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Evidence of a common understanding of proximate and distal drivers of reef health

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ABSTRACT

Marine management has typically prioritised natural science methodological traditions as an evidence base for decision-making; yet better integration of social science methods are increasingly shown to provide a more comprehensive picture to base management decisions. Specifically, perceptions-based assessments are gaining support, as they can provide efficient and holistic evaluation regarding management issues. This study focuses on coral reefs because they are particularly threatened ecosystems, due to their ecological complexity, socio-economic importance, and the range of environmental drivers that impact them. Research has largely concentrated on assessing proximate threats to coral reefs. Less attention has been given to distal drivers, such as socio-economic and governance factors. A common understanding of threats related to coral reef degradation is critical for integrated management that takes account of peoples' concerns. This study compares perceptions of drivers of reef health among stakeholders (n = 110) across different sectors and governance levels, in four Caribbean countries. Interview data identified 37 proximate and 136 distal drivers, categorised into 27 themes. Five sub-groups of themes connecting proximate and distal drivers were identified. Perceptions of two of these narratives, relating to 'fishing and socioeconomic issues' and 'reef management and coastal development', differed among respondents from different countries and sectors respectively. However, the findings highlight a shared perception of many themes, with 18 of the 27 (67%) mentioned by > 25% of respondents. This paper highlights the application of perceptions data for marine management, demonstrating how knowledge of proximate and distal drivers can be applied to identify important issues at different context-specific scales.

1. Introduction

The effectiveness of natural resource management is a continuing global concern, and is hindered by incomplete knowledge and understanding of complex social-ecological systems [1], leading to a limited appreciation of the impacts of social, economic, political and environmental change on natural resources exposed to threats such as climate change [2]. This complexity presents natural resource managers with the challenge of prioritising and addressing a multitude of threats to natural resources, often with limited financial resources [3,4]. Prioritisation of research and management strategies for natural resources rely on the perceptions and knowledge of managers, policy makers and scientists, their ability to share understanding, and to develop common goals and research priorities. While scientific knowledge and evidence-based management are typically given precedence as a basis for resource management decisions, priority- and agenda-setting [5–7], there are compelling reasons to understand how individuals involved in the management of natural resources perceive environmental threats.

Several studies have highlighted the benefits of collaborative priority-setting exercises with various actor groups (policy makers, managers and scientists) involved in conservation science and natural resource management [8–10]. Priority-setting exercises to identify and prioritise research questions have been undertaken across a range of scales and contexts, including for specific resource sectors such as agriculture, fisheries and marine conservation [11–14]. However, few studies have applied participatory methods to collate perceptions regarding environmental threats, specifically in relation to globally declining marine ecosystems, for example coral reefs [4,15–17]. Gathering opinions with the aim of developing a common understanding and building consensus regarding environmental issues can facilitate

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shared understanding in natural resource management [1,18,19]. For example, it has been suggested that informing policy with a shared understanding of key individuals' perceptions about threats may help reduce the uncertainty and competing knowledge and priorities that currently beset coral reef management [20]. Furthermore, as the underlying foundation of beliefs and perceptions of individuals are known to influence and determine behaviour [21], awareness of perceptions is key when implementing effective management.

Coral reefs are an ideal case study to explore these issues, because many are impacted locally and to varying degrees by several key drivers (i.e. fishing, pollution, development), yet also all face significant pressure from climate change impacts [22]. It is widely acknowledged that coral reefs are some of the most complex, and heavily threatened marine ecosystems worldwide, that they continue to deteriorate as a result of human activities [23–25] and governments urgently need to prioritise effective management measures to address this negative trend. More than 60% of reefs are estimated to be under immediate and direct threat from local stressors such as overfishing, coastal development, and physical damage [26,27]. In conjunction with climatic changes, this figure rises to 75% [27]. Caribbean coral reefs are particularly at risk [28], experiencing rapid ecological decline [29]. Growing demands for coral reef-related ecosystem services, from fisheries, dive tourism and shoreline protection, together with predicted impacts from climate change, make improving Caribbean coral reef management a necessity [27,30,31].

As the intensity of stressors affecting coral reefs is expected to increase, managing and discriminating among threats will be critical to support conservation efforts [24]. Several reviews highlight a broad suite of proximate and distal threats affecting coral reefs globally [23,32,33]. Proximate drivers are those acting directly on the reef to produce a negative impact on its health, for example coral bleaching (e.g. [34]), increasing algal cover [35], removal of herbivores [36] and coral disease [23]. Distal drivers are those that are physically removed from the reef, but underlie proximate impacts; such as, climate change [37,38], poverty [10], and poor governance [30,39].

Understanding the implications of all drivers of reef degradation is of both scientific interest and practical relevance for coral reef management [31]. However, research on distal drivers remains limited in comparison to the range of studies assessing proximate drivers of coral reef degradation [2,16,40,41], particularly when the regional Caribbean picture is considered [28,42,43]. While many coral reef management interventions are based on sound scientific knowledge, it is argued that they often fail due to a poor understanding of the underlying social, economic and governance contexts [40,44]. There is a pressing need to re-focus research on the role of distal drivers of coral reef decline to understand the diverse human dimensions of coral reefs [2]. This is critical to ensure the continued flow of coral reef ecosystem services in this period of rapid environmental change [30,33,45].

This research addresses a knowledge gap in coral reef management by specifically focusing on an assessment of perceived proximate and distal threats to Caribbean reefs among individuals involved in coral reef management, including managers, policy-makers and scientists. The Caribbean is an ideal case study because the coral reefs in the region have been highlighted as particularly threatened by a range of common stressors (e.g. 27,28,46), and it is geographically, socio-economically and politically diverse, which may influence perceptions of threats. There has not yet been a systematic assessment of perceived threats to Caribbean coral reefs that includes the broadest suite of both proximate and distal drivers.

This study demonstrates the importance of understanding perceptions of threats among individuals responsible for reef management across different countries, employed in a range of reef-related sectors (e.g. fisheries, environment, tourism, and conservation), and working at different governance levels (local and national). The coral reefs of the four study countries (Barbados, Belize, Honduras and St Kitts and Nevis) all face common anthropogenic threats, for example from fishing, coastal development, pollution and climate change [27]. However, each country's reefs have experienced a different history of natural disturbance and varying levels of marine protection, (e.g. see 47,48–50), leading to country-specific differences in the status of reef health [51]. This study therefore hypothesised that perceptions would differ among countries. For example, actors in the Central American countries (Belize and Honduras) with a long and extensive history of marine protection, might be expected to have different perceptions regarding reef health and management compared to the island countries (Barbados and St Kitts and Nevis). Similarly, there was an expectation that divergences in perceptions between different sectors and governance levels, as expertise in different areas or at different jurisdictional scales, will focus attention and develop a knowledgebase around specific threats. The objectives of this study were therefore to: 1) identify both the proximate and distal drivers of coral reef health perceived by individuals involved in coral reef research and management in the four Caribbean countries; and 2) to explore differences in perceptions of these drivers among countries, sectors and governance levels.

2. Methods

2.1. Study sites

Data were collected in Barbados, Belize, Honduras, and St Kitts and Nevis, selected to represent a range of coral reef health, social and economic conditions, governance and management structure, and levels of marine resource dependency across the region (Table 1). Coral reefs are important for small-scale fisheries and coastal tourism in all four countries, providing employment, income and food security; although levels of dependence differ among countries (Table 1).

As reef management takes place at both national and local levels within each country, three sites were chosen for study at the local level (Fig. 1b–e). Site selection sought to capture a gradient of reef resource use, selecting one site where reef use is predominantly by reef fisheries, one where reef-related tourism is predominant, and one where a mixture of reef-related tourism and fishing was present.

2.2. Data collection

Semi-structured interviews were carried out in each country at local (n = 49) and national (n = 61) levels, enabling collection of rich and detailed data of perceptions of current drivers of reef health at different scales. Local level respondents included individuals involved in reef management or decision-making within the twelve communities (Fig. 1b–e). National level respondents included individuals involved in reef management, decision-making or policy at a national level.

Interviews were conducted between February 2011 and August 2012. Lists of potential respondents in each country were derived from preliminary internet searches and grey literature (e.g. documents and reports by local organisations), and validated during initial interviews. Snowball sampling was used to further populate the list of respondents to interview. Respondents were targeted purposively to be representative of the range of actors involved in reef management in each country. A broad range of individuals representing a variety of sectors and organisations at different levels participated in the study (Table 2). Sectors included reef resource use (fisheries and tourism), and those relating to the community, enforcement, conservation, environment, and research. Sectors spanned government departments or ministries with a responsibility for reef management or resource use, non-governmental organisations involved in reef management, research and stakeholder support, industry organisations with interests in reef or marine resources, and educational organisations such as universities undertaking research on coral reefs.

Interviews lasted between 45 and 90 min. Interviews were audio recorded and then transcribed verbatim, unless participants were