

Green Economy Report

Fisheries Chapter

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List of Acronyms

F_{MSY} – Fishing Effort at MSY
FAO – Food and Agriculture Organization
ITQ – Individual Transferable Quota
IUU – Illegal, Unreported and Unregulated
MCS – Monitoring, Control and Surveillance
MPA – Marine Protected Area
MRA – Marine Recreational Activity
MSY – Maximum Sustainable Yield
OECD – Organization for Economic Cooperation and Development
R – Internal rate of growth of a stock
SSF – Small scale fisheries
TAC – Total Allowable catch
UN – United Nations
UNEP – United Nations Environment Programme
USD – United States Dollars
WTO – World Trade Organization
WWF – World Wildlife Fund

Objectives

The overall aim of this chapter is to demonstrate the current economic and social value of marine fisheries to the world even in their current depleted states, and more importantly, estimate the full potential economic and social value to the world if the sector were managed sustainably in a green economy framework. An important goal is to discuss the enabling conditions (institutional; investment; incentive; financing; technological, etc.) needed to move global marine fisheries from their current overcapitalized and overfished states to more sustainable and green ones.

More specific objectives of the chapter are:

- Contribute to gaining a better understanding of the contribution and impact of marine fisheries and fishing activities to the global economy;
- Demonstrate the potential gains of global fishery reform to national, regional and the global economy from the perspective of sustainable economic development, saving and creating gainful employment, and sustainable management of fishery resources;
- Estimate the financial requirements for investing in fisheries conservation and sustainable use and compare these to the long-term economic, social and environmental gains;
- Demonstrate that long-term economic benefit in investing in rebuilding fisheries and in improving fisheries management is higher than the actual shorter-term costs.

0. Key messages

- Global marine fisheries are currently underperforming in economic and social terms. This conclusion is in agreement with the general consensus in the literature and in management circles;
- Still, global marine fisheries currently contribute to the world both economically and socially by:
 - delivering annual profits to fishing enterprises worldwide of about US \$8 billion;
 - directly and indirectly supporting 170 million jobs and US \$35 billion fishing household income a year.
- However, the owners of the resource (citizens of world) currently receive negative US \$26 billion a year from fishing because the sector is subsidised to the tune of about 27 billion a year.

- Hence, the total added value from current global fisheries, which is the sum of payments to labour, capital (profits) and resource rent, is US \$17 billion in 2005.
- In addition to the fisheries direct benefit listed above, global fisheries support significant numbers of jobs, marine recreational activities, and impact positively on economy through contributions along the fish chain at the way until the fish is served in a restaurant, for example;
- Greening the fisheries sector by rebuilding depleted stocks and putting in place effective management could increase marine fisheries catch from about 80 million t. to an estimated 113 million t. a year. This gives a total catch value or gross revenue of about US \$120 (against the current US \$85) billion annually.
- Greening the fisheries sector is likely to deliver annual profits to fishing enterprises worldwide of about US \$11 billion;
- Support total global fishers household income of US \$44 billion a year in a green economy scenario;
- The resource rent from global fisheries are estimated to increase dramatically from negative US \$26 to positive US \$10 billion a year;
- The total added value to the global economy from fishing in a green economy scenario is estimated at about US \$70 billion a year;
- The estimated total cost of ‘greening’ the fisheries sector worldwide is US \$220 and US \$320 billion worldwide;
- If the gain in annual added value from fishing in a green economy, which is US \$53 billion), is discounted through time at 3% and 5% real discount rates, we obtain present values of benefits from greening the fishing sector of US \$1,053 and US \$1,756 billion, respectively, which is about 3 to 5 times of the high end estimate of the cost of greening global fisheries.
- So, even without counting the potential boost to recreational fisheries, multiplier and non-market values that are likely to be realised from greening the fisheries sector, the potential benefits are at least 3 times the cost of the investment needed.
- Our report identifies a number of tools and management instruments 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.
- Finally, we identify a number of ways by which the cost of greening the fisheries sector can be paid, ranging from the global to the local, and the public to the private sector.

1. Introduction

1.1 What does this chapter do?

The fisheries sector consists of three main parts: (i) marine; (ii) aquaculture and (iii) inland fisheries. This contribution focuses on marine fisheries. It discusses aquaculture only with respect to how it relates to the marine fisheries sector. The chapter does not treat the inland sector because it is quite diverse and involves a different set of experts to deal with it.

This chapter discusses the marine fisheries sector with respect to how to ‘green’ it. For fisheries, we interpret ‘greening’ the sector to mean rebuilding overfished and depleted fish populations so they deliver maximum sustainable yield, and sustaining them at this level through time, for the benefits of both current and future generations of fishers and non-fishers alike. There is general consensus that, in general, most capture fisheries of the world are in crisis (e.g., Pauly et al., 2002). However, there are a few fisheries that are reasonably well managed (e.g.), which means that there are some success stories to learn from in our effort to move global fisheries from their current to a green economy state.

1.2 Why is the chapter important?

Fish populations are probably the most important renewable resources of the global ocean in ecological, economic and social terms. Over time they have contributed significantly to the global economy, provided seafood to feed millions and jobs and incomes to many. Even in their current ‘ungreen’ state, ocean fish populations contribute significantly to global wellbeing as explained later in this paper. There is the potential for this contribution to increase significantly after ‘greening’ the sector. Ocean fish populations are important to many ecological processes, for example, a recent paper published in *Science* shows that the droppings of ocean fish populations serves as an effective carbon sink by absorbing CO₂; they contribute to the economy of the world along the complete fish chain, starting from fishing all the way to final consumption. Ocean fisheries are very important in providing food security and livelihood to many coastal communities, especially, in the developing world (e.g., Pacific island countries, West African countries).

As coastal populations continue to grow, the future benefits these resources can provide will depend on how well we succeed in greening the sector. We present, in this chapter, a summary estimate of the current economic contributions from ocean fish populations, and what they could be if the sector were greened; and under what institutional conditions we can achieve maximum economic benefits while conserving these vital renewable ocean resources for the benefit of all generations.

Often, fisheries managers feel pressured to sacrifice the long term health of marine fish resources in favor of short term economic needs of the fishing industry and consumers of fish. Gaining a better understanding of the potential contribution and impact of marine fish populations on the global economy may provide a broader, longer term,

economic perspective for fisheries managers. In this way, the world may be motivated to balance the increasing demands on fisheries with the limits to the capacity of oceanic and coastal fish stocks in the context of a green economy.

1.3 How is the chapter organized?

We present in the next section current challenges and opportunities in global fisheries with emphasis on catch and catch values; number of jobs and the contribution of recreational and tourism values to the global economy. Section 3 estimates current economic and social benefits from marine fisheries. In Section 4, we focus on scenarios of increased investments, and estimate the potential costs and benefits of rebuilding depleted fisheries. We devote Section 5 to the discussion of how to finance investments in rebuilding. We present various approaches to creating enabling conditions for a green global fisheries sector. We discuss the nature and types of institutions, both national and international that are needed to help move the fisheries sector from its current to a green economy state.

1.4 What are the connections between this chapter and the rest of the report?

This chapter is connected to the ‘Modeling’ and ‘Enabling’ chapters. In the case of the former, some of the data in this chapter have been provided to the Modeling chapter group for their use, and results from this group will be compared with some of our results. On the ‘Enabling’ chapter, the sections in our report that deal with how to move current fisheries to a green one could feed nicely into this chapter. Also, the work of the ‘Enabling’ team can inform our work. We also expect the work of the forestry and water teams to relate to the work of our team.

2. Challenges and opportunities in the global fishery industry

2.1 Catches from world oceans (volume & gross output value)

Since 1950, the total output from marine capture fisheries¹ has risen from 16.7 million tonnes in 1950 to 80.2 million tonnes² in 2005 (Figure 1). Fishes made up 86.2% of the total landings, with crustaceans, molluscs and other invertebrates accounting for 6.0%, 7.7% and 0.1%, respectively. The total landed value (gross output value) of the world’s marine capture fisheries was about US \$20 billion³ in 1950; increased steadily to about US \$100 billion in the late 1970s and remained at that level throughout the 1980s despite further increase in the total landings.

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

² All landings figure reported here are corrected for the suspected over-reporting of fisheries statistics by China (see (Watson, Pauly 2001))

³ All values expressed in real 2005 US dollars.

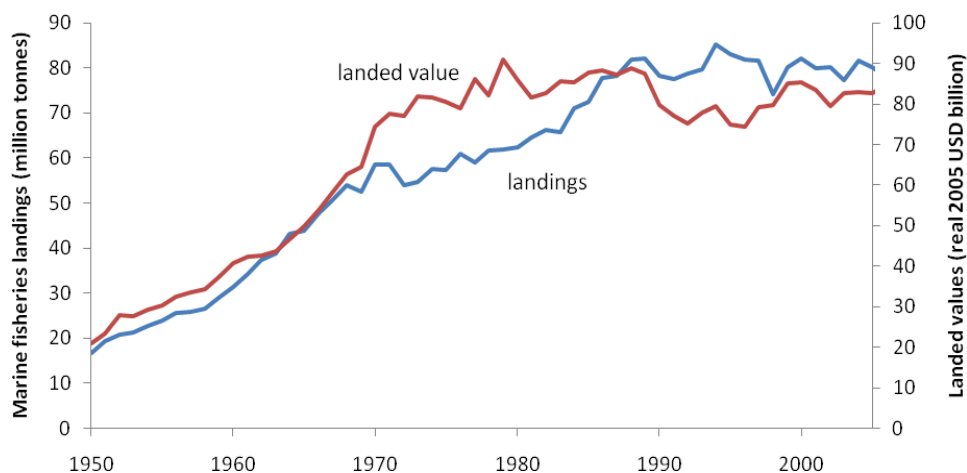


Figure 1: Total landings (blue) and landed values (red) from the world’s marine capture fisheries: 1950 to 2005.

From the late 1980s, the landed values have declined, recording US\$93.5 billion in 2005 (Figure 1). The decline in the landed value through the early 1990s correspond to the increase in the landings of low valued Peruvian anchoveta (*Engraulis ringens*) which accounted for over 10% of the total landings from 1993 to 1996, reaching 15% in 1994. About 60% of the total landings in 2005, by volume, and over 50% by value, were recorded by ten countries.

Table 1: Top ten marine fishing countries by landings (2005) ¹

	Landings (million tonnes)	Percentage of total landings	Landed values (billion 2005 real USD)	Percentage of total landed value
China	9.95	12	15.19	16
Peru	9.35	12	0.98	1
USA	4.79	6	4.22	5
Indonesia	4.39	5	2.36	3
Chile	4.33	5	1.26	1
Japan	4.03	5	14.38	15
India	3.34	4	3.28	4
Russia	2.98	4	3.20	3
Thailand	2.58	3	2.23	2
Norway	2.39	3	1.11	1

In terms of commercial groups, the value of non-tuna pelagic fisheries increased from US \$5 billion in 1950 to over US \$30 billion in the late 1970s before declining to about US \$17 billion in 2005 (Figure 2). The value for demersal fisheries increased in value from US \$6.5 billion in 1950 to a peak of US \$22 billion in 1971 and have since remained at around US \$20 billion. The value of tunas and billfishes increased steadily from US\$1.7 billion in 1950 to US \$20 billion in 2005 and now are the most valuable fisheries. Shrimp, squid, lobster and crab values all increased more or less steadily throughout the period, though their share in terms of value is still about 30%.

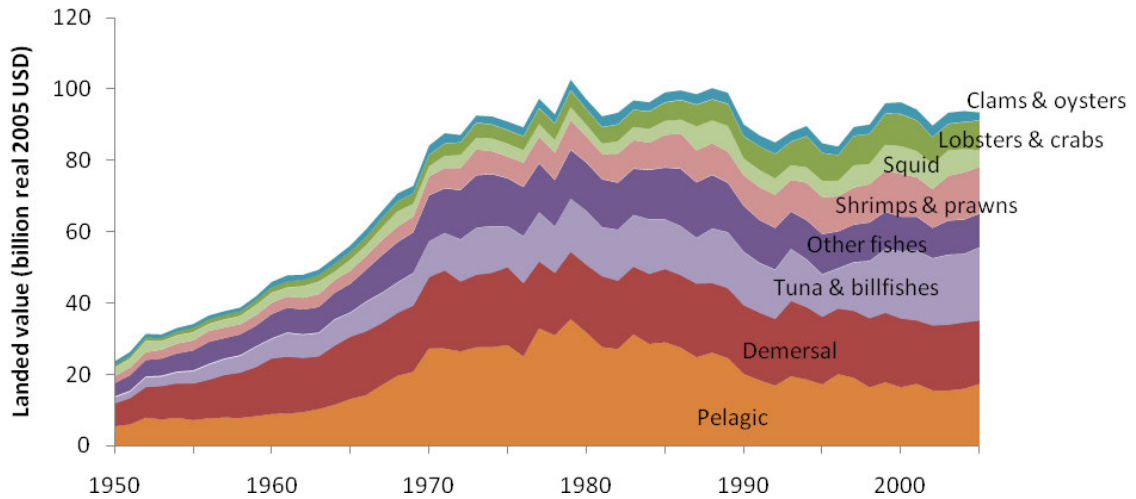
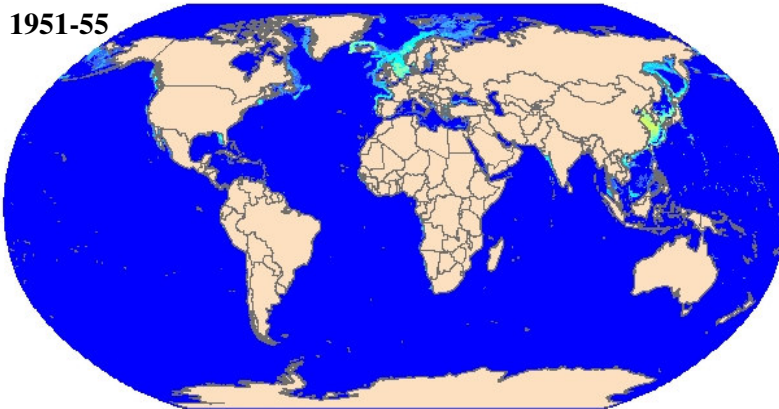


Figure 2: Total landed value by commercial groups: 1950 to 2005.

Figure 3 presents three examples of spatialized landed value maps, each representing the landed values of the world's fisheries over the five year periods of 1951-55, 1971-75 and 2001-05. In all three maps, concentrations in catch value can be seen in the productive coastal areas of Europe and Asia, as well as along areas of major upwelling such as the western coast of South America.

By the early 1970s, the areas with high values per area expanded particularly in Asia, but also along the Chilean coast, where large quantities of anchoveta were taken. By 2005, there was a contraction of the high value areas, particularly in the South China Sea. However, there has been a considerable expansion of the fisheries into the high seas, most notably in the North Atlantic and South Pacific.



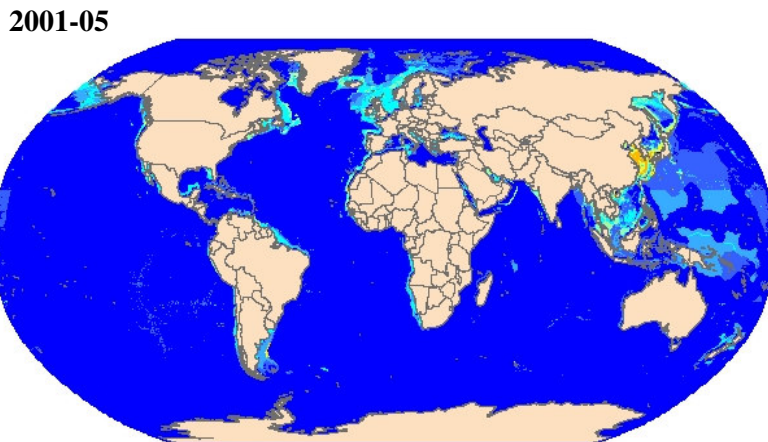
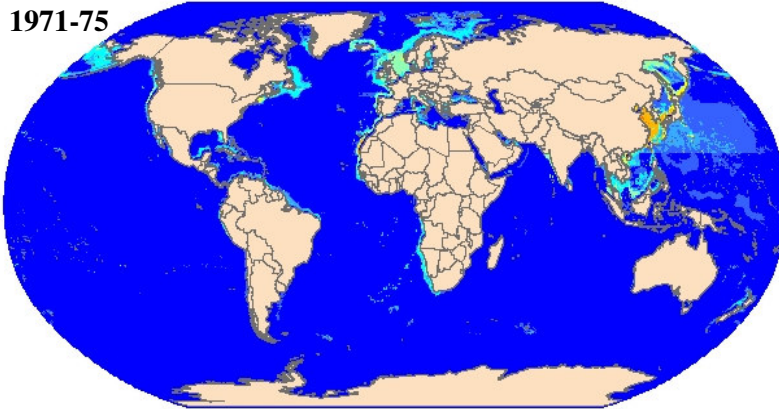


Figure 3: Spatial landed values⁴

2.2 Contribution to economic activity:

Recent estimates of gross revenues from capture fisheries suggest that this sector directly contributes between US \$ 80 - 85 billion to world output annually (World Bank 2008, Sumaila *et al.* 2007, FAO 2008?). This amount is by no means the total contribution from ocean fish populations. As a primary industry, there are a vast number of secondary economic activities – from boat building to international transport – that are supported by world fisheries (Pontecorvo *et al.*, 1980).

When fisheries output is combined with other sectors dependent on ocean resources its contribution to the economy can be much greater (Pontecorvo *et al.*, 1980). Hence, although the national contribution to output for many countries ranges between 0.5 – 2.5%, the industry supports more output throughout the national economy by way of ‘trickle-up’ linkages in the economy (Béné *et al.*, 2007). These linkages are referred to in the literature using the term ‘multiplier’, which, is a factor by which we can multiply

⁴ Each map represents a five year period from 1951-55, 1971-75 and 2001-05, respectively.

the value of an economic activity's output to obtain its total contribution to the economy, including activities directly and indirectly dependent on it.

The economic multiplier is used in fisheries research to emphasize that the industry has many linkages throughout the economy. Therefore, the importance of this industry to the economy may be understated when considering only the direct values obtained through the usual method of national accounting. The total value of fisheries sector catch is the value of fish when they change hands for the first time after leaving the boat. In input-output analysis, this is considered to be the direct economic value of fisheries sector output and is just one part of the total economic impact of this industry.

Dyck and Sumaila (2009) applied an input-output approach to estimate the total of direct, indirect, and induced economic effects arising from ocean fish populations in the world economy. While their results suggest that there is a great deal of variation in fishing output multipliers between regions and countries, when the authors applied the output multipliers to the ocean fisheries sector at the global scale, they find that due to significant indirect and induced effects (Table 2), the contribution of this sector to world output was more than four and a half times larger than the value of fish at first sale – about US\$ 380 billion per year.

Table 2: World fisheries sector output by region (US\$ billions)

	Landed Value	Indirect Effect	Induced Effect	Total Supported Output
Africa	2.10	2.47	4.29	8.86
Asia	49.89	53.81	114.80	218.50
Europe	11.45	15.74	28.74	55.94
Latin America & Caribbean	7.20	6.38	12.46	26.04
North America	8.23	8.90	30.08	47.21
Oceania	5.22	8.21	12.64	26.08
World Total	84.10	95.51	203.02	382.63

2.3 Jobs supported by global fisheries

Global fisheries provide livelihoods to millions of coastal inhabitants and contribute to national economies worldwide. In addition, 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 well-being of nations, through direct employment in fishing, processing, and ancillary services, as well as through subsistence based activities at the community level. Nearly one billion people worldwide, or about 20% of the global population, rely on fish as a primary source of animal protein (FAO 2009). The impact of fisheries collapse can be devastating, as evidenced by the Newfoundland cod crash of 1992, in which 18,000 direct jobs were

lost; fishing towns shrank in population by up to 20% and the Canadian tax payer spent billions of dollars to deal with the aftermath of the collapse (Hirsch 2002).

One hundred and forty four of the world's nations possess marine fisheries, which provide jobs for local and foreign workers. It is estimated that in 2006, there were 35 million people around the world who were directly involved either part time or full time in fisheries primary production (FAO 2009). This number expands to 170 million fisheries participants if post-fishing activities are included, and if extrapolated by an average of three dependants per fisher, it turns out that almost 8% of the world's population, or about 520 million people, are supported by the fishing industry (FAO 2009). There has been a steady increase in fisheries employment in most low-income and middle-income countries, while in most industrialized countries, the trend has been towards a decrease in the number of fishers in capture fisheries. For example, since 1970, the number of fishers has fallen by 61% and 42% in Japan and Norway, respectively (FAO 2009). Overall, fisheries employment was less than 0.2% in some coastal EU regions (Eliassen undated). But even in these countries, marine fisheries provide jobs in processing, restaurants, etc.

2.4 Recreational and tourism

Marine recreational activities (MRAs) such as recreational fishing, whale watching and diving have recently come to the forefront of discussion and research regarding their ecological, economic and social impacts and importance (e.g., Aas 2008; Pitcher 2002; Hoyt 2001).

To estimate the value of MRAs, Cisneros-Montemayor and Sumaila (2009) first identify three indicators of socio-economic value in ecosystem-based marine recreational activities, which are (i) the level of participation; (ii) the total employment in the sector; and (iii) the sum of direct expenditure by users. A database of reported expenditure on MRAs is then compiled for 144 coastal countries. Using this database, a meta-analysis is performed to calculate the yearly global value for MRAs in terms of expenditure, participation and employment.

Cisneros-Montemayor and Sumaila (2009) find that recreational fishing takes place in 118 maritime countries around the world; country-level data on expenditure, participation and employment is found for 38 of these countries (32% of total). The authors estimate that in 2003, nearly 60 million recreational anglers around the world generated a total of about US\$ 40 billion in expenditure, supporting over 950 thousand jobs. In their analysis, countries with data account for almost 95% of estimated total expenditures and 87% of participation, so the authors argue that this estimate likely provides a close approximation to actual recreational fishing effort and expenditure.

Data on whale watching was 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. The estimated total expenditure by these participants is US\$ 1.6 billion for the year 2003 (Cisneros-Montemayor and Sumaila, 2009). Based on available data, it is estimated that 18 thousand 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 marine mammals are found in all of the world's oceans

(Kaschner *et al.* 2006) and currently only a few countries have well-established whale watching industries.

There is limited country-level data on recreational diving outside of the U.S.A., Australia, and to some extent, Canada and the Caribbean region. Using market surveys and other data on active divers (Cesar *et al.* 2003), it is estimated that every year, 10 million active recreational divers and 40 million snorkelers around the world generate over US\$ 5.5 billion (2003) in direct expenditure, supporting 113 thousand jobs.

In total, Cisneros-Montemayor and Sumaila (2009) estimate that 121 million MRA participants generate US\$ 47 billion in expenditures annually and support over one million jobs (Table 3).

Table 3: Estimated global participation, expenditures and employment in ecosystem-based marine recreational activities in 2003.

	Total	Recreational Fishing	Diving and Snorkeling	Whale Watching
Participation (Millions)	123	60	50	13
Expenditure (USD Billions)	47.1	40	5.5	1.6
Employment (Thousands)	1,081	950	113	18

3. Current economic and social benefits from global marine fisheries

3.1 Cost of fishing

Fishing costs play an important role in economic analysis fishing, and thus are useful pieces of information for sustainable fisheries management policy decision and planning processes (Sainsbury and Sumaila 2001, Le Gallic 2002, Christensen *et al.* 2009). This indicator is useful for monitoring and assessing the economic performance of fisheries and the impact of fisheries in a broader extent. However, most of these data are neither well documented nor readily available. Deficiency of these data may lead to inaccurate estimation of management options.

Although fishing cost is important information in analyzing, managing and studying fisheries, a global cost of fishing database did not exist until now. Fishing cost data in most of the countries and regions is scarce, widely scattered and incomplete. There are several reasons for the fishing cost data deficiency and they include fisheries enterprises are generally reluctant to disclose their fishing cost information because this information might be essential to their competitors (Obeng 2003). In addition, there is generally no mandatory law in most of the countries for fisheries to systematically record and provide this kind of information (Bonzon 2000, Gasalla *et al.* unpubl., Whitmarsh *et al.* 2000). Meanwhile, there is usually no mutual trust between the fishers and the government institutions. As fishing cost is not systematically collected by many

countries, there is no global data set of cost of fishing. On the regional scale, the Annual Economic Report (2005) on 'Economic performance of selected European fishing fleets' provides comprehensive cost and landing data for different vessel types operating in 20 European countries. For countries in other regions, fishing cost data of each country are usually collected by their own government and non-governmental bodies and these information are available on the website or reported in Annual Reports, for example, Japan (Statistics Department, Ministry of Agriculture, Forestry and Fisheries, 2006) and the United Kingdom (Sea Fish Industry Authority⁵). However, for a large proportion of countries, fishing cost data is not collected or not made available to the public by the government. Scattered information on fishing cost data can only be found in published and gray literatures of various fisheries studies. The United Nations Food and Agricultural Organization (FAO) also provides fishing cost information for some countries in its technical papers (e.g., Lery *et al.* 1999). However, FAO does not provide a comprehensive database of fishing cost on a global scale.

The World Bank and FAO (2008) attempted to estimate global fishing cost in the Sunken Billion project, a project that sought to evaluate the loss of economic rent due to the mis-management of world fisheries. They estimated the global total fishing operating cost (including fuel and labor) to be about \$80 billion annually in 2004. However, the cost information reported in the Sunken Billion project was only based on the detailed cost data of European fleets and India's fisheries. The fisheries of these countries only contributed about 8.5% to global marine fish landings (World Bank and FAO 2008) and hence the results might not be robust. In order to improve upon this estimate, Lam *et al.*, (in prep.) developed a new global cost of fishing database from which the authors provide a estimates of global annual variable cost per tonne of catch of US \$1,125 per tonne of fish landed. Thus, the total cost of landing 80 million tonnes in a year is US \$90 billion.

3.2 Cost of fisheries management

Following the FAO, the OECD, the World Bank and Sumaila *et al.* (2009), we define fisheries management cost here as the expenditure associated with enhancing the growth of fish stocks through conservation and monitoring of fishing effort. It consists of the following: i) cost of fisheries management programs and service; ii) fishery research and development (R&D); and iii) the cost of establishing and running marine protected areas (MPA). Fisheries management programs and service has four categories: (a) monitoring, control and surveillance programs; (b) stock assessment and resource surveys; (c) fishery habitat enhancement programs; and (d) stock enhancement programs.

Until recently, the cost of fisheries management is easily ignored in both academic studies and policy practices. For example, the most influential fisheries economics textbooks all but disregard management cost (Anderson, 1986; Clark, 1990), and in

⁵ Sea Fish Industry Authority (SeaFish): <http://www.seafish.org> Statistics. Last accessed in December 2009.

practice, fisheries managers usually hold an implicit assumption that management cost is relatively small to the policy benefit such that they simply exclude it from consideration in the policy design and implementation. But is this assumption true? If it is not true and there exist a significant amount of cost, it could change our understanding of the effectiveness of fisheries management in many ways including derivation of optimal exploitation paths and stock levels (Sutinen and Andersen, 1985) and choices of alternative policies.

Here, we provide a summary of a comprehensive estimate of the costs of fisheries management for 148 maritime countries in the world. Regional estimates of both the cost of fisheries management and the cost intensity, defined as the ratio of management cost to catch value can be found in Table 4 below. From the table, we see that the cost of fisheries management is far from being trivial. The global cost is about US \$7.95 billion a year, which is about 9.5% of the global annual value of marine fisheries catch. Among these six regions of the world, Asia has the highest management cost, US \$3,505 million, which is about 44% of the total global costs, while Africa has the lowest cost level at US \$301 million. The ranking of management cost from high to low is: Asia, North America, Europe, Latin America and Caribbean, Oceania, and Africa. We find that the cost intensity ranking from high to low changes to: North America, Africa, Oceania, Latin America and Caribbean, Asia and Europe. It is interesting to see that although Asia has the highest management cost in absolute terms, its intensity level is almost the lowest in these six regions. This is because Asia captures the lion share of total global catch values of ocean fisheries.

Table 4: Management cost and cost intensity by regions for the year 2003

	Fisheries management (USD billions)	Share of world management spending (%)	Landed value (USD billions)	Management cost intensity (%)
Africa	0.30	3.79	2.10	14.30
Asia	3.51	44.10	49.77	7.00
Europe	1.26	15.90	12.38	10.2
South and Central America	0.66	8.25	5.45	12.00
North America	1.59	20.00	9.21	17.20
Oceania	0.63	7.96	5.06	12.50
Total	7.94	100.00	83.97	9.50

The existence of significant fisheries management costs would raise a lot of consequent questions. First, who should pay the management costs? A common opinion is that the main beneficiary of management, the industry, should pay for this (Haynes, 1986). However, since fishery management has a characteristic of public policy, the service provision raises the next question: how should the cost recovery be implemented? Should we use taxation, entry fee or other alternatives? Last but not least, what is the optimal management level? Since management cost is not trivial, we need to reconsider the amount of management we should provide. These questions all need to be addressed in order to fully understand the global fisheries management cost.

3.3 Subsidies and other economic distortions

Fisheries subsidies are defined as financial transfers, direct or indirect, from public entities to the fishing sector, which help the sector make more profit than it would otherwise (Sumaila *et al.*, 2008). Such transfers are often designed to either reduce the costs of production or increase revenues. In addition, they may also include indirect payments that benefit fishers, such as management and decommissioning programs.

Subsidies have gained worldwide attention because of their complex relationship with trade, ecological sustainability and socioeconomic development. It is widely acknowledged that global fisheries are overcapitalized, resulting in the depletion of fishery resources (Hatcher and Robinson, 1999; Munro and Sumaila, 2002). Although many reasons have been ascribed to the decline of fishery resources, the contribution of subsidies to the expansion of capacity and overfishing cannot be sufficiently emphasized (WWF, 2001). Subsidies that enhance revenues or reduce fishing costs lead to a marginal increase in profit, thereby increasing participation and fishing effort (Sumaila, 2003). Subsidies that promote fishery resource conservation and management are, however, regarded as beneficial and necessary (Milazzo, 1998).

Sumaila *et al.* (2009) set out to estimate the amount and extent of several different subsidy types nationally, regionally and globally in order to determine the proportion of the estimated subsidies that contribute to increased fishing capacity.

Previous studies of global fishery subsidies have included estimates of US\$ 14-20 billion (Milazzo, 1998) and US\$ 54 billion (FAO, 1992). The Organization for economic Cooperation and Development (OECD), the WWF, the Asia-Pacific Economic Cooperation (APEC) and the United Nations Environmental Program (UNEP) have also produced significant data on fisheries subsidies. Regional estimates of about US\$ 12 billion have been provided for the Asia Pacific Rim (APEC, 2000) and about US\$ 2.5 billion for the North Atlantic (Munro and Sumaila, 2002). A more recent estimate of global fisheries subsidies stands between US\$ 30 and 34 billion for the year 2000 (Sumaila and Pauly 2006). Sumaila *et al.* (2009) builds on these estimates by collecting more recent data and improving the methodology for estimating missing data.

Khan *et al.* (2006), classified subsidies into three categories labeled the ‘good’, the ‘bad’ and the ‘ugly’. The basis for this classification is the potential impact of given subsidy types on the sustainability of the fishery resource. ‘Good subsidies’ enhance the conservation of fish stocks through time, e.g., subsidies that fund fisheries management. A new addition to ‘good’ subsidies is spending by governments to establish and operate marine protected areas (Cullis-Suzuki and Pauly, 2008). ‘Bad’ subsidies lead to overcapacity and overexploitation, e.g., fuel subsidies. ‘Ugly’ subsidies can lead to either the conservation or overfishing of a given fish stock, e.g., buyback subsidies, which if not properly designed, can lead to overcapacity.

After updating the database reported in Sumaila and Pauly (2006), the information therein was used to estimate and analyze subsidies paid by governments of maritime countries throughout the world in 2003 (Table 5).

Table 5: Fisheries Subsidies by category

	World total (US\$ billions)
Good	7.9
Bad	16.2
Ugly	3.0
Total	27.1

From the table, we estimated the total annual subsidies in marine capture fisheries to be US\$27 billion per year. Subsidies in the ‘bad’ category are the highest, totalling about US\$ 16 billion, with about 70% of this total provided in developed countries. ‘Good’ subsidies, which are also mostly provided in developed nations, are the next highest in total (US\$ 8 billion). Subsidies categorized as ‘Ugly’ contribute the least amount to the global total (US\$ 3 billion), with more than 90% provided in developed countries.

4. Scenarios of increased investment in world fisheries

4.1 *The need for and benefits of rebuilding fisheries*

A number of studies have shown that marine fisheries around the world have been devastated over the years (Pauly et al., 1998, FAO, 2007) to the extent that the FAO believes that only about 25% of the commercial stocks, mostly of low priced species, are currently underexploited (Arnason, *Technical Appendix*). Worm et al. (2006) estimated that by 2003, some 27% of the world’s marine fisheries had already collapsed in the sense that their current catch level was less than 10% of the maximum registered catch. Extrapolating these trends, the authors predicted that virtually all of the world’s commercial fisheries would have collapsed before 2050. Given all these, it must be the case that efforts to rebuild depleted fish stocks could pay big dividends. We present below estimates of the current contribution of global fisheries and, through modelling, predict the potential gain from rebuilding depleted marine fish stocks.

Box 1: Getting the incentives right with fisheries subsidies

Fisheries subsidies have been identified as an influential factor in world fisheries; financial transfers from government to the fishing industry are estimated to be in the order of \$US 25 – 30 billion per year or about 35 percent of the annual value of fisheries landings (Sumaila et al. 2009); some have even suggested that fisheries subsidies could be in excess of \$US 50 billion per year (FAO, 1995). Subsidies are important to consider in maintaining sustainable fisheries due to the potential for distorting economic incentives. When subsidies are directed to the fishing industry that reduce fishing costs or increase revenue, an incentive to fish beyond sustainable levels is created by such programs.

However, there are many different programs that are funded by government, from subsidizing the cost of fuel purchases and unemployment insurance to funding the development of new fishing technology. One way to green the world’s fisheries is to identify types of subsidies that are likely to induce unsustainable fishing practices and either eliminate these subsidy programs or re-direct the funding into programs that will help green world fisheries. The World Trade Organization (WTO) has been working towards developing an agreement on fisheries subsidies within the Doha round of trade negotiations that has great promise for halting the provision of fisheries subsidies successful.

4.1.2 Current contribution of fisheries

Direct benefits from fishing

As discussed earlier in this Chapter, global ocean fisheries caught an estimated 80 million t. of fish resulting in a total catch value or gross revenue of about US \$85 billion in 2005. We will use these numbers as the starting point of our analysis in this section.

The most upto date estimate of the variable cost of fishing worldwide is US \$1,125 per tonne of fish landed (Lam et al. in prep.). This cost includes returns to labour (that is, labour cost) and returns to capital or the normal profit to the fishing enterprise. Data in the cost of fishing database of Lam et al. (in prep.) shows that returns to capital or normal profit from the world fishing fleet is US \$7.73 billion, and payment to labour is estimated to be US \$34.94 billion a year.

The resource rent (the return to ‘owners’ of the resource, that is, all citizens of the world) from ocean fisheries is defined here as the difference between total (gross) revenues and total cost plus fishing subsidies not already captured in either the price of fish or the cost of fishing. As stated earlier, the most recent estimate of global fisheries subsidies is US \$27.1 billion a year. This includes an estimated US \$6.3 billion of fuel subsidies, which we believe is included in the total cost calculations of fishing enterprises. Since fisheries subsidies are provided by citizens of the world, the total estimated resource rent is negative US \$25.8 billion a year. Therefore, the net gain or added value to the world economy from fishing, which is the sum of payments to labour, profits made by fishing enterprises and the resource rent, is estimated to be US \$16.87 billion in 2005.

Indirect benefits from fishing

The total benefits from fishing do not consist of only the value of the catch when the fish change hands for the first time after leaving the boat. As stated earlier, when the input-output approach was used to estimate the total of direct, indirect, and induced economic effects arising from ocean fish populations in the world economy, it was found that due to significant indirect and induced effects the contribution of this sector to world output was more than four and a half times larger than the value of fish at first sale – about US\$ 380 billion per year.

Benefits from recreation and tourism

As stated in a previous section, there are about 121 million marine recreational activities participants worldwide who generate US\$ 47 billion in expenditures annually and support over one million jobs.

4.1.3 Potential contribution from rebuilding and sustaining fisheries

It is generally accepted that ocean fisheries are currently overcapitalized and overfished, and many have argued for a concerted effort to rebuild depleted fish stocks when and

where possible. The question we address in this section is: what are the potential gains, if any, from rebuilding ocean fish stocks. We discuss this in terms of potential increase in current catches, catch value, profits, resource rent, nutrition and employment.

To do this, we develop a green economy fisheries sector model, which is structured to achieve Maximum Sustainable Yield (MSY) (Vasconcellos and Cochrane 2005). Using this model, we predicted MSY, fishing mortality to achieve MSY (F_{MSY}), and current (year 2005) level of fishing mortality for each of the existing 18 FAO areas. Specifically, we applied a single-species population dynamic model originally developed by Vasconcellos and Cochrane (2005) to get these estimates. In this model, fishing population dynamics follow a simple logistic growth model with intrinsic population growth rate and carrying capacity as the leading parameters. Also, fishing effort changes according to stock abundance and such changes follow a logistic growth model, determined by parameters that determine the rate of investment in fishing effort and biomass (Vasconcellos and Cochrane 2005).

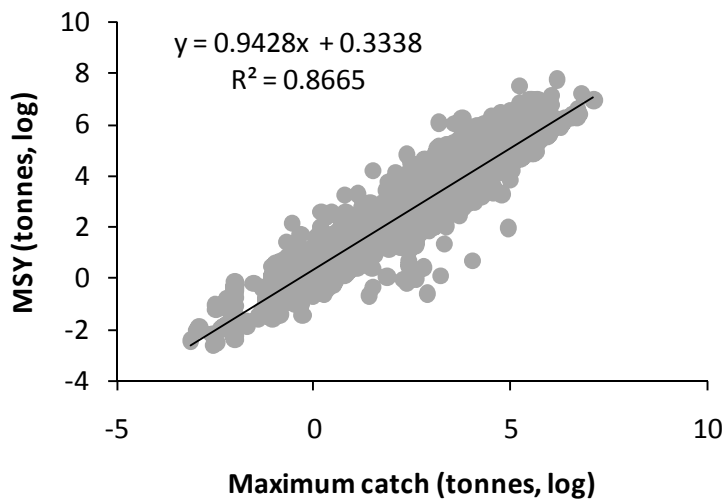
Catch time-series and species' life history data were used to estimate the model parameters. We defined exploited stocks based on the *Sea Around Us* global catch database (www.seaaroundus.org), in which each species that is caught from a specific FAO area is defined as a stock. For the modelling analysis, we only included species that are reported at the species level and those that have at least 10 years of data. To reduce the number of parameters to be estimated, we calculated the intrinsic population growth rate of each species using the Euler method (McAlister *et al.* 2001) based on life history data from FishBase (www.FishBase.org). We then estimated the carrying capacity, rate of fishing effort investment and biomass at bionomic equilibrium by fitting the predicted catch with observed catch using the maximum likelihood method. The outputs were then used to derive MSY and fishing effort at MSY (Hilborn and Walters 1993).

Next, we extrapolated from the model outputs to develop general scenarios of future catch for each FAO. The robustness of the estimated MSY varies between stocks according to how informative the catch time-series data is. Thus, we did not directly use model outputs to develop the scenario. Instead, we first developed a statistical relationship between maximum annual catch of a catch time-series (often assumed to be a proxy of MSY) and the estimated MSY across species (Figure 4). We then applied the relationship developed from this analysis to predict MSY for all reported taxa (including taxa reported in all taxonomic levels) in each FAO area.

For scenarios of future fishing effort, we developed a range of potential changes in fishing effort that would be required to achieve MSY. These were represented by the ratio between current fishing effort level (2005) ($F_{current}$) to the F_{MSY} that were predicted by the model. The range of estimates were calculated from assuming that (1) $F_{MSY} = R/2$, (2) $F_{MSY} = R/3$. Also, the aggregated $F_{current}/F_{MSY}$ values from stock-specific values for each FAO area were calculated from: (1) mean values weighted by the maximum catch of each stock (i.e., multi-species aggregated MSY); and (2) the 75 percentile of the stock-specific values (i.e., aiming to have at least 75% of the stocks fishing at F_{MSY}).

Table 6: Maximum sustainable yield MSY in tonnes) and current catch

FAO Area	Estimated MSY 2000s' catch	2000 catch/MSY	2000 catch/MSY
88	5,100	2,045	0.40
18	20,861	9,957	0.48
58	532,562	12,136	0.02
48	820,617	123,632	0.15
81	1,214,129	727,383	0.60
37	2,172,388	1,592,331	0.73
31	2,349,341	1,604,834	0.68
77	2,524,031	1,760,487	0.70
41	3,203,048	2,065,126	0.64
67	3,429,989	2,647,067	0.77
47	4,097,889	1,645,227	0.40
34	4,756,635	3,563,124	0.75
51	5,300,965	5,021,650	0.95
57	5,538,485	5,816,999	1.05
21	5,782,145	2,186,270	0.38
71	9,789,504	10,298,385	1.05
27	16,265,799	10,315,287	0.63
87	19,630,132	13,542,618	0.69
61	25,071,108	18,301,026	0.73
Total	112,504,728	81,235,582	0.72

**Figure 4: Relationship between maximum catch and sustainable yield***Direct benefits from fishing*

The main results from the simulations are given in Table 6 from which, we see that, currently (average annual catch in the 2000s) about 81 million tonnes of fish are caught from the world ocean per year. The table also reports that the current catch is 72% lower than the potential catch (at about 112 million t.) under effective management to achieve the maximum sustainable yield.

Let's make the following assumptions:

- Real price (nominal price adjusted for inflation) of fish is constant through time. There is evidence from historical data that real prices have not changed much in the last few decades;
- Cost of fishing will decrease (by 20%, because of the twin effects of higher fish biomass in the ocean under a green economy scenario and increasing technological progress);
- Since it is necessary that harmful subsidies are removed to achieve the goal of greening the fisheries sector, we assume that the estimated \$16 billion a year of harmful subsidy will be re-directed toward helping the transition to a green fisheries sector. Similarly, ambiguous subsidies such as those for buybacks will also be re-directed;
- The remaining annual subsidy of about US \$8 billion a year is money spent to manage fisheries worldwide. We assume here that this amount will continue to be spent on management after greening the sector.

Given the above assumptions, global ocean fisheries are projected to catch an estimated 112.5 million t. a year in a green economy scenario. This gives a total catch value or gross revenue of about US \$119.5 (1062*112.5) billion per year. The total cost of fishing in a green economy scenario is estimated to be US \$101.25 (900*112.5) per t. Returns to capital or normal profit from the world fishing fleet in a green economy is estimated at US \$10.7 billion (7.73*100/72), and payment to labour is similarly estimated to be US \$48.5 billion a year.

The resource rent for a green fisheries sector is estimated to be US \$10.28 billion a year (Gross revenue – total cost – management cost).

The total added value to the global economy from fishing in a green economy scenario is then estimated at US \$69.56 billion a year (Resource rent + payments to labour + normal profits).

Indirect benefits from fishing

With the global catch values increasing from about US \$85 billion to US \$119.5 billion a year in a green economy scenario, the total of direct, indirect, and induced economic effects arising from ocean fish populations in the world economy increases from US \$380 to US \$538 billion per year.

Benefits from recreation and tourism

In general recreational fishers do not necessary fish for the catch but rather for experience. Still, it should be reasonable to assume that a healthier ocean full of life is likely to increase the utility and therefore the benefits derived by recreational fishers.

However, due to the lack of information to calculate this we refrain from doing so in this report.

4.2 Investing in rebuilding fisheries

4.2.2 The financing and investment requirements

Greening of 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 will require some investment into rebuilding initiatives, management programs, and scientific research.

Box 2: Climate change impacts on global fisheries

Climate change will significantly increase the problems discussed in this report. Climate change has begun to alter ocean conditions, particularly water temperature, ocean currents, upwelling, and biogeochemistry, leading to productivity shocks for marine fisheries (IPCC 2007; Diaz and Rosenberg 2008). Other studies have documented shifts in species distribution (Perry and others 2005; Dulvy and others 2008) and growth rates (Thresher and others 2007) as a result of changes in ocean temperatures. Climate change may also alter the phenology of marine organisms, creating mismatches between prey availability and predator requirements and leading to coral bleaching and habitat loss for reef-associated fish species (Sumaila and Cheung 2008). These changes will affect the distribution and volume of catch worldwide thereby affecting global fisheries socially and economically.

4.2.3 Rebuilding 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 partly due to fishing subsidies. Also, the use of damaging fishing methods such as bottom-trawling, unselective fishing, pollution and human induced changes in climate have changed the productivity of many aquatic environments. Rebuilding initiatives for fisheries will involve practices that are designed to ease the impact of high fishing pressure caused by overcapacity or direct investment in the improvement of aquatic ecosystems that have been damaged by human activity.

The issue of overcapacity can be addressed by investigating some of the common sources of excess fishing capacity. In several places, fishing may be considered an employer of last resort where people with few other job options find themselves trying to make a living from fishing. One way to reduce fishing pressure, especially in areas dominated by artisanal fishers is to invest in re-training and education programs for fishers.

Fishing capacity can be further reduced by taking steps to directly reduce the effective fishing effort using decommissioning fishing vessels or reducing the number or available permits or licences. Much attention has been given to decommissioning programs, which are intended to reduce effort by reducing the number of fishing vessels. Unfortunately, some research suggests that vessel buyback programs may actually increase fishing effort if not implemented properly (e.g., Clark et al., 2005). This occurs when loopholes allow decommissioned vessels to find their way into other fisheries, whether they be local or in other parts of the world.

Box 3: Making vessel buybacks work for fisheries sustainability

Many strategies to green the world's fisheries focus on reducing current fishing capacity capable of catching far more fish than can be supported by the ocean. One solution proposed to reduce fishing capacity is to directly reduce fishing capacity through programs where government buys and decommissions gear and vessels from fishermen. Such buyback programs are promoted by some economists (Milazzo, 1998), while others are more convinced that fishing capacity removed through buyback programs can re-appear in the fishery if the program is not carefully implemented (Holland, Gudmundsson, and Gates, 1999).

The issue of designing effective vessel buyback schemes has been recently investigated considering that such programs may be less effective when anticipated by fishermen (Clark, Munro and Sumaila. 2007). For buyback schemes to help green the global fisheries sector, they have to be designed to (i) avoid the seeping back of effort after they are taken out; (ii) avoid the building up of fishing effort in anticipation of the introduction of the buyback; and (iii) in a targeted way to remove bottom destroying and non-selective gear.

In some fishing areas, not only have fish stocks been reduced by over-capitalization and overfishing, but their productivity has also been negatively affected by the use of damaging fishing gear such as bottom-trawlers or dredgers. In such cases as this, as well as in instances where pollution or climate changes, some mitigating investment in the natural environment itself will be helpful in bringing now-damaged ecosystems back to past levels of health and productivity.

Box 4: How can improvement in gear impacts and selectivity contribute to the greening of global fisheries?

One way of greening the global fisheries would be to be more engaged in ‘environmentally friendly fishing’ (Lone Grønbaek Kronbak and Niels Vestergaard, *Technical Appendix*). Greening global fisheries can be supported by improving gear selectivity, thereby targeting the desired species and age class. There are, however, several issues to keep in mind; one is the benchmark for which a fishery is greened, e.g., the targeted type of overfishing (recruitment, growth or economic).

The increasing awareness about the high ecosystem impacts of gears such as trawling has given rise to major policy interventions that include worldwide mandatory use of turtle excluder devices in shrimp trawls and banning of trawlers in near shore areas in many countries (Chuenpagdee, *Technical Appendix*). Another example of successful ‘shifting gear’ policy for a green fisheries sector is the spot prawn fishery in California where the change from trawls to traps in 2003 resulted in significant reduction in rockfish bycatch (Morgan and Chuenpagdee 2003). In the case of trawls, the increasing understanding about their impacts, especially in terms of benthic habitat damages and bycatch, is well established with numerous studies, such as Hall (1996), Watling and Norse (1998), and NRC (2002). Drawing from scientific judgments of a wide range of experts, including knowledgeable and experienced fishers, studies in the US and Canada reveal that ecosystem effects of bottom-tending gears such as trawls are considered to be most severe when compared to other gears (Morgan and Chuenpagdee 2003; Fuller et al. 2009). Recent advancement in gear modification and alteration to minimize seafloor contact and to reduce bycatch, such as the use of the Nordmore grate in shrimp fishery (Richards and Kendrickson 2006), is certainly important in alleviating the problem but more is needed to address the large operational scale of trawls and other high impact gears if we want to achieve a green ocean fisheries sector.

4.2.3.1 Management programs

Having effective management is crucial for ensuring a green marine fisheries sector. As an example, Costello et al. (2009) suggests that implementing a form of management known as Individual Transferable Quotas (ITQs) can explain the improvement and rebuilding of many fish stocks around the world. However, ITQs are no panacea and need to be design carefully (see Box 5).

Box 5: A balanced approach to the use of ITQs/catch shares in fisheries management

ITQs have their merits, because they are underpinned by TACs, they can constrain the catch and therefore become valuable fisheries management tools. But it is also increasingly acknowledged that ITQs cannot be seen as a panacea for solving fisheries management problems since they also have their disadvantages (Hilborn et al. 2005, Townsend et al. 2006, Pinkerton and Edwards, 2009, Gibbs 2009, Essington, 2009, Clark et al. in press). In addition to the fact that they do not confer to ITQ owners' full property rights, it is widely acknowledged that even if they were to provide such rights, there are still conservation and social concerns to worry about. Hence, ITQ management, where implemented, need to be part of a broad management system that will ensure that their shortcomings are addressed. 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 need to be part of an ITQ management system if it is to achieve economically, ecologically and socially desirable outcomes (Sumaila, *Technical Appendix, in press*):

1. ITQs must be supported by an arms-length stock assessment unit and backed with strong arms-length monitoring, control and surveillance (MCS) to deal with lack of full property rights and 'emptying' the ocean of fish under certain conditions;
2. Some restrictions on the ownership of ITQs to people who actually fish the stocks may be needed to mitigate against diluting ITQ performance when quota owners are different from those who fish;
3. Measures to ensure resource sustainability by taking an ecosystem-based management approach including paying special attention to the management of essential habitat, use of safe minimum biomass levels, applying input controls, etc.; Networks of reasonably large marine protected areas need to accompany the implementation of ITQs to deal broadly with the ecosystem effects of overfishing, to allow for recovery, and to recognize the effects of uncertainty on the performance of ITQs. In implementing this network, it would be useful to ensure that they are designed to make them compatible with conservation and ITQ goals and objectives;
4. Imposing limits to quota that can be held by each quota owner, to mitigate the social problem of concentration of fishing power. 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 ITQs 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 (Wingard 2000, Christy Jr. 1982). With such schemes in place, the economic efficiency benefits of ITQs may be captured while minimizing their negative social impacts;
5. Auctioning of quotas could be used in some fisheries (Macinko and Bromley 2002, Bromley 2009) to deal with the problem of initial allocation of quota and its equity implications.

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

- Stock-assessment programs;
- Monitoring and control programs;
- Marine protected areas (MPA).

Stock assessment programs are helpful for fishery managers who require accurate 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. Monitoring and control programs are those that allow fishery managers to determine whether fishermen are acting in compliance with catch quotas. Such programs are also quite useful in terms of mitigating the impact of illegal and unreported fishing activity.

Box 6: IUU fishing and the greening of the fisheries

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

To green the 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, especially some high sea catch (OECD 2004).

Historically, MPAs have not been a major tool used in the management of the world's fisheries although, their role as a management tool has become more popular in recent years. MPAs 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 the net and ensuring the future resilience of the fishery through their offspring.

Box 7: Marine protected areas and the greening of the fisheries

Marine protected areas (MPAs) have been implemented in many countries and are regarded as one very important management instrument for fisheries. The assumption underlying the MPAs is that they can conserve the resources and increase biomass therein, and consequently benefit surrounding areas through species migration. Theoretical studies generally support the benefits of MPAs under specific conditions (Sumaila, 1998; Sanchirico and Wilen, 1999). However, there is no consensus about the benefit of MPAs in the empirical studies and contradictory evidences exist. Therefore, the MPAs literature asks the questions about how to evaluate effectiveness of MPAs, e.g., Alder et al. (2002), Hockey (1997).

In terms of policy design and implementation, a lot of questions need to be addressed, including how to select MPA sites, how large should a MPA be, and how costly is MPA, etc. Once the MPA site is selected, MPAs are easy to implement, which is one of its advantages compared to other management tools. In addition, there are obvious social and ethical reasons to conserve species using MPAs. Thus, although there is no agreement on empirical economic evidences of MPAs, there is growing consensus on including MPAs in marine management plans (Costanza, 1998; Sumaila, 2000). MPAs will continue to work as a valuable management instrument for the greening of ocean fisheries.

4.2.4 Investment: What additional funding is required for a green economy?

The most cited figure of the number of times current fishing capacity exceeds what is needed to land the maximum sustainable yield is 2.5 times (e.g., Pauly et al., 2002). Using the rebuilding model described earlier, we estimated that current fishing effort is between 1.8 and 2.8 times what is needed. As stated earlier, in order to shift the fishing industry to MSY levels, we will need to trim excess fishing capacity through investing in the areas of rebuilding, management and scientific research. The way by which we can reduce fishing capacity to MSY levels through investment in these three areas is investigated below.

Vessel buyback programs and fisherman re-training and education programs are two areas where fishing effort can be directly reduced. It is estimated that there are currently 35 million fishers and more than 20 million boats actively engaged in fisheries. For the range of fishing effort calculated from our model, we need to remove between 9 and 13 million of the current fishing vessels and find alternative jobs and livelihoods for between 15 and 22 million fishers.

Assuming the average cost of a vessel buyback to be \$7,500 and the average cost of relocating a worker to be \$10,000, we estimate that the total investment needed to reduce fishing capacity to MSY would be between USD 220 and 320 billion worldwide.

4.2.5 Estimating economic returns of investment in rebuilding

As presented earlier, greening the fisheries sector will lead to an increase in net gains (added value) globally from US \$16.87 billion to US \$69.56 billion a year. This is a net increase of US \$52.69 a year. Discounting this flow of benefit through time at 3% and 5% real discount rates gives a present value of benefit from greening the fishing sector of US \$1,053 and US \$1,756 billion, which is 3 to 5 times of the high end estimate of the cost of greening global fisheries.

5. Financing

As shown in section 4, ensuring the sustainability of fisheries requires accessing or raising the necessary finance 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; strengthening markets in fishery products; promoting partnerships between researchers and fishers; diversifying and strengthening economic development in areas affected by the decline in fishing activities; provision of technical assistance and 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.

5.1 Global Financing Arrangements

5.1.2 Public Investment

Greening the fisheries sector would require a significant amount of public investment given the public good nature of the undertaking. Public funding for fisheries sustainability includes direct funding from national budgets, national budget contributions to 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) (along the lines of the Global Environmental Facility (GEF)) can be set up into which 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 would regularly review funding availability and expenditure and provide recommendations for improvements.

National Income Contributions

All countries (especially the developed) countries can be asked to contribute a proportion of Gross Domestic Product (GDP) e.g. 0.5% -1.0% of GDP annually for greening the fisheries sector. For the High Income countries of the world, 0.1 percent of GDP will amount to about \$40 billion.

Sale of IMF Gold reserves.

At its founding, the IMF acquired gold under its Articles of Agreement as the basis for reserves for the Fund. The world operated on the ‘gold standard’ where currencies of member countries were tied to the value of gold under a regime of fixed exchange rates (The Bretton Woods System). With the collapse of the “gold standard” in 1971, the IMF kept the gold as a “rainy day fund” (Birdsall and Williamson, 2005). The IMF’s gold reserves are the third largest in the World after the United States and Germany and are valued at \$9 billion dollars on its balance sheet but with a market value of some \$86.2 billion as at August 31, 2008.

The idea of using IMF gold reserves as development finance is not new. Between 1976-1980 \$3.3 billion of IMF gold sales was used to finance concessional loans to low income countries. In 1999 the IMF Board also approved gold sales to finance IMF participation in the Highly Indebted Poor Country (HIPC) Initiative.

The Fund needs near universal support (85 percent majority voting power) from the IMF Executive Board to engage in the use of its gold reserves. The US holds 17 percent of the votes so its agreement is necessary. The IMF is also required under U.S. Law to gain support from Congress before selling any IMF gold. The sale of some 15% of IMF gold reserves to help developing countries deal with greening fisheries could yield some \$13 billion at 2009 prices.

Issuance of new Special Drawing Rights (SDRs).

Nancy Birdsall, Joe Stiglitz, Dani Rodrik, George Soros, Montek Ahluwalia, have all called for a new issue of SDRs by the IMF to deal with the global recession and financial crisis. This method of finance can also be used to raise resources for fisheries greening. This can be done almost immediately and does not require the IMF to negotiate a program for every country that needs a loan. A \$100 billion new SDR issue can be undertaken and after a 90-day period of prior consultation with the US Congress by the US Treasury. These new SDRs would be donated to finance fisheries sustainability.

5.1.3 Regional Financing Arrangements

A regional financing facility or mechanism is one in which (i) the activities its funds are limited to the region and (ii) the arrangement’s member countries or governments from within the region have a substantial role in decision making (Sharan, 2008). Regional financing arrangements to deal with 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. All regions do not require identical mitigation and adaptation measures for example. The decline of the fish stock and its impacts is unlikely to be confined within any one country and one country will not be able to address such impacts alone. Thus regional financing arrangements will 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.

Leveraging Multilateral Banks Capital

The capital of multilateral banks such as the World Bank, Asian Development Bank, and African Development Bank, could be leveraged to the extent that their outstanding loans do not exceed their paid or callable capital to raise additional funding for greening fisheries.

5.1.4 Fiscal Incentives

Environmental Fiscal Reform

“Environmental Fiscal Reform” (EFR) refers to a range of taxation and pricing measures which can raise fiscal revenues while furthering environmental goals (OECD/DAC, 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. In addition individual operators have no direct incentive to restrict their catch, since they do not, individually, derive any direct benefits from doing so. Imposition of levies on volume caught, in combination with proper management measures – which may include restricting access to fishing grounds – can generate revenues to compensate the owners of the resource, (*i.e.* the country whose fishing stocks are being exploited) and help reduce fishing efforts.

Redirection of Subsidies

A reduction of existing 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 \$ 25-30 billion annually (Sumaila et al., 2009). Limiting subsidies to those used for management, the so-called, good subsidies, will generate savings of the magnitude of some \$19 billion annually which can be reallocated to the Global Fisheries Fund or some other Fund to finance greening fishery projects.

5.1.5 Economic Tools

Market-Based Levies

Predictably generated over a period of years, these levies would be generated independent of national budgetary processes, but the levies would be collected by national governments. Financial resources can be generated and collected at the international level. E.g. levies on marine transport

Auctioning Access to fishing quota

Another avenue for raising finance to sustain fisheries is through the auctioning and assignment of private property rights to parts of the oceans over which property rights are not clearly defined. The revenues from such auctions can be placed in a global fund and leveraged for investment in fisheries sustainability.

Capital Market Finance

The International Finance Institutions, e.g. World Bank and governments can explore the possibility of issuing bonds on the international financial market and using the proceeds to finance initiatives aimed at helping poor developing countries with greening fisheries. The concept would be to raise money in the capital market to fund critical investments immediately and to repay the bonds from future ODA commitments, levies, or other innovative sources.

Asset-Backed Finance

Asset finance typically includes a significant debt component that can come from a local or international bank, or local or international capital markets, on commercial terms or with credit enhancement structures offered by international institutions. To attract the required additional investment, governments need to institute regulations, policies and laws that offer the prospect of a growing fisheries market long term.

Funds to Invest Foreign Exchange Reserves

The idea here is that countries could transfer a small part (e.g. 1%) of their foreign exchange reserves into funds that would invest the money in greening the fisheries. The investors would establish the fund policies, such as eligibility of investments and target rates of return on investment. 1% of global foreign reserves in October 2009 is estimated at \$70 billion.

Tobin Tax

James Tobin proposed a currency transaction tax as a way to enhance the efficacy of national macroeconomic policy and reduce short term speculative currency flows. Nissanke (2003) estimates that a tax of 0.01 percent applied to wholesale transactions would generate revenues of 2003 \$15-20 billion. The revenue raised could be placed in a Global Fisheries Fund to finance sustainable fisheries.

Debt for Green Fisheries Swap

Under a debt swap program, creditors negotiate an agreement whereby a portion of the debt owed to them is cancelled in exchange for a commitment by the debtor government to convert the cancelled amount into local currency for investment in green fishery projects.

5.1.6 Private Investment

Venture Capital/Private Equity

Individual consumers in developed countries 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, which can be certified as environmentally friendly on consistent with sustainability. This is also the case for fisheries. Emerging high growth sectors have traditionally been a target for venture capitalists, who invest equity capital, trusting the market potential and entrepreneurial capacity of the managers. In exchange for the high risk taken, venture capitalists expect higher returns and will impose certain conditions that guarantee their sale of equity stake to third parties. Markets for products and services such as eco-tourism can present attractive sources of income for protected areas and their surrounding communities. Enabling productive projects for private sector actors in protected with specific profit sharing agreements can provide an alternative source of financing.

Regional Private Financing Mechanisms

The advantages of regional public financing arrangements for fisheries are also applicable to the private sector. Risk transfer mechanisms such as Catastrophe (CAT) bonds can be adapted for issue in regions to raise finance for greening fisheries. Private equity funds specializing in fisheries sustainability at the the regional level is another potential source of funds.

5.1.7 Public Private Partnership (PPP)

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 is one which is applicable in the fisheries sector. PPPs can take place at the local, national, regional, national or global levels.

6. Enabling conditions: Institutions, planning, policy and regulatory reform

6.1 Building effective national, regional and international institutions

The root cause of overexploitation of fish stocks is lack of control over fish catches or fishing activity, or both. One individual fisherman competing with many others has an incentive to take as much fish as he can as quickly as he can. The result of such uncoordinated efforts of many competing fishermen is 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 (Gordon, 1954; Hannesson, 2004; Hardin, 1968).

In addition, even if a fish resource is privatized there are conditions under which the private owner may find it optimal to overfish the stock, sometimes to extinction (Clark, 1973, Clark et al., in press; Sumaila, in press). 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.

Box 8: Updating international law on shared fish stocks

A shared fish stock is one that either i) is a highly migratory species (ie. tunas), ii) occurs in the territorial waters of more than one political entity, iii) occurs in the high seas where it may be targeted by a multitude of fleets, or iv) any combination of the previous three. Often times, the management of shared fish stocks is considered what game theorists term a ‘prisoner’s dilemma’, where parties sharing the 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 (UN, 1995) 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, *Technical Appendix*). 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 Regional Fisheries Management Organizations (RFMO) 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.

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 fish stocks. Some fish stocks spend their lives completely in the EEZs of country – 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 their lives completely with the EEZs of more than two countries. For these fish stocks, they must agree on the management of the stock in order to make it effective (Munro; Hannesson, *Technical Appendix*). 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 organizations (RFMOs) (Hannesson, *Technical Appendix*).

6.2 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 (i) a mechanism to set such a target level; and (ii) a mechanism to monitor and to enforce it. The basic question to ask is whether there is in place the scientific, administrative and law-enforcing capability 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 will 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 maximizes long term benefits in the form of food supplies or fishing rent (difference between revenues and costs). The latter requires an efficient and uncorrupted administration that strives for the best possible economic (or food supply) situation of the country in question.

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. 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 return, and even threats to life and limb through undue risk-taking encouraged by narrow time opportunities to catch fish. The 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 (Hannesson, *Technical Appendix*).

6.3 The economics of fishery management tools

The basic fishery management tools can be grouped into (i) output and (ii) input controls, and (iii) auxiliary measures. Both (i) and (ii) control the rate of exploitation, which is the basic thing that needs to be controlled, as stated earlier.

Output control means 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. The target output should be set on the basis of maximizing either food supply or fishing rent, depending on what is deemed most appropriate.

In addition to setting an overall catch quota, it should be allocated among the players in the industry and made transferable, in order to avoid a 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. I 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 an ideal, but in practice we are unlikely to achieve anything better than getting close.

Under some circumstances effort controls could be better than quota controls. This could 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 time. 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 realized 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 I’ve 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 and to 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 authorized to take. While this is indeed desirable, such regulations are wasteful and one should look for ways to achieve the desired outcome in less wasteful ways.

6.4 Managing the transition process

This will 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 will 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 incomes in the future. Likewise, having some boatowners leave the fishery means that they will be foregoing earnings they otherwise would have obtained, and those who leave would in any case not share in the higher incomes to be realized in the future. Since the justification of rebuilding fish stocks is higher future incomes, it would in principle be possible for those who remain in the fishery to buy out those who leave and in this way share the future income recovery with them. 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 realization of any income recovery. Those who remain in the industry could therefore be reluctant to offer much of the income recovery they expect, and even less likely to be able to borrow the money they would need to finance it, in case they do not have sufficient cash (and boat owners in a depleted fishery are unlikely to have much cash). 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 to be bought out later.

6.5 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. Most of these cases involve a limit on the total catch and, on that basis, individual transferable quotas. The comments here all pertain to that kind of regime. Below some of these cases and their most salient features are mentioned (there are more cases and some of them may indeed be just as or more interesting). The lessons that can be learned from these cases are the following (Hannesson, *Technical Appendix*):

It is important to find an initial allocation of quotas that is generally understood to be equitable and immune to challenge as far as possible (there will 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. This aggravates the overexploitation and overcapacity prior to establishing a quota system.
- There may be a case for government help with 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.

6.6 Socioeconomic challenges in small-scale fisheries worldwide

A key issue along any coast is that of the local ‘small-scale’ fisheries – which often provide crucial food supplies, sustain regional economies, and support the social and cultural values of the areas, but which 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 (Charles, *Technical Appendix*).

There are many definitions of ‘small-scale’ but essentially such fisheries are characterized by being relatively more labour-intensive and less capital-intensive, more tied to coastal communities and less mobile (Berkes et al. 2001; Charles 2001). 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, such as climate change and globalization of fish markets, that can negatively affect the small-scale fisheries. In addition, over-fishing by SSF themselves contributes to the problem in many cases, but it is important to recognize that given the above external factors, ‘solving’ the sustainability challenge for SSF requires coordinated, multi-faceted approaches, ones 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, with improving coastal environmental quality, and with market and infrastructure issues. An ‘integrated’ approach would seem the most effective approach (Charles, *Technical Appendix*).

Certain realities of small-scale fisheries pose challenges but also provide opportunities (Charles, *Technical Appendix*):

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

- SSF are utilized by a very large number of people on the coast, 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 capitalization, and consequent debt payments, that seriously limit flexibility in industrial fisheries. Furthermore, small-scale fisher organizations can be drawn upon to play a constructive role in policy actions (e.g. Salas et al. 2007). It should not be forgotten as well that the high levels of employment provided by SSF may well help to limit resource exploitation elsewhere on the coast. An integrated 'systems' analysis is needed to properly recognize these interactions (Garcia and Charles 2007);
- 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 significantly to the negative climate externalities imposed by fisheries (due to their fuel-intensive nature) and to excessive high-seas resource exploitation. Furthermore, they have received the bulk of fishery subsidies globally. Given all this, 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).

Box 9: The role of aquaculture in greening the fishing sector

Aquaculture supplies a significant component of global seafood, and it can continue to do so into the future only if fish farming is carried out in a green economy framework. The sector need to (i) be organized to ensure minimal environmental degradation (Naylor et al. 1998); (ii) stop the farming of carnivorous fish (e.g., salmon, bluefin tuna, seabass) until non-wild fish source of meal are developed; (iii) adopt integrated technologies and (iv) developing reliable management system.

Box 10: Subsidies and small-scale fisheries (SSF)

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 tending in conservationist directions. 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 catch levels for 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 subsidies 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 in modern times would be to orient subsidies as incentives to shift from industrial to small-scale fisheries, thereby having both human and ecological benefits.

7. Conclusion and recommendations

The goal of this chapter was to gain a better understanding of the contribution and impact of marine fisheries and fishing activities to the global economy; demonstrate the potential gains of global fishery reform to the global economy from the perspective of sustainable management of fishery resources worldwide; estimate the financial requirements for investing in fisheries conservation and sustainable use and compare these to the long-term economic, social and environmental gains; and finally but not the least, to demonstrate that long-term economic benefit in investing in rebuilding fisheries and in improving fisheries management is higher than the actual shorter-term costs.

The results of our analysis, suggest that global marine fisheries are currently underperforming in economic and social terms. This conclusion is in agreement with the general consensus in the literature and in management circles; greening the fisheries sector by rebuilding depleted stocks and putting in place effective management could increase marine fisheries catch; total catch value or gross revenue; annual profits to fishing enterprises; fishers household income; resource rent; total added value to the global economy from fishing in a green economy scenario.

The study also showed that greening the fisheries sector will cost billions. The good news is that the gains from greening will more than pay for itself. 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 green. Finally, we identify a

number of ways by which the cost of greening the fisheries sector can be paid, from the global to the local, and the public to the private sector.

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