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COMMENT

Coral reef conservation and political will

Reefs are in trouble

Coral reefs and their societal benefits are in decline, chiefly due to overfishing, pollution and inappropriate coastal development. Strengthened management is possible, but collective failure to build the needed political will to act diminishes lives of millions of people along tropical coasts. Political will can be built, but it requires committed leadership and sustained investment of time and resources. Accepting failure as inevitable is inappropriate.

The 'decline' includes loss of diversity and biomass of fish and other organisms, greater incidence of disease, and marked loss of spatial dominance of living corals. Percentage cover of corals has fallen on average by 51% across the Great Barrier Reef in the 27 years to 2012 (De'ath *et al.* 2012), and by 47% across the Caribbean over the same general period (Jackson *et al.* 2014). Comparable declines are reported in less well-documented regions (Chin *et al.* 2011; Wilkinson 2008). Putative causes, and temporal patterns of decline, vary among locations.

Reefs can be damaged by storms, by low salinity following heavy rain, or by tectonic events that elevate, drown or bury them (Glynn 1997), but most commonly they degrade through overfishing, pollution, or the sedimentation and disruptions to water flow caused by poorly planned coastal development (Sale 2008). Diseases (Jackson *et al.* 2014), and outbreaks of *Acanthaster* starfish (De'ath *et al.* 2012) are important causes of coral mortality in some locations; both appear to be facilitated by pollution. Extractive activities other than fishing, such as use of reef rock in construction, are occasionally a factor. All these problems can be tackled locally.

Our CO_2 emissions have added to stress on coral reefs (Hoegh-Guldberg *et al.* 2007; Pandolfi *et al.* 2011). Episodes of warmer rthan usual water cause mass coral bleaching; a process in which stressed corals expel their symbiotic dinoflagellates. Recovery from bleaching is possible, but extended periods under stress result in significant mortality, and corals have only limited capacity to acclimate as temperatures rise (Rodolfo-Metalpa *et al.* 2014). CO_2 emissions also reduce ocean pH, which affects calcification rates, usually reducing skeletal density and/or growth rates in corals (D'Olivo *et al.* 2013; Tanzil *et al.* 2013; but see Doney *et al.* 2009). Both impacts of CO_2 emissions will intensify in coming decades as temperatures rise and pH falls further (Cunning & Baker 2012), leading to profound alterations in composition of reef communities (Dove *et al.* 2013).

Reported rates of reef decline, lack of progress in reducing locally caused stresses, and anticipated effects of future CO_2-driven warming and acidification suggest that reefs could lose all coral cover by mid-century (Hoegh-Guldberg *et al.* 2007; Sale 2011). Bradbury (2012) admonished the science community for failing to communicate the true risk to reefs, referring to a 'state of denial' shared by leading reef scientists, and a widespread attitude in that community emphasizing a need to 'continue to give people hope' rather than report 'doom and gloom'. His article elicited plenty of criticism, including claims that he was exaggerating the seriousness of the problem.

Solving the problem: not rocket science

The widespread degradation of coral reefs has been well reported, and the message has been communicated to coastal communities over many years. The value of 'healthy' coral reefs is widely recognized, including aesthetic, cultural and biodiversity value, as well as the economic value of fisheries, other products and tourism (Brander *et al.* 2007). The possible solutions to local anthropogenic stresses are technically simple, and if implemented will substantially alleviate locally caused damage, making reefs better able to resist warming (Wooldridge 2009), and perhaps acidification. Implementation requires real change to human behaviour that can be challenging, but is not impossible, even in impoverished communities dependent on nearby reefs for food. The growing success in the Philippines of networks of small locally-managed marine protected areas (MPAs) as a conservation and fisheries management tool confirms this (Horigue *et al.* 2012).

These solutions are:

- reduce fishing effort and eliminate methods that damage reef environment, protect nursery habitats including sea grass and mangroves, reduce harvest of herbivorous species to keep algal growth controlled;
- reduce pollution of coastal waters by implementing appropriate sewage treatment, curtailing use of fertilizers, and employing best agricultural practices for water and soil management;
- manage coastal development to minimize sedimentation and turbidity by curtailing dredge and fill operations, planning any alterations to waterways to ensure nearby reefs are not impacted, and avoiding direct burial or destruction of living reefs.

While some communities, and some individuals, may not yet understand the many causes of coral reef decline, or the solutions for local stresses, factual stories about effective reef management permeate coastal communities, and continue to be delivered by local and global non-governmental organizations (NGOs), governments, and multinational development agencies.

A lack of political will

Acting on these stories has yielded good news; the Cabo Pulmo National Park, México (Aburto-Oropeza *et al.* 2011), The Healthy Reefs Initiative on the Mesoamerican Reef (McField & Kramer 2006), and the Great Barrier Reef Marine Park (McCook *et al.* 2010) are three examples, vastly different in scale, of demonstrable management effectiveness. Yet, the great majority of coral reef habitat continues to degrade. Everyone may know the stories, but many fail to apply them (White *et al.* 2005). This weak performance by coastal communities and by aid agencies, is often rationalized by the observation that many communities lack political will.

As an example of lack of will, consider paper parks, namely MPAs that exist in law, but are not actually protected. The solution to a paper park is to introduce sustained on-the-ground management that reduces extractive activities. Kelleher *et al.* (1995) reported that the operators of just 31% of the 1306 MPAs in their global survey believed they were achieving their management objectives. Edgar *et al.* (2014) showed little had changed in 19 years. Some of the large, EEZ-sized MPAs now being formed will likely become paper parks, as will many tiny MPAs set up by communities that fail to sustain them (Graham & McClanahan 2013).

While the approaches available to remedy locally caused reef decline are technically mostly rather simple, even inexpensive, they force us to confront aspects of human behaviour that can be difficult to change (Christie *et al.* 2005; McClanahan *et al.* 2009; Gutiérrez *et al.* 2011). By modestly degrading the reef environment in various ways, individuals are able to feed their families fish, grow bountiful crops, and (for entrepreneurs) develop new money-making coastal enterprises. With costs externalized as environmental degradation, these strategies yield personal success and are resistant to being altered. A community wishing to improve reef management must apply sufficient pressure to force change in behaviour that is counter to the best short-term personal interests of individuals, and may also need to provide alternative food and employment.

Building political will: the only real way to restore coral reefs

The reef science community invests considerable effort into attempts to help improve reef management. The resulting transfer of new science into management, at least at the level of discussion and planning, is substantial. As witness, reef connectivity principles have become quickly incorporated into the theory of marine spatial planning (McCook *et al.* 2009) to build effective MPA networks, although examples of this science affecting on-the-ground reef management are far fewer (McCook *et al.* 2010). I suggest reef scientists could do more to push ideas beyond theory to practice; managers also have a responsibility to become scientifically informed. However, I think both scientists and managers use absence of political will both as a talisman to excuse failure, and as a justification for continued failure. It is instead an urgent call from the real world of coastal communities to develop new, more effective strategies to effect management change.

Building political will takes courage and it does not happen by itself (Christie *et al.* 2005, 2009). In my view, individuals first must recognize that political will is an amalgam including managers with adequate financial, technical and administrative capacity over sufficient periods of time, a political agenda with space for environmental issues, leadership in government and the community, manageable levels of corruption, and an environmentally well-informed community giving strong support for management actions. All these are necessary, and can be built when absent, but that requires consistent effort over time (Sale *et al.* 2014). That effort begins with three primary requisites. Committed leadership must be built first if not already present. Also essential are informed outreach and education, and tangible demonstration of positive results.

Leadership

A community which has committed leaders within its political class, its environmental agencies, or simply among the people can build will to improve environmental management. Leaders are sometimes strong enough to act alone, but usually they need help in the form of initial finance, technical and governance advice, or education and public relations. Providing such help is a crucial role for NGOs, the science community, and multinational agencies. A community lacking committed leaders will be unlikely to build effective management until such leadership develops. Such communities do exist, and projects to improve environmental sustainability within them largely waste money. In such cases, it is appropriate for funding agencies to advise governments that they will not be eligible for development assistance directed to sustainable environmental management until they develop the required leadership.

An informed community

Because sustainable environmental management usually carries immediate costs in harvests not taken, wastes processed more fully, and infrastructure projects that are technically more complex, it requires a well-informed community if it is to have support. The support must come at the ballot box and in day-to-day compliance with regulations. This support can be built through a coordinated programme of outreach and education tailored to each stakeholder group.

The complexity of the ecological processes underlying sustainable management is such that this is a challenging educational programme to deliver, especially to those members of the community who are by nature or experience sceptical about the value of a sustainable environment. This is especially so when the target audience is unlikely to benefit immediately and individually from the improved environmental conditions, yet must pay some of the costs for the needed changes (for example fishers facing a need to reduce overall catch, or farmers required to manage their land and their fertilizers differently). It is also challenging when the messages being delivered run counter to deeply entrenched belief systems, including the belief that the sea is bountiful and will continue to produce baby fish even if we catch all the adults (an idea as widespread among recreational fishers in advanced nations, as it is among artisanal fishers who feed their families on a tropical shore).

The outreach effort can be more effective if it includes local data on non-harvest values of a sustainably managed system. Most people take their environment for granted, not appreciating the many ways in which it services their needs. Showing how a coral reef protects a coastal lagoon and nearby villages, or wide beaches and ocean-front hotels, can help build support for sustainable management. Effectiveness also grows if charismatic species are identified and used to build an emotional link. Providing solid economic data on the tourism benefits of high-quality coral reefs can be persuasive for government economists and business leaders. Far too often, development projects centred on reef management include an 'education and outreach' component that is tacked on, with insufficient capacity for sustained engagement, with inadequate depth, and with messages that are not crafted to resonate with the community. Such messages are not upheld. Attitudes remain unchanged. And management intervention fails because the community lacks belief in its efficacy.

Tangible results

We live in a world that is degrading rapidly on ecological timescales (Sale *et al.* 2014), but slowly in terms of human attention spans. Most people continue with a world view in which ecological systems do not change, or change in seasonal or slower cycles, reliably returning to former states. Despite abundant evidence of ecological degradation, their faith in the balance of nature seems undiminished. This widespread perspective makes it difficult to convince people that strong environmental management is needed. It also makes it difficult to demonstrate the effectiveness of new management initiatives. Slowing the decline is actually real progress, just as is reaching a point of balance, but these modest accomplishments will be ignored by people who expected stasis in the first place.

One challenge in implementing sustainable management, therefore, is that demonstrably positive results may take several years to appear, while the costs appear more quickly. It is therefore vital to have appropriate monitoring programmes in place so that quantitative evidence of success can be demonstrated as early as possible. This monitoring must be designed to be statistically powerful and to include monitoring at control sites not receiving the new management treatment. Investment in the design and application of a formal before-after-control-impact (BACI) approach is definitely worthwhile. It is also wise to stage the introduction of a programme of improved management so that there are some early victories to sustain commitment and compliance during the years when the costs of sustainability mount faster than the perceived benefits.

Coda

Real improvements in management of coral reefs will only result if sufficient effort is invested, if the degree of engagement with the community is deep, and if the time frame for results is set to decades, rather than just three to five years. Far too many projects to build sustainable management fail in one, and often all three of these ways. Helping people do a better job of managing the local stressors on their coral reefs is a worthwhile goal, even in the face of climate change, because of the added resilience that improved management will bring. Failing to take the task of improving management seriously enough to do it properly just wastes time, money, and the good will of the community. At present, while there are many dedicated front-line workers doing their best with limited funds or support on a task they really believe in, there are too many more senior members of the international multinational and NGO community comfortably going to conferences, talking to colleagues, setting up projects, getting them funded, and implementing them in well-worn ways that are almost guaranteed to fail.

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