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Valuing marine and coastal ecosystem service benefits: Case study of St Vincent and the Grenadines' proposed marine protected areas

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ABSTRACT

This paper reports the results of a choice experiment (CE) that values the ecosystem service benefits from extending the current network of marine protected areas (MPAs) in St Vincent and the Grenadines (SVG), Caribbean. We considered two future options: an 'improved' scenario in which marine protection is increased, and a 'decline' scenario in which current protection mechanisms are removed. The CE was administered at two sites (the degraded St Vincent South Coast and the pristine Tobago Cays) and to tourists and local residents. Results suggest that both groups value health protection, fishing, coastal protection, ecosystem resilience, and diving/snorkelling. Values are higher for the 'decline' scenario compared to the 'improved' scenario. Also, tourists had significantly higher WTP values than locals. Our analysis also enabled an evaluation of the benefits derived from alternative policy interventions that may be used to protect and enhance SVG's marine parks. Stopping pollution from agriculture run-off and sewage was found to generate the highest ecosystem service benefits, with restricting over-fishing and bad fishing practices also being important. We demonstrate how economic valuation of marine ecosystem service might be used to design and target marine conservation policies that maximise welfare benefits.

1. Introduction: Marine and coastal ecosystems, ecosystem services and valuation

Marine and coastal ecosystems are one of the most productive, diverse and valuable ecosystems on Earth (Souter and Linden, 2000; Spalding et al., 2001; Wilkinson, 2008; Wilkinson and Buddemeier, 1994). For example, coral reefs are thought to host 25% of the World's fish species (Spalding et al., 2001). However, marine and coastal ecosystems are currently being threatened worldwide from a wide range of anthropocentric as well as non-anthropocentric pressures including unsustainable fishing practices, the development of tourism and urban infrastructure, pollution from land-based sources, ocean acidification and sea level rise (Allsopp et al., 2009; Beharry-Borg and Scarpa, 2010; Butchart et al., 2010; Cinner et al., 2012; Secretariat of the Convention on Biological Diversity, 2010; van Beukering et al., 2007). This has resulted in a significant loss and degradation of these important habitats (Butchart et al., 2010; Jameson et al., 1995; Moberg and Folke, 1999) which in turn is likely to negatively impact the welfare and livelihood of people living in coastal areas (MEA, 2005; van Beukering et al., 2007). Wilkinson (2004) estimates that 30 million (m) people in coastal and island communities are totally reliant on reef-based ecosystems for their primary means of food production, income and livelihoods, while Cesar et al. (2003) estimates that the global reef-based tourism and recreation market is worth US$9.6 billion per annum.

Marine and coastal ecosystems provide a wide array of services, which are of value to human populations. Waite et al. (2014) classifies marine and coastal ecosystem services into *provisioning* services (Food/fisheries, Raw materials, Medicinal resources and Genetic resource), *regulating* services (Flood/storm/erosion regulation, Climate regulation), *cultural* services (Tourism and recreation, History, cultural and traditions, Science, knowledge and education) and *supporting* services (Primary production, Nutrient cycling, Species/ecosystem protection). Increasingly, however, it is being recognised that a key contributing factor to the loss and degradation of ecosystems has been a failure of people to fully recognise, and account for, the range of 'ecosystem service' benefits provided by those ecosystems (Costanza et al., 1997; Daily, 1997; MA, 2005; Sachs et al., 2009; Secretariat of the Convention on Biological Diversity, 2000; TEEB, 2010). Understanding the values of biodiversity and ecosystem services and embedding these values in decision-making is essential for ensuring more equitable, cost effective and sustainable biodiversity conservation policies (TEEB, 2011a,b). Further, demonstrating the economic and societal benefits from marine conservation is important to (i) justify expenditures on marine conservation

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programmes, and (ii) to provide evidence to help better target resources to policy actions that maximise societal benefits (or minimise costs). The ecosystem services approach to policy appraisal provides a mechanism to achieve such ambitions (TEEB, 2011a,b; Waite et al., 2014).

Over the past decade, there has been a significant research effort to value the ecosystem services provided by marine and coastal biodiversity (Schuhmann, 2012; Schumann and Mahon, 2014; van Beukering et al., 2007; Waite et al., 2014), and explore how these values may be embedded into decision making (TEEB, 2011a,b; Waite et al., 2014). Most of these studies, however, tend to only address a handful of ecosystem services with only a limited number of studies having attempted to value the full range of provisioning, regulating and cultural services.

This paper contributes to the literature eliciting values for marine and coastal ecosystem services by implementing a stated preference choice experiment that aims to evaluate the benefits derived from protecting and enhancing a range of ecosystem services delivered through two proposed marine protected areas in St Vincent and the Grenadines (SVG), Caribbean. The two case study sites are the proposed 2.5 ha South Coast marine park that is currently in a degraded condition due to human pressures and the almost pristine 11.25 ha Tobago Cays marine park. The evidence collected in this study demonstrates that locals and tourists value different aspects of SVG's marine ecosystems, and we argue that these findings provide useful evidence as to how MPA conservation policies might best be designed to maximise societal benefits.

This paper is organised as follows. In the next section we provide some background to the two case study marine parks in SVG. We then describe the choice experiment that was used to value a bundle of ecosystem services provided by the two proposed parks. The results from the CE are then reported. We conclude the paper with some policy recommendation for the future management of SVG's MPAs based on the findings of the choice experiment.

2. Case study: Marine protected areas in St Vincent and the Grenadines

St. Vincent and the Grenadines (SVG) comprise a series of islands located in the Eastern Caribbean. The main island of St. Vincent is 345 km^2, while the Grenadines are 44 km^2 and comprise a series of smaller islands including Bequia, Mustique, Canouan, Mayreau, Union Island, Palm Island, Petit St. Vincent, and 28 uninhabited islets including those of the Tobago Cays. The combined population of SVG is approximately 109,400 people (World Bank, 2012).

St. Vincent has a mountainous landscape that includes 12,700 ha of tropical forests, while the Grenadines predominantly comprise low dry islands. All of the SVG islands are surrounded by extensive coral reefs and seagrass beds that are globally significant and are host to several endemic species (NPRBA, 2009). However, these important ecosystems are currently being threatened by a number of anthropocentric activities, including:

- *Tourism development*—In response to the downturn in the banana industry, the Government of St Vincent and the Grenadines (GoSVG) made a strategic decision to fill the void created in the national economy by targeting growth of the tourism sector. Direct incomes from tourism account for a large proportion of the GDP. However, uncontrolled tourism development is likely to be a major cause of ecosystem degradation through: (i) destruction of habitats for the development of infrastructure; (ii) degradation of habitats from an increased quantity of waste generated; (iii) damage to habitats as a result of recreational activities; and (iv) transportation facilitating the introduction of invasive alien species.
- *Over-exploitation and unsustainable uses of biodiversity*—Overfishing, over-hunting, over-grazing and over-harvesting are major causes of biodiversity loss in the island ecosystems. Overfishing, for instance, can cause significant declines in fish populations of coral reefs and can have long-lasting negative effects on all aspects of reef ecology. Furthermore, overharvesting significantly threatens queen conchs, spiny lobsters and hawksbill among other species.
- *Pollution and waste disposal*—Pollution from liquid (e.g. agrochemicals) and solid waste/sewage, is causing degradation of rivers, subsurface and coastal water quality, compromising island habitats and having adverse effects on recreational activities.
- *Deforestation and land degradation*—The loss of forests to agriculture (legal and illegal) in watershed areas is leading to soil erosion and land degradation, reducing the capacity of the land to provide nutrient cycling and to support biodiversity. Siltation of rivers and coastal areas due to run-off also threaten sensitive riverine and coastal ecosystems.

Human activities are clearly impacting SVG's marine ecosystems, which in turn undermine the capacity of these habitats to deliver ecosystem services that are fundamental for people's well-being and livelihoods. To tackle some of these issues, as well as to meet its commitments under the Convention on Biological Diversity (CBD), the Government of SVG (GoSVG) has established a suite of protected areas. These policies are set out in the GoSVG's *SVG National Parks and Protected Areas System Plan 2010–2014* report (NPRBA, 2009). Currently, the GoSVG has designated 35 protected area sites in SVG; of which there is one Marine Park, one Marine Reserve and six Marine Conservation Areas (Table 1). Following recommendations from Jackson (2004), the GoSVG now wish to consolidate and upgrade SVG's marine protected areas. The proposed new system would include five Marine Parks, three Marine Reserves and three Marine Conservation Areas (Table 1).

To provide evidence to support these developments, the GoSVG commissioned this study to assess the costs and benefits provided by the proposed expansion of its marine protected areas network. Specifically, this research will explore local people's and tourist's preferences for a range of ecosystem services provided by the marine and coastal ecosystems in SVG and the values they attached to the protection and enhancement of their provision.

3. Research method

Quantifying the costs and benefits associated with changes in the provision of ecosystem services requires the researcher to first understand the complex ecological linkages between biodiversity (the ecosystem) and ecosystem service provision, and then perform a valuation study to examine how much people value the changes to ecosystem service provision (Haines-Young and Potschin, 2008). Accordingly, in this paper, we first conducted a series of stakeholder workshops to explore how MPA policy in SVG may affect the capacity of marine ecosystems to deliver ecosystem services. Once the linkages were established, preferences and values were elicited through a choice experiment. Below, we detail on our research approach.

3.1. Stakeholder workshops: Linking policy interventions to changes in the provision of ecosystem services

A series of stakeholder workshops were conducted at the two case study sites in 2011 to collate information that would be used