

Guidelines for Coastal and Marine Ecosystem Accounting:

Incorporating the Protective Service Values of Coral Reefs and Mangroves in National Wealth Accounts



Project Background

Wealth Accounting and Valuation of Ecosystem Services (WAVES) is a global partnership led by the World Bank that aims to promote sustainable development by mainstreaming natural capital in development planning and national economic accounting systems (the System of National Accounts), based on the System of Environmental-Economic Accounting (SEEA). This global partnership (www.WAVESpartnership.org) brings together a broad coalition of governments, UN agencies, nongovernment organizations and academics for this purpose.

Eight developing countries - Botswana, Colombia, Costa Rica, Guatemala, Indonesia, Madagascar, Philippines, and Rwanda – are currently partnering with WAVES to establish natural capital accounts, and more are expected to join over the next two years. These accounts include experimental accounts for ecosystems and ecosystem services, and mangroves have been identified as a priority ecosystem. The methodology for measuring and valuing the provisioning and tourism services of mangroves are well established and these values are, in principle, included in the national economic accounts. But methodology for including the regulating services in national economic accounts, notably, coastal protection services, as well as fisheries enhancement and carbon storage, is not well developed. Guidance is needed for countries that want to build comprehensive accounts for mangroves that include all these services.

The WAVES Policy and Technical Experts Committee (PTEC), which was established in the fall of 2012, has a mandate to guide the development and implementation of scientifically credible methodologies for ecosystem accounting; identify opportunities to contribute to policy and mainstreaming, and ensure cohesion, consistency and scalability among the country studies. The PTEC will therefore work in close collaboration with the WAVES team and The Nature Conservancy, to develop guidance on incorporating the protective service values of coral reefs and mangroves in national wealth accounting.

1.0 Description of Approach, Methodology and Work Plan

1.1 Technical Approach and Methodology

This project brief describes the scope and process for developing **Guidance** for how the protective services of mangroves and coral reefs can be included in national economic accounts to support development planning. This is an important step towards recognizing the critical value of coastal ecosystem services for adjacent human populations that are now regularly cited in both conservation and development literature with coral reefs and mangroves frequently singled out. Both mangroves and reefs are increasingly recognized for their role in natural coastal protection; i.e. for their value in reducing the impacts of coastal erosion and inundation during storms, as well as providing important co-benefits for fisheries production, tourism, and in the case of mangroves, carbon sequestration.

We will focus on reviewing factors that create variation in ecosystem services and their production functions for coastal defense. Some of the key variables that we will consider include how erosion and flooding are affected by habitat area, depth, rugosity, width, stem density (for

mangroves), and hazard intensity among other factors. It is these factors that will help us understand the non-linear nature of the production functions.

Why a focus on Coastal Protection?

In 2011, insured losses from natural disasters (especially coastal and riverine hazards) reached an all-time high and impacts will continue to worsen with continued climate change. Erosion, inundation and extreme weather events affect hundreds of millions of vulnerable people, important infrastructure, tourism, and trade—with significant losses to national economies and major impacts on human suffering. Already, the proportion of the world's GDP annually exposed to tropical cyclones has increased from 3.6 % in the 1970s to 4.3 % in the first decade of the 2000s (UNISDR 2011).

Coastal and marine habitats, particularly coral reefs and mangroves can substantially reduce vulnerability and risk, providing “natural protection”. Yet the value of these systems as “green infrastructure” is still not fully recognized, and they continue to be lost and degraded. Global losses of coastal habitats are as high; 30-50% for wetlands (Zedler and Kercher 2005), 19% loss of mangroves from 1980-2005 (Spalding et al. 2010), while around 75% of the world's coral reefs are rated as threatened (Burke et al., 2011). Often the loss of these habitats is greatest around population centers. That is, where the most people could benefit from these ecosystems is often where their impacts and loss have been the greatest.

Without changes in both policy and perception as to the values of these systems, we can expect the trends in habitat loss to continue. Including the value of these systems in development and investment decisions and National Accounts provides a huge opportunity for positive change. By recognizing and incorporating the true value of these ecosystems in National Accounts, decision-makers will be much more likely to consider these values in decision-making. The urgency of mainstreaming the coastal protection value of mangroves and reefs is great, as over the next 5 to 10 years there are both substantial opportunities and risks that will affect both the ecosystems themselves and the communities that rely on them for the services they provide. Sixty percent of the world population is expected to live in urban areas by 2030, with greater concentration around coastal areas. This means that rates of coastal development will be increasing with heavy investments in coastal infrastructure and potential of loss of more coastal habitats. In addition, climate change and coastal hazards such as storm floods are adding significant risks to coastal population, infrastructure and economic assets, often concentrated in the coastal zone. The impacts of coastal hazards such as tropical cyclones can be devastating to the coastal economies, particularly those of small island nations. Hurricane Gilbert in 1998 caused damages exceeding 365% of St. Lucia's GDP, in 2004 the losses caused by hurricane Ivan in Grenada were more than twice the nation's GDP.

The 2011 Global Assessment Report on Disaster Risk Reduction highlights that economic loss risk due to tropical cyclones and floods is growing as exposure of economic assets increases and the status of ecosystem services degrades, and this is particularly true for coastal areas (UNISDR). In addition, climate change impacts on the coastal zone will result in significant economic and social losses.

Billions of dollars are moving to reduce risks from disasters and climate change, creating both threats and opportunities for natural systems. Total Fast Start Finance commitments under the UNFCCC (through 2012) include roughly \$3 billion for climate adaptation assistance. In the US, FEMA spends \$500 million/year to reduce flooding hazards. Middle income countries such as Colombia, Brazil and China are making multi-billion dollar investments to address risks of flooding and other disasters exacerbated by climate change. Most of these funds are destined for the creation of “grey infrastructure” such as seawalls, which will further degrade coastal ecosystems, and may not be cost effective for risk reduction when compared to more natural and hybrid alternatives. Following the 2004 Indian Ocean tsunami and Hurricane Katrina, there has been substantial scientific focus on recognizing and quantifying

- How effective natural ecosystems-coral reefs and mangroves- are for coastal defense
- The value provided by these systems when compared with hard or built infrastructure such as seawalls, especially when co-benefits are considered
- Where mangroves and reef systems are found and the level of risk reduction they provide.

There has also been an increasing focus on identifying what policies are needed to encourage **ecosystem protection specifically for coastal protection and risk reduction**, and where beneficial and cost effective, their restoration.

1.2 Work Plan

We will work collaboratively with the World Bank WAVES group to develop a Guidance Document that provides a “State of the Art” summary of the protective services of mangroves and reefs and gives guidance about how to use this information for National Wealth Accounting.

Our work will be conducted over the course of 12 months (March, 2014 – February, 2015) in three phases; each elaborated (along with the products associated with each phase) below:

1. **Preparation of a Guidance Document** – Review Sections on the “State of the Knowledge of the Protective Services and Values of Mangrove and Coral Reef Ecosystems (months 1 to 8).
2. **Expert Workshop** to build from the Guidance Document to develop recommendations on how to use the gathered information as part of the National Accounting and other decision-making processes (month 9).
3. **Guidance Document** completion (months 10-12).

2.0 Guidance Document - Review Sections on the Extent and Value of the Protective Services of Mangroves and Coral Reefs

We provide details on the major sections of the Guidance Document below.

Section 1: Introduction: This section will include a description of the WAVES project; an introduction to Why we focus on the protective services of mangroves and coral reefs; the process for developing the document; how to use/apply the information; and limitations and cautions in the use of the information.

Section 2: Mangroves: Mangrove forests are the predominant coastal wetland in tropical and sub-tropical waters. World-wide they cover 152,000 square kilometers and are found in 123 countries particularly along low-energy coastlines, embayments and coastal lagoons. Mangroves provide a considerable range of ecosystem services to adjacent coastal populations; however their location also places them in the way of human development. Vast areas have been converted to aquaculture, agriculture, infrastructure or urban use, and although the social and economic costs of these losses may far outweigh the benefits, few such holistic cost: benefit assessments have been undertaken.

Much is written about the role of mangroves in protecting adjacent coastal land from the impacts of inundation and erosion, both during natural disasters and through their longer-term influence on coastal dynamics, including their potential response to sea level rise. Multiple studies are helping to quantify these processes, while others have begun to build models which provide some level of predictive capacity in this regard. One of the most important observations arising from these studies is the enormous variability in the coastal protection function of mangroves. These need to be well documented and explained if mangroves are to be more widely used for coastal protection purposes. For example, wind waves are typically reduced in height by 13-66% as they pass through 100m stretch of mangroves (McIvor et al. 2012a). By contrast for mangroves to significantly reduce storm surges, a much larger expanse of mangroves is needed: studies indicate from 5-50cm of surge reduction through a kilometer of mangroves (McIvor et al. 2012b). Even so, when combined with the concomitant benefits of wind-wave reduction mangroves can still considerably reduce inundation of adjacent land areas during storms.

Mangroves are also highly dynamic and in some settings are able to maintain their elevation even in the face of rising sea levels (McIvor et al. 2013). Many mangrove restoration efforts have focused on restoring these coastal protection functions, and there is growing interest in using mangroves in hybrid engineering approaches, where mangroves may work alongside engineered sea defenses to further reduce risks.

Some of the co-benefits of mangroves have also been quantified. Among the more widely quantified benefits of mangroves is their role in fisheries enhancement. Mangroves provide a critical habitat for fish, mollusks and crustaceans that provide both income and a critical protein source. Mangrove wood also represents an important resource – as firewood and timber. Much of this is for artisanal use, but in a few places, such as Matang in Malaysia, major commercial silviculture operations are proving to be highly profitable as well as sustainable. Mangroves are

also rich in carbon and highly productive, and play a critical in carbon storage and sequestration, with living biomass estimates over double that of the average for tropical forests and typically very high concentrations of soil carbon. TNC has recently published a global model of mangrove biomass based on a model developed from existing studies from 242 locations in 35 countries (Hutchinson et al. 2013). Other values, locally important, include the production of food and beverages, fodder, pollution reduction, tourism and recreation.

Reviews of mangrove values vary considerably, with fisheries values ranging from \$100-21,000 per hectare per year and forestry values ranging from \$10-1000 (Spalding et al, 2010). Economic assessments of coastal protection values of coastal mangroves are rare and considerably more work is needed to devise consistent, comparable methods.

In the Background Paper, we will bring together existing information from disparate sources, and adapt and update this material in order to generate consistent and comparable outputs that will enable scientifically sound and pragmatic guidance to be developed.

Section 3: Coral Reefs. Coral reefs are hugely important from a risk reduction perspective because they often form large, robust offshore barriers adjacent to vulnerable low lying human settlements. In many places, these reefs serve as breakwaters and are the first line of coastal defense for hazards associated with waves, erosion and flooding (e.g, Sheppard et al. 2005, Burke et al 2011, Beck and Shepard 2012). The role of reefs as barriers is something that is visually apparent from shore as they break waves (sometimes very large waves) and substantially reduce the energy and height that would otherwise hit the shore far more directly. Despite this seemingly well-known role of reefs for coastal defense, there has not been a comprehensive and quantitative review of these coastal defense functions or the factors that create variation in this service.

The Conservancy and partners from the University of Bologna, Stanford , USGS and UC Santa Cruz have sought to fill this quantitative gap with a global review and meta-analysis of coral reef and coastal defense studies (Ferrario in review). We will draw on and expand these efforts in this coral reef section of the WAVES report. Overall, we show that coral reefs dissipate 97% of the wave energy that would otherwise impact the shoreline and that most of this energy reduction happens at the reef crest (88%). As part of this meta-analysis we have been able to quantify the role of reef crest relative to reef flats. Further we are able to begin to quantify the non-linear relationships between (a) hazard intensity and wave energy reduction and (b) reef flat width and wave energy reduction. We also identify some of the key factors to consider in understanding the variation in the coastal defense benefits of coral reefs. From an engineering point of view, some of the most critical features for reefs are height, hardness, and friction. These explain why reefs are so critical; they are large, hard and structurally complex.

The value of reefs for providing numerous benefits and reducing risk directly depends on reef condition; hence reef loss and degradation is expected to result in large increases in wave height and energy impacting the coast. Unfortunately, many reefs are in declining condition and more are at risk as assessed by the Reefs at Risk reports (Burke et al. 2011). For example, in the Caribbean, there have been huge losses of coral reefs and their structural complexity has

declined, which is critical in considerations of coastal protection (Alvarez-Filip et al. 2009). Among the corals that have been lost, most are the staghorn and elkhorn corals, which are complex branching corals that exist in shallower high energy zones on and near reef crests. Their loss can affect both reef height and complexity (i.e., friction), which are critical parameters from a coastal defense standpoint. Where reefs are lost and degraded, we can reasonably expect that exposure to wave energy (daily and from storms) will increase and so will the need for investment in solutions (either gray or green) to stabilize shorelines and protect people and property.

There are few direct economic analyses of the value of coral reefs for coastal protection (e.g. Laurans et al. 2013), but we will bring together the lines of evidence that exist on this topic.

Section 4: Review of Models that evaluate the extent and value of Mangrove and Coral Reef Protective Services. There are a growing number of ecosystem service tools (hereafter referred to as ES Tools) that consider the coastal protection services from coastal habitats such as mangroves and reefs. These include tools such as Marine InVest, ARIES, MIMES, RiVamp, and Climada. In this section, we will compare some of the most common and well-known ES Tools.

We will also identify some of the key coastal engineering models and how they are incorporated in the ES Tools to examine coastal defense benefits. At the core of these ES tools are a set of more traditional coastal engineering approaches, models and tools (hereafter just referred to as engineering tools). These engineering tools are used to estimate exposure to wind, waves and storm surge and to estimate levels of erosion and flooding. The engineering tools are incorporated within the ES tools to assess wave attenuation and erosion reduction and sometimes to estimate the people and assets affected under different exposure considerations. Key engineering tools include software solutions like Delft 3D, Mike21, SMC (IHC) or SMS (USACE-Aquaveo); erosion and flooding formulations and assessments (e.g., USACE Shore Protection Manual, UNECLAC-IHC); coastal infrastructure guidelines (e.g., USACE, FEMA); and other independent models used for the definition of coastal hazards (e.g., WW3-NOAA, SWAN, ROMS) and coastal infrastructure design (e.g. SWASH, Boussinesq and RANS models).

There are very significant differences in the engineering tools and models used at site-scales (km's) as compared to most other scales (e.g., national, regional and global). For example, engineering tools used for infrastructure design are usually numerical models with high computational demands. ES Tools are usually based on engineering models that are valid at national, regional and global scales.

This section will provide a general review of these different approaches indicating some of their strengths and weaknesses and the contexts under which they are most useful. Some of the key considerations we will consider include:

- Major Assumptions
- Data requirement and availability, especially in developing countries
- Ease of Use
- Accuracy and spatial explicitness and resolution,
- Temporal Resolution

Section 5: Review of Existing Valuation Studies of Coral Reefs and Mangroves & Identification of Approaches for Integrating Ecosystem Service Values into National Accounts

Over the past 15 years, there has been growing interest in the quantification of the values associated with provisioning, regulating, and cultural ecosystem services (e.g., Daily, 1997, Heal 2000, Bockstael et al. 2000). There have been a number of studies, for example, highlighting the economic value of coral reefs and mangroves, at scales ranging from local to global. Those published prior to 2008 were compiled in a Global Compilation database by Conservation International, but there has been no synthesis of more recent literature, which has increased substantially (e.g., Barbier et al. 2008, Pendleton et. al 2012, Polak and Shashar 2013, Salem and Mercer 2012, and Siikamaki et. al. 2012).

The basis for the growing interest stems from two distinct but related areas of inquiry. First, there is the concern that by not valuing explicitly these resources, decision-makers are implicitly placing a value of zero on them (Bateman et al., 2013a; Sanchirico and Springborn, 2011). The implication of a zero value in a cost-benefit analysis is that activities that degrade the ecosystem functions will be favored over those that maintain or restore the functions that lead to provisioning, regulating, or cultural ecosystem services (see, e.g., Heal et al. 2005, Bateman et al. 2013a, Bateman et al. 2013b).

Second, a long-standing critique of national accounts that rely on gross domestic product (GDP) or gross national product (GNP) as indicators of the well-being of an economy is that these measures are not very good measures of welfare (Lindahl 1933), especially for environmental and natural resources (Maler 1991). Further they are not adjusted to account for the depletion of natural resources (minerals, oil, forests, and fisheries) and ecosystem services more broadly. This critique has resulted in two strands of literature. One set of papers advocate for the development of a “green national accounting” system (e.g., Maler 1991, Maler et al. 2008, Dasgupta 2009). These papers are trying simultaneously to supplant GDP with a better measure of well-being (social welfare) following the long-standing critique of Lindahl (1933) and include natural capital into the accounts (Dasgupta, 2009). In this literature, the value of ecosystem services is captured by understanding how a change in the service impacts current and future social welfare levels (shadow price).

The other set of literature starts with the assumption that we should try to incorporate ecosystem services directly into the existing or a slightly modified system of national accounting (SNA) framework that is used currently to measure GDP (e.g., Edens 2013a, 2013b, Edens and Hein 2013). These latter efforts have resulted in a recently released UN System of Environmental-Economic Accounting (SEEA) (Obst et al., 2013). However these approaches are still new and it is not yet clear how best to value ecosystem services within SNA frameworks and the best approach likely depends on the type of service (provisioning, cultural, or regulating). Edens and Hein (2013) propose a number of different approaches that attempt to disentangle the value of the service from the management regime, as the latter can result in low values due to

mismanagement (Barbier 2013)¹. For example, the value of mangroves that provide nursery habitat for a commercial fish stock could be deduced by understanding the contribution the mangroves make to the economic rent from harvesting a unit of the resource, which is itself a function of the prices, costs, fish stock levels, and regulatory regime. Furthermore, Edens and Hein (2013) suggest that a simulated market exchange where the supply and demand for the service are estimated could be a viable method of disentangling the value of the ecosystem service from the institutional setting. Siikamaki et al. (2012) present such an approach for valuing carbon in mangrove forests.

While the two strands of literature are not necessarily in agreement on what economy-wide measures of well-being to incorporate ecosystem services in to (Edens, 2013b), both literatures do agree for the need to include them. They also agree that production methods of valuation should be the main basis for inclusion, especially with respect to provisioning and regulating services. There are questions, however, with respect to the merits of a replacement cost or avoided damages valuation approach for coastal protection, especially if the goal is to include these values in SNA (Edens and Hein 2013). Furthermore, there is agreement that issues of spatial scale (local, regional, national), marginal vs. average values (Sanchirico and Mumby, 2009), and valuation estimation techniques for cultural services (contingent valuation, travel cost, hedonic pricing) need to be addressed.

These are all important considerations since the ultimate goal of accounting for ecosystem services is to influence the choices that decision makers make. Oftentimes, choices between promoting GDP (or a similar measure) and protecting the environment may be false choices once environmental degradation is appropriately included in the measurement of economic performance (Stiglitz, Sen and Fitoussi. 2009. Report of the Commission on the Measurement of Economic performance and Social Progress).

Therefore, we will focus our review on production function methods with special attention to the spatial scale, estimation methods, and the type of values in assessments of coastal protection, fish enhancement and carbon storage services from coral reefs and mangroves.

We will also review the growing literature on SNA especially with regards to the issues regarding the nature of the data and valuation methods acceptable for a SNA (Edens, 2013b; Edens and Hein, 2013) and the potential double-counting issues (e.g., Boyd and Banzhaf 2007; 2012). The review will also describe some of the payments for ecosystem services initiatives that have been implemented in some regions to guarantee ecosystem service provision for the population, ensuring sustainability. Double counting is especially important in the case of supporting or regulating ecosystem services, such as coastal protection (Edens and Hein, 2013). For example, a recent paper by Barbier (2013) uses an adjusted net domestic product (NDP) measure to account for the direct benefits provided by natural capital but not for its indirect contributions in terms of protecting or supporting economic activity, property and human lives. The latter he argues are already valued in the accounts via the economic activity that is being protected or supported. The question on whether to include coastal protection services into the accounts, however, does not reduce the importance of measuring the value of these services, as it

¹ Note the issue of how to control for the current management regime is not pertinent in “green” accounting literature because that literature focuses on the change to social welfare assuming that the ecosystem services and underlying ecosystem assets are optimally managed.

is especially important for decision-makers to understand the contribution of natural capital to other sectors.

Section 6: Applying Ecosystem Service Models to Decision-Making at Different Scales

We will review and identify how information on reef and mangrove coastal protection (and other ecosystem) services has been or could be used to inform decision-making within and between countries. Below we identify some examples of how an understanding of variation in coastal protection services can be used by decision-makers.

(i) Better valuations of services (coastal protection, fisheries, tourism) can influence many land- and sea-use decisions. For example, Barbier et al. (2008) consider if it makes more economic sense to cut mangroves and to develop aquaculture ponds or to leave mangroves intact in Vietnam. They showed that leaving mangroves intact would deliver ten times more value in terms of coastal protection, fisheries and forest harvest (e.g., fuelwood, honey) services than cutting mangroves for aquaculture benefits alone. They revealed that (i) subsidies make aquaculture seem more attractive and (ii) most importantly that intact mangroves have real, relevant and quantifiable economic benefits that should be accounted for in decision-making.

(ii) A better understanding of how to model coastal protection services in depth can help decision-makers make more cost-effective investments within sites (e.g., ports). Narayan (2009) identified that mangrove islands were an under-recognized part of effective protection for the Dhamra Port in India. He further identified, using standard coastal engineering models, how these benefits might be effectively expanded.

(iii) Within countries, Arkema et al. (2013) identified qualitatively the variation in coastal protection services from reefs and mangroves (and other coastal habitats) along the entire US coastline. They showed that an understanding of this variation in coastal protection services can help identify national-scale conservation priorities for effective risk reduction.

(iv) It is also increasingly possible to do more quantitative, national-level comparisons of the cost effectiveness of nature-based coastal protection approaches relative to other “gray” solutions such as breakwaters and levees. These approaches have been developed as part of the Economics of Climate Adaptation efforts by Swiss Re, McKinsey & Company and others. Recently they examined costs and benefits of some 20 different approaches for coastal risk reduction and adaptation from mangrove restoration to new building codes in eight Caribbean nations (CCRIF 2010). They found that reef and mangrove restoration was always substantially more cost effective than breakwaters across all eight nations, even though the only reef benefit considered was coastal defense. Moreover, reef and mangrove restoration was one of the most cost-effective of all approaches in seven of eight nations.

(v) The Philippines has just indicated that one of their post-Typhoon Haiyan investments will be \$8 million in mangrove restoration for coastal protection services (see Wall Street Journal -Asia Edition blogs)². An understanding of the factors that create variation in the coastal protection

² <http://blogs.wsj.com/searealtime/2013/11/28/philippines-plans-mangrove-forest-to-protect-coasts-from-storms/>

services of mangroves could help identify what restoration sites might offer the greatest benefits and how wide and dense the mangrove belts may need to be to offer anticipated protection benefits.

(vi) A better accounting for services including carbon sequestration, fisheries production and coastal protection can help in setting restoration goals, approaches for the payments of ecosystem services, and an identification of where actions may have the greatest value. For example, Siikamaki et al. (2012) and Hutchinson et al. (2013) have identified many of the economic and ecological factors relevant for assessing how and where mangrove restoration and conservation may offer the greatest value for carbon sequestration.

Section 7: Recommendations and Next Steps

Sections 1-6 will be drafted before an experts workshop. Section 7 will be drafted after workshop and focus on developing specific recommendations and next steps on how to include the protective services of mangroves and coral reefs in National Accounts and other national decision-making processes.

3.0 Expert Workshop to Review and Revise Guidance & Develop Recommendations

A small 20 -25 person expert workshop will be convened 9 months into the project. The Workshop will build on the Review sections of the Guidance Documents to develop specific recommendations for next steps on how to include the protective services of mangroves and coral reefs in National Accounts and other national decision-making processes. We will also develop recommendations for next steps regarding the application of the guidance and additional needs for research and/or information and model development. The identification of participants for the workshop and its agenda will be developed in close cooperation with the WAVES team.

3.1 Guidance Document

The final Guidance Document will be a technical report of 50-100 pages with supporting documentation including and review and Guidance for including protective services in National Accounts, National Decision-making and Recommendations for Next Steps.

We will coordinate with the Waves team to distribute the document to relevant practitioners and decision makers. We will also coordinate media and policy outreach. This publication is highly relevant to input into the 2014-2015 policy agenda and events around climate change adaptation, post-Hyogo framework on Disaster Risk Reduction, and the post 2015 development agenda where resilience and disaster risk reduction are being considered as possible SDGs.

4.0 Key Project Personnel

Project Lead/Manager & Coral Reef, Adaptation, and Risk Reduction Specialist: Dr. Michael Beck, Lead Marine Scientist, Global Marine Team, TNC. He is responsible for the outcomes and the overall successful completion of the contract. He co-leads the work related to coral reefs and their ecological services. He also oversees the review of models.

Economist, Project Coordinator- Dr. Montserrat Acosta Morel, TNC, serves as project coordinator and provides expertise on the estimation of economic values of mangroves and reefs.

Mangrove Specialist: Dr. Mark Spalding, Senior Marine Scientist, Global Marine Team, TNC leads the work related to mangroves and their ecological services

Policy Specialist - Imen Meliane, International Marine Policy Director, TNC provides key inputs on enabling conditions and policy elements

Economist- Dr. Jim Sanchirico, UC Davis provides expertise on the estimation of economic values of mangroves and coral reefs including their connection to Systems of National Accounts.

Economist-Dr. Juha Siikamäki, Resources for the Future (RFF) provides expertise on the estimation of economic values of mangroves and coral reefs including their connection to Systems of National Accounts.

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