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Analysis

Recreational diver preferences for reef fish attributes: Economic implications of future change

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ABSTRACT

This study sought to quantify the potential effects of changes in Caribbean reef fish populations on recreational divers' consumer surplus. Over five hundred tourist SCUBA divers were interviewed at seven sites across three Caribbean countries representing a diversity of individuals within the Caribbean dive market. A choice experiment was used to assess willingness to pay as a function of the abundance and size of reef fishes, the presence of fishing activity/gear, and dive price. Despite some preference heterogeneity both between and within sites, the results indicate that future declines in the abundance of reef fishes, and particularly in the number of large fishes observed on recreational dives, will result in significant reductions in diver consumer surplus. On the other hand, improvements in fish populations and reduced fishing gear encounters are likely to result in significant economic gains. These results can be used to justify investment in pre-emptive management strategies targeted at improving reef fish stocks (namely reducing unsustainable fishing activities and land-based reef impacts), managing conflicting uses, as well as to indicate a possible source of financing for such conservation activities.

1. Introduction

The Wider Caribbean is the most tourism dependent region in the world (WTTC, 2014) and each year, billions of dollars are generated from recreational SCUBA diving in the region (Burke et al., 2011). However, coral reef health has declined dramatically within the last few decades, as indicated by declines in reef fish populations, live coral cover and by simultaneous increases in macro-algae (Bruno et al., 2009; Paddack et al., 2009). This trend, largely driven by decades of overexploitation, and land-based activities reducing nearshore water quality (Jackson et al., 2014), is now being accelerated by external drivers including climate change (Hoegh-Guldberg et al., 2007) and marine invasive species (Green et al., 2012). Of particular concern here is the fact that continual declines in reef fish populations will not only affect reef health (Mumby, 2006), but will also have direct effects on income generating activities such as dive tourism, as observing reef fish is an important component of the recreational dive experience (Parsons and Thur, 2008; Schuhmann et al., 2013a). The potential for substantial economic losses in the Caribbean tourism industry as a result of declining coral reef health (Burke et al., 2011) highlights the importance of improving our understanding of the implications of current declines in reef fish populations and how improving reef management across the region might mitigate some of the harmful socioeconomic impacts on Caribbean coastal communities.

1.1. Drivers of Reef Fish Decline

Fishing pressure and habitat degradation stand out as two of the most prominent drivers of reef fish decline in the Caribbean (Paddack et al., 2009). With regard to fishing pressure, fisher preference for high valued, large-bodied individuals and species (e.g. large snappers and groupers), together with life history strategies that make these large-bodied species especially vulnerable to fishing effects (slow growth, delayed maturity, long-lived, aggregated spawning events) has resulted in reefs today having fewer mature and large fish, except where protected from fishing (Froese, 2004; Hawkins and Roberts, 2004). Furthermore, coral reef degradation is known to limit fish abundance, given the relationship between reef structural complexity and juvenile recruitment success (Rogers et al., 2014).

Although the effects of fishing pressure on average fish size, and coral reef degradation on fish abundance are not mutually exclusive, an economic assessment of their continued and potentially differential effects on reef fish communities can be useful for guiding policy with regard to which stressors may have a greater impact on recreational diver demand if left unabated. Further, measuring the potential economic gains from maintaining or even improving fish stocks can also help policy makers make informed decisions about whether the costs of addressing these drivers are justifiable.

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Non-market valuation is a useful tool to assess the potential economic impacts (i.e. changes in consumer demand) of future changes in environmental attributes (Louviere et al., 2000). With a limited number of studies in the Caribbean that specifically measure divers' demand for healthy reef fish populations (e.g. Parsons and Thur, 2008; Rudd and Tupper, 2002; Schuhmann et al., 2013a) and even fewer that estimate values at multiple sites (Schuhmann, 2012), this study aims to highlight some of the economic implications of changes in reef fish resources to the dive sector within multiple coastal communities across the Caribbean. These changes can be examined within the context of expected changes in reef fish populations from unsustainable fishing and habitat degradation (caused by land-based activities and future climate variability and change), as well as the successful implementation of management interventions that improve reef fish stocks.

2. Methods

Over the period March 2011 to March 2012, 505 tourist SCUBA divers were interviewed using self-administered surveys (with the researcher present) at seven sites across the Caribbean: Barbados (Six Men's, Holetown, Pile Bay), the Bay Islands, Honduras (West End, Roatan; East Harbour, Utila) and St. Kitts and Nevis (Jessups, Nevis; Newtown, St. Kitts) where nearby reefs were utilized by divers as well as fishers (excluding marine protected areas; Fig. 1). The survey instrument (Gill, 2014; Supplement 1) was pre-tested and modified with feedback from dive operators, researchers and tourist divers to ensure its effectiveness, and adjustments were made to increase clarity and to reduce complexity before implementing. Choice experiments were used to estimate the willingness to pay (WTP) of recreational tourist divers for varying levels of reef fish attributes (described below), and trip information, demographics, dive experience data and dive satisfaction ratings were also collected as potential covariates for diver preferences in the analysis.

At each site, interviews were first conducted with dive operators at all dive shops in the vicinity to inform the diver sampling strategy. Sampling effort (diver interviews) at any given dive shop was then weighted based on the shop's relative contribution of divers to reefs at or adjacent to the study sites. It is recognized that the short duration of the study in each site could contribute to a seasonal bias, potentially leading to an over or under-representation of segments of the diver population. Nevertheless, based on divers' countries of origin and on local tourism data, the sample appeared to be representative of the tourist populations within the countries/sites (CTO, 2011; ECCB, n.d.; IHT, 2012).

2.1. Choice Experiment Design

Choice modelling (CM) has important advantages over other non-market valuation methods as it can collect large amounts of data from a single application (Hanley et al., 2001) and it allows for the estimation of the effects of changes in multiple resource attributes on consumer welfare (Louviere et al., 2000). For this study, four attributes were selected based on specific research questions (i.e. economic impact of changes in reef fish populations) as well as a pre-test exercise administered to a sample of tourist divers ($n = 77$) in Barbados where divers rated the importance of 25 fish and non-fish attributes (coral cover, crowding, customer service, etc.) to their dive experience (Gill, 2014). The final selection of attributes was fish abundance, numbers/proportion of large fish, chance of encountering fishing activity (e.g. spearfishing) or gear (e.g. fish traps), and price (Table 1). Fish abundance was identified as an important fish attribute by divers in the pre-test exercise and is also important to reef management, given that it is particularly sensitive to habitat quality (Rogers et al., 2014). On the other hand, the numbers/proportion of large fish at a given reef has a strong, negative relationship with fishing pressure and is therefore also important to fisheries and reef management (Ault et al., 2005; Hawkins and Roberts, 2004; Vallès and Oxenford, 2014). Encounters with fishing activity and/or fishing gear (known hereafter as fishing activity/gear) was identified as one of the most important site attributes in the pre-test exercise and is an important issue for marine spatial planning efforts that seek to separate potentially conflicting uses. In the choice experiments, divers were instructed to assume that all other dive attributes were equal between choices (Supplement 1).

To ensure realistic values, attribute levels for fish abundance and numbers of large fish were selected based on a review of reef fish population data from the 1998–2004 Atlantic Gulf and Caribbean Rapid Reef

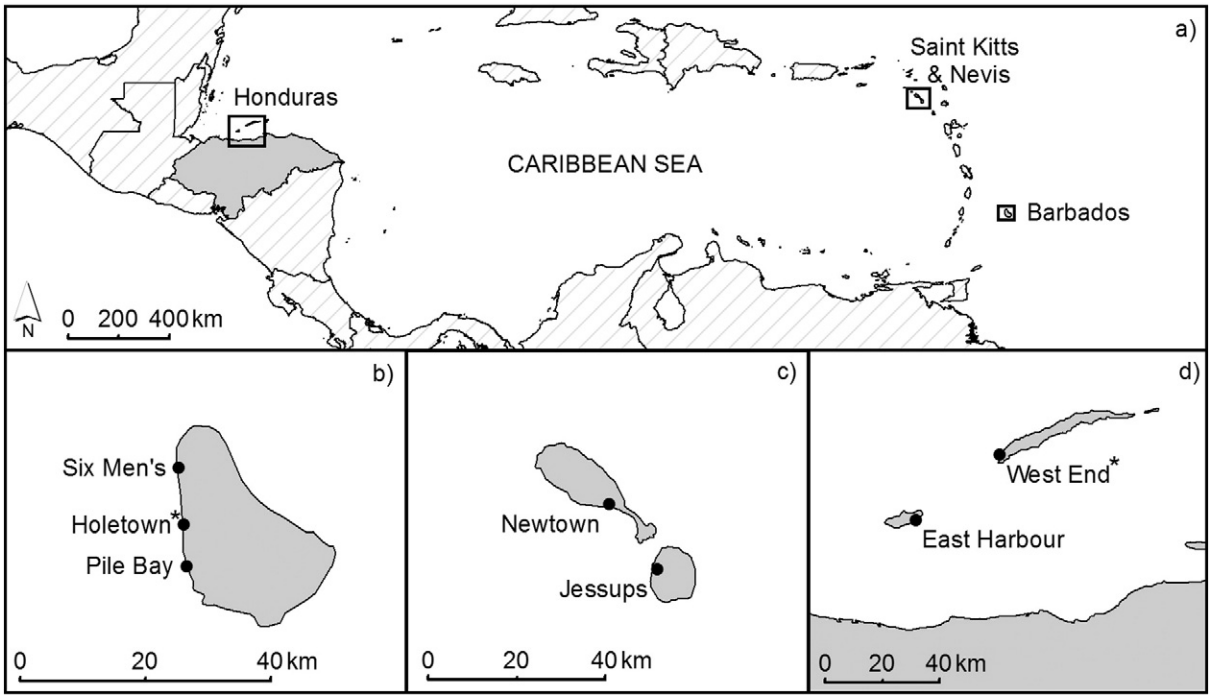

Fig. 1. Locations of the seven study sites (a) across the Caribbean, in (b) Barbados, (c) St. Kitts and Nevis, and (d) the Bay Islands, Honduras. * indicates sites with marine protected areas.