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The valuation of marine ecosystem goods and services in the Caribbean: A literature review and framework for future valuation efforts

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ABSTRACT

This paper reviews economic valuation of marine ecosystem services in the Wider Caribbean Region (WCR) for the three major marine ecosystems addressed by the Caribbean Large Marine Ecosystem (CLME) Project: reef, pelagic and continental shelf. A review of over 200 value estimates suggests that marine economic valuations in the WCR have focused on a limited number of benefits derived from marine ecosystems, primarily those that are relatively easy to measure and convey, such as recreation opportunities in protected areas, and benefits that are ascribed to easily measured market indicators. Values associated with reefs have received far more attention than those associated with the pelagic or shelf ecosystems. The economic impacts of overfishing remain largely unexplored. Regulating and maintenance services provided by the marine ecosystems of the WCR have been recognized as important, but have not been linked to valuation. Finally, estimates of non-use values for WCR marine ecosystem goods and services are few. It is suggested that future work on valuation be coordinated among countries and agencies so that gaps can be prioritized and valuation studies can be directed toward a more comprehensive understanding of the full value of the goods and services provided by marine ecosystems in the WCR.

1. Introduction

1.1. The economics of marine ecosystem goods and services

Marine ecosystems supply a variety of goods and services that provide direct and indirect contributions to human well-being. These include goods traded in formal markets such as food and materials as well as non-market goods and services such as waste regulation, climate regulation, coastal protection and opportunities for recreation. The countries of the WCR are highly dependent on marine ecosystems for a variety of goods and services. These ecosystems are known to be under significant threat, and many of these threats are transboundary in nature (CLME Project, 2011). The need for, and interest in, policy advice based on valuation of marine ecosystem goods and services was identified in a region-wide survey of policy advisers and provided the impetus for this study (McConney et al., 2012). This paper first provides an overview of economic analyses of marine ecosystem services for the three major marine ecosystem types in the Wider Caribbean Region (WCR) - reef, pelagic and continental shelf (CLME Project, 2011). Gaps, deficiencies and unknowns in the extant literature are discussed as a basis for a framework for valuation in the WCR so that future work can be directed toward areas of policy importance.[1]

A broad literature provides classifications of ecosystem services (e.g., Daily, 1997; De Groot et al., 2002; Boyd and Banzhaf, 2007; Moberg and Folke, 1999; Wallace, 2007). The 2005 Millennium Ecosystem Assessment ([WRI] World Resources Institute, 2005) also provides a typology, categorizing ecosystem services as supportive, regulating, provisioning or cultural and gives descriptions of ecosystem services. Table 1 gives some common examples and is the typology that will be used here.

Despite the fact that the entire market economy depends on the existence of natural systems, values derived from environmental goods and services are often ignored by policy makers. Part of the explanation for this stems from the fact that people and governments most often respond to monetary price signals which may differ from economic values (Dixon, 1998). Without an understanding of the

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Table 1
ICES classification of ecosystem services.

Ecosystem service themes	Principle classes of service
Provisioning	Nutrition Materials Energy
Regulating and maintenance	Mediation of wastes, toxics and other nuisances Flow mediation Maintenance of physical, chemical, biological conditions
Cultural	Physical and intellectual interactions Spiritual, symbolic and other interactions

monetary worth of natural resources, conservation efforts may be stymied because they are viewed as costly in terms of precluding activities that have large immediate financial rewards (Schuhmann et al., 2013). Simply put, the true value of the goods and services provided by natural resources, in the WCR and around the world, is largely unknown, and as a consequence may not be given due attention in the policy process.

Understanding and measuring the contributions of ecosystem services to human well-being is the domain of economic valuation; hence ecosystem services must be linked with human well-being and economic value. Ecosystem services (processes and functions), however, are not synonymous with ecosystem benefits (outcomes that affect the wellbeing of people) (Boyd and Banzhaf, 2007; Fisher and Turner, 2008). While the former may be difficult to quantify, measurements of the latter are more often of interest for informing policy. Importantly, it is these benefits that provide the basis of economic valuation studies. The distinction between ecosystem services and ecosystem benefits avoids the problem of double counting when estimating economic values, because we only seek to measure distinct benefits (Fisher and Turner, 2008; Lele et al., 2013). For example, the processes associated with primary production by coral reef or mangrove ecosystems provide benefits via food and materials. It is the economic value of these benefits that is of interest for valuation studies. Monetizing the worth of both primary production processes and the resulting food and material output would amount to double-counting.

Valuation studies can generate information on the costs associated with species and habitat loss, the benefits of conservation and restoration efforts, or economic dependence on natural systems. Such information, reported in a common and easily understood monetary metric, can be valuable information for decision-makers attempting to allocate scarce resources among competing demands (Turner et al., 2003). Economic valuation can support decision-making at the national level, and incorporating the value of natural assets into national income accounts provides a more complete indication of economic performance or national wealth (Dharmaratne and Strand, 1999).

There are many situations where measuring and understanding the value of particular natural resources can be useful. In general, anytime there is a potential for a tradeoff between market values and non-market values, economic valuation can facilitate this comparison by expressing all impacts in monetary units. This is necessary because alternative uses of natural resources create a range of impacts, which are usually not in comparable units (changes in fish stocks, water or air quality changes, or reef degradation).

Valuation of any sort requires understanding how changes in environmental goods and services affect human well-being, and then determining how much individuals are willing to pay (WTP) for beneficial changes, or willing to accept (WTA) as compensation for unfavorable changes (Bockstael et al., 2000; Barbier et al., 2011). Thus, valuation allows a comparison of two alternative states of the world (e.g., with policy and without policy).

Most often, value estimates should be derived in the context of marginal changes to resource quality or ecosystem services. Care must be taken when attempting to use values derived in the context of incremental changes to value ecosystems as a whole. First, value estimates for particular ecosystem services are typically derived assuming all other factors are held constant. Second, unit values associated with ecosystem goods or services (market or non-market) will be a function of relative scarcity and the scale of measure. For example, the value of a given percent improvement in coral quality will depend on the baseline level of quality. Further, because of substitution possibilities, the value of a given percent change in coral cover on all reefs cannot be derived by scaling up the value of that change on one reef by some measure of total physical area (Bockstael et al., 2000). Hence, understanding the relationship between values and the scale of analysis is critical before attempting to assign values to entire ecosystems or natural populations.

Moreover, aggregated values may be difficult to incorporate into appraisals of the costs and benefits of policy change (Turner et al., 2003). That is, attempts to estimate the total value of a given ecosystem are unlikely to be useful in most policy contexts. Conservation decisions are most often directed at incremental changes to resource quality or ecosystem service flows, rather than absolute "all-or-nothing" changes. As noted in Bockstael et al. (2000), to value a complete ecosystem, we must be able to compare the state of the world with the system in place to a prediction of what the world would be like without the ecosystem. For large scale ecosystems, upon which the existence of a large sector of society depends, the notion of willingness to pay or accept compensation for loss of the entire system simply cannot be quantified in a finite fashion (Steiner et al., 2004). Valuation studies should therefore attempt to match desired value targets with resource quality changes or service flows that would feasibly result from policy actions or inaction.

There are many approaches to valuation, coincident with the many ways that humans can interact with the environment and the array of benefits that result. The method(s) chosen often depends on what is being valued and the intended use or policy purpose of the values. When value is easily revealed through market transactions (such as benefits associated with direct extractive uses), monetization may be accomplished via the relatively straightforward *market price approach* (MP). This approach values environmental goods and services based on profits or market value-added (Huber and Ruitenbeek, 1997). Other valuation methods that rely on market data include the *replacement cost approach* (RC) which is based on the idea that some goods and services provided by the natural environment can be replaced by manmade goods and services, and *the cost* (*damage*) *avoidance approach* (CA), which uses estimates of the expenditures that would be incurred to prevent, diminish or avoid harmful effects associated with degradations to natural resources.

The estimation of non-market values, while much less known outside the economics profession, are facilitated by a variety of valuation techniques.[2] *Revealed preference methods* include the *travel cost method* (TCM) and *hedonic pricing* (HP). *Stated Preference Methods* include the *contingent valuation method* (CVM) and *choice modeling* (CM), and are the only empirical methods available for the estimation of non-use values. When time or budget constraints prevent application of one of the above methods, existing value

[2] For background information and reviews of valuation techniques, see Bockstael et al. (1987, 1989), Braden and Kolstad (1991), Champ et al. (2003), Christie et al. (2012), Freeman (2003), Haab and McConnell (2002).