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Fisheries

Investing in natural capital

Acknowledgements

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BAU	Business-as-usual
CBD	Convention on Biological Diversity
CTQ	Community Transferable Quota
EC	European Commission
EEZ	Exclusive Economic Zone
EFR	Environmental Fiscal Reform
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GFF	Global Fisheries Fund
ITQ	Individual Transferable Quota
IUU	Illegal, unreported and unregulated
MCS	Monitoring, Control and Surveillance
MEY	Maximum economic yield
MPA	Marine Protected Area
MRA	Marine recreational activity
MSY	Maximum sustainable yield
NRC	National Research Council
OECD	Organisation for Economic Co-operation and Development
PPP	Public-private partnership
RFMO	Regional Fisheries Management Organization
SCFO	Standing Committee on Fisheries and Oceans
SSF	Small-scale fisheries
T21	Threshold 21 model
TAC	Total allowable catch
TURFs	Territorial rights in fisheries
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
WTO	World Trade Organization

Key messages

1. The world's marine fisheries are socially and economically vital, providing animal protein and supporting food security to over 1 billion people. An estimated half of these people live in close proximity to coral reefs, relying on them not just for fish, but also for livelihoods – from small-scale fishing to tourism. Currently, the world's fisheries deliver annual profits of about US$ 8 billion to fishing enterprises worldwide and support 170 million jobs, directly and indirectly, providing some US$ 35 billion in household income a year. When the total direct, indirect and induced economic effects arising from marine fish populations in the world economy are accounted for, the contribution of the sector to global economic output amounts to some US$ 235 billion per year.

2. Global marine fisheries are currently underperforming in both economic and social terms. Society at large receives negative US$ 26 billion a year from fishing, when the total cost of fishing (US$ 90 billion) and non-fuel subsidies (US$ 21 billion) are deducted from the total revenues of US$ 85 billion that fishing generates. This negative US$ 26 billion corresponds roughly to the estimated US$ 27 billion in subsidies a year (including US$ 21 billion in non-fuel subsidies), the latter of which contributes directly to over-fishing and depletion of fish stocks.

3. Investing to achieve sustainable levels of fishing will secure a vital stream of income in the long run. Greening the sector requires reorienting public spending to strengthen fisheries management, and finance a reduction of excess capacity through de-commissioning vessels and equitably relocating employment in the short-term. Thus, measures to green the sector will contribute to replenishing overfished and depleted fish stocks. A single investment of US$ 100-300 billion would reduce excessive capacity. In addition, it should result in an increase in fisheries catch from the current 80 million tonnes a year to 90 million tonnes in 2050, despite a drop in the next decade as fish stocks recover. The present value of benefits from greening the fishing sector is about 3 to 5 times the necessary additional costs. In a scenario of larger and deeper spending of 0.1 to 0.16 per cent of GDP over the period 2010-2050, to reduce the vessel fleet, relocate employment and better manage stocks to increase catch in the medium and longer term, 27 to 59 per cent higher employment would be achieved, relative to the baseline by 2050. In this same scenario, around 70 per cent of the amount of fish resources in 1970 would be available by 2050 (between 50 million tonnes and 90 million tonnes per year), against a mere 30 per cent under a business-as-usual (BAU) scenario, where no additional stock management activities are assumed.

4. Greening the fisheries sector would increase resource rent from global fisheries dramatically. Results outlined in this chapter indicate that greening world fisheries could increase resource rents from negative US$ 26 to positive US$ 45 billion a year. In such a scenario, the total value added to the global economy from fishing is estimated at US$ 67 billion a year. Even without accounting for the potential boost to recreational fisheries, multiplier and non-market values that are likely to be realised, the potential benefits of greening fisheries are at least four times the cost of required investment.

5. A number of management tools and funding sources are available that can be used to move the world's fisheries sector from its current underperforming state to a green sector that delivers higher benefits. Aside from removing environmentally harmfully subsidies, a range of additional policy and regulatory measures can be adopted to restore the global potential of fisheries. Economic studies generally demonstrate that marine protected areas (MPA), for example, can be beneficial under specific conditions as an investment in the reproductive capacity of fish stocks. Currently, MPAs comprise less than 1 per cent of the world's oceans. To fully utilise MPAs as a management tool, the 2002 World Summit on Sustainable Development set a target to establish a global network of MPAs covering 10-30 per cent of marine habitats by 2012. This deadline was extended to 2020 and the target lowered to 10 per cent at the CBD meeting in Nagoya, Japan in late 2010.

1 Introduction

1.1 Objectives and organisation of the chapter

The aim of this chapter is to demonstrate the current economic and social value of marine fisheries to the world and, more importantly, estimate the sector's full potential economic and social value if it were managed within the framework of a green economy. Setting the conditions that will be needed to shift marine fisheries to a more sustainable future is crucial, and the chapter explores how best to provide appropriate incentives, engender reforms and channel investment.

Specific objectives of the chapter are to:

■ Gain a better understanding of the contribution and impact of marine fisheries to the global economy;

■ Demonstrate the potential benefits of sustainably managing the world's fisheries to national and regional economies and to the global economy;

■ Estimate the financial requirements for investing in fisheries conservation and sustainable use, comparing these to long-term economic, social and environmental gains; and

■ Demonstrate that the long-term economic benefit of investing in rebuilding fisheries and improving their management outweighs the short-term costs.

The fisheries sector consists of three main parts: 1) marine capture; 2) inland capture; and 3) aquaculture. This contribution focuses on marine fisheries. Inland fisheries and aquaculture are discussed with respect to how they relate to marine-capture fisheries.

The prospects for greening the world's marine fisheries are explored in this chapter. For fisheries, we interpret greening as: 1) recognizing that there are limits to what the oceans can provide; 2) acknowledging that rebuilding overfished and depleted fish populations is needed to maximise sustainable yield, through time, for the benefits of both current and future generations; 3) essential habitats for living marine animals need to be protected and preserved; and 4) fishing and other activities involving ocean fish populations are organised to minimise the release of greenhouse gases. We will emphasise point 2) in this report because there is general consensus that many of the world's capture fisheries are in crisis. Overexploitation, pollution and rising temperatures threaten 63 per cent of the world's assessed fisheries stocks (Worm et al. 2009). However, several fisheries are reasonably well managed, which provide important lessons for our effort to shift the world's fisheries to a greener, more sustainable state.

Fish are one of the planet's most important renewable resources. Beyond their crucial role in marine and freshwater ecosystems, fish make a vital contribution to the survival and health of a significant portion of the world's population. Marine fisheries provide nutrition and livelihoods for millions of people in coastal communities, notably in South and South-East Asia, West Africa and Pacific Island states. As coastal populations continue to grow, the future benefits these resources can provide will depend on how well fisheries can be greened. We present an estimate of the current economic and social contributions from marine fish populations, and what they could amount to if the sector were greened. We also state the institutional conditions under which we can increase economic benefits while conserving these vital renewable ocean resources for the benefit of all.

Often, fisheries managers and policy-makers are under pressure to sacrifice the long-term health of marine fish resources in favour of perceived short-term economic benefits to the fishing industry and consumers. Gaining a better understanding of the potential contribution and impact of marine fish populations on the global economy will provide broader, longer-term, economic and social perspectives. Our goal is to show policy-makers that a green economic approach will chart the course to balancing increasing demands for fish with the limits to the capacity of oceanic and coastal fish stocks.

We present the current status of global fisheries in the next section with an emphasis on catch and catch values, employment and the contribution of marine and coastal recreation and tourism to the global economy. The challenges and opportunities associated with establishing green fisheries are discussed in Section 2. In Section 3, we focus on scenarios of fleet adjustment, and estimate the potential costs and benefits of rebuilding depleted fisheries. Section 4 explores some of the conditions and the institutions, both national and international, that will be required to bring about the greening of the world's fisheries. We devote Section 4.6 to the discussion of how to finance the transformation.

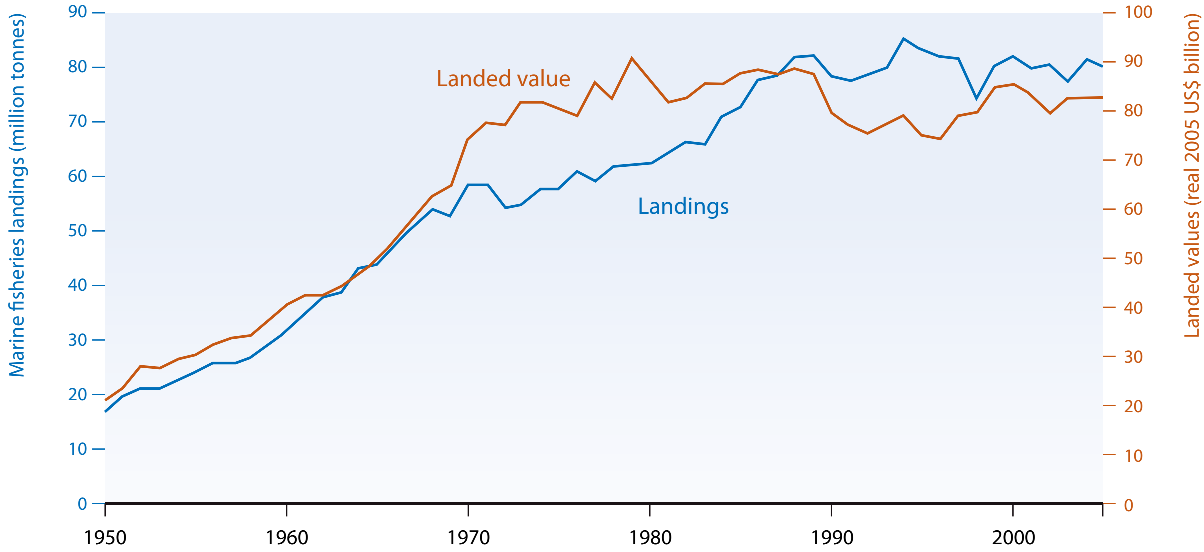

Figure 1: Landings and landed value of global marine fisheries: 1950-2005

Source: Based on Sumaila et al. (2007) and Watson et al. (2004)

1.2 Review of the status of global fisheries

The total catch from the world's marine capture fisheries[1] rose from 16.7 million tonnes in 1950 to 80.2 million tonnes in 2005. It reached a peak of 85.3 million tonnes in 1994 (Figure 1). For these 56 years, fish comprised about 86 per cent of the total landings, with crustaceans and molluscs accounting for 6 per cent, and 8 per cent respectively. The total landed value (gross output value) of the world's marine capture fisheries was about US$ 20 billion[2] in 1950. It increased steadily to about US$ 100 billion in the late 1970s and remained at that level throughout the 1980s despite further increases in the total landings (FAO 2005; *Sea Around Us project*[3]; Sumaila et al. 2007; Watson et al. 2004).

1. Excluding catch of marine mammals, reptiles, aquatic plants and algae.

2. All values are expressed in real 2005 US$.

3. The Sea Around Us project, compiles a global fishery database based on FAO reports and many other data sources (Pauly 2007).

Box 1: Inland capture fisheries

Around the world, inland fisheries are an increasingly important factor for communities because of increasing consumption per capita and the inability of people to purchase other animal protein. In a recent *State of World Fisheries and Aquaculture* report, the UN Food and Agriculture Organization (FAO) estimates that inland fisheries generate 10 million tonnes in landings annually; this amounts to about 11 per cent of the total capture fisheries catch from both inland and marine sources (FAO 2009). South-East Asia's Mekong river system, which is home to more than 850 freshwater species including many economically important species of catfish and carp, is estimated to provide fisheries landings worth around US$ 2 billion per year (Barlow 2008).

Lake Victoria in Africa's rift valley, the world's second-largest inland body of water, contains more than 500 species of freshwater fish. Of these, Nile perch, tilapia and dagaa (a small sardine-like fish) are highly sought-after in commercial fisheries, with landings totalling more than 1 million tonnes per year and a landed-value of US$ 350-400 million.[4] Unfortunately, estimates of inland capture landings and value must be viewed with a high degree of uncertainty, owing to a lack of consistent data collection in many countries.

For this reason, it is inherently difficult to include inland capture fisheries into global analysis of the fisheries sector. Nevertheless, many concepts from marine capture fisheries such as over-capacity and subsidisation are also applicable to inland fisheries.

4. Lake Victoria Fisheries Organization, Available at: http://www.lvfo.org

	Fishing Effort (million kW sea days)	Landings (million t)[2]	Landed value (2005 real US$ billion)*
Russia	432	3	3.2
Japan	398	4	14.4
China	301	10	15.2
Taiwan	261	1	2.7
USA	225	4.8	4.2
Spain	147	0.9	1.3
Korea Republic	138	1.6	2.5
France	116	0.6	1
New Zealand	115	0.5	1.1
Italy	100	0.3	1

* Total world landings were 80.2 million tonnes in 2005 with an estimated landed value of US$ 94.8 billion.

Table 1: Top ten marine fishing countries/entities by fleet capacity

Source: Based on Sumaila et al. (2007), Watson et al. (2004) and Anticamara et al. (2010)

Since the late 1980s, landed values have declined, falling from around US$ 100 billion to almost US$ 90 billion in 2005 (Figure 1). The decline in the landed value through the early 1990s corresponds to the increase in landings of low-valued Peruvian anchoveta, which accounted for over 10 per cent of the total landings from 1993 to 1996 and reached 15 per cent in 1994 (Sumaila et al. 2007; Watson et al. 2004). The top ten countries/political entities by fleet capacity are reported in Table 1. The fleet capacity indices in Table 1 are relative to the estimated capacity for Spain. Hence, Russia, sitting at the top of the table is estimated to have nearly three times the fishing capacity of Spain, while the US has 30 per cent more capacity. The top ten countries/political entities captured about a third of the global annual catch in 2005, with an estimated landed value of nearly 50 per cent of the global total. This implies that for the world to succeed in greening the fishing sector, the ten countries listed in Table 1 will have to be committed participants.

2 Challenges and opportunities in global fisheries

2.1 Challenges

Overfishing
In the early 1970s, fishing activity expanded, particularly in Asia, but also along the Chilean coast, where large quantities of anchoveta were taken, and along the coast of West Africa. By 2005, there was a contraction of high-value areas. However, there has been a considerable expansion of fisheries into the high seas, most notably in the North Atlantic and South Pacific. The maps in Figure 2 represent the annual landed values of the world's fisheries by decade from 1950 to 2005. In all six maps, concentrations in catch value can be seen in the productive coastal areas of Europe and Asia, as well as areas characterised by the significant upwelling of nutrient-rich water, such as the western coast of South America.

The spatial expansion of marine fisheries around the world partially masks the extent to which fisheries have been overfished (Swartz et al. 2010). In fact, the FAO believes that only about 25 per cent of the commercial stocks, mostly of low-priced species, are currently underexploited, 52 per cent are fully exploited with no further room for expansion, 19 per cent overexploited and 8 per cent depleted (FAO 2009). Studies have estimated that by 2003, some 29 per cent of the world's marine fisheries had collapsed in the sense that their current catch level was less than one-tenth of the maximum registered catch (Worm 2006). In the business-as-usual (BAU) scenario, as presented in the Modelling chapter, half the amount of fish available in 1970 would be available by 2015 and only one-third in 2050. Practices such as "fishing down marine food web", where species are targeted and fished to depletion from largest to smallest species, can bring about significant changes to the balance of species in the ecosystem (Pauly et al. 1998; Hannesson 2002).

The collapse of cod stocks off Newfoundland in 1992 devastated local communities and the economic aftershock is still being felt far beyond Canada's Atlantic coast. Some 40,000 people lost their jobs, fishing towns shrank in population by up to 20 per cent and the Canadian taxpayer spent billions of dollars dealing with the aftermath of the collapse (Mason 2002; Rice et al. 2003; SCFO 2005). Despite a moratorium on fishing cod since 1992, the stock has failed to rebuild to pre-crash levels (Charles et al. 2009).

Halting the fishing of vulnerable, overexploited species and establishing conditions so that stocks can recover are clearly major challenges that have to be achieved despite demand for fish. Explaining the scale of the issue is a challenge in developed and developing countries and catalysing policy reform is particularly difficult when there are legitimate fears that fish stocks might not recover even if complete bans on fishing in certain areas are enforced.

Subsidies
Fisheries subsidies are defined here as financial transfers, direct or indirect, from public entities to the fishing sector, which help the sector make more profit than it would otherwise (Milazzo 1998). Such transfers are often designed to either reduce the costs of fishing or increase revenues. In addition, they may also include indirect payments that benefit fishers, such as management and decommissioning programmes. Subsidies have gained worldwide attention because of their complex role in trade, ecological sustainability and socio-economic development (UNEP 2003; UNEP 2004; 2005; 2011).

It is widely acknowledged that global fisheries are over-capitalised, resulting in the depletion of fishery resources (Hatcher and Robinson 1999; Munro and Sumaila 2002). There are many reasons for the decline of fishery resources, but the contribution of subsidies to the expansion of capacity and overfishing cannot be over-emphasised (Milazzo 1998; WWF 2001). Global fisheries subsidies have been estimated at US$ 27bn in 2003 (Sumaila et al. 2010). Regional estimates of about US$ 12 billion have been provided for the Asia Pacific Rim (APEC 2000) and around US$ 2.5 billion for the North Atlantic (Munro and Sumaila 2002).

Khan et al. (2006), classified subsidies into three categories labelled "good", "bad" and "ugly" according to their potential impact on the sustainability of the fishery resource. Good subsidies enhance the conservation of fish stocks through time (for example subsidies that fund effective fisheries management or marine protected areas). Bad subsidies are those that lead to overcapacity and overexploitation, such as fuel subsidies. Ugly subsidies can lead to either the conservation or overfishing of a given fish stock, such as buyback subsidies, which, if not properly designed, can lead to overcapacity (Clark et al. 2005).

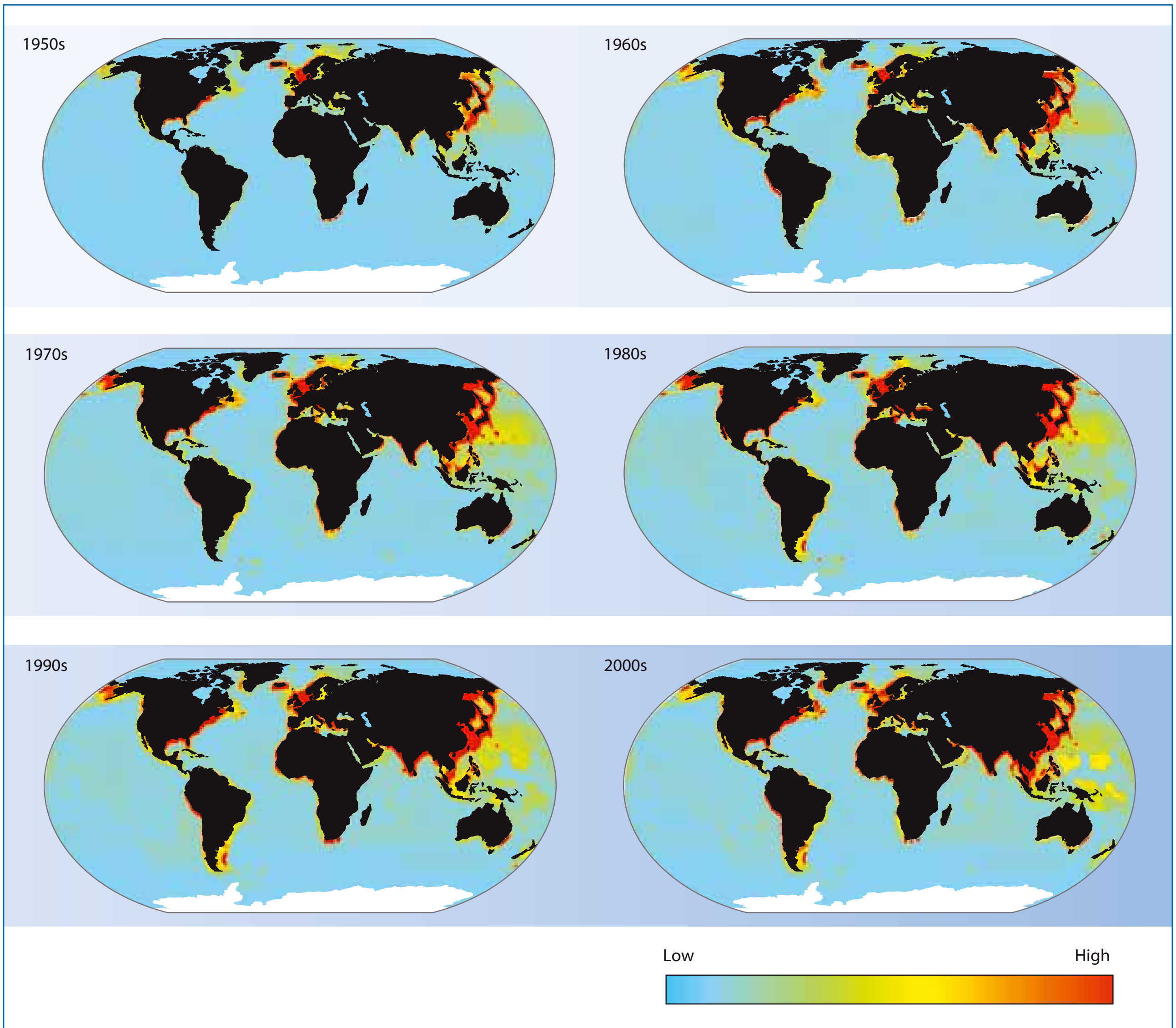

Figure 2: Spatial distribution of marine capture fisheries landed value by decade
Source: Sumaila et al. (2007)

The challenge is that once subsidies are provided they become entitlements, which makes them politically difficult to remove. Only concerted action by groups such as civil society organisations, international bodies and governments can bring about the removal of such subsidies. Also, one strategy that may help is to keep the amount of the subsidy within the fishing community but divert it from increasing overfishing to enhancing fish stocks. This can be achieved by converting bad subsidies into good ones, using bad subsidies to fund transition programmes to help fishers move to greener fishing approaches and other non-fishing activities to support their livelihoods.

Small-scale fisheries

A key issue along any coast is that of the local small-scale fisheries (SSF), which often provide crucial food supplies, sustain regional economies and support the social and cultural values of the areas, but are threatened as pressures on coastal areas are growing. This poses what is undoubtedly a major socioeconomic challenge: how to balance current and future needs for fishery resources.

There are many definitions of small-scale but such fisheries are usually characterised by being relatively more labour-intensive and less capital-intensive, more tied to coastal communities and less mobile (Berkes et al. 2001; Charles 2001; Pauly 2006). Other terms sometimes used for these fisheries are artisanal (versus industrial), coastal or inshore.

While all fisheries face a range of challenges, for SSF many of the challenges are related to factors that are external to the fisheries *per se* but within the broader social-ecological system (McConney and Charles 2009). These include (1) negative impacts of industrial and foreign fleets, depleting coastal fish stocks, and in some cases destroying coastal fishing gear; (2) degradation of coastal environments and fish habitat, through land-based sources of marine pollution, development of urban areas, shrimp farming, tourism, mangrove extraction, etc., leading in each case to reduced fish stocks; (3) infrastructure challenges, such as limitations on transportation of fish products; and (4) global forces,

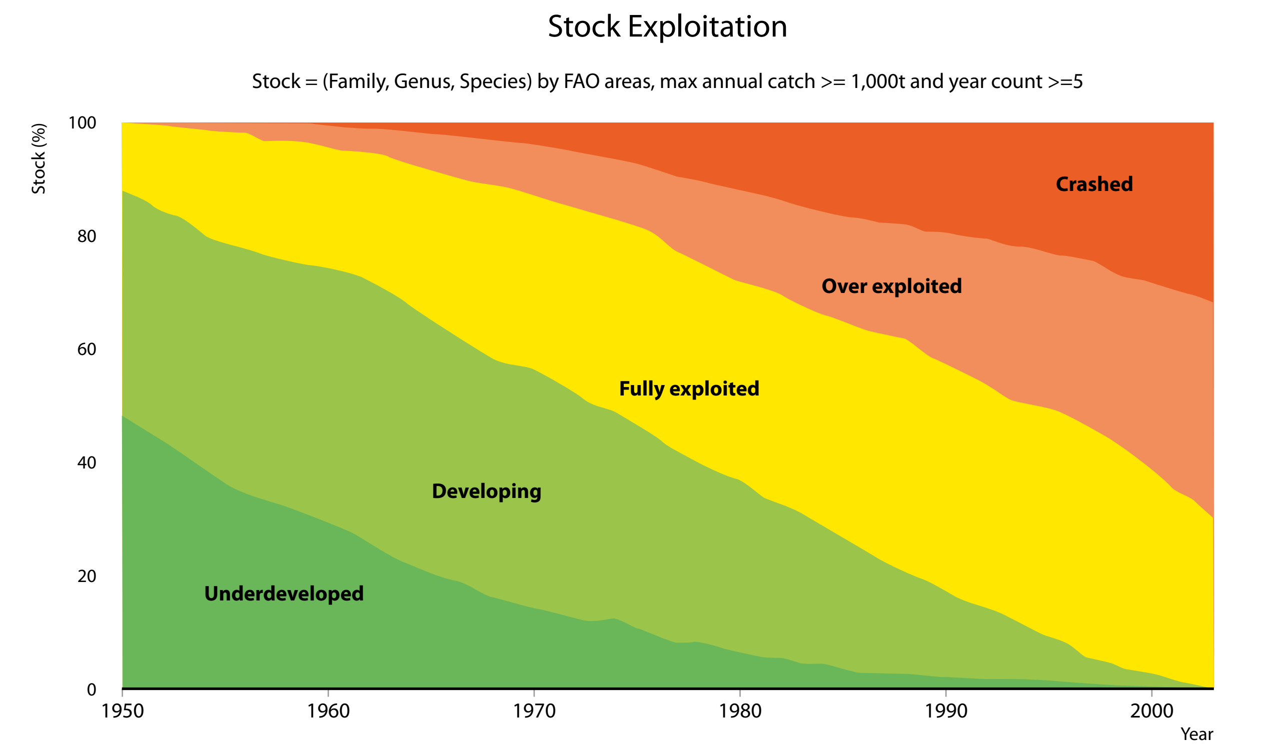

Figure 3: Status of fish stock exploitation: 1950-2000

Source: Froese and Pauly (2003)

such as climate change and globalisation of fish markets, that can negatively affect the small-scale fisheries. In addition, over-fishing by SSF contributes to the problem in many cases. It is important to recognise that given the above external factors, solving the sustainability challenge for SSF requires coordinated, multi-faceted approaches that aim to improve fishery governance at a local level – so that coastal fishers are involved in developing, and thereby support fishery management measures – while simultaneously dealing with other fleets, and market and infrastructure issues to improve coastal environmental quality. An integrated approach is thus unavoidable.

Certain realities of SSF pose challenges but also provide opportunities:

■ Small-scale fisheries are relatively immobile and are closely tied to coastal communities. This implies that fishers may have few other livelihood opportunities and may have high dependence on the fishery resources. Such a situation can lead, at times, to over-fishing, but alternatively this can lead to stewardship over local fish stocks that are so important to the community. The key is to discourage the former and encourage the latter;

■ Small-scale fisheries benefit a very large number of people, and the recognition of this reality can make it difficult to reduce fishing effort when that is needed to ensure ecological sustainability. On the other hand, the labour-intensive nature of SSF also means that there is less sunk capital – the capitalisation, and consequent debt payments, that seriously limit flexibility in industrial fisheries. Furthermore, small-scale fisher organisations can be drawn upon to play a constructive role in policy actions (Salas et al. 2007). It should be noted that the high levels of employment provided by SSF may well help to limit resource exploitation elsewhere in coastal areas. Again, an integrated systems analysis is required to properly recognise these interactions (Garcia and Charles 2007); and

■ Many small-scale fishing fleets are capable of depleting fish stocks and damaging aquatic ecosystems. There is thus a direct challenge both to the aquatic ecosystem and to economic sustainability. Moving to sustainable paths for the future implies improving the ecological sustainability of SSF. At the same time, SSF also provide an opportunity for environmental improvement, one that arises in comparing such fisheries with the major alternative, namely, fuel-intensive industrial fishing. Industrial fisheries are not only a threat to coastal small-boat fishers, as discussed above, but also contribute most

Type	World total (US$ billion)
Good	7.9
Bad	16.2
Ugly	3.0
Total	27.1

Table 2: Global fisheries subsidies

Source: Sumaila et al. (2010)

significantly to the negative climate externalities imposed by fisheries (due to their fuel-intensive nature) and to excessive high-seas resource exploitation. Furthermore, they receive the bulk of fishery subsidies globally. Given the above, there is an opportunity to move to a more sustainable model for the future, through an approach as in Indonesia, in which coastal waters are reserved for SSF. In this approach, industrial fleets are used only to catch fish that are beyond the reach of the SSF, and then only if such fishing is profitable from a full-cost accounting perspective (i.e., including the negative externalities resulting from such activity).

Greening aquaculture

According to FAO (2009), aquaculture supplies around 50 per cent of the world's seafood. However, a close look at the total world fish supply from aquaculture reveals two disturbing issues. Firstly, as the supply from aquaculture increases, the supply from capture fisheries decreases. In fact, there is an almost one to one change in opposite directions. This means that aquaculture is not adding to the world supply of fish; rather it is displacing wild fish supplies. Secondly, aquatic plants account for about 23 per cent of the reported increase in aquaculture supply. Even in Japan, where aquatic plants are commonly eaten, these plants do not replace the need for real fish; they are used mainly as supplements. Deducting the 23 per cent of aquaculture supply that is aquatic plants reveals that the total supply of real fish from both the wild and farms is declining.

There are many challenges to aquaculture as a source of animal protein in a green economy. Many farms still rely on wild caught fish as feedmeal and oil. The potential for disease from fish farms impacting wild populations is also an issue. Finally, there is the potential that fish farms can pollute the environment because of the waste they produce. Given these challenges, it is clear that current aquaculture practices need to be modified to make fish farming green.

The sector needs to 1) be organised to ensure minimal environmental degradation (Naylor et al. 1998); 2) stop the farming of carnivorous fish such as salmon, bluefin tuna and seabass until non-wild fish sources of fish meal are developed; 3) adopt integrated technologies that would make fish farming as self-contained as possible; and 4) develop reliable management systems for green aquaculture practices.

Climate change and greenhouse gas emissions in fisheries

Climate change has begun to alter marine conditions, particularly water temperature, ocean currents, upwelling and biogeochemistry, leading to productivity shocks for fisheries (Diaz and Rosenberg 2008). Shifts in species distribution that appear to be caused by changes in sea temperature are well documented (Cheung et al. 2009; Dulvy et al. 2008; Perry et al. 2005), as are variations in growth rates (Thresher et al. 2007). Climate change may also alter the phonology of marine organisms, creating mismatches between the availability of prey and predator requirements and leading to coral bleaching and habitat loss for reef-associated fish species. These changes would affect the distribution and volume of

Box 2: Subsidies and small-scale fisheries

Moves to shift to a green economy can provide opportunities to invest in SSF in a manner that enhances sustainability of the resource base as well as the coastal economy and society. The key lies in using the investments to build institutional strength and suitable incentives at a local scale. Measures such as subsidies and investment strategies can be used as incentives to change human behaviour positively, supporting long-term objectives in moving the fishery toward sustainability, without serious negative impacts. For example, this could involve providing funds to encourage certain actions such as conversion of fishing gear to less damaging choices, or a shift from fuel-intensive to more labour-intensive fishing methods.

In the context of SSF, this implies a careful examination of which subsidies are truly sustainable, equitable and moving in the direction of conservation. For example, a fuel subsidy is common in fisheries, but this tends to promote more fuel-intensive and capital-intensive fleets, which leads not only to over-fishing, but also to inequitable expansion of catching power for some (those who can take advantage of the subsidy) at the expense of others (with less capital). On the other hand, a subsidy that is used to provide more secure livelihoods for coastal fishers, and one that leads to a shift of SSF, where necessary, to more ecologically suitable methods, may be very helpful. The subsidy issue also relates to the balance of small-scale and industrial fishing. Past subsidies on vessel construction and on fuel led to a favouring of industrial fleets that are too capital- and fuel-intensive. A better policy would be to orient subsidies as incentives to balance industrial and small-scale fisheries, thereby generating both human and ecological benefits.

catch worldwide, thereby affecting global fisheries socially and economically (Cheung et al. 2010). For instance, recent studies estimate that climate change may lead to significant losses in revenues, profits and/or household incomes, although estimates are considered preliminary (Cooley and Doney 2009; Eide, 2007; Sumaila and Cheung 2010; Tseng and Chen 2008).

It is estimated that the world's fishing fleet contributes 1.2 per cent of global greenhouse gas emissions (Tyedmers et al. 2005). The challenge is to find ways to reduce this contribution, such as by phasing out subsidised trawler fleets, which generate extremely high emissions per tonne of fish landed.

2.2 Opportunities

Greening the world's fisheries will help restore damaged marine ecosystems. When managed intelligently, fisheries will sustain a greater number of communities and enterprises, generating employment and raising household income, particularly for those engaged in artisanal fishing.

Jobs supported by global fisheries

The world's fisheries provide livelihoods to millions of people in coastal regions and contribute significantly to national economies. They are relied upon as a safety net by some of the world's poorest, providing cash income and nutrition, especially during times of financial hardship. Healthy fisheries support the wellbeing of nations, through direct employment in fishing, processing, and ancillary services, as well as through subsistence-based activities. Overall, fish provides more than 2.9 billion people with at least 15 per cent of their average per capita animal protein intake (FAO 2009). The impact of the collapse of fisheries would be devastating. Some 144 of the world's countries possess marine fisheries, which provide jobs for local and foreign workers alike. It is estimated that in 2006, about 35 million people around the world were directly involved, either part time or full time, in fisheries primary production.

When considering post-catch activities and workers' dependants, the number of people directly or indirectly supported by marine fisheries is about 520 million or nearly 8 per cent of the world's population (FAO 2009).

There has been a steady increase in fisheries employment in most low-and middle-income countries, while in most industrialised countries, the trend has been towards a decrease in the number of people employed in capture fisheries. For example, since 1970, the number of fishers has fallen by 61 per cent and 42 per cent in Japan and Norway, respectively (FAO 2009).

Recreation and tourism

Marine recreational activities (MRAs) such as recreational fishing, whale watching and diving have grown in popularity in recent years and they have consequently come to the forefront of discussion and research on the ecological, economic and social impacts of more benign forms of interacting with the sea (Aas 2008; Hoyt 2001; Pitcher and Hollingworth 2002).

To estimate the value of MRAs, Cisneros-Montemayor and Sumaila (2010) first identified three indicators of socio-economic value in ecosystem-based marine recreational activities, which are 1) the level of participation; 2) the total employment in the sector; and 3) the sum of direct expenditure by users. A database of reported expenditure on MRAs was then compiled for 144 coastal countries. Using this

Box 3: Small-scale fishing in Indonesia

Located at the north-eastern tip of Bali, Indonesia, is the fishing community of Les. Around 7,000 people live there, of whom some 1,500 make their living from fishing in coastal waters that have traditionally been rich in coral, fish and other marine organisms. Fishing for the aquarium trade has become one of the main sources of livelihood, with 75 households in the village now fully engaged in catching ornamental fish (UNEP 2006). Fishers in Les and neighbouring communities are switching from pelagic to ornamental fishing as the pelagic stocks become depleted in traditional fishing grounds, but ornamental fish are themselves threatened by damage to in-shore coral reefs caused by practices such as cyanide fishing. As a result, villagers are being forced to fish for ornamentals further offshore and for longer periods.

Poison fishing has also led to substantial losses in revenue - estimated to amount to a net loss of as much as US$ 476,000 per km^2 a year in Indonesia (Cesar 2002). The authors also estimate that the net loss from the deterioration of fisheries could be about US$ 40,000 per km^2 a year. Given that Indonesia has the world's largest coral reef system, Wicaksono et al. (2001), estimate that the country could meet 60 per cent of global demand for ornamentals, compared with just 6 per cent currently, if its fisheries are managed effectively.

Item (units)	Recreational fishing	Whale watching	Diving and snorkelling	Total
Participation (million)	60	13	50	123
Expenditure (US$ billion)	40	1.6	5.5	47.1
Employment (thousand)	950	18	113	1,081

Table 3: Ecosystem-based marine recreational activities in 2003

Source: Cisneros-Montemayor and Sumaila (2010)

database, the authors estimated the missing values and calculated the yearly global value for MRAs in terms of expenditure, participation and employment. They found that currently, recreational fishing occurs in 118 maritime countries and that country-level data on expenditure, participation and employment are available in 38 of these countries (32 per cent of total). The authors estimated that in 2003, nearly 60 million recreational anglers around the world generated a total of about US$ 40 billion in expenditure, supporting over 950,000 jobs. In their analysis, countries with data account for almost 95 per cent of estimated total expenditure and 87 per cent of participation, so the authors argue that this estimate likely provided a close approximation to actual recreational fishing effort and expenditure.

Data on whale watching were found for a total of 93 territories (70 countries), mostly from 1994-2006 (Hoyt 2001; Hoyt and Iñiguez 2008). It is estimated that over 13 million people worldwide participated in whale watching in 2003, with expenditure reaching around US$ 1.6 billion in that year (Cisneros-Montemayor and Sumaila 2010). It is also estimated that 18,000 jobs worldwide are supported by this industry each year. These numbers are only an indication of the potential economic contribution that can be expected from whale watching, given that the marine mammals are found in all of the world's oceans (Kaschner et al. 2006). Currently only a few countries have well-established whale watching industries.

There is limited country-level data on recreational diving outside of the USA, Australia, and to some extent, Canada and the Caribbean region. Using market surveys and other data on active divers, it is estimated that every year, 10 million active recreational divers (Cesar et al. 2003) and 40 million snorkelers generate over US$ 5.5 billion globally in direct expenditure, supporting 113,000 jobs. In total, it is estimated that 121 million MRA participants generate US$ 47 billion in expenditure annually and support over one million jobs (Cisneros-Montemayor and Sumaila 2010) (Table 3).

Marine protected areas

Marine protected areas (MPAs) have been implemented in many countries and are regarded as a very important management instrument for fisheries. The assumption underlying the MPAs is that they can conserve the resources and increase the biomass therein, and consequently benefit surrounding areas through species migration and enhanced recruitment. Economic studies generally demonstrate that MPAs can be beneficial under specific conditions (Hannesson 1998; Sanchirico and Wilen 1999; Sumaila 1998). In addition, the MPA literature evaluates effectiveness of MPAs (Alder et al. 2002; Hockey and Branch 1997), Hockey and Branch (1997). In terms of policy design and implementation, many questions need to be addressed, including how to select MPA sites, how large should an MPA be, and how costly are MPAs, etc.

Marine Protected Areas will be a valuable management instrument for the greening of certain fisheries. There is growing consensus in the literature on the need to add MPAs in marine management plans (Costanza et al. 1998; Sumaila et al. 2000). Currently, MPAs comprise less than 1 per cent of the world's oceans (Wood et al. 2008). To fully utilise MPAs as a management tool, the Johannesburg Plan of Implementation adopted at the World Summit on Sustainable Development in 2002 aims to establish a global network of MPAs covering 10-30 per cent of marine habitats by 2012. This deadline was extended to 2020 and the target lowered to 10 per cent at the CBD meeting in Nagoya, Japan in late 2010.

Consumer Awareness

In recent years, we have seen a relative explosion in the number of programmes that seek to help consumers make informed decisions in terms of sustainability about their consumption of fish products. Although such programmes are not without criticism, it is clear that consumer awareness of marine fishery issues, if properly designed and implemented, would be an important driver of greening world fisheries as such awareness programmes expand into more and more places around the world.

Examples of resources that consumers can use to inform their purchase of sustainably caught fish include:

- The Monterey Bay Aquarium's Seafood Watch, Available at: (http://www.montereybayaquarium.org/cr/seafoodwatch.aspx);

- The Marine Stewardship Council certification programme, Available at: http://www.msc.org/; and

- The U.S. National Oceanic and Atmospheric Administration's Fish Watch, Available at: http://www.nmfs.noaa.gov/fishwatch/

3 The economic case for greening fisheries

3.1 The contribution of fisheries to economic activity

Recent estimates of gross revenue from marine capture fisheries suggest that the sector directly contributes US$ 80-85 billion to world output annually (Sumaila et al. 2007; World Bank and FAO 2009). However, this amount is by no means the total contribution from marine fish populations. As a primary industry (Roy et al. 2009), there are a vast number of secondary economic activities – from boat building to international transport – that are supported by world fisheries (Dyck and Sumaila 2010; Pontecorvo et al. 1980).

The weighted mean cost of fishing was estimated by Lam et al. (2010) to be US$ 1,125 (range of US$ 732 - US$ 1,605) per tonne, which works out at about US$ 90 billion for an annual catch of 80 million tonnes. The cost per tonne is split into the following cost components: 1) fuel cost (US$ 216); 2) running cost, for e.g., cost of selling fish via auction, cost of treatment of fish (US$ 162); 3) repair cost (US$ 108); 4) payments to labour (US$ 434); 5) depreciation (US$ 101); and 6) payment to capital (US$ 101).

Although the national contribution of fisheries to economic output is officially recorded as ranging between 0.5 per cent and 2.5 per cent for many countries (based on the total value of fish when they change hands for the first time after leaving the boat), the sector supports considerable economic activity by way of trickle-up linkages (Béné et al. 2007), also referred to as multipliers. The multiplier effect can be dramatic in coastal communities where small-scale fisheries not only generate direct revenues, but also represent the economic heart of coastal communities and the engine of the broader economy.

Dyck and Sumaila (2010) applied an input-output analysis to estimate the total direct, indirect and induced economic effects arising from marine fish populations in the world economy. Their results suggest there is a great deal of variation in fishing-output multipliers between regions and countries. When the output multipliers were applied at the global scale, the authors found that the contribution of the sector to global economic output amounted to some US$ 235 billion per year (Table 4), close to three times the conventionally measured ex-vessel value of marine capture fisheries.

3.2 The potential contribution from rebuilding and sustaining fisheries

As discussed earlier, global ocean fisheries caught an estimated 80 million tonnes of fish with a total value of about US$ 85 billion in 2005. The question we address in this section is: what are the potential gains, if any, from rebuilding marine fish stocks? We discuss this in terms of the potential increase in current catches, catch value, profits, resource rent and employment.

Using data from a recently published paper (Srinivasan et al. 2010), we assume that world fisheries landings could increase by 3.6 million tonnes-19.2 million tonnes per year if currently over-fished species are rebuilt to stock sizes allowing for maximum sustainable yield (MSY). This represents a potential to increase the value of landings by US$ 6.4 billion-US$ 36 billion per year. We nevertheless recognise the limitations of the MSY approach in global fisheries. However, since the approach involves rebuilding those fisheries currently classified as collapsed, we avoid issues involved when assuming all species can be fished at MSY.

For the further analysis, we make the following assumptions:

- The real price (nominal price adjusted for inflation) of fish is constant through time. There is evidence from historical data that real prices for fish have not changed much in the last few decades;

	Landed value (US$ billion)	Indirect effect (US$ billion)
Africa	2	5
Asia	50	133
Europe	12	36
Latin America & Caribbean	7	15
North America	8	29
Oceania	5	17
World Total	84	235

Table 4: World marine capture fisheries output by region

Sources: For landed values see Sumaila et al. (2007) and for multipliers see Dyck and Sumaila (2010)

	Current fisheries (US$ billion)	Green fisheries (US$ billion)
Value of landings	85	101
Cost of fishing	90	46
Non-fuel subsidies	21	10*
Rent**	-26	45
Wages	35	18
Profit	8	4
Total added-value	17	67

* The estimated US$ 10 billion in green subsidies would be to fund management programmes.
** The rent is the return to owners of fisheries resources, which is the surplus from gross revenue after total cost of fishing is deducted and subsidies taken into account. Here, rent is total revenue (US$ 85 billion) less total cost (US$ 90 billion) less non-fuel subsidies (US$ 21 billion). Note that fuel subsidies are usually in the form of rebates at the pump and therefore are already excluded.

Table 5: Green fisheries: key figures

■ As overfished stocks are rebuilt, there would be no substitution between capital and labour. That is, the various costs of fishing would stay in proportion to the current situation;

■ The practice of providing harmful subsidies to the fisheries sector is fundamentally at odds with green fisheries. Therefore, we assume that the estimated US$ 16 billion per year in harmful subsidies are eliminated or re-directed toward aiding the transition to green fisheries. Similarly, we assume that the US$ 3 billion per year in ambiguous subsidies, such as those for buybacks, would also be re-directed or eliminated;

■ The cost of fisheries management would increase by 25 per cent, from about US$ 8 billion a year to US$ 10 billion a year, to support better management under green fishing regimes;

■ Fisheries rent, that is, the return to owners of fisheries resources, would be US$ 45 billion per year in a green economy scenario. This is based on evidence from a recent report showing that potential total rent in world fisheries is about US$ 50 billion per year at Maximum Economic Yield (MEY), where the catch is about 10 per cent lower than our proposed scenario (World Bank and FAO 2009).

Given the above assumptions, global marine fisheries are projected to catch 90 million tonnes a year in a green economy scenario with lower and upper bounds of 84–100 million tonnes. The estimated value corresponding to this level of catch is about US$ 101 billion per year (with a range of US$ 91 billion-US$ 121 billion. The total cost of fishing in a green economy scenario is estimated to be US$ 46 billion, compared to US$ 90 billion currently. Assuming that payments to capital (normal profit) and labour (wages) remain proportionally constant in relation to total costs, the normal profit and wage income would amount to US$ 4 billion and US$ 17.8 billion, respectively. Resource rent for a green fisheries sector is assumed to be US$ 45 billion per year based on recent research (World Bank and FAO 2009).

Total value added, or fisheries contribution to human welfare, in a green economy scenario is estimated at US$ 67 billion a year (the sum of resource rent + payments to labour + normal profits). This represents a green economy improvement of US$ 50 billion per year compared with the sector's existing contribution to human welfare (Table 5).

Indirect benefits from rebuilding

As the value of the global marine catch increases from about US$ 85 billion to US$ 101 billion a year in a green-economy scenario, the total of direct, indirect and induced economic effects, arising from marine fish swells from US$ 235 billion to US$ 280 billion per year, assuming a linear relationship between catch and multiplier effects.

Benefits from recreation and tourism

In general, recreational fishers do not necessarily fish for the catch but rather for experience. It should be reasonable to assume that a healthier ocean rich in biodiversity is likely to increase the utility and therefore the benefits derived by recreational fishers. However, owing to the lack of information, we refrain from doing so in this report.

3.3 The cost of greening global fisheries

A key element of greening the fisheries sector involves moving from the current situation where we are not fishing the resource in a sustainable manner to one where the fish we catch each year is equal to or less than the growth of wild stocks. To make the change from the current state of affairs would require some investment into adjusting fishing capacity, managing transitions in labour markets, management programmes and scientific research. Two modelling exercises were undertaken to estimate the cost of greening fisheries. A one time investment of US$ 100-300 billion was calculated in this chapter to reduce excessive capacity, retrain fishers and improve fisheries management. Under the Green Economy Report T-21 modelling, a scenario of a larger and deeper spending of 0.1 to 0.16 per cent of GDP over the period 2010-2050 was considered to reduce the vessel fleet, relocate employment and better manage stocks to increase catch in the medium and longer term.[5]

5. See the Modelling chapter in this report.

Identifying greening efforts

There is widespread agreement that the world's fisheries are currently operating at overcapacity. Advances in technology have made it possible for a much smaller global fleet to catch the maximum sustainable yield, but the global fishing capacity keeps on growing owing to the common property nature of fisheries and the provision of fishing subsidies by many maritime countries of the world. Also, the use of sometimes damaging fishing methods such as bottom-trawling, unselective fishing, pollution and human-induced variations in climate has changed the productivity of many aquatic environments.

The issue of overcapacity can be addressed by investigating some of the common sources of excess fishing capacity. In several places, fishing is considered employment of last resort, attracting people with few other job options. Investing in re-training and education programmes for fishers and creating alternative employment has been successful in reducing fishing pressure, especially in places that are known for artisanal fishing.

Fishing capacity can be curtailed by taking steps to decommission fishing vessels or by reducing the number of permits or licences. Much attention has been given to decommissioning programmes, which are intended to reduce effort by reducing the number of fishing vessels. Unfortunately, some research suggests that vessel buy-back schemes may actually increase fishing effort if not properly implemented (Hannesson 2007). This occurs when loopholes allow decommissioned vessels to find their way to other fisheries and increase their catching capabilities (Holland et al. 1999). Fishing enterprises may also act strategically in anticipation of a buy-back by accumulating more vessels than they would otherwise (Clark et al. 2005).

Many fishing grounds that have been over-exploited have suffered lasting damage to the sea bed by trawl nets, affecting the ability of certain species to reproduce (Morgan and Chuenpagdee 2003). In these cases, as well as in instances where pollution or climate change have had an impact, mitigating investment in the natural environment is essential if ecosystems are to be brought back to past levels of health and productivity.

The cost of fishing fleet adjustment

The world's current fishing capacity is widely estimated to be 2.5 times more than what is needed to land the maximum sustainable yield (MSY) (Pauly et al. 2002). This implies that in order to shift the fishing industry to MSY levels, we would need to trim excess fishing capacity. However, the cumulative power of the global fleet is presently increasing at a rapid rate, notably in Asia (Anticamara et al. in press).

It is estimated that some 4 million boats[6] are actively engaged in marine fisheries. If we assume that current fishing capacity is between 1.5 and 2.5 times the level needed to maximise sustainable catch, fishing effort would need to be reduced by between 40 and 60 per cent. This means that the active fishing fleet may need to be reduced by up to 2.4 million vessels. This calculation does not, however, account for differences in fishing capacity by vessel type. For instance, areas dominated by large-scale vessels (i.e., vessels larger than a given size, which varies from one country to another) may need to reduce fewer vessels than areas with more small-scale boats because large-scale operations represent greater fishing effort per unit.

It is estimated that the fishing industry employs more than 35 million people, which implies that between 15 and 22 million fewer fishers would be required in a green-fisheries scenario. However, research indicates that up to 75 per cent of fishers in Hong Kong would be willing to leave the fishing industry if suitable compensation were available (Teh et al. 2008). Alternative livelihood programmes that have been successful involve activities such as seaweed farming

6. Based on 2002 data and stagnant growth in fleet size as suggested by FAO trends. Available at http://www.fao.org/fishery/topic/1616/en.

Box 4: How improvement in fishing gear can contribute to green fisheries

The potentially devastating impact of trawling, especially in terms of damage to the sea bed and bycatch, is well known (Hall 1996; NRC 1999; Watling and Norse 1998) and has given rise to legislation such as the mandatory use of turtle-excluder devices in shrimp trawls and bans of trawlers in the in-shore waters of many nations. In California, a shift from trawls to traps in the state's spot prawn fishery in 2003 resulted in a significant reduction of rockfish bycatch (Morgan and Chuenpagdee 2003). Recent improvements to the design and use of fishing gear to minimise seafloor contact and to reduce bycatch, such as the use of the Nordmore grate in shrimp fishery (Richards and Hendrickson 2006) have been encouraging, but more investment is needed to address the impacts of large scale trawling and other high-impact fishing gear.

and recreational angling (Sievanen et al. 2005). Clearly, this is a difficult task for policy-makers to implement. Nevertheless, there are options:

Scenario one: An across-the-board fishing capacity cut
Assuming that the current global fishing fleet represents an average distribution of capacity throughout the world, we estimate that decommissioning of between 1.4 – 2.4 million vessels would be required. Similarly, between 15 million and 22 million workers would be removed from a green fishing industry. Based on vessel and crew data from the European Union (EC 2006), we calculate that the average cost of a vessel buyback is roughly equal to the average interest payments on a vessel for five years and the average cost of crew retraining is estimated as 1.5 years average annual crew wages. These values are estimated to be US$ 15,000 per vessel buyback and US$ 18,750 per crew retraining, respectively. Based on this information, we estimate that the total investment needed to reduce fishing capacity in this scenario to be between US$ 290 billion and US$ 430 billion worldwide. It should be noted that this total amount can be spread over time if necessary.

Scenario two: Accounting for catch capacity distribution differences
The above scenario assumes that, on average, vessels have similar catch capacity and impact ecosystems in similar ways. In fact, the distribution of fishing effort exhibits a great deal of variation around the globe (Anticamara et al. in press). Large-scale, high capacity vessels also tend to use more capital in place of labour so that the number of workers per weight of landings is lower than small scale fleets. For policy-makers concerned about reducing fishing effort while minimizing the impact on workers, it is probably prudent to focus on buybacks of large-scale fishing vessels.

The catching power of large-scale vessels implies that 160,000 of the world's 4 million fishing vessels catch the same amount of fish as the remaining 3.84 million vessels. Using data on fishing employment in small and large scale fleets (EC 2006), we calculate that, on average, large scale vessels employ about 3.6 times as many workers as small scale vessels. This implies that large scale fleets employ about 5 per cent of the world's 35 million fishers or 4.6 million workers. Combining these figures with our assumptions outlined above implies that cutting 130,000 – 160,000 large-scale vessels along with 1.4 – 1.7 million jobs supported by these vessels will achieve roughly the same green economy results as cutting 15 to 22 million fishing jobs across the board. In this scenario, the total cost of adjustment to green fisheries is between US$ 115 and US$ 175 billion since the high cost of worker re-training is minimised. The reason why the cost of greening world fisheries under this scenario is lower than under scenarios one and three is that the cost of compensating, re-training and re-settling small scale fishers is much higher in those two cases.

Scenario three: Global fleet capacity distribution
If large and small scale fishing vessels were evenly distributed around the globe, scenario two would be an effective strategy to minimise the effect on employment numbers by decommissioning only the large scale vessels and affecting a smaller number of workers. However, many large-scale vessels are concentrated in developed countries while small-scale vessels are mostly found in developing countries. Although the same green economy result could potentially be achieved by making cuts to just large-scale vessels, this would be ineffective in areas dominated by small-scale fishing that are currently overfished, such as in India and Senegal.

In this scenario, we explore the possibility of putting three-quarters of the responsibility for cutting fishing effort on large-scale vessels, with the remaining quarter filled by small-scale vessels. In such a case, reducing a combination of 120,000 large-scale vessels and 960,000 small-scale vessels would halve the world's fishing capacity. However, unlike scenario one, the effect on workers in this scenario is greatly reduced, requiring provisions to deal with 1.3 million large-scale workers and 8.3 million small-scale fishers. Also, in this scenario, we allow for differences in the cost of decommissioning and re-training to vary between large and small-scale vessels. Using data from Lam et al. (2010), we calculate that large and small-scale crew workers earn average wages of US$ 20,000 and US$ 10,000 per year, respectively. Furthermore, we determine that large and small scale vessels pay an average of US$ 11,000 and US$ 2,500 per year in capital costs. This implies that, following the same assumptions as scenario one, the average cost of decommissioning for large and small-scale vessels is US$ 55,000 and US$ 12,500, respectively. Likewise, retraining efforts for large and small-scale crew members are estimated to be between US$ 30,000 and US$ 15,000 per worker.

By focusing effort reductions on large-scale vessels, the total cost of adjustment to green world fisheries in this scenario is much less costly than the first scenario, requiring a one-time total investment of between US$ 190 billion to US$ 280 billion with a mean of US$ 240 billion to decommission vessels and provide for workers as they transition to other forms of employment. It would also be necessary to increase management expenditure by 25 per cent to US$ 2 billion on an annual basis.

Given the current distribution of large and small-scale fishing vessels in the world, both scenarios one and two appear to be unrealistic. Therefore, we use the cost estimates in scenario three in the following cost-benefit analysis.

3.4 Cost-benefit analysis of greening fisheries

As presented earlier, greening the fisheries sector would lead to an increase in value added from fishing, globally, from US$ 17 billion to US$ 67 billion a year. This is a net increase of US$ 50 billion a year. Given that the cost of restructuring the global fishing fleet under scenario three is a one-time investment of about US$ 240 billion, benefits would be realised very quickly if fish stocks recover fast. Discounting the flow of US$ 50 billion per year over the next 50 years at 3 per cent and 5 per cent, real discount rates represent a present value from greening ocean fisheries of US$ 960 and US$ 1,325 billion, which is between 4 and 5.5 times the mean estimate of the cost of greening global fisheries. This signals that there is a potentially a huge green advantage. Although a variety of assumptions are needed to produce estimates in this section, it is clear that economic gains from greening world fisheries are substantial enough to compensate for even drastic changes in these assumptions.

3.5 Managing fisheries

Effective management is crucial for ensuring a green marine fisheries sector, although this has so far proved difficult to achieve. Research suggests that implementing a form of management known as individual transferable quotas (ITQs), also known as catch shares, can explain the improvement and rebuilding of many fish stocks around the world (Costello et al. 2008; Hannesson 2004). However, it has also been argued by many authors that ITQs are no panacea and need to be designed carefully (Clark et al. 2010; Essington 2009; Gibbs 2009; Hilborn et al. 2005; Pinkerton and Edwards 2009; Townsend et al. 2006).

Catch shares can be an effective tool in controlling fishing pressure. Because they are underpinned by Total Allowable Catch (TAC) limits, they can constrain catch to sustainable levels and, therefore, become valuable management tools (Arnason 1995). Individual transferable quotas do not confer full property rights to the ITQ owner, and furthermore, it is widely acknowledged that even if they were to provide such rights, there are still conservation and social concerns to worry about (Bromley 2009). Understanding these limitations to ITQs as a management regime, where this tool is implemented, must be part of a broader management system that ensures that these limitations are addressed appropriately. Measures are needed to ensure that ITQs work to improve economic efficiency, while ensuring the sustainable and equitable use of the fishery resources and the ecosystems that support them.

Below are some of the strategies that are needed as part of an ITQ management system if it is to achieve economically, ecologically and socially desirable outcomes (Sumaila 2010):

- Individual transferable quotas must be supported by an arm's-length stock assessment unit that is independent of industry and backed by strong monitoring, control and surveillance (MCS) to deal with the lack of full property rights, which can lead to "emptying" the ocean of fish under certain conditions;

- Some restrictions on the ownership of ITQs to people actively engaged in fishing may be needed to mitigate against diluting ITQ performance when quota owners are different from those who fish;

- Measures to ensure resource sustainability by taking an ecosystem-based management approach including

Box 5: Illegal, unreported and unregulated fishing and the greening of fisheries

The FAO identifies Illegal, Unreported and Unregulated (IUU) fishing as one of the major factors driving overexploitation of marine resources worldwide (FAO 2001). Based on case studies, MRAG (2005) estimate that the total loss due to IUU fishing is about 19 per cent of the total value of the catch. The commonly accepted economic reason for the persistence of IUU fishing is that detection rates and fines are too small relative to the catch value (Griggs and Lugten 2007; Kuperan and Sutinen (1998). In fact, Sumaila et al. (2006) suggest that the reported fines should be increased by at least 24 times to equalise the expected costs and benefits.

To green fisheries and prevent overexploitation, it is necessary to reduce IUU fishing. The direct way is to strengthen monitoring and control through strict policy enforcement, and the indirect way is through economic incentives, e.g., increasing fines or decreasing reporting costs. While reducing IUU fishing within a country using these direct and indirect ways is important, cooperation among countries is also very critical, since lots of IUU fishing occurs in the areas accessed by multiple countries.

Source: OECD (2004)

special attention to essential habitats, safe minimum biomass levels, input controls, etc.;

- Networks of reasonably large marine protected areas may be needed to accompany the implementation of ITQs to deal broadly with the ecosystem effects of overfishing, to allow for recovery, and to recognise uncertainty in the performance of ITQs. Such a network would benefit greatly by ensuring that it is designed to be compatible with conservation and ITQ goals and objectives;

- Imposing limits to quota that can be held by each quota owner, to mitigate social problems associated with the concentration of fishing power, although its effectiveness is very variable. It is worth noting that this is already a feature of many existing ITQ systems. In some fisheries, equity concerns may be alleviated by allocating quotas to communities or to residents of a territorial area in the form of community transferable quotas (CTQs) and territorial user rights in fisheries (TURFS), respectively (Christy 1982; Wingard 2000; Charles 2002). With such schemes in place, the economic efficiency benefits of ITQs may be captured while minimising negative social impacts; and

- Auctioning of quotas can be used in some fisheries to deal with the problem of initial allocation of quota and its equity implications (Macinko and Bromley 2002; Bromley 2009).

There are several areas of management where increased investment can be extremely beneficial. These include:

- Stock-assessment programmes;

- Monitoring and control programmes; and

- Establishment of marine protected areas (MPA).

Stock assessment programmes are basic for fishery managers who require reliable statistics to inform them of the state of fish stocks so that they may keep a careful eye on whether fishing effort is appropriate for the sustainable use of the stock (Walters and Martell 2004).

Monitoring and control programmes are those that allow fisheries managers to determine whether fishers are acting in compliance with catch quotas or not. Such programmes are also necessary in terms of mitigating the impact of illegal and unreported fishing activities.

Historically, MPAs have not been used as a major tool in the management of the world's fisheries. However, their role as a management tool has become more popular in recent years. Marine Protected Areas attempt to maintain the health of fish stocks by setting aside an area of the ocean that is free from fishing activity – allowing mature fish in these areas to escape into unfished areas, thereby ensuring the future resilience of the fishery.

4 Enabling conditions: Institutions, planning, policy and regulatory reform and financing

4.1 Building effective national, regional and international institutions

The root cause of overexploitation of fish stocks is the lack of control over fish catches or fishing capacity, or both. Individual fishers competing with many others have an incentive to take as much fish as quickly as they can. If this incentive is not controlled, the result of such uncoordinated efforts of many competing fishers is the depletion of fish stocks to the point of harming future fish catches, raising the cost of catching fish, and possibly wiping out fish stocks once and for all (Hannesson 2004; Hardin 1968; Gordon 1954. Fortunately, it has been shown over the past several decades that very often communities or groups of fishers develop institutions that can regulate the incentives and create the conditions for sustainability (Dietz, T. et al. 2003). This is not guaranteed to occur, however, and it is unlikely in industrial or high-seas cases, where other measures are needed.

In this regard, note that privatising use of the fishery resource is not necessarily advisable. Even if a fish resource is privatised, there are conditions under which the private owner may find it optimal to overfish the stock, sometimes to extinction (Clark 1973; Clark et al. 2010). This happens when the stock in question grows very slowly compared to the rate of discount, so that the present value of future catches is low, compared to the once-and-for-all gain from depleting the stock. However, such restrictions are not necessarily best imposed by a governmental fisheries administration. Successful examples around the world of community-based or fisher-led restrictions are common, often in conjunction with spatial or territorial limits.

We need effective institutions at all levels of government, from the local to the provincial/state to the national, regional and international because of the migratory nature of many fish stocks. Many fish stocks spend their lives completely in the Exclusive Economic Zones (EEZ) of countries – they do not migrate across EEZs of other countries or straddle into the high seas. For these fish stocks, effective national institutions are all that is needed. Then we have fish stocks that are shared by two or more countries, the so-called transboundary fish stocks that live completely within the EEZs of more than one country. For these fish stocks, participants in the fishery must agree on the management of the stock in order to make it effective (Munro et al. 2004). Then there are fish stocks that are partly or wholly located in what is left of the high seas. It has for a long time been a concern that the regulation of these fisheries is ineffective and that regulation of stocks that are governed by one or more coastal states but which straddle periodically into the high seas is undermined by the open access to the high seas. This prompted a conference on high seas fisheries in the 1990s under the auspices of the UN. This resulted in what is usually called the UN Fish Stocks Agreement, which vests the authority to regulate high seas fisheries in Regional Fisheries Management Organisations (RFMOs) (United Nations 1995), whose functioning was recently reviewed by Cullis-Suzuki and Pauly (2010b) and generally found wanting.

4.2 Regulatory reform

The basic requirement for a successful management of a fish stock is limiting the rate of exploitation to some sensible level. This necessitates 1) a mechanism to set such a target catch level and 2) a mechanism to monitor and to enforce it. The basic question to ask is whether the scientific, administrative and law-enforcing capability is in place to make this happen. The presence of strong social norms and cultural institution are great tools for enforcement where they work.

In practice, effective management institutions would have in place mechanisms for providing scientific advice, as well as a mechanism to set the rate of exploitation on the basis of that advice and in such a way that it maximises long-term benefits in the form of food supplies or fishing rent (difference between revenues and costs adjusted for subsidies). The latter requires an efficient and uncorrupted administration that strives for the best possible economic (or food supply) situation of the country in question (UNEP 2008).

As to the specific means by which the fisheries administration achieves its goals, these must be decided on a pragmatic basis. A limit on the total catch is perhaps the most obvious instrument to use, but there are circumstances where it might not be adequate. Catch limits are notoriously difficult to monitor in small-scale fisheries, and even monitoring the boats and their use need not be much easier in that context. Yet, it is quantitative restriction of either kind that is needed in order to limit exploitation of fish stocks.

It has been pointed out repeatedly and supported by empirical evidence that limiting fish catches alone achieves very limited objectives in the fisheries (Costello et al. 2008; Hannesson 2004). It may, and it often has, succeeded in maintaining the fish stocks at healthy levels, while leaving the industry in shambles economically, with short fishing seasons, inferior products, low economic returns, and even threats to life and limb through undue risk-taking encouraged by narrow time opportunities to catch fish. One way to deal with this is to allocate the total fish quota among the vessels or fishing communities in the industry and make the quota allocations transferable, where feasible.

4.3 The economics of fishery management tools

The basic fishery management tools can be grouped into 1) output controls; 2) input controls; and 3) auxiliary measures. Both 1) and 2) control the rate of exploitation, which is the fundamental factor that needs to be controlled, as stated earlier.

Output controls mean limiting the total amount of fish that can be caught. We do not know what this means in terms of rate of exploitation unless we know what the size of the fish stock is. This can only be estimated with a considerable and possibly high degree of imprecision. Nevertheless, catch quotas are often set on the basis of some target rate of exploitation, and to make any sense of them we must have a reasonably reliable idea about what the stock size is. This is admittedly an unlikely scenario in most fisheries of the world, which are small-scale and local in nature, and for which output controls may be of limited use. However, where feasible, the target output should be set on the basis of maximizing either food supply or fishing rent, depending on what is deemed most appropriate.

Where it is feasible to set a catch quota, and where there are strong monitoring and enforcement capabilities, it might be feasible to allocate the quota among the players in the industry, and make it transferable. This should help avoid wasteful competition for the largest possible share of a given catch and to achieve a reasonable correspondence between the fleet capacity and the available catch quotas. We stress reasonable, because there are several reasons why there is likely to be some mismatch between fleet capacity and catch quotas. One is variability of the fish stocks, another is the remuneration system used on the fishing boats. The optimal solution is ideal, but in practice we are unlikely to achieve anything better than getting closer to it.

Under some circumstances, effort controls could be better than quota controls. This can happen if quotas are difficult to monitor, or if the size of the fish stock cannot be estimated while we can be reasonably certain that it is always evenly distributed in a given area so that a unit of effort produces a given rate of exploitation. A problem here is technological progress by which a unit of effort (say, a boat-day) becomes more and more effective over

Box 6: Updating international law on shared fish stocks

A shared fish stock is one that either 1) is a highly migratory species (i.e., tuna); 2) occurs in the EEZ waters of more than one political entity; 3) occurs in the high seas where it may be targeted by a multitude of fleets; or 4) any combination of the previous three. Often, the management of shared fish stocks is needed to counter what game theorists term the prisoner's dilemma, where parties sharing a stock would be better off cooperating on management initiatives but fail to do so because they are concerned other parties may free-ride on their investment in the resource.

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) was implemented to deal with some problems associated with shared fish stocks, giving special rights and responsibilities over near-shore marine resources to coastal nations. However, this agreement and the 1995 United Nations Fish Stock Agreement, which was meant to reinforce UNCLOS, have left the management of shared and transboundary fish stocks open to management problems that game theorists have predicted (Munro 2007). It is suggested that, in order to green fisheries that are shared or transboundary in nature, the body of international law concerning access rights in fisheries must be re-examined with a focus on the establishment of RFMOs with the teeth to oversee the use of these fish stocks; for such laws to be effective, international law should be reviewed as soon as possible – before serious harm to shared fish stocks occurs.

time. Such increases in effectiveness usually reach 2–3 per cent per year, and hence can double the impact of a fleet after two decades (Pauly and Palomares 2010). In fact, this method of management encourages technological progress for the sole purpose of catching more fish, even to the point of exceeding the target rate of exploitation. Some efficiency gains are likely to be realised through allowing trade in effort. The total effort should be determined on the basis of the same principles as the total catch quota.

Then there are several measures which are termed auxiliary, as they do not primarily address the basic problem of controlling the rate of exploitation but promote greater yields from fish stocks in various ways. One is selectivity of fishing gear (mesh sizes, for example). Larger meshes allow young, fast growing fish to escape capture and to be caught at an age when they have grown to a more appropriate size. Closing off nursery areas serves the same purpose. Protecting the spawning stock could be desirable, if the extent the size of the spawning stock is critical for recruitment of young fish. Regulations such as mandatory discarding of marketable fish are highly doubtful, as is mandatory retention of unmarketable fish. The rationale for such measures is to discourage people from seeking fish that they are not authorised to take. While this is indeed desirable, such regulations are economically wasteful and one should look for ways to achieve the desired outcome in less wasteful ways.

4.4 Managing the transition process

This would be most challenging when we are dealing with depleted fish stocks that need to be rebuilt. This situation arises because the capacity of the fishing fleet has outgrown the available resource, and so the fleet would have to be downsized. Both of these necessitate a cutback in fishing activity. Fish quotas that are lower than contemporary and recent catches which have depleted the fish stock are necessary to rebuild the stock. Such small quotas mean that some of the fishing capacity is redundant, and even with rebuilt stocks it is highly likely to remain redundant if a repeated depletion of the stock is to be avoided.

All this implies investment in the fish stocks as it were, through foregone earnings in the short-term for the purpose of obtaining higher benefits in the future. Likewise, having some boat owners leave the fishery means that they would be foregoing earnings they otherwise would have obtained, and those who leave would in any case not share in the higher benefits to be realised in the future. Since the justification for rebuilding fish stocks is higher future benefits, it would in principle be possible for those who remain in the fishery to buy out those who leave; in this way share the future income recovery with them (Martell et al., 2009). The problem is, however, that future income is an expected and not a certain variable, and the vagaries of nature could in fact greatly delay the realisation of any income recovery. Those who remain in the industry could, therefore, be reluctant to offer much of the income recovery they expect.

There is also a key issue in SSF, particularly a lack of access to capital, limiting the potential for this process. There is therefore a case for governments to come up with funds to finance the transition from overexploitation and overcapacity to an optimally exploited fishery with optimal fleet capacity. It should be stressed, however, that this is only bridge financing; in due course those who remain in the fishery should pay back the loans they got for the transition. Anything else could create the expectation that boat owners in an overexploited fishery will always be bought out, which could entice people to invest in overcapacity purely on the expectation of being bought out later.

4.5 Learning from successful international experience

There are a number of cases of successful transitions from an overexploited fishery, or a fishery with overcapacity, to a better managed fishery, albeit not fully optimal. Below is a non-exhaustive selection of these cases and their most salient features are mentioned.

New Zealand

One of the early cases of control by ITQs is the bottom trawl fisheries in New Zealand. One interesting aspect of how that regime was implemented in the inshore fishery was how excess fishing capacity was bought out by having fishers tendering quotas. These buyouts were, however, financed with public money and never recovered; plans to charge resource rentals were abandoned early on. This case is well documented in a number of papers (Ackroyd et al. 1990; Batstone and Sharp 1999; Clark et al. 1989; Hersoug 2002).

Pacific halibut

Individual transferable quotas were first introduced in the Canadian halibut fishery. One noteworthy feature is industry participation and payment for monitoring of quotas. Another lesson is how individual quotas provide economic benefits in the form of higher catch value due to longer fishing season and more leisurely fishing (Fox et al. 2003; Rice 2003; Turris 2000; Wilen 2005).

Ayvalik-Haylazli Lagoon fishery

The Ayvalik-Haylazli Lagoon fishery, near a major agricultural and commercial centre city in Turkey, is an example of successful community management (Berkes 1986). In this fishery, fishers from three neighbouring villages formed a cooperative in 1994. This cooperative organised fishers to cooperate in work to reduce fishing costs and restricted the resources access only to those members.

Alaska Regional Fisheries Association
This association, formed by fishers themselves to conserve and rebuild salmon stock in the middle of 1970s, is another successful case of fishery management. By self-imposing a tax of 3 per cent of the value of their catch, the association was able to increase salmon abundance and benefit the fishers (Amend 1989).

Fisheries adjustments in Spain
Starting in the mid-1970s, the extension of national fisheries jurisdiction into 200-nautical mile exclusive economic zones forced Spanish distant fishers were forced to depart from various fishing grounds where they had fished for decades, if not centuries. This resulted in a decline in employment by roughly a third over a few decades. However, government-supported unemployment subsidies, training programmes, public investment and transfers to new sectors, such as fish farming, fish processing and coastal tourism, enabled Spanish communities that were reliant on fishing to ensure a continued high standard of living and to avoid any major social crisis, despite a significant decline in fisheries employment (OECD 2000).

The lessons that can be learned from these cases are the following:

■ It is important to find an initial allocation of a quota that is generally understood to be equitable and immune to challenge as far as possible (there might always be controversial cases, however);

■ The allocation criteria should be fixed as quickly as possible, to avoid positioning such as participation in the fishery or investment in boats only to ensure inclusion in the system. The latter aggravates the overexploitation and overcapacity prior to establishing a quota system (bringing loans only);

■ There may be a case for government to help with the provision of funds, to be paid back later, to buy out excessive fishing vessels;

■ Equitable distribution of gains from individual transferable quotas is important, in order to avoid challenges on the grounds that the quotas make only a few people rich and leave little for the rest of society. Note that these challenges can emerge well after the quota system is established and even if the initial allocation of quotas was deemed acceptable, as gains from a quota regime take some time to emerge;

■ There can be very substantial gains from individual quotas, in the form of lower fishing costs and a higher catch value. Not all these gains are due to rebuilding of fish stocks. Some are due to less fishing capacity used, others to longer fishing season and more leisurely fishing; and

■ Under certain circumstances, fishing communities have the potential to maintain resources sustainably (Berkes et al. 2001; Ostrom et al. 1999).

4.6 Financing fisheries reform

As shown earlier, green fisheries require accessing or raising the necessary funds to meet the economic, environmental and social goals in order to: ensure the long-term future of fishing activities and the sustainable use of fishery resources. Financing is required for measures to adapt the fishing fleet; promote the use of appropriate gear; strengthen markets in fishery products; promoting partnerships between researchers and fishers; diversify and strengthen economic development in areas affected by the decline in fishing activities; and provide technical assistance and (human) capacity building in developing countries.

Activities aimed at greening the fisheries sector are diverse and would take place at the local, national, regional and global levels. Financing arrangements or options would also have to be tailored to meet the needs at these levels. We must also keep in mind when considering options for financing fisheries reform that ample investment may not be sufficient for greening the fisheries sector if not combined with effective management regimes.

Public investment in fisheries reform
Since fisheries are considered by many to be a public resource and the public has much to gain through improved management, significant public investment in this industry can be justified. Public funding for fisheries sustainability includes direct funding from national budgets, contributions from multilateral funds, resources raised from capital markets backed by government guarantee and a share of government taxes, levies or revenues earmarked at a national level for a fisheries fund. A Global Fisheries Fund (GFF), run by the United Nations, along the lines of the Global Environmental Facility (GEF), can be set up. Funding from various public sources can be pooled for greening the fisheries sector. A high level forum on international fisheries finance can be established to bring together key decision makers from the public and private financial sector, as well as international financial institutions. It could regularly review funding availability and expenditure and provide recommendations for improvements.

National fisheries reform funding opportunities
National fiscal incentives can be a powerful source of investments for green fisheries since political economy problems that would normally be encountered in trying to raise funds at the regional and/or global levels can be avoided. Such sources of investment may be most effective when the distribution of fishery resources is fairly well contained within national boundaries. However, given the transboundary nature of many marine species such as tunas that are targeted by many countries, national funding programmes may fail to generate adequate funding to green some fisheries. Two fiscal incentive programmes that can be effective for funding fisheries investment are Environmental Fiscal Reform (EFR) and the redirection of harmful subsidies to green activities. These are:

Environmental Fiscal Reform refers to a range of taxation and pricing measures which can raise revenue while furthering environmental goals (OECD 2005). In the absence of taxation, the financial benefit from exploiting fisheries resources are fully captured by the private sector, without compensation to society at large. Additionally, individual operators have little direct incentive to restrict their catch, since they do not, individually, derive any direct benefits from doing so while others continue to over-exploit. Imposing levies on the volume of catch, in combination with proper management measures – which may include restricting access to fishing grounds – can be effective in both generating revenue to compensate the owners of the resource, (i.e., the country whose fishing stocks are being exploited) as well as create a natural incentive to reduce fishing effort.

Redirection of Subsidies or elimination redirecting existing harmful subsidies in the fisheries sector globally can provide a significant additional source of financing for greening the fisheries sector. Fisheries subsidies have been estimated at some US$ 25-30 billion annually (Sumaila et al. 2010). Limiting subsidies to those used for management, the so-called, beneficial subsidies, would generate savings of about US$ 19 billion annually, which can be reallocated to finance green fisheries initiatives.

Regional financing arrangements
A regional financing facility or mechanism is one in which:

■ the activities it funds are limited to a given region (e.g., the Coral Triangle in the Western Central Pacific or West Africa); and

■ the arrangement's member countries from within a given region have a substantial role in decision-making (Sharan 2008).

Regional financing of the greening of fisheries is important for a number of reasons. First, while the issue of fisheries sustainability is a global one, it has strong regional dimensions as well. Obstacles and measures required to adapt depend on regional biological and political landscapes and as such, would not be identical for all regions. The decline of the fish stock and its impacts is unlikely to be confined within any one country, and one country would not be able to address such impacts alone. Thus, regional financing arrangements would strengthen the overall global collective action for greening fisheries. A regional approach also offers proximity benefits such as closer interaction and learning, and lower transaction costs. A regional financing arrangement can also attract additional resources within the region as countries feel that they are in charge of decisions. In this regard, Regional Fisheries Funds can be set up in various regions of the world.

Private investment in fisheries reform
Venture capital and private equity – Consumers are increasingly sensitive to the wider impacts of unsustainable fishing practices as they are with climate change. The result has been consumer pressure for products that are certified as environmentally friendly or consistent with sustainability. Emerging high growth sectors have traditionally been a target for venture capitalists, who invest in entrepreneurial activities and expect high returns for their risks. Markets for sustainable products and services such as eco-tourism and certified seafood can present attractive sources of income for the management of protected areas and their surrounding communities. Enabling productive projects for private sector actors in protected areas, with specific profit sharing agreements, have the potential to be an important potential source of financing.

Public-private partnership
While the public and private sectors have important roles to play in generating new sources of funding for greening the fisheries sector, the mechanism of a Public Private Partnership (PPP) where the public sector's investment is leveraged to attain private sector participation in projects with public good characteristics can be applied in the fisheries sector.

Evaluation of financing options
There are a myriad of financing options that have been outlined above ranging from those best implemented at national or global scales and those operated by public or private entities. Given the common property nature over much of the world's oceans living resources, which is detrimental to the success of private investment, it is unlikely that this avenue can be expected to fill much of the needed investment. That said, where sufficient access rights and regulations exist, this environment has the potential to spawn a great deal of innovative

private business activity that can be effective in both greening fisheries as well as driving new employment opportunities and wealth creation.

In regions of the world where rights are difficult to implement or communities prefer other forms of management, it is clear that the public has a large role in investing in green fisheries. This is an opportunity for public funds to be used in an area that will create jobs and yield benefits for public resource owners. National strategies such as environmental fiscal reform are likely to be successful in cases where fish stocks remain within national boundaries. In other cases where stocks travel between the boundaries of two or more countries, regional or global strategies such as market based levies combined with international cooperation have a great deal of potential. Even in cases where green investment is to operate at the national level, international cooperation on topics such as the redirection of fisheries subsidies can be highly influential in driving change.

5 Conclusions

Our analysis confirms that global marine fisheries are underperforming both in economic and social terms. Greening the fisheries sector by rebuilding depleted stocks and implementing effective management could increase the overall marine fisheries catch, and raise the economic contribution of ocean fish populations to the global economy.

While important efforts have been made in national fisheries administrations around the world, and through regional fishery management organisations, more is needed to enhance the management of the resources in a green economy context.

In order to achieve sustainable levels of fishing from an economic, ecological and social point of view, a serious reduction in current excessive capacity is required. Given the wide difference in the catching power, the job creation potential, and the livelihood implications of large-scale versus small-scale fishing vessels, it appears that a reduction effort focused on large-scale vessels could reduce overcapacity at lower socio-economic costs to society.

This chapter demonstrates that greening the fisheries sector would cost billions of dollars. However, the gains from greening would more than pay for the investments. Most of the cost involves helping the fisheries sector adjust to lower fishing capacity, which is a prerequisite for greening the fisheries sector and keeping it economically viable over the long-term.

The contribution revealed that there are successful experiences with mechanisms to manage the transition and adjustment within the fishing industry, through vessel buyback programmes, compensation, provision of social security and retraining programmes for fishers, to learn from and build upon.

More investment is required to improve fisheries management in most parts of the world. This would enable a more effective implementation of all management tools that have proven to be effective, including stock assessments, monitoring and controlling programs, transferable and non-transferable quota systems, and expanding marine protected areas. In addition, strengthening fishery institutions both in national administrations and regional fishery management organisations would allow a more effective governance and management of resources within and outside nations' Exclusive Economic Zones.

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