The Economics of Ecosystems & Biodiversity

Why Value the Oceans?

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1972-2012: Serving People and the Planet

Why Value the Oceans?

Oceans cover almost three-quarters of the planet, yet we are just beginning to discover the extent of the resources, both biotic and abiotic, that lie beneath their surfaces. We are also just beginning to understand the complexity of the interactions that tie oceans to the rest of Earth's systems. And then there is the coastal biome, where vital ecosystem services are most vulnerable. The coastal biome's links with both land and ocean extend its reach and vulnerability both far inland and well out to sea.

This discussion paper is based on contributions from an international group of experts. (To see their detailed comments and sources, please refer to Appendix: "Perspectives"). The paper is not intended to be comprehensive. Instead, it highlights areas of ocean and coastal management for which a better understanding of the economic value of marine ecosystem services could:

- substantially improve the management of critical marine resources;
- improve governance, regulation, and emerging ocean policy; and,
- provide a better understanding of the potential economic challenges that arise from a rapidly changing ocean environment.

Oceans and Coasts: Value and Vulnerability

The ocean and coastal ecosystems are extremely important in terms of ecosystem services and their economic values. According to some estimates, the ocean and coastal biomes may provide as much as two-thirds of the ecosystem services that make up the planet's natural capital. At the same time, we know remarkably little about them. Ocean and coastal ecosystems suffer—perhaps more than any other ecosystem—from both knowledge and governance deficits.

Ocean and coastal biomes are especially vulnerable because they cross borders and jurisdictions, or—as is the case with the high seas—lie beyond traditional jurisdictions. More and more often, we recognize and take into account the role of marine biomes, including the open oceans, coastal marine systems, and coral reefs, in sustaining a wide range of human and natural economic activity. International treaties, such as the Convention on Biological Diversity, promote the identification and documentation of marine organisms and ecosystems, including those of economic importance.

Conserving and enhancing these ecosystem services is, in reality, a matter of managing human actions within the marine environment, rather than managing the physical ecosystem itself. Management is complicated, however, not just by our limited understanding of the ecosystems, but also by the lack of broad-based standards for assessment. Initiatives like the UN Secretary General's Global Oceans Compact, currently under discussion internationally to unify the efforts of UN agencies, governments, civil society and the private sector, to address some of the most critical challenges affecting the marine and coastal environment, including the potential role that the green economy could have in strengthening the sustainable use of marine resources, and the forthcoming

Rio+20 Conference, will provide a forum to address governance challenges associated with economically important marine ecosystems..

A Green Economy Approach for the Blue World

In order to effectively mainstream ocean and coastal ecosystems into national budgetary and planning processes, we need to find a common language that enables common standards by which to value these important ecosystems. We need, in short, a green-economy approach as outlined in the recent report, *Green Economy in a Blue World*. If economic development is to contribute to the sustainable well-being of people, we need to balance a number of components: market and non-market values, living and non-living resources, and uses now and in the future.

Such an approach does not rule out industrial uses of the ocean and coast, nor does it mean “zero tolerance” for land-based industrial activities. Rather, it recognizes the pressures that such activities place on environmental resources and natural capital, and it identifies opportunities to reduce those pressures while still promoting environmental and economic benefits. It identifies opportunities to extract more value and revenue from the ocean without diminishing natural capital, and it encourages active reinvestment in environmental and social capital.

Moving towards a greener economy requires a better understanding of the economic value of marine and coastal ecosystems and biodiversity, as well as the contribution of these ecosystem services to societal, cultural, and ecological well-being. Demonstrating the economic value provided by ocean and coastal biomes could reveal new economic opportunities. It could also play a role in policy and management approaches that enhance the sustainable development of natural resources in the marine environment.

Incorporating marine ecosystem services into fiscal, planning and regulatory regimes requires more and better information about the ways in which ecosystems contribute to people’s well-being. The need for improved information is especially clear and urgent for such systems and services as ocean fisheries, coastal ecosystems and coral reefs, oceanic carbon processes, and polar seas. In all cases, whether listed here or not, understanding the systems and services is not enough. Legal, regulatory, and policy issues are also likely to require careful consideration.

KEY QUESTIONS WORTH ASKING: What economic information related to the oceans is needed to promote the transition towards a green economy? What is the best strategy for identifying priority areas of study? What is the role of global or regional organizations?

Ocean Fisheries

Ocean fisheries—fish in the net—are huge contributors to the world economy, both cash and non-cash. In 2008, nearly 80 million tonnes of fish were captured, with an estimated value of more than 80 billion USD. That catch meant 35 million jobs directly linked to the industry, the livelihoods of more than 300 million people, and food security for millions of coastal communities. The figures for the direct value of food provisioning services are likely underestimates, since our understanding of small-scale fisheries is just emerging.

Fish not caught—fish in the sea—also contribute substantially to the economy through ecosystem services, including nutrient recycling, biodiversity, biological regulation, medicines, and cultural services. How substantial are those services? We don't know. Values for biodiversity and other ecosystem services have been calculated for only a few locations. Understanding these values is key to making good and sustainable decisions about how fisheries and oceans are managed.

The decisions involve more than finding the balance between fish in the net and fish in the sea. What fish remain in the ocean, and where, also matter. With climate change and ocean acidification changing the nature of the seas, we need to build resilient fisheries or risk the food security of much of the world's population. While the ultimate effects of ocean acidification are still uncertain, key shellfish species are known to be vulnerable. These vulnerable species, in turn, are central to the economies and food supplies of many coastal communities. For example, the United States community of New Bedford, Massachusetts, gets 77 per cent of its fishing revenues from scallops (306 million USD in 2010), which are known to be vulnerable to changing ocean acidity. That alone is cause for concern, but the impact of the potential loss of scallops and other species from the ecosystem is an added worry. Resilience comes, to a considerable extent, from the ecosystem services fish and shellfish provide: nutrient recycling, biological regulation, and—most obviously—biodiversity.

KEY QUESTIONS WORTH ASKING: How could fisheries reform affect both the extractive and non-extractive values of commercially important fish and their associated species? Can a better understanding of the economic value of seafood and "in-sea" values of fish promote better coordination among fishers, fisheries managers, conservationists, and the tourism sector?

The Deep Ocean

Defined as the area beyond the continental shelf, where water depths vary from 200 metres to 11,000 metres, deep ocean constitutes the world's largest biome and covers more than 87 per cent of the ocean floor. It includes vast abyssal plains, seamounts, mid-ocean ridges, trenches, canyons, cold seeps, hydrothermal vents, and deep-water coral systems. The poorly documented deep-sea benthic ecosystems are thought to contain the deep ocean's largest reservoir of biomass and largest number of undiscovered species. Studies suggest that conservation of deep-sea biodiversity is essential for sustainable functioning of the entire ocean.

Unsustainable fishing, non-renewable resource exploration and exploitation, submarine cable installation, and waste disposal all derive economic benefit from access to deep-sea habitats. Some features, such as seamounts, are known to be important to commercial fishing. Researchers at the Secretariat of the Pacific have identified deep sea pelagic organisms in the guts of commercially important fish. There is evidence that many deep-sea seamounts and submarine canyons have been severely affected by fishing. Other features provide less direct ecosystem services, such as regulation of the global carbon cycle or enhanced primary production.

Some progress has been made in protecting deep-ocean fisheries through resolutions of the United Nations General Assembly and through efforts by the Food and Agriculture Organization of the United Nations, starting in 2006, to map vulnerable marine ecosystems. Due to the lack of broad data, however, putting an economic value on deep-ocean ecosystems and biodiversity is at least as difficult as evaluating their ecological value. Mapping the spatial distribution of deep-sea ecosystems

KEY QUESTIONS WORTH ASKING: What economic information do we need to weigh the tradeoffs between the industrial exploitation of the deep sea and the emerging economic value of living resources there? Can a better economic understanding of the value of deep sea ecosystems help in the design of industrial best practices, deep sea marine protected areas, and international governance of the deep sea?

and biodiversity hot spots and estimating their economic value are important steps in developing a framework for the sustainable management of deep-sea areas.

Coastal Ecosystems: From Mudflats to Coral Reefs

Salt marshes, tidal mudflats, salt pans, seagrass beds, mangroves, and other estuarine and coastal ecosystems provide food, fibre, firewood, access to recreation, habitat and shoreline protection, and water filtration. They are also important components of nutrient, carbon, water, and oxygen cycles. Although they clearly provide economic, cultural, and ecological benefits to communities, many of these coastal ecosystem services have not been evaluated systematically around the globe.

The ecological aspects of marine conservation have been studied, but research into its social and economic dimensions is rare. An exception is a four-year in-depth analysis of the socioeconomics and governance of coastal and marine ecosystems at 17 marine managed areas (MMAs) in Belize, Ecuador, Fiji, and Panama. The study showed higher average income, more diversified sources of income, and improved environmental awareness among community members whose livelihoods are tied directly to the MMAs through such activities as artisanal fishing and tourism. Visitors to Panama's Coiba National Park said they were willing to pay significantly more than the current entry fees, and the park's annual value was estimated to be 36 per cent greater than its budget.

With managers and decision makers constantly seeking funding for marine protected areas (MPA), such evidence-based valuation of their services is one way to demonstrate the importance of investing in effective protection. Indeed, recognition of the value of protecting the marine environment is spreading around the world. In November 2011, for example, the UK government announced a commitment to create a network of national protected areas in British seas, with the first step being the identification of new marine conservation zones (MCZs)[i].

The argument for the value of sandy tourist beaches and good fishing grounds is relatively easy to make. The value of less aesthetically appealing components of the coastal biome is often harder to convey. A meta-analysis by Conservation International—using existing data and spatial and econometric methods—shows that mangroves, coral reefs, and coastal wetlands provide shoreline protection of high ecosystem-service value in the Pacific Islands. Again, solid data illuminate both the economic value of these habitats and the need for better management.

Coastal Blue Carbon: An Emerging Payment Scheme for Marine Ecosystem Services

Blue carbon is the carbon captured and stored in coastal habitats like mangroves, seagrasses, and salt marshes. Conversion of coastal habitats for agriculture, aquaculture, and other development has resulted in an estimated global habitat loss rate of 0.7 to 2.0 per cent annually. Climate mitigation researchers are already attempting to place a value on the carbon protected by coastal habitats, particularly mangroves, already partially covered under the United Nations' REDD+ protocols.

Assigning an economic value to the carbon stored within coastal habitats allows individuals and governments to compare that value to the value of development, and opens the possibility that investment in conserving these systems is a way to offset carbon emissions. Carbon benefits alone may justify protecting some habitat from conversion to agriculture and aquaculture. In other cases, the value of carbon combined with the value of other ecosystem services might make conservation and restoration preferable to development.

Coastal ecosystem service values must also be weighed against the costs of pollution, poor land use, water consumption, and other harmful activities in watersheds upstream. Solid scientific data will be required to assess the economic activities and values of terrestrial environments and of the ocean in the coastal biome, where the two meet. Without this data, a blue carbon policy that focuses on carbon alone risks undervaluing the substantial economic benefits the coastal biome contributes towards the provision of ecosystem services in other biomes.

KEY QUESTIONS WORTH ASKING: In addition to market data, what other economic information is needed to ensure that the pursuit of blue carbon improves the economic value of coastal habitat and habitat protection? In addition to land managers, who benefits from the creation of blue carbon markets and how can these players be brought together to promote better coastal management?

Coral Reefs

Because of their rich biodiversity, coral reefs have been called the rainforests of the ocean. Properly managed, coral reefs provide many goods and services to coastal communities, including recreation, real estate, research, fisheries, protection against natural hazards, and climate regulation. Up to half a billion people are thought to depend economically on coral reefs. Roughly 850 million people live within 100 km of a coral reef and likely derive some benefits from the reef's ecosystem services. More than 275 million people reside in the direct vicinity of coral reefs, many of them in developing countries and island nations that rely heavily on coral reefs for both food and livelihoods.

Coral reef values have been studied many times, but there has been no effort to develop a systematic approach to understanding the full suite of coral values across the globe. We still know little about the value of ecosystem services of most coral reef areas. Over the past few decades, great strides have been made in developing management processes to harness the value of ecosystem services provided by coral reefs and integrate these values into national and global planning. Many of these efforts, however, are hindered by incomplete knowledge of the full economic costs of and benefits of management alternatives.

KEY QUESTION WORTH ASKING: How can the vast body of coral reef valuation research be better harnessed to change destructive human behaviours?

Oceans and the Carbon Cycle

The oceans play several vital roles in the global carbon cycle. All of these roles are affected by climate change, and all are potential feedback mechanisms that can affect atmospheric carbon. Carbon dioxide from the atmosphere dissolves into the oceans, but how much dissolves and how much remains in the atmosphere depends on ocean temperature. Organisms from phytoplankton to large marine animals pull carbon from the atmosphere and deposit it in the deep ocean. Finally, massive currents of dense, cold, salty water sink, when they enter fresher waters around the Arctic and Antarctic, and pull carbon deep into the sea.

Because these processes are complex and much of the research into them is relatively new, researchers are still trying to determine how to assign value to them. An added complication is ocean acidification, caused by increased levels of atmospheric carbon dioxide being dissolved by the ocean. Because the acidification process has only recently been recognized, science and policy lag behind comparable global threats, such as climate change.

KEY QUESTION WORTH ASKING: What data are needed to understand the magnitude and distribution of economic impacts that climate change will cause to marine ecosystems and the people that depend upon them?

Polar Seas: The Opportunities and Costs of Change

There is growing potential for conflict among various polar ecosystem service functions, particularly in the Arctic. Climate change is reducing sea ice and driving changes in polar marine ecosystems. Industrial development carries threats to ecosystem functions and biodiversity.

Detailed information about the values of ecosystem services in the Arctic is often incomplete at best, and the traditional benefits of arctic ecosystems (e.g., subsistence, cultural uses, shoreline protection) typically take place outside the cash economy and may be overlooked entirely. Existence values of polar species are difficult to quantify, but advocates for charismatic species can wield considerable political power. Finally, the potential impacts of some industrial and transportation activities are poorly understood. In all cases, better data on the nature, extent, and value of the ecosystem services are needed.

The urgency of acquiring detailed and accurate data on arctic ecosystem services is driven, in part, by the scale and speed of change. The progressive loss of sea ice in the past few years has triggered fundamental biological and physical changes triggered in the Arctic Ocean. With ice diminishing, northern sea routes are becoming attractive to shipping, and offshore oil and gas reserves are more accessible; ship-based tourism is growing, and commercial fishing could expand.

The impacts of the change in sea ice on ecosystem services provided by the Arctic's marine systems, however, are likely to be even more dramatic than the economic opportunities, and many of these services are not easily measured in market terms. The melting of sea ice makes the ocean darker. As a result, it absorbs more solar radiation and contributes to rising temperatures at Earth's surface. The loss of sea ice opens the path for storm surges that erode arctic coastlines and necessitate the relocation of some communities. Declining sea ice degrades habitats vital to seals, polar bears, walrus, and some fish and birds, while improving habitat for other species, including top predators like killer whales. The consequences of dwindling sea ice will reverberate throughout the food web.

KEY QUESTIONS WORTH ASKING: What economic data are needed, right now, to safeguard ecosystem values from the new industrial uses of the Arctic that are emerging as a result of climate change? How can the valuation of ecosystem services better inform decisions and international cooperation regarding management of resources and activities in the Arctic?

Ocean Governance

Marine biomes are changing rapidly. Melting polar ice, increasing prices for energy, minerals, and ocean commodities, and new technology mean new competition and, potentially, new environmental impacts. Coastal habitat continues to be lost, and dead zones in coastal waters continue to increase. Weighing the competing values of fish in the net versus fish in the sea becomes more urgent as stocks decline.

Of particular concern are the high seas and seabed area beyond national jurisdictions. They cover nearly half the planet, and harbour most of the oceans' biodiversity, as well as important fisheries and genetic and mineral resources. As with other ocean areas, they are also under increasing pressure from overexploitation, pollution, climate change, and ocean acidification.

A New Era for Ocean Governance?

Local, national, regional, and even global governance is evolving rapidly to address these challenges. There is increased willingness to invest in coastal and marine management and to create new institutions, processes, and approaches that can balance human needs with environmental sustainability in marine and coastal ecosystems. New taxation regimes are being developed to encourage green industry and re-invest economic flows into environmental and social capital. Payments go directly to communities to conserve ecosystems and natural capital. Ecosystem-based management and supportive tools, such as marine spatial planning, are starting to be applied in coastal seas, the deep sea, and even the high sea.

KEY QUESTIONS WORTH ASKING: Can a strategy of economic valuation and data collection be tailored to meet and anticipate the needs of emerging regional governance? What social science methods can be used to prioritize these needs?

Managing in a Knowledge Vacuum

In most cases, however, policy makers are forced to move forward with marine management and governance in the face of insufficient information on the economic value of marine and coastal ecosystems. Market forces alone do not provide the information required, and few market mechanisms reflect the cost of human activities in terms of lost ecosystem service value. Ecosystem services are difficult to incorporate into traditional market models, since they are often public goods that defy ownership. While systems of ownership and markets for ecosystem services are emerging, there are no ownership rights to many ecosystems and the services they provide and, therefore, no way to claim for their use. As a result, their contribution is generally not recognized by the markets.

As we understand more about the market and non-market values that ecosystem services provide, there are new opportunities to develop instruments and strategies for capturing those values. Payments for ecosystem services (PES) is an emerging mechanism for capturing the values of ecosystem services and transforming them into investments and sustainable financing that can maintain and protect ecosystems. Incentive agreements are another approach. They allow people who value marine ecosystem services to provide direct benefits to those who maintain the ecosystems that support these services.

Handling Cumulative Impacts While Running Out of Space

An additional problem facing managers and regulators of the marine environment is the competition for space. Wind farms and other energy facilities, recreational uses, offshore drilling, shipping superhighways, commercial fishing, and aquaculture facilities: all of them compete for what once seemed like limitless space. Marine management that considers single sectors or single objectives often treats commercial and non-commercial uses of the ocean as competing with one another.

Ecosystem services are likely to fall to the bottom of that measure, with long-term detrimental consequences. To maintain and maximize the ecological and economic benefits provided by the oceans, we urgently need a rational process to guide the management of multiple objectives.

Ecosystem-based management (EBM) is one approach to maintaining an ecosystem in a healthy, productive, and resilient condition so that it can provide the services humans want and need. EBM differs from current approaches that usually focus on a single species, sector, activity, or concern. Instead, EBM examines interactions, such as tradeoffs and synergies, and considers cumulative impacts of multiple activities. Marine spatial planning is a planning process that uses EBM principles and focuses on the spatially explicit nature of many ocean activities and resources. Ecosystem-based management and supportive tools, such as marine spatial planning, provide a basis for incorporating ecosystem service values in decision making.

KEY QUESTION WORTH ASKING: What steps must be taken to push economic knowledge and valuation beyond a "single good or service approach" to one that more accurately reflects the interconnectedness of values and the economic consequences of cumulative impacts to marine ecosystems?

A Way Forward

These and other solutions require data—sound, science-based information about the status of ocean ecosystems and the functioning of marine ecosystem services. They also require consistent ways of integrating the value of ecosystem services into accounting systems. A growing body of scholarly research on ecosystem services was brought together in the 2005 Millennium Ecosystem Assessment. Since then, The Economics of Ecosystems and Biodiversity (TEEB) study has promoted a global effort to improve our understanding of the value of ecosystems.

The original TEEB effort, launched in 2007, set out to show how holistic, green economic thinking and the recognizing, demonstrating and capturing of ecosystem service values could help realign a faulty economic compass that currently pursues market value at the expense of the value of nature. Building on decades of science about the valuation of nature, TEEB embarked on a global effort to estimate the value of environmental change, especially in terrestrial areas, with the intention of becoming a catalyst for green economy thinking.

A targeted exercise for the marine environment—a TEEB for the Ocean—would supply the foundation needed to understand the complex interactions of marine ecosystems within our economic settings, thereby stimulating a green thinking in the blue realm.

APPENDIX: PERSPECTIVES

The original TEEB (The Economics of Ecosystems and Biodiversity) effort, launched in 2007, set out to show how more holistic, green economic thinking and the quantification of nature's value could help reform a faulty economic compass that currently emphasizes market value at the expense of the value of nature. Building on decades of science on the valuation of nature, TEEB embarked on a global effort to estimate the value of environmental change, especially in terrestrial areas. By doing so, TEEB sought to become a catalyst for "green" economic thinking - one that would inspire further investigation into the value of nature and its application to the globe's most critical environmental management issues.

IDEAS, STRATEGIES AND FUNDAMENTALS

Ecosystem Services and Marine Ecosystem-Based Management

The unprecedented environmental challenges facing the oceans require a broader vision than ever before of what we want to achieve through coastal and ocean management.[ii] Ecosystem-based management (EBM) for the oceans focuses on the range of benefits that we receive from marine systems, rather than on individual benefits.[iii] [iv] These benefits include healthy fisheries, biodiversity conservation, renewable energy, coastal protection, and recreation.[v]. In order to fully implement EBM, we need to understand the connections among these ecosystem services and the suite of factors affecting their production and delivery.

Being explicit about trade-offs among multiple objectives (which often correspond to ecosystem services) is a critical component of EBM. The value of such analyses is emerging in the context of ongoing ecosystem-based management efforts around the world. For example, in the state of Massachusetts (USA), as part of the first comprehensive ocean planning process in the nation, an ecosystem services framework was a central part of the planning process.[vi] While trade-off analyses were not formally incorporated into the plan itself, qualitative knowledge of the interactions among different human activities and their cumulative influences on ecosystem services influenced the development of the marine spatial plan (Leslie, pers. obs.). On the West Coast of Vancouver Island (Canada), more formal trade-off analyses are being conducted as part of the region's marine spatial planning process. There, a consortium of government agencies and stakeholder groups have joined forces with the Natural Capital Project to explore how alternative spatial plans might affect a wide range of ecosystem services in the region.[vii]

Unfortunately, explicit trade-off analyses in the marine and coastal realm are the exception rather than the rule at this stage. Even when used, such analyses often are hampered by a lack of data on the estimated value of marine and coastal ecosystem services. In order to fully leverage ecological and economic knowledge of oceans and their value to humans, **there is a need to generate and provide access to more and better data regarding key ecosystem services - including biological, economic, and societal measures.**

(Heather M. Leslie, Brown University and Karen L. McLeod, COMPASS)

Understanding the Full Economic Impact of Resource Damage Mitigation and Mitigation in the Marine World

Marine resources regularly suffer unintended damage from human activities (e.g., ship groundings, oil spills, land based pollution and runoff, coastal development). Assessment of the magnitude and scale of these damage events is necessary for setting appropriate fines, awarding compensation to affected parties, and determining required levels of restoration or equivalent replacement. Determining the level of fines, compensation and restoration that are commensurate with the damage caused provides an incentive to users of the marine environment to mitigate the risk of causing damage. Resource damage assessment therefore requires accurate and transparent valuation of the full impacts to ecosystem services. Current approaches to mitigating and compensating for damages to natural capital (e.g., ecosystem offsets, replacement cost or gross revenue valuation) often underestimate the full cost of environmental damage. Attempts to create standardized approaches to estimate the economic value of environmental damage (e.g., a fixed dollar amount per hectare) are generally inaccurate. Biophysical approaches (e.g., a 'no net loss' approach in which a damaged hectare of coral reef is replaced with a hectare of coral reef at another location) suffer from the fact that "replacement reefs" are generally not equivalent in terms of the value of ecosystem services provided.

As noted in the original TEEB, the economic value of impacts to marine ecosystem services is highly context-specific with regards to both the characteristics of the ecosystem (biological, physical, abundance, resilience, health) and the socio-economic system that benefits from them (population of beneficiaries, dependence, vulnerability, preferences). Damage assessments therefore need to take account of the specific context in which the damage occurs.

Conducting new primary assessments for every damage event is not feasible; therefore a need exists to accurately estimate damage costs using existing value information. This need could be addressed by developing a framework and guidelines for a more comprehensive (full) ecosystem service approach to marine damage assessment that recognizes the direct and indirect impacts of human activities on the provision of ecosystem services and captures the temporal dimension of impacts (i.e., the flow of services from impacted natural capital). This framework would aid the identification, quantification and valuation of damaged ecosystem services and thereby provide a means to determine compensation and mitigation that reflects the full scale of damage and context specific characteristics.

So much of the value of oceans and coasts lies outside the market. As a result, it is difficult to make policy that promotes a sustainable, green economy in the absence of good information about the economic value of marine and coastal ecosystem services and biodiversity. A targeted ocean value study could provide much needed guidance and real estimates regarding the economic value of key ecosystem services in the marine realm - including biological, economic, and societal measures.

Providing a standardized and systematic framework for valuing marine ecosystem services could help fill the gap in our understanding of the value of ocean and coastal ecosystems. This framework could help identify priority needs for marine ecosystem service information and could tailor recommendations for the differing needs of developed and developing countries, as well as the many different biomes, habitats, and jurisdictions of the world's coasts and oceans.

These different needs include different types of services, different time scales of analysis, and even different types of data that correspond to differing policy needs. This could begin to put more concrete value estimates on the cost of human impacts to the oceans and coasts and also the benefits and opportunities of a more sustainable, green approach to the ocean economy.

(Luke Brander, private consultant)

OCEAN BIOMES

Fisheries: Balancing Fish in the Net with Fish in the Sea

Fish in the net does not just include the nearly 80 million tonnes of fish captured in 2008 and worth over 80 billion USD, but also 35 million jobs directly linked to the industry, over a 100 thousand secondary jobs and over 300 million people's livelihoods and food security for millions of coastal communities.[viii] These same fish in the sea provide several key ecosystem services, in particular nutrient recycling and biodiversity. Other ecosystem services that fish populations contribute to include biological regulation, medicines and cultural services.

The direct value of the food provisioning services is considered to be an underestimate since our understanding of small-scale fisheries is only now just emerging. The values for biodiversity and other ecosystems services are known for only a few locations such as California.[ix] Understanding these values is key to shifting the status quo on how fisheries and oceans are managed.

The key to the future of fish stocks and the ecosystem services they provide is finding the balance between not just how much fish stays in the sea, but what fish and where. The threats of climate change and ocean acidification further highlight the need to not only find the balance but to build resilient fisheries, otherwise food security for much of the world's population is at risk. Building resilient fisheries depends on ecosystem services such as nutrient recycling, biological regulation and most importantly biodiversity.

Right now, many would argue that we have not found this balance in many respects with many commercially important species and many small-scale fisheries significantly overfished, degraded marine waters due to pollution and altered coastal habitats. Balancing the fish in the net and those in the sea needs a shift in the status quo especially for the use of subsidies, fishing capacity, property rights and marine protected areas.

A TEEB-type study for the Oceans could make a significant contribution to our understanding of how fisheries impact marine and coastal ecosystems and their ability to deliver services such as nutrient cycling and biological regulation, and also how important these same services are to the fisheries sector in ensuring food security (provisioning), livelihoods and economic development (employment). Such information is necessary to ensure that trade-offs that are made by decision makers are based on objective sound science.

(Jackie Alder, UNEP)

Deep-Sea Habitats

The deep ocean, defined as the area beyond the continental shelf, where water depths vary from 200 m to 11,000 m, constitutes the world's largest biome and covers more than 87% of the ocean floor. Deep-sea benthic ecosystems are the least well documented ecosystems, but are thought to contain the largest reservoir of biomass[x] and the largest number of undiscovered species.[xi] Deep-sea benthic environments are often overlooked when considering the economic benefits of marine biodiversity, but studies suggest that conservation of deep-sea biodiversity is essential for sustainable functioning of the entire ocean.[xii]

Although human impacts are greatest in shallow coastal regions, almost no part of the ocean is unaffected by human activities.[xiii] Due to the general lack of data, putting an economic value on deep ocean ecosystems and biodiversity is currently difficult. The diverse range of ecosystems that constitute the deep ocean include vast abyssal plains, seamounts, mid-ocean ridges, trenches, canyons, cold seeps, hydrothermal vents and deep water coral systems. Some of these features, like seamounts are important in the commercial fishing industry, while others provide more intangible ecosystem services like regulation of the global carbon cycle or enhanced primary production. There is evidence that many deep-sea seamounts and submarine canyons have been severely affected by fishing[xiv] [xv]. As mentioned, calculating the value of deep-sea ecosystems is not straightforward – they are complex, interlinked and underexplored.

Fishing, non-renewable resource exploration and exploitation, submarine cables, waste disposal – all derive economic benefit from access to deep sea habitats, but their impact is poorly understood. However, there is evidence that many deep-sea seamounts and submarine canyons have been severely affected by fishing.[xvi] [xvii] As mentioned, calculating the value of deep-sea ecosystems is not straightforward – they are complex, interlinked and underexplored and there may be many as yet undiscovered uses associated with them. The TEEB approach acknowledges that it is important to identify changes in ecosystem services, even if it is not possible or necessary to monetize all of these changes.[xviii] Demonstrating the value of one of the more widely studied of the deep-sea ecosystems, cold-water corals, may be a possible starting point. This could be based on TEEB methods for determining the value of shallow water corals. The economic value of species as sources of genetic material for the pharmaceutical and manufacturing industries is an unknown, but potentially significant.

In general terms, the economic value of most deep-sea environments is conceptually difficult to define. The Kaplan Project, which looked at species composition on the manganese nodule-rich abyssal plains of the Central Pacific Ocean, found very high biodiversity with considerable regional variability. Even though we may not be able to easily demonstrate the monetary value of this biodiversity, we can recognize that it does have a value. The ocean's inhabitants are largely unknown, but they are a valuable natural resource; the distribution of marine species is poorly constrained but managing their exploitation is a priority for governments; we do not fully understand the functioning of ocean ecosystems, but our measurements show that human impacts on ocean life are damaging, significant and increasing. Understanding the spatial distribution of deep-sea ecosystems, especially biodiversity hot spots and assigning some value to these systems, can provide a framework for marine management where currently very little exists.

(Elaine Baker, UNEP/GRID-Arendal, Peter H Harris, Geoscience Australia)

Ocean Carbon Cycle

The oceans deliver three major ecosystem services related to the global carbon cycle: the first is known as the 'solubility pump' service in which carbon dioxide from the atmosphere chemically dissolves into. The solubility pump can be either a source or a sink of carbon dioxide with respect to the atmosphere as a cold ocean holds more dissolved carbon dioxide and a warmer ocean less.

The second service is known as the 'biological pump', in which planktonic algae and bacteria in the surface ocean create carbohydrates using photosynthesis to fix carbon from carbon dioxide dissolved in seawater. Some of this carbon then sinks into the deep ocean where it stays out of the atmosphere over thousand-year timescales, thereby cooling the Earth.

The third service is known as the 'physical pump', or the 'global thermohaline circulation', in which carbon dissolved in seawater and in the bodies of various organisms is taken down into the deep ocean where huge currents of dense, cold salty water sink when they enter fresher waters around the Arctic and Antarctic.

It is also becoming more and more evident that large marine organisms greatly enhance the biological pump service in three major ways. Firstly, turbulence and drag from the physical movements of whales, fish and even jellyfish bring nutrients up from the deep ocean to the surface ocean, thereby stimulating the growth of photosynthesizing plankton. Secondly, organisms such as sperm whales release nutrients when they defecate at the surface having fed on nutrient-rich prey at depth. Finally, baleen whales recycle nutrients in the upper ocean by excreting dense plumes of faeces rich in iron originally found in the bodies of krill, one of their major prey items.

There Is a clear opportunity to greatly improve our capacity to calculate the value of the various carbon-fixing services provided by the global ocean and its organisms and provide decision makers with practical and focused data and information to help narrow the wide ranging valuations that have been estimated to date.

(Stephan Harding, Schumacher College)

Understanding The Potential Human Dimensions of Ocean Acidification

Because marine ecologists have only recently recognized the risk that ocean acidification poses to marine organisms and ecosystem services, its science and policy lag that of other comparable global threats, such as climate change. Ocean acidification (OA) is an emerging field of scientific investigation. Thus far, much effort has been devoted to ocean chemistry, species sensitivity tests, defining research priorities, establishing best practices, and designing monitoring networks. We still have little understanding of how OA will affect people and the coastal and marine economies upon which many people depend.

Only a small handful of studies have attempted to estimate the potential social and economic impacts of ocean acidification.[xix] [xx] Without a good understanding of the potential economic costs of ocean acidification, the topic continues to be absent from research and monitoring priorities around the world. The lack of attention to the human dimension of ocean acidification has impeded both a commitment of funds to conduct research about its consequences and the adoption of possible solutions to the challenges presented by ocean acidification. Because ocean acidification is often viewed as an abstract problem, remote from daily life, it has had limited success in gaining traction among policy makers and the public.

Examining the above could help estimate the potential magnitude of economic damages associated to ocean acidification and thus help focus attention on the economic incentives inherent with insuring that permanent damage is prevented. Understanding the who and how of ocean acidification impacts will allow policy makers to develop a public understanding of the problem, create a constituency to address the problem, and prepare vulnerable communities for the potential economic consequences.

(Lisa Suatoni, Natural Resources Defense Council)

ECOSYSTEM-DEPENDENT COASTS

In addition to providing economic, cultural and ecological benefits to communities, coastal ecosystems (including coral reefs which are discussed later) deliver a variety of ecosystem services that have not been valued well systematically across the globe. Collectively, salt marshes, tidal mudflats, salt pans, seagrass beds, mangroves, and other estuary and coastal ecosystems provide valuable services that include food, fiber, firewood, access to recreation, habitat/shoreline protection, water filtration, and act as important components of nutrient, carbon, water, and oxygen cycles. Here we examine just a few of the many potential areas in which a TEEB for the Oceans could be instrumental in improving our understanding and management of these valuable habitats.

How Economic Valuation Data Can Improve Coastal Management: Recreation, Tourism, and Shoreline Protection

The economic valuation of coastal marine goods and services provides insight not only into the magnitude of their contribution to economies and livelihoods of coastal populations, but can actively influence policy and decision making, thus improving the management and governance of our ocean. In this section, we provide insights into how the valuation of recreation, tourism and shoreline protection – a few of the important coastal marine services, can inform conservation, management and highlight beneficial trade-offs associated with development that precludes habitat changes.

Although significant research has been done on the ecological aspects of marine conservation, research on the social and economic dimension of marine conservation is rare. An in-depth analysis of the socioeconomics and governance of coastal and marine ecosystems of 17 marine managed areas (MMAs) in Belize, Ecuador, Fiji, and Panama[xxi] over four years exemplifies how data can better inform action, in what we call a science to action approach.[xxii] Analysis of MMAs at these sites showed higher average income, more diversified livelihoods and improved environmental awareness for community members whose livelihoods (i.e., artisanal fishing and tourism) are directly tied to MMAs. Another interesting results of an economic valuation analysis within the scope of that project was the analysis conducted at the Eastern Tropical Pacific seascape in the Coiba National Park, in Panama, which found that visitors were willing to pay significantly more than the current entry fees charged, and that the park's annual value is 36% greater than its budget. As managers and decision-makers are constantly seeking more funding for marine protected areas

(MPA), valuing their services is one means to demonstrate the importance of investing in their effective protection.

Different environmental and cultural indicators play a significant role for a specific segment of more environmentally aware tourists, especially the international ones.[xxiii] [xxiv] An integrated study could begin to shed light on the economic contribution to tourism of coastal ecosystems. This kind of information is important in setting conservation priorities and would complement other existing classification schemes for marine coastal areas; it also provides guidance for the design of proper market strategies and "attractiveness" policies.

Working with existing data, a recent meta-analysis (using spatial and econometric methods) by Conservation International shows that indirect use of mangroves, coral reefs and coastal wetlands determined relatively high shoreline protection ecosystem service values in the Pacific Islands.[xxv] This points to the economic potential and thus need for better management of these habitats. A collaborative effort could thus provide a critical confirmation and expansion of this work by acting as a catalyst for a more systematic set of value estimates on these important habitats.

Applying a TEEB approach for the Oceans would enhance our knowledge of the economic valuation of ecosystems that provide shoreline protection, recreation and tourism and would serve to highlight spatially, explicit values of market and non-market goods and services. It would also promote further analyses in other spatial contexts, providing insights and support to the need for "greener accounting" – one that considers the contribution of healthy oceans to long-term human well-being, poverty alleviation and mitigation of climate change impacts.

(Rosimeiry Portela, Keith Lawrence, Giselle SamonteTan, Nalini Rao, Andrea Ghermandi, Laura Onofri, Paulo Nunes, Rashid Sumaila)

How can we better value our Blue Carbon ecosystem services?

Valuing the economics of ecosystems and biodiversity in oceans has the potential to impact the way society places value on the ecosystem services of terrestrial coastal habitats. Enhanced oceans and coastal policy through better information about these systems' economic value may have practical implications for work conducted on carbon stored in coastal habitats, known as blue carbon.

Blue carbon is the carbon removed and captured by coastal habitats such as mangroves, seagrasses, and salt marshes. Conversion of coastal habitats for agriculture, aquaculture, and other development has resulted in an estimated habitat loss rate of 0.7% to 2% annually.[xxvi] [xxvii] [xxviii] International climate mitigation efforts have already taken strides in attempting to place a value on the protection of specific land areas containing coastal carbon, particularly forests.

Placing an economic value on the carbon stored within coastal habitats allows individuals and governments to compare the value of development against the value of the carbon stored within these systems, and to conduct due diligence for making investments in preserving these systems in order to offset carbon emissions. A TEEB approach to valuing carbon in coastal ecosystems can help policymakers identify the vital areas where the need to protect blue carbon stands highest and prioritize their protection.

However, carbon storage is only one of multiple ecosystem services provided by blue carbon habitats. While carbon benefits alone may be enough to justify protecting habitat from conversion to agriculture and aquaculture, it may not show enough value alone to protect such habitats against industrial and residential development pressures. Better estimates of the costs of pollution, poor land use, water consumption and other activities that harm ecosystem services produced by watersheds and coastal ecosystems coupled with institutional changes that integrate coastal and terrestrial economies and with governance changes that assign costs and benefits to the right individuals and entities are needed to alleviate land-based impacts on coastal ecosystems and coastal habitat conversion.

A TEEB approach would enhance blue carbon knowledge by linking economic values of terrestrial environments and the ocean where the two meet. When an individual drains a tidal wetland for agriculture, not only is carbon lost, so is vital habitat for aquatic species that may be essential to oceanic ecosystems. Valuing additional ecosystem services outside of carbon allows businesses, governments, and individuals to more fully weigh the costs and benefits of habitat conversion, water consumption patterns, soil management practices, etc. A blue carbon policy that only focuses on carbon risks undervalues the substantial economic benefits mangroves, seagrasses, and salt marshes provide towards the ocean ecosystem.

(Brian Murray and David Gordon, Duke University)

CORAL REEFS: NATURALLY DIVERSE AND ECONOMICALLY POTENT

Coral Reefs have been called the rainforests of the ocean because of their rich biodiversity. As noted in previous TEEB reports, coral reefs, if properly managed, provide many goods and services to coastal communities through a variety of quantifiable benefits including for example, recreation, amenity (real estate), research and fishery, protection against natural hazards and climate regulation.

As many as a half a billion people are thought to depend economically on coral reefs in some way. One-eighth of the world's population—roughly 850 million people—live within 100 km of a coral reef and are likely to derive some benefits from the ecosystem services that coral reefs provide. More than 275 million people reside in the direct vicinity of coral reefs (within 30 km of reefs and less than 10 km from the coast), where livelihoods are most likely to depend on reefs and related resources.[xxix] Many of these people live in developing countries and island nations where dependence on coral reefs for food and livelihoods is high.

While there exists many studies on coral reef values, there has been no effort to develop a systematic approach to understanding the full suite of coral values across the globe. Many studies focus on the market value of coastal tourism. Far fewer studies account for the broader array of market and non-market values of corals. We remain ignorant of the ecosystem service values of most coral reef areas.

Over the past few decades, great strides have been made to develop management plans and processes that could harness the full value of coral reef ecosystems services and better integrate these values in national and global planning. Many of these efforts, however, are moving forward with only incomplete knowledge of the full economic costs of and benefits of management alternatives. A TEEB approach could build upon existing work to increase the accessibility and usefulness of new data and information and tools.

Studies of the value of tourism, recreation and fisheries associated with coral reefs are fairly common, though the diversity of methods used makes it more difficult to draw conclusions and generalize about these values. Studies of more specific values derived from coral reefs such as shoreline protection (reduced erosion / reduced flooding) are limited. Moreover, analyses of the roles of rights, incentives, and governance in resource stewardship and the optimization of revenue from coral reefs are lacking. A TEEB approach could contribute in this area by synthesizing existing knowledge and developing guidance on these critical elements of improved coral reef management.

(Linwood Pendleton, Duke University)

POLE TO POLE

Polar marine ecosystems provide provisioning services, cultural services, and have existence value. In recent decades, there has been only modest conflict between the three. Provisioning services are primarily from fisheries, which are valuable especially in sub-polar seas such as the Bering and Barents seas in the Arctic. Cultural services include traditional practices of indigenous peoples in the Arctic (there being no indigenous Antarctic inhabitants), which in turn include traditional hunting and fishing and thus have a provisioning component. Existence values are most obvious in the global attention given to iconic species such as polar bears and penguins.

Today, as climate change reduces sea ice and drives extensive changes in polar marine ecosystems, there is the prospect for greater conflict and also for threats to ecosystem functions and biodiversity from greater industrial development. Offshore oil and gas activity and commercial shipping are the leading areas of greater industrial presence in the Arctic, and both create risks of oil spills, chronic pollution, and noise disturbance, all of which could affect fisheries and traditional indigenous activities. Furthermore, ecosystem change and management actions could lead to conflicts between commercial fisheries and indigenous practices. As one example, by-catch of king salmon in Bering Sea fisheries affects Yupik and Athabascan fishermen on the Yukon River. In addition, perceptions of competition for prey species could put commercial fisheries at odds with existence values, if those who value (for example) penguins fear that krill fisheries may reduce the prey available for beloved birds.

In each case, detailed information about the values of ecosystem services in the Arctic is often incomplete at best. Even for commercial fisheries, which are relatively well documented, the full benefits of these fisheries to regional and national economies have not been well documented. Traditional benefits of Arctic ecosystems (e.g., subsistence, cultural uses, shoreline protection) typically take place outside the cash sector of the economy, and so may be overlooked entirely. Existence values are poorly known, but are nonetheless real, and advocates for charismatic species may wield considerable political power. Finally, the impacts of industrial development and related threats on these ecosystem values are poorly understood. In all cases, better data on the nature, extent, and value of the services provided or threatened is needed. A TEEB approach could include important first steps in better understanding the value of Arctic ecosystems and the impact of human activities upon them.

(Henry Huntington, Pew Foundation)

Changes in the Arctic Ocean's Ecosystem Services Resulting from the Collapse of Sea Ice

The Arctic Ocean is experiencing fundamental biological and physical changes triggered by the collapse of sea ice during 2007 and the ensuing years. Not only is sea ice retreating; it is also thinning. Relatively little multi-year ice remains. The total volume of sea ice in the Arctic Basin is at an historical minimum. Current projections suggest that the Arctic Ocean will be ice-free during the summer months as early as 2025-2030.

The change in sea ice has enormous consequences for ecosystem services provided by the Arctic's marine systems. Public attention has focused on opportunities for commercial development made possible by these changes or based on sea ice melt and thus new water that is predicted to open up during the foreseeable future. The Northwest Passage and especially the Northern Sea Route are becoming attractive to those interested in commercial shipping. The recession of sea ice is increasing the accessibility of offshore oil and gas reserves. Ship-based tourism in the Arctic is growing rapidly. Opportunities for commercial fishing may arise during the near future.

Yet the change occurring in the Arctic is proving costly in terms of ecosystem services that are not subject to commoditization or to valuation in terms of market prices and that are often overlooked in thinking about the consequences of this change. This is especially true of services provided by sea ice. The melting of sea ice is lowering the albedo of the Arctic Ocean, thereby increasing the absorption of solar radiation in the high latitudes and contributing to rising temperatures at the Earth's surface. The loss of sea ice makes possible storm surges that erode coastlines in the Arctic, producing conditions that will necessitate the relocation of coastal communities in the near future. The loss of sea ice degrades habitats of importance to seals, polar bears, and walrus, raising questions about whether these species are threatened or endangered. The collapse of sea ice eliminates the possibility of using ice islands as platforms for the conduct of scientific research.

The loss of these services is almost certainly irreversible during the course of this century. Yet it is worth weighing the losses attributable to lowered albedo, coastal erosion, the destruction of habitat important to key Arctic species, and the elimination of opportunities for conducting scientific research against the prospect of benefits associated with services like shipping routes, access to oil and gas reserves, and opportunities for ship-based tourism in any accounting of the balance of benefits and costs arising from the changes now occurring in the Arctic.

(Oran R. Young, UC Santa Barbara)

POLICY AND REGULATION

Fiscal Policy to Promote More Sustainable Uses of Marine and Coastal Ecosystems

Market forces alone do not provide incentives for the provision of most Ecosystem Services and few market mechanisms exist that reflect the cost of human activities in terms of lost ecosystem service value. These market failures take place when the full social and economic value of a good (whether positive or negative) is not reflected by the markets (see earlier section on *Understanding the Full Economic Impact of Resource Damage Mitigation and Mitigation in the Marine World*). This is often the case with Ecosystem Services for three core reasons: 1) they are often public goods that defy ownership; 2) even when these ecosystem services can be made "exclusive" there is absence of ownership rights of their ecosystems and the services they provide and therefore the incapacity to claim for their use, and 3) their positive economic externalities are not recognized by the markets.

In many cases, these market failures could be diminished or eliminated by providing financial incentives or disincentives through fiscal policies (e.g., taxes, fees, royalties, subsidies, etc.). Such fiscal policies could be designed to provide a carrots (payments to the provider for ecosystem services utilized) as well as sticks (payments or compensation from those who use, damage or reduce the long-term supply).

Policy Challenge: Determination of a basis for Taxation

Taxation of Ecosystem Services is a challenge because it is often difficult to make a clear and accurate assessment of their true value. Determination of such a value is essential in order to establish a clear basis for taxation. A TEEB process could provide clear guidance for the measurement of such economic values for marine and coastal ecosystem services.

When ecosystems play a supporting role in the production of other ecosystem services (e.g., soil formation, photosynthesis, nutrient cycling), their value is often difficult to assess. On the other hand, the economic value of ecosystem services that feed directly into production of commercial marketed products (e.g., genetic resources, food, fuel or natural medicines) or services (e.g., tourism), can be determined much more easily.

In the same manner, it is easier to develop fiscal policy mechanisms for those ecosystem services that regulate ecosystem processes (whether regulation of air quality, climate, water or erosion) than when they provide purely socio-cultural benefits, the latter being very difficult to value because of their intrinsic non-material nature.

Benefits of a Fiscal Policy

Although challenging, fiscal policy may help the development and the sustainability of Ecosystem Services in many different ways. First, by taxing for the use ecosystem services, it increases the cost of use by recognizing the intrinsic economic value they provide. This will be beneficial from a public policy point of view either by: 1) making their use less economically attractive, 2) by encouraging more efficient use and finally, 3) promote the development of alternatives. Any of these may lead to reduced use and help building resilience in ecosystems and ensuring their long-term sustainability.

The second benefit comes from the fact that the proceeds from taxation could be used to restore, mitigate or increase the supply of Ecosystem Services. In other words, taxation is a way for governments to reinvest in their environmental and social capital.

A TEEB approach could enhance fiscal policy by providing better guidance and real estimates of the economic value of environmental damages to the oceans and coasts. It could also identify economic activities that affect environmental quality (for better or worse) and show the potential revenue implications of environmentally-based fiscal policy.

(Daniel Dumas, Commonwealth Secretariat)

Addressing Market Failures that Degrade Marine Ecosystem Services with Bundles of Rights and Privileges

Economic thinking can illuminate drivers of marine ecosystem degradation that in many cases overwhelm good intentions and create incentives to circumvent regulations. For example, when rights and privileges to fish stocks – along with responsibilities attached to rights and privileges – are not clearly delineated, the stocks can be rapidly depleted and much economic benefit is forgone because the fish have no value until they are landed, and because fishermen compete with each other to maximize shares of the catch. This common property problem can be solved in two basic ways: (1) fishermen can agree to cooperate with each other to prevent stock depletion, maximize economic returns, and achieve other collective goals; (2) various kinds of rights and privileges can be assigned to individuals or groups to reduce incentives to maximize catch and reward resource stewardship. The success of well designed cooperatives and catch share systems in preventing overfishing and improving economic performance bears this out. Fisheries are just one of many services that marine ecosystems produce; hence, this kind of thinking can be applied to the protection of other ecosystem services too.

A TEEB approach could bring many different kinds of expertise together including institutional design and analysis, the sociology of rights and social contracts, market design, payments for ecosystem services, ecosystem service valuation - to address the many challenges inherent in an effort to create the rights regimes, institutions, accountability mechanisms, and markets that will protect natural capital while generating revenue and enhancing human welfare.

(Rod Fujita, Environmental Defense Fund)

Marine Spatial Planning

Today's oceans face an era of unprecedented activity. Wind farms and other energy facilities, diverse recreational uses, offshore drilling, shipping superhighways, commercial fishing, and aquaculture facilities are competing for what once seemed like limitless space. But our oceans are limited and in order to maximize the benefits our oceans provide, both ecologically and economically, we urgently need a process to rationally guide the management of multiple objectives for the oceans.[xxx] [xxxi]

Ecosystem-based management (EBM) is one approach to maintain an ecosystem in a healthy, productive, and resilient condition so that it can provide the services humans want and need.

Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it examines interactions like tradeoffs and synergies, and considers cumulative impacts of multiple activities.[xxxii] Marine Spatial Planning (MSP) is a planning process that uses EBM principles and focuses on the spatially explicit nature of many ocean activities and resources.

Marine management that considers single sectors or single objectives often treats commercial and non-commercial uses of the ocean as competing with one another. The value of marine ecosystems often are not reflected in decisions made today. In contrast, through MSP various management scenarios can be identified and evaluated, and spatial tradeoffs that include tradeoffs between industrial/extractive uses and ecosystem services can be made in order to pursue goals that attempt to balance many potential uses of the ocean.[xxxiii]

Key Principles for MSP

MSP should be **ecosystem-based** to the maximum extent possible while recognizing geopolitical boundaries. This implies an integrated approach that considers the entire ecosystem, including humans. A TEEB process could help bring to this process the ecosystem service values that reflect the importance people derive from ocean and coastal resources.

MSP is **spatially explicit**, analyzing and potentially allocating three-dimensional marine spaces for specific management objectives. It should seek to minimize use-use and use-environment conflicts, maximize co-location of compatible uses, and protect, maintain and restore ecosystem function and resilience. This type of spatially explicit planning requires good information on the economic value of marine ecosystems, the benefits and costs associated with different uses of the ocean, and the benefits and costs associated with different spatial planning scenarios.

MSP addresses **cumulative impacts** of relevant policies and multiple current and future human activities that affect ecosystems (including location, timing and intensity), and addresses ecosystem changes including but not limited to **climate change**.

A TEEB approach that could shed light on methods for estimating the cumulative impacts of changes in the marine ecosystem services would be particularly useful for MSP.

(Larry Crowder, Stanford University)

Designing and Siting Marine Protected Areas to Protect and Harness Ecosystem Value

MPAs Can Protect and Improve the Economic Value of Marine Ecosystems.

Marine protected areas (MPAs) are now used throughout the world to protect and manage coastal and marine resources. MPAs are most often used to control fishing pressure, but can also be used to limit physical damage (such as from boats and anchors), manage tourism pressure and reduce pollution. They are an important instrument for protecting spawning areas and sources of larvae. By protecting these features, MPAs promote healthy ecosystems within their boundaries, but also promote health in adjacent areas.

Additionally, there must be sufficient financing to support the day-to-day management of MPAs. Too many MPAs become paper parks for this reason. By providing guidance and resources for economic valuations, a TEEB approach could help guide the setting of user fees and could support the development of sustainable financing schemes, as has been shown in Bonaire Marine Park in the Netherlands Antilles and Olongo Island in the Philippines.[xxxiv]

Creating new MPAs has been a challenge historically because they often require that many people change their behaviour. Those affected by MPAs need to know how MPAs will affect their economic, cultural, and social well-being. Fortunately, MPAs could be sited and designed not only to protect habitats but to enhance the economic value and sustainability of ecosystem services.

There it is important to be both strategic and opportunistic in establishing and designing MPAS. There are multiple factors (or filters) which are important to consider when creating and managing MPAs:

- Economic – the projected benefits ecosystem services will likely change with an MPA (increase in goods and services). These benefits should exceed the costs of establishing and managing the area. (Is it worth the cost?)
- Biological – what effect would different MPA shapes, sizes and management options have on future conditions in the area (biomass, species diversity and abundance) and the related provision of goods and services; (Would management make a big difference? Can threats be controlled?)
- Social –stakeholder involvement and support for MPAs is important in the success of MPAs. It is important to consider current users and uses, as well as the costs and benefits of the MPA on current users; (Would the management rules be accepted? Are rules fair to existing resource users? How can we manage single sectors like fisheries to produce conditions conducive to MPA creation?). Perhaps the most important consideration is whether appropriate rights and responsibilities are in place that empower a group of people to become coral reef stewards able to benefit economically from their stewardship efforts resulting in the continued production of an array of ecosystem services at high levels.

(Lauretta Burke, WRI)

Importance of economic values

Estimates of the economic benefits produced by marine protection support the development of marine management in several ways. Having the financial resources to implement management is critical to MPA success. Valuation can help set user fees, as well as develop schemes for other sources of sustainable financing. Perhaps more importantly, before the MPA is established, it makes sense to estimate the change in ecosystem goods and services associated with different scenarios of management (both within and beyond the MPA boundaries). This is useful for confirming that the increase in benefits exceeds the costs, and for identifying the most efficient management option – evaluating trade-offs. This said, the extent of uncertainty of doing projections of benefits of proposed management changes is large. Although there is uncertainty associated with projections of changes in direct use values (fisheries, tourism and recreation), the uncertainties are even larger for indirect use values (such as shoreline protection provided by coral reefs and mangroves).

A TEEB approach could be instrumental in identifying marine and coastal areas of high economic and social value and areas where active marine protection is likely to be economically beneficial.

(Linwood Pendleton, Duke University)

Payment for Ecosystem Services

With the expanding knowledge that ecosystem services provide both market and non-market values to societies, there are new opportunities to develop market-based instruments and strategies for capturing those values. Payments for ecosystem services (PES) is one such emerging mechanism for harnessing the yet uncaptured values of ecosystem services and transforming them into investments in and sustainable financing for maintaining and protecting these ecosystems.

In PES, a buyer(s) makes payments to a seller(s) in exchange for the provision of an ecosystem service of interest. The payment amount is negotiated between the buyer and seller and depends on multiple factors, such as the economic value, the opportunity costs, the financial value, transaction price, and relative costs of alternatives. While ecosystem service value information does not set the "price", it does inform potential buyers of the benefits they will likely receive, e.g., the revenue they generate from intact coral reefs, stable beaches, and healthy fisheries, and the potential economic losses from degradation. This knowledge can help identify opportunities for PES and encourage investments in the protection of ecosystem services. Valuation studies could help build the business case for PES deals, influence the negotiations on the range of bids and offers, and, in some cases (though these may be rare), generate demand for a service.

(Winnie Lau, Forest Trends)

Ecosystem service-based incentive agreements

Incentive agreements allow people who value marine ecosystem services to provide direct benefits to those who play a key role in maintaining the ecosystems that support these services. Incentive agreements are among the more direct forms of payments for ecosystem services – a type of PES that does not require a market, simply individuals or organized groups willing to make a deal to provide financial incentives, access to technologies, and science support needed to protect marine and coastal resources. A network of incentive agreements is being developed by OneReef in the Pacific Region to protect the economic, social and cultural values that are produced by coral reefs and associated ecosystems. These agreements provide jobs and skills development to communities of resource owners willing to commit to long-term management interventions on their reefs. Moreover, they are designed to complement other marine policies that are emerging in the Pacific and elsewhere to protect marine ecosystem services.

Networks of incentive agreements and emerging policies have great potential to mutually support and complement each other. Under incentive agreements for example, communities monitor vessel traffic and wield the authority needed to prevent unauthorized activities in the nearshore environment. Without supporting policies and implementation capacity (e.g., support of commercial vessel host countries), however, the success in preventing unauthorized take is limited, especially in remote locations. Emerging national and international policies can fill this gap and benefit from strong community-level participation fostered through incentive agreements.

A TEEB approach could improve the application of incentive agreements by providing data on ecosystem service flows that are needed to identify the best places to invest limited resources, adjust management interventions adaptively, anticipate needs as climate shifts, and inform the development of multi-lateral agreements that are needed to maintain flows. In particular, there is a need for the information a TEEB approach could supply in several key areas:

- Direct value, significance, and probable resilience of coral reef and related ecosystems, especially in relation to rural/remote households with few alternative sources of income or protein,
- Spatial patterns of consumptive use by commercial vessels, over large areas that encompass multiple countries and territories, including estimates of associated tax and license fees, etc.
- Existing and potential contribution of tourism, and related significance of charismatic species and species that are integral to maintaining ecosystem structure, function, and fitness, e.g., Scleractinian reef-building corals, mangroves/seagrass areas, and predators that maintain top-down forcing

(Chris LaFranchi, OneReef)

Managing the Global Commons: Marine Biodiversity beyond National Jurisdiction

The high seas and seabed Area (beyond national jurisdiction) span nearly 50% of the planet, and harbor most of the oceans' biodiversity as well as important fisheries, genetic and mineral resources. As with other ocean areas, they are also under increasing pressure from overexploitation and pollution, climate change and ocean acidification. This is leading to significant habitat degradation and threats to key ecosystem services and processes.

Unlike areas closer to shore, the high seas and seabed Area can only be managed through global cooperation and coordination. The United Nations Convention on the Law of the Sea (UNCLOS) provides the overarching framework of rights and duties of States, supplemented by treaties and intergovernmental bodies governing specific ocean uses. However to date nothing explicitly addresses the conservation or sustainable use of marine biodiversity and ecosystems beyond national jurisdiction.

Recognizing this gap, States at the United Nations are currently debating the next steps. Many States are calling for a new multilateral agreement under UNCLOS to specifically address biodiversity beyond national jurisdiction; other States say the focus should be on improved implementation of existing instruments. What unites both sides is agreement on the need for science-driven ecosystem-based management, including tools such as marine protected areas, environmental impact assessments and strategic environmental assessments. Also needed to improve implementation are capacity building, transfer of technologies and new sources of funding to support sustainable management and conservation. Another priority for many is a mechanism to fair and equitably share the benefits derived from marine genetic resources found beyond national jurisdiction.

Improved understanding of marine ecosystem services and values beyond national jurisdiction will be essential in underpinning any new biodiversity management regime, creating a tremendous need for what a TEEB approach could deliver.

In particular, a TEEB approach could supply information in several key areas:

- To improve the science-basis for sustainable management and conservation based on economic values (both market and non-market, calculable and incalculable) and ecosystem services.
- To enable an informed discussion on the possible need for a new multi-lateral agreement or agreements to implement ecosystem-system-based management and broad-scale spatial planning,
- To support the effective implementation of tools such as marine protected areas, environmental impact assessments and strategic environmental assessments,
- To provide incentives for transfer of technology and innovative financial mechanisms for capacity development and implementation;
- To explore the full range of value from marine genetic resources beyond national jurisdiction in order to inform discussions on potential benefit-sharing mechanisms.

(Kristina Gjerde, IUCN)

Informing the Implementation of International Environmental Policies in the Areas Beyond National Jurisdiction

International ocean policy is often implemented in a fragmented, sectorally focused manner, which leads to notable shortcomings in the sustainable regulation of the impact of human activities upon the marine environment. Even in cases where international agreements exist related to ocean management, there are significant limitations. The UN Convention on Biological Diversity, for example, does not regulate processes and activities occurring in areas beyond national jurisdiction (ABNJ), only obliging states to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or ABNJ.

Consequently, the management of marine ABNJ, would benefit from efforts to bring more integrated approaches to international waters including the integration of ecosystem service value data into environmental policies. One area of particular importance is developing measures to better identify and manage vulnerable or biologically significant areas. For example, there is currently no North Atlantic-wide, systematic, and coordinated process for identifying and adopting cross-sectoral management measures for these regions. Similar needs may exist for the identification of areas of high ecosystem service value.

A second area in which international environmental policy can be strengthened is ensuring that impact assessments are undertaken for the expanding number of activities on the high seas. Impact assessments in ABNJ are required by a variety of international instruments. Indeed, the International Tribunal for the Law of the Sea recently affirmed that the obligation to conduct impact assessments prior to undertaking a new activity can be regarded as a general requirement of customary international law. Nevertheless, implementation of these requirements is uneven, and there are many human activities that take place in ABNJ for which prior assessments are not yet required under international law.

A TEEB approach could deliver improved understanding of marine ecosystem services and values beyond national jurisdiction, which would be essential in underpinning any new biodiversity management regime. The Convention on Biological Diversity's 10th meeting of the Conference of the Parties (CBD COP 10) has called on the CBD Secretariat to support the development of technical and scientific guidance regarding the implementation of environmental impact assessments for planned activities in ABNJ that may have significant adverse impact on biodiversity or the marine environment. Ecosystem service value data, as part of the TEEB, would be a critical component of the environmental impact assessments.

(Laura Cantral, Meridian Institute)

Valuing Oceans and Coasts: An Ocean Industries Perspective

Access to marine space and resources by ocean industries is increasingly under scrutiny as the impacts of ocean use accumulate. Expanding operations by offshore oil and gas, shipping, ports, offshore renewable energy, fisheries, aquaculture and other commercial activities both impact and depend on marine ecosystem goods and services.

Ocean businesses that fail to assess their impacts and dependence on biodiversity and ecosystem services may be creating and carrying undefined risks to reputation, supply chains and the bottom line. In order to reduce risk and ensure continued access to marine space and resources for responsible use, it is critical for the diverse ocean business community to develop an understanding of the issues, stakeholders and processes concerned with the health of marine ecosystems.

Ocean industries are subject to a growing number of international, regional and national ocean policy and planning developments that are pursued through both sectoral and non-sector specific processes. Ocean policy and planning developments present both challenges and opportunities for the ocean business community to have security and predictability for offshore economic development and investment.

Addressing private sector interaction with the fluid, globally interconnected ocean ecosystem, requires looking beyond sites and individual activities to the wider seascape of synergies, cumulative impacts and undetermined interactions. A multi-sectoral approach that engages all ocean economic actors is required. To be meaningful, practical, and have its results and recommendations actually make a difference towards achieving healthy and productive marine ecosystems that support responsible use, a in depth study must proactively seek and engage the involvement of the diverse ocean business community.

A TEEB process would ideally develop (or lead to) the ocean business community having the incentives, information and tools to: identify industry impacts and dependencies on biodiversity and ecosystem services; assess the business risks and opportunities associated with these; develop information systems, set targets, measure and value performance, and report results; develop strategies and take action to avoid, minimize and mitigate impacts and risks.

More specifically, a well structured study could: provide information on marine ecosystem service benefits and the costs of their loss; create a common language for business that enables the real value of natural capital, and the services it provides, to become understood and be mainstreamed in decision making; emphasize the urgency of action through demonstrating where and when the prevention of biodiversity loss is cheaper than allowing the impact to occur; generate information about value for designing policy incentives; encourage and assist the development of methodologies, metrics and standards for sustainable management and integrated accounting of marine biodiversity and ecosystem services.

(Paul Holthus, World Ocean Council)

Challenges and opportunities for coastal developing countries

Many developing countries now face the challenge of meeting UN targets to ensure poverty is reduced, sustainable livelihoods maintained and improved access provided to better health and education for children. In this context the ocean environment is taken for granted largely due its size. There is a lack of understanding of the economic consequences of environmental change in ocean and coastal areas, including climate change impacts on the marine environment and its impacts on coastal communities. Increased awareness and education is required and must be understood by communities especially those that may be impacted.

Better environmental management requires a better understanding of the value of ecosystem services and who owns, controls, manages, or damages these resources. In some of the developing countries, the customary rights to fishing/reef areas, mangroves, spawning areas, fragile marine areas and important ecosystems are found in coastal areas. Deltas, estuaries, rivers, reef areas and mangroves, are found in many coastal communities. Many of these rights are managed by clans, family groups for the use of resources; in essence, confined to customary uses. For ecosystem initiatives, this is a challenge for overall planning and integration of local issues with overall national efforts at the higher levels of Government.

New Opportunities for Developing Countries

Under UNCLOS, developing coastal states are granted sovereignty over exploitation, conservation and management of natural resources, both living and non living found within territorial and waters and exclusive economic zones. But that right also comes with responsibilities. The Convention clearly states that coastal states have the obligation and responsibility to initiate the necessary measures for conservation of natural resources within their maritime zones. A TEEB for the Ocean could provide critical information needed to understand the costs and benefits of enacting conservation measures and could also help target specific policies and actions.

Additionally international laws may give rights to developing countries to the seabed and subsoil of their extended continental shelf (but not to the water column) subject to lodgment and successful outcome of their claims within the required UN deadline. These rights come with legal, policy, and technical responsibilities including the delineation of maritime boundaries. Understanding the economic value of the living and non-living resources of these areas will be critical in making the case for better delineation and trans-boundary governance.

Opportunities

UNCLOS obviously presents developing countries with opportunities to reap many economic benefits from living and non-living resources including fisheries, deep sea minerals, including oil and gas, and marine biodiversity. Again the ability to manage the rights to the natural resources, and improved capacities to enforce these rights requires more and better economic valuation information. A TEEB approach, combined with country-level TEEB studies, could provide much needed data on the economic value of these resources as well as on the full range of costs associated with extracting and using them.

Bio-prospecting, seabed mining, and the value of marine ecosystems

New industrial development of the deep-sea and high seas has developing countries wondering how best to balance these uses of living and non-living resources. In seabed developments, proper environmental protection and environment impact assessments need to be strengthened. Better knowledge about the impacts of mining on the values of bio-prospecting and marine biodiversity is essential in the application of environmental impact assessments. Other legal and policy issues such as royalties, taxes, the types of contracts for seabed mining, benefit sharing arrangements and fees are matters of concern that could benefit from a better understanding of the value of ecosystem services in the deep seas and high seas.

Under UNCLOS, and also under the Convention on Biological Diversity, coastal states have an obligation to protect and preserve the marine environment. Coastal States have the obligation to control, prevent and reduce marine pollution from dumping, land-based sources or seabed activities within their EEZ through the enforcement of national environmental laws and regulations. In reality the value of marine ecosystems is overlooked and not properly addressed in most developing countries. It is observed that it is difficult to evaluate marine diversity to generate economic benefits. Many developing countries do not have technical capabilities to be able to deal with such matters and so a concerted effort could help address these gaps in our knowledge of these values.

(Masio Nidung, Papua New Guinea)

References

i For details see http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm111115/wmstext/111115m0001.htm
ii UNEP (2006). Marine and coastal ecosystems and human wellbeing: A synthesis report based on the findings of the Millennium Ecosystem Assessment. UNEP.
iii Rosenberg, A. A. and K. L. McLeod. (2005). Implementing ecosystem-based approaches to management for the conservation of ecosystem services. Marine Ecology Progress Series 300:270-274.
iv McLeod, K. L. and H. M. Leslie, editors. (2009). Ecosystem-Based Management for the Oceans. Island Press, Washington, DC.
v Millennium Ecosystem Assessment. (2003). Ecosystems and Human Well-being: A Framework for Assessment. Island Press, Washington, DC.
vi Daily, G. C., S. Polasky, J. Goldstein, P. M. Kareiva, H. A. Mooney, L. Pejchar, T. H. Ricketts, J. Salzman, and R. Shallenberger. (2009). Ecosystem services in decision making: time to deliver. Frontiers in Ecology and the Environment 7:21-28
vii Guerry et al. in press. Modelling benefits from nature: Using ecosystem services to inform coastal and marine spatial planning. International Journal of Biodiversity Science, Ecosystem Services & Management.
viii FAO. (2011). State of World Fisheries and Aquaculture 2011.
ix Worm, B., Hilborn, R., Baum, J. K., Branch, T. A., Collie, J. S., Costello, C., Fogarty, M. J., Fulton, E. A., Hutchings, J. A., Jennings, S., Jensen, O. P., Lotze, H. K., Mace, P. M., McClanahan, T. R., Minto, C., Palumbi, S. R., Parma, A. M., Ricard, D., Rosenberg, A. A., Watson, R. and Zeller, D., (2009). Rebuilding Global Fisheries, Science 31 July 2009: 325 (5940), 578-585.
x Parkes, R. J. et al. (1994) Deep bacterial biosphere in Pacific Ocean sediments. Nature 371, 410–413 (1994)
xi Ausubel, J.H., Crist, D.T., Waggoner, P.E. (Eds.). (2010). First census of marine life 2010: highlights of a decade of discovery. Census of Marine Life, Washington DC. www.coml.org
xii Danovaro R. , et al. (2008). Exponential decline of deep-sea ecosystem functioning linked to benthic biodiversity loss. Curr. Biol., 18 (2008), pp. 1–8.
xiii Halpern, B.S., Walbridge, S., Selkoe, K.A., Kappel, C.V., Micheli, F., D'Agrosa, C., Bruno, J.F., Casey, K.S., Ebert, C., Fox, H.E., Fujita, R., Heinemann, D., Lenihan, H.S., Madin, E.M.P., Perry, M.T., Selig, E.R., Spalding, M., Steneck, R., Watson, R. (2008). A Global Map of Human Impact on Marine Ecosystems. Science 319, 948 - 952.
xiv Clark, M.R., Watling, L., Smith, C., Rowden, A., Guinotte, J.M., 2011. A global seamount classification to aid the scientific design of marine protected area networks Ocean & Coastal Management 54 (1), 19-36.
xv Buhl-Mortensen, L., Bøe, R., Dolan, M.F.J., Buhl-Mortensen, P., Thorsnes, T., Elvenes, S., Hodnesdal, H., 2012. Banks, troughs and canyons on the continental margin off Lofoten, Vesterålen, and Troms, Norway. Chapter 51, In: Harris, P.T., Baker, E.K. (Eds.), Seafloor Geomorphology as Benthic Habitat: GeoHab Atlas of seafloor geomorphic features and benthic habitats. Elsevier, Amsterdam.
xvi Clark, M.R., Watling, L., Smith, C., Rowden, A., Guinotte, J.M., (2011). A global seamount classification to aid the scientific design of marine protected area networks Ocean & Coastal Management 54 (1), 19-36.
xvii Buhl-Mortensen, L., Bøe, R., Dolan, M.F.J., Buhl-Mortensen, P., Thorsnes, T., Elvenes, S., Hodnesdal, H. (2012). Banks, troughs and canyons on the continental margin off Lofoten, Vesterålen, and Troms, Norway. Chapter 51, In: Harris, P.T., Baker, E.K. (Eds.), Seafloor Geomorphology as Benthic Habitat: GeoHab Atlas of seafloor geomorphic features and benthic habitats. Elsevier, Amsterdam.
xviii TEEB . (2010) . The economics of ecosystems and biodiversity: mainstreaming the economics of nature: a synthesis of the approach, conclusions and recommendations of TEEB . UNEP .
xix Cooley, S. R. and Doney, S. C. (2009). Anticipating ocean acidification's economic consequences for commercial fisheries. Environmental Research Letters
xx Cooley, S. R., Lucey, N., Kite-Powell, H. and Doney, S. C. (2011), Nutrition and income from molluscs today imply vulnerability to ocean acidification tomorrow. Fish and Fisheries.
xxi Samonte G, Karrer L, Orbach M. (2010). People and Oceans. Science and Knowledge Division, Conservation International, Arlington, Virginia, USA
xxii For details, see www.science2action.org and www.conservation.org.mmas
xxiii Onofri L. and P.A.L.D. Nunes .(2012). "Beach "Lovers" and "Greens": A Worldwide Empirical Analysis of Coastal Tourism", Environmental and Resource Economics (accepted upon revision)
xxiv Nunes P.A.L.D. and L. Onofri. (2011). "De rationibus est disputandum : profiling warm glowers", in Designing Institutions Taking into Account Individual Preferences (Eric Brusseau, Tom Dedeuwardere and Marc Willinger, Editors), The Oxford University Press.
xxv Rao, N.S., Ghermandi, A., Portela, R., and Wang, X. (2011). Global Values of Shoreline and Coastal Protection: A Spatial Economics Analysis. In Prep.
xxvi Duke NC, et al. (2007) A world without mangroves? Science 317:41-42.
xxvii FAO. (2007) The World's Mangroves 1980-2005, (FAO, Rome).
xxviii Duarte, C. M., Dennison, W. C., Orth R. J. W., Carruthers, T. J. B. (2008). The charisma of coastal ecosystems: Addressing the imbalance. Estuaries and Coasts 31:233-238.
xxix Burke L, Reytar K, Spalding M, Perry A. (2011). Reefs at Risk Revisited Washington DC: World Resources Institute, 114 pp. http://www.wri.org/project/reefs-at-risk
xxx Turnipseed, M., Crowder, L. B., Sagarin, R. D. and Roady, S. E. (2009). Legal Bedrock for Rebuilding America's Ocean Ecosystems, Science 324, 183.
xxxi C.V. Kappel et al. (2009). Issues in Science and Technology, Spring 2009.
xxxii K.L. McLeod et al., (2005). Scientific Consensus Statement on Marine Ecosystem-Based Management (Communication Partnership for Science and the Sea).
xxxiii C. Ehler and F. Douvere, (2007), Visions for a Sea Change: Report of the First International Workshop on Marine Spatial Planning [Intergovernmental Oceanographic Commission (IOC) and Man and the Biosphere Programme, IOC Manual and Guides 46: ICAM Dossier 3. Paris: UNESCO, 2007] (available at http://www.unesco-ioc-marinesp.be/ Spring 2009
xxxiv Dixon J, Scura L, van't Hoft. (1993). Ecology and Microeconomics as "Joint Products": The Bonaire Marine Park in the Caribbean.

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