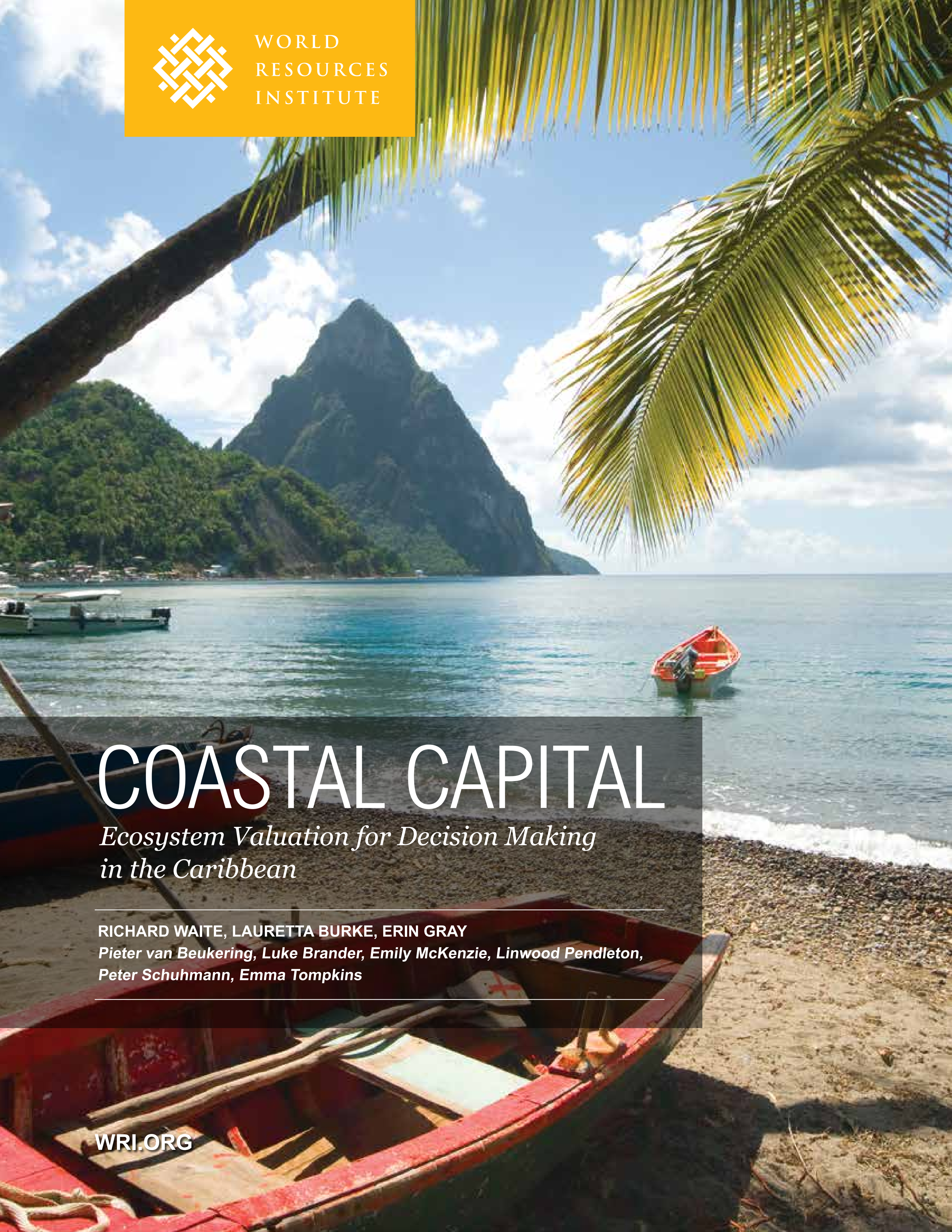

WORLD RESOURCES INSTITUTE

COASTAL CAPITAL

Ecosystem Valuation for Decision Making in the Caribbean

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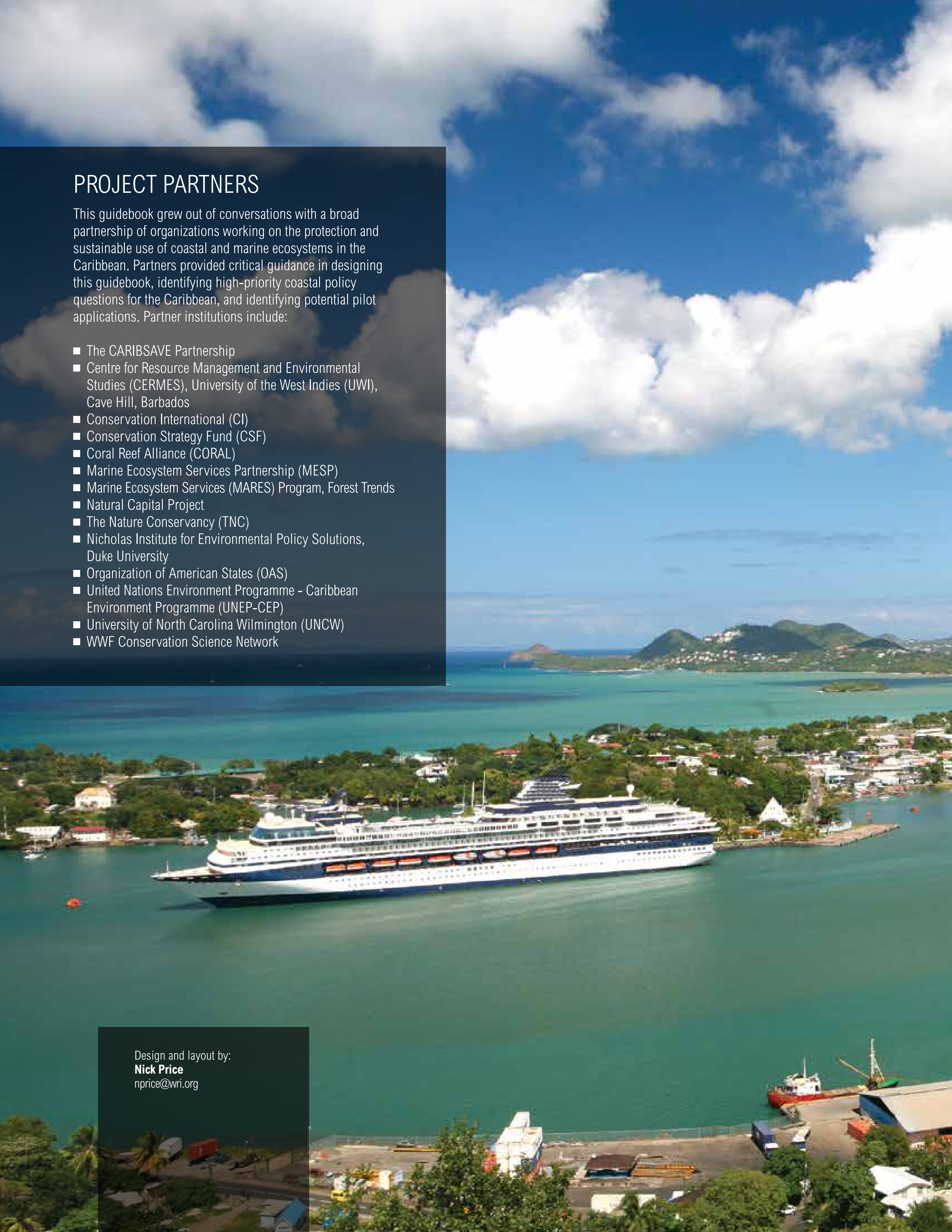

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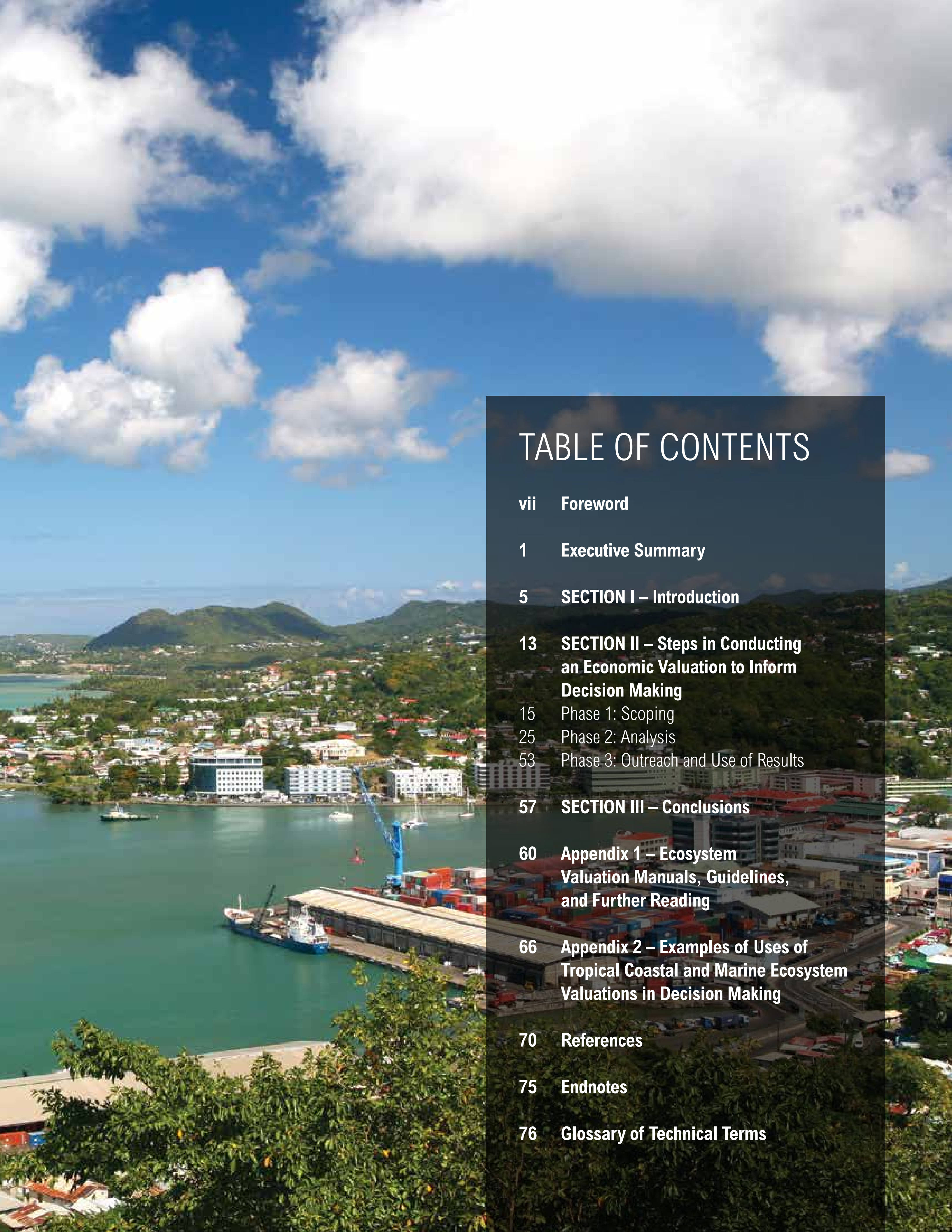

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TABLES, FIGURES, AND BOXES

FOREWORD

Coastal ecosystems—including coral reefs, mangroves, and beaches—are essential to the well-being of the Caribbean's people and economies. They contribute to food security for hundreds of thousands of fishing families, protect coastal communities and infrastructure against tropical storms, and provide economic livelihoods in the form of fishing and nature-based tourism.

Yet 75 percent of the Caribbean's coral reefs are at risk from overfishing and pollution. In addition, nearly a quarter of the region's mangrove area was lost between 1980 and 2005, mainly to urban and tourist development. These human pressures, combined with rising sea levels and increasing storm intensity due to climate change, threaten to accelerate beach erosion and coastal flooding. Between 1985 and 2000, beaches in several Eastern Caribbean countries eroded at a rate of half a meter per year. In a region where more than half of the population lives within 1.5 km of the shoreline, these trends pose serious social and economic risks.

Because many benefits of healthy ecosystems do not show up on balance sheets and are not sold in markets, governments and businesses often make decisions that favor short-term gain but compromise long-term ecosystem health. In recent years, researchers have turned to ecosystem valuation, which quantifies the monetary value of ecosystem goods and services, to make the economic case for protection of coastal ecosystems. Yet surprisingly few of these valuation studies have led to action.

Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean seeks to fill the critical gap between research and action. WRI's analysis of coastal valuation studies that *have* successfully informed decisions in the Caribbean suggests some common features. These include economic analysis based on solid science and focused on a clear policy question, broad participation by local stakeholders, and effective communication and collaboration with decision makers. Our guidebook walks practitioners through the process of conducting an ecosystem valuation with a goal to inform decision making.

Following the advice in this guidebook will allow valuation practitioners to make the best use of their scarce funds and time—increasing the likelihood that their important work will have real-world impact on policy, management, and investment decisions. In this way, ecosystem valuation will contribute to sustaining the Caribbean's coastal capital for generations to come.

Andrew Steer
President
World Resources Institute

EXECUTIVE SUMMARY

Coastal ecosystems are valuable to people and economies across the Caribbean, but are threatened by human pressures. Ecosystem valuation can make the economic case for protection of coastal ecosystems, but in many cases valuation studies have had a limited impact on decision making regarding coastal resource use in the Caribbean. Drawing on the lessons learned from coastal valuations that have successfully informed decision making in the Caribbean, this guidebook leads valuation practitioners through the three phases of a valuation effort to inform decision making:

1. Scoping
2. Analysis
3. Outreach and Use of Results.

Tropical coastal ecosystems—including coral reefs, mangroves, beaches, and seagrasses—provide a range of valuable goods and services to people and economies across the Caribbean. These ecosystems contribute to tourism, fisheries, shoreline protection, and more. However, despite their importance, coastal ecosystems are under threat from numerous human pressures, including overfishing, pollution, and climate change. Left unchecked, these pressures will degrade coastal ecosystems, reducing benefits from these ecosystems in the future.

A wide range of policy, regulatory, and management tools are available to reduce pressures on coastal ecosystems and promote their sustainable use. These include marine spatial planning, marine protected areas, fishing regulations, land use planning, sewage treatment requirements, integrated watershed management, and many others.

Decision makers rely on many types of information and analysis—including political, social, economic, and environmental—to identify issues of concern and choose among alternative courses of action. Balancing conservation and development requires consideration of all these factors in determining which projects to pursue, policies to enact and enforce, and investments to make.

Economic analysis, in particular, can help decision makers allocate scarce resources among competing societal demands. However, traditional economic analysis often fails to fully consider benefits provided by coastal ecosystems and other natural resources—especially those services, such as coastal protection, that are not bought and sold in markets. Undervaluing the benefits that coastal ecosystems provide—as well as the costs of insufficient coastal protection—can lead to underinvestment in the protection and management of these ecosystems, and encourage short-sighted decisions that fail to take the long-term benefits provided by healthy ecosystems into account.

Economic valuation has the potential to help turn the tide by making the economic case for investment in coastal ecosystem protection. Economic valuation can show the benefits that coastal and marine ecosystems provide to society using monetary, social, and biophysical metrics that are easily understood and are the basis for many policy decisions. In the Caribbean, coastal ecosystem valuation has contributed to better informed and more holistic decision making about resource use, justified policies and investments that protect coastal ecosystems or promote their sustainable use, and identified sources of finance for coastal conservation. However, while more than 100 valuation studies have been conducted in the Caribbean's coastal areas, only a minority of these studies have had an observed influence on policy, management, or investment to date.

While these cases of observed use in decision making are limited in number, they contain valuable lessons for future studies and highlight economic valuation's potential impact in the region. A number of key enabling conditions have contributed to these studies' influence, including:

- A clear policy question
- Local demand for valuation
- High levels of economic dependence on and threats to coastal resources
- Strong stakeholder engagement
- Good governance
- Effective communications and access to decision makers
- A clear presentation of methods, assumptions, and limitations.

These enabling conditions informed the development of this guidebook, which details the main steps in conducting an economic valuation of coastal ecosystems to inform decision making in the Caribbean. The guidebook leads practitioners through the scoping, analysis, and outreach and use of results phases of a valuation effort, summarized below (Figure ES-1):

1. **Scoping.** In this phase, valuation practitioners identify the policy question and think critically about the potential for economic valuation to inform decisions in the potential study area. Practitioners also conduct a review of previous relevant studies, identify and engage stakeholders who are interested in the policy question, and identify key decision makers with a view to developing a communications strategy.

2. **Analysis.** The guidance for this phase draws heavily on existing economic valuation guidelines, frameworks, and tools (see Appendix 1). Practitioners use a participatory process to develop scenarios of alternative futures (e.g., alternative development, conservation or man-

agement pathways). They then identify the causal links between the scenarios, changes in ecosystem health, and provision of ecosystem goods and services. The next step is to choose methods to value the changes in human well-being (ecosystem services) due to ecosystem change. They then collect and analyze the biophysical and socioeconomic data, and report valuation results using a set of best practices—keeping in mind the needs of stakeholders and decision makers.

3. **Outreach and Use of Results.** In this phase, practitioners work with stakeholders to develop products derived from the valuation results (e.g., non-technical summary brochures), and communicate the results to decision makers. In order to make the valuation more useful to a wider community of decision makers and interested parties, they share the results in online databases and help to monitor the impact of their study.

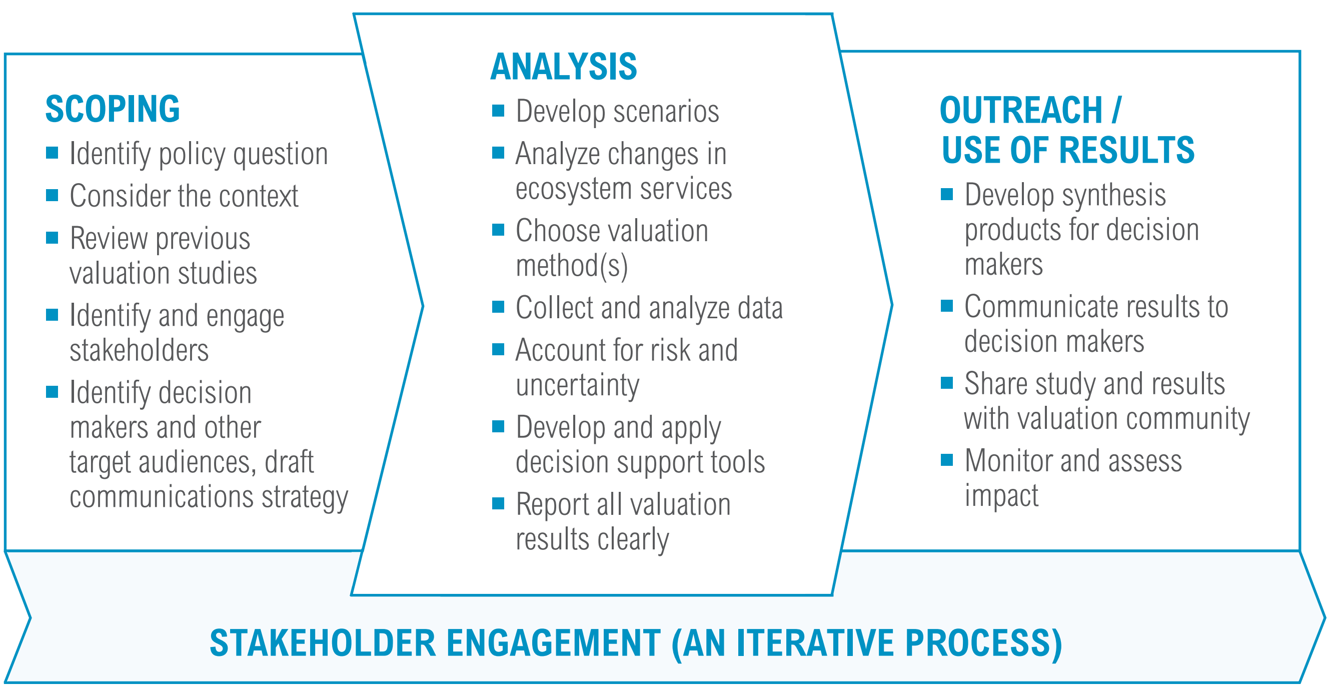
The most effective studies typically entail close collaboration between valuation practitioners, stakeholders, and decision makers throughout all phases of the valuation effort. This collaboration is often an iterative process, where analysis, interpretation of results, and reanalysis occur until the final results reflect scenarios and policy outcomes that are broadly acceptable to stakeholders and decision makers.

There are already many economic valuation guidelines, frameworks, and tools in the public domain (see Appendix 1). This guidebook builds on these resources whenever possible. It fills three significant gaps by providing:

- Advice on conducting coastal ecosystem valuation with a specific emphasis on informing decisions (section II—the main body of this guidebook).
- Examples of best practice studies that use valuation to address the most pressing coastal policy questions in the Caribbean (Table 2).
- Best practice reporting guidelines for new coastal valuation studies (Table 11).

Human pressures on coastal ecosystems are considerable across the Caribbean, but keeping these valuable ecosystems healthy is critical to the continued well-being of people and economies in the region. This guidebook aims to help practitioners conduct coastal valuations in the Caribbean that will have greater influence on policy, management, and investment decisions—ultimately helping to safeguard these resources for generations to come.

Figure ES-1 | **Steps in conducting coastal ecosystem valuation to inform decision making in the Caribbean**



SECTION I

INTRODUCTION

Ecosystem valuation can make the economic case for protection of coastal ecosystems, but many valuation studies have had a limited impact on decision making regarding coastal development and resource use in the Caribbean. Still, the cases where coastal valuation studies *have* informed decision making reveal a pattern of enabling conditions that encourage use of valuation information. These conditions include a clear policy question, strategic choice of study area, strong engagement with stakeholders and decision makers, and transparency in reporting of valuation results.

Why conduct economic valuation of coastal ecosystems in the Caribbean?

Tropical coastal ecosystems—including coral reefs, mangroves, beaches, and seagrasses—provide a valuable range of goods and services to people and economies across the Caribbean, which contribute directly and indirectly to human welfare (Table 1). For example, these ecosystems provide critical habitat to commercially important fish, attract tourists from around the world, and protect coastal communities and infrastructure from the ravages of tropical storms.

Despite their importance, these ecosystems are under threat. More than 75 percent of the Caribbean's coral reefs are threatened by human activities, including overfishing, pollution, and climate-related threats such as coral bleaching and ocean acidification.[1] Left unchecked, these pressures will degrade coastal ecosystems, leading to reduced benefits from these ecosystems in the future.

There are a wide range of policy, regulatory, and management tools available to reduce pressures on coastal ecosystems and promote their sustainable use. These include marine spatial planning to determine efficient zoning of coastal resource uses, marine protected areas to allow for management of fishing and other activities, and fishing regulations (such as restrictions on gear types, catch limits, fishing seasons, or capture of certain species). Land use planning can play an important role in managing pressure on coastal areas, through outright protection of critical habitat (e.g., mangroves), or restrictions on development in sensitive areas (such as coastal buffer zones or steep slopes). Sewage treatment requirements, regulation of discharge from ships, and incentives for integrated watershed management can also play a role in improving coastal water quality.

Decision makers rely upon many types of information and analysis—including political, social, economic, and environmental—to identify issues of concern and choose among alternative courses of action.[2] Balancing conservation and development requires that decision makers consider all of these factors in determining which projects to pursue, policies to enact and enforce, and investments to make. Economic analysis, in particular, can help decision makers allocate scarce resources among competing societal demands.[3]

However, traditional economic analysis, such as cost-benefit analysis, often fails to fully consider benefits provided by coastal ecosystems and other natural resources. This is especially true for benefits that are not bought and sold in markets, such as those provided by coastal protection. Undervaluing the benefits that coastal ecosystems provide—as well as the costs of insufficient coastal protection—can lead to underinvestment in the protection and management of these ecosystems. Many of the activities

Table 1 | **Examples of coastal ecosystem goods and services**

ECOSYSTEM GOODS AND SERVICES	CORAL REEFS	MANGROVES	BEACHES	SEAGRASSES
Provisioning services				
Food (e.g., fisheries)	X	X	X	X
Raw materials	X	X	X	X
Medicinal resources	X	X		X
Genetic resources	X	X		X
Regulating services				
Flood/storm/erosion regulation	X	X	X	X
Climate regulation	X	X	X	X
Cultural services				
Tourism and recreation	X	X	X	
History, culture, traditions	X	X	X	X
Science, knowledge, education	X	X	X	X
Supporting services				
Primary production	X	X	X	X
Nutrient cycling	X	X		X
Species/ecosystem protection	X	X	X	X

Sources: Adapted from Schuhmann 2012a, UNEP 2006, Barbier et al. 2011, Costanza et al. 2006.

that damage coastal ecosystems arise from short-sighted decisions that fail to take long-term benefits provided by healthy ecosystems into account.

Economic valuation can contribute to more informed and holistic decision making about resource use and identify opportunities for effective conservation and sustainable use. Economic valuation of ecosystem goods and services provides policy makers and decision makers with easy-to-understand metrics (including monetary, biophysical, and social) and is frequently used for investment and development decisions. In the Caribbean, valuation has been used to:[4]

- **Evaluate the environmental, social, and economic impact** of a proposed development or policy
- **Justify, support, inform, and advocate policies** that restore or protect coastal ecosystems or promote their sustainable use
- **Raise awareness** of the value of coastal ecosystems
- Inform **green national accounting**
- Establish levels of **damage compensation**
- Determine appropriate **charging rates for ecosystem use** (such as marine park user fees)
- Design methods to **extract finances** from coastal ecosystem services (such as payments for ecosystem services schemes)

- **Compare costs and benefits** of different uses of the coastal environment and assess tradeoffs, including distribution of effects among winners and losers
- **Determine the most cost-effective strategy** for meeting a specific policy objective
- **Develop marine spatial plans** that balance multiple—and sometimes conflicting—uses of the coastal and marine environment
- **Develop climate adaptation strategies** to reduce the vulnerability of people to climate-related risks, including comparison of the tradeoffs of built and ecosystem-based adaptation options (i.e., gray vs. green infrastructure, such as levies and coastal ecosystem restoration as alternatives to protect coastal communities).

In the Caribbean, valuation could shed light on a number of important policy questions related to the protection, restoration, and sustainable use of coastal ecosystems—including questions related to tourism, fisheries, shoreline protection, climate change, pollution, and marine spatial planning. See Table 2 for examples of high-priority policy questions and examples of valuation studies that address them.

Table 2 | **High-priority policy questions and examples of studies**

POLICY QUESTION	EXAMPLE STUDIES
1. Tourism: How responsive are tourists to changes in environmental quality (e.g., changes in beach or water quality, or coral reef condition)? What will happen to tourism revenue or visitation in a country following a change in condition—using scenarios of possible futures? How will tourist arrivals be redistributed to other countries in response to environmental change?	■ **Schuhmann 2012b** used **choice modeling** to elicit tourist preferences for coastal tourism attributes in Barbados (e.g., beach cleanliness, beach width, proximity to beach, water quality). The study found that tourists prefer wider and cleaner beaches, but once beaches reached a particular width, tourists were indifferent to additional width. ■ **Edwards 2009** used **contingent valuation** and **choice modeling** to gauge tourist willingness to pay for a range of variables in Jamaica (e.g., beach cleanliness, beach width, water quality, coral reef quality, fish abundance) and to determine an appropriate environmental tax level (for tourists) to finance coastal protection. The study found that a small tax could completely finance coastal zone management and effects of the tax on the visitation rate would be negligible.
2. Fisheries: What are the economic benefits of no-take zones (and other marine protected areas) to nearshore fisheries? What are the economic returns to investing in more effective protected area management?	■ **McClanahan 2010** used a **market price** approach to examine empirically the effects of fisheries closures and gear restrictions on the long-term profitability of fishing in Kenya. Areas with fishing restrictions saw profitability increase by about 50 percent. ■ **White et al. 2008** used the **production function** method to evaluate the economic performance of fishing reserves. The results indicated that reserves can maximize fishery profits when a moderate proportion of the coastline is in reserves (in contrast to ecological studies focusing on maximizing fish yields, which recommend a greater area under reserves).
3. Climate Change: How are coastal ecosystem service values—especially tourism, fisheries, and shoreline protection—likely to change given threats such as climate change and ocean acidification? How could communities adapt to climate change, maintaining important ecosystem services?	■ **Simpson et al. 2010** used a combination of geospatial modeling of sea level rise along with several valuation methods (including **benefits transfer** and **cost of avoided damage**) to estimate the damages and costs likely to result from sea level rise (1 meter and 2 meter scenarios) by 2100 in CARICOM countries. ■ **Forster et al. 2012** used **choice modeling** to examine the implications of increased hurricane risk for tourism in Anguilla. The study shows that the perception of increased hurricane risk could have a significant impact on the island’s tourism industry. ■ **Haites et al. 2002** used **benefits transfer** and **cost of avoided damage** to assess the economic impact of climate change on CARICOM countries, through losses in tourism, fisheries, shoreline protection, and other services.

Table 2 | **High-priority policy questions and examples of studies (cont.)**

POLICY QUESTION	EXAMPLE STUDIES
4. Simple values for advocacy: What is at stake if coastal ecosystems degrade? What is the annual economic contribution (or economic impact) of fisheries, tourism, and shoreline protection in a site or country? (This question could also inform green national accounting, if values are tracked over time.)[5]	■ **Cooper et al. 2009** evaluated the net annual benefits from reef- and mangrove-associated fisheries and tourism in Belize using a **market price** approach; and evaluated annual shoreline protection value from these ecosystems using **cost of avoided damage**. The study found that the economic impact of these ecosystems was significant in relation to Belize's GDP. ■ **Hargreaves-Allen and Pendleton 2010** used a **market price** approach to present data on annual and future economic impacts associated with two flagship national parks in the Bahamas, documenting income, employment, and food security benefits associated with fishing, recreation and tourism, and other non-extractive uses (e.g., research, education).
5. Reduced pollution: What are the benefits (i.e., increases in coastal ecosystem service values) stemming from improved sewage treatment at the primary, secondary or tertiary levels?	■ **Waterman 2009** used **choice modeling** to estimate the economic value of hypothetical environmental management changes in the Folkestone Marine Reserve, Barbados, including additional sewage treatment. Residents were found to be willing to pay less for higher levels of treatment than tourists.
6. Marine spatial planning: How to achieve equitable and sustainable use of coastal and marine environments to benefit local and global populations?	■ **Clarke et al. 2013** used several methods to assess how alternative coastal and marine zoning plans in Belize would affect ecosystem services. This study identified areas for coastal development that limit impacts on habitats and the services they provide, as well as areas most critical for conservation and the sustainable delivery of ecosystem services.

Sources: Authors and project partners.

Has economic valuation lived up to its potential to inform decision making in the Caribbean?

Over the past 30 years, the literature on economic valuation of the Caribbean's coastal and ocean resources has increased dramatically. More than 100 coastal and marine valuation studies have been conducted in the Caribbean.[6] The quality of analysis, data, and communication of methods and results, however, has varied. The studies have employed different valuation methods, including market-based methods, non-market methods, and benefits transfer. This wide variety of methods, coupled with the variation in study quality, yields results that are not comparable, particularly across countries and time.[7]

Recent reviews of coastal valuation literature reveal challenges related to integrating valuation results into decision making, and evaluating the extent of the real-world use of valuation studies. For example, a review by the World Resources Institute (WRI) and the Marine Ecosystem Services Partnership (MESP)[8] found that although valuation studies have raised awareness about the economic importance of coastal ecosystems in the Caribbean, only a minority of studies have had a direct, observable influence on policy, management, or investment decisions. Through a series of interviews, WRI and MESP were only able to identify 16 coastal valuation studies that have directly influenced decision making in the Caribbean (see Appendix 2). Other researchers have also found low use of ecosystem valuation in decision making.[9] Still, these reviews found some notable and encouraging successes.

The 16 Caribbean coastal valuation success stories highlight the potential for economic valuation to improve decision making in the region. For example, economic valuation can inform efforts to create new fishing regulations, establish sustainable marine protected area financing through user fees, and recover damages after ship groundings. From these cases, WRI, MESP, and others identified key enabling conditions that likely led to success in informing decision making:[10]

- A clear policy question
- High levels of stakeholder interest and engagement, with meaningful participation
- High levels of economic dependence on and threats to coastal resources
- Strong local partnerships
- Good governance and strong institutions
- Opportunities for revenue raising (e.g., establishing user fees in a marine protected area)
- Effective communications and access to decision makers and/or media
- Use of scenarios in the valuation analysis
- Integration of local and traditional knowledge with scientific knowledge
- A clear presentation of methods, assumptions, and limitations.

Conversely, these researchers identified several possible explanations for the lack of observed influence of many valuation studies:[11]

- Absence of key enabling conditions for influence (e.g., effective communications, a clear policy question, good governance)
- Difficulty in tracking and observing influence
- Informing decision making is not the primary goal of the valuation study (in the case of strictly academic research, it may not be a goal at all)
- Inaccuracy of results or lack of relevance of results to decision-making processes
- Lack of familiarity with and/or confidence in valuation methods and results among decision makers
- Insufficient time having passed since the study (it can take many years to influence decision making).

In April 2013, Schuhmann conducted a series of conversations with Caribbean policy makers in which a majority indicated that valuation studies have indeed influenced their coastal policy and management decisions.[12] While anecdotal, such conversations undermine the notion that few studies have influenced decision making. In the Caribbean, interest in ecosystem valuation to inform smart choices about coastal resource conservation and management is growing, as evidenced by recent government initiatives.[13] However, the direct influence of valuation is difficult to assess; policy makers rely on many types of information when making decisions—including budgets, time constraints, equity concerns, political concerns, and other constituent concerns. More research is necessary to analyze the influence of economic valuation on coastal policy to date, including through more direct interaction with policy makers and decision makers.

Has economic valuation lived up to its potential? Relatively few coastal valuation studies demonstrate direct influence, yet there are notable success stories and demand for valuation information is growing. The influence of valuation may be underestimated, given the difficulty in tracking it.

Either way, a pattern of enabling conditions for use of valuation information is emerging—and valuation practitioners, donors, and others who are designing initiatives with a valuation component should do more to ensure that valuation studies have greater influence. Efforts are needed to strategically scope out, design, and execute valuation studies, and communicate study results to target audiences through a collaborative and iterative process with stakeholder groups. In addition, the use of guidelines, tools, and best practices for valuation methods, reporting results and monitoring influence, and building more local capacity could contribute to more strategic, cost-effective, and influential valuations.

Best practices for conducting coastal ecosystem valuation to inform decision making

Drawing on the experience of coastal valuation success stories (Appendix 2), this guidebook details the steps in conducting a coastal ecosystem valuation to inform decision making in the Caribbean.[14] It guides valuation practitioners through three phases of a valuation effort: scoping, analysis, and outreach and use of results. Its intended audience includes:

- **Economists** who aspire to conduct valuation research that will be used by decision makers. Economists will probably be most interested in Phase 1 (scoping) and Phase 3 (outreach and use of results), as they will likely already have extensive training in economic valuation techniques.
- **Non-economists (such as researchers from other disciplines, government officials, and other stakeholders)** who want to use valuation as a strategy to inform or improve decision making. These practitioners will benefit from the guidance in all three phases (all of section II).

This guidebook also counsels users on reporting valuation results (Table 11). By applying its best practice guidelines, valuation results can be more easily compared (e.g., over time or across countries), or used in future benefits transfer studies. Adherence to standard guidelines should also yield more credible results with greater potential to inform decisions.

There are already many economic valuation guidelines, frameworks, and tools in the public domain (Appendix 1). Although this guidebook builds on and refers to these resources whenever possible, it fills three notable gaps by providing:

- Advice on conducting coastal valuation with a specific emphasis on informing decisions (Section II).
- Examples of best practice studies that use valuation to answer the most pressing coastal policy questions in the Caribbean (Table 2).
- Best practice reporting guidelines for future coastal valuation studies (Table 11).


SOUTHERN
PLANNING
REGION

SECTION II

STEPS IN CONDUCTING AN ECONOMIC VALUATION TO INFORM DECISION MAKING

Drawing on the experience of coastal valuation success stories, this guidebook details the steps in conducting a coastal ecosystem valuation to inform decision making in the Caribbean. It guides practitioners through the three phases of a valuation effort to inform decision making:

1. Scoping
2. Analysis
3. Outreach and Use of Results.

Analysis of previous coastal valuations in the Caribbean shows that certain enabling conditions can help economic valuations inform decisions. WRI and MESP categorized these enabling conditions into three types:[15]

- **Contextual** conditions are largely outside of a valuation practitioner's control, such as a study area's economic dependence on coastal resources, or quality of governance.

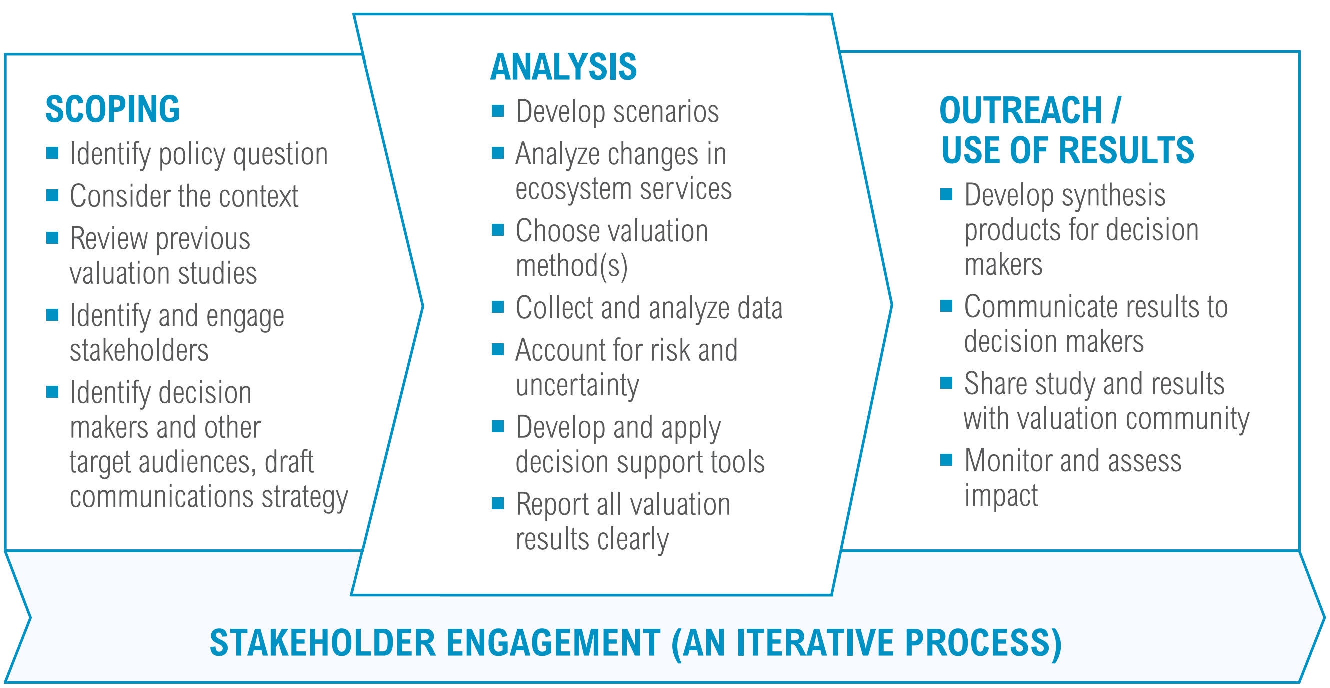
- **Procedural** conditions are largely within a valuation practitioner's control, such as level of stakeholder engagement or existence of an outreach strategy.

- **Methodological** conditions are related to the economic valuation method used and characteristics of the information and knowledge produced (e.g., what metrics, ecosystem services, and scenarios are considered). There is no one "best" valuation method—rather, the choice of method should depend on the policy question being addressed, as well as the amount of time and resources available to the practitioner.

These enabling conditions underlie the steps in conducting an economic valuation to inform decision making—through the scoping, analysis, and outreach phases of a valuation effort (Figure 1). While not all valuations will go through all steps, these steps form a checklist that practitioners should consider when designing and implementing a new valuation (Box 1).

In practice, steps may occur in a different sequence or there may be feedback loops requiring some steps to be repeated as the analysis proceeds.[16] The most effective studies typically include close collaboration between valuation practitioners, stakeholders, and decision makers throughout all phases. This collaboration is often an iterative process, where analysis, interpretation of results, and reanalysis occur until the final results reflect scenarios and policy outcomes that are broadly acceptable to stakeholders and decision makers.

Figure 1 | **Steps in conducting coastal ecosystem valuation to inform decision making in the Caribbean**



Phase 1: Scoping

The scoping phase includes the following steps:

1.1. Identify the policy question to be addressed by coastal ecosystem valuation.
1.2. Consider the context of the study area to determine if economic valuation is the right approach.
1.3. Conduct a review of previous relevant coastal valuation studies.
1.4. Identify and engage stakeholders who are interested in the policy question, clarify objectives of the study, and clarify how stakeholders will be engaged throughout the process.
1.5. Identify decision makers and other target audiences and begin to develop a communications strategy.

Step 1.1. Identify the policy question

If the goal of the valuation is to inform decisions regarding coastal policy, management, or investment, then identifying the policy, management, or investment question (called the "policy question" in this guidebook) the valuation will help to address is a logical first step. Identifying a clear policy question at the outset will determine the appropriate level of stakeholder engagement, the appropriate valuation method, the level of accuracy required, data needs, costs, scale, and time constraints. (Table 2 provides examples of policy questions and published studies that address each question.)

Coastal ecosystem valuation can help inform a range of decisions, which are summarized—along with examples of influential studies—in Table 3.

When identifying the policy question, consider:

- What are the coastal ecosystem services at stake? (e.g., tourism, fisheries, shoreline protection)
- What is the appropriate geographical scale? (e.g., site-specific/protected area, subnational, national, regional)
- What are the policy options or range of possible futures under consideration?
- What are current and desired human uses of the environment?
- What are the likely economic effects of policy action or inaction? What is likely to change?
- What are the time and budgetary constraints?
- What is the necessary level of accuracy?

BOX 1 | CAPACITY ISSUES: WHO IMPLEMENTS THE VALUATION STUDY?

Limited human resources in many Caribbean governments and nongovernmental organizations (NGOs) mean that even when the skills to do an economic valuation are available in-house, the appropriate personnel may not be available. Furthermore, complex ecological and economic modeling methods may require skills that many organizations in the region do not possess. In this case, hiring an outside consultant or partnering with a local research institute may be necessary.

A non-specialist can use this guide to manage the consultants and experts, and to participate fully in the valuation design and process, thereby building local capacity for future ecosystem valuation exercises. Van Beukering et al. (2007, chapter 9) provide additional advice on finding valuation consultants, writing terms of reference, and budgeting for an economic valuation study.

Source: van Beukering et al. 2007.

The level of accuracy needed for valuation results will inform the choice of valuation method (Step 2.3). Sometimes, a quick "ballpark" estimate will be sufficient to inform a decision, and other times, more detailed data collection and analysis will be necessary. Valuation practitioners should weigh the benefits of a more complex and sophisticated analysis (e.g., improved accuracy or greater applicability to the policy question), with the potential costs and technical expertise required.

If the proposed valuation is "demand driven"—that is, the desire for a valuation originates from near the proposed study area to help solve a specific problem—it will almost certainly involve a clear policy question. If it is "supply driven"—that is, originating from an academic source, from an NGO in another country, or from another actor farther removed from the proposed study area—local stakeholders should be engaged to identify a relevant policy question and build support for the valuation (Step 1.4) so it can effectively inform decision making.

Table 3 | **Common uses of coastal ecosystem valuation for decision making**

USE IN DECISION MAKING	EXAMPLE OF USE	STUDIES
Evaluate the environmental, social, and/or economic impact of a proposed development or policy	In California, a valuation influenced a decision by the regional water board to require the County of Los Angeles to divert storm water runoff to the local sewage treatment plant in order to improve coastal water quality. The study showed that the health benefits of reduced storm water flow far outweighed the cost of the diversions.	Given et al. (2006)
Justify, support, inform, and/or advocate policies that protect or sustainably use coastal ecosystems	In St. Maarten, a valuation found that coral reefs inside a proposed marine park contributed $58 million per year to the local economy through tourism and fisheries. These findings helped convince the government to establish the Man of War Shoal Marine Park—the country's first national park.	Bervoets (2010)
Raise awareness of the value of coastal ecosystems	A valuation showed that coral reefs and mangroves contribute to a significant portion of Belize's GDP. These results supported action on multiple fronts, including a landmark Supreme Court ruling to fine a ship owner for a grounding on the Mesoamerican Reef, the government's decision to enact a host of new fisheries regulations, and a successful civil society campaign against offshore oil drilling.	Cooper et al. (2009)
Inform **green national accounting**	The governments of Namibia, Norway, Iceland, the Philippines, and the United States have created integrated environmental and economic accounts for marine fisheries. Tracking economic values associated with fish stocks and harvests over time helps fisheries managers and policy makers design policies for sustainable fisheries management.	FAO (2004)
Establish levels of **damage compensation**	Valuation results were used to establish a schedule of escalating fines for injury to live coral in Florida, with assessed fines based on the area of impact. As a result, the Florida Keys National Marine Sanctuary has recovered millions of dollars for reef restoration after ship groundings.	Leeworthy (1991)
Determine appropriate **charging rates for environmental use** (e.g., marine park user fees)	Several valuations justified the Bonaire Marine Park's adoption, and later increase, of user fees, making it one of the few self-financed marine parks in the Caribbean.	Dixon et al. (1993) Uyarra (2002) Uyarra et al. (2010) Thur (2010)
Design methods to **extract finances** from coastal ecosystem services (e.g., payments for ecosystem services schemes)	A valuation justified the establishment of a PES scheme in Honduras in which the tourism sector will pay a national park to maintain coastal water quality in collaboration with the palm oil industry.	PNUMA (2013)
Compare costs and benefits of different uses of the coastal environment and assess tradeoffs	A valuation played a key role in the development of Belize's national Integrated Coastal Zone Management Plan (currently in draft form) by comparing ecosystem services provision and value under three coastal zoning scenarios developed iteratively with stakeholders: "conservation," "development," and "informed management."	Clarke et al. (2013)
Determine the most cost-effective strategy for meeting a specific policy objective (e.g., coral reef health, water quality, climate change adaptation)	A valuation assessed 18 potential initiatives related to conservation, ecotourism, fisheries, and sustainable development in the Bahamas' Exuma Cays. The study ranked the initiatives using criteria of costs, benefits, and feasibility. The study aims to influence land and sea use plans and the ongoing discussion about new regulations for the area.	Hargreaves-Allen (2012)

Sources: van Beukering et al. 2007, Laurans et al. 2013, Kushner et al. 2012, authors' interviews.

Step 1.2. Consider the context[17]

Valuation can be a powerful tool to inform decisions regarding policy and management of coastal resources. However, many factors related to the context of the study area—which are outside of a valuation practitioner's control—bear on the potential influence of a study (see Box 2 for an example of the importance of such factors in Bonaire). When assessing whether valuation would be an effective pathway to inform decision making, practitioners should look for:

- **Visible or impending threats to resource and economic health.** Visible threats to resource and economic health—such as poaching, pollution, and competition for tourists from nearby countries—encourage demand for valuation and the likelihood of use of valuation results, because the urgency for action to protect or better manage coastal resources is readily apparent.

- **Dependence on coastal resources.** Valuation is more likely to inform decision making when dependence on coastal resources in the study area is high. Coastal resource dependence refers to reliance on coastal and marine goods and services—including food, tourism, shoreline protection, medicine, and culture—by resource users or beneficiaries. Beneficiaries include, for example, subsistence fishers, hotel operators or owners, dive shop operators, residential and commercial property owners, and national and international tourists.

- **In-country champions.** Local people who understand economic valuation; can communicate results effectively; have good access to stakeholders, decision makers, and media; and can help integrate valuation results into decisions are critical to success. Local champions can be the face of the effort and help to establish a study's legitimacy and credibility. They can coordinate stakeholders, government officials, and others who can help navigate political and bureaucratic processes.

- **Good governance**, which includes:
    - *Transparency and public participation.* These factors promote credibility and provide opportunities for stakeholders to introduce new information, such as valuation results, into decision-making processes.

    - *Existence of a legal framework for protection and utilization of coastal resources and an ability to enforce laws.* Valuations are more likely to inform decision making where marine resources are protected by law and government has the legal authority to adopt conservation-oriented policy, legislation, or investments (such as to establish protected areas, collect user fees, or levy fines for ship groundings), as well as the capacity to enforce laws. However, in places where these elements are lacking, valuation could support the development of a legal framework or encourage investments in enforcement capacity.

    - *Nongovernmental management of revenue.* Arrangements that allow the autonomous or separate management of revenue—through sanctioned and legally recognized co-management institutions—may create greater incentive to use valu-

BOX 2 | CASE STUDY: RIPE GROUND FOR INFLUENCE IN BONAIRE

The island of Bonaire exemplifies many of the conditions necessary for a successful valuation study. Not surprisingly, it has been the site of several coastal valuation success stories. A suite of economic valuation studies (Dixon et al. 1993, Pendleton 1995, Uyarra 2002, Uyarra et al. 2010, Thur 2010) found that divers were willing to pay more than $30 per year for park management that would maintain coral reef quality, and that the economic benefits of marine protection far outweighed protection costs. These findings justified the Bonaire National Marine Park's adoption of entry fees in 1992, and a subsequent fee increase in 2005. The park is now one of the few self-financed marine parks in the Caribbean. Context-related factors that led to success include:

- **Coastal resource dependence:** Bonaire has few terrestrial natural resources (Thur 2010) and coastal tourism (particularly diving and snorkeling on coral reefs) is the mainstay of Bonaire's economy. More than half of the country's GDP comes from tourism. Dive tourism relies on a small number of visitors with high disposable income. The industry would suffer from the loss of even a few tourists, which would be likely if the reefs degrade.

- **Threats to resource and economic health:** Before the park was established and its regulations enforced, the largest threat to Bonaire's reefs was from dive tourism—through direct contact with divers and boats (Thur 2010). Heavily used sites began showing signs of degradation in the 1980s, and the threat of losing dive tourists to other countries with healthier coral reefs contributed to the willingness to establish park entry fees to pay for marine conservation efforts (Dixon et al. 1993).

- **Good governance:** Efficiency and transparency in the management of entry fee revenue has helped the fee system sustain broad support from both tourists and dive operators. Revenue has supported regular park patrols, educational materials, and more than 100 well-maintained moorings. Integration of fee collection directly into existing operations—dive operators and hotels collect fees and remit them to the park on a weekly basis—eliminates administrative costs and increases accountability for the funds.

Source: Adapted from Kushner et al. 2012.

ation results. It is generally difficult for governments to segregate revenue from user fees or payments for ecosystem services for management of a protected area; all government income may be expected to flow into the national treasury and be allocated according to national priorities.

- ☐ *Local control over coastal resource management.* Local control may allow for greater flexibility to use value estimates, as local authorities will be less constrained by bureaucratic processes. Local management capacity also can support and facilitate valuation efforts, through data collection, application of valuation results to policy, and stakeholder communication.

- **Low institutional turnover.** Low institutional turnover—within governments, NGOs, and other key stakeholder organizations—leads to retention of institutional knowledge and ultimately an increased commitment to use valuation results. Conversely, when a valuation "champion" leaves an organization, the momentum to integrate valuation results into that organization's decisions may dissipate.

If several of these conditions are missing, and it is not clear how more information about the economic values of coastal goods and services would change stakeholder behavior, valuation may not be an effective way to inform decision making in this case. Other approaches might prove more effective, such as:

- Analyses of threats and changes to the ecosystem
- Qualitative descriptions of potential losses from ecosystem degradation
- Efforts to improve coastal resource tenure and governance
- Education, training, and capacity building
- Monitoring and research.

Practitioners who are unsure whether an economic valuation would be effective—or whether an alternate approach would be a better use of resources—can consult with stakeholders with an interest in the policy question (Step 1.4) to determine the best course of action.

Step 1.3. Review previous valuation studies

There is a wealth of ecosystem valuation studies, including nearly 2,000 marine and coastal value estimates from more than 900 valuation studies globally.[18] While these studies vary in quality and policy relevance, they are an excellent starting point for a practitioner seeking to embark on a new valuation. Reviewing relevant valuation studies can help leverage and complement previous work and avoid duplicating efforts. Additionally, these studies can be a good source of data and provide context for value estimates from other, possibly similar locations that can be used to complement or compare with valuation results. Table 4 provides a list of online libraries and databases containing references to and results of ecosystem valuation studies.

Table 4 | **Online libraries and databases of ecosystem valuation studies**

NAME OF LIBRARY/ DATABASE	DESCRIPTION	URL
Marine Ecosystem Services Partnership (MESP)	MESP is a virtual center for information and communication on the human uses of marine ecosystems around the world, including an extensive database of marine and coastal valuation studies with nearly 2,000 value estimates.	http://www.marineecosystemservices.org/
Caribbean Large Marine Ecosystem (CLME) Information Management System	The CLME project contains a literature review and annotated bibliography of marine and coastal valuations in the Caribbean, including approximately 200 value estimates from more than 100 studies.	http://cermes.cavehill.uwi.edu/publications/CLME_marine_resource_valuation_2012_1_30.pdf https://clmeims.gcfi.org/valuations
National Ocean Economics Program (NOEP)	NOEP provides economic and socioeconomic information on changes and trends along the U.S. coast, and will soon expand its scope internationally. NOEP includes databases on market and nonmarket values of coastal and marine resources.	http://www.oceaneconomics.org/
Environmental Valuation Reference Inventory (EVRI)	EVRI is a searchable storehouse of more than 2,000 empirical studies on the economic value of environmental benefits and human health effects. It has been developed as a tool to help policy analysts use the benefits transfer approach.	https://www.evri.ca/
Ecosystem Service Valuation Database (ESVD)	ESVD, initially developed for the TEEB initiative, contains more than 1,350 data points from more than 300 case studies on both marine and terrestrial ecosystem services.	http://www.es-partnership.org/esp/80763/5/0/50
Earth Economics: Ecosystem Valuation Toolkit (EVT)	EVT houses the world's largest bibliographic database of ecosystem service papers, including more than 44,000 paper abstracts on marine and terrestrial ecosystem services.	http://www.esvaluation.org/index.php
Catalogue of Assessments on Biodiversity and Ecosystem Services	This database, which was under construction at the time of this publication, will provide access to marine and terrestrial valuation studies and guidelines for practitioners, and will inform the work of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).	http://ipbes.unepwcmc-004.vm.brightbox.net/

Sources: Authors and project partners.

Step 1.4. Identify and engage relevant stakeholders[19]

The best practice in policy-focused economic valuation encourages the identification and engagement of stakeholders early in the process, with continued engagement throughout the analysis and outreach and use of results phases.[20] Stakeholder engagement supports:

- Local capacity building and collaboration
- Study design appropriate to the local context and relevant to local issues
- Data collection, including the integration of local and traditional knowledge
- Local ownership of the analysis
- Legitimacy and credibility of results
- Identification of opportunities for outreach and influence, tracking of influence, and ways to lessen conflicts and overcome obstacles.

Local stakeholders should help identify the policy question around which the study is designed, as well as the valuation's objectives. It is also good practice to involve stakeholders in the valuation whenever possible, so as to foster buy-in, promote understanding, and reduce potential future opposition to uses of valuation results. Additionally, studies that are done on-site—with local data, in collaboration with local partners and experts—may further encourage buy-in and facilitate follow-up (Box 3).

Because different policy questions require different levels and types of stakeholder engagement, this section considers who stakeholders are, who should be involved in a valuation effort, and how and when to engage stakeholders.

Who are the stakeholders?

Key questions in identifying stakeholders include:

- Who has an interest in, or will be affected by, the policy question—including the valuation results and their implications? Who will use the valuation results and how?
- Who can inform the valuation process by providing information, leveraging relationships, and influencing policies or decision makers?
- Who are the target audiences for the valuation results?

BOX 3 | CASE STUDY: STAKEHOLDER ENGAGEMENT LEADS TO USE OF VALUATION RESULTS IN BELIZE

Under the *Coastal Capital: Belize* project (Cooper et al. 2009), the World Resources Institute (WRI) worked closely with Belize-based partners at WWF-Central America and World Conservation Society, along with more than 10 Belizean NGOs and government departments, to design and conduct an assessment of the economic contribution of Belize's coral reefs and mangroves. The project partnership represented the views and expertise of a wide range of primary, secondary, and external stakeholders. The valuation study found that coral reef- and mangrove-associated tourism contributed an amount equivalent to 15 percent of Belize's GDP in 2007, and that the shoreline protection afforded by reefs and mangroves avoided damages equivalent to more than 20 percent of GDP.

The project's Belizean partners had critical access to decision makers that allowed *Coastal Capital* to become influential in the country. NGO partners put the valuation results in front of national legislators, including the prime minister, who attended the launch gala and later cited videos featuring the valuation results as key to his decision to approve several new fishing regulations. Several months after the launch, when a container ship ran aground on the Belize Barrier Reef, the government decided to sue for damages—something it had not done with past groundings. NGOs also used the *Coastal Capital* results to successfully advocate a ban on offshore oil drilling. Armed with hard economic data, Belizean partners are still using the results of *Coastal Capital* to further their advocacy. Strong stakeholder engagement throughout all phases of the valuation effort allowed this study to inform decision making in Belize.

Source: Authors.

Key questions when engaging stakeholders include:

- What are the possible economic effects/ramifications for different stakeholders? Who (at local, national, and/or global levels) stands to gain or lose under scenarios related to the policy question?

- How do stakeholders currently use and benefit from the environment? What are their planned or desired uses for the future?

- What does the valuation practitioner want from these stakeholders? How and when should the practitioner engage them?

Stakeholders can be groups or individuals, and can be grouped by socioeconomic classifications such as occupational group/sector, income level, and employment status. Stakeholders include those who benefit and those who lose from policy actions, as well as those who can influence decisions. In general, stakeholders can be considered primary, secondary, or external.

Primary stakeholders experience the impacts of decisions involving natural resources and development most severely either on their livelihoods or well-being. They sometimes have little power to influence the outcome of a decision-making process. These stakeholders are likely to be highly dependent on coastal resources, and include:

- Fishers
- Farmers
- Local tourism businesses (e.g., dive shops, hotels)
- Coastal communities
- Local community and civil society groups
- Families of these groups
- Future generations

Secondary stakeholders are the people with the power to make and shape decisions, but they are unlikely to be directly impacted by these decisions. This group tends to comprise:

- National government departments and ministries
- Local government officials
- Coastal and marine resource managers

External stakeholders are those who are not impacted significantly by the valuation and its potential findings and recommendations, but whose interests are affected. These people and organizations may have the power to influence decisions. They may include:

- Environmental, conservation, or sustainable development NGOs not based locally at the valuation site
- Land developers
- Multinationals investing in the area (e.g., cruise tourism operators)
- Domestic and international tourists
- Trade groups
- Lobbying organizations
- Universities and other researchers
- Media

What are the possible economic effects for different stakeholders?

Once the stakeholders are known, practitioners should think about the possible economic effects of the policy question on each group (e.g., policy action or inaction, future decisions about resource use and management). For example, who stands to gain or lose? It is important to identify how stakeholders currently benefit from and use coastal ecosystems, as well as how certain groups might incur costs or realize benefits due to a policy action. Beneficiaries could include not only local populations dependent on ecosystems but also regional and even global communities that benefit from these goods and services. Practitioners should also consider interdependencies between stakeholder groups, and how benefits and costs might be distributed and at what scale, to help identify potential stakeholder conflicts.

In addition, it is important to consider who holds the most power to influence the policy or decision. These individuals can be targeted throughout the valuation process, especially during the outreach and use of results phase.

How and when to engage stakeholders?

Full participation by all people affected by or interested in a valuation study is often not possible. Therefore, at the beginning of the planning process, practitioners should consider the level and timing of stakeholder engagement carefully. A valuation study that is not supported by local stakeholders is less likely to be influential. Gaining that support requires careful consideration of when to engage each group.

Primary stakeholders: Valuation practitioners should reach primary stakeholders as early as possible and encourage them to participate. If the practitioner is not from the study area or country, it will often be necessary to contact primary stakeholders through local community or civil society groups, NGOs with trusted relationships, local business (e.g., tourism) associations, or local government agencies.

Secondary stakeholders: Practitioners should include resource managers and decision makers throughout the process. Bringing all decision makers on board at an early stage ensures that they understand how the results are generated and what they mean. Practitioners should not allow secondary stakeholders to dominate combined stakeholder group meetings—and they should treat primary stakeholders equally and give them as much time to talk as the secondary stakeholders.

External stakeholders: External stakeholders, such as developers or international NGOs, are sometimes more vocal and powerful and hence can intimidate those with less access to resources. External stakeholders should be engaged throughout the valuation process, but the nature of their engagement should be thoughtfully managed.

There are several methods to engage stakeholders, listed below in order of increasing participation:

- **Information giving.** Stakeholders participate by answering questions posed by valuation practitioners at points during the scoping, analysis, and outreach phases. Practitioners then feed information back to the various groups intermittently.

- **Consultation.** Stakeholders are consulted and valuation practitioners listen to the views expressed (e.g., through a workshop to refine the valuation design and construct a work plan). Practitioners may modify solutions in light of stakeholders' responses.

- **Interactive participation.** Stakeholders participate in the valuation process, and the development and analysis of different options (e.g., through data collection and analysis, participatory scenario development). Stakeholders and valuation practitioners learn together.

- **Active participation.** Stakeholders participate by taking initiatives independent of valuation practitioners to effect change (e.g., by using the valuation results independently of practitioners to lobby decision makers).

Further reading: See Beierle and Cayford 2002 and Reed 2008 (see Appendix 1 for full references).

Step 1.5. Identify decision makers and other target audiences and draft a communications strategy[21]

A strategy that identifies decision makers and other target audiences, and outlines tangible opportunities to access these groups and apply valuation results to decision making, is critical to success. Whenever possible, valuations should target immediate opportunities for application, including market mechanisms (such as payments for ecosystem services or user fees) or policy processes (such as legislation, regulations, or permitting). A well-developed communication and outreach strategy, drawing on diverse media platforms such as traditional and social media, allows for both widespread and targeted communication of results. It is best to think about the target audience and develop a communication strategy early in the process, to enable decision makers to be involved from the outset. The communication strategy can be sharpened as the valuation results become clearer.

Key questions include:

- Who is the target audience? Whose behavior or policies are targeted for change? How can they be engaged throughout the process (not only at the end when results are produced)? While target audiences vary by study, they will almost certainly be among the stakeholder groups identified in Step 1.4—see the list of common primary, secondary, and external stakeholders above.

- Who are other messengers that can help raise awareness about the valuation's findings? For example, are there locally respected thought leaders (e.g., academics or government officials) who can help build support and disseminate information? Are there celebrities or other recognized individuals who can help build excitement?

- How can practitioners engage the target audience early in the analysis to get their input on the scope and objectives of the analysis, to enhance relevance to key questions they face?

- What is the "hook" for this audience? In other words, what is new and exciting about the valuation? What economic values or additional metrics (e.g., jobs, revenue, total value, value per capita, avoided damages, area of affected ecosystem) are important to the audience (Table 5)? What does the target audience stand to gain or lose through improved coastal policy or management? What information is important to make the case for improved policies (e.g., new regulations, new zoning, new protected areas, new fee systems, better enforcement of existing laws)—or to advocate inaction, which is sometimes the best course?

- What is the best strategy to deliver the valuation results to the target audience? Who has the best access to that audience? What kind of materials or products would be most effective in communicating results?

- What are the best communication channels to reach the target audience (e.g., through direct outreach, email, conferences, or the media)? How can online tools and social media help drive interest in the valuation findings? What stories or experiences will help bring the valuation results to life for the target audience?

Table 5 | **Economic values and other metrics important to common target audiences**

METRIC	IMPORTANCE	WHO CARES?
Net economic value (e.g., consumer surplus, producer surplus)	Used by policy analysts in cost-benefit analysis. Shows net value to society, but requires distributional analysis to know who wins or loses.	Government policy analysts, development banks, business community
Gross and net revenues and economic impacts	Helps people understand how ecosystem services contribute to local economic activity.	Business community, tax collectors, local governments
Social metrics of ecosystem services (e.g., jobs, number of people protected from coastal hazards, nutritional benefits of fish consumption)	Helps identify the groups (e.g., fishers, tour operators, coastal communities) that directly depend on ecosystem services for their livelihoods and well-being.	Business community, government officials, local residents, development banks, NGOs
User fees (e.g., park entry fees) and/or estimates of users' willingness to pay	Demonstrates how ecosystem services might contribute to local conservation financing.	Park managers, tour operators
Number of users or user days	Helps identify the groups that benefit from ecosystem services (e.g., tourists).	Government officials, local residents
Ecological outcomes (e.g., beach width, percent live coral cover, area of mangrove cover, area of tourism development and/or land protected, tons of fish caught, water quality index)	Helps people focus on parts of coastal ecosystems that they care about and can be easily measured. Useful if monetary metrics are difficult to calculate with existing data, or considered unnecessary or controversial.	Coastal managers, government regulatory agencies, conservation organizations, local residents

Sources: Pendleton, L. (personal communication) and authors.

- What actions or approaches will build and sustain interest in the findings over time? What events or conferences offer venues for sharing the valuation findings? Are there other opportunities to extend the life of the analysis and results?

- Finally, what is the "call to action"? What change in the world would indicate success, and how can others be engaged to help bring about that change?

Once the analysis is complete, valuation practitioners can hone the key messages, refine the outreach strategy, and develop products targeted at decision makers (see Step 3.1).

Phase 2: Analysis

The guidance for this phase draws heavily on the wealth of other economic valuation guidelines, frameworks, and tools in the public domain (see Appendix 1).

The analysis phase includes the following steps:

2.1. Develop scenarios of possible futures through a participatory process.
2.2. Analyze the changes in ecosystem services under the scenarios.
2.3. Choose methods to value or monetize the changes in human well-being.
2.4. Collect and analyze biophysical and socio-economic data.
2.5. Account for risk and uncertainty in the valuation results.
2.6. Develop and apply decision support tools.
2.7. Report valuation results clearly.

Step 2.1. Develop scenarios of possible futures[22]

To inform decision making, economic valuation typically explores the change in ecosystem services (and associated value) stemming from change on the ground; for example, a policy or management change, population growth, changes in climate, or new development. Such an assessment involves comparison of possible futures or scenarios. This section explains how to identify or create scenarios that represent possible futures or changes on the ground. Step 2.2 helps practitioners identify how to analyze changes in ecosystem services under these scenarios.

A scenario is an internally consistent and plausible description of a possible future state.[23] Scenarios are not forecasts, but are alternative visions of how the future could unfold. Scenarios help to emphasize important factors influencing the future (including those over which stakeholders have no control) and highlight uncertainties. Scenarios also help to establish a boundary for the analysis.

Stakeholder participation

Many organizations have begun to use a participatory scenario development (PSD) process to engage a wide range of stakeholders, integrate public and expert opinions, and collectively develop plans and strategies. PSD involves facilitated workshops and consultations with stakeholders to develop scenarios of future socioeconomic, policy, environmental, and climate conditions. PSD gives stakeholders an opportunity to highlight which drivers of change they feel are most important and which uncertainties are most relevant, as well as their own objectives and desires for future change. Participants then explore these important choices, drivers, and uncertainties through scenarios. Rather than attempting to predict the future with precision, the scenarios illustrate a range of potential futures designed to help stakeholders weigh their priorities and assess tradeoffs as they try to achieve their goal, while contending with future risks, including climate change.[24] For example, important trends could include increased demand for residential housing and freshwater, while key uncertainties could be rate of sea level rise, increased storm intensity, and changes in the seasonality of precipitation.

During PSD, participants should explore the following questions (see Box 4 for an example):[25]

- What is the policy question?
- What are the long-term goals for the area (relevant to the policy question)?
- What are the ongoing trends that could influence the question or goals?
- What future changes are expected and what factors are driving these changes?
- What are some of the major characteristics of possible futures for this area?

BOX 4 | EXAMPLE OF PARTICIPATORY SCENARIO DEVELOPMENT (PSD) OUTPUTS

Policy question: How to further develop tourism and housing on the island sustainably, without degrading coastal ecosystems?

1. **Long-term goals:** Expand accommodation for tourists; develop additional housing (for residents and retirees); protect coastal water quality; protect coral reefs, mangroves, and seagrass beds; provide jobs to local residents; and ensure that most revenue stays on the island.

2. **Ongoing Trends:** Coastal water quality is declining in some areas from sewage and runoff from roads and construction; undeveloped land near the coast is limited (some is very low-lying, some is steep and forested); and hotels and other vacation properties are generally profitable.

3. **Future changes:** Population is increasing due to local growth plus immigration of foreign and domestic retirees; and sea level rise and increased intensity of storms put low-lying areas at risk.

4. **Major characteristics of possible futures:** Extent and type of coastal tourism development, different coastal zoning schemes, levels of sewage treatment, levels of enforcement of regulations, and future sea level and storm intensity.

Scenario Characteristics

Scenarios are most useful when they have the following characteristics (although it is not always possible to achieve all):

- **Relevant:** aligning with the policy question of interest to the stakeholders
- **Understandable:** both to the layperson and the target audience
- **Plausible and realistic:** describing credible potential futures and based, where possible, on existing information and projections
- **Distinct:** different from each other
- **Legitimate:** derived from the views and beliefs of a diverse group of stakeholders
- **Comprehensive:** considering relevant drivers of change, including those beyond the control of decision makers and other stakeholders.

The number of scenarios developed will be influenced by resource constraints; the more scenarios created, the more resource-intensive the valuation will be. It is typically advisable to create a baseline or "business as usual" scenario and at least two scenarios of alternative futures that represent a range of possibilities—that is, a best and worst case or high- versus low-impact scenario. For example, The Natural Capital Project and the World Wildlife Fund (WWF) worked with stakeholders in Belize to develop scenarios of conservation, development, and informed management (see Figure 3 and Box 7 at the end of this step).

There are two commonly used approaches for developing scenarios of alternative futures for a given policy question:

- **The development-pressure-state-impact-response (DPSIR) framework** explores the key drivers of change and the implications of these drivers; and
- **The critical uncertainty approach** considers current trends in light of major uncertainties (such as future climate, the economy, or ecosystem response).

Both approaches can employ a participatory process, but are suited to different contextual situations. The DPSIR framework is best suited to situations where there are clear and distinct drivers of change that need to be considered, such as increased tourism or an influx of retirees increasing demand for development near the coast. The critical uncertainty approach is better suited to situations where there is significant uncertainty about the impact of some driver, such as a coral reef ecosystem's response to warming seas, or increases in coastal erosion and flooding due to sea level rise. Examples suitable to each approach are provided below.

DPSIR approach

The DPSIR framework is an extension of the pressure-state-response framework developed by the Organisation for Economic Co-operation and Development (OECD).[26] The European Environment Agency, the United States Environmental Protection Agency, and others have adopted this approach.[27] The DPSIR approach allows stakeholders to think through how drivers and pressures cause changes in land and seascapes, what the potential impacts are, and what responses (such as a policy change) could reduce or eliminate the impacts or improve ecosystem condition. This approach is useful for identifying the key factors that should be explored through the scenarios. For example, stakeholders might want to explore the tradeoffs of upland versus coastal development, and might want to evaluate the costs and benefits of stricter development regulations (with enforcement of those regulations). Each scenario will describe different possible trajectories for the drivers of change that the participants feel are most critical to the future of their community. Box 5 provides an example of the DPSIR approach and scenarios.

BOX 5 | EXAMPLE OF DPSIR APPROACH

Policy question: How to further develop tourism and housing on the island sustainably, without degrading coastal ecosystems?

Development Pressure: Increased demand for housing (local and retiree); and increased demand for tourist accommodation.

Change in State: Land clearance for development (lowland and/or upland); potential loss in mangrove area; runoff of sediment from roads and upland development; and increased sewage.

Impact: Soil erosion (loss from uplands); increased sediment and nutrients in coastal water; coral degradation; diminished storm protection by reefs and mangroves; increased beach erosion; increased coastal flooding; and increased employment.

Possible Responses:

- Coastal zoning: Restrict removal of coastal mangroves and establish a coastal development setback.
- Land management: Establish and enforce strict controls on upland development (maximum slope and controls on erosion, such as sediment traps).
- Nutrient Control: Require sewage treatment for all new developments; improve treatment of existing sources.
- Incentives: Provide economic incentives for smaller, high-end, eco-friendly or "green" tourist accommodation versus mass tourism development (quality over quantity).

Scenario development:

- Scenario 1: Business as usual. Develop the coast freely, with no new regulations to guide development or promote best practices; unrestricted coastal development and extensive loss of mangroves.
- Scenario 2: Sustainable Coasts. Development is predominantly on the coast, with some upland development; strict regulations are established and enforced on retention of mangroves and coastal development setbacks; incentives promote high-end green tourism.
- Scenario 3: Upland Development. Policies encourage upland development with guidelines to limit impact, such as a maximum slope for development and retention of riparian buffers to control erosion.

BOX 6 | EXAMPLE OF CRITICAL UNCERTAINTY APPROACH

Policy question: Should gray infrastructure (e.g., sea walls) or green solutions (e.g., coral reef protection) be employed to protect coastal infrastructure and populations over the next 20 years, in light of warming seas and changes in coral reef health? Which approach should be chosen and when?

Uncertainties:

1. How resilient are coral reefs to increased nutrients and warming seas?
2. What levels of ocean warming and nutrient pollution are expected over the next 20 years?

Note: Sea level rise and future storm regimes are additional uncertainties, which are not included in this simplified example.

Critical Uncertainty Approach

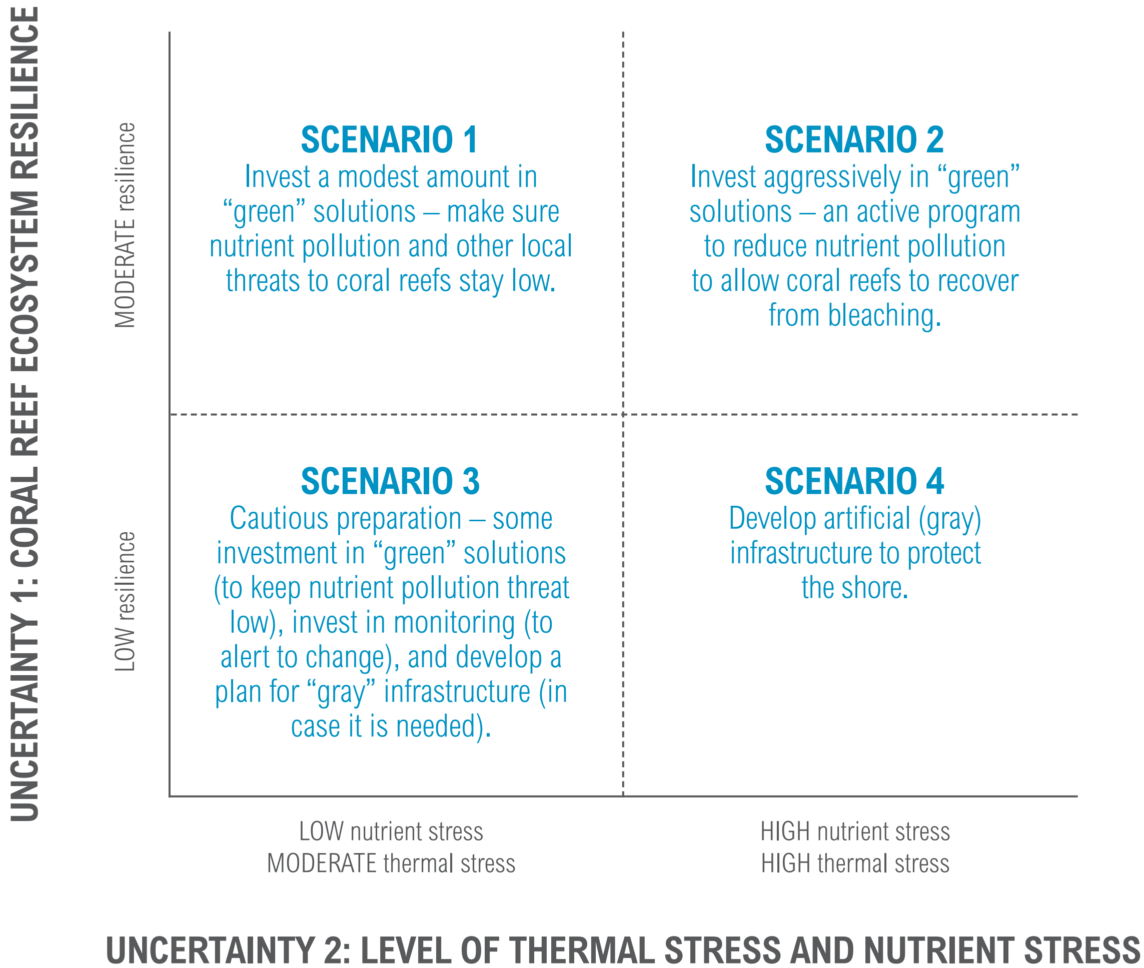
The critical uncertainty approach is useful when there are wide-ranging possibilities regarding future trends and ecosystem response. The practitioner begins by identifying two key uncertainties relevant to the policy question. These uncertainties are used to frame scenario development by making assumptions at the extremes of the uncertain parameters (see Box 6 and Figure 2 for additional explanation).

Both the DPSIR and the critical uncertainty approaches should ideally employ a participatory process, engaging relevant stakeholders to identify plausible futures. Scenarios are the starting point for the subsequent analysis of impacts on the ecosystem, changes in ecosystem services, and changes in economic value. The examples in this section focus on defining future threats, and policy and management options. The PSD process can also be extended to identify the effect on ecosystems—such as the change in coral reef condition or fisheries abundance—provided the expertise needed to inform and guide these estimates is available in the PSD process (see Step 2.2 for more information on this approach).

Difficulties employing the PSD approach include:

- **Achieving broad and meaningful participation by stakeholders.** In some situations, primary stakeholders may be limited in their ability to participate in the process. Stakeholders may also perceive their ability to participate as limited by low levels of education or by their socioeconomic status, and might shy away from the public consultative process. To address this, local community groups, local NGOs, local government agencies, and other organizations can help ensure that the voices of primary stakeholders are heard. The practitioner, however, should ensure that these organizations are as representative of the primary stakeholders as possible.

Figure 2 | **Scenario development using the critical uncertainty approach**

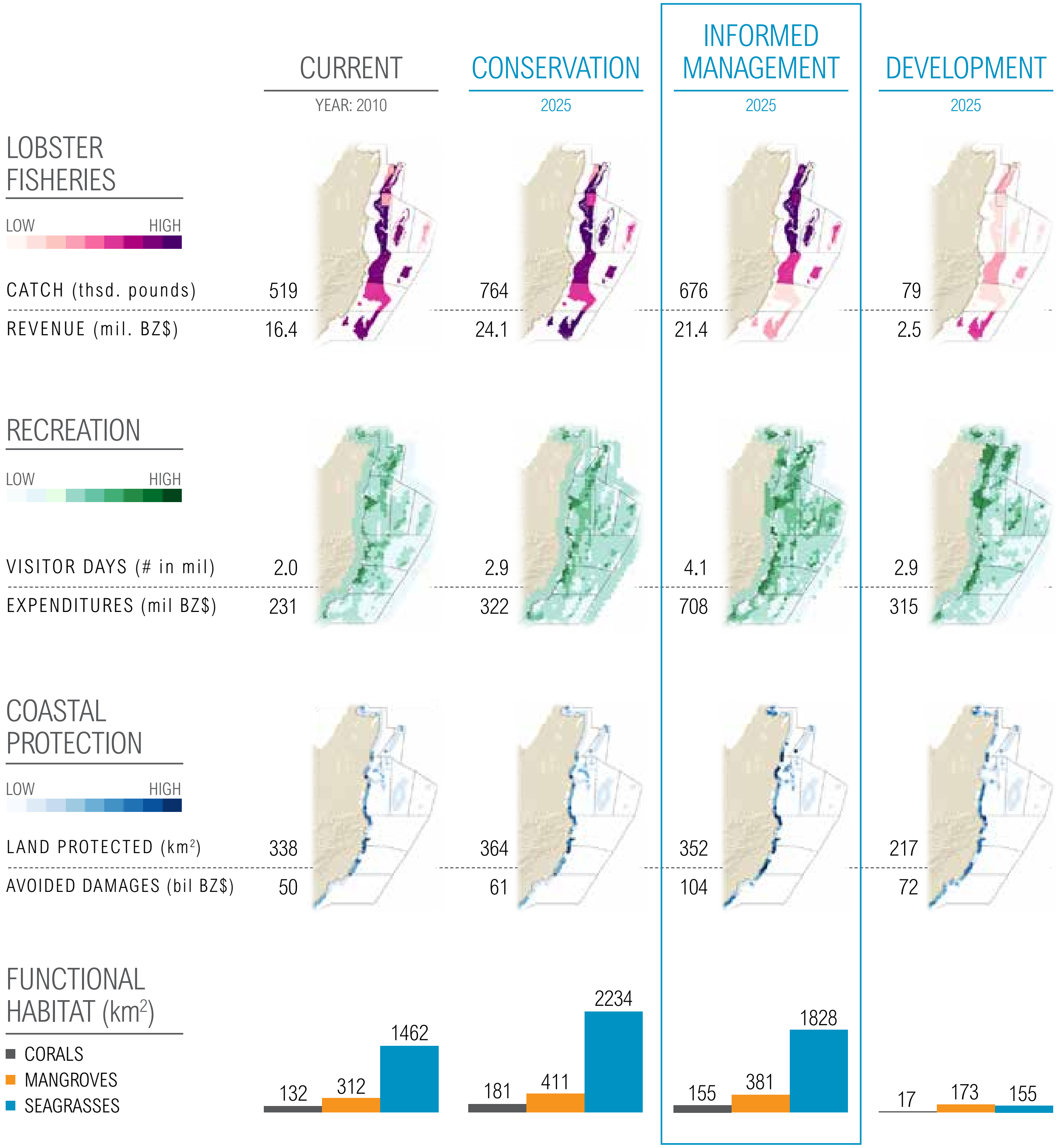


Source: Adapted from van Beukering et al. 2007.

- **Ecosystem change is complex and multi-faceted.** It can be difficult to capture all the factors and interactions that will affect ecosystem service availability in the future. To address this, the scenario development process should try to focus on the main factors influencing change.

Further Reading: See Jäger et al. 2007, McKenzie et al. 2012, and World Bank 2010 (see Appendix 1 for full references).

Figure 3 | **Coastal habitats and the delivery of ecosystem services by scenario in Belize**



Source: Clarke et al. 2013.

BOX 7 | CASE STUDY: USING PARTICIPATORY SCENARIO DEVELOPMENT AND MODELING TO PLAN FOR COASTAL ZONE MANAGEMENT IN BELIZE

In Belize, an applied valuation that informed marine spatial planning used a participatory process that brought together scientists, local experts, coastal and marine stakeholders, and decision makers. In 2010, Belize's Coastal Zone Management Authority and Institute (CZMAI) began working with the Natural Capital Project (NatCap) and the World Wildlife Fund (WWF) to create a national coastal zone management plan. The partners worked together to gather existing information about habitat distribution and current and potential uses of Belize's coastal and marine areas.

The partners then worked with local stakeholders (particularly via Coastal Advisory Committees) to co-develop scenarios of alternative coastal zoning schemes that emphasized conservation, development, or informed management. To understand the implications of each scenario, the team used a decision support tool for mapping and valuing ecosystem services called InVEST (Integrated Valuation of Environmental Services and Tradeoffs), developed by NatCap. Maps such as those in Figure 3 were presented in stakeholder meetings, along with maps of zones of human activities (e.g., marine transportation, coastal development, dredging) under the three future zoning schemes. In the meetings, stakeholders helped refine the scenarios or generate alternative scenarios based on local knowledge and preferred outcomes. The "informed management" scenario, honed through several iterations, now serves as the cornerstone of the national Integrated Coastal Zone Management Plan (Clarke et al. 2013) that is under public review and expected to be signed into law.

Without close collaboration between CZMAI, NatCap, WWF, and local stakeholders, CZMAI would have had significantly less scientific capacity to inform their planning process and produce the country's first coastal zone management plan that incorporates biodiversity and ecosystem services. NatCap would have missed critical local knowledge, and the economic valuation would have been an academic exercise unlikely to find its way into the planning process. Through this process, local stakeholders gained knowledge about key coastal ecosystem services and how alternative choices could affect the value and distribution of those services.

Sources: Summarized from Clarke et al. 2013 and Ruckelshaus et al. 2013.

Step 2.2. Analyze the changes in ecosystem services under the scenarios[28]

Through developing scenarios, valuation practitioners will identify sets of conditions—such as policy change, population growth, and changes in climate—to evaluate. The next step after scenario development is to quantify the likely changes in ecosystem services under each scenario, tracking changes in social and environmental metrics (e.g., beach width, fish abundance, employment, human health). These changes may ultimately be monetized through valuation.

Analyzing the changes in ecosystem services under each scenario requires clearly identifying the causal links between the scenarios, ecosystem health, ecosystem services, and resource users. Identifying these relationships helps to ensure that the eventual valuation approach is appropriate and engages stakeholders with vested interests.

When identifying possible impacts stemming from the scenarios, relevant questions include:

- Where is the impacted area and what are its current (baseline) physical, biological, social, and economic features?
- How, and to what extent, will the scenarios change the environment (e.g., ecological, economic, cultural, aesthetic, health and safety, social impacts)?
- What methods could be used to assess the impacts of the scenarios on the ecosystem and ecosystem services?
- Are data available to assess these impacts?
- Who are the key stakeholders likely to be affected by the different scenarios, and how will these groups be engaged/consulted?
- What is the relative significance of the environmental impacts to key stakeholders under the different scenarios?
- What measures would reduce or minimize the negative impacts of the alternative scenarios?

Exploring these questions will reveal key impacts—or causal chains—for further analysis in the valuation.

It is important to identify local, national, and regional or international beneficiary groups and their specific needs or concerns—such as storm protection, recreation, food, or livelihoods. The

Table 6 | **Examples of pathways between scenario examples and changes in human well-being and economic value**

SCENARIO		EFFECT ON ECOSYSTEM	CHANGE IN ECOSYSTEM SERVICE	CHANGE IN BENEFITS MEASURES	CHANGE IN VALUE
Scenario 1: Business as usual	■ Extensive coastal development (for tourism and housing) ■ 200 jobs created during construction period ■ 40 jobs created after construction	■ Extensive loss of mangroves ■ Sediment delivery on reefs reduces live coral cover ■ Erosion of reefs over time	■ Reduced shoreline protection ■ Reduced fisheries production ■ Short-term increase in tourism ■ Longer term loss in tourism	■ Increased coastal/beach erosion and flooding ■ Reduced food supply for coastal communities ■ Large increase in employment for two years ■ Small increase in long-term employment	■ High losses from flood damage to roads and coastal infrastructure ■ Short-term gains from tourism and construction employment ■ Longer-term loss in tourism value
Scenario 2: Sustainable Coasts	■ Some high-end coastal tourism development ■ Some upland housing development ■ Slight increase in coastal pollution ■ 100 jobs created during construction ■ 80 jobs created after construction	■ Very limited loss of mangroves ■ Slight increase in sediment reaching coral reefs ■ Slight loss of live coral cover	■ Minimal change in shoreline protection ■ Minimal change in fisheries production ■ Moderate increase in tourism	■ No loss in coastal goods and services ■ Moderate increase in jobs during construction ■ Larger increase in long-term employment	■ No losses from flood damage (gain in benefits relative to BAU) ■ Moderate but sustained increase in high-end tourist revenue and related employment
Scenario 3: Upland Development	■ Extensive upland development (for housing), with best practices employed ■ Some increases in sediment and nutrients in coastal waters ■ 100 jobs created during construction ■ 30 jobs created after construction	■ No loss of mangroves ■ Moderate increase in sediment on reefs ■ Pulses of sediment during large storm events ■ Moderate loss of live coral cover ■ Some erosion of reefs over time	■ Some loss of shoreline protection ■ Slight reduction in fisheries production ■ Slight loss in tourism	■ Slight increase in coastal/beach erosion and flooding ■ Moderate increase in short-term employment ■ Slight increase in long-term employment	■ Some losses from flooding damage along the coast (though less than under BAU) ■ Slight loss of tourism revenue ■ Slight increase in long-term employment

Source: Adapted from Schuhmann 2012a.

needs and concerns of these groups may indicate their willingness to pay to protect critical ecosystem services. The identification of causal links can also highlight potential poverty and equity issues; that is, winners and losers under decision-making scenarios or unavoidable tradeoffs.

Table 6 illustrates a qualitative exercise for identifying causal pathways from scenarios to changes in human well-being and ecosystem value. Identifying causal pathways can be challenging, but engaging stakeholders in this process can help ensure that the most relevant ecosystems and ecosystem goods and services are properly identified.

Estimating the changes in the quantities of ecosystem services under the different scenarios is, in many ways, more difficult than monetizing (or valuing) these changes because of the complexities of social and biophysical relationships, which are often poorly understood and for which data are often lacking.[29] There are several approaches to reaching this end result; each has a different implementation cost and accounts for uncertainty in a different way. The approaches include:

- **Modeling:** This approach uses models (including biophysical models and production functions) to estimate each step in the causal chain under each scenario, including (a) the ecosystem state resulting from the scenario; (b) the change in ecosystem service; and (c) the resulting change in benefits (see examples in Table 6 above).

- **Expert Opinion:** This approach can be an extension of participatory scenario development (Step 2.1), where participants go beyond describing the policy and trends to be explored in a scenario, but also project the effect on the ecosystem and the changes in ecosystem services.

- **Rough estimation through informed function or information transfer:** This approach examines relevant studies, values, and biophysical relationships to approximate ecosystem conditions and ecosystem services provision in the location of interest.[30]

Each approach is discussed in detail below.

Modeling changes in ecosystem services

There are a variety of freely available tools for quantitatively evaluating changes in ecosystems and ecosystem services. Some of the tools in Table 7 address multiple steps in the causal chain between scenarios and changes in ecosystem value.

These models vary in terms of spatial data and other data requirements, and require some level of technical skill to implement. It is important to remember that models, by nature, are imperfect approximations of reality, and model results typically have considerable uncertainty.[31] In addition, the type of ecosystem service being valued influences the complexity of the modeling. For example, evaluation of the complex problem of fish spillover from mangrove nurseries or the shoreline protection provided by coral reefs both require complex biophysical models. The multiple stages of modeling—to get from change in pressure to change in ecosystem service—introduce compound uncertainties. These uncertainties should be acknowledged, but quantitative biophysical modeling remains the best means of evaluating the implications of different scenarios on ecosystem service provision.

In cases where quantitative modeling is impossible, infeasible, or inappropriate to the policy question—due to high cost, lack of data, lack of technical capacity, or problems of uncertainty—simpler approaches can provide appropriate solutions. These approaches include scenario development using expert/participant opinion, or extrapolating from published relationships to estimate changes in ecosystem services.

Expert and/or participant opinion

The participatory scenario development (PSD) process (Step 2.1) can engage experts or local populations to use their experience to estimate changes in ecosystem services under the different scenarios (e.g., changes in fisheries productivity after the establishment of a marine reserve, changes in coastal erosion and flooding following coral reef degradation). Producing a range of estimates to appropriately reflect uncertainties is probably best. Local experts and stakeholders can also provide data required to feed into many of the modeling approaches outlined above.

Table 7 | **Modeling and decision support tools to quantify, map, and value changes in ecosystem services**

MODEL OR DECISION SUPPORT TOOL	DESCRIPTION
Artificial Intelligence for Ecosystem Services (ARIES) Developed by: Basque Center for Climate Change (BC3), the University of Vermont, and Conservation International with the collaboration of Earth Economics and United Nations Environment Programme–World Conservation Monitoring Centre (UNEP-WCMC) (www.ariesonline.org)	ARIES is an integrated web-based tool that allows users to model, map, and quantify the impacts of environmental changes on the provision of ecosystem services to evaluate and compare alternative scenarios for climate change, land use, or land cover and policies for addressing them.
Atlantis Developed by: Commonwealth Scientific and Industrial Research Organization (CSIRO) Marine and Atmospheric Research (atlantis.cmar.csiro.au)	Atlantis integrates physical, chemical, ecological, and fisheries dynamics in a three-dimensional, spatially explicit system. Atlantis is primarily used in fishery applications, where it allows users to identify tradeoffs between and among species, fishing gear types, management goals, and the direct and indirect effects of different management policies.
Coastal Resilience Developed by: The Nature Conservancy, University of Southern Mississippi, and University of California, Santa Barbara (www.coastalresilience.org)	The Coastal Resilience project delivers geospatial information on coastal ecosystems, socioeconomics, community vulnerability, and coastal hazards (including sea level rise and storm surge) via an internet mapping application, which allows users to test alternative future scenarios. It includes a summary tool for calculating economic and ecological loss.
Cumulative Impacts Developed by: National Center for Ecological Analysis and Synthesis (NCEAS), University of California, Santa Barbara, and Stanford University (www.nceas.ucsb.edu/globalmarine)	Cumulative Impacts supports marine spatial planning and ecosystem-based management efforts by helping practitioners assess the most vulnerable locations, identify priority stressors, and identify compatible and incompatible ocean uses based on ecosystem vulnerability. It uses spatial data and expert opinion to predict a relative cumulative impact score for each unit (i.e., pixel) of the study region, based on the type and intensity of human pressures, the type of ecosystems present, and the assigned impact weight for each pressure.
Integrated Valuation of Environmental Services and Tradeoffs (InVEST) Developed by: The Natural Capital Project–Stanford University, World Wildlife Fund, The Nature Conservancy, and the University of Minnesota (www.naturalcapitalproject.org/InVEST.html)	InVEST is a free, open-access software tool for identifying where ecosystem services are provided, where they are consumed, and how resource management decisions will affect the economy, human well-being, and the environment, under alternative, spatially explicit future scenarios. InVEST uses various valuation techniques with limited data requirements, such as market price and cost of avoided damage. InVEST has models for ecosystem services, including carbon storage, wave energy, recreation, fishery production, erosion control, habitat quality, and water quality. The models offer both biophysical (e.g., meters of shoreline eroded) and socioeconomic (e.g., monetary values or number of people affected) outputs.
Multi-scale Integrated Models of Ecosystem Services (MIMES) and Marine Integrated Decision Analysis System (MIDAS) Developed by: AFORDable Futures and Conservation International (www.afordablefutures.com/services/mimes, people.bu.edu/suchi/midas/index.html). The ongoing work of MIMES is archived at a Google Code site: http://www.uvm.edu/giee/mimes/.	MIMES is a multi-scale, integrated suite of models that assess the value of ecosystem services under land management and land use scenarios. The target audience is land managers, policy analysts, and scientists. MIMES can be run at global, regional, and local scales to quantify the effects of land and sea use change on ecosystem services as well as human and built capital. MIDAS is a user-friendly, web-based mapping and visualization tool designed to help marine managed area (MMA) managers and users quickly analyze and visualize outcomes from the interaction of socioeconomic, governance, and ecological factors of MMAs. Users input data for these factors, and the tool displays possible outcomes, such as state of governance, livelihoods, ecosystem health, and MMA effectiveness. MIDAS helps MMA managers understand ecosystem service tradeoffs and compare alternative policy options.

Source: Adapted from Center for Ocean Solutions 2011.

Informed function or information transfer

If modeling is not possible and expert opinion on ecosystem and ecosystem service impacts are not available, a third approach is to use existing observed relationships from other locations to help approximate the change in ecosystem condition or ecosystem services in the study site. The existing relationships might need to be adjusted to account for differences between the two sites (or many sites, if multiple observations are available). For example, the U.S. Army Corps of Engineers has established "depth-damage" functions,[32] which estimate property damages under different flooding scenarios, and several researchers have estimated fish productivity rules for coral reefs in different regions in different condition.[33] For more about designing appropriate information transfer, see Box 8.

Further Reading: See Center for Ocean Solutions 2011 (for more on the modeling tools listed in Table 7), Box 8 (for more on designing appropriate information transfer), and the Ecosystem-Based Management Tools Network (www.ebmtools.org) (see Appendix 1 for full references).

Step 2.3. Choose the economic valuation method(s)

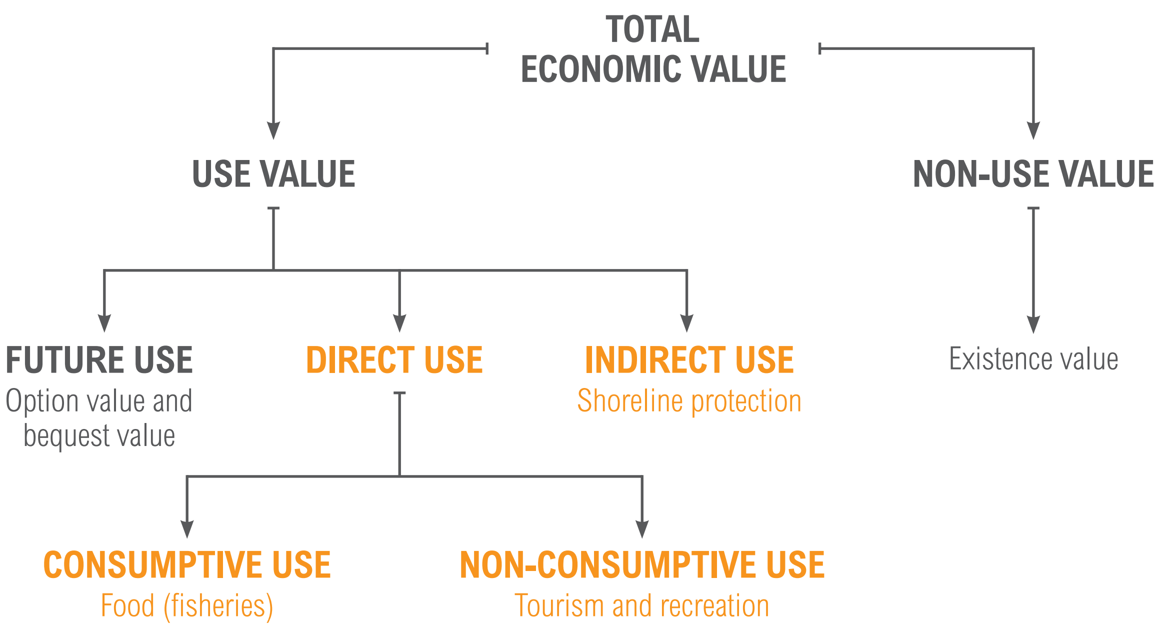
After identifying the changes in ecosystem condition and services under the scenarios, the next step is to monetize the benefits or costs associated with the changes in ecosystem services. Expressing all impacts in monetary units can facilitate comparison of scenarios and related impacts in a language familiar to decision makers and other stakeholders.

The valuation method chosen should be appropriate to the policy question, and should produce results that are accurate enough for decision makers or other users of the results in a timely and cost-effective way. It will be necessary to balance scientific and analytical rigor with financial, data, time, and skills constraints.[34]

Assessing economic value: which components are most policy relevant?

Economic valuation assesses a resource in terms of its value to humans.[35] The commonly used Total Economic Value (TEV) framework (Figure 4) divides the value of a resource into use and non-use values. Use values are further broken into direct use (e.g., fisheries, tourism, and recreation); indirect use (e.g., shoreline protection); and option or future use values (e.g., avoided damage from climate change).

Figure 4 | **Total Economic Value (TEV) framework with examples of coastal ecosystem services**



Source: Adapted from Pagiola et al. 2004.
Note: The most policy-relevant components are shown in orange.

Non-use values typically refer to existence value: that is, the value humans place on the knowledge that a resource such as a coral reef or charismatic fish species exists, even if they never visit or use it. Economic valuation studies may attempt to quantify all or some of the use and non-use values of a resource.

Economic valuations are often conducted to help policy makers answer questions about how to meet regulations cost-effectively, how to maximize public benefits, and how to mitigate public risk.[36] Policy makers are more likely influenced by direct and indirect use values, especially if the policy question concerns short-term investment decisions. Non-use and option values are frequently the most controversial elements of TEV because they are the most difficult to quantitatively measure, they have the greatest uncertainty attached to them, they introduce potential for double-counting and overlap with other elements of TEV, and they are farthest from most policy makers' concerns. Figure 4 highlights in orange the elements of TEV that are often most relevant to policy.

Choosing a method

Some changes in human well-being—such as an increase or decrease in coastal fisheries or tourism—can be observed in markets and are thus relatively easy to value. Other coastal ecosystem services, however—such as shoreline protection and carbon sequestration—are not traded in conventional markets. A variety of approaches have been developed to estimate the value of ecosystem services, whether traded in markets or not.

Table 8 summarizes economic valuation methods that have been used to value the benefits of coastal ecosystem services. Table 9 provides examples of valuation methods by coastal ecosystem service, along with an assessment of the ease of valuation.

Table 8 | **Valuation methods, typical applications, examples, and limitations**

VALUATION METHOD	APPROACH	APPLICATIONS	EXAMPLES	LIMITATIONS
Market-based methods				
Market price (MP)	Observe market prices to analyze the economic activity generated by use of an ecosystem good or service. (Includes economic impact analysis, which examines the impacts of spending related to the good or service, and can also include indirect impacts in related economic sectors, as well as financial analysis, where operating costs are subtracted.)	Coastal goods and services that are traded in markets	Fisheries, tourism, mangrove timber	Market prices can be distorted (e.g., by subsidies) and they can overestimate ecosystem values if current use is above sustainable levels. Many ecosystem services are not traded in markets.
Replacement cost (RC)	Estimate cost of replacing ecosystem service with man-made service Requires three conditions be met to be valid: (1) man-made equivalent provides the same level of ecosystem service; (2) man-made equivalent is the least-cost option of providing the service; (3) people would be willing to incur the cost rather than forego the service.[37]	Ecosystem services that have a man-made equivalent that provides similar benefits	Shoreline protection by reefs and mangroves, water filtration by forests and wetlands	Estimates might not reflect the true value of ecosystem goods and services and might inaccurately suggest that man-made goods and services are appropriate substitutes. For example, a seawall might effectively protect the shore, but does not provide fish habitat in the way a healthy coral reef does.
Cost of avoided damage (CA)	Estimate damage avoided (e.g., from hurricanes or floods) due to ecosystem service	Ecosystem services that provide protection to houses, infrastructure or other assets	Shoreline protection by reefs and mangroves	Difficult to relate damage levels to ecosystem quality.
Production function (PF)	Estimate value of ecosystem service as input in production of marketed good	Ecosystem services that provide an input in the production of a marketed good	Commercial fisheries	Technically difficult to determine and model the relationship between ecosystem change and its impact on the provision of the ecosystem service. High data requirements.

Table 8 | **Valuation methods, typical applications, examples, and limitations (cont.)**

VALUATION METHOD	APPROACH	APPLICATIONS	EXAMPLES	LIMITATIONS
Non-market methods				
Hedonic pricing (HP)	Estimate influence of environmental characteristics on price of marketed goods	Environmental characteristics that vary across goods (e.g., houses, hotels)	Tourism, shoreline protection	Technically difficult. High data requirements.
Travel cost (TC)	Travel costs to access a resource indicate its value	Recreation sites (e.g., marine protected areas)	Tourism	Technically difficult. High data requirements.
Contingent valuation (CV)	Ask survey respondents directly for willingness to pay for ecosystem service	Any ecosystem service (most widely used for non-market ecosystem and services)	Tourism	Expensive to implement. Vulnerable to many sources of bias and requires careful survey design.
Choice modeling (CM)	Ask survey respondents to trade off ecosystem services to elicit their willingness to pay	Any ecosystem service (most widely used for non-market ecosystem and services)	Tourism	Expensive to implement. Vulnerable to many sources of bias and requires careful survey design. Technically difficult.
Benefits transfer				
Benefits transfer	Value transfer: Use values estimated at other locations (“study sites”) Function transfer: Use a value function estimated at another location to predict values	Any ecosystem service	Any ecosystem service	Possible transfer errors if the “study sites” and “policy site” are different.
Meta-analysis	Synthesize results from multiple existing valuation studies, using statistical regression to estimate a value function. Meta-analysis can be used for benefits transfer.	Any ecosystem service	Any ecosystem service	Requires compilation of multiple studies and statistically significant sample size of value estimates. Adequacy of studies may vary. Can lead to a loss of important valuation information during data aggregation process.[38]

Source: Adapted from van Beukering et al. 2007, Pagiola et al. 2004, and Schuhmann 2012a.

Table 9 | **Appropriate valuation methods by coastal ecosystem service**

SOURCE OF BENEFITS	DIFFICULTY OF VALUATION	APPROPRIATE METHODS*
Food	Low to Medium	MP, PF
Raw materials	Low to Medium	MP, PF
Medicinal resources	Low to High	CA, RC, PF
Tourism and recreation	Low to High	MP, TC, CM, CV, HP
Flood/storm/erosion regulation	Medium	RC, CA
Species/ecosystem protection	Medium	CM, CV, TC, HP
Nutrient cycling	Medium	CA, CV
History, culture, traditions	Medium	CV, CM
Genetic resources	High	MP, CA
Climate regulation	High	CV, CM
Science, knowledge, education	High	CV, CM

Source: Adapted from Schuhmann 2012a.

Notes: * Abbreviations of valuation methods: CA = cost of avoided damage; CM = choice modeling; CV = contingent valuation; HP = hedonic pricing; MP = market price; PF = production function; RC = replacement cost; TC = travel cost.

Other considerations when choosing a valuation method

- **No particular method is always "best."** Although practitioners may prefer certain valuation methods over others, Kushner et al. (2012) found a variety of methods in the 16 cases of use of coastal valuation in decision making in the Caribbean. The methods included economic impact analysis, production functions, financial analysis, hedonic pricing, contingent valuation, benefits transfer, and replacement cost. This breadth of methods in influential studies suggests that the particular method used does not determine the likelihood that the study will have an impact. In each case, practitioners chose methods appropriate to the policy question, executed the studies well, made their methods and assumptions transparent, engaged important stakeholders and decision makers, and followed many of the other "best practice" steps presented in this guide.

- **Total versus marginal values.** Figure 4 illustrates the elements of TEV that policy makers tend to be most concerned about. Another decision for practitioners is whether to conduct a valuation that produces "total" or "marginal" values. Total value refers to the total economic contribution of a set of ecosystem services and represents a static value (e.g., economic contribution of coral reef-related fisheries and tourism in a country per year).

BOX 8 | DESIGNING APPROPRIATE BENEFITS TRANSFER

Benefits transfer involves borrowing a value from one site (the "study site") and applying it to another (the "policy site"). Depending on the context, the value may be unadjusted or modified to "suit" the new site. The attraction of benefits transfer is that it avoids the cost and time involved in conducting primary valuation studies, which can be prohibitive in Caribbean countries.

Several conditions must be satisfied for benefits transfer to provide valid estimates:

- The "primary" value from the study site must be theoretically and methodologically valid.
- The populations in the study and policy sites must be similar.
- The difference between baseline ecosystem conditions and extent of ecosystem change must be similar across study and policy sites.
- The study and policy sites must be similar in terms of environmental characteristics.
- The distribution of property rights and other institutions must be similar across sites.

There are two general sources of error in the values estimated using benefits transfer: (1) errors associated with estimating the original measures of value at the study site(s); and (2) errors arising from the transfer of these study site values to the policy site.

The main steps in conducting benefits transfer are:

1. *Describe the scenarios.* Identify the ecosystem goods and services to be valued at the policy site. Describe the characteristics and consequences of the scenarios including the population that is affected (see Step 2.1). Information on the affected population will generally be used to convert per person, per household, or per unit area values to an aggregate benefits estimate.
2. *Identify existing, relevant studies.* Conduct a literature review to identify valuation data relating to the specific goods and services identified in the scenarios above. See Table 4 (Step 1.3) for a list of valuation databases.
3. *Assess available studies for quality and applicability.* Assess the relevance (suitability) of the study site values for transfer to the policy site, considering the similarity of the policy site to the study site, the similarity of impacts considered, baseline ecosystem condition, the affected populations, and so on. The quality of the collected primary valuation literature should also be reviewed. Indicators of quality will generally depend on the method used. The analyst should also determine whether adjustments can be made for important differences between the policy case and the study case.
4. *Transfer the benefit estimates.* Transfer the value measures from the study site(s) to the policy site. There are three main types of benefits transfer studies (Boyle et al. 2010):
   a. Value transfer. Uses a single value from a study site (or a mean value from multiple sites) to provide an estimated value at the policy site.
   b. Function transfer. Uses a valuation function (from a single study site) to estimate the value at the policy site, which is then calibrated to the conditions of the policy site by adjusting the variables in the function equation. Function transfers are generally more accurate than value transfers.
   c. Meta-analysis. Uses a valuation function (from multiple study sites) to estimate the value at the policy site.
5. *Determine the population and spatial extent over which impacts at the policy site are aggregated.* Value estimates are generally aggregated over the affected population or the area of ecosystem affected to compute an overall benefits estimate.
6. *Address uncertainty.* Throughout the analysis, the researcher should clearly describe all judgments and assumptions and their potential impact on final estimates, as well as any other sources of uncertainty inherent in the analysis. See Step 2.5 for more on addressing risk and uncertainty.

Further Reading: See Boyle et al. 2010, U.S. EPA 2010 (pp. 7-44 to 7-49), Navrud and Ready 2007, and Wilson and Hoehn 2006 (see Appendix 1 for full references).

Source: Summarized from van Beukering et al. 2007.

Marginal value usually refers to the incremental change in value from an ecosystem from a baseline condition to a condition established by a future scenario, such as the change in fisheries or in reef recreation demand with a change in coral condition. Total values can be effective in raising awareness—for instance, Cooper et al. (2009) found that coral reef-related tourism contributes 15 percent of Belize's GDP per year. These findings catalyzed several policy changes (Box 3). However, marginal values are more relevant for decision making, as they reflect the change in value attributable to a policy action. To estimate marginal value, it is necessary to understand the baseline or "business as usual" condition and compare this to the condition based on a future scenario (see Figure 3 for another example from Belize).

- **Using benefits transfer.** Benefits transfer (Box 8) is a useful valuation approach where modeling is not possible and resources to conduct a primary valuation study are limited. However, practitioners should be careful to choose studies that are representative of their policy site.

Further Reading: See Appendix 1 for a list of economic valuation manuals and guidelines, with a column listing valuation methods covered in each.

Step 2.4. Collect and analyze data[39]

Once the scenarios have been developed and the ecosystem service quantification and economic valuation method(s) selected, the next challenge is to gather data to assess the physical and social impacts under the alternative scenarios and to estimate the economic value of the impacts.

All valuation methods require data collection. However, valuation methods differ in terms of data needs (Table 10). Broadly there are three main types of data that will be used:

- Market prices found through secondary data collection from private sector sources (e.g., fish markets, tourism organizations), government statistics, or international organizations.
- Local social, environmental, and economic information that relates to how a change in ecosystem use or management leads to a change in ecosystem function and service provision. This information can be found through local surveys, modeling, and other primary data collection activities.
- Preference data generated by asking people through questionnaire surveys or interviews.

The categories are described in further detail below. Benefits transfer (Box 8) relies on existing studies and therefore is excluded from Table 10.

Market prices and other statistics gathered through secondary data collection

For any valuation exercise, it is necessary to first investigate what data already exist by conducting a literature review of the economic, social, and environmental reports relating to the ecosystem and ecosystem services under consideration. The private sector—such as tourism organizations, fish markets or cooperatives, chambers of commerce, or extractive industries—is a good source of market information.

Most governments also collect information about the way the society, economy, and environment function, in the form of national assessment reports, statistical databases, or local-scale interview reports or discussion papers. University research reports may be available describing impacts of similar projects in comparable countries and can be used for benefits transfer. Alternatively, local expert opinions can be used, as can historical records and surveys. A government department may collect biophysical data about the ecosystem. Finally, market information can be found in customs and excise department reports that contain export data.

Table 10 | **Data requirements and sources for different valuation methods**

VALUATION METHOD	DATA REQUIREMENTS	POSSIBLE SOURCES OF DATA	EXAMPLES OF SOURCES OF DATA
Market price (MP)	Market prices of goods and services (e.g., for fish or dive trips), optional: operating costs (e.g., equipment, tools, fuel, and supplies, hired labor, license fees)	■ International organizations relating to that ecosystem service (e.g., FAO, UN World Tourism Organization, World Travel and Tourism Council) ■ Government ministries relating to that ecosystem service (e.g., Fisheries, Tourism) ■ Local dive shops ■ Fish markets and cooperatives	■ FAO FishStat: http://www.fao.org/fishery/statistics/software/fishstatj/en ■ UNWTO tourism statistics: http://statistics.unwto.org/en ■ WTTC tourism economic impact research: http://www.wttc.org/research/economic-impact-research/
Replacement cost (RC)	Market prices for man-made equivalent (e.g., replacing coral reefs with sea walls)	■ International organizations (e.g., disaster and relief agencies) ■ Quotes or expert opinion at engineering firms ■ Existing valuation reports from other locations	■ Project proposals for similar projects in that country or others
Cost of avoided damage (CA)	Probability assessments, market prices of assets at risk (e.g., coastal property or infrastructure)	■ Insurance companies ■ International organizations (e.g., disaster and relief agencies) ■ Real estate agencies	■ Flood risk maps ■ Disaster frequency (e.g., Caribbean storm frequency): http://www.nhc.noaa.gov/climo/ ■ Flood depth-damage functions (e.g., U.S. Army Corps of Engineers): http://planning.usace.army.mil/toolbox/library/IWRServer/92-R-3.pdf
Production function (PF)	Market price and output of marketed good (output determined by the function linking ecosystem condition to production), price and quantity of other inputs (e.g., labor, fishing equipment)	■ Government statistics office ■ Survey of local costs of labor and price of goods and services (final market prices, transportation costs, other intermediary costs)	■ Government-collected socioeconomic data ■ Model (function) that determines the output of marketed good as a function of ecosystem condition and other inputs (see Step 2.2 and Table 7)

Table 10 | **Data requirements and sources for different valuation methods (cont.)**

VALUATION METHOD	DATA REQUIREMENTS	POSSIBLE SOURCES OF DATA	EXAMPLES OF SOURCES OF DATA
Hedonic pricing (HP)	Environmental characteristics that vary across goods (e.g., houses and hotels), data on property amenities (e.g., number of bedrooms, bathrooms, size)	■ Government statistics office ■ Real estate agencies ■ Tourism association or ministry	■ Market sales prices of houses or hotel rooms ■ Physical surveys of neighborhood attributes ■ Government-collected socioeconomic data at the neighborhood scale (e.g., income levels, employment) ■ Google Earth: http://earth.google.com
Travel cost (TC)	Maps, market prices of costs to travel site, number of visitors	■ Government statistics office ■ Tourism ministries or boards ■ Questionnaires/surveys	■ Questionnaires/surveys ■ Maps ■ Market prices ■ Socioeconomic data ■ Google Earth: http://earth.google.com
Contingent valuation (CV)	Population information, preference data	■ Questionnaires/surveys	■ Questionnaires/surveys
Choice modeling (CM)	Population information, preference data, biophysical data (e.g., types of products; biophysical structure; harvest, yield or use rates; rates of biological productivity)	■ Questionnaires/surveys	■ Questionnaires/surveys

Source: Adapted from van Beukering et al. 2007.

Economic, social, and environmental information

Practitioners with sufficient time and resources should collect primary data. Once stakeholders have agreed on the scope of the analysis, practitioners can collect data in the field or remotely, such as through remote sensing or through the use of satellite imagery. For example, data on beach width may be collected using Google Earth.[40] Ecosystem surveys should consider both the structure and the function of the ecosystem under consideration.

Where more resources are available, it may be possible to develop computer simulations of the possible changes to the ecosystem (see "modeling" in Step 2.2). Many of the modeling tools that quantify and value changes in ecosystem services, described above in Table 7, provide guidance on data requirements for using those tools (e.g., user guides for InVEST[41] and ARIES[42]). Another option is to undertake small controlled pilot experiments to see what happens to ecosystems when stressors are introduced in reality. These options are expensive and may only be possible if students or volunteers are available to undertake research, or where formal collaborations exist with external research institutes that can provide the resources and the expertise to undertake the modeling or experiments.

When adequate resources are available, valuation practitioners can also gather socioeconomic information through direct data collection such as surveys.[43] Surveys can record the traditions and customs of local groups associated with use of a specific resource, as well as the benefits that are gained from access to the resource. To ensure surveys are replicable, practitioners should use robust methods and keep copies of the questionnaires. The data collection process must be as scientifically rigorous as possible to ensure that the data are accurate and reliable.

Where budgets and time are limited, a set of techniques known as rapid research approaches may be useful. Although such techniques are often not as reliable or robust as literature surveys or primary data collection, they can nevertheless be informative. Some rapid research approaches are:

- Desk estimates of economic losses or gains due to ecosystem change based on observable market prices and/or quantities.
- A short field visit to estimate changes in ecosystem productivity through discussions with local resource users.
- Interviews with consumptive users (e.g., fishers) to learn how they use the resource and how much they benefit financially or otherwise from this use.

Preference data from questionnaires

Direct or indirect questionnaires or surveys can elicit information from individuals about their preferences for ecosystem goods and services and are the primary data source for stated preference valuation approaches (e.g., contingent valuation, choice modeling). Practitioners should carefully design surveys to maximize the proportion of people willing to answer the questionnaire, and to generate accurate and relevant information.

Questionnaires can include open or closed format questions:

- **Open-ended:** This type of question allows a range of answers. For example: "Why is the prevention of mangrove loss important to your household?"
- **Closed:** This type of question limits the options available to the respondent. For example: "Which of the following benefits from mangroves are important to your household?"

Open-ended questions require more time and effort by survey respondents. They may, therefore, inhibit participation or necessitate a shorter survey. The practitioner can avoid open-ended questions by first presenting the questions to focus groups and then coding the most popular responses as (closed format) options in the main survey effort. Responses beyond those provided by the focus group can be captured through an "other" option with space for written responses.

Valuation practitioners should design the questionnaire with budget and timeframe in mind, but also ensure that it is easy and quick to complete, simple to code, and straightforward to analyze.

Basic principles for designing questionnaires include:[44]

- Use short and simple sentences.
- Ask for only one piece of information at a time.
- Avoid negative questions where positive ones could be used.
- Ask precise questions providing a clear frame of reference.
- Provide background information as to what exactly is being valued (to minimize information bias).
- Question order is important to avoid "survey fatigue." For example, survey respondents might be less willing to answer or provide detailed answers to difficult questions that are placed at the end of a survey.
- Structure the questionnaire so that sensitive issues are tackled carefully and last.
- Shorter questionnaires receive a higher response rate than long ones.
- Photographs and other visuals can be useful.
- Collect respondent sociodemographic information, which is essential when aggregating results to a wider population.
- Always pilot test and evaluate first drafts of questionnaires (e.g., through focus groups).

Sampling

The survey will require the identification of a sample of a population (e.g., tourists, fishers, household residents). Ideally all stakeholders who may be affected by the different scenarios would be included in a survey; however, this is usually not possible because of the costs and time involved. Practitioners should therefore draw a sample representative of the entire population (e.g., of home owners in the local area) such that each individual in the population of interest has an equal opportunity to be included in the sample. Practitioners can then conduct the survey among this sample and extrapolate the results to the wider population. If the sample does not reflect the wider population, then the economic value derived could be misleading. It is therefore important to correctly identify the sample, and avoid approaches that bias the sample, such as convenience sampling. Government statistical departments frequently use sampling methods and may be a useful source of information.

Data limitations

Data are not always available of sufficiently high quality. Three issues may affect the quality of data:

- **Data availability:** Long-term data may not be available simply because no one has collected data over time. This can lead to a lack of baseline data against which change can be compared. In other cases, a variety of groups may have collected data using different methods; in these circumstances, data will not be comparable and should not be pooled. Finally, for various reasons there can be gaps in the data. Gaps may be attributable to hazards affecting data collection, inadequate resources for data collection, or simply a failure to prioritize data collection.

- **Data accessibility:** Even when data are available, they may not be available for analysis. In many cases private sector actors collect data to undertake environmental audits to assess their impacts on the environment, including collection of baseline data. However, these reports are internal to the company and the data are often not shared. Even within governments, there may be a lack of willingness to share data.

- **Data quality:** Where the data do exist and are available, they may not be of the highest quality, perhaps because inadequate resources were invested in their uptake or the data was not collected carefully. Practitioners can resolve these problems by extrapolating future impacts from existing data, identifying an academic partner who can provide a student to collect data, or contacting NGOs or external funders who may be able to finance the data collection.

A participatory process—to define scenarios and engage stakeholders—can help overcome these data limitations. Meeting participants and experts contacted during the process can help to fill data gaps and estimate quantities and values where data cannot be otherwise obtained. Participants can also help to validate the data collected. In all cases, a combination of data limitations and assumptions built into the ecological and economic analyses will lead to a level of risk and uncertainty around the valuation results—and the recommendations flowing from those results. Transparency and thoughtfulness about these risks and uncertainties should ensure that the results are more credible and potentially more influential. Step 2.5 explores how to address these risks and uncertainties.

Further Reading: See Appendix 1 for a list of economic valuation manuals and guidelines, with a column listing valuation methods covered in each. The following resources are particularly helpful on the subjects of survey design and sampling: American Association for Public Opinion Research n.d., Bateman et al. 2002, Champ et al. 2003, Constant Contact n.d., Dillman et al. 2008, Haab and McConnell 2002, and Whitehead 2009.

Step 2.5. Account for risk and uncertainty

There are many risks and uncertainties associated with decision making on coastal ecosystems. Risk and uncertainty both relate to outcomes of a proposed or ongoing project, event, or policy. “Risk” describes a situation where there is an understanding of the probability distribution—the function relating the probability of all possible values—of an outcome or outcomes occurring. “Uncertainty” exists when the probability distribution is unknown.[45] Polasky and Binder (2012) state, “For environmental issues involving complex system dynamics, such as climate change or the provision of ecosystem services, the list of possible outcomes in the future may be unknown, much less how to specify probabilities or likely values for each of these outcomes.”

There are three general categories of uncertainty:[46]

- **Scientific uncertainty:** Uncertainty regarding how human actions impact ecosystems and an ecosystem’s provision of goods and services (see Step 2.2).

- **Behavioral uncertainty:** Uncertainty regarding the way humans form their preferences about ecosystem services.

- **Value uncertainty:** Uncertainty regarding economic valuation and how human welfare is impacted by a change in ecosystem service provision as well as choice of discount rate (Box 9). It is important to consider the critiques of different valuation approaches, especially approaches for valuing non-market goods and services where value estimates are not directly available on a market.

There are several ways to address risk and uncertainty in an economic analysis, which range in complexity. One of the easiest ways to address risk is to base calculations on expected values of uncertain parameters, whereby values are weighted by their probability of occurrence. This requires the valuation practitioner to have a good knowledge of the probability of an event occurring.[47]

- **Probabilistic analysis** is a more robust approach for quantitatively assessing risk and allows variation of more than one uncertain variable at a time. This approach is beneficial

BOX 9 | ACCOUNTING FOR TIME: DISCOUNT RATES AND INFLATION

When conducting an economic valuation it is important that costs and benefits accrued over time are presented in comparable terms, generally today's present value. For an ex-post or retrospective analysis, costs and benefits accrued in the past should be adjusted for inflation. For situations where costs or benefits occur in the future, it is important that values are adjusted for the time preference of money by discounting.

Inflation occurs when the price of goods and services rises over time due to a change in demand for those goods and services. To adjust values for inflation and convert them to present year values, economists generally use a price or inflation index such as the U.S. Consumer Price Index. The Consumer Price Index estimates inflation by dividing the price of a consistent group of goods and services by its price in a fixed base year and multiplying that by 100.

For valuations requiring construction of future scenarios, it is common practice to adjust for the time value of resources through discounting. Chee (2004) states that there are two main reasons for discounting in ecosystem valuation. First, people have different time preferences due to impatience, risk of death, or uncertainty about the future. Second, people may prefer having more money today as they can put their money into an interest-bearing account resulting in more money in the future. Discounting adjusts values estimated in the future for these time preferences to show them in present value terms. Valuation practitioners should be careful to remove the effect of inflation if present value calculations are all in present value dollars (e.g., inflation has already been accounted for).

There is no single discount rate that is appropriate for economic valuation. Rather, the choice of discount rate will be tied to local contexts, including a country's general state of development and a society's collective sense of immediacy (Conrad 1999). For example, developing countries with higher rates of poverty might have a higher discount rate as they prefer money today to pay for basic needs. Discount rates are also tied to ethical considerations. For example, a higher discount rate could lead to long-term degradation of biodiversity and ecosystems, but a low discount rate for the entire economy could also result in environmental degradation as it could inspire more growth and development (Gowdy et al. 2010, Conrad 1999).

Many guidance documents are available on how to choose a discount rate. Often, however, national governments are good resources for choosing a discount rate and their recommendations therefore might be seen as more credible. Discount rates are often tied to financial instruments such as the payback term on bonds or bank deposits.

Valuation practitioners often recommend varying the discount rate as part of a sensitivity analysis. For studies conducted in the Caribbean, discount rates have varied from 0 percent (suggesting a dollar today is worth a dollar at any time in the future) to 15 percent (suggesting a dollar today is worth much more than a dollar in the future). Rationales for low discount rates include the need to consider environmental sustainability of decisions far into the future. Rationales for high discount rates point to the relatively low incomes of many Caribbean nations. In any case, best practice calls for valuations of future costs and benefits to include a range of reasonable discount rates so that decision makers understand the sensitivity of value estimates to this parameter (Schuhmann 2012a).

Further Reading: See Chee 2004, Conrad 1999, U.S. EPA 2010 (chapter 6: "Discounting Future Benefits and Costs"), and Gowdy et al. 2010 (see Appendix 1 for full references).

where there are multiple uncertain parameters and for ecosystem valuations that involve complex system dynamics (e.g., climate change). Monte Carlo analysis is a popular approach that requires assigning a probability distribution to each of the uncertain variables. Monte Carlo analysis conducts statistical manipulations of the probabilities and then models results on the probability distribution of the economic valuation outcome.[48]

- **Scenario development** (Step 2.1) is a relatively straightforward method for addressing uncertainty and generally includes working with stakeholders and available biophysical data and models to define realistic scenarios of outcomes and cost estimates. For example, "minimum" and "maximum" scenarios could be constructed by using the minimum and maximum values for uncertain parameters (e.g., monetary cost of change in coral reef area) so that the two scenarios represent a range of economic values for the outcome. In some cases, it might be necessary to create more than two scenarios to reflect policy or event outcomes.

- **Sensitivity analysis** is another approach to addressing uncertainty by testing the relative importance of variables to the valuation outcome. Sensitivity can be tested by simply altering variables one by one to see how the valuation outcome changes. For example, in valuation studies that examine changes in values or benefits into the future, the choice of discount rate (Box 9) can make a large difference in the results. In this case, studies should report valuation results using several discount rates to account for uncertainty in time preferences for the target population.

Researchers report that when conducting ecosystem valuation, it is better to report on a range of possible values (rather than a single value) if the intent of the valuation is to make results more useful and inform decision making.[49] Additionally, reporting a range of values for each ecosystem service value reflects uncertainty in a transparent way, increasing the credibility of the results. Furthermore, a clear presentation of methods, assumptions, and limitations should increase the likelihood of use in decision making.[50]

Step 2.6. Develop and apply decision support tools[51]

Valuation results must be reported in a way that is useful to the project's stakeholders. In Step 1.5, practitioners determined the economic values and additional metrics important to the target audience and other stakeholders (e.g., jobs, revenue, total value, value per capita, avoided damages).

If the valuation targets a specific decision, decision support tools can structure valuation results in a way that is familiar to policy makers, helping them to weigh alternative scenarios, and to choose between alternative investments, projects, or policies.

Common decision support tools include cost-benefit analysis, cost-effectiveness analysis, and multicriteria analysis. Distributional, spatial, and temporal issues are also important when examining the costs and benefits of various policy options.

Cost-Benefit Analysis

Cost-benefit analysis is the most commonly used decision support tool for assessing and comparing economic and financial tradeoffs. It is the standard tool for appraising and evaluating investments, projects, and policies within many government departments and donor organizations. With a cost-benefit analysis, the costs and benefits of alternative options are expressed and compared in monetary terms over a period of time. Cost-benefit analysis indicates how much a prospective project or investment contributes to social welfare by calculating the extent to which the benefits of the project exceed the costs—essentially society's "profit" from a project.

Because the steps in a cost-benefit analysis are largely computational, the analysis can be completed reasonably quickly. However, an important drawback of cost-benefit analysis is the requirement that all costs and benefits be expressed in monetary terms. Although there are well-developed economic valuation methods that estimate values for a wide range of non-market ecosystem goods and services (Step 2.3), the uncertainty associated with the results these methods generate (Step 2.5) can inhibit their usefulness in a cost-benefit analysis. Furthermore, the application of non-market valuation techniques can be expensive and time consuming. For these reasons it may not be possible to estimate monetary values for some costs and benefits, meaning they cannot be entered into a cost-benefit analysis. The omission of certain costs and benefits that cannot be monetized may affect the decision result, although whether or not the omission affects the result is case specific. In some cases the omitted impacts can be significant.

Cost-Effectiveness Analysis

Cost-effectiveness analysis can help decision makers select between options to achieve a single specific goal (e.g., achieving a coastal water quality standard, protecting coastal infrastructure) or determine whether benefits are comparable with costs. The decision maker will normally choose the option of lowest cost or the option that produces the greatest benefits for the same cost. However, the best approach considers all of the costs and benefits of each option and evaluates each option several ways (e.g., cost-to-benefit ratio, net value or benefits minus costs) to select the preferred option.[52]

Ecosystem valuation can help compare "green" options (e.g., reforesting upland riparian areas, protecting coral reefs) with more traditional "gray" options (e.g., sewage treatment plants, sea walls) to determine the most cost-effective means of reaching the desired goal. The replacement cost method (see Table 8) is often the appropriate economic valuation method to use in a cost-effectiveness analysis.[53]

Multicriteria Analysis

Multicriteria analysis has become a well-established tool for decision making that involves conflicting or multiple objectives. Multicriteria analysis can be used to establish preferences between alternative options by reference to a set of measurable criteria that stakeholders have defined (see Box 10 for a recent example from the Bahamas).

Unlike in a cost-benefit analysis, impacts in a multicriteria analysis do not need to be quantified in monetary terms, although (as in Box 10) costs and benefits can be included in a broader analysis. Multicriteria analysis provides a number of alternative ways of aggregating data to provide indicators of the overall performance of options. In short, multicriteria analysis provides systematic methods for comparing these criteria, some of which may be expressed in monetary terms and some of which are expressed in other units (e.g., jobs, beneficiaries, relative political feasibility).

Because it is not necessary to quantify all impacts in monetary terms in a multicriteria analysis, complex and expensive valuation studies of all environmental impacts can be avoided, and qualitative criteria such as political feasibility can be included in the decision framework. Multicriteria analysis can therefore provide a degree of structure, analysis, and openness to decision problems that lie beyond the practical reach of cost-benefit analysis.

Multicriteria analysis is, however, reliant on the judgment of the valuation practitioners (and stakeholders who help design the valuation) in defining alternatives and criteria, estimating the relative importance of criteria, and in calculating and inputting data. Because the process of conducting a multicriteria analysis requires stakeholder input in defining and weighting criteria, it is slower and more labor intensive than conducting a cost-benefit analysis. Another important limitation of multicri-

BOX 10 | CASE STUDY: RANKING POTENTIAL CONSERVATION PROJECTS IN THE BAHAMAS

Hargreaves-Allen (2011) found that the coastal ecosystems of the Exuma Cays in the Bahamas generated benefits worth $230 million (or more than $100,000 per square kilometer) per year. But these ecosystems are threatened by poorly planned coastal development, pollution, overfishing, and climate change. Conservation initiatives are urgently needed to preserve the area's ecosystem services and scenic beauty. But with so many potential conservation projects and limited funding and political will, how are decision makers to choose which projects to pursue?

Hargreaves-Allen (2012) answered this question using a multicriteria analysis to compare potential projects using a standard framework. The study assessed 18 projects related to conservation, ecotourism, fisheries, and sustainable development and ranked them using criteria of costs, benefits, and feasibility, as well as distribution of costs and benefits between stakeholders and across time.

Under the multicriteria analysis, the highest scoring projects were those that minimized costs, maximized benefits, were highly feasible, generated quick and sustained benefits, and benefited a high number of stakeholder groups. The highest ranking projects were:

- Active management of the Jewfish Cays Marine Reserve
- Mangrove replanting to cover areas of historical clearance and low water quality
- Enforcement of current fisheries regulations (e.g., minimum sizes, closed seasons)
- Eco-certification training and qualifications for tour guides
- Establishment of the Exuma Cays as a World Heritage Site.

Encouragingly, the results were fairly consistent whether projects were ranked by cost efficiency, benefit maximization, or other equity and feasibility criteria. This multicriteria analysis study aims to influence land and sea use plans and the ongoing discussion about new regulations for the area.

Source: Adapted from Hargreaves-Allen 2012.

teria analysis is that the results do not necessarily show whether alternative options produce welfare gains or losses. Unlike cost-benefit analysis, there is no rule that benefits should exceed costs. It is, however, often possible to include a "business as usual" alternative in the set of options analyzed, and this should be used as a reference point to indicate whether the other options are better or worse than not acting at all.

Other important considerations

The allocation of benefits and costs of different policy options across stakeholder groups, and across space and time, may also interest decision makers. Further analysis can help illuminate these issues:

- **Distribution of impacts across individuals and groups.** Allocation of the benefits and costs of different policy options across stakeholder groups (as identified in Step 1.4) has practical, political, and ethical consequences. It is important to assess potential "winners" and "losers" when presenting results and recommending a course of action.

- **Spatially distributed impacts.** The spatial distribution of impacts from different policy options may also interest decision makers, and can be an extension of a distributional analysis. Geographic Information Systems (GIS) can be helpful in conducting spatial analysis and communicating analysis results through maps. There are an increasing number of tools for mapping and valuing ecosystem services in GIS (Table 7).

- **Temporally distributed impacts.** Most policy options will result in impacts not only in the current year but also over a number of years into the future. It is important to account for the distribution of costs and benefits over time because people tend to value a benefit or cost in the future less than the same benefit or cost now.[54] The choice of an appropriate discount rate is therefore critical, and sensitivity analysis should be used to show how varying the discount rate influences the results (Step 2.5, Box 9).

Further Reading: See Gustavson et al. 2000 and van Beukering et al. 2007 (chapter 7) (see Appendix 1 for full references).

Step 2.7. Report all valuation results clearly

Beyond reporting the valuation results in a way most immediately useful to stakeholders, studies that include additional useful information (see Table 11 below) can be compared to others over time and between locations. Practitioners can increase the valuation's transparency and credibility by fully documenting the study context; methods used; assumptions made; and uncertainties, limitations, and caveats attached to results.[55]

By providing such information, practitioners can also help ensure that the valuation results can be included in future benefits transfer studies. For example, Brander et al. (2006) performed a meta-analysis of the tourism and recreation values of coral reefs, and found that out of 166 studies from around the world, only 52 included sufficient information to be included in the statistical meta-analysis. The database they developed from these 52 studies includes these core elements, which could be considered an absolute minimum for reporting:

- Name of lead author(s)
- Year of publication
- Title of study
- Objective of study
- Funding source
- Country
- Location description (including longitude and latitude)
- Scale of the study site (local, province, national, regional)
- Name of ecosystem (where relevant)
- Type of ecosystem(s)
- Ecosystem service(s) analyzed
- Valuation method(s)
- Value estimate (original currency and units)
- Units (e.g., currency, per person, hectare, month, year)

Guidelines for more extensive reporting of economic valuation results already exist—in the textbooks, manuals, and other economic valuation resources listed in Appendix 1. In Table 11, we synthesize advice from these resources and from project partners with extensive experience conducting coastal valuation to inform decision making in the Caribbean. While not all information categories will be relevant for all valuation studies, practitioners should report the information in Table 11 to the extent possible.

Table 11 | **Best practice guidelines for information to be included in reporting the results of economic valuation studies**

INFORMATION	DESCRIPTION
Research question / policy context	■ Purpose of the study and intended application of results ■ Description of scenario development process
Study site description	■ Spatial extent of study site ■ Type, spatial extent, and quality of ecosystem(s) (baseline) ■ Change in type, extent, and quality of ecosystem(s) under scenarios ■ Description of new/replaced land or coastal resource uses (e.g., shrimp ponds replacing mangroves) ■ Location, preferably including spatial coordinates
Ecosystem services	■ Definition and description of the ecosystem services that are valued (e.g., tourism, fisheries, shoreline protection – see Table 1) ■ Change in the provision of ecosystem services under scenarios (quantified if possible) ■ Description of ecosystem service quantification methods, calculations, and assumptions
Valuation methods	■ Description of methods ■ Survey approach ■ Sampling approach ■ Sample size ■ Response rate ■ Sample representativeness (e.g., discussion of time period and possible seasonality bias) ■ Sample characteristics (e.g., income and demographic description of respondents) ■ Change in value under scenarios ■ Secondary data sources ■ Calculation methods ■ Assumptions
Valuation estimates	■ Marginal, average, or total value ■ Currency ■ Year of value/price level ■ Spatial unit (e.g., per hectare, km^2, total) ■ Population unit (e.g., per person, household, total) ■ Temporal unit (e.g., per day, week, month, year, present value over some time horizon) ■ Discount rate
Uncertainty	■ Sources and magnitude of uncertainty ■ Sensitivity analysis ■ Range of valuation results
Distribution of values across stakeholder groups	■ Disaggregation of values by gender, income level, economic sector, location, etc. ■ Highlighting vulnerability by group ■ Cost per household or beneficiary ■ Cost per unit area (if applicable)

Source: Jungwiwattanaporn 2012, authors and project partners.

While including all information in Table 11 would be ideal, it may not be easy. Practitioners who are planning to publish results in an academic journal may find that journal criteria conflict with what the practitioner would like to report. More broadly, reporting all of the above information takes time and effort—and there may not be an immediate "reward" for doing so.[56] Nevertheless, thorough reporting can increase the likelihood that the valuation will be used in decision making—through increased transparency and credibility, and through improved detail and thus likelihood of replication or use in other policy-focused valuation studies.

Further Reading: See Appendix 1 for a list of ecosystem valuation manuals and guidelines, organized by valuation methods and themes covered.

Phase 3: Outreach and Use of Results

The outreach and use of results phase includes the following steps:

3.1 Develop synthesis products derived from the valuation results for decision makers.

3.2 Communicate valuation results to decision makers, ideally through an interactive and iterative process.

3.3 Share the study and results with the wider coastal valuation community.

3.4 Monitor and assess the impact of the economic valuation study.

Step 3.1. Refine communications strategy and develop synthesis products for decision makers

Complete reporting of the valuation methods, data collection and analysis, results, and recommendations will likely take the form of a longer research or technical paper, to allow others to scrutinize the results and replicate the study.[57] However, non-technical summaries and related products aimed at decision makers or other key stakeholder groups are necessary to maximize the use of the results and recommendations in decision making.

It is also important to be adaptive, as circumstances may change during the valuation project. As the analysis proceeds and results and recommendations become apparent, practitioners should revisit the communications strategy mapped out above in Step 1.5 with project partners. A communications strategy should target windows of opportunity (e.g., impending legislation, policy debates, investment decisions) whenever possible, and outreach and dissemination should be opportunistic to reflect changing circumstances.

The media and online outlets (social media and blogs) can raise awareness and drive conversations around the valuation results and recommendations. In today's world, media channels are becoming more integrated; outreach efforts can make the most of this integration by using multiple products and channels, such as traditional media, websites, videos, and maps. Because coastal ecosystems are beautiful, photos, videos, and online slideshows can be an effective way to communicate valuation results.

As practitioners develop products derived from the valuation results and recommendations, they should keep the target audience in mind, including the metrics that the audience cares about (see Steps 1.5 and 2.7), and the format(s) that would work best for them. Project partners and "champions" within target audience organizations can help identify the most important metrics, products, and opportunities for dissemination.

Metrics (see Table 5, Step 1.5) include:

- Changes in GDP
- Changes in employment
- Changes in income or revenue
- Changes in food security or nutrition
- Changes in consumer surplus
- Damages avoided
- Distributional effects (winners and losers)

Possible products include:

- Policy briefs
- Brochures
- Posters
- Presentations or slideshows
- Videos
- Newsletters
- Press releases for the media
- Sample interview responses for media coverage
- Maps, charts, and infographics
- Website material
- Visuals that display tradeoffs (e.g., spider diagrams, bar charts, summary tables)

Step 3.2. Communicate valuation results to decision makers (ideally through an interactive and iterative process)

For valuation practitioners to effectively communicate results to the target audience, it is important to remain focused on key messages, the audience's current understanding of the issue, and the need to clearly state the underlying assumptions of the research. Practitioners may need to simplify their results to make them accessible to a broader, non-technical audience, while ensuring that the important nuances of the analysis are not lost.

Involving decision makers in the production and interpretation of valuation results can be a particularly effective way of encouraging the use of those results in decisions. An iterative process to jointly examine early results and refine the analysis can lead to final results and recommendations accepted by a wide range of stakeholder groups (see Box 7 for an example from Belize).[58] Results co-produced with partners, other stakeholders, and local "champions" within decision-making bodies tend to achieve the greatest influence.

Avenues for communicating and disseminating results and recommendations include:

- Traditional media
- Social media (e.g., Facebook, Twitter)
- Launch events
- Stakeholder workshops or other public meetings
- Partners' networks
- Targeted private meetings
- Relevant conferences and events
- Information campaigns—advertisements or social marketing
- Tourist education (e.g., on importance of coral reefs and responsible diving)
- Websites

Practitioners should keep in mind:

- The action they would like the audience to take.
- The need to maintain credibility and communicate the quality of the research.
- The benefits of working with partners, other influential stakeholders, and local "champions" whenever possible.

Step 3.3. Share the study and results with the wider coastal valuation community

As the coastal ecosystem valuation literature continues to grow, online databases (Table 4) are increasingly gathering valuation results, study references, and other study information into easily searchable platforms. These databases can help with scoping for future valuation studies, benefits transfer, and meta-analysis. They can also help deliver the results of a particular valuation to the wider coastal and marine valuation community, and to decision makers beyond the study area. Practitioners can contact the database administrators by visiting the websites listed in Table 4.

Step 3.4. Monitor and assess the impact of the economic valuation

Reviews of the use of previous coastal valuations for decision making in the Caribbean[59]—and similar studies looking at the use of valuations of other ecosystems and in other regions[60]—have found relatively low levels of observed influence thus far. However, these studies have acknowledged that the reviews were not exhaustive—whether in the sets of valuation studies and policy changes considered, or decision makers interviewed. Furthermore, there are almost certainly cases where valuations were used in decision making that have not yet been discovered, documented, and analyzed.

Influence can be difficult to observe or track. It can take a long time—sometimes many years—to come to fruition, as new windows of opportunity for influence emerge, awareness of valuation results grows, and as political processes evolve. Furthermore, valuation results are often only one component of a larger effort to influence policy, legislation, or investment. Consequently, it is often difficult to determine the degree to which valuation studies directly contribute to a policy success or investment decision.

Still, it is possible to more systematically monitor and assess the impacts of valuation studies, in order to learn from successful uses in decision making and to replicate the enabling conditions for influence in future studies. Best practices for practitioners seeking to monitor and assess impact include:

- Build influence tracking into the valuation project through open communications between the valuation practitioner, partners, target audiences, and other stakeholders. Practitioners can follow up with partners and stakeholders periodically, even after all formal outreach activities have occurred, to see if there have been any additional uses of the study in decision making.

- Encourage local stakeholders—especially those interested in conducting their own valuations—to contact the valuation practitioner when an outcome occurs, and to engage directly with the wider valuation community (e.g., MESP, Ecosystem Services Partnership—http://www.es-partnership.org/esp) to help publicize cases of use of valuation in decision making and to increase the effectiveness of ecosystem valuation as a tool to further conservation and sustainable development goals.

- Work with the valuation community to develop more standard and systematic approaches to monitor, evaluate, and report on the use of coastal valuations in decision making. As a first step, the databases mentioned in Table 4 (e.g., MESP, Ocean Economics) could also include a field to describe the observed uses of each valuation study, which could be updated over time as new uses are observed.

An enlarged catalog of valuation success stories—including from other regions—would offer additional opportunities for qualitative and quantitative analysis of trends and causality in the use of coastal valuations in decision making, further refining the best practices presented in this guidebook. Additional research could also deepen the understanding of conditions that enable the use of ecosystem valuation in decision making. Such work could include content analysis of policy documents and meeting minutes to show how dialogue, understanding, preferences and policy commitments evolve, as well as semi-structured interviews and surveys to shed further light on the experience and perspectives of valuation practitioners, decision makers, and other stakeholders.[61] A better understanding of these enabling conditions could help prioritize valuation efforts or design valuation projects that can adapt to environments where critical enabling conditions for influence are absent.

SECTION III

CONCLUSIONS

This guidebook lays out steps for valuation practitioners who are planning new coastal ecosystem valuations in the Caribbean. It will help practitioners design and conduct coastal valuations that will have greater influence on policy, management, and investment decisions–ultimately helping to safeguard the Caribbean's coastal resources for generations to come.

Ecosystem valuation has demonstrated its potential to encourage sustainable coastal development in the Caribbean and turn the tide of coastal ecosystem degradation. A number of coastal valuation success stories (summarized in Appendix 2) highlight this potential. Coastal valuation in the Caribbean has helped justify new fishing regulations, establish marine protected areas, award or settle damage claims, and identify sustainable sources of finance for conservation.

The number of success stories is low relative to the overall number of coastal valuation studies conducted in the region to date. However, the encouraging nature of these successes, combined with the difficulty of tracking and observing influence, suggests a picture that is not as discouraging as it appears on first glance. From a pragmatic standpoint, the success stories reveal a pattern of common and important enabling conditions for the use of coastal valuation for decision making in the Caribbean.

Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean lays out steps to help practitioners replicate those enabling conditions in their studies and increase the prospects for achieving positive outcomes. From the scoping phase, through the analysis and the outreach and dissemination of results, this guidebook focuses on increasing the likelihood of impact on decision making. It highlights the importance of extensively engaging stakeholders (including close collaboration between valuation practitioners, key stakeholder groups, and decision makers), selecting the best available methods that can feasibly be applied, and executing a targeted outreach strategy. Throughout, the guidebook identifies a wide variety of additional resources for practitioners—many of them freely available on the Internet.

The realities imposed by limited resources are inescapable. Just as policy makers face difficult choices allocating scarce resources across social programs and ensuring the provision of goods and services,[62] so do valuation practitioners when allocating scarce resources across the steps in the valuation process. At all phases—from scoping through analysis and outreach—practitioners will inevitably need to reconcile "ideal" execution with the reality of limited time, staff, and financial resources. Yet unduly shortchanging one component to the benefit of others could ultimately undermine the valuation's impact.

Human pressures on coral reefs, mangroves, beaches, and seagrasses are considerable across the Caribbean, but keeping these valuable ecosystems healthy is critical to the continued well-being of people and economies in the region. Over time, WRI looks forward to working with partners in the Caribbean to pilot-test this guidebook to conduct and publicize new economic valuations of coastal ecosystems. Ideally, valuation practitioners will use this guidebook across the region to design and conduct coastal valuations that will have greater influence on policy, management, and investment decisions—ultimately helping to safeguard the Caribbean's coastal resources for generations to come.

APPENDIX 1. ECOSYSTEM VALUATION MANUALS, GUIDELINES, AND FURTHER READING

FULL CITATION (AND URL IF AVAILABLE FOR FREE DOWNLOAD)	PURPOSE	VALUATION METHODS* AND/OR THEMES COVERED
Alberini, A., and J. R. Kahn (eds.). 2009. *Handbook on Contingent Valuation.* Cheltenham, UK: Edward Elgar Publishing.	Focuses on contingent valuation as a method for evaluating environmental change.	CV
American Association for Public Opinion Research (AAPOR). n.d. "Best Practices (how to produce a quality survey)." Deerfield, Illinois: AAPOR. Accessible at: <http://www.aapor.org/Best_Practices1.htm>.	Presents best practices in design and implementation of high-quality surveys.	Survey design and implementation (appropriate for non-market methods)
Arrow, K. et al. 1993. *Report of the NOAA Panel on Contingent Valuation.* Silver Spring, MD: NOAA. Accessible at: <http://www.darrp.noaa.gov/economics/pdf/cvblue.pdf>.	Presents best practices and guidelines in design of contingent valuation surveys.	CV
Bateman, I. J. et al. 2002. *Economic Valuation with Stated Preference Techniques: A Manual.* Cheltenham, UK: Edward Elgar Publishing.	Provides a detailed explanation of how to carry out economic valuation using stated preference techniques.	CV, CM
Barbier, E. B. 2007. "Valuing Ecosystem Services as Productive Inputs." *Economic Policy* 22: 177–229.	Uses production function and cost of avoided damage methods to show different valuations of Thailand mangrove ecosystems than would be yielded through methods typically used in cost-benefit analysis.	PF, CA
Beierle, T., and J. Cayford. 2002. *Democracy in Practice: Public Participation in Environmental Decisions.* Washington, DC: Resources for the Future.	Uses more than 200 cases to evaluate the success of public participation and key factors that lead to success. Includes a systematic guide for designing successful public participation efforts.	Stakeholder engagement
Boyle, K., N. V. Kuminoff, C. F. Parmeter, and J. C. Pope. 2010. "The Benefit-Transfer Challenges." *Annual Review of Resource Economics* 2: 161–182. Accessible at: <https://economics.byu.edu/Documents/Jaren%20Pope/BKPP10.pdf>.	Reviews the benefits transfer literature and presents a framework to guide the design and evaluation of benefits transfer studies.	Benefits transfer
Center for Ocean Solutions. 2011. *Decision Guide: Selecting Decision Support Tools for Marine Spatial Planning.* Stanford, California: The Woods Institute for the Environment, Stanford University.	Assists practitioners in selecting appropriate decision support and ecosystem modeling tools to conduct marine spatial planning (or ecosystem valuation).	Scenario development, ecosystem service quantification
Chee, Y. E. 2004. "An ecological perspective on the valuation of ecosystem services." *Biological Conservation* 120: 549–565. Accessible at: <http://www.epa.gov/nhrlsup1/arm/streameco/docs/Chee2004.pdf>.	Reviews economic valuation methods and the economic welfare approach to decision making from an ecological perspective. Emphasizes public participation, explicit treatment of uncertainty, and transparent decision-making processes.	All

FULL CITATION (AND URL IF AVAILABLE FOR FREE DOWNLOAD)	PURPOSE	VALUATION METHODS* AND/OR THEMES COVERED
Conrad, J. M. 1999. *Resource Economics*. Cambridge, UK: Cambridge University Press.	A text in resource economics with an emphasis on using Microsoft Excel spreadsheets to model resource management issues and explore the tradeoffs inherent in resource management.	All
Constant Contact. n.d. "Top 12 Survey Best Practices." Waltham, MA: Constant Contact, Inc. Accessible at: <http://img.constantcontact.com/docs/pdf/Top12SurveyBestPractices.pdf>.	A list of the top 12 best practices for building and promoting an online survey	Survey design and implementation (appropriate for non-market methods)
Champ, P. A., K. J. Boyle, and T. C. Brown (eds.). 2003. *A Primer on Non-Market Valuation, The Economics of Non-Market Goods and Services: Volume 3*. Dordrecht, The Netherlands: Kluwer Academic Press.	Describes non-market valuation techniques and their implementation, including survey design.	HP, TC, CV, CM, CA, survey design and implementation
Department for Environment, Food, and Rural Affairs (DEFRA). 2007. *An Introductory Guide to Valuing Ecosystem Services*. London: DEFRA. Accessible at: <https://www.gov.uk/government/publications/an-introductory-guide-to-valuing-ecosystem-services--2>.	Provides a systematic approach to include ecosystem valuation within government policy appraisal.	All
Dillman, D. A., J. D. Smyth, and L. M. Christian. 2008. *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. Hoboken, NJ: Wiley.	A succinct review of survey research methods using a variety of communication channels. Includes practical how-to guidelines on survey design and implementation.	CV, CM
Ecosystem-Based Management Tools Network (www.ebmtools.org)	A leading source of information about coastal and marine planning and management tools.	Ecosystem service quantification
Freeman, A. M. III. 2003. *The Measurement of Environmental and Resource Values: Theory and Methods*. 2nd ed. Washington, DC: Resources for the Future.	Provides an introduction to principal methods and techniques for natural resource valuation for those not directly in the field.	All
Gowdy, J., R. B. Howarth, and C. Tisdell. 2010. "Discounting, ethics, and options for maintaining biodiversity and ecosystem integrity." In P. Kumar (ed). *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. London: Earthscan. Accessible at: <http://www.teebweb.org/wp-content/uploads/2013/04/D0-Chapter-6-Discounting-ethics-and-options-for-maintaining-biodiversity-and-ecosystem-integrity.pdf>.	Discusses the choice of a proper discount rate for economic analyses of future values, costs, and benefits related to ecosystem services.	Discount rates

APPENDIX 1. ECOSYSTEM VALUATION MANUALS, GUIDELINES, AND FURTHER READING (CONT.)

FULL CITATION (AND URL IF AVAILABLE FOR FREE DOWNLOAD)	PURPOSE	VALUATION METHODS* AND/OR THEMES COVERED
Gustavson, K., R. M. Huber, and J. Ruitenbeek (eds.). 2000. *Integrated Coastal Zone Management of Coral Reefs: Decision Support Modeling.* Washington, DC: World Bank. Accessible at: <http://www.oas.org/dsd/IABIN/Component1/ReefFix/Bookseng.htm>.	An application of various valuation methods and decision support tools with a particular focus on supporting integrated coastal zone management in Montego Bay, Jamaica.	MP, CA, CV, decision support tools
Haab, T. and K. McConnell. 2002. *Valuing Environmental and Natural Resources: the Econometrics of Non-Market Valuation.* Cheltenham, UK: Edward Elgar Publishing.	A guide to several non-market valuation methods: contingent valuation, travel cost models, random utility (discrete choice) models, and hedonic models.	CV, TC, CM, HP
Hanley, N. and E. Barbier. 2009. *Pricing Nature: Cost-Benefit Analysis and Environmental Policy-Making.* London: Edward Elgar.	Offers an in-depth look at cost-benefit analysis and how it can be used in policy choices and resource management with case studies in Europe, North America, and developing countries.	All
Heal, G. M., E. Barbier, K. Boyle, A. Covich, S. Gloss, C. Hershner, J. Hoehn, C. Pringle, S. Polasky, K. Segerson, and K. Shrader-Frechette. 2005. *Valuing Ecosystem Services: Toward Better Environmental Decision Making.* Washington, DC: The National Academies Press. Accessible at: <http://www.nap.edu/openbook.php?record_id=11139&page=R1>.	Evaluates methods for ecosystem service quantification and valuation, with a focus on aquatic ecosystems in the United States, and considers how valuation can best be used to inform natural resource planning, management, and regulation.	All
Hensher, D. A., J. M. Rose, and W. H. Greene. 2005. *Applied Choice Analysis: a Primer.* New York: Cambridge University Press.	Focuses on choice analysis and how to design experiments studying choices made by individuals.	CM
Jäger, J., D. Rothman, C. Anastasi, S. Kartha, and P. van Notten. "Scenario Development and Analysis." In UNEP. 2007. *IEA Training Manual: A training manual on integrated environmental assessment and reporting.* Nairobi: UNEP. Accessible at: <http://www.unep.org/ieacp/iea/training/manual/module6.aspx>.	Provides guidance on scenario development and analysis, and how to relate scenarios to environmental impacts and policy recommendations.	Scenario development
Kanninen, B. (ed.) 2006. *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice, The Economics of Non-Market Goods and Services.* Volume 8. Dordrecht, The Netherlands: Springer.	Offers practical, research-based advice to conduct stated choice studies including supporting questions, experimental design, and multinomial choice modeling.	CM
Kumar, P., M. Verma, M. D. Wood, and D. Negandhi. 2010. *UNEP Guidance Manual for the Valuation of Regulating Services.* Liverpool, UK: University of Liverpool. Accessible at: <http://www.unep.org/pdf/Guidance_Manual_for_the_Regulating_Services.pdf>.	Evaluates different methods for valuing regulating systems and how to use valuation in decision-making processes.	All

FULL CITATION (AND URL IF AVAILABLE FOR FREE DOWNLOAD)	PURPOSE	VALUATION METHODS* AND/OR THEMES COVERED
Louviere, J., D. A. Hensher, and J. Swait. 2000. *Stated Choice Methods: Analysis and Applications.* New York: Cambridge University Press.	Provides insight into the study and prediction of consumer choice behavior using stated preference methods.	CV, CM
McKenzie, E., A. Rosenthal, J. Bernhardt, E. Girvetz, K. Kovacs, N. Olwero, and J. Toft. 2012. *Developing Scenarios to Assess Ecosystem Service Tradeoffs: Guidance and Case Studies for InVEST Users.* Washington, DC: World Wildlife Fund. Accessible at: <http://www.naturalcapitalproject.org/pubs/ScenariosGuide.pdf>.	Helps practitioners select the most appropriate types of scenarios and methods to use, decide how to engage stakeholders, and learn how to make scenario maps.	Scenario development
Mitchell, R. C., and R. T. Carson. 1989. *Using Surveys to Value Public Goods. The Contingent Valuation Method*. Baltimore: Johns Hopkins University Press.	Shows how contingent valuation is an effective method to determine public willingness to pay for public goods.	CV
Navrud, S., and R. Ready (eds.). 2007. *Environmental Value Transfer: Issues and Methods*. Dordrecht, The Netherlands: Springer.	Assesses ongoing research in the area of benefits transfer and covers the latest developments in the field.	Benefits transfer
Pagiola, S., K. von Ritter, and Bishop, J. T. 2004. *How Much is an Ecosystem Worth? Assessing the Economic Value of Conservation.* Washington, DC: The World Bank. Accessible at: <http://documents.worldbank.org/curated/en/2004/10/5491088/much-ecosystem-worth-assessing-economic-value-conservation>.	Discusses how valuation should be conducted to inform specific policy questions, including (1) determining total ecosystem values, (2) determining net benefits of policy interventions, (3) conducting distributional analysis, and (4) identifying conservation finance sources.	All
Pascual, U., and R. Muradian. 2010. "The economics of valuing ecosystem services and biodiversity." In P. Kumar (ed). *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations.* London: Earthscan. Accessible at: <http://www.teebweb.org/wp-content/uploads/2013/04/D0-Chapter-5-The-economics-of-valuing-ecosystem-services-and-biodiversity.pdf>.	Provides an overview of ecosystem valuation, including methods, stakeholder involvement, benefits transfer, and policy influence.	All
Pearce, D., E. Özdemiroglu, et al. 2002. *Economic Valuation with Stated Preference Techniques: Summary Guide.* London: Department for Transport, Local Government and the Regions. Accessible at: <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191522/Economic_valuation_with_stated_preference_techniques.pdf>.	Summarizes the essential steps for conducting high quality stated preference valuation studies (choice modeling and contingent valuation methods).	CV, CM

APPENDIX 1. ECOSYSTEM VALUATION MANUALS, GUIDELINES, AND FURTHER READING (CONT.)

FULL CITATION (AND URL IF AVAILABLE FOR FREE DOWNLOAD)	PURPOSE	VALUATION METHODS* AND/OR THEMES COVERED
Reed, M. 2008. "Stakeholder participation for environmental management: A literature review." *Biological Conservation* 141: 2417–2431. Accessible at: <http://sustainable-learning.org/wp-content/uploads/2012/01/Stakeholder-participation-for-environmental-management-a-literature-review.pdf>.	Summarizes the benefits of stakeholder participation in environmental decision making and details eight "best practices" in stakeholder participation and engagement.	Stakeholder engagement
Turner, R. K., S. Georgiou, and B. Fisher. 2008. *Valuing Ecosystem Services: The Case of Multi-functional Wetlands.* London: Earthscan.	Provides guidance on ecosystem valuation, including various methods and techniques, and shows how legal obligations and other management targets should be incorporated into valuation exercises.	All
U.S. Environmental Protection Agency (EPA). 2009. *Valuing the Protection of Ecological Systems and Services: a Report of the EPA Science Advisory Board.* Washington, DC: EPA. Accessible at: <http://yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/ValProtEcolSys&Serv>.	Examines ecological valuation practices, methods, and research needs for the U.S. Environmental Protection Agency. Recommends ways that valuations can be strengthened in national rule making, regional partnerships, and site-specific decisions.	All
U.S. Environmental Protection Agency (EPA). 2010. *Guidelines for Preparing Economic Analyses.* Washington, DC: EPA. Accessible at: <http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-50.pdf/$file/EE-0568-50.pdf>.	Provides guidance on the preparation and use of sound science and economic analysis in support of environmental decision making.	All
van Beukering, P., L. Brander, E. Tompkins, and E. McKenzie. 2007. *Valuing the Environment in Small Islands: an Environmental Economics Toolkit.* Peterborough, UK: Joint Nature Conservation Committee and OTEP. Accessible at: <http://jncc.defra.gov.uk/page-4065>.	Provides clear guidance on valuing the environment, implementing a valuation study, and incorporating the results into planning and development decisions. Written specifically for small-island states, government officials, and NGOs, but useful for everyone.	All

FULL CITATION (AND URL IF AVAILABLE FOR FREE DOWNLOAD)	PURPOSE	VALUATION METHODS* AND/OR THEMES COVERED
Whitehead, J. C. 2009. "A practitioner's primer on the contingent valuation method." In A. Alberini and J. R. Kahn (eds.). *Handbook on Contingent Valuation.* Cheltenham, UK: Edward Elgar Publishing. Accessible at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.134.5664&rep=rep1&type=pdf>.	Provides an introduction to the collection of contingent valuation survey data, including survey design, data collection approaches, and data analysis.	CV, survey design and implementation
Wilson, M. A., and J. P. Hoehn. 2006. "Valuing Environmental Goods and Services Using Benefit Transfer: The State-of-the Art and Science." *Ecological Economics* 60 (2): 335–342. Accessible at: <http://www.sciencedirect.com/science/article/pii/S0921800906004460.>	Reports on the state-of-the-art and science of environmental benefits transfer in order to assist in the design and reporting of future benefits transfer studies.	Benefits transfer
World Bank. 2010. *Participatory Scenario Development Approaches for Identifying Pro-Poor Adaptation Options: Capacity Development Manual.* Washington, DC: World Bank. Accessible at: <http://climatechange.worldbank.org/sites/default/files/documents/ESSA-IISD_CapacityDevManual-EACC-Social.pdf>.	Provides guidance on the development and delivery of participatory scenario development (PSD) workshops.	Scenario development
World Business Council for Sustainable Development (WBCSD). 2011. *Guide to Corporate Ecosystem Valuation (CEV).* Geneva: WBCSD. Accessible at: <http://www.wbcsd.org/work-program/ecosystems/cev.aspx>.	Presents businesses with a framework that improves decision making through valuing ecosystem services and is complementary to other business tools (e.g., environmental and social impact assessments, life cycle analysis).	All

Sources: Brouwer et al. 2013, authors, partners.

Notes: * Abbreviations of valuation methods: CA = cost of avoided damage; CM = choice modeling; CV = contingent valuation; HP = hedonic pricing; MP = market price; PF = production function; RC = replacement cost; TC = travel cost.

APPENDIX 2. EXAMPLES OF USES OF TROPICAL COASTAL AND MARINE ECOSYSTEM VALUATIONS IN DECISION MAKING (NOT EXHAUSTIVE)

COUNTRY	STUDY SITE	ECOSYSTEM	ECOSYSTEM SERVICES VALUED	VALUATION METHOD(S)
Caribbean / Atlantic Ocean				
Bahamas	Andros Island	Coral reefs / beaches / wetlands / forest & mangroves	Use & non-use	Benefits transfer
Belize	National-level	Coral reefs / mangroves	Tourism / fisheries / shoreline protection	Market price, cost of avoided damages
Belize	Hol Chan Marine Park	Coral reefs	Tourism	Contingent valuation
Belize	Gladden Spit Marine Reserve	Coral reefs	Tourism / fisheries	Contingent valuation
Belize	National-level	Coral reefs, mangroves, seagrasses	Fisheries, tourism, shoreline protection	Market price, production function, cost of avoided damages
Cuba	Jardines de la Reina National Park	Coral reefs, mangroves, seagrasses	Use & non-use	Contingent valuation, travel cost, benefits transfer, market price
Dominican Republic	La Caleta Marine Reserve	Coral reefs	Dive tourism	Hedonic price, market price, contingent valuation, travel cost
Honduras	Parque Nacional Bianca Jeannette Kawas	Coral reefs, mangroves, seagrasses	Use & non-use	Market price; cost of avoided damages
Mexico	Cancun	Coral reefs	Tourism	Contingent valuation
Netherlands	Bonaire National Marine Park	Coral reefs	Dive tourism	Contingent valuation
St. Maarten	The Man of War Shoal Marine Park	Coral reefs	Tourism / fisheries	Market price, contingent valuation
United States	Florida	Beaches	Tourism	Travel cost
United States	Florida	Coral reefs	Recreational fisheries	Contingent valuation
United States	Florida	Coral reefs / beaches	Tourism	Market price, cost of avoided damages
United States	Florida	Marine reserves	Tourism / fisheries	Market price
United States	Florida Keys National Marine Sanctuary	Coral reefs	Tourism	Travel cost

USE OF VALUATION IN DECISION MAKING	STUDY REFERENCE
Justified the protection of the west side of Andros Island. The Bahamas Science and Technology Commission is also using the results to inform coral reef damage estimates; furthermore, valuation results are being used to raise awareness of the economic benefits of conservation to decision makers and the general public.	Hargreaves-Allen (2010)
Supported action on multiple fronts, including a landmark Supreme Court ruling to fine a ship owner an unprecedented and significant sum for a grounding on the Mesoamerican Reef; the government's decision to enact a host of new fisheries regulations (a ban on bottom trawling, the full protection of parrotfish, and the protection of grouper spawning sites); and a successful civil society campaign against offshore oil drilling.	Cooper et al. (2009)
Justified the Hol Chan Marine Park's increase in user fees, making it one of the few self-financed marine parks in the Caribbean.	Trejo (2005)
Justified funding requests for ongoing planning and management of the Gladden Spit Marine Reserve, resulting in increased donations; additionally, valuation results helped the Gladden Spit Marine Reserve facilitate a historically strained dialogue with fishers and tour operators.	Hargreaves-Allen (2008)
Played a key role in the development of Belize's national Integrated Coastal Zone Management Plan (currently in draft form) by ecosystem services provision and value under three coastal zoning scenarios: conservation, development, and informed management.	Clarke et al. (2013)
Helped to justify the establishment of the Jardines de la Reina National Park, which includes the largest marine reserve (no-take zone) in the Caribbean region.	Figueredo Martín et al. (2009)
Findings used to justify significant increase in user fees. Additional revenue has been used to help establish an aquatic center, a conservation fund to support park management, and a community fund to support local development projects.	Wielgus et al. (2010)
Justified the establishment of a payment for ecosystem services scheme in Honduras in which the tourism sector will pay a national park to maintain coastal water quality in collaboration with the palm oil industry.	PNUMA (2013)
Justified the collection and distribution of revenues from tourist user fees to support local MPAs.	Rivera-Planter et al. (2005)
Justified the Bonaire Marine Park's adoption, and later increase, of user fees, making it one of the few self-financed marine parks in the Caribbean.	Dixon et al. (1993) Uyarra (2002) Uyarra et al. (2010) Thur (2010)
Used by the government of St. Maarten to establish the Man of War Shoal Marine Park—the country's first national park; furthermore, the valuation results are currently being used to sue for damages caused by the sinking of a boat inside the Man of War Shoal Marine Reserve.	Bervoets (2010) WRI (2008a) (tourism) and WRI (2008b) (fisheries)
Helped justify the passage of a $4 billion Save our Coast Trust Fund to buy up beaches in order to provide access to the public.	Bell and Leeworthy (1986)
Justified the issuance of statewide saltwater fishing licenses, which raised revenue for enforcement.	Bell et al. (1982)
Justified Broward County, Florida's revision of their beach renourishment plans to minimize damage to reefs from sedimentation related to pumping sand on the beach; furthermore, valuation results have been used by counties in Florida to justify investments in artificial reefs to support economic development.	Johns et al. (2001)
Supported the design of the regulatory alternatives adopted by government agencies, including the Tortugas Ecological Reserve in the Florida Keys National Marine Sanctuary; furthermore, the integration of socioeconomic information has resulted in increased regulatory compliance, lower enforcement costs, and the development of cooperative management processes with stakeholders.	Leeworthy and Wiley (2000)
Justified a schedule of escalating fines for injury to living coral based on the area of impact; as a result, the Florida Keys National Marine Sanctuary has recovered millions of dollars for reef restoration after ship groundings.	Leeworthy (1991)

APPENDIX 2. EXAMPLES OF USES OF TROPICAL COASTAL AND MARINE ECOSYSTEM VALUATIONS IN DECISION MAKING (NOT EXHAUSTIVE) (CONT.)

COUNTRY	STUDY SITE	ECOSYSTEM	ECOSYSTEM SERVICES VALUED	VALUATION METHOD(S)
Southeast Asia				
Philippines	Pagbilao mangrove forest	Mangroves	Carbon storage	Multiple
Philippines	Palawan Island	Coral reefs	Fisheries / dive tourism	Multiple
Philippines	Olango island reef	Coral reefs / mangroves	Use & non-use	Market price
Pacific				
Costa Rica	Térraba-Sierpe National Wetland Reserve	Mangroves	Use & non-use	Benefits transfer
United States	Hawaii / Big Island and Maui	Coral reefs	Use & non-use	Multiple
United States	Hawaii	Coral reefs	Use & Non-use	Multiple
Indian Ocean				
Sri Lanka	National-level	Coral reefs	Tourism	Market price; contingent valuation

Source: Kushner et al. 2012, authors.

	USE OF VALUATION IN DECISION MAKING	STUDY REFERENCE
	Highlighted the benefits of wetlands as carbon sinks, which helped to justify investments in mangrove reforestation–particularly from the private sector.	Slootweg et al. (2008) Janssen et al. (1999)
	Banned logging in Palawan, established El Nido Managed Resources Protected Area (a marine reserve), and promoted ecotourism development.	Cesar (2000) Hodgson et al. (1988)
	Justified investment in management and protection at the municipal and city levels, increased investment in the Gilutongan MPA, helped to establish the Talima MPA, justified increases in MPA user fees, and encouraged ecotourism development.	White et al. (2000) White et al. (1998)
	Informed the Térraba-Sierpe National Wetlands Management Plan, which was completed by stakeholders in the Térraba-Sierpe community in 2008.	Earth Economics (2010)
	Supported the creation of a Reef Fund for dive and snorkel operators to collect voluntary donations from clients to fund marine protection programs.	Slootweg et al. (2008) Cesar and van Beukering (2004)
	Justified the establishment of administrative penalties for damage to coral reefs in Hawaii.	Slootweg et al. (2008) Cesar (2000)
	Supported a ban on coral mining in Sri Lanka, which was adopted; additionally, influenced the development of national strategies to promote conservation, including Coastal Zone Management plans (which are updated every 5 years).	White et al. (1997)

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ENDNOTES

1. Burke et al. 2011.
2. Karrer et al. 2011.
3. Schuhmann 2012a.
4. Adapted from van Beukering et al. 2007, Laurans et al. 2013, Kushner et al. 2012.
5. Pagiola et al. 2004. "Green national accounting" is a system of accounting for national welfare that takes environmental and sustainability considerations (e.g., stocks of natural capital) into account. It is a more complete measure of wealth than gross domestic product (GDP).
6. Schuhmann 2012a, MESP 2013. The majority of these valuations were for coastal ecosystems (especially coral reefs), probably due to the valuation researchers' ease of access to associated user groups and the relatively straightforward linkages between changes in coastal resource quality and human well-being.
7. Schuhmann 2012a. Besides the multitude of valuation methods and variable quality in application of the methods, there is also an uneven understanding of values across ecosystem services and countries across the region.
8. Kushner et al. 2012.
9. See, for example, Laurans et al. 2013, Ruckelshaus et al. 2013, Rogers et al. 2013, Slootweg et al. 2008, Pagiola 2008, Adamowicz 2004.
10. Kushner et al. 2012, Ruckelshaus et al. 2013, McKenzie et al. (in press).
11. Kushner et al. 2012, Laurans et al. 2013, Adamowicz 2004, Government of South Australia 1999.
12. Schuhmann, P., personal communication.
13. Kushner et al. 2012. For example, the Jamaica National Environment and Planning Agency is currently working to incorporate ecosystem valuation into its environmental impact assessments, and the Caribbean Large Marine Ecosystem (CLME) project—which is working to promote an ecosystem-based management approach throughout the region—is gathering coastal and marine economic valuation data to support policy making.
14. Although this guidebook focuses on the Caribbean, its guidance is applicable to other tropical coastal ecosystems (e.g., Southeast Asia, Pacific), although the high-priority coastal policy questions will most likely be different in other regions.
15. Kushner et al. 2012 and McKenzie et al. (in press) concur that "product, process, and general conditions all matter" in determining whether ecosystem service knowledge and valuation results are used in decision making.
16. U.S. EPA 2009.
17. This step is adapted from Kushner et al. 2012.
18. MESP 2013.
19. This step is adapted from van Beukering et al. 2007, chapter 3.
20. Ruckelshaus et al. 2013.
21. This step is adapted from van Beukering et al. 2007, chapter 8.
22. Parts of this step are adapted from van Beukering et al. 2007, chapter 4.
23. IPCC 1994.
24. World Bank 2010.
25. McKenzie et al. 2012.
26. OECD 1993.
27. For more detail and an example, see: <http://www.epa.gov/ged/tutorial/docs/DPSIR_Module_3.pdf>.
28. Parts of this step are adapted from Schuhmann 2012a and van Beukering et al. 2007, chapter 4.
29. Pagiola 2008.
30. Boyle et al. 2010.
31. Ruckelshaus et al. 2013.
32. U.S. Army Corps of Engineers 1992.
33. Munro 1974, Mahon 1993, Sary et al. 2003, McAllister 1988.
34. van Beukering et al. 2007, p. 50.
35. This step is adapted from WRI 2009.
36. Talberth et al. 2013.
37. U.S. EPA 2009.
38. Bergstrom and Taylor 2006.
39. This step is summarized from van Beukering et al. 2007, chapter 6.
40. See, for example, Wielgus et al. 2010.
41. Tallis et al. 2013.
42. Bagstad et al. 2011.
43. See van Beukering et al. 2007, chapter 9 for an indication of likely resource requirements to undertake various types of economic valuation studies.
44. van Beukering et al. 2007, authors, project partners.
45. Berdica 2002, Pascual and Muradian 2010.
46. Pascual and Muradian 2010, Polasky and Binder 2012.
47. van Beukering et al. 2007, Champ et al. 2003, Polasky and Binder 2012.
48. Freeman 2003, USDOT 2013.
49. Polasky and Binder 2012, Robinson and Hammitt 2011.
50. Kushner et al. 2012.
51. This step summarizes van Beukering et al. 2007, chapter 7.
52. U.S. EPA 2012.
53. Heal et al. 2005.
54. However, discounting of future costs and benefits may be unethical from an intergenerational equity perspective, and a wide literature on the debate of the desirability of discounting exists (e.g., Heal 1998, Portney and Weyant 1999, summarized in NRC 2004).
55. Ruckelshaus et al. 2013.
56. Jungwiwattanaporn 2012.
57. van Beukering et al. 2007, p. 111.
58. Ruckelshaus et al. 2013.
59. Kushner et al. 2012.
60. Laurans et al. 2013, Rogers et al. 2013, Adamowicz 2004.
61. McKenzie et al. (in press).
62. Robinson and Hammitt 2011.

GLOSSARY OF TECHNICAL TERMS

Annual value (as opposed to "marginal value"). The value of an ecosystem good or service at a particular point in time, evaluated over a year.

Benefits transfer. A group of valuation methods that involve applying results (values or functions) obtained in existing studies to different areas (e.g., estimating the value of one beach using the value calculated for a different beach of a similar size and type in a different area). Both value transfer and function transfer are types of benefits transfer.

Choice modeling (CM). A valuation method that allows multiple environmental attribute changes (e.g., beach width, water quality, reef health, park entry fees) to be valued simultaneously. CM can be used to generate estimates of the relative value of multiple attributes, as well as to analyze tradeoffs that individuals are willing to make between environmental factors.

Consumer surplus. The difference between the maximum price a consumer is willing to pay and the actual price the consumer pays.

Contingent valuation (CV). A stated preference valuation method that places a value on ecosystem goods or services by directly asking people to state their willingness-to-pay (WTP) or willingness-to-accept (WTA) for a specific set of ecosystem goods and services or for changes in those goods and services. This method is useful for assessing non-use values such as the value of simply knowing that a coral reef exists.

Cost of avoided damage (CA). A valuation method that looks at the costs that are avoided because a given ecosystem service is present. It is often used to estimate the damages avoided by having protection against natural disasters such as hurricanes and floods.

Cost-benefit analysis (CBA). The standard decision support tool for appraising and evaluating investments, projects, and policies within many government departments and donor organizations. It compares the costs and benefits of alternative options in monetary terms over a period of time, to provide an indication of how much a prospective project or investment contributes to social welfare.

Cost-effectiveness analysis (CEA). A decision support tool that can help decision makers select between options to achieve a single specific goal (e.g., achieving a coastal water quality standard, protecting coastal infrastructure). The decision maker will normally choose the option of lowest cost or the option that produces the greatest benefits for the same cost.

Critical uncertainty approach. An approach to scenario development used when there is significant uncertainty about the impact of a driver of ecosystem change (e.g., coral reef ecosystem response to warming seas, increases in coastal erosion and flooding due to sea level rise).

Damage compensation. A monetary award to be paid to a person or entity as compensation for loss, injury, or harm.

Direct use value. The value assigned to goods and services that are directly used by people, such as forest products or fisheries.

Discount rate. Adjustment to ecosystem service values estimated in the future. Generally, because people prefer having money now as opposed to in the future, the discount rate adjusts future values downward to reflect this preference.

Economic impact analysis. Analysis of the impacts of spending (e.g., revenues, wages, taxes) related to market-based uses of an ecosystem good or service. Optionally, it can include indirect economic impact (impacts on the wider economy spurred by direct spending).

Economic valuation. An assessment of the value of ecosystem goods and services, or changes in the value of ecosystem goods and services, using monetary, social, or biophysical metrics.

Ecosystem goods and services. Goods and services provided by ecosystems that contribute directly and indirectly to human welfare. Ecosystem goods and services are often divided into provisioning services, regulatory services, supporting services, and cultural services.

Ecosystem valuation. See "economic valuation."

Existence value. The value humans place on the knowledge that a resource (e.g., a coral reef) exists, even if they never visit or use it.

Financial analysis. A valuation method that uses observed market prices to analyze the economic activity generated by use of an ecosystem good or service. Unlike an economic impact analysis, operating costs are subtracted from all revenue calculations to arrive at net revenue.

Gray infrastructure. Human-built approaches to environmental management (e.g., water filtration plants to improve water quality; seawalls to prevent coastal flooding). Gray infrastructure is a possible alternative or complement to "green infrastructure."

Green infrastructure. An approach to environmental management that uses natural processes to obtain desired outcomes, while providing a suite of ecosystem goods and services (e.g., planting trees in watersheds to improve water quality; protecting coral reefs to prevent coastal flooding and erosion). Green infrastructure is a possible alternative or complement to "gray infrastructure."

Green national accounting. A system of accounting for national welfare that takes environmental and sustainability considerations (e.g., stocks of natural capital) into account. It is a more complete measure of wealth than gross domestic product (GDP).

Hedonic pricing (HP). A valuation method used to estimate economic values for ecosystem services that directly affect market prices. It is most commonly used to examine variations in housing prices that reflect the value of local environmental attributes (e.g., ocean view, distance to beach).

Indirect use value. The value of goods and services that support economic activities from which benefits are derived (e.g., flood protection, erosion prevention).

Marginal value (as opposed to "annual value"). The change in value of an ecosystem good or service resulting from a change in ecosystem condition due to a change in human pressure (e.g., increased pollution or improved management).

Market-based methods. Valuation methods used when market transactions help to shed light on ecosystem value (e.g., market price methods, replacement cost).

Market price methods (MP). Valuation methods that use market prices to analyze the economic activity generated by use of an ecosystem good or service. These methods include economic impact analysis and financial analysis.

Meta-analysis. A valuation method that synthesizes results from a collection of existing valuation studies by using statistical analysis to regress value estimates from similar studies on study and site characteristics. Meta-analysis results can be used to generate value estimates at a new site, but requires thoughtful implementation to generate meaningful results.

Monte Carlo analysis or simulation. A statistical risk analysis method that constructs models of possible outcomes by substituting a range of values for independent variables that have known uncertainty, using their probability distribution.

Multicriteria analysis (MCA). A support tool for decisions involving conflicting or multiple objectives. It can be used to establish preferences between alternative options using a set of quantified criteria, some of which may be expressed in monetary terms and some of which are expressed in other (non-monetary) units.

Non-market methods. Valuation methods used when market prices are not available for a good or service. Non-market methods include both revealed and stated preference techniques which are based on developing proxy markets or surveys of populations of interest.

Non-use values. A value ascribed to goods and services that are not associated with actual use but rather with the knowledge of knowing that a good or service exists or could be used in the future. Examples of non-use values include option or future use value and existence value.

Option value / future use value. The value humans place on having the option to use or visit a resource or ecosystem in the future.

Participatory scenario development (PSD). A process that relies on input from stakeholders to explore likely futures.

Payments for Ecosystem Services (PES). Programs or payment schemes that incentivize sustainable use or conservation of ecosystems by requiring beneficiaries to pay a fee for that ecosystem's goods and services.

Policy question. A question that would inform a policy, management, or investment decision.

Probability distribution. A statistical function of a random variable that describes the probability of all possible values for that variable.

Producer surplus. The difference between the minimum price a producer is willing to accept and the actual sale price.

Production function (PF). A valuation method that estimates a change in value by assessing the change in a provided good or service resulting from a change in the environmental resource.

Replacement cost (RC). A valuation method that estimates the value of an ecosystem service by determining the cost of manmade infrastructure required, or products that need to be purchased, to replace the service provided by the ecosystem in its current state. It has been frequently used to assess values such as shoreline protection by coral reefs.

Revealed preference approach. Non-market valuation methods that determine the value of an ecosystem good or service using data from other market transactions or proxy markets.

Stated preference approach. Non-market valuation methods that rely on input from individuals through surveys to determine the value of an ecosystem good or service. Contingent valuation and choice modeling are examples of a stated preference approach.

Travel cost (TC). A valuation method that uses data about visitation to a site or set of sites to construct a demand curve for an environmental resource (e.g., a beach). This method is primarily used to estimate the recreational use value of a resource based on its specific characteristics.

Total Economic Value (TEV). The total value, including use and non-use value, of an ecosystem.

Use values. Values ascribed to goods and services that are directly used for consumption.

User fee. A fee or tax imposed on the consumption of services or facilities.

Valuation practitioner. A person responsible for conducting or overseeing an economic valuation. Such an individual could be a trained economist, an expert from another relevant discipline, or a non-technician. (This guidebook is designed for all kinds of practitioners.)

Valuation stakeholder. A person or group who has an interest in, or will be affected by (a) the policy question; (b) the design and implementation of an economic valuation; (c) the valuation results and the implications of the results; and/or (d) the outreach process.

Willingness to accept (WTA). The amount a person is willing to accept in compensation for losing access to a good or service or for putting up with an externality (e.g., pollution), which cannot be directly valued in a marketplace.

Willingness to pay (WTP). The maximum amount a person is willing to pay for a good or service.

ACRONYMS LIST

ARIES	Artificial Intelligence for Ecosystem Services
CA	cost of avoided damage
CBA	cost-benefit analysis
CEA	cost-effectiveness analysis
CLME	Caribbean Large Marine Ecosystem
CM	choice modeling
CV	contingent valuation
DPSIR	Development-Pressure-State-Impact-Response framework
ESVD	Ecosystem Service Valuation Database
EVRI	Environmental Valuation Reference Inventory
EVT	Ecosystem Valuation Toolkit
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
GIS	Geographic Information System
HP	hedonic pricing
InVEST	Integrated Valuation of Environmental Services and Tradeoffs
MCA	multicriteria analysis
MESP	Marine Ecosystem Services Partnership
MIMES	Multiscale Integrated Models of Ecosystem Services
MP	market price
NGO	nongovernmental organization
NOAA	National Oceanic and Atmospheric Administration
NOEP	National Ocean Economics Program
PF	production function
PSD	participatory scenario development
RC	replacement cost
TC	travel cost
TEV	total economic value
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WRI	World Resources Institute
WTA	willingness to accept
WTP	willingness to pay

ABOUT WRI

WRI is a global research organization that works closely with leaders to turn big ideas into action to sustain a healthy environment—the foundation of economic opportunity and human well-being.

Our Challenge
Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision
We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT
We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT
We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT
We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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