INTERNATIONAL SUSTAINABILITY UNIT

TOWARDS GLOBAL SUSTAINABLE FISHERIES

THE OPPORTUNITY FOR TRANSITION

FEBRUARY 2012

TOWARDS GLOBAL SUSTAINABLE FISHERIES

THE OPPORTUNITY FOR TRANSITION

TABLE OF CONTENTS

Foreword by HRH The Prince of Wales 2

Executive Summary 5

1 Introduction 8
1.1 The International Sustainability Unit 8
1.2 The ISU Marine Programme 8
1.3 About the Report 9
1.4 Defining Concepts 12

2 The Benefits of Sustainable Fisheries 13
2.1 The Economic Case 13
2.2 Sustainable Livelihoods 15
2.3 Food Security 16
2.4 Ecosystem Resilience 17

3 Tools for Rebuilding Global Fish Stocks 20
3.1 Tools for Smart Economics 21
3.2 Tools for an Ecosystem Approach 24
3.3 Tools for Robust Management 29

4 Enablers of Change 31
4.1 Knowledge and Awareness 31
4.2 Transition Finance 32
4.3 Supply Chain Signals 34

5 ISU Next Steps 36

Annexes
A The Economics of Fisheries: A Summary 38
B The ISU Fishing Industry Ambassadors 43

References 44

CLARENCE HOUSE

When it comes to the changing state of the natural environment, most of our attention in recent decades has been focussed on what is happening on land. Perhaps this is to be expected, given that people are terrestrial beings and that we are naturally drawn to seeing our fortunes tied to what goes on in our immediate surroundings. However, the mismanagement of our oceans will have serious consequences for life on Earth and therefore their management must be, surely, of immediate concern to us all.

I am pleased to say that attitudes are beginning to change, in part because of recent scientific research which has highlighted the profound changes now underway in the seas. From acidification to ocean warming, and from habitat loss to the appearance of so-called 'dead zones' caused by nutrient pollution from industrialized farming systems on land, we can see that the relative indifference we have shown to the marine environment beyond our beaches and shorelines is no longer an option, particularly so when you consider the effects of the overexploitation of fisheries.

Marine capture fisheries represent the last major international industry based on the hunting and gathering of wild animals. It is, however, an industry that is far from primitive, and indeed far from marginal in an economic or social sense, for fishing remains an essential component of food security and vital for the well-being of hundreds of millions of people.

Despite the current vulnerable state of global fisheries, if managed properly with a focus on the resilience of the marine ecosystem as a whole, our seas could still provide us with the opportunity to continue harvesting seafood long into the future at similar, or perhaps even higher, volumes than at present...

However, it is only too apparent that we do not have very much time to change our ways and this is why I asked my International Sustainability Unit (I.S.U.) to gather as much information as possible on what people feel needs to be done to ensure that we have at least some chance of keeping our marine fisheries productive, as well as identifying examples of good practice around the world that could perhaps be scalable for all our benefit.

The I.S.U. has consulted widely across the public, private and NGO sectors and the accumulated result of hundreds of conversations and much original research is found in this report, which represents the core of a consensus on how we might manage the world's fisheries in a more sustainable manner. Crucially, the report's findings are shared by key actors in the global fishing industry. This is critical, because it will be the fishers themselves who are the vital linchpin and who are, and indeed must be, the major part of any solution.

At the heart of what the I.S.U. has found is that the sustainable management of our fisheries would, apart from any other environmental benefit, actually be more profitable than perennially succumbing to the temptation of maximizing short-term income while deferring the costs until later. The fact that fisheries could be worth as much as U.S.$ 50 billion more per year, if managed optimally, is surely a figure that is worthy of serious attention. The economics are brought into focus, it seems to me, by the fact that in many places these costs, including the loss of jobs, decline of communities, shortage of food, and the loss of natural capital on which the entire system depends, are no longer in some theoretical future, but part of present reality. I take great encouragement from the view expressed by many experts that this emerging reality is not inevitable, that there are other ways to proceed, and that the more sustainable use of marine resources can lead to more desirable outcomes than business as usual.

On this latter point, I have been constantly struck by the growing number of positive stories about fisheries that have been certified as sustainable or in transition towards sustainability. The picture need no longer be one of doom and gloom and of inevitable decline, but rather one about the many possibilities for gaining more value from a resource, if only we can manage it well. And this, of course, is the big question – how best can fisheries be managed so that the wealth and benefits they provide are able to support us long into the future?

There is no simple answer to this, but I do believe there are some principles to guide us. What these could be are among the core findings presented in this I.S.U. report and, I must say, are very much at the heart of what I believe to be a sensible approach towards the management of natural capital more broadly.

For a start, the I.S.U. has found a strong consensus on the need to manage fisheries in the context of their broader ecosystem. It would seem to me to be self-evident that fisheries do not exist in isolation, but as part of the wider marine ecosystem in which they reside. Therefore, in order to ensure ecosystem integrity, it is essential to ensure the supply of nutrients in our oceans, while also being aware, at the very least, of the impacts of removing other species from a fishery. We also need to understand, of course, the dynamics at work in how fish sustain other important species, such as seabirds and marine mammals.

The second message that came from the I.S.U.'s consultation is the need for the enhancement of appropriate governance, management and regulation to support the fishing sector and ensure the resource's sustainability. Such regulation would include the development of better spatial planning, and more environmentally-intelligent

fishing equipment. It would also ensure that illegal fishing is curtailed and provide 'access rights' to reward and ensure proper fisheries management practice.

However, the implementation of both the ecosystem approach and robust fisheries management requires the economics of fishing to provide adequate incentives towards long-term prosperity and to overcome the short-term economic dislocation of such a transition. There are many ways to make this shift, including through market mechanisms, the redirection of public subsidies and by finding new ways to harness private finance for investment.

These three key building blocks of sustainable fisheries management are not simply abstract ideas to be applied in some idealized and theoretical future. They are already being used in real world situations to reshape fisheries management. In a growing number of places, tangible, positive outcomes are visible and this, I believe, should encourage us all to be even more convinced about the scale of the opportunity.

Our marine ecosystems are a vitally important part of our planet and yet, in relative terms, we know very little about them. We are aware that they are under threat and that our current attitude of resource exploitation, which is essentially a mining operation, is inherently unsustainable. As in so many other areas of the environment, we are coming to this conclusion rather at the eleventh hour. As for all other sectors dependent on natural capital, the fishing sector's economic, environmental and social health can only be guaranteed if we view it in an holistic and integrated way, taking into account as many factors as possible, but also realizing that while urgent action is needed, we already have to hand the means, the skills and the possibility to stave off catastrophe.

It is my fervent hope that this report will contribute to a broader understanding of the steps that we can, and indeed must, take if we are to preserve not only a vitally important source of food, but also an utterly essential component of our planet's life-support system.

Executive Summary

The ISU Marine Programme

The Prince's Charities' International Sustainability Unit (ISU) was created to help build consensus on solutions to some of the major environmental problems facing the world. Over the past two years, the ISU has commissioned research and worked with numerous organisations to develop an understanding of the sustainability and resilience of food systems. This work has led to two in-depth research and consultation processes that have in turn led to the production of two reports – this one summarising the emerging consensus on solutions to sustaining and increasing food production from the sea, and the other concerned with food production on land.

The increased pressure on marine capture fisheries – from growing populations, rising demand for seafood, and a rapid increase in fisheries exploitation – has caused a decline in the productivity of many fisheries. According to the UN Food and Agriculture Organisation (FAO), 32% of fish stocks are now overexploited, depleted or recovering from depletion, and this figure is rising every year. As well as delivering less food and income and supporting fewer livelihoods than they could, overexploited fisheries are also more vulnerable to external pressures such as climate change and pollution. However, research and consultation undertaken by the ISU shows that practical solutions are available. The ISU Marine Programme was initiated to help strengthen consensus around these solutions and to catalyse action through partnerships between the public sector, the fishing industry, the wider private sector and NGOs.

This report presents a synthesis of research commissioned by the ISU, together with findings from a broad stakeholder consultation. It seeks to outline the critical importance of wild fish stocks and the benefits that come from their sustainable management. It shows how these benefits are already being realised in fisheries around the world through the implementation of a wide range of tried and tested tools for sustainability. If managed responsibly, wild fish stocks can play a crucial role in food security, sustainable livelihoods and resilient economies.

The benefits of sustainable fisheries – profits, jobs, food security, resilience

Wild fish stocks are of enormous importance to economic output, livelihoods and food security. If degraded fisheries are rebuilt and sustainably managed, they can make an even larger contribution. The transition of global fisheries to sustainable management will secure these benefits for the long term.

Fisheries contribute approximately US$274 billion to global GDP. However, they are currently an underperforming asset. The World Bank estimates that if fisheries were managed optimally they could deliver an additional $50 billion each year. At a local level, one study concluded that the Hilsa Shad fishery in Bangladesh could be worth nearly US$260 million more annually, while research commissioned by the ISU estimated that recovering the North-East Atlantic bluefin tuna fishery could lead to economic gains of up to US$510 million per year. In addition to these studies of the potential benefits there is also clear evidence of their existence in many fisheries, such as in the Pacific halibut fishery where the introduction of a catch-share system lengthened the fishing season and consequently increased the value of fish sold from $1 to $7 per pound. Economic benefits will flow to those operating in well regulated and sustainable fisheries.

Directly and indirectly, fisheries provide employment for hundreds of millions of people. The vast majority of these people are in developing countries where the sector often plays a key role in preventing and reducing poverty; it is likely that millions more people are involved in fishing activities than appear in official statistics. Only sustainably managed fish stocks can ensure the viability of these livelihoods and, following recovery, generate more employment in the long term. For example, the Ben Tre Clam fishery in Vietnam, after making the transition to sustainability, is now able to support 13,000 households compared to 9,000 in 2007. It goes beyond numbers as sustainable fisheries often also provide a better quality of employment with higher safety standards.

In light of recent crises, the contribution of fish and fish products to national and global food security has never been of greater importance. Fish is a renewable and healthy food source which currently supplies 1 billion people with their main source of protein.

Beyond the direct economic, social and food security benefits to be gained from rebuilding fisheries, the transition to sustainable management is likely to make marine ecosystems more resilient to external stresses, including those stemming from climate change and pollution. Fisheries are vital components of ecosystems, and healthy ecosystems are key to the continued productivity of fisheries. Climate change is one of the biggest threats to marine capture fisheries and there is research suggesting that those countries most vulnerable to its impacts are often amongst the poorest and most reliant on wild fish for food security.

Tools for rebuilding global fish stocks – smart economics, the ecosystem approach, robust management

Research commissioned by the ISU shows that there are many fisheries around the world that have already embarked on the transition to sustainability. The case studies illustrate unequivocally how such transitions are both beneficial and achievable. The tools and interventions that are used

in these fisheries are varied and context-specific. There is no universal method. However, it is possible to group the available tools under three headings: smart economics; an ecosystem approach; and robust management. Before these instruments can be implemented, there is one overarching requirement: good governance involving comprehensive stakeholder engagement.

Good governance is a prerequisite for sustainable and profitable fisheries. Frameworks which uphold good governance are accountable, transparent, responsive, efficient and subject to the rule of law. And while top-down frameworks are most effective when they allow for differences at a local level, stakeholder participation at every level, particularly by the fishers themselves, has emerged as one of the most crucial elements of good fisheries governance. Such broad-based participation allows for the incorporation of local and traditional knowledge that, when it comes to the management of fish stocks, can help to instil a sense of responsibility. Many of the case studies outlined in this report highlight the importance of co-management models as a way of incorporating stakeholders into decision making processes.

Tools for smart economics

The implementation of smart economics has improved the sustainability of many fisheries. In some instances this has been achieved through the introduction of limits on the capacity and usage of fishing vessels (effort restriction) and the allocation of access rights. As in so many other economic sectors dependent on natural resources, having the right to a portion of these resources creates incentives for fishers to maintain the resource in the long term. There are many different ways to establish access rights. They vary from the more advanced individual transferable quota (ITQ) system, implemented with success in countries such as New Zealand and the US; to the territorial user rights system (TURF), implemented in sedentary fisheries such as the Ben Tre Clam fishery and the Chilean Loco fishery; to less complex systems in countries such as Fiji where local traditions dictate access rights.

In many parts of the world the transition to more sustainable fishing will require that the question of perverse public subsidies is addressed. These typically encourage excess fleet capacity and the over-exploitation of stocks. Such subsidies are estimated to total approximately $16 billion per year globally. Developed countries spend twice as much on these types of industry support as they do on protecting the ocean. Examples of the successful redirection and reduction of subsidies include the fisheries of Norway and New Zealand.

Tools for an ecosystem approach

An ecosystem approach, defined as one that reflects the diverse and dynamic nature of marine ecosystems, is essential to sustainable fisheries management. Many tools exist to help implement the ecosystem approach. These include:

- *Data collection and analysis*. It is difficult to make effective management decisions in the absence of good, usable data. Collaboration between scientists and fishers can be extremely valuable, as shown in the Isle of Man scallop fishery, where strong fisher-scientist partnerships have yielded benefits for stock recovery and fishers' livelihoods.
- *Precautionary management*. Flexible and dynamic management practices are needed to cope with the uncertainty inherent in marine ecosystems. An example is that of real-time management in the Spencer Gulf prawn fishery in Australia that enables changes to fishing activities to be made in just one hour in the event of undersize prawn catches.
- *Managing competing uses*. In areas where there are competing users, such as the energy, extractive and tourist industries, marine spatial planning with comprehensive stakeholder engagement is important. Case studies have shown how conflicting interests between artisanal, recreational and industrial fishing activities can be resolved by this tool.
- *Establishing protected areas*. Permanent, temporary or rolling closures of some areas of the marine environment can have benefits for both conservation and fishing activities. One example of this is in the Mediterranean where the fishers of the *Prud'hommes de la pêche* organisation have implemented their own protected area and have noted larger and more abundant fish as a result.
- *Reducing bycatch*. The reduction in the catch of non-target species is critical to the sustainability of a fishery and the maintenance of ecosystem health. There are many examples of techniques being developed that aim to reduce bycatch. The 'eliminator' trawl is one such innovation which is able to differentiate between cod and haddock behaviour, and thus reduce the catch of non-quota cod.

Tools for robust management

Robust management through monitoring and enforcement ensures compliance with sustainable fishery goals and regulations. This is necessary for the creation of a level playing field, whereby fishers can operate in the knowledge that the resource is not being overexploited by others. Illegal, unreported and unregulated (IUU) fishing activities are estimated to account for approximately one quarter of global marine capture landings. Technologies such as vessel monitoring systems (VMS) and unique vessel identifiers (UVI) are helping to address the problem. Observer systems, such as the voluntary scheme in the Australian northern prawn fishery also encourage compliance. In other fisheries such as in Sierra Leone, community surveillance has succeeded in reducing IUU fishing activities. On the high seas, international cooperation is fundamental.

In the majority of case studies the transition to sustainability was not based on one or other tool or intervention, but on a package tailored to the needs and constraints of the individual fishery. The implementation of these tools for the transition to sustainability in capture fisheries is beneficial at many scales – local, national and international, and demonstrably achievable.

Enablers of change – knowledge and awareness, transition finance, private sector

Significant steps are being taken in fisheries across the world to move towards more sustainable management and these fisheries provide grounds for considerable optimism. However, many fisheries are still in a perilous state, not least because the tools and interventions highlighted in the case studies are not being deployed, or if they are, at inadequate scale. In turn, this reflects the fact that transition from business as usual to a sustainable state is a complex process which involves trade-offs and losers as well as winners, especially in the short term. In many cases, the transition requires upfront investment, and leads to temporary decreases in jobs and income, before the economic, social and environmental benefits are realised. It requires strong will and leadership from the fishing industry, government and local communities.

The critical question, therefore, is how can the transition to sustainable fisheries management be more widely enabled and the pace of change accelerated? This report suggests that there are three key enablers of change:

1. *Increasing knowledge and awareness of the importance of sustainable fisheries*, both by raising the relative importance given to fisheries in international and national discussions and by increasing data collection and collaborative research between scientists and the fishing industry;
2. *The provision of significant funding for fisheries in transition* so as to finance management changes and tools, and to mitigate the impact of short-term reductions in fishing activity and incomes; and
3. *Greater participation from the private sector along the supply chain*, in the form of support for fisheries improvement projects, demand for seafood that is certified sustainable, and taking responsibility for supply chain traceability and the sustainability of inputs such as fishmeal and fish oil.

ISU Next Steps

The next phase of the ISU's Marine Programme will involve convening stakeholders to take forward two interrelated areas of work. The first of these is to continue building on the emerging consensus between stakeholders about the importance of sustainable fish stocks and the solutions required to achieve their sustainable management. The second is to help facilitate agreement on how the 'enablers of change' described above might be developed to support and increase the number of sustainable fisheries around the world.

1 Introduction

The Prince's Charities' International Sustainability Unit (ISU) seeks to build consensus around solutions to some of the world's key environmental challenges, and hopes it can play a role in supporting the transition to more sustainable and resilient fisheries.

1.1 The International Sustainability Unit

HRH The Prince of Wales established the International Sustainability Unit (ISU) to facilitate consensus on how to resolve some of the key environmental challenges facing the world – these include food security, ecosystem resilience and the depletion of natural capital. The ISU works with governments, the private sector and non-governmental organisations with the aim of building partnerships to help address these challenges.

1.2 The ISU Marine Programme

The degradation of the marine environment has at last begun to command attention. The marine environment is under considerable pressure from humanity's activities, fishing not least of all. A growing global population, now past 7 billion, together with higher incomes, has led to an ever-rising demand for seafood and a resultant increase in fishing effort. The latest FAO figures report that 32% of marine fisheries are overexploited, depleted or recovering from depletion, up from 25% in 2006 and 10% in 1970 (see figure 1). A further 53% of fisheries are being exploited at their maximum level, and many without the management measures in place to prevent over-exploitation. On top of this, climate change and pollution are exacerbating the damage to fragile marine ecosystems.

The scale of the challenge demands an urgent response: 'business as usual' is no longer a viable option.[1] It is critical to signal the need to rebuild global wild fish stocks and highlight the crucial contribution they make to food security, livelihoods and economies. Coupled with external stresses and shocks, current levels of exploitation are unsustainable. The provision of these most vital ecosystem services will not be maintained without substantial reform.

Research and consultation undertaken by the ISU, however, shows that there is emerging consensus on the solutions that are available. The ISU's Marine Programme was initiated to help build on this consensus, and catalyse action through partnerships between the public sector, the fishing industry, the scientific sommunity, the wider private sector and NGOs.

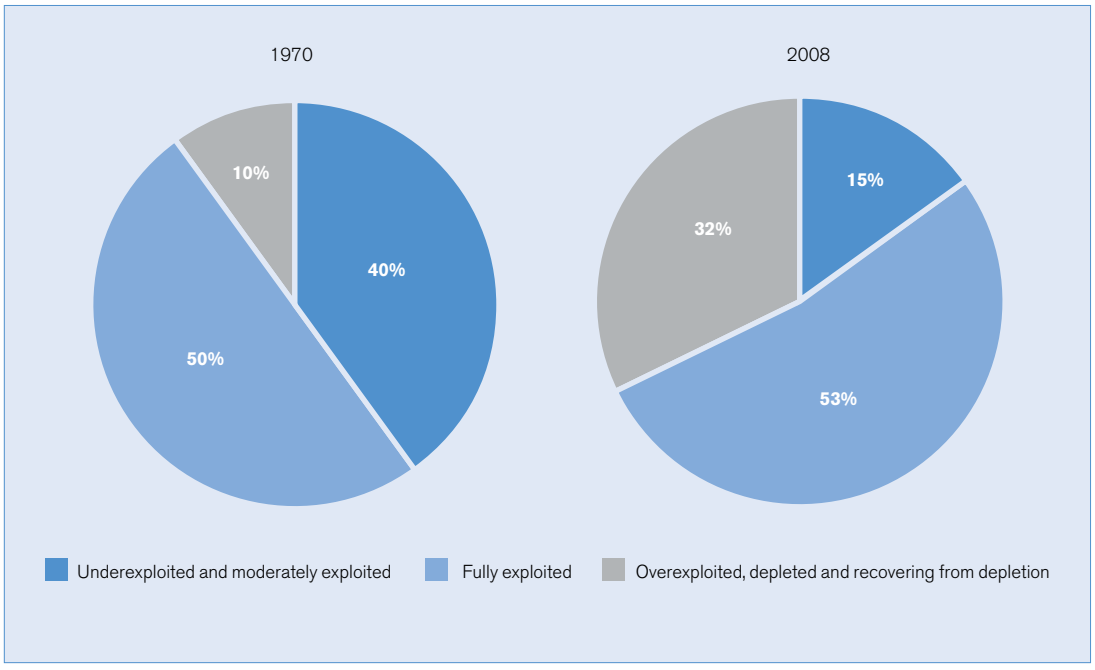


Figure 1 – The increase in fisheries exploitation since 1970
Source: FAO, 2010(a)

1 Foresight, 2011

Fishing vessel in New Zealand waters
© J.Peacey|MRAG

This report seeks to outline the importance of wild capture fisheries and the significant benefits that come from the sustainable management of fish stocks. It shows how these benefits are already being realised in fisheries around the world through the implementation of a wide range of tools for sustainability. The overall message is one of hope and opportunity. The fishing sector, *if* managed responsibly, *can* play an important role in the food security of future populations, in sustainable livelihoods and resilient economies.

1.3 About the report

The ISU commissioned three research projects that focus on case studies of best practice and undertook a comprehensive stakeholder engagement process that included workshops with fishing industry representatives from around the world. This report represents a synthesis of what was learnt during this process.

- The first of the research projects was an in-depth study that compared the economics of 'business as usual' with a scenario where fish stocks are allowed to recover to a sustainable level. This was undertaken in order to understand the costs and benefits of a transition to sustainability for case study fisheries. An economic model was developed that provided a holistic view of fisheries, valuing some of the environmental externalities and social benefits, in addition to the industry's costs and revenues.[2]
- The second of these projects was research commissioned from the consulting firm MRAG to understand the drivers of change in twenty case study fisheries that have led to fisheries improvements around the world and the tools used to achieve these.[3]
- The third project was to summarise the benefits from a transition to sustainable management through fifty interviews with fishers and fisheries around the world that have started this journey. The interviews were, as much as possible, written from the perspective of the fishers themselves in order to understand the direct benefits that have occurred within each fishery. These interviews were undertaken, edited and compiled by the Charlotte Tindall consulting firm and they are available on the ISU Marine Programme website www.pcfisu.org/marine-programme/case-studies.

A map illustrating the breadth of engagement undertaken by MRAG and the Charlotte Tindall consulting firm can be found overleaf (figure 2). Recognising the impressive progress towards sustainability being made by some parts of the fishing industry in almost all areas of the world, the ISU has also established a fishing industry ambassadors group who are able to act as vital agents of change within their industry.[4] A few of these ambassadors were identified through the interviews and case studies of best practice described above.

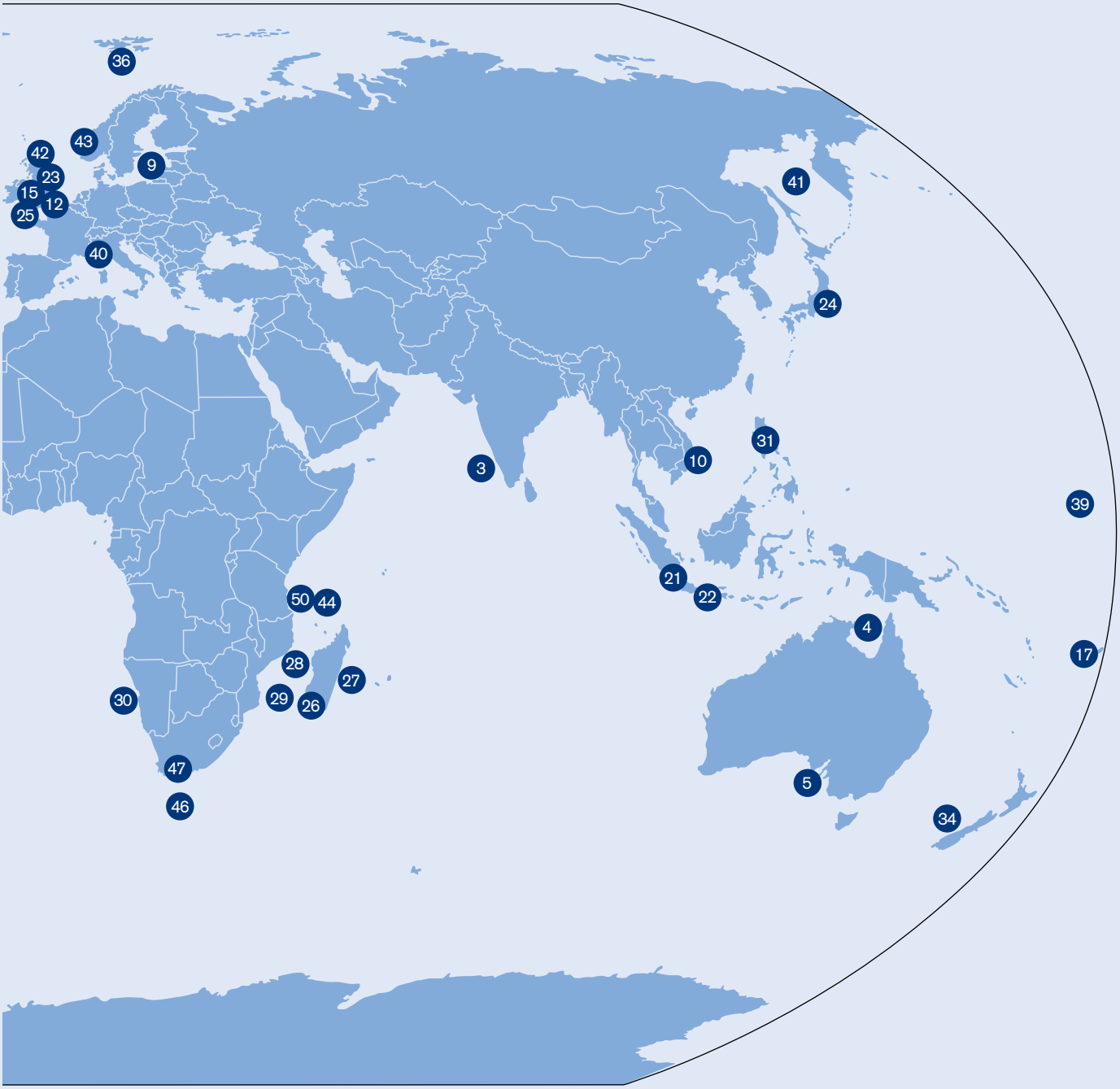
"The question is not – should we have sustainable fisheries? – but rather – how can we not do everything we possibly can to make sure that we always shall?"
– Jeremy Brown, Fisher and board member, Commercial Fishermen of America

2 Please see Annex A for more details
3 Please see www. pcfisu. org/reports for the full report
4 Please see Annex B for more details

Figure 2 – Global Overview of Case Studies

No.	Fishery	Country
1	Alaskan Bering Sea Crab Fishery	United States
2	Alaskans Own	United States
3	Ashtamudi Short Neck Clam Fishery	India
4	Australian Northern Prawn Fishery	Australia
5	Australian Spencer Gulf Prawn Fishery	Australia
6	Bahamian Spiny Lobster Fishery	Bahamas
7	Bahia Solano Community Fishery	Colombia
8	Baja California Red Rock Lobster Fishery	Mexico
9	Baltic Sea Cod Fishery	Denmark
10	Ben Tre Clam Fishery	Vietnam
11	British Columbian Spiny Dogfish Fishery	Canada
12	Brixham Beam Trawl Fishery	United Kingdom
13	California Morro Bay Groundfish Fishery	United States
14	Chilean Loco Fishery	Chile
15	Cornish Sardine Fishery	United Kingdom

No.	Fishery	Country
16	Ecuadorian Mahi-mahi Fishery	Ecuador
17	Fijian Subsistence Fisheries	Fiji
18	Gambian Red and Black Sole Fishery	Gambia
19	Gulf of Mexico Red Snapper Fishery	United States
20	Icelandic Groundfish Fishery	Iceland
21	Indonesian Blue Swimming Crab Fishery	Indonesia
22	Indonesian Sardine Fishery	Indonesia
23	Isle of Man Scallop Fishery	Isle of Man
24	Kyoto Prefecture Snow Crab Fishery	Japan
25	Lira Coastal Community Fishery	Spain
26	Malagasy Octopus Fishery	Madagascar
27	Malagasy Shrimp Fishery	Madagascar
28	Mozambican Fisheries Surveillance	Mozambique
29	Mozambican Shallow Water Shrimp Fishery	Mozambique
30	Namibian Fisheries	Namibia



No.	Fishery	Country
31	Negros Island Community Fisheries	Philippines
32	New England Groundfish & Scallop Fishery	United States
33	New England's Eliminator trawl	United States
34	New Zealand Sanford Fisheries	New Zealand
35	North Pacific Halibut Fishery	United States
36	Norwegian Discard Ban	Norway
37	Patagonian and Antarctic Toothfish Fisheries	Australia
38	Peruvian Anchovy Fishery	Peru
39	PNA Tuna Fishery	PNA Countries (1)
40	Prud'hommes de la Pêche	France
41	Russian Sakhalin Salmon Fishery	Russia
42	Scottish Groundfish Fishery	United Kingdom
43	Scottish Pelagic Fishery	United Kingdom
44	Seychelles Hook and Line Fishery	Seychelles

No.	Fishery	Country
45	Sierra Leone Community Fisheries	Sierra Leone
46	South African Hake Fishery	South Africa
47	South African Rock Lobster Fishery	South Africa
48	Surinamese Atlantic Seabob Shrimp Fishery	Suriname
49	West Coast Pacific Albacore Tuna Fishery	United States
50	Zanzibar's Village Fishermen Committees	Tanzania

(1) Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu

1.4 **Defining Concepts**

Several concepts of critical importance to this report are defined below.

Sustainability in Fisheries

The maximum sustainable yield (MSY) is frequently used as a measure of sustainable fisheries management since this is the level at which the largest catch can be maintained indefinitely. However, the key point to emphasise is that where catch from a fishery is at or greater than the MSY, and no sustainable management measures are in place, the fishery is likely to be heading for depletion over time. It should also be noted that management targets and limits such as MSY are set for individual fisheries or fish stocks. Additional or modified management objectives need to be adopted in order to ensure the sustainability of the wider marine system.

Increasingly, however, fisheries are being managed with a range of alternative targets and limits. These targets and limits may be expressed in terms of yield or catch, the biomass of the fish stock remaining in the water, or measures of fishing mortality. For example, the Maximum Economic Yield (MEY) seeks the maximum economic profitability (catch yield less costs) of a fishery by reducing fishing effort below that of MSY (see figure 3). As the MEY target is below that of MSY it is generally at a biologically safer level of fishing than the MSY and builds a level of resilience into the system.

Fishing Effort and Effort Management

Throughout this document the term fishing effort is used to describe the level of physical effort applied to a fishery to extract a certain amount of fish. More simply, it is typically a proxy of the number of hours at sea, the amount of fuel used (energy use) or the ability of nets to catch fish over a given period.

Ecosystem Services

These are services to humanity provided by an ecosystem. In the strictest sense, all products and processes of an ecosystem that are beneficial to humans can be considered as a service, including the production of food and potable water. Many of these services are enormously significant to the health of the planet, assisting in the regulation of climate and the decomposition of waste. Aesthetic enjoyment of the natural world can also be considered an ecosystem service. Charismatic organisms like whales or attractive natural landscapes such as coral reefs, for example, provide aesthetic value as well as many other services.

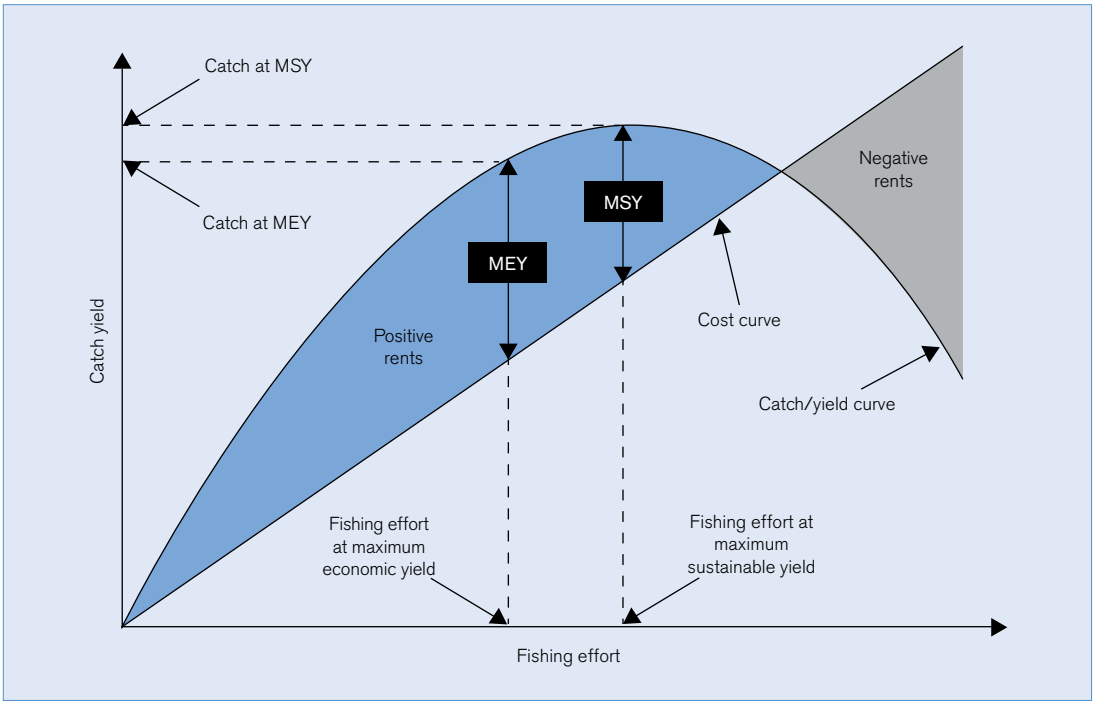


Figure 3 – An illustration of fishing effort versus yield at the MSY and MEY

Source: Adapted from World Bank, 2009

2 The Benefits of Sustainable Fisheries

Sustainable fisheries and the ecosystems in which they function provide significant benefits. These might be categorised as economic output, livelihoods, food security and ecosystem services. A transition to the sustainable management of fish stocks will ensure that these benefits are available to future generations.

Table 1 – Global indicators of fisheries production, value and consumption	
Total Seafood Production (2009)	145.1 million tonnes
Global Marine Capture Production (2009)	79.9 million tonnes
Global Revenue from capture fisheries (2009)	US$93. 9 billion
Global Contribution to the economy (2007)	US$274 billion
Total Direct Employment (2010)	120 million
Average annual per capita consumption (2011)	17 kg

Sources: World Bank, 2009; World Bank, 2010; FAO, 2010; FAO, 2011

2.1 **The economic case**

Currently fisheries contribute approximately US$274 billion to global GDP.[5] This number increases by a further US$160 billion per year when upstream activities, such as boat building, are included. Although amounting to approximately 1% of total global GDP, these figures do not convey the relative importance of fisheries to national or regional GDPs. For example, fisheries in Ghana account for around 3% of GDP, and in the Seychelles for approximately 30% of GDP.[6,7] Fisheries contribute to economies through tax generation, and fish products are now a widely traded commodity generating valuable foreign exchange, particularly for developing countries. The FAO estimates that 37% of fish is now traded internationally, making it one of the most traded protein commodities, generating US$102 billion in export value. Developing countries had a net export value for fish products of US$27 billion in 2008 which is significantly higher than other traded commodities such as coffee and rice, which were worth approximately US$10 billion and US$13.5 billion respectively.[8,9] In countries such as Mozambique and Mauritania, fisheries have historically contributed as much as 40% and 50% of export earnings.[10]

Net Value

Even in their current state it is clear that fisheries are of great economic importance. However, results from analysis commissioned by the ISU (figure 4) show that at the global level fisheries

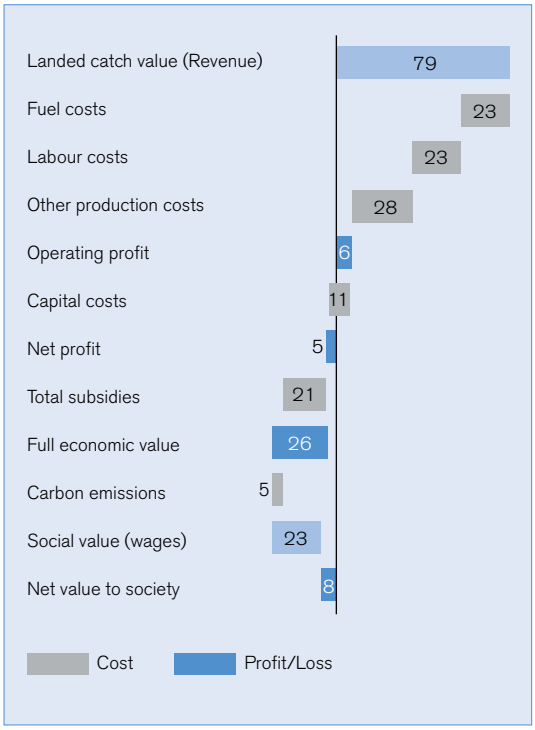


Figure 4 – The current value to society of global wild fisheries
Source: ISU commissioned research

"We have to operate our fisheries sustainably now, simply because we cannot compromise living marine resources for our descendents"
– Roy Bross, Executive Secretary, Deep Sea Trawling Industry Association

5 World Bank, 2009
6 FAO, 2012 (a)
7 FAO, 2012 (b)
8 FAO, 2010 (c)
9 FAO, 2011 (d)
10 FAO, 2007

Bluefin tuna being transferred in a floating cage
© Parsons|Greenpeace

"A sustainable fishery ultimately equates to a viable, healthy fishery, which strengthens our culture and provides economic opportunities for families well into the future" – Mia Isaacs, President, Bahamas Marine Exporters Association

are an underperforming asset. The global fishing industry revenue of US$79 billion per year results in an operating profit of approximately US$6 billion after fuel, labour and other production costs are accounted for. The inclusion of capital costs of US$11 billion a year produces a net loss for the global industry of approximately US$5 billion per year. This becomes a US$26 billion loss after the removal of subsidies. Figure 4 also shows the costs and value of global fisheries to society when carbon emissions and wages are included. When these additional costs and benefits are accounted for the total 'cost' of global fisheries to society is US$8 billion.[11]

Potential Value

The World Bank's 'Sunken Billions' report on the global economic opportunity of more responsible fisheries management concludes that 75% of the world's fisheries were underperforming in 2004 to the order of US$50 billion dollars annually. Over a thirty year period (up to 2004) this amounts to a loss of approximately US$2 trillion.[12] This shows the potential prize from a transition to sustainably managed fish stocks in pure economic terms.

A number of studies have attempted to measure these economic benefits at a local fishery level. For example, one study on eastern Pacific Ocean tuna stocks shows that the annual revenue of the tuna fleet would be US$93 million greater under better effort management.[13] Another study concludes that the potential economic gains from reducing current fishing effort of the Hilsa Shad fishery in Bangladesh, the biggest single species fishery in the country, to a sustainable level are in the order of US$260 million annually compared to almost no economic benefit in the business as usual scenario.[14] In the Gulf of Tonkin in Vietnam a study showed that if over-exploitation was curbed the economic benefits could be 56% greater than current levels.[15]

Research undertaken by the ISU also outlines the hypothetical economic benefits of recovering both North-East Atlantic bluefin tuna and coastal Senegalese fisheries to sustainable levels (see figures 5 and 6).[16] This study showed that, in the bluefin tuna case, whilst currently operating at a value of US$90 million per year, the fishery

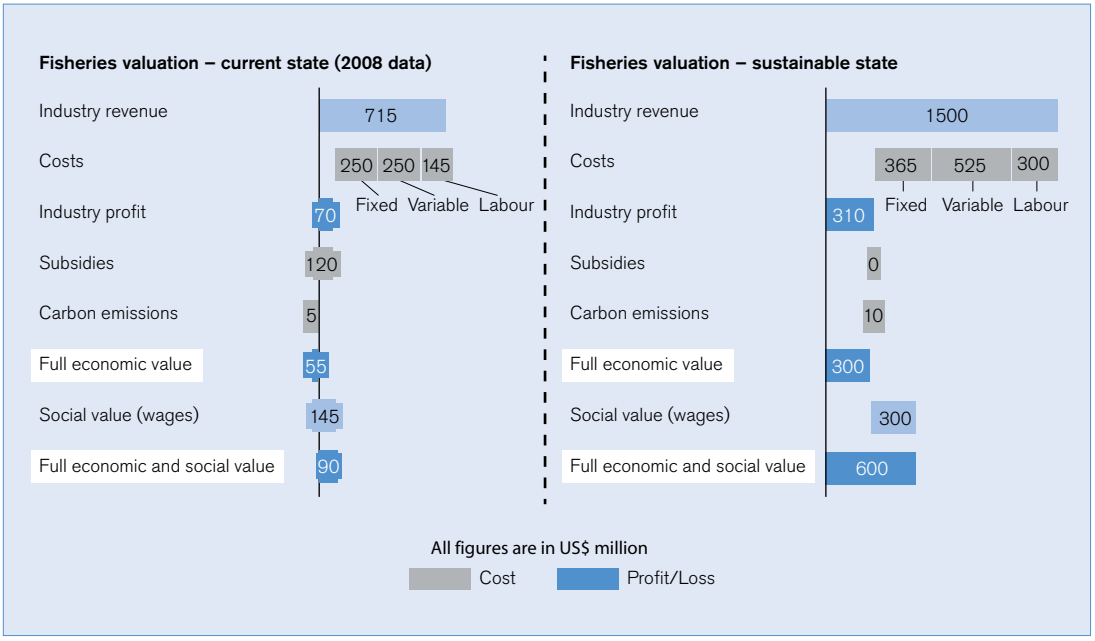


Figure 5 – The current and potential value to society of the North-East Atlantic bluefin tuna fishery
Source: ISU commissioned research

11 ISU commissioned research; see Annex A
12 World Bank, 2009
13 Sun et al, 2010
14 Ara Mome, 2007
15 World Bank, 2010
16 See Annex A for more details

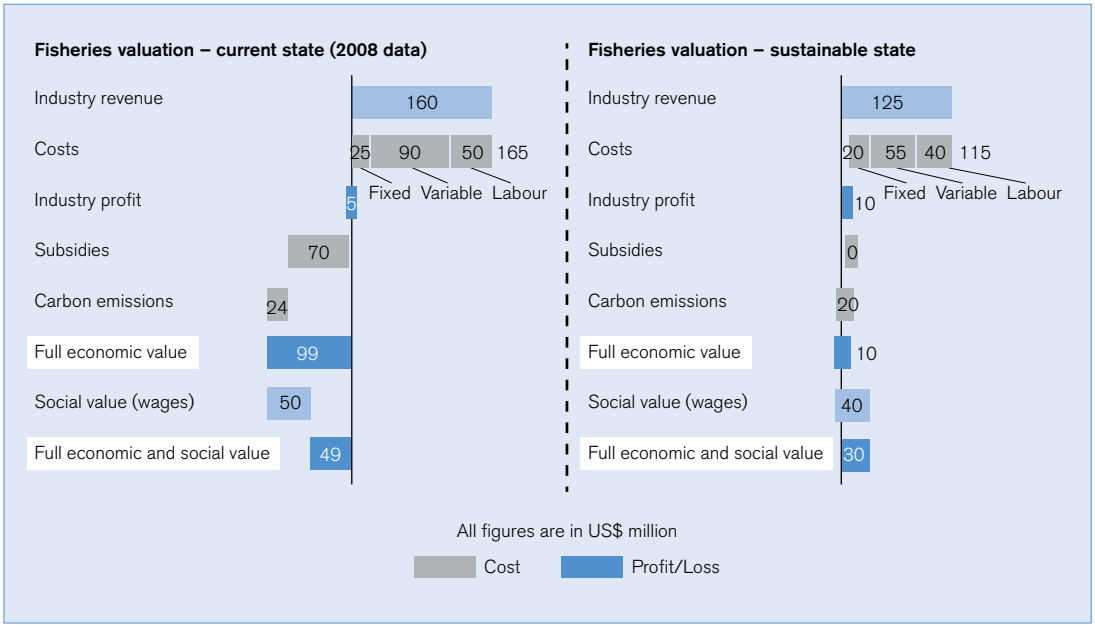


Figure 6 – The current and potential value to society of the Senegalese coastal fishery

Source: ISU commissioned research

could be worth some US$600 million to society if management interventions such as the elimination of IUU fishing, the removal of capacity enhancing subsidies and a short-term reduction in effort were stringently enforced. In the case of the Senegalese mixed coastal fishery, the research showed that it is currently operating at a loss to society of US$49 million. If this fishery was managed in a sustainable manner at MSY, it is estimated that it could be worth US$30 million, a net economic benefit of US$80 million to society.

In fisheries that have started the transition towards sustainability, economic benefits have already been documented. These have been seen in the price of fish as well as in the value of fishing quota. Companies such as Austral in Peru have seen an increase in the value of their company as a result of sustainable management introduced into the anchovy fishery. The higher quality of their product has resulted in higher prices fetched at market. In the Ben Tre Clam fishery in Vietnam the total value of landings has increased by 165%. In the Japanese snow crab fishery, price per kg of produce increased from US$28 to US$40 and in the Pacific Halibut fishery the price rose from US$1 per pound to US$7 per pound. In Iceland, the value of quotas rose from US$25 million to US$4 billion in 2004.[17] Economic benefits will flow to those operating in well-managed, sustainable fisheries.

The economic opportunity inherent in the recovery of a degraded fishery will depend of course on how degraded the fishery is. A fishery in which catch is greater than the maximum economic yield –i.e. one where the difference between the costs of fishing and the revenues from catch is not at its greatest – is not returning as much resource rent as one operating *at* the maximum economic yield. Furthermore, if the catch is above the maximum *sustainable* yield limit the fish stocks will decline over time and the fishery will not be able to sustain economic benefits for the long-term.

"Sustainable fisheries management is important because people's livelihoods depend on it"
– Kristján Þórarinsson, Federation of Icelandic Fishing Vessel Owners

2.2 Sustainable Livelihoods

A sustainable fishery is one that provides safe, secure and long-term employment. Fisheries globally employ between 120 and 200 million[18,19,20] people both directly as fishers and indirectly in activities such as processing, marketing and distribution, as well as creating valuable multiplier effects in the wider economy. Fishing as an activity is also strongly associated with the cultural identity and heritage of coastal communities.

Ben Tre Clam Fishery

© Kyle Cathie|MSC

17 *Case Studies: Ben Tre Clam Fishery; Kyoto Prefecture Snow Crab Fishery; North Pacific Halibut Fishery*
18 World Bank, 2009
19 World Bank, 2010
20 FAO, 2010 (b)

"It's only by means of a sustainable fishery that we can ensure a fishing industry with a future, renewable marine resources and healthy protein to feed the increasing world population"
– Javier Garat, President, Europeche

Box 1 – Ben Tre Fishery, Vietnam – Household benefits

Initially an open-access resource, the clam fishery of Ben Tre province in Vietnam faced increased pressures towards the end of the 20th century. In 1995, the government began to create cooperatives to protect the natural resource and delineate fishing areas for management. However, fishers themselves were unrestricted, and further stock declines led to the establishment of area rights to restrict fishing in 2006.

These further efforts proved successful, and the fishery was Marine Stewardship Council (MSC) certified in 2009. The certification brought significant benefits to the fishery, both social and economic. Eight months after full assessment, the price of the clams increased by 20-30%. "Before, I would collect clams and work from morning to late afternoon I would fill two baskets. Yet there was a limited market, and if I was unable to sell the clams I would have to return them to the sea" explains Vo Thi Binh, a local clam fisher from the Rang Dong cooperative. "Since the cooperative has been established, the harvest is planned according to contracts with the processing plants, so every day that I go to work I get paid and I don't have to worry about selling the clams." Wages have increased five-fold since 2007.

Because of these economic benefits, 13,000 households are now supported by the fishery, compared to less than 9,000 in 2007. As a result, more people are now able to pay for their children's school fees, and support them through vocational training, boosting their chances of a better future. This has been one of the lasting benefits of transitioning this fishery to sustainability.

Interviews with fishery stakeholders, Vietnamese Ben Tre Clam Fishery

97% of those employed in fishing are in developing countries and the vast majority of these are small-scale operators.[21] There are also millions of people who are involved in seasonal or occasional fishing activities who do not appear in official statistics.[22] Many of those involved in the small-scale sector are based in remote areas where there are few alternative livelihood options. Fisheries therefore have an important role to play in both poverty prevention and poverty reduction.[23] One fishery that showcases these benefits is the Ben Tre fishery in the Mekong Delta in Vietnam (box 1).

Sustainably managed fisheries not only provide steady and long-term employment opportunities but also a better standard of employment. There are many examples of this from around the world. For example, the Pacific Halibut fishery on the West coast of USA used to be a 'derby' fishery open for just 24 hours a year with fishers competing for the same resource, often in very precarious conditions. The fishery was providing highly dangerous, part-time employment. With an overhaul of management and a change of mindset towards long-term stewardship of the resource, the fishers now have full-time jobs, steady income and the ability to choose when to fish.

Sustainable fisheries are also more likely to attract future generations to fishing and at the same time encourage innovation. In Lira in Northern Spain, the artisanal fishers who co-manage their fishery have found that many more young people are attracted to fishing now that their industry has clear economic and social benefits and a good reputation.[24]

2.3 Food Security

As a result of food price spikes during 2007 and 2008 a global food crisis occurred. The impact of this has been enormous, particularly in poor countries where people often spend 50% to 80% of their incomes on food.[25] The contribution of fish and fish products to global nutrition is

Vendors arrange their stalls at a fish market in Jakarta, 27 December 2007

21 World Bank, 2010
22 FAO, 2007
23 Ibid
24 *Case Studies: North Pacific Halibut Fishery; Lira Coastal Community Fishery*
25 Evans, 2009

therefore of great importance. One study recently concluded that if overfishing had not been so dramatic approximately 20 million people could have avoided under-nourishment in 2000.[26] Fish catches can contribute directly and indirectly to individual or national food security: directly, through the supply of the food commodity itself, i.e. subsistence level; or indirectly, when income obtained by those involved in the fishing industry is used to purchase food for families.

In 2009, the UK Chief Scientist highlighted the 'perfect storm' of pressures that the world is likely to face by 2030: 50% more energy will be needed and 30% more fresh water to produce 50% more food.[27] The contribution of fish and seafood is already vital to the world's food security, and will become ever more important given the challenges that lie ahead for terrestrial food production. A recent analysis has suggested that shifting 20% of the world's 2010 calorie consumption from meat to fish would save about 60 to 80 million hectares of cropland.[28] Furthermore, other reports have emphasised the high relative efficiency of energy return on investment (EROI) of capture fisheries compared to many forms of terrestrial livestock production. For example, the EROI of some pelagic fisheries is over 0.5 (i. e. 50% efficiency), whereas the EROI for intensive, grain-fed beef production averages around 0.019.[29]

According to most recent FAO figures, fish consumption has reached an all time high of 17kg per person, supplying approximately 1 billion people with their main source of protein.[30] In some countries where there is a lack of alternative sources of animal protein, or where a preference for fish has developed, the relative importance of fish is much higher than the world average. The populations of Indonesia and Japan consume the most fish, obtaining 40 to 50% of their animal protein from fish, compared to only 8% in the United States.

Many suggest that aquaculture can fill the gap between supply and demand for seafood that is bound to widen because of population growth and rising incomes. With an average growth rate of 6.6% per year since the 1970s, aquaculture remains the fastest-growing food production activity in the world and now accounts for almost half of total food fish supply.[31] Aquaculture is clearly going to increase in importance as an economic activity as well as a source of animal protein but it is not simply a case of one system replacing the other. Firstly, even if aquaculture can meet the growth in demand for seafood, it is very unlikely that it will be able to fill the gap left by declining wild fisheries. Secondly, wild fish will continue to be needed to supply fishmeal and fish oil for the production of aquaculture (as well as pigs and poultry). Furthermore, aquaculture can also place extreme demands on the environment and lead to significant levels of pollution and habitat loss.[32]

2.4 Ecosystem resilience

"Protecting the planet's renewable resources is a serious responsibility that faces this generation, and every generation that follows" – Mike Park, Executive Chairman, Scottish Whitefish Producers' Association

Rebuilding degraded fisheries will help to increase their resilience and the resilience of wider marine ecosystems to withstand external shocks and stresses such as climate change and pollution events. It would also help to ensure other benefits provided by oceans such as their ecosystem service value for coastal protection and tourism. According to a recent study that maps the total human impact on the oceans, unsustainable fishing practices, climate change and pollution have left an indelible mark. Scientists found that almost no areas have been left pristine, and that more than 40% have been heavily affected.[33] There has been significant degradation of coastal ecosystems over the past two or three decades, with 50% of marshes, 35% of mangroves and 30% of reefs either lost or degraded.[34]

Sustainable fish stocks are a key component of any healthy ecosystem and, likewise, healthy

Swarms of anthias fish shelter near coral outcroppings and feed in the passing current in Fiji

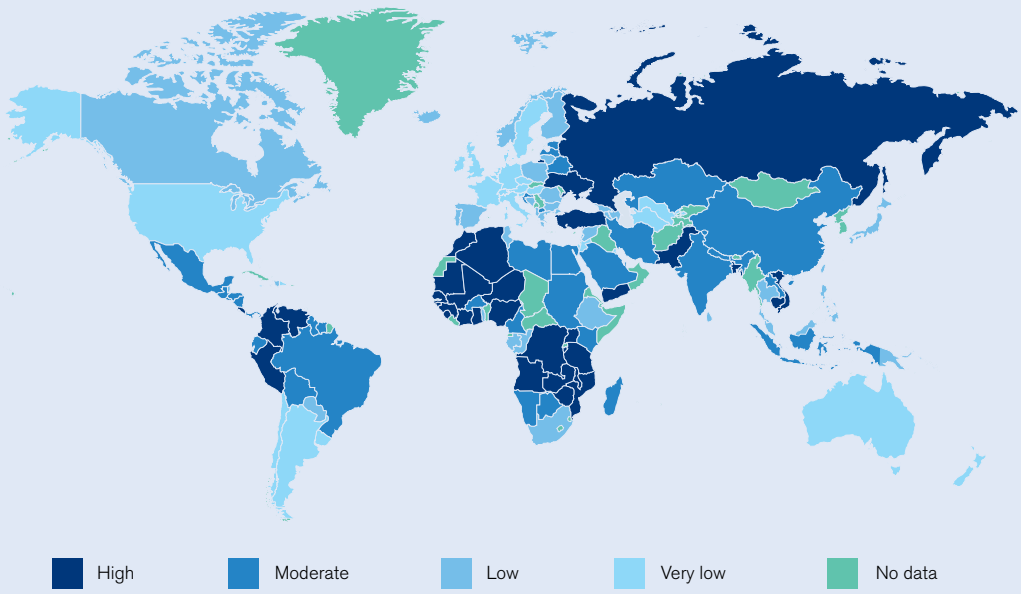
26 Srinivasan et al, 2010
27 Beddington, 2009
28 Mckinsey, 2011
29 Tyedmers, 2004
30 FAO, 2010 (a)
31 Ibid
32 See *What Price Resilience? Towards Sustainable and Resilient Food Systems.* www. pcfisu. org/reports
33 Halpern, 2008
34 Barbier et al, 2008

ecosystems are absolutely essential to the continued productivity of fisheries. Occupying some 70% of the surface of the planet, the oceans are home to a large proportion of the world's biodiversity. Removing any one species can have ramifications for the whole ecosystem by disrupting ecological relationships between species. These are complex systems, the details of which are frequently poorly understood. We do know, however, that unsustainable fishing practices often contribute to the destruction or damaging simplification of the very ecosystems on which they depend, which can lead to significant shifts to alternative states within a marine ecosystem. One well-documented example of this is the Newfoundland cod fishery, where long-term over-exploitation of the once highly abundant cod stock (suffering a loss of over 95% of its historical population size)[35] pushed the ecosystem from one stable state to another. The reduction in cod populations altered the system from a fish-dominated to an invertebrate-dominated seascape. Due to the nature of these complex interactions, shifts to alternative states can be difficult to reverse, and stock recovery may take decades, if it occurs at all.

Another example of the value of marine ecosystems is that of coral reefs. Coral reefs are estimated to be home to more than a quarter of all marine fish species and represent very important areas for fish nurseries.[36] In addition, coral reefs provide valuable ecosystem services such as coastline protection and tourism. But, destructive fishing practices can destroy coral reefs. In Belize, an evaluation by World Resources Institute (WRI) found that coral reefs and mangroves were worth between US$395 to US$559 million per year (up to 40% of GDP) through tourism, coastal protection and fishing.[37] The coral reefs were becoming badly degraded due to the use of destructive fishing practices and this was eroding their value to the economy as a whole.

Exogenous shocks and stresses on fisheries and ecosystems are a significant challenge for the fishing industry and are likely to become more so in the future. Climate change is perhaps one of the biggest threats facing the world's oceans. Possible impacts on fisheries include variation in abundance, fecundity and migratory patterns because of temperature changes; the continued bleaching effect on coral reefs through ocean acidification; and rising sea levels.[38] Experts have found that climate change has already affected the abundance of North Atlantic plankton and Antarctic Krill and the rate of stock growth of Pacific tuna.[39] Given the importance of fisheries

Figure 7 – Vulnerability of countries to potential climate change impacts of fisheries
(Allison et al, 2008)



NB: This map integrates indicators of exposure, sensitivity and adaptive capacity to climate change impacts on fisheries where 1) exposure is measured as country-specific mean surface temperature increase by 2050 under IPCC scenario B2 2) sensitivity is a composite indicator of the fisheries dependence of countries 3) adaptive capacity is a composite index calculated from indices of health, education, governance and size of economy. Those countries found to be most vulnerable were Central and Western Africa, Peru, Colombia, and tropical Asian countries. Russia and Ukraine were also identified as being highly vulnerable due to their high exposure to climate change impacts and relatively low adaptive capacity

35 Rose, 2004
36 TEEB, 2010
37 Cooper et al, 2008
38 Roessig et al, 2005
39 Brander, 2010

to economies, livelihoods and food security, these changes are likely to have significant impacts. A study that looked at the vulnerability of countries to climate change impacts on fisheries found that those that were the most vulnerable were also some of the poorest and most reliant on fish for food security (figure 7).[40]

Pollution is another threat to the health and productivity of fisheries. 'Dead zones', which are no longer able to support marine life, are being created by eutrophication due to the run-off of agricultural pollutants from land. Rapid coastal development is projected to have impacts on 91% of all inhabited coasts by 2050 and cause up to 80% of marine pollution.[41] The oceans are the final destination for a wide range of chemical pollutants, some of which are bio-accumulative, endocrine-disrupting or carcinogenic and have been found in fish destined for human consumption.[42]

Whilst both pollution and climate change are exogenous to the fishery itself, and overwhelming challenges even on their own, the effects are likely to be exacerbated when combined with unsustainable fishing practices. As with all climate change predictions there is a high level of uncertainty around the precise nature of the impacts and their effects on fishing activities but a healthy and sustainable marine ecosystem will be more resilient to these impacts than a degraded one.

40 Allison et al, 2008
41 UNEP, 2008
42 Greenpeace China, 2010

3 Tools for Rebuilding Global Fish Stocks

The case for a transition to sustainable global fish stocks is compelling. Whilst the challenge is considerable, research on fisheries in transition commissioned by the ISU[43] shows that a process of change is not only highly desirable but also achievable.

"A sustainable fishing industry in ecological, economic and social terms is within our grasp – if we can get the governance right." – Barrie Deas, National Federation of Fishermen's Organisations, United Kingdom

The case studies and interviews commissioned by the ISU highlight that there is no one, universal method by which to rebuild fish stocks and transition to a sustainable fishery. This chapter summarises the plethora of existing tools and interventions used by fisheries around the world. Depending on geography, political economy, ecology and social context, the path to a more sustainable fishery will vary and the tools available will not be equally suited to each fishery. But through these case studies it is possible to identify certain key themes under which these individual tools can be grouped. These are: smart economics; the ecosystem approach; and robust management. It seems that a sustainable fishery is one that incorporates all three of these principles. What is even clearer is the need for good governance, which includes comprehensive stakeholder engagement at its core, as the framing narrative for any sustainable fishery.

Governance and Stakeholder Engagement

Good governance with effective stakeholder participation should allow for the adoption of an appropriate package of tried and tested tools to ensure smart economics, an ecosystem approach, and robust management measures. Good governance, as outlined by the FAO, is understood to be a governance approach that is accountable, transparent, responsive, efficient and effective, and subject to a sound rule of law.[44] Fisheries are, by their nature, hugely diverse in spatial scale, so top-down frameworks must allow for individual differences and be joined with local approaches.

Stakeholder engagement at all levels has emerged as one of the most crucial elements for sustainable management. It can help produce management frameworks that incorporate local and traditional knowledge, improve community relations and instil a sense of responsibility over the resource.[45] Cases have shown that co-management models have often been promoted as an effective way to ensure stakeholder requirements are taken into consideration. These models range from total self-governance to a shared responsibility approach. For instance, the Australian Northern prawn fishery is an example of an advanced form of co-

Stationary Trap Net Fishing In The Sakhalin Salmon Fishery

43 See www. pcfisu. org/reports
44 FAO, 2008
45 Ibid

management, where the industry has taken on a number of functions on behalf of government such as running the crew member observer programme, collecting and analysing catch data, and investing significantly in buy-back schemes to reduce capacity.[46]

Rodeo at sea. Purse seiners in the Herring Roe fishery in Vancouver

3.1 Tools for Smart Economics

Whilst the depletion of marine fisheries, and the associated marine ecosystems that sustain them is irrational in the long term, it is made logical in the short-term through perverse economic incentives. Aligning the economic incentives within a fishery to promote profitable and sustainable activity is, therefore, a necessity. The ISU commissioned research indicates that this can be done by restricting effort and establishing access rights and redirecting or eliminating perverse public subsidies.

Restricting effort and establishing access rights

Oceans have always been considered a 'global commons' and, as such, very few countries have imposed constraints on their use. This has resulted in the age-old problem of the 'tragedy of the commons'. Highlighted by Garrett Hardin in his seminal paper,[47] this is the concept that anyone with access to a shared valuable resource has an interest in over exploiting it, while it is in nobody's interest to maintain it alone. At the heart of global fisheries decline is the unrestricted adoption of more powerful technology and a rapid increase in global fishing capacity leading to the over-exploitation of this renewable resource.

At the most basic level the setting of a total allowable catch limit (TAC) establishes a level above which it becomes illegal to fish. If this limit is set at the level of MSY or below and is well-enforced it will immediately reduce effort and catch to a more sustainable level. Although effort restriction is a crucial first step in the transition to sustainability, if a fishery remains open-access the result is a 'race to fish': fishers are encouraged to fish as quickly and as hard as possible before the TAC is reached and the fishery closes. These 'races' were particularly well-known in the Gulf of Mexico red snapper fishery, where catch restriction reduced the annual season yet still resulted in overfishing (box 2). Similarly, in the North Pacific halibut fishery, the truncated fishing season led to

"The long term sustainable exploitation of fish stocks can only be guaranteed if the fishing industry is allowed to have co-ownership of the entire process"
– Gerard Van Balsfoort, President, Pelagic Freezer-trawler Association

Box 2 – US Gulf of Mexico Red Snapper Fishery – benefits of the catch share system

The Gulf of Mexico red snapper fishery suffered from declining stocks throughout the 1990s. The fishery was initially closed, then reopened with a limited season. Stocks recovered, though the quota system led to a race to fish for two months out of the year, and discarding was high.

It was decided that change was urgently needed, and a catch share system was voted into existence by the fishers with 80% support. In the first two years of the catch share the quota was reduced from 9 to 5 million lbs (2267 tonnes), but as stocks rebuilt so too did the quota.

The benefits of the catch share system have been numerous, and have changed the situation from a derby fishery with an over-capacity and a limited season to one where the capacity matches the resource. Fishers have slowed the pace at which they fish, and now focus on reduced volumes but a high quality and high value product. Discards have been reduced as fishers are able to take more time to be selective, and the fishery is open all year round providing full time employment, with higher wages to match – up to US$50,000 per year.

Current efforts to further improve the sustainability of the fishery are underway with the launch of the Gulf Wild programme, allowing for tracking where, when and by whom any fish was caught. Fishers are signing up to conservation covenants to reduce discarding. The economic benefits are tangible. "Already we are rebuilding markets and starting to see interest in Europe" says David Krebs of the Gulf of Mexico Reef Fish Stakeholders' Alliance, "Our reputation is changing and Monterey Bay is considering moving Gulf Wild red snapper off the 'fish to avoid' list."

Interview with David Krebs, Gulf of Mexico Red Snapper Fishery

46 *Case Study: Australian Northern Prawn Fishery*
47 Hardin, 1968

dangerous fishing activity as vessels had no option but to fish in all weather conditions.

When fishers are allocated a proportion of a restricted catch limit they are provided with an incentive as their fishery's productivity is explicitly linked to sustainable fisheries management. Some system of restricted access or privileged access rights is generally acknowledged to be a useful way to sustainably govern a fishery. It is important to note that there are many different ways to design access rights, and any individual fishery will have a complex set of factors that will determine which is the most appropriate. Although the more complex systems can impose high costs, establishing rights that give fishers clear and long-term access to the resource does not have to be costly or complex. Indeed, in Fiji, the local chieftains restrict access to the resource by specifying who can fish in which areas.

One of the more advanced access right systems is the Individual Transferable Quota (ITQ) system. Not only are fishers allocated a quota of catch but are also able to trade this quota with other participants in the fishery. It is used successfully in a variety of fisheries including New Zealand and Iceland (box 3). Due to its methodology and operating mechanisms, ITQ systems can be relatively costly to implement and therefore the institutional capacity and socio-economic status of a fishery will need to be taken into consideration.

Another system, the Territorial Use Rights in Fisheries (TURF) system, is used in, amongst others, the Chilean Loco Fishery and the Vietnamese Ben Tre clam fishery. This system designates access to a portion of a seabed or sea area rather than to the catch itself. This is most successful for sedentary species such as oysters, mussels, loco and clams. There is evidence to suggest that TURFs are especially useful in giving small fishing communities privileged access to a resource for their increased welfare.[48] This is certainly the case in Ben Tre Province in Vietnam where the open-access nature of the fishery up until the early nineties led to over-exploitation and a decline in catch. With the establishment of co-operatives that were given clear area rights, the stock, the value of the catch and the fishers' income all increased. In the Chilean Loco fishery, legislation was introduced in 1991 to create areas for the management and exploitation of benthic resources (MEABRs), broadly analogous to TURFs, which allow for community management of individual areas of the seabed. In both cases, greater control over the resource led to a stronger sense of responsibility.

With any reduction in fishing effort, there are going to be winners and losers. However, there are ways of mitigating potential negative socio-economic effects. In ITQ systems there are concerns that quota can become concentrated as more efficient vessels outperform the less efficient. Whilst this can be beneficial if the preferred objective is economic efficiency, ITQ systems can be designed such that other objectives can be achieved. For example, in the Alaskan Bering sea crab fishery there are strict caps on quota ownership – at 1%

Box 3 – Icelandic Groundfish – The Successes of an ITQ system

Iceland is hugely dependent on its marine resources for economic and food security benefits. Icelandic fisheries span a vast area of the North Atlantic and have traditionally suffered from high levels of overexploitation from a variety of international vessels. Following the establishment of the Icelandic exclusive economic zone (EEZ) in 1975, Icelandic vessels rushed in to replace the departed foreign vessels, and overexploitation continued.

The importance of restricting catch levels of these crucial resources was soon realised, and Icelandic fisheries were radically redesigned, with economic viability and sustainability of the resource as the central focus. A harvest control rule was introduced in the cod fishery, which dictated the maximum percentage of total stock allowed to be extracted in a given year. Using this system, the annual total allowable catch (TAC) is established every year, based on previous year's stock information.

Iceland was one of the pioneers of the individual transferable quota (ITQ) system, and introduced individual, tradable shares of the overarching TAC as a means of providing fishers with secure fishing rights and allowing them to plan their operations. Reducing fish caught under their catch share in the present no longer equated to losing potential catch in the future and fishers are now provided with an incentive to maintain stocks into the future.

Now, the fishery is not only sustainable but also profitable. In this particular case the economic benefits of consolidating fishing effort into fewer vessels have been clear. Following an increased understanding of the importance of sustainability and an understanding of the marine environment, spawning stock now not only exceeds 300,000 tonnes – as opposed to 125,000 tonnes in 1993 – but it is also made up of larger, older and more profitable fish.

Interview with Kristján Þórarinsson, Icelandic Groundfish Fishery

48 FAO, 1992

Box 4 – Peruvian Anchovy – Socially Responsible Effort Reduction

The Peruvian anchovy fishery is the largest fishery in the world, producing over 6 million tonnes of anchovy annually.

Prior to 2009, it was recognised that the fishery was suffering from over-capacity. To manage this, the season had been reduced to 50 days, but this had led to a race to fish, high risks for crew and low quality fish. Furthermore, the fishery is frequently subject to environmental change including that which can be brought about by the El Niño weather phenomenon. To better manage the fishery in the face of such variability, it was concluded that effort reduction and the consequent reduction of pressure on stocks was necessary.

Over time, the fishery has reduced capacity from 1,172 to 868 boats. 2,500 individuals have left the industry. Fortunately, the government introduced legislation that ensured mitigation measures were in place. Now, crew can only be made redundant voluntarily and receive over 1.5 times the usual redundancy payments. Former employers are required to support them through a training programme for a new career. This reduces the likelihood of unemployment, and the training is accompanied by funds to help with living costs until a new job has been found. Furthermore, companies now invest US$1.95 per tonne of fish caught into a pension fund for remaining crew members.

There have been significant economic gains made from the effort reductions that have taken place – fewer vessels crowd ports and fishing bays, and crew safety has gone up. Fish quality, too, has increased as catch arrives earlier and fresher resulting in an increase in the value of the fish of up to US$200 per tonne.

Interview with Adriana Giudice Alva, Peruvian Anchovy Fishery

"It is my desire that fisheries provide an abundant, renewable resource that supports future generations with employment, recreation and a healthy source of nutrition" – Thomas Kraft, Owner, Norpac Fisheries Export

of the total for individuals and 5% for communities owning quota – and any one potential buyer has to have a background within the fishery before being allowed to purchase any quota. Alternative livelihoods and financial compensation can also be secured for those exiting the fishery. In the Peruvian anchovy fishery, legislation ensured that there were buffers in place to cope with the social upheaval that resulted from effort reduction (box 4).

Ultimately, experience shows that giving selected individuals, fishing communities or associations the privilege of long-term, secure rights to harvest a specific area or percentage of the fishery's total quota can encourage those fishing to take a longer term interest in the future health and sustainability of their stock.[49]

Tuna fleet in Samoa
IUCN Global Marine and polar Programme © WolcottHenry

Public subsidies for sustainability

The allocation of public subsidies that contribute to increasing capacity can also contribute to the over-exploitation of a fishery. According to one study these subsidies are worth US$16 billion per year.[50] In addition, subsidies for fuel account for approximately US$4 to US$8 billion per year and subsidies for bottom trawl fleets (that are ecologically destructive in some places) approximately US$152m per year.[51] Perverse subsidies artificially reduce the input costs of fishing, thereby enabling fishing to continue beyond the point at which it would otherwise become unprofitable. This leads to the overcapitalisation of fishing fleets and consequently the over-exploitation of the resource. The impact of these subsidies is so great that some organisations argue that eliminating or redirecting them is the single most important action that can be taken to move toward more sustainable fisheries.

49 *Case Studies: Gulf of Mexico Red Snapper Fishery; North Pacific Halibut Fishery; Fijian Subsistence Fisheries; Alaskan Bering Sea Crab Fishery; Peruvian Anchovy Fishery; Australian Northern Prawn Fishery*

50 Sumaila & Pauly, 2006

51 Ibid

"With a population of more than 7 billion people, the world's only chance to feed its population properly is to harvest our marine resources in a sustainable way" – Johannes Nakken, Managing Director, Norwegian Fishermen's Sales Association

Subsidies were initially introduced to help drive technological improvements after World War II. At this time fisheries were believed to be inexhaustible and governments wanted to encourage investment in the sector to provide food security and jobs in struggling coastal regions. However, as early as the 1960s the Organisation for Economic Cooperation and Development (OECD) warned of the link between subsidies and overfishing. Since then there have been many calls for subsidies to be eliminated, redirected or reformed. The fear that the realignment of these perverse incentives will lead to negative social and economic outcomes lies at the heart of the challenge. However, prioritising short-term outcomes will inevitably undermine livelihoods and food security in the long-term.

A few governments have taken on this challenge with positive and lasting effects. For example, in Norway, subsidies were reduced by 85% between 1981 and 1994 (from AUS$150 million to AUS$30 million) and compensation in the form of optional alternative livelihood opportunities allowed the sector to downsize without significant negative effects. In New Zealand, removal of subsidies in the mid 1980s was part of a wholesale reform of the fisheries sector, which included the allocation of property rights, a reduction in overall exploitation of the fishery, and the payment by industry of a levy contributing to the costs of fisheries management.[52]

It would appear that instead of propping up unprofitable elements of the fishing industry, it would be more economically, socially and environmentally rational to redirect these subsidies to promote more sustainable fishing practices and to aid the smooth transition from business as usual to sustainability.

3.2 **Tools for an Ecosystem Approach**

Traditionally, fisheries management has focused on what is known as single-species management. This approach does not always recognise the full complexity and dynamic nature of marine environments, nor the inherent levels of uncertainty involved in predicting the outcomes of the interactions within an ecosystem.

"Sustainable fisheries management incorporating ecosystem considerations entails taking into account the impacts of fisheries on the marine ecosystem and the impacts of the marine ecosystem on fisheries" – Reykjavik declaration on Responsible Fisheries in the Marine Ecosystem, Reykjavik, 2001

To halt the decline of fisheries and maintain stocks in the long term, many experts conclude that an 'ecosystem approach' to fisheries (EAF) is required. The principle difference between EAF and traditional fisheries management is the shift in conceptual focus to view a fishery within a wider ecosystem, allowing for the consideration of interactions within and between species, and between species and their environment.[53] This approach is increasingly shared within the political community, as reflected in the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem[54] and the European Commission's 2008 Marine Strategy Framework Directive, which has the ecosystem approach at its core.[55] While the concept remains relatively new, some of the case studies show the promise of this approach for achieving sustainable fisheries. It is important to acknowledge that the achievement of the sustainable management of target species is a key first step towards a more holistic ecosystem approach.[56]

The case studies highlight five key elements that are necessary for the successful implementation of the ecosystem approach, all of which require continuous engagement with all users of the marine environment.[57,58] These are: data collection and analysis; precautionary management measures; marine spatial planning; marine protected areas; and the reduction of bycatch.

Data Collection and Analysis

The most basic need for an ecosystem approach is the collection of comprehensive data on the stocks and habits of both target and non-target species within an ecosystem.[59] However, in some fisheries, even a basic stock assessment is missing. There is a need for the development of more efficient ways to collect better data and to use this data in management decisions. Good use of available data

52 MRAG, 2010 (a)
53 Zhou et al, 2010
54 FAO, 2011 (b)
55 European Commission, 2008
56 Hilborn, 2011
57 Norse, 2010
58 Taladon, 2011
59 Hilborn, 2011

Net sensors are fitted to the trawl to measure trawl opening and headline height in the Tasman Peninsula

can significantly improve the chances of setting appropriate catch limits.

Data collection, data processing and the use of data in management decisions can be resource intensive. However, useful data will inevitably be held by fishers themselves. Strong partnerships between the fishing and scientific communities are crucial for acquiring locally held or traditional knowledge. It is often easy for the scientific community to impose external scientific knowledge on fishing communities without sufficient context or explanation, and for fishing communities to dismiss scientific inquiry. The Gambian sole fishery highlights the usefulness of local knowledge and partnerships between fishers and scientists. Fishers accompanied scientists to map fish breeding grounds and this locally held information was incorporated into management efforts for the fishery.

The importance of ongoing dialogue between scientists and fishers is particularly highlighted in the case of the Isle of Man scallop fishery. Good relations with scientists have been established over the years, as management changes based on data collection have increased catch and improved livelihoods for the fishers. Workshops on fishery science and the ecosystem approach maintain this dialogue to mutual benefit.

For an ecosystem approach, it is important to understand the biology and interactions of non-target species as well as target species. For example, it is useful to determine to what extent different species are under pressure from fishing effort. This will assist in deciding on best management practice.[60] Similarly, a better understanding of abiotic factors such as the impacts of climate change will improve the chances of the successful application of an ecosystem based approach.[61,62]

Precautionary Management

Uncertainty is inherent in all natural systems and the ability to cope with this uncertainty will only become more important in the future with the effects of climate change on marine ecosystems. According to the FAO Code of Conduct for Responsible Fisheries: "*The absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species and non-target species and their environment.*"[63] It is still possible to achieve sustainable fisheries management under uncertain conditions or a lack of data but a precautionary approach based on best available data may help to prevent over-exploitation of a fishery.

Related to this more precautionary approach is the adoption of a process known as adaptive management. It is important to remember that ecosystems are not static, but rather dynamic systems with no discrete baseline from which to measure change.[64,65,66] Thus, fisheries management cannot feasibly operate around absolute parameters of what defines a 'healthy ecosystem'. Rather, improvements should be measured and assessed against relative milestones or indicators of progress over time. Through adaptive management the sustainability of a fishery can be gradually improved based on best available data. One excellent example of this is in the Australian Spencer Gulf prawn fishery (box 5) where a real-time management system has been established. If undersize prawns are seen in active fishing areas then fishery managers are notified and changes are able to be made within one hour. This system has deep involvement from the fishers themselves which is key to making it function.[67]

It is no good exploiting the resource without good information. I want to have sustainable fisheries for years to come.'
– Ousman Bojang, President, Gambia Artisanal Fisheries Development Agency

60 Norse, 2010
61 Botsford et al, 1997
62 *Case Studies: Gambian Red And Black Sole Fishery; Isle of Man Scallop Fishery*
63 FAO, 2011 (a)
64 Pauly et al, 2002
65 Morishita, 2008
66 Roberts, 2007
67 *Case Study: Australian Northern Prawn Fishery*

Managing Competing Uses

"We are committed to sustainable management because it maintains the harvesting possibilities of the stocks, and thus ensures the continued livelihoods of our fishers" – Niels Wichmann, Chairman, Danish Fishermen's Association

As well as requiring the comprehensive collection of marine data, adopting an ecosystem approach to fisheries management also requires that all users of the marine environment, including the fishing industry, aquaculture, energy companies, shipping companies, government interests and conservation groups, are brought together to make coordinated decisions about how to use their marine resource. To reconcile the competing interests of different users in each area and decide how to allocate the resource optimally between users, marine spatial planning (MSP) can be employed. However, for MSP to be an effective tool, it is essential that all users of the marine environment work together from the outset to define the boundaries of their activities and minimise the likelihood of any conflicts.

Even within the fishing sector, conflicts often arise between small-scale and industrial fishers which the MSP process can help to avoid. For example, small-scale fishers in Sierra Leone, the Philippines and Fiji had all previously suffered from the impact of industrial fishing on their traditional fishing grounds. In the case of the Philippines and Fiji, establishing a zone explicitly for artisanal fishers and making sure this was enforced was a particularly effective means to reduce conflict. Other conflicts that exist include those between commercial and recreational fishers, where catches within recreational fisheries can be significant but are not always included within stock assessments or controlled to the same degree.

Another good example of MSP in practice derives from the MarViva project in Colombia, where it was used to map out conflict between tourism activity, artisanal and industrial fisheries. As a result of this use of spatial planning, the MarViva project revealed a lack of access to markets for artisanal fishers. This led to efforts to provide access and improve the financial situation of Colombian artisanal fishing communities.

Given that industries such as aquaculture and offshore energy are set to increase their use of the marine environment in the future, it is likely that the usefulness of MSP will continue to grow. As in all areas where usage conflicts exist, trade-offs will be necessary, and a sufficiently powerful institutional framework will be required to make difficult decisions.[68]

Marine Protected Areas

Marine protected areas (MPAs) are a vital tool for the effective conservation of ocean systems and, as is the case on land, MPAs will prove increasingly important. Global targets have been set and are in the process of being implemented. For example, the 10th meeting of the Convention on Biological Diversity agreed in 2010 that 10% of marine and coastal systems would would be protected by 2020. Many governments are now conceiving strategies to meet that goal.

In addition to the undoubted benefits that come from protected areas in meeting conservation goals, in some cases there can also be benefits for fisheries management. These benefits might include the protection of juvenile commercially relevant fish, a reduction in pressure on stocks during critical breeding periods, and the provision of pristine areas such as coral reefs for ecosystem

Box 5 – Spencer Gulf Prawns – a real-time strategy

The Spencer Gulf prawn fishery along the south coast of Australia has a long history of sustainable management, capping the number of boats at 39 in 1976 and using gear adapted to maximise the survivability of bycatch of blue crabs, fish, small sharks and rays. However, it wasn't until 1998 that the management committee introduced real-time fisheries management, one of the most innovative management practices yet.

Under real-time fisheries management, the Spencer Gulf is surveyed three times per year, to establish harvest strategies for the following season. One of their activities is to estimate average prawn size in each area and consequently only fish in those areas that contain prawns above the minimum size. Once these areas have been established, all other areas are closed, and the active fishing area is monitored on a nightly basis to determine if smaller, juvenile prawns are entering the area. The Committee at Sea, made up of actively fishing members of the Fishermen's Association, can close an area experiencing a sudden influx of small, juvenile prawns within one hour.

As a result, over the past six years small prawns have comprised less than 7% of the catch, compared with up to 40% before. The number of lucrative extra large prawns being caught has also doubled. In addition to voluntary closures to avoid interactions with other species and restricting fishing to only 50 nights of the year, this has allowed the fishery to remain profitable, sustainable and resilient to fluctuations in prawn abundance. As an added benefit, the number of people employed by the fishery has stayed the same.

Interview with Simon Clark, Australian Spencer Gulf Prawn Fishery

68 *Case Studies: Negros Island Community Fisheries; Fijian Subsistence Fisheries; Bahia Solano Community Fishery*

Box 6 – Japan Snow Crabs – closures initiated by the fishing association

The Kyoto Danish Seine Fishery Federation, so named due to its use of large, trawl-like Danish seine nets, was established in 1944 and today represents 15 Danish Seine trawlers. Almost half of the Federation's income comes from the snow crab fishery, and as such sustaining this fishery into the future is vital for the Kyoto fisher community.

Following a sharp decrease in the stock in the 1970s, where landings diminished from more than 500 tonnes per year to no more than 100 tonnes per year, the Kyoto Danish Seine Fishery Federation took the initiative of setting up permanent and temporary closed areas to trawling.

Since 1983, six no-take zones have been established to protect critical habitats of the snow crabs in which concrete blocks have been placed at regular intervals to prevent any trawling. Temporary area closures at specific depths have also been put in place for trawling outside of the snow-crab season to prevent the capture of soft shelled crabs before they mature into hard-shelled crabs worth 10 times the value.

In addition to this, government established a total allowable catch (TAC) system in 1997, as well as quota allocations for the different regions including Kyoto prefecture, and created a crab-exclusion system in their netting to avoid catching snow crabs out of season.

Following this unilateral regulation of the fishery by the Federation, the snow crab stocks are slowly recovering and it is hoped that a full recovery will be possible over the next 10 years. Due to the successes of managing the snow crabs, the Federation now hopes to take the experience gained to improve the management of other species.

Interview with Takashi Hamanaka, Kyoto Prefecture Snow Crab Fishery

service provision. However, as with all the tools presented in this document MPAs are but one of many options for consideration in the achievement of sustainable and resilient fish stocks, and may not be equally applicable, or suited, to all fisheries.

Where they are used, MPAs can be effective both as temporary rolling closures of an area, as is the case in the Spencer Gulf prawn fishery (box 5), or as permanent area closures, as in the case of the Isle of Man Scallop fishery. Both styles have advantages and disadvantages, with some arguing that permanent area closures may be prohibitively costly to fishers' livelihoods, and others raising concerns over the costs of operating a comprehensive rolling area closure. For instance for the Brixham trawlers of Devon, a permanent closure of an area to fishing would not be helpful as they fish for over 31 different species, targeting different species in different areas at different times of the year, allowing stocks time to recover.

As is the case on land, protected areas will be most successful when there is clarity as to the goals they are seeking to achieve, and when there is stakeholder participation in both their designation and management.

Many case studies highlight the benefits of the creation of MPAs within a fishery. In the Malagasy octopus fishery, the establishment of temporary area closures resulted in increased size and catch of octopus and a significantly better price at market. These temporary reserves have proven so successful that they have been introduced throughout the south-west Malagasy coastline. In the Negros Island community fisheries in the Philippines, the establishment of 'no take zones' has heralded significant improvements, with a three-fold increase in catches, more predictability and less time spent fishing. In Japan, a series of temporary and permanent closed areas have protected snow crab populations, particularly during breeding seasons, and helped to rebuild stocks (box 6). Likewise, the fishers of the *Prud'hommes* organisation in the South of France, who unanimously voted for a reserve to be created off the coast, have noticed that fish are twice as large within the reserve and that the fish "are left in peace to spawn contributing to the rest of our fishing grounds". [69]

"Sustainable oceans, sustainable fisheries, sustainable seafood"
– George Clement, Chief Executive, Deepwater Group

A prawn trawler is silhouetted at sunrise in the Spencer Gulf

69 *Case Studies: Australian Spencer Gulf Prawn Fishery; Brixham Beam Trawl Fishery; Malagasy Octopus Fishery; Negros Island Community Fisheries; Kyoto Prefecture Snow Crab Fishery; Prud'hommes de la Pêche.*

Bycatch discarded by a trawler

Reducing Bycatch

The reduction of bycatch is particularly important given its high incidence within marine fisheries and its effect on the delicate balance of marine ecosystems. Bycatch adds approximately 8% to total global catch, and as much as 62% to the catch of some tropical shrimp fisheries.[70] The capture of juveniles, females or species of importance is particularly damaging to the functionality of a fishery and its ecosystem. Bycatch reduction is key to any transition to a sustainable and resilient fishery and a cornerstone of the ecosystem approach. In addition, bycatch reduction has further economic benefits for fishers, as reductions in catch of non-target species leaves more time and space onboard for target species, ultimately improving their quality and market value.

Many efforts to reduce bycatch result from technical innovations. Progress has been made in recent years to develop more selective trawl gear, for example through the use of the 'eliminator trawl' off the coast of New England in the United States. This capitalises on the difference in behaviour between cod and haddock; an escapement panel in the bottom of the trawl net allows for the natural response of the cod to dive when trapped, thereby almost entirely eliminating the accidental catch of this species. In another example, fishers from the Cornish sardine fishery are able to identify shoals of sardines, their target species, and have become sufficiently proficient in the use of this technology to be able to identify shoals of the largest specimens. This increases the profitability of their individual trips to sea as well as reducing the incidence of bycatch of non-target and undersize species.

Increasing the efficiency of fishing gear by decreasing the amount of fuel used also has the added advantage of lowering carbon emissions. In the Brixham beam trawler project, which sought to reduce bycatch by 50% or more, the design of the new trawl nets had the added benefit of reducing drag in the water, thus decreasing overall fuel costs and carbon emissions by 20% (box 7) .

There are several technological innovations that can have a significant impact on the sustainability of fisheries including those profiled above. Whilst technology will likely continue to play a large role in the future sustainability of global fisheries, care must be taken to ensure that technological advances only take place within the context of sustainable management.[71]

Box 7 – Brixham 50% Project – Incentivising Bycatch Reduction

Britain once played host to numerous fishing ports along the length of its coastline. Over the course of the 20th century, extensive exploitation of marine resources forced many of these ports to close. Among the few remaining is the port of Brixham in Devon.

Having seen the need for change after the closure of other British fisheries and their associated ports, the Brixham beam trawlers decided it was time to improve the sustainability of their fishery and secure the future of their trade. One of the largest changes made was in decommissioning the majority of their fishing vessels, significantly reducing fishing effort.

For those vessels that remained, the selectivity of the trawl nets was increased in order to reduce bycatch. In partnership with the Centre for Environment, Fisheries & Aquaculture Science (CEFAS), the fishers established a project allowing them to design and trial their own net modifications, with the goal of reducing bycatch of non-target fish by at least 50%. Since then, 90% of the fleet has started using their own modified nets and, as intended, there has been a more than 50% reduction in discards in the fishery.

While there have been clear environmental benefits to reducing bycatch, the subsequent reduction in discards has also had economic benefits, with increased wages for fishers, more efficient nets reducing drag and saving on fuel, and increasing the value of the catch.

Interview with Alex Philips, Brixham Beam Trawl Fishery

70 Kelleher, 2005

71 *Case Studies: New England's Eliminator Trawl; Cornish Sardine Fishery; Brixham Beam Trawl Fishery*

Box 8 – Sierra Leone – Community Surveillance

The community fishery of the Sherbro river estuary in Sierra Leone was once plagued by illegal, unreported and unregulated (IUU) fishing, predominantly by foreign trawlers within the Inshore Exclusion Zone (IEZ). The environmental and social impacts were enormous, with IUU trawlers destroying domestic fishing gear and taking fish away from areas reserved for the artisanal community fisheries. Without any resources to control and monitor fishing activities in Sierra Leonean waters, fishers were powerless against the ongoing illegal activity.

In order to combat this problem, fishers realised better monitoring, control and surveillance (MCS) of their fisheries was needed, and they collaborated with the Ministry of Fisheries and Marine Resources as well as the Environmental Justice Foundation and local authorities, to develop a community surveillance programme. Through this partnership, an EJF-funded surveillance vessel was launched to patrol the IEZ along Sierra Leone's coastline. Fishers alert the vessel to any irregular activity and the surveillance vessel then records that activity and collects evidence that is used towards the arrest and, hopefully, prosecution of illegal fishers. The fines levied to illegal fishers and the seizures of illegal goods also generate revenue for the government to reinvest.

The fishery is now on the road to sustainability. Already improvements have been noted and illegal activity has dropped significantly in the year since the introduction of the patrol boat. Now, community fishers can once again fish outside their estuary, and are working towards a catch reporting scheme, to further improve efforts to manage their fishery.

Interview with Thomas Siddiqui, Sierra Leone Community Fisheries

3.3 **Tools for Robust Management**

Management for sustainability involves the setting of goals and regulations that enhance the sustainability of the fishery. Compliance with such regulations by the fishing community is crucial as it creates a level playing field. Illegal, unreported and unregulated (IUU) fishing is estimated to account for as much as 25% of global marine fish landings.[72] Fishers can only operate sustainably in the knowledge that their resource is not being overexploited by others. Whilst well-aligned economic incentives can help with this there are also other tools available. This section highlights some of these.

Monitoring and Enforcement

Many fisheries worldwide have implemented either state-owned or community-based methods of monitoring and enforcement (box 8). Through improved monitoring, control and surveillance (MCS) and collaboration and information sharing between legal operators, governments and NGOs, significant strides have been made to reduce the incidence of IUU fishing. In the Patagonian toothfish fishery IUU fishing has been reduced by 97% since 1996, with illegal catches down from approximately 32,000 tonnes per year to 1,000 tonnes. While stakeholder involvement is critical, the government's role in enforcing regulations is important. For example, in Mozambique the arrest of an IUU vessel and its re-use as a patrol boat has sent a strong signal to illegally operating vessels, and in the case of the South African rock lobster fishery, illegal fishing was reduced through pursuing prosecutions, leading to fines and imprisonment.

As a first step towards enforcing fishing regulations, many countries are adopting vessel monitoring systems (VMS) using satellite technology to automatically plot the positions of fishing vessels. In Gabon, the SEAS (Surveillance de l'Environnement Assistée par Satellite) programme aims to monitor the Congo basin and the coastal regions of Gabon for the integrated management of coastal zones. This will enable them to monitor the movements of individual fishing vessels.[73] Unique vessel identifiers (UVI)[74] that do not change regardless of the life history or flag state of the vessel are also useful. However, significant levels of international cooperation are a prerequisite to the success of VMS in enforcement of international fisheries legislation.

The importance of observers, for MCS purposes, aboard fishing vessels cannot be over-estimated. Where the cost of comprehensive observer coverage is prohibitive, alternatives can be found. In the Scottish whitefish fishery and British Columbian dogfish fisheries, closed-circuit television is used to record the actions of fishers.

Self-enforcement is a distinct possibility in many places lacking the centralised governance frameworks required for nationally imposed enforcement mechanisms. In co-managed fisheries the incentive to enforce runs parallel to the personal interests of each fisher and therefore the social enforcement mechanisms can be as

72 Agnew et al, 2008
73 SEAS Gabon, 2012
74 FAO, 2011(c)

"We are responsible for ensuring the sustainability, food security and economic opportunity for the future generation of our nations for whom there is little beyond the ocean" – Maurice Brownjohn, Commercial Manager of PNA

effective as state-led regulation, if not more.[75] In the local community fisheries in Zanzibar, community surveillance complements government efforts to reduce IUU. As a result, more and higher quality fish are caught by legitimate fishers and the local area has profited from increased tourism as coral reef structures are better protected.

While enforcement efforts have improved within the national jurisdictions of many countries, this is by no means a universal trend. In an international context, collaboration is crucial for agreements such as on access to the fishing grounds of other countries' and straddling stock assessments.[76] International harmonisation of regulations goes some way towards compliance on a regional level. But there is a pressing need for better oversight and management of fishing activity on the high seas through Regional Fisheries Management Organisations (RFMOs). One promising example of an alternative to RFMO-style high seas management is the management of tuna in the Pacific by the Parties to the Nauru Agreement (PNA). Under this agreement, marine resources are managed by coastal state rather than flag state. PNA countries have vastly increased the monitoring of tuna fishing in their waters: compulsory transhipments (the unloading of one fishing vessel onto another, either at sea or in port, to account for all tuna catch), 100% observer coverage, and satellite tracking have been introduced.

In summary, it is clear that the tools and interventions available to the fishing community are many and varied and while they are not all universally applicable, many can be tailored to the needs and constraints of individual fisheries. In all fisheries, the transition to sustainability will require a whole variety of interventions. Sustainable fisheries are generally ones that have smart economic incentives, follow, to the extent possible, an ecosystem approach and are managed in a robust manner. It should also be made clear that the body of case studies compiled from around the world is not exhaustive; there are many that were not included. The enduring message from these case studies is that sustainability in capture fisheries is beneficial at many levels – locally, nationally and internationally – and in many ways – economically, socially and ecologically – and that it is achievable through the application of a range of existing tools, methodologies and types of expertise.[77]

75 FAO, 2009

76 FAO, 2011(a)

77 *Case Studies: Patagonian and Antarctic Toothfish Fisheries; Mozambican Fisheries Surveillance; South African Rock Lobster Fishery; Scottish Groundfish Fishery; British Columbian Spiny Dogfish Fishery; Zanzibar's Village Fishermen Committees; PNA Tuna Fishery*

4 Enablers of Change

By drawing lessons from all of the case studies and interviews outlined in the report, this chapter seeks to summarise some of the barriers to change that, if overcome, might enable the examples of sustainable fisheries management to be replicated at scale.

The previous chapter indicates how much work is already being done around the world to implement a transition to sustainable fisheries management. This gives grounds for considerable optimism. There are many tools that can be used to achieve the transition, and the benefits are apparent in terms of food security and economic welfare. However, despite this positive action, FAO assessments of the state of global fisheries suggest that there is still much work to be done. There are many parts of the world where fishing practices are unsustainable and where marine ecosystems are under serious and immediate threat. The question, therefore, arises as to why the tools described in the previous chapter are not being implemented in more fisheries. More importantly, how can they be scaled up?

It is important to understand the barriers that exist. The transition from business as usual to a sustainable state is a complex process and may involve trade-offs, especially in the short term. For example, the actions taken to maximise the economic efficiency of a fishery may not be the same as those that will maximise the size of the catch or its contribution to the local food security of the poor. Protecting marine ecosystems from long-term harm may have immediate impacts on jobs and livelihoods. Implementing the transition may require upfront investment, while the prevailing economic incentives do little to reward more sustainable management. In many cases, there are losers as well as winners from the transition to sustainable management, which can be a powerful obstacle.

A prerequisite for any transition to sustainable fisheries management is the will to change, especially from the fishing industry. The case studies profiled within this report show that those fisheries that have made changes have often done so due to strong and effective leadership from within government, the fishing industry or the local community. Leadership emerges as a result of a variety of factors. Unfortunately, it often emerges only as a response to a crisis, such as the collapse of fish stocks. It can also come about due to a heightened awareness of the impacts of unsustainable fishing practices on the economy, the fishers' livelihoods or the ecosystem. NGO and media pressure, and compelling scientific studies, have sometimes catalysed the overhaul of management systems.

Even when the will to change is present, the capacity to enact change may be missing. This may be in the form of technical or financial capacity or both. The case studies of transition from around the world, together with other research commissioned by the ISU and its consultation with a range of stakeholders, has led to the identification of several barriers to achieving the scale of change required. Three barriers of particular importance are the lack of knowledge and awareness about the opportunity presented by sustainable fisheries management; a lack of coordinated financing to aid the transition period; and insufficient private sector supply chain involvement in the improvement of fisheries. To enable change, we must collectively work to address these gaps.

4.1 **Knowledge and Awareness**

Increasing knowledge and awareness of the opportunity that sustainable fisheries present could help to create the enthusiasm required by all stakeholders to drive positive change. At the highest level, there is a need for fisheries to be elevated in importance on the agendas of national governments to reflect their importance to local and national economies, food security and livelihoods. Whilst the contribution to economies and livelihoods at a local or national level is often well understood, the ability to maintain this contribution for the long-term is not always connected to the need for sustainable management of the resource. Short-term socio-economic gains are often prioritised. Economic studies such as the ones described in previous chapters can provide compelling evidence to policy makers that in order for the economic benefits to be maintained, sustainable management measures must be put in place. All too often the continued supply of fish is left off the agenda at national or international discussions regarding food security. The elevation of the importance of sustainable

"Managing fisheries sustainably eventually means more fish, more profits and more jobs" – Nguyen Duy Lam, Vice-Chair, Binh Dinh Tuna Association, Vietnam

fisheries in these discussions will help to catalyse action.

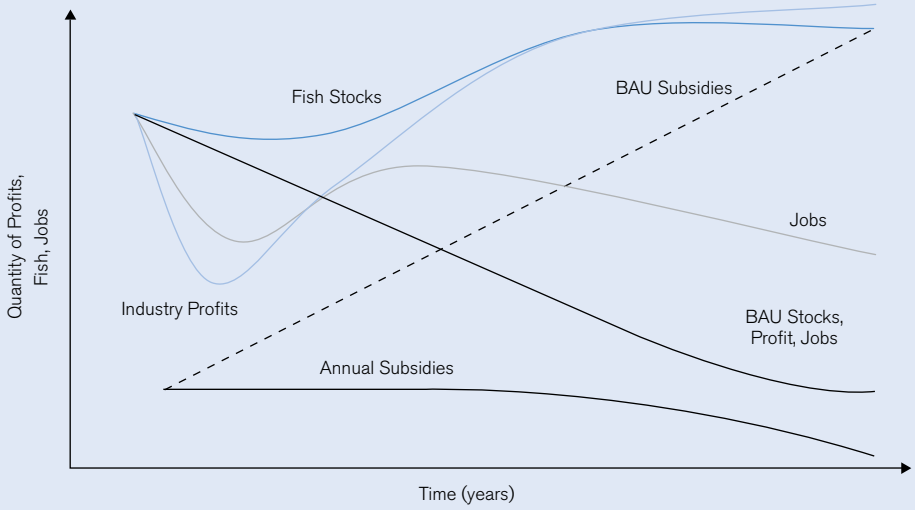
At the local and regional scales, significant gaps remain in the availability and quality of scientific data regarding the state of fish stocks and the marine ecosystems in which they reside. The lack of sufficient data and the ability of all stakeholders to analyse this data, presents great uncertainty and opens fisheries management up to value judgements. There is a need for more practical and empirical data. Where sufficient data does exist, it is often not available in a useable format. Finding ways to increase the amount of fisheries and marine data that is collected will be essential. The previous chapter highlighted the importance of good relations and ongoing dialogue between scientists and fishers for sustainable fisheries management. The collaborative partnerships between fishers and scientists outlined in many of the case studies are far from universal. Scaling up these models would be an important step in catalysing the transition to sustainability.

4.2 Transition Finance

One of the biggest barriers to change within a fishery can be the lack of financial capital. Finance is needed to fund the implementation of the tools needed to rebuild fish stock and to compensate fishers for lost income during the transition from 'business as usual' to sustainable management. In many fisheries there will be short-term pain before the long-term benefits are realised. As illustrated by figure 8, reducing pressure on fish stocks in an overexploited fishery may require effort reduction, which can result in a drop in the amount of fish harvested, as well as a loss of jobs and income. In its recent Green Economy Report, The United Nations Environment Programme (UNEP) estimated that to reduce fishing effort to more sustainable levels, 9. 6 million fishers worldwide would need to diversify out of direct fishing activities into alternative livelihoods.[78] It is evident that a highly degraded fishery will require finance to minimise the negative impacts and to help to aid the smooth transition. Conversely, it should be remembered that if reforms are not made the benefits from fisheries will decline over time, and future generations will not be able to profit from them.

While there is a good understanding about the need for transition finance, the amount required is still subject to debate. Nonetheless, UNEP estimates that an investment of 0.1% to 0.16% of GDP over the next forty years (until 2050) is needed to rebuild global stocks. Under this scenario, it is estimated that the world's fisheries will be able to produce 90 million tonnes of seafood annually, 10 million tonnes more than today. Their research also estimates that employment figures would be 27% to 59% higher. The story is one of upfront investment leading to long-term, sustainable returns. Research by the World Bank, as previously highlighted, indicates that the potential size of the economic prize is

Figure 8 – An illustration of a potential transition pathway



This graph attempts to illustrate the financial progression of the win-win opportunity for fish stocks, jobs and industry profits. Upon allowing fish stocks to recover to optimum level, jobs decline as capacity is reduced, then recover as stocks bounce back, before slowly declining with productivity gains over time. Profits decline sharply with effort reduction before recovering with increased fish stocks. The nature of industry profits following recovery will be fishery-dependent; though it is highly unlikely they will fall. Subsidies are maintained through 'down cycle' but redirected as transition finance; they are wound down thereafte

78 UNEP, 2011

US$50 billion annually. The same economic case can be made at a local level for many over-exploited fisheries.

Sources of transition finance do exist. One recent report has summarised the types of funding that are available for financing fisheries recovery (table 2).[79] Funding streams are available from governments, in the form of subsidies, but also from fishery-focused foundations, multi-lateral organisations such as the World Bank, and aid organisations. We do not yet have a precise understanding of the amount of finance required, nor sufficient understanding of the size of the gap between the current level of fisheries finance and the amount required. Defining the problem by conducting an analysis of the gap in transition finance would seem a logical next step. In the meantime, coordinating existing sources of fisheries finance so that it is used for purposes that aid the transition to sustainable management would be a significant step towards enabling large-scale change. A brief summary of two existing sources of fisheries finance that could be harnessed for the transition process is provided below.

Redirection of subsidies

One clear way of shifting the focus from short-term to long-term is through the redirection of public subsidies. At present, the financial incentives that exist often work perversely, making a shift to more sustainable practices even harder to implement. In Chapter 3 it was highlighted that global subsidies used to finance capacity-enhancing fishing activities are in the order of US$16 billion with additional subsidies of up to $8 billion going towards fuel. Capacity-enhancing subsidies enable fishing to continue beyond the point at which it would otherwise become unprofitable. If capacity-enhancing subsidies could be reoriented towards sustainable fisheries management, this would likely go a long way towards filling the funding gap.

Private financing of fisheries recovery

It should be possible to make a compelling case for private investment in the recovery of capture fisheries. Sustainably managed fisheries are inherently profitable, generating long-term income streams that could attract private investment. This is the underlying proposal of the WWF Banking on Cod initiative, which works on the principle that future benefits can be expected from sustainable fisheries in the form of more productive stocks, increased catches and higher value products. Investors would buy the rights to a portion of the future income stream derived from fisheries that are currently underperforming or depleted. The money raised would be invested in implementing a management plan that reorients the fishery towards sustainability and allows the population of fish to recover. It would subsequently generate an annual catch greater than the one achieved in the 'business as usual' scenario and one that could be maintained annually thereafter without depletion.[81]

Consultation that the ISU has undertaken with the finance community indicates that should a 'fishery asset' be created, the full range of financial instruments could be applied in whatever mix was optimal for the asset in question. At a time when returns from many traditional instruments are very low, there is appetite for new and uncorrelated assets. However, as yet no one has created a structure that could attract the scale of private

Table 2 – Sources and Forms of Capital Commonly Used by Different Investor Types[80]

	Foundations	Government	Blended Investors	Commercial
Grants	Grants for: ▪ Seeding new concepts ▪ Programs ▪ Technical Assistance ▪ Asset purchase ▪ Operations	▪ State/Fed Grants ▪ Gear Rebates ▪ Vessel Buybacks ▪ New Market Tax Credits	▪ Sometimes provided alongside a debt or equity investment	▪ Generally not applicable
Debt	▪ PRIs (Program Related Investments)	▪ SBA (Small Business Administration) loans	▪ CDFI (Community Development Financial Institution) ▪ Microfinance	Bank Loans: ▪ Recourse or non-recourse ▪ Bridge, short term, or long term
Equity	▪ MRIs (Mission Related Investments) ▪ Endowments ▪ PRIs (under certain structures)	▪ World Bank social equity portfolios	▪ Social Investors ▪ Social Venture Capital funds	▪ Angel Investors ▪ Venture Capital / Private Equity ▪ Tax-Equity investors

Source: Adapted from From Financing Fisheries Change: Learning from case studies, Manta Consulting, 2011

79 Manta Consulting, 2011
80 ibid
81 Davies and Rangeley, 2010

Commercial fishing docks of Morro Bay California

capital required to achieve sustainable fisheries management. As rights-based management systems evolve, it is only a matter of time before one is created that has the structure and risk/reward profile that makes it compete favourably with other investment opportunities.

In the meantime there are several organisations that have experimented successfully with the creation of innovative 'blended' financing mechanisms to support the transition to sustainable fisheries with beneficial outcomes.[82] Two organisations, the California Fisheries Fund (CFF)[83] and Verde Ventures[84] have established revolving loan funds that are designed to improve the performance of ailing fisheries. The CFF was established with a number of partners including the Environmental Defense Fund, the ShoreBank Enterprise, Cascadia and the Sustainable Fisheries Group. It lends to fishers, fishing businesses, ports and fishing communities in order to help them achieve environmental conservation measures that in turn enable them to improve profitability. Verde Ventures offers loans of US$30,000 to US$500,000 to small and medium sized businesses seeking to improve the long-term sustainability of their fisheries. The Nature Conservancy (TNC) in the Morro Bay fishery in California financed the purchase of trawl permits following a 75% reduction in catches and a loss of processing facilities, and invested in supporting the struggling trawl fishery and changing fishing practices to improve sustainability (see box 9).

4.3 Supply Chain Signals

The majority of fisheries around the world exist in the context of a supply chain whereby the fish produced is sent to market through processors, distributors and retailers before ending up on the consumer's plate. In some cases this process happens through many different actors, whereas in others it may be the sole responsibility of a few larger actors. Either way, there are usually private sector actors that have a stake in the fishery and therefore a responsibility to ensure its sustainability.

Consumer demand for sustainable seafood can often be transferred down the supply chain to the producers, providing an incentive to secure certification. The most widespread and well known, of these certificates is the Marine Stewardship Council (MSC) label. These certificates can attract a price premium, as in the Scottish herring fishery, or open up new and lucrative markets. For example in the Mozambique shrimp fishery, certification was considered a prerequisite for access to the European market. Alternative certification options exist, including the Global Trust certification model as used by the Icelandic and Alaskan fisheries.[85] These fisheries are assessed against the FAO

Box 9 – US Morro Bay trawl fisheries, California – financing sustainable change

The Morro Bay fishery was, like many others, over-exploited throughout the 1980s and 1990s, with groundfish stocks declining, leading to area closures and a 75% drop in catches.

In 2005, The Nature Conservancy (TNC) purchased 7 trawl permits with the plan to retire them on the basis that trawling was unsustainable, but through close working partnerships with fishers in Morro Bay, they came to the realisation that trawling was a necessary component of the fishery and an activity which brings much-needed business to the local community every year.

TNC set up a real time e-catch system to log encounters with overfished species and trialled new gear that reduces bycatch and habitat impacts. Using technology to reduce the impact of the fishery on the ecosystem has been one of the lasting benefits of the changes taking place in Morro Bay.

Though an unlikely alliance, the partnership between TNC and the Morro Bay fishers has worked well so far. The two groups share the aim of creating a fishery that can sustain fishers and revitalise the local community as well as protect the ocean's resources. Although too early to show that the fishery is once again thriving, fishers in the community have high hopes for the future, and have formed the Central Coast Sustainable Groundfish Association to help build a cooperative relationship between local stakeholders and help manage their catch.

Interview with Bill Blue, California Morro Bay Groundfish & Scallop Fishery

82 Manta Consulting Ltd, 2011
83 CFF: http://www. californiafisheriesfund. org/
84 CI: http://www. conservation. org/sites/verdeventures/Pages/partnerlanding. aspx
85 Global Trust (2012)

code of conduct for responsible fisheries, a UN FAO standard that forms the basis for other certification models.

As well as providing the producers with market access and recognition of good governance, the *process* of certification can often be as valuable as the end certification itself, as it provides a framework for transition.[86] The use of credible standards as transparent frameworks for fisheries improvement has often proved a good way to measure starting points, set milestones and agree end objectives with the added benefit of having third party auditors to demonstrate authenticity. A case study that demonstrates this is the Baja California Red Rock lobster fishery in Mexico where the recertification of the fishery under the MSC improvement programme has required the redevelopment of a management plan that includes more specific references to ecological interactions. As a result, a more collaborative and closer relationship between artisanal fishers and scientists has been fostered. In Gambia, the process of going through an MSC pre-assessment has provided the Sole fishery with a route-map for improved fisheries management.

However, the cost of certification can often be a barrier and in many of the examples provided in the case studies the initial cost has been supported by an NGO or buyer. For example the initial certification costs of the Cornish Sardine fishery were supported by Marks & Spencer and members of the Cornish Sardine Management Association are concerned that with only 4-5 operating boats they will not be able to cover the cost of re-certification in three years. Private sector actors therefore have a valuable role to play here, not only in helping with improvement costs, but also by maintaining market security for producers. These types of collaborations are known as Fisheries Improvement Projects (FIPs).

A good example is in the Bahia Solano community fishery on the Pacific coast of Colombia. The NGO MarViva established a commercial alliance with a restaurant chain, Wok, in the Colombian capital in order to link small-scale fishers to the commercial market. In return for sustainably-caught, high-quality

Certified red snapper for sale in the Gulf of Mexico, USA
© GulfWildTM

fish, Wok provides a secure market with a good price for the fishers as well as training. Another example of this is in the Indian Ashtamudi short neck clam fishery where buyers contribute to sustainability efforts by refusing to buy under-sized clams.

Two NGOs that are leading the way in terms of establishing FIPs around the world are the Sustainable Fisheries Partnership[87] and WWF,[88] who typically work with the supply chain to leverage change.[89] These NGOs tend to become the key partner for the fishery and facilitate collaborative relationships with other stakeholders in order to establish a robust project plan that is based on an opening assessment, agreed timelines, milestones and measurements. For example, in the spiny lobster fishery in the Bahamas, WWF helped to establish a collaborative partnership between fishers, the Department of Marine Resources and major US and European supermarkets. This led to the establishment of the Bahamas Marine Exporters Association and eventual certification by the Marine Stewardship Council. SFP is currently supporting a range of fisheries through improvement projects including the Bali sardine and the blue swimming crab fisheries in Indonesia.

Given the examples above and all of the interviews and case studies contained in this report, there is an evident need to replicate the number of examples of fisheries in transition around the world. In order to ensure that the private sector can continue to support Fisheries Improvement Projects, it is important that these projects achieve measurable change towards the ultimate goal of ensuring a sustainable supply of seafood.[90]

"Working in integrated shrimp farming operations, the sustainability of marine resources is one of the key elements that we need to achieve" – Arianto Yohan, Senior Vice President of Marketing, CP Prima, Indonesia

86 MSC: http://www. msc. org/about-us/standards/methodologies

87 SFP: http://www. sustainablefish. org/about-us

88 WWF:http://www. worldwildlife. org/what/globalmarkets/fishing/sustainableseafood. html

89 Other NGOs and research institutes noted in the case studies include Blue Ventures, the University of Rhode Island, the Wild Salmon Centre, Environmental Justice Foundation (EJF), Oak Foundation, The Nature Conservancy (TNC), Friends of the Environment, MarViva, CORAL, Wildlife Conservation Society (WCS), Lonxanet Foundation, and French Sea Bass Association.

90 *Case Studies: Scottish Pelagic Fishery; Mozambican Shallow Water Shrimp Fishery; Baja California Red Rock Lobster Fishery; Gambian Red and Black Sole Fishery; Cornish Sardine Fishery; Bahamian Spiny Lobster Fishery; Indonesian Sardine Fishery; Indonesian Blue Swimming Crab Fishery; Bahia Solano Community Fishery; Ashtamudi Short Neck Clam Fishery*

5 ISU Next Steps

The ISU intends to convene leaders of change to catalyse actions that will help sustainable fisheries become the norm rather than the exception.

"Well managed fisheries will provide health benefits and prosperity for future generations: let's make a difference by working together"
– Adriana Giudice Alva, CEO, Austral Group CAA

Many fisheries have already embarked on the transition toward more sustainable practices and are reaping considerable rewards. This report documents a small proportion of these fisheries but in so doing highlights the considerable opportunity that exists for the 32% of fisheries worldwide that are being overexploited. The conclusion of this report is that these fisheries provide empirical evidence of their ability to capture the economic, social and environmental benefits associated with sustainably managed marine capture fisheries, and that sustainable fisheries could be the norm rather than the exception.

During the past two years, the ISU has worked to compile evidence concerning the scale and nature of the opportunity for fisheries to move towards more sustainable management. It has also sought to build consensus on such a positive narrative, especially from within the fishing industry, and attempted to identify the potential impediments to such an opportunity being realised. The publication of this report marks the completion of our research and consultative phase.

The next phase of the ISU Marine Programme will comprise several interrelated areas of activity. The first involves continuing to build consensus among all stakeholders, acknowledging that continued commitment from the fishing industry, government and local communities will be particularly vital in creating the conditions necessary for delivering durable change. Demonstrating this consensus is important, particularly in 2012, a year in which there will be several high-level gatherings at which it will be possible to profile a positive narrative on the opportunities offered by sustainable marine fisheries.

The second activity involves convening around the gaps that have been identified as preventing the scale-up of fisheries improvements, namely knowledge and awareness, transition finance, and private sector supply chain involvement.

In recent years, the creation of Fisheries Improvement Projects with agreed timelines, milestones and measurements has proven a very effective model for catalysing change in many fisheries around the world. The ISU intends to convene discussions about how to expand the number of credible FIPs. Since the lack of transition finance and reliable data have been identified as two of the gaps limiting the effectiveness of such projects, the ISU also intends to facilitate dialogue on how best to address these issues. This will require, among other priorities, the building of trust and collaboration between the scientific community and the fishing industry.

Although the ISU can play a convening role in these areas, change will need to be driven by leadership from the fishing sector itself, from private companies along the seafood supply chain, and from policymakers, NGOs and scientists. The ISU has been heartened by the willingness shown by all stakeholders to engage in the Marine Programme so far and hopes for their continued participation as critical leaders of change.

Annexes

ANNEX A
The Economics of Fisheries: A Summary

ANNEX B
The ISU Fishing Industry Ambassadors

ANNEX A

The Economics of Fisheries: A Summary

This annex aims to give further details on the full economic, environmental and social evaluation of two case study fisheries. It is a summary of research commissioned by the ISU from an independent consulting firm.

Case Study 1: The North-East Atlantic bluefin tuna fishery
– a subsidised fishery facing commercial extinction which has the opportunity to provide a US$600 million a year benefit to society

Case Study 2: The Senegalese coastal fishery
– a US$50 million loss could become a US$30 million benefit to society

A.1 Limitations of the research

The ISU recognises the limitations of this research. The results are only as good as the data that could be found within existing scientific or economic literature. In all cases local data was sought for case studies but, where such data did not exist, proxies and extrapolations were used to derive estimates – there may be considerable error in these estimates.

The approach was purposefully narrow and did not include downstream activities such as trading, processing, distribution and retailing. The case studies focused on activity within individual countries or fisheries and did not attempt to estimate the implications for trade or other decisions made in other parts of the world. The analysis was primarily static, rather than dynamic, and did not attempt to model the transition itself. It is recognised that all of these factors would need to be part of a comprehensive food systems analysis.

A.2 Summary of the methodology

A complete understanding of the economics of fisheries must take into account not only the direct revenues and costs of the fishing industry, but also the broader environmental and social costs and benefits that the industry provides. This is necessary in order to provide an estimate of the aggregate 'value to society' that fisheries provide. To this end, where possible, monetised values were sought. However, it is fully appreciated that where it is not possible to put a dollar value on a cost or benefit, this should not mean that the aspect should be disregarded.

The methodology as a framework for analysis is illustrated in the text box below using global figures and then the methodology is applied to each case study to arrive at a total economic, environmental and social value for each.

Economic value
This is the total profit (or loss) from global fisheries, as measured by total revenues minus total costs. Total subsidies are subtracted from this, as they represent an additional cost to society of the fishing industry.

The FAO's estimate of the value of annual global catch in 2004 was around US$79 billion. According to the World Bank, the operating costs, including fuel costs, labour costs and other operating costs, totalled around US$73 billion, with the total capital costs of the industry estimated at US$11 billion. This implies that the industry as a whole made a loss of US$5 billion. At the same time the fishing industry also benefits from significant government subsidies. Accurately measuring the amount of global subsidies is difficult, but estimates indicate that the total amount of subsidies given to the fishing industry is around US$27 billion.[91] These need to be subtracted from the economic profit. Fuel subsidies make up about US$6. 4 billion of this total. Fuel subsidies are typically provided by government through a reimbursement directly to the fishing companies,[92] and so the cost of the subsidy is already accounted for in the cost structure of the fishing fleet. The cost of fuel subsidies is therefore not added back together with other subsidies. Taking into account all other subsidies except fuel subsidies, if the total value of subsidies is taken into account, the full economic value of the fishing sector is equal to a cost or loss of US$26 billion.

Value of environmental externalities
Global fisheries have a number of environmental consequences. These represent a cost to society, which is generally not accounted for by the industry's direct revenues and costs. Many of them are also very difficult to assign a monetary value to. This valuation of externalities at the global level is therefore limited to the cost of carbon dioxide emissions from global fisheries, although it is evident that there are other externalities that would represent a negative cost even if they cannot be quantified. Other major externalities are: destruction of coral reefs; unwanted bycatch and discards; and destruction of benthic habitats. Particularly destructive practices are discussed in relation to the individual case studies.

91 Sumaila & Pauly, 2006
92 Sumaila, 2010

Total CO_2 emissions from fisheries globally are around 132 million tonnes.[93] The cost of carbon has a wide range of estimates across the literature. After considered analysis this methodology uses a social cost of carbon of US$29 based on Tol, 2009, but recognises the high margins of error and differences of opinion inherent in this analysis. Alternative assumptions for the social cost of carbon that were considered and rejected include the Stern Review cost of US$86, Tol's median cost estimate of US$8 per tonne of CO_2e, the McKinsey marginal abatement cost estimate of about €50 (about US$70), the related marginal abatement cost for agriculture and forestry estimated at €30, and the market price of carbon, currently €15/t CO_2e in the EU. Using the chosen value of US$29, total carbon emissions from global fisheries have a social cost of US$5 billion. To account for this, the cost of US$5 billion is added to the full economic cost of fisheries of US$26 billion, to get a total cost of US$31 billion.

Social value

Total employment generated by fisheries is around 120 million jobs. In many cases, this is likely to be an important reason why governments persist in supporting unprofitable and environmentally destructive fishing practices.

In the analysis above, wages are only accounted for as a cost, although they clearly have an important societal value. To take into account the value of this employment created, the total labour cost has been added back in (i.e., the sum of all salaries paid by the industry). This serves as an estimate of the annual value of the labour created by the industry. This approach is in line with what has been proposed for the UNEP Green Economy initiative. There are also other social benefits from fishing, including the preservation of traditional ways of life and social payoffs from employment beyond the wages paid. At the same time, there are some negative aspects of employment in the fishing industry, including use of child labour, forced labour and generally poor working conditions. These are acknowledged but are not able to be quantified.

If the benefit of employment (the labour cost), estimated to be US$23 billion, is added to the total economic value of fisheries, including economic externalities, the loss of US$31 billion, the overall estimate of the total value to society of fisheries is a cost of US$8 billion dollars a year.

A.3 **CASE STUDY: The North-East Atlantic bluefin tuna fishery**

A.3.1 'Business as usual' in the North-East Atlantic bluefin tuna fishery

Assumptions

In order to estimate the current total social economic value of the North-East Atlantic bluefin tuna fishery a number of assumptions were made: firstly, tuna farming and any other intermediate value-adding activities were excluded from the analysis; secondly, downstream activities were excluded, essentially valuing the catch at the dock; thirdly, due to the lack of data surrounding IUU fishing in this fishery, the associated catch has been excluded despite recognition that this will likely have impacts on the estimate; and finally, that vessels target bluefin tuna exclusively, which although unlikely, was due to a lack of appropriate data.

Economic value

Total reported catch was around 24,000 tonnes in 2008 and a price of US$30,000 per metric tonne (US$30 per kilo) was assumed based on the 2005-2009 average monthly price of frozen bluefin tuna at the Tokyo Central Wholesale Market. This price and volume data values the industry at around US$715 million in revenue.

In terms of industry costs, given the lack of aggregate data and wide variation in vessel cost structures, costs were estimated from FAO survey data. Net profit margins for the vessels detailed were around 10% of revenue. The cost structure is composed of labour costs, variable operating costs, and fixed costs. Fishers are typically paid on a crew share system – with labour costs of about 20% of revenue, corresponding to an annual salary of around US$24,000 per fisher. Other operating costs include fuel and bait and are estimated at 35% of revenue. Current fixed costs, including gear, maintenance, capital and interest payments, are estimated at 35% of 2008 revenue. Consequently, in total, costs were estimated at US$145 million for labour, US$250 million for variable and US$250 million for fixed. This gives the industry profit of US$70 million.

The industry also receives significant subsidies, which are evaluated as a cost to society. It is generally not possible to observe fisheries subsidies directly and this would be particularly difficult for a multi-national fishery. However, extrapolating from Munro & Sumaila's[94] methodology for calculating national subsidies and adjusting for bluefin catch by country suggests subsidies amount to 17% of revenue (compared to a global average of 19%), totalling around US$120 million annually. These are mostly through capacity support and fuel subsidies, although a breakdown between the different kinds of subsidies is not available for the bluefin boats specifically. So, the total economic cost to society is US$70 million dollars minus subsidies of US$120 million dollars giving a total loss to society of US$50 million dollars.

Value of environmental externalities

Due to the scarcity and high value of the catch, tuna vessels travel relatively far compared to other fishing vessels and the fleet is relatively industrial. Their fuel use, and hence their CO_2 emissions, are therefore, significantly higher than that of the average fishing boat. The estimate used here is Tyedmers' estimate that total CO_2 emissions for vessels targeting large pelagic species in the North Atlantic represent 5. 5 metric tonnes per tonne of landed catch, which is more than three

93 Tyedmeyers & Pauly, 2005

94 Munro & Sumaila, 2002

times the average for wild fish catch.[95] Valued at a social cost of carbon of US$29 per tonne of CO_2 this creates a negative externality of approximate US$5 million. Aggregating these costs to society (US$120 million and US$5 million) and subtracting them from the industry profit of US$70 million results in a loss, or cost of US$55 million.

Although it is not quantified, bycatch resulting from the fishery is important to mention. Bycatch in the bluefin tuna fishery comes from both purse seiners and longliners, but estimates indicate that bycatch levels are highest from long-line vessels which set thousands of baited hooks on longlines. Systematic bycatch data for the fishery is not available, but ICCAT SCRS researchers observed bycatch of around 34% through field observations in the Maltese bluefin fishery in 2008.[96] The bycatch consisted of 13 other marine species, predominantly loggerhead turtles, broadbill swordfish and violet stingray.

Social value

The Northeast Atlantic bluefin tuna fishery is a source of employment. Whilst the total number of jobs is not high compared to other fisheries (around 6,000 people employed directly), these are often located in areas with few other employment opportunities. Unions are common and most fishers receive the minimum wage or above (usually more given the high revenue from this expensive catch). Working conditions are generally safe and hygienic. In quantifiable terms, the total wage bill of the industry is estimated at about US$145 million. Adding this benefit to the cost of US$55 million, results in a total value to society of US$90 million a year.

Whilst the 'social' importance of the fishery might be seen to compensate for its negative impact on public finances, the environment and the long-term vulnerability of the fish stock, it is important to note that this social value will not be maintained through current fishing practices and can be expected to disappear as fish stocks collapse, thereby driving down its own value. It is also important to note that given the high end nature of the catch and the fact that the overwhelming majority is exported, bluefin tuna cannot be seen to contribute greatly to food security at a national or international level.

A. 3. 2 A more sustainable scenario for the North-East Atlantic bluefin tuna fishery

Whilst estimates of future stock trajectory are highly contested, continuing to overfish at current levels will likely force stocks into a state of collapse within the next 12-15 years at the latest.[97]

Assumptions

In order to illustrate the 'size of the prize', which could result from sustainable management of the fishery, what the bluefin tuna fishery may look like in an alternative, sustainable state has been modelled (see figure 5, chapter 2). This alternative state assumes a number of changes to the fishery: namely, that IUU fishing is completely eliminated; stocks are allowed to recover to the level which will allow fishing at the long-term maximum sustainable yield; subsidies are discontinued (but redirected for the transition period to support capacity reduction); fleet capacity is reduced in the short term; gear restrictions, size and age limits, and catch documentation are implemented effectively.

Economic value

These assumptions would mean that after stock recovery and assuming appropriate size and age restrictions to preserve population structure, annual catch could be increased to about 50,000 metric tonnes per year.[98] Assuming that the average price of US$30,000 per metric tonne stays the same and increasing volumes to 50,000 tonnes would give total revenue of US$1.5 billion for the fishery. In the sustainable state, it was assumed that labour and variable costs would remain at the same percentage but that fixed costs would need to be scaled up to the number of vessels required to catch 50,000 tonnes of bluefin. In the sustainable state, total costs fell from around 90% to around 80% of revenue and industry profit increased to around US$310 million versus US$70 million today.

In a sustainable state, there would be no direct subsidies to the fishery, although during the transition period subsidies would be required, in particular to retire existing vessels and reduce capacity in the short term.

Valuing environmental externalities

Assuming that CO_2 emissions would remain constant per tonne of fish caught, a total of 275,000 tonnes of CO_2 would be emitted, with a total environmental cost of US$10 million. Through potential gear restrictions, bycatch could also be reduced, for example through the use of malleable hook designs tested in US waters for longline vessels. If this were the case it is likely that bycatch would decline. Given that the average tuna bycatch is 20%, substantially lower than the bluefin fishery, a decline even to the global average would be extremely beneficial.

In total, therefore, the industry in this more sustainable scenario has a positive economic value to society of around US$300 million (US$310 million profit less environmental costs of US$10 million). This is a significantly improved outcome to the BAU scenario.

Social value

The fishery in the long term would also employ more people, seeing an increase in total employment from about 6,000 people to around 8, 800, if it is assumed that vessel capacity and employment per vessel remains at current levels. As

95 Tyedmeyers & Pauly, 2005
96 Burgess et al, 2009
97 MacKenzie et al, 2009
98 ICCAT, 2010

fishers are paid as a share of revenues, average wages would increase from around US$24,000 to around US$34,000 per person. Total estimated wage costs are US$300 million, up from US$145 million today. Add this benefit to the economic value of US$300 million and the total value to society of this fishery in its sustainable state would be US$600 million. This is a dramatic improvement on the current value to society of US$90 million, which is likely to decline over time as stocks deplete under a BAU scenario.

A.4 **CASE STUDY: The Senegalese coastal fishery**

A.4.1 'Business as usual' in the Senegalese coastal fishery

Assumptions

In order to simplify the economic analysis due to a lack of robust data a number of assumptions have been made. First, it is assumed that the fishery has two clearly defined sectors – artisanal and industrial – with no overlap between them. Second, although the fishery contains over 100 different species of fish, a single fish stock was assumed. Third, downstream processing industries were excluded, in effect valuing the industry 'at the wholesale dock'. Fourth, despite IUU fishing catch estimated to be around 8% of total catch,[99] a lack of robust data has meant exclusion of this from the analysis.

Economic value

In 2005[100] the total catch in Senegal was approximately 480,000 tonnes, of which 425,000 was caught by the artisanal fleet and 55,000 tonnes for the industrial[101]. The total value of this catch was estimated at US$77 million and US$82 million respectively. This gives an estimate for price per tonne of US$182 and US$1,435. Total industry revenue, at the wholesale dock, is therefore US$159 million.

There is a lack of systematic cost data for Senegal and as a result the analysis of cost structure is based on FAO survey data in 2003.[102] Based on the multipurpose canoe (pirogue) for the artisanal fishery, the cost structure of the artisanal fleet is as follows: operating costs at 27.5% revenue, labour costs at 49.3% of revenue, and fixed costs at 13. 8% revenue i. e. a profit margin of around 10%. Using data from a Senegalese deep water trawler as a proxy for the industrial fleet the cost structure is: operating costs at 79.9% of revenue, labour costs at 15.4% of revenue and fixed costs at 21% of revenue. This would indicate that the industrial fleet is loss-making with total costs of ~116% of revenue. The fishery involves ~12, 500 artisanal vessels with an implied annual fixed cost of around US$850 per vessel, and ~2, 500 industrial vessels with an implied annual fixed cost of around US$110,000 per vessel. In total, taking into account revenues of ~US$160 million and total costs of ~US$165 million, these calculations thus suggest that the industry is losing US$5 million a year before subsidies.

Senegal provides significant subsidies to its fisheries, primarily through tax breaks on vessel upgrades, and export subsidies. The total aggregate subsidy estimate from Munro & Sumaila[103] is around US$70 million annually. This figure is used for this analysis, although other sources, such as the Sea Around Us Project, estimate total subsidies to be lower at around US$50 million annually.

Valuing environmental externalities

To calculate the global cost to society of the impact of greenhouse gas emissions linked to the fishery the average global figure for CO_2 emissions of 1.7 tonnes of CO_2 per tonne of catch was used. This gives a total of around 818,000 metric tonnes of CO_2. Valued at a social cost of carbon of US$29 per tonne of CO_2, this creates a negative global externality valued at around US$24 million. Therefore, by taking subsidies and environmental externalities of US$70 million and US$24 million into account, and combining them with the industry loss of US$5 million, the industry is costing society US$99 million a year before consideration of its social value.

Bycatch in Senegalese fisheries is estimated at around 50%. Although this is not quantified it is clear that this is a high percentage of catch.

Social value

The fishery in Senegal is an important source of income in a country that has very few jobs outside of the agriculture sector. The fishery employs ~42,000 artisanal fishers. Working conditions are thought to be poor generally with child labour making up 15-30% of vessel crews[104] and conditions described as described as 'difficult and precarious'. On the other hand, it is an important source of employment corresponding to around 1% of total employment. Perhaps more significantly, fish represents a very important part of the diet in Senegal. 61% of the catch is consumed domestically and it represents 49% of animal protein consumption.[105]

In quantifiable terms, the cost structure described above indicates an implied artisanal salary of around US$900 per year. The industrial fleet employs around 2, 500 people, with an implied salary of approximately US$5,000 per year. This adds up to a total wage bill of about US$50 million, which, whilst significant, remains less than the total level of

99 MRAG, 2010 (b)
100 2005 data was used in this analysis as it is the last year in which data on a relatively broad set of indicators was available
101 FAO Senegal, 2008
102 FAO, 2003
103 Munro & Sumaila, 2002
104 FAO/ILO, 2010
105 FAO Senegal, 2008

subsidies. Add this benefit of US$50 million to the economic and environmental loss of US$99 million and the total cost to society of the fishery is US$49 million.

A.4.2 A more sustainable scenario for the Senegalese coastal fishery

In order for the Senegalese coastal fishery to move towards a sustainable state, fishing effort needs to be reduced. Given the limited amount of information on stock levels, it is, however, difficult to say exactly how much catch volumes need to be reduced, and how long it will take for stocks to recover to a sustainable level. This is further complicated by the significant impact of the Senegalese coastal upwelling on Sardinella catch volumes.

However, a number of assumptions have been made in order to see what a sustainable state might look like (see figure 6, Chapter 2). First it is assumed that catch volumes decline by 25% and that there is a more sustainable mix of species to reduce overall overfishing. Second, that catch reductions are accompanied by 5% price uplift in the sustainable state, as fishers catch more valuable species ('fishing up the value chain'). This is consistent with the global methodology used by the World Bank in 'Sunken Billions' regarding the price elasticity of biomass. Further, it is assumed that subsidies are completely eliminated once the sustainable state has been achieved and as a consequence the unprofitable sub-set of industrial vessels will exit the market, shifting the weighted average cost structure of the industry from loss-making to a 10% profit margin in line with the artisanal fleet's current profit margin. At the same time the overall fleet is re-calibrated to a more efficient level, with small increases in catch per vessel. It is assumed that labour costs remain the same in percentage of the cost structure but decrease slightly in absolute terms as revenue falls.

Economic value

In this sustainable scenario, overall catch falls from circa 480,000 metric tonnes to circa 360,000 metric tonnes. At the same time, the assumption that a slight increase in price as stocks recover and fishers increase their catch of high-value species, means that revenues fall from ~US$160 million to US$125 million. Based on this, the average industry profit margin for vessels would increase from around – 5% to ~10% as the unprofitable segment of industrial vessels are eliminated, shifting the fishery from loss-making to profitable. Private profits would be around US$10 million.

As subsidies would be eliminated, there would be no additional cost to society from subsidies once the fishery has reached its sustainable state.

Valuing environmental externalities

Greenhouse gas emissions are assumed to be proportional to catch in this scenario, so with a reduction of 25% in catch, CO_2 emissions would see a similar reduction, to just over 600,000 metric tonnes. This represents a total externality cost of around US$20 million, down from US$24 million. It is assumed that the boats that cause the most bycatch are the least efficient and therefore bycatch figures will also fall when the least efficient vessels are eliminated, from approximately 50% to below 40%.

The total economic value of the fishery would therefore still be negative (US$10 million industry profit, less US$20 million environmental costs), although now at around negative US$10 million rather than negative US$100 million as was previously the case.

Social value

At the same time, average salary would increase from US$1,100 to US$1,400 as labour costs decline by less than the number of fishers which falls from circa 44,500 to circa 27,000 across both sectors. This would mean that total wages in the industry would reach about US$40 million. If this value is included in the total calculation, this gives a total value to society of US$30 million, which is a major improvement from the BAU scenario. However, a decline in catch would mean a decline in available protein. Whilst it is assumed that the share of fish used for domestic consumption would remain equal, the share of protein consumption that comes from fish will decline in line with the volume of catch.

Sustainable management, therefore, has the potential to create around US$80 million in annual economic and social value for the fishery. In this sustainable state, the fishery would be economically more productive, have reduced environmental externalities, and increased social value. By contrast, if left in its current structure there will be a decline in fish stocks, a consequent reduction in value to society and a steady erosion in employment from the fishery.

ANNEX B

The ISU Fishing Industry Ambassadors

"It is an honour and a privilege to be part of the ISU Fisheries Ambassadors' Group and to share this journey with many others who also aspire to a world where global fisheries sustainability is the norm, not the exception" – Annie Jarrett, Managing Director, Pro-Fish PTY Ltd

We have appointed 20 individuals from the fishing industry around the world, based on their experience and influence within their sector, as informal advisers to the ISU Marine Programme. This group of individuals continue to provide valuable advice, assistance and support to the ISU Marine Programme. At the time of publication, the group comprised the following people:

Australia
Annie Jarrett, *Managing Director, Pro-Fish Pty Ltd.*

Bahamas
Mia Isaacs, *President, Marine Bahamas Exporters*

Canada
Christine Penney, *Director, Corporate Affairs, Clearwater Seafoods*

Denmark
Niels Wichmann, *Chairman, Danish Fishermen's Association*

The Gambia
Ousman Bojang, *President, Gambia Artisanal Fisheries Development Agency*

Iceland
Kristján Þórarinsson, *Federation of Icelandic Fishing Vessel Owners*

Indonesia
Arianto Yohan , *SVP Marketing, CP Prima*

Japan
Norio Koyama, *President, Yokohama Coastal Fisheries Association*

Mozambique
João Marcos Mangave, *President, Mozambican Association of Industrial Prawn Fishing Companies*

The Netherlands
Gerard van Balsfoort, *President, Pelagic Freezer-trawler Association*

New Zealand
George Clement, *Chief Executive, Deepwater Group*

Norway
Johannnes Nakken, *Managing Director, Norwegian Fishermen's Sales Association*

Parties to the Nauru Agreement (PNA)
Maurice Brownjohn, *Commercial Manager, PNA*

Peru
Adriana Giudice Alva, *CEO, Austral Group CAA*

South Africa
Roy Bross, *Executive Secretary, Deep Sea Trawling Industry Association*

Spain
Javier Garat, *President, Europeche*

United Kingdom (England)
Barrie Deas, *Chief Executive, National Federation of Fishermen's Organisations*

United Kingdom (Scotland)
Mike Park, *Executive Chairman, Scottish Whitefish Producers' Association*

USA
Tom Kraft, *Owner, Norpac Fisheries Export*
Jeremy Brown, *Fisher and board member, Commercial Fishermen of America*

Vietnam
Nguyen Duy Lam, *Vice Chair, Binh Dinh Tuna Association*

References

Agnew, D. , Pearce, J. , Peatman, T. , Pitcher, T. J. & Pramod, G. (2008). *The global extent of illegal fishing*. London: MRAG, 32 pp.

Allison, E. H. , Perry, A. L. , Badjeck, M. , Adger, W. N. , Brown, K. , Conway, D. , Halls, A. S. , Pilling, G. M. , Reynolds, J. D. , Andrew, N. L. , Dulvy, N. K. (2008) Vulnerability of national economies to the impacts of climate change on fisheries. In *Fish and Fisheries* DOI: 10. 1111/j. 1467-2979. 2008. 00310.x.

Ara Mome, M. (2007) *The Potential of the Artisanal Hilsa Fishery in Bangladesh: An Economically Efficient Fisheries Policy.* United Nations Fisheries Training Programme. Reykjavik.

Barbier, E. B. , Koch, E. W. , Silliman, B. R. , Hacker, S. D. , Wolanski, E. , Primavera, J. , Granek, E. F. , Polasky, S. , Aswani, S. , Cramer, L. A. , Stoms, D. M. , Kennedy, C. J. , Bael, D. , Kappel, C. V. , Perrilo, G. M. E. , Reed, D. J. (2008) Coastal Ecosystem-Based Management with Nonlinear Ecological Functions and Values. In *Science*(319) 321-323.

Beddington, J. R. (2009) *Food, Energy, Water and the Climate: A Perfect Storm of Global Events?* Government Office for Science, London.

Botsford, L. W. , Castilla, J. C. , Peterson, C. H. (1997) *The Management of Fisheries and Marine Ecosystems*. In: Science (277) p509-515.

Brander, K. (2010) Impacts of Climate Change on Fisheries. In *Journal of Marine Systems*. (79) 389-402.

Burgess, E., Dimech, M., Caruana, R., Darmanin, M., Raine, H., Harrison, A., Schembri, P.J. (2009) *Non-target bycatch in the Maltese bluefin tuna longline fishery*. ICCAT SCRS.

California Fisheries Fund (n. a.) *Home Page*. [Online] Available from: http://www. californiafisheriesfund. org/ (accessed 21/12/2011).

Conservation International (n. a.) *Verde Ventures*. [Online] Available from: http://www. conservation. org/sites/ verdeventures/Pages/partnerlanding. aspx (Accessed 21/12/2011).

Cooper, E. , Burke, L. , Bood, N. (2008) *Coastal Capital: Economic Contribution of Coral Reefs and Mangroves to Belize.* World Resources Institute, Washington DC.

Davies, R.W.D., Rangeley, R. (2010) Banking on cod: Exploring economic incentives for recovering Grand Banks and North Sea cod fisheries. In *Marine Policy* (34), p92-98.

European Commission (2008) *The Ecosystem Approach to Fisheries – Fact Sheet*. European Commission, Brussels.

Evans, A (2009) *Feeding the Nine Billion.* Chatham House, London.

Food and Agriculture Organisation of the United Nations (FAO) (1992). *Territorial use rights in marine fisheries. Definitions and conditions.* FAO Fisheries Technical Paper 227.

FAO (2003).*Economic performance and fishing efficiency of marine capture fisheries*. FAO.

FAO (2007) *Increasing the contribution of small-scale fisheries to poverty alleviation and food security*. FAO Fisheries Technical Paper 481. FAO, Rome.

FAO (2008) *Human dimensions of the ecosystem approach to fisheries: An overview of context, concepts, tools and methods.* FAO Fisheries Technical Paper 489.

FAO (2009) *Technical Guidelines for Responsible Fisheries.* No 4, Suppl. 2, Add. 2. Rome, FAO.

FAO (2010) (a). *The State of world fisheries and aquaculture 2010*. Rome, Italy.

FAO (2010) (b). *Report of the Africa regional consultative meeting on securing sustainable small-scale fisheries: bringing together responsible fisheries and social development.* Fisheries and aquaculture report no. 963. Maputo, Mozambique.

FAO (2010) (c) *Fact Sheet: The international fish trade and world fisheries*. FAO, Rome.

FAO (2011) (a) *Code of Conduct for Responsible Fisheries*, FAO, Rome.

FAO (2011) (b). *Fisheries and Aquaculture Department: Trade and Fisheries*. [Online] Available from: http://www. fao. org/ fishery/topic/2004/en [Accessed 18/11/2011].

FAO (2011) (c). *GR project – Web site. Unique Vessel Identifier (UVI) – Global Record.* In: FAO Fisheries and Aquaculture Department [online], Available from: http://www. fao. org/fishery/topic/18021/en (Accessed 21/12/2011).

FAO (2011) (d) *FISHSTAT Database.* [Online] Available from: http://www.fao.org/fishery/statistics/software/en (accessed 21/12/2011).

FAO (2012) (a) Fishery and Aquaculture Country Profiles: Seychelles [Online] Available from: http://www. www. fao. org/fishery/countrysector/FI-CP_SC/en (Accessed 13/01/12).

FAO (2012) (b) Fishery and Aquaculture Country Profiles: Ghana [Online] Available from: http://www. www. fao. org/fishery/countrysector/FI-CP_GN/en (Accessed 13/01/12).

FAO/ILO (2010) *Shedding Light on Child Labour in Fisheries.*

FAO Senegal (2008) *FAO Fisheries and Aquaculture Report: Report of the FAO working group on the assessment of small pelagic fish off northwest Africa.* FAO. Report number: 882.

Foresight (2011) *The future of food and farming: Challenges and choices for global sustainability. London*. The Government Office for Science.

Global Trust (2012) *FAO Responsible Fisheries Management Certification* [Online] Available from: http://www.gtcert. com/fao-responsible-fisheries-management/ (Accessed 17/01/12).

Greenpeace China (2010) *Swimming in Poison*. Greenpeace China, Beijing.

Halpern, N. (2008) A Global Map of Human Impact on Marine Ecosystems. In *Science* (319), 948.

Hardin (1968) The Tragedy of the Commons. In *Science* (162), p1243-1248.

Hilborn, R. (2011). Future directions in ecosystem based fisheries management: A personal perspective. In *Fisheries Research* (108) p235-239.

ICCAT (2010) *Panel 2: Northern temperate tunas.* ICCAT 2010 Conference Presentation.

Kelleher, K (2005) *Discards in the world's marine fisheries. An update.* FAO Fisheries Technical Paper No 470. Rome, FAO.

MacKenzie, B.R., Mosegaard, H., Rosenberg, A.A. (2009). Impending Collapse of Bluefin Tuna in the Northeast Atlantic and Mediterranean. In *Conservation Letters* (2), p25-34.

Manta Consulting Ltd (2011) *Financing Fisheries Change: Learning from Case Studies.*

Marine Stewardship Council (MSC) (n. a.) *MSC Certification Requirements* [Online] Available from: http://www. msc. org/about-us/standards/methodologies (accessed 21/12/2011).

McKinsey (2011) *Resource Revolution: Meeting the world's energy, materials, food and water needs*. Mckinsey Global Institute.

Morishita, J. (2008). What is the ecosystem approach for fisheries management? In *Marine Policy* (32) p19-26.

MRAG (2010) (a) *Towards sustainable fisheries management*. MRAG Ltd: London. 93pp.

MRAG (2010) (b) *Estimation of the costs of illegal fishing in West Africa.* MRAG West Africa Regional Fisheries Project.

Munro, G., and Sumaila, R. (2002) The Impact of Subsidies on Fisheries Management and Sustainability: The Case of the North Atlantic. In *Fish and Fisheries* (3), p233-250.

Norse, E. (2010). Ecosystem-based Spatial Planning and Management of Marine Fisheries: Why and How? In *Bulletin of Marine Science* (86) p179-195.

Ostrom, E. , Burger, J. , Field, C. B. , Norgaard, R. B. , Policansky, D. (2007) Revisiting the Commons: Local Lessons, Global Challenges. In *Science* (284), 278-282.

Pauly, D. , Christensen, V. , Guenette, S. , Pitcher, T. J. , Sumaila, U. R. , Walters, C. J. , Watson, R. , Zeller, D. (2002) Towards sustainability in world fisheries. In *Nature* (418) p689-695.

Roberts, C (2007). The Unnatural History of the Sea. Island Press, London.

Roessig, J. M. , Woodley, C. M. , Cech, J. J. , Hansen, L. J. (2004) Effects of global climate change on marine and estuarine fishes and fisheries. In *Fish Biology and Fisheries* (14) 251-275.

Rose, G. A. (2004) Reconciling Overfishing and climate change with stock dynamics of Atlantic cod over 500 years. In *Canadian Journal of Fisheries and Aquatic Sciences* (61) 1553-1557.

SEAS Gabon (2012) *Surveillance de l'environnement assistee par satellite (French)* (Online) Available from: http://seas-gabon.espace-dev.fr/seasgabon/ (Accessed 17/01/12).

Srinivasan, U. T. , Cheung, W. W. L. , Watson, R. , Sumaila, U. R. (2010) *Food security implications of global marine catch losses due to overfishing*. In *Journal of Bioeconomics* (12) 183-200.

Sumaila, R. , Pauly, D. (2006) *Catching More Bait: A Bottom-up re-restimation of Global Fisheries Subsidies*. Fisheries Centre, University of British Columbia, Canada.

Sumaila, R. (2010) A Bottom-up re-estimation of global fisheries subsidies. In: *Journal of Bioeconomics* (12), p201-225.

Sun, J. , Maunder, M. N. , Aires-da-Silva, A. , Bayliff, W. H. (2010) *Economics and Conservation: Increasing the Economic Value of the Eastern Pacific Ocean Tropical Tuna. Workshop Background Discussion Paper No. 1.* International Workshop on Global Tuna Demand, Fisheries Dynamics and Management in the Eastern Pacific Ocean. La Jolla.

Sustainable Fisheries partnership (n. a.) *About us* [Online] Available from: http://www. sustainablefish. org/about-us (accessed 21/12/2011).

Taladon, P. (2011). Understanding the Ecosystem Approach to Fisheries and its applicability in Southeast Asia. In "*Fish for the people 2020: Adaptation to a Changing Environment*", ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020, Bangkok.

TEEB (2010) *TEEB – The Economics of Ecosystems and Biodiversity Report for Business – Executive Summary*.

Tyedmeyers, P. (2004) *Fisheries and Energy Use.* In: Encyclopedia of Energy (2) p683-693.

Tyedmeyers, P. and Pauly, D. (2005) Fueling Global Fishing Fleets. In *Ambio: A Journal of the Human Environment* (34), p 635-638.

United Nations Environment Programme (UNEP) (2011*) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, www.unep.org/ greeneconomy.*

World Bank (2009) *The Sunken Billions. The Economic Justification for Fisheries Reform: Examples of Economic Studies on Specific Fisheries*. Washington.

World Bank (2010) *The hidden harvests: the global contribution of capture fisheries*. Washington.

World Wildlife Fund (n.a.) *Sustainable Seafood* [Online] Available from: http://www. worldwildlife. org/what/ globalmarkets/fishing/sustainableseafood.html (accessed 21/12/2011).

Zhou, S. , Smith, A. D. M. , Punt, A. E. , Richardson, A. J. , Gibbs, M. , Fulton, E. A. , Pascoe, S. , Bulman, C. , Bayliss, P. , Sainsbury, K. (2010) Ecosystem-based fisheries management requires a change to the selective fishing philosophy. In *Proceedings of the National Academy of Sciences* (107) p9485-9489.

ISU Marine Team

Charlotte Cawthorne
Jack Gibbs
John Goodlad
Lucy Holmes
Tony Juniper
Melanie Siggs
Klaas de Vos

With contributions from:

Peter Collecott
Paul McMahon
Justin Mundy
Sir Graham Wynne

The ISU team would also like to thank the many individuals and organisations who have provided contributions during the writing of this report. The insights, ideas and information that were so willingly shared enriched our understanding and enormously aided our process.

The Prince's Charities Foundation registered charity number 1127255

Contact Details

The Prince's Charities' International Sustainability Unit
Clarence House
London
SW1A 1BA

0207 024 2106
info@pcfisu.org

The stock this is produced on is Oxygen. Oxygen is one of Europe's leading manufacturers of uncoated, recycled papers, with an outstanding reputation for making products which meet the latest environmental standards.

The manufacturing mill is in France and is ISO 9001, ISO 14001 and FSC certified.

Oxygen is made using 100% recycled pulp. A large percentage of which is de-inked, with up to 20-30% of the mills requirement being obtained from UK waste, thus reducing landfill.

Oxygen is an FSC certified product, it also carries the NAPM 100% recycled mark.

Smith & Watts Print holds Forest Stewardship Council (FSC) Chain of Custody C004309

Typeset by Soapbox, www.soapbox.co.uk