Fishers remain as participants in the fishery and vessel owners within a pool may change which vessel from the licence pool actually conducts the fishing each year. From the perspective of each vessel, this is not the method which will result in maximum possible profits. Currently fishing costs are reduced because only a small amount of the vessels actually do the fishing, yet profits need to be divided amongst other members of the pool. In order for stakeholders to leave the fishery permanently, more incentives would need to be in place.

At the moment, stakeholders do not leave the fishery altogether as they also fish in other areas for other species. This means that there are other fisheries, at other times of the year, where their fishing vessel can make profits independently. There is no incentive to sell their vessel and leave the herring roe fishery given the potential profits in this fishery and others, hence stakeholders want to remain as participants in the fishery as much as possible.

As a means to reduce fishing capacity and increase profits, vessel pooling will only be useful in scenarios where the vessels remaining in the fishery can fish in other areas. Without the option to fish in other regions, the cost of maintaining vessels will be wasted as they may potentially only be in action for a limited time during the year. While this may not create profits as high as other capacity reduction schemes, the social costs and political pressure is substantially less as fishers are not required to permanently leave the fishery.

Vietnam: Ben Tre clam



Species	Ben Tre Clam
Fishing Method	Gathering by Hand
Fishery Tonnage	9,521 t (2009)

The problem and driver: Overcapacity in hand-gathered fisheries

The Ben Tre clam fishery in Vietnam is primarily harvested by hand-gathering. Fishing takes place at low tides mainly between April and October, but can occur all year round. During the 1980s and 1990s the fishery was poorly managed, which prompted the establishment of a cooperative in 1997.

The cooperative was allocated 900 hectares to manage, with the expectation that it would address income and food security issues. In 2000, the harvest of clams was relatively large, but given the Ben Tre clam market was only domestic, prices were low. The cooperative idea continued to be developed and by 2006, 13 cooperatives were established. However, there was a concern that the cooperatives had little guidance and that management could be improved.

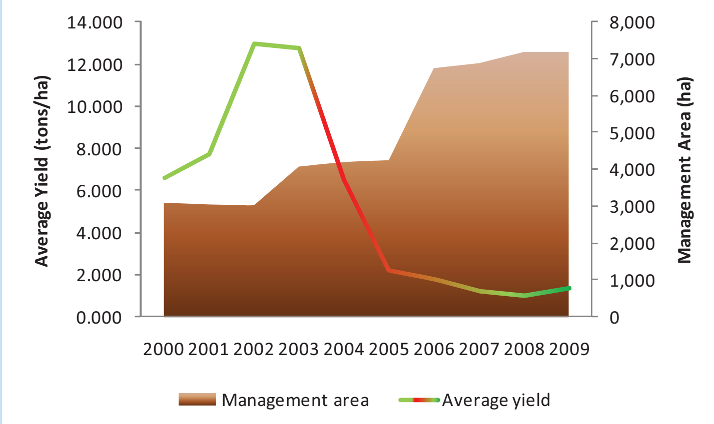


Figure 13: Management area and average yield in the Ben Tre clam fishery, 2000–2009 (based on Department of Fisheries Ben Tre data).

Despite the low price, increasing harvests attracted more participants to the fishery. Combined with a lack of management measures, clam populations began to decline. As in many other cases of overcapacity, this led to the harvesting of seed and undersized clams. Prices also continued to decrease due to the oversupply of clams in the market. Additionally, as cooperative numbers began to increase without regulations, social issues began to arise between the cooperatives and harvesters that did not belong to the cooperatives. Total clam catches remained relatively stable, but average catch per hectare decreased rapidly between 2003 and 2005. After management measures were implemented and the area under management controls was increased, average harvests stabilised in 2007–2008 (Figure 13).

The driver for change occurred after identifying the declines in catches, poor quality product and low prices. At this point, Ben Tre province began to collaborate with Vietnam's Department of Agriculture and Rural Development (DARD) to implement a series of management measures. This included management of capacity through allocating area rights to the cooperatives. By doing so, the cooperatives were then required to report landings to the relevant authorities in order to control supply, increase quality and thus improve the reputation of the Ben Tre clam on the international market. This improved management of the clams attracted the attention of WWF who provided partial funding in order to pay for the full MSC assessment of the fishery.

Adjustments in management and MSC certification have led to a good intentional reputation of Ben Tre clams. (Photo: Aquatex).

The innovation: MSC certification in Ben Tre

WWF-USA, in collaboration with the Sustainable Fisheries Fund, secured funding for the Ben Tre clam fishery to undergo Marine Stewardship Council (MSC) assessment — an ecolabel that certifies the fishery is sustainable and well-managed (see also Chapter 3) — which led to a successful full certification in 2009.

Prior to MSC certification, the fishery's managers implemented much greater levels of regulating and monitoring clam catches. This included: banning the harvest of clams below a certain size; banning the use of tractors on sand flats to transport catch; allowing only rakes and sieves to be used to harvest the clams; introducing closure guidelines if the area is considered necessary for environmental development; devolving higher levels of authority to cooperatives; and, improving data collection and reporting from cooperatives to the fishery's management.

Costs and benefits of MSC certification

In total, the MSC certification cost USD 120,000, which included USD 68,380 to conduct the full assessment. Without the financial assistance from WWF and the Sustainable Fisheries Fund, this assessment could not have been completed.

The investment seems worthwhile however, as the stocks benefited from the new management measures leading to sustainable clam catches (Figure 13). Through the introduction of those measures, the reduction in yield per hectare began to ease in 2005 and has remained constant at 1.2–1.3 tonnes per hectare (total production: 8,503 - 9,520 tonnes).

Through sustainable catch levels, the fishery also experienced more sustained economic output. Cooperatives were able to manage the catch levels and the amounts supplied to the market. This helped regulate supply to the market and thus increased prices — in one area the harvesting of clams decreased by 22%, yet the overall price increased by 156%, which increased the overall value of the fishery (Table 3). Applying the 2007 price for clams from the Dong Tam cooperative to the entire catch of the fishery in 2007, 9,000 tonnes, this would have been worth VND 91 billion (USD 4.7 million). The same catch at the 2010 price would have been worth VND 324 billion (USD 16.6 million). Much of this increase in unit price came from the increased willingness of retail markets in the EU (particularly Spain and Portugal) to purchase this product as a result of the new management measures and MSC certification.

Without certification, it is possible that prices would not have risen so much, thus reducing revenue and the incentives for sustainable harvesting. Certification itself is an expensive process and it was only through grants and in-kind contributions (research officers) from WWF which allowed the process to go ahead. However, to remain a fishery under the MSC label, re-certification is required on a semi-regular basis. In order to remain MSC certified, the fishery's managers must now develop a financial strategy to fund the follow up assessments.

Table 3: Total catches and values in Dong Tam cooperative (based on Department of Fisheries Ben Tre data)

Year	Yield (kg)	Value (VND)	Unit value VND/kg)
2007	1,761,235	17,825,808,159	10,121
2008	1,206,181	18,273,089,650	15,150
2009	1,341,667	28,168,428,582	20,995
2010 (Jan-Jul)	738,510	26,595,728,920	36,013

Note that once the supply of clams had been controlled, the unit value per kg increased. This substantial increase in price in 2010 also coincided with the fishery becoming MSC certified.

One recognisable social cost is related to access to the fishery resulting from greater levels of control; harvesters from outside the province have had their access restricted. Given that these harvesters were seen to be acting outside the law, both the provincial and national governments have concluded that there will be no provision of substitute sources of income.

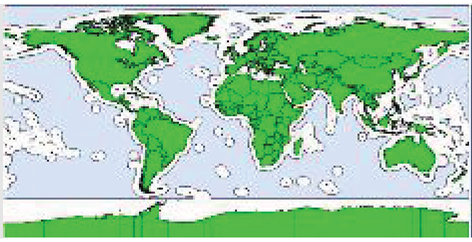
Uptake potential: Controlling capacity through market forces

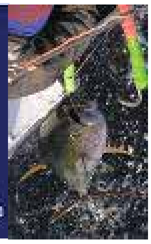
This case study has highlighted the potential role of market forces in creating incentives for better management and controlling capacity. Within developed country economies, it is possible to allow capacity to reduce independently - such was the case in the Icelandic and the Alaskan case studies. However, the income and incentives stemming from internationally recognised certification (such as MSC) has helped management understand the importance of controlling capacity.

The success of the Ben Tre province has meant that fishers from other provinces have begun planning to achieve MSC certification. However, as with the Ben Tre province prior to intervention from WWF, there is the issue that fisheries in Vietnam generally lack suitable levels of enforcement and accurate data. This is one major barrier to other provinces achieving MSC certification.

In this particular case, in order to control capacity, technological development of the fishery has been halted. By setting a regulation that harvesting of clams can only occur through gathering with hand rakes and sieves, managers have blocked the potential for cooperatives to develop the fishery to a more efficient level, although this does ensure higher levels of employment in the fishery. There is concern by the fishery's managers that if capacity was able to experience any form of technological creep, that it wouldn't be possible to ensure sustainable harvesting. Further assistance to develop sustainable methods of harvesting clams would mean that Ben Tre clams can keep their environmentally-friendly status yet also encourage social development.

ISSF: Market-demand innovation





The problem and driver: IUU and overcapacity

IUU fishing is both a symptom of overcapacity, and contributes to it. IUU fishing is particularly difficult to control in the high seas, because outside the EEZ the only authority able to bring a prosecution of a vessel is its flag state. Specific multilateral or bilateral agreements are required even to allow international inspection of vessels in high seas waters. The first tuna Regional Fisheries Management Organisation (RFMO) came into force in 1949 — the Inter-American Tropical Tuna Commission (IATTC) — before the implementation of UNCLOS. The most recent tuna RFMO, the Western and Central Pacific Fisheries Commission (WCPFC), came into force in 2004. Currently, there are five major tuna RFMOs covering all tuna, tuna-like species and billfish fisheries (Figure 14).

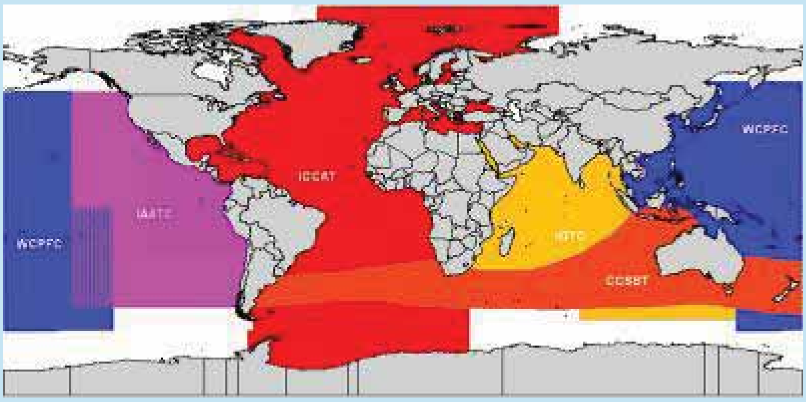


Figure 14: Global coverage of Tuna RFMOs. All major tuna stocks are managed under an RFMO agreement. (Source: MRAG).

The tuna RFMOs, and some non-tuna RFMOs, hold substantial databases on vessels which are authorised to fish in their waters as well as lists of IUU vessels that have been sighted or otherwise demonstrated to have been engaging in fishing in contravention of conservation measures. The actions taken against these vessels by the states that are party to the RFMOs vary, but include measures such as refusing port access. However, there is not a global list across all tuna RFMOs and consequently control of IUU vessels that operate between various RFMOs is difficult to coordinate. Furthermore, once identified on an RFMO's database as an IUU vessel, vessel owners are able to easily change some of the characteristics of the vessel, re-name and re-flag it, making it difficult to track it. Similarly, there is no global list of authorised vessels across RFMOs, which makes it difficult to quantify and manage the global tuna fleet's capacity.

Recognising that this lack of coordination can compromise compliance with conservation measures, there has been widespread agreements that a global database with a global IUU list needs to be created. Representatives from the five major RFMOs met in Kobe, Japan in 2007 and agreed that a new unique vessel identifier (UVI) would be a pre-requisite for such global database and allow to track vessels even through re-registrations (MRAG AP 2010). The International Maritime Organization (IMO) offers the most widely-recognised UVI system.

Unfortunately, the development of an IMO number requires the collation of multiple pieces of information for each vessel which are not uniformly collected by any RFMO. Little progress has been made despite the Kobe process.

The innovation: International Seafood Sustainability Foundation's Resolution 10-01

The International Seafood Sustainability Foundation (ISSF), established in 2009, is a global partnership of leaders in fisheries science, the tuna seafood industry and WWF. The main focus of the foundation is to ensure that RFMOs implement effective conservation and management measures that are consistent with scientific recommendations.

In recognition of the importance of achieving global vessel lists to combat IUU fishing and to manage fishing capacity, and the lack of progress, ISSF developed its own plan of action. From 31 May 2010, ISSF implemented Resolution 10-01, which requires that starting in June 2011 participating companies (processors and traders) not purchase tuna from any vessels which do not have an IMO number. This puts the onus on the vessels to apply for a UVI. Once the vessels have gained the UVI themselves, they can then report it to the relevant authorities and by only purchasing tuna from IMO-numbered vessels, ISSF participants assist in achieving two outcomes. Firstly, the building block for global databases is in place, meaning that IUU-listed vessels will no longer be able to move from one RFMO to another without check, as RFMOs will be able to track individual vessels. Secondly, if the uptake of IMO numbers is large enough, it will also give an accurate indication of the total capacity fishing for tuna. However, the key aspect is the ISSF's ability to influence change on practical fisheries management issues.

Costs and benefits of unique vessel identifiers

It is expected that ISSF members will hold sufficient influence over the tuna industry as approximately 60% of global tuna catches are by processed by ISSF participating companies (V. Restrepo pers comm. 2010). Furthermore, ISSF by-laws require that all participating companies abide by its resolutions.

All ISSF participating companies are required to have a traceability program to track all tuna from capture (vessel/trip) to the store shelves. Companies also pledged to recall any tuna which was later found to be caught as a result of IUU fishing. Also, despite the UN ban on driftnets longer than 2.5 km, many RFMOs had not successfully tackled this issue. In light of this, ISSF members agreed not to purchase tuna caught by these large scale driftnets (ISSF 2010).

ISSF is able to achieve such measures through market influence, due the fact that there is no affiliation to political states. The purpose of ISSF is to promote science-based conservation measures that ensure sustainable tuna supplied as opposed to public policy. Without strong private industry support, it would also not be possible to influence change through such market-dependent strategies. The commitment of ISSF participants, and the incentives for them to do so, are paramount.

Tuna being offloaded from a fishing vessel within ICCAT waters. Vessels such as these are those which will need to have an IMO number by March in accordance with ISSF Resolution 10-01 (Source: MRAG 2010).

There are no costs involved for a vessel to register for an IMO number, the number is allocated free of charge from the Internet, given that all of the necessary information is available for a vessel For individual vessels, certain costs may be incurred to ensure the vessel and documentation meet all the requirements. In terms of benefits, advancing the acquisition of UVIs through the ISSF resolution will make the global coordination role by RFMOs more efficient and effective.

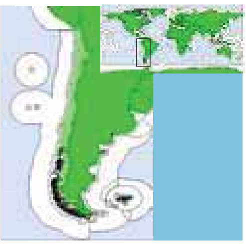
A risk to this program identified by ISSF, which is not possible to estimate, is whether the agency that issues IMO numbers will always assign them to vessels under 100GRT that request them (currently it is only mandatory to register requesting vessels greater than 100GRT). Therefore, ISSF will need to determine if it should require further developments to the resolution to deal with this problem if it arises. With UK retailers increasingly committing to selling only pole and line-caught tuna (typically much smaller vessels), the importance of these smaller vessels should not be underestimated (Sharpe 2011).

Uptake potential of market pressures

This innovation currently has the potential to achieve a global reach for all canned tunas. It is also possible to more widely apply this concept to other species or markets if required. Traceability within other markets, such as fresh tuna, could be more difficult as they can be much more dynamic. ISSF acknowledge that a system to achieve this, if required, could need further development. Nevertheless, a portion of the longline fleets catch tunas for both the fresh and shelf-stable markets, and these vessels are expected to obtain IMO numbers.

The general concept of this innovation though is fundamental. Canning companies that already have traceability protocols are now able to extend this to ensuring that the actual supplier vessel holds an IMO number. This can contribute to reducing the potential of IUU fish entering the chain. This is a good example of a non-governmental organisation harnessing purchasing power to create change. Without the barriers arising from political pressures, NGOs and industry partnerships are able to influence policy efficiently and effectively. This demonstrates the benefits of multi-level stakeholder involvement in management.

Chile: Territorial use rights



Species	Chilean Loco
Fishing Method	Gathering by Hand
Fishery Tonnage	9,521 t (2009)

The problem and driver: Local management of Chilean loco

Chilean benthic fisheries are based around molluscs and algae, with the most significant resource being the snail locally known as loco. The loco is a valuable mollusc superficially resembling an abalone. Artisanal fishers, *caletas*, harvest the snail mainly through commercial diving. In 1976 loco was introduced to the Japanese market and as a result landings climbed to around 25,000 tonnes and it was estimated that 15,000 divers from all over Chile were involved in fishing (Gelcich et al. 2010).

At this point the loco fishery was regulated by the Chilean government. Yet, despite legal size restrictions and fixed fishing seasons, resources suffered from increasing overfishing. In 1989, recognising the danger signs, the government decided to close the fishery entirely, and it remained closed for three and a half years (Castilla and Fernandez 1998).

Throughout the loco moratorium social unrest fuelled political tensions with fishers who strongly opposed the ban arguing that stocks were in fact recovering and fishing should resume. The deadlock was broken by Oscar Avilez, leader of the regional federation of artisanal fishers, who interrupted a political meeting to deliver the message of the loco fishers to the Chilean President directly. The President, apparently persuaded, instructed the Undersecretary of Fisheries to consider the evidence of a stock recovery assembled by fishers and the ban was subsequently lifted.

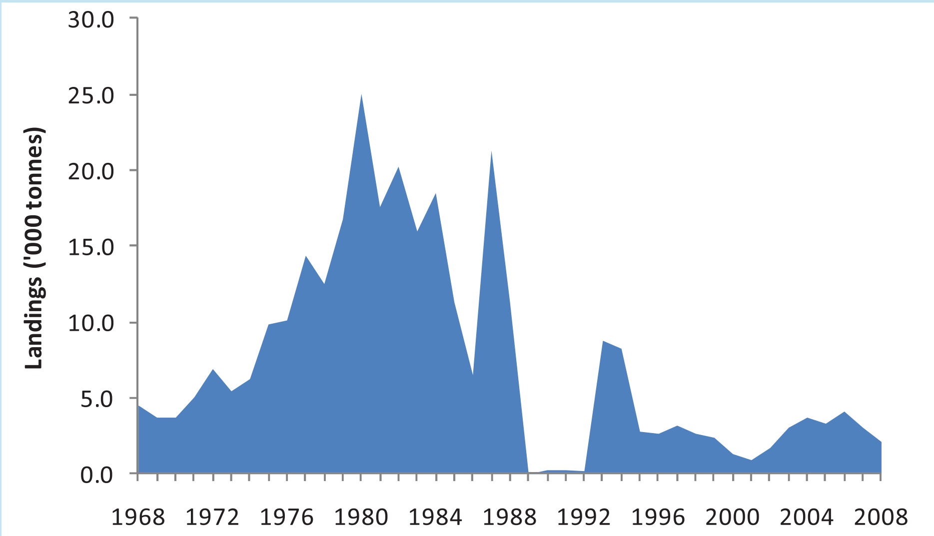


Figure 15: Total landings of Chile Loco, note the harvest moratorium between 1989 and 1992 and the initial peak during the quota system (1993-97). Since the AMERBs in 1997, harvest levels have remained relatively constant (Source: Gelcich et al. 2010).

The fisheries authority implemented a new management regime consisting of individual non-transferable quotas. This individual quota system was intended to ensure the fishery did not revert back to the open access system which had been considered the source of the problem in the past. However, despite these intentions of sustainable fisheries management, within five years catch per unit effort (CPUE) had fallen to pre-moratorium levels due to a poorly constructed rights based management system, ineffective enforcement and illegal trading of rights (Orensanz and Parma 2010).

This issue, and the original harvest moratorium, led to one of the main drivers to shift the fishery's management into a territorial rights-based approach. With the assistance of academic researchers, most notably Juan C. Castilla, local fishers have begun successfully experimenting with self-imposed closed areas, which appeared to aid loco recovery. These local experiences were the starting point for the development of a new and improved territorial user rights system – AMERBs (after the Spanish for 'areas for the management and exploitation of benthic resources').

The innovation: Introduction of territorial use rights in the loco fisheries

During and before the loco closure, a number of fishers had been successfully experimenting with self-imposed closed areas, which appeared to aid loco recovery. These local experiences were the starting point for the development of AMERBs. AMERBs were adopted into a new fisheries act passed by Chilean Congress, and implementation started in 1997. By 2000 loco could be legally harvested only within AMERBs, of which 237 (from a total of 732) had locally-designed management plans officially identifying loco as the target species.

The AMERBs, which are granted to fishers' organisations cover an area of seabed and grant members of the organisation exclusive privileges over the benthic resources within.

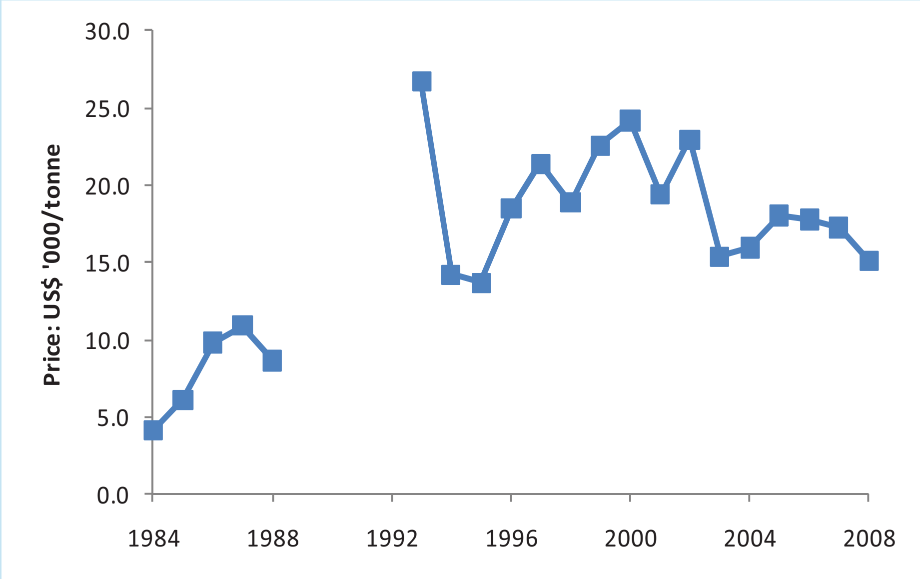


Figure 16: Price per tonne of exported Loco. Gaps in the series indicate the harvest moratorium between 1989 and 1992 (Source: Gelcich et al. 2010).

Costs and benefits

The granting of rights led to the implementation, by fishers themselves, of effective monitoring, control and surveillance procedures that have reduced government enforcement costs and increased the effectiveness of effort regulation. To keep these rights the organisation must conduct regular science-based surveys of the loco and, after the second assessment, pay the government an annual fee for the right to manage and fish the area. These mandatory assessments are carried out by third parties reporting directly to the administration. The cost of these studies are high and unpopular with the fishers, but until recently have mainly been paid for through subsidies.

Due to the recovery and good management of the loco stocks the fisheries have been reopened and AMERBs now have 14,324 registered fishers. Furthermore, a harvest control rule (HCR) is in place whereby fishers are only able to harvest 15–25% of the total stock. With the relatively stable harvest levels of 2,000–4,000 tonnes since 1997 we can assume stocks have remained stable at a level at least three times higher than the catches (Figure 15). Anecdotal evidence in Gelcich et al. (2010) also suggests that a benefit of the AMERBs is the increased abundance of the stock.

New neoliberal policies following the coup contributed to increasing export earnings from the loco fishery (Gelcich et al. 2010). Figure 16 indicates that overall there has been a decreasing trend in export price since implementation of AMERBs with prices declining to USD 15,000 in 2008, despite an initial increase in export price to USD 24,000 in 2002. However, these fluctuations in export price approximately track the same fluctuations in exchange rates between the US dollar and the Chilean peso.

Uptake potential of territorial user rights

The uptake potential for territorial user rights is high amongst fisheries where the stock is less mobile, and especially for coastal fisheries. In this case study, it was demonstrated that prior to the development of external stock assessment, the use of local knowledge of fisheries can be key to identifying areas of stock decline risk and implementation of self-imposed closures. This concept is further discussed in Chapter 4 when considering lack of data and has also been regularly cited in literature (e.g. St. Martin 2004).

Similarly to the Ben Tre clam case study, locally managed cooperatives in loco fisheries have also demonstrated effective monitoring and control regimes to ensure that catches remain up to or below TACs and that stocks remain sustainable. Furthermore, the devolution of power to the cooperatives has meant that individual rights were not required to control capacity; instead the closer proximity of management and the overall community stake in the fishery ensures that monitoring of catches is adequately completed.

While this innovation began as a more locally-driven and managed system, management authorities have now added the requirement for expensive, independent stock assessments. This development has led to a digression from the use of valuable local knowledge and the fishery now also requires subsidies in order to comply with these new management regulations. Evidence suggests that due to this, local support for the imposed management measures has been wavering and that this may be impacting the accuracy of the stock assessments.

Addressing overcapacity

Capacity control options

Matching fishing capacity to the available fish resources is a common problem and the case studies highlight a variety of measures that have been developed by a range of actors to address this issue. In particular the case studies have illustrated the application of rights-based approaches by centralised authorities and the granting of increased authority to local management institutions to address the issue. Individual rights-based approaches draw on economic analyses of fisheries and are increasingly being used as a mechanism to reduce capacity in fisheries. Tradable rights allocated to the industry to fish the quota, that allow market forces to operate, allow fishing capacity to be adjusted to fit the available fishing opportunities.

Traditional forms of fisheries management and local management institutions have begun to receive increased attention as an alternative to centralised control of fishing capacity and as the basis for forms of community-based management and co-management (e.g. Mozambique and Fiji, see Chapters 4 and 5 respectively). In the case of the Chilean loco case study, communities, in conjunction with academic researchers, began to experiment with territorial use rights which allowed local entities to manage the total quota allowed for the particular area and match capacity to the available resources.

The costs and benefits of individually transferable rights

Rights-based approaches have emerged as a means to address the problem of the 'race to fish'. This was a particular issue in the Pacific halibut and roe herring fisheries, that led to poor quality of fish, oversupply followed by low supply, and high risks faced by crew. Individual transferable quota systems reduced capacity by 66% in Iceland and 41% in the Pacific halibut. Due to this reduction in capacity, individual vessels' profits increased and fleets became economically viable again. Supply of fish to the market was stabilised in the Pacific halibut case study, resulting in a higher quality product and increased prices.

Importantly, the use of individual transferable rights achieved capacity reductions without the use of decommissioning subsidies, which, in addition to costing tax-payer money, often lead to reinvestment in capacity within the fishery, or other associated fisheries. Where decommissioning subsidies are necessary to ensure a rapid reduction in capacity, they should follow the OECD guidelines (OECD 2008). The Icelandic cod case study highlighted that individual rights need to be freely transferable in order achieve effective capacity reductions.

This Alaskan fishery is similar to that of the Herring Roe fishery in Vancouver. Large groups of purse seine vessels gather in the 'race to fish'. Without any quota rights or capacity controls, vessel owners can be forced into a high risk situation such as this. (Photo by: Randy Sponholz).

While the reduction in fleet capacity can simplify the enforcement task of the relevant authorities, the use of ITQs requires increased monitoring and control, both for monitoring catches, and carrying out stock assessment to assess the available quota. This has cost implications. Cost-recovery has greater potential where there is a more profitable industry, as seen in the Pacific halibut fishery case.

The implementation of ITQ systems can be particularly appropriate where fishing represents an important local economic activity pursued for commercial gain. Limiting the transfer of quota for social reasons, for example to prevent larger interests from buying-out the smaller operators for their fishing rights, could lead to the introduction of safeguard measures. Safeguarding can be seen in Norway, where vessel quotas cannot be transferred from smaller communities in the north to the more industrialised communities in the south (Hanneson 2009). Alternative solutions can also be seen in other fisheries: in Estonia, larger vessels are allocated quota of fish they can catch whereas the smaller vessels are allocated an amount of effort in which they can fish (MRAG et al. 2009).

The equitable allocation of these rights initially is also important. In the Alaskan case, quotas were allocated to eligible participants based on catch history. These eligible participants were vessel owners which were active in any years between 1988–1990 and the catch history was established through any five of the seven years between 1984 and 1990. Ensuring that rights are allocated to all participants with a recognised stake in the fishery is key to establishing a rights-based system that is acceptable to all, with minimised social costs.

Monitoring and controlling capacity in small-scale fisheries

As an alternative to individual transferrable quota systems, the Chilean loco and Ben Tre clam case studies highlighted how local management measures can support efforts to control capacity in smaller fisheries that are managed to generate financial returns from fishing. In both these cases greater authority was given to local groups that allowed them to make and enforce some local management actions that included taking steps to address capacity within the fishery, both in terms of the number of fishers and the types of gears used..

Influencing capacity control through the value chain

Consumer and retailer awareness can create market pressure that can, in turn, influence the behaviour of fishers and managers. In addition, market-based incentives have played an important role in capacity control in several cases. For example, through the growing consumer demand for sustainably sourced fish, fishery managers in Ben Tre were encouraged to limit capacity and improve monitoring as a means to gain MSC certification that, in turn, enabled them to gain access to a wider, more lucrative market. Similarly, ISSF have addressed issues related to traceability and capacity to highlight the sustainability of tuna supply to retailers. By requiring all of their members only purchase supplies from vessels with an UVI, it is expected that 60% of total canned tuna sales will be covered under this resolution.

Identifying candidates for capacity reduction

This chapter has highlighted a number of successful innovations and approaches to addressing issues of overcapacity. In large-scale fisheries, fleets with low or zero profitability are likely to be overcapitalised. These fleets should be the target of the capacity reduction schemes studied here, particularly the introduction of transferable rights based systems with suitable safeguards for small-scale fishers. These systems should be capable of removing capacity without the need for decommissioning, to match with available fishing opportunities. However, it should be recognised that these approaches may incur additional social costs as there will be losers (those excluded from the fishery) as well as winners (those who gain rights and stand to benefit from long term sustainability) and these may need to be explicitly addressed.

New management measures encouraged by the potential of new markets in Ben Tre clam fishery require landing of clams to occur on vessels such as this moving in and out of harvest grounds with the tide. Previously tractors were driven over areas at low tide to land catch damaging stocks (Photo: VINAFIS).

PERVERSE SUBSIDIES

Inappropriate subsidies to the fishing industry are contributing to worldwide fisheries depletion, overcapitalisation and ecosystem degradation. Nearly 60% of global fisheries subsidies go to unsustainable, capacity-enhancing activities, and large developed countries are spending twice the amount of tax-payer money on global fisheries subsidies that encourage overfishing than they are on subsidies that protect oceans (Sumaila et al. 2010).

Removing inappropriate subsidies, reorienting subsidies to contribute towards positive environmental outcomes, and creating positive financial incentives for sustainable fisheries will help make global fisheries sustainable and will benefit the marine environment. Action can be taken at international and national levels, from governments, NGOs and the private sector.

Fisheries subsidies

Agricultural subsidies, including those which led to the surpluses of production and the 'sugar mountains' and 'wine lakes' of the 1980s in the EU, are well-known. Fisheries subsidies are less well-publicised, but have encouraged fishing fleets to search further and deeper for fish than ever before, expanding the problem of overfishing.

Subsidies are financial contributions made by governments or public bodies which provide a private benefit (Cox and Schmidt 2002). Sumaila and Pauly (2006) estimate global fisheries subsidies at USD 30–34 billion per year (Table 4); more than the GDP of half the countries of the world. The amount spent by governments subsidising the fishing industry represents 35–40 % of the first-sale value of total fisheries production.

A brief history

Fisheries production declined dramatically during the Second World War. There was a subsequent surge in subsidies to marine capture fisheries during the 1950s and 1960s as countries tried to rebuild their commercial fishing industries to secure and augment food supplies. In the 1970s and 1980s, as national control over marine resources was extended out to the 200 nautical mile EEZ, many countries began subsidising the construction of domestic fishing vessels and fishing-related infrastructure in order to take advantage of the fishing opportunities created by the displacement of foreign fleets.

Support to fishing is provided mainly through government expenditure on ports, subsidies for vessel modernisation or construction, subsidies or tax waivers on fuel, buy-back (decommissioning) schemes, government-to-

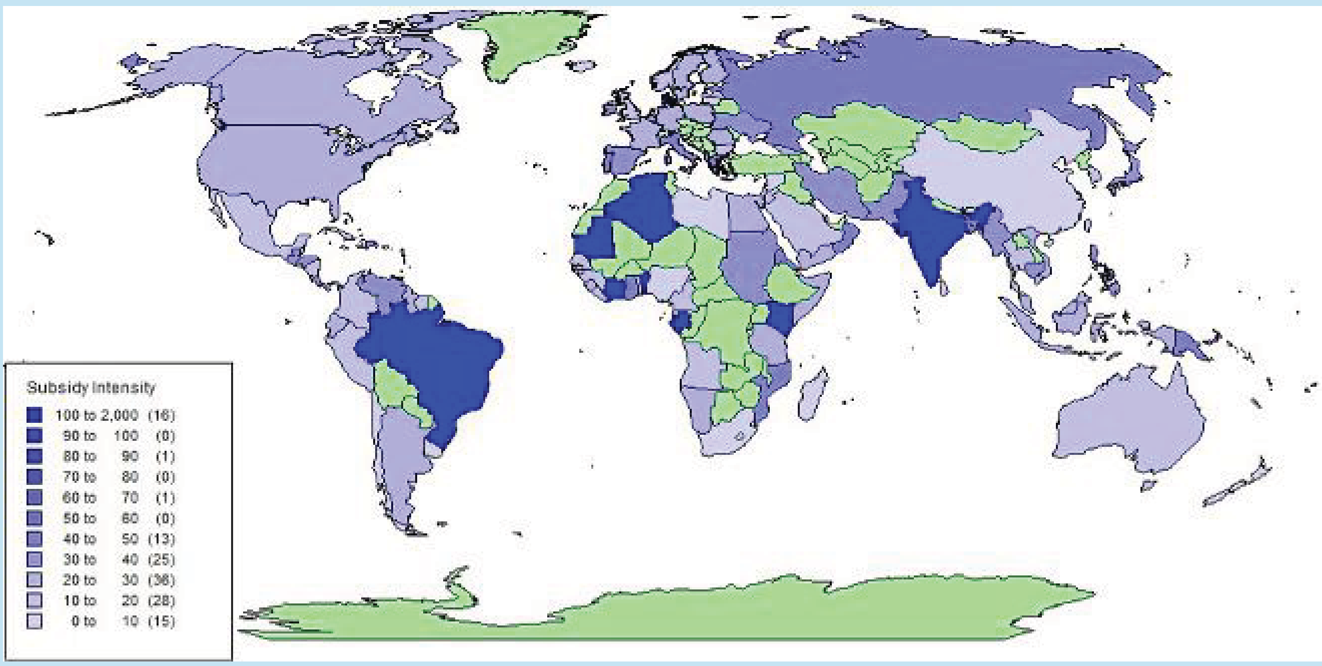


Figure 17: Value of subsidies to the fishery sector as a percentage of the total value of fishery production (Data source: Sumaila and Pauly 2006).

government payments for access to another country's EEZ (also called 'access payments') that are not fully recovered from the fishing vessels, income support for commercial fishers during periods when fishing is banned or disrupted, and fish price support mechanisms that maintain prices for fishers artificially high.

Several hundred million dollars are spent each year on decommissioning fishing vessels, buying up surplus licences, and helping to retrain fishers for other occupations. Decommissioning can sometimes have unintended consequences. Fishers are paid to remove surplus, loss-making capital, and thus have more financial resources with which they buy new vessels and gear.

Subsidies have been used for construction and modernisation of fishing vessels, contributing to overcapacity (Photo source: C. Barnes)

Experience from a number of countries shows that it is extremely difficult to design a decommissioning scheme that will stem the continued growth of fishing capacity as long as the overall incentive structure in the sector continues to encourage because the money provided for decommissioning simply supports additional investment (Munro 1999). Decommissioning subsidies are often anticipated by the industry and unnecessary fishing capacity may be accumulated with the expectation of future decommissioning payouts.

The countries that provide the most subsidies are Japan (USD 5.1 billion), India (USD 4.5 billion), the EU (USD 3.2 billion) and China (USD 2.7 billion); seven countries provide two-thirds of all subsidies (Sumaila and Pauly 2006). Developed countries provide the majority of fishing subsidies (55 %), and developing countries the remaining 45%. However, on a per country basis, developed countries provide more than three times as much in subsidies as developing countries.

Subsidising fisheries depletion

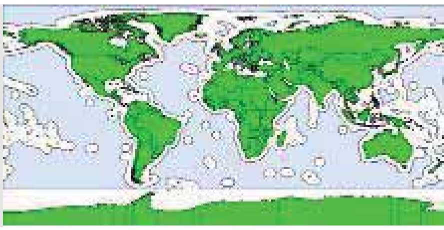
By reducing the input costs of fishing, subsidies artificially increase profits for the industry and can enable fishing to continue beyond the point where it would normally be unprofitable. This leads to the build-up of excessive fishing capacity, resulting in problems with control of the excessive fishing effort and overexploitation of fishery resources. Overcapacity, supported by subsidies, means that the net contribution of fisheries to the global economy is negative, with total operating costs higher than gross revenue, as discussed in Chapter 2. Often, the money used to subsidise the industry could be better invested in other more innovative financial mechanisms to promote sustainability and reduce overcapacity. The following case studies showcase some innovative approaches to the subsidy issue, showing that it is possible to remove subsidies and also introduce new financial mechanisms, with overall benefits to fisheries and the environment .

Table 4: Value of global fisheries subsidies by type (USD billion)

Subsidy type	Developing countries	Developed countries	Global total
Management programmes and services, research and development (good)	1.1	5.5	6.6
Boat construction, renewal and modernisation, fishing port construction and renovation, marketing support, tax exemptions, access agreements and development projects (bad)	12.3	9.7	22.0
Vessel buyback schemes, fisher assistance programmes, community development programmes (ambiguous)	0.9	2.5	3.4
Total	**14.3**	**17.7**	**32.0**

Source: Compiled from Sumaila and Pauly 2006

Tackling subsidies through the WTO



Species	All
Fishing Method(s)	All

The problem and driver: Subsidies contribute to overexploitation

As discussed in the previous section, it is well acknowledged that subsidies are a significant driver for unsustainable fisheries. Discussions began in the 1990s on the need to reduce harmful subsidies to fisheries. Recognition of the harmful effects of subsidies and their widespread use, by international organisations and NGOs, led to pressure to address the issue by the international community.

The innovation: International action on subsidies

Fisheries subsidies are a global problem which require a global solution. In Doha in 2001, the World Trade Organisation (WTO) undertook to 'clarify and improve WTO disciplines on fisheries subsidies, taking into account the importance of this sector to developing countries'. Subsequently in the Johannesburg World Summit on Sustainable Development, there was a call to 'eliminate subsidies that contribute to illegal, unreported and unregulated fishing and to over-capacity'.

The WTO deals with the rules of trade between nations at a global level. Because subsidies can have an effect on trade, by affecting prices, the WTO plays a role in regulating the use of subsidies that affect trade. Currently, the WTO is the only international body with a mandate to regulate and restrict the use of subsidies in fisheries.

Negotiating positions at the WTO may be made by individual countries or the European Commission for the EU, or by groups of countries that associate together due to a common stance on a particular issue. Different countries want to restrict subsidies to different extents, from a general prohibition of all subsidies with specific exceptions, to all subsidies being allowed apart from specific prohibitions (Box 2).

Nine years from the start of the Doha Round, the negotiations are ongoing. The negotiations group on Rules (which deals with fisheries subsidies) has recently appointed a new chairperson, reinvigorating the discussions and contributing to a window of opportunity to conclude the talks in 2011. The successful negotiation of a WTO agreement on restricting and controlling subsidies to the fisheries sector would be a major step forwards for reducing subsidies' harmful effects. However, any agreement reached must restrict effectively the use of harmful subsidies and avoid providing excessive exemption clauses that reduce its effectiveness for ensuring fisheries sustainability. A classification of subsidies is provided in Table 5.

Challenges: Developing countries and small-scale fisheries

Fisheries are important in many developing countries as they provide a range of benefits in situations where there may be few alternatives. Developing countries have argued that they may need more flexibility in the implementation of rules on subsidies as a result, but not to the detriment of the overall effectiveness of any agreement. Countries such as China, India and Indonesia have called for exemptions from subsidies disciplines for developing country small-scale fishers, infrastructure and capital and operating costs. Many countries have highlighted the need for them to encourage development of their

Table 5: Classification of subsidies in Sumaila et al. (2010)

Category	Types
Beneficial (support healthy fish stocks through conservation, enforcement or improved fishing methods)	Fisheries management Fisheries research and development Marine Protected Areas
Capacity-enhancing (enhance fishing capacity and contribute to overfishing)	Boat construction, renovation Fisheries development projects Fishing access Fishing port development Fuel subsidies Marketing and storage infrastructure Tax exemption
Ambiguous (can either improve fish stocks or result in overexploitation)	Fisher assistance Rural fishing community development Vessel buy-back (decommissioning)

Box 2: Proposals for restricting fisheries subsidies at the WTO

There are two main negotiating positions regarding which subsidies should be allowed and which should be prohibited. The 'top-down approach' argues that all fisheries subsidies should be prohibited apart from certain exemptions. Members of this group include Australia, Chile, Ecuador, New Zealand, Peru, Philippines and the US (and previously Iceland). In contrast, the 'bottom-up approach', argues that all subsidies should be allowed, apart from those that are specifically prohibited. Members of this group include Japan, Korea, Taiwan and the EU.

There is general agreement that subsidies that support capital costs should be prohibited (e.g. the acquisition, modification or construction of fishing vessels). However, it is also important to restrict subsidies for operating costs such as fuel, ice and labour. The position of subsidies for infrastructure, income support, price support and access agreements is not clear.

The November 2007 draft text includes prohibiting a broad range of capacity- or effort-enhancing subsidies, as well as subsidies that affect fishing on 'unequivocally overfished stocks', along with exemptions for specific types of subsidy from prohibition (e.g. for vessel safety or reducing vessel capacity).

There may be a requirement for permitted subsidies to be allowed only where basic fisheries management systems are in place, or that subsidies should have no adverse effects on fish stocks or trade. Prohibited subsidies may have to be listed, with an explanation of why they contribute to overcapacity and overfishing, although for a specific subsidy not to be prohibited, there may have to be an explanation of why it does not contribute to overcapacity and overfishing.

domestic fisheries and fish processing infrastructure through the use of subsidies, but this does run the risk of fomenting overcapacity in developing countries.

Some developed countries have also requested exemptions for their small-scale fisheries. However, small-scale does not necessarily mean small impact, and effective management measures are also needed for these sectors. There is ongoing discussion about the definition of 'small-scale' for special treatment in subsidies disciplines, and the type of exemption that small-scale fisheries and developing countries should be eligible for.

Costs and benefits: Reducing harmful subsidies would benefit fisheries

Restricting harmful fisheries subsidies on a global scale would benefit fish stocks by removing cost-reduction mechanisms that allow fishing to continue when it would otherwise be economically unviable, and would probably result in a reduction in global fishing capacity. Clearly this issue is closely linked to the need to reduce capacity worldwide (Chapter 2) which would allow fish stocks to rebuild and the fishing industry to become more profitable. An immediate benefit would be the saving of USD 25 billion per year in subsidies currently paid by governments.

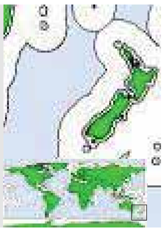
However, fishery reform of this type is not easy otherwise it would already have been done. It can cause acute economic and social hardship as subsidies that supported fishing costs are removed. A transition phase is usually required to support investment in other areas of the economy to develop alternative opportunities, and investment in education and infrastructure so that future generations have more options open to them.

Uptake potential: Influencing the negotiations

If an effective agreement is reached at the WTO on fisheries subsidies, it would have significant uptake potential as all WTO members will be obliged to abide by the rules. WTO membership covers 153 (out of 195) countries, including all major fishing nations except Russia, which is currently in talks about joining. WTO rules on fisheries subsidies are likely to include a requirement to report information to the WTO on any subsidies that are provided, and the WTO provides a dispute resolution mechanism if any members feel that another member is not abiding by the rules.

The WTO process represents the best opportunity to tackle harmful fisheries subsidies on a global level. The right political conditions are needed whereby WTO members are prepared to address subsidies meaningfully. The path to achieving such conditions may lie with influencing public opinion prior to negotiation rounds as opposed to trying to shape political views during negotiations.

New Zealand: Removal of subsidies



Species	130 different demersal and pelagic species
Fishing Methods	Trawls, longlines, dredges and pots

The problem and driver: Recognition of declining fish stocks

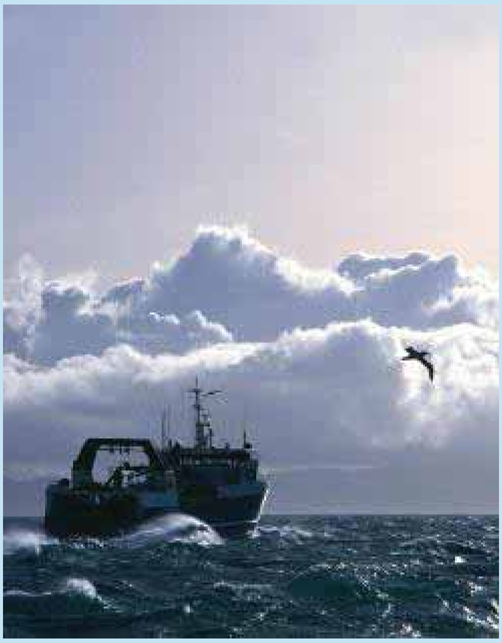
In New Zealand in the early 1980s, subsidies aimed to develop deepwater resulted in overcapacity in both inshore and deepwater fleets. A lack of catch limits also resulted in 'boom and bust' fisheries, which had a disruptive influence on local communities. Fisheries management included non-restrictive permits, lack of catch limits, and availability of various subsidies such as for building fishing vessels and promoting seafood exports. This combination of measures is typical of those used by many countries to encourage fisheries development.

The declining state of the inshore fisheries in the early 1980s was impacting on both commercial and amateur fisheries and on the marine environment. There was recognition by the public, industry and amateur fishers that something needed to be done to avoid severe overfishing and the collapse of the industry in the near-future. The successful trial of an innovative management system in deepwater fisheries, strong support from a few industry leaders, and concurrent reforms to the wider economy all acted as drivers for the reform of the fisheries sector. Additionally, the relatively short history of commercial fishing and weak industry organisations facilitated the implementation of change in New Zealand, enabling it to take a different approach from most other countries.

The innovation: Fisheries reform and removal of subsidies

Subsidy removal in New Zealand's fisheries was part of a wholesale reform of the fisheries and agriculture sector involving the removal of open access and input controls and the introduction of output controls and individual transferable quotas (ITQs). Instead of fishing to catch as much as possible, with no overall limits on catches, fishers were given long-term 'shares' in various fish stocks, known as ITQs. This gave fishers the entitlement to catch a certain amount of those stocks over the year, depending on the expected productivity of the stocks.

The reform was a process that took place over several years and began with 19 inshore and seven deepwater species. It involved the allocation of quota to fishers without charge. This system was considered least economically disruptive method and allowed vessels in the short-term to operate as per usual. To then reduce exploitation rates, the government bought back NZD 42 million (USD 25 million) of provisional catching rights. However, since then it has recovered substantially more in resource rents, sales of quota and levies.



The New Zealand fishing industry pays a levy to government which covers fisheries management costs (Photo: J Peacey).

As part of the reform, subsidies were removed and the industry pay a levy which contributes to the costs of fisheries management services — initially, quota owners paid a resource rental based on the value of their quota shares; from 1994, this was replaced with a levy to contribute to the government's costs associated with management of the commercial fisheries, including services such as research and compliance. The cost to industry is approximately NZD 35 million (USD 20 million) per year. In recent years the only government assistance provided to the industry has been co-financing of industry training and environmental certification, and one-off assistance to the industry to cope with the costs of moving to a new greenhouse gas emissions trading system.

The New Zealand industry had previously received subsidies such as the financing of an organisation for promoting industry development, various tax breaks, low interest loans and import and export subsidies. The industry did not receive ongoing support to fishing costs, such as fuel subsidies or minimum price support, which may have meant the removal of subsidies was less problematic.

Costs and benefits: Reducing management costs, increasing profitability

The reforms have made New Zealand's commercial fisheries self-financing; even the costs of management services are recovered from the industry. There is at least some evidence of good resource conservation, increased prices for fish, increased profits, generation of resource rent, greater economic stability, and an improved investment climate. New Zealand was rated as one of the best-performing countries in its progress in implementing ecosystem -based management of fisheries (Pitcher et al 2009).

The Ministry of Fisheries reports that 72% of total catch is taken from assessed stocks. Of the 117 assessed stocks 67% are at or near target levels (MoF 2010). There are rebuilding plans in place for most of the 38 fish stocks that are below target levels, including reductions in catch limits and closure of some areas to fishing.

The removal of fisheries subsidies cost the New Zealand government NZD 42 million (USD 25 million) to buy back provisional quota allocations. Approximately NZD 35 million (USD 20.7 million) annually is contributed by industry towards management and monitoring costs. The removal of subsidies from fisheries is of particular benefit to taxpayers, who no longer have to support the industry.

It is difficult to assess the total value of the fishery in terms of landed value as the extent to which companies are vertically integrated through all sectors makes it difficult to obtain this figure. However, as a proxy to the value of fishing, the change in overall asset value based on the trading price of quota shares and annual catch entitlements) is positive and has been increasing since 1998 (Figure 18). It has increased from NZD 2.65 billion in 1996 to NZD 4 billion in 2009 (USD 1.57 billion to USD 2.3 billion). This indicates that quota owners are confident of the sustainability of New Zealand fisheries and future income from them.

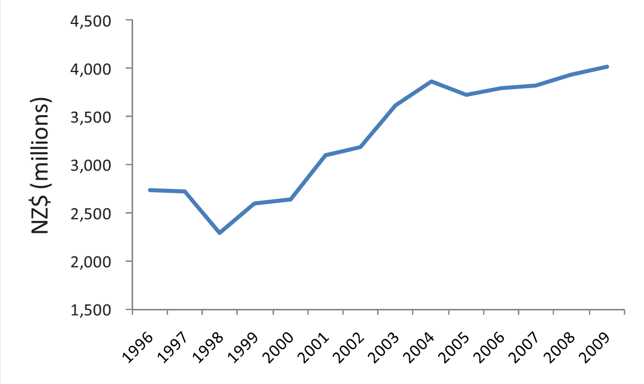


Figure 18: The asset value (nominal) of New Zealand's fish stocks is positive and rising since the introduction of ITQs and removal of subsidies to the sector (Source: Statistics New Zealand 2010).

The fisheries industry is profitable without the need for subsidies. Instead of relying on catching more fish to increase income, fishers had to adjust to a new system of adjusting their inputs to match the amount of catch entitlement they have. This has led to more efficient fisheries, indicated by an ongoing reduction in the number of fishing vessels. Alongside this, there is an incentive for fishers to obtain the best value possible from the fish they catch — either by catching when market prices are highest or by ensuring maximum value-added returns through quality or product diversification.

It should be noted that there were some losers in the process as well; some 1,500 part-time fishers were excluded from the fishery and did not receive quota allocation, and crew members received no compensation if the vessel on which they worked was removed from the fishery by its owner.

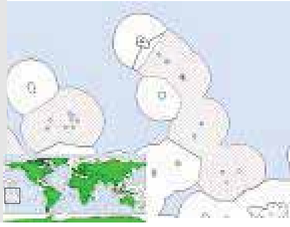
Uptake potential

The removal of subsidies is difficult, but New Zealand demonstrates that fishery management in which the industry is not only profitable without the use of subsidies, but also covers the costs of research and enforcement, is possible. It should be noted that the benefits in this case cannot be attributed solely to the removal of subsidies, but rather to the package of innovations that were implemented in the 1980s and refined since then.

Whilst there are international moves through the WTO to restrict subsidies to the fisheries sector, countries do not have to wait for the conclusion of the WTO talks to rules to remove subsidies to their fisheries sector. New Zealand unilaterally removed subsidies as part of a wider sector reform policy in the 1980s and now recoups the costs of its fisheries management services from the industry.

The relatively short history of commercial fishing and the previous absence of certain types of subsidy to support ongoing costs (e.g. fuel, minimum price support) may have facilitated the changes that were introduced. As a result, attempting to introduce similar changes in other countries may encounter more resistance. The way in which such changes are introduced must be tailored to the specific circumstances of each fishery, as different political, social, economic, biological and infrastructure factors are at play in different fisheries.

Investing in conservation



The problem and driver: Lack of financial incentives for conservation

The transformation from an overexploited fishery to a sustainable fishery often involves short-term social and economic costs related to this transition phase (or longer-term in the case of conservation actions such as closed areas). Innovative ways of financing change can provide financial resources that can mitigate the short-term costs and allow conservation-oriented actions which will yield greater returns in the future. Two examples of promising innovative financing mechanisms, which are in the early stages of development, are explored here: the Kiribati Phoenix Islands Protected Area (PIPA) and Banking on Cod.

Kiribati: Phoenix Island Protected Area

Kiribati is located in the western central Pacific and the country is made up of three separate groups of islands — the Gilbert group in the west, the Phoenix group in the centre, and the Line Islands in the east — each surrounded by its own discrete portion of the EEZ. Stimulated by research conducted by the New England Aquarium, which highlighted the richness of reef biodiversity and abundance of top predators otherwise missing from many other Pacific island marine ecosystems, the Kiribati government recognised the potential biodiversity and conservation importance of the marine environments around the Phoenix Island group. The idea of formally protecting the Phoenix Islands and their near-shore ecosystems was championed by the President of Kiribati, partly motivated by concerns of the potential impact of climate change on low-lying nations such as Kiribati, thus lending high-level political support to the process. However, over one third of government revenue comes from the sale of fishing licences to foreign vessels to fish in the Kiribati EEZ, and closing a large area to fishing would imply a reduction in revenue from fishing licences. There was therefore a need to develop an alternative financing mechanism to support the costs of implementing and enforcing a closed area, and to compensate the country for lost fishing licence revenue.

Banking on Cod

All but two of the twelve cod stocks in the Northwest Atlantic severely depleted, and the Grand Banks cod fishery — which was once the world's most productive and valuable fishery — was so severely depleted that in July 1992, the cod fishery was closed. This heralded the end of a USD 500 million industry which employed up to 40,000 Canadians and represented up to 90% of regional employment. Initial signs of recovery in the stock forced a premature reopening of the fishery. This rapidly depleted any increases in the cod population and resulted in a further closure of the fishery that has yet to be lifted. There is a need to meet the short-term social costs and provide industry with income during the closure period and, at the same time, enable the fishery to shift towards long-term profitability and environmental sustainability.

The innovation: Alternative financing mechanisms

Kiribati — Phoenix Island Protected Area

An endowment fund is being established to cover the costs of management of PIPA in Kiribati and provide an extra payment to the government to compensate for the opportunity cost of not issuing fishing licences. The endowment fund will be capitalised through public and private investment, and administered by the Phoenix Island Protected Area Conservation Trust, established by the Kiribati Government in partnership with Conservation International and the New England Aquarium. PIPA will be managed by the Kiribati Government under an agreement with the PIPA Trust in the form of a five-year recurring conservation contract (currently being formalised). The contract defines the management obligations, and the Kiribati Government will receive annual payments from the endowment fund (as compensation for the loss of fishing licence revenue) in return for satisfactory performance.

The implementation appears to be progressing well, although it is still in its initial phases. The structures have been established and a Trust Executive Director is being recruited to focus on fundraising to capitalise the endowment fund. While PIPA is not directly aimed at management or conservation of the tuna stock, providing a compensation payment to the government for lost fishing licences enabled the protected area to be established and the inshore ecosystems protected, which will benefit the wider marine ecosystem.

Banking on Cod

As a means to finance the industry during the closure, WWF have proposed an alternative financing mechanism, *Banking on Cod*. The basis of Banking on Cod is that future benefits can be expected from more productive stocks and increased catches. The proposed mechanism would allow investors with an interest in environmental stewardship ('interested investors'), and subsequently others looking for a return on their investment ('disinterested investors'), to contribute to a fund that would provide loans to fisheries bodies on the basis of long-term business and management plans (Figure 19). These plans demonstrate how long-term sustainability and profitability will be achieved. Plans should therefore demonstrate long-term profitability based on long-term sustainability, through a management system that confers stewardship incentives and accountability on to fishers.

The expectation is that both stocks and the broader ecosystem will recover, creating a mutually reinforcing positive feedback loop in which fishing becomes profitable. Portions of this profit are then used to benefit the original investors and remaining portions could be recycled back in to the financial institution for further loans.

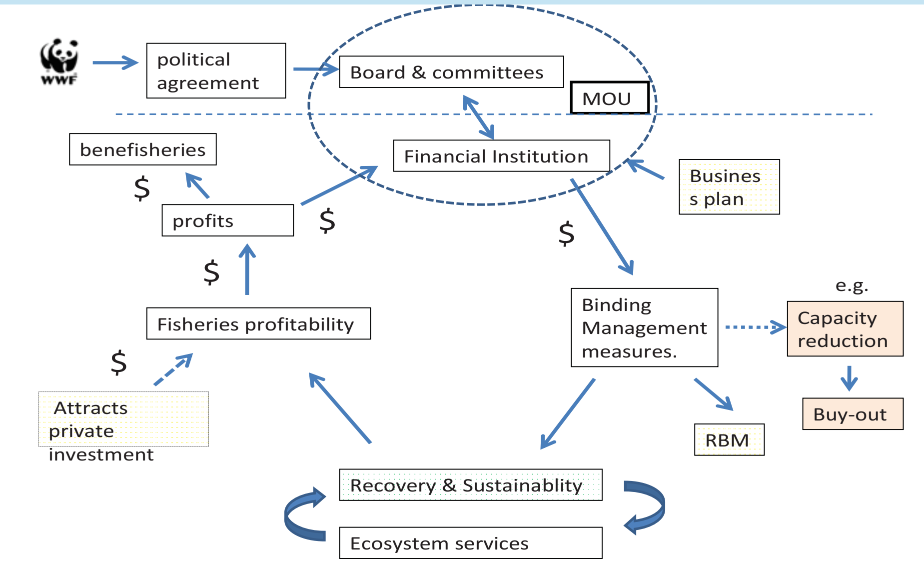


Figure 19: Proposed Banking on Cod financing model. This conceptual model of the funding system shows the Financial Institution at its core, which must have political endorsement to provide investors with the confidence to invest (Source: Rangeley, R. pers. comm. 2010)

Costs and benefits

Both of these initiatives provide innovative financing mechanisms to overcome the costs associated with actions that require a reduction or cessation of fishing effort. They allow payments for not fishing and reward environmental stewardship.

The initial aim for capitalisation of the PIPA endowment fund is USD 25 million. This will be used to cover the park management costs as well as an annual payment of USD 1–3 million to the government to compensate for lost fishing licence payments. There will have been costs associated with the initial scientific research to establish the need for the protected area, but data on this was not available. The primary benefit will be environmental in the form of ensuring that the reef systems remain pristine.

Banking on Cod has not been implemented. There are no estimates available on the size of the fund required or the size/number of loans yet. However, the potential returns are substantial. Atlantic Canada is estimated to be losing CAD 820 million (USD 800 million) per year of potential earnings that would accrue from a sustainable demersal fishery, of which cod would be an important contributor (MacGarvin 2001). In the Atlantic US the total value of the north-east groundfish fishery landings are projected to quadruple to around USD 425 million if the fishery was completely rebuilt (NEFMC 2001), with cod again playing an important role. However, as with any investment, there is risk involved.

Uptake potential: Mechanisms could be used more widely

The PIPA example provides a financing mechanism that enables conservation actions in nations that are otherwise heavily dependent on income derived from the exploitation of marine resources. It follows a model of 'payments for ecosystem services' (Wunder 2005) which is often used in terrestrial conservation but is relatively new to marine conservation. Establishment of PIPA was facilitated by the islands having almost no resident population. Establishing a similar protected area in another part of the world would require full consultation and participation of local communities.

While the Banking on Cod mechanism is still theoretical there would be potential for wider application. However, it requires investors to have confidence in future fish prices, the potential for stock recovery and good management. Similar approaches are already used in futures markets for other natural resources such as oil and wheat.

MSC: Harnessing market power

Species: multiple

Fishing Method: mutiple

The problem and driver: Lack of reward for sustainable practices

There are many incentives for overexploitation of fisheries and often there is a lack of reward for sustainable practices. Fisheries that are responsibly managed and sustainable need a way of communicating this to consumers so that consumer choice and market demand can reward these practices.

Fisheries sustainability concerns are becoming more widely known, particularly in key developed country markets for fish such as the US and Europe. Consumers that wish to make purchasing decisions based on environmental factors such as sustainability need a way of differentiating between sustainably-fished and less sustainable products. The processing and retail sectors also recognised the need for a sustainable supply of fish to ensure business sustainability in the future and to demonstrate their own commitment to sustainability.

Ecolabels provide a different entry point for driving sustainability in fisheries, focusing on the market power of consumers and retailers, in addition to regulation at the fishery level.

The innovation: Ecolabels reward industry for sustainability

Ecolabels provide a visible endorsement of the sustainability of a product that consumers can use to decide what products to purchase. Organic labels for agricultural products have a long history, and dolphin-safe tuna was one of the first such types of ecolabels in fisheries. The Marine Stewardship Council (MSC) provides a fisheries ecolabel and certification scheme that assures consumers that the fish was caught in an environmentally responsible manner from fish stocks that are sustainable and effectively managed. The demand for this type of assurance is increasing rapidly (Figure 20).

The MSC sets a standard against which individual fisheries are assessed by third-party certifiers, providing an independent assessment of a fishery and its practices, the sustainability of the stock, environmental impacts and management system. Fisheries that comply with the criteria can use the scheme's label on their products.

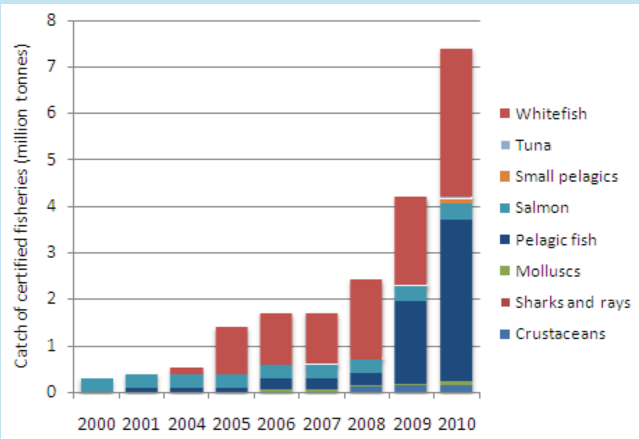


Figure 20: Tonnage of MSC-certified fisheries (Source: D Agnew, based on MSC data)

Both large-scale and small-scale fisheries are eligible. Examples are the South African Hake fishery (Chapter 4), the Cornish mackerel handline fishery in the UK and the Ben Tre clam fishery in Vietnam (Chapter 2).

The Cornish mackerel handline fishery operates mainly within six nautical miles of the UK coast in Cornwall. It is based on a traditional, relatively low intensity handline technique, selectively targeting mackerel and takes almost no by-catch. The Ben Tre clam fishery is managed by cooperatives together with local and regional government. Live clams are handpicked on coastal sand flat areas. A number of management improvements, such as setting clear management objectives, strengthening the management capacity of the cooperatives, setting harvest limits and stricter control on clam exploitation contributed to the fishery achieving MSC certification.

Costs and benefits: environmental improvements and market access

Fisheries certification promotes environmental benefits because a fishery must comply with sustainability and environmental criteria to achieve certification, and have management systems are in place to ensure future sustainability. In most certified fisheries, conditions must be met to maintain certification which often serve to reduce environmental impact such as by-catch and habitat impacts. In the case of the South African Hake fishery, conditions ensured that stocks started to recover, bird by-catch was significantly reduced and the impact of the fishery on benthic habitats was minimised. For Ben Tre clam, we have shown in Chapter 2 that its certification was conditional on capacity management.

Certified fish are increasingly in demand from retailers, especially in developed countries, because of sustainability commitments and the demand from consumers. Achieving MSC certification has increased the market access of the Ben Tre clam fishery, which has increased its exports to markets such as the EU, Japan, China, Taiwan and the USA. The certification process for Ben Tre clam in Viet Nam cost approximately USD 120,000. Yields have become increasingly stable and cooperatives' profits have increased. Clam price has increased, and the increase was particularly marked for the year that MSC certification was achieved.

Prices per tonne paid to one cooperative rose from USD 615 in 2007 to USD 1,874 in 2010, including a 71% increase between 2009 and the first half of 2010, subsequent to MSC certification. The increases in unit price and profits to cooperatives that have been observed the result of achieving MSC certification and the willingness of buyers in developed markets to pay premium prices. A number of other factors have also contributed: improved value chains and traceability; establishment of a brand name; meeting stricter trade requirements of processors and exporters; better size selectivity; and more market-demand-driven harvesting. Similarly, the entry of South African hake into northern European markets was coincident with acquisition of MSC certification.

MSC certification of the Ben Tre clam fishery has contributed to increasing market access and improved prices for the harvesters (Photo: T. Chuong Ngo).

Source:

Challenges: externalities affect fisheries

The MSC-certified Cornish mackerel fishery operates within the EU's Common Fisheries Policy, catching fish within the quota allocated to the UK. At the time of certification, the mackerel stock was considered to be sustainably fished; the number of fish caught and the overall biomass of the fish stock and mature fish were within precautionary sustainable limits. However, recent shifts in the geographical distribution of the mackerel stock as resulted in new claims from Iceland and the Faroe Islands for a greater share of the total allowable catch and they have unilaterally increased their quota. These moves potentially threaten the sustainability of the stock, and there may be an impact on the Cornish mackerel handline fishery as a result.

This illustrates that although individual fisheries may be well-managed and responsible, they can be subject to external forces beyond their control that may affect stock sustainability. Furthermore, this certification may address only part of the problem. It may reward environmentally sustainable practices without addressing either the cumulative effect of the fisheries exploitation or where there is a particular issue, e.g. overcapacity, within a fishery or region.

However, MSC is being increasingly criticised for its policy of encouraging change in what some environmental organisations consider to be uncertifiable fisheries, such as those using bottom trawls (Jacquet et al. 2010). As we have seen above, it is precisely the engagement in these types of fisheries which gives MSC leverage to create change.

Uptake potential: Increasing importance of Ecolabels

Ecolabels are increasing in importance worldwide, especially in developed countries where consumers are increasingly aware of sustainability issues. Industry is becoming more pro-active in seeking certification due to the demand from retailers and consumers.

Most certified fisheries to date are in developed countries. It is more difficult for developing country and small-scale fisheries to obtain certification due to the cost involved, the need for effective management and stock assessment requirements. However, a number of developing country fisheries have been, and are being assessed, and certification schemes are developing risk-assessment methods for 'data-poor' fisheries that lack traditional stock assessment data so that they are not unnecessarily excluded from certification.

Addressing perverse subsidies

Economic incentives need to be reoriented

Many economic incentives contribute to the overexploitation of fish stocks, and act as barriers to achieving sustainability. Incentives such as subsidies may prevent industry from responding to signs of overexploitation and continue to fish beyond the point at which it would otherwise be unprofitable. However, there are a range of emerging positive financial mechanisms that can be used to encourage and reward sustainability and which do not bring the perverse incentives of subsidies.

Subsidies are a key challenge for fisheries sustainability

The WTO process represents an opportunity to tackle harmful fisheries subsidies on a global level and lead to real sustainability gains. However, for such benefits to be realised, any agreement reached must effectively ban the use of the most harmful subsidies such as those that enhance capacity or effort, as well as subsidies that affect fishing on overfished stocks. While there is a need for special and differential treatment for developing countries and small-scale fisheries, this should not be to the detriment of the overall effectiveness of the agreement, and such countries and fisheries must also act responsibly and work towards sustainability and good governance.

Removal of subsidies at national level is difficult but possible. The New Zealand case study demonstrates that fisheries can not only be profitable without subsidies, but can also contribute financially to management and assessments costs. However, achieving the removal of subsidies is likely to encounter significant resistance from the industry, and is likely to result in social and economic changes as adjustments are made. In most cases a transition phase will be beneficial to support retraining of fishers, investment in other areas of the economy and investment in education.

Alternative financing mechanisms can be applied to fisheries

There are a range of alternative financing mechanisms that could be more widely used in fisheries. The case studies have shown the potential for alternatives such as endowment funds to finance conservation (PIPA) and private finance mechanisms to provide loans to fishers and fisheries organisations to limit fishing and allow stocks to rebuild, based on expected future returns (Banking on Cod). These mechanisms are still in development, however. Banking on Cod is still in the early stages, and will depend on the willingness of investors. Although the PIPA endowment fund has been established, the protected area is new and as such there is little evidence yet that it has generated significant environmental gains, and the phase of capitalising the fund with the required USD25 million is yet to be completed.

The use of alternative financing mechanisms in fisheries faces a number of difficulties, including raising sufficient capital for the funds, and the uncertainties related to conservation and sustainability outcomes. However, these are not insurmountable; similar financing mechanisms have been used for terrestrial conservation and for other natural resource commodities. They offer potential for promoting actions oriented to conserving and sustainably exploiting fish stocks and marine resources rather than overexploiting them.

Ecolabelling and market-based incentives

Increasing consumer awareness about the state of fisheries, and more ethical purchasing choices, holds promise for the future of ecolabelling and market-based mechanisms to promote sustainable fisheries. Consumers, and more importantly retailers, increasingly wish to know the provenance of their food and ensure its sustainability. Many retailers have established their own sustainability criteria and are accountable against them. This has proved to be a powerful way in which markets have been able to influence both policy and practice. For consumers, the award of an ecolabel to fishery products demonstrates that an external body has judged that the fishery is conducted in a sustainable manner, with minimal environmental impacts. Benefits of certification are often in the form of access to additional markets and enhanced prices (MSC 2009). The philosophy of creating incentives, demonstrated in a number of MSC fisheries now (such as the serial application for certification by toothfish fisheries) is being shown to improve performance in fisheries across management systems.

However, the cost of obtaining certification can be relatively high for some smaller fisheries and those in developing countries, which can act as a barrier to its implementation. Despite this, a number of small-scale and developing country fisheries have already been certified and in the Ben Tre clam fishery, the certification process was financed by external NGOs. Ecolabel organisations such as the MSC are also piloting certification processes that are appropriate for such fisheries.

Uptake potential

Across the case studies, there is potential for intervention at all levels in fisheries related to the removal of subsidies and the implementation of economic incentives that are better aligned with sustainability outcomes — from the level of individual fisheries undergoing ecolabel certification, through national schemes for removing subsidies or financing conservation actions, to international action through the WTO aimed at limiting or removing subsidies to the fisheries sector.

However, there is a risk with all financing mechanisms and economic incentives that they may have unintended consequences. For example, subsidies were not designed to overexploit fish stocks, but have often had this effect; options and futures markets can cause market price fluctuations which impact on producers. While the increased sourcing of certified seafood represents the greater influence of such schemes, there is a potential issue if the diversity of fisheries types and seafood species that come to market is further reduced to only those fisheries where certification is financially viable and/or low risk.

The WTO negotiations on subsidies have good uptake potential as a result of the wide applicability they would have, but their impact is dependent on the outcome of the negotiations and what special treatment is agreed for developing countries and small-scale fisheries. Removing subsidies at a national level can be difficult, and the approach will be dependent on the situation in individual countries. In New Zealand, this was facilitated by a relatively young fishing industry, which was weakly organised, and fisheries reform went hand-in-hand with wider political and governance reforms in the country. Elsewhere, removing subsidies may encounter substantially more resistance from industry.

At the level of individual fisheries, ecolabelling provides a good opportunity to reward good practice and sustainability. Increasing consumer awareness, increasing demand for certified product from retailers, suppliers and processors, and as a result increasing numbers of fisheries entering certification processes, all point towards this being a growing sector in the years to come.

Certified sustainable seafood has potential to encourage sustainable practices by industry through harnessing market incentives (Source: MRAG).

POOR GOVERNANCE

Governance is the process of decision-making and the legal frameworks, structures and processes by which decision are implemented (or not implemented) (UNESCAP, no date). Governance is therefore largely about the politics of natural resource management (e.g. Béné and Neiland 2006) and how policy and management decisions are made and implemented. It relates to how people are involved in decision-making and how this affects their abilities to empower themselves and others and derive benefits from the process. Power, and the way that power is distributed between different stakeholders, are key aspects of governance. Stakeholders include those directly involved in fisheries (the fishers, processers and fisheries departments) as well as those with a broader stake or interest in the outcomes of fisheries management — including NGOs, policy makers and wider civil society. Poor governance is variously characterised by corruption and a lack of transparency, lack of participation by key stakeholders, a lack of accountability and lack of the rule of law. This chapter explores some of the issues related to poor governance in fisheries and case studies highlight some of the approaches to governance reform that can provide important insights to addressing these issues.

Governance as a political challenge

Meeting present and future food needs, ensuring environmental integrity and providing income and employment in the fishery sector is a balancing act given the finite productive capacity of resources and, as Chapter 5 highlights, a complex challenge given the uncertainty over this productivity. Establishing the objectives for a fishery is a political process and is therefore a matter of governance. Without addressing these important governance aspects, the potential positive contributions of technical and management innovations may be undermined. As an example, Figure 21 shows how high levels of illegal, unregulated and unreported (IUU) fishing are correlated with poor governance. Poor governance has ramifications throughout the fishery management system.

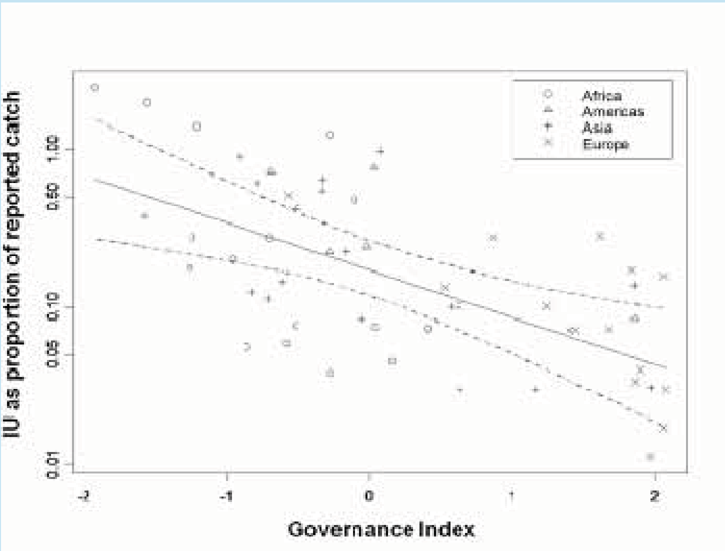


Figure 21: Relationship between governance score (based on three global governance indicators) and the percentage of IUU fishing. (Source: Agnew et al. 2009).

However, addressing these issues is what makes governance possibly the most complex of the challenges. There are potentially many stakeholders who may wish to gain access to, or control over fisheries resources or influence management decisions. These individuals and groups may have very differing views of what sustainability is, based on their world views and attitudes to risk, and therefore what sorts of priorities, decisions and outcomes would be appropriate for a fishery.

In any fishery there are a variety of benefits (based on food and income) that can be derived sustainably and, associated with these, different costs and risks. As Figure 22 shows, catch increases with increasing fishing effort up to a maximum (referred to as the Maximum Sustainable Yield, MSY) where there will be maximum food provision. As fishing effort increases beyond this, catches decrease as there are fewer individuals to maintain the stock size and the risk of stock collapse increases. An advantage of fishing beyond MSY is that large numbers of people can subsist and/or be employed in the fishery. However, individual returns are lower and social conflicts may increase as users compete for fish. On the other hand, maximum profits can be expected towards the left of the figure, at lower levels of effort and less risk to the stock. This highlights two important points. Firstly, there are alternative sustainable outcomes as all points on the curve represent logical, but differing, objectives for a fishery that, at least on face value, have equal validity. Secondly, selecting between these alternatives (and their associated benefits and risks) is a matter of societal choice.

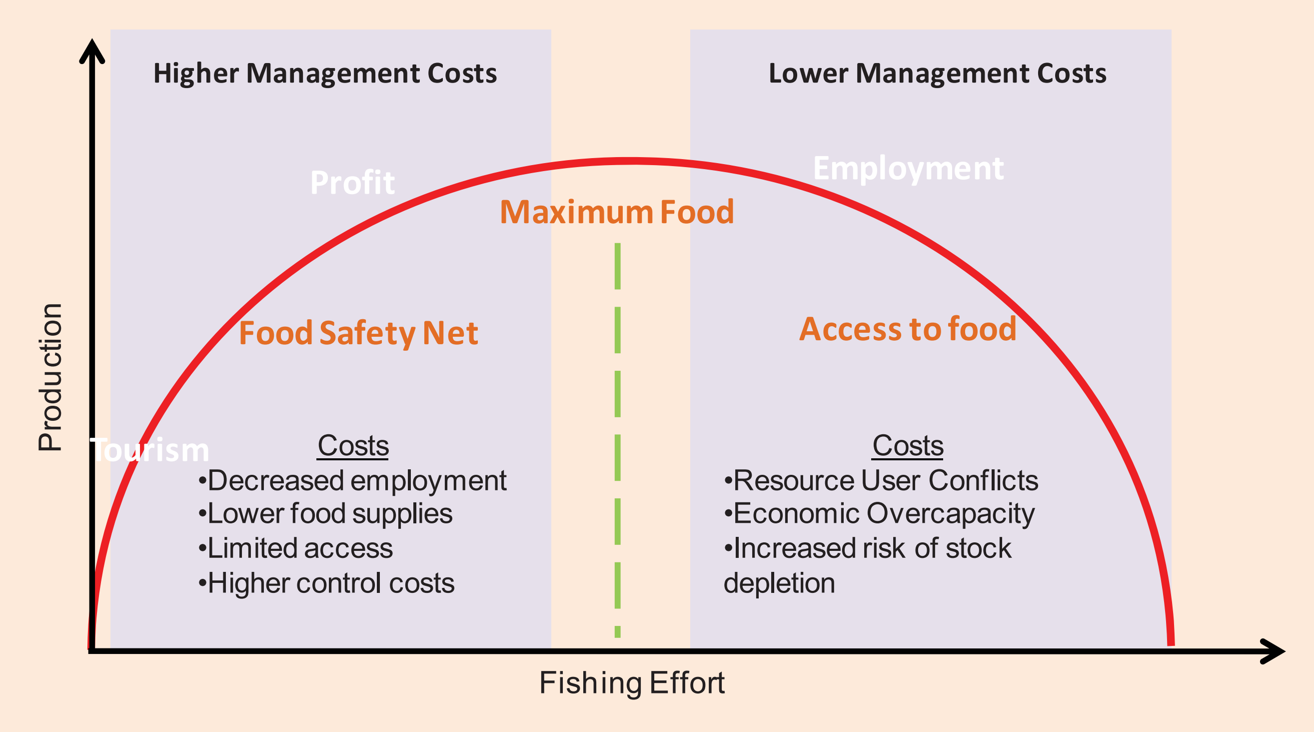


Figure 22: The relationship between fishing effort and yield based on a surplus production model and highlighting the different costs and benefits associated with management. (Figure adapted from Beddington et al. 2007).

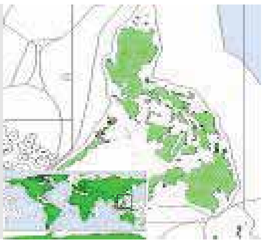
Decentralisation: a key governance reform

At the same time as there has been growing attention on the need for transparent, accountable processes, there has been a recognition that many centralised management arrangements have failed to deliver sustainable fisheries. Both of these have led to increased interest in the potential of decentralised decision-making, including community-based management and co-management. Central to decentralised approaches are notions of sharing responsibility and authority between resource users and other stakeholders. Interest in these forms of governance reform has largely taken two forms. More instrumental approaches take participation by those who are subject to regulation as a means to improve management, for example to strengthen compliance to regulations. In this way, reform and greater participation can reduce the costs of data collection, monitoring and enforcement and assist with conflict resolution. Alternatively, these approaches have emerged as a people-centered response to Hardin's (1968) 'tragedy of the commons', highlighting the knowledge, skills and rights of local resource users in of managing their own natural resources (e.g. Ostrom et al., 1999) and an interest in the empowerment of local people. In practice, decentralisation can be pursued for a number of reasons and the roles and level of authority that is shared can vary considerably.

The case studies illustrate how more inclusive forms of governance and management have been applied. They highlight in particular how different groups have been able to work together, negotiate fisheries objectives and develop mechanisms to achieve these.

Debates on sustainability of fisheries systems can often involve broader debates that encompass impacts and choices outside the fisheries sector. Fisheries is one part of this negotiation of the multiple uses of water resources. (Photo source: A. Halls)

The Philippines: Aquaculture governance in Lake Taal



Species	Tilapia
Fishing Method	Aquaculture
Fishery Tonnage	~70,000t (2010)

The problem and drivers: Addressing environmental degradation

Lake Taal is situated approximately 65 km south of the Philippines' capital, Manila. At 28.3 km^2, it is the third-largest lake in the Philippines and is surrounded by six different local municipalities. The lake has an endemic sardine (*tawilis*) that forms the basis of a wild capture fishery and the lake is also used for aquaculture using floating cages (mainly to produce the non-native Nile Tilapia). Aquaculture developed in the 1970s, expanded rapidly in the 1980s and production peaked in the 1990s. Over this time, aquaculture gained importance with respect to the level of fish production from Lake Taal (Figure 23). Overall, Lake Taal represents an important local source of food and income and it also provides an additional source of income through tourism.

The large increase in aquaculture development has contributed to increasing negative environmental impacts. Between 1997 and 2006, there were large quantities of fish dying in Lake Taal (both wild and farmed), mainly as a result of the effects sulphide and ammonia releases from the lake floor and 'overturns'.

Overturns are a particular feature of volcanic lakes resulting from deep water with a low oxygen content being brought to the surface (due to currents, winds and cooling of surface waters following rains). The oxygen needs of the dense caged fish populations and the plankton and fish around them (denser than in open waters) cannot be met and fish die as a result.

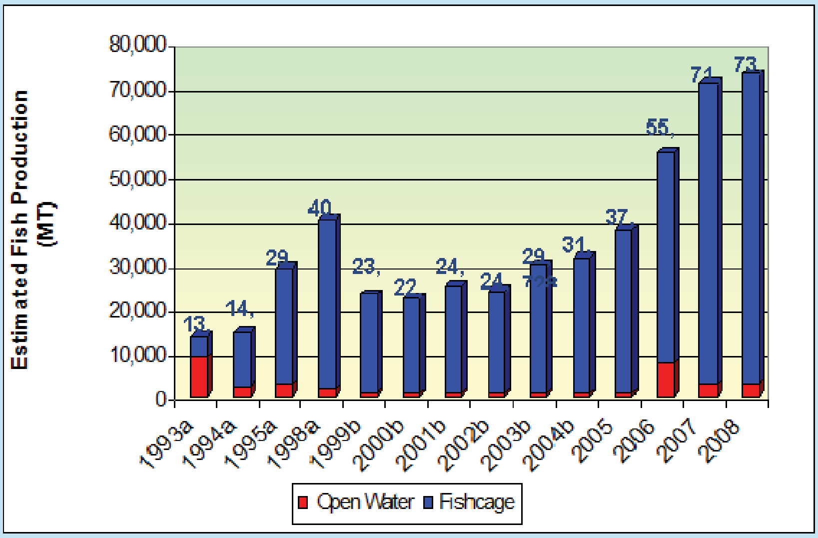


Figure 23: Openwater (red) and fishcage (blue) production from Lake Taal (Source: based on Mutia (1999) and BAS (2004) for relevant production figures).

Additional effects on the lake environment arise from the provision of artificial feeds to the fish cages that adds large amounts of nitrogen and phosphorus to the lake. The lake's increasing eutrophication can cause additional problems of low oxygen levels. However, amongst some local people, this process has been welcomed as an 'enrichment' of the lake that they expect will contribute to increases in fisheries production.

Conflict and increasing competition between users have been a feature of the use of Lake Taal. Fishers (targeting *tawilis*), leaving aside their own illegal practices, blame fish farmers for the decline in the lake's fisheries. They argue that the fish cages obstruct fishing, occupy the fish sanctuary in the lake and impede the flow of the Pansipit River into the lake. Furthermore, uneaten feed escaping from the cages attracts the wild fish but when fishers follow the fish, they are chased away by cage farmers who fear poaching and sabotage. Furthermore, tourist operators have objected to the spread of cage culture that they view as unsightly while NGOs and researchers have increasingly warned of the environmental and social costs of unchecked development.

The innovation: The Taal Volcano Protected Landscape Management Plan

Lake Taal is a designated protected area that is managed by a Protected Area Management Board (PAMB). This is the only body that has the right to give permits for fish cages in the lake. It is outside the jurisdiction of the municipal councils around the lake. Following the difficulties to develop and enforce earlier plans, the PAMB undertook a consultative process to develop a Taal Volcano Protected Landscape Management Plan involving negotiation among a wide range of users and interest groups. The resulting plan includes commitments to maintain water quality, zoning for forests, aquaculture, fish sanctuary and agro-tourism, better law enforcement and maintaining current population levels, disaster preparedness and solid waste management.

Under the plan, the number of fish cages is to be limited to 8,000; in line with the estimated carrying capacity for the lake. While there were groups (including NGOs and tourist operators) who would have preferred no cage culture, the final target was arrived at by consensus and compromise. Licensing requirements have been strengthened with regard to farming equipment and production. Cages are required to be manufactured from certain materials and located at least 100m from the shore. Stocking densities within the cages are to be limited to reduce the incidence of disease, because infestation by the parasitic isopod, *Alitropus typus* (known as *timud*) was cited by cage farmers as a major impediment and risk to fish farming. Demonstrating the degree of commitment to the plan, and as a means of ensuring accountability, a copy of the final plan was buried under a tree by the Governor of Batangas to be unearthed after ten years to see how it has fared.

Tilapia farms in Lake Taal. (Photo source: Charlotte Cawthorne).

Despite broad support and this high level commitment, the plan faces a number of obstacles, not least from influential groups who are benefiting from aquaculture and who are resisting changes in the way Taal Lake is managed. These groups have resisted the process to regulate cage culture and, as it appeared inevitable, requested extensions to maintain current levels of production for as long as possible.

Costs and benefits

Despite determined opposition, over 5,000 illegal aquaculture structures were removed by the end of 2009 and an inventory of the fish cages within the legal fish cage zones has begun. It is expected that removal of these cages will facilitate the flow of water and assist in increasing water quality. Costs of funding the activities under the plan will be met through the licensing and there are also plans to set up a Taal Lake Conservation Foundation that can provide opportunities to mobilise private sector financing to support the activities.

Because of the vested interests and the influential groups involved there will be difficulties to implement the plan. While many illegal structures have been removed, the cages are relatively cheap and new cages are being put up. Levels of aquaculture production have not yet fallen and this may be because removal of cages has taken out unproductive and inactive cages, stocking densities have not yet been controlled and because of the building of new cages. As an example of the contested and political nature of the process, the process of dismantling illegal cages has been put on hold during elections. Maintaining continued support for the plan, vigilance and enforcement are likely to remain challenging.

Uptake potential

While it is too early to determine how successful the regulations have been at reducing the environmental damage caused by aquaculture practices, many people have been involved in the process and have a stake in its success. This includes local government planning, environment and agriculture personnel who set up the public consultations, local people who engaged in these, facilitators and experts from the national agencies and Universities as well as volunteer experts and NGOs who helped draft the plan, and the political figures, including the governor, who have endorsed it. The planning process was a long (over two years) but the achievement has been considerable in moving from a situation of no regulation, conflict and environmental degradation, to the development of a plan in which there is general consensus.

This case study illustrates that with consensus on a problem, if not on the solution, and a commitment to full participation, it is possible to mobilise a process that can result in a plan that has broad agreement, includes aspects of environmental stewardship, economic development and social equity, and achieves political support.

South Africa: Certification of the hake fishery

Species	Deepwater and shallow water hake
Fishing Methods	handline, longline, offshore and inshore trawling

The offshore hake (*Merluccius paradoxus*) fishery in South Africa (Figure 24) employs around 7,000 people and contributes over 50% of the total value of all fisheries in South Africa with the main markets being Europe and the domestic market. The industry has annual sales of ZAR 4.15 billion (USD 600 million), generating ZAR 2.65 billion (USD 400 million) of foreign exchange and ZAR 0.95 billion (USD 140 million) revenue for government.

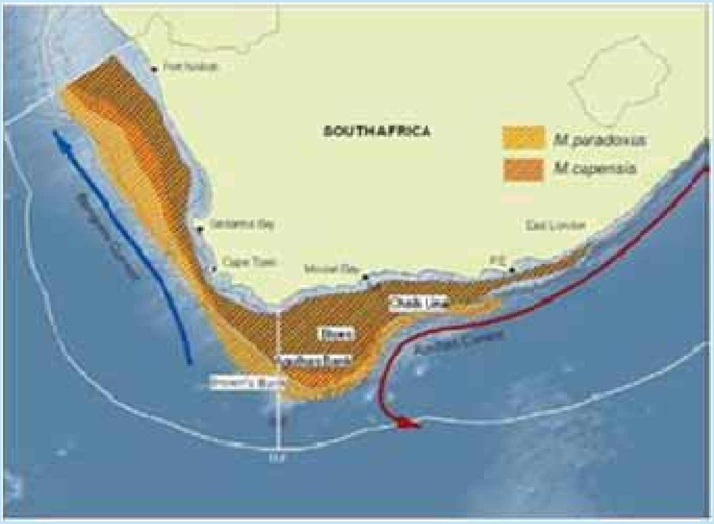


Figure 24: South African hake fishing areas for the two target hake species *Merluccius paradoxus* and *M. Capensis* (Source: Powers et al. 2010).

The problem and driver

From the start of the century the fishery developed and grew rapidly after World War II. In the 1960s a large number of foreign fleets started to operate along the western African coastline, and entered the South African hake fishery (Spanish, followed by Japanese, Soviet and Polish vessels). The fishery developed rapidly in the 1960s, reaching peak catches of almost 300,000 tonnes in 1972, less than half of which was accounted for by the domestic fleet.

The governance challenge within the hake fishery has concerned rights to fish and who benefits from the fishery. The first change was the introduction of a 200 nm fishing zone in 1977 and the exclusion of foreign vessels. The South African trawler association was formed in 1973, and received almost the entire quota that was re-distributed in 1978.

From 1984, government policy included some redistribution of quota to new fishery entrants, and the pioneer companies' share of the quota fell to 68%. Under the 1998 Act the number of rights holders stabilised, and allocation policy included consideration of the applicant's historical catch, performance (jobs, training, investment) and transformation (management, ownership and shareholding) and specifically aimed to foster Black Economic Empowerment.

The fishery is sustainably managed, and has a good governance structure involving decision-making and consultation between industry, government, independent scientists and environmental organisations. Governance is strengthened by the presence of a cohesive industry body, comprising a limited number of cooperating sectors, supported by the continued policy of rights allocation, and involvement of the large industrial operators — including the original beneficiaries, now the South African Deep-sea Trawling Industry Association (SADSTIA) — whilst also allowing some redistribution and empowerment. However, an equally important part of the system is strong, nationally- and internationally-respected science.

A particular concern of industry, in 1998, was the maintenance of strong sustainable management under the 1998 Act, and it was concern about the continuation of these policies that stimulated the industry to apply for MSC certification.

The innovation: MSC certification

The fishery is currently assessed as meeting the MSC's criteria for sustainability, being first certified in 2004. Decision rules are chosen by managers in collaboration with the industry so as to achieve outcomes that are acceptable to both, and supported by robust scientific testing. An observer programme is in operation with coverage targets of 10% for trawl and 15% for longline, which is financed by an industry levy. In the past,

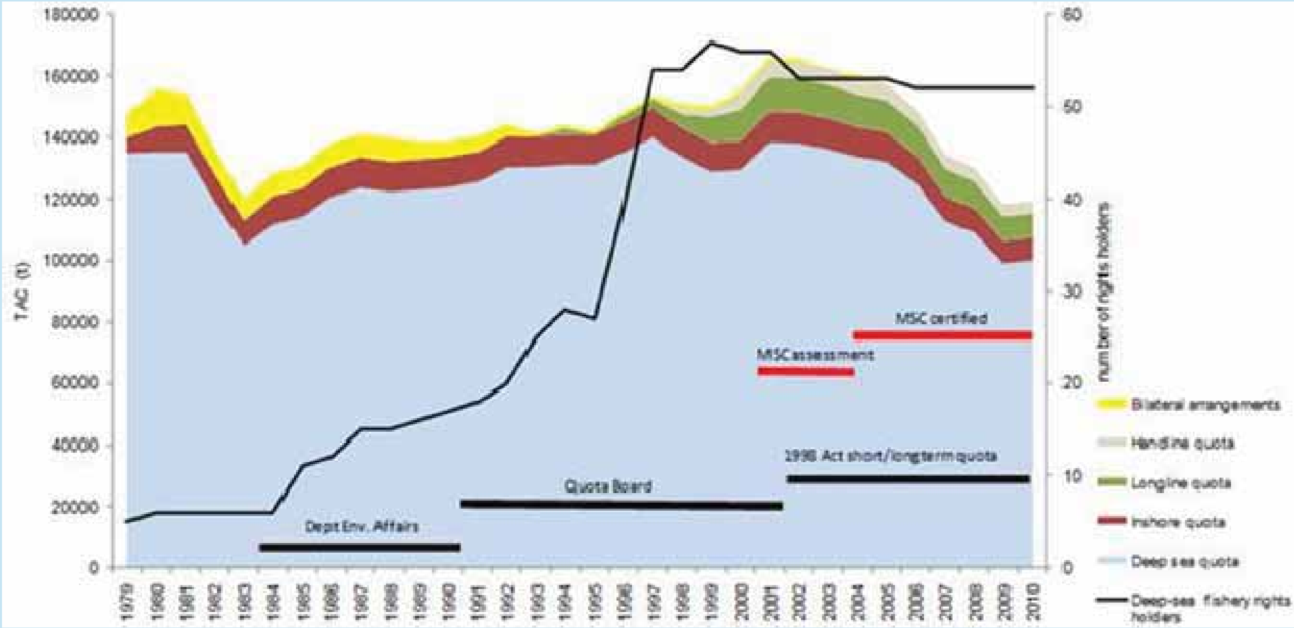


Figure 25: Development of the South African hake fishery over time (Source: Powers et al. 2010).

industry has argued strongly for reductions in catch and effort, both to maintain stock status and to avoid unacceptable management interventions. Industry has cooperated with NGOs to develop mitigation measures for bird by-catch and is responding to pressure to create marine protected areas.

All parties perceive the MSC certification as providing them with additional leverage. Industry argues that it provides added value to South Africa, and that sustainability must be ensured. Government use the MSC requirements to improve management, particularly of by-catch species, and increase observer coverage. Environmental organisations use the MSC requirements to stimulate better environmental performance in the fishery, in particular reduction in bird by-catch.

Costs and benefits

The costs of MSC certification are placed at ZAR 600,000 (USD 86,000), with surveillance costs about 10% of this annually. The larger cost borne by the industry has been in making changes to comply with the conditions, estimated at ZAR 12 million (USD 1.7 million). However, industry has been able to access new markets in northern Europe, which were previously inaccessible to them without MSC certification. This has partially compensated for the currently very difficult international market in whitefish. Current assessments put the *M. paradoxus* stock as likely to be below B_{MSY} but increasing under the influence of the current operational management procedure. Catch rates are increasing, bringing profitability up with them. Levies on industry (permit fees and levies on landings) have generated ZAR 24 million (USD 3.4 million) in 2009 to support management costs. There have been significant environmental gains, including reductions in by-catch of birds and non-target fish. The social cost in this case study is that limiting access rights limits who can benefit from a sustainably managed and certified fishery.

Uptake potential

South African hake provides an example of a fishery in which limiting the rights to the fishery has led to sustainability benefits, including the recent MSC certification and stock recovery. Industry works with management authorities to ensure that management measures provide positive environmental benefits, without creating significant impacts on employment and maintaining relative stability in catch levels between years and acceptable increases in catches.

However, the case study also highlights the contested nature of resources and the way that actors respond to change. The state is intervening in fisheries, as a result of major changes in government priorities arising from significant political changes within South Africa, to achieve wider societal goals. Part of the industry’s motivation for certification, in addition to securing markets and increasing environmental sustainability, included defending against further erosion of the management system, and changes in industry composition, by government policy.

Mozambique: Co-management

Species	Pomfret, shrimp
Fishing Methods	Beach seine

The problem and drivers: Overexploitation and conflict

As a result of the civil war in Mozambique (1975–1992), people increasingly moved to the coastal areas from the interior as a means to escape the conflict. For local people, fishing is an important source of income, food and employment. Many took up fishing and as the population of costal areas increased, the pressure on fish resources increased substantially. The resulting coastal fisheries are multi-species, and the beach seine net is one of the main fishing gears used. Beach seines — a net approximately 500m long, deployed using a small boat to encircle fish and crustaceans — provided a relatively easy entry into the fisheries. People moving to the coast lacked financial resources and the skills to operate more advanced fishing gear or larger boats. Boats were also lacking as a result of the devastation of the civil war.

Beach seine operation in Kwirikwige village in Mozambique. (Photo source: F. Leotte).

The increasing pressure on coastal resources increasingly led to conflicts between fishers. These conflicts occasionally spilled over into physical violence and the destruction and theft of fishing gear. From the point of view of sustainability the regulation of effort and overexploitation became key problems, with access and rights to fish an important consideration. By the time of the peace accords in 1994, these problems reached such proportions that the government had to intervene and try to reduce conflict and introduce better regulation, yet recognising that these were problems that the government would not be able to control directly.

The innovation: Establishment of local co-management committees

The Institute for the Development of Small-Scale Fisheries (IDPPE) was created at this time and sent a team of local experts together with foreign technical assistance to coastal villages to facilitate the establishment of co-management committees (*Comités de Co-gestão de Pesca*, CCPs). Pilot studies were conducted, one in Kwirikwidge and another in Inhassoro, where the CCPs provided an opportunity for local people to discuss the problems related to the fishery and fishing activities. Through these discussions it became clear that there was a strong local sense of the need for preservation and rational use of marine resources and to establish some rights over access to the resource. The latter was addressed by licences issued by the CCPs to beach seine operators in order to control the number of people who could fish within their delimited areas of influence. The CCP was also responsible for collecting revenues and passing these to the Fisheries Administration. Other issues that were raised as concerns by local people were the lack of knowledge to diversify into other forms of fishing (to provide new opportunities and reduce the pressure on coastal resources) and access to markets. As a result, IDPPE worked with the CCPs to introduce other gears, such as gillnets and trammel nets.

Costs and benefits

The initiative proved promising as it was able to reduce conflict through the licensing and the support that was provided through IDPPE to local regulations. The initiative was extended to other nearby coastal villages and this provided an opportunity to extend the scheme and create a network of CCPs that could share information between themselves and also discuss common issues with the government. Throughout this period, IDPPE continued to guide the locally-elected CCP leaders through the process of promoting regular meetings, issuing the fishing licences, preparing meeting notes and helping them to prepare the agenda for the discussion of relevant

Asserting community rights over the local resources in Kwirikwige village in Mozambique (Photo source: F. Leotte).

issues at a provincial level. However, the nature of these fisheries means that it is not possible to provide quantitative estimates of changes within the fisheries and the coastal villages or to establish the extent to which this process has had beneficial impacts on fish stocks.

The networking of the communities enabled them to collectively address another issue affecting them — the fishing operations of larger shrimp trawlers fishing that caught fish as by-catch and often fished very close to shore and their interactions with the coastal fishery. Again, the coastal communities were able to use the mechanism of the CCPs to put forward their perspective on the issue and to assert rights over the coastal resources. As a result, agreement was reached between these communities and the semi-industrial trawler fleet in that the latter stopped operating within the area up to three miles from the coast. This was an important agreement that is claimed to have virtually eliminated problems relating to the damage of fishing nets by shrimp trawlers.

Challenges: The changing nature of the problem

In terms of governance this co-management initiative has proven to be a successful mechanism to bring together stakeholders to discuss the issues facing the users of coastal resources. The CCPs have also provided an effective mechanism to establish claims on the resources. However, while effective in addressing this concern, the CCPs were less successful at providing the villages with increased authority over resources and new problems began to emerge. Even with the licensing of beach seines, and attempts to introduce new gears, there was increasing use of fine-meshed nets (such as mosquito nets) and the catching of juvenile fish. Catches continue to fall and, given the short-term need for food and income, there is a reluctance to enforce the ban on these gears.

There have also been concerns raised within the villages about the operation of the CCPs. In some cases there have been complaints that the CCPs have become a mechanism by which the government passes on its responsibilities to local communities. Because the CCP issue licences and collect the revenues on behalf of the state, they believe they should be paid for what they see as work for the government.

Uptake potential

The establishment of co-management committees to involve local resource users in management and decision-making has been widely seen as a positive move. The implementation and extension of the CCP has been so successful that today there are over 150 CCPs spread along the whole coast. It is believed that almost all fishing communities in the country are now represented by a CCP, and the CCPs are represented at national level on the Fisheries Advisory Committee.


An outstanding issue, small fish fry caught by fine-mesh nets in coastal beach seine fishing, threatening the long-term sustainability of these resources (Photo source: F. Leotte).

Co-management, and the sharing of authority and responsibility, has potential in many contexts. While it may be established to address one particular set of issues, it may begin a process that can respond to further challenges. A stronger local voice can provide a different perspective and highlight further challenges to sustainability that may not be apparent to external actors. However, as this case highlights, stakeholders have their own interests and will also act in ways that promote these.

Addressing poor governance

Many of the issues of management are, at heart, issues of governance. This section draws on the governance case studies as well as highlighting the governance aspects related to overcapacity (Chapter 2) and lack of data (Chapter 5). Overall, the case studies emphasise the dynamic nature of fisheries the governance challenges within fisheries as different actors, interests and issues emerge over time.

Governance is a complex problem

Governance is the most complex of the challenges because it is a human and a political challenge. Within any given fishery there are a range of interests at play and these interests may be variously supported and challenged by efforts to transform fisheries. As other chapters in this report also illustrate, many of the key challenges also raise aspects of rights of access and entitlement, which are governance issues. As the South African hake and Lake Taal case studies showed, efforts to restrict or redistribute rights can be resisted by actors within the fishery and sustainability initiatives and the rhetoric of sustainability can even be deployed in support of these interests.

Co-management committees, such as this CCP in Mozambique, can form part of the governance arrangements for fishery management at a local level. (Photo source: S.F. Walmsley).

What this highlights is that there is unlikely to be a single solution to governance challenges. As the case studies in this Chapter show, the introduction of more inclusive decision-making processes have been able to start the process of transforming a number of fisheries. These processes have had different starting points, recognise different objectives and bring together stakeholders, creating debate, compromise and negotiation, creating the space in which positive transformations become possible and within which, as Figure 22 illustrates, more than one sustainable outcome is possible.

Pathways and processes of transformation

Creating transformative processes requires careful facilitation and it also requires us to accept that different values and world views are equally valid and must be actively represented. In doing so we must consider our own position. Underpinning many approaches to sustainability has been an emphasis on the application of science and rational planning to sustainability challenges. Applied to governance challenges this can lead to a focus on solutions and models of success that can downplay the political (and historically situated) dimensions of what are fundamental challenges of rights and power (e.g. Arthur et al. in press). As Pitcher and Lam (2010) in a recent review concluded, there are no simple solutions to complex fisheries problems but management measures that are context specific. Identifying which measures are appropriate is part of the process.

These case studies illustrate that transformation not always straightforward. Changes in the nature of the fishery, in those seeking access to the resources, and changes in the capabilities across the stakeholder groups involved over time, will mean that the process will be ongoing and can be expected to change over time. There is no 'one size fits all' set of guidelines or prescriptive arrangements for governance reform. Local, national and regional level processes have all been instrumental in bringing about or initiating positive changes in which context-specific management plans have been identified. The ISSF case study (Chapter 2) shows that even on a regional basis it has been possible for actors to pursue sustainability goals.

It is the multi-stakeholder nature of the process that has been important. Different types of knowledge, world views and values can be represented in identifying and framing the issues and assumptions about the nature of the problem can be assessed and challenged. Within these processes, local fishers and those dependent on the fisheries represent critical stakeholders. As Chapter 2 points out, they have important local knowledge and capabilities, often overlooked. Even in the absence of government regulation, effective local management is possible, with these groups often choosing solutions that are consistent with biological sustainability. Indeed, where there are issues of poor governance, corruption and ineffective institutions, it may be necessary to engage, in the first instance, with wider civil society organisations.

Barriers to transformation

The case studies repeatedly reinforced the contested nature of decision-making and the way in which different groups sought to advance their interests and the way in which sustainability arguments can be deployed to support these interests. Furthermore, as the nature of the challenge changed, protagonists of change could become antagonists as their interests were challenged by the proposed changes. In Mozambique, while local communities were supportive of co-management plans that reinforced their rights over the resources, they were less supportive of efforts to introduce gear bans.

Within governance processes narratives and discourse play an important role in shaping arguments by presenting straightforward assessments, creating simple story lines of how a 'problem' has arisen, how it will unfold, and therefore what the necessary course of action should be (e.g. Roe 1995). Within capture fisheries, the dominant discourse of the individual economic behaviour of fishers within the context of open access resources leading to overfishing has proved powerful in shaping approaches to sustainability that emphasise external top-down control, constraining debates on the options for fisheries management. It is important such discourses, and the courses of action they support, can be placed under scrutiny.

Across the case studies, changes in management and governance were sometimes used as as a means to further influence and control — variously by fishers, by NGOs and by the state. As such, initiatives to improve sustainability have been translated, implemented and resisted by actors within the process, with the eventual outcomes being either supportive, undermining or neutral to the initial aims. Individuals involved have the ability to affect the process and outcomes and the extent to which they can do so is often also dependent on their power and influence. As a result, as the Lake Taal case study showed, there may be actors involved whose interests may be best met by resisting change or by adopting the rhetoric of sustainability while continuing to pursue 'business as usual'. The South African hake case study also highlights this point through the role of the state in the governance of fisheries resources—the state can intervene as an interested party, whose objectives may not be limited to environmental sustainability and whose actions may even compromise sustainability.

A way forward

Because of the complex nature of the challenge and the diversity of fisheries contexts, it is almost inevitable that addressing poor governance will require different approaches from fishery to fishery. It is also important to accept that both the nature of the process, who drives it and where it starts from can differ. However, a number of key principles can be identified. The most suitable approach to deliver accountable management is to develop an inclusive and participatory process that is fishery-specific and takes into account the local context, history and all interests in order. This will not always be straightforward, and reaching consensus on issues where there may be winners and losers is not always possible.

Governance indicators are negatively correlated with the level of IUU fishing. Good governance supports effective fisheries patrols and enforcement. (Photo source: R. Gater).

LACK OF DATA AND STOCK ASSESSMENT

Much of the blame for the decline in fish stocks across the world has been pinned on failures in fisheries management. While the failure of management systems has often resulted from poorly defined objectives and the way that decisions about fisheries are made (see Chapter 4), there is often a lack of data on which to base management decisions. Additional problems arise through the inappropriate selection and application of management measures. Many of these problems are related to the way that information for management is generated and used and the way in which responsibility for enforcing decisions is shared.

In this chapter we draw attention to how these problems can arise and examine, through four very different management situations, some of the innovative ways in which groups are beginning to try to address these issues and where these problems have been overcome: management of common resources on the high seas, the application of ecosystem-based management in the CCAMLR region; management at the local level in Fiji and Senegal; and management of a Northeast Atlantic cod fishery.

Information, data and management

As Charles (2001) uncomfortably highlights, what we do not know about fisheries systems far exceeds what we do know. This is a problem of data collection as well as the inherent uncertainty associated with fisheries systems. Fish (and many other components of the ecosystem) are effectively invisible; what we know about stock dynamics is inferred from fishing and research sampling. Fish stocks are affected not only by fishing but also by other environmental factors such that the relationship between stock variability and fishing is not always clear.

Given this situation, it is important to identify the information that is critical to managing fisheries, whether this information exists and (if it does) how it can be incorporated into decision-making, and (if it does not) how the resulting uncertainty can be addressed, which may include taking more precautionary approaches or identifying what data are required to generate the information.

Critical elements to consider are information about the biology, ecology and productivity of the fish stocks and their interactions with the environment and other species. It is important to distinguish the difference between data and information in that information is data that has been processed or analysed to provide information. In this respect local knowledge can be considered information while observer records, which require analysis to be informative, represent data.

Information from within the fishery is vital for identifying and applying management targets and limits for species and ecosystems. These, in turn, are important for determining at what stage fishing controls (e.g. deployment of effort, closed areas and/or total catch) may be needed in order to ensure the objectives are being met. Without targets and limits and a process for assessing how well the fishery is doing against them, agreement over whether the harvest controls should be altered will rarely occur.

Targets and limits for the fishery can be derived from both the stated objectives and the level of risk that society is prepared to accept to derive benefits from the fishery. This is an issue of governance (see Chapter 4), but it is important that these targets and limits are clearly identified. Because there may be different opinions about the objectives for the fishery and appropriate level of risk, uncertainty about fish and fish stocks can lead to disagreement about how well the fishery is doing and thus what action needs to be taken as a result. It is also therefore important that methods for assessing stocks and performance are also agreed in advance.

In addition to information about the stocks and their dynamics, it is important to consider the human dimensions of fishing, for example the extent of fishing operations and how they affect fish stocks, other species and the wider environment. Particularly where overcapacity is a concern, information is also needed about what is driving capacity development (see Chapter 2 and also the Senegal case study in this chapter) and how the benefits from fisheries are derived and shared. This information can come from a number of sources and the experiences from the case studies demonstrate that many actors (governments, NGOs, local people and industry) can play a role and have provided information that has contributed to identifying issues within the fisheries. These stakeholders have also assumed roles in developing and applying the innovations that have addressed the challenge (see also Chapter 4).

Ecosystem-Based Fisheries Management and the Precautionary Approach

Ecosystem-Based Fisheries Management (EBFM) arose from the recognition that individual fish stocks need to be managed as part of dynamic ecosystems that consist of directly and indirectly interacting species (fish and non-fish) and it is viewed as a means to incorporate these wider effects into decision-making (Figure 26). EBFM is now commonly expanded in meaning beyond the UNCLOS (1982) text (*effects on species associated with or dependent upon harvested species*: UNCLOS, Article 61) to include the concept that fisheries should be managed without jeopardising the options for future generations to benefit from a full range of goods and services provided by marine ecosystems (FAO 2003).

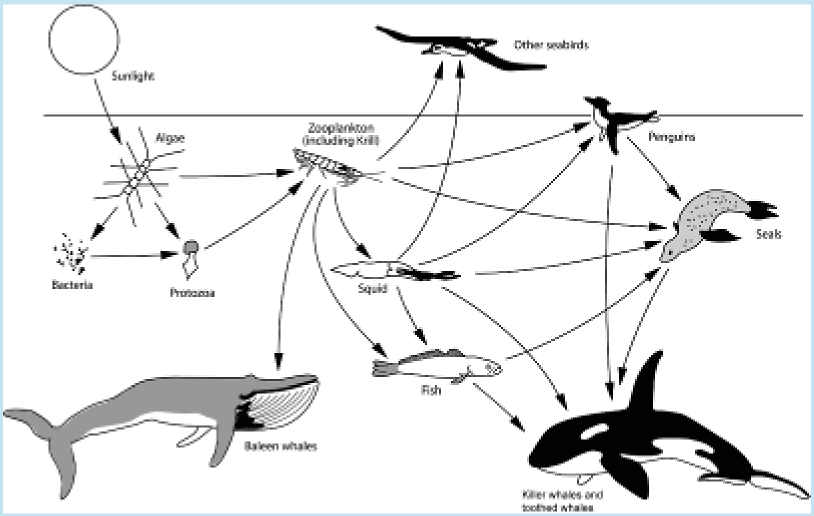


Figure 26: CCAMLR foodweb highlighting the direct relationship between fished stocks and species in trophic levels higher and lower (Source: modified from Kock et al. 2000, original S. Cowell)

Given the uncertainty associated with fisheries, and the lack of precision in stock assessments, a more risk-averse attitude has emerged and been promoted as part of a Precautionary Approach to fisheries management.

Under this approach, which is at the core of the UN 'Fish Stocks Agreement' and the FAO Code of Conduct for Responsible Fisheries, the burden of proof is shifted. The Fish Stocks Agreement introduces the concept of the precautionary approach in Article 6: *States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.*

Controlling exploitation and IUU fishing

Responding to change in the perceived state of the fishery is an important aspect of management. A crucial aspect of the capacity to respond is the ability to control the level of exploitation and maintain stocks within safe biological limits. While there are a range of ways that control can be exerted (from self regulation through to external control), capability to implement, enforce and assess effectiveness are crucial in selecting the approach and the appropriate measures.

The ability of the state to control fisheries through centralised management systems has been questioned, particularly in countries where governance is an issue and where resources may be limited. At the same time there are also questions about the ability of industry to self-regulate. Under such conditions Illegal, Unregulated and Unreported (IUU) fishing can undermine fisheries sustainability.

Not only are there direct effects on the fisheries (including the use of destructive gears), but IUU fishing also introduces further uncertainties into decision-making and makes additional demands on the control and enforcement measures. Unreported catch creates gaps in data which can affect the accuracy of stock assessments. This unreported catch can occur legally within the framework of current legislation where quota is related to landings rather than total catches. Illegally caught and landed fish exacerbates these problems.

IUU fishing is recognised to be a global problem and one of the main impediments to the achievement of sustainable world fisheries, worth between USD 10 billion and USD 23.5 billion per year. Controlling capacity is a critical element of addressing IUU fishing but, as the case study from Senegal illustrates, it can also be important to understand the drivers of IUU fishing as IUU fishing may be a symptom of problems that exist outside the fishery.

Antarctic: Ecosystem-based and precautionary management

Species	toothfish, icefish, krill
Fishing Methods	trawling, longline

The problem and drivers: decreasing seabird populations and increasing krill catches

The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) Convention Area consists of the whole Southern Ocean, bounded to the south by continental Antarctica and to the north by the Antarctic Convergence (Figure 27).

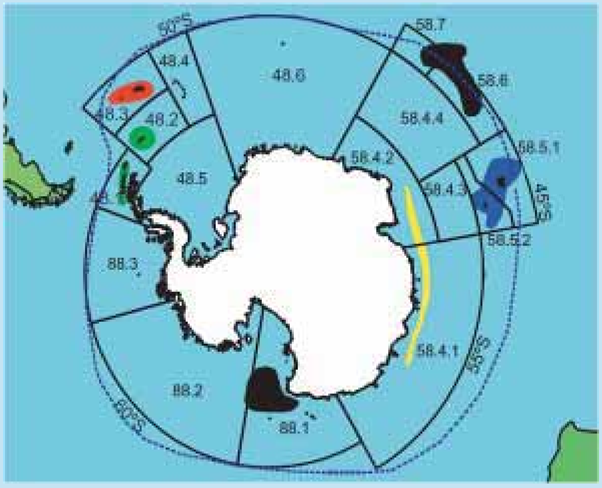


Figure 27: The CCAMLR Convention Area, showing fishing areas and the Polar Front (Antarctic Convergence – dashed blue line). With colours showing the distribution the krill, toothfish and icefish fisheries (Source: Agnew 2004).

CCAMLR was negotiated within the framework of the Antarctic Treaty (1961) which suspends territorial claims over Antarctica and sets the region aside for science. Conservation rather than economic optimisation was therefore very much in the minds of the negotiators and a key driver for the adoption of a management approach that considered all ecosystem interactions.

Although highly productive in some areas, Southern Ocean ecosystems are also sensitive to exploitation. Within Article II of the Convention, EBFM includes conservation defined to include rational use (i.e. fishing) and aims to a) prevent the decrease of harvested populations below levels which ensure stable recruitment, and maintain populations at a level equivalent to maximum sustainable yield; b) maintain ecological relationships between harvested, dependent and related populations, and restore depleted populations; and c) minimise the risk of changes to the ecosystem that are not reversible over two or three decades. The wider interactions of fisheries and the exploited species with the ecosystem have been of central concern in Antarctic fisheries.

In the 1970s, the krill fishery was developing rapidly. This was the basis for concern as it was recognised that krill was a key component of the ecosystem with a vital role. Scientists were unsure of the level of krill which could be harvested before there would be risks to the recruitment and growth of krill which would then have implications for populations of other species which are dependent on krill. In response, CCAMLR took a precautionary approach to modelling of krill stock dynamics and the setting of catch limits, the Krill Yield Model (Constable et al. 2000). The development of ecosystem-based management of the krill fishery has been implemented by the scientific community within CCAMLR.

In contrast to krill, concern arising from the toothfish has been the incidental mortality of seabirds as a result of the fishing method. Toothfish are primarily caught with bottom longlines and birds are attracted to the bait on the hooks, get caught, and are dragged under the water to drown. Since the longline fishery developed in the late 1980s, many thousands of birds were suspected to be killed each year. A large proportion of these were endangered albatross species (particularly wandering and black browed albatross) whose populations at South Georgia, and other areas of the southern ocean, had been declining. In 1989, CCAMLR urged fishing countries to investigate methods of mitigating bird by-catch in CCAMLR waters.

The innovation: Application of EBFM and the Precautionary Approach

The Krill Yield Model, developed by CCAMLR in 1994, combines the known information – estimates of krill biomass—with uncertain information, such as the variability in krill recruitment rates and natural mortality and the impact of the krill fishery on dependent and related populations. The decision rules apply both EBFM and the precautionary approach to state that a) the krill stock should not be reduced to below 75 % of its level in the absence of exploitation and b) there should be only a low probability of the stock being at levels which might impair recruitment (Constable et al. 2000). Catch limits are set in a precautionary fashion and are only increased as more data becomes available. CCAMLR has also defined small areas where shore-based predators forage for krill, and has put a cap on catches for these areas.

For toothfish a Conservation Measure was agreed in 1991/92 under which vessels are required to use weighted longlines, avoid fishing in particular seasons, set lines only at night, retain hooks and offal and use streamer lines to scare birds away from hooks (Figure 28). The effectiveness of these measures has been significantly enhanced by the 100 % scientific observer coverage requirement on toothfish vessels and scientists were very active in collaborating with industry to develop mitigation measures.

Figure 28: Brightly coloured streamer lines suspended from the back of the fishing vessels create a deterrent to seabirds such as black browed and grey headed albatross, preventing them from taking baited hooks at they are set. In CCAMLR, streamer lines are one of several technical measures used to reduce seabird by-catch, which was considered a major issue in the 1990s. Since the introduction of such measures, for which compliance is very high due to the presence of onboard scientific observers, seabird mortality caused through interactions with fishing gear has been reduced to virtually zero. (Photos source: D. Agnew).

Costs and benefits of ecosystem-based management

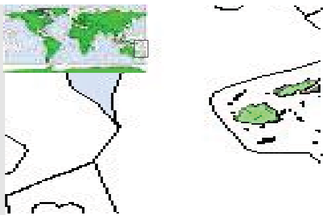
The overall catch of krill has been very low in comparison to estimated abundance and productivity, CCAMLR's efforts to develop management approaches for the krill fishery that are both precautionary and ecosystem-based have exceeded approaches taken by other RFMOs. This has been the basis for certification of the fishery and to date one krill fishing company (Aker Biomarine) has achieved MSC certification. These steps should allow sound development of the fishery as new krill-based products are developed in the future.

Seabird mortality in the toothfish fishery was reduced to negligible levels as a result of observer programmes and by-catch mitigation measures. For example, in Subarea 48.3 catches dropped from 5,755 in 1997 to zero ten years later. However, observer programmes come at considerable cost. Details of observer costs for CCAMLR are not available as the costs are managed by the member states, but they are probably in the region of 3% of the value of the catches. In this case, these costs are in relation to the estimated annual yield of approximately USD 293 million. The value of a comprehensive scientific observer scheme cannot be underestimated. Information regarding the scale of the problem of seabird by-catch, and effectiveness of solutions, only became available once scientific observers became mandatory on longline vessels. There are also benefits for the industry and as a result, the South Georgia toothfish fishery has been certified by the MSC since 2004, and three more fisheries are undergoing assessment.

Uptake potential

A feature of the CCAMLR system which has been very important in generating effective solutions is the conservation-focused objectives for CCAMLR. CCAMLR has shown the potential for RFMOs to adopt and apply precautionary and EBFM approaches and the benefits of observer programmes. The experiences within CCAMLR provide evidence of the effectiveness of these measures that can be considered by other RFMOs and management bodies for national waters where the scale and value of the fishery is sufficient to cover the costs. The challenge for many other bodies, regional and national, comes in balancing the need for conservation against the other management objectives for the fishery.

Fiji: Local knowledge and traditional management practices



Species	Mixed pelagic (e.g. trevally and mackerel) and demersal reef (e.g. Snapper and grouper)
Fishing Methods	Handline, trap, gillnet, spear

The problem and driver: Developing community-based ecosystem management

A key characteristic of successful management is the incorporation of different types of knowledge into the decision-making process. This can not only improve the knowledge base upon which management decisions are made, but can also result in greater acceptance of management decisions by all. When management decisions are being made or enforced in a centralised fashion, it can give rise to a disconnect between the way that the fishery is considered by the management body and the way it is perceived by fishers and other stakeholders.

Pacific island communities have long practised traditional methods of preserving their valuable marine resources. In many areas these community-based methods of management have been maintained. Where government resources are limited, communities have often taken the initiative to reinforce customary village management systems which are based firmly on traditional knowledge. This allows them to assert control over their natural resources, health and way of life.

Whilst the Fiji Department of Fisheries retains primary responsibility for licensing and enforcement of all commercial and artisanal fishing activities in Fiji, coastal resources are largely governed by customary marine tenure and customary management. Fiji's system of local marine tenure consists of traditional fishing grounds, or *qoliqolis,* that are under the control of the communities adjacent to them. *Qoliqolis* have legal recognition as customary fishing rights areas. Traditionally the management of *qoliqolis* has included temporary area closures, restrictions on the number of fishers, control over the use of certain fishing practices, and the imposition of a *tabu*, or prohibition, on fishing for certain species.

Throughout Fiji, marine scientists have worked alongside villagers to apply scientific monitoring and survey techniques to *tabu* areas. (Photo source: MRAG Asia-Pacific).

In Kubulau District, on the island of Vanua Levu, sustainability concerns amongst local people emerged as larger commercial fishing vessels started operating within locally- managed areas. This occurred as a result of the lack of government capacity to monitor and enforce commercial coastal fishing activities.

Villagers felt that this was undermining their attempts to sustainably manage their resources and conserve village food security and local culture. Local grievances were taken up by the press and NGOs who put pressure on the government to better enforce the commercial fisheries. They also leveraged financial resources and expertise to enable villages in the area to visit places where local management was successful. The objective of these visits were to learn from successes and to include additional, scientific, information in their decision-making and management.

The innovation: Linking science and local knowledge

With assistance from NGOs, scientific research programmes have been established that complement Fijian traditional knowledge and provide additional information for local decision-making. Working with local and international scientists, villagers started to map fishing pressures, collect data on species abundance and size to identify management objectives and develop management strategies for the fishing grounds. This resulted in a protected area network being established in 2005. This network has since expanded to 17 small, traditional closed (*tabu*) areas within estuarine and reef areas; and three large, district-wide no-take fisheries areas, all with defined boundaries and management rules.

Using information from the surveys, village chiefs have increasingly been applying *tabu* to protect spawning areas and overexploited species. The location and size of the *tabu* area is considered by members of the village, depending on how much they feel they can close and still meet their needs. External experts may advise a community on what they consider to be the optimal placement of the *tabu* area for conservation benefits, but ultimately the community has the final say about location.

The combination of scientific and traditional knowledge helped highlight the links between the local terrestrial, freshwater and marine habitats and these findings encouraged village chiefs to take a more ecosystem-based approach to the management of their natural resources and the impacts of their villages.

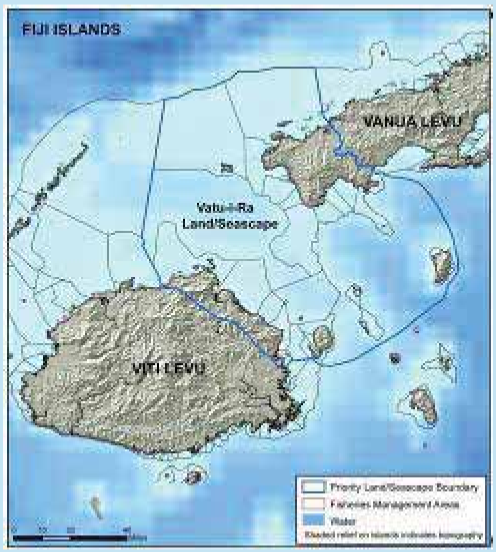


Figure 29: Map outlining the Vatu-i-ra land/seascape (Source: WCS 2009)

Costs and benefits of community-based ecosystem management in Fiji

Overall, the benefits in Kubulau have included renewed awareness and respect for traditional village hierarchies, resulting in better management of the *qoliqoli*. The use of destructive fishing methods such as dynamite and poison fishing are now thought to have been eliminated. Additionally, community members perceive benefits in terms of increased fish and invertebrate size and abundance and coral cover since the innovation and scientific assessments support this, demonstrating significant increases in reef fish biomass in a number of closed areas compared to open (Jupiter and Egli in press). However, there have been conflicts between villages over the management decisions, with the one village that takes the majority of fish for sale feeling that they are being disadvantaged by the changes. This is subject to ongoing negotiation.

In contrast to many sites in Fiji , a comprehensive research and assessment program was launched to inform the development of Kubulau's ecosystem-based management plan and a similar plan (still under development) in the nearby Macuata Province on the north coast of Vanua Levu. While a study in 2009 by Fiji's Community Conservation Investment Forum into local management areas in Fiji estimated the cost per site to be approximately FD 1,300 per year (USD 707), two rounds of funding by US foundations provided contributions totalling approximately USD 3 million over four years (2005-2009) to the NGO partner organisations working in Kubulau and Macuata, largely to fund an additional comprehensive research and assessment program.

Uptake potential

This case study provides evidence of how science can provide additional information and bring a new perspective to a situation that complements local knowledge. However this can also be challenging. Scientists and local people often have different ways of representing, interpreting and talking about the fishery and may have different objectives. The power and access to resources (financial and other) may also be very different.

While traditional management systems may not have originally been established on the basis of environmental concerns, but rather to address social issues, the case study also demonstrates how traditional management arrangements, with support, can provide a means to move to greater sustainability. This is something that potentially has global applicability yet the case study also highlights that this is not straightforward and there may be conflict between different local users, local fishers and other users of the marine environment (e.g. tourists and divers).

However, there is much that can be learned from this example as meaningful engagement between actors, based on mutual respect, could have much wider application and open up new opportunities and alternative forms of assessment and enforcement.

Senegal: IUU fishing in small-scale fisheries

Species	Coastal pelagic and demersal species including sardinella, anchovy, mackerels, octopus
Fishing Methods	Ringnets, gillnets, hook and line

The problem and drivers: Illegal, unreported and unregulated fishing

A central problem with all fisheries management systems is ensuring compliance with regulations and avoiding illegal, unreported and unregulated (IUU) fishing. IUU fishing is defined in the FAO International Plan of Action (IPOA) to consist of:

- Illegal fishing: fishing in contravention of the laws of that state; or fishing by a flag state in high seas waters in contravention of the conservation measures adopted by an RFMO to which the flag state is a party;
- Unreported fishing: fishing that is not reported, where this is in contravention of national laws or RFMO reporting obligations;
- Unregulated fishing: fishing in the area of application of an RFMO, in a manner inconsistent with the conservation measures of that RFMO, by vessels without nationality or states that are not party to the RFMO, and on high seas waters with no RFMO authority if this is in contravention of state responsibilities.

One of the major issues associated with IUU fishing has been in the effective control of fishing effort (see Chapter 2 - ISSF). Developing countries are not immune from these problems and increases in the number of fishers and fishing capacity have been observed across many small-scale fisheries. Senegal provides an example of one such fishery and of the challenges presented by IUU fishing and control of fishing.

Senegal has a very important and productive fisheries sector. Senegal has a long history dating back to the 1960s of fishing access agreements with other countries, including Asian nations and the EU. Over this period there was increasing conflict between the industrial vessels fishing under access agreements and the artisanal fishers, with accusations of IUU fishing and resource overexploitation. Over the last 20 years, there has been a large increase in artisanal fishing capacity (see Figure 30). While Figure 30 indicates reductions in foreign industrial fleets, total industrial fishing capacity may not be decreasing because since the EU-Senegal agreement ended in 2005, most foreign industrial vessels are now Senegalese-flagged. Conflict between the industrial and artisanal fleets remains (MRAG 2010).

The total annual landings of the artisanal sector are estimated at 488,100 tonnes, some 85–90% coming from the marine artisanal fleet, of which approximately 66% is for local consumption. Fish provides 75% of local protein needs and fishing plays an important role in the national economy (Brown 2005). Women have a significant role in these fisheries in processing the local catches.

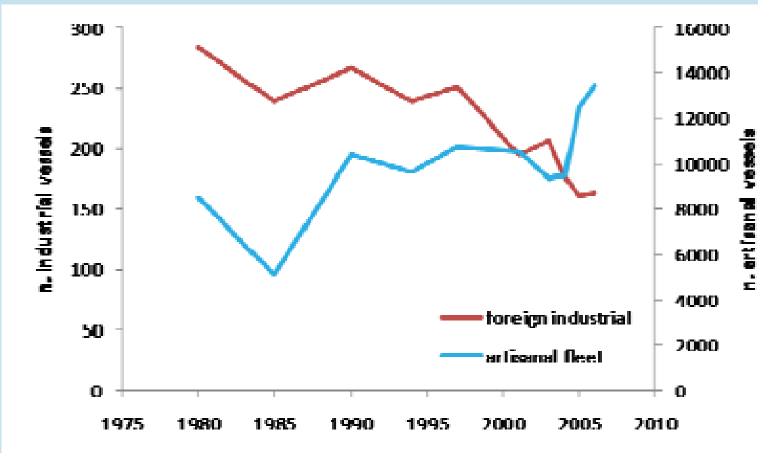


Figure 30: Number of artisanal and foreign industrial vessels fishing in Senegalese waters, 1975–2007 (Source: Data from MRAG, 2010).

The importance of the coastal fisheries extends beyond the coastal areas. Senegal's rural population is dependent on agriculture and highly susceptible to droughts and other disruptions in agricultural production. During droughts or periods of low agricultural production, farmers migrate to the coast to take up fishing. In this way, coastal resources have an important function as a safety net. A role that is dependent on the low barriers of entry to the artisanal fisheries, but this has contributed to increasing capacity in the artisanal sector and putting additional strain on marine resources.

The effect of this increase in capacity has been that while catches from within the artisanal sector are believed to have remained fairly constant (Blueyou and ENDA / REPAO, 2007), the catch per fisher has been falling to the extent that fishers are having to fish harder in Senegalese waters, go further afield and place themselves in danger, and resort to using illegal gears. According to a World Bank study, about 30% of the artisanal demersal fish catch is caught outside of Senegalese waters with around 2,000 vessels fishing in the waters of neighbouring Guinea-Bissau, Guinea, The Gambia and Mauritania.

This IUU fishing represents losses of about USD 100 million annually to those neighbouring countries (MRAG 2010). Some of the fish is exported to Europe, and some of it to other west African countries. The situation is exacerbated by the low level of control exerted over artisanal vessels in Senegal by the central government, without effective enforcement of limits on licensing or gears (MRAG 2010) and increases in the fishing power (technology) of Senegalese artisanal boats.

The innovation: Emergent local management regimes

With the state lacking the capability to enforce management measures in the artisanal fisheries, local fisher initiatives have emerged. Alioune and Catanzano (2005) have described the example of Kayar village, where local fishers have collectively developed local management committees to regulate fishing and enforce fines for non-compliance, and established marketing arrangements that benefited local fishers. These systems are dependent on local information about the fisheries and the prices of fish.

Artisanal pirogues in Senegal. (Photo source: C. Tindall).

While local management systems may operate very effectively they depend on social cohesion that enables collective action and can be undermined by external agents against whom regulations can be difficult to enforce, and where sanctions that are effective locally cannot be applied. However, in the case of Senegal the situation is complicated by the movement of rural people into the fishery and conflict between the artisanal and industrial fleets. To simply increase the emphasis on control of artisanal fishing alone, the effect of preventing or limiting their entry into the fishery could either cause further hardship for these people or increase the likelihood of illegal fishing activity.

Clearly it is important to understand the role of fisheries in livelihoods in order to develop appropriate management and control measures. Many of the issues lie outside the fishery in the relationship between agriculture and fisheries and the role of fisheries in times of hardship. Although the situation is currently exacerbated by the legacy of earlier fishing agreements, the solution requires better control of industrial fishing, support to local fisheries management and, critically, addressing the driver of movement into the fishery by enhancing livelihood options for rural farmers and considering the management and institutions related to both land and sea.

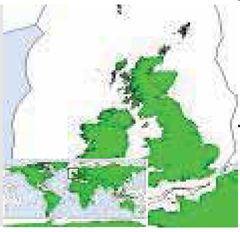
Costs and benefits of local management regimes

Better control and management of the fisheries of Senegal can help secure the resource base for a fishery that supports some 57,000 people directly and provides an important food source for many more, especially in the coastal communities. It is not possible to directly quantify these benefits as local management objectives and arrangements can differ (Alioune and Catanzano 2005) but generally there have been benefits in terms of better control of artisanal fishing and more advantageous marketing arrangements. Similar benefits will flow to the neighbouring countries in which Senegalese artisanal fishers are currently having to fish. These benefits have come at little or no cost to the state (although NGOs have supported the process and will have incurred costs as a result).

Uptake potential

As this case demonstrates, control is an important element of addressing IUU fishing, which must be addressed in both artisanal and industrial fisheries. However, IUU fishing can also be more than simply an issue of control. Artisanal fisheries in developing countries can have an important safety net function and increasing the barriers to entry can undermine this. Rather, the issue is to examine the drivers of IUU fishing in more detail to identify why IUU is occurring. As the case study demonstrates, this can be because of factors external to the fishery that lead people to have to enter the fishery. It can also be as a result of policies, such as foreign fishing agreements, that appear inequitable and that can act to undermine local management initiatives.

Scotland: Conservation Credits Scheme



Species	Mixed demersal (cod, haddock, whiting)
Fishing Method	Trawl, Scottish seine

The problem and driver: The need for increased conservation measures

The management of a fish stock explicitly for its recovery often requires large reductions in allowable catch or effort. Such measures can then impact upon the economic welfare of fishers. Where these measures are externally decided, such measures may be met with social and political objection.

Where unpopular management decisions are made, levels of non-compliance (effectively IUU fishing) may increase and experience has shown that simply increasing the level of inspections and penalties does not always solve the problem. Furthermore, mismatches between management approaches - such as requiring very low catch levels of a species under recovery but allowing high catches of other species in the same multispecies fishery - can lead to perverse results, such as increased discarding. This case study looks at the potential for collaborative approaches between management and the fishing industry to solve problems with achieving compliance in recovery programmes.

Scottish demersal fisheries for cod, haddock and whiting operate in coastal shelf waters throughout the northern and central North Sea, as well as to the west of Scotland. As with many demersal fish species, cod are often caught as part of a mixed demersal fishery, and within Scottish waters. Vessels predominately fish using towed gears such as trawls and Scottish seine. Over the last few decades, cod stocks have declined dramatically throughout European waters. In the North Sea, annual landings of cod declined from an average of 250,000 tonnes during the period 1965-85 to just 95,000 tonnes by 2000 (Figure 30). Stock size has declined over the same period from more than 264,000 tonnes in 1971 to less than 50,000 tonnes by 2000.

The scientific body ICES estimates catches to be much higher than reported because of vessels catching in excess of their quota (particularly prevalent in the early 2000s) and discarding of cod by vessels targeting other species. Management, compounded by issues of overcapacity, has proven unable to address the problem. Rebuilding of cod stocks was being compromised and fishers were frustrated at being forced to throw away perfectly marketable fish that were unlikely to survive anyway. Cod stocks continued to decline, and catches were not restrained to the limits set by the EU's cod recovery plans.

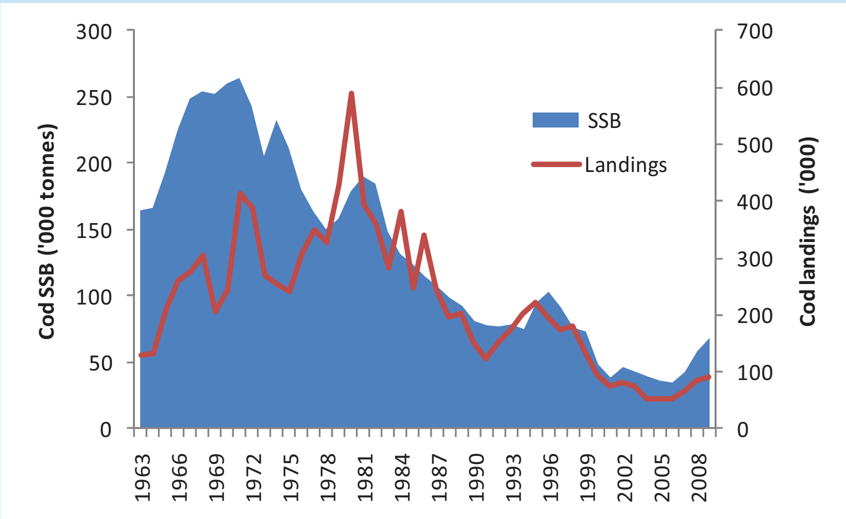


Figure 30: Cod SSB and landings in North Sea - 1963-2009. Note that catches were regularly above the SSB which is likely to be the cause of the declining stock (Source: graph produced from data in ICES 2010).

Recognising this as a problem, government, industry and NGOs came together to develop an innovative solution to this problem. The challenge was how to reduce the fishing mortality of cod within the mixed-species whitefish fleet, in line with the targets outlined in the recovery plan, whilst maximising the number of fishing days available to the fleet in the face of ongoing effort reductions required by the EU.

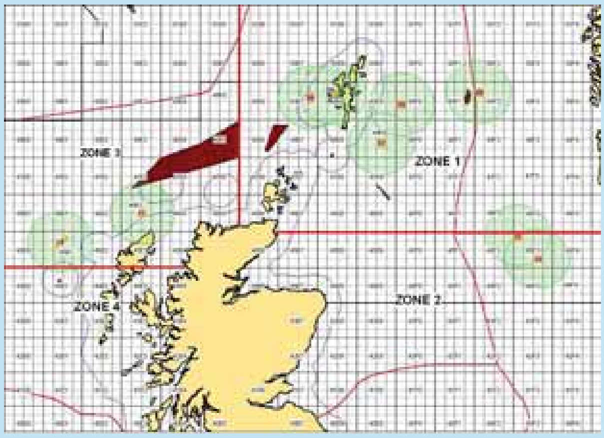
The aggregating behaviour of cod was used as a basis for developing temporary closures of areas for fishing that would be compensated for by allowing vessels additional opportunities to fish in other, open areas, where they would be less likely to encounter cod. Fishers have an important role providing information about catch rates that are needed to trigger the real time closure of the areas (Box 3).

Box 3: Real Time Closures

Real Time Closures (RTCs) have been introduced across the North Sea under the CCS, although currently not within the 12 mile zone. These RTCs are not permanent, but are instead established in real time in response to a predetermined trigger based of the cod catch rate reaching 40 cod per hour. This trigger rate was established at the start of 2009.

The RTCs are set for a period of 21 days, which is considered to allow sufficient time for cod aggregations to disperse, after which the areas automatically reopen. As of 2010 each RTC covers a maximum of 15 nautical miles by 15 nautical miles, and there cannot be more than three RTCs in any given Commercial Impact Zone.

There should be a maximum of 9 RTCs in place at any given time, and these are monitored through a combination of ongoing inspections and analysis of Vessel Monitoring System (VMS) data and associated landings. Vessels are notified of new and existing closures through communications with fishing associations, email, radio and online.



Real Time Closures in place on the 16th March 2009. The yellow squares indicate RTCs, green circles show Commercial Impact Zones and the red areas are seasonal/permanent area closures. (Source: Marine Scotland).

The innovation: Scottish Conservation Credit Scheme

As part of the amended cod recovery plan, the EU granted Member States the flexibility to run their own effort limitation schemes based on days-at sea. The Scottish Government took up this opportunity and on 1st February 2008 the Scottish Conservation Credits Scheme (CCS) was launched. The CCS takes the form of a mechanism that allows the Scottish whitefish fleet to reduce impacts on the cod stocks (enabling the stocks to recover) but also ensures that the whitefish fleet is able to fish and land other species. The CCS sets out to do this in a two tiered approach: through cod avoidance (e.g. RTCs); and by an EU-mandated reduction in effort. The centrepiece of the CCS is that by adopting the cod avoidance measures specified within the scheme, vessels increase their effort allocation, being allowed to 'buy-back' days at sea and fish for other species. The buy-back system acts as a buffer shielding Scottish fishers from the full impact of the EU-wide cuts in fishing effort.

Costs and benefits

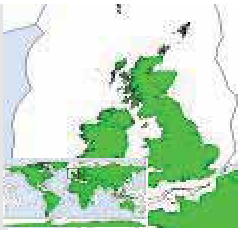
Although the CCS is still in its infancy, it is possible to identify some positive impacts. Discards of juveniles have decreased in all of the demersal fleet segments as a result of improved gear selectivity and avoidance. An economic benefit to fishers has been that the allocation of further effort days has In 2009 the fleet was able to fish for the full year, although the total number of fishing days were too few to catch the available cod allocation, which remains a problem. ICES has not yet been able to evaluate the consequences of the CCS on North Sea cod, but have suggested that vessels have been compliant with CCS real-time closures. Although the cod stock is gradually increased to 68,000 tonnes in 2009 (from the record low of 34,000 tonnes in 2006) however, this is still below what ICES estimates as sustainable limit - 70,000 tonnes. In addition the landings of 91,000 tonnes in 2009 was higher than regulation allowed, suggesting that the CCS has not yet achieved the complete desired effect.

The costs of implementing the CCS are difficult to isolate given that management and logistical tasks are built into the wider effort management regime i.e. vessel monitoring system cross check with logbook data as part of monitoring, control and surveillance (MCS) activities. The Scottish Government administrative arrangements of fisheries management measures are already in place. In fact, arguably it is this ease of integration which has aided the adoption of the CCS. There are a few elements of the Scheme however which increase the work burden and have a cost, such as translating MCS findings into RTCs and 'Amber Areas', and running the observer programme. This is paid for by the European Fisheries Fund (EFF) under Axis 3 funding (S. Baxter, Marine Scotland, pers. comm.).

Uptake potential

The Scottish Conservation Credits Scheme is a conceptually simple solution to a relatively widespread problem. However, the practicalities are regionally specific, and given the narrow applicability the most obvious targets to create a similar scheme are those EU Member States which share the North Sea cod resource. To this end, the UK Government (Westminster) is currently undertaking preliminary discussions with industry in mind of establishing their own version of the Conservation Credits Scheme.

Scotland: Salmon aquaculture



Species	Atlantic salmon
Fishing Methods	Cage culture

The problem and driver: Increasing environmental impacts

Salmon farming was established in Scotland during the 1970s, with development along the west coast and in the Northern and Western Isles. Salmon farms are generally cage-based and located in sheltered sea lochs in systems that mimic the natural life cycle of the salmon. From hatching, the salmon goes through four stages in freshwater (egg, alevin, fry, parr). The salmon are transferred to sea water at the smolt stage, when wild fish would be migrating to the sea at one to two years old. The fish are grown on in cages and fed pelleted feeds with harvesting usually starting from when they are at least two kilograms.

The increase in salmon aquaculture has been important for the Scottish economy and for rural areas of Scotland in particular. However, there have been a number of criticisms of salmon farming practices and of the impacts of salmon farms on the environment. These arise from the discharge of nutrients and solid waste from feeds and faeces, pharmaceuticals and antifoulants (used to keep the cages clean). Solid wastes from fish farms can collect on the seabed under fish cages, particularly where the currents are low, smothering the seabed and animals and plants. The organic nature of the material can also cause harm by altering the chemistry of the sea bed. Nutrients released into the waters surrounding the cages can increase the amount of algae in the water and the growth of seaweeds and may be connected with poisonous algal blooms

Additional impacts through interaction with wild salmon and sea trout stocks, which are themselves part of economically important recreational fisheries in Scotland, have also raised concerns. Fish can escape from hatcheries into rivers and from the cages into the sea. Perhaps the most common cause is predators (especially seals) damaging the nets of fish farm cages. Escaped fish can have a number of impacts. Diseases such as infectious salmon anaemia (ISA) can be transferred from escaped fish to wild fish stocks and farmed fish may also compete for food with the wild stocks. Perhaps though of greatest concern is the potential for interbreeding between escaped fish and wild populations, resulting in losses of genetic variability, including evolved adaptations.

Sea pens such as these are usually situated in protected inlets for protection. (Photo source: STV, 2009).

A final area of concern is the sustainability of the fisheries supplying wild-caught fish meal and oil as feed to salmon. These are low trophic level species-anchovy, sardine, sandeel, krill-and many of the stocks are already fully exploited. Any expansion of aquaculture without changes in the feed composition could place additional pressure on these stocks.

The problem with salmon farming is, in fact, a number of problems. These have emerged and been recognised as information has become available about the implications of aquaculture activities and practices, particularly as the scale and intensity of farming operations has increased. The response to these issues and the sources of information have come from the industry itself (as Scottish salmon is a premium product), NGOs and from the regulatory bodies.

The innovation: Multi-stakeholder inputs to reduce aquaculture impact

Efforts have been made by a number of stakeholders from farmers to government and NGOs to reduce the impacts of aquaculture. Within Scotland, the Scottish Executive and the Scottish Environment Protection Agency (SEPA) have taken steps to approve applications for the leases and discharge consents to develop a salmon farm. Additionally, the size of farms is regulated to reduce the impacts on the local marine environment. Long-term monitoring by Marine Scotland is part of an effort to investigate the impact of aquaculture on wild fish.

The Scottish Salmon Producers Organisation has established a Code of Good Practice for Scottish Finfish Aquaculture that addresses procedures for escaped fish, nutrient discharge and for the management protocols for sea cages. Reducing fish farm escapes is being addressed by cage manufacturers who have developed new cage designs that are more resistant to both predator damage and storm damage. Research by industry in partnership with academics and the Sea Mammal Research Unit (SMRU) has focused on developing non-lethal methods to reduce net damage from marine mammals that can also reduce the reliance on acoustic deterrents, which have been criticised for affecting the hearing of marine mammals.

The aquaculture industry has made efforts to reduce the amount of wild fish in feeds, by increasing the use of processing by-products and using vegetable oils (nearly 25% of fish meal comes from by-products). However, use of vegetable oils also raises sustainability questions, as there is the issue of whether these should be consumed directly by humans. Alternatives for the use of fish meal and fish oils in feeds remain an important focus for investigation.

Despite all the progress to date, a significant challenge that remains is the issue of sea lice (Figure 31). These are a natural parasite of salmon but in aquaculture systems they can become abundant, causing injury, reduced growth rates and mortality. These lice may also spread other microbial and bacterial disease that can further affect the fish. The chemicals that are used to treat sea lice can cause pollution. Wild salmon and sea trout are at risk from sea lice infection, especially during the juvenile period. They are most at risk in cases where they have to move through lochs and pass several farms during their migration. At present there are efforts by farmers to take coordinated action on sea lice through a national strategy that aims to reduce sea lice numbers in the spring when wild smolts are migrating to the sea. Furthermore, finding a new way to deal with the issue of sea lice would represent a significant advance that would have benefits for both the salmon farming industry and for wild salmon and sea trout.

Figure 31 Sea lice which has the potential to become more abundant during farming activities (Photo source: anon, commons; Marine Scotland).

Costs and benefits

Scotland is now the second largest salmon producer in the world (after Norway) with a value in the region of £ 350 million (USD 557 million). The industry provides important employment opportunities in rural areas. Considering the upstream and downstream added-value processing it is estimated that salmon farming contributes £ 700 million (USD 1.14 billion) to the Scottish economy. Addressing the environmental issues of salmon farming has created a stronger regulatory framework for developing and undertaking salmon farming. Many of the costs of addressing the challenges are difficult to assess because of commercial confidentiality. However, costs of compliance and economies of scale are such that they represent a significant barrier to entry and, as a result, the industry has become highly integrated throughout the value chain and global in nature.

Uptake potential

The global nature of the industry and the consolidation that has taken place produces both opportunities and obstacles for increasing sustainability. The intensification of the industry has brought to the fore a number of challenges and is likely to continue to do so in the future. However, problems faced in Scotland are similar to elsewhere so the opportunities for solutions to be identified are also greater. The consolidation within salmon farming has created a few large players and has also increased the strength of the retailers (and consumers), making sustainability a more high profile issue but also making it likely that these players will respond and that proven solutions will be widely adopted.

The economies of scale in the industry mean that the feed manufacturers and other suppliers can afford to innovate. This has provided additional opportunities to bring together producers, NGOs, researchers, retailers and governments to develop standards and to address the outstanding areas where further innovation is required: the reduction of escapees; developing alternatives for fish meal and oils and; the issue of sea lice. Examples of the kids of platforms that have been created to achieve this collaboration include the WWF Salmon dialogue initiated in 2004 and global Aquaculture Stewardship Council.

Addressing information gaps

Limited information and/or a disconnect between scientists, management authorities and fishers can act as a key obstacle to transforming fisheries to achieve sustainability. The case studies in this chapter suggest some steps that fisheries have taken to identify and address these and some of the different roles and responsibilities that stakeholders have assumed in providing data and information that have contributed to improving sustainability. Bringing together the existing knowledge of different stakeholders and their capacity to contribute to both data collection and analysis can improve the information on which management decisions are made as well as the responsiveness of this decision-making.

Observer programmes

Some of the information gaps have been related to the biological elements of the fisheries and how data on the amount of catch, species caught and by-catch can be improved. The most significant impact that fisheries have on ecosystems is through their extractive activities, and it makes sense to monitor these as closely as possible. As the case study from CCAMLR indicated, observers on board vessels can be highly-effective in this respect. In large - scale or high value fisheries, the acquisition of additional information through the use of scientific observers, has generally been proven to be cost-effective. Management systems with a good record of success—such as CCAMLR, the USA, Australia and New Zealand—make extensive and effective use of scientific observers. Management systems with poor records—for instance the EU—often have inadequate or non-existent observer systems. However, the cost of observer programmes can be quite high and observers often cannot be placed on very small vessels. For these fisheries other sources of information can be used, including from fishers themselves.

Scientific observers on fishing vessels can collect valuable data about target and by-catch species and are particularly effective for large-scale fisheries. (Photo source: MRAG).

Ecosystem-Based Fisheries Management

The case studies also provided different examples (CCAMLR and Fiji) where EBFM has been applied to capture fisheries and helped to account for the wider interactions between fishers, fish stocks and other elements of the ecosystem. As these two case studies demonstrate, consideration of the ecosystem within a fisheries management context does not always require significant levels of investment; it can also be brought about simply by increasing awareness of the types of interaction that occur. The concept of EBFM can be applied to virtually any fishery. However, the intricacy of the management applied depends largely on the capacity of the management authority to collect, analyse and draw conclusions from large volumes of data. In the absence of such data, and in the presence of uncertainty, the Precautionary Approach should be applied.

Roles and responsibilities in information generation

The sections below highlight again the fact that capabilities define what is possible and practicable within the specific fisheries context. In some cases, where there is political will and available resources, it is possible to have a highly centralised management system (e.g. CCAMLR and Scotland), while in others the particular nature of the fishery requires much greater involvement of local people in decision-making, information generation and enforcement (Fiji and Senegal). Within both of these systems, the case studies have shown that fishers can make an important contribution to management through the information that they can provide. Indeed, managing without local information may be counter-productive. In the example of the Scottish conservation credits scheme, previous management approaches did not reward conservation-oriented behaviours and were causing fishers to fish in excess of their quota.

Fishing in excess of quota creates its own problems. Once quota of a species has been exhausted, in fisheries where quota is managed based on landings, fishers are required to then discard any over-quota catches. This occurs as despite having exhausted their quota in one species, fishers may continue to fish whilst targeting another species. The perverse incentives and requirements to discard will be dealt with further in Chapter 6. However, it is important to note the differences in data availability which can be achieved using catch quotas as opposed to landings quotas. Managing using landings quotas retains a degree of uncertainty about the level of discarding that is occurring while, with good compliance, there is a better estimation of the total fish caught, and hence of total fishing mortality. Due to this greater understanding of total fishing mortality, the accuracy of scientific stock assessments are increased greatly.

Fishers are interacting with the fish and the wider environment on a daily basis. In addition to providing data on total catches, they often have a wealth of time and place knowledge and can provide important insights into changes in stocks (e.g. changes in cod catch rates in the Scottish example) and into changes that may be driven by environmental change (including climate change). Fishers often have an interest in conserving stocks and reducing environmental impacts and have demonstrated that they will cooperate with each other and with management bodies to achieve this (e.g. Fiji, Senegal and Scotland).

Science represents an important information source and scientists can and do play an important role in contributing to information. However, the way that scientists and fishers perceive the system may differ and the assumptions of fisheries science and about the contributions fisher knowledge could make can limit what can be said about fisheries and the options available to management. This is particularly critical for the design of Marine Protected Areas and Real Time Closures if they are to be effective. In these instances the spatial/temporal knowledge of fishers can be vital in providing real-time feedback.

Some of the best results are being achieved where fishers, scientists and other groups are able to work together to address sustainability issues. This has been the case in Scotland and in Fiji. In both cases there was also an important role for consumers, NGOs and wider civil society in highlighting and maintaining a focus on sustainability. This pressure has helped to drive innovation and has had benefits, for example, in providing a price premium for Scottish salmon. However, fishers should not be seen as a cheap or free alternative to funded data collection programmes.

Controlling fisheries

Fisheries managers, whether in centralised government agencies, communities or some collaborative body, face the challenge of creating rules that can, and will, be complied with by fishers and that can be enforced. Where fishers have a strong role in deciding management they often prefer to do it by area-based and cooperative forms of management, for instance in the tabu systems in Fiji and the cooperative management methods in Senegal. These approaches can be beneficial in collaborative forms of management between stakeholders. For example, the Scottish CCS scheme is an example of fishers, government and other stakeholders, working to create a system that rewards fishers for avoiding catching large quantities of by-catch. Although it has not yet been credited with generating a recovery of the cod stock, it does have wide buy-in and compliance from fishers. The implementation of restrictive quotas did not have such buy-in nor did it result in a cod recovery. Similarly, the WWF aquaculture dialogues have been an attempt to bring together different players to identify the critical areas that need to be addressed and targets that should be achieved to improve sustainability and to get broad agreement and commitment to achieving these.

Information and governance

The case studies in Fiji and Senegal highlighted an additional factor related to information and fisheries sustainability — while many of the environmental sustainability issues can be addressed through direct sampling and working with fishers, there are aspects related to the human dimensions that require information and initiatives that target areas that lie outside the fishery. In the case of conflict (Fiji) and IUU fishing (Senegal), what may, at first glance, appear to be management issue and a failure of control can, on closer inspection, be identified as a governance challenge. Within these contexts, applying management (control) responses to governance challenges may simply exacerbate the problem.

BY-CATCH AND DISCARDS

Direct interactions with the environment as a result of fishing operations are numerous: the destruction of seabed habitats, by-catch of non-target fish; and the incidental mortality of birds, mammals and reptiles. An aspect of by-catch that is particularly wasteful, and has complex impacts on the ecosystem, is the discard of unwanted fish and other organisms.

It is important to distinguish between by-catch and discards. By-catch is all species caught which were not the intended (or target) species. It also refers to the catch of juveniles or undersize fish of the species targeted. By-catch can still hold economic value and may be kept on board to sell. Discards is a term specifically used for catch which is not kept and thrown back, often dead, in to the sea. This may be either unwanted by-catch or target fish. Discarding may occur for a number of reasons, including the lack of value of fish compared to others (high grading), or because landing or retention is prohibited by regulation. Globally, discarding is estimated to be 8% (6.8 million t) of the total volume of fish caught annually (Kelleher 2005).

Of the all the discarding occurring in fisheries, 27% is caused by tropical shrimp trawling alone. By-catch in tropical shrimp fisheries is estimated to be 15-20 million tonnes (Kelleher 2005). The reason for such high levels of by-catch in these fisheries is clear; in order to catch small species, such as shrimp, nets with very small mesh size must be used. In some cases the total weight of by-catch can be 20 times the total weight of shrimp caught (Eayrs 2007) (Figure 32). Most of this by-catch is valuable enough to sell, but nearly 13% is simply discarded back in to the sea.

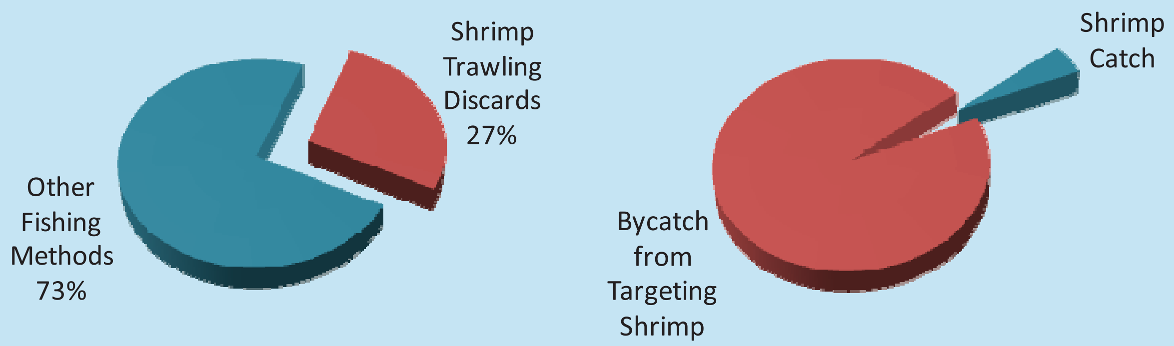


Figure 32: Levels of by-catch attributable to shrimp trawling (Source: graphs created from figures in Kellher 2005 and Eayrs 2007).

Measures to reduce by-catch

A range of measures have been implemented in the past to reduce this high level of by-catch. Most commonly used throughout trawling fisheries are by-catch reduction devices (BRDs), also known as sorting grids. This system allows for an initial sorting of larger and smaller species from the trawl net.

Turtle exclusion devices (TEDs) are based on a similar concept where turtles are separated from the remainder of the catch and allowed to escape the trawl net. For some fisheries it may be possible to switch to other fishing methods, such as hook and line fishing, which have lower by-catch levels. Although this is possible if the target fish can be caught by other methods, in many cases (such as shrimps) there is no alternative method other than trawling.

Furthermore, it must be recognised that negative interactions can occur through the use of any fishing method, including hook and line. For instance, in pelagic hook and line fisheries, it is estimated that over 250,000 sea turtles were caught in one year (Lewison et al. 2004), and BirdLife International have estimated that in the EU alone, 2 million seabirds have been killed over the last ten years by methods of fishing other than trawling.

Mitigation measures such as bird scaring devices, weighted line and setting fishing gear only at night have been

Sea turtle caught on a pelagic longline (Source: MRAG).

used as ways to reduce bird mortalities in hook and line fisheries. Additionally, varying shapes of hooks and types of bait have been known to reduce capture and mortalities of sea-turtles (e.g. Read 2007; MRAG et al. 2008) and banning the use of wire trace in longlines has been implemented to reduce shark by-catch in some tuna fisheries. For example wire trace has been banned in the British Indian Ocean Territories offshore fisheries since 2007 (The Fisheries Conservation and Management Ordinance 2007), following the prior ban of wire trace in the inshore fisheries and IOTC resolution 05/05 recommends that wire trace should not be used in fishing gear for vessels operating in the IOTC tuna fisheries.

Impacts of by-catch and discards

By-catch and discards may affect ecosystem structure, for instance by removing parts of marine populations. Discarding may encourage the population growth of scavenging animals, and attract seabirds and marine mammals. Furthermore, the level of uncertainty over total catches that arises from discarding can hamper efforts to accurately assess current stock levels. In an economic and social sense discarding is wasteful of the energy and cost used to catch the fish. It also represents a waste of wealth and resources, perturbing given the importance of fish as a source of food to the world's population and future food security scenarios highlighted in Chapter 1.

While we are unlikely ever to completely eliminate the interactions between fishing gear and the environment, many interactions can be minimised by either reducing the potential for interaction, particularly through avoiding fishing in areas or at times of year when interactions are greatest, or by the development of specific gear configurations that minimise the impact, including changing gear types entirely (e.g. replacing trawls with longlines).

Many of these measures are already being successfully employed in fisheries around the globe, and the following case studies present some of them. The case studies highlight not just technical solutions, but more importantly the innovative methods taken to arrive at the solutions.

Australia: Prawn seawater hopper

Species	Prawns (Multiple)
Fishing Method	Trawling
Fishery Tonnage	7,185t (2008/09)

The problem and driver: High discard mortality

Australia's Northern Prawn Fishery (NPF) is a typical tropical shrimp fishery in the sense that it faced the common issues with regards to by-catch and discards (Table 6). Tropical shrimp fisheries tend to have extremely high by-catch and discards because the diversity of ecosystems generally increases with greater proximity to the equator (Cheung et al. 2005), with the result that there are very many more potential discard species in tropical shrimp fisheries than in temperate ones. However high levels of by-catch and discarding also occur in temperate shrimp and Norway lobster trawl fisheries.

In the NPF, approximately 516 separate species have been recorded as by-catch, including six species of turtles (Griffiths et al. 2007). Strong pressure was applied by the public to address this as discards from fishing boats were beginning to wash up on to tourist beaches. Following this, the government and industry worked together and agreed to widely implement by -catch reduction devices (BRDs) which would sit in the trawl net and reduce unwanted catch. While this strategy made the NPF the world's first tropical shrimp fishery to introduce a by-catch action plan, it was commercial drivers that paved the way for a different innovation in the 1980s: the seawater hopper.

Table 6: Landings and discards (tonnes) and discard rates for the 5 tropical shrimp fisheries with the highest discard rates

Country	Fishery	Period	Landings	Discards	Discard rate (%)
US	Gulf of Mexico	2000	116,408	480,183	80.5
Indonesia	Arafura Sea	1998	53,786	239,594	81.7
Ecuador	Industrial	1996	24,113	91,211	79.1
Venezuela	Total shrimp trawl fleet	2000 - 2003	33,600	86,400	72.0
US	South Atlantic	2000	14,646	73,230	83.3

(Source: Venezuela: Davies et al. 2009; other countries: calculated from source data presented in Kelleher 2005).

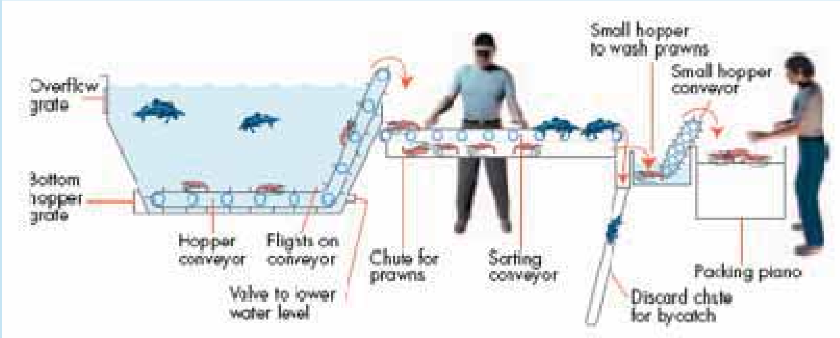
The main driver for this particular innovation was industry demand. Sorting shrimp from catches with high levels of by-catch was time consuming work. The combination of time and the regular 30^{0}C temperatures, meant that the quality of the shrimp decreased rapidly. As the quality of the shrimp decreased, so did its market value, hence there was a great incentive to reduce the sorting time to a minimum and/or reduce the temperature. Consequently the innovation was driven purely by the possibility of commercial gain, yet has also delivered significant environmental gains. Furthermore, this was an innovation purely driven by industry's requirements and design.

The innovation: Seawater hoppers

Catch is emptied from the trawl net into a 'hopper' of seawater on the back of the fishing vessel. Due to their natural behaviour, the shrimp settle on the bottom of the hopper while much of the fish by-catch remains swimming in the upper levels of the hopper. This not only separates shrimps from by-catch automatically, but it also increases the quality of the product by keeping the shrimp alive and away from the hot, outside temperatures.

Different versions of the hopper technology exist depending on the scale of the fishing vessel — larger scale vessels have a much more complicated system than small vessels. In the larger-scale version, once the shrimp sink to the bottom of the hopper, they travel on to a conveyor belt from the bottom of the hopper on to a workbench which allows for easy sorting and packing. Any by-catch to be discarded also travelling along the conveyor belt can be set aside and placed into a chute leading directly back in to the sea. Once all the shrimp has been sorted from the catch, the hopper is drained and the remaining by-catch is sent up the conveyor belt, in to the exit chute and back to the sea. The small-scale version is similar except that swimming by-catch is skimmed off the top of the hopper and placed in a chute back to the sea and then the shrimp are removed from the bottom of the hopper for packing.

This hopper is not required by regulation and uptake in the NPF has been purely industry-driven. However, the



Side view of a large hopper of the type used in the NPF. Prawns sink to the bottom to be collected by the conveyor belt as other species swim in hopper (Source: Ocean Watch Australia 2004).

Queensland Government is attempting apply the hopper in an adjacent fishery through subsidised purchases.

Costs and benefits

The cost of the seawater hopper varies depending on the size of the setup. The small-scale hoppers which do not require any mechanisation can be installed for roughly AUD 1,000 (USD 1000). However, the larger scale versions with a much more complicated set up, can cost AUD 80,000 (USD 80,200) – AUD 120,000 (USD 120,350). Importantly, because the initial intention of this innovation is for financial gain, this investment is made solely by the vessel owner as a business decision; subsidies were not required to implement this innovation.

Subsidies have been offered by the Queensland government for the adjacent Queensland East Coast Trawl Fishery (QECTF) of up to AUD 30,000 (USD 30,080). Subsidies were required as uptake has been much less in this fishery due to safety regulations within that state. If the older vessels install hoppers, they will then require regular inspections which they are not currently subject to. Even with the offer of subsidies, only an additional four of the 470 possible vessels have implemented the hopper.

The hopper successfully achieved its intended purpose by improving catch quality and reducing sorting time thus leading to higher income for fishers. The catch retained in the hopper has an opportunity to recuperate after the stress of initial capture which leads to 5–10% less damaged product. Furthermore, processing and packing time is 30–50% faster (Ocean Watch Australia 2004). These aspects combined have had positive impacts on the reputation of Australian prawn products on domestic and international markets.

Currently, there have not been any studies conducted specifically in the NPF on the survival rate of discarded fish from vessels with seawater hoppers. However, anecdotal evidence suggests that survival rates of discarded fish is 30–95% depending on the length and depth of the trawl. Also, scientific research conducted in the nearby Torres Strait Prawn Fishery (TSPF) found that 4 hours after capture the survival rate of the discarded fish roughly doubled from 8% to 16% (see Figure 33) for vessels with seawater hoppers as opposed to those without (Dell et al. 2003).

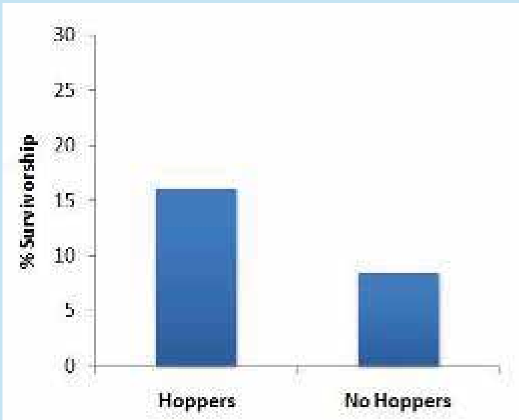


Figure 33: Survival at four hours post capture of trawl caught by-catch in the TSPF (Source: Dell et al. 2003).

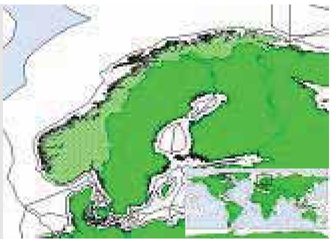
Given the combination of innovations implemented in to the NPF — the BRDs and the seawater hopper — it is difficult to attribute benefits specifically to the seawater hopper alone. Regardless, the NPF in its entirety should be recognised as a leading example of both management-led and industry-led innovations which have assisted in addressing the societal concerns of by-catch and discards.

Uptake potential

In practical terms, the uptake potential of this innovation in other tropical shrimp fisheries is high. Australian manufacturers have reportedly provided seawater hoppers to vessel owners in Mozambique, Spain and French Guyana (R. Tedman, FishQuip, pers. comm.). The regions in Table 6 where discard rates have been indicated as high are areas considered to be particularly suitable for further uptake.

The method of implementation of the seawater hopper in the NPF is possible within any fishery which can benefit from the same commercial gains found in the NPF — greater income generated from a higher quality product. As shown in the QETCF though, managers must ensure that the implementation of such innovations does not interfere with fishing operations. Given that this was a purely industry driven initiative, the main barrier to implementation in other fisheries will be the initial financial investment.

Norway: Discard ban



Species	North East Arctic Cod
Fishing Method(s)	Trawling, Gillnet, Longline
Fishery Tonnage	607,000t (2010)

The problem and driver: Cod stocks declining

The Barents Sea cod (or North east Arctic cod) is fished by both Norwegian and Russian vessels and includes some by-catch, both undersize (juvenile) cod and non-target species. In the Norwegian management system, vessel owners do not have the right to sell a species unless they hold a licence, and sufficient quota, to sell the fish. This led to significant discarding of non-quota fish. Vessel owners not holding a licence to fish cod often had to discard the catch as they did not hold the rights to sell it. With minimum size limits introduced in 1970s, this meant that landing undersize cod was also illegal and had to be discarded. Catching juvenile cod has a number of consequences: catching fish before they breed damages sustainability of the stock (Hylen et al. 2008); and, cod of this size are not as valuable as larger cod, therefore economically, it would be more efficient to allow these fish to grow before capture. However, perhaps the most damaging effect of discarding is the loss of accurate information on the size and composition of the catch, which makes assessing and managing the stock extremely difficult.

Discarding was exacerbated by the practice of high-grading. Vessels have a fixed hold capacity and quota. If they catch fish that are of low value (e.g. of smaller size) they may discard them in favour of catching larger of higher value. This maximises their revenue, but creates incentives for discarding.

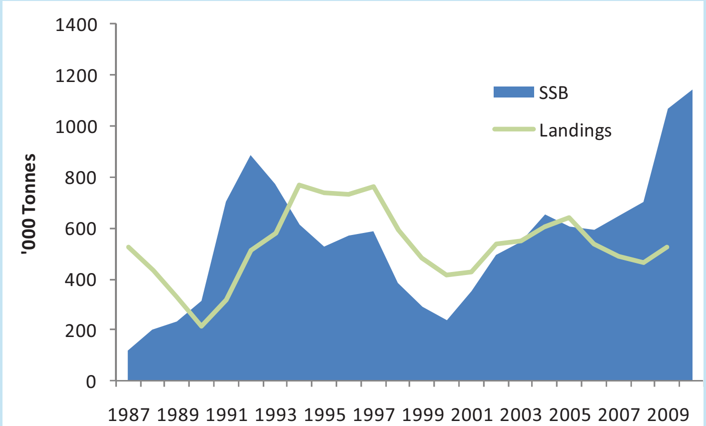


Figure 34: Total spawning stock biomass (SSB) and catches of cod since the discard ban in 1987 (Source: ICES, 2010). Note that landings are now below SSB.

The key drivers to change in the Barents Sea fishery were multiple: industry, media, and the Ministry of Fisheries and Coastal Affairs. As some discarding of fish occurred due to management requirements, industry would often argue that this seemed a waste given the cost involved to catch that fish, particularly when it was known that fish could fetch reasonable prices in markets. Norwegian media also joined in the debate and through the varying channels, alerted the public to the consequences of discarding (e.g. P. Gullestad and B. Shultz, pers comm.) Due to this, it is believed that eventually a discard ban would have been put in place regardless. However, significant events leading up to the mid-1980s were the real trigger for the innovation.

For seven years before 1986, cod catches had only been 50% of the level caught in the late 1970s (Hylen et al. 2008). This was due to a combination of human interaction and also natural fluctuations. However, the Institute of Marine Research (IMR) was aware that due to natural environmental reasons, a particularly large and healthy population of cod was about to reach legal catching size — this is referred to as a strong year class. In the past, strong year classes had occurred, but due to discarding and high-grading this year class was not given the opportunity to sufficiently boost future cod populations, and the potential benefit was lost. The media then began pushing this issue, and the lack of stocks available for fishers, into national news.

In light of this, the Minister for Fisheries at the time, Bjarne Mørk Eidem, thought that it would be a wasted opportunity to allow another strong year class to be decimated by poor fishing practices and wanted to control discards and high-grading. Management's suggestion to this was that it would be too difficult to monitor. However, Eidem's response was that it should at the very least be illegal despite the difficulty of enforcement. This strong political will was the real driver for the innovation that was introduced in 1986 for cod and haddock which has since developed to encompass many other species since.

The innovation: Discard ban regime

The Norwegian discard ban is part of a management regime which aims to guide fishers away from needing to ban discards to a situation where by-catch and discards are minimised entirely. It applies to all Norwegian fisheries not just cod. The combined package consists of banning discards, fishing area closures (similar to Scotland, see Box 3) and fishing gear restrictions such as the mandatory sorting grid. The discard ban was initially introduced for cod and haddock in 1987 and has subsequently been modified in stages to include all species with any commercial value. As an incentive to fishers to keep all catch, when fishers come to port to sell their catch, they are compensated for the catch which does not meet management regulations — such as undersized fish or over-quota fish. Without this compensation, there would be little incentive for fishers to keep this catch on board and illegal discarding might still occur. However, the payment they receive does not cover more than the cost of fishing i.e. they cannot make a profit from it.

The sale of fish is monitored and conducted by Norway's sales association which is a non-governmental body. In addition to monitoring catch at port, catch at sea is monitored by government coastguard inspectors. Even so, some high-grading and slippage (release of fish while still in the net) probably takes place, and is extremely difficult to monitor. Inspectors board fishing vessels to ensure discarding is not taking place, and in addition if they find that too high a percentage of the catch does not meet regulations, then the area in which the fish was caught is closed until it can be proven by research that the area is fit for fishing again (Hyen et al. 2008).

Over-quota fishing by Russian vessels had also been a problem, and this was addressed by increasing communication between Russian and Norwegian authorities, and the implementation of port state measures to ensure that only legally-caught fish could be landed. This helped address the problem of illegal fishing and the extra pressure that this was having on the cod stocks.

Costs and benefits of banning discards

The monitoring from the coastguard, which is a pivotal aspect to the regime, is extremely intensive with approximately 2,200 boat inspections per year. The resulting cost to the Norwegian government is approximately £ 86 million (USD 137.8 million). Estimates suggest that only 70% of this cost is attributable to fisheries (£ 60 million; USD 96.1 million).

The combination of measures has acted effectively to discourage the targeting of by-catch at the same time as encouraging its retention and landing. This has improved the recording of catch composition and allowed comprehensive stock assessments. The discard ban, combined with other initiatives and events such as strong recruitment and the elimination (in 2009) of the very large levels of unreported catch from the fishery (Diamond and Beukers-Stewart 2009), has resulted in an increase in stocks from 121,243t in 1987 to 1,145,460t in 2010 (844% increase) (see Figure 34).

With the increasing size of the cod stock comes a more stable economic outlook for the fishery. The value of total catch increased by 57% from 1989, when catches were at minimum as a result of fishing levels above SSB (see Figure 34) to 2009. The value of catch the catch was approximately £352 million (USD 546 million) in 2009 and is expected to increase with the TAC increase set by ICES in 2010.

Cod Stockfish at the Bergen fish market. Stockfish has been supplied to Southern Europe for 1000 years by small northern Norwegian communities. (Photo source: MRAG).

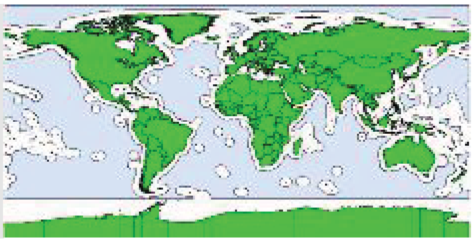
The entire offshore fishery has now become MSC-certified which allows fishers to provide well-recognised sustainable products and receive premium prices for their catch. As in many other case studies examined positive changes in fisheries are being rewarded in the market-place by such certification.

Uptake potential

In theory, a discard ban could be implemented in any region. The regime as a whole is a good concept and has proven to be successful. The main barrier to uptake will be the cost that is involved to conduct the necessary inspections. Without these inspections, it would be more difficult to identify where the area closures should occur which are vital to the success of the program. In areas where this cost would be difficult to cover, it is possible to put in place tax regimes for the industry or consumers to recover these costs. The justification for such taxes would be the large economic gains being made by fishers.

The Norwegian innovation for dealing with discards has proven successful, but it must be appreciated that without very good monitoring (involving inspectors, observers, and industry cooperation and self-regulation) placing an economic value on by-catch may not deliver similar benefits. Even within Norway, this incentive scheme has been removed from the pelagic sector as it was considered too lucrative.

International: WWF SmartGear Competition



SmartGear is an international competition which aims to solve problems of direct impact of fisheries on the ecosystem. The competition creates incentives for fishers and other stakeholders to come together and arrive at technical solutions to particular problems.

Drivers: increasing uptake of successful innovation

At a research workshop in 2004, it was realised that while many environmentally positive developments are being made in fishing method technology, not enough was effort was placed on drawing these technologies into the global arena or rewarding them for the initiative shown to tackle the issue of by-catch. With that, in 2005 WWF held its first SmartGear Competition (SGC).

The Innovation: The SmartGear Competition

The SGC brings together the fishing industry, research institutes, universities, and government, to inspire and reward practical, innovative fishing gear designs that reduce by-catch. The SGC aims to fuel innovation rather than simply reward existing solutions, and offers USD 50,000 in awards to attract innovative ideas that offer a potential — although not necessarily yet proven — solution to some of the most pressing by-catch problems in fisheries.

Each year the competition receives between 70 and 90 entries from around 30 countries (Mike Osmond; pers comm.), e.g. Box 4. Despite so many entries and only a limited number designs receiving awards, competition judges and organisers provide feedback to each entrant and suggestions for further development. In many cases, entrants have taken this feedback and re-entered the competition in later years.

Within the with total prize pool, there are two runner-up prizes of USD 10,000 and a USD 30,000 first prize. Winners of the first prize cash amount, are required to invest a minimum of USD 10,000 in to further development of the design and implementation of the method in to actual fisheries. WWF also assist with this development use their international network to promote implementation of the winning design in to fisheries.

Box 4: The 'traffic cone' to reduce seabird mortality in trawls

The "Traffic Cone" is one of the runner up designs in the 2007 competition which is a simple yet cost-effective concept designed to reduce seabird mortalities in trawl fisheries. Diego González-Zevallos, designer of the Traffic Cone, focused his idea specifically on the Argentine hake (*Merluccius hubbsi)* fishery which operates in the San Jorge Gulf, Patagonia (see map).

These mortalities occur when seabirds attempt dive for fish from the front of the trawl net during hauling. The seabirds then collide with the trawl's towing cables and either drown instantly or die at a later time due to injuries. Seabird mortality rates are lower in trawling operations than they are with other methods such as longlines yet populations are known to be extremely sensitive to changes in their natural process (Furness and Monaghan 1987).

The Traffic Cone acts as a device to scare seabirds. It wraps around the towing cables (also known as warp cables) and sits constantly at the water's level (see left). This discourages seabirds from diving for fish at the riskiest point; where the warp cable is in a range of just above to just below the water surface.

During hake fishery season between January and February 2006, the Traffic Cone was tested onboard a commercial hake trawler operating in the San Jorge Gulf, Argentina. Cones were set in 12 of 22 alternate fishing operations over the course of eight days; in which the numbers of fatal and non-fatal contacts were recorded. In hauls employing Traffic Cones, no seabirds were killed and the number of warp cable contacts was reduced by 89%; in hauls without the device, 11 fatalities were recorded.

The Traffic Cone is a mitigation device that may help fishermen comply with international conservation agreements, such as the Agreement on the Conservation of Albatrosses and Petrels. However, it does represent an additional work burden to the fisher, albeit a simple device to install and use. As an indication of the uptake of the Traffic Cone amongst hake fishers, of the 11 man trawler crew who field tested the cone, nine thought the device did not affect fishing practices and eight expressed willingness to adopt it voluntarily.

Since the start, the SGC has not directed any focus toward particular by-catch concerns — for example, whether or not the design should be for trawlers, or should try to reduce by-catch of a particular species. However, in 2011 a new category will be introduced which focuses specifically on reducing by-catch within global tuna fisheries (Mike Osmond; pers. comm.).

The competition is funded by multiple donor agencies such as National Oceans and Atmospheric Administration and Canada's Department of Fisheries and Oceans. There are also multiple private corporations supporting the competition. The level of developmental support for the winning design is dependent on the level of donations acquired.

Costs and benefits

One of the largest benefits from this initiative is the large incentive for non-governmental development of environmentally-friendly fishing methods. In terms of winners and runners up alone, the competition has identified four winning designs, eight runner-up designs and two regional-specific winners (Table 7). This is aside from the several hundred competition-driven designs. Furthermore, because categories of methods don't exist, these gear designs cover all methods of fishing and address an assortment of negative interactions that occur. Winners often find they can turn their solutions into businesses.

Table 7: Award winning gear designs from 2005–2009

Year	Place	Design	Purpose
2009	First Prize	Underwater baited hooks	Reduce bird mortality on hooks
	Runner up	Batwing otterboard	Reduce seabed impact in bottom trawls
	Runner up	Hovercran	Reduce seabed impact in shrimp trawl
	Regional Prize	The Selector	Reduce goldfish by-catch in Lake Victoria
2007	First Prize	The Eliminator	Reduces cod by-catch in trawls
	Runner up	Traffic cone	Reduces bird mortality in trawls
	Runner up	Nested Cylinder	Reduces red snapper by-catch in shrimp trawl
	Regional Prize	Passive porpoise deterrent	Reduce by-catch of marine mammals
2006	First Prize	Shark deterring magnets	Reduce shark by-catch on hooks
	Runner up	Carefree's cunning contraption	Reduce bird mortality in trawls
	Runner up	Flexigrid	Reduces cod by-catch in trawls, increase safety to fishers
2005	First Prize	Deep-setting longline technique	Reduce by-catch of sea turtles
	Runner up	Net chemical deterrent	Reduce by-catch of marine mammals in gill net fishing
	Runner up	Shrimp trawl modification	Reduce by-catch in Indian Ocean shrimp fisheries

(Source: http://www.smartgear.org/about_smargear/ [Accessed August 23, 2010]).

Uptake potential

The key to this innovation is to harness the knowledge of fishers to arrive at solutions to by-catch problems which benefit both them (because most by-catch is unwanted) and other stakeholders. This approach should be transferable, with suitable modifications to other situations. For instance, the Birdlife Albatross Task Force has modified the approach to work with fishers directly to solve problems of albatross by-catch in southern hemisphere fisheries; although a reward is not given for innovative development, the fisher's own experiences are harnessed to mutual benefit. Clearly, and additionally, the actual gear innovations themselves are transferable, in the same way as the development and wider applicability of the seawater hopper (see page 72).

Reducing by-catch and discards

Generating an incentive

Fisheries by their nature will always impact on the environment, but that impact can and should be mitigated to the greatest extent possible, and its impact monitored. The examples in this section, and also some in Chapter 5, show that significant gains can be made by introducing mitigation measures so long as:

- the knowledge of fishers drives innovation to generate solutions to gear-related impacts;
- the incentive structure is such that fishers see an economic (such as new markets), as well as an environmental, benefit from developing and implementing mitigation;
- fishers do not perceive disadvantages to their main business, such as reductions in catches and sales of their major target species.

Discarding poses significant problems for fisheries because in addition to killing non-target fish, it is usually extremely difficult to monitor the actual level of by-catch which increases uncertainty over the state of the stock and the impact that the fishery is having on the ecosystem. This uncertainty addressed by the Norwegian discard ban where all catch is now accounted for. This increased certainty about stock status has led, in part at least, to a recovery of the stock and an increased TAC for the entire fishery (including Russia) to 703,000 tonnes. The new management measures have also allowed the offshore fishery to become MSC certified.

The NPF case study shows that technical solutions to the discard problem exist even for tropical shrimp fisheries. This case study highlighted the wide uptake of seawater hoppers despite the requirement for fishers' individual investment due to the fact that this system enhanced the quality of product and thus the price per kg at market. From an ecological perspective, survival rates of discarded fish approximately doubled from 8% to 17%. With the seawater hopper and other by-catch mitigation measures, such as turtle excluder devices, the NPF has been included in the list of the highest class of sustainable fisheries measures within the Australian legislative system.

A common feature of the development of these solutions was the involvement of multiple stakeholders in the processes and generation of suitable economic incentives. In the NPF case, a purely industry driven design resulted in increases in both economic and ecological performance. In the Norwegian example, NGOs and industry bodies such as the sales associations were included in the catch monitoring process. Furthermore, management recognised that there are costs involved for fishers in landing the previously discarded catch, and conservative compensation is given to the fishers by the sales associations.

These benefits are now starting to be realised by the fishers and, particularly in Norway, feedback from industry suggests that they understand how important these management measures were and how beneficial healthy fish populations can be to securing long-term incomes. These positive results should be highlighted when looking to apply innovations more widely.

Uptake potential elsewhere

The NPF and Norwegian discard case studies focussed on the mitigation of fish by-catch and discarding, but the impact of by-catch on birds, mammals and turtles is equally important. As the SmartGear case study showed, technical solutions now exist for most fishery interaction types:

- by-catch and discard of fish in most fisheries, through the use of selective gear (such as the cod large-mesh separator trawl and the shrimp seawater hopper);
- by-catch of birds in trawl and longline fisheries, through the use of fast sink rates for longlines and methods of scaring birds away from active gear e.g. hooks, trawl warps and nets;
- by-catch of turtles in longline fisheries, through the use of different hook and bait types;
- by-catch of turtles in trawl fisheries, through the use of turtle exclusion devices;
- by-catch of birds in gillnet fisheries is currently difficult to mitigate except with area or season closures;
- marine mammals in trawl fisheries, through the use of escape hatches in trawls;
- in all fisheries, by avoiding areas, depths and seasons in which the distribution of affected species overlaps with the fishery, including the use of marine protected areas and prohibitions of bottom trawling on sensitive habitat.

Clearly fisheries experiencing these problems can look elsewhere for technical solutions that, with some adaptation to local conditions, can be readily implemented. Although few of the technical solutions are 100% effective, there are only a few by-catch problems that currently have no technical solution, and for these fisheries the avoidance of interactions (through the use of area, season or depth closures) is always an option.

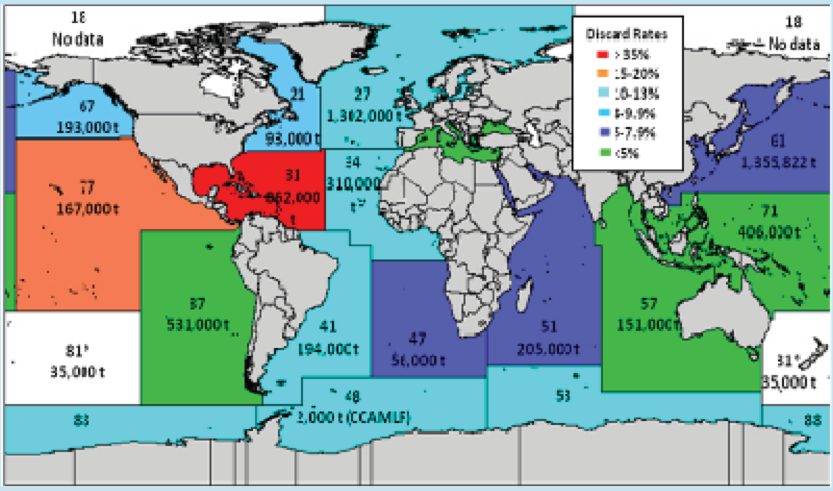


Figure 35: Percentage of discard rates by FAO statistical areas. The actual volume of estimated discards are also included. High percentages indicate poor catch selectivity and large volumes indicate wastes of protein (Source: Kelleher, 2005).* Note data are skewed in Area 81, therefore ranking is not possible.

However, the wider lesson to be drawn is in the engagement process. The introduction of the WWF SmarGear competition shows what can be done to create incentives for fishers to develop mitigation methods, and the other solutions (Norway, NPF) were also developed with industry and other stakeholder participation. In this regard, the lesson is somewhat similar to that expressed elsewhere in this report, particularly in respect of governance and capacity problems: that engagement of stakeholders is a key aspect of developing a successful solution to fisheries problems.

SmartGear is clearly meeting its objective to recognise and reward the initiatives of fishing gear designs and to fuel innovation of further developments. For the first time in the upcoming around, the competition will also open a new segment specifically for by-catch mitigation designs in tuna fisheries. The SmarGear competition may be relatively small at this point, but the process of encouraging industry to design innovative concepts will be key to ensuring wide uptake of by-catch mitigation designs.

These developments are not happening in isolation. A SmartGear design with high uptake (Faroese, Icelandic and Norwegian fisheries) was the Flexigrid, which is a further adaptation of the same grids used in both the NPF and Barents Sea which is lighter and more flexible. This means is it safer for fishers to handle and will reduce the damage caused to by-catch coming into contact with it and target species passing through the grid. Thus once it has been shown that gear modifications can lead to significant economic and environmental benefits without creating problems for a fishery (such as increased costs, operating time or compromising safety) they are likely to be taken up and modified for use in many different fisheries.

When it comes to introducing a discard ban regime to other areas, the cost of doing so through the same method as done by Norway, with high levels of inspection, is often seen as prohibitive. The only way to generate high compliance with a discard ban is through regular inspections or the use of on-board observing systems, which are also expensive. New technological solutions are being developed, based around electronic (camera) monitoring systems, but while these are cheap to install they still require expensive human operators (MRAG 2006).

However, observers can be very cost-effective on large vessels with high incomes, and provide the certainty of monitoring required for accurate stock assessment. At £220 (USD 352) per observer day (a high estimate based on European observer programmes) (MRAG 2006), 254,545 observer days would be available for the same price as the cost of the Norwegian coastguard for fisheries (£ 60 million; USD 96.1 million). Across the industrial fleet of 400 fishing for cod in the Barent Sea, this would equate to 636 days per vessel per year. Furthermore, this cost could then be 100% attributable to the fishing industry.

Figure 35 allows for the possibility to consider areas for applying the experiences from these case studies. The map highlights all the FAO areas and their respective estimated percentage of discards to catch. Areas of higher percentages indicate where current selectivity measures are inadequate to mitigate high levels of by-catch. Furthermore, the volumes indicated in each area highlight regions where levels of protein are wasted and in areas where volumes are high, this could also impact stock assessments based on landed catch; as was the case in Norway prior to the discard ban.

CONCLUSIONS

As the introduction highlighted, world fisheries are in a critical state. Some 28% of stocks are identified as overexploited, depleted, or recovering; most of the world's fishing fleets are overcapacity; approximately 10 million tonnes of fish are discarded; 11–26 million tonnes (worth USD 10–23 billion) are lost to IUU fishing; and, underperformance due to inefficient operations, overexploited stocks and perverse incentives result in an estimated loss of USD 50 billion in economic rent each year.

This report has presented case studies that address the key challenges — overcapacity, perverse subsidies, poor governance, lack of data and by-catch and discards – and has emphasised the complex, dynamic and inter-linked nature of these challenges. Poor management is often a result of poor governance and non-engagement of key stakeholders. This in turn can a) lead to the use of inappropriate management tools, that can have impacts on the environment and also b) generate perverse incentives for unsustainable practices leading to the inefficient economic operation, overcapacity and non-compliance with rules. There can also be substantial feedback between (a) and (b). The case studies show that there are practical ways of meeting these challenges (these are summarised in Table 35).

Addressing overcapacity

Overcapacity has been identified as one of the most significant challenges facing global fisheries. The case studies highlight that the problem of overcapacity is often one of control and that drivers of overcapacity may have their origins outside of the fishery. Examples include the incentives created by markets (herring roe) or changing environmental conditions (Senegal). It is important that these wider governance issues are considered when seeking to address overcapacity. Two main solutions are identified in the report:

Rights-based approaches are proving to be highly effective as a means to address overcapacity and eliminate the 'race to fish' in fisheries whose objective is to create an economically efficient fishery and where there are capable enforcement systems. This race for fish can lead to problems of 'high-grading' and over quota catches. Rights-based approaches, particularly those allowing the transfers and trade in rights and quota, can play an important role in aligning fishing capacity with fishing opportunities and create economically efficient fleets (e.g. Icelandic ITQs). Because these systems generally encourage consolidation in the industry, safeguards may need to be put in place to protect some fishery sectors (as in the Pacific halibut fishery).

Local management measures, often based on traditional practices, have also proven effective in addressing overcapacity. These approaches are effective where local people have the authority to make and enforce management measures. Management tends to have less emphasis on enforcing catch limits and instead seeks to maintain and enhance resource productivity. While these approaches have often been found in small-scale fisheries (where rights-based approaches may be expensive in relation to the scale of the fishery), the methods that are used, including restrictions on gears and spatial and temporal closures, have wider applicability.

Addressing perverse subsidies

Subsidies contribute significantly to the creation of perverse economic incentives, although inappropriate management may also generate them. The WTO process represents the best opportunity to tackle harmful fisheries subsidies on a global level and lead to real sustainability gains. **Influencing public opinion** to shape political views in advance of the negotiation rounds as opposed to trying to do so during negotiations is the most likely means to realise these gains. Unilateral removal of subsidies at a national level may affect international competitiveness of domestic industry in the short term, and while possible is likely to encounter significant industry resistance.

Harnessing ethical purchasing choices through market-based mechanisms, including eco-labelling, and putting pressure on retailers can be very effective in generating positive economic incentives for sustainable fishing. Our case studies have highlighted a range of emerging financial mechanisms and incentives, with entry points at all levels, from individual fisheries to national and international initiatives (e.g. MSC and ISSF).

Addressing poor governance

Governance is about the politics of natural resource management. Many of the issues of management are, at heart, issues of governance. The case studies have demonstrated that even where good management occurs, it can be threatened or undermined by poor governance, or be impacted by decisions taken outside the fishery (e.g. Senegal, Fiji, Cornish mackerel). In addressing governance challenges through more inclusive and interlinked decision-making processes we are seeking governance arrangements (both formal and informal) that make good management possible.

Because governance is a complex challenge, individual solutions will differ depending on the nature and the history of the particular fishery. A common conclusion from our case studies is that **bringing stakeholders together to address governance challenges** is a vital step in making sustainable management possible.

The case studies also repeatedly reinforced the contested nature of decision-making and the way in which different groups sought to legitimise their claims and advance their interests. As the examples of Lake Taal, Fiji and Senegal showed, even where there have been powerful vested interests, stakeholders have been able to work together and negotiate fisheries objectives and develop mechanisms to achieve these. Within these processes of deliberation and debate, **local fishers and those dependent on the fisheries represent critical stakeholders**. The case studies also highlighted that these processes represents a longer-term commitment and that there may be situations where there will be winners and losers when reaching consensus on issues is not always possible.

Addressing key gaps in data and control

Critical data about the operation of fisheries, the target species and the ecosystem are often insufficient to allow for evidence-based decision-making. The case studies showed that acquiring such data can immediately suggest solutions to key problems. The placement of **scientific observers** on vessels is an obvious step to address this, and is adopted by many of the world's most successful management systems, including CCAMLR.

A key area of uncertainty in many fisheries is discarding, which should be monitored closely or eliminated, for example the discard ban in Norway. Addressing issues of governance and responsibility can contribute to improving data quality. The conservation credits scheme, and examples of local management and control, provide examples where collaborative approaches have been able to foster both greater compliance with regulations and more reliable data.

Multi-stakeholder management councils such as these can greatly assist in decision-making processes. (Photo source: C. Cawthorne).

Implementation of **Ecosystem-Based Fisheries Management** in combination with the **Precautionary Approach** allows for the development of suitable approaches in both data-rich and data-poor situations. The CCAMLR approach to krill fishery management is one example that utilises concepts from EBFM and the Precautionary Approach, explicitly acknowledging the key role that krill plays in the Antarctic food chain. These concepts are not new, but they have yet to be consistently applied (Pitcher et al. 2009). Indeed many traditional management systems include ecosystem considerations and, as in both the Fiji and Chile case studies, local knowledge underpinned the selection of suitable areas for closure. Elsewhere, explicit guidelines are being developed by the MSC and Lenfest working groups to ensure that fisheries targeting critical low trophic-level species in similar ecosystems such as sardines and anchovies do not adversely impact other species.

Addressing by-catch and discards

Application of the EBFM, and relevant international agreements such as UNCLOS and UNFSA, require that both direct and indirect impacts of fishing should be considered. Chapter 6 demonstrated that solutions to address direct impacts are often obvious when the nature of the problem is understood. Although the solutions may not be simple, they are **best developed in cooperation with fishers** who will then be more willing to implement them — such as in the case of the Norwegian discard scheme. These schemes are most successful if they work to the mutual advantage of fishers and the environment, creating positive financial incentives for their effective implementation. The WWF SmartGear competition has been very successful at creating positive incentives, and the concept could translate well to other environmental problems.

Recommendations: Addressing the challenges

This final section outlines some of the key areas we believe that the case studies have highlighted as a means to bring about transformations in fisheries systems. These are presented as recommended actions that can contribute to more sustainable and well managed fisheries.

Harnessing wider support through markets and the value chain

Fish is the most widely-traded global agricultural commodity, so it is not surprising that our first recommendation is that one of the most effective ways to control overcapacity and to encourage better environmental performance is to **harness the global market to generate change in fishery management**. The value chain can represent an important entry point through which stagnant management processes can be held to account.

Actors that are external to the fishery with wide market power can potentially tackle a wide range of problems. Many retailers and processors need to secure supplies of fish and therefore have an interest in ensuring fisheries are well-managed fisheries and that fishing and aquaculture operations are low impact. Consolidation within the sector means that individual processors and retailers are often gaining increasing power to influence the operations of fish producers, management bodies and essentially act as informal regulators.

Changing public opinion on products available in markets will place pressure on retailers and political players (Photo: MRAG, 2010)

Food health and hygiene regulations represent a formal or legislative entry point for change. Requirements for products to demonstrate sustainable sourcing could be incorporated into such regulations. Other options include retailer and processor sustainability commitments and certification schemes. Many retailers and processors are developing and applying 'best practice' and several already have sustainability criteria against which they make themselves accountable. Furthermore, retailers and processors are working with suppliers to reduce the impact and improve the sustainability of their supply chains. Certification schemes can have an important role in support of these efforts as they provide more formal assurance of sustainability and are recognised by consumers. Examples include the MSC, ASC and other traceability and certification schemes as illustrated in the case studies on South African hake, ISSF, Ben Tre clam and salmon farming.

A key entry point is raising awareness among consumers of how they can contribute to increasing sustainability through their purchasing choices. This can help build the political pressure necessary for changes in regulations and increase the commitment amongst retailers to source sustainable and certified fish. NGOs and the media have an important role to play increasing consumer awareness about the state of fisheries, highlighting more ethical purchasing choices and placing pressure on producers. Given the global nature of modern retail operations, ensuring retailers and processors hold the same standard across their global branches and operations is another key role for consumers, NGOs and media.

Support subsidy reform and create economic incentives for change

Our second recommendation is that the **economic inefficiencies in the global system must be addressed by removing subsidies**. Developing innovative financial mechanisms and the inclusion of private financing can provide positive economic incentives for more sustainable practices. Even fairly small sums have proven to be effective (e.g. supporting technology prizes like SmartGear or contributions to the costs of certification in Ben Tre). At the larger scale, endowment funds can be used to finance conservation and management plans. Private finance mechanisms can also be used to mitigate short-term costs, for example providing loans to fishers on the condition that they limit fishing and allow stocks to rebuild. However, as with state subsidies, the role, mechanisms and outcomes of all types of private sector financing need to be clear and accountable. A key challenge is to identify and mobilise sources of funds, including public-private partnerships, to support these innovative schemes.

Promote rights-based approaches to solve overcapacity

Rights-based approaches have a high profile in fisheries debates. Many fisheries that are managed for economic returns have implemented rights-based systems giving use rights and responsibilities to fishers. When combined with tradability and transferability, these systems can provide the opportunity for fishers to maximise their efficiency and profitability, and through this to adjust fishing capacity to better match catching opportunities.

Our third recommendation is that **fisheries managed with the objective of maximising economic returns should become rights-based, and preferably with tradable rights and quota (ITQ)**. If the fishery is controlled effectively, such systems can generate significant increases in profitability, and at the same time reduce capacity to an economic optimum. With increased profitability, governments can capture resource rents that can be used to pay for research and management costs. The smaller fleets that result from consolidation (capacity reduction) of ITQ fisheries generally mean that control is improved.

However, ITQs do not automatically improve ecological sustainability. Equity and social issues will also need to be explicitly considered as consolidation of large fleets removes smaller players. Because ITQs are an economic measure, their implementation may be inappropriate where the main objective of the fishery is not economic — for instance, where important objectives are to ensure access to fisheries resources, maximise food production or employment. Thus we qualify our recommendation to fisheries managed with economic objectives in mind (wealth creation).

Promoting comprehensive data acquisition to fill information gaps

Our fourth recommendation is increased investment in data collection, including **promoting the use of scientific observers** and other methods of comprehensive data acquisition including information from fishers and a greater role for local knowledge. This will improve knowledge of stock status, improve information flow from fisheries and contribute to implementation of Ecosystem-Based Fisheries Management.

It is difficult to overstate the benefits that arise from independent scientific observation of a fishery. In addition to improving the quality of information on catches, discards and impacts of the fishery on the ecosystem, human observation can allow the rapid identification and solution to problems that a management authority did not know existed. We would recommend the use of observers on board all large vessels, where space and cost are not significant issues. Systems should aim to observe 20% of hauls or days fished. Costs of observers should be met by industry levy, and will generally be lower than inspection costs, particularly in ITQ fisheries. The high performing CCAMLR, USA, New Zealand, South Africa and Australian fisheries have extensive observer programmes.

Biological sampling of catch at-sea. Tasks such as these carried out by scientific observers is key to filling information gaps and having a greater understanding of ecosystem interactions (Photo: MRAG, 2010)

Discard bans (such as in Norway) and moves from landings quotas to catch quotas can also increase the information available about fishing, catches and interactions with the environment. Where the costs of observers are an issue we would recommend investment to explore the use of automated data collection systems (e.g. Norway and the North Pacific longline fisheries).

Small vessels and smaller fisheries cannot usually support observers, but here the most effective way of acquiring information may be collaboration with fishers, including supporting fishers to contribute to research and even undertake their own research. Fishers have extensive knowledge of the fishery and may be able to identify, or contribute to identifying, both pressing problems and innovative solutions. In Fiji, Scotland, Senegal fisher knowledge has played an important role in improving data quality and fishers and scientists have appreciated and benefited from working together. **Encourage collaboration between fishers and management authorities on research and data collection**.

Ecosystem-Based Fisheries Management

Our fifth recommendation is the **widespread application of Ecosystem-Based Fisheries Management**. Consideration of the ecosystem within a fisheries management context does not always require significant levels of investment and the concept of EBFM can be applied to virtually any fishery. However, for more complex multispecies fisheries, understanding the dynamics of the ecosystem and developing appropriate management measures can prove challenging in practice.

Where there is uncertainty about the interactions, more precautionary approaches may be more suitable. For static habitats (such as coral reefs, spawning grounds of fish, sensitive habitat types) MPAs can make an important contribution. It is important that the development and implementation of MPAs is conducted in collaboration with industry and local stakeholders and that the MPA are located where they are likely to be most effective (e.g. Garaway and Esteban, 2003). For mobile animals, such as juvenile fish, protection is best done through interactive closures (such as in Scotland and Norway). Setting management targets and limits in a manner that accounts for interactions and interdependencies, for example in the CCAMLR krill fishery, can minimise the likely impacts on the wider ecosystem. Management systems should also take note of the recent advances in the development of guidelines for fisheries targeting low trophic level species. Raising awareness of the importance of considering the interactions between fished stocks and the wider environment and advocating the wider application of Ecosystem-Based Fisheries Management and risk-based approaches represents an important first step.

Promote collaboration in policy making to solve governance problems

Engaging with industry is key to encouraging moves towards sustainability. (Photo source: S.F.Walmsley).

The case studies have shown that there is one prerequisite for the design of successful solutions that is common to almost all the challenges, and that is to address governance issues. Thus, our sixth recommendation addresses this **aspect of improving fisheries governance**. Good governance can support good management and create the conditions within which more sustainable outcomes are achievable. Poor governance can undermine good management. The case studies have repeatedly shown that there are benefits in collaborative and inclusive approaches to management, bringing together different stakeholders with different knowledge, perspectives to address management challenges (e.g. South Africa hake, Fiji, Mozambique, Scottish aquaculture, ISSF, SmartGear). It is important that these processes are transparent and accountable, with assumptions and competing objectives for the fishery held up to scrutiny and open to debate.

We recognise that developing these types of collaborative approaches may not be straightforward. Many fisheries are characterised by a history of competing claims. Conflict and confrontation are often a part of the process and power relations and vested interests can present significant obstacles to transformation (e.g. Lake Taal). Nevertheless, collaborative processes that respect the knowledge, perspectives and positions of different parties can help highlight the strengths of stakeholder groups and identify management arrangements that develop their potential roles in contributing to sustainability. Working together to achieve sustainability becomes a means to further develop trust and respect.

The most important international governance initiatives currently in existence are the UNFSA and Port States Agreement. Key action which will bring about significant benefits is **to facilitate and assist the ratification of these two instruments by all states.**

Support innovation as a processes

Our final, seventh, recommendation is to **support processes rather than single solutions**. The case studies have repeatedly highlighted that fisheries are dynamic: fluctuations in fish populations, environmental conditions and changes over time in societal needs and aspirations and economic conditions, while unpredictable, are to be expected. However, they also highlight that, against this backdrop, fisheries stakeholders are constantly innovating and developing new solutions to emergent challenges. For example, fuel price increases have stimulated many developments in fishing technology, particularly with low-impact/drag fishing gears.

Working with fishers to identify resource-use patterns and prioritise management activities and processes. (Photo source: R. Arthur).

As initiatives such as the Marine Stewardship Council, Aquaculture Stewardship Council, ISSF and Aquaculture dialogues have shown, it is possible to initiate processes that develop standards that contribute to increased environmental sustainability. Similarly, the WWF SmartGear competition represents an initiative that supports industry (and other actors) to develop innovative solutions to by-catch and environmental impacts, such as the incorporation of seal escape panels in nets. With suitable investment (e.g. from NGOs, governments and the private sector), these types of process have a potentially wider applicability and can be used to address other challenges, for example innovations to improve sustainability of aquaculture operations.

For these measures to be effective and widely applied, without fear that they will compromise the efficiency of fishing operations (and therefore cost the industry money), they must be developed in cooperation with industry. Where possible economically advantageous methods, or methods that do not economically disadvantage fishers, should be sought as these will be more acceptable and their implementation is likely to be much more effective than imposed solutions. As with many of the management challenges, ultimately the process of arriving at new solutions is as important as the solutions themselves.

Table 35: List of case studies, entry points for change, key change agents within the fishery system and lessons learned.

While many of the issues and innovations may have occurred at the management and industry levels, results below highlight that other components of the fishery system can act as effective and efficient change agents.

Case study	Driver	Key entry points	Lessons learned
Alaska: Transferable quotas for Pacific Halibut, Canada	Inefficiency and a race for fish	Government agencies, fishers	Transferable rights can be an effective method to reduce capacity and increase fleet profitability.
Iceland: Transferable quotas	Stock decline due to overcapacity	Government agencies	When implementing a transferable rights system, the effects on small-scale fleets and communities need to be considered.
Canada: Quota pooling for herring roe	Dangerous short seasons	Government agencies	Where capacity cannot leave the fishery, quota pooling may be used to reduce management tasks and increase profitability.
Vietnam: Ben Tre clam	Overharvestin g driving stock declines	NGOs, government agencies, fishers	Certification can increase product prices. However, in small-scale fisheries the cost of MSC certification and fishery objectives may represent an obstacle to certification.
ISSF: Market-demand innovation	Overcapacity leading to IUU fishing	NGOs, retailers, processing industry, RMFO	Industry can be responsive to consumer awareness of sustainability issues and NGO pressure. NGOs can be effective in assisting industry to respond and address these concerns.
Chile: Territorial use rights	Economic hardship	Government agency, fishers	Local knowledge can be key input to successful management measures. Need for limiting expectation of stock assessment; other approaches exist than purely scientific based.
Tackling subsidies through the WTO	Subsidies contribute to overharvesting	Governments, NGOs and public	International agreement on subsidy restrictions could have a positive impact on global fisheries sustainability, if restrictions are effective and enforced.
New Zealand: Removal of subsidies	Declining fish stocks	Government agencies, NGOs, public, fishers	Subsidy removal at national level is possible, but may be difficult in many cases. Profitable fisheries can enable management costs to be recovered.
Kiribati: Phoenix Island Protected Area	Lack of financial incentives for conservation	NGO, government agencies	Private investors are prepared to finance conservation measures when benefits are sufficiently high.
Banking on Cod - Private Investment	Creating long-term sustainability	NGOs, fishers	Private investors could be prepared to finance conservation measures when benefits are sufficiently high.
UK: Cornish mackerel	Lack of reward for sustainable practices	Fishers, consumers	Certified fisheries are still subject to externalities which may affect their sustainability, and subsequently their certification status.
The Philippines: Aquaculture governance in Lake Taal	Addressing environmental degradation	Government agencies, NGOs, public	Sustainability may require holding government agencies to account; creating pressure for them to address their responsibilities.
South Africa: Certification in the hake fishery	Maintaining sustainable management	Fishers, NGO, government agencies	Fishers may adopt sustainability measures as a means to achieve other objectives and this can represent an opportunity.
Mozambique: Co-management	Overexploitati on and conflict	Government agency, fishers	Local people can make valuable contributions to management but should not be seen by managers as a means to transfer responsibilities and costs.

Case study	Driver	Key entry points	Lessons learned
Antarctic: Ecosystem-based and precautionary management	Decreasing seabirds and increasing krill catches	RMFO	Observer programs offer data sources which allow for comprehensive ecosystem-based management.
Fiji: Local knowledge and traditional management practices	Developing community-based ecosystem management	Fishers, public, NGOs	Local knowledge and authority can underpin successful management and researchers and other stakeholders can have roles in supporting local management.
Senegal: IUU fishing in small-scale fisheries	IUU fishing	Fishers, NGOs, government	Factors external to the fishery can contribute to increasing capacity and illegal fishing and solutions may lie outside the fishery.
Scotland: Conservation Credits Scheme	Need for responsive conservation measures	Government agencies, NGOs, fishers	Real-time closures based on active fisher involvement can be an effective method, responsive to the dynamic nature of fisheries.
Scottish salmon aquaculture	Increasing environmental impacts	Fish farmers, government agencies, NGOs	Development of the industry highlighted a range of emerging issues that could be addressed by working collaboratively to innovate and identify solutions.
Australia: Prawn seawater hopper	High discard mortality	Fishers	Industry driven innovations can work with rather than replace current fishing practices.
Norway: Discard ban	Cod stocks declining	Government agencies, fishers	Discard bans allow for 100% of catch to be recorded, thus aiding accurate stock assessment.
International: WWF SmartGear Competition	Increasing uptake of successful innovation	Fishers, NGO,	Private investment can be used to encourage innovation to meet sustainable fishing challenges.

Fishers in India repairing their nets. (Photo source: S.F.Walmsley).

List of References

Agnew D.J., J. Pearce, G. Pramod, T. Peatman, R. Watson, J.R. Beddington & T.J. Pitcher (2009) Estimating the worldwide extent of illegal fishing. *PLoS ONE,* 4(2).

Agnew, D.J. (2004) *Fishing South: The history and management of South Georgia fisheries*. Government of South Georgia & the South Sandwich Islands.

Alioune S.Y. & J. Catanzano (2005) Self-regulation of Senegalese artisanal fisheries; a case study of Kayar. In: S. Cunningham and T. Bostock (Eds) *Successful Fisheries Management* Eburon, Delft, The Netherlands.

Arnason, R. (2005) Property rights in fisheries: Iceland's experience with ITQs. *Reviews in Fish Biology and Fisheries*. 15: 243-264.

Arnason, R. (1995) The Icelandic fisheries, evolution and management of a fishing industry. Fishing News Books, Oxford UK, 177 pages.

Arthur, R.I., R.M. Friend & M. Marshke (in press) Making Adaptive Co-management more than a Marriage of Convenience: Reconciling Theory and Practice in the Management of Fisheries in the Mekong Region. In: B. Goldstein (Ed). *Collaborative Resilience to Crisis: Healing Community, Responding to Hazards, and Protecting Natural Resources*. MIT Press.

Banks, R., S. Cunningham, W.P. Davidse, E. Lindebo, A. Reed, E. Sourisseau & J.W. de Wilde (2001). The impact of technological progress on fishing effort. Agricultural Economics Research Institute (LEI) Report PR.02.01.

Beddington, J.R., D.J. Agnew, & C.W. Clark (2007) Current problems in the management marine fisheries. *Science*, 316 (5832):1713-1716.

Béné, C. and A.E. Neiland (2006) From participation to governance: A critical review of the concepts of governance, co-management and participation, and their implementation in small-scale inland fisheries in developing countries. A review Prepared for the Challenge Programme on Water and Food. WorldFish Center, Penang, Malaysia and CGIAR CPWF, Colombo, Sri Lanka.

Bennett, E. (2005) Success in fisheries management: a review of the literature. In: S. Cunningham and T. Bostock (Eds.) *Successful fisheries management*. Eburon Academic Publishers, The Netherlands.

Blueyou, A.G. & ENDA/REPAO (2007) Feasibility study eco -labelling of artisanal coastal fisheries in Senegal. Zurich & Dakar. 75 p.

Brown, O. (2005) Policy Incoherence: EU Fisheries Policy in Senegal. Human Development Report Office Occasional Paper, United Nations Development Programme, Geneva

Bureau of Agricultural Statistics (BAS – Philippines) (2004) CountrySTAT Philippines. Available on-line at: http://countrystat.bas.gov.ph/.

Castilla, J.C. & M. Fernandez (1998) Small-scale benthic fisheries in Chile: on co-management and sustainable use of benthic invertebrates. *Ecological Applications* 8(1): 124–132.

Charles, A.T. (2001) *Sustainable Fishery Systems*. Blackwell Science Limited, Oxford

Cheung W.W.L., R. Watson, T. Morato, T.J. Pitcher & D. Pauly (2007) Intrinsic vulnerability in the global fish catch. *Marine Ecology Progress Series* 333: 1–12.

Clark, W.G. & S.R. Hare (2006). Assessment and management of Pacific halibut: data, methods, and policy. International Pacific Halibut Commission Scientific Report No. 83.

Constable, A.J., W.K. de la Mare, D.J. Agnew, I. Everson and D. Miller (2000) Managing fisheries to conserve the Antarctic marine ecosystem: practical implementation of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). *ICES Journal of Marine Science* 57: 778–791.

Cox, A. & C.-C. Schmidt (2002) Subsidies in the OECD fisheries sector: A review of recent analysis and future directions. OECD.

Danielsson, A. (1997) Fisheries management in Iceland. *Ocean & Coastal Management* 35: 121-135.

Davies, R.W.D., S.J. Cripps, A. Nickson & G. Porter (2009) Defining and estimating global marine fisheries by-catch. *Marine Policy* 33(4): 661-672.

Dell, Q., N. Gribble, S. Foster & D. Ballam (2003) Evaluation of hoppers for reduction of by-catch mortality in the Queensland East Coast Prawn Trawl Fishery. FRDC Project Report 2001/098. 68 pp.

Diamond, B. & Beukers-Stewart, B.D. (2009) *Fisheries Discards – Waste of a resource or a necessary evil?* The University of York, York, UK.

Eayrs, S. (2007) A guide to by-catch reduction in tropical shrimp-trawl fisheries. FAO Fisheries Department, Rome, Italy.

FAO (1993) Marine fisheries and the loaw of the sea: a decade of change. Special chapter (revised) of *The State of Food and Agriculture 1992*. FAO Circular 832, Rome.

FAO (2000). Fisheries Management 1: Conservation and Management of Sharks. FAO Technical Guidelines for Responsible Fisheries - No.4, Suppl.1. FAO Fisheries Department, Rome, Italy. Available online at: http://www.fao.org/DOCREP/003/X8692Ex8692e06.htm#bm06.3.

FAO (2002a). Code of Conduct for Responsible Fisheries. FAO Fisheries Department, Rome, Italy. Available online at: http://www.fao.org/fi/agreem/codecond/codecon.asp.

FAO (2002b). Implementation of the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing. FAO Technical Guidelines for Responsible Fisheries. No. 9. FAO Fisheries Department, Rome, Italy. Available online at: http://www.fao.org/DOCREP/005/Y3536E/Y3536E00.htm.

FAO (2003) The ecosystem approach to marine capture fisheries. FAO Technical Guidelines for Responsible Fisheries, No. 4(Supplement 2). FAO Fisheries Department, Rome, Italy. 112 pp.

FAO (2007) *State of the World's Fisheries and Aquaculture 2006*. FAO, Rome, Italy.

FAO (2009) *State of the World's Fisheries and Aquaculture 2008*. FAO, Rome, Italy.

FAO (2010) Total fishery production 1950-2008. FISHSTAT

Plus - Universal software for fishery statistical time series [online or CD-ROM]. FAO Fisheries Department, Rome, Italy.

Fitzpatrick, J. (1996) Technology and fisheries legislation. In: *Precautionary Approach to Fisheries. Part 2: Scientific Papers*. FAO Fisheries Technical Paper 350, Part 2. Rome, FAO.

Furness R.W. & P. Monaghan (1987) *Seabird ecology*. Blackwell, New York

Garaway, C.J. and N. Esteban (2003) Increasing MPA effectiveness through working with local communities: guidelines for the Caribbean. MRAG Ltd. London. 43p.

Garcia, S. M. & A. A. Rosenberg (2010) Food security and marine capture fisheries: characteristics, trends, drivers, and future perspectives. *Philosophical Transactions of the Royal Society B* 365: 2869–2880.

Garcia, S. M. and C. Newton (1997) Current situation, trends and prospects in world capture fisheries. In: E.L. Pickitch, D.D. Huppert & M.P. Sissenwine (Eds.) *Global trends: Fisheries management*. Symposium 20, Bethesda, MD: American Fisheries Society.

Garibaldi, L. and L. Limongelli (2003) Trends in Oceanic Captures and Clustering of Large Marine Ecosystems - Two Studies Based on the FAO Capture Database. FAO Fisheries Technical Paper 435. FAO Fisheries Department, Rome, Italy.

Gelcich, S., T.P. Hughes, P. Olsson, C. Folke, O. Defeo, M. Fernandez, S. Foale, L.H.. Gunderson, C. Rodriguez-Sickert, M. Scheffer, R.S. Steneck & J.C. Castilla (2010) Navigating transformation in governance of Chilean marine coastal resources. *PNAS*, 107 (39): 16794 – 16799.

Gilroy, H., L. M. Erikson, and K. A. MacTavish (2009) commercial fishery and regulation changes. International Pacific Halibut Commission, Report of Assessment and Research Activities 2009.

Griffiths, S., R. Kenyon, C. Bulman, J. Dowdney, A. Williams, M. Sporcic & M. Fuller (2007) Ecological risk assessment for the effects of fishing: Report for the Northern Prawn Fishery. Report for the Australian Fisheries Management Authority, Canberra.

Hanneson R. (2009) Norway's experience with ITQs. The Norwegian School of Economics and Business Administration, Bergen, Norway.

Hardin, G. (1968) The tragedy of the commons. *Science* 162: 1243-1248.

Hare, S. (2010) *Assessment of the Pacific Halibut Stock at the end of 2010*. International Pacific Halibut Commission, Seattle, USA. Available on-line at: http://www.iphc.washington.edu/papers/sa10.pdf.

Hatcher, A. (2005) Non-Compliance and the quota price in an ITQ fishery. *Journal of Environmental Economics and Management* 49: 427-436.

Hylen, A., Nakken, O. & Nedreaas, K. (2008) Northeast Arctic Cod: Fisheries, Life History, Stock Fluctuations and Management. (in Nakken, O. (2008) Norwegian Spring-Spawning Herring & Northeast Arctic Cod: 100 Years of Research and Management. Tapir Academic Press, Trondheim, Norway

ICES (2010) Advice on Barents Sea and Norwegian Sea Cod in Subareas I and II (Northeast Arctic cod). Available on-line at: http://www.ices.dk/committe/acom/comwork/report/2010/2010/cod-arct.pdf

IPHC (2011) International Pacific Halibut Commission: Technical Reports (internet). Available from URL: http://www.iphc.washington.edu/research.html.

ISSF (2010) Statement by ISSF on a comprehensive list of authorized tuna fishing vessels. International workshop on improvement, harmonization and compatibility of monitoring, control and surveillance measures, Spain.

ISSF (2010) Statement by ISSF on a comprehensive list of authorized tuna fishing vessels. International workshop on improvement, harmonization and compatibility of monitoring, control and surveillance measures, Spain.

Jacquet, J., D. Pauly, D. Ainley, P. Dayton, S. Holt, & J. Jackson (2010) Seafood stewardship in crisis. *Nature* 467: 28-29.

Jupiter, S.D. & D.P. Egli (in press) Ecosystem-Based Management in Fiji: successes and challenges after five years of implementation. *Journal of Marine Biology*

Kelleher, K. (2005) Discards in the world's marine fisheries: an update. FAO Fisheries Department, Rome.

Kim, K. (2002) Korea-Japan fish dispute. ICE Case Studies. Inventory of Conflict and Environment Database. Washington DC: American University. Available on-line at: http://www.american.edu/ted/ice/korea-japan-islands.htm

Knútsson, Ö., H. Gestsson & Ó. Klemensson (2008) Structural changes in the Icelandic fisheries sector. p. 631-644. In: I. Hannibalsson (eds) *Rannsóknir í Félagsvísindum IX*, (Researches in the Social Sciences IX). Reykjavík: Institute of Social Sciences.

Knútsson, Ö., Ó. Klemensson & H. Gestsson, (2009) Changes in strategic positioning in the Icelandic fish industry´s value chain. p. 601-613 In: H. Gestsson and Ó. Klemensson (eds.): *Rannsóknir í félagsvísindum X* (Researches in the Social Sciences X). Reykjavík: Institute of Social Sciences.

Kock, K-H., D. Agnew, I. Boyd, D. Butterworth, J.P. Croxall, W.K. de la Mare, I Everson, M. Mangel, D.G.M. Miller & R. Thomson (2000) Understanding CCAMLRs Approach to Management. CCAMLR, Hobart, Australia.

Lewison, R. L., S.A. Freeman & L.B. Crowder (2004) Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. *Ecology Letters* 7: 221-231.

MacGarvin, M. (2001) Now or Never – The Cost of Canada's cod collapse and disturbing parallels with the UK. WWF report.

Marchal, P., B. Andersen, B. Caillart, O. Eigaard, O. Guyader, H. Hovgaard, A. Iridono, F. Le Fur, J. Sacchi & M. Santurtún (2007) Impact of technological creep on fishing effort and fishing mortality, for a selection of European Fleets. *ICES Journal of Marine Science* 64 (1): 192-209.

Ministry of Fisheries (MoF) (2010) Fisheries at a glance, http://www.fish.govt.nz/en-nz/Fisheries+at+a+glance/default.htm?WBCMODE=Pr.

Moloney, D.G. (1981) Canadian Regulation of Pacific Fisheries In: H.E. English & A. Scott (Eds.) *Renewable Resources in the Pacific*. International Development Research Centre, Ottawa, Canada.

MRAG (2006) Observer programmes: best practice funding options and North Sea case study. Report prepared for

WWF UK, Godalming, UK.
MRAG (2010) Estimation of the cost of illegal fishing in West Africa. MRAG Ltd., London. 97 p.
MRAG AP (2010) Investigation of Unique Vessel Identifier (UVI) and phasing options. Report for FAO Fisheries Department, Rome, Italy.
MRAG, IFM, CEFAS, AZTI Tecnalia & PolEM (2009) An analysis of existing Rights Based Management (RBM) instruments in Member States and on setting up best practices in the EU. Final Report, MRAG Ltd. London. 117 p.
MRAG, Lamans & AZTI (2008) Field study to assess some mitigation measures to reduce by-catch of marine turtles in surface longline fisheries. MRAG Ltd., London. 215 p.
MSC (2009) Net benefits: The first ten years of MSC certified sustainable fisheries. London: Marine Stewardship Council.
Munro, G. (1999) A theoretical framework for examining interactions between subsidies, overcapitalization and resource overexploitation: short-term and long term consequences. In: M. Riepen, (Ed.) *The impact of government financial transfers on fisheries management, resource sustainability and trade*. Report of the Proceedings of the PECC Workshop held on 17-19 August 1998, Manila, Philippines
Mutia, T. M., M.D.L. Magistrado & M.C. Muyots (2000) Status of *Sardinella tawilis* in Taal Lake, Batangas, Philippines. Available on-line at: http://www.pcamrd.dost.gov.ph/systems/zone2/papers/8th/mutia.pdf.
NEFMC (2001) Frequently Asked Questions about the Groundfish Fishery. New England Fishery Management Council. Available on-line at: http://www.nefmc.org/nemulti/faqs/gf_facts.PDF.
Neiland , A.E., C. Béné, T. Jolley, B.M.B Ladua, S. Ovie, O. Sule, M. Baba, E. Belal, F. Tiotsop, K. Mindjimb, L. Dara, A. Zakara & J. Quensiere (2002). The Lake Chad Basin Fisheries: A strategic analysis of key policy issues affecting aquatic resource management, stakeholder livelihoods and economic development. In: A.E. Neiland and C. Béné (Eds.) *Sustainable Development of African continental Fisheries: A regional study of policy-formation mechanisms in the Lake Chad Basin*. Final Report. Commission INCO. Project No. ERBICI18CT980331.
NMFS (2009). Economic status of the groundfish fisheries off Alaska, 2008 (internet). Available from URL: http://www.afsc.noaa.gov/refm/docs/2009/economic.pdf.
NWWG (2010) Report of the North-western working group (NWWG). ICES CM 2010/ACOM:07.
Ocean Watch Australia (2004) Hoppers in Australian trawl fisheries – A handbook for fishers. Ocean Watch Australia Ltd, Pyrmont NSW, Australia.
Orensanz, J.M. & A.M. Parma (2010) Chile Territorial Use Rights: Successful experiment? *Samudra,* 55: 42-46.
Ostrom, E., J. Burger, C.B. Field, R.B. Norgaard & D. Policansky (1999) Revisting the Commons: local lessons, global challenges. *Science* 284: 278.
Perry, A.L., P.J. Low, J.R. Ellis, J.D. Reynolds (2005) Climate change and distribution shifts in marine fishes. *Science* 308: 1912 – 1915.
Pitcher, T. J., & Lam, M. E. (2010). Fishful thinking: rhetoric, reality, and the sea before us. Ecology and Society 15 (2): 12. [online] URL: http://www.ecologyandsociety.org/vol15/iss2/art12/
Pitcher, T.J., Kalikoski, D., Katherine, S., Varkey, D. and Pramod, G. (2009), An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries. *Marine Policy* 33(2):223-232.
Powers, J., G. Tingley, D. Japp, J. Combes & A. Hough (2010) MSC Reassessment Report for South African Hake Trawl Fishery. Report prepared for the Marine Stewardship Council.
Read, A.J. (2007) Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments. *Biological Conservation* 135: 155-169.
Robinson, M.A. & R.M. Lawson (1986) Some reflections on aid to fisheries in west Africa *Marine Policy* 10: 101-110.
Roe, E. (1995) Except Africa: postscript to a special section on development narratives. *World Development* 23**:** 1065-1069.
Sharpe, A. (2011) TV programme prompts shift in UK retailers' canned tuna policy. *Food News* 39 (3): 13.
St. Martin, K. (2004) GIS in marine fisheries science and decision-making. In: W.L. Fisher and F.J. Rahel (Eds.) *Geographic Information Systems in Fisheries*. American Fisheries Society, pp. 237-258.
Statistics Iceland (2010) Statistics: Statistics Iceland (internet). Available on-line at: http://www.statice.is/Statistics
Statistics New Zealand (2010) Fish Monetary Stock Account: 1996–2009. Statistics New Zealand, Auckland, New Zealand.
Sumaila, R. & D. Pauly (2006) Catching more bait: A bottom-up re-estimation of global fisheries subsidies. Fisheries Centre Research Reports 14(6). University of British Colombia Fisheries Centre, Vancouver, Canada.
Sumaila, U.R., A.S. Khan, A.J. Dyck, R. Watson, G. Munro, P. Tydemers & D. Pauly (2010) A bottom-up re-estimation of global fisheries subsidies. *Journal of Bioeconomics*. 12:201-225
UNESCAP (no date) What is good governance? Bangkok, Thailand: United Nations Economic and Social Commission for Asia and the Pacific. Available on-line at http://www.unescap.org/pdd/prs/ProjectActivities/Ongoing/gg/governance.pdf
WCS (2009) Best of the Wild: Wildlife Conservation Society and the Vatu-i-Ra Land/Seascape. Information Brochure.
World Bank & FAO (2009) The Sunken Billions: The economic justification for fisheries refor. The International Bank for Reconstruction and Development /The World Bank, Washington 100 p.
Wunder, S. (2005) Payments for environmental services: some nuts and bolts. CIFOR Occasional Paper No. 42. Jakarta, Indonesia: Centre for International Forestry Research. 24 p.

THIS PAGE HAS BEEN LEFT BLANK INTENTIONALLY

GLOSSARY

Artisanal fisheries
Traditional fisheries, typically small-scale, involving households and communities rather than commercial companies. Fishers generally use basic technology and work inshore by foot, or near to the coast from small vessels.

Benthic
Refers to the bottom of water bodies, such as the sea floor.

Biodiversity
The variability among living organisms from all sources including, among others, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species and ecosystems.

Biomass
In a fisheries context: the total weight of a stock of living organisms (e.g. fish, plankton) or of some defined fraction of it (e.g. spawning females), in an area, at a particular time.

By-catch
Fish and other animals besides the primary target species that are caught incidental to the capture of the primary target species. By-catch may be retained or discarded.

Catch per unit effort (CPUE)
Catch per unit of fishing effort. The total catch divided by the total amount of effort used to capture the fish.

Closed season
A period during which fishing for a particular species, often within a specified area, is prohibited.

Collapsed fish stock
Prolonged lack of annual recruitment of juvenile fish due to excessive fishing pressure that leads to the reduction of stock abundance to levels at which production is negligible compared to historical levels.

Co-management
A process of management in which government shares power with resource users, with each given specific rights and responsibilities relating to information and decision-making.

Demersal species
Fish that inhabit the bottom of a water body during their adult life. Often referred to as ground fish.

Depleted stock
A fish stock where a high proportion of one or all age classes of individuals are harvested because of excessive fishing pressure that leads to a reduction in the spawning stock, limiting the natural reproduction or annual recruitment levels.

Discards
Fish and other animals that are disposed of, usually at sea, after being caught.

Distant water fishing nation (DWFN)
A national which has a fishing fleet operating far outside of it’s Exclusive Economic Zone.

Effort control
A system of fishery management that focuses on limiting the quantity of fishing gear or the duration of its deployment rather than on limiting the quantity of catch that can be taken.

Exclusive Economic Zone (EEZ)
A zone of water up to 200 nautical miles from the boundary of a coastal State within which the coastal State has the right to explore and exploit, and the responsibility to conserve and manage, the living and non-living resources.

Exploited stock
Any stock of fish that is subject to commercial fishing activity.

Moroccan fishing harbour. (Photo source: A. Wales).

French artisanal fishing vessel . (Photo source: I. Parkes).

Fish stock
Scientifically, a population of a species of fish that is isolated from other stocks of the same species and does not interbreed with them and can, therefore, be managed independently of other stocks.

Fishing effort
The level of fishing gear of a certain type used on the fishing grounds over a given unit of time: e.g. hours trawled per day, number of hooks set per day, or the total number of boats engaged in a fishery and/or the number of days they were fishing.

Ghost fishing
The continued capture of animals by fishing gear that has been lost or abandoned at sea.

Harvest Control Rule
A set of defined rules used to determine exploitation rates through controlling factors, e.g. catch or effort limits.

High grading
The discarding of smaller or lower quality fish of the target species to make room in the fish hold for larger, more valuable fish caught later in the day.

High seas
High seas is a legal term used to describe the areas of water outside of a any national EEZ.

Highly migratory species
Species or stocks that carry out extensive migrations throughout the oceans, usually crossing territorial boundaries such as EEZs and between EEZs and the high seas. This term is usually used to describe tuna and tuna-like species such as marlins, and swordfish.

Illegal, unreported, and unregulated fishing (IUU fishing)
Fishing practices and activities that: contravene applicable laws and regulations, or the standards set out within international agreements; are not reported, or are misreported to a relevant authority; or for which there are no applicable conservation or management measures.

Individual transferable quota (ITQ)
A type of quota management system that typically entails the allocation of a part of the Total Allowable Catch to individual fishermen or vessel owners. The quota, once distributed, can be sold to others.

Maximum sustainable yield (MSY)
The largest average catch or yield that can continuously be taken from a stock under existing environmental conditions, without significantly affecting the reproduction capacity of the stock.

No-take zone
A form of marine protected area that is permanently protected from all forms of resource exploitation and direct destructive activities. Also referred to as a "marine reserve" or a "marine sanctuary."

Open access
The right to catch fish is free and open to all. Fishing is essentially unrestricted.

Output controls
The management measures that limit the catch fishers can take. Options include the Total Allowable Catch (TAC), and individual quotas (IQ).

Quota
Amount of catch allocated to a fishing license.

Recruitment
A measure of the number of fish that enter a class—such as the spawning class or fishing-size class—during some time period.

Total Allowable Catch (TAC)
The annual permitted catch for a species or species group. Usually a regional council or similar administrative body sets the TAC based on the range of the allowable biological catch.