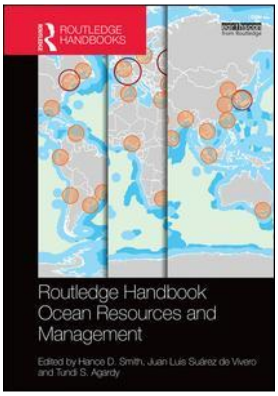

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Greening The Ocean Economy

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GREENING THE OCEAN ECONOMY

A progress report

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Introduction

The way we manage our global ocean economy continues to evolve. While new research clearly shows the importance of ocean ecosystems to people (Barbier *et al.*, 2011), other evidence clearly depicts an ocean in decline (Pandolfi *et al.*, 2003; Pauly *et al.*, 2005; Worm *et al.*, 2006). In response, the United Nations Environment Program along with organizations including UNDESA, UNDP, IMO, FAO, IUCN, GRID-Arendal and World Fish Center have promoted a new effort in relation to marine management and economic development that applies a green economy approach to the Blue World (UNEP *et al.*, 2012). This approach seeks to change economic and industrial behavior to reduce impacts on the marine environment and in turn increase human welfare by carefully balancing the environmental, economic, and social capital that are required to support a sustainable, ecosystem-based approach to marine economic activity.

What is a green economy?

The green economy offers an alternative framework to the largely unsustainable conditions promoted by current growth and development policies. To date, nearly every ocean and coast on the globe has been impacted by human activity (Lotze *et al.*, 2006; Halpern *et al.*, 2008). This has led to the destruction of 35 percent of the world's mangrove forests and 20 percent of the world's coral reefs, with a further 20 percent of coral reefs considered degraded (MEA, 2005). Over 30 percent of fish stocks are overexploited, depleted, or just recovering from depletion; and over 400 oxygen-poor "dead zones" have been identified throughout the world (Diaz and Rosenberg, 2008). The current trend is pushing the planet's limits and could negatively impact social and economic well-being in the future.

The green economy is an approach that attempts to align economic development with social and environmental goals. A green-economy encourages institutional and policy reforms as well as changes in private and public expenditure, in order to cut carbon emissions, reduce pollution, improve resource efficiencies, improve social equity and prevent biodiversity loss. The green economy relies on a variety of economic and policy tools to promote environmental, social, and economic well-being. The transition to a global green economy will, however, be impossible without considering the planet's heavy reliance on marine and coastal resources.

The three capitals of the green economy

A green economic approach simultaneously pursues economic, social, and environmental goals. It also recognizes the importance of economic, social, and environmental capital in achieving such goals. These three forms of capital are essential to long-term prosperity and together form the foundation of a sustainable "green" economy. The three capitals are closely linked. Environmental capital, such as trees, land, and non-renewable resources, can be transformed into the tools and industry that make up economic capital. Developing economic capital can lead to poverty alleviation and increased standards of living, forming a society's social capital. Ideally, increased productivity and living standards will enable societies to reinvest in their environmental and social capital in order to ensure sustainable growth. Unfortunately, this often does not occur. Even as global GDP increases, poverty rates in many areas are rising as habitat loss and pollution are increasing (UNEP *et al.*, 2012).

The economic value of the marine world

Investing in the long-term health of coastal and marine resources is vital to the success of the global economy. The ocean provides a vast amount of wealth, and yet many of its habitats are deteriorating. Ecosystem services are the benefits humans receive from nature. The marine world offers an abundance of ecosystem services—some of which are currently valued on the market and some of which are not. Current estimates for the value of marine ecosystem services are in the realm of trillions of US dollars per year (Costanza *et al.*, 1997), ranging from the open ocean's value of $491/ha/year to the $352,249/ha/year of coral reefs (de Groot *et al.*, 2012). Yet much of the value of ocean and coastal ecosystems has been lost due to poor management. Fisheries particularly exemplify the potential wealth and loss of the ocean economy. In 2009, over 80 million tonnes of fish were harvested globally with an estimated value exceeding US $100 billion dollars (FAO, 2010). However, overfished stocks mean that fisheries are producing far less value than they could. A World Bank study estimated that overfishing results in lost economic value of $50 billion each year (World Bank, 2009). Proper management of ocean resources would ensure their long-term profit and viability.

Marine values: market and non-market

The seas provide a large array of resources currently valued on the market. Oceans contribute to the market via tourism revenues, improving real estate prices, and through goods sold on the market such as seafood, sand, minerals, and mangrove wood. The market value of these contributions is significant. World travel and tourism currently produce 9 percent of the global GDP, with coastal and marine areas remaining a popular destination (UNEP, 2011c). In 2003, nearly 60 million recreational anglers spent US$40 billion in expenditures (Cisneros-Montemayor and Sumaila, 2010). The 10 million recreational divers and 40 million snorkelers active in the world are estimated to generate over US$5.5 billion each year (Cisneros-Montemayor and Sumaila, 2010). Other sectors, such as fishing, contribute billions of dollars each year to the global market. The ocean is economically important on an international scale; locally, many developing countries are heavily dependent on marine-based revenues.

Many of the services provided by the ocean are not easily captured on the market. Such services include human uses that are not charged for (e.g. recreation and views), natural processes such as nutrient balancing and coastal protection from storms, as well as non-use values that may be rooted in cultural and indigenous values and preferences. Many economists have attempted to capture the economic value of these non-marketed resources through a variety of techniques (Naber *et al.*, 2008; TEEB, 2010; UNEP-WCMC, 2011). Further, markets are being created to capture some of these previously "non-marketed" goods and services through Payments for Ecosystem Services (PES).

Examples of the greener ocean sectors

The following paragraphs highlight trends in ocean uses, wherein marine values are captured with fewer externalities and greater sustainability. This discussion is not meant to be comprehensive but rather exemplary; readers are encouraged to examine sector-specific chapters that provide further detail (especially Chapter 14–17 on fisheries and mariculture; Chapters 18–21 on energy and genetic resources; Chapters 22–24 on shipping, communications, and seapower; and Chapters 26–27 on tourism and marine heritage).

Fishing

The importance of the fisheries sector to food security and poverty alleviation gives it a significant role in the transition to a green economy. Fishers provide food for 500 million people—or 8 percent of the world population (FAO, 2010). There are 120 million people employed by fisheries in the world, 90 percent of which work in small-scale fisheries, mostly in developing countries (World Bank, 2010). Aquaculture is growing, supplying over half of the world's fish; and alone generated $US 98.5 million in 2008 (FAO, 2010). Unfortunately, many of the world's fisheries are being harvested unsustainably—such that 32 percent of global stocks are considered overexploited, depleted or recovering, with a further 50 percent considered fully exploited (FAO, 2010).

Overfishing, especially in small-scale fisheries, could exacerbate poverty levels and affect food security. Already many fishers are finding they must travel farther, and spend more on fuel, in order to find fish (Tyedmers, 2004; World Bank *et al.*, 2010; Suuronen *et al.*, 2012). The fishing sector must also address the effects of agricultural runoff and climate change on fish populations, the increasing number of powerful fishing vessels (Tyedemers *et al.*, 2005), and the pollution produced by aquaculture.

Although the fishing sector faces a variety of issues, its future in the green economy is bright. The industry will need to address the three capitals of the green economy by investing in environmental sustainability via resource efficiency and a reduced carbon footprint, while also considering social equity and the health of small-scale fisheries. This transition to a green economy will likely rely on increased investments in fishing operations and technical innovations, as well as management and governance reforms.

Fortunately, positive examples within the fishing sector already exist. The FAO Code of Conduct for Responsible Fisheries has informed fishery and aquaculture policies around the world. A study of 130 fisheries showed that establishing a system of co-management led to social, economic, and environmental success 70 percent of the time (Gutierrez *et al.*, 2011). The increasing use of eco-labels could lead to increased conservation and the shifting of consumer preferences.

Shipping

The size and international character of the shipping industry make it one of the leading drivers of the global economy. Maritime shipping carries approximately 90 percent of world trade; while freight rates contribute about US$380 billion to the world economy (ICS, 2012a). The shipping industry is furthermore an important employer, giving jobs to 1.5 million seafarers even as it generates many more onshore jobs (ICS, 2010). The industry can thus play an important part in the green economy and has to date recognized this role.

The shipping industry's impacts on the environment can include: pollution, the release of invasive species from ship ballast, sea life collisions, the recycling of old ships, and CO_2 emissions. Such impacts can come at a high economic cost. For example, invasive species can disrupt fisheries, cause fouling, and affect recreation at an estimated cost of $100 billion each year (Chisholm, 2004). Fortunately, the global nature of the shipping industry has long made regulations necessary to ease the flow of trade. This long regulatory history has created the frameworks necessary to implement policies for a green economy.

The main regulatory body for the shipping and cruise line industry is the International Maritime Organization (IMO). Acknowledging the environmental impacts of shipping, the IMO has instituted several conventions, including:

- International Convention for the Prevention of Pollution by Ships (MARPOL, 1973, amended 2010)
- International Management Code for the Safe Operation of Ships and for Pollution Prevention (the ISM Code, 1993)
- International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004)
- International Convention for the Safe and Environmentally Sound Recycling of Ships (2009)
- Ship building standards in the International Convention on the Safety of Life at Sea (SOLAS, 2010).

(IMO, 2012)

Going forward, the main area for improvement in the shipping industry likely lies in reducing CO_2 emissions. The introduction and increasing use of Liquified Natural Gas (LNG)-powered vessels has caused some reduction in CO_2 and in other pollutants such as sulfur. Other sources of power, such as hybridized sail and fuel or solar and fuel ships are in development. However, truly "green" alternative fuel sources are not yet a practical source of power for ship engines. Improvements will most likely come from increasing efficiency across the transport chain, greening supply chains, and building local economies. The shipping industry has begun improving ship performance and expects a 20 percent emission reduction per ton of cargo moved per kilometer by 2020 (ICS, 2012b).

Marine-based renewable energy

The transition to a green economy will require investing in renewable sources of energy that are cleaner and less volatile than the fossil fuels currently in use. Fortunately, coastal and marine environments offer several potential options as research focuses on the ability of wind, tides, ocean currents, salinity gradients, and marine algae to produce energy. Research and development for over 100 different marine-based technologies is currently underway in over

30 countries (IPCC, 2011). Meanwhile, the IPCC's Special Report on Renewable Energy Sources (2011) estimates marine-based renewables could generate 7,400 exajoules (EJ) annually, a number that exceeds today's energy needs.

Currently there are over 85 countries that have established renewable energy targets (UNEP, 2011c). Further, the production of wind energy is increasing as wind power becomes more economically competitive (Mosegaard *et al.*, 2009). The global capacity to generate wind energy increased tenfold from the end of 2000 to June 2011 (WWEA, 2011). Wind energy is cleaner than its non-renewable counterparts; it can also provide certainty to investors as its costs are constant over its lifetime—which helps hedge against the changing prices of fossil fuels (Awerbuch, 2003).

Many marine-based technologies are still undergoing development—tidal, wind, and algae-based energy are not yet economically feasible. Yet research is ongoing to make these energy types more competitive, by reducing upfront capital costs and increasing output. The main challenges to deploying marine-based renewable energy on a global scale will likely revolve around government incentives and policy, continued financing, creating the necessary infrastructure, and gaining social acceptance. However, while challenges do exist, the technologies for renewable energy suggest a positive step forward.

Deep sea mining

There are three main classes of globally occurring deep-sea mineral deposits—manganese nodules, manganese crusts, and seafloor massive sulphides (SMS) (Rona, 2003). Recently, significant occurrences have been found in the exclusive economic zones of several Pacific Island Countries (PICs) (Glasby, 1982; Hein, *et al.*, 2005); these include SMS deposits containing copper, lead and zinc, gold and silver; and manganese nodules and crusts that contain nickel, copper, cobalt, and rare-earth elements. The refinement of deep-sea mining (DSM) technology, the continued rise in global demand for metals (UNEP, 2011a), the high potential ore grades and increased clarity in the governance of exploration and extraction, have led industry to consider DSM as a viable prospect.

DSM activities have the potential to damage important ecosystem goods and services (e.g., fish habitat, genetic resources, scientific research opportunities). While the mining footprint at sites (e.g., SMS) is expected to be small in comparison to land-based operations (Scott, 2006), there remain large gaps in our understanding of associated ecosystems, including spatial connectivity and the resilience of the ecosystems (Nautilus, 2008; Van Dover *et al.*, 2011).

Benefits, costs and policy perspectives

The primary potential economic benefit of DSM is linked to the value of metals on the world market. Incidental benefits include advances in technology and advances in scientific understanding that are difficult to put a price on. Benefits of technological advances fall into two categories: (1) advances that will improve the feasibility and profitability of future DSM, and (2) advances that will benefit other industries.

Key costs of DSM include destruction of the physical habitat of the sea floor and associated biota and accidental release in the water column of contaminated materials during the recovery process. Destruction of ecosystems associated with deep-sea minerals might involve the loss of "existence values," or "bequest values,"[1] or there may be future-use values of which we are unaware. Studies have also shown the link between mining and political instability[2] whereby mineral wealth may increase the risk of conflict in four ways: by affecting a country's performance in other economic sectors; by making government weaker; by giving resource-rich regions incentives to seek autonomy; and by providing financial resources to support political conflicts.

Environmental regulatory regimes that directly address DSM are either new or under development. At a regional scale, Pacific Island Countries are leading the way with the development of a framework for the environmental management of deep sea areas that can be adapted for national implementation. The International Seabed Authority, for its part, recommends the "Dinard Guidelines" for the environmental management of deep-sea ecosystems, which aims to protect natural diversity, ecosystem structure, function and resilience, while enabling rational use (Van Dover *et al.*, 2011).

Biodiversity and pharmaceuticals

The pharmaceutical industry is increasingly engaging in marine bioprospecting in the hopes of discovering new drugs under the sea. Compounds produced by marine plants and animals may hold the secret to new cures and products. Already there are several marine-based drugs on the market. Retrovir (AZT), the first drug licensed for treating HIV, was based on compounds extracted from a sponge (Harbor Branch, 2006a). Prialt (Ziconitide) was created from compounds extracted from sea snails and is used to treat chronic pain in cancer and AIDs patients (Harbor Branch, 2006b). A 2003–2004 marine pharmacology review shows initial results for 166 marine-based chemicals (Mayer *et al.*, 2007). Meanwhile, drug developments from coral reefs are estimated to be over US$ 6,000 per hectare (OECD, 2005).

The success of this industry is threatened however by biodiversity loss, as pollution, climate change, and other environmental pressures threaten the health of marine populations. A transition to a green economy will be necessary to ensure the continued success of this industry. Bioprospecting itself is not without issues, however. In ensuring a green economy, frameworks will have to be established ensuring the fair distribution of wealth and respect for indigenous knowledge. In terms of environmental effects, the pharmaceutical industry often needs only small samples in which to focus on genetic materials.

Tourism

Tourism is responsible for a significant proportion of world production, trade, employment, and investments (UNEP *et al.*, 2012). It is projected that the number of international tourists will reach the historic one billion mark by December 2012 (UNWTO, 2012). As arguably the largest global industry, tourism is also the largest sector supporting protected areas. The tourism economy represents 9 percent of world GDP and contributes to 6–7 percent of total employment (UNEP *et al.*, 2012). In 150 countries it is one of the five top export earners and in 60 countries it is the first. It is the main source of foreign exchange for one-half of Least Developed Countries (LDCs).

Tourism is growing at more than 4 percent per year; ecotourism is believed to be growing at three times that rate (Milder *et al.* 2010; UNWTO 2012). There is international demand for these services and tourism-related Payment for Ecosystem Services (PES) can be a sustainable financing mechanism for biological and cultural conservation. Globally, coastal tourism is the largest market segment and is growing rapidly (Orams, 1999; Hall, 2001).

Challenges

In a business-as-usual (BAU) scenario, by the year 2050, overall tourism growth will result in increases in energy consumption (111 percent), greenhouse gas emissions (105 percent), water consumption (150 percent), and solid waste disposal (252 percent) (UNEP *et al.*, 2012).

Rapid growth in travel and preferences for further distances, shorter time-periods and energy-intensive activities are resulting in the sector's contribution of 12.5 percent of radiative forcing and 5 percent of anthropogenic emissions of CO_2 (UNEP *et al.*, 2012). Emissions cause coral bleaching, ocean acidification, and sea level rise. Other coastal tourism pressures include water pollution, land conversion, biodiversity, and loss of local and indigenous cultures and built heritage.

Opportunities

Sustainable tourism incorporates positive economic, sociocultural, environmental and climate considerations and impacts, during planning and implementation. Sustainable tourism can serve as a conduit for bio-cultural conservation and has major potential to raise investments for conservation. The green investment scenario is expected to undercut the corresponding aforementioned BAU scenario by 18 percent for water consumption, 44 percent for energy supply and demand, and 52 percent for CO_2 emissions (UNEP, 2011c). Efficiency improvements, local hiring, sourcing local products, and safeguarding local culture and environment can reinforce employment potential. On the demand side, more than a third of travellers favor environmentally friendly experiences. Increasing involvement of local communities in the value chain can contribute to the development of local economies and poverty reduction and create "green services" in energy, water, and waste management efficiency (UNEP *et al.*, 2012). Meanwhile, a combined Blue Carbon and sustainable tourism strategy can result in conservation and climate change mitigation.

In addition there is a potential for financial mechanisms that result in payments for ecosystems services (Wunder *et al.*, 2008). These services may involve the protection of natural heritage sites, coral reefs, cultural sanctuaries, or traditional livelihoods (Mayrand and Paquin, 2004).

In summary, investment in energy efficiency and improving waste management can save money for tourism businesses, create jobs, and enhance destination aesthetics. Investment requirements in conservation and restoration are small relative to the high value of ecosystem services (ES) that are essential for continued economic activities and human survival (UNEP *et al.*, 2012).

The majority of tourism businesses are small- and medium-sized enterprises (SMEs) and contribute mostly to local livelihoods (UNEP *et al.*, 2012). The use of internationally recognized standards can assist businesses in understanding aspects of sustainable tourism and mobilize investment. Innovative multi-sector partnerships and financing strategies are required and can spread the costs and risks of green investments. Cross-sectoral consultation and Integrated Coastal Zone Management (ICZM) are required for good sustainable tourism, destination planning, and development strategies (UNEP *et al.*, 2012). Tourism planning has to include capacity building, government commitment, enforcement, and climate change considerations. Tourism's impacts on local communities are complex and demand careful planning. Governments can use tax concessions and subsidies to encourage investment.

Climate change is a key risk factor for tourism. The information base for effective adaptation remains inadequate for developing nations, particularly SIDS. An efficient instrument to deal with greenhouse gas emissions is to introduce carbon taxes on production and consumption but can be challenging in developing nations (UNEP *et al.*, 2012).

Making tourism businesses more sustainable will foster the industry's growth, create more and better jobs, consolidate higher investment returns, benefit local development and contribute to poverty reduction, while raising awareness and support for the sustainable use of natural resources (UNEP *et al.*, 2012: 107). More research into Payment for Ecosystem Services including markets for landscape beauty are crucial for valuing intact marine and coastal environments.

Incorporating green economic thinking into ocean management

Planning for a green economy

The success of the green economy will largely depend on introducing proper policy frameworks, incentives, and education platforms specific to each sector. In terms of ocean management, many of the green economy success stories thus far have been due to excellent planning. Maritime shipping instituted many green reforms largely because of the international frameworks already in place to regulate shipping. Strides were made towards a greener shipping sector as governments and industry agreed to conventions made through the IMO. In the fisheries sector advances towards a greener economy have been made through co-management plans at the local level and FAO conventions at the international scale. Certifications in Coastal Tourism can engage businesses in sustainable actions and implement internationally recognized standards.

Planning for a green economy can occur at varying scales and a variety of planning tools exist for policy makers. Planning can involve developing the regulatory frameworks necessary at the international, national, or local level. Regulatory bodies can create the guidelines and enforcements that are necessary and unique to each industry. Governments can also create incentive plans to encourage green industry, or use taxes to discourage unsustainable behavior. Education and capacity building can help foster engagement and support for a green economy at a broader level. For example, the use of internationally recognized standards for sustainable tourism is necessary to monitor tourism operations and management. The Global Sustainable Tourism Criteria (GSTC) provides a promising current platform to begin the process of grounding and unifying global standards (UNEP *et al.*, 2012).

Strategic Environmental Assessments (SEAs) are often conducted at the earliest stages of a project in order to evaluate environmental impacts and help decision makers adjust their plans (see Chapter 12 of this Handbook). Such assessments can also include alternative options and ensure projects or policies are aligned with larger national goals.

Ultimately, planning for a green economy will help policy makers achieve strategic decision making, avoid costly mistakes, and strengthen public support for programs that encourage developing all three capitals of a green economy.

Ecosystem based management and marine spatial planning

Marine ecosystems are highly interconnected, with their inhabitants weaving delicate webs of interdependencies. Ecosystems are also spatial units in the oceans, defined by specific characteristics such as productivity, and components both non-living and living.

Classical management of human activities in the marine environment is organized along political boundaries and manages economic sectors independently of each other. This approach does not necessarily align with how natural systems are structured, and so classical management fails to consider critical aspects, including the compatibility of activities with each other and with ecosystems, and the cumulative nature of impacts on species and ecosystems both within and across boundaries. Further, management is often implemented from a human, not an ecosystem perspective, failing to recognize all goods and services valuable in both monetary and non-monetary terms.

Ecosystem based management (EBM) is an approach that explicitly recognizes ecosystem services, builds on ecosystem boundaries and takes account of ecosystems' inherent interactions and dependencies (McLeod and Leslie, 2009; Agardy *et al.*, 2011; UNEP, 2011b). It regards associated human populations as integral parts of the ecosystem (UNEP, 2006). EBM allows for the development of management plans on small and large geographic scales, which can be tailored to meet multiple, defined objectives. It is an approach enabling nature-based socio-economic development.

EBM is not a product or endpoint, but rather an interactive process embracing change and adaptation as objectives are redefined. Through continued stakeholder engagement and monitoring and evaluation, the EBM process allows for management improvements to be made, for example, in response to ecosystem changes (such as climate change).

Building on existing legislation and tools, such as fisheries management or Marine Protected Areas, and building on knowledge that is readily available, EBM can mature from one focused activity, time, or location into an ongoing highly inclusive process. An essential aspect of the process is the continuous integration of management sectors and ecosystem elements. For example, shipping channels can be moved away from cetacean migration corridors, or total allowable fish catches can be linked to maximum bycatch levels of endangered species. EBM shares its integrative nature with other management approaches such as ICZM, Watershed management or Marine Spatial Planning (MSP). In fact, EBM can incorporate these approaches. MSP in particular can be regarded as one of the most widely applied tools of EBM.

Where EBM aims at reconciling human activities with one another on the basis of marine ecosystems' services, MSP focuses on the compatibility of activities. "Marine Spatial Planning is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process" (Ehler and Douvere, 2009). Originating in Australia's response to concerns over the need to protect the Great Barrier Reef, it has now been applied by a growing number of countries and regions, including the US, in the UK, the Netherlands, Belgium, Germany, and the Baltic Sea.

Long-established vested interests in the marine environment, such as fishing in certain areas, which competes with growing sectors such as maritime transport and tourism, and new uses of the sea, such as offshore wind farms, have made marine spatial planning a necessary process for conflict resolution. While some human activities are incompatible, such as naval military exercises with small-scale commercial fishing, others may be beneficial to one another, such as small-scale commercial fishing and coastal tourism. In some areas, there may not be perceived user conflict over marine space, and hence no immediate need for an MSP initiative. However, rather than being reactive, MSP allows for future-oriented planning, and for optimizing economic activities.

Usually encompassing the mandates of several management authorities, a clear governance structure should support the application of MSP. These can include new or adapted legislation, but could also be based on inter-ministerial or inter-agency consultations. The objectives of MSP are a matter of definition, and a public process of informed stakeholder consultation should guide MSP from the very beginning. This can ensure the process is meeting both needs and objectives, and should be repeated as spatial plans, maps, and agreed-upon visions are reviewed periodically.

Both EBM and MSP are approaches and tools that can resolve conflicts between our marine activities; and help us achieve cultural, social, and environmental development based on the goods and services marine ecosystems provide us with.

Environmental and ecological impact assessments

Environmental impact assessments (EIAs) have become a standard planning tool that examines the possible positive and negative effects a proposed project may have on the environment and nearby communities. The International Association for Impact Assessment (IAIA) defines EIAs as "The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made" (IAIA, 1999). Social Impact Assessments (SIAs) too are becoming recognized tools to assess community impacts. SIA and EIA are essentially management tools for policy makers to inform and encourage taking environmental issues into account during their decision making process.

The specific methodology used in an EIA will depend on the industry and project being assessed. Tools can vary from life-cycle analysis to mathematical modeling to rapid rural appraisals (UNEP, 2008). The process, however, generally involves an initial screening and scoping stage, followed by a mitigation stage and monitoring stage, and ending with an audit of the EIA itself. The goal of the EIA is to suggest ways in which a policy or project can mitigate environmental impacts and display a variety of options.

EIAs are currently in use in a variety of countries. The United States was among the first to promote the use of this tool with its National Environmental Policy Act of 1969 (EPA, 2012). The act requires all federal agencies to conduct an EIA on projects receiving federal funding. Many countries have since implemented their own equivalents including Australia, the EU, China, and India (UNEP, 2004).

Conclusions

A greener approach to the marine and coastal economy will require new management approaches and new science. Integrated, indeed transdisciplinary science that combines natural and social sciences will be required to understand how humans affect marine ecosystems and how changes in these ecosystems in turn affect human well-being. Such integrated science needs to be driven by carefully articulated policy and management needs. We will never fully understand the entire marine and coastal ecosystem, but we can begin to understand those key components that are most affected by people and upon which people most critically depend.

Notes

1 Existence value can be defined as the benefit derived from simply knowing something exists even if it is never used. Existence values are often associated with marine biodiversity (Hageman, 1985). Bequest value is the value placed on the knowledge that resources and opportunities will be available to future generations (Beaumont *et al.* 2007).

2 Examples include Professor Michael Ross of UCLA and Professor Paul Collier of Oxford University.

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