

# Objectives for management of socio-ecological systems in the Great Barrier Reef region, Australia

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**Abstract** A wide range of goals and objectives have to be taken into account in natural resources management. Defining these objectives in operational terms, including dimensions such as sustainability, productivity, and equity, is by no means easy, especially if they must capture the diversity of community and stakeholder values. This is especially true in the coastal zone where land activities affect regional marine ecosystems. In this study, the aim was firstly to identify and hierarchically organise the goals and objectives for coastal systems, as defined by local stakeholders. Two case study areas are used within the

Great Barrier Reef region being Mackay and Bowen–Burdekin. Secondly, the aim was to identify similarities between the case study results and thus develop a generic set of goals to be used as a starting point in other coastal communities. Results show that overarching high-level goals have nested sub-goals that contain a set of more detailed regional objectives. The similarities in high-level environmental, governance, and socio-economic goals suggest that regionally specific objectives can be developed based on a generic set of goals. The prominence of governance objectives reflects local stakeholder perceptions that current coastal zone management is not achieving the outcomes they feel important and that there is a need for increased community engagement and co-management. More importantly, it raises the question of how to make issues relevant for the local community and entice participation in the local management of public resources to achieve sustainable environmental, social, and economic management outcomes.

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## Introduction

Successful natural resource management can be partly attributed to an adaptive management approach (Walters and Hilborn 1978; Walters 2007). In turn, success in adaptive management decision-making is very much dependent on clearly articulated goals and objectives that define what managers (and stakeholders) want to achieve within a predetermined time frame (Bennett et al. 2005; Cinner et al. 2006). Clear objectives also allow data and

information gaps to be identified as part of the adaptive management process (Thom 2000; Walters 2007) and progress of management actions to be assessed over time. In principle, adaptive management requires knowledge of the desired future state of a system and is underpinned by a level of understanding of the way a system works. In social ecological systems (SESs) where it is recognised that the human and ecological systems are linked (Berkes and Folke 1998), the desirable future state of the system means that goals and objectives for that system have to be understood.

Adopting an adaptive management approach requires dealing explicitly with the high uncertainty and lack of understanding of many key underlying processes within the SES (Sainsbury et al. 2000; Cinner et al. 2009). Due to the inherent uncertainties in SESs, an effective monitoring protocol has to be incorporated so decision-makers can evaluate the consequences of decisions. Decision-makers can adjust actions based on the feedback received via the monitoring protocol that indicate whether resource goals and objectives are being achieved.

Sustainability and biodiversity, culture and heritage, and productivity and equity are all natural resource management goals and objectives that have to be taken into account by resource managers and decision-makers. Resource goals are generally long-term “big picture” statements that are not readily or easily measurable (West 2005). In contrast, objectives are more specific in nature, locally relevant, and considered over a shorter term and therefore more easily quantifiable. Natural resource management objectives describe the desired future use and condition of the resources in some detail and are context-dependent, that is, they can be spatially specific or apply to areas with different jurisdictional, social, economic, and ecological characteristics. In addition to being specific, objectives need to be attainable, meaningful, valued, and measurable (Walters 2007; Ludwig 2001). However, making these relate to regional management is often difficult given the different scales of management, institutions, organisations, and stakeholder engagement processes.

Where objectives are specified, they are in fact the stepping stones for achieving the higher-level goals. Objectives can be nested inside goal statements and are directly derived from the goals. Often another layer (here called sub-goals) is needed between goals and objectives to further articulate and make a link between broad statements and the specifics. In the context of forestry for instance, an objective, such as optimising tree growth, gives way to goals or sub-goals such as sustaining the function and dynamics of ecosystems, maintaining ecosystem diversity, resilience or protecting sensitive species, and providing for a variety of ecosystem services of value to humanity

(Coates and Burton 1997). Goals are often part of business plans and vision statements, for example, for natural resource management organisations (e.g. Department of Environment and Resource Management 2011).

It is important for resource management agencies to specify both goals and objectives in order to set clear and explicit directions following an adaptive management framework. Clear direction will ensure better prioritisation of funding allocated to management actions to address local natural resource issues. Moreover, local community and stakeholder involvement in setting clear nature resource goals and objectives are likely to create local awareness and potentially increase support for future management actions (Dale et al. 2013; Davidson Davidson et al. 2013). The involvement of stakeholders in the development of objectives is important, but it is distinct from involving these stakeholders in the actual adaptive management process (Walters 1986). An adaptive management process should monitor and consider whether objectives are being met or not. Involvement of stakeholders in a collaborative and participatory process of regulatory decision-making and adaptive management is here referred to as co-management (Jentoft 1989; Pinkerton 1989; McCay and Svein 1996).

Natural resource management goals and objectives for coastal socio-ecological systems can relate to many different resource aspects (Olson 2003) such as: maintaining scenic quality (aesthetics), conserving critical habitat, promoting water resource development, or creating recreation and tourism opportunities (Ministry of Sustainable Resource Management 2004). The area included in a coastal socio-ecological system is not only the coastal strip where people live and work but also the marine environment within which they interact for commercial, recreational, or other purposes.

The goals and objectives for the marine environment are mostly focussed on fisheries activities and comprise four major categories of management goals: biological, economic, social, and political (Mardle et al. 2002; Hilborn 2007a, b; Wattage et al. 2005; Charles 1989; Cochrane 2002). Although worded differently, fisheries objectives set by different jurisdictions and organisations often have a similar focus.

The coastal zone is inherently about managing both the terrestrial and marine socio-ecological continuum in terms of use and cumulative impacts. Even though there are a number of sectoral and industry examples of goals and objectives of coastal socio-ecological systems (Fidelman et al. 2012), there are notably few examples that explicitly apply to multiple use coastal socio-ecological systems. A reason for the lack of goals and objectives in multiple use settings is that generally goals and objectives are developed and monitored independently by the agencies responsible

for managing the resource, industry, or sector in question (like fisheries, national parks, or forests).

Not only are there few examples of documents that set out multiple use coastal zone (including terrestrial and marine) goals and objectives, but there are also few examples where these goals and objectives are determined by local communities and incorporated into the official management frameworks. The latter may be due to the fact that the process of capturing individual's goals and objectives and then incorporating them into the official management arrangements to achieve effective adaptive resource management is not a straightforward and easy process to complete. As a consequence, regional goals and objectives are often divergent, not well articulated, or not made explicit to the wider community (de Geus 1988; Ward and Schriefer 1997; Ludwig 2001; Burt 2011).

Complications arise from using community input, as people have different perceptions about resource use goals and objectives, largely driven by their morals and values (Conroy and Peterson 2013), and these may compete or conflict with one another. At a regional scale, where local people feel they want involvement in decisions made about their local environment, conflicting goals and objectives from community members can lead to negative interactions and local divisions. Not only do people hold different and potentially conflicting objectives for their immediate natural environment, but the weight and significance they attribute to each of these goals and objectives also differs. The difference in the relative importance, weight, and significance, of goals and objectives, reflects heterogeneity in people's values (Zandstra 1994) that can only be resolved when people are willing to negotiate and make inevitable trade-offs.

Despite inherent difficulties associated with allowing for people's differences in goals and objectives, achieving efficient and representative regional resource management, through the active involvement of local communities is the aim of many management bodies. However, few resource management agencies have made formal decisions regarding the process of setting and evaluating goals and objectives using community inputs. As a result, the goals and objectives have to be inferred from the management actions that are taken (Hilborn 2007a, b). This can lead to tensions within and between local community groups due to lack of transparency in the decision process by which management actions are chosen (Dutra et al. 2015).

In this study, a regional stakeholder-driven approach (in this case involving managers, industry representatives, and local community volunteers) is used to develop management goals and objectives for a coastal socio-ecological system, including terrestrial and marine aspects. Two case study areas adjacent to the Great Barrier Reef (GBR) in Queensland, Australia, are used. The aims are to: (1)

understand different social, ecological, economic, and governance goals and objectives for two coastal socio-ecological systems, and (2) generate a generic set of goals that can support engagement processes with the community and facilitate their involvement in coastal regional management.

The efficiency and effectiveness of the processes by which the objectives were developed and compiled into a hierarchical format<sup>1</sup> (herein referred to as a three-level coastal objectives tree) in each of the case studies are evaluated, and the resultant objectives for the two regions are compared.

### Case study areas

Two case study areas (Mackay and the Bowen–Burdekin—Map 1) were selected to develop the set of goals and objectives reported here. As part of a larger project reported elsewhere (Dichmont et al. 2014) and not further detailed here, this was followed by the weighing of objectives by community members in one of the areas (reported in Dutra et al. in review and Dichmont et al. 2014) and the development of local management options.

Mackay is a city of about 112,000 people (Map 1). Sugar cane production is an important economic driver and employer in the region (Australian Bureau of Statistics 2012). The mineral resource industry, particularly coal exports, is responsible for most of the activity in the port and is important economically. A significant number of people 'fly in and fly out' (FIFO) of Mackay to work in the local resource extraction industry. Natural assets in the Mackay region include a national park, many beaches, offshore islands, and inshore and offshore reefs that are part of the GBR. The environment is tropical with the marine area influenced by large tidal ranges (approximately 5 m during spring tides). The coastal shores contain habitats such as mangroves and seagrass, and threatened, endangered, and protected (TEP) species groups such as dugongs and flatback turtles (Roelofs and Roder 2002; Limpus 2007).

The second case study area encompassed the mainly rural Bowen–Burdekin shires. The Burdekin Shire contains the towns of Ayr and Home Hill (Map 1) (south of Townsville and north of Mackay) with a combined population of about 17,000. Bowen is located approximately 2.5 h south of Townsville in the Whitsunday regional Shire, which had a population of about 32,400 people in 2011 (Australian Bureau of Statistics 2012). The Burdekin

<sup>1</sup> The development of the hierarchical format is necessary if the aim is to later prioritise and weight these objectives (Pascoe et al. 2013) Prioritised objectives generated using the hierarchical objectives tree can be used by local management groups and authorities to better target their management actions.

region is rural, and sugar cane farming provides much of its economic development and employment (Australian Bureau of Statistics 2012). Bowen has a diversified economy based on agriculture, fishing, tourism, and mining. Just north of Bowen is the Abbot Point coal loading port. The Bowen–Burdekin is also a tropical environment that borders the GBR coral reef system.

## Methods

Two methodologies were used: (1) a participatory action research and (2) a case study approach. Adopting a participatory approach provides an opportunity to both understand and influence participants' understanding of coastal issues and any differences in goals and objectives that the community may hold. Participatory research also facilitates communication between the community, scientists, and resource managers on different issues that arose in the course of the research (Bergold and Thomas 2012).

Case studies are used to investigate phenomena within a real-life context (Yin 1984). We applied the case study approach to investigate differences and similarities in regional goals and objectives for the coastal zone. Two case studies were chosen to provide insights and allow these to be contrasted and compared (Flyvbjerg 2006). Ideally, additional case studies would have been chosen, but this was not feasible with project time and financial constraints.

The two specific case study locations were chosen because they are both on the GBR, they were somewhat different with respect to their socio-demographic characteristics (as described above), and they had an active regional community engagement body—Local Marine Advisory Committee's (LMAC)—at the time of the project. In both case study areas, existing LMACs were used as the initial point of contact to develop a set of local objectives. LMACs were created by the Great Barrier Reef Marine Park Authority (GBRMPA) “to provide an equitable forum for discussion of matters relevant to the management, the ecologically, socially and economically sustainable use, and the conservation of marine and coastal resources in the (GBR) World Heritage Area especially in matters relevant to the local region” (Great Barrier Reef Marine Park Authority 2012, p. 6). LMAC members were chosen as the first port of call as members generally have an interest in coastal zone management. LMAC members were complemented by representatives from the local council and major resource user groups to create a case study research reference group.

The specific aim of the reference group was to engage with the project team and meet on a more regular basis than the standard quarterly meetings for the LMAC. In Mackay,

much of the objective elicitation process was undertaken with this reference group. In the Bowen–Burdekin a similar process was initiated, but attendance of the reference group was low warranting its disbanding and consequent alteration of the objectives elicitation process. The reason for the low attendance may have been due to challenges posed by a controversial local port development proposed at the time and existing community conflict between recreational and commercial fishing sectors, which complicated group dynamics at the reference group level.

The two case studies are not characterised by a single predominant indigenous group as may be the case in the more northern parts of the GBR. However, indigenous groups are represented on the LMACs and the individuals representing the groups were also invited to be part of the reference group for this research. In Bowen–Burdekin the indigenous representative did not engage with the reference group beyond the regular LMAC meetings. As indigenous representative was initially active as a member of the reference group in Mackay and this person participated in the early stages of the process. However, this person ceased to attend reference group meetings for reasons independent of this research. Consequently, where indigenous objectives could not be obtained directly from the local groups (in either location), the published literature was consulted.

The data gathering stage and the method used to set goals and objectives in the two case study areas is outlined in Table 1(i–iv). Data gathering followed the CSIRO Ethics protocol approved by the CSIRO Ethics Committee.

Due to the lack of a formal reference group in the Bowen–Burdekin, a more adaptive approach was applied in this region. This means the two case studies used a mixed-method approach to gather information on community goals and objectives for the coastal zone. These were: (1) reference group workshops in Mackay (an open deliberation process) and (2) semi-structured interviews (a closed deliberation process) in the Bowen–Burdekin to individual members of the disbanded reference group were applied. The management goals and objectives for Mackay were gathered first, followed by interviews with Bowen–Burdekin stakeholders. Collaborative workshops were undertaken in Mackay between the months of September 2012 and July 2013 to develop a hierarchical goals and objective tree. The interviews in the Bowen–Burdekin were administered in October/November 2013 and involved a total of 15 interviews.

A total of ten LMAC and LMAC reference group meetings were held in Mackay to develop the goals and objective tree, which were attended by an average of ten people at each meeting (70 meeting hours by the community group and about 50 h by the project team). The Mackay LMAC and reference group represented up to 14 stakeholder groups. The final hierarchical goals and

**Table 1** Methods used to gather community information in Mackay and the Bowen–Burdekin

Project steps (Dichmont et al. 2014)	Description of steps in Mackay	Description of steps in Bowen–Burdekin
Select a community group	LMAC sub-committee formed	Individual LMAC members
1. Elicit coastal management objectives	<p>(i) Literature review of existing objectives for the region and higher-level objectives for fisheries and natural resources</p> <p>(ii) Existing objectives not categorised but provided as a list</p> <p>(iii) Objectives list from the literature provided at the workshop/meeting for sub-committee members' consideration and discussion</p> <p>(iv) Sub-group meeting to determine abbreviated list of critical objectives. Sub-committee member awareness and knowledge of each other's responses</p> <p>(v) Agreement on the set, summarising and rewording of objectives by the stakeholder group at a meeting</p>	<p>Literature review of existing objectives for the region and higher-level objectives for fisheries and natural resources</p> <p>Existing objectives categorised according to level (high, medium, low)</p> <p>Provision of list of medium-level objectives prior to the interview</p> <p>One-to-one or small group interviews to determine list of objectives. Anonymity of responses between stakeholders</p> <p>Email confirmation and comment on wording and summarising of objectives from stakeholders</p>
2. Develop hierarchical tree	<p>(i) Hierarchical tree developed at the workshop/meeting by the stakeholder group</p> <p>(ii) Categorisation and grouping of objectives followed from the stakeholder group discussion and final hierarchy tree supported (after small edits) by the LMAC</p>	<p>Researchers and stakeholders to reword and summarise list of objectives into hierarchical tree</p> <p>Hierarchical tree with predefined groups of objectives (environmental, socio-economic, and governance)</p>
3. Weight objectives relative to each other	<p>(i) Objectives weighted by LMAC and sub-group</p> <p>(ii) Weighing of objectives by public via survey form and open evening survey sessions (See Dutra et al. in prep)</p>	To be carried out in the future on the LMACs initiative
4. Develop management "strategies"	<p>(i) Management actions developed by stakeholders after weighing of objectives</p> <p>(ii) Undertake a relative impact assessment of each strategy (See Dichmont et al. 2014)</p> <p>(iii) Develop management implications for handover to various managers (See Dichmont et al. 2014)</p>	To be carried out in the future on the LMACs initiative

objectives tree was endorsed by the LMAC and weighted by the reference group. Towards the end of the workshop period (15th and 19th of April 2013), managers and the general public were invited to weight the set of objectives as developed in the workshop (the results of this public consultation phase are reported in Dichmont et al. 2014).

In the Bowen–Burdekin two initial, but unsuccessful, workshops to develop objectives were held before the reference group was subsequently disbanded. Instead three separate visits were made to the region for the purpose of gathering stakeholder perceptions of objectives using one-on-one or small group semi-structured interviews (during October and November 2013).

A total of 15 persons were interviewed (for 1–2 hours in a location of their choice) in the Bowen–Burdekin with questions focussing on the main objectives for managing inshore natural resources in their area. Even though the number of interviewees is relatively small and some additional interviewees would have been beneficial, a wide diversity of stakeholders was represented with different

areas of expertise or interest (including recreational fishers, commercial fishers, charter fishers, port authority, farmers, municipal representatives, environmental groups, and NRM groups).

A set of pre-existing goals and objectives (collated from the literature review) were made available to the stakeholders prior to the interview. These were organised into different categories (environmental, socio-economic, and governance). The categories were based on the experience in the other case study location (Mackay) and the literature (Pascoe et al. 2013).

A complete list containing the goals and objectives from all interviews was then compiled by the researchers while keeping respondent information confidential following standard ethical considerations. The complete hierarchical goals and objectives tree, with all environmental, socio-economic, and governance goals and objectives, was emailed to stakeholders for final consideration and confirmation. Any comments about the process of developing the goals and objectives were elicited by the researchers over

**Table 2** Environmental goals, sub-goals, and objectives for Mackay

Goal	Sub-goal	Objective
<i>Environment</i>		
1. Protect and restore inshore environmental assets	1.1 Improve ecosystem connectivity	1.1.1 Reduce direct impacts of infrastructure and development
		1.1.2 Minimise human induced changes in water flow regimes
		1.2.1 Ensure Reef Plan water quality targets are met
	1.2 Improve water quality	1.2.2 Increase in environmentally friendly feral and weed control strategies
		1.2.3 Reduce influx of pollutants
		1.3.1 Sustainable human use of marine resources
	1.3 Conserve inshore living resources	1.3.2 Maintain habitat function and structure
		1.3.3 Reduce impacts on threatened, endangered, protected (TEP) species

the duration of the project and additional verbal explanation and feedback was obtained from participants.

## Results

Although initially it was not easy to explain the benefits of setting goals and objectives to local stakeholders, community members generally agreed it was important to understand the *breadth* of goals and objectives, and the heterogeneity of values and opinions that influenced their importance. Some stakeholders focussed more on objectives (small-scale, shorter-term, local issues) while others tended to think more broadly and longer term, focussing on goals and sub-goals. The structure and wording of the goals and objectives tree was controlled by the reference group in Mackay where the project team acted like facilitators and a source of information. In the Bowen–Burdekin the wording was per agreement via email and there was no group effect.

Despite stakeholders thinking at different spatial and temporal scales, there was a high level of agreement on framing the goals and sub-goals. The bulk of the discussion was in fact about the contents of the lower-level objectives. Issues, differences and commonalities were identified on the basis of the final hierarchical trees and were used to develop a set of generalised hierarchical goals. This generalised tree can be used as a starting point in eliciting more detailed objectives for the coastal zone.

### The elicitation process

The initial list of goals and objectives in Mackay contained 72 statements obtained from a literature review relevant to the region. This list was reduced down to a final hierarchical goals and objectives tree that contained 24 objectives under three goals (eight environmental, socio-economic, and governance objectives each) (Tables 2, 3, 4,

5, 6, 7).<sup>2</sup> Obtaining group consensus on accurately wording goals and objectives and their position in the hierarchical tree took up a considerable amount of time (four 4-h workshops) in Mackay. This perceived need to be exact in the wording of goals may have been due to the diversity of stakeholder representation at the workshops and also as a consequence of the importance they attributed to articulating objectives accurately to management bodies.

In Bowen–Burdekin, participants started with a total of 139 goals and objectives. The final hierarchical goals and objectives tree for Bowen–Burdekin was condensed into a total of 27 low-level environmental, socio-economic, and governance objectives (nine objectives each). The wording in the hierarchical goals and objectives trees reflects the text agreed upon by stakeholders in the respective case study locations.

### Commonalities between the two case studies

In both case studies, the environmental goals and objectives were raised first. Even though there were resource-sharing conflicts in both regions and disagreements on a range of local environmental issues (such as the impact of port development), there was almost unanimous agreement on the high-level goals. After agreeing on high-level goals, stakeholders were keen to detail locally specific objectives to ensure tangible on-ground management actions were implemented in the future.

While recognising that on-ground outcomes are often driven by location-specific objectives, stakeholders in both regions appeared to find it difficult to disentangle objectives from management strategies and actions. For example in a fisheries context, stakeholders would confuse management strategies, such as minimum size limits and area closures, with the objective of sustaining critical fish

<sup>2</sup> Note that the numbering and ordering of the objectives in Tables 2, 3, 4, 5, 6, 7 does not in any way reflect their relative importance.

**Table 3** Environmental goals, sub-goals, and objectives for Bowen–Burdekin

Goal	Sub-goal	Objective
<i>Environment</i>		
1. Maintain and improve environmental conditions and natural assets in the Bowen–Burdekin for future generations	1.1 Improve biodiversity	1.1.1 Reduce the impact of pest plants and animals by preventing their introduction and spread
		1.1.2 Increase habitat protection from human degradation while maintaining accessibility
		1.1.3 Better manage (riparian) vegetation, maintain vegetation corridors, and improve vegetation management through fire/burn regimes
	1.2 Improve water quality and ensure adequate water quantity	1.2.1 Ensure adequate water flow mitigate floods and manage water tables and aquifer using a whole of systems approach
		1.2.2 Improve water quality for biodiversity, domestic, and industrial use and reduce the water footprint on the environment
		1.2.3 Improve function and connectivity between freshwater systems and wetlands
	1.3 Improve sustainable resource use	1.3.1 Maintain productive capacity of existing agricultural land and develop new land while preventing the degradation of natural resources
		1.3.2 Reduce the impact of mining and other (associated) industries on water quality
		1.3.3 Stock appropriate areas with fish or improve fish recruitment to sustain critical populations and sustained resource use

**Table 4** Social and economic goals, sub-goals, and objectives for Mackay

Goal	Sub-goal	Objective
<i>Social and economic</i>		
2. Improve regional economic and social well-being	2.1 Increase economic growth	2.1.1 Improve regional economic development and industry diversity
		2.1.2 Improve family livelihoods in the region
		2.2.3 Ensure that natural resource based industries are profitable and sustainable
	2.2 Increase social cohesion	2.2.1 Minimise conflicts between stakeholders
		2.2.2 Conserve traditional activities and cultures
		2.2.3 Ensure community equity
	2.3 Increase social capacity	2.3.1 Improve workplace and family health and safety in the region
		2.3.2 Improve education, training, social infrastructure and networks

populations (objective number 1.3.3, Table 2). Interestingly, discussions on the overall objectives were less politically charged than discussions on the choice of ‘most effective’ management actions.

#### *Environmental objectives*

High-level environmental goals are similar for the two case studies. The main difference between the two regions is that the Bowen–Burdekin objectives are focussed on the future and future generations. The focus was on ‘maintaining and improving’ coastal

resources. In Mackay there was a focus on ‘protecting and restoring’ coastal resources. Restoring can be interpreted as dealing with legacy issues arising from past behaviours.

Both areas identified clear water quality objectives despite the stated focus on the coastal zone and not upper catchment, which implies that the groups in both case studies understood the inherent connectivity of the socio-ecological system. In the Bowen–Burdekin region, there is more agriculture supported by irrigation when compared with Mackay, which is reflected in the added water quantity sub-goal.

**Table 5** Social and economic goals, sub-goals, and objectives for Bowen–Burdekin

Goal	Sub-goal	Objective
<i>Social and economic</i>		
2. Equal access and ability to interact with environment to achieve quality of life now and into the future	2.1 Promote sustainable industry sectors and create employment	2.1.1 Encourage diversification of economic activities by means of food production (agriculture, fishing and aquaculture) and promote the tourism industry
		2.1.2 Increase the value of nature to locals by maximising sustainable yield and recognising the economic value of tourism
		2.1.3 Create long-term employment opportunities that support natural resource management outcomes
	2.2 Increase equity and sense of ownership, and reduce social exclusion of natural resources	2.2.1 Increase equitable allocation of resources and community resource-sharing
		2.2.2 Increase community empowerment and sense of ownership to improve sustainable natural resource management practices
		2.2.3 Promote indigenous and alternative livelihoods and nurture cultural values associated with natural resources
	2.3 Encourage sustainable resource use through improved access and understanding	2.3.1 Increase community recreational and boating access
		2.3.2 Increased productivity and sustainable use of wetlands and agricultural systems
		2.3.3 Encourage increase learning and understanding of natural systems through interaction and targeted education

**Table 6** Governance goals, sub-goals, and objectives for Mackay

Goal	Sub-goal	Objective
<i>Governance</i>		
3. Improve governance systems (i.e. leadership, institutions, rules and decision-making processes involved in managing inshore biodiversity)	3.1 Increase management effectiveness	3.1.1 Remove regulatory barriers to flexibility (alternative harvesting techniques, zoning, diversification in the economy)
		3.1.2 Increase compliance with environmental and resource use regulations
	3.2 Increase management support	3.2.1 Increase management acceptability
		3.2.2 Increase stakeholder engagement and community ownership/stewardship
		3.2.3 Sustainable financial costs
	3.3 Increase management integration	3.3.1 Increase policy integration
		3.3.2 Increase regulatory integration
		3.3.3 Increase implementation integration

In the Bowen–Burdekin, the pest management issue was seen as one more closely aligned to improving biodiversity (1.1.1). Aside from feral animals (i.e. feral pigs), weeds are also an issue for waterway health. The weeds issue in Mackay was related to water quality within the coastal waterways and the need to adopt practices that minimise the use of chemicals to control weeds. Riparian zones are increasingly recognised as important features of the rural landscape and contribute positively to rural productivity. Re-vegetation and riparian zone rehabilitation featured

more heavily for Bowen–Burdekin (possibly because the region is more rural). In the latter region with a mainly rural landscape, there was also mention of the need for appropriate fire management to maintain and improve biodiversity values and control weeds (there was no mention of this in Mackay). The focus in Mackay was not so much on vegetation but more on connectivity (sub-goal 1.1) both on land and within the waterways, reflecting the much more complex landscape of rural, urban, and industrial land-uses.



**Table 7** Governance goals, sub-goals, and objectives for Bowen–Burdekin

Goal	Sub-goal	Objective
<i>Governance</i>		
3. Management that ensures sustainable resource use and availability and achieves a shared understanding of a sustainable future	3.1 Improve and encourage a co-management approach to guide natural resource use	3.1.1 Improve the alignment of stakeholder objectives through promotion of cooperative government and inclusive management
		3.1.2 Improve linkages and increase communication to establish better connections between managers, scientists, and stakeholders
		3.1.3 Address gaps in natural resource management controls while increasing efficiency and effectiveness of management outcomes
	3.2 Implement a proactive and flexible approach to natural resource management	3.2.1 Increase management capability and effectiveness to adequately administer legislation (increase compliance)
		3.2.2 Increase a flexible and dynamic management approach to natural resource use and planning
		3.2.3 Improve scientific research to inform management decision (reduce the science–policy gap) and increase community understanding of science
	3.3 Increase community participation and support for long-term management solutions	3.3.1 Encourage increased participation in proactive management
		3.3.2 Increase community participation in catchment management activities to better understand natural resource management issues
		3.3.3 Increase the availability of support and provision of incentives for long-term natural resource management solutions

Wetlands with world-renowned biodiversity values in the GBR are recognised for their pivotal role in water filtration and providing critical habitat for wildlife. Objectives for wetland in both regions related not only to the protection and maintenance of quality wetland areas, but also to equitable access and distribution of benefits from the remaining wetlands.

There was explicit mention of the impact of infrastructure associated with the mining sector on the environment in Bowen–Burdekin (1.3.2), even though the Abbot Point (near Bowen in the Burdekin) and Mackay ports face many of the same issues. The fact that the large and controversial expansion of the Abbot Point terminal was very much on the political agenda at the time of the research (e.g. the final decision allowing local dredging was announced at the time of writing) underscores the participants focus on the potential impact of mining in the Bowen–Burdekin which was at the front of their mind at the time.

#### *Socio-economic objectives*

Stakeholders were inclined to combine economic, social, and cultural issues into a single goal, labelled socio-economic. The similarity between the socio-economic

objectives for the Bowen–Burdekin and Mackay was reflected in their respective aim for equity, sustainable resource use, and profitable industry.

In the Bowen–Burdekin, there was a greater focus on sustainable resource use through improving access and gaining understanding (of resource characteristics) (reflected in sub-goal 2.3). The logic that underpinned this was that an increase in understanding of environmental issues through exposure (access) could conceivably lead to more equitable and sustainable resource use.

As mentioned above, profitable industries were considered an important goal in both areas but in the Bowen–Burdekin the issue of industry diversification (2.1.1) to increase adaptability and resilience was considered explicitly. In the Bowen–Burdekin, tourism was seen as an important industry focus for future development. Tourism is often seen as the corollary, or alternative, to natural resource extraction and development (Archer 1996). Some interviewees in the Bowen–Burdekin discussed how the natural resources in the region could attract more tourism (i.e. developing viewing platforms in the wetland areas). The longevity of development and the associated employment creation (e.g. 2.1.3) was considered very important in the Bowen–Burdekin, with short-term fixes no longer considered an adequate solution.

Interestingly in Mackay, minimising conflict over resource access (2.2.1) is a separate objective, whereas in the Bowen–Burdekin it is not. The Bowen–Burdekin, however, seemed to be the area where conflict was more obvious at the time this research was undertaken. However, Mackay is a much more populated area with a growing city and potential for conflicting uses of the coastal areas and resources.

The inclusion of cultural objective related to indigenous livelihoods was almost considered a given, and it was incorporated under 2.2.2 in Mackay and 2.2.3 in the Bowen–Burdekin.

### *Governance objectives*

Perhaps somewhat surprisingly, governance goals and objectives were prominent in both locations, and stakeholders spent much time discussing them. It was in fact of such importance that it was made into a high-level goal. The prominence of governance objectives highlights the importance of management processes and instruments (regulation, legislation) in managing inshore biodiversity in the coastal region (Dichmont et al. 2013).

In the Bowen–Burdekin, many interviewees emphasised the importance of the community's ability to participate and contribute to management. In other words, they identified the importance of a co-management approach (sub-goal 3.1) and community participation (sub-goal 3.3). However, to achieve effective co-management communities need to have an 'engaged' population willing to spend (often their own) time participating in co-management fora and associated committees. Participation is currently an issue in Bowen–Burdekin as people seem disengaged from community processes, hence the focus and number of objectives aimed at achieving increased 'engagement' (3.1.1–3.1.3).

An important consideration in terms of governance in both areas was around the perception that current natural resource management was inadequate or ineffective. In the Bowen–Burdekin, the issue converged around the objective of being proactive and flexible. In Mackay, much of it centred on management support (sub-goal 3.2). The objective in Mackay was to keep costs under control (3.2.3) in providing this management support. In both regions, an important link was made between the fact that effective management was considered only possible if the community actively participated in natural resource management (co-management).

### **Goals and sub-goals for coastal areas: a starting point**

On the basis of the consultation and data gathered in this research, similarities and differences in goals and sub-goals between the two case studies were identified and a generic hierarchical set of goals and sub-goals for coastal regions was developed (Table 8). The development of the generic hierarchical set of goals and sub-goals was not an aim in and of itself, but the generic overarching goals and sub-goals (1) allow fine scale—locally specific—objectives to be more easily framed and developed, and (2) can encourage stakeholder thinking outside their own value system and think about goals that may not normally be a priority for them (which can be elucidating and could potentially increase understanding and acceptance of other people's values). The more time-consuming approach in Mackay highlighted that reducing the length of what was otherwise a good engagement process would be beneficial.

We argue that this generic set of hierarchical goals can be used to initiate community consultation and encourage community involvement in setting regionally specific objectives (and developing a hierarchical objectives tree) for regional coastal areas potentially short cutting tens of hours of engagement input that would otherwise be required to get to such a stage. Our approach is useful for application in places with strong community involvement, such as Mackay, but also in situations where community engagement is more difficult, such as the case in the Bowen–Burdekin. The flexible approach showcased here can encourage effective local management to occur that transparently evaluates and incorporates community values into coastal natural resource management.

After the creation of the list of objectives by the community and the standardisation of the objectives into a hierarchical format, a well-established method can be applied to assess the spread in community values and prioritisation of outcomes (Dutra, in review). Using a decision analysis method as shown in relative objective, weights can be obtained (see (Dichmont et al. 2013) (Appendix 1) for more information). In addition, by developing a generic set of goals and sub-goals, it will streamline the subsequent detailing of objectives further while keeping the process transparent and collaborative. It also allows different approaches to information gathering to be applied (i.e. face-to-face, workshops, or focus groups) to populate the hierarchical goals and objectives tree.

A list of objective topics is provided in Appendix 2.

**Table 8** Generalised environmental, socio-economic, and governance goals and sub-goals for coastal areas

Environment goals	Environment sub-goals
(A) Protect, maintain <sup>a</sup> , restore, and improve environmental assets	1. Improve biodiversity <sup>b</sup> 2. Conserve coastal living resources and their use 3. Improve water quality and ensure adequate water quantity
Social and economic goals	Social and economic sub-goals
(B) Improve regional economic and social well-being now and into the future	4. Promote sustainable growth of industry sectors and create local employment 5. Increase social capacity <sup>c</sup> and sense of ownership <sup>d</sup> 6. Increase equity and improve access <sup>e</sup>
Governance goals	Governance sub-goals
(C) Improve management effectiveness <sup>f</sup> to ensure long-term sustainable resource use and availability	7. Encourage and improve community participation and create co-management solutions <sup>g</sup> 8. Implement and increase flexible and proactive approach to natural resource management 9. Increase support for management solutions and increase the effectiveness of management integration

<sup>a</sup> Only the environmental goals has a ‘maintain’ as all the other goals are assumed to be open for improvement

<sup>b</sup> Improve system connectivity is an objective rather than a sub-goal as for instance biodiversity can be improved through improving connectivity of the system

<sup>c</sup> Improving socio-ecological system understanding (objective) will increase social capacity

<sup>d</sup> Includes indigenous cultural objectives (but not exclusively as Australian and other national cultural traditions are also important)

<sup>e</sup> Reducing social exclusion (objective) will achieve increased equity

<sup>f</sup> Increased management support (e.g. financing or infrastructure) is an objective as it can achieve an increase in management effectiveness

<sup>g</sup> Shared understanding of a sustainable future is an objective

## Discussion

In this study, environmental, governance, and socio-economic goals and objectives for two coastal socio-ecological systems adjacent to the GBR were developed. The process of developing these hierarchical goals and objectives, applying different community engagement approaches (open and closed deliberation), gave insight into the differences and similarities between the management goals and objectives in the two locations. In both case studies, high-level goals were used to guide and catalyse discussions about objectives that were relevant to the local coastal context.

Participants in both case studies seemed to identify much more with locally specific objectives (some referring to higher-level goals as “motherhood statements”). Yet the literature review highlighted that most objectives as stated by local, regional, state, or commonwealth agencies were more in the goal and sub-goal format. It was therefore timely to develop a generic set of overarching goals and objectives within which finer scale—locally specific objectives could be more easily framed and developed. This will reduce research team time and effort, while

maintaining community engagement and promoting ownership of the final product. Reducing the time involved in setting locally specific objectives in the context of broader goals can avoid possible consultation fatigue (Jackson et al. 2008), a common and dangerous feature that challenges participatory approaches.

The value to communities of using the generic set of goals as a starting point for developing an explicit set of fine scale objectives is that it sets up the groundwork for a truly adaptive management process. If objectives are known and explicitly identified, an adaptive management process should ensure that management actions are adapted if it becomes apparent that objectives are not being met (Pressey et al. 2003). Yet these case studies showed that a starting point was useful. In the case studies a list of stated objectives were provided, but the relative consistency of goals shows that a number of steps can be avoided by starting with a generic set of goals upon which to build objectives.

The local specifics and fine scale issues that differ between communities can be expressed in terms of the objectives (while the overarching goal can be the same) as was evident in some of the environmental objectives in the case studies. For instance, there was a focus on ‘protecting

and restoring’ in one case study, reflecting a view towards the future and future generations, and ‘restoring and maintaining’ reflecting legacy issues in the other case study. The difference in focus between the two case studies could be partly explained by the progress in port development. In Mackay, the local port has already been developed (thus needing to ‘protect and restore’), whereas (at the time of research) in Bowen–Burdekin there was a controversial proposal to expand the port in the future explaining the former case study focus on and the latter on ‘maintain and improve’. The case study experience indicated that there was very little disagreement about the overarching environmental, governance, and socio-economic goals, and with the goals being very similar this justified the development of a generic set useful for application in other communities. However, it may be true that because the two case studies were in the GBR they did not provide an exhaustive list of generic goals that cover all issues in coastal communities outside this region. It should therefore be kept in mind that use of the existing set of goals in other communities may bring up additional goals that can be added to the existing set—and thus refining it over time.

A lesson learnt from the case study approach used to elicit goals and objectives in quite dissimilar regional situations (i.e. strong community participation in Mackay and weak community engagement in Bowen–Burdekin) suggests that applying the generalised framework to elicit management objectives is likely to be successful even with different levels and methods of community engagement.

The case study experience showed that much more time was taken up in the development of environmental and governance goals and objectives than the combined social and economic goals and objectives. The discussion of ‘precedence’, in the sense that the environmental objectives need to be achieved *before* the governance or socio-economic outcomes can be, may explain the prominence of environmental objectives in the discussions. Environmental issues were mostly centred around waterways, wetlands, and water quality (and to some degree water quantity or supply). This focus is not surprising given that improving water quality was the focus of considerable research effort in the GBR (Peterson et al. 2010; Lynam et al. 2010). Water quality issues have led to some division in the community as farmers were perceived to some degree as being held solely responsible for influencing water quality (e.g. through reducing nutrient input) in the GBR. Water quality and vegetation management are arguably long standing and connected objectives relevant to the whole GBR (Great Barrier Reef Marine Park Authority 2012) of particular pertinence with recent changes in land clearing legislation and a reduction of land clearing restrictions by the Queensland State Government.

Some issues that did not pose a ‘threat’ or were not a politically sensitive issue were relatively easily resolved. This was for instance the case with the inclusion of feral animals and weeds control in both Mackay and the Bowen–Burdekin. The weeds and feral animal issue is of particular importance mainly for one interest group but its inclusion as an objective does not pose a perceived conflict (or it is not a political issue) for others in the group.

An important new finding from the case studies is the prominence of governance goals and objectives which highlights the importance of management processes and instruments (regulation, legislation) in managing inshore biodiversity. It also highlights the complex governance setting in the coastal region. In the literature, governance objectives are not always considered as a stand-alone group. Most studies (Taylor 2005; Pascoe, et al. 2013) report three groups of goals and objectives: environmental, social, and economic (and sometimes cultural) – mirroring the triple bottom line (Millennium Ecosystem Assessment 2003). It is interesting to note that in the Bowen–Burdekin, where engagement with the local LMAC and stakeholders proved challenging, the governance objectives were primarily around increasing community engagement and co-management. The question of how to make issues relevant to the local community and how to entice them into participating in local management of coastal resources featured highly. There was a belief that increased access (in particularly boating access) and participation in recreational fishing and outdoor activities would lead to an increase in the community’s understanding of the role and importance of local natural resources and their management. People would presumably become more appreciative of the need for sustainable resource use by ‘seeing what is out there’ and more likely to become actively engaged in co-management.

However, there are obvious difficulties in engaging and retaining people in the co-management process. The main reasons for this are that people generally volunteer their time and in many cases this is not rewarded, with the actual management decision-making divested to another authority such as government. In addition, where much local conflict over natural resources characterises a community, the hurdles faced in involving people in group situations will be much greater.

The importance of governance objectives are not restricted to the co-management issue, but there is also a real or perceived view that management is failing in the coastal zone due to disparate and not well-connected management arrangements and a lack of on the ground knowledge of management authorities. An open deliberation process which also engages policy makers and managers will give credence to the possibility that goals and objectives will be communicated to the decision managers.

There are few surprises in the socio-economic objectives in either region. As in other studies, socio-economic objectives are based on growing industry profitability (tourism, agriculture, fishing, and other resource extraction such as mining and its related infrastructure), community income and employment (Pascoe et al. 2013). Aside from these general (possibly more predictable) objectives, indigenous livelihoods and equitable resource-sharing are featured highly. Indigenous ownership and participation in management are often stand-alone objectives in natural resource management in Australia, but in these case studies they were viewed as integrated with other socio-economic objectives. After much discussion, cultural values in Mackay included indigenous and non-indigenous values since participants felt there were important shared and individual cultural values (as opposed to exclusively indigenous cultural values). However, the low engagement with indigenous stakeholders may have influenced this outcome.

Structuring goals and objectives hierarchically as done in this study has added value in that this can make explicit the relative importance of different objectives and any existing heterogeneity in community values. An awareness of the range and difference in the relative importance of objectives helps managers focus on those that are potentially more important or conversely, more difficult to deal with. Our case studies showed that acknowledging and making explicit heterogeneity in stakeholder values can prevent potential disillusionment and disengagement that may arise when a consensus process is difficult (Dichmont et al. 2014). Another key aspect of preventing disengagement is the willingness of management agencies to acknowledge community objectives priorities and incorporate some of the more important and feasible into their management actions and policies.

Even with a predefined set of goals and sub-goals, the creation of a set of objectives is by no means a trivial exercise. For instance, objectives need to be meaningful and re-examined over time and when circumstances change. And as previously mentioned, after a set of objectives has been developed, decision-making organisations have to be willing to incorporate the objectives into their management planning processes. Without management willingness to incorporate objectives, there is little point in involving the community in determining the objectives in the first place, and potentially creating false expectations.

An important aspect of ensuring initial community engagement, the subsequent successful development of objectives, and implementation of management actions, which cannot be underestimated is the presence of a dedicated local person (the Mackay-based GBRMPA Liaison Manager) to link locals and researchers. The facilitation of community interactions by a dedicated local person helped

facilitating the process significantly in Mackay and potentially increased ownership of the final results. In the Bowen–Burdekin a number of ‘hot’ political issues (the proposed Abbot Point port development and ongoing resource-sharing issues between recreational and commercial fishers) divided stakeholders at the time of study. From communications received after completion of the project, it is evident that in the Bowen–Burdekin there is less ownership of the objectives set than in Mackay, even at the LMAC level.

Ownership of the objectives means that community members or community champions feel more empowered to lobby and to request that management organisations use these objectives to guide their decisions (Dutra et al. 2014). Community ownership also facilitates communication and collaboration and the flow and exchange of information and knowledge between participants (local/indigenous groups, government, industry, and science providers). Lastly, community ownership can help local community leaders to be more effective in lobbying for funds and other resources to achieve objectives (Dutra et al. 2014).

## Conclusion

Both an open and closed deliberation process to set goals and objectives for management of coastal areas can create awareness that differences in values exist within a community. Conversely, the same process also makes explicit that in fact there is a high level of agreement on higher order, overarching environmental, governance, and socio-economic goals. In order to successfully complete the complex process of determining the right management solutions to achieve locally relevant objectives, it is likely to be helpful to use a generic set of higher order goals as a first step. Availability of generic higher order goals, which the case studies showed, was very similar despite local political and community engagement differences and will allow an increased focus on locally relevant objectives and the management actions needed to achieve or address them.

It is important to consider the likelihood that legacy issues will not only influence community participation but also directly influence the focus of lower-level objectives. In an open deliberation process, the presence of local (politically divisive) issues, or if issues arise during the deliberation process, might take precedence and could influence the outcomes. Careful timing is essential as the presence of politically charged issues might derail the consultation process and the willingness to participate in group negotiations.

Coastal SESs are complex systems, and this study suggests that decision-makers have to meet an important

challenge embodied in the way local communities are engaged in the natural resource management process thus meeting stated governance objectives.

## References

- Archer B (1996) Sustainable tourism: an economist's viewpoint. In: Briguglio L, Archer B, Jafari J, Wall G (eds) Sustainable tourism in Islands and small states: issues and policies. Pinter, London
- Australian Bureau of Statistics (2012) Census Quickstats 2011
- Bennett J, Lawrence P, Johnstone R et al (2005) Adaptive management and its role in managing Great Barrier Reef water quality. *Mar Pollut Bull* 51:70–75. doi:10.1016/j.marpolbul.2004.10.034
- Bergold J, Thomas S (2012) Participatory research methods: A methodological approach in motion. *Forum Qual Social Res* 13(1): 30. <http://nbn-resolving.de/urn:nbn:de:0114-fqs1201304>
- Berkes F, Folke C (1998) Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge University Press, London
- Burt G (2011) Towards the integration of system modeling with scenario planning to support strategy: the case of the UK energy industry. *J Oper Res Soc* 62:830–839. doi:10.1057/jors.2010.47
- Charles AT (1989) Bio-socio-economic fishery models: labour dynamics and multi-objective management. *Can J Fish Aquat Sci* 46:1313–1322. doi:10.1139/f89-169
- Cinner J, Marnane MJ, McClanahan TR, et al. (2006) Periodic closures as adaptive coral reef management in the Indo-Pacific. *Ecol Soc* 11(1): 31. <http://www.ecologyandsociety.org/vol11/iss1/art31/>
- Cinner J, Fuentes M, Randriamahazo H (2009) Exploring social resilience in Madagascar's marine protected areas. *Ecol Soc* 14(1): 41. <http://www.ecologyandsociety.org/vol14/iss1/art41/>
- Coates KD, Burton PJ (1997) A gap-based approach for development of silvicultural systems to address ecosystem management objectives. *For Ecol Manag* 99:337–354. doi:10.1016/S0378-1127(97)00113-8
- Cochrane K (2002) A fishery manager's guidebook. Management measures and their application, FAO, vol 424. FAO, Rome
- Conroy MJ, Peterson JT (2013) Decision making in natural resource management: a structured, adaptive approach. Wiley, UK
- Dale A, Vella K, Pressey RL et al (2013) A method for risk analysis across governance systems: a Great Barrier Reef case study. *Environ Res Lett* 8:1–14. doi:10.1088/1748-9326/8/1/015037
- Davidson J, Van Putten I, Leith P et al (2013) A working indicator framework to operationalize resilience concepts in Australian marine sectors dealing with climate change. *Ecol Soc* 18(1–20):4. doi:10.5751/ES-05607-180304
- De Geus AP (1988) Planning as learning. *Harvard Business Review* March–April, 70–74. <http://www.sims.monash.edu.au/subjects/ims5042/stuff/readings/de%20geus.pdf>
- Department of Environment and Resource Management (2011) Queensland Regional Natural Resource Management Framework. <https://www.ehp.qld.gov.au/land/natural-resource/pdf/qld-regional-nrm-framework.pdf>. Accessed 20 Aug 2015
- Dichmont CM, Pascoe S, Jebreen E et al (2013) Choosing a fishery's governance structure using data poor methods. *Mar Policy* 37:123–131. doi:10.1016/j.marpol.2012.02.018
- Dichmont CM, Dutra LXC, van Putten I, Deng RA, Owens R, Jebreen E, Thompson C, Pascual R, Warne MJ, Quinn R, Thébaud O, Bennett J, Read M, Wachenfeld D, Davies J, Garland A, Dunning M, Waycott M, Collier C, Dambacher J, Playford J, Harm R, Gribble N, Pitcher R (2014) Design and implementation of management strategy evaluation for the Great Barrier Reef inshore (MSEGBR). Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns. <http://www.nerptropical.edu.au/sites/default/files/NERP-TE-PROJECT-9.2-FINAL-REPORT-COMLETE-PART-A.pdf>. Accessed 20 Aug 2015
- Dutra LXC, Ellis N, Perez P et al (2014) Drivers influencing adaptive management: a retrospective evaluation of water quality decisions in South East Queensland (Australia). *Ambio* 43:1069–1081. doi:10.1007/s13280-014-0537-4
- Dutra LXC, Bustamante RH, Sporne I, van Putten I, Dichmont CM, Ligtermoet E, Sheaves M, Deng RA (2015) Organizational drivers that strengthen adaptive capacity in the coastal zone of Australia. *Ocean Coast Manag* 109:64–76. doi:10.1016/j.ocecoaman.2015.02.008
- Fidelman P, Evans L, Fabinyi M, Foale S, Cinner J, Rosen F (2012) Governing large-scale marine commons: contextual challenges in the Coral Triangle. *Mar Policy* 36:42–53. doi:10.1016/j.marpol.2011.03.007
- Flyvbjerg B (2006) Five misunderstandings about case-study research. *Qual Inq* 12:219–245. doi:10.1177/1077800405284363
- Great Barrier Reef Marine Park Authority (2012) Local Marine Advisory Committee: terms of reference. Townsville, Australia. [http://www.gbrmpa.gov.au/\\_data/assets/pdf\\_file/0008/17459/LMAC-Terms-of-Reference-April-2012-V1.pdf](http://www.gbrmpa.gov.au/_data/assets/pdf_file/0008/17459/LMAC-Terms-of-Reference-April-2012-V1.pdf). Accessed 20 Aug 2015
- Hilborn R (2007a) Defining success in fisheries and conflicts in objectives. *Mar Policy* 31:153–158. doi:10.1016/j.marpol.2006.05.014
- Hilborn R (2007b) Defining success in fisheries and conflicts in objectives. *Mar Policy* 31:153–158. doi:10.1016/j.marpol.2006.05.014
- Jackson S, Stoeckl N, Straton A et al (2008) The changing value of Australian tropical rivers. *Geogr Res* 46:275–290. doi:10.1111/j.1745-5871.2008.00523.x
- Jentoft S (1989) Fisheries co-management: delegating government responsibility to fishermen's organizations. *Mar Policy* 13:137–154. doi:10.1016/0308-597X(89)90004-3
- Limpus CJ (2007) A biological review of Australian marine turtle species Flatback turtle, *Natator depressus* (Garman), Environmental Protection Agency. Environmental Protection Agency, Brisbane
- Ludwig D (2001) The era of management is over. *Ecosystems* 4:758–764. doi:10.1007/s10021-001-0044-x
- Lynam T, Drewry J, Higham W et al (2010) Adaptive modelling for adaptive water quality management in the Great Barrier Reef region, Australia. *Environ Model Softw* 25:1291–1301. doi:10.1016/j.envsoft.2009.09.013
- Mardle S, Pascoe S, Boncoeur J et al (2002) Objectives of fisheries management: case studies from the UK, France, Spain and Denmark. *Mar Policy* 26(6):415–428. doi:10.1016/S0308-597X
- McCay BJ, Svein J (1996) From the bottom up: participatory issues in fisheries management. *Soc Nat Res* 9(3):237–250. doi:10.1080/08941929609380969
- Millennium Ecosystem Assessment (2003) Ecosystems and human well-being: a framework for assessment World Resources Institute. World Resources Institute, Washington
- Ministry of Sustainable Resource Management (2004) A guide to preparing effective resource management plans forests, lands and marine branch, forests, lands and marine branch. [https://www.for.gov.bc.ca/tasb/slrp/policies-guides/writing\\_resource\\_objectives.pdf](https://www.for.gov.bc.ca/tasb/slrp/policies-guides/writing_resource_objectives.pdf). Accessed 20 Aug 2015
- Olson SB (2003) Frameworks and indicators for assessing progress in integrated coastal management initiatives. *Oceans Coast Manag* 46:347–361. doi:10.1016/S0964-5691(03)00012-7

- Pascoe S, Dichmont CM, Brooks K et al (2013) Management objectives of Queensland fisheries: putting the horse before the cart. *Mar Policy* 37:115–122. doi:[10.1016/j.marpol.2012.02.016](https://doi.org/10.1016/j.marpol.2012.02.016)
- Peterson A, Walker M, Maher M et al (2010) New regionalism and planning for water quality improvement in the Great Barrier Reef, Australia. *Geogr Res* 48:297–313. doi:[10.1111/j.1745-5871.2009.00634.x](https://doi.org/10.1111/j.1745-5871.2009.00634.x)
- Pinkerton E (ed) (1989) Cooperative management of local fisheries. New directions for improved management and community development. University of British Columbia Press, Vancouver
- Pressey RL, Cowling RM, Rouget M (2003) Formulating conservation targets for biodiversity pattern and process in the Cape Floristic Region, South Africa. *Biol Conserv* 112:99–127. doi:[10.1016/S0006-3207\(02\)00424-X](https://doi.org/10.1016/S0006-3207(02)00424-X)
- Roelofs A, Roder C (2002) Seagrass and marine resources of the Newry region and sand bay dugong Protection areas, Great Barrier Reef Marine Park Authority and The State of Queensland, Department of Primary Industries, Research publication No. 72, Great Barrier Reef Marine Park Authority and The State of Queensland, Department of Primary Industries
- Sainsbury KJ, Punt AE, Smith ADM (2000) Design of operational management strategies for achieving fishery ecosystem objectives. *ICES J Mar Sci* 57(3):731–741. doi:[10.1006/jmsc.2000.0737](https://doi.org/10.1006/jmsc.2000.0737)
- Taylor A (2005) Guidelines for evaluating the financial, ecological and social aspects of urban stormwater management measures to improve waterway health. Cooperative Research Centre for Catchment Hydrology, Melbourne
- Thom RM (2000) Adaptive management of coastal ecosystem restoration projects. *Ecol Eng* 15:365–372. doi:[10.1016/S0925-8574\(00\)00086-0](https://doi.org/10.1016/S0925-8574(00)00086-0)
- Walters CJ (1986) Adaptive management of renewable resources. Macmillan, New York
- Walters CJ (2007) Is adaptive management helping to solve fisheries problems? *Ambio* 36(4):304–307. doi:[10.1579/0044-7447\(2007\)36\[304:IAMHTS\]2.0.CO;2](https://doi.org/10.1579/0044-7447(2007)36[304:IAMHTS]2.0.CO;2)
- Walters CJ, Hilborn R (1978) Ecological optimization and adaptive management. *Annu Rev Ecol Syst* 9:157–188. <http://www.jstor.org/stable/2096747>
- Ward E, Schriefer AE (1997) Dynamic scenarios: systems thinking meets scenario planning. In: Fahey L, Randall RM (eds) Learning from the future: competitive foresight scenarios. Wiley, New York
- Wattage P, Mardle S, Pascoe S (2005) Evaluation of the importance of fisheries management objectives using choice-experiments. *Ecol Econ* 55(1):85–95. doi:[10.1016/j.ecolecon.2004.10.016](https://doi.org/10.1016/j.ecolecon.2004.10.016)
- West D (2005) Vickers' concept of 'relationship-maintenance' as an alternative to 'goal-seeking' models of organisation: a difference in the notion of control. *Syst Pract Action Res* 18:261–274. doi:[10.1007/s0000-005-4814-7](https://doi.org/10.1007/s0000-005-4814-7)
- Yin RK (1984) Case study research: design and methods. Sage, Newbury Park
- Zandstra, H. (1994) A case for setting common objectives for natural resource management. IN Goldsworthy P, Penning de Vries FWT (Ed.) Opportunities, use, and transfer of systems research methods in agriculture to developing countries. Kluwer Academic Publishers, Dordrecht
- Zandstra H (1994b) A case for setting common objectives for natural resource management. In: Goldsworthy P, de Vries PFWT (eds) Opportunities, use, and transfer of systems research methods in agriculture to developing countries. Kluwer Academic Publishers, Dordrecht