



A generic method of engagement to elicit regional coastal management options



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ARTICLE INFO

Article history:

Received 24 July 2015

Received in revised form

1 February 2016

Accepted 5 February 2016

Available online 22 February 2016

Keywords:

Regional management

Community engagement

Generic framework

Management strategies

Objective weights

ABSTRACT

Stakeholder engagement is important for successful management of natural resources, both to make effective decisions and to obtain support. However, in the context of coastal management, questions remain unanswered on how to effectively link decisions made at the catchment level with objectives for marine biodiversity and fisheries productivity. Moreover, there is much uncertainty on how to best elicit community input in a rigorous manner that supports management decisions. A decision support process is described that uses the adaptive management loop as its basis to elicit management objectives, priorities and management options using two case studies in the Great Barrier Reef, Australia. The approach described is then generalised for international interest. A hierarchical engagement model of local stakeholders, regional and senior managers is used. The result is a semi-quantitative generic elicitation framework that ultimately provides a prioritised list of management options in the context of clearly articulated management objectives that has widespread application for coastal communities worldwide.

The case studies show that demand for local input and regional management is high, but local influences affect the relative success of both engagement processes and uptake by managers. Differences between case study outcomes highlight the importance of discussing objectives prior to suggesting management actions, and avoiding or minimising conflicts at the early stages of the process. Strong contributors to success are a) the provision of local information to the community group, and b) the early inclusion of senior managers and influencers in the group to ensure the intellectual and time investment is not compromised at the final stages of the process.

The project has uncovered a conundrum in the significant gap between the way managers perceive their management actions and outcomes, and community's perception of the effectiveness (and wisdom) of these same management actions.

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1. Introduction

Pressure on ecosystems in the coastal zone has increased with time due to population growth and the social and economic importance of these areas (Halpern et al., 2009). Effective management of this zone is important as they contain many iconic and threatened species (such as dugongs, water birds, turtles) and also key habitats (wetlands, seagrasses, mangroves).

The coastal zone of the Great Barrier Reef in Australia experiences the impacts of cumulative effects, most notably inputs of sediment, nutrient and contaminants from rural and urban land sources (Kroon et al., 2013). However, managing cumulative impacts can be seen as a “wicked” problem because interactions within and among the social, economic and ecological systems are highly complex, non-linear and mostly unknown, which has often led to management failure (Ludwig, 2001; Rittel and Webber, 1973). Science is categorised as only being able to solve “tame” problems (Rittel and Webber, 1973).

Two solutions have been put forward to address this dilemma: a) Adaptive management, which involves iterative decision making, via evaluating the outcomes from previous decisions and adjusting subsequent actions on the basis of this evaluation (Sainsbury et al., 2000; Walters and Hilborn, 1976), and b) effective stakeholder engagement to facilitate social learning improving outcomes (Muro and Jeffrey, 2008). If these two processes are combined, they form essential foundational steps to achieve effective environmental management, through good information, development of identity, and institutions and incentives (Van Vugt, 2009).

In the coastal zone, governance is complex with many organisations and associated institutions designated to manage the system (local, regional, national and international) and many forms of “ownership” models (government, semi-government, public open access, private). To some, the solution to the complex governance situation is to create boundary organisations either through a non-government organisation (NGO) or develop collaborative efforts between scientists and government organisations. Boundary organisations cross the boundary between science and government as a network which draws on both sides to facilitate evidence-based decisions (Guston, 2001). These organisations attempt to solve problems by meeting three criteria, which are: a) creating opportunities and incentives for boundary products, b) facilitating participation of actors from different sides of the boundary and c) establishing or strengthening links between politics and science (amongst others). Boundary organisations are effective, for instance, in the health sector (Drimie and Quinlan, 2011) and in waterway management (Abal et al., 2005).

Whether attempting management with or without these boundary organisations, stakeholder or community engagement is seen as crucial to management success (Dietz et al., 2003; Ostrom, 2009; Van Vugt, 2009). Similarly, the scale of management should include local input into regional management rather than only distant high level and scale management (Ostrom, 2009). Stakeholder engagement has been successfully applied in many single use applications such as fisheries. Often engagement has been established through technical and management boundary organisation (Smith et al., 1999) or various forms of devolved management such as through Territorial User Rights (Chandra, 2011), community based special marine protected areas (Ma et al., 2013) or self management in fisheries (Townsend et al., 2008). However, moving from stakeholder engagement to community engagement has generally not been undertaken as many scholars have presumed that these resource users could not self organise nor be representative (Cox et al., 2011). In the review by Cox et al. (2011) of “self-organised regimes”, their findings supported Ostrom’s (2009) eight design principles of local stable common pool resource

management, which includes well defined boundaries, institutions that are adapted to local conditions, participatory decision-making processes, effective monitoring, scaled sanctions for those who violate rules, mechanisms for conflict resolution, recognition of community self-determination by higher-level authorities, and nested enterprises for large common pool resources.

1.1. Study area

The Great Barrier Reef World Heritage Area (GBRWHA) includes the world’s largest coral reef system, the Great Barrier Reef (GBR), stretching over 2300 km of the coastline of Queensland, Australia (Fig. 1). The Australian Commonwealth’s Great Barrier Reef Marine Park Authority (GBRMPA) manages much of the reef. Although GBRMPA manages the biodiversity assets and most activities therein, fisheries and much of the coastal zone inshore of 3 nm are managed by various other agencies such as the Queensland State Department of Agriculture and Fisheries (DAF), and local councils. There is growing interest and success in engaging local coastal communities to achieve reef management goals. NGOs have played a key role through engaging especially with the farming community to minimise the effects of agricultural runoff (sediments, nutrients and pesticides) (<http://reefcatchments.com.au/>). Although these NGOs are in many aspects boundary organisations, they have until recently only concentrated on a few impacts areas.

The communities who live in the coastal zone of the GBR value the GBR highly (Marshall et al., 2013) and as such there is a significant desire to be involved in local management. It is generally understood by managers that a) it is difficult to regulate all impacts that affect the GBR coast and reef so stakeholder support is essential, and b) given the size of the area and its complexity, it is not possible to have both regional and local knowledge without local input.

In a perfect world, high values attributed by a community to an area would generate voluntary compliance and regulation. However, the challenge remains on how to include community input in determining objectives for marine biodiversity and fisheries productivity and effectively link these objectives to decisions made by multiple management authorities, and to do this in a safe and cooperative manner. In an increasingly connected community in Queensland, social media has become a progressively useful medium to focus public opinion (for example the 2014 GetUp campaign against a port development – <https://www.getup.org.au/campaigns/great-barrier-reef-3/protect-our-reef/protect-our-reef>). However, these forums are seen as not engaging science, management and community in a non-adversarial long-term framework as described in Cox et al. (2011). There are several case studies and suggestions of what constitutes successful engagement. For example, a successful case study (reviewed by Vural-Arslan and Cahantimur (2011)) in Turkey showed that community intelligence could be influential to the decision making process. However, there are practical considerations when engaging the community over a longer timeframe, including scheduling and other time commitments. Many emphasise the importance of gaining trust and respect (Vural-Arslan and Cahantimur, 2011), and provide models of engagement (Rowbottom and Bueno, 2009) and move beyond simple models of socio-ecological systems and the perception that most resource users are the same (the “panacea”) (Ostrom et al., 2007).

2. Method

2.1. Case studies

Two coastal regions within the GBRWHA area were chosen as

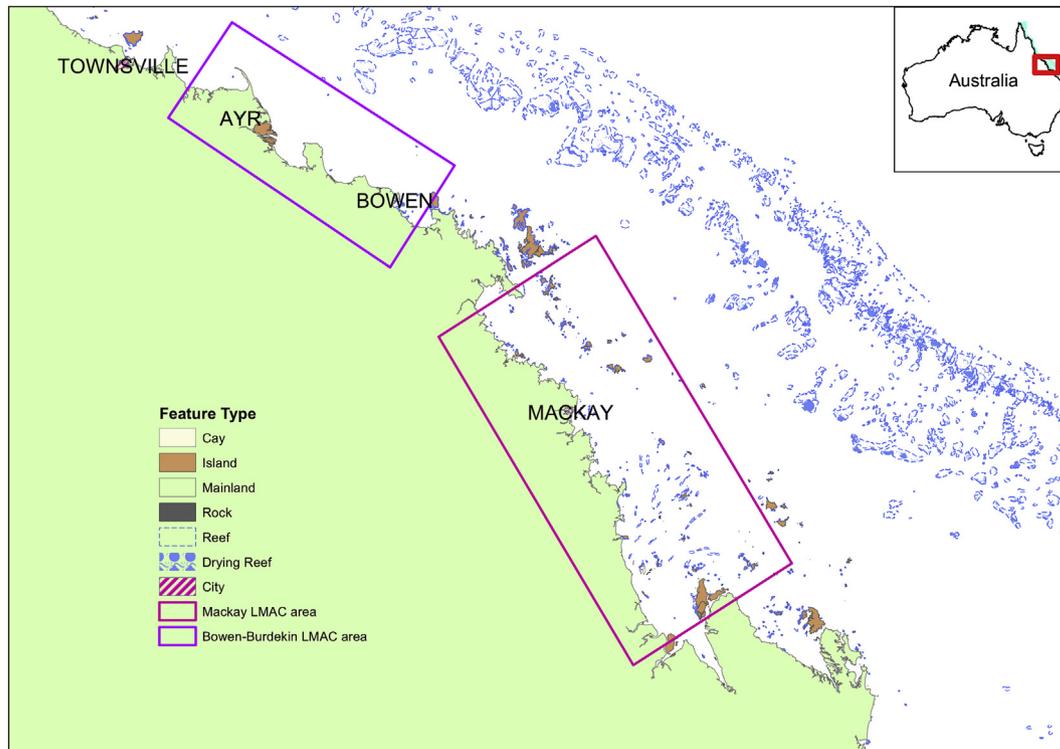


Fig. 1. Location of the two case studies shown in the context of the Great Barrier Reef in Queensland, Australia. Inset Map of Australia showing the Great Barrier Reef region (shaded) and the study region (box outline).

case studies. Mackay was chosen as it represented a growing city of about 167,000 people (Australian Bureau of Statistics, 2013) and a large associated Fly-In and Fly-Out community servicing the local mining industry (Fig. 1). It also has an active port, Hay Point, just south of Mackay with the main export being coal. Another major economic driver and employer in the region is sugar cane, where the cane is locally grown and refined into sugar. In terms of natural assets it has national parks, many beaches, offshore islands, inshore and offshore reefs that are part of the GBR. The environment is tropical with the marine environment characterised by very large tidal ranges, key habitats such as mangroves and seagrass, and threatened, endangered and protected (TEP) species groups such as dugongs, turtles and inshore dolphins.

In contrast, for the second case study the Bowen-Burdekin Shire has a population of about 26,000 people (Australian Bureau of Statistics, 2013) and is approximately 60 km south of a major city Townsville (and about 350 km north of Mackay) with Ayr and Home Hill as its main towns (Fig. 1). It is a region characterised as being mainly rural with sugar cane farming as the major source of economic development and employment.

These two case studies were chosen for what they have in common while recognising their differences. Both case studies are in rural areas where farming is very important for the areas' wealth generation and employment. A lot of management effort has gone into reducing the amount of sediment, nutrient and pesticide runoff to the GBR in both case study areas. However, the two regions' ports are distinct in size and activity, and both are important in terms of active development and extension proposals. During the study period, a major port upgrade in the Abbott Point area (just south of Burdekin), with associated dredging, was proposed. This port upgrade was a source of conflict in the local region and also created great controversy in wider Australia. Whereas the Mackay port was well established with no upgrades happening at the time

the research was undertaken and, therefore, activities in the Mackay port were not as controversial as the Abbott Point development. The population size was also very different with Mackay having a far larger urban footprint with a growing city although this may have slowed down in recent years due to the general downturn in mining activity.

2.2. Engagement process

A hierarchical system of engagement was attempted in both regions. At the highest level, a community group, the Local Marine Advisory Committee (LMAC) run by GBRMPA was already established in each of the regions; although the one in the Bowen-Burdekin was more recently established than the one in Mackay. Their charters are to advise GBRMPA on local management issues (<http://www.gbrmpa.gov.au/about-us/local-marine-advisory-committees>). Although the chair is elected and paid a nominal fee, the members are volunteers sourced from the community. LMACs have a 3-year term and calls for nominations are made normally to stakeholder groups, although a nominee can be independent. There is some vetting based on experiences GBRMPA (or a referee) has had with individuals and their ability to contribute constructively. Membership of the LMACs in our case studies included representatives from GBRMPA, cane growers, commercial and recreational fishers, and local Port and Council employees. The LMAC's aim is to achieve a balanced representation, although this is not always achieved. The quality of participation and 'team' output can be highly variable.

Since the LMACs met every quarter with a full agenda, a sub-committee was formed and called the LMAC Reference Group (RG). This was made up of LMAC members who volunteered for the group and additional members (i.e. people who were previously on the LMAC) that would cover a broader skill set. The project lead

facilitated the RG meetings, with a member elected as the RG chair.

In addition to the project team, who facilitated and attended the RG meetings, “managers” (defined as people that either directly or indirectly influence management decisions) from DAF and GBRMPA, and social, economic, mathematical and environmental scientists from State and Commonwealth agencies participated in the RG meetings.

Within a few months of project engagement in the Bowen-Burdekin area, historical and present issues (such as the Abbott Point port development controversy; members of the LMAC being stretched over two distinct regions meaning members often had to travel long distances to attend meetings, previous poor engagement processes) meant that participation was minimal. An alternative approach was undertaken described in detail in [Dichmont et al. \(2014\)](#), but generally it meant the project team engaged with individuals directly and separately instead of in a group. Outside this one-to-one engagement interactions between the different RG and LMAC members were minimal. In Mackay, the RG was very successful and there was engagement with this group throughout the process. However, the indigenous member resigned from the group due to circumstances external to the RG.

At various stages in the process (described further below) community and senior level managers’ input was sought. All documentation was kept in a traceable format, i.e. iterations of all steps could be traced through the various meetings to its original source.

A local Mackay GBRMPA person devoted an enormous amount of time on support and engagement in-between meetings. This support was essential and provided local continuity.

A sequence of steps were undertaken – see [Dichmont et al. \(2014\)](#) for more details. Steps 3 to 12 were undertaken in the Mackay case study only:

1. Qualitative modelling ([Dambacher et al., 2003](#); [Dambacher and Ramos-Jiliberto, 2007](#)) of the Mackay coastal system was carried out ([Dichmont et al., 2014](#)) (both case studies). The RG was asked to list assets of importance to them in the region and identify the impacts on these assets. They were then asked to select their priority asset for which the impacts and feedback were modelled in more details. An introduction on terminology and how the method works were also provided to the group (see [Dichmont et al. \(2014\)](#));
2. A review of existing objectives from government organisations, NGOs and Natural Resource Management (NRM) bodies that were directly or indirectly relevant to the region was undertaken (both case studies). This was then combined into a hierarchical tree format using input from a series of workshops attended by the RG and LMAC ([Dichmont et al., 2014](#); [Van Putten et al., 2015](#)). After this stage, the Bowen-Burdekin case study was discontinued given the controversy around the Port development and its overwhelming impact on the issues being discussed.
3. A survey of the RG, LMAC and Mackay public was undertaken to ascertain the relative importance of different objectives. [Dichmont et al. \(2014\)](#) describe the analysis details and survey methods in detail but two approaches were undertaken – the recommended Analytical Hierarchical Process ([Pascoe et al., 2013](#); [Saaty, 1980](#)) and a new Point Allocation method at each level of the objective tree and called the Hierarchical Point Allocation method ([Dichmont et al., 2014](#)). The survey form is provided for illustration in [Supplementary Material \(SM\) Section 1](#);
4. Managers gave presentations to the RG about existing management actions that were being undertaken in the Mackay coastal zone so that they could subsequently discuss any

remaining management actions that needed to be addressed for the different assets;

5. Topics relevant to the focal question of management of biodiversity and fisheries in the coastal zone were developed in session (see [SM Section 2](#)). These described both key assets (such as mangroves and seagrass) and key issues (such as development).
6. Over a period of just over 12 months, the RG undertook a series of workshops that discussed management options for these topics. Each workshop included:
 - a. Presentation by an expert of background information pertinent to Mackay about the specific topic being discussed at the workshop;
 - b. The RG, project team and invited expert workshopped an issues register, direct and indirect management options, and responsible agencies for each issue ([Dichmont et al., 2014](#)) (see [SM Section 2](#)). The discussions were held either in small groups or as a whole group, depending on the number of workshop participants. Direct management options were defined as a management action that is undertaken directly by the agency responsible for managing the issue and could include proposing legislative changes, whereas indirect management options were those that could have the same impact as the direct option, but undertaken indirectly through a non-responsible agency or the community. Issues or management options could be geo-located using a Google™ map of the study region. Relevant qualitative models were also made available to assist with highlighting past discussions on the relationships within the system on that topic.
 - c. Initially, the issues list was developed separately from the management actions, but this was seen as inefficient. The meeting length was increased from a couple of hours to half a day and all aspects of a topic (i.e. issues and actions) were covered together as described above.
 - d. The topic sequence was generally down the catchment (i.e. geographically in direction of flow from source to river mouth and then into near-shore domain), but most of the contentious topics (port and urban development, fisheries) were addressed as the last topic.
7. The project team combined all the management options into management strategies (see [SM Section 3](#)), which were presented to the RG and these were subsequently modified during two workshops. In order to articulate the pathway of combining management options, the project team used the well-known United Nations Environment Program risk assessment framework known as DPSIR (Drivers, Pressures, States, Impacts and Response) ([Pirrone et al., 2005](#); [Smeets and Weterings, 1999](#)). A more simplified form of Pressure-State-Response –was ultimately used. The results were presented with an associated storyline for each Management Strategy that provided background and a list of the relevant management options (see example [SM Section 4](#)).
8. An impact assessment was undertaken in two phases (with the analysis method described in [Dichmont et al. \(2014\)](#)):
 - a. The RG was asked to rate each management strategy from –3 (“considerably worse than current situation”) to +3 (“considerably better than current situation”) against the low level objectives.
 - b. They were also asked to score their level of confidence in their ability to answer questions for each objective from a score of 1 (“very unsure”) to 5 (“certain”).
 - c. A subsequent workshop was then held where the RG, Mackay coastal managers and NRMs were asked to undertake the same impact assessment scoring. However,

due to time constraints scores were made during the meeting against the high level goals only (although well-being was split into social and economic goals).

9. The overall priority list and final set of management strategies (SM Section 3) were provided to the RG for comment, and thereafter to the management workshop.
10. Storylines in the form of report cards were developed that described the management strategies and actions for use by RG and LMAC members. These were made available online for the community.
11. Letters to the two management agencies most affected were also written, but drafted in language more appropriate for this target audience.
12. All documentation was always approved by RG members before release.

A review of the successes and failures of the two case studies by the project team were undertaken through questionnaires to the Mackay RG and managers. A final framework was developed for future engagement.

3. Results and discussion

3.1. Comparing the case studies

The progress of the different case studies was heavily impacted by external factors, in the case of Bowen-Burdekin a contentious port development proposal and previous unsuccessful engagement processes, amongst others. The Bowen-Burdekin LMAC was also split over two reasonably different regions and was also the newest formed committee of the LMACs. This case study also did not have a local GBRMPA member (as opposed to the Mackay case), which helped build trust and continuity. The level of distrust and at times acrimony divided the volunteers from the Bowen-Burdekin RG and LMAC such that the engagement process was not completed in this case study. In that context, however, it was still possible to complete the objective review and hierarchy through individual or smaller group interactions that produced a useful product (Van Putten et al., 2015). In contrast, the RG in Mackay was highly functional and delivered more than 150 h of volunteer time (not including the project team time). Given the time and energy they put in, ownership of the output by the Mackay RG increased over time with members controlling the final product (in terms of both content and detailed wording). This was not the case in the Bowen-Burdekin where the project team was more influential on the final product. However, despite these differences in approach the final objective trees from each case study were quite similar which allowed generic objectives to be developed.

A further issue in the Bowen-Burdekin case study was stakeholder fatigue. Previous studies had used several of the members for other strategy discussions especially on fisheries. There had been significant progress in developing regional management strategies for the Burdekin area, with genuine interest and support by the then Minister for Fisheries, but which failed to be progressed because of poor overall project management and poor communication of the objectives of the project to the community. Vocal opposition to the project by a particular influential stakeholder group also influenced this outcome, but who were not resident in the area. This meant that some of the members felt the project was repeating previous work and were worried that the end result would be the same. The Mackay case demonstrated that the process followed as part of this project could in fact lead to avoiding conflict and that a rigorous semi-quantitative sequential approach contributes to a successful completion and overall outcomes.

Interestingly, as the Mackay RG increased in confidence and

realised the value of their contribution and increased knowledge due to access to experts, the link between the RG and LMAC became more tenuous. RG members expressed their frustration with the LMAC and developed a perception that they only discussed small-scale issues compared to RG discussion.

Aspects that contributed most to the successes in Mackay were that:

- There were a large number of highly dedicated local volunteers within the local community, scientific community, and amongst the managers.
- The scientific input was of an excellent standard with well-pitched presentations due to verbal or written communications indicating what was required provided beforehand. These presentations were very motivational to RG members who indicated they valued them and that they influenced the way they understood both management and biophysical processes.
- Of key importance in terms of generating interest and knowledge was the dedication to provide mostly local content. In addition RG members (and managers) also gained immense local knowledge through visits to local examples of good and bad management practices.
- There were strong links established between managers and RG members. Discussions about contentious issues occurred, but debates over these occurred in a climate of mutual respect and understanding.

However, senior management support for the uptake of the final management strategies was variable. Lack of uptake of the final outcome by some agencies were because:

- The RG had no broad official mandate to represent Mackay, as they were not elected, which makes management action perceived as being more risky.
- There was basic resistance on behalf of management to change and lack of enthusiasm to undertake the effort that would be required to effect any change. This is related to the conundrum that as part of the project the managers needed to be open and empathetic to community input (as presented through the RG) despite this input being given by a community group that by nature was not representative of a large region. This meant that there was a perception that it would be difficult or less attractive to act on the basis of their advice.
- Managers' perception of what was happening on the ground was considerably different from that of the RG. This was due to a mixture of managers not being aware of local issues and RG members not being aware of what work management agencies were, or were not, undertaking.
- The final management strategies were seen as "wishy-washy" and not radical, and also managers perceived that many of the strategies had already been implemented. However, this again highlighted differences in manager's perception about what had been implemented and what had actually happened on the ground as understood by the RG. Evidence of bad and good practices and of the discrepancy between management decisions and on-ground actions was shown to the project team and to some of the managers. These demonstrated that manager's perception that issues had already been addressed was not always borne out by the evidence and therefore their developed management strategies still had great significance to the RG members.

The process followed was accepted as comprehensive, but required significant volunteer input. Some of this time commitment was due to the test case nature of the work where several

approaches were trialled by RG members. A shorter, less time consuming version is suggested below as a refinement based on the outcomes of our work.

3.2. Review of process

The qualitative modelling was used as an introduction for the members to discuss their present knowledge of the area, for their views were valued and to inform the project team on key issues that needed to be addressed and which assets needed to be protected. Although the project team provided the qualitative models to the RG at the time of management strategy development, the RG members did not use the models. Since the process of qualitative model development is quite extensive – in this case partly due to the fact that different methods were trialled – and because the models were not used later in the process, this step could be removed from the process. Alternatively it could be enhanced, or further value could be added to the models, by developing them into Bayesian Belief Networks (Hosack et al., 2008). This enhanced approach may be more useful to developing management strategies and the additional effort thus beneficial.

Undertaking the objective development process before discussing management options was essential to encourage group cohesion and trust. This sequence of events was based on the adaptive management loop (Sainsbury et al., 2000; Walters and Hilborn, 1976), where objectives are defined so that management strategies can be contextualised and actions can be reviewed once they are implemented. Conflict is reduced because all objectives can be included in the objectives setting process (i.e. there is no need to exclude any specific objective). In addition, each participants' individual weightings are preserved in the objectives scoring process giving each participant a sense that their opinions are considered and important. In summary, at this early stage of the process, the group is new and trust has yet to be developed. The objective stage does not need consensus or agreement as a person can down weight an objective they disagree with and highlight those they feel are most important. For this reason, undertaking the objective process first builds trust. Conflicts are diffused and informal feedback from the group indicated that generally participants found this aspect interesting and unique, particularly given that their past experiences mostly bypassed this part and instead moved straight to the management strategies.

The objective review was surprisingly quick and easy (given that most of the agencies had a strong online presence and documents were therefore easily obtainable). In addition, the process followed with the Mackay RG to develop the hierarchy led to increased group cohesion and the process was generally enjoyed. However, a successful review was also achieved in the other case study site through a more individual approach although perhaps with not as much attachment to the final product.

Several approaches were trialled when developing the management strategies with the RG in Mackay. Group input in the process highlighted that discussing the each asset in conjunction with the issues that pertain to as one topic, and covering only one topic per meeting, worked best. At each meeting, access to an expert with local knowledge on each topic was essential. Undertaking the 'Issues Register', and listing direct and indirect management options at the same time was the most productive and produced a more cohesive product.

The sequence by which topics were discussed roughly reflected a progression from the top of the catchment, down along the catchment to the ocean. This sequence made intuitive sense, reduced overlap and highlighted the connectivity of the system. The most controversial topics arose at the end of the discussion process (at the bottom of the catchment) and by this stage the

group was very familiar with each other's views and therefore more open to opposing proposal for management actions. The motive for undertaking the most controversial topics towards the end is that the investment of the RG by this stage was high thereby reducing the incentive to abandon the process but rather to remain engaged in finding a solution. Members were also aware of the different weights given to the various objectives, so many of the contentious views were already generally known and were often discussed out of session. In other words, members were more prepared to "agree to differ" or accommodate their ideas rather than increase conflict and risk breaking the process, which was now more than a year long. In the Burdekin the group was unable to progress past the objectives stage. In this case study, extant conflict in the community already existed due to past experiences and the controversial Port development. This indicates that existing conflicts may not be easily be resolved by the process proposed in this research, but that the process is better at deferring potential future conflicts as was evident from the Mackay case study.

Traceability about where the objectives and management options came from was an essential component that maintained trust between participants and trust in the process. The RG feedback emphasised this point and that they felt their views were listened to through having this transparency.

Explicitly making the relative importance of the defined objectives to the whole group helped highlight that there was in fact quite a lot of consistency in the RG's view and their attribution of the relative importance for each goal. In session discussion of the results allowed general articulation of RG member's values and opinions in a more factual manner.

By embedding managers in the project team and RG was an extremely important component of linking the community with the management system and, as such, was successfully implemented. However, connection to more senior management and leaders in strategic thinking which has been shown to be very influential in other studies, for example Dutra et al. (2014), was weak in our process partly due to the project team's work load and other commitments of the participants and managers. The lack of connection to senior management made it more difficult to get traction (with regard to implementation) at the end of the process. However, senior managers were approached at the early stages of the process and the project team was told to wait until the end when there was more substance. Some of the reason for this was that senior managers wanted to stay at arms length from the process so they could wait to pick and choose options that are possible to implement without having directly or indirectly endorsed them by being involved in the process. As a consequence, the final manager meeting was destructive for some RG members even though the project team warned the RG that some negative response from managers could be expected. As a result, a balance between the RG and managers' needs is required, where more regular contact is made rather than using the manager's approach of 'connecting towards the end'. Closing this engagement and timing gap between managers and the RG (highlighted in the Mackay example) throughout the process is a priority. If these gaps were addressed this may assist in solving the conflict in perception such that managers felt much work is already being undertaken in some areas whereas the RG believe these were ineffective or absent in the ground actions.

Managers suggested the most useful part of the process was the impact assessment. This provided them with a list of relative priorities for each management strategy they could use for funding purposes. It also uncovered a significant gap between what managers thought was a priority and this same perception by the community, in addition to the mismatch in the eyes of the community of the effectiveness (and wisdom) of the management

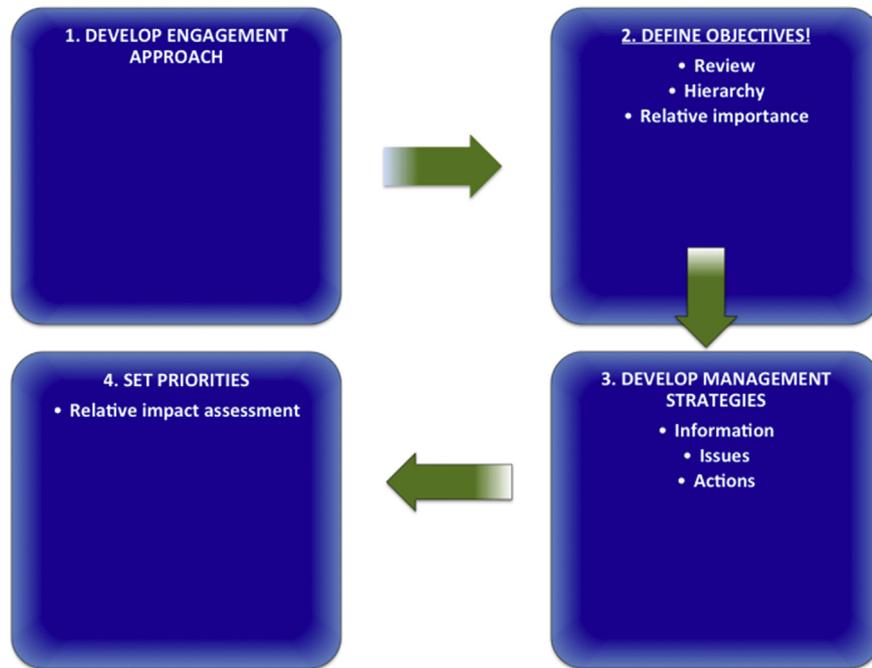


Fig. 2. Generic process of developing management strategies using local community input.

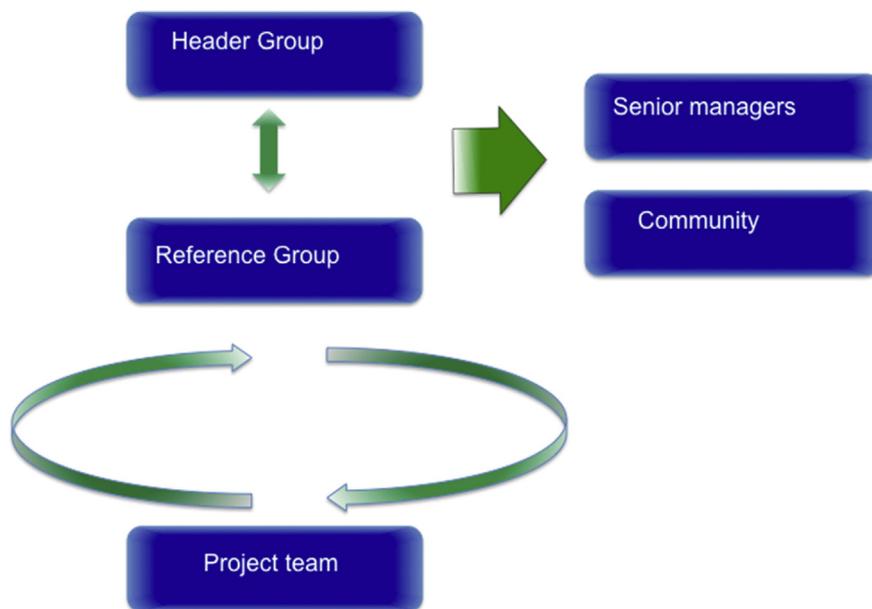


Fig. 3. Generic engagement process.

action(s) that addressed the managers perceived priorities.

After the managers meeting, the final set of management strategies was separated into products specific to the two major agencies relevant to the coastal zone (fisheries management – DAF and local government arrangements – Regional Council) and these were much more successful in terms of uptake. These included letters to each agency that highlighted the possible management solutions to specific issues highlighted by the RG. These two letters were also promoted behind the scenes by key members of the project team and were worded in the language used in the bureaucratic system of government agencies rather than those of the RG. Both products were needed for the process, as there was a

demonstrated disconnect between local and manager's views.

Disputes (potential or actual) were resolved with the aid of very clear ethics guidance processes, by the sequence of the stepwise process allowing open and transparent discourse, by the independence of the project team, and imbedding a local in the project team. In Burdekin, adapting the process to one based on an individual rather than workshop format reduced additional conflict in that area (where conflict was already extant). In Burdekin, the LMAC and other participants agreed to stop half way through. The acceptance that circumstances were too difficult and stopping the process was an important learning outcome that can be drawn from this project. In Mackay, a RG member was the chair but the

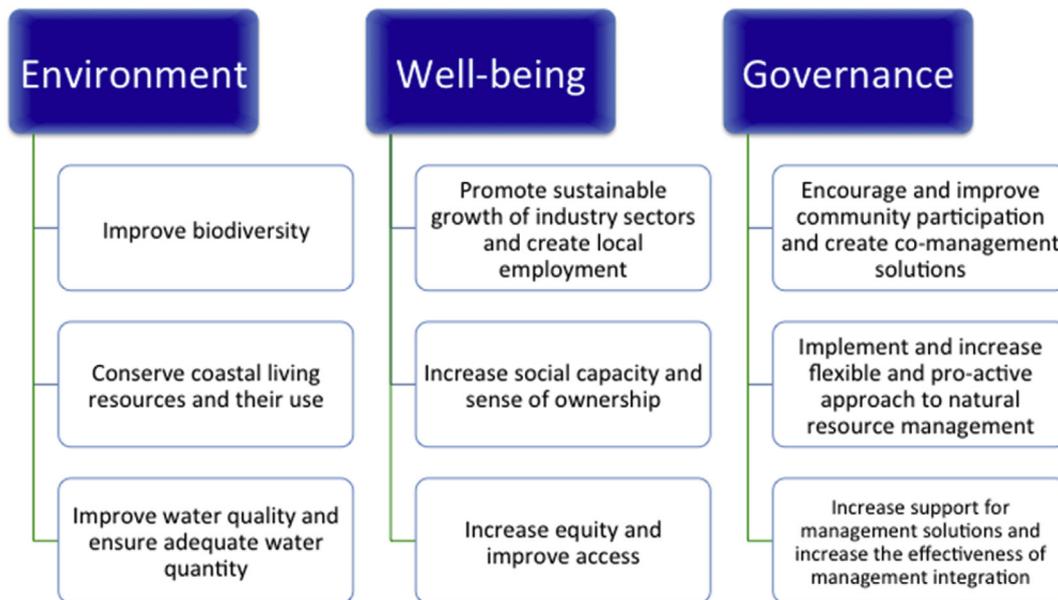


Fig. 4. Generic objectives hierarchy for the management of the coastal zone fisheries and biodiversity (Van Putten et al., 2015).

facilitator was from the project team, which meant that these two were able to control any conflict without compromising the local or the research team. Clear guidance on workshop behaviour has been provided at the start of the process to all participants, and these were consistently adhered to.

3.3. Generic process

The following describes a generic community engagement process. However, it is not a recipe for engagement, but more a guide that helps outline what is possible. The community engagement process can be simplified into four steps (Fig. 2):

- i) developing the engagement process;
- ii) defining objectives (which includes the review of existing objectives, creating the hierarchy and obtaining their relative importance);
- iii) developing the management strategies (provide information, define issues and develop actions); and
- iv) setting the priorities through a relative impact assessment.

It is recommended that community engagement be conducted following the approach in the Mackay RG but with enhanced LMAC (generically called the Header Group) involvement where the header group gives direction by defining the RGs tasks and timelines (Fig. 3). The header group should meet less frequently than the RG. Managers should be embedded in the RG. The header group should preferably have some authority and representativeness, whereas the RG membership should maintain some representation but mainly consists of volunteers willing to generously provide their time. Important influencers should be identified at an early stage in the process so that they can be included in the discussions as much as possible. The RG chair should be elected from the RG membership but facilitation should be provided by the project team to allow all RG members equal access to the discussion, but also for the chair to be able to contribute to the discussion. A local person that is a member of the project team is a huge advantage as this person can be a conduit for out of session conversations.

A very important aspect of building trust is for the objectives

review to maintain links to source documents and also to keep track of versions when the RG and Header Group input is obtained. If there is a need to speed up the process, a generic objective tree to develop management strategies for coastal zone fisheries and biodiversity can be used and the lower level (the objectives) can be subsequently added for more local content (Fig. 4).

Determining the objective relative weighting can be kept within the Header Group and RG (rather than going to the community as well), as this data will be used when the management strategies are created by the Header Group and RG. Obtaining objective weightings from the community is time consuming. However, if a community survey is part of the project plan can be obtained, doing local radio interviews in which the link to online surveys is

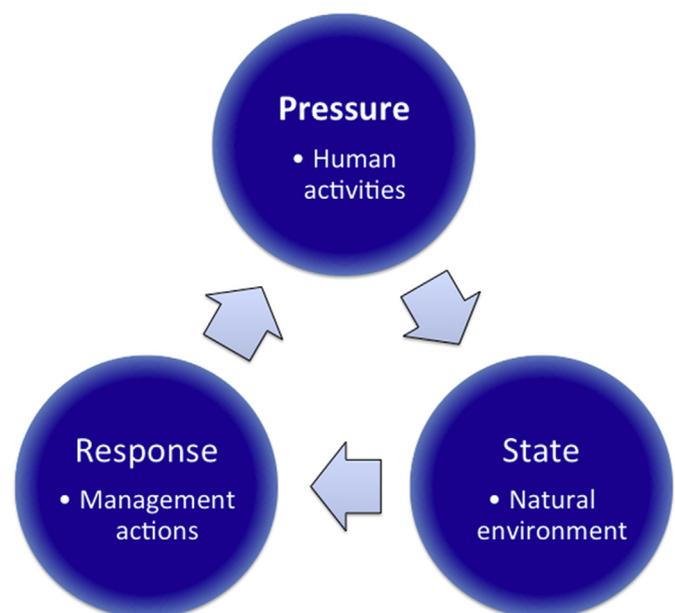


Fig. 5. A drawing that could be provided to explain the Pressure-State-Response framework.

Table 1
Generic management action table for use in RG discussions.

Topic		
Issue	Direct management action	Indirect management action
Issue 1	Action 1a	Action 1b
Issue 2	Action 2a	Action 2b
	Action 3a	Action 3b

publicised seems to work well in obtaining participation (Dichmont et al., 2014). A paper backup survey available from a local office is also needed for those people who wish to participate but are not able to access the internet. There should be a preference for the simplest cognitive method to obtaining relative objective weightings. More confusing and controversial approaches such as the Analytical Hierarchical Process as described in Dichmont et al. (2014) should be used only in appropriate circumstances. An example of the simple survey using the generic objectives approach is provided (Supplementary materials Section 1).

To ensure that the existing management situation can be adequately described before the management strategies are fleshed out, it is suggested that this part of the process starts with a meeting between managers and the RG and Header Group in which existing management measures are comprehensively described. The management strategy question should be divided into topics that combine key assets and with the relevant issues that pertain to them. The topic sequence should allow for connectivity in the system to be highlighted but controversial topics should be raised

toward the end of the process when trust and awareness have already been established. For each topic, an expert with local knowledge on that topic should attend. Using the simpler Pressure-State-Response framework (Fig. 5) – the precursor to the Driver-Pressure-State-Impact-Response approach (Pirrone et al., 2005; Smeets and Weterings, 1999) – an issues register can be developed with direct and indirect management actions (Table 1). Some flexibility on the day is needed in terms of whether discussions are made in small groups or the whole. The project team should collate these using a database and provide these to the RG for input. The Header Group should support the final product.

Given the time usually available, particularly to senior managers, the impact assessment should be undertaken for the highest level objectives by both the RG and the Header Group prior to the key managers meeting. It can be repeated in session at the managers meeting to obtain information on influence – see example tables in Dichmont et al. (2014). Undertaking the impact assessment at these two separate meetings highlights relative priorities and the difference between managers and RG members. The analysis method is provided in Dichmont et al. (2013, 2014).

At least one managers meeting between senior managers, embedded managers, the Header Group and RG should be undertaken. In order to increase the chance of implementation, it is likely that follow up meetings with managers are essential and documents specific to their needs and communication style will need to be produced.

A generic strategy communication tool (Fig. 6) can be used for each of the different management strategies to ensure that all bases are covered. All management actions can be the result of either

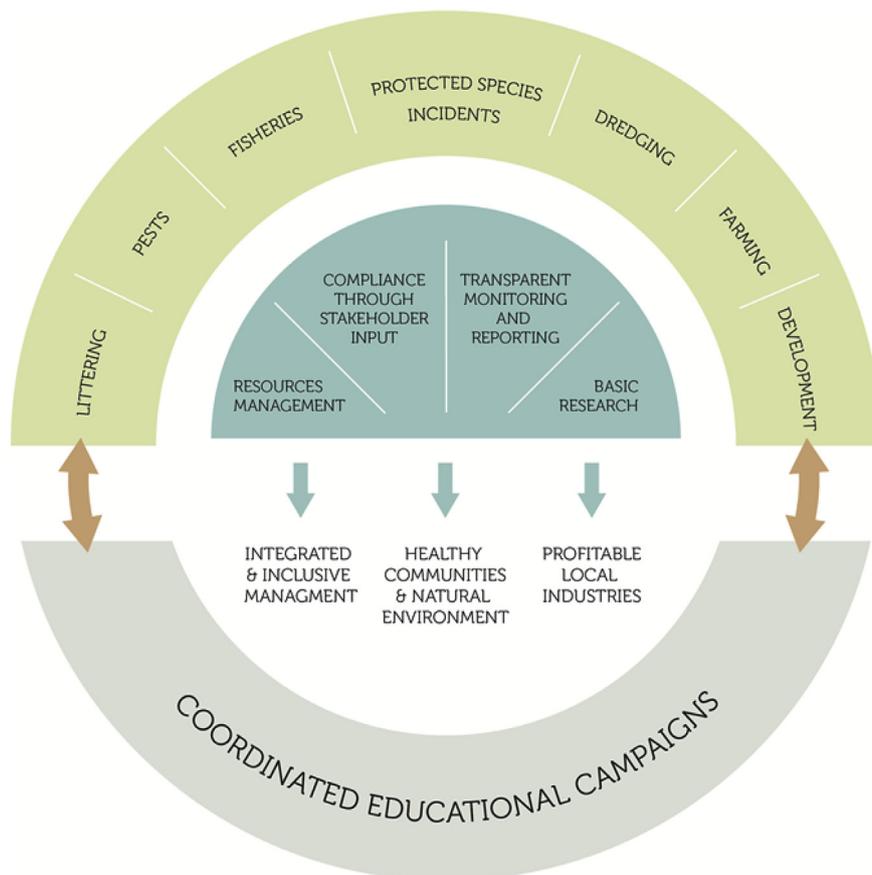


Fig. 6. Generic classes of management strategies as a communication tool with which to explain the management strategies. Graphic design: Dr Manuela B. Taboada, Queensland University of Technology.

direct actions on individual impacts, such as reducing littering and runoff from farms and development (outer ring at top), or responses by means of resource management, added compliance, and basic research (inner top semi-circle). Coordinated educational campaigns targeted at the local community, industries and government agencies (bottom ring) are a key action that can help influence positive behaviour and attitudes towards inshore resources. The final outcomes expected from the management strategies are:

1. Healthy communities and natural environment
2. Integrated and inclusive management
3. Profitable local industries

A clear ethics approval process that includes the stage at which further engagement with communities or an individual member of the group is deemed as potentially damaging is important. The steps described in the ethics application used for this research was in fact used for one of the two case studies where engagement was discontinued. A flexible approach is therefore still important to keep in mind, as each situation is likely to bring its own idiosyncrasies.

4. Conclusions

A generic approach to developing management strategies based on two case studies is outlined. The case study experience highlights that embedding managers and person from a local government agency within the community group that develops the objectives and prioritises the management actions is essential to successful implementation. In addition, senior managers and thought leaders should be part of the process from the start rather than coming in only at the end at which time a more tangible but less controversial product is available. Continuous engagement by senior managers and thought leaders is important because failure is most likely to occur at the implementation phase. Throughout the process steps are needed to ensure reduced risk of conflict. The most important step in risk reduction is to discuss objectives prior to management strategies. This allows the group to value and understand each other's perspective. The gap between the perception of managers that their management actions are in place and outcomes are achieved, and the community's perception of the effectiveness of the same actions needs to be at least narrowed but preferably closed. This is particularly important as the significant volunteer time required to support the process evident in this project, showed the wish for local scientists and community members to be part of regional management.

Acknowledgements

This work would not have been possible without the incredible input from the Mackay and Bowen-Burdekin community, and their associated LMAC members. Most notably, those that helped us tirelessly in Mackay as members of the Mackay LMAC RG. We developed a survey in Mackay to gauge residents' opinions of what mattered to them with regard to coastal management, and more than 140 completed what was a taxing survey. These respondents also helped recruit other survey participants. Some of the participants attended in-person sessions held in Mackay and stayed to give us robust advice on the survey design. These comments were instrumental when developing a new method. Special mention must be made of Carolyn Thompson, GBRMPA, Mackay – her involvement and tireless work was probably the most significant factor allowing us to get real traction in Mackay.

We thank the CSIRO and external reviewers of the paper and Dr Manuela B. Taboada for graphic design of Fig. 6.

This research was funded by the Department of Environment; the Commonwealth Scientific and Industrial Research Organisation; the Queensland State Department of Agriculture Fisheries and Forestry; the Great Barrier Reef Marine Park Authority; the Queensland State Department of Environment, Heritage and Protection; and James Cook University.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.ocecoaman.2016.02.003>.

References

- Abal, E.G., Dennison, W.C., Bunn, S.E., 2005. Healthy Waterways Healthy Catchments: Making the Connection in South East Queensland, Australia. Moreton Bay Waterways and Catchment Partnership, Brisbane, p. 222.
- Australian Bureau of Statistics, 2013. State and Territory Statistical Indicators. Technical Report 1367.0. Australian Bureau of Statistics.
- Chandra, A., 2011. A deliberate inclusive policy (DIP) approach for coastal resources governance: a Fijian perspective. *Coast. Manag.* 39, 175–197.
- Cox, M., Arnold, G., Tomás, S.V., 2011. A review of design principles for community-based natural resource management. *Ecol. Soc.* 15, 38.
- Dambacher, J.M., Luh, H.K., Li, H.W., Rossignol, P.A., 2003. Qualitative stability and ambiguity in model ecosystems. *Am. Nat.* 161, 876–888.
- Dambacher, J.M., Ramos-Jiliberto, R., 2007. Understanding and predicting effects of modified interactions through a qualitative analysis of community structure. *Q. Rev. Biol.* 82, 227–250.
- Dichmont, C.M., Dutra, L.X.C., van Putten, I., Deng, R.A., Owens, R., Jebreen, E., Thompson, C., Pascual, R., Warne, M.S.J., Quinn, R., Thébaud, O., Bennett, J., Read, M., Wachenfeld, D., Davies, J., Garland, A., Dunning, M., Waycott, M., Collier, C.J.D., Playford, J., Harm, R., Gribble, N., Pitcher, R., 2014. Design and Implementation of Management Strategy Evaluation for the Great Barrier Reef Inshore (MSE-GBR), p. 284. Report to the National Environmental Research Program, and Reef and Rainforest Research Centre Limited Cairns. <http://www.nerptropical.edu.au/publication/project-292-final-report-design-and-implementation-management-strategy-evaluation-great>.
- Dichmont, C.M., Pascoe, S., Jebreen, E., Pears, R., Brooks, K., Perez, P., 2013. Choosing a fishery's governance structure using data poor methods. *Mar. Policy* 37, 123–131.
- Dietz, T., Ostrom, E., Stern, P.C., 2003. The struggle to govern the commons. *Science* 302, 1907–1912.
- Drimie, S., Quinlan, T., 2011. Playing the role of a 'boundary organisation': getting smarter with networking. *Health Res. Policy Syst.* BioMed Central 9 (Suppl. 1), S11.
- Dutra, L.X., Ellis, N., Perez, P., Dichmont, C.M., de la Mare, W., Boschetti, F., 2014. Drivers influencing adaptive management: a retrospective evaluation of water quality decisions in South East Queensland, Australia. *Ambio* 43, 1069–1081.
- Guston, D.H., 2001. Boundary organizations in environmental policy and science: an introduction. *Special Issue Bound. Organ. Environ. Policy Sci.* 26, 399–408 (Autumn, 2001).
- Halpern, B.S., Kappel, C.V., Selkoe, K.A., Micheli, F., Ebert, C.M., Kontgis, C., Crain, C.M., Martone, R.G., Shearer, C., Teck, S.J., 2009. Mapping cumulative human impacts to California Current marine ecosystems. *Conserv. Lett.* 2, 138–148.
- Hosack, G.R., Hayes, K.R., Dambacher, J.M., 2008. Assessing model structure uncertainty through an analysis of system feedback and bayesian networks. *Ecol. Appl.* 18, 1070–1082.
- Kroon, F., Turner, R.E., Smith, R., Warne, M., Hunter, H., Bartley, R., Wilkinson, S., Lewis, S., Waters, D., Caroll, C., 2013. Sources of Sediment, Nutrients, Pesticides and Other Pollutants in the Great Barrier Reef Catchment. Queensland State Government, Reef Water Quality Protection Plan Secretariat, Brisbane.
- Ludwig, D., 2001. The era of management is over. *Ecosystems* 4, 758–764.
- Ma, C., Zhang, X., Chen, W., Zhang, G., Duan, H., Ju, M., Li, H., Yang, Z., 2013. China's special marine protected area policy: Trade-off between economic development and marine conservation. *Ocean Coast. Manag.* 76, 1–11.
- Marshall, N.A., Bohensky, E., Curnock, M., Goldberg, J., Gooch, M., Pert, P., Scherl, L., Stone-Jovicich, S., Tobin, R.C., 2013. A Social and Economic Long Term Monitoring Program for the Great Barrier Reef. Key Findings 2013. Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns, p. 52.
- Muro, M., Jeffrey, P., 2008. A critical review of the theory and application of social learning in participatory natural resource management processes. *J. Environ. Plan. Manag.* 51, 325–344.
- Ostrom, E., 2009. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press.
- Ostrom, E., Janssen, M.A., Anderies, J.M., 2007. Going beyond panaceas. *Proc. Natl. Acad. Sci. U. S. A.* 104, 15176–15178.
- Pascoe, S., Dichmont, C.M., Brooks, K., Pears, R., Jebreen, E., 2013. Management objectives of Queensland fisheries: putting the horse before the cart. *Mar. Policy*

- 37, 115–122.
- Pirrone, N., Trombino, G., Cinnirella, S., Algieri, A., Bendoricchio, G., Palmeri, L., 2005. The Driver-Pressure-State-Impact-Response (DPSIR) approach for integrated catchment-coastal zone management: preliminary application to the Po catchment-Adriatic Sea coastal zone system. *Reg. Environ. Change* 5, 111–137.
- Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a general theory of planning. *Policy Sci.* 4, 155–169.
- Rowbottom, D.P., Bueno, O., 2009. How to change it: modes of engagement, rationality, and stance voluntarism. *Synthese* 178, 7–17.
- Saaty, T.L., 1980. *The Analytic Hierarchy Process*. McGraw-Hill, New York.
- Sainsbury, K.J., Punt, A.E., Smith, A.D.M., 2000. Design of operational management strategies for achieving fishery ecosystem objectives. *ICES J. Mar. Sci.* 57, 731–741.
- Smeets, E., Weterings, R., 1999. *Environmental Indicators: Typology and Overview*. European Environment Agency Technical Report No. 25, Copenhagen, p. 19.
- Smith, A.D.M., Sainsbury, K.J., Stevens, R.A., 1999. Implementing effective fisheries-management systems - management strategy evaluation and the Australian partnership approach. *Ices J. Mar. Sci.* 56, 967–979.
- Townsend, R., Shotton, R., Uchida, H., 2008. *Case Studies in Fisheries Self-governance*. FAO Fisheries Technical Paper. FAO, Rome, p. 451.
- Van Putten, I.E., Dichmont, C.M., Dutra, L.X.C., Thébaud, O., Deng, R.A., Jebreen, E., Owens, R., Pascual, R., Read, M., Thompson, C., 2015. Objectives for Management of Socio-Ecological Systems in the Great Barrier Reef region, Australia. *Regional Environmental Change*.
- Van Vugt, M., 2009. Averting the tragedy of the commons: using social psychological science to protect the environment. *Curr. Dir. Psychol. Sci.* 18, 169–173.
- Vural-Arslan, T., Cahantimur, A., 2011. Revival of a traditional community engagement model for the sustainable future of a historical commercial district: Bursa/Turkey as a case. *Futures* 43, 361–373.
- Walters, C.J., Hilborn, R., 1976. Adaptive control of fishing systems. *J. Fish. Res. Board Can.* 33, 145–159.