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FISHERIES COMMITTEE

GREEN GROWTH AND FISHERIES ISSUES

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The attached report by Kieran Kelleher, Consultant, is made available for the Committee's discussion on Agenda item 9: Further Consideration of Elements of the Programme of Work 2011-2012, in particular the item ii) on Green Growth in Fisheries and Aquaculture. The document is submitted for information and consideration.

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GREENING THE BLUE ECONOMY: APPROACHES TO GREEN GROWTH IN FISHERIES

1. Executive Summary

1. In June 2009, the OECD adopted a green growth declaration[1] that aims to pursue economic growth and development, while avoiding environmental degradation, biodiversity loss and unsustainable natural resource use. The **objective** of this paper is to contribute to a discussion on the 'green fisheries economy' as part of preparation for a broader OECD green growth framework and specifically the task of meeting the demand for food fish and social wellbeing while maintaining environmental health. The paper identifies key green growth issues in the sector; describes the policies and instruments which may be used to manage transitions towards green growth in fisheries and aquaculture, including consideration of green technologies, green jobs and associated distributional issues, while acknowledging the risks and uncertainties facing the emerging green paradigm. The paper covers marine and inland capture fisheries and aquaculture. However, if guidelines are to be developed these sub-sectors might more conveniently be separated, as despite many commonalities, the challenges and priorities differ. The paper concludes that there is no generic formula for maintaining economic and social growth while reaching environmental targets at the least cost. It recognizes that diverse political priorities, social values and economic constraints will shape the green growth agenda in different countries and fisheries. The discussion paper is intended to inform the dialogue on objectives, on trade-offs, on pathways, on transitions and the distribution of costs and benefits.

Broad consensus

2. Many of the challenges facing a green fisheries economy are already well known. Economists, fisheries scientists and administrators agree broadly on the issues and the requirements for sustainable fisheries and many elements of a green fisheries economy are already embedded in international instruments and statements. This broad consensus includes: rebuilding fish stocks, balancing fishing capacity with the state of the stocks, implementing key elements of an ecosystem approach, and a reduced carbon footprint along production and marketing chains. It includes farming of more herbivores, integrated aquaculture systems and ensuring clean and healthy oceans and freshwaters. There is broad agreement on the need to internalise environmental costs and for environmental accounting, to make the polluter pay, to phase out fuel subsidies and protect critical habitats. Many of these activities are 'no regrets' approaches, that is, they make economic and environmental sense even without the pressure of climate change or green initiatives, and in many cases they contribute to both climate change adaptation and mitigation. The paper discusses these approaches for the capture and culture production chains and draws on emerging green growth initiatives in other fields such as economics and innovation.

Framework

3. The discussion paper attempts to organise the diversity of fisheries and green growth approaches into a framework which distinguishes the state of sector capital from the flow of fisheries goods and services: it illustrates the linkages capital and flow and suggests means of aligning the sector with other dimensions of the green economy. The framework that is proposed is based on evolving economic thinking on environmental economics as set out in World Bank publication: *Where is the Wealth of Nations?* The framework considers natural **capital** – the fish stocks and the associated aquatic ecosystems; produced capital, such as the fishing fleets, harbours, processing plants and marketing chains, and intangible capital

[1] See http://www.oecd.org/dataoecd/58/34/44077822.pdf

- the social and institutional frameworks, such as the fisheries laws and management regimes. The **flow** of goods and services is considered not only as reflected in GDP, but also in social wellbeing and the supply of environmental services. Potential **indicators** of green growth, in terms of capital, or wealth and in terms of the flow of goods and services are identified.

Vectors of transition

4. The key questions are how to transition to this green economy. The paper discusses the range of instruments and initiatives, but concludes that green growth outcomes are likely to require a **paradigm shift** in political willingness and a corresponding change in public perceptions and consumer attitudes. The choice of measures or suites of activities are bounded by the public and political perceptions of OECD members and their willingness to pay for a green economy, given the uncertainties surrounding the choices. Both the perceptions and the willingness to pay may need to change and the systemic nature of global and national environmental problems may need to be more clearly recognised. Food production is a case in point as many food production and distribution systems are increasingly fragile. Many fisheries have a high dependence on fossil fuels with volatile fuel prices and high exposure to the impacts of climate change. Almost 40% of recorded global fish production is traded and fish supply in most OECD countries is heavily dependent on **fish trade** and developing country production. The **commitments** made by OECD countries on climate change, environment, biodiversity and development will need to translate into concrete fisheries sector actions that complement national green growth and climate change programs. **Externalities** must be appropriately taken into account and failures to account for public goods corrected. The interests of future generations will need to be respected and social inclusion and fairness must become an integral part of the analysis. Articulating the green growth rationale and building voter and **stakeholder buy-in** for the transition is likely to be fundamental.

5. Improved **tenure** systems are an important first step. More robust tenure supports a more adaptive fishery economy, places a market value on fish resources or aquaculture sites, and can create stewardship incentives and facilitate attribution and charges for externalities. Improved tenure can underpin rebuilding of fish stocks, reduction of overcapacity and a range of conventional fisheries management measures.

6. Greening of fishing fuel **subsidies** is an important and symbolic second step. This can take several forms: budget allocations currently set aside for fuel subsidies and other perverse incentives that support intensive use of fossil fuels can be redirected to support the transition to less fuel intensive fishing and reducing overcapacity. Progressive reduction and removal of fuel subsidies helps reach national emissions targets, fosters reduction in overfishing and progress towards a more healthy fisheries economy and can reduce fiscal burdens. It may generate employment if labour substitutes previously subsidized capital. A further step could envisage carbon taxes progressively applied to fisheries.

7. A third important action area is to progressively constrain **externalities**. These include discards, ecosystem degradation and biodiversity loss (including loss of genetic diversity) both through capture fisheries, aquaculture and restocking. This could be addressed through regulatory measures, charges for loss of natural capital and investment in mitigating technology and applied research. This means accounting for natural capital in national accounts (green, or environmental accounts), monitoring the footprint of fish production systems and facilitating payments for ecosystem services. Many externalities that arise beyond the remit of fisheries administrations, such as aquatic pollution, hydropower schemes, rivers, or offshore oil and gas extraction can reduce the wealth of fisheries and will need inclusion in the green fisheries agenda.

8. The fourth action area is to build public, corporate and consumer **awareness** on green fisheries. This requires a benchmarking and harmonization of certification systems, or green labels. It means close

collaboration with industry, including with the multiples (retail giants), careful consideration of trade issues including the possible application of tariffs non-green products, while noting that market distortions will generate inefficiencies. It requires the means of tracking progress on green fisheries at national and at product levels. The objective would be to change consumer and corporate behaviour based on shared, transparent and verified standards and recognition that seafood consumption patterns are unsustainable in a world where one billion go hungry.

9. The fifth potential action area is investment in **knowledge**, applied research and technology, including review of fisheries management measures that constrain productivity, and assessment of the costs and 'green benefits' of alternative technical approaches and suites of policy measures. There will be costs. Production systems with a high carbon footprint, or environmental impact may disappear. But failure to recognize and internalize these environmental costs means higher future costs. The objective is not only to underpin low-carbon, environmentally sustainable jobs using smart technologies and adaptive policies, but to build the economic rationale for change and to deploy knowledge, innovation, education and skills to address the social equity challenges that will emerge.

10. Greening the fisheries economy will not occur in isolation. Linkages with actions in environment, energy, climate actions and **international development** will need to be forged. Key components of a green fisheries strategy will need to be blended into national economic agendas. There is ample justification for raising the profile of fisheries in the green economy: coastal fishing communities are in the front line of climate change; the oceans have picked up half the global carbon debt; ocean acidification will irreversibly alter marine food webs; and aquaculture offers new pathways for sustainable food production, for waste management and possibly for biofuels in an increasingly hungry world.

Managing and tracking

11. The paper suggest some elements of a process to build a green fisheries economy and indicates areas which may require more in-depth consideration. Many existing sector reports offer a means of establishing baselines and monitoring the indicators of green growth in fisheries in a cost effective manner.

12. In summary, the discussion paper examines a wide range of approaches and instruments that can contribute to green growth in fisheries. Some of the more pressing issues and promising approaches are examined in more detail and certain essential activities highlighted. A number of **broad conclusions** emerge:

- Natural capital (fish stocks, water quality, and ecosystem services) will need to be rebuilt by reinvesting surpluses, some generated by the sector.

- Produced capital will need to adopt new smart technologies and reduce its current environmental footprint.

- The quality of human and institutional capital will be a determining conduit in the greening process.

- The flow of goods and services may be constrained as natural capital is rebuilt and as aquaculture and smarter production increases to fill supply shortfalls.

- Success in creation of green jobs may shape the sector's political agenda. Green jobs are likely to be in ecosystem services, new technologies and arise possibly through substitution of capital with labour. However if technology drives more efficient production, labour may exit from the sector.

This will require a labour force which is more adaptable than the current fisheries labour force, if employment is to be maintained.

- Investment in innovation and public awareness, building stakeholder consensus, creating adaptive policy and institutional instruments will be necessary. Green accounts and increased corporate social responsibility can contribute to transparent tracking of progress towards a green fisheries economy.

13. Numerous **questions** remain. Criteria for prioritisation of actions require appraisal, particularly in the current fragile economic climate. Analysis of how policies and instruments can be mutually supportive requires attention. Coherence issues are likely to emerge in the change process and the changing roles and relationships of public and private actors will present opportunities. Innovations in payments for ecosystem services, best practices for internalizing the costs of fisheries management and avoidance of aquaculture boom and bust cycles will all require additional guidance.

2. Introduction

14. The OECD has recently adopted a Green Growth Strategy[2]. Green Growth is seen as a means of maintaining economic growth and development, while preventing environmental degradation, biodiversity loss and unsustainable natural resource use. Partly driven by the climate change agenda and oil, food, and economic shocks, G8 and G20 leaders have recognized that existing pathways of economic growth are largely unsustainable, that new models of growth must move 'beyond GDP' and include a sustainable environment as a pillar of growth.

15. The task of this discussion paper is to describe the policies, institutional arrangements and approaches required for green growth in capture fisheries and aquaculture. The paper is intended to serve as a basis for discussion rather than as a blueprint, as the suite of measures suitable for one OECD member or fishery may have limited application in another and the greening of fisheries[3] will need to form part of a diversity of national plans, programmes and priorities.

16. This discussion paper examines: (i) the green policies and approaches advocated, (ii) the challenges and uncertainties facing green growth and jobs; (iii) how the transition towards a green fisheries economy can be managed; and (iv) the distributional issues associated with change.

3. Unbundling the issues

3.1 The changing ideas of growth

17. It is timely for the fisheries sector to assess the options for green growth. Recent statements by the G8 and G20, commitments by OECD members at the recent Convention on Biological Diversity meeting and agreement emerging from the UNFCC at Cancun (see box 8, section 3.4) call for concrete programs of action. High-level commissions and studies, including the Sarkozy/ Stiglitz commission and the EC's '*GDP and Beyond*', similarly call for a fundamental reorientation of thinking on the notion of growth itself and how to measure human progress in the face of ecosystem decline and climate change.

18. Whether speaking on food security, biodiversity, or climate change these statements have several common themes: environmental health, economic efficiency and productivity and distributional equity, which all underpin social cohesion and national and international stability. In the fisheries sector, these three pillars are interwoven: there is a dynamic tension between environmental health and productivity, while resource allocation is both a driver of productivity and a primary source of social and political frictions. As the fisheries sector has grappled with these tensions long before the term 'green growth' was coined, the sector can offer many lessons from successful fisheries management (Cunningham and Bostock, 2005). On the other hand, these successes have been limited , partly because some of the 'solutions' lie outside the remit of fisheries sector stakeholders and partly because a robust framework for comprehensively dealing with the trade-offs has often been lacking. The green growth agenda offers opportunities to build this framework and draw on the rest of the economy – energy, environment, consumer affairs - to resolve some of the challenges facing the sector. The choice of framework for greening the fisheries economy will profoundly influence the shaping of the green fisheries economy. It is suggested that the framework will need to address at least three tasks. First, the analytical framework will need to interpret the environmental, economic and social trade-offs. Second, the analytical outputs should contribute to green fisheries guidelines of an action program. Third, both the analyses and actions will be bounded and constrained by national action programs and the political economy so green growth actions in fisheries will have to integrate with the overarching national framework for green growth.

[2] See http://www.oecd.org/dataoecd/58/34/44077822.pdf

[3] The term 'fisheries' is used throughout to include capture fisheries and aquaculture.

19. Gross Domestic Product (GDP) has traditionally been the measure of growth. It is a good measure of the size of an economy. However, it often includes the environment and natural resources on the 'wrong side' of the balance sheet. For example, the catch from a fishery contributes to GDP, even when the fishery is exploited beyond its capacity to recover. This loss of natural capital is not discounted in the GDP estimate, which measures production flows rather than changes in capital stock. Similarly, expenditures in the aftermath of a typhoon, flood, or oil spill are counted towards growth, even though the wealth of the affected community has suffered a net decrease. In a green fisheries account, the value of fish catches reflected in GDP would be qualified by a measure of any loss of fish capital (stock decline), or by an improvement in the state of the stocks, reflected, for example, by capitalized quota values. Environmental or green (national) accounting (UN and FAO, 2004) means that GDP must be complemented by other metrics to take into account the depletion of natural capital, including environmental degradation of the environment. Green growth requires recognition not only of product flows, capital and wealth accumulation, but also the wellbeing of the population. Several approaches have been developed for national and corporate 'triple-bottom-line accounting', that embrace people, planet and profit. The additional measures of human wellbeing provide a 'third pillar' of green growth (Stiglitz et al. 2010). These approaches, which can measure both output and wealth, include: the Index of Sustainable Economic Welfare, the Genuine Progress Indicator, the UN's Human Development Index and the UN's System of Integrated Environmental and Economic Accounting. Green growth is today's formulation of several ancient values. An important modern expression of green growth was the Club of Rome's 'Limits to Growth' published in 1972. It is also instructive to examine suggested drivers of unsustainable growth (Lees, 2009, box 1).

Box 1. Drivers of unsustainable growth

1. The inadequate concept of economic growth. Economic growth measures material production rather than human wellbeing and wellbeing is considered synonymous with material wealth. This is compounded by past failure of economics to adequately reflect environmental sustainability and social equity in the measure of growth.

2. Excessive belief in market forces. Markets are based on prices and exchange. Neither prices, or exchange instruments, or property rights are sufficiently robust with respect to environmental goods and services because of the existence of, *inter alia*, complex non-linear supply and demand relationships, intergenerational timescales and attribution of the impact of externalities.

3. Reduction in the role of government. The notion that excessive government intervention constrains growth has undermined environmental regulation.

4. Counterproductive values and doubtful assumptions. These include :

- Values founded on an imbalance between consumption and saving and its extension: the imbalance between exploitation and conservation; the imbalance balance between private and public benefits and intergenerational benefits.
- Changing environmentally corrosive values maybe the greatest challenge for the green economy.
- Toxic belief in infinite growth in material wealth.
- The belief that economic growth – in terms of increasing GDP – will resolve poverty and that the poor will await the trickle down effects without social disruption or political instability.
- Technology can resolve the social, economic and environmental challenges.
- The decision to act now or act later to address major environmental issues can be determined by an economic analysis.

Source: Lees, 2009

20. In many OECD fisheries economies, these environmental and social parameters are acknowledged but may not formally be integrated or weighted into a national fisheries report card. The green paradigm will need not only a stronger base in public and stakeholder awareness to support the political underpinning of green growth transition, but also viable pathways to green growth targets. Core elements of the transition will include internalizing environmental costs, addressing market failures with institutional and fiscal instruments, building corporate and public awareness, and greening the international playing field in seafood[4] trade.

3.1.1 Definitions of Green Growth

21. The definitions of the green economy, green growth and green jobs are not just theoretical, as the definition guides the construction of the green fisheries economy and helps establish the milestones for greening fisheries. A functional definition underpins decisions on policy, research funding, business investment and job creation (box 2). Further, assessing the impact (for example) of government transfers to create green jobs requires a definition that enables use of readily measurable indicators. Green growth does not simply mean jobs in renewable energy or recycling, but altering a sector's production pattern to reduce environmental pressure and ultimately to achieve environmentally sustainable economic growth.

Box 2. Definitions of the green economy

California's working definition of the green economy

Green or clean is any activity or service that performs at least one of the following:

- Generating and storing renewable energy
- Recycling existing materials
- Energy efficient product manufacturing, distribution, construction, installation, and maintenance
- Education, compliance and awareness
- Natural and sustainable product manufacturing

A green fisheries economy [clean energy] economy generates jobs, businesses and investments while expanding fisheries [clean energy] production, increasing fisheries [energy] efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and fisheries [other natural] resources.

Modified from The Clean Energy Economy (The Pew Charitable Trusts)

Industries that provide products or services related to renewable energy, increased energy efficiency, clean transportation and fuels, agriculture and natural resource conservation, and pollution prevention or environmental cleanup.

Michigan Green Jobs Report

22. A recent OECD presentation suggests that green growth is "a way to pursue economic growth and development while preventing environmental degradation, biodiversity loss and unsustainable natural resource use." The OECD Green Growth Strategy uses the following working definition: "Green growth is about maximising economic growth and development while avoiding unsustainable pressure on the quality and quantity of natural assets. It is also about harnessing the growth potential that arises from transiting towards a green economy." The Strategy indicates that green growth is part of sustainable development – in fact the action framework for the environment-economy dimension of sustainable development. The

[4] The term 'seafood' is used throughout in a generic sense to indicate all food fish products.

working definition for a green fisheries economy used for the purposes of this discussion paper is: 'fisheries-based environmentally sustainable economic growth and social wellbeing'.

3.1.2 Where is the wealth of fisheries?

23. The World Bank report '*Where Is the Wealth of Nations?*' (World Bank, 2006) classified wealth in three categories: natural resources, such as fish, forests, land, water and minerals; produced wealth such as fishing vessels, processing plants, fish farms and infrastructure; and intangible wealth, which includes the institutional and social fabric and knowledge of society. This framework can complement the metrics for production flows – sector GDP, catch, value added, employment and sector emissions. The latter category – intangible wealth - is of particular interest for fisheries as it captures the value of fisheries institutions, including the management framework and compliance. The returns to the wealth of fisheries are measured in enterprise profits, economic rents, wages and fish sales. At the global level capture fishery rents are negative (World Bank 2008). As the fish and vessels produce value, the losses can be largely attributed to the nature of the intangible capital – the management regime. Reform of capture fisheries management regimes would appear to be an important entry point for greening the capture fishery economy. Under this wealth classification and within national environmental accounts, farmed fish is considered as produced assets rather than natural resources, although the aquafarm habitat itself is a natural resource.

24. It is worth focusing on the intangible component of fisheries wealth because the under-performance of fisheries assets in terms of rent generation can be attributed to these intangibles and overall economic growth in OECD countries is attributed largely to intangible wealth (World Bank, 2011). The World Bank quantifies the components of intangible wealth in terms of institutional quality (using the World Development Indicator 'rule of law' as a proxy), human capital (a composite reflecting education and health) and a factor to account for technological progress. The application of this approach to the fisheries sector is further elaborated in the discussion of indicators (section 4.4). The '*Wealth of Nations*' framework outlined above describes the economic growth or development pathway as transforming natural capital into produced and intangible capital. Thus the sale of fish finances vessel construction; fish commerce underpins fish processing (produced capital); investments in education and social infrastructures grow from this suite of economic activities (intangible capital). Green growth consequently implies generating a real net surplus from the natural resource base of fisheries.

3.1.3 Market and institutional failures

25. A series of market and institutional failures characterize unsustainable fisheries and aquaculture. Although several are common to the fishery subsectors, the discussion of these issues is organised firstly by production system, or fishery value chain. Global environmental externalities such as climate change, ocean acidification, marine and freshwater pollution are not detailed, except where generated by the fisheries sector, as the sector is a relatively minor source of these impacts.

3.2 The environmental impacts of fish production systems

26. The environmental impact of different fish production systems can be described in terms of:

- the inputs and factors of production and their respective environmental profiles;
- the impact of the fish harvesting and production operations on the environment;

- the impact of the post-harvest activities; and
- the impacts associated with the distribution and consumption stages of product use.

27. The focus of this section is largely on negative externalities, or the environmental costs caused by fishing and aquaculture which are generally not reflected in the price of fish products. Aquaculture in particular can also generate positive externalities. These include fish ponds that help water management, rehabilitation of oyster beds that improve water quality. In some cases, discards are important to maintain seabird populations. Life cycle analysis measures and identifies many of the externalities in the fisheries production cycle. In many case the valuation of these externalities is challenging and in the absence of a monetary valuation of impacts, prioritization of mitigating actions may be more subjective than evidence-based. Secondly, many indicators of environmental quality, e.g. for biodiversity or water quality are a function of a complex of environmental stresses and may be difficult to attribute to fisheries activities. These stresses include aquatic pollution, including unsustainable land use and fertilizer runoff, wetland conversion, hydroelectric schemes that interfere with the life cycle of commercial and recreational species, water abstraction from rivers and water pricing policies. Actions to address these externalities form an essential part of the green growth agenda.

3.2.1 Life cycle analysis (and environmental footprints)

28. One of the most comprehensive approaches to assessing the environmental impact of production systems is life cycle analysis (LCA) (ISO, 2006). A comprehensive set of LCA studies on the range of fish production systems can help guide a green growth agenda. LCA can be a powerful tool but it rests on a definition of the production system under review, the boundaries stipulated for the analysis of that system, the quality of the data, the weighting of different elements of the analysis and the interpretation of the results. There is a growing number of LCA studies on fish production systems and the following table summarizes some key points from selected LCA studies (table 1). Consumption, the final element in the value chain, including fish consumption patterns and consumer awareness is addressed in a subsequent section.

Table 1. Selected life cycle analysis results

Fishery (source)	Impacts and conclusions
Spanish tuna purse seine (Hospido and Tyedmers, 2005)	Fuel use 436 litres/ tonne of fish harvested; 1.8 tonnes CO2 equivalent per tonne of tuna landed in Spain; values for production and use of anti-fouling paints (marine toxicity), vessel construction inputs.
Global salmon aquaculture (Pelletier et al., 2009)	Feeds account for 92% of energy use, biotic resource use, GHG and acidifying emissions. Substantial variations exist between the footprints of various producer countries (e.g. Canada, Norway, Chile, and UK). Opportunities exist to improve least environmental cost feeds (e.g. certification or Peru anchoveta).
Denmark flatfish (Thrane, 2006)	Almost all of global warming, ozone depletion, acidification and marine toxicity impacts attributed to harvest operations. Fuel use could be reduced by a factor of 15 by a switch from trawl to seine gear.
Iceland frozen cod (Eyjolfsdottir et al., 2003)	Fishing gear operation accounts for 70% of fuel use. One kg of catch, which produces 0.4 kg of frozen fillets, requires 0.65 litres of fuel.
Cod Sweden (Krav, 2010)	Links LCA directly to an ecolabelling scheme. KRAV certified 400 gm cod fillet pack has less than half the conventional GHG emissions (0.6 kg compared to 1.3 kg). The additional cost to the consumer is about $0.75/ kg. KRAV-labelled fish sales increased by around 60% in 2008 and by 126% in 2009, indicating a significant 'willingness to pay' by Swedish consumers.
Vessel design (Ellingsen and Pedersen, 2004)	Application of LCA to optimize vessel energy use over life of vessel.
Various aquaculture system (Tydemers and Pelletier, 2007)	Overview – extensive systems have (relatively) low environmental impact, are energy efficient; intensive systems can be among the most energy inefficient animal protein production systems.

Sources: see table

3.2.2 Capture fisheries production chain

29. Several closely related market failures can be distinguished. All involve a failure to internalize the environmental costs of fisheries. The first and most obvious is the decline of the target fish stocks. The market failure derives partly from the failure to close access and institute property rights or other incentives so that a market mechanism can operate. The result of the failure is overfishing and fleet overcapacity, a subject frequently addressed by the OECD (OECD, 2010).

30. The failure to internalize the collateral environmental damage on biodiversity and non-target species is closely associated with a functioning market for access to target fish stocks. FAO has recently produced draft guidelines (FAO, 2010) for bycatch and discards. While the guidelines focus mainly on technological and management issues and reference is also made to social and economic efficiency of measures, little attention is devoted to the assessment of environmental costs or means to internalize these costs. For example, if a no-discards fishery would be desirable, a reducing 'cap-and-trade' for discards could create a market mechanism to drive a gradual reduction in discards and foster adaptation of more eco-friendly fishing technologies. Denmark and other North Sea countries have tested a remote monitoring system for accounting for total fishing mortality. This allows catch quotas to be linked to mortality rather than landings, thereby essentially internalizing the discards. Institutional arrangements and cooperation on discards in US Northwest Pacific fisheries has reduced bycatch; economic instruments such as a 'bycatch bank' (Iceland) and deemed values (New Zealand) have been used with effect (Kelleher, 2005).

31. The third and related market failure is degradation of biodiversity and critical habitats. The oceans contain 90% of the earth's biomass; almost half of major biodiversity classes (phyla) are found only in the oceans, and the estimate of ocean and aquatic biodiversity at species level is increasing. Impacts of fisheries on biodiversity may not easily be resolved by market mechanisms, as the benefits are perceived as largely public rather than private and attribution of value may be partly subjective. Biodiversity loss may often be irreversible and the loss of biodiversity and related ecological function impacts disproportionately on the poor. All fishing is selective so it may favour genotypes with early maturity and a consequent loss of genetic biodiversity, lower size composition of catches and possible ecosystem changes (Smith, 1994). Fishing operations with high impact on biodiversity, such as beam trawling or some deep-water trawling may require progressive regulation, environmental taxes and marine protected areas. The Eastern Tropical Pacific tuna purse seine fishery has a cap and quota on dolphin mortality monitored by 100% observer coverage. A number of OECD countries have committed to international biodiversity targets[5]. Payment for ecosystem services (PES, see below) offers another approach. The design of effective measures to counter intra-species biodiversity loss, arising particularly from aquaculture will need further consideration.

32. The fourth externality is GHG emissions, control of which is closely associated with the issue of carbon taxes. The impact on sustainability of government financial transfers to the fisheries sector (loosely termed subsidies) has already been exhaustively examined by OECD (OECD, 2006). Transitioning capture fisheries to a low carbon trajectory may require that fisheries fuel be subject to any emerging carbon tax regime, and require that fuel subsides (either hidden, explicit, or under-reported) are progressively removed. It is recognized that there have been significant advances in energy efficiency. Nevertheless, additional incentives for fleet and fishing operations to adopt more energy efficient technologies, including hull designs and propulsions systems (Sterling and Goldsworthy, 2007) and smart gears (http://smartgear.org/) might emerge from a review of the effectiveness of existing subsidies. Many OECD countries already have baseline fleet fuel consumption profiles and the technical steps to improve fuel efficiency are known (Ministry of the Environment nd.; Seafish, 2006; van Marlen, 2008) (see table 2). For example, a shift from trawl to pot (creel) gear in the *Nephrops* fishery can reduce fuel consumption from 9 to 2.2 litres per kg and with less bycatch; four times more fuel is used per kg of cod caught by Sweden's

[5] CBD, Aichi Declaration.

trawl fishery that in the gill net fishery (North Sea Foundation, n.d.). Numerous other examples illustrate emissions reduction resulting from a switch to passive gears.

Table 2. Indicative fuel consumption and fuel cost as share of earnings in EU fleets (litres/ kg and %)

Gear type	litres/kg fish	% gross earnings
Beam trawl	2 to 5	19% to 36%
Bottom trawl or seine	0.3 to 1.3	16% to 25%
Passive gears	0.002 to 1.9	6% to 11%

Source: ESIF project Interim Report, years 2004 2006

33. Externalities arising from other inputs to the harvesting operations also need to be considered in a life cycle analysis. Antifoulants contribute to marine pollution and refrigerants contribute to green house gas (GHG) emissions. Netting is often non-biodegradable and lost fishing gear has significant impacts. Timber used in vessels construction may be unsustainably sourced. Steel and GRP hulls depend on non-renewable extractive industries. Energy use in processing, preservation (for example chilling, and freezing) and transporting all contribute to the footprints of fish products. Many of these externalities extend beyond the fisheries sector and are likely to be best handled by their respective sectors – clean energy grids, sustainable forests, or anti-pollution measures. Waste water from processing plants is generally covered under various clean water measures.

34. The closely related institutional failure of inadequate specification of property rights, or tenure in wild fisheries (and sometimes in culture fisheries) has been exhaustively treated elsewhere (Metzner *et al*. 2010). It has consequences not only for stewardship, but also for profitability and for labour and capital mobility which will be increasingly important in an adaptive green fisheries economy (Daníelsson, 2005). Scott (2010) identifies six dimensions of tenure: exclusivity, permanence, transferability, divisibility, quality of title, and flexibility. The stronger and more formally specified these rights, the greater the fisher's incentives to sustainably manage the fishery. If labour or capital productivity is to increase, the consequence is concentration of such rights.

3.2.3 Aquaculture chain

35. Several main market failures and resulting negative externalities can be distinguished in aquaculture production systems. The Global Aquaculture Performance Index (GAPI) attempts to quantify the physical dimensions of many of these externalities.

36. Loss of biodiversity and natural capital is perhaps the most insidious effect, as the loss of genetic diversity it is mostly irreversible and can impact both on capture fisheries and the future of aquaculture. New genetic techniques are evolving as are cost effective means of calibrating the physical losses, but placing a value on these losses is challenging. The populations of many wild anadromous species, such as salmon, or sturgeon are maintained only be restocking and release of seed or fingerlings which have not been subject to the same selection rigors as the wild seed. Consequently there is particularly high loss of genetic diversity at species level. This diversity is a natural 'portfolio strategy' or insurance which allows populations to survive disease epidemics and parasites and respond to ecosystem changes – changes that are increasingly uncertain in a changing climate and increasing ocean acidification (Schindler, 2010). At least some of the costs incurred by disease epidemics in cultured species can be attributed to the genetic specialization of the broodstock and loss of the living fabric of these important food production systems. In an era of changing climate the value of this genetic insurance is increasing even as its supply dwindles. Neither the maintenance of seed banks, use of sterile seed, rigorous application of best aquaculture practices, or protected areas may provide fully satisfactory solutions. The issue of GMOs may also benefit from a more full and frank discussion.

37. Point source pollution, including fish wastes and fertilizers, contribute to eutrophication and habitat destruction. Though vaccines and breeding of disease resistant stock has reduced the use of pesticides and antibiotics in well managed productions systems, where aquaculture is weakly governed, use of these chemicals has well-documented effects on human and animal health (Fortt and Buschmann, 2007).

38. The notion that overfishing of fodder (fish meal and trash fish) fisheries is an aquaculture externality appears to unduly expand the concept of an externality. However, the environmental impact of these fisheries needs to be considered in a life cycle analysis of aquaculture. Similarly the environmental costs of other inputs - cages, netting, energy need to be included in an environmental footprint of aquaculture. Comparison of footprints of alternative animal protein production systems (fish versus livestock) may help build the case for growth in farmed fish production, in particular production of molluscs or herbivores.

3.2.4 Recreational fisheries and marine tourism

39. Little attention has been devoted to marine and aquatic tourism and recreational fisheries in this discussion paper. Both are important. A recent analysis (World Bank 2010) estimates that expenditures by some 220 million recreational fishers worldwide are in the order of $190 billion annually. Recreational fisheries can be of greater economic importance than commercial fisheries in some countries and contributes in the order of $70 billion to global GDP. Many, though not all, activities associated with aquatic tourism and recreational fishing are environmentally benign, may have positive externalities that need to be included in green growth accounting.

3.3 Fisheries in the broader aquatic environment

3.3.1 Externalities impacting on fish production

40. Numerous anthropogenic activities impact on fish production systems and many are not explored in this discussion paper. Impacts from other industries arise through restrictions on fishing due to gas and oil operations and pipelines, submarine power and transmission cables, dredging and extractive industries. Impacts arise from pollution, including by marine litter, noise, chemical and radioactive materials and oil spills. Invasive species are introduced with ballast water, aquarium fish and plants alter ecosystems as do hydroelectric schemes, the alteration of river beds with concrete storm drains or conversion of wetlands for industrial or real estate use. Many of these activities impact indirectly on fisheries production systems by degrading the ecosystem services on which fisheries depends. GHG emissions are a particular instance considered under the heading ‘climate change’ below. In many cases, the means to address these impacts lie outside the fisheries sector, thus the key action required by the fisheries sector is to ensure that the appropriate instruments adequately address the impact on fisheries and that these impacts feature in green growth accounting.

3.3.2 Ecosystem services

41. The Millennium Assessment provided an overview of global ecosystem services, indicated the global deterioration of these services and attributed the failure to value these services as a major cause of their degradation. The Economics of Ecosystems and Biodiversity (TEEB) stressed the need to include effective valuation of non-market environmental services in policy frameworks and investment decisions. Ecosystem services lump at least three different benefits: (i) goods such as fish; (ii) services such as recreation, tourism and spiritual benefits; and (iii) ecological regulatory functions such as nutrient cycling, coastal and river erosion control, and climate regulation. For example the oceans have taken up about half the anthropogenic CO_2 emitted; wetlands and mangroves are important habitats that support terraforming, nutrient recycling and fish nursery and breeding grounds. Coastal tourism and real estate development

result in lost wetlands and seagrass beds; salt pans and shrimp farms have caused losses of mangroves. However, the conventional market, or regulatory mechanisms often fail to address the loss of the ecosystem services provided by these habitats.

42. The design of market and institutional systems to account for or charge for loss of these fishery-related ecosystem services faces several challenges: (i) the definition of the ecosystem service; (ii) the assessment and attribution of the links between the ecosystem service and the fishery benefits; and (iii) the valuation of the ecosystem service, which can inform tradeoffs and design of regulatory or market instruments. Estimates of fishery related losses per km^2 of lost mangrove for Thailand range from $12,000 to $400,000 for shellfish fisheries (Barbier, 2003) and the relationship between mangrove habitat and shrimp production in Mexico (1980-1990) at $140,000 per km^2 of mangrove (Barbier and Strand, 1998).

43. There may be a delicate balance between human ecosystem impacts and fishery productivity. For example, primary productivity and shellfish production can benefit from eutrophication (caused by fertilizer runoff, or sewage), but excessive eutrophication causes stress resulting in disease, loss of ecosystem function, loss of fish production and anoxic conditions in freshwater and marine habitats.

3.3.3 Climate change impacts and responses

44. Climate change is a symptom of unbridled growth in material consumption, waste and pollution, rather than an environmental issue, *per se*. The cause is not simply GHG emissions, but human values, economic and technological choices and market failures.

45. GHG emissions have already caused three important and mostly negative, or at least uncertain impacts on oceans: rising sea levels, rising ocean temperatures and rising acidity. All are irreversible within a 50-year framework, placing added stresses on a fishery economy targeting green growth. Changing climatic conditions are also predicted to cause erratic rainfall and increased frequency and intensity of storms. These will affect both capture fisheries and aquaculture through droughts, floods and storm damage and affect the infrastructure on which fisheries and fishing communities depend. Fishing communities tend to be in the front line of climate change.

46. Distribution of fish stocks and the geographical ranges of species are already altering as a result of rising ocean temperatures. In general stocks and species are moving towards the poles and these movements are forcing changes in fishing patterns and stresses on international fisheries agreements. Coral bleaching, which has resulted in major losses of coral reef fisheries, is largely attributable to rising sea temperatures and ocean acidification (Hoegh-Guldberg, 2007). Ocean acidification (OA) is of growing concern for marine fisheries, including shellfish aquaculture. Apart from its uncertain impact on ecosystems it has a direct impact on the growth of shellfish (Orr *et al.* 2005), in fact any animal with a skeleton or shell based on calcium.

Box 3. Ocean Acidification and fisheries

The Monaco Declaration reflected broad concern on Ocean Acidification (OA). Unlike some real or perceived uncertainties associated with global warming science, the rising ocean acidity is indisputable. The uncertainties relate to the nature, scale, timeline and severity of the impacts. Oceans have picked up half the global carbon debt. Oceans contain five times more carbon than all other sinks combined. Acidification is undermining marine ecosystem function, reducing the productivity of the shell forming organisms at base of the food chain (Cocolithophores, Pteropods, corals and planktonic crustacean, such as krill). Acidification will increase as the ocean continues to absorb CO_2 and is irreversible in the medium term (100 years), even if emissions decline.

The impact on US shellfish fisheries alone is estimated to be substantial. NPV of projected losses range from $1.5 to $6.4 billion through 2060 (2% discount rate) and in a high-CO_2 scenario losses are almost 1.7 times larger (Cooley and Doney, 2009). There is no valuation of global ecosystem service losses, although the annual cost of lost fisheries and coral reefs have been estimated in the order of $30 billion (Cooley et al. 2009). Without action, most tropical coral reefs, which support 25% of marine biodiversity, are likely to disappear by 2050, due to the combined effects of ocean acidification, warming, disease and overfishing. Work is under way to model the impacts and will need to draw on ocean biogeochemistry, oceanography, ecology, environmental economics and climate science (EPOCA 2010; Moore 2010).

The warmer and the more acidic the oceans become, the less carbon can be absorbed and changes in the ocean's ability to bury carbon could nullify efforts to reduce emissions. Efforts to secure the ocean's continued ability to sequester carbon face significant scientific and institutional challenges with substantial knowledge gaps at across a complex spectrum of scientific and economic disciplines.

Source: Author

47. Climate change responses are usually considered to be mitigation if the benefits are global (e.g. reducing emissions) and adaptation if the benefits are local (e.g. strengthening shoreline erosion defences). The distinction between mitigation and adaptation is that the benefits of adaptation are local; the benefits of mitigation are global. This distinction has important implications for the financing of climate change responses. Actions to combat rising ocean temperature, OA and its impacts fall into three categories. First, reducing GHG emissions is the only way to reduce and reverse OA – reduction of fishery-generated emissions will set a useful example, but in isolation will have negligible impact. Second, reducing fishing and other environmental pressures (e.g. pollution) on fisheries and critical habitats is likely to build more resilient ecosystems that can adapt to changing climatic conditions to continue to provide the ecosystem services that underpin human wellbeing. The third approach is to safeguard or rebuild the capability of aquatic ecosystems to capture and bury, or sequester CO_2. The most favoured actions are those that have dual benefits from mitigation and adaptation. Reduction of fleet overcapacity is one such example. Another is the rehabilitation of wetland habitats and coastal and ocean carbon sinks. The policies and instruments used to address mitigation and adaptation are essentially those of the green economy seen through the lens of climate change.

3.3.4 Climate change mitigation in fisheries and oceans

48. Reduction of GHG emissions is the single most important action which can address the impacts of climate change on fisheries. On land, healthy forests and enhanced forest biomass means enhanced levels of carbon capture and burial, or sequestration of CO_2. Healthy marine ecosystems can also contribute to carbon sequestration and several scientific initiatives are contributing to understanding of marine carbon dynamics (e.g., EPOCA). Although coastal carbon stocks are relatively small, conservation of wetlands and other coastal carbon sinks can contribute both to mitigation and adaptation (see box 4).

Unlike forests however, the science of ocean and coastal carbon sinks is not sufficiently robust to avail of carbon funding to rehabilitate aquatic ecosystems or ocean biomass. Increased investment in development of algal biofuels may also provide a carbon positive alternative to fossil fuels and terrestrial biofuels (U.S. DOE 2010) and large-scale expansion of algal aquaculture and potential use of organic wastes can be envisaged as technologies improve.

Box 4. Wetlands and sunken deltas

Marine ecosystem carbon sinks – sometimes referred to as 'blue carbon' - are a vital component of the global carbon cycle and are over ten times the size of terrestrial sinks.

- These sinks are being lost or degraded through drainage of wetlands, coastal and ocean pollution, or irresponsible fishing. For example some 20% of mangroves have been lost since 1980 and annual losses are about 0.7%.
- Not only does drainage of coastal wetlands cause the loss of the carbon sink, but transforms the drained lands into net carbon emitters. When coastal wetlands are drained – often to create agricultural land – the aquatic soils dry and compact. For example, some of the lands behind Holland's famous dykes are some 7 meters below sea level. These compacted soils may release up to 0.25 million tons of CO_2 per km^2 for every meter of subsidence. In the Sacramento–San Joaquin Delta the drained wetlands release between 10 and 15 million tons of CO_2, equivalent to 2-3% of California's annual GHG emissions..
- These ecosystems also provide additional fundamental ecosystem services such as storm protection and nutrient recycling which has been valued at $300/ hectare/ year.
- Raising the profile of marine and coastal ecosystems in climate change discussions is important for their conservation and restoration.
- Currently these sinks, or loss of these sinks are generally not included in national carbon accounts.
- Development of pathways for these ecosystems to access carbon finance will underpin efforts to secure and enhance their role in CC mitigation and adaptation.
- Scientific consensus on the scale and role of these important carbon sinks is emerging. More accurate measurement of carbon in these diverse ecosystems will require investment in science, which can help build the path to access carbon finance and payments for other ecosystem services.

Source: World Bank, IUCN and ESA PWA, 2010.

49. Motorized fisheries have a relatively high carbon footprint compared to other animal protein production systems. In addition to a more effective implementation of conventional management approaches, carbon taxes or similar instruments may reduce these emissions, but to be truly sustainable in the broader environmental and emissions context, motorized fisheries could offset their emissions. This could be done, for example, by contributing to conservation of coastal wetlands or seagrass and kelp beds, which act both as a carbon sink and a critical habitat for fisheries. To put this in perspective, if for each ton of fish caught it is assumed that 1.7 tons of CO_2 is emitted (Northsea Foundation, no date), then some 0.002-0.01 km^2 of seagrass beds (World Bank, IUCN, PWA, 2011) might be designated as a protected area for each tonne produced.

3.3.5 Adapting fisheries to climate change

50. Estimates of the cost of climate change range as high as 12% of GDP for some developing countries, suggesting a strong case for investment in adaptation (World Bank Climate Data Portal). The challenge is to prioritize the most cost-effective adaptation measures, determine who pays, who loses and who compensates for changes in the environmental status quo. This is both a technical problem and a political economy issue that requires building a consensus across political constituencies and communities

with particular attention to equity. The impacts of climate change have a high degree of uncertainty. Effective decision-making requires that this uncertainty is acknowledged and assessed, and measures engaged to reduce uncertainties (Economics of Climate Adaptation, 2009)[6]. International organizations and OECD countries have developed a number of analytical tools[7] to support climate change response decision-making. As the greatest burden of climate change falls on developing countries with potential impacts on fish supplies to OECD markets, projects for fisheries sector adaptation supported by the climate funds[8] may benefit from dissemination of OECD green fisheries innovations to developing countries.

51. Choice of cost-effective climate change responses requires economic analyses which take account of intergenerational costs and benefits and must value ecosystem services not usually priced by the market. The choice of societal discount rate is essentially an ethical rather than an empirical choice. A low rate favours future benefits, for example the Stern Report used a rate of 1.4%; use of a 4% discount rate means that the value of a benefit to a grandchild is considered to be one seventh of today's value. However, intergenerational discount rates and alternative approaches remain the subject of discussion both on theoretical and applied levels (Heal, 1997, Chichilnisky, 1997).

3.4 Economic, social and political issues

3.4.1 Accounting for natural capital

52. GDP is a key measure of growth but it is an 'income statement' rather than a 'balance sheet' as it cannot reflect changes in the natural capital – the fish stock, or environmental quality upon which the income stream is based. Put another way, the rate of growth in GDP can be seen as a rate of return on investment, but one that is deeply flawed, as it omits depreciation of the natural capital and its impact on future 'earnings'. Green or environmental accounts are required to show the true performance of the fisheries sector. Few fishing companies report changes in fish stocks in their balance sheet, even though their future incomes depend on these changes. This is generally because weak property rights may not enable the company, or fisher to include these assets in accounts: if the enterprise does not own the fish or fishing rights then energy may be directed at maintaining the 'lease', or access right, rather than on increasing the value of the 'asset'.

53. National fish stocks are a national asset and however the property rights are organised, responsible stewardship requires a public accounting to the changes in these assets. Yet few countries (they include Australia, Iceland, Japan, Namibia, New Zealand, Norway and South Africa) report changes in their fish stocks in their national accounts as part of more comprehensive environmental accounts (ABS, 2007; Daníelsson, 2004; Daníelsson, 2005a; Harkness, 2008). Part of the difficulty in preparing environmental accounts arises from valuation of the natural capital. Where tradable quotas or similar tradable property rights exist a market price is set and the value of the fish capital can be estimated. Charges for aquaculture concessions or their sale price may provide indicative values, but are likely to be constrained by shallow aquaculture asset markets and failures to internalise environmental costs or capture rents in concession fees. Because of these and other data weaknesses, the World Bank report "*Where Is the Wealth of Nations?"* was unable to include fisheries in global wealth estimates. The authors considered that many fisheries do not generate rents as the natural capital in wild fisheries is increasingly depleted; that as many fisheries are subsidized, the net transfers are from society to the fisheries sector, so that at global aggregate level the sector may not generate any wealth (pers. comm.). Detailed guidelines on preparation of fisheries environmental accounts are available (UN and FAO, 2004).

[6] http://media.swissre.com/documents/rethinking_shaping_climate_resilent_development_en.pdf

[7] UNDP, ALM; World Bank, ADAPT; UK, Wizard; USA and others, SERVIR.

[8] Climate Investment Funds. http://www.climateinvestmentfunds.org/cif/

54. Adjusted net savings, often expressed as a percentage of GNI, measures the true rate of savings in an economy after taking into account investment in human capital, depletion of natural resources and damage caused by pollution. It provides a measure of a country's sustainability by measuring the change in comprehensive wealth during an accounting period. It also gives an indication of how rents from natural capital (e.g. fish stocks) are transformed into other forms of wealth. However, fish capital is not normally included in the estimates because the data is not available (see box 5). National ANS values for countries are compiled as part of the World Bank's World Development Indicators.

Box 5. Estimating Adjusted Net Saving

Measurement of adjusted net saving (ANS) is based on standard national accounting concepts. Adjusted net saving is obtained using the following:

Gross national saving
LESS Consumption of fixed capital
EQUALS **Net national saving**
PLUS Education expenditure
LESS Energy depletion, Mineral depletion, Net forest depletion, Damage from carbon dioxide emissions, Damage from particulate emissions
EQUALS **Adjusted net saving**
All the terms are expressed as percent of Gross National Income (GNI)

ANS highlights the fiscal aspects of environment and resource management, since collecting resource royalties and charging for environmental impacts are basic ways to both raise development finance and ensure efficient use of the environment. ANS makes the growth-environment trade-off quite explicit, since those countries planning to grow today and protect the environment tomorrow will be notable by their depressed rates of adjusted net saving.

Sources: UN ESA http://www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/econ_development/adjusted_net_saving.pdf; World Bank http://go.worldbank.org/OV4R25M150; Bolt et al. 2002

55. The World Bank study "*Rising to Depletion*" offers a standardized method of approximating medium to long-term changes in fish capital in physical terms (see box 6). With further testing and tuning, the approach could serve as a basis for including fish in ANS estimates. However this approach, which is based on national catches as reported to FAO, requires further verification by cross checking with the more detailed catch estimates available at national level. In conclusion, several approaches and tools can be used to more accurately measure green growth in fisheries.

Box 6. Rising to Depletion – a generic measure of the state of national marine fisheries

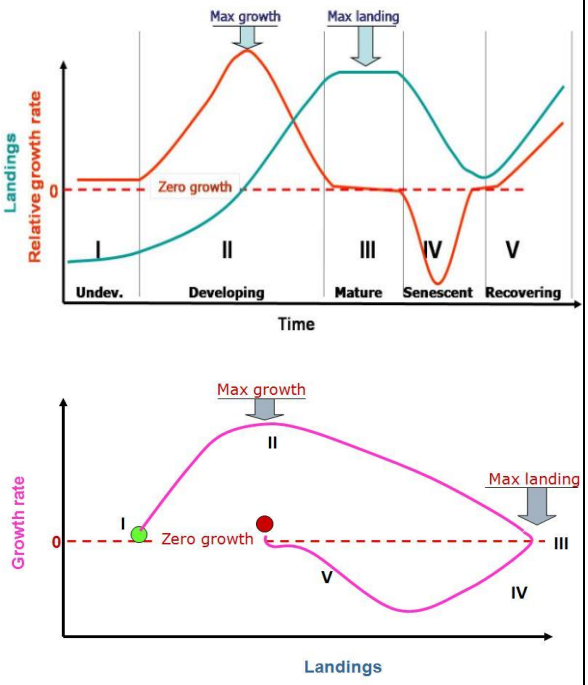
Rising to Depletion provides a country-by-country (baseline) on the state of fisheries, based exclusively on catch information provided to FAO by countries. It should be seen as a rapid diagnostic tool and starting point for more profound analysis. The results are a proxy for the trend in increase, or more commonly (see figures) the depletion of Many countries and regions show a historical pattern of rising catches paralleled by a declining rate of increase in catches (see figure). Catches peak and the rate of increase in catches correspondingly falls to zero. In a 'depletion phase' catches decline (and the rate of increase becomes negative).

The results rely both on the quality of the data used and the hypothesis underlying the analysis. As the quality of catch/ landings data supplied to FAO is highly variable. The analysis is based on a general fishery development model which may not account for variability between countries.

The model uses the trends in landings and in the relative annual rate of increase (ROI) in landings to distinguish between five phases of fishery development: I) un-developed, II) growth, III) mature, IV) senescent and, possibly, V) recovery. The ROI is nil during periods of stagnation and at maturity. It is maximal in the middle of the growth phase and decreases as the sector reaches the limits imposed by the set of resources and within the prevailing productivity and socio-economic conditions.

The diagnostic tool requires country-level verification prior to any possible use as a rapid means of assessing loss of potential rents.

http://siteresources.worldbank.org/EXTARD/Resources/336681-1224775570533/RisingtoDepletion.pdf



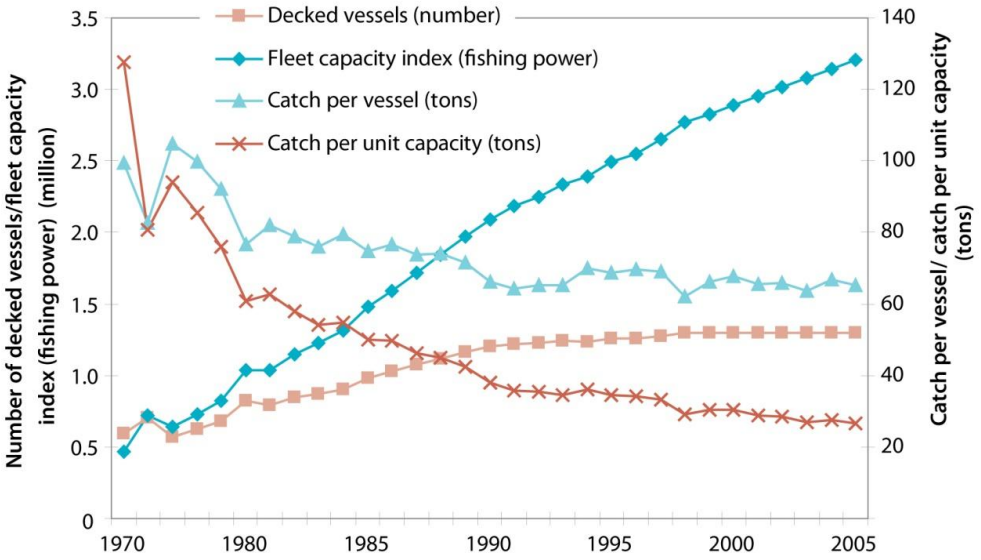
3.4.2 Productivity

56. A component of OECD green growth is to 'decouple growth from environmental pressure'. However productivity will have to be maintained or improved. At harvest level in capture fisheries, productivity has at least three parameters: use of fish resources; use of other inputs such as fuel, fleet and processing plants; and use of labour. As in agriculture, capital has tended to substitute labour in OECD countries with a consequent increase in output per unit of labour and often a decline in physical output per unit of capital (see figure 1). Total employment in capture fisheries has declined and some of the more labour-intensive segments of the value chain have been outsourced to developing countries. The substitution of labour by capital has been underpinned by subsidies and other supports for capital investment

57. The largest fish biomass (capital) will, in general, support the highest biological productivity. If there is investment in human capacity, or smart, more efficient fishing technology, either labour or fleet capital must be reduced to maintain the fish capital (stocks) and productivity. If the objective is to maximize green jobs and labour productivity, then capital, such as fleet capacity will need to be adjusted. Appropriate adjustments in the physical component of fishing capacity (i.e. smaller more fuel efficient

fleet) not only make good climate sense, but oil price projections (EIA reference scenario) strongly suggest, that in addition to increasing capital and labour productivity, these adjustments make economic sense. Thus the metrics of capture fishery performance in the green economy for a given state of fish (stocks) capital would include: (i) increased labour productivity (e.g. kg per employee); (ii) a reduced environmental footprint of the factors of production (e.g. trophic profile of catch); (iii) enterprise profits (economic productivity); and (iii) catch trend per unit of GHG emissions (usually expressed as CO2 equivalents).

Figure 1. Global fishing fleet trends



3.4.3 Social issues and political issues

58. Greening of the fishery economy implies an alteration of the environmental status quo and redistribution of economic costs and benefits of natural resource use. The costs and benefits are distributed among various categories of stakeholders: enterprises, employees, the public (taxable rents or lack of, and subsidies) and consumers (through fish prices).

59. In general, the costs of environmental degradation and climate change fall disproportionately on the poor (World Bank, 2010a). This is particularly true in developing countries where the poor often rely on ecosystem services for survival – subsistence fishing, collection of firewood and clean water from rivers. In OECD countries the poor tend to live on the environmental margins, in proximity to industrial complexes with toxic emissions, or in areas prone to flooding. In many OECD countries, those most dependent on fisheries are often vulnerable, rural, isolated communities with fewer alternative livelihoods and poor access to social services. Maintenance of the social fabric of these communities can be an important social and political objective and public support or government financial transfers to fisheries may be an important means to that end. Consequently removal of subsidies or measures to adjust fishing capacity can have important distributional impacts. A suite of policies, incentives and public supports have been applied with varying degrees of success using dedicated fisheries funds and associated social and structural support (EC, 2008). Initiatives include improving labour mobility, creation of green jobs in renewable energy (such as coastal wind farms), in marine tourism, aquaculture, cottage industries and marine technology, including offshore oil and gas. If green jobs are the priority, a set of small-scale

fisheries may be favoured over larger, more capital intensive harvesting, particularly if productivity, adaptive capacity, net economic benefit and environmental footprints are comparable. The following box illustrates one approach to the social challenge.

Box 7. Indonesia's trawl ban – a 'social adjustment'

In 1989 President Suharto banned all trawlers from waters around Java and Bali. According to the Director General of Fisheries, the ban was a "political decision" made with the goal of reaching "social peace and stability, by way of providing better protection to the poor traditional fishermen". There was also an underlying political motive as the fishermen's association could influence votes in the election. Further, previous attempts to limit licenses proved ineffective leaving fisheries managers with limited alternatives. As the navy had a significant influence over fisheries, the operational simplicity of the ban was also attractive in terms of enforcement.

Source: Butcher 2004

60. The distribution of economic rents generated by a capture fishery between private profits and public revenues may be a useful measure of distribution. Negative rents imply subsidies if the fishery is a 'going concern'. Management costs can exceed 10 % of the value of landings (largely enforcement costs) and rent estimates need to take account of the costs of fishery management. In a green fisheries economy, these costs would ideally be internalised in payments for the fishery concession, or financed directly by the privates sector, for example through contracted research.

61. Enterprises will bear much of the direct and investment costs of transition to the green economy. Even with smart technologies and efficient production and distribution systems, it is reasonable to expect that the production costs of green seafood may exceed costs of production in less green or non-green production systems. The key question is how these costs will be distributed between producers, processors, distributors and consumers as this will determine the political buy-in to the greening process. Three closely related exercises may be necessary. First is the preparation of estimates of the comparative costs of different production systems and their respective distribution and product consumption patterns (*e.g.* fresh/ frozen/ supermarket/ restaurant) taking full account of the environmental externalities and social implications (*e.g.* labour intensive/ carbon intensive). Second is the identification of 'green savings' along each production chain to define best/ better green practices for that production system. Third is the design of transition pathways which distribute the burden of transition to better green practices while maintaining production efficiency and supply. In order to build buy-in for change, it is likely that substantial investment in awareness-building will be required, among producers to invest in the changes, among distributors to offset potentially higher production costs for some products, and among consumers to buy into the green economy.

62. The transition may well require a rethinking of fishing and aquaculture concession values and payments, in particular how to internalise public costs of monitoring and enforcement. If producer are required to pay such charges (*e.g.* fishing licenses, or quota charges which recover the costs of control), producers are likely to demand greater efficiencies. This can be achieved in at least two ways: by outsourcing certain services on a competitive basis (*e.g.* research and monitoring of landings is outsourced in some OECD countries); and greater compliance and cooperation through peer pressure. A green fisheries economy does not necessarily imply higher costs. Emissions reduction implies reduced fuel and greater efficiency; innovation including smart fishing, electronic markets, contract fishing and inventory management can reduce cold storage, logistics and transport costs, households, the food service industry and retailers can further reduce waste.

63. As about 37% of global seafood production is traded, the move to a green fisheries economy by OECD countries implies that OECD producers may call for trade measures against 'non-green' seafood imports. Quotas and tariffs are likely to raise prices for OECD consumers, be counterproductive to global trade deals, distort markets, generate inefficiencies and may not assist developing country efforts to build sustainable fisheries. More innovative solutions could require exporters to purchase carbon credits to support domestic climate change mitigation, or contribute to national green funds. The green trade issue pertains to the entire green economy and is closely linked to the developing country agenda, to the transfer of green technologies and trade agreements. Trade in green fish may be complicated by the processing of OECD-harvested fish in non-OECD low labour cost countries for subsequent re-export to OECD members. The green trade issue may also raise questions concerning the commitments of trading partners to international instruments, in particular to Cancun commitments (see box 8), to biodiversity conservation targets and international fisheries management measures, including effective flag and port state measures to combat illicit fishing activities.

3.4.4 Consumption, public awareness and political process

64. Fish consumption patterns link the economic dimensions to many of the social dimensions of the green economy. In particular, the interplay between consumer attitudes and preferences and income levels will be a major driver of the green economy. Where income levels and public awareness allow consumers to choose green products a greener fishery economy is likely to emerge more rapidly. In countries with less environmentally discriminating and more cost-conscious consumers, the evolution is likely to be more protracted. The latter will be a major challenge for developing countries, responsible for some 55% of the global seafood trade.

Box 8. Fisheries and selected Cancun commitments

Countries agreed on several activities with the objective of restricting emissions and setting an overall 2 degree temperature rise target. Countries undertook to:

- provide details to the UN on activities to reduce emissions. It means that the fisheries sector will need baselines and to program activities to reduce emissions, e.g. reduction in fleet capacity;
- institute emissions monitoring systems to measure, report and verify (MRV) emissions, e.g. fuel use by fishing vessels;
- finance developing country efforts to reduce emissions, for example, OECD importers could work with developing country producers to raise productivity and reduce emissions.
- Although the Cancun 'forest outcomes' may only be directly applicable to mangroves, other marine and coastal systems are significant carbon sinks. These include wetlands and estuaries (World Bank, IUCN, ESA PWA, 2010), seagrass, seaweed and maerl beds (Foster, 2002). The continued destruction of these critical marine carbon sinks will need to be reversed and their status monitored. However, there are numerous unresolved scientific and procedural issues constraining inclusion of marine and coastal sinks in national carbon accounts and carbon finance instruments.
- With respect to technology and adaptation, countries undertook to set up the mechanisms to help developing countries access low carbon technology, and adapt to climate change. A range of adaptation measures in fisheries have been described by OECD, FAO and the World Bank.

65. Public perceptions face several challenges. Producers may have difficulty in recognizing and accepting an increased burden of environmental stewardship and the costs involved, particularly when many OECD fisheries are in economic difficulty. Distributers may resist paying a premium on green

seafood. The public at large may have difficulty in accommodating the intergenerational cost implications, particularly with respect to ocean acidification or temperature impacts which are both uncertain, lack robust valuation and accrue over decades rather than short investment cycles. The economic crisis has fostered some changes in attitudes – a behavioural shift from consumption to more savings which may be reflected in another form of savings – the investment in natural capital. Fisheries administrations will need to mainstream a green fisheries economy into broader national green growth strategies and identify links to national energy, innovation, awareness and labour mobility initiatives.

66. Corporate social responsibility, which in many enterprises has already embraced the green growth agenda, will need to extend along the length of the value chain. This will require greater credence with respect to products and processes, building consumer confidence that purchasing decisions have an environmental benefit. The recent mandate of FAO to develop a benchmarking for ecolabels will assist this process. However, social issues, carbon and environmental footprints and waste reduction may be difficult to include if the benchmarks have a primary focus on fish stock sustainability. The consumption end of the green value chain depends on food literacy and more specifically fish food literacy underpinned by credible and consumer friendly information via ecolabels and socially responsible producers and distributors. Though discards, sanitary measures and processing all generate fish waste, a large proportion of the fish waste in OECD countries occurs at the retail/ consumer level and can be reduced through changes in consumer behaviour. In contrast, the high levels of waste in developing countries will require investment in hard infrastructure, market information and sanitary control systems.

67. Political support for the transition to a green fisheries economy will need the support of the industry and the consumers. The political process involved will need a clear articulation of the case for green(er) fisheries, a specification of the future shape of the sector, the costs and benefits of transition, and an indication of the distribution of those costs and benefits. The efficiency and technical feasibility of the instruments to be used – whether these are market, regulatory or technical instruments – will need to be evaluated and the sequencing, the mix and the interactions among the various instruments will require understanding. Change implies winners and losers and the transition process will need to deal specifically with the losers. Fisheries administrators and NGOs may have to shoulder the burden of communicating the vision of a green(er) fisheries economy to industry and the broader public and requiring other sectors, in particular those responsible for aquatic pollution to shoulder a share of the costs.

4. Greening the blue economy. instruments and actions for green growth in fisheries

4.1 Framework and instruments

68. The instruments can be considered in relation to two linked frameworks: the state of fisheries capital and flow of goods and services. The objective is to move towards defined targets for both capital and output of goods and services. The capital framework has three components: (i) natural capital – fish stocks and aquatic environmental health; (ii) the produced capital – vessels, processing plants and fish farms; and (iii) the intangible capital – the human resource base, including the policies, institutional frameworks and consumer behaviour. This latter component of capital is the means to convert the natural capital into the other two. Green growth will capture and convert the rents from the natural resource wealth into produced and intangible capital, while maintaining the natural resource capital. The flow of goods and services framework focuses on the outputs of the capital components over time. This flow includes the fish production, employment, and the investments in innovation and productive assets. In a green growth scenario, the physical output of the capture fisheries is likely to remain relatively constant, given that in many OECD countries, many wild fish stocks are exploited close to their biological limits. However, productivity will increase in terms of labour and capital as the fish stocks increase and as fishing technology and skills improve. In order to maintain or further increase productivity (catch per vessel or person) the number of vessels (or capacity) or fishers will need to decrease. If the objective is to maintain

or increase green jobs in capture fisheries, then the policy instruments are likely to favour substituting capital with labour, probably by preferential access for small-scale inshore fishing at the expense of more capital intensive offshore fishing. An expanding green aquaculture is likely to focus on more intensified but integrated systems, farming of herbivores, improved environmental governance of farms and niche technologies for recycling of wastes, for fish supply to recreational fisheries and possibly for algal biofuels. Productivity and efficiency will be driven by investment in technology and innovation (e.g. smart gear and e-markets, selective breeding and vaccines) and market arrangements that reduce supply and price volatility. The following figures contrast the sustainable and **un**sustainable capital and flow frameworks (figures 2 and 3).

69. The mix of instruments used will be specific to the fishery or country, some of which will be outside the fisheries sector. The instruments and activities that need to be considered in a green fisheries agenda include the following:

- Conventional fisheries management measures;

- **Economic instruments**, including (i) valuing, pricing and charging for natural resource use and environmental impacts; (ii) markets and incentives including payment for ecosystem services and removal of barriers and subsidies; and (iii) accounting and transparency including green, or environmental accounts ;

- **Investment in knowledge and awareness**, including investment in innovation, science and technology, in public awareness and behavioural change;

- Robust processes for **change management** and decision making, including international cooperation on global goods and trade; and partnerships and private sector initiatives;

Figure 2. Capital and flows in a green fisheries economy

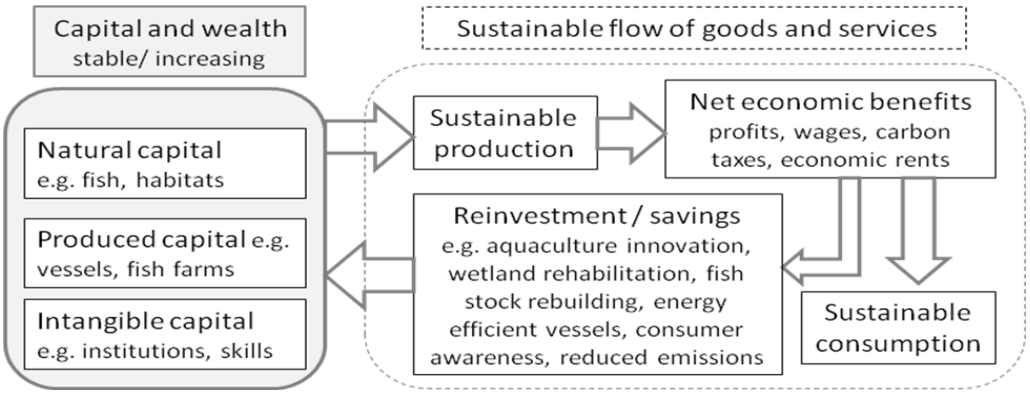
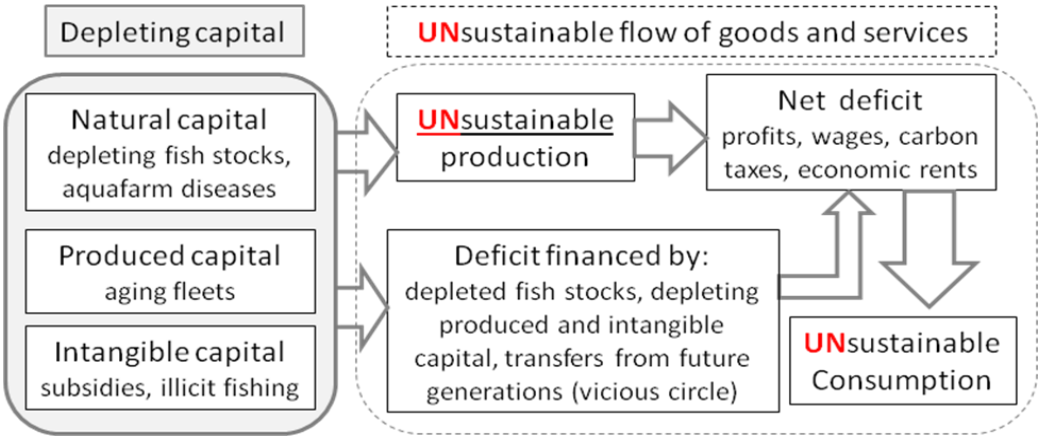


Figure 3. Capital and flows in an unsustainable fisheries economy



4.2 Fisheries and aquatic ecosystem management

70. This section briefly refers to the instruments of fisheries management. The public instruments are well known, sometimes divided into technical measures, such as gear restrictions or area closures, or structural measures such as fleet reduction. They are exhaustively considered elsewhere and the purpose here is to flag that they are essential tools in the fisheries management arsenal and indicate their changing nature when viewed as part of a green fisheries paradigm and through the lens of green growth and climate change.

- Target levels of fishing. Indicators which target economically sustainable levels of fishing (MEY, or equivalent) are superior to those which specify a biological maximum (MSY, or equivalent) as the economic target potentially reduces the overfishing and overcapacity incentives and generates rents, an essential requirement for green growth. Biological targets do not necessarily generate rents.

- Technical measures. Passive fishing techniques will generally have a lower environmental footprint. A 'no discards' regime, is a useful aspirational target with time bound derogations allowing for the transition. Such a regime can be complemented with a full accounting for discards.

- Structural measures (e.g. fleet reduction schemes) may need to take greater account of the emissions from various fleet segments.

- Quota trading or pooling will facilitate implementation of measures and improve efficiency, especially in multi-fleet, multi-species fisheries. In general, greater flexibility in resource allocation regimes will facilitate transitions in an uncertain and changing climate. For example moving from single species, single area quotas to all species, all area quotas and allowing the market to determine who fishes what species and where (Knapp, 2008). Given increasing climate-driven uncertainty, flexibility and adaptive management and more timely management decision-making will facilitate the evolution of a green fisheries economy.

- The ecosystem approach to fisheries (EAF) can be considered 'mainstream green growth' but will need further work on its economic and ecosystem valuation application.

- Application of existing aquaculture codes and best practices will contribute to the green fisheries economy. Specific measures may be required to conserve genetic biodiversity.

- Studies will be needed to provide greater precision and comparability on ecosystem impacts and environmental footprints of different production systems. For example, a robust comparison of the combined environmental, economic and social profiles of large-scale and competing small scale fisheries can inform policy in moving towards a greener fisheries economy.

- It is clear that aquatic biodiversity needs to be preserved in its natural habitat. Less than 0.5% of marine habitats are protected versus 11.5% of land area, indicating the scale of the challenge facing stakeholders. The scale of conservation areas need to account for 'genetic leakage' from aquaculture and it may be necessary to require aquaculture to finance gene banks to preserve the genetic biodiversity of farmed species.

- Aquatic pollution has a significant effect on fisheries production and aquatic ecosystem health. While physical accounting for aquatic pollution exists, estimates of the economic costs are fragmented. For example, an estimate of the economic costs of marine pollution can underpin polluter pays initiatives in other polluting sectors.

4.3 Economic instruments: values, prices and payments

4.3.1 Pricing of natural resource use and internalising externalities

71. A fundamental step for capture fisheries (and to a lesser extent for aquaculture) is to remove the open access regimes and replace it with secure tenure regimes. Tenure enables the resource value to be formalized and in particular, if the tenure is transferable, a market price to be generated. However, although care is needed to distinguish between the value of use rights and the value of the fish stock itself or a public fish farm site and its accompanying water body. While robust tenure *per se* may not create the incentives for good stewardship, it is a foundation upon which other market instruments can be based. Where tenure is transferable it facilitates the movement of labour and capital in and out of the sector. Where 'rental' charges for use of public natural resources are applied, concession values provide a baseline for estimating appropriate levels of charges, for example, by considering current rents in relation to 'normal' rates of return on capital. Tenure also enables attribution of externalities and the benefit of public services, as stewardship obligations can be aligned with tenure. For example, the costs of fishery control and surveillance, or red tide monitoring, can be internalized into the payments for the resource use concession. Where externalities (pollution, offshore oil extraction) impact on fisheries, it also enables valuations for payments by polluters.

72. Approaches to internalising aquatic biodiversity (loss) externalities will benefit from further review. Accounting for discards and possible charges for high environmental impact gears have already been mentioned. Charges for loss of genetic diversity may be attributable directly to aquaculture and appropriate charges levied. Pollution and loss of critical habitats (estuaries, wetlands, seagrass beds) have a significant but largely un-attributable impacts and internalizing these externalities may prove challenging. Revenues accruing can be directed to habitat restoration, creation of protected areas and applying improved codes and standards (EPA, 2010).

4.3.2 Environmental taxes, incentives and barriers

73. OECD member countries apply over 600 environmental taxes and fees which are considered one of the most effective policy tools available as they not only reduce the environmental burden but are also considered to be an incentive or driver of innovation, for example, a carbon tax could spur investment in

fuel efficient fishing technologies. Revenues from environmental taxes are currently in the order of 0.7 % (USA) to 2.5% (Europe) of GDP, so revenue generation has not been a primary consideration. About 90% of this revenue is derived from taxes on road transport (vehicles and fuels). Concerns over loss of sector competitiveness and negative distributional impacts are among the constraints to their expanded use (OECD, 2006b).

74. Removal of barriers to green growth will be an important ingredient of a green fisheries economy. As already indicated, robust tenure systems allows mobility of both labour and capital. So weak quota trading or leasing markets, tethering quota ownership to vessel ownership, inability to pool quotas or rights (which can be subject to anti-trust legislation) may constitute barriers to green growth. Fisheries subsidies and related trade implications have been the subject of considerable study and debate (UNEP, 2011). Annual subsidies (government transfers) to fisheries, which are acknowledged to be an under-estimate, are in the order of $6.4 billion (OECD, 2006) and removal, or 'greening' of perverse subsidies (fuel and fishing capacity) can be a primary target for OECD countries. Some subsidies are directed at improved fleet performance and care is required to ensure that green innovations, such as for fuel saving and efficiency, are adopted even as fishing capacity is moderated.

75. This impact of technology creep has already been identified and reviews of some fleet adjustment programs show that despite a reduction in the fleet, the catching power of the fleet increased, contrary to the objective of the scheme (EC, 2010; Poseidon, 2010). Put another way: when innovations mean greater catching efficiency by individual vessels, then the number of vessels must decrease proportionately to maintain profitability and fish resource capital. This may mean fewer jobs at sea, but more jobs producing the technologies. In summary, the frequently cited arguments for progressively dismantling many fisheries subsidies appear overwhelming, strongly indicating that subsidy reform must be an integral part of the fisheries green growth agenda. A case can be made for subsidies as transitional and emergency arrangements, for correction of market or social inequities, to maintain the fabric of traditional, or isolated communities, or as proven incentives for greening the fisheries economy. In such cases, subsidies need to be temporary and targeted, produce the desired impacts and avoid elite capture (World Bank, 2008).

76. As many OECD fleets benefit from various fuel tax 'exemptions' and as fuel comprises a large proportion of operating costs, capture fisheries carbon taxes may prove difficult to introduce. Nevertheless the reported fuel consumption per kilo of fish caught in many OECD fisheries appears unsustainable and carbon taxes will be an important instrument in reducing emissions. Postponing carbon taxes may mean greater future hardship as the entire pattern of fishing may need time to evolve, probably towards more passive gears and possibly towards more coastal and smaller scale fisheries with the more distant offshore areas considered as 'reserves' which supply the inshore fisheries.

4.3.3 Voluntary instruments: codes, ecolabels and advocacy

77. The voluntary instruments fall into two categories: codes of practice, such as corporate social responsibility, and market instruments such as ecolabels. Advocacy campaigns may be closely linked to both and also to altering consumer behaviour and public perceptions. The role of ecolabels has been the subject of recent OECD attention (OECD, 2009) and the intricacies of organic standards and ecolabels, are consequently not examined here.

78. In general, fisheries ecolabels focus on the sustainability of the fish resource and the integrity of the associated ecosystem. However, several other considerations are of relevance to the social and economic dimensions of the green growth agenda. These include the overall environmental footprint, including the carbon footprint of the product or fishery and the social benefits and their distribution (such as fair-trade considerations). While some schemes, such as the Global Aquaculture Performance Index include metrics for the overall environmental impact, none encompass metrics for efficiency of production,

net benefits, or rents, food safety and the distributional impacts of the production scheme. Including such diverse dimensions in a unified green label may appear overambitious; for example, environmentally sustainable fisheries may not generate a social or economic surplus to 'close the loop' on green growth. There is general agreement that supervision and benchmarking of ecolabels is important for producers, distributers and consumers. It is the subject of ongoing work by the FAO Sub-Committee on Fish Trade. The credence and utility of ecolabels will be enhanced by public disclosure of the analysis and underlying data, by fostering equivalence and adherence to standards. Governments have a role in facilitating consumer environmental choices by helping interpretation of ecolabels. For example, if the product carbon footprint was expressed as "% of daily carbon allowance" it might more readily help consumers reduce their "personal" carbon footprint. In conclusion, the various forms of ecolabels and indices are an essential and evolving instrument in the move to a green fisheries economy. However, the multiplicity of schemes, retailer requirements and the competition among labels raises costs, confuses consumers, and calls for rationalisation.

79. Life cycle analysis is an important tool for monitoring the environmental performance of products. Analyses follow the product from 'net to plate' and determine its environmental footprint along a range of parameters. Product carbon footprint (PCF) is the total amount of GHGs emitted during the life cycle of a good or service measured as Grams CO2-equivalent per unit of product. PCF is a subset of life cycle analysis has no dominant standard (see the Carbon Trust[9] for an example of an emerging standard) and has limited public and industry uptake. The PCFs tend to be characterized by private standards and a limited number of large retailers and manufacturers. Though conceptually attractive, it is costly to implement, and at producer level reduction of GHG emissions at corporate rather than product level may prove more tractable. In addition, product carbon footprints may not necessarily provide the incentives to develop sustainable production systems. Ethical concerns such as animal welfare are not seen as a major part of the green agenda, but may influence shelf life as there is evidence that stress in slaughter results in poorer quality fish flesh (Poli *et al.*, 2005).

80. Corporate social responsibility (CSR) is a powerful instrument for green growth as it sets out principles and practices to address the financial, environmental and social trade-offs with the mantra – 'people, planet, profit' … in varying orders of priority . It will be useful to review and practices of selected seafood producers and distributors, identifying challenges, solutions and best practices from net to plate. National seafood charters, or codes of industry conduct can set sustainability targets and exercise peer pressure, particularly if backed by national fishing industry associations, for example as advocated by ALLFISH[10]. The effectiveness of these instruments require credence based on transparency and disclosure, conformity to accepted standards and where possible independent audits. The Global Reporting Initiative (GRI)[11] provides extensive guidance on CSR (see box); ISO 26000 is the recognised international CSR standard, but it is a guide, rather than a certifiable scheme. Buyer indicators, such as the Walmart Sustainability Index, give information about the environmental and social performance of companies or the profile of products. These corporate instruments inform purchasing, contribute to their sustainability effort and protect retailers from negative advocacy. Although in an early stage of development, these indices enable more responsible purchasing when the supply of ecolabelled products cannot meet demand.

[9] http://www.carbontrust.co.uk/Pages/Default.aspx

[10] http://www.allfish.org/

[11] http://www.globalreporting.org/Home

Box 9. Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) is a network-based organization that pioneered a global sustainability reporting framework. GRI's core goals are disclosure on environmental, social and governance performance.

GRI's Reporting Framework sets out the principles and Performance Indicators that organizations can use to measure and report their economic, environmental, and social performance. Using a standardized approach, the GRI establishes Sustainability Reporting Guidelines, Protocols, Sector Supplements and unique country-level Annexes through a consensus-seeking, multi-stakeholder process involving business, civil society, labour, academic and professional stakeholders. The reports can demonstrate and compare commitment to and measure performance of sustainable development with respect to laws, norms, standards and voluntary initiatives. The GRI helps organizations to disclose their sustainability performance, facilitates transparency and accountability, and provides stakeholders a widely-applicable framework to interpret and compare disclosed information. The GRI framework has been used by thousands of organizations worldwide as the basis for their sustainability reporting

The Guidelines are broadly relevant to all organizations regardless of size, sector, or location, contain principles and standard disclosures (including indicators) and provide a framework that organizations can voluntarily, flexibly, and incrementally, adopt. Protocols define key terms for indicators, compilation methodologies, intended scope of the indicator, and other technical references.

Source: http://www.globalreporting.org/

81. Advocacy has proven successful when campaigns have clear targets, focus on key stakeholders and require concrete verifiable actions. For example, Greenpeace established a seafood sustainability scorecard in 2008, which forced changes in the buying practices of some lower scoring retailers and one of the largest foodservice companies committed to source only sustainably caught wild fish by 2015. In some countries advocacy has sought to have fisheries, or environmental agencies apply existing legislation more effectively, or lobby for legislative change. Targeted green advocacy is likely to become a more prominent feature of the political economy of fisheries reform in the OECD, such that a more structured stakeholder engagement may assist the green growth transition. Broad based campaigns to change public awareness and have an important role in changing consumer preferences, although the impacts may be more difficult to monitor. They are complemented by investigative reporting and the use of Internet media and television. BBC's *Panorama*, France3's *Thalassorama* and a range of National Geographic programmes have informed public opinion and sustainable seafood product information is already available through mobile phone applications[12]. Buy local initiatives lie in an interface between advocacy, green jobs, product labelling and securing market share and supply. Major US retailers such as Whole Foods and Safeway have launched such campaigns and EU fruit and vegetable producers have forced retailers to source more local supplies.

82. These voluntary instruments converge. This is illustrated by the food giant '*Macdonald's*'. Its brand is protected by a strong CSR code[13]. Much of its seafood is MSC certified, suppliers must meet codes of practice and its future sourcing is informed by NGO's, such as Conservation International and the Sustainable Fisheries Partnership which also have advocacy roles.

[12] http://www.montereybayaquarium.org/cr/SeafoodWatch/web/sfw_iPhone.aspx

[13] http://www.aboutmcdonalds.com/mcd/csr.html

4.3.4 Payment for Ecosystem Services

83. Payment for ecosystem services (PES) are agreements between 'buyers' and 'sellers' with respect to a defined ecosystem service. Many examples exist, in particular for water and watershed management (The Ecosystem Marketplace, 2009). Recreational angling association pay landowners to maintain wetlands, hotels pay fishers to create an MPA to support marine tourism and carbon credits are used to maintain mangroves. PES faces several practical challenges. The ecosystem services needs to be quantified and valued. Opportunity costs for providers (sellers) may vary across the spatial range of the ecosystem generating pricing anomalies. PES ideally requires the removal of perverse incentives, such as farm subsidies that cause eutrophication. It requires the establishment of rights over the ecosystem service involved, or other rights which may impact on the ecosystem service. For example, if an MPA is established and fishing is to be halted, a payment for the surrender of the right to fish requires that this right is formalised in the PES agreement. Verifying delivery of the purchased services requires a robust monitoring of agreed indicators. Bundling multiple services – for example a coral reef MPA could reduce erosion of beachside properties, underpin dive tourism and help rebuild commercial fish stocks. PES could be supported by group pressure and ideally payments could be performance based. Well-designed reverse auctions could make effective use of a limited envelope of PES finance (OECD, 2010d). NRC reports progress on the mapping of ecological function to economic valuation for **single** ecosystem services, but little progress on multiple services (NRC 2005). PES remains constrained by difficulties in attributing specific ecosystem benefits to payments for specific actions because of the complex structure and functional relationships of ecosystems.

84. PES in inland fisheries is likely to be embraced in a landscape approach. The following therefore focuses on marine ecosystem services or MES, which are generally grouped into four types: (i) provisioning (e.g. fishing); (ii) regulating, which refers to services provided, for example, by coral reefs in protecting coasts; (iii) supporting, which includes the nutrient cycling and carbon sequestration services; and (iv) cultural, such as the recreational opportunities provided. For fisheries, some key metrics for these services include biodiversity, water quality, the state of critical fish habitats, or nursery grounds (Forest Trends, nd). PES can probably be most effectively applied to commercial fisheries when the use rights are well specified Deacon and Parker, 2009). A useful example is provided in California by The Nature Conservancy. It purchased trawl permits from fishers and leased some back to fishers under more environmentally-friendly fishing rules. The activities helped to offset the impact of designating a 15,000 km2 no-trawl zone. The Chesapeake Bay provides another example. Oysters and other bivalves provide an important ecosystem service by filtering and purifying water: historically the oysters could filter the entire water volume of the Bay in one day. But about 85% of native oyster reefs in the Bay have been lost as a result of pollution, overfishing and other factors (Beck, *et. al.* nd). Now oyster culture earns conservation credits in the Bay Bank portfolio.

4.4 "You can't manage what you can't measure"

4.4.1 Environmental accounts

85. Environmental or green accounts have already been referred to above and are an essential feature of a green growth agenda (Lange, 2003) and detailed guidance is available on creating green fisheries accounts (UN and FAO, 2004). Environmental accounts, as conceived under the UN system, only consider owned assets. Assets such as fish stocks may be owned collectively or by governments, and not only by enterprises as in the case of 'regular' national accounts. For example, high seas fish stocks are not considered 'owned' and fall outside the definition. Similarly the marine or aquatic ecosystem is not generally an 'owned asset' generating direct income, but ecosystems are included in environmental accounts. As indicated previously, tenure formalises ownership (or proxies in the case of user rights) and the resulting valuations can facilitate environmental accounting. The formal environmental accounts

require the necessary data sets and will need to be supplemented by additional metrics to measure, manage and account for fisheries performance. The World Bank is launching an international partnership for ecosystem valuation and wealth accounting to prepare ANS and green accounts based on the UN SEEA. The objective is to make environmental values more explicit in policy formulation and macroeconomic decisions. The real contribution of the fisheries sector to a national economy is not reflected in the conventional sector GDP estimates which do not generally account for the post-harvest economy, or recreational fisheries (World Bank, 2010). In some cases aquaculture may be included with livestock. If green growth is to embrace the entire value chain, then preparation of satellite GDP estimates for the 'missing' contribution may be of value.

4.4.2 Green fisheries indicators

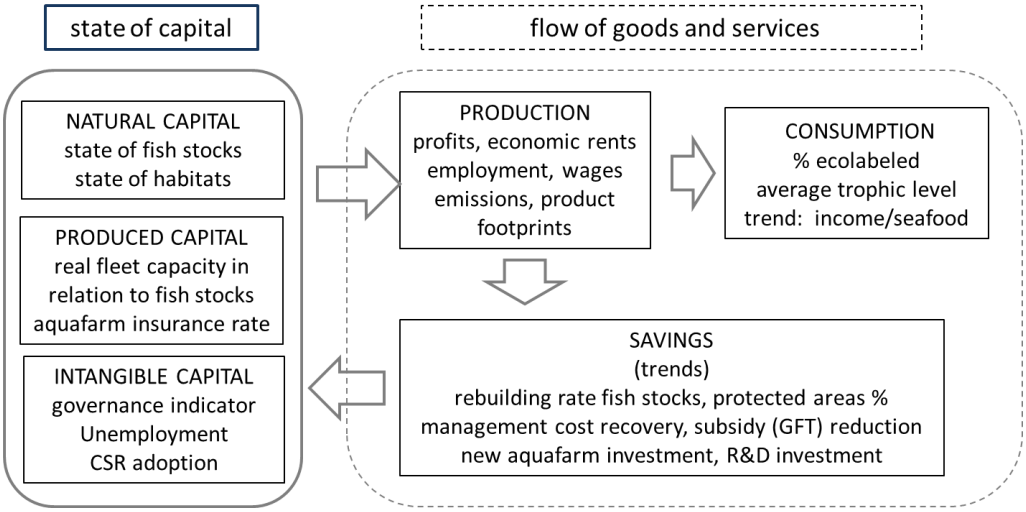
86. Indicators would accurately reflect both the status and trends in the sector, be cost effective to collect, link to, or be a subset of broader national green growth indicators and where necessary align with international norms (for example in the case of emissions and carbon accounting). For example, Norway focuses on three key indicators for policy purposes: state of the fish stocks, enterprise profits and employment (Gullestad, 2010). China, the world's leading seafood producer also tracks some forty social and environmental indicators in its '*All around Xiaokang Programme*,' as a step to assess progress toward a "harmonious society". Accurate and timely tracking of these indicators is fundamental not only for gauging wealth, productivity and distributional impacts of fisheries, but as an input to green growth accounting. Ideally, existing data and statistics would be assembled and tuned rather than incurring additional monitoring costs. OECD suggests a number of generic criteria and a framework for production, consumption and environment indicators (OECD, 2010b). If the World Bank "*Where Is the Wealth of Nations?*" framework is used, the following broad classes of indicators can be considered to establish baselines and track progress towards a green fisheries economy.

87. Individually, indicators serve a useful role, but carefully chosen and functioning in concert they can become actionable instruments. Figure 4 attempts to build on the figures and tables already presented (figures 1 and 2, table 3).

Table 3. Possible indicator framework for a green fisheries economy

Type of capital	State of capital/ wealth	Production efficiency	Distribution
Natural capital	State of fish stocks State of habitats Biodiversity including genetic diversity, discards	Rents per unit of stock Corporate profits Landed cost of fish	Allocation of access (ratio large/ small-scale) Employment Concentration of rights
Produced capital	Fleet and processing capacity / overcapacity. Aquaculture insurance rates	Carbon footprint of sector (CO_2 per kg of fish) Returns to assets and Returns to labour Extended GDP	Concentration of ownership of fleet, processing and markets Employment
Intangible capital	Governance indicators Labour force skills Private sector integrity (application of CSR and industry codes) Sector conflicts	Compliance costs as % of landed value Seafood health Adoption of innovation (patents, returns to new technologies)	Cost recovery Market penetration of ecolabels Sector labour mobility Consumer seafood literacy

Figure 4. Actionable indicators for green fisheries growth



88. The OECD targeted key environmental indicators in 2004. The following table provides a fisheries perspective on these indicators and additional commentary is provided in the subsequent paragraphs (table 4).

Table 4. Fisheries dimensions of the OECD Environmental Indicators, 2004

OECD Environmental indicators 2004	Fisheries dimensions and potential sources of indicators
Climate change – GHG emission intensities	kg fish per kg CO_2
Ozone layer - ozone depleting substances	Use of refrigerants. Monitoring of implementation of Montreal Protocol, for example there have been significant changes in the EU from 2010.
Air quality – SOx and NOx emission intensities	Use of marine diesel – recommendations by International Council on Clean Transportation and IMO/ MARPOL Annex VI (Tier II/III) (2008) which introduced new NOx emission standards marine engines.
Waste generation – municipal waste generation intensities	Waste and efficiency, See FAO papers: Gonzalez,1995) and Gill, 2000.
Freshwater quality – waste water treatment connection rates	Marine water quality is not included in the 2004 indicators. See GESAMP (1996) and (for example) EU Waste Water Directive.
Freshwater resources – intensity of use of water resources	Major impacts on freshwater and anadromous species. The state of wild salmon, eels, sturgeon and freshwater recreational fisheries may provide useful baselines.
Forest resources – intensity of use of forest resources	Applicable to OECD countries with mangroves, such as Australia, USA, or certain overseas territories.
Fish resources – intensity of use of fish resources	Range of specific fisheries indicators, see e.g. Le Gallic (2010) Anderson and Anderson (2009), OECD (2010c)
Energy resources – intensity of energy use	Delivery of green innovation such as fuel saving, green gear and aquaculture technology. See OECD (2010) for an examination of innovation.
Biodiversity – threatened species.	Marine and wetland protected areas targets, implementation of legislation on endangered species, effective handling of CITES targets.

89. In a green economy fisheries will be obliged to contribute to national emissions targets, so emissions will need to be tracked – both production driven and demand driven (imports of fish). The timescales for preparation and implementation of national coastal and fisheries climate change mitigation

and adaptation plans may suggest indicators. The fundamental state of fish stocks metrics have already been noted above as is progress on endangered species, critical habitats, MPAs, discards and high impact gears. Aquaculture indicators (GAPI, for example) already focus on feed conversion efficiency, trophic scale of production, disease incidence and impact on generic diversity and wild stocks. The energy efficiency of fleet and fleet capacity are already targeted in many national programs. Employment, green jobs and the sector's social indicators are tracked in many OECD countries (OECD, 2007). A basis for social indicators Social issues have CSR, codes of responsible industry practice and product environmental footprints all contribute to a menu of potential indicators that can be prioritized.

90. Indicators of compliance or target achievement are required under many international conventions and could contribute to international indicators of a green fisheries economy: in the North-East Atlantic, OSPAR[14] member countries report on levels of eutrophication in coastal waters; under MARPOL, countries report on marine pollution; under the 1996 Protocol to the London Convention, disposal at sea of fish processing waste requires a permit. The European Court of Justice has required EU member countries to take action on shellfish monitoring because of the quality of coastal waters. A number of OECD countries have committed to the Convention on Biological Diversity's Aichi Target: "*By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits*." For some areas the status of top predators and megafauna, such as marine mammals, may provide a crude indicator of trends in application of an ecosystem approach (Hoyt, 2005). FAO compiles information on national implementation of the Code of Conduct and on the state of marine fish stocks, though the latter is not on a country-by-country basis. NGOs provide some independent reporting on the adoption of effective management measures and national compliance (or lack of compliance) with RFMO management measures.

91. Tracking the application of the Work in Fishing Convention 2007 could indicate the status of sector workers – access to social security and medical insurance for those paid on a catch share basis, working hours and safety at sea records. The UNDP Human Development Index calibrates social progress and draws the attention of policy makers to the human dimensions of development. Social indicators developed at OECD in the seventies have added social dimensions to economic analysis. For consumers, the proportion of sustainable fish, or an index of mean trophic level of fish consumption may be useful.

4.5 Intangible capital: knowledge, awareness and innovation

4.5.1 Innovation, science and technology

92. Innovation does not only refer to new technologies, but also the creation financial and institutional instruments which address public goods as part of efficient and productive enterprises. Innovation contributes to and is founded on intangible capital and can underpin resilience and adaptive capacity in fisheries. Many countries see innovation as a core path for greening the economy and the means to stimulate, protect, nurture and disseminate innovation is the subject of intense study and debate (OECD, 2010a; OECD, 2010; OECD and Eurostat, 2005).

93. The demand for fisheries innovation will increase. Renewable energy from tidal, wind, wave and solar power, algal biofuels, low trophic level aquafeeds and integrated fish farms, fish vaccines and pharmaceuticals, smart gears and ecosystem services are but some of the more obvious fields. Eco-innovation is not only a source of green jobs, but will give competitive advantages in the fast-growing

[14] The Convention for the Protection of the Marine Environment of the North-East Atlantic.

environmental goods and services sector, and is probably essential to allow capture fisheries to reduce its elevated carbon footprint and adapt to future energy shocks. The recent growth of aquaculture provides a striking example of innovation. Advances in feeds, seeds (disease free, high growth rate) and disease control (vaccines, environmental management) drove increased productivity. The increase in low cost supply (e.g. for salmon, or shrimp) expanded markets, while profits and, intensification challenges and competition drove a new cycle of innovation.

94. OECD countries might accelerate this powerful engine of growth or direct it to addressing the technical, economic and social challenges in fisheries by applying the lessons of other sectors to fisheries. These lessons include determining the role of government (and the limits to that role) in demand-side policies, such as, standards, pricing and smart regulations. Identifying and removing bottlenecks and using taxation, public procurement and investment in science and technology and facilitating the private sector in 'picking winners' and protecting and disseminating green intellectual property (Kwon, Soung-An, 2009; Haščič, I. *et al*, 2010).

4.5.2 Consumption and consumer behaviour

95. Current global and particularly OECD fish (and meat) consumption patterns are unsustainable (The Government Office for Science, 2011). As noted above (section 4.3.3.), part of the solution lies in changing consumer behaviour not only with respect to food, but also in relation to energy and water use (OECD, 2008a). Important evaluation criteria in the choice of a food product include product quality, safety, price, brand name/reputation, nutritional quality, freshness and origin (Steenkamp, 1997). Many of the credence attributes may be unobservable, generating a problem of asymmetric information which can partly be addressed by guarantees in the form of ecolabels, quality standards, brands, origin, or retailer reputation inform consumers, in particular if they are backed by CSR, disclosure and advertising.

96. Public/ private partnerships can support the consumption dimension of the green fisheries economy. They can target seafood literacy, align public health advice, advocacy and responsible advertising, and reduce household waste and retailer commitments to sustainability. Conflicting signals on the nutritional benefits of fish, on wild versus cultured fish products, or lack of coherency in ecolabels can be avoided, and efforts redirected to increasing understanding of the effects of socio-demographic and attitudinal factors and households' seafood choices in response to changing incomes, sustainable seafood messages and policy measures.

Sharing costs and benefits

97. The transition to green growth implies some redistribution of costs and benefits. In the current challenging economic climate, the notion of pumping up the economy, creating green jobs and improving energy security while also addressing climate change is attractive. However, the policies and instruments will not only need to ensure delivery of green growth targets, be cost-effective and maintain enterprise competitivity, but also secure political buy-in through a measure of equity. Clear policies and clear targets will help inform the discourse on how the burdens and benefits can be shared. The choices will need to articulate the balance and trade-offs between the following:

- producers or consumers: greener, efficient producers and distributors can maintain seafood prices;
- fisheries sector or the broader economy: perverse subsidies eliminated;
- national or foreign: any tariffs on non-green seafood complemented by efforts to green developing country seafood;

- planet or people: ecosystem approaches deliver sustainable seafood and ecosystem services;

- today or tomorrow: 'no regrets' climate change options exercised, greener consumer preferences and politics of environmental expediency in decline.

98. The shorter-term challenges are likely to include the creation of green jobs, volatile fuel prices, energy efficiency and security, food price shocks creating erratic seafood markets, and the speed with which innovations can deliver green jobs, seafood production efficiencies and ecosystem services. Green jobs will be underpinned by an adaptable skilled labour force, utilising skills in local economies, gearing education skills upgrading to emerging sectors and good local governance. The conventional environmental industries such as waste and water management, renewable energy and conservation will provide some green jobs. New smart technologies, algal bioenergy, use of coastal spaces for wind wave and tidal energy, tourism and recreational fisheries will generate jobs. In capture fisheries, efficiency gains may need to be offset by reduced direct employment to maintain incomes and environmental sustainability. Increased preferential access for small-scale fisheries may substitute capital with more local jobs. The demand for management of 'green knowledge', education and re-tasking of the labour force and targeted research will also create new green jobs.

99. The developed world has generated most of the global carbon debt and it has been suggested that the developed world has incurred a moral responsibility to reduce emissions and support developing country adaptation. Climate issues will complicate dialogue on trade and environment. Similarly, the oceans have absorbed about half the carbon debt: the analogy is that fisheries will pay the 'interest' through the impacts of acidification and redistribution of fish stocks. In order to raise awareness and foster international actions on ocean issues, member countries may need to coordinate and prioritize actions in key international fora and with respect to implementation of key international instruments and declarations in integrated ocean management[15]. In particular OECD may wish to consider coordinated actions on oceans in relation to the Rio+20 process and further enhancing engagement in the ocean science dimension of IPCC.

4.7 Building a green fisheries agenda

100. A green fisheries agenda will need to address the diversity of fisheries – capture and culture, national and international and a range of external influences that shape the fisheries economy. This discussion paper provides some background for a range of questions that will frame the green fisheries agenda:

- which instruments or sets of instruments perform best in given fisheries?

- which approaches can achieve green growth and simultaneously address climate change mitigation and adaptation?

- where are the limits of public interventions?

- how can equity be built into policies and instruments?

- how can the environmental costs and benefits be weighed in decisions on 'people and profits'?

[15] These include: the Jakarta mandate on Marine and Coastal Biodiversity; the Washington Global Program of Action (GPA); Manado Ocean Declaration; UN Oceans and Law of the Sea processes; the UNEP Regional Seas Programme and the International Oceans Commission monitoring of ocean health.

101. As previously indicated, the suite of measures will need to balance economic efficiency, environmental sustainability and social equity, seek the least cost solutions while meeting environmental requirements, and maintain productivity and employment while minimizing environmental impacts. Inter-ministerial collaboration guided by clear policies, leadership and clear roles and responsibilities for actors can guide broad-based stakeholder engagement and co-ordinating funding of priority initiatives. Building consensus across the political spectrum will ensure that core green initiatives will continue in the event of a change in the balance of political power, but few policies or instruments will be effective if not aligned with other policies and instruments, such as in agriculture (Joint Working Party on Agriculture and the Environment, 2010). The OECD has already examined fisheries coherence (OECD, 2006a), a subject which has recently attracted high level attention: *"Then there's my favourite example: Interior Department is in charge of salmon while they're in fresh water, but the Commerce Department handles them when they're in saltwater. I hear it gets even more complicated once they're smoked."* (President Barack Obama, State of the Union 2011).

102. There are a range of leverage points for greening the fisheries economy. These include:

- Articulating the green paradigm – its goals, structure and 'rules' - moving 'beyond GDP' to the 'triple bottom line' and including environmental accounts and wellbeing in the measure of growth.

- Building public awareness of the complex interplay between natural systems and human actions to help manage incentives, expectations and feedback loops.

- Using social media and access to information to build consensus and public awareness.

- Establishing a dashboard of indicators to focus public and private collaborative actions.

- Building on the common ground between public and private sectors through supporting

- CSR, codes and best practices, partnerships with industry and forging common purpose with NGOs, consumer and producer groups, academia and the media.

103. The summary (section 1) has already summarized the 'vectors of transition' which have been further discussed in the body of the report. The vectors identified included:

- a paradigm shift in political and public perceptions built through public awareness of the green growth agenda and its rationale;

- attention to the character of tenure in aquatic ecosystems to evolve more transparent, explicit and efficient tenure systems;

- addressing externalities within fisheries and those affecting fisheries;

- the greening of subsidies, economic distortions and hidden government financial transfers, in particular distortions associated with GHG emissions;

- investment in knowledge, innovation and human capacity; and

- inclusion of international development, with particular attention to greening the trade in seafood products from the developing world.

104. Some of the targets and activities suggested include:

- articulating a clear vision of the green fisheries economy, including the transition paths and the distribution of costs and benefits;
- building stakeholder consensus and promoting corporate social responsibility and accredited ecolabelling schemes;
- rebuilding of fish stocks and fisheries economies and fostering low trophic level and integrated aquaculture;
- adopting new smart technologies to reduce the environmental footprint of fisheries and to create green jobs;
- adapting human and institutional capital to perform in increasingly volatile seafood and energy markets; and
- building transparent and efficient metrics for the green fisheries economy, including environmental accounting and indicators of social wellbeing and economic performance.

105. This discussion paper also raises questions:

- Can capital be substituted with labour, for example by increasing preferential access by small scale fishers to inshore waters, and what are the likely environmental and economic outcomes?
- Can more robust or empirical relationships be established between tenure, green growth and distribution of benefits?
- Are there institutions which can underwrite comparative footprint analysis for different animal protein production systems?
- What constrains countries from preparing green accounts?
- How can healthy oceans contribute to climate change mitigation: can a scientific consensus emerge prior to completion of the next IPCC report?
- How can green growth policies and instruments be mutually supportive and coherent?
- How can governance arrangements facilitate payments for ecosystem services?
- What are the economic costs of marine pollution?
- And last but perhaps most important: What are the costs of moving to a green fisheries economy and how will they be distributed?

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